DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m\cdot s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}\ m\cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J\cdot s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}\ N\cdot m^{2}\cdot C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	$8,85 \times 10^{-12}\ F\cdot m^{-1}$

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES

EXAMINATION GUIDELINES

GRADE 12

2017

These guidelines consist of 34 pages.

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/*of* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s}f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b}f_b$	$E = hf$ $E = h\frac{c}{\lambda}$
$\sin\theta = \frac{m\lambda}{a}$	$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F=\frac{kQ_1Q_2}{r^2}$	$E=\frac{kQ}{r^2}$
$E=\frac{V}{d}$	$E=\frac{F}{q}$
$U=\frac{kQ_1Q_2}{r}$	$V=\frac{W}{q}$
$C=\frac{Q}{V}$	$C=\frac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R=\frac{V}{I}$	emf (ε) = I(R + r) emk (ε) = I(R + r)
$R_s=R_1+R_2+...$ $\frac{1}{R_p}=\frac{1}{R_1}+\frac{1}{R_2}+...$	$q=I\ \Delta t$
W = Vq $W=VI\Delta t$ $W=I^2R\Delta t$ $W=\frac{V^2\Delta t}{R}$	$P=\frac{W}{\Delta t}$ P = VI $P=I^2R$ $P=\frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms}=\frac{I_{max}}{\sqrt{2}}$ / $I_{wgk}=\frac{I_{maks}}{\sqrt{2}}$ $V_{rms}=\frac{V_{max}}{\sqrt{2}}$ / $V_{wgk}=\frac{V_{maks}}{\sqrt{2}}$	$P_{average}=V_{rms}I_{rms}$ / $P_{gemiddeld}=V_{wgk}I_{wgk}$ $P_{average}=I_{rms}^2R$ / $P_{gemiddeld}=I_{wgk}^2R$ $P_{average}=\frac{V_{rms}^2}{R}$ / $P_{gemiddeld}=\frac{V_{wgk}^2}{R}$

TABLE OF CONTENTS

1. INTRODUCTION

The Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences outlines the nature and purpose of the subject Physical Sciences. This guides the philosophy underlying the teaching and assessment of the subject in Grade 12.

The purpose of these Examination Guidelines is to:

- Provide clarity on the depth and scope of the content to be assessed in the Grade 12 National Senior Certificate (NSC) Examination in Physical Sciences.
- Assist teachers to adequately prepare learners for the examinations.

This document deals with the final Grade 12 external examinations. It does not deal in any depth with the School-Based Assessment (SBA).

These Examination Guidelines should be read in conjunction with:

- The *National Curriculum Statement (NCS) Curriculum and Assessment Policy Statement (CAPS):* Physical Sciences
- The National Protocol of Assessment: *An addendum to the policy document, the National Senior Certificate: A qualification at Level 4 on the National Qualifications Framework (NQF), regarding the National Protocol for Assessment (Grades R–12)*
- The national policy pertaining to the programme and promotion requirements of the National Curriculum Statement, Grades R–12

2. ASSESSMENT IN GRADE 12

2.1 Format of question papers

Paper	Type of questions	Duration	Total	Date	Marking
1	**Physics** 10 multiple-choice questions – 20 marks Structured questions – 130 marks	3 hours	150	October/November	External
2	**Chemistry** 10 multiple-choice questions – 20 marks Structured questions – 130 marks	3 hours	150	October/November	External

2.2 Numbering and sequence of questions

QUESTION 1: Multiple-choice questions
Subquestions numbered 1.1 to 1.10 (2 marks each)
Questions will be arranged from lower to higher cognitive levels (easier to more challenging) and may cover all cognitive levels.

QUESTION 2 onwards:
Longer questions assessing skills and knowledge across cognitive levels. Numbering starts with QUESTION 2 and will be continuous. Subquestions will be numbered by two digits, e.g. 2.1, 2.2. Numbering is restricted to a maximum of three digits, e.g. 2.1.1, 2.1.2.

2.3 Information sheets

The separate information sheets for Paper 1 and Paper 2 are included in this document.

2.4 Weighting of cognitive levels

Papers 1 and 2 will include questions across four cognitive levels. The distribution of cognitive levels in Physics and Chemistry papers is given below.

Cognitive level	Description	Paper 1 (Physics)	Paper 2 (Chemistry)
1	Remembering (Recall)	15%	15%
2	Understanding (Comprehension)	35%	40%
3	Applying and analysing	40%	35%
4	Evaluating and creating (synthesis)	10%	10%

2.5 Weighting of prescribed content

Paper 1: Physics Focus							
Content	**Marks**	**Total**	**Duration**	**Weighting of questions across cognitive levels**			
Mechanics	63	150 marks	3 hours	15	35	40	10
Waves, sound and light	17						
Electricity and magnetism	55						
Matter and materials	15						

Paper 2: Chemistry Focus							
Content	**Marks**	**Total**	**Duration**	**Weighting of questions across cognitive levels**			
Chemical change	84	150 marks	3 hours	15	40	35	10
Chemical systems	18						
Matter and materials	48						

2.6 Skills in Physical Sciences

- Identify and question phenomena:
  - Formulate an investigative question.
  - List all possible variables.
  - Formulate a testable hypothesis.

- Design/Plan of an investigation:
  - Identify variables (dependent, independent and controlled variables).
  - List appropriate apparatus.
  - Plan the sequence of steps which should include, amongst others:
    - The need for more than one trial to minimise experimental errors.
    - Identify safety precautions that need to be taken.
    - Identify conditions that ensure a fair test.
    - Set an appropriate control.

- Graphs:
  - Draw accurate graphs from given data/information.
  - Interpret graphs.
  - Draw sketch graphs from given information.

- Results:
  - Identify patterns/relationships in data.
  - Interpret results.

- Conclusions:
  - Draw conclusions from given information, e.g. tables, graphs.
  - Evaluate the validity of conclusions.

- Calculations:
  - Solve problems using two or more different calculations (multistep calculations).

- Descriptions:
  - Explain/Describe/Argue the validity of a statement/event using scientific principles.

2.7 Prior knowledge from Grades 10 and 11

All skills and application of knowledge learnt in Grades 10 and 11 are applicable to assessment in Grade 12. In addition to content from Grades 10 and 11 included under examinable content for Grade 12, skills and knowledge from Grades 10 and 11 that may be assessed in Grade 12 include the following:

- The use of equations of motion in solving problems dealing with momentum, vertical projectile motion, work, energy and power
- Sound waves and properties of sound
- Electromagnetism

NOTE: Although there will be no direct questions about these aspects, applications thereof can be assessed.

3. ELABORATION OF THE CONTENT FOR GRADE 12 (CAPS)

The final examination in Physical Sciences will cover the topics outlined below.

3.1 PAPER 1: PHYSICS

Newton's Laws and Application of Newton's Laws (Grade 11)
(This section must be read in conjunction with the CAPS, p. 62–66.)

Different kinds of forces: weight, normal force, frictional force, applied force (push, pull), tension (strings or cables)
- Define normal force, N.
- Define frictional force, *f*.

Force diagrams, free-body diagrams
- Draw force diagrams.
- Draw free-body diagrams.
- Resolve two-dimensional forces (such as the weight of an object with respect to the inclined plane) into its parallel (x) and perpendicular (y) components.
- Determine the resultant or net force of two or more forces.

Newton's first, second and third laws
- State Newton's first law: A body will remain in its state of motion (at rest or moving at constant velocity) until a net force acts on it.
- Discuss why it is important to wear seatbelts using Newton's first law.
- State Newton's second law: When a net force acts on an object, the object will accelerate in the direction of the force and the acceleration is directly proportional to the force and inversely proportional to the mass of the object.
- Draw force diagrams and free-body diagrams for objects that are in equilibrium or accelerating.
- Apply Newton's laws to a variety of equilibrium and non-equilibrium problems including:
  - A single object:
    - Moving on a horizontal plane with or without friction
    - Moving on an inclined plane with and without friction
    - Moving in the vertical plane (lifts, rockets, etc.)
  - Two-body systems (joined by a light inextensible string):
    - Both on a flat horizontal plane with and without friction
    - One on a horizontal plane with and without friction, and a second hanging vertically from a string over a frictionless pulley
    - Both on an inclined plane with or without friction
    - Both hanging vertically from a string over a frictionless pulley
- State Newton's third law: When one body exerts a force on a second body, the second body exerts a force of equal magnitude in the opposite direction on the first body.
- Identify action-reaction pairs.
- List the properties of action-reaction pairs.

Newton's Law of Universal Gravitation
- State Newton's Law of Universal Gravitation: Each body in the universe attracts every other body with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.
- Solve problems using $F = \frac{Gm_1m_2}{r^2}$.

- Describe weight as the gravitational force the Earth exerts on any object on or near its surface.
- Calculate weight using the expression w = mg.
- Calculate the weight of an object on other planets with different values of gravitational acceleration.
- Distinguish between mass and weight.
- Explain weightlessness.

Momentum and Impulse
(This section must be read in conjunction with the CAPS, p. 99–101.)

Momentum
- Define momentum as the product of an object's mass and its velocity.
- Describe linear momentum as a vector quantity with the same direction as the velocity of the object.
- Calculate the momentum of a moving object using p = mv.
- Describe the vector nature of momentum and illustrate it with some simple examples.
- Draw vector diagrams to illustrate the relationship between the initial momentum, the final momentum and the change in momentum for each of the cases above.

Newton's second law in terms of momentum
- State Newton's second law of motion in terms of momentum: The net (or resultant) force acting on an object is equal to the rate of change of momentum of the object in the direction of the net force.
- Express Newton's second law in symbols: $F_{net} = \frac{\Delta p}{\Delta t}$
- Calculate the change in momentum when a resultant force acts on an object and its velocity:
  - Increases in the direction of motion, e.g. 2nd stage rocket engine fires
  - Decreases, e.g. brakes are applied
  - Reverses its direction of motion, e.g. a soccer ball kicked back in the direction it came from

Impulse
- Define impulse as the product of the net force acting on an object and the time the net force acts on the object.
- Deduce the impulse-momentum theorem: $F_{net}\Delta t = m\Delta v$
- Use the impulse-momentum theorem to calculate the force exerted, the time for which the force is applied and the change in momentum for a variety of situations involving the motion of an object in one dimension.
- Explain how the concept of impulse applies to safety considerations in everyday life, e.g. airbags, seatbelts and arrestor beds.

Conservation of momentum and elastic and inelastic collisions
- Explain what is meant by:
  - An isolated system (in Physics): An isolated system is one on which the net external force acting on the system is zero.
  - Internal and external forces
- State the principle of conservation of linear momentum: The total linear momentum of an isolated system remains constant (is conserved).
- Apply the conservation of momentum to the collision of two objects moving in one dimension (along a straight line) with the aid of an appropriate sign convention.
- Distinguish between elastic collisions and inelastic collisions by calculation.

Vertical Projectile Motion in One Dimension (1D)
(This section must be read in conjunction with the CAPS, p. 102–103.)

- Explain what is meant by a projectile, i.e. an object upon which the only force acting is the force of gravity.
- Use equations of motion to determine the position, velocity and displacement of a projectile at any given time.
- Sketch position versus time (x vs. t), velocity versus time (v vs. t) and acceleration versus time (a vs. t) graphs for:
  - A free-falling object
  - An object thrown vertically upwards
  - An object thrown vertically downwards
  - Bouncing objects (restricted to balls)
- For a given x vs. t, v vs. t or a vs. t graph, determine:
  - Position
  - Displacement
  - Velocity or acceleration at any time t
- For a given x vs. t, v vs. t or a vs. t graph, describe the motion of the object:
  - Bouncing
  - Thrown vertically upwards
  - Thrown vertically downward

Work, Energy and Power
(This section must be read in conjunction with the CAPS, p. 117–120.)

Work
- Define the work done on an object by a constant force F as $F\Delta x\cos\theta$, where F is the magnitude of the force, Δx the magnitude of the displacement and θ the angle between the force and the displacement. (Work is done by a force – the use of the term 'work is done against a force', e.g. work done against friction, must be avoided.)
- Draw a force diagram and free-body diagrams.
- Calculate the net work done on an object.
- Distinguish between positive net work done and negative net work done on the system.

Work-energy theorem
- State the work-energy theorem: The work done on an object by a net force is equal to the change in the object's kinetic energy:
  $W_{net} = \Delta K = K_f - K_i$
- Apply the work-energy theorem to objects on horizontal, vertical and inclined planes (for both frictionless and rough surfaces).

Conservation of energy with non-conservative forces present
- Define a conservative force as a force for which the work done in moving an object between two points is independent of the path taken. Examples are gravitational force, the elastic force in a spring and coulombic force.
- Define a non-conservative force as a force for which the work done in moving an object between two points depends on the path taken. Examples are frictional force, air resistance, tension in a chord, etc.
- State the principle of conservation of mechanical energy: The total mechanical energy (sum of gravitational potential energy and kinetic energy) in an isolated system remains constant. A system is isolated when the net external force (excluding the gravitational force) acting on the system is zero.)
- Solve conservation of energy problems using the equation: $W_{nc} = \Delta E_k + \Delta E_p$
- Use the relationship above to show that in the absence of non-conservative forces, mechanical energy is conserved.

Power

- Define *power* as the rate at which work is done or energy is expended.
  In symbols: $P = \frac{W}{\Delta t}$
- Calculate the power involved when work is done.
- Perform calculations using $P_{ave} = Fv_{ave}$ when an object moves at a constant speed along a rough horizontal surface or a rough inclined plane.
- Calculate the power output for a pump lifting a mass (e.g. lifting water through a height at constant speed).

Doppler Effect (relative motion between source and observer)
(This section must be read in conjunction with the CAPS, p. 121–122.)

With sound and ultrasound

- State the Doppler effect as the change in frequency (or pitch) of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation.
- Explain (using appropriate illustrations) the change in pitch observed when a source moves toward or away from a listener.
- Solve problems using the equation $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ when EITHER the source OR the listener is moving.
- State applications of the Doppler effect.

With light – red shifts in the universe (evidence for the expanding universe)

- Explain red shifts.
- Use the Doppler effect to explain why we conclude that the universe is expanding.

Electrostatics (Grade 11)

Coulomb's law

- State Coulomb's law: The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the magnitudes of the charges and inversely proportional to the square of the distance (r) between them:
- Solve problems using the equation $F = \frac{kQ_1Q_2}{r^2}$ for charges in one dimension (1D) (restrict to three charges).
- Solve problems using the equation $F = \frac{kQ_1Q_2}{r^2}$ for charges in two dimensions (2D) – for three charges in a right-angled formation (limit to charges at the 'vertices of a right-angled triangle').

Electric field

- Describe an electric field as a region of space in which an electric charge experiences a force. The direction of the electric field at a point is the direction that a positive test charge would move if placed at that point.
- Draw electric field patterns for:
  - A single point charge
  - Two point charges
  - A charged sphere
- Define the electric field at a point: The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point.
  In symbols: $E = \frac{F}{q}$

- Solve problems using the equation $E = \frac{F}{q}$.
- Calculate the electric field at a point due to a number of point charges, using the equation $E = \frac{kQ}{r^2}$ to determine the contribution to the field due to each charge. Restrict to three charges in a straight line.

Electric Circuits
(This section must be read in conjunction with the CAPS, p. 88–89 & 121.)

Ohm's law (Grade 11)
- State Ohm's law in words: The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.
- Determine the relationship between current, voltage and resistance at constant temperature using a simple circuit.
- State the difference between ohmic conductors and non-ohmic conductors and give an example of each.
- Solve problems using $R = \frac{V}{I}$ for series and parallel circuits (maximum four resistors).

Power, energy (Grade 11)
- Define power as the rate at which work is done.
- Solve problems using $P = \frac{W}{\Delta t}$.
- Solve problems using $P = VI$, $P = I^2R$ or $P = \frac{V^2}{R}$.
- Solve circuit problems involving the concepts of power and electrical energy.
- Deduce that the kilowatt hour (kWh) refers to the use of 1 kilowatt of electricity for 1 hour.
- Calculate the cost of electricity usage given the power specifications of the appliances used as well as the duration if the cost of 1 kWh is given.

Internal resistance, series and parallel networks
- Solve problems involving current, voltage and resistance for circuits containing arrangements of resistors in series and in parallel (maximum four resistors).
- Explain the term internal resistance.
- Solve circuit problems using $\varepsilon = V_{load} + V_{internal\ resistance}$ or $\varepsilon = IR_{ext} + Ir$.
- Solve circuit problems, with internal resistance, involving series-parallel networks of resistors (maximum four resistors).

Electrodynamics
(This section must be read in conjunction with the CAPS, p. 130–131.)

Electrical machines (generators, motors)
- State the energy conversion in generators.
- Use the principle of electromagnetic induction to explain how a generator works.
- Explain the functions of the components of an AC and a DC generator.
- State examples of the uses of AC and DC generators.
- State the energy conversion in motors.
- Use the motor effect to explain how a motor works.
- Explain the functions of the components of a motor.
- State examples of the use of motors.

Alternating current
- State the advantages of alternating current over direct current.
- Sketch graphs of voltage vs. time and current vs. time for an AC circuit.
- Define the term rms for an alternating voltage/current. The rms value of AC is the direct current/voltage, which dissipates the same amount of energy as AC.
- Solve problems using $I_{rms} = \frac{I_{max}}{\sqrt{2}}$, $V_{rms} = \frac{V_{max}}{\sqrt{2}}$.
- Solve problems using $P_{ave} = I_{rms}V_{rms} = ½\ I_{max}V_{max}$ (for a purely resistive circuit), $P_{ave} = I^2_{rms}R$ and $P_{ave} = \frac{V^2_{rms}}{R}$.

Optical Phenomena and Properties of Materials
(This section must be read in conjunction with the CAPS, p. 132–133.)

Photo-electric effect
- Describe the photoelectric effect as the process whereby electrons are ejected from a metal surface when light of suitable frequency is incident on that surface.
- State the significance of the photoelectric effect.
- Define threshold frequency, f_o, as the minimum frequency of light needed to emit electrons from a certain metal surface.
- Define work function, W_o: The work function of a metal is the minimum energy that an electron in the metal needs to be emitted from the metal surface.
- Perform calculations using the photoelectric equation:
  $E = W_o + E_{kmax}$, where $E = hf$ and $W_o = hf_o$ and $E_{kmax} = ½\ m(v_{max})^2$
- Explain the effect of intensity and frequency on the photoelectric effect.

Emission and absorption spectra
- Explain the formation of atomic spectra by referring to energy transition.
- Explain the difference between atomic absorption and emission spectra.

3.2 PAPER 2: CHEMISTRY

Representing Chemical Change (Grade 10)
(This section must be read in conjunction with the CAPS, p. 37.)

Balanced chemical equations
- Write and balance chemical equations.
- Interpret balanced reaction equations in terms of:
  - Conservation of atoms
  - Conservation of mass (use relative atomic masses)

Quantitative Aspects of Chemical Change (Grade 11)
(This section must be read in conjunction with the CAPS, p. 82.)

Molar volume of gases
- 1 mole of any gas occupies 22,4 dm^3 at 0 °C (273 K) and 1 atmosphere (101,3 kPa).

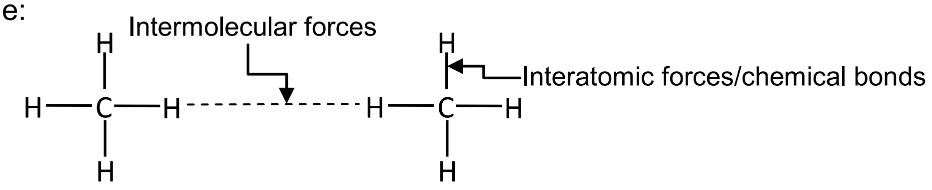
Volume relationships in gaseous reactions
- Interpret balanced equations in terms of volume relationships for gases, i.e. under the same conditions of temperature and pressure, equal number of moles of all gases occupy the same volume.

Concentration of solutions
- Calculate the molar concentration of a solution.

More complex stoichiometric calculations
- Determine the empirical formula and molecular formula of compounds.
- Determine the percentage yield of a chemical reaction.
- Determine percentage purity or percentage composition, e.g. the percentage $CaCO_3$ in an impure sample of seashells.
- Perform stoichiometric calculations based on balanced equations.
- Perform stoichiometric calculations based on balanced equations that may include limiting reagents.

Intermolecular Forces (Grade 11)
(This section must be read in conjunction with the CAPS, p. 71–73.)

Intermolecular and interatomic forces (chemical bonds)
- Name and explain the different intermolecular forces (Van der Waal's forces):
  - (i) Dipole-dipole forces:
    Forces between two polar molecules
  - (ii) Induced dipole forces or London forces:
    Forces between non-polar molecules
  - (iii) Hydrogen bonding:
    Forces between molecules in which hydrogen is covalently bonded to nitrogen, oxygen or fluorine – a special case of dipole-dipole forces
- Describe the difference between intermolecular forces and interatomic forces using a diagram of a group of small molecules; and in words.
  Example:



- State the relationship between intermolecular forces and molecular size. For non-polar molecules, the strength of induced dipole forces increases with molecular size.

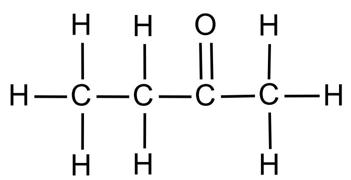
- Explain the effect of intermolecular forces on boiling point, melting point and vapour pressure.
  Boiling point:
  The temperature at which the vapour pressure equals atmospheric pressure. The stronger the intermolecular forces, the higher the boiling point.
  Melting point:
  The temperature at which the solid and liquid phases of a substance are at equilibrium. The stronger the intermolecular forces, the higher the melting point.
  Vapour pressure:
  The pressure exerted by a vapour at equilibrium with its liquid in a closed system. The stronger the intermolecular forces, the lower the vapour pressure.

Organic Molecules
(This section must be read in conjunction with the CAPS, p. 104–116.)

- Define organic molecules as molecules containing carbon atoms.

Organic molecular structures – functional groups, saturated and unsaturated structures, isomers

- Write down condensed structural formulae, structural formulae and molecular formulae (up to 8 carbon atoms, one functional group per molecule) for:
  - Alkanes (no ring structures)
  - Alkenes (no ring structures)
  - Alkynes
  - Halo-alkanes (primary, secondary and tertiary haloalkanes; no ring structures)
  - Alcohols (primary, secondary and tertiary alcohols)
  - Carboxylic acids
  - Esters
  - Aldehydes
  - Ketones
- Know the following definitions/terms:
  - Molecular formula: A chemical formula that indicates the type of atoms and the correct number of each in a molecule.
    Example: C_4H_8O
  - Structural formula: A structural formula of a compound shows which atoms are attached to which within the molecule. Atoms are represented by their chemical symbols and lines are used to represent ALL the bonds that hold the atoms together.

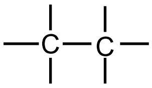
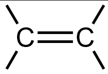
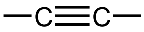
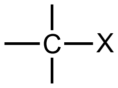
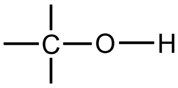
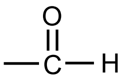
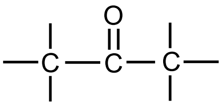
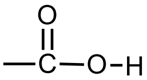
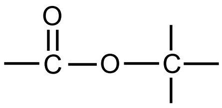


  - Condensed structural formula: This notation shows the way in which atoms are bonded together in the molecule, but DOES NOT SHOW ALL bond lines.

$CH_3CH_2COCH_3$ OR $CH_3CH_2C(=O)CH_3$

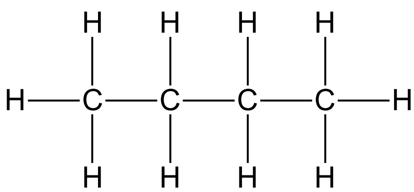
  - Hydrocarbon: Organic compounds that consist of hydrogen and carbon only.
  - Homologous series: A series of organic compounds that can be described by the same general formula OR in which one member differs from the next with a CH_2 group
  - Saturated compounds: Compounds in which there are no multiple bonds between C atoms in their hydrocarbon chains

- Unsaturated compounds: Compounds with one or more multiple bonds between C atoms in their hydrocarbon chains
- Functional group: A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds

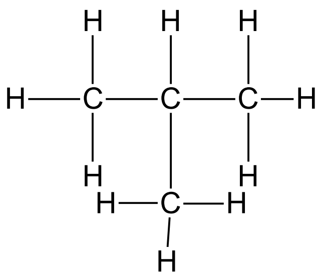
Homologous series	**Structure of functional group**	
	Structure	**Name**
Alkanes		Only C-H and C-C single bonds
Alkenes		Carbon-carbon double bond
Alkynes		Carbon-carbon triple bond
Haloalkanes	 (X = F, Cℓ, Br, I)	-
Alcohols		Hydroxyl group
Aldehydes		Formyl group
Ketones		Carbonyl group
Carboxylic acids		Carboxyl group
Esters		-

- Structural isomer: Organic molecules with the same molecular formula, but different structural formulae

- Identify compounds (up to 8 carbon atoms) that are saturated, unsaturated and are structural isomers.
- Restrict structural isomers to chain isomers, positional isomers and functional isomers.
  - Chain isomers: Same molecular formula, but different types of chains, e.g. butane and 2-methylpropane

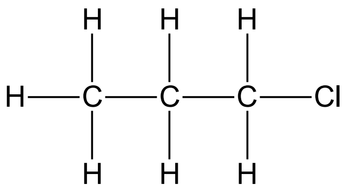


Butane

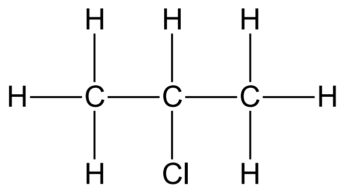


2-methylpropane

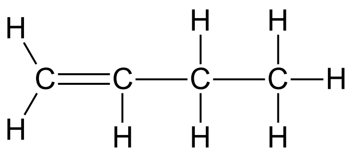
- Positional isomers: Same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain, e.g. 1-chloropropane and 2-chloropropane or but-2-ene and but-1-ene



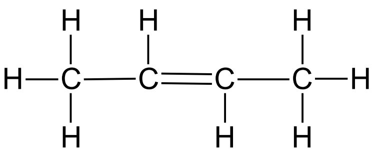
1-chloropropane



2-chloropropane

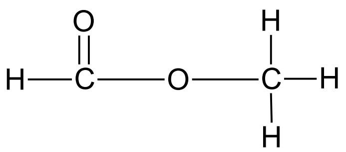


but-1-ene

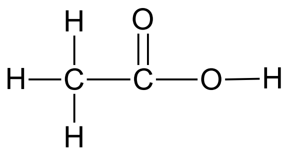


but-2-ene

- Functional isomers: Same molecular formula, but different functional groups, e.g. methyl methanoate and ethanoic acid



methyl methanoate



ethanoic acid

IUPAC naming and formulae

- Write down the IUPAC name when given the structural formula or condensed structural formula for compounds from the homologous series above, restricted to one functional group per compound, except for haloalkanes. For haloalkanes, maximum two functional groups per molecule.
- Write down the structural formula when given the IUPAC name for the above homologous series.
- Identify alkyl substituents (methyl- and ethyl-) in a chain to a maximum of THREE alkyl substituents on the parent chain.
- When naming haloalkanes, the halogen atoms do not get preference over alkyl groups – numbering should start from the end nearest to the first substituent, either the alkyl group or the halogen. In haloalkanes, where e.g. a Br and a Cℓ have the same number when numbered from different ends of chain, Br gets alphabetical preference. When an alkyl group is a substituent in a molecule, it should be treated as a substituent.
- When writing IUPAC names, substituents appear as prefixes written alphabetically (bromo, chloro, ethyl, methyl), ignoring the prefixes di- and tri.

Structure and physical properties (boiling point, melting point, vapour pressure) relationships

- For a given example (from the above functional groups), explain the relationship between physical properties and:
  - Strength of intermolecular forces (Van der Waal's forces), i.e. hydrogen bonds, dipole-dipole forces, induced dipole forces
  - Type of functional groups
  - Chain length
  - Branched chains

Oxidation of alkanes

- State the use of alkanes as fuels.
- Write down an equation for the combustion of an alkane in excess oxygen.

Esterification

- Write down an equation, using structural formulae, for the formation of an ester.
- Name the alcohol and carboxylic acid used and the ester formed.
- Write down reaction conditions for esterification.

Substitution, addition and elimination reactions

- Identify reactions as elimination, substitution or addition.
- Write down, using structural formulae, equations and reaction conditions for the following addition reactions of alkenes:
  - Hydrohalogenation:
    The addition of a hydrogen halide to an alkene
  - Halogenation:
    The reaction of a halogen (Br_2, $C\ell_2$) with a compound
  - Hydration:
    The addition of water to a compound
  - Hydrogenation:
    The addition of hydrogen to an alkene
- Write down, using structural formulae, equations and reaction conditions for the following elimination reactions:
  - Dehydrohalogenation of haloalkanes:
    The elimination of hydrogen and a halogen from a haloalkane
  - Dehydration of alcohols:
    Elimination of water from an alcohol
  - Cracking of alkanes:
    The chemical process in which longer chain hydrocarbon molecules are broken down to shorter more useful molecules.
- Write down, using structural formulae, equations and reaction conditions for the following substitution reactions:
  - Hydrolysis of haloalkanes
    Hydrolysis: The reaction of a compound with water
  - Reactions of HX (X = $C\ell$, Br) with alcohols to produce haloalkanes
  - Halogenation of alkanes
    The reaction of a halogen (Br_2, $C\ell_2$) with a compound

Plastics and polymers (ONLY BASIC POLYMERISATION as application of organic chemistry)

- Describe the following terms:
  Macromolecule: A molecule that consists of a large number of atoms
  Polymer: A large molecule composed of smaller monomer units covalently bonded to each other in a repeating pattern
  Monomer: Small organic molecules that can be covalently bonded to each other in a repeating pattern
  Polymerisation: A chemical reaction in which monomer molecules join to form a polymer
- Distinguish between addition polymerisation and condensation polymerisation:
  Addition polymerisation: A reaction in which small molecules join to form very large molecules by adding on at double bonds
  Addition polymer: A polymer formed when monomers (usually containing a double bond) combine through an addition reaction
  Condensation polymerisation: Molecules of two monomers with different functional groups undergo condensation reactions with the loss of small molecules, usually water

Condensation polymer: A polymer formed by monomers with two functional groups that are linked together in a condensation reaction in which a small molecule, usually water, is lost

- Identify monomers from given addition polymers.
- Write down an equation for the polymerisation of ethene to produce polythene.
- State the industrial uses of polythene.

Energy and Change
(This section must be read in conjunction with the CAPS, p. 90–91.)

Energy changes in reactions related to bond energy changes

- Define heat of reaction (ΔH) as the energy absorbed or released in a chemical reaction.
- Define exothermic reactions as reactions that release energy.
- Define endothermic reactions as reactions that absorb energy.
- Classify (with reason) reactions as exothermic or endothermic.

Exothermic and endothermic reactions

- State that $\Delta H > 0$ for endothermic reactions, i.e. reactions in which energy is absorbed.
- State that $\Delta H < 0$ for exothermic reactions, i.e. reactions in which energy is released.

Activation energy

- Define activation energy as the minimum energy needed for a reaction to take place.
- Define an activated complex as the unstable transition state from reactants to products.
- Draw or interpret fully labelled sketch graphs (potential energy vs. course of reaction) of catalysed and uncatalysed endothermic and exothermic reactions.

Rate and Extent of Reaction
(This section must be read in conjunction with the CAPS, p. 123–124.)

Rates of reaction and factors affecting rate

- Define reaction rate as the change in concentration of reactants or products per unit time.
- Calculate reaction rate from given data.

  $\text{Rate} = \frac{\Delta c}{\Delta t}$ (Unit: $mol \cdot dm^{-3} \cdot s^{-1}$)

  Questions may also include calculations of rate in terms of change in mass/volume/ moles/per time.
- List the factors that affect the rate of chemical reactions, i.e. nature of reacting substances, surface area, concentration, pressure for gases, temperature and the presence of a catalyst.
- Explain in terms of the collision theory how the various factors affect the rate of chemical reactions. The collision theory is a model that explains reaction rate as the result of particles colliding with a certain minimum energy to form products.

Measuring rates of reaction

- Answer questions and interpret data (tables or graphs) on different experimental techniques for measuring the rate of a given reaction.

Mechanism of reaction and of catalysis

- Define the term (positive) catalyst as a substance that increases the rate of a chemical reaction without itself undergoing a permanent change.

- Interpret graphs of distribution of molecular energies (number of particles against their kinetic energy also known as Maxwell-Boltzmann curves) to explain how a catalyst, temperature and concentration affect rate.
- Explain that a catalyst increases the rate of a reaction by providing an alternative path of lower activation energy. It therefore decreases the net activation energy.
- Use a graph showing the distribution of molecular energies (number of particles against their kinetic energy) to explain why only some molecules have enough energy to react, and hence how adding a catalyst and heating the reactants affects the rate.

Chemical Equilibrium
(This section must be read in conjunction with the CAPS, p. 125–126.)

Chemical equilibrium and factors affecting equilibrium
- Explain what is meant by:
  - Open and closed systems: An open system continuously interacts with its environment, while a closed system is isolated from its surroundings.
  - A reversible reaction: A reaction is reversible when products can be converted back to reactants.
  - Chemical equilibrium: It is a dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction.
- List the factors that influence the position of an equilibrium, i.e. pressure (gases only), concentration and temperature.

Equilibrium constant
- List the factors that influence the value of the equilibrium constant, K_c.
- Write down an expression for the equilibrium constant, having been given the equation for the reaction.
- Perform calculations based on K_c values.
- Explain the significance of high and low values of the equilibrium constant.

Application of equilibrium principles
- State Le Chatelier's principle: When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance.
- Use Le Chatelier's principle to explain changes in equilibria qualitatively.
- Interpret graphs of equilibrium, e.g. concentration/rate/number of moles/mass/ volume versus time.
- Explain the use of rate and equilibrium principles in the Haber process and the contact process.

Acids and Bases
(This section must be read in conjunction with the CAPS, p. 127–128.)

Acid-base reactions
- Define acids and bases according to Arrhenius and Lowry-Brønsted theories:
  Arrhenius theory: An acid is a substance that produces hydrogen ions (H^+) in water. A base produces hydroxide ions (OH^-) in water.
  Lowry-Brønsted theory: An acid is a proton (H^+ ion) donor. A base is a proton (H^+ ion) acceptor.
- Distinguish between strong acids/bases and weak acids/bases with examples.
  Strong acids ionise completely in water to form a high concentration of H_3O^+ ions. Examples of strong acids are hydrochloric acid, sulphuric acid and nitric acid.
  Weak acids ionise incompletely in water to form a low concentration of H_3O^+ ions. Examples of weak acids are ethanoic acid and oxalic acid.
  Strong bases dissociate completely in water.
  Examples of strong bases are sodium hydroxide and potassium hydroxide.
  Weak bases dissociate/ionise incompletely in water to form a low concentration of OH^- ions.

Examples of weak bases are ammonia, calcium carbonate, potassium carbonate, calcium carbonate and sodium hydrogen carbonate.

- Distinguish between concentrated acids/bases and dilute acids/bases.
  Concentrated acids/bases contain a large amount (number of moles) of acid/base in proportion to the volume of water.
  Dilute acids/bases contain a small amount (number of moles) of acid/base in proportion to the volume of water.
- Write down the reaction equations of aqueous solutions of acids and bases.
  Examples: $HC\ell(g) + H_2O(\ell) \rightarrow H_3O^+(aq) + C\ell^-(aq)$ ($HC\ell$ is a monoprotic acid.)
  $NH_3(g) + H_2O(\ell) \rightarrow NH_4^+(aq) + OH^-(aq)$
  $H_2SO_4(aq) + 2H_2O(\ell) \rightarrow 2H_3O^+(aq) + SO_4^{2-}(aq)$ (H_2SO_4 is a diprotic acid.)
- Identify conjugate acid-base pairs for given compounds. When the acid, HA, loses a proton, its conjugate base, A^-, is formed. When the base, A^-, accepts a proton, its conjugate acid, HA, is formed. These two are a conjugate acid-base pair.
- Describe a substance that can act as either acid or base as amphiprotic. Water is a good example of an amphoteric substance. Write equations to show how an amphoteric substance can act as acid or base.
- Write down neutralisation reactions of common laboratory acids and bases.
  Examples: $HC\ell(aq) + NaOH(aq)/KOH(aq) \rightarrow NaC\ell(aq)/KC\ell(aq) + H_2O(\ell)$
  $HC\ell(aq) + Na_2CO_3(aq) \rightarrow NaC\ell(aq) + H_2O(\ell) + CO_2(g)$
  $HNO_3(aq) + NaOH(aq) \rightarrow NaNO_3(aq) + H_2O(\ell)$
  $H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$
  $(COOH)_2(aq) + NaOH(aq) \rightarrow (COO)_2Na_2(aq) + H_2O(\ell)$
  $CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(\ell)$

  NOTE: The above are examples of equations that learners will be expected to write from given information. However, any other neutralisation reaction can be given in a question paper and used to assess, e.g. stoichiometry calculations.
- Determine the approximate pH (equal to, smaller than or larger than 7) of salts in salt hydrolysis. Define hydrolysis as the reaction of a salt with water.
  - Hydrolysis of the salt of a weak acid and a strong base results in an alkaline solution, i.e. the pH > 7. Examples of such salts are sodium ethanoate, sodium oxalate and sodium carbonate.
  - Hydrolysis of the salt of a strong acid and a weak base results in an acidic solution, i.e. the pH < 7. An example of such a salt is ammonium chloride.
  - The salt of a strong acid and a strong base does not undergo hydrolysis and the solution of the salt will be neutral, i.e. pH = 7.
- Motivate the choice of a specific indicator in a titration. Choose from methyl orange, phenolphthalein and bromothymol blue. Define the equivalence point of a titration as the point at which the acid/base has completely reacted with the base/acid.
  Define the endpoint of a titration as the point where the indicator changes colour.
- Perform stoichiometric calculations based on titrations of a strong acid with a strong base, a strong acid with a weak base and a weak acid with a strong base. Calculations may include percentage purity.
- For a titration, e.g. the titration of oxalic acid with sodium hydroxide:
  - List the apparatus needed or identify the apparatus from a diagram.
  - Describe the procedure to prepare a standard oxalic acid solution.
  - Describe the procedure to conduct the titration.
  - Describe safety precautions.
  - Describe measures that need to be in place to ensure reliable results.
  - Interpret given results to determine the unknown concentration.
- Explain the pH scale as a scale of numbers from 0 to 14 used to express the hydrogen ion concentration.
- Calculate pH values of strong acids and strong bases.
- Define the concept of K_w as the equilibrium constant for the ionisation of water – the ionic product of water (ionisation constant of water).

- Explain the auto-ionisation of water, i.e. the reaction of water with itself to form H_3O^+ ions and OH^- ions.
- Interpret K_a values of acids to determine the relative strength of given acids. Interpret K_b values of bases to determine the relative strength of given bases.
- Compare strong and weak acids by looking at:
  - pH (monoprotic and diprotic acids)
  - Conductivity
  - Reaction rate

Electrochemical Reactions
(This section must be read in conjunction with the CAPS, p. 134–137.)

Electrolytic cells and galvanic cells

- Define the galvanic cell as a cell in which chemical energy is converted into electrical energy. A galvanic (voltaic) cell has self-sustaining electrode reactions.
- Define the electrolytic cell as a cell in which electrical energy is converted into chemical energy.
- Define oxidation and reduction in terms of electron (e^-) transfer:
  Oxidation is a loss of electrons. Reduction is a gain of electrons.
- Define oxidation and reduction in terms of oxidation numbers:
  Oxidation: An increase in oxidation number
  Reduction: A decrease in oxidation number
- Define an oxidising agent and a reducing agent in terms of oxidation and reduction:
  Oxidising agent: A substance that is reduced/gains electrons.
  Reducing agent: A substance that is oxidised/loses electrons.
- Define an anode and a cathode in terms of oxidation and reduction:
  Anode: the electrode where oxidation takes place
  Cathode: the electrode where reduction takes place
- Define an electrolyte as a substance of which the aqueous solution contains ions OR a substance that dissolves in water to give a solution that conducts electricity.
- Electrolysis: The chemical process in which electrical energy is converted to chemical energy OR the use of electrical energy to produce a chemical change.

Relation of current and potential difference to rate and equilibrium

- Give and explain the relationship between current in an electrolytic cell and the rate of the reaction.
- State that the potential difference of a galvanic cell (V_{cell}) is related to the extent to which the spontaneous cell reaction has reached equilibrium.
- State and use the qualitative relationship between V_{cell} and the concentration of product ions and reactant ions for the spontaneous reaction, namely V_{cell} decreases as the concentration of product ions increases and the concentration of reactant ions decreases until equilibrium is reached at which the V_{cell} = 0 (the cell is 'flat'). (Qualitative only. Nernst equation is NOT required.)

Understanding of the processes and redox reactions taking place in galvanic cells

- Describe the movement of ions in the solutions.
- State the direction of electron flow in the external circuit.
- Write down the half-reactions that occur at the electrodes.
- State the function of the salt bridge.
  Use cell notation or diagrams to represent a galvanic cell.
  When writing cell notation, the following convention should be used:
  - The $H_2|H^+$ half-cell is treated just like any other half-cell.
  - Cell terminals (electrodes) are written on the outside of the cell notation.
  - Active electrodes:
    reducing agent | oxidised species || oxidising agent | reduced species
  - Inert electrodes (usually Pt or C):
    Pt | reducing agent | oxidised species || oxidising agent | reduced species | Pt
    Example: Pt | $C\ell^-$(aq) |$C\ell_2$(g) || F_2(g) | F^-(aq) | Pt
- Predict the half-cell in which oxidation will take place when two half-cells are connected.
- Predict the half-cell in which reduction will take place when connected to another half-cell.
- Write down the overall cell reaction by combining two half-reactions.
- Use the Table of Standard Reduction Potentials to calculate the emf of a standard galvanic cell.
- Use a positive value of the standard emf as an indication that the reaction is spontaneous under standard conditions.

Standard electrode potentials

- Write down the standard conditions under which standard electrode potentials are determined.
- Describe the standard hydrogen electrode and explain its role as the reference electrode.
- Explain how standard electrode potentials can be determined using the reference electrode and state the convention regarding positive and negative values.

Understanding the processes and redox reactions taking place in electrolytic cells

- Describe the movement of ions in the solution.
- State the direction of electron flow in the external circuit.
- Write equations for the half-reactions taking place at the anode and cathode.
- Write down the overall cell reaction by combining two half-reactions.
- Describe, using half-reactions and the equation for the overall cell reaction as well as the layout of the particular cell using a schematic diagram, the following electrolytic processes:
  - The decomposition of copper(II) chloride
  - Electroplating, e.g. the electroplating of an iron spoon with silver/nickel
  - Refining copper
  - The electrolysis of a concentrated solution of sodium chloride and its use in the chlor-alkali industry
  - The recovery of aluminium metal from bauxite (South Africa uses bauxite from Australia.)
- Describe risks to the environment of the following electrolytic processes used industrially:
  - The production of chlorine (the chemical reactions of the chloro-alkali industry)
  - The recovery of aluminium metal from bauxite

Chemical Industry
(This section must be read in conjunction with the CAPS, p. 138–140.)

The fertiliser industry (N, P, K)

- List, for plants:
  - Three non-mineral nutrients C, H and O and their sources, i.e. the atmosphere (CO_2) and rain (H_2O)
  - Three primary nutrients N, P and K and their sources
- Explain why fertilisers are needed.
- Explain the function of N, P and K in plants.
- Interpret the N : P : K fertiliser ratio and perform calculations based on the ratio.
- Describe/Explain/Write balanced equations and interpret flow diagrams of the following processes in the industrial manufacture of fertilisers:
  - N_2 – fractional distillation of air
  - H_2 – at SASOL from coal and steam
  - NH_3 – Haber process
  - HNO_3 – Ostwald process
  - H_2SO_4 – Contact process
  - NH_4NO_3; $(NH_4)_2SO_4$
- Evaluate the use of inorganic fertilisers on humans and the environment.
- Define eutrophication as the process by which an ecosystem, e.g. a river or dam, becomes enriched with inorganic plant nutrients, especially phosphorus and nitrogen, resulting in excessive plant (algae) growth. As plant growth becomes excessive, the amount of dead and decaying plant material increases rapidly.
- Discuss alternatives to inorganic fertilisers as used by some communities.

4. GENERAL INFORMATION

4.1 Quantities, symbols and units

The most common quantities, symbols and SI units used in introductory Physics are listed below. **A quantity should not be confused with the unit in which it is measured**.

Quantity	Preferred symbol	Alternative symbol	Unit name	Unit symbol
mass	m		kilogram	kg
position	x, y		metre	m
displacement	$\Delta x, \Delta y$	s	metre	m
velocity	v_x, v_y	u, v	metre per second	$m \cdot s^{-1}$
initial velocity	v_i	u	metre per second	$m \cdot s^{-1}$
final velocity	v_f	v	metre per second	$m \cdot s^{-1}$
acceleration	a		metre per second per second	$m \cdot s^{-2}$
acceleration due to gravity	g		metre per second per second	$m \cdot s^{-2}$
time (instant)	t		second	s
time interval	Δt		second	s
energy	E		joule	J
kinetic energy	K	E_k	joule	J
potential energy	U	E_p	joule	J
work	W		joule	J
work function	W_0		joule	J
power	P		watt	W
momentum	p		kilogram metre per second	$kg \cdot m \cdot s^{-1}$
force	F		newton	N
weight	w	F_g	newton	N
normal force	N	F_N	newton	N
tension	T	F_T	newton	N
friction force	f	F_f	newton	N
coefficient of friction	μ, μ_s, μ_k		(none)	
torque	τ		newton metre	N·m
wavelength	λ		metre	m
frequency	f	ν	hertz or per second	Hz or s^{-1}
period	T		second	s
speed of light	c		metre per second	$m \cdot s^{-1}$
refractive index	n		(none)	
focal length	f		metre	m
object distance	s	u	metre	m
image distance	s'	v	metre	m
magnification	m		(none)	
charge	Q, q		coulomb	C
electric field	E		newton per coulomb or volt per metre	$N \cdot C^{-1}$ or $V \cdot m^{-1}$
electric potential at point P	V_P		volt	V
potential difference	ΔV, V		volt	V
emf	**E**	ε	volt	V
current	I, i		ampere	A
resistance	R		ohm	Ω
internal resistance	r		ohm	Ω
magnetic field	B		tesla	T
magnetic flux	Φ		tesla·metre^2 or weber	$T \cdot m^2$ or Wb
capacitance	C		farad	F
inductance	L		henry	H

Conventions (e.g. signs, symbols, terminology and nomenclature)
The syllabus and question papers will conform to generally accepted international practices.

NOTE:
1. For marking purposes, alternative symbols will also be accepted.
2. Separate compound units with a multiplication dot, not a full stop, e.g. $m{\cdot}s^{-1}$.
   For marking purposes, $m.s^{-1}$ will also be accepted.
3. Use the equal sign only when it is mathematically correct, e.g.
   Incorrect: 1 cm = 1 m (on a scale drawing)
   Correct: 1 cm = 10^{-2} m 1 cm represents 1 m (on a scale drawing)

4.2 INFORMATION SHEETS – PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9{,}8\ m{\cdot}s^{-2}$
Universal gravitational constant	G	$6{,}67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Speed of light in a vacuum	c	$3{,}0 \times 10^{8}\ m{\cdot}s^{-1}$
Planck's constant	h	$6{,}63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant	k	$9{,}0 \times 10^{9}\ N{\cdot}m^2{\cdot}C^{-2}$
Charge on electron	e	$-1{,}6 \times 10^{-19}\ C$
Electron mass	m_e	$9{,}11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE

MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ OR $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ OR $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p = mv_f - mv_i$	$w = mg$

WORK, ENERGY AND POWER

$W = F\Delta x \cos\theta$	$U = E_P = mgh$
$K = E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K = \Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ OR $E = h\frac{c}{\lambda}$
$hf = W_0 + \frac{1}{2}mv^2 = hf_0 + \frac{1}{2}mv^2$	

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ OR $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$
$R_s = R_1 + R_2 + ...$	emf (ε) = I(R + r)
$Q = I\Delta t$	$W = Vq = VI\Delta t = I^2R\Delta t = \frac{V^2\Delta t}{R}$
$P = \frac{W}{\Delta t} = VI = I^2R = \frac{V^2}{R}$	

ALTERNATING CURRENT

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$	$P_{average} = V_{rms}I_{rms} = I_{rms}^2R = \frac{V_{rms}^2}{R}$

4.3 INFORMATION SHEETS – PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Avogadro's constant	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Standard pressure	p^θ	$1{,}01 \times 10^{5}$ Pa
Molar gas volume at STP	V_m	$22{,}4\ dm^3 \cdot mol^{-1}$
Standard temperature	T^θ	273 K

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	pH = $-\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY/*SLEUTEL*

Atomic number / *Atoomgetal*	29
Electronegativity / *Elektronegatiwiteit*	1,9
Symbol / *Simbool*	Cu
Approximate relative atomic mass / *Benaderde relatiewe atoommassa*	63,5

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

TABLE 4A: STANDARD REDUCTION POTENTIALS

Half-reactions			E^θ (V)
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$Na^+ + e^-$	⇌	Na	– 2,71
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Cs^+ + e^-$	⇌	Cs	- 2,92
$K^+ + e^-$	⇌	K	– 2,93
$Li^+ + e^-$	⇌	Li	– 3,05

Increasing oxidising ability (↑ left of table)

Increasing reducing ability/ (↓ right of table)

TABLE 4B: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability ↓

Increasing reducing ability ↑

Half-reactions			E^{θ} (V)
$Li^+ + e^-$	⇌	Li	– 3,05
$K^+ + e^-$	⇌	K	– 2,93
$Cs^+ + e^-$	⇌	Cs	– 2,92
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Na^+ + e^-$	⇌	Na	– 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87

5. MARKING GUIDELINES: PAPER 1

5.1 CALCULATIONS

5.1.1 **Marks will be awarded for:** correct formula, correct substitution, correct answer with unit.
5.1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.
5.1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.
5.1.4 If **no formula** is given, but **all substitutions are correct**, the candidate will **forfeit one mark**.
5.1.5 **No penalisation if zero substitutions are omitted** in calculations where **correct formula/principle is given correctly**.
5.1.6 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.
5.1.7 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer given.
5.1.8 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.
5.1.9 Final answers to all calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.
5.1.10 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.
5.1.11 Questions in which a series of calculations have to be made (e.g. a circuit-diagram question) do not necessarily always have to follow the same order. FULL MARKS will be awarded, provided it is a valid solution to the problem. However, any calculation that will not bring the candidate closer to the answer than the original data, will not count any marks.

5.2 UNITS

5.2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.
5.2.2 Units are only required in the final answer to a calculation.
5.2.3 Marks are only awarded for an answer, and not for a unit per se. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

5.2.4 SI units must be used, except in certain cases, e.g. $V{\cdot}m^{-1}$ instead of $N{\cdot}C^{-1}$, and $cm{\cdot}s^{-1}$ or $km{\cdot}h^{-1}$ instead of $m{\cdot}s^{-1}$ where the question warrants this.

5.3 GENERAL

5.3.1 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.
5.3.2 For marking purposes, alternative symbols (s, u, t, etc.) will also be accepted.
5.3.3 Separate compound units with a multiplication dot, not a full stop, e.g. $m{\cdot}s^{-1}$. For marking purposes, $m.s^{-1}$ and m/s will also be accepted.

5.4 POSITIVE MARKING

Positive marking regarding calculations will be followed in the following cases:

5.4.1 **Subquestion to subquestion:** When a certain variable is incorrectly calculated in one subquestion (e.g. 3.1) and needs to be substituted into another subquestion (3.2 or 3.3), **full marks** are to be awarded for the subsequent subquestions.

5.4.2 **A multistep question in a subquestion:** If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

5.5 NEGATIVE MARKING

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.1, and QUESTION 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for, for example, QUESTION 3.1 is based on a calculation, the motivation for the incorrect answer in QUESTION 3.2 should be considered.

6. MARKING GUIDELINES: PAPER 2

6.1 CALCULATIONS

6.1.1 **Marks will be awarded for:** correct formula, correct substitution, correct answer with unit.

6.1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.

6.1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.

6.1.4 If **no formula** is given, but **all substitutions are correct**, the candidate will **forfeit one mark**.

Example: No K_c expression, correct substitution:

$$K_c = \frac{(2)^2}{(2)(1)^3} \checkmark = 2 \checkmark \qquad (\frac{2}{3})$$

6.1.5 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer has been given.

6.1.6 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.

6.1.7 The final answer to all calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.

6.1.8 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.

6.1.9 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.

Example:

CORRECT	ANSWER (1)	POSSIBLE	ANSWER (2)	POSSIBLE
$n=\frac{m}{M}$ ✓ $0{,}01$✓ $= \frac{m}{52}$ ✓ m = 0,52 g ✓ (4)	$n=\frac{m}{M}$ ✓ $0{,}01$ ✓$= \frac{52}{m}$ × m = 5 200 g × (2)	$m=\frac{n}{M}$ × $= \frac{0{,}01}{52}$ = 0,002 g (0)	$n=\frac{m}{M}$ ✓ $m=\frac{M}{n}$ × $= \frac{52}{0{,}01}$ ✓ = 5 200 g× (3)	$n=\frac{m}{M}$ ✓ = 0,52 g ✓ (2)

6.2 UNITS

6.2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.
6.2.2 Units are only required in the final answer to a calculation.
6.2.3 Marks are only awarded for an answer and not for a unit per se. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

6.2.4 Separate compound units with a multiplication dot, not a full stop, for example $mol{\cdot}dm^{-3}$. Accept $mol.dm^{-3}$ (or mol/dm^3) for marking purposes.

6.3 GENERAL

6.3.1 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.
6.3.2 When a chemical **FORMULA** is asked, and the **NAME** is given as answer, the candidate forfeits the marks. The same rule applies when the **NAME** is asked and the **FORMULA** is given.
6.3.3 When redox half-reactions are to be written, the correct arrow should be used.
If the equation

$H_2S \rightarrow S + 2H^+ + 2e^-$ $(\frac{2}{2})$

is the correct answer, the marks must be given as follows:

$H_2S \rightleftharpoons S + 2H^+ + 2e^-$ $(\frac{1}{2})$

$H_2S \leftarrow S + 2H^+ + 2e^-$ $(\frac{0}{2})$

$S + 2H^+ + 2e^- \leftarrow H_2S$ $(\frac{2}{2})$

$S + 2H^+ + 2e^- \rightleftharpoons H_2S$ $(\frac{0}{2})$

6.3.4 When candidates are required to give an explanation involving the relative strength of oxidising and reducing agents, do not accept the following:
- Stating the position of a substance on Table 4 only (e.g. Cu is above Mg).
- Using relative reactivity only (e.g. Mg is more reactive than Cu).
- The correct answer would be for instance: Mg is a stronger reducing agent than Cu, and therefore Mg will be able to reduce Cu^{2+} ions to Cu. The answer can also be given in terms of the relative strength as electron acceptors and donors.

6.3.5 One mark is forfeited when the charge of an ion is omitted per equation (not for the charge on an electron).

6.3.6 The error-carrying principle does not apply to chemical equations or half-reactions. For example, if a learner writes the wrong oxidation/reduction half-reaction in the subquestion and carries the answer to another subquestion (balancing of equations or calculation of E^{θ}_{cell}), then the learner will not be credited for this substitution.

6.3.7 In the structural formula of an organic molecule all hydrogen atoms must be shown. Marks will be deducted if hydrogen atoms are omitted.

6.3.8 When a structural formula is required, marks will be deducted if the candidate writes the condensed formula.

6.3.9 When a IUPAC name is asked and the candidate omits the hyphen (e.g. instead of pent-1-ene or 1-pentene the candidate writes pent 1 ene or 1 pentene), marks will be forfeited.

6.3.10 When a chemical reaction is asked, marks are awarded for correct reactants, correct products and correct balancing.
If only a reactant(s) followed by an arrow, or only a product(s) preceded by an arrow, is/are written, marks may be awarded for the reactant(s) or product(s). If only a reactant(s) or only a product(s) is/are written, without an arrow, no marks are awarded for the reactant(s) or product(s).

Examples:

$N_2 + 3H_2$ ✓$\rightarrow 2NH_3$ ✓ bal. ✓	$^3/_3$
$N_2 + H_2 \rightarrow$✓	$^1/_3$
$\rightarrow NH_3$ ✓	$^1/_3$
$N_2 + H_2$	$^0/_3$
NH_3	$^0/_3$

6.4 POSITIVE MARKING

Positive marking regarding calculations will be followed in the following cases:

6.4.1 **Subquestion to subquestion:** When a certain variable is calculated in one subquestion (e.g. QUESTION 3.1) and needs to be substituted in another (QUESTION 3.2 or QUESTION 3.3), e.g. if the answer for QUESTION 3.1 is incorrect and is substituted correctly in QUESTION 3.2 or QUESTION 3.3, **full marks** are to be awarded for the subsequent subquestions.

6.4.2 **A multistep question in a subquestion:** If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

6.5 NEGATIVE MARKING

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.1, and QUESTION 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for e.g. QUESTION 3.1 is based on a calculation, the motivation for the incorrect answer in QUESTION 3.2 could be considered.

7. CONCLUSION

This Examination Guidelines document is meant to articulate the assessment aspirations espoused in the CAPS document. It is therefore not a substitute for the CAPS document which teachers should teach to.

Qualitative curriculum coverage as enunciated in the CAPS cannot be over-emphasised.

Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2014

PHYSICAL SCIENCES P1

MARKS: **150**

TIME: **3 hours**

PHSCE1

This question paper consists of 17 pages including a 3 page data sheet.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Choose the best answer and write down **A**, **B**, **C** or **D** next to the question number (1.1–1.10) on your ANSWER BOOK.

1.1 A builder throws a brick vertically upwards with an initial velocity of 7,35 m•s^{-1}. When the brick reaches its maximum height, then the …

A acceleration of the brick is 7,35 m•s^{-2} and its potential energy is a maximum.

B velocity of the brick is 0 m•s^{-1} and its potential energy is a minimum.

C velocity of the brick is 9,8 m•s^{-1} and its potential energy is a maximum.

D acceleration of the brick is 9,8 m•s^{-2} and its kinetic energy is a minimum. (2)

1.2 A vehicle with mass *m* is moving horizontally at a constant velocity on a frictionless path. The kinetic energy of the vehicle is K and the momentum is p. The velocity of the vehicle can be given as:

A $\frac{K}{2p}$

B $\frac{2K}{p}$

C $\frac{K}{P}$

D $\frac{p}{K}$ (2)

1.3 When an airbag inflates in a car during a collision, the chances of serious injury to a passenger is reduced because the …

A passenger is brought to rest in a shorter period of time.

B net force acting on the passenger is reduced.

C passenger's change in momentum is reduced.

D passenger's change in momentum is increased. (2)

1.4 A spaceship experiences a weight of X on earth. It is sent into space and lands on a planet which has a mass twice that of the earth and a radius ½ that of the earth. The weight of the spaceship will be ...

A 8X

B ½X

C X

D ¼X (2)

1.5 Astronomers observe that the emitted light of a star shifts to the red part of the visible spectrum. The observation confirms that the ...

A star is moving closer towards earth.

B earth is moving towards the star.

C temperature of earth is increasing.

D universe is expanding. (2)

1.6 A girl stands next to the road as a fire engine approaches her with its sirens blaring and the red flashlights on. She makes the following observations:

	Frequency of sound heard	Colour of flashlight
A	Higher	Red
B	Lower	Red
C	Higher	Orange
D	Lower	Orange

(2)

1.7 Which statement below is CORRECT for resistors connected in parallel in a circuit?

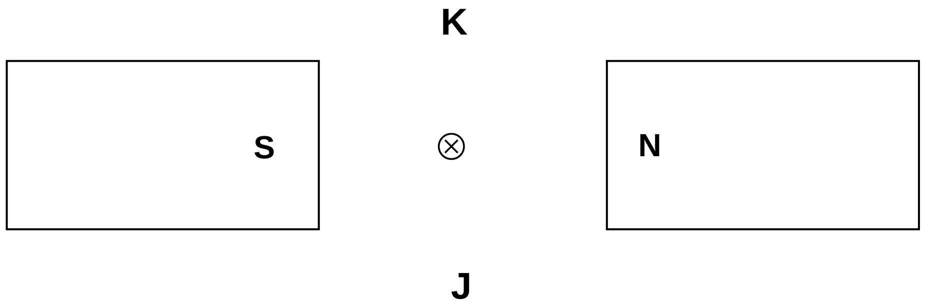
A The voltage (V) across the combination is divided but the resistors each have the same current (I).

B The current (I) across the combination is divided but the resistors each have the same voltage (V).

C The current (I) and the voltage (V) across the combination is divided.

D The current (I) and the voltage (V) across the combination is the same across each resistor. (2)

1.8 Two strong bar magnets are arranged with the north and south poles facing each other as shown in the diagram below. A current-carrying conductor placed between the two magnetic poles carries conventional current into the plane of the page.



The conductor would experience a force towards …

A N.

B S.

C K.

D J. (2)

1.9 If a light is passed through a cold, diluted gas, the atoms of the gas absorb photons at a certain …

A velocity and form an absorption spectrum.

B velocity and form a continuous spectrum.

C frequency and form an absorption spectrum.

D frequency and form a line emission spectrum. (2)

1.10 An atom in the ground state absorbs energy, E, and is excited to a higher energy state. When the atom returns to the ground state, a photon with energy …

A E is absorbed.

B E is released.

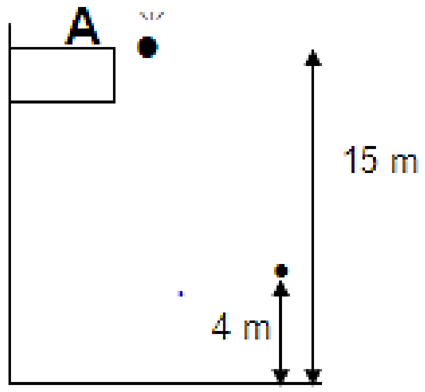
C ½E is absorbed.

D ½E is released. (2)

[20]

QUESTION 2 (Start on a new page.)

A cricket ball, mass 156 g, is dropped from point **A** on a tall building, 15 m high. It strikes the concrete pavement and it then bounces to a maximum height of 4 m.



2.1 Calculate the velocity with which the cricket ball strikes the pavement. (3)

2.2 If the effects of air friction are NOT ignored during the fall of the cricket ball, how would the value you calculated in QUESTION 2.1 change? Write down HIGHER, LOWER or STAYS THE SAME. (1)

2.3 The cricket ball is in contact with the concrete pavement of 0,8 s. Ignore the effects of air friction. Take DOWNWARD motion as POSITIVE.

2.3.1 Calculate the impulse of the cricket ball on the pavement. (8)

2.3.2 Calculate the (net) average force exerted by the pavement on the cricket ball. (4)

2.4 Sketch the **position versus time** graph for the motion of the cricket ball from the moment it is dropped until it reaches its maximum height after the bounce.

USE POINT **A** AS THE ZERO POSITION.

Indicate the following on the graph:

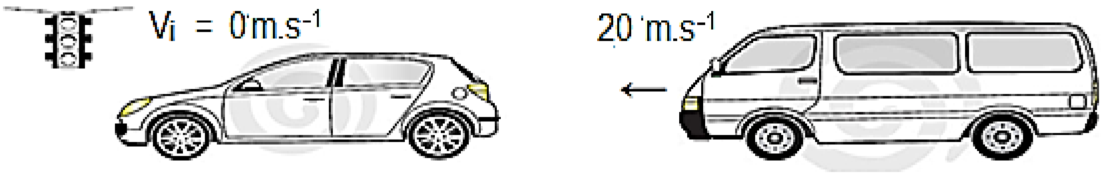
- The height from which the cricket ball is dropped
- The height reached by the cricket ball after the bounce
- Time with which the cricket ball is in contact with the concrete pavement (4)

2.5 The cricket ball is now replaced with a softer ball of similar mass. State how the (net) average force exerted by the concrete pavement on the softer ball compares with your answer in QUESTION 2.3.2.
(Write down only GREATER, SMALLER or STAYS THE SAME).
Use physics principles to explain your answer. (3)
[23]

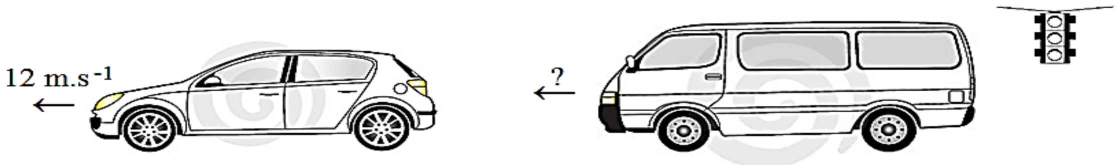
QUESTION 3 (Start on a new page.)

A car of mass 1 500 kg is stationary at a traffic light. It is hit from behind by a minibus of mass 2 000 kg travelling at a speed of 20 m•s^{-1}. Immediately after the collision the car moves forward at 12 m•s^{-1}.

BEFORE



AFTER



3.1 State the LAW OF CONSERVATION OF LINEAR MOMENTUM in words. (2)

3.2 Calculate the speed of the minibus immediately after the collision. (4)

3.3 The driver of the minibus is NOT wearing a seatbelt.

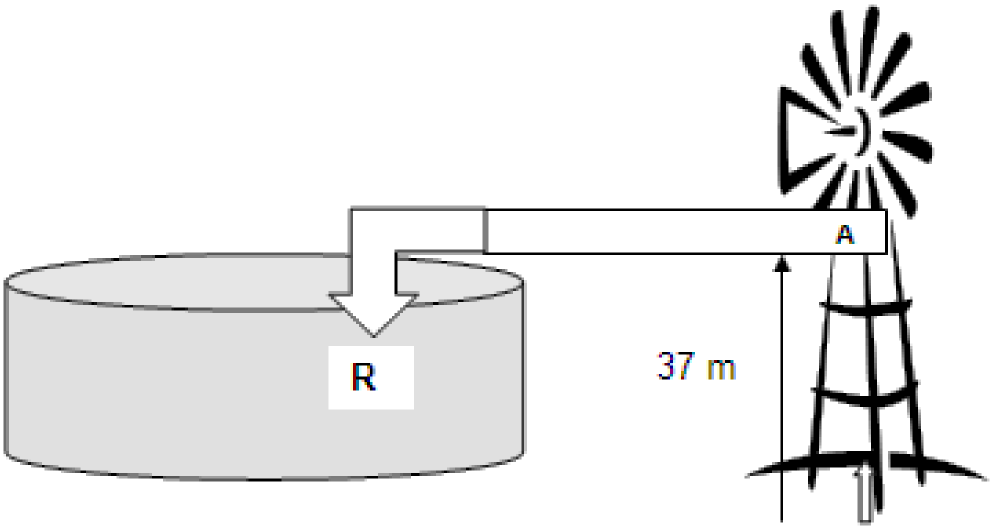
Describe the motion that the driver undergoes immediately after the collision. (1)

3.4 State the law of physics which can be used to explain your answer about the motion of the driver in QUESTION 3.3. (2)

[9]

QUESTION 4 (Start on a new page.)

A windmill is used on a farm to pump water out of a well that is 37 m deep. The water flows past point A, 37 m above the well to the dam with a constant velocity of 2 $m{\bullet}s^{-1}$.



4.1 Calculate how much energy is necessary to pump 90 kg of water out of the well to point **A**. (4)

4.2 It is necessary to pump 90 kg of water per minute. What is the maximum power that the windmill must produce? (3)

4.3 The farmer wants to modernise the farm. The farmer decides to buy a 0,5 kW petrol water pump.

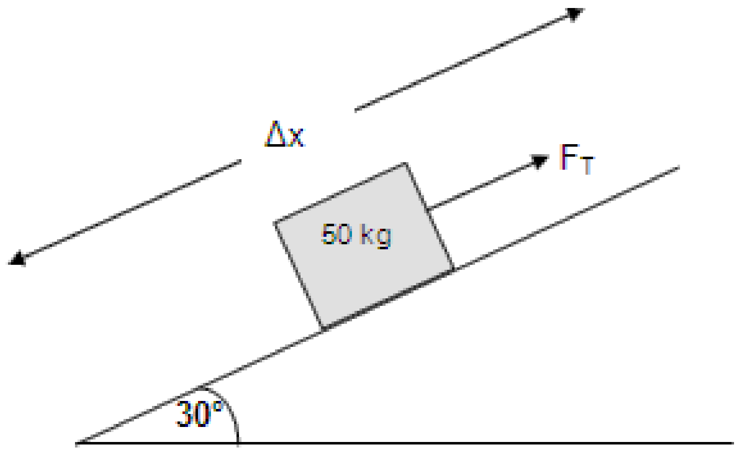
4.3.1 Will the petrol water pump be able to produce the required power? (YES or NO) (1)

4.3.2 Why would you advise the farmer to rather use a windmill instead of a petrol water pump? (1)

[9]

QUESTION 5 (Start on a new page.)

The diagram below shows a crate of mass 50 kg sliding down a steep slope. The slope makes an angle of 30° with the horizontal. The motion of the crate as it moves down the slope is controlled by a worker using a rope attached to the crate. The rope is held parallel to the slope. The tension in the rope, F_T, is 300 N and a constant frictional force of 50 N acts on the crate as it slides down the slope.



5.1 Draw a **labelled free-body diagram** showing the forces parallel to the slope acting on the crate as it moves down the slope. (3)

5.2 State the WORK-ENERGY THEOREM in words. (2)

5.3 The change in kinetic energy of the crate is 450 J as it slides from the top to the bottom of the slope.

Use the **work-energy theorem** to calculate the length of the slope, Δx. (5)

5.4 Calculate the coefficient of kinetic friction on the crate as it moves down the slope. (4)

[14]

QUESTION 6 (Start on a new page.)

An ambulance approaches an accident scene at a constant velocity. The siren of the ambulance emits sound waves with a constant, unknown frequency. A detector at the scene measures the frequency as 1,07 times the frequency of the siren.

6.1 State the DOPPLER EFFECT for sound in words. (2)

6.2 Calculate the speed at which the ambulance approaches the accident scene. Use the speed of sound in air as 340 $m \cdot s^{-1}$. (5)

6.3 Explain, in terms of wave motion, why the frequency detected by the detector is higher than the frequency of the source. (2)

6.4 State TWO uses of the Doppler flow meter in humans. (2)

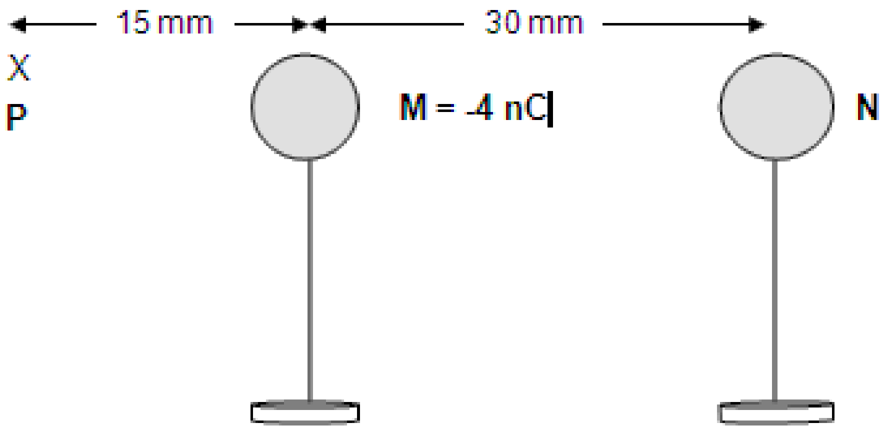
6.5 A line in a hydrogen spectrum has a frequency of $7,55 \times 10^{14}$ Hz when measured in a laboratory. The same line in the light of a star has a frequency of $7,23 \times 10^{14}$ Hz.

Is this star moving TOWARDS or AWAY from the Earth? Explain your answer. (2)

[13]

QUESTION 7 (Start on a new page.)

Two metal spheres, **M** and **N,** are on insulated stands. **M** with charge of -4 nC is placed 30 mm away from **N**. **P** is a point at a distance 15 mm from sphere **M** as shown below. The NET ELECTRIC FIELD STRENGTH at point **P** due to presence of **M** and **N** is 2×10^5 $N \cdot C^{-1}$ eastwards.



7.1 Define the term *ELECTRIC FIELD* at a point. (2)

7.2 Calculate the magnitude and direction of the electric field at point **P** due to the presence of sphere **M**. (5)

7.3 Calculate the magnitude of the charge on sphere **N**. (5)

7.4 Is the charge on sphere **N,** POSITIVE or NEGATIVE? (1)

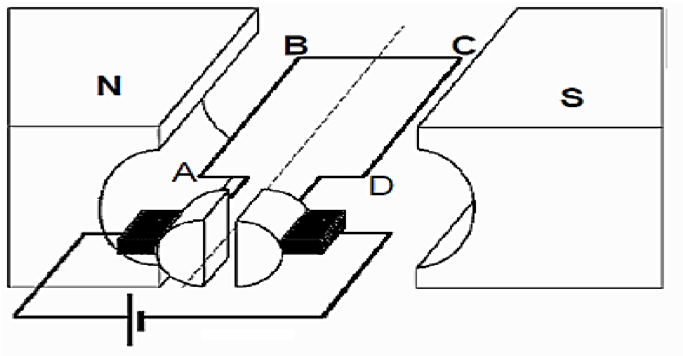
7.5 Sketch the net electric field pattern due to the two spheres, **M** and **N**. (3)

7.6 Calculate the magnitude of the electric force that an electron will experience when placed at point **P**. (3)

[19]

QUESTION 8 (Start on a new page.)

The simplified sketch below represents a DC motor.



8.1 Name the principle on which the motor operates. (1)

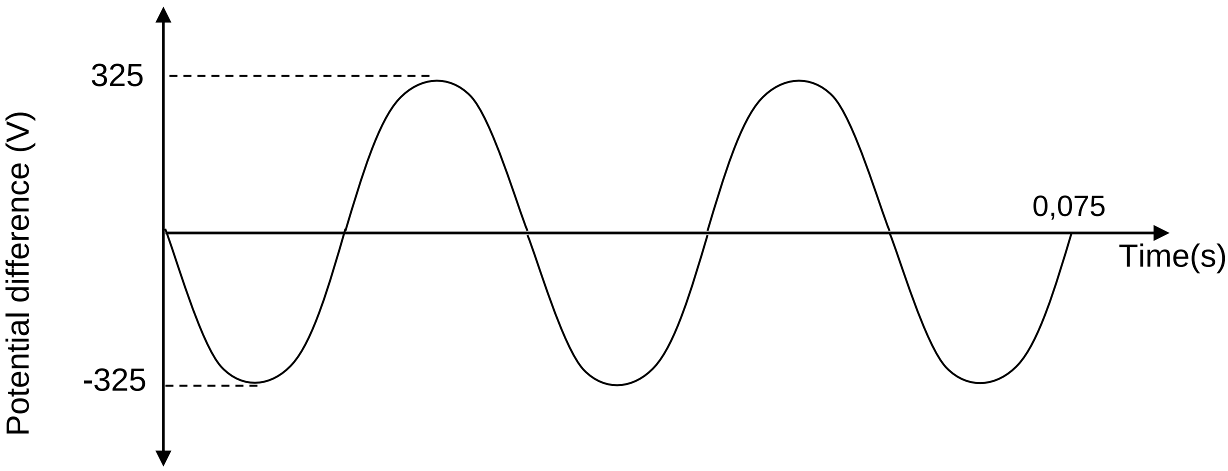
8.2 State the energy conversion which takes place in a DC motor. (1)

8.3 Give a reason why section BC in the above diagram does NOT experience a magnetic force whilst the coil is in the position as shown. (2)

8.4 In which direction will the coil rotate, CLOCKWISE or ANTI-CLOCKWISE? (1)

8.5 Write down ONE way in which the turning effect (torque) can be increased. (1)

8.6 The graph below shows how the alternating voltage, produced by the AC generator, varies with time.



8.6.1 Calculate the frequency of the alternating voltage. (3)

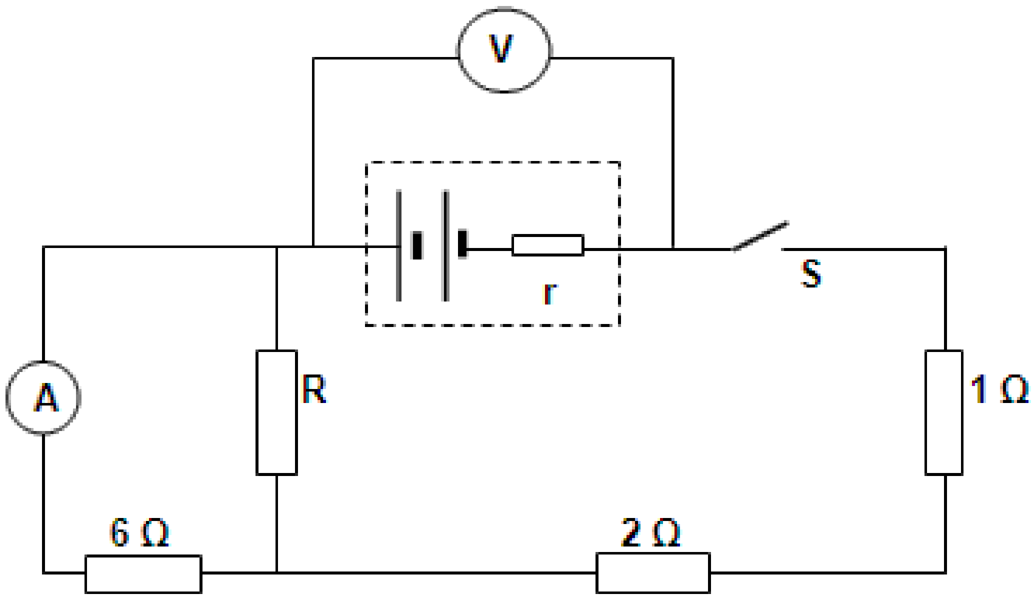
8.6.2 The generator's average power output is 2,7 kW. Calculate the maximum current that the generator produces. (5)

[14]

QUESTION 9 (Start on a new page.)

A learner wants to use a battery with an emf of 13 V to operate a walking doll. The battery has an unknown internal resistance of **r**. The walking doll has a resistance of 6 Ω. The learner uses the circuit below to obtain the potential difference required for the walking doll to function.

When switch **S** is closed, the reading on the voltmeter drops to 12 V and the walking doll functions at its maximum power of 6 W.



9.1 Explain briefly why the reading on the voltmeter drops when switch **S** is closed. (2)

9.2 Calculate the internal resistance, **r**, of the battery. Show all the steps in your calculations. (9)

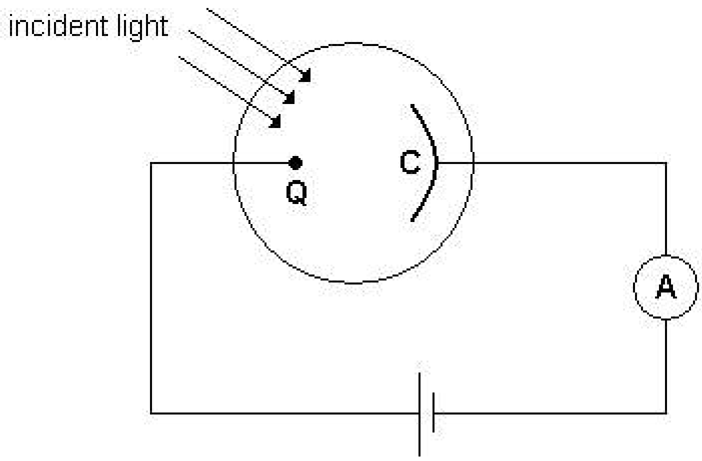
9.3 Calculate the magnitude of the unknown resistor, **R**. (3)

9.4 The resistor **R** is replaced with a conducting wire of negligible resistance. What effect will this have on the "lost volts"? Fully explain your answer. (4)

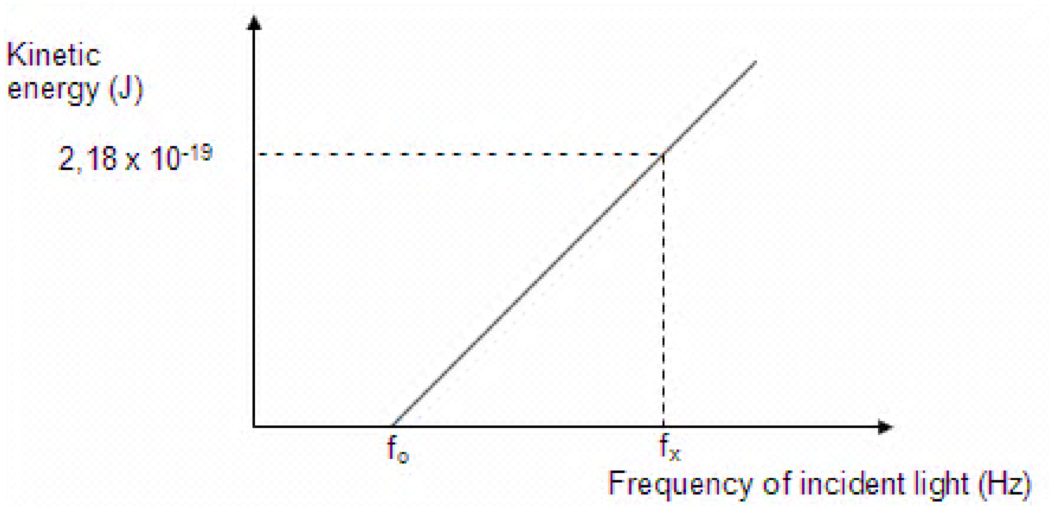
[18]

QUESTION 10 (Start on a new page.)

Learners in a physics class perform an experiment using a photo cell to investigate the relationship between photo electrons emitted and the frequency of the incident light.



A graph is plotted of the maximum kinetic energy (E_k) against the frequency of the incident light. When the straight line graph is extrapolated, it intercepts the x-axis at $f_o = 4{,}29 \times 10^{14}$ Hz.



10.1 Write an investigative question for this investigation. (2)

10.2 What is the frequency, f, in the graph called? (1)

10.3 Calculate the frequency, f_x, in the graph. (5)

10.4 Draw a sketch-graph of the **kinetic energy** of the photo-electrons (on the y-axis) **versus** the **intensity** of the incident light. (No values needed on the graph.) (3)

[11]

TOTAL: 150

QUESTION 1/*VRAAG 1*

1.1	D ✓✓	(2)
1.2	B ✓✓	(2)
1.3	B ✓✓	(2)
1.4	A ✓✓	(2)
1.5	D ✓✓	(2)
1.6	A ✓✓	(2)
1.7	B ✓✓	(2)
1.8	C ✓✓	(2)
1.9	C ✓✓	(2)
1.10	B ✓✓	(2)
		[20]

QUESTION 2/*VRAAG 2*

2.1

OPTION 1/*OPSIE 1* **DOWNWARDS AS POSITIVE** $v_f^2 = v_i^2 + 2g\Delta y$ ✓ $= 0^2 + 2(9,8)(15)$ ✓ $v_f = 17,15\ m{\cdot}s^{-1}$ ✓ (3) **OR/*OF*** **DOWNWARDS AS NEGATIVE** $v_f^2 = v_i^2 + 2g\Delta y$ ✓ $= 0^2 + 2(-9,8)(-15)$ ✓ $v_f = 17,15\ m{\cdot}s^{-1}$ ✓ (3)	**NOTES/*AANTEKENINGE*** **Accept/Aanvaar** ***g*** or/of ***a*** $v^2 = u^2 + 2a\Delta x$ $v^2 = u^2 + 2as$
OPTION 2/*OPSIE 2* **DOWNWARDS AS POSITIVE** $W_{net} = \Delta K$ ✓ $F_{net}\Delta y\cos\theta = ½m(v_f^2 - v_i^2)$ $m(9,8)(15)\cos 0^0 = ½m(v_f^2 - 0^2)$ ✓ $\therefore v_f = 17,15\ m{\cdot}s^{-1}$ ✓ (3) **OR/OF** **DOWNWARDS AS NEGATIVE** $W_{net} = \Delta K$ ✓ $F_{net}\Delta y\cos\theta = ½m(v_f^2 - v_i^2)$ $m(-9,8)(-15)\cos 0 = ½m(vf^2 - 0^2)$ ✓ $\therefore v_f = 17,15\ m{\cdot}s^{-1}$ ✓ (3) **OR/OF**	**NOTES/*AANTEKENINGE*** **Accept/Aanvaar:** $F_{net}\Delta x \cos\theta$ $W_{net} = \Delta E_k$
OPTION 4/*OPSIE 4* $F_{net} = ma$ ✓ $mg = \frac{m(v_f^2 - v_i^2)}{2\Delta x}$ $(0,156)(9,8) = \frac{0,156(v_f^2 - 0)}{15}$ ✓ $v_f = 17,15\ m{\cdot}s^{-1}$ ✓ (3) **OR/OF** **DOWNWARDS AS NEGATIVE** $F_{net} = ma$ ✓ $mg = \frac{m(v_f^2 - v_i^2)}{2\Delta x}$ $(0,156)(-9,8) = \frac{0,156(v_f^2 - 0)}{-15}$ ✓ $v_f = 17,15\ m{\cdot}s^{-1}$ ✓ (3)	**NOTES/*AANTEKENINGE*:** **Accept/*Aanvaar*:** ***g*** or/of ***a*** $v^2 = u^2 + 2a\Delta x$ $v^2 = u^2 + 2as$
OPTION 5/OPSIE 5 $\Delta y = v_i\Delta t + ½g\Delta t^2$ $15 = 0(\Delta t) + ½(9,8)\Delta t^2$ $\Delta t = 1,75\ s$ ✓ $v_f = v_i + g\Delta t$ $= 0 + 9,8(1,75)$ ✓ $= 17,15\ m.s^{-1}$ ✓	**NOTES/ *AANTEKENINGE*:** **Accept/Aanvaar:** ***g*** or/of ***a*** $s = ut + ½a\Delta t^2$ $v = u + at$

(3)

2.2 Lower/*Laer* ✓ (1)

2.3 **POSITIVE MARKING FROM QUESTION 2.1/**
POSITIEWE NASIEN VAN VRAAG 2.1

IF/INDIEN:
Downwards taken as negative in any one of QUESTION 2.3 and deduct only ONE mark at the first infringement.
Indicate at which question the mark is deducted by cancelling one tick and draw an upward arrow with positive sign next to it.

Afwaarts as negatief geneem in enige van VRAAG 2.3 en trek slegs EEN punt by die eerste oortreding af.
Dui aan by watter vraag die punt afgetrek is deur een reg merkie te kanselleer en trek 'n opwaartse pyl met 'n positiewe teken langsaan. ↑ +

2.3.1

DOWNWARDS AS POSITIVE	NOTES/ AANTEKENINGE
$v_f^2 = v_i^2 + 2g\Delta y$ ✓ 0^2 ✓ = $v_i^2 + 2(9,8)(-4)$ ✓ $v_i = 8,85\ m \cdot s^{-1}$ ✓ $F_{net}\Delta t = \Delta p$ $F_{net}\Delta t = m(v_f - v_i)$ } Any **ONE/**Enige **EEN** ✓ $\Delta p = (0,156)$ ✓ $(-8,85 - 17,15)$ ✓ $= -4,056\ kg \cdot m \cdot s^{-1}$ $= 4,06\ N \cdot s$ upwards/opwaarts ✓ (8) **DOWNWARDS AS NEGATIVE** $v_f^2 = v_i^2 + 2g\Delta y$ ✓ 0^2 ✓ = $v_i^2 + 2(-9,8)(4)$ ✓ $v_i = 8,85\ m \cdot s^{-1}$ ✓ $F_{net}\Delta t = \Delta p$ $F_{net}\Delta t = m(v_f - v_i)$ } Any **ONE/**Enige **EEN** ✓ $\Delta p = (0,156)$ ✓ $(8,85 - (-17,15))$ ✓ $= 4,056\ kg \cdot m \cdot s^{-1}$ $= 4,06\ N \cdot s$ upwards/opwaarts ✓ (8)	**Accept/Aanvaar** ***g*** or/of ***a*** $v^2 = u^2 + 2a\Delta x$ $v^2 = u^2 + 2as$

(8)

2.3.2 **POSITIVE MARKING FROM QUESTION 2.3.1/**
POSITIEWE NASIEN VAN VRAAG 2.3.1

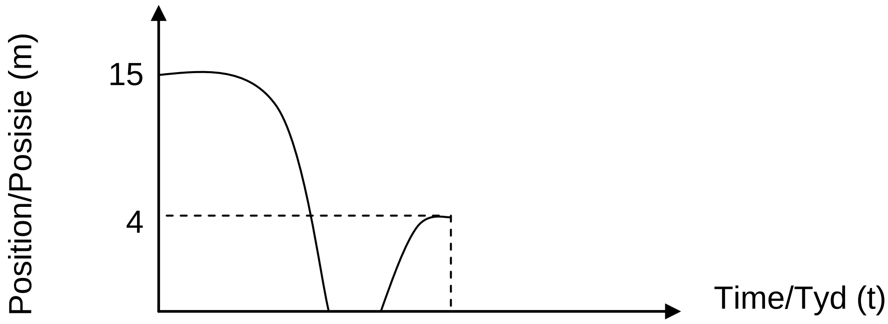
DOWNWARDS AS POSITIVE

$F_{net} = \frac{\Delta p}{\Delta t}$ ✓ $= -\frac{4,056}{0,80}$ ✓ $= -5,07$ N = 5,07 N upwards/opwaarts ✓ (4)

DOWNWARDS AS NEGATIVE

$F_{net} = \frac{\Delta p}{\Delta t}$ ✓ $= \frac{4,056}{0,80}$ ✓ $= 5,07$ N upwards/opwaarts ✓ (4)

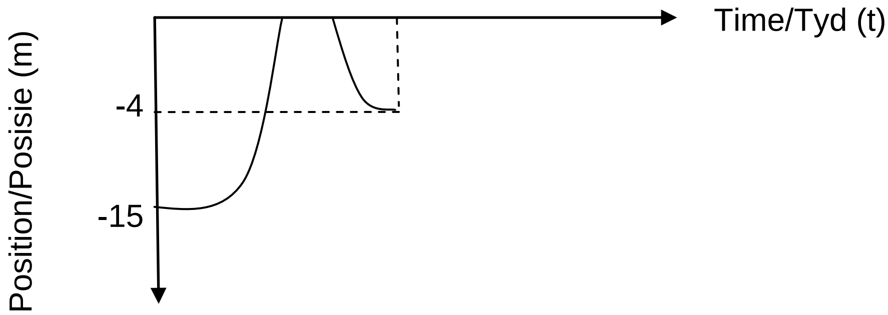
2.4 **DOWNWARD POSITIVE/AFWAARTS POSITIEF:**



Criteria for graph/Kriteria vir grafiek	**Marks/ Punte**
Correct shape (Both curves)/ *Korrekte vorm (Beide kurwes)*	✓
Graph starts at y = 15 m at t = 0 s *Grafiek begin by y= 15 m by t = 0 s*	✓
Second maximum height at y = 4 m *Tweede maksimum by y = 4 m*	✓
Contact time shown as space on x-axis between two curves *Kontak tyd aangetoon as spasie op x-as tussen twee krommes*	✓

(4)

DOWNWARD NEGATIVE/AFWAARTS POSITIEF:



Criteria for graph/Kriteria vir grafiek	**Marks/ Punte**
Correct shape (Both curves)/ *Korrekte vorm (Beide kurwes)*	✓
Graph starts at y = -15 m at t = 0 s *Grafiek begin by y= -15 m by t = 0 s*	✓
Second maximum height at y = -4 m *Tweede maksimum by y = -4 m*	✓
Contact time shown as space on x-axis between two curves *Kontak tyd aangetoon as spasie op x-as tussen twee krommes*	✓

(4)

2.5 SMALLER/KLEINER ✓

$F_{net} = \frac{\Delta p}{\Delta t}$

OR/OF

$F_{net} \propto \frac{1}{\Delta t}$ (Δp constant)

Δt increases/*neem toe* ✓

$\therefore F_{net}$ decreases/*neem af* (3)

[23]

QUESTION 3/VRAAG 3

3.1 The total linear momentum of a closed system remains constant (is conserved) ✓✓ or ✓
Total linear momentum before a collision = total linear momentum after a collision in a closed system. ✓
Die totale linieêre momentum in 'n geslote sisteem bly konstant (behoue).✓✓
Totale linieêre momentum voor 'n botsing = totale linieêre momentum na 'n botsing ✓ in 'n geslote sisteem. ✓ (2)

3.2 **Consider LEFT as positive/*Beskou LINKS as positief***
$\sum p_i = \sum p_f$
$m_M v_{iM} + m_C v_{iC} = m_M v_{fM} + m_C v_{fC}$ } ✓

$\underline{(2000)(20)} + (1\,500)(0)$ ✓ $= \underline{(2000)(12) + 1500 v_{fC}}$ ✓
$V_{f\,M} = 11\ m{\cdot}s^{-1}$ ✓ (4)

Other formulae/*Ander formules:*
$m_M v_{iM} + m_C v_{iC} = m_M v_{fM} + m_C v_{fC}$
or/of
$m_M u_M + m_C u_C = m_M v_M + m_C v_C$
or/of
$m_1 v_{i1} + m_2 v_{i2} = m_1 v_{f1} + m_2 v_{f2}$
or/of
$m_1 u_{i1} + m_2 u_{i2} = m_1 v_{f1} + m_2 v_{f2}$
$p_{total\ before} = p_{total\ after}$

Accept/Aanvaar: $p_{before} = p_{after}$ or/of $p_i = p_f$

3.3 The driver will continue moving foward at the same velocity until the driver strikes the dashboard or windscreen. ✓

Die bestuurder hou aan vorentoe beweeg teen dieselfde snelheid totdat die bestuurder die paneel of voorruit tref. ✓ (1)

3.4 A body will remain in its state of rest or motion at constant velocity✓ unless a non-zero resultant force acts on it. ✓

'n Liggaam sal in sy toestand van rus of beweging teen 'n konstante snelheid volhard,✓ *tensy 'n nie-nul resulterende krag daarop inwerk.*✓ (2)
[9]

QUESTION 4/*VRAAG 4*

4.1 $W = \Delta K + \Delta U$ ✓
$= \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_2 - h_1)$
$= \frac{1}{2}(90)(2^2 - 0^2)$ ✓ $+ (90)(9,8)(37)$ ✓
$= 32\ 814$ J ✓ (4)

4.2 **POSITIVE MARKING FROM QUESTION 4.1/**
POSITIEWE NASIEN VAN VRAAG 4.1

$P = \frac{W}{t}$ ✓
$= \frac{32\ 814}{1 \times 60}$ ✓
$= 546,9$ W ✓ (3)

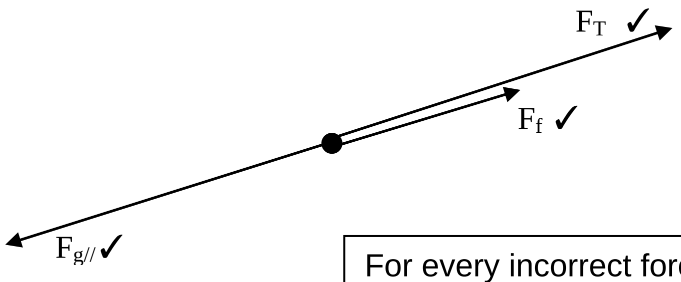
4.3 4.3.1 No/*Nee* ✓ (1)

4.3.2 Windmill is more environmental friendly. ✓ (Or similar)
Windpomp is meer omgewingsvriendelik. ✓ *(Of soortgelyk)* (1)
[9]

QUESTION 5/*VRAAG 5*

Accepted Labels/*Aanvaarbare Benoemings*	
$F_{applied}$ *$F_{toegepas}$*	F_T/T/Force on crate/F_A/Tension/300 N *F_T/T/Krag op krat/F_A/Spanning/300 N*
Friction *Wrywing*	F_f/$F_{friction}$/friction *F_f/$F_{wrywing}$/wrywing*
$F_{g//}$	$F_{//}$/mg sin 30°/F_g sin 30°/$F_{W//}$

5.1



For every incorrect force shown (-1 mark)
Vir enige verkeerde krag getoon (-1 punt) (3)

5.2 The net (total) work done (on an object) ✓is equal to the change in kinetic energy (of the object). ✓ **OR**
The work done (on an object) by a net (resultant) force ✓is equal to the change in (the object's) kinetic energy. ✓

Die netto (totale) arbeid (verrig op 'n voorwerp) ✓ is gelyk aan die verandering in kinetiese energie (van die voorwerp) ✓ **OF**
Die arbeid verrig (op 'n voorwerp) deur 'n netto (resulterende) krag ✓ is gelyk aan die verandering in kinetiese energie (van die voorwerp). ✓ (2)

5.3 **OPTION 1/*OPSIE 1***

$W_{NET} = \Delta K$
$W_{Fg} + W_{FT} + W_{Ff} + W_{FN} = \Delta K$ } ✓Any one/*Enige een*

$F_g\Delta x\cos\theta + F_f\Delta x\cos\theta + F_T\Delta x\cos\theta + 0 = 450$

$\underline{(50)(9,8)\Delta x\cos 60°}$ ✓ + $\underline{50\Delta x\cos 180° + 300\Delta x\cos 180°}$ ✓ = 450 ✓

$(245 - 50 - 300)\Delta x = 450$

$\Delta x = 4,29$ m ✓ (5)

OPTION 2/*OPSIE 2*

$W_{NET} = \Delta K$
$W_{Fg//} + W_{Ff} + W_{FT} + W_{FN} + W_{Fg\perp} = \Delta K$ } ✓ Any one/*Enige een*

$F_{g//}\Delta x\cos\theta + F_f\Delta x\cos\theta + F_T\Delta x\cos\theta + 0 + 0 = 450$

$\underline{(50)(9,8)\sin 30°\Delta x\cos 0°}$ ✓ + $\underline{50\Delta x\cos 180° + 300\Delta x\cos 180°}$ ✓ = 450 ✓

$(245 - 50 - 300)\Delta x = 450$

$\Delta x = 4,29$ m ✓ (5)

OPTION 3/*OPSIE 3*

$F_{net} = F_T + F_f + W_{//}$
$= 300 + 50 - mg\sin 30°$
$= \underline{300 + 50 - (50)(9,8)\sin 30°}$ ✓
$= 105$

✓Both formulae/Albei formules

$F_{net}\Delta x\cos\theta = \Delta K$
$\underline{105\Delta x\cos 0°}$ ✓ = 450 ✓
$\Delta x = 4,29$ m ✓ (5)

5.4 $f_k = \mu_k N$
$= \mu_k(mg\cos\theta)$ } ✓ Any ONE/Enige EEN

50 ✓ = $\mu_k(50)(9,8)\cos 30°$ ✓

$\mu_k = 0,12$ ✓ (4)

[14]

QUESTION 6/*VRAAG 6*

6.1 The Doppler Effect is the perceived change in frequency of sound caused by either the listener or the source moving relative to each other. ✓✓

Die Dopplereffek is die waargenome verandering in frekwensie van 'n klank wat veroorsaak deurdat óf die luisteraar óf die bron met betrekking tot mekaar beweeg. ✓✓ (2)

6.2

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$1,07 f_s$ ✓ = $\frac{340}{340 - v_s}$ ✓ f_s ✓

$v_s = 22,24\ m{\cdot}s^{-1}$ ✓ (5)

6.3 Ambulance moves towards detector, with constant velocity (speed) of sound,✓ λ decreases and the frequency increases. ✓

Ambulans beweeg na die detektor met konstante snelheid (spoed) van klank,✓ λ neem af en frekwensie neem toe.✓ (2)

6.4
- Determine whether arteries are clogged/narrowed ✓
- Determine heartbeat of fetus✓

- *Bepaal of are verstop/vernou is.* ✓
- *Bepaal die hartklop van 'n fetus* ✓ (2)

6.5 AWAY/*WEG* ✓
Light from a star is shifted towards a lower frequency (red light has the lowest frequency). ✓
Die ster se lig word verskuif na 'n laer frekwensie (rooi lig besit die laagste frekwensie.) ✓ (2)

[13]

QUESTION 7/*VRAAG 7*

7.1 (Electrostatic) force experienced per unit positive charge placed at a point. ✓✓

(Elektrostatiese) krag wat per eenheidspositiewe-lading by daardie punt geplaas is, ondervind word.✓✓ (2)

7.2 $E = \frac{kQ_M}{r^2}$ ✓ $= \frac{(9 \times 10^9)(-4 \times 10^{-9})}{(15 \times 10^{-3})^2}$ ✓✓ $= 1{,}6 \times 10^5 N \cdot C^{-1}$ ✓ east/*oos*✓ (5)

7.3 $E_{net} = E_M + E_N$
2×10^5✓ $= 1{,}6 \times 10^5 + E_N$✓
$E_N = 4{,}5 \times 10^5 N \cdot C^{-1}$ east/*oos*✓

NOTES/AANTEKENINGE
Mark direction independently./*Merk rigting onafhanklik*.

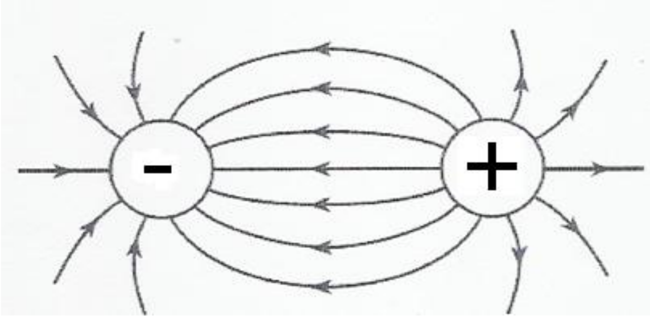
$E_N = \frac{kQ_N}{r^2}$

$4{,}5 \times 10^5 = \frac{(9 \times 10^9)Q_N}{(45 \times 10^{-3})^2}$ ✓

$Q_N = 9 \times 10^{-9}$ C east/*oos* ✓ (5)

7.4 Positive/*Positief*✓ (1)

7.5 **POSITIVE MARKING FROM QUESTION 7.4**
POSITIEWE NASIEN VANAF VRAAG 7.4



Criteria for sketch:/*Kriteria vir skets*:	**Marks/Punte**
Correct shape *Korrekte vorm*	✓
Correct direction *Korrekte rigting*	✓
Field lines not touching each other or entering the spheres. *Veldlyne raak nie mekaar nie of wat die sfere binnegaan*.	✓

(3)

7.6 $E = \frac{F}{q}$ ✓

$2 \times 10^5 = \frac{F}{1,6 \times 10^{-19}}$ ✓

$F = 3,2 \times 10^{-4}$ N✓ (3)

[19]

QUESTION 8/VRAAG 8

8.1 Motor effect/*Motor-effek* ✓ (1)

8.2 Electrical (energy) to mechanical (energy) ✓
Elektriese (energie) na meganiese (energie) ✓ (1)

8.3 Current in section BC is parallel ✓ to the magnetic field. ✓
Stroom in gedeelte BC is parallel ✓*aan die magneetveld.* ✓ (2)

8.4 ANTI-CLOCKWISE/ANTI-*KLOKSGEWYS* ✓ (1)

8.5 Increase the speed of rotation/
Increase the number of turns in the coil.
Increase the strength of the magnetic field
} ANY ONE ✓

Verhoog spoed van rotasie.
Vermeerder die aantal windings van die spoel. ✓
Verhoog die magnetiese veldsterkte.
} *ENIGE EEN* ✓ (1)

8.6.1 $T = \frac{0{,}075 \times 2}{5}$ ✓
$= 0{,}03$ s
$f = \frac{1}{T}$
$= \frac{1}{0{,}03}$ ✓
$= 33{,}3$ Hz ✓

OR/*OF*

$f = \frac{\text{no of cycles}}{\text{time}}$ ✓ $= \frac{2{,}5}{0{,}075}$ ✓ $= 33{,}3$ Hz ✓

$f = \frac{\text{aantal siklusse}}{\text{tyd}}$ ✓ $= \frac{2{,}5}{0{,}075}$ ✓ $= 33{,}3$ Hz ✓ (3)

8.6.2

OPTION 1/*OPSIE 1*

$P_{ave} = V_{rms}I_{rms}$ ✓
$= \left(\frac{V_{max}}{\sqrt{2}}\right)\left(\frac{I_{max}}{\sqrt{2}}\right)$ } ✓ BOTH formulae/*ALBEI formules*

$2\ 700$ ✓ $= \left(\frac{325}{\sqrt{2}}\right)$ ✓ $\left(\frac{I_{max}}{\sqrt{2}}\right)$

I_m $I_{max} = 16{,}62$ A ✓ (5)

OPTION 2/*OPSIE 2*

$P_{ave} = \frac{V_{max} I_{max}}{2}$ ✓✓ ✓

$2\ 700$ ✓ $= \frac{(325)I_{max}}{2}$ ✓

$I_{max} = 16{,}62$ A ✓ (5)

OPTION 3/*OPTION 3*

✓ $V_{rms} = \frac{V_{max}}{\sqrt{2}} = \frac{325}{\sqrt{2}}$ ✓ $= 229{,}80$ V

$P_{ave} = V_{rms}\frac{I_{max}}{\sqrt{2}}$

$2\ 700$ ✓ $= (229{,}80)\frac{I_{max}}{\sqrt{2}}$ ✓

$I_{max} = 16{,}62$ A ✓ (5)

[14]

QUESTION 9/*VRAAG 9*

9.1 The battery has internal resistance ✓ therefore work per Coulomb charge must be done by charges to move through the battery. ✓

Die battery het interne weerstand ✓daarom word arbeid per Coulomb lading deur ladings verrig om deur die battery te beweeg. ✓ (2)

9.2 **OPTION 1/*OPSIE 1***

$P = I^2R$ ✓

$6 = I^2(6)$

$I = 1\ A$

$V_{6\Omega} = IR = 1(6) = 6V$ ✓

$V_{3\Omega} = 12 - 6 = 6\ V$ ✓

$I_{3\Omega} = \frac{V}{R} = \frac{6}{3}$ ✓ $= 2\ A$ ✓

$\varepsilon = IR + Ir$ ✓

$13 = 12 + 2r$ ✓

$r = 0,5\ \Omega$ ✓ (9)

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$ ✓

$6 = \frac{V^2}{6}$ ✓

$V = 6V$ ✓

$6V + Ir + 3I = 13$ ✓

$6 + 1 + 3I = 13$ ✓

$3I = 6$

$I = 2A$ ✓

Lost/*Verlore volt*: $Ir = 1$ ✓

$2r = 1$ ✓

$r = ½\ \Omega$ ✓ (9)

9.3 $R = \frac{V}{I}$ ✓ $= \frac{6}{1}$ ✓ $= 6\ \Omega$ ✓ (3)

9.4 Increases/*Vermeerder* ✓

Total Resistance decreases/*Totale Weerstand verminder* ✓

Current increases/*Stroom vermeerder* ✓

Ir increases/*Ir vermeerder* ✓ (4)

[18]

QUESTION 10/*VRAAG 10*

10.1 What is the relationship between the frequency of the incident light and the number of photo electrons emitted?
Wat is die verwantskap tussen die frekwensie van die invallende lig en die aantal foto-elektrone wat vrygestel word?

CRITERIA for investigation question: ***KRITERIA vir ondersoekende vraag*:**	**Mark/*Punt***
The dependent and independent variables are stated. *Die afhanklike en onafhanklike veranderlikes is genoem.*	✓
Asks a question about the relationship between dependent and independent variables. *Vra 'n vraag oor die verwantskap tussen afhanklike en onafhanklike veranderlikes.*	✓

(2)

NOTES/*AANTEKENINGE*

A question that results in a "YES" or "NO" answer MAX. ½
'n Vraag wat "JA" of "NEE" as antwoord het MAKS. ½

10.2 Cut-off frequency/Threshold frequency ✓
Afsnyfrekwensie/Drumpelfrekwensie ✓ (1)

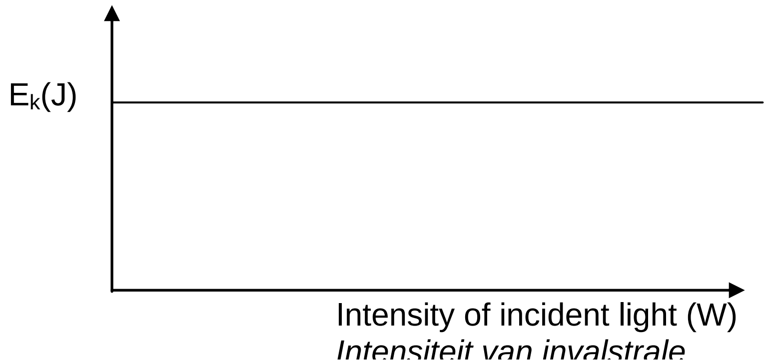
10.3 $hf_x = W_o + E_K$
$hf_x = hf_0 + E_K$ } ✓ ANY one/*ENIGE een*

$(6,63 \times 10^{-34}) f_x$ ✓ $= (6,63 \times 10^{-34})(4,29 \times 10^{14})$ ✓ $+ (2,18 \times 10^{-19})$ ✓

$$f_x = \frac{5,02 \times 10^{-19}}{6,63 \times 10^{-34}}$$

$= 7,58 \times 10^{14}$ Hz ✓ (5)

10.4



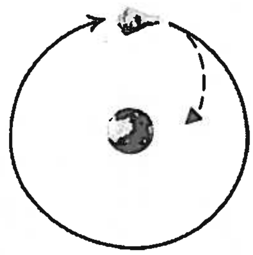
CRITERIA/KRITERIA	**MARK/*PUNT***
Correct unit and labels/*Korrekte beskrywings en eenhede*	✓
Correct shape/*Korrekte vorm*	✓✓

(3)
[11]

TOTAL/TOTAAL: 150

QUESTION 3 (Begin on a new page.)

The diagram below shows a spaceship, mass 3 500 kg, travelling in the vacuum in space in an orbit around the earth at a constant speed.



3.1 Name and define in words the law in Physics that explains the continuous orbiting of the spaceship around the earth at a constant speed in the vacuum of space. (3)

3.2 The spaceship is orbiting in a *closed system*. Explain in words the meaning of this statement. (2)

The rocket engines are now ignited and exert a force of 12 000 N for 30 s on the spaceship to redirect and accelerate it back to earth.

3.3 Calculate the change in the velocity of the spaceship. (3)

The spaceship, with the rocket engines switched off, strikes the earth's atmosphere vertically at a speed of 800 $m \cdot s^{-1}$ and decelerates to a speed of 100 $m \cdot s^{-1}$ within 20 s before it lands in the sea.

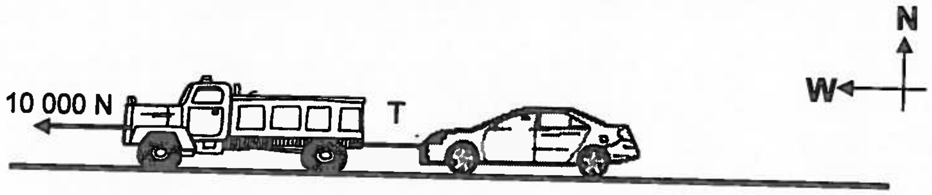
3.4 Draw a labelled free body diagram to indicate all the forces acting on the spaceship when it enters the earth's atmosphere vertically. (2)

3.5 Calculate the magnitude of the average frictional force acting on the spaceship when it moves through the earth's atmosphere. (5)

[15]

QUESTION 4 (Begin on a new page.)

The diagram below shows a truck of mass 1500 kg, and a broken down car of mass 500 kg, connected with a towing rod. The coefficient of static friction is 0,35 and the coefficient of kinetic friction 0,2 for both the car and the truck.



4.1 Define Newton's second law of motion. (3)

4.2 Calculate the magnitude of the minimum force needed to get the car to start moving. (3)

The engine of the truck exerts a force of 10 000 N on the truck causing the truck-car system to experience a constant acceleration of 3,04 $m \cdot s^{-2}$.

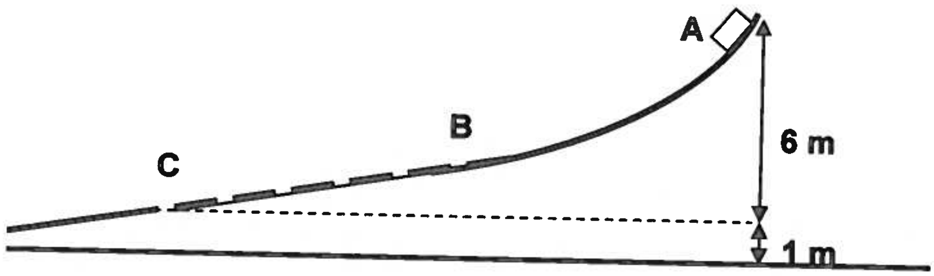
4.3 Draw a labelled free-body diagram showing ALL the HORIZONTAL forces acting on the truck. (3)

4.4 Calculate the magnitude of the force (T) in the towing rod. (5)

[14]

QUESTION 5 (Begin on a new page.)

A 3 kg metal block moves from rest at point **A** down an incline as shown in the diagram below and reaches a speed of 6 m·s^{-1} at **B**. Section **AB** of the path is frictionless.



5.1 Would you describe the movement of the block on section **AB** of the path as free fall? Give a reason for your answer. (2)

5.2 Calculate the net work done on the block as it moves down section **AB** of the path. (3)

5.3 Calculate the height of the block at position **B**. (4)

5.4 On reaching point **B**, the block continues to move down section **BC** of the path which is 5 m in length. The block now experiences a frictional force and reaches point **C** at a speed of 2 m·s^{-1}.

Use the principle of the conservation of energy to calculate the magnitude of the frictional force acting on the block as it moves down section **BC** of the path. (5)

[14]

QUESTION 6 (Begin on a new page.)

Light emitted from distant stars demonstrates the phenomenon known as red shift.

6.1 Briefly describe what is meant by the *red shift* in light emitted from distant stars. (2)

6.2 A line in the hydrogen absorption spectrum has a frequency of $3,6 \times 10^{14}$ Hz when measured in a laboratory. The same line in the absorption spectrum of a distant star has a frequency of $3,4 \times 10^{14}$ Hz. Is the star moving away from or coming towards the earth? Give a reason for your answer. (2)

6.3 A racing car, with its headlights on, is approaching a spectator standing next to a track, at a constant speed of 280 $km \cdot h^{-1}$. The engine produces sound of frequency 1200 Hz.

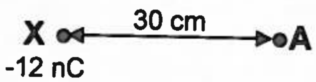
6.3.1 Briefly explain why there is no observed colour change in the light from the headlights of the racing car while approaching a spectator. (2)

6.3.2 Calculate the frequency of the sound as heard by the spectator. (4)

[10]

QUESTION 7 (Begin on a new page.)

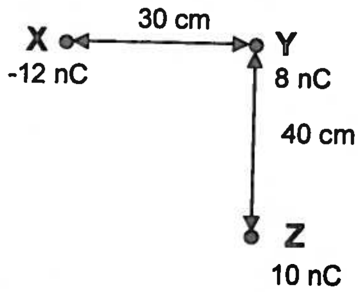
In the diagram below, point charge **X** has a charge of -12 nC. **A** is a point 30 cm from point charge **X**.



7.1 Define an electric field at a point in space. (2)

7.2 Calculate the magnitude of the electric field at point **A** due to point charge **X**. (3)

A second point charge **Y**, carrying a charge of 8 nC, is now placed at position **A** and a third point charge **Z**, carrying a charge of 10 nC, is placed at a distance of 40 cm from **Y** as shown below.



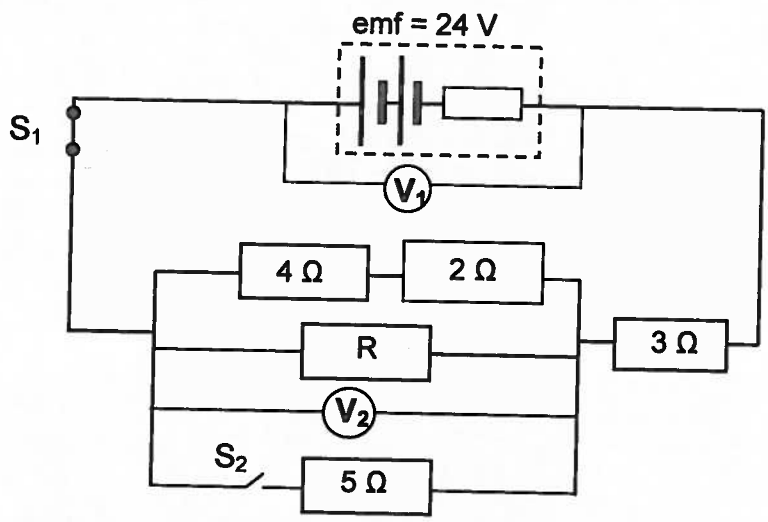
7.3 Draw a vector diagram to indicate the electrostatic forces exerted by point charges **X** and **Z** on point charge **Y**. (2)

7.4 If the magnitude of the electrostatic force exerted by point charge **X** on point charge **Y** equals $9,6 \times 10^{-6}$ N, calculate the net electrostatic force exerted by point charges **X** and **Z** on point charge **Y**. (6)

[13]

QUESTION 8 (Begin on a new page.)

In the circuit diagram below, resistors are connected in parallel as well as in series. The battery has an emf of 24 V and an internal resistance of 1,0 Ω. When switch S_1 is closed the reading on V_1 is 21,0 V.



8.1 Explain, in words, the meaning of a *potential difference of 21 V.* (2)

8.2 Calculate the:

8.2.1 Reading on voltmeter V_2 (4)

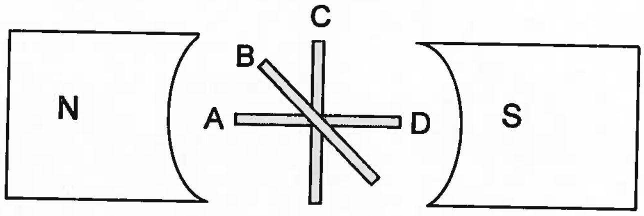
8.2.2 Power dissipated by resistor R (8)

8.3 Switch S_2 is now closed. How will the power dissipated by the 3 Ω resistor be affected? (Write down only INCREASE, DECREASE or STAYS THE SAME). Explain the answer. (4)

[18]

QUESTION 9 (Begin on a new page.)

9.1 The diagram below demonstrates the principle for the generation of electricity. Four positions of the coil, **A**, **B**, **C** and **D** are shown.



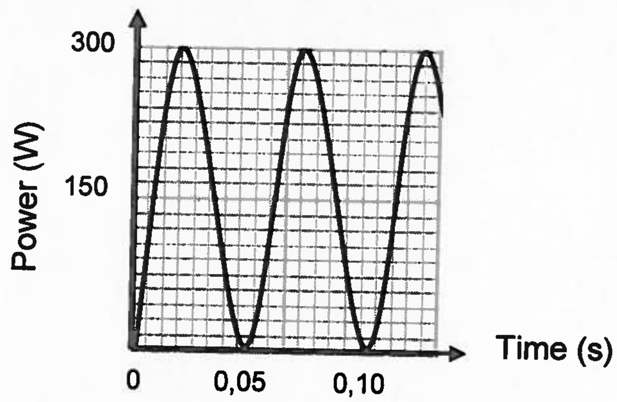
9.1.1 On what principle does a generator work? (1)

9.1.2 Is the magnetic flux passing through the coil at position **C** a MAXIMUM or a MINIMUM? (1)

9.1.3 At which position of the coil's rotation cycle will the maximum emf be induced? (Write only **A**, **B** or **C**.) Give an explanation to your answer. (3)

9.1.4 Sketch a graph of emf versus position of the coil for a clockwise rotation from **A** to **D**. Indicate the positions **A**, **B**, **C** and **D** on the graph. (4)

9.2 The graph below shows the power delivered by an **AC** source versus time. The peak/maximum voltage generated by the **AC** source is 80V.



9.2.1 Name ONE advantage of alternating current. (1)

Calculate:

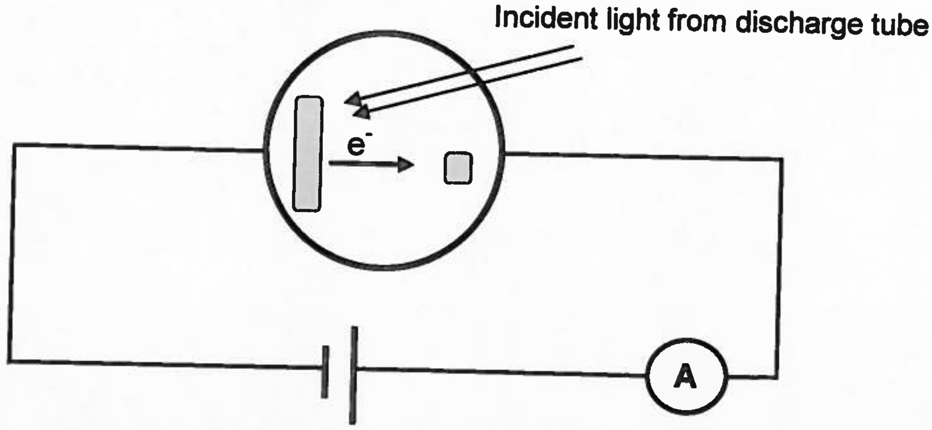
9.2.2 The rms current induced by the AC source (5)

9.2.3 The frequency delivered by the AC source (3)

[18]

QUESTION 10 (Begin on a new page.)

10.1 A blue light filter is placed in front of a hydrogen discharge tube and the blue light is shone onto a photocell. An ammeter reading is recorded.



10.1.1 What type of spectrum is produced by the hydrogen discharge tube? (1)

10.1.2 Name one apparatus that you will need to make the spectrum produced by the hydrogen discharge tube visible to the human eye. (1)

10.2 The blue filter is removed and replaced by a red light filter. No ammeter reading is recorded. Explain this observation. (2)

10.3 The cut-off (threshold) frequency of the metal used in the photo cell is $1{,}1 \times 10^{15}$ Hz. The discharge tube is removed and the photo cell is radiated with green light of wavelength 450 nm.

10.3.1 Define the cut-off frequency of a metal. (2)

10.3.2 Will you observe an ammeter reading? Show all necessary calculations to indicate how you have arrived at the answer. (5)

[11]

TOTAL SECTION B: 130
GRAND TOTAL: 150

SECTION A

QUESTION 1/*VRAAG 1*

1.1 C ✓✓ (2)

1.2 D ✓✓ (2)

1.3 C ✓✓ (2)

1.4 C ✓✓ (2)

1.5 D ✓✓ (2)

1.6 D ✓✓ (2)

1.7 B ✓✓ (2)

1.8 B ✓✓ (2)

1.9 D ✓✓ (2)

1.10 D ✓✓ (2)
[20]

TOTAL SECTION A/*TOTAAL AFDELING A*: 20

SECTION B/*AFDELING B*

QUESTION 2/*VRAAG 2*

2.1.1

Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$v_f = v_i + a\Delta t$ ✓ $\underline{0 = 30}$✓ + - 9,8Δt Δt = 3,06 s✓	$v_f = v_i + a\Delta t$ ✓ $\underline{0 = -30}$✓ + 9,8Δt Δt = 3,06 s✓

(3)

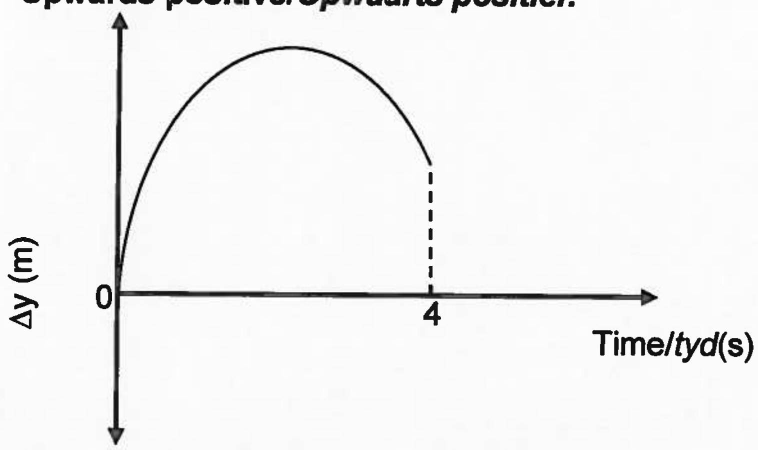
2.1.2

Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ = 30(4) ✓ + ½(-9,8)(4)^2✓ = 41,6 m Height /Hoogte= 41,6 m✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ = - 30(4) ✓ + ½(9,8)(4)^2✓ = - 41,6 m Height/Hoogte = 41,6 m✓

(4)

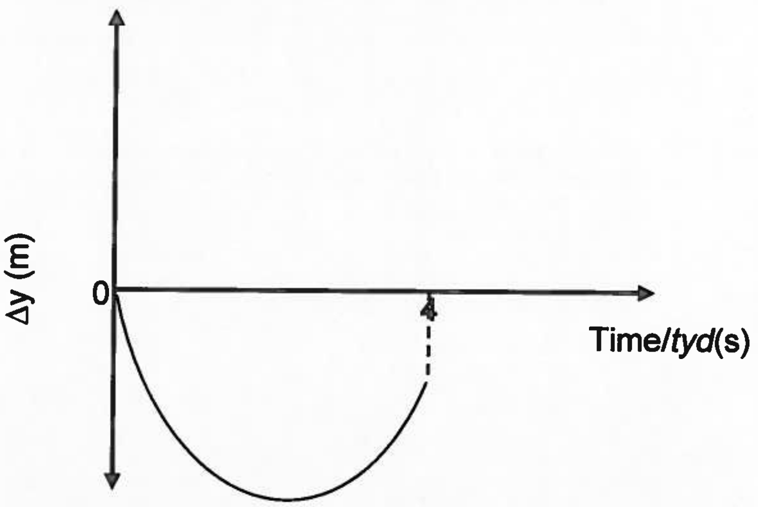
2.2 **<u>OPTION 1/*OPSIE 1*</u>**

Upwards positive/*Opwaarts positief:*



Criteria for graph/*Kriteria vir grafiek:*	**Marks/ *Punte***
Shape of first part of graph up till maximum height. *Vorm van eerste deel van grafiek tot by maksimum hoogte.*	✓
Shape of second part of graph and above zero height at t = 4 s. *Vorm van tweede deel van grafiek en bokant zero hoogte by t = 4 s*	✓
Ground not zero position (provided everything else is correct): ½ *Grond nie zero posisie (indien die res korrek is): ½*	(2)

OPTION 2/*OPSIE 2*
Downwards positive/*Afwaarts positief:*



Criteria for graph/*Kriteria vir grafiek:*	**Marks/ *Punte***
Shape of first part of graph up till maximum height. *Vorm van eerste deel van grafiek tot by maksimum hoogte.*	✓
Shape of second part of graph and above zero height at t = 4 s. *Vorm van tweede deel van grafiek en bokant zero hoogte by t = 4 s*	✓
Ground not zero position (provided everything else is correct): ½ *Grond nie zero posisie (indien die res korrek is): ½*	(2)

2.3

Positive marking from 2.1.2/ Positiewe merk vanaf 2.1.2.	**Positive marking from 2.1.2/ Positiewe merk vanaf 2.1.2**
Upwards positive/*Opwaarts positief:* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = (24)^2 + 2(-9,8)\Delta y$ ✓ Δy = 29,39 m Total dispalcement = -41,6 + ✓29,39 *Totale verplasing* = - 12.21 m = 12.21 m✓ downwards✓/*afwaarts*	**Downwards positive/*Afwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0 = (-24)^2 + 2(9,8)\Delta y$ ✓ Δy = -29,39 m Total dispalcement = 41,6 - ✓ 29,39 *Totale verplasing* = 12,21 m ✓ downwards✓/*afwaarts*

(5)

2.4 Inelastic✓
The velocity/speed with which the ball bounces from the ground is less than/differs from the velocity/speed at which the ball strikes the ground. ✓
The kinetic energy is not conserved/changes. ✓

Onelasties
Die snelheid/spoed waarmee die bal vanaf die grond bons is minder as/verskillend van die snelheid waarmee dit die grond tref.
Die kinetiese energie word dus nie behou nie/verander. (3)

[17]

QUESTION 3/*VRAAG 3*

3.1 Newton's First Law of motion. ✓ A body will remains in its state of rest or motion at constant velocity✓ unless a non-zero resultant/net force acts on it.✓

Newton se Eerste bewegingswet. 'n Liggaam sal in sy toestand van rus of konstante snelheid beweging volhard tensy 'n nie-nul resultante/netto krag daarop inwerk. (3)

3.2 A system in which no net external forces are acting on the spaceship.✓✓

'n Sisteem waarin geen netto eksterne kragte op ruimtetuig inwerk nie. (2)

3.3

$F_{net}\Delta t = \Delta p$

$F_{net}\Delta t = mv_f - mv_i$ ✓

$(12\ 000)(30)$ ✓ $= 3500(v_f - v_i)$

$\Delta v = 102{,}86\ m\cdot s^{-1}$ ✓ (3)

3.4

$f/F_f/F_{friction}$/friction✓/$F_{wrywing}$, *wrywing*

F_g/w/weight/force of gravity✓/*gewig,gravitasiekrag* (2)

3.5

$F_{net} = ma$ ✓
$w + f = ma$

$(3500)(9{,}8)$ ✓ $+ f = 3500\left(\frac{100-800}{20}\right)$ ✓✓

$f = -156\ 800\ N$

$\therefore f = 156\ 800\ N$ ✓ (5)

[15]

QUESTION 4/*VRAAG 4*

4.1 Newton's Second Law of motion. ✓ When a resultant/net force acts on an object, the object will accelarates in the direction of the net force at an accelaration which is directly proportional to ✓the force and inversly proportional to the mass of the object. ✓

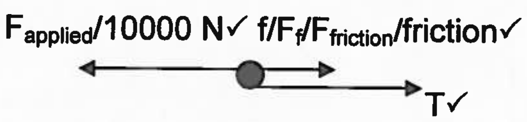
Newton se Tweede bewegingswet. Indien 'n resulterende/netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die netto krag met 'n versnelling wat direk eweredig is aan die krag en omgekeerd eweredig aan die massa van die voorwerp. (3)

4.2 $f_{s(max)} = \mu_s F_N$ ✓

$= \underline{0,35(500)(9,8)}$ ✓

$= 1715$ N ✓ (3)

4.3



(3)

4.4 Left positive: /links *positief:*

Car: $F_{net} = ma$ ✓

$T + f = ma$

T ✓ $- (0,2)(500)(9,8)$ ✓$= 500(3,04)$✓

$T = 2500$ N✓

OR/*OF*

Truck/*Trok*: $F_{net} = ma$ ✓

$F_{applied}/F_{toegepas} + T + f = ma$

$10\ 000$ ✓ $+ T - (0,2)(1500)(9,8)$ ✓$= 1\ 500(3,04)$✓

$T = -2500$ N

$\therefore T = 2500$ N✓ (5)

[14]

QUESTION 5/*VRAAG 5*

5.1 Yes, ✓ no other forces other than the gravitational force is acting on the block.✓

Ja, geen ander krag behalwe gravitasiekrag werk op die blok in nie. (2)

5.2 $W_{net} = \Delta K$ ✓
$= \underline{½(3)(6^2) - 0}$ ✓
$= 54$ J ✓ (3)

5.3

OPTION 1/ OPSIE 1	**OPTION 2/ OPSIE 2**
$(U + K)_A = (U + K)_B$ ✓ $\underline{(3)(9.8)(6) + 0}$✓ $= \underline{(3)(9.8)h + ½(3)(6^2)}$ ✓ h = 4,16 m✓	$W_{net} = \Delta E_k/\Delta K$ ✓ $(3)(9,8)\Delta y\cos 0°$ ✓$= \underline{½(3)(6^2) - 0}$✓ Δy = 1,84 m ∴ h = 6 – 1,84 = 4,16 m✓

(4)

Positive marking from 5.3/ Positiewe merk vanaf 5.3

5.4

OPTION 1/ OPSIE 1

$W_{nc} = \Delta U + \Delta K$ ✓/ $W_{nc} = \Delta E_p + \Delta E_k$
$(f)(5)\cos 180°$✓ $= \underline{(3)(9.8)(1) - (3)(9.8)(4.16)}$ ✓ $+ \underline{½ (3)(2)^2 - ½ (3)(6)^2}$ ✓
f = 28,18 N ✓

OPTION 2/ OPSIE 2

$W_{net} = \Delta E_k/\Delta K$ } ✓
$W_f + W_g = \Delta K$
$(f)(5)\cos 180°$✓ $+ \underline{(3)(9.8)(4.16 - 1)\cos 0°}$ ✓$= ½ (3)(2)^2 - ½ (3)(6)^2$ ✓
f = 28,18 N ✓

(5)
[14]

QUESTION 6/*VRAAG 6*

6.1 Red shift is a shift in the spectra of distant stars ✓towards the longer wave lengths/red end of the spectrum.✓

Rooi verskuiwing is `n verskuiwing in die spektra van verafgeleë sterre na die langer golflengte/rooi kant van die spektrum. (2)

6.2 Moving away from the earth✓
The wavelength of the light coming from the distant star has increased/ shift towards longer wavelengths. ✓

Beweeg weg van die aarde af.
Die golflengte van die lig komende van die ster het toegeneem/verskuif na die langer golglengtes. (2)

6.3.1 The difference between the speed of the car and the speed of light is very large.✓ The frequency shift/increase is too small to observe.✓

Die verskil tussen die spoed van die kar en die van lig is baie groot. Die frekwensieskuif toename is dus te klein om waar te neem. (2)

6.3.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ***OR/OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

$\therefore f_L = \frac{340}{340 - 77,78}$ ✓ (1200) ✓

$= 1555,95$ Hz ✓ (4)

[10]

QUESTION 7/*VRAAG 7*

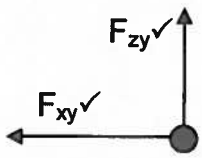
7.1 Electrostatic force experienced✓per unit positive charge✓ at that point./*Die elektrostatiese krag ervaar per eenheid positiewe lading by daardie punt.* (2)

7.2 $E_1 = \frac{kQ}{r^2}$ ✓

$= \frac{9 \times 10^9 \times 12 \times 10^{-9}}{0,3^2}$ ✓

$= 1,2 \times 10^3$ N.C^{-1} ✓ (3)

7.3



Note: No deduction of marks for labels.
***Let wel**: Geen punte aftrek vir byskrifte nie.* (2)

7.4 $F_{ZY} = \frac{kQ_YQ_Z}{r^2}$ ✓

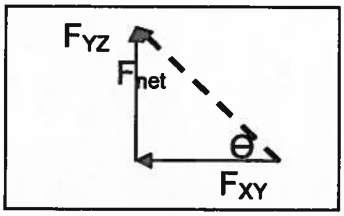
$= \frac{9 \times 10^9 \times 8 \times 10^{-9} \times 10 \times 10^{-9}}{0,4^2}$ ✓

$= 4,5 \times 10^{-6}$ N

$F_{net}^2 = F_{XY}^2 + F_{ZY}^2$

$= (9,6 \times 10^{-6})^2 + (4,5 \times 10^{-6})^2$ ✓

$F_{net} = 1,06 \times 10^{-5}$ N



$\tan \Theta = \frac{4,5 \times 10^{-6}}{9,6 \times 10^{-6}}$ ✓

$\Theta = 25,11^\circ$

$\therefore F_{net} = 1,06 \times 10^{-5}$ N ✓, 295,11°/ 25,11° North of West/Noord van wes
25,11° upwards from negative x-axis ✓/*opwaarts vanaf negatiewe x - as* (6)

[13]

QUESTION 8/*VRAAG 8*

8.1 21 J of work done /energy transfered✓per coulomb/unit charge✓ that is moved between two points in an electric field./ *21 J arbeid verrig/energie oorgedra per coulomb/eenheid lading wat tussen twee punte in `n elektriese veld beweeg.* (2)

8.2.1

$I = \frac{V_i}{r}$ ✓

$= \frac{3}{1}$ ✓ ← $V_i = 24 - 21 = 3\ V$

$= 3A$

$V = IR$

$= (3)(3)$ ✓

$= 9V$

$V_2 = 21 - 9$

$= 12V$ ✓

(4)

8.2.2

Positive marking from 8.2.1/ *Positiewe merk vanaf 8.2.1* **OPTION 1 / *OPSIE 1***	**OPTION 2 / *OPSIE 2***
$R = \frac{V}{I}$ $= \frac{21}{3}$ ✓ $= 7\ \Omega$ $R_p = 7 - 3$ ✓ $= 4\Omega$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\frac{1}{4}$ ✓ $= \frac{1}{6} + \frac{1}{R}$ ✓ $\therefore R = 12\ \Omega$ $V_p = 21 - 9$ $= 12\ V$ $P = \frac{V^2}{R}$ $P = \frac{12^2}{12}$ ✓ ✓ $= 12\ W$ ✓	$E = I(R + r)$ $24 = 3(R + 1)$ ✓ $R = 7\ \Omega$ $R_p = 7 - 3$ ✓ $= 4\Omega$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\frac{1}{4}$ ✓ $= \frac{1}{6} + \frac{1}{R}$ ✓ $\therefore R = 12\ \Omega$ Ratio of current in parallel branches:2:1/*Verhouding van stroom in parallelle vertakking: 2:1* $I_R = 1\ A$ $P = IR^2$ $= (1)$ ✓ (12) ✓ $= 12\ W$ ✓

(8)

8.3 Increase✓/*vergroot*
Total resistance in circuit decrease.✓/*Totale weerstand in stroombaan verklein.*
Total current increase✓ (and through 3 Ω resistor)./*Totale stroom vegroot*
Therefore: Power increase according to $P = I^2R$ for R (3Ω) staying constant.✓/
Daarom: Drywing vergroot ooreenstemmend met $P = I^2R$ vir R (3 Ω) bly konstant. (4)

[18]

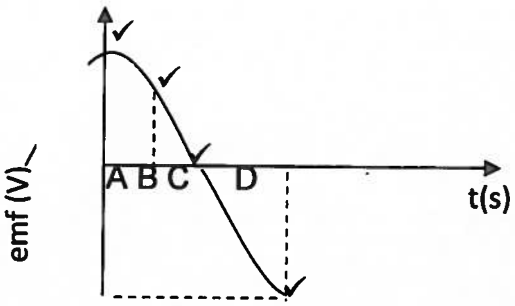
QUESTION 9/*VRAAG 9*

9.1.1 Electromagnetic Induction✓/*elektromagnetiese induksie* (1)

9.1.2 Maximum✓/ maksimum (1)

9.1.3 A✓
The rate of change in the magnetic flux✓ is a maximum✓ at position C./ *Die tempo van verandering in die magnetiese vloed is `n maksimum by punt C.* (3)

9.1.4



Mirror image of graph also correct.
Spieëlbeeld van grafiek ook korrek.

(4)

9.2.1 AC voltages can be stepped up or down by making use of transformers✓for different users. OR
Electrical energy can be transmitted over long distances✓ with low current and high voltage. (ANY ONE)
WS spanning kan m.b.v transformators verhoog of verlaag word vir verskillende vebruikers OF
Elektriese energie kan oor lang afstande oorgedra word deur lae stroom en hoë spanning. *(ENIGE EEN)* (1)

9.2.2 $P_{max} = V_{max}I_{max}$ ✓
300 ✓ $= 80(I_{max})$ ✓
$(I_{max}) = 3{,}75$ A

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$
$$= \frac{3{,}75}{\sqrt{2}} \checkmark$$
$= 2{,}65$ A✓ (5)

9.2.3
$$T = \frac{1}{f} \checkmark$$
$$= \frac{1}{0{,}05} \checkmark$$
$= 20$ Hz✓

(3)
[18]

QUESTION 10/*VRAAG 10*

10.1.1 Line emission (spectrum)✓/*Lynemissie(spektrum)* (1)

10.1.2 Driffraction grating✓ / *Diffraksierooster*
Prism / Prisma
(Any one/ Enige een) (1)

10.2 The frequency of red ✓light is smaller than the threshold frequency✓of the metal used in photo cell. / *Die frekwensie van rooi lig is kleiner as die drumpelfrekwensie van die metaal gebruik in fotosel.*
OR/OF
The energy of the photon of red light is lower✓ than the work function ✓of the metal used in photo cell./ *Die energie van die foton van rooi lig is minder as die werksfunksie vir die metaal gebruik in fotosel.* (2)

10.3.1 The minimum energy✓ needed for an electron to be set free from the surface of a metal.✓/ *Die minimum energie nodig om 'n elektron uit die oppervlak van 'n metaal vry te stel.* (2)

10.3.2

OPTION 1 / *OPSIE 1*	**OPTION 1 / *OPSIE 1***
$E = hf_0$ ✓	$c = \lambda f$✓
$= (6{,}63 \times 10^{-34})(1{,}1 \times 10^{15})$✓	3×10^8✓ $= \times 10^{-9}$ (f) ✓
$= 7.29 \times 10^{-19}$ J	$f = 6.67 \times 10^{14}$
$E = h\frac{c}{\lambda}$	$f_0 = 1{,}1 \times 10^{15}$ (given/*gegee*)
$= \frac{6{,}63 \times 10^{-34} \times 3 \times 10^8}{450 \times 10^{-9}}$ ✓	No, ✓ $f_{photon}/f_{foton} < f_0$ (cut-off f)✓
$= 4{,}42 \times 10^{-19}$ J	
No, ✓ E_{photon}/E_{foton} < Work Function✓/*Werksfunksie*	

(5)

[11]

TOTAL SECTION B/*TOTAAL AFDELING B*: 130

GRAND TOTAL/*GROOTTOTAAL*: 150

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GAUTENGSE DEPARTEMENT VAN ONDERWYS
VOORBEREIDENDE EKSAMEN

2014

10841

FISIESE WETENSKAPPE

EERSTE VRAESTEL

PUNTE: **150** **Bladsye 23**
TYD: **3 uur**

FISIESE WETENSKAPPE: Vraestel 1
1084A
10841A
X10

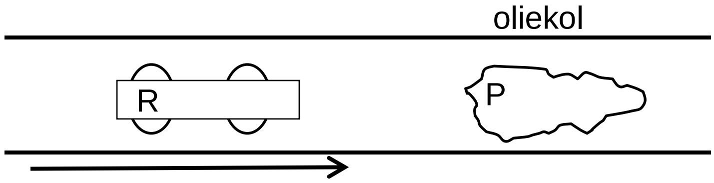
12

b.o.

VRAAG 1: MEERVOUDIGEKEUSE-VRAE

Vier opsies word as moontlike antwoorde vir die volgende vrae gegee. Elke vraag het slegs EEN korrekte antwoord. Skryf slegs die letter (A–D) langs die vraagnommer (2.1–2.10) in die ANTWOORDEBOEK neer.

1.1 Die volgende diagram toon ’n renmotor R wat in ’n reguit lyn na regs ry.



Die bestuurder van die renmotor trap rem sodra die motor die oliekol by posisie P bereik.

In watter van die volgende rigtings sal die renmotor R gly?

A

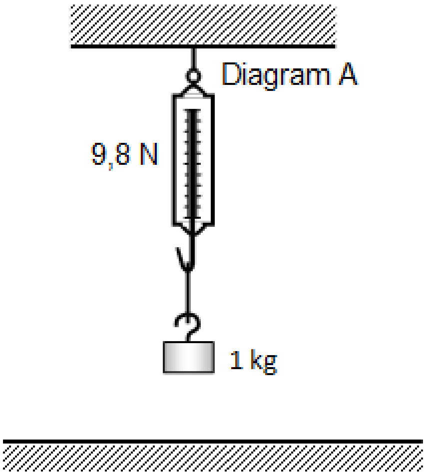

B


C

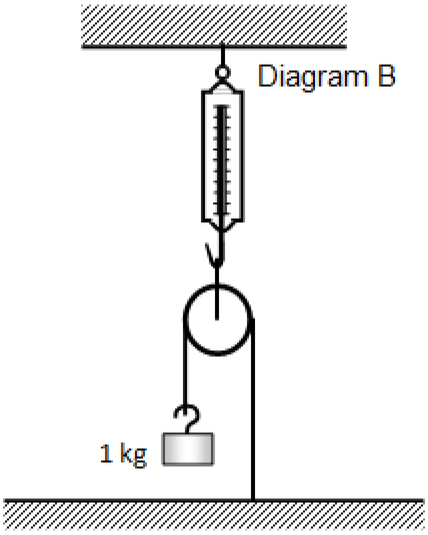

D


(2)

1.2 'n Massa van 1 kg hang aan 'n Newton-trekskaal wat aan die plafon vasgemaak is, soos in diagram A.



In diagram B word dieselfde 1 kg-massastuk vanaf 'n gewiglose, wrywinglose katrol gehang deur die tou aan die grond vas te maak.



Indien die lesing op die skaal in diagram A 9,8 N is, wat is die lesing op die skaal in diagram B?

A 4,9 N

B 9,8 N

C 14,7 N

D 19,6 N (2)

1.3 Die gravitasiekrag tussen twee voorwerpe is **F** wanneer hulle middelpunte 'n afstand **d** uitmekaar is. Wat sal die grootte van die krag in terme van **F** wees indien die massa van een voorwerp verdubbel en die afstand **d** halveer?

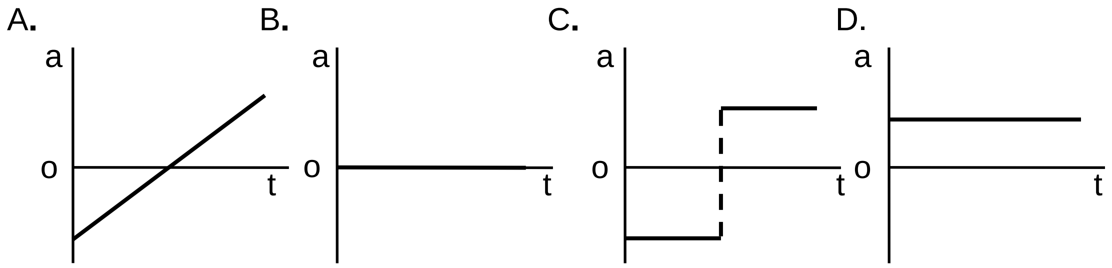
A **8F**

B **F**

C $\frac{1}{2}$**F**

D $\frac{1}{8}$**F** (2)

1.4 'n Voorwerp het 'n momentum **p** vir 'n tydperk van **t** sekondes. Watter EEN van die volgende grafieke stel die versnelling-tyd verband vir hierdie tydinterval korrek voor?



1.5 Watter EEN van die volgende stellings in verband met die rooiverskuiwing van lig as gevolg van die Doppler-effek is waar?

A Indien 'n bron van blou lig weg van die waarnemer beweeg, sal die lig violet vertoon

B Indien 'n bron van rooi lig weg van die waarnemer beweeg, sal die lig blou vertoon

C Indien 'n bron van blou lig weg van die waarnemer beweeg, sal die lig meer groen vertoon

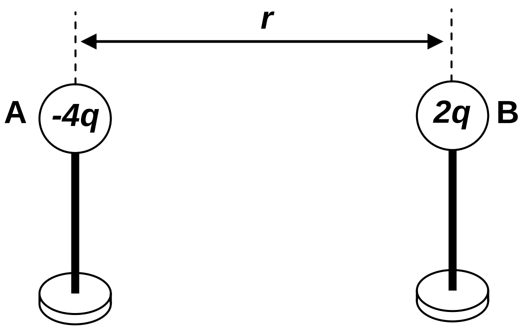
D Indien 'n bron van rooi lig weg van die waarnemer beweeg, sal die lig meer oranje vertoon (2)

1.6 Watter EEN van die volgende kombinasies is korrek ten opsigte van die eienskappe van elektriese veldlyne?

	Rigting	Sterkte van die veld
A	Positief na negatief	Sterkste waar die digtheid van die lyne die digste is
B	Negatief na positief	Swakste waar die digtheid van die lyne die minste is
C	Noord na suid	Sterkste waar die digtheid van die lyne die digste is
D	Noord na suid	Swakste waar die digtheid van die lyne die minste is

(2)

1.7 Twee gelaaide sfere, A en B, word op geïsoleerde staanders op 'n afstand ***r*** van mekaar af geplaas, soos hieronder getoon. Die grootte van die elektrostatiese krag tussen hulle is ***F***.



Die sfere word toegelaat om aan mekaar te raak en word weer op hulle oorspronklike posisies teruggeplaas. Die grootte van die elektrostatiese krag in terme van ***F*** is nou …

A $8F$

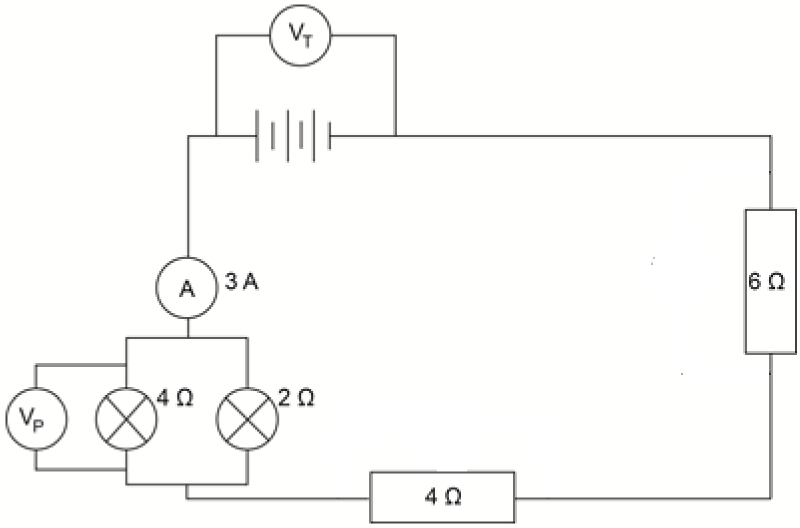
B F

C $\frac{1}{2}F$

D $\frac{1}{8}F$

(2)

1.8 Die stroombaan-diagram toon twee gloeilampe met weerstande van 4 Ω en 2 Ω elk in parallel geskakel in die stroombaan. Die twee resistors met weerstande van 4 Ω en 6 Ω elk is in serie in die stroombaan geskakel.



Indien die 2 Ω-gloeilamp uitbrand, wat gebeur met die lesing op V_P?

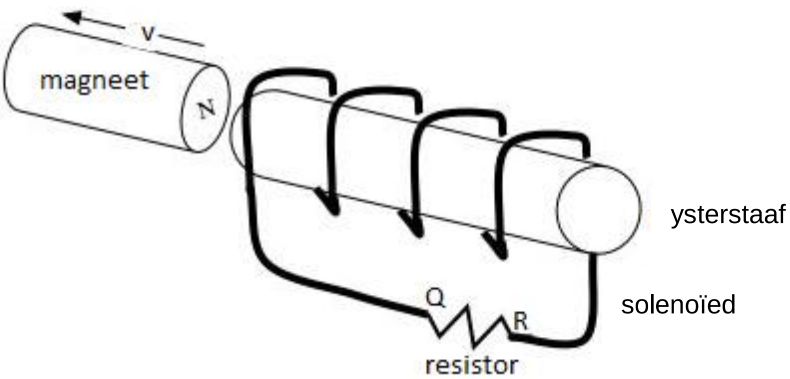
A Bly dieselfde

B Neem af

C Neem toe

D Word nul (2)

1.9 Die magneet in die volgende diagram beweeg weg van die solenoïed. Die geïnduseerde stroom vloei deur die resistor in ’n rigting van ...



A Q na R

B R na Q

C Q na R en dan van R na Q

D R na Q en dan van Q na R (2)

1.10 'n Opgewekte elektron is in energievlak 3. Die maksimum moontlike emissiespektrum-lyne wat hierdie elektron kan opwek is …

A 1

B 2

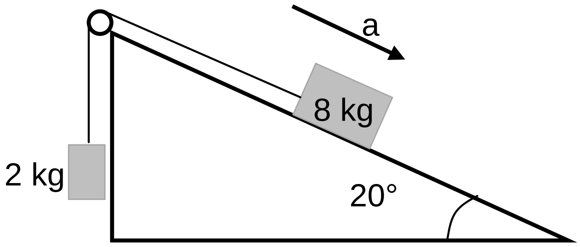
C 3

D 4 (2)

[20]

VRAAG 2 (Begin op 'n nuwe bladsy.)

'n 8 kg-houtblok is vasgemaak aan 'n 2 kg-houtblok met 'n gewiglose, onelastiese tou wat oor 'n wrywinglose katrol beweeg. Die blok versnel afwaarts teen 'n rowwe skuinsvlak met 'n helling van 20° ten opsigte van die horisontaal soos hieronder aangetoon.



Die spanning in die tou is 21 N.

2.1 Definieer *versnelling*. (2)

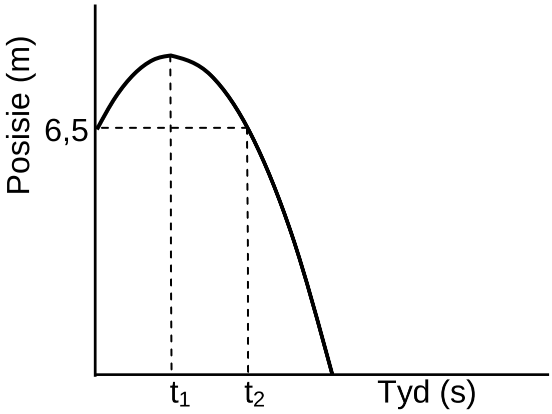
2.2 Teken 'n benoemde kragtediagram van al die kragte wat op die 8 kg-blok inwerk. (3)

2.3 Bewys met 'n berekening dat die grootte van die versnelling van die sisteem 0,7 $m \cdot s^{-2}$ is. (3)

2.4 Bereken die grootte van die wrywingskrag wat die 8 kg-blok ervaar. (4)
[12]

VRAAG 3 (Begin op 'n nuwe bladsy.)

Die posisie-tydgrafiek vir 'n tennisbal wat vertikaal opwaarts vanaf die tweede vloer van 'n skoolgebou gegooi word, word hieronder getoon.
Ignoreer alle effekte van lugweerstand.



Die hoogte van die tweede vloer is 6,5 m. Die bal styg 0,9 m bokant die beginposisie voordat die bal afwaarts begin val.

3.1 Skryf die grootte en rigting van die versnelling van die bal neer terwyl dit opwaarts beweeg. (2)

3.2 Bereken die tyd t_1 wat dit die bal neem om sy maksimum hoogte te bereik. (4)

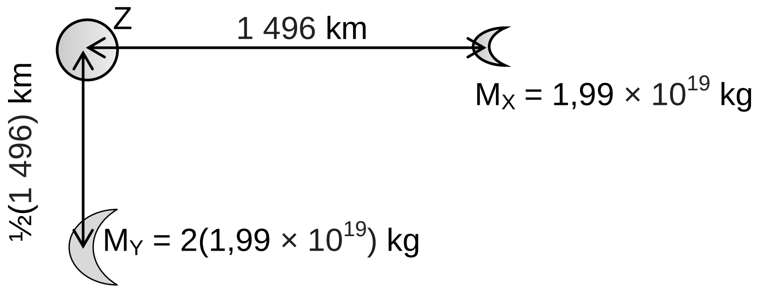
3.3 Bereken die beginsnelheid van die tennisbal die oomblik wat dit losgelaat word. (4)

3.4 Skets 'n snelheid-tydgrafiek vir die beweging van die bal van die oomblik dat dit vertikaal opwaarts gegooi word totdat dit die grond bereik. Benoem die asse en toon al die relevante waardes op die grafiek aan. (4)

[14]

VRAAG 4 (Begin op 'n nuwe bladsy.)

Die diagram hieronder toon 'n planeet Z en sy twee mane X en Y wat reghoekig ten opsigte van mekaar is. Die gemiddelde afstand tussen die middelpunt van die planeet en maan X is 1 496 km en die gemiddelde afstand tussen die middelpunt van die planeet en maan Y is ½(1 496) km.



Neem die massa van X as $1,99 \times 10^{19}$ kg, die massa van die planeet Z as $5,98 \times 10^{24}$ kg en die massa van Y as twee keer die massa van X.

4.1 Bereken die gravitasiekrag tussen maan X en planeet Z. (4)

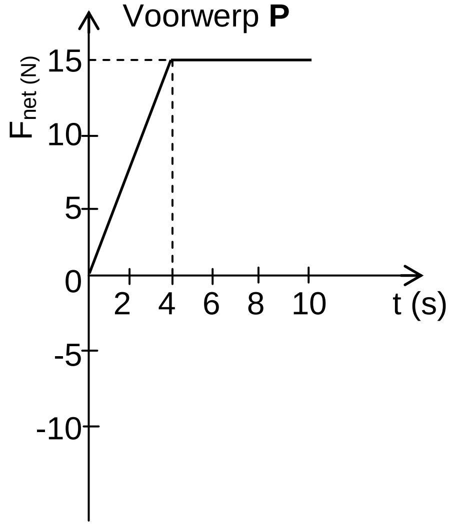
4.2 Skryf die grootte van die gravitasiekrag wat maan Y op planeet Z uitoefen neer. (2)

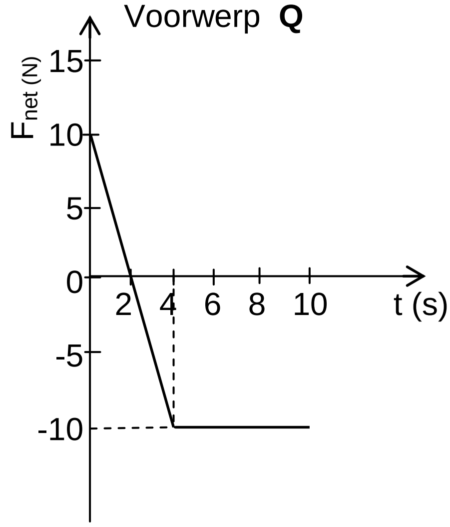
4.3 Bereken die grootte van die netto gravitasiekrag wat die twee mane op die planeet uitoefen. (2)

[8]

VRAAG 5 (Begin op 'n nuwe bladsy.)

Twee identiese voorwerpe **P** en **Q**, elk met 'n massa 12 kg, beweeg langs mekaar teen 'n aanvanklike snelheid van 5,5 $m \cdot s^{-1}$ oos op 'n horisontale oppervlakte.
Die volgende grafieke toon die netto krag wat deur elke voorwerp onderskeidelik gedurende dieselfde tydinterval ervaar word.





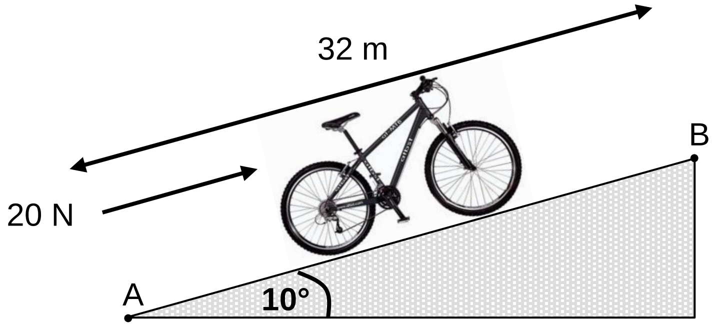
5.1 Bereken die totale impuls wat voorwerp **Q** ervaar in 10 s. (3)

5.2 Vergelyk sonder enige berekening, die totale impuls van voorwerp **P** met dié van voorwerp **Q**. Skryf slegs GROTER AS, KLEINER AS of DIESELFDE AS neer. (1)

5.3 Bereken die eindsnelheid van voorwerp **Q**. (4)
[8]

VRAAG 6 (Begin op ‘n nuwe bladsy.)

’n Fietsryer stoot sy fiets met massa 6,1 kg teen ’n bult op met ’n krag van 20 N. Die fiets word van ’n beginsnelheid van 5 $m \cdot s^{-1}$ van punt A na punt B gestoot. Die helling van die pad is 10° ten opsigte van die horisontaal en die afstand van A na B is 32 m soos hieronder voorgestel.



Die padoppervlakte oefen ’n wrywingskrag van 11 N uit op die bande van die fiets.

6.1 Bereken die arbeid wat die fietsryer op die fiets verrig. (3)

6.2 Gebruik die arbeid-energie stelling en bereken die grootte van die snelheid van die fiets by 32 m. (5)

6.3 Verduidelik hoekom wrywingskragte as nie-konserwatiewe kragte beskou word. (2)

[10]

VRAAG 7 (Begin op ’n nuwe bladsy.)

7.1 Keenan, wat by die bopunt van die Leunende Toring van Pisa staan, laat per ongeluk sy selfoon val wanneer dit begin lui teen ’n frekwensie van 497×10^3 Hz. Die hoogte van die toring is 56 m.

7.1.1 Gebruik die wet van behoud van meganiese energie en bereken die spoed van die selfoon op ’n hoogte van 18 m. (4)

Nerisse staan by die voet van die toring en hoor hoe die selfoon lui terwyl dit in haar rigting val. Ignoreer die effekte van lugweerstand.

7.1.2 Bereken die frekwensie van die klank wat deur Nerisse waargeneem word wanneer die selfoon op ’n hoogte van 18 m bokant die grond is. Neem die spoed van klank in lug as 340 m·s^{-1}. (4)

7.1.3 Verduidelik in terme van golflengte en frekwensie van klank, hoekom sal Keenan, wat bo-op die toring is, ’n laer frekwensie van klank waarneem as die waarde wat in VRAAG 7.1.2 bereken is. (2)

7.1.4 Hoe sal die frekwensie van die klank wat Nerisse waarneem vergelyk op ’n hoogte van 18 m met dié op ’n hoogte van 3 m? Skryf slegs HOËR, LAER of BLY DIESELFDE neer. (1)

7.2 Spoedkameras bepaal die spoed van ’n motor deurdat dit die sein van ’n radiogolf wat deur die motor gereflekteer word, meet.

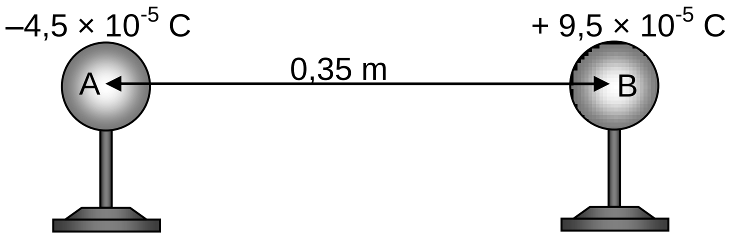
7.2.1 Verduidelik hoekom die spoedkamera nie die spoed van ’n motor akkuraat kan meet op die oomblik wat die motor verby die kamera beweeg nie. (2)

7.2.2 Wat is die spoed van die radiogolf in lug? Gee ’n rede vir jou antwoord. (2)

[15]

VRAAG 8 (Begin op 'n nuwe bladsy.)

Die diagram hieronder toon twee sfere, A met 'n lading $-4,5 \times 10^{-5}$ C en B met 'n lading $+ 9,5 \times 10^{-5}$ C op geïnsuleerde staanders. Die afstand tussen die middelpunte van die twee sfere is 0,35 m.



8.1 Teken die elektriese veldpatroondiagram van die elektriese veld wat bestaan as gevolg van die twee ladings. (3)

8.2 Bereken die grootte en rigting van die elektrostatiese krag wat deur sfeer B op sfeer A uitgeoefen word. (4)

8.3 Bereken die elektriese veldsterkte by B as gevolg van lading A. (4)

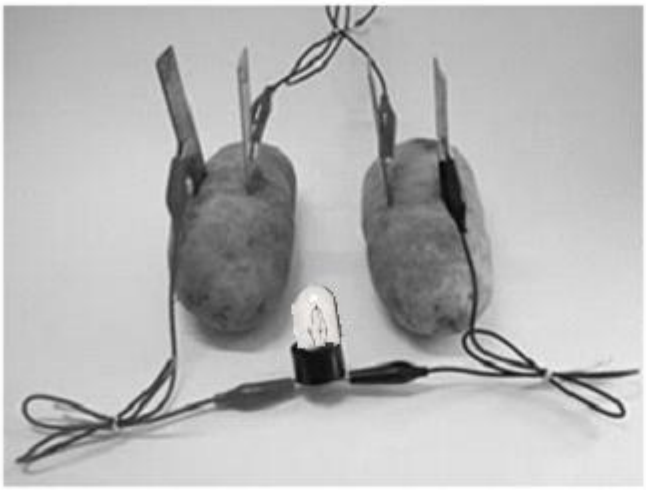
[11]

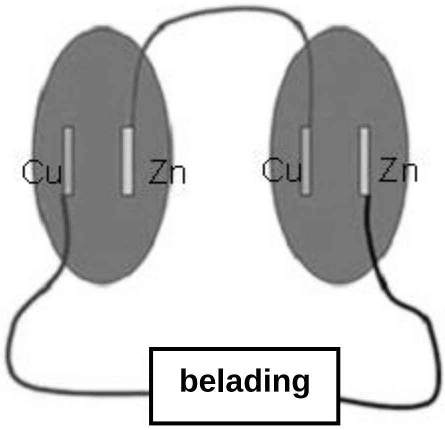
VRAAG 9 (Begin op ’n nuwe bladsy.)

Sandile en Peter het ’n battery vir die wetenskapuitstalling gebou. Hulle het aartappels gebruik met sink- en koperplate as elektrodes.
Sandile en Peter was nuuskierig om uit te vind hoeveel aartappelselle in serie geskakel moet word om ’n flitslig-gloeilampie te laat brand.

9.1 Skryf ’n gepaste hipotese vir die ondersoek neer. (2)

9.2 Skryf die afhanklike veranderlike vir hierdie ondersoek neer. (1)





http://www.sciencebuddies.org/science-fair-projects/project_ideas/Energy_p010.shtml#procedure

Sandile en Peter het met twee aartappels begin wat in serie geskakel is soos getoon in die foto hierbo. Hulle gebruik ’n voltmeter wat direk oor die buitenste elektrodes geskakel is en meet ’n potensiaalverskil van 1,6 V.
Daarna verbind hulle ’n 1,5 V flitslig-gloeilampie tussen die elektrodes. Hulle neem waar dat die gloeilamp nie brand nie.
Wanneer hulle die potensiaalverskil oor die gloeilampie meet, is dit 0,02 V.

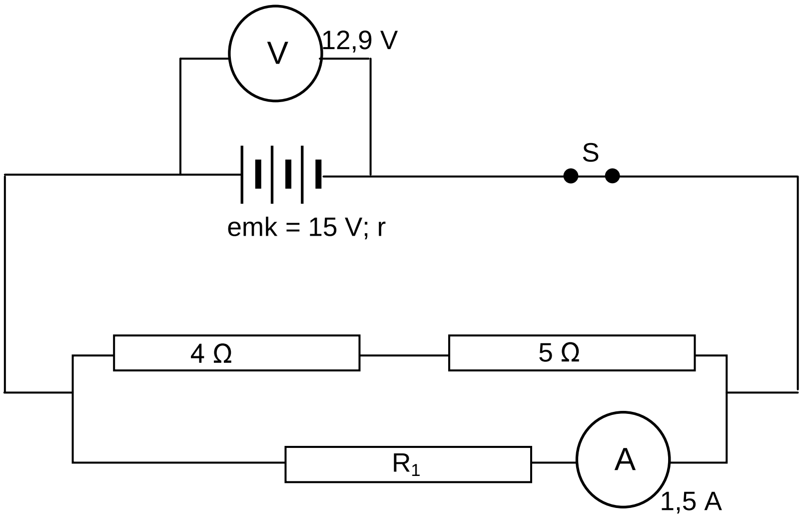
9.3 Wat is die emk van die battery met twee aartappelselle wat in serie verbind is? (1)

9.4 Gee ’n rede hoekom die potensiaalverskil oor die gloeilamp slegs 0,02 V is. (1)

9.5 Die gloeilamp het ’n weerstand van 2 Ω. Bereken die drywing wat deur die gloeilamp verkwis word al brand dit nie. (3)
[8]

VRAAG 10 (Begin op 'n nuwe bladsy.)

Die stroombaandiagram hieronder toon twee resistors met 'n weerstand van 4 Ω en 5 Ω elk in parallel geskakel met resistor R_1 met 'n onbekende weerstand. Die battery het 'n emk van 15 V en 'n onbekende interne weerstand.



10.1 Stel Ohm se wet in woorde. (2)

Wanneer skakelaar S gesluit word, het die ammeter 'n lesing van 1,5 A en die voltmeter het 'n lesing van 12,9 V.

10.2 Bereken die weerstand van resistor R_1. (3)

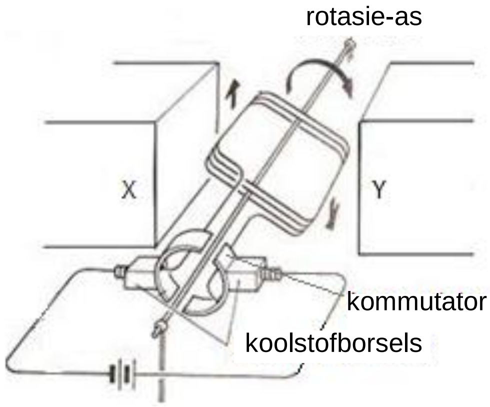
10.3 Bereken die ekwivalente weerstand van die parallelle stroombaan. (3)

10.4 Bereken die interne weerstand van die battery. (4)

[12]

VRAAG 11 (Begin op 'n nuwe bladsy.)

11.1 Bestudeer die diagram van 'n elektriese **motor** hieronder. Die spoel roteer tussen die teenoorgestelde pole X en Y van twee magnete.



11.1.1 Is hierdie 'n GS- of 'n WS-motor? Gee 'n rede vir jou antwoord. (2)

11.1.2 Noem TWEE veranderings wat aan hierdie motor gemaak kan word om die tempo van rotasie te laat toeneem. (2)

11.1.3 Wat is die polariteit van die twee magnetiese pole X en Y? (2)

11.2 **Generators** benodig 'n bron van meganiese energie om die spoel in 'n magneetveld te draai. Die foto hieronder toon 'n voorbeeld van 'n windgenerator.

'n Windgenerator het rotorlemme wat 100 m in diameter is. Wanneer die wind teen maksimum spoed waai, verskaf die generator 'n maksimum WS-stroom van 80 A in 'n resistor van 510 Ω.

11.2.1 Bereken die wgk-potensiaalverskil oor die resistor. (5)

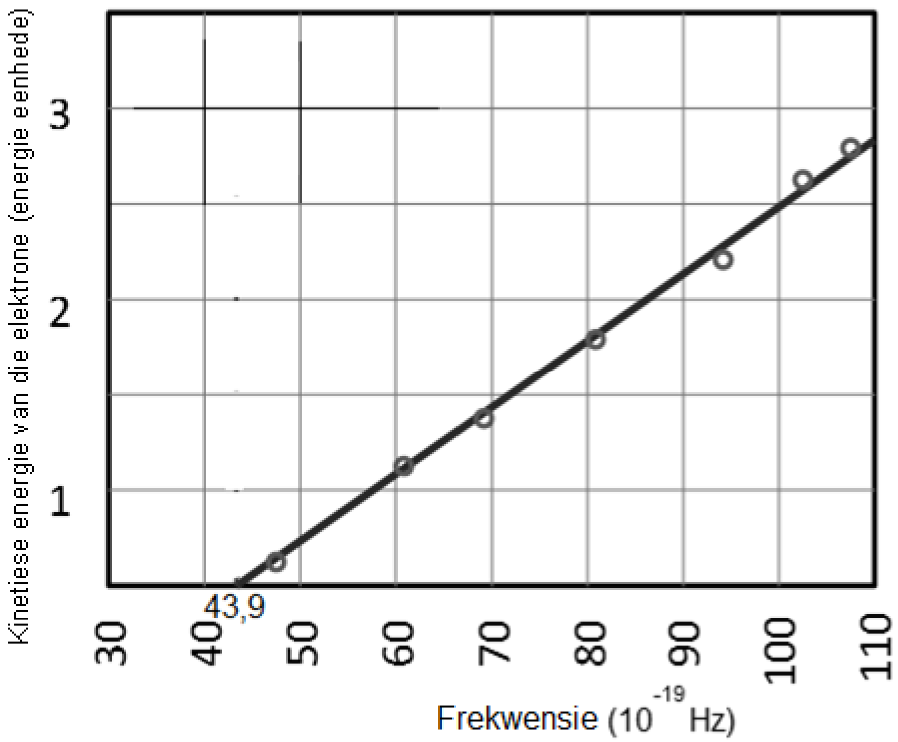
11.2.2 Bereken die gemiddelde drywing wat deur die generator gegenereer word. (3)

11.2.3 Teken 'n sketsgrafiek van die verandering in die stroomsterkte wat deur hierdie WS-generator gegenereer word. Toon TWEE volledige siklusse vir die verandering in die stroom op die grafiek aan. Toon die toepaslike waardes van die stroom op die as aan. (4)

[18]

VRAAG 12 (Begin op ’n nuwe bladsy.)

12.1 Die grafiek hieronder toon die verband tussen die maksimum kinetiese energie van elektrone wat vrygestel is van die oppervlakte van ’n sekere metaal wanneer elektromagnetiese straling met verskillende frekwensies daarop skyn.



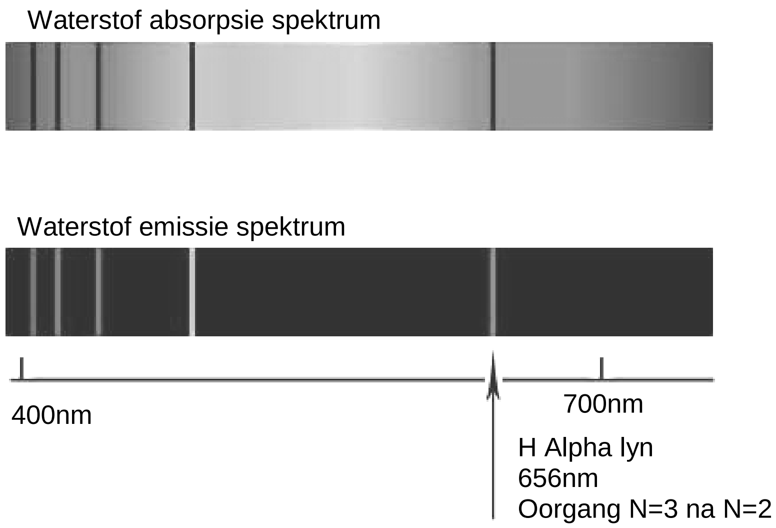
12.1.1 Definieer die werksfunksie vir ’n spesifieke metaal. (2)

12.1.2 Gee die grootte van die drumpelfrekwensie van die metaal soos aangetoon op die grafiek. (1)

12.1.3 Bereken die maksimum snelheid wat ’n vrygestelde elektron het as elektromagnetiese straling met ’n frekwensie van 100×10^{-19} Hz op die metaal skyn. (5)

12.1.4 Die grafiek word beskryf as “die bespassende lyn”. Verduidelik wat dit beteken. (1)

12.2 Die volgende diagram toon die verskillende lyne van die lyn emissie-spektrum (gekleurde lyne op ’n swart agtergrond) asook die absorpsie-spektrum (swart lyne op ’n gekleurde agtergrond) van die waterstofatoom onderskeidelik. Die lyne stem ooreen met die oorgange van elektrone tussen spesifieke energievlakke.



12.2.1 Verduidelik die verskil tussen ’n *emissiespektrum* en ’n *absorpsie-spektrum*. (2)

12.2.2 Wat is die mees waarskynlike kleur van die H-Alpha lyn? Kies uit ROOI, GROEN of VIOLET. Gee ’n rede vir jou antwoord. (2)

[14]

TOTAAL: 150

GAUTENG DEPARTMENT OF EDUCATION/
GAUTENGSE DEPARTEMENT VAN ONDERWYS
PREPARATORY EXAMINATION/
VOORBEREIDENDE EKSAMEN

PHYSICAL SCIENCES: PHYSICS (P1)/
FISIESE WETENSKAPPE: FISIKA (V1)

MEMORANDUM

QUESTION 1/*VRAAG 1*

1.1	B ✓✓	(2)
1.2	D ✓✓	(2)
1.3	B ✓✓	(2)
1.4	B ✓✓	(2)
1.5	C ✓✓	(2)
1.6	A ✓✓	(2)
1.7	D ✓✓	(2)
1.8	C ✓✓	(2)
1.9	A ✓✓	(2)
1.10	C ✓✓	(2) **[20]**

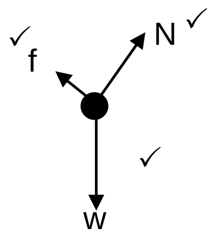
QUESTION 2/*VRAAG 2*

2.1 Acceleration is the rate ✓of change in velocity / ✓
Versnelling is die tempo ✓van verandering in snelheid ✓

Acceleration is the change in velocity ✓per unit time / ✓
Versnelling is die verandering in snelheid ✓per eenheid tyd✓ (2)

2.2 **Accepted Labels/*Aanvaarde benoemings***

w F_g/F_w/force of Earth on block/weight/49 N/mg/gravitational force
F_g/F_w/krag van Aarde op blok/gewig/49 N/mg/gravitasiekrag
N F_N/normal
F_N/normaal
f Friction/F_f
Wrywing/F_f



Note/*Nota*
One mark for correct arrow **and** label.
If **any** other forces shown max. $\frac{2}{3}$

*Een punt vir die korrekte pyl **en** benaming*
*Indien **enige** ander krag getoon word maks. $\frac{2}{3}$*

(3)

2.3

OPTION 1/*OPSIE 1*
Upward positive:
Opwaarts positief:
For/*Vir* 2 kg

$F_{net} = ma$ ✓
$T - F_G = ma$
✓ $21 - 19{,}6 = 2a$ ✓
$a = 0{,}7\ m\cdot s^{-2}$

OPTION 2/*OPSIE 2*
Upward negative:
Opwaarts negatief:
For/*Vir* 2 kg

$F_{net} = ma$ ✓
$F_G - T = ma$
✓ $19{,}6 - 21 = 2a$ ✓
$a = -0{,}7\ m\cdot s^{-2}$
$\therefore a = 0{,}7\ m\cdot s^{-2}$ (3)

2.4 **OPTION 1/OPSIE 1**
Parallel down positive:
***Parallel af positief*:**
For/Vir 5 kg

$$F_{net} = ma$$
$$F_G \sin\theta - T - f = ma \checkmark$$
$$78{,}4\sin 20° - 21 - f = 8(0{,}7) \checkmark \checkmark$$
$$f = 0{,}21\text{N} \checkmark$$

OPTION 2/OPSIE 2
Parallel down negative:
Parallel af negatief:
For/Vir 5 kg

$$F_{net} = ma$$
$$-F_G \sin\theta + T + f = ma \checkmark$$
$$-78{,}4\sin 20° + 21 + f = 8(-0{,}7) \checkmark \checkmark$$
$$f = -0{,}21\text{N}$$
$$\therefore f = 0{,}21\text{N} \checkmark$$

Note/*Nota*
Any one of the two answers.
Enige een van die twee antwoorde

(4)
[11]

QUESTION 3/*VRAAG 3*

3.1 9,8 m·s^{-2} ✓ downward/to the centre of the earth / ✓
9,8 m·s^{-2} ✓ afwaarts / na die middelpunt van die aarde ✓ (2)

3.2

OPTION 1/ *OPSIE 1*
Downward positive:
***Afwaarts positief*:**
From t_1 to t_2 / *Vanaf t_1 na t_2*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$0,9$ ✓ $= 0 + \frac{1}{2}(9,8)\Delta t^2$ ✓
$\Delta t = 0,43$ s ✓

OPTION 2 / *OPSIE 2*
Downward negative:
Afwaarts negatief:
From t_1 to t_2 / *Vanaf t_1 na t_2*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-0,9$ ✓ $= 0 + \frac{1}{2}(-9,8)\Delta t^2$ ✓
$\Delta t = 0,43$ s ✓

OPTION 3 / *OPSIE 3*
Downward positive:
***Afwaarts positief*:**
From 0 to t_1 / *Vanaf 0 na t_1*

$v_f^2 = v_i^2 + 2a\Delta y$
$0 = v_i^2 + 2(9,8)(-0,9)$ ✓
$v_i = \pm 4,2\ m\cdot s^{-1}$
$\therefore v_i = -4,2\ m\cdot s^{-1}$
$v_f = v_i + a\Delta t$ ✓
$0 = -4,2 + (9,8)\Delta t$ ✓
$\Delta t = 0,43$ s ✓

OPTION 4 / *OPSIE 4*
Downward negative:
***Afwaarts negatief*:**
From 0 to t_1 / *Vanaf 0 na t_1*

$v_f^2 = v_i^2 + 2a\Delta y$
$0 = v_i^2 + 2(-9,8)(0,9)$ ✓
$v_i = \pm 4,2\ m\cdot s^{-1}$
$\therefore v_i = 4,2\ m\cdot s^{-1}$
$v_f = v_i + a\Delta t$ ✓
$0 = 4,2 + (-9,8)\Delta t$ ✓
$\Delta t = 0,43$ s ✓

OPTION 5 / *OPSIE 5*
Downward positive:
***Afwaarts positief*:**
From 0 to t_1 / *Vanaf 0 na t_1*

$v_f^2 = v_i^2 + 2a\Delta y$
$0 = v_i^2 + 2(9,8)(-0,9)$ ✓
$v_i = \pm 4,2\ m \cdot s^{-1}$
$\therefore v_i = -4,2\ m \cdot s^{-1}$

$\Delta y = \frac{v_i + v_f}{2}\Delta t$ ✓
$-0,9 = \frac{-4,2 + 0}{2}\Delta t$ ✓
$\Delta t = 0,43\ s$ ✓

OPTION 6 / *OPSIE 6*
Downward negative:
***Afwaarts negatief*:**
From 0 to t_1 / *Vanaf 0 na t_1*

$v_f^2 = v_i^2 + 2a\Delta y$
$0 = v_i^2 + 2(-9,8)(0,9)$ ✓
$v_i = \pm 4,2\ m \cdot s^{-1}$
$\therefore v_i = 4,2\ m \cdot s^{-1}$

$\Delta y = \frac{v_i + v_f}{2}\Delta t$ ✓
$0,9 = \frac{4,2 + 0}{2}\Delta t$ ✓
$\Delta t = 0,43\ s$ ✓

(4)

3.3 **POSITIVE MARKING FROM QUESTION 3.2**
POSITIEWE NASIEN VANAF VRAAG 3.2

OPTION 1 / *OPSIE 1*
Downward positive:
***Afwaarts positief*:**
From 0 to t_1 / *Vanaf 0 na t_1*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
✓ $0 = v_i^2 + 2(9,8)(-0,9)$ ✓
$v_i = \pm 4,2\ m \cdot s^{-1}$
$\therefore v_i = -4,2\ m \cdot s^{-1}$
$\therefore v_i = 4,2\ m \cdot s^{-1}$ upward/*opwaarts* ✓

OPTION 1 / *OPSIE 1*
Downward negative:
***Afwaarts negatief*:**
From 0 to t_1 / *Vanaf 0 na t_1*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
✓ $0 = v_i^2 + 2(-9,8)(0,9)$ ✓
$v_i = \pm 4,2\ m \cdot s^{-1}$
$\therefore v_i = 4,2\ m \cdot s^{-1}$ upward/*opwaarts* ✓

OPTION 3 / *OPSIE 3*
Downward positive:
***Afwaarts positief*:**
From 0 to t_2 / *Vanaf 0 na t_2*

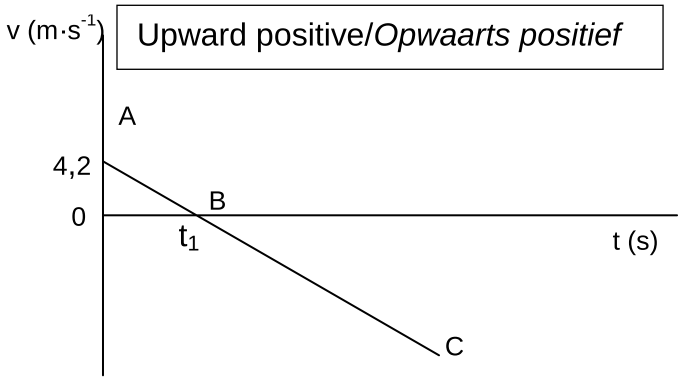
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$0,9 = v_i(0,43) + \frac{1}{2}(9,8)(0,43)^2$ ✓ ✓
$v_i = -4,2\ m \cdot s^{-1}$
$\therefore v_i = 4,2\ m \cdot s^{-1}$ upward/*opwaarts* ✓

OPTION 4 / *OPSIE 4*
Downward negative:
***Afwaarts negatief*:**
From 0 to t_2 / *Vanaf 0 na t_2*

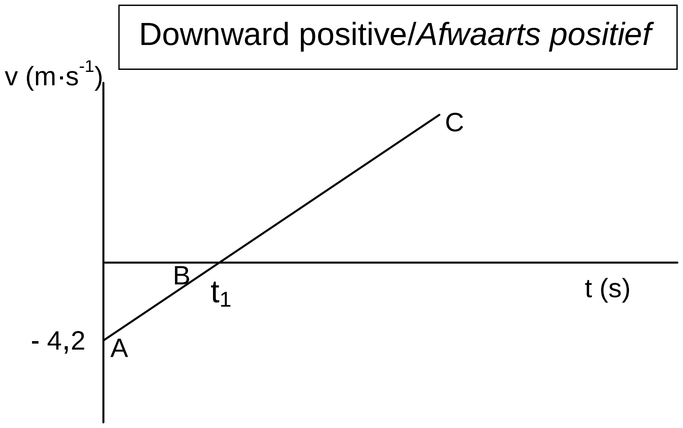
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$-0,9 = v_i(0,43) + \frac{1}{2}(9,8)(0,43)^2$ ✓ ✓
$v_i = 4,2\ m \cdot s^{-1}$
$\therefore v_i = 4,2\ m \cdot s^{-1}$ upward/*opwaarts* ✓

(4)

3.4 **POSITIVE MARKING FROM QUESTION 3.2 AND 3.3**
POSITIEWE NASIEN VANAF VRAAG 3.2 EN 3.3



Criteria for graph/*Kriteria vir grafiek:*	Marks/ *Punte*
Straight line, crossing x-axis *Reguitlyn, kruis die x-as*	✓
AB is shorter than BC *AB is korter as BC*	✓
$v_i = \pm 4{,}2\ m \cdot s^{-1}$	✓
$t_1 = 0{,}43\ s$	✓



Note/*Nota*
if no/incorrect labels on axis: max. $\frac{3}{4}$

as geen/verkeerde benamings vir asse dan: maks. $\frac{3}{4}$

(4)
[14]

QUESTION 4/*VRAAG 4*

4.1 $F_G = \dfrac{Gm_Z m_X}{d^2}$ ✓

$F_G = \dfrac{(6,67\times10^{-11})(5,98\times10^{24})(1,99\times10^{19})}{(1,496\times10^{6})^2}$ ✓ ✓

$F_G = 3,52\times10^{21}$ N attractive / *aantrekkend* ✓

OR/OF

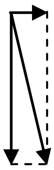
$F_G = 3,55\times10^{21}$ N towards X / *na X* (4)

4.2 (3,55 × $10^{21)}$ × 8 = 2,84 × 10^{22} N towards moon Y / *na maan Y* ✓✓ (2)

4.3 $F_{net}^2 = F_{MX}^2 + F_{MY}^2$ ✓

$F_{net}^2 = (3,55\times10^{21})^2 + (2.84\times10^{22})^2$

$F_{net} = 2,86\times10^{22}$ N ✓



(2)

[8]

QUESTION 5/*VRAAG 5*

5.1 Impulse = area between graph and x - axis

Impuls = oppervlakte tussen grafiek en x - as

$\text{Impulse} = \tfrac{1}{2}bh + \tfrac{1}{2}bh + lb$ ✓

$\text{Impulse} = \tfrac{1}{2}(2)(10) + \tfrac{1}{2}(2)(-10) + (6)(-10)$ ✓

$\text{Impulse} = -60\ N\cdot s$ ✓

∴ Impulse = 60 N·s in opposite direction/west

∴ *Impuls = 60 N·s in teenoorgestelde rigting/wes* (3)

5.2 Greater than / *Groter as* ✓ (1)

5.3

OPTION 1 / *OPSIE 1*
East positive:
***Oos positief*:**

$\text{Impulse} = mv_f - mv_i$ ✓

✓ $-60 = (12)v_f - (12)(5,5)$ ✓

$v_f = 0,5\ m\cdot s^{-1}$ east / *oos* ✓

OPTION 2 / *OPSIE 2*
West positive:
***Wes positief*:**

$\text{Impulse} = mv_f - mv_i$ ✓

✓ $-60 = (12)v_f - (12)(5,5)$ ✓

$v_f = 0,5\ m\cdot s^{-1}$ east / *oos* ✓

(4)

[8]

QUESTION 6/*VRAAG 6*

6.1 $W = F\Delta x \cos\theta$ ✓

$W = (20)(32)\cos 10°$ ✓

$W = 630{,}28\ \text{J}$ ✓ (3)

6.2 **OPTION 1 / *OPSIE 1***

$F_{net} = F - F_G \sin\theta - f$

$F_{net} = 20 - 59{,}78 \sin 10° - 11$ ✓

$F_{net} = -1{,}38\ N$

$F_{net} = 1{,}38\ N$ backwards/*agteruit*

$W_{net} = \Delta E_K$ ✓

$F_{net}\Delta x \cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ ✓ ✓

$(1{,}38)(32)\cos 180° = \frac{1}{2}(6{,}1)(v_f^2 - 5^2)$

$v_f^2 = 10{,}51$

$v_f = 3{,}24\ \text{m}\cdot\text{s}^{-1}$ ✓

Notes/*Aantekeninge:*

If "net" left out for F_{net} : Max. $\frac{2}{5}$

As "net" uitgelaat is vir F_{net}: Maks. $\frac{2}{5}$

(5)

OPTION 2 / *OPSIE 2*

$W_{net} = \Delta E_K$

$F\Delta x \cos\theta + f\Delta x \cos\theta + F_g \Delta x \cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ ✓

$(20)(32)\cos 0° + (11)(32)\cos 180° + (59{,}78)(32)\cos 10° = \frac{1}{2}(6{,}1)v_f^2 - \frac{1}{2}(6{,}1)(5^2)$ ✓ ✓ ✓

$v_f^2 = 10{,}51$

$v_f = 3{,}24\ \text{m}\cdot\text{s}^{-1}$ ✓

OPTION 3 / *OPSIE 3*

$W_{net} = \Delta E_K$

$F\Delta x \cos\theta + f\Delta x \cos\theta + F_g\Delta x \cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ ✓

$(20)(32)\cos 0° + (11)(32)\cos 180° + (59{,}78 \sin 10°)(32)\cos 180° = \frac{1}{2}(6{,}1)v_f^2 - \frac{1}{2}(6{,}1)(5^2)$ ✓ ✓ ✓

$v_f^2 = 10{,}51$

$v_f = 3{,}24\ \text{m}\cdot\text{s}^{-1}$ ✓

6.3 The net work done by the non-conservative force / frictional force depends on the path the object travelled ✓✓ /
Die netto arbeid verrig deur 'n nie-konserwatiewe krag / wrywingskrag is onafhanklik van die roete geneem ✓✓
OR/*OF*
The mechanical energy is not constant ✓✓for a non-conservative force /
Die meganiese energie is nie konstant ✓✓*vir 'n nie-konserwatiewe krag nie* (2)

[10]

QUESTION 7/*VRAAG 7*

7.1.1

$$\Sigma E_{m\,56m} = \Sigma E_{m\,18m}$$
$$(E_P + E_K)_{56m} = (E_P + E_K)_{18m} \checkmark$$
$$\cancel{m}gh + 0 = \cancel{m}gh + \tfrac{1}{2}\cancel{m}v^2$$
$$9{,}8(56) \checkmark = (9{,}8)(18) + \tfrac{1}{2}v^2 \checkmark$$
$$v = 27{,}29\ m\cdot s^{-1} \checkmark$$

(4)

7.1.2 **POSITIVE MARKING FROM QUESTION 7.1**
POSITIEWE NASIEN VANAF VRAAG 7.1

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$$

OR/*OF*

$$f_L = \frac{v}{v - v_s} f_s \checkmark$$

$$\checkmark\ f_L = \left(\frac{340}{340 - 27{,}29}\right) 497 \times 10^3 \checkmark$$

$$f_L = 5{,}4 \times 10^5\ \text{Hz} \checkmark$$

Notes:
- Any other Doppler formula, e.g. $f_L = \frac{v + v_L}{v - v_s} f_s$ - Max. $3/4$ for calculation
- Marking rule 1.5: No penalisation if zero substitutions are omitted.

Aantekeninge:
- *Enige ander Dopplerformule, bv.* $f_L = \frac{v + v_L}{v - v_s} f_s$ - *Maks.* $3/4$ *vir berekening*
- *Nasienreël 1.5: Geen punte word verbeur indien nul substitusies weggelaat word nie.*

(4)

7.1.3 The phone is moving away from Keenan who is stationary, the phone is increasing the distance between each wavefront and therefore the wavelength increases✓. This causes the frequency to decrease ✓since $f \alpha \frac{1}{\lambda}$ for the same speed of sound ✓ /
Die selfoon beweeg weg van Keenan af, die foon vergroot dus die grootte van die afstand tussen die golffronte en die golflengte vergroot. ✓ Dit veroorsaak dat die frekwensie afneem ✓ aangesien $f \alpha \frac{1}{\lambda}$ vir dieselfde spoed van klank.✓ (3)

7.1.4 HIGHER; ✓ /
HOËR ✓ (1)

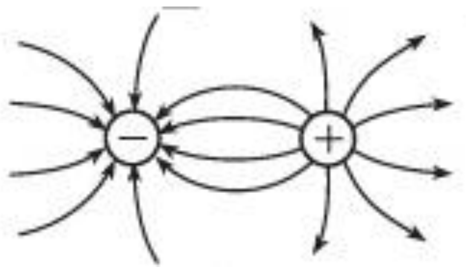
7.2 7.2.1 The observed frequency is the same as the original frequency of the source.✓ / the car is moving perpendicular to the camera /
Die waargenome frekwensie is dieselfde as die oorspronklike frekwensie van die bron✓ / die motor beweeg loodreg ten opsigte van die kamera. (1)

7.2.2 $3 \times 10^8\ m\cdot s^{-1}$ ✓
It is an electromagnetic wave. ✓/
Dit is 'n elektromagnetiese golf. ✓ (2)

[15]

QUESTION 8/*VRAAG 8*

8.1



Criteria for sketch ***Kriteria vir skets***	**Marks** ***Punte***
Correct shape as shown. *Korrekte vorm soos getoon*	✓
Direction from positive to negative. *Rigting van positief na negatief.*	✓
Field lines start on spheres and do not cross. *Veldlyne begin op elke sfeer en kruis nie.*	✓

(3)

8.2

$$F_{B\,on\,A} = \frac{kQ_AQ_B}{r^2} \checkmark$$

$$F_{B\,on\,A} = \frac{(9\times10^9)(4,5\times10^{-5})(9,5\times10^{-5})}{(0,35)^2} \checkmark \checkmark$$

$$F_{B\,on\,A} = 314,08 \text{ N to the right/ } \textit{na regs} \checkmark$$

(4)

8.3 **POSITIVE MARKING FROM QUESTION 8.2**
POSITIEWE NASIEN VANAF VRAAG 8.2

Option 1/*Opsie 1*

$$E_A = \frac{kQ_A}{r^2} \checkmark$$

$$E_A = \frac{(9\times10^9)(4,5\times10^{-5})}{(0,35)^2} \checkmark$$

$$E_A = 3,31\times10^6 \text{ N}\cdot\text{C}^{-1} \text{ to the right / } \textit{na regs} \checkmark$$

Option 2/*Opsie 2*

$$E_A = \frac{F_{A\,op\,B}}{q_B} \checkmark$$

$$E_A = \frac{314,08}{9,5\times10^{-5}} \checkmark$$

$$E_A = 3,31\times10^6 \text{ N}\cdot\text{C}^{-1} \text{ to the right / } \textit{na regs} \checkmark$$

(3)
[10]

QUESTION 9 / *VRAAG 9*

9.1

Criteria for hypothesis /*Kriteria vir hipotese:*	**Mark/ *Punt***
The <u>dependent</u> and <u>independent</u> variables are stated. *Die <u>afhanklike</u> en <u>onafhanklike</u> veranderlikes is genoem*.	✓
Makes a statement <u>about the relationship</u> between dependent and independent variables. *Maak 'n stelling <u>oor die verwantskap</u> tussen die afhanklike en onafhanklike veranderlikes.*	✓

<u>Independent variable/*Onafhanklike veranderlike*</u>:
Amount of potato cells / *Aantal aartappelselle*

<u>Dependent variable/*Afhanklike veranderlike:*</u>
Bulb glows or not /*Gloeilampie gloei of nie*
*Or/*of
Current (strength) /*Stroom(sterkte)*

Examples/*Voorbeelde:*
More potato cells will increase the brightness of the bulb/
Meer aartappelselle sal die helderheid van die gloeilampie laat toeneem.

More potato cells will increase the current through the bulb/
Meer aartappelselle sal die grootte van die stroom deur die gloeilampie laat toeneem.

Notes/
Aantekeninge:
A statement that does not contain a relationship: Max ½

'n Stelling wat geen verwantskap bevat nie: Maks. ½

Example/
***Voorbeeld*:**
Three potato cells are needed to make penlight bulb glow. ½

Drie aartappelselle is nodig om die gloei-lampie te laat gloei. ½

(2)

9.2 **<u>Dependent variable/*Afhanklike veranderlike:*</u>**
Bulb glows or not /*Gloeilampie gloei of nie* ✓
*Or/*of
Current (strength) /*Stroom(sterkte)* ✓ (1)

9.3 1,6 V ✓ (1)

9.4 The battery has an <u>internal resistance</u> / ✓
Die battery het 'n <u>interne weerstand</u> ✓ (1)

9.5

$$P = \frac{V^2}{R} \checkmark$$

$$P = \frac{(0{,}02)^2}{2} \checkmark$$

$$P = 2 \times 10^{-4}\ \text{W} \checkmark$$

(3)

[8]

QUESTION 10/*VRAAG 10*

10.1 The potential difference is directly proportional to the current ✓ through the resistor if the temperature stays the same. ✓
Die potensiaalverskil is direk eweredig aan die stroomsterkte ✓ deur die resistor, mits die temperatuur konstant bly ✓ vir die resistor. (2)

10.2
$$R_1 = \frac{V}{I} \checkmark$$
$$R_1 = \frac{12,9}{1,5} \checkmark$$
$$R_1 = 8,6\ \Omega \checkmark$$
(3)

10.3 **POSITIVE MARKING FROM QUESTION 11.2**
POSITIEWE NASIEN VAN VRAAG 11.2

$$\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_{series}} \checkmark$$
$$\frac{1}{R_{tot}} = \frac{1}{8,6} + \frac{1}{(4+5)} \checkmark$$
$$\frac{1}{R_{tot}} = \frac{88}{387}$$
$$R_{tot} = 4,4\ \Omega \checkmark$$
(3)

10.4 **POSITIVE MARKING FROM QUESTION 11.3**
POSITIEWE NASIEN VAN VRAAG 11.3

Option 1/*Opsie 1:*

$$I_{total} = \frac{V}{R_{total}} \checkmark$$
$$I_{total} = \frac{12,9}{4,4} \checkmark$$
$$I_{total} = 2,93\ A$$
$$r = \frac{V_{lost}}{I}$$
$$r = \frac{15 - 12,9}{2,93} \checkmark$$
$$r = 0,72\ \Omega \checkmark$$

Option 2/*Opsie 2*:

$$I_{total} = \frac{V}{R_{total}} \checkmark$$
$$I_{total} = \frac{12,9}{4,4} \checkmark$$
$$I_{total} = 2,93\ A$$
$$\varepsilon = IR + Ir$$
$$15 = (2,93)(4,4) + (2,93)r \checkmark$$
$$r = 0,72\ \Omega \checkmark$$

Option 3/*Opsie 3:*

$I_{serie} = \frac{V}{R_{serie}}$ ✓

$I_{serie} = \frac{12{,}9}{9}$ ✓

$I_{serie} = 1{,}43$ A

$I_{total} = 1{,}5 + 1{,}43$

$I_{total} = 2{,}93$ A

$r = \frac{V_{lost}}{I}$

$r = \frac{15 - 12{,}9}{2{,}93}$ ✓

$r = 0{,}72\ \Omega$ ✓

Option 4/*Opsie 4:*

$I_{serie} = \frac{V}{R_{serie}}$ ✓

$I_{serie} = \frac{12{,}9}{9}$ ✓

$I_{serie} = 1{,}43$ A

$I_{total} = 1{,}5 + 1{,}43$

$I_{total} = 2{,}93$ A

$\varepsilon = IR + Ir$

$15 = (2{,}93)(4{,}4) + (2{,}93)r$ ✓

$r = 0{,}72\ \Omega$ ✓

(4)
[12]

QUESTION 11/*VRAAG 11*

11.1 11.1.1 DC; ✓ It is powered by a DC-source ✓
GS; ✓ *Dit word aangedryf deur 'n GS-bron* ✓ (2)

11.1.2
- Increase the emf of the source
- Increase the amount or turns on the coil
- Increase the strength of the magnet ✓✓ [any two]

- *Verhoog die emk van die bron*
- *Vermeerder die aantal windings op die spoel*
- *Gebruik 'n sterker magneet* ✓✓ [*enige twee*] (2)

11.1.3 X: South pole / *Suidpool* ✓
Y: North pole / *Noordpool* ✓ (2)

11.2 11.2.1 **Option 1/*Opsie 1:***

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{rms} = \frac{80}{\sqrt{2}}$ ✓

$I_{rms} = 56{,}57$ A ✓

$V_{rms} = I_{rms}R$

$V_{rms} = (56{,}57)(510)$ ✓

$V_{rms} = 2{,}89 \times 10^4$ V ✓

Option 2/*Opsie 2:*

$V_{rms} = I_{rms}R$ ✓

$V_{rms} = \frac{I_{max}}{\sqrt{2}}R$ ✓

$V_{rms} = (\frac{80}{\sqrt{2}})(510)$ ✓ ✓

$V_{rms} = 2{,}89 \times 10^4$ V ✓

(5)

11.2.2 **Option 1/*Opsie 1:***

$P_{ave} = I_{rms}^2R$ ✓

$P_{ave} = (56{,}57)^2(510)$ ✓

$P_{ave} = 1{,}63 \times 10^6$ W ✓

Option 2/*Opsie 2:*

$P_{ave} = \frac{V_{rms}^2}{R}$ ✓

$P_{ave} = \frac{(2{,}89 \times 10^4)^2}{510}$ ✓

$P_{ave} = 1{,}63 \times 10^6$ W ✓

Option 3/*Opsie 3:*

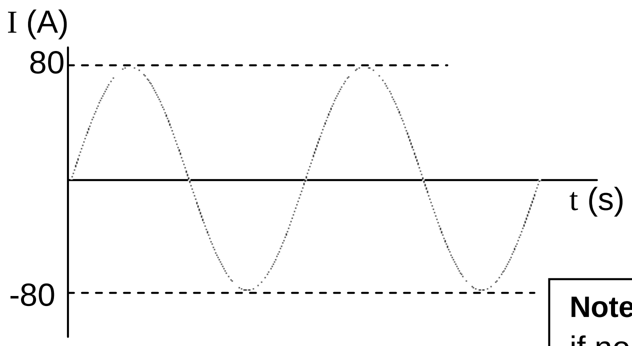
$P_{ave} = V_{rms}I_{rms}$ ✓

$P_{ave} = (2{,}89 \times 10^4)(56{,}57)$ ✓

$P_{ave} = 1{,}63 \times 10^6$ W ✓

(3)

11.2.3



Criteria for graph/*Kriteria vir grafiek:*	Marks/ *Punte*
Sinus or cosines graph *Sinus of kosinus grafiek*	✓
Two cycles *Twee siklusse*	✓
Max and min I-values indicated *Maks en min I-waardes getoon*	✓

Note/*Nota*
if no/incorrect labels on y-axis: max. $\frac{2}{3}$

as geen/verkeerde benamings vir y-as dan: maks. $\frac{2}{3}$

(4)
[18]

QUESTION 12/*VRAAG 12*

12.1 12.1.1 Workfunction is the <u>minimum energy of a photon</u> ✓needed to <u>set an electron free</u> from the surface of a metal✓ /
Werksfunksie is die <u>minimum energie wat ’n foton</u> ✓moet hê om ’n <u>elektron vry te stel</u> uit die oppervlak van ’n metaal.✓ (2)

12.1.2 $43{,}9 \times 10^{-19}$ Hz ✓✓ (2)

12.1.3 **POSITIVE MARKING FROM QUESTION 13.1.2**
POSITIEWE NASIEN VAN VRAAG 13.1.2

<u>Option 1/*Opsie 1*:</u>

$$E = W_0 + E_K$$
$$hf = hf_0 + \tfrac{1}{2}mv^2$$
✓ Any one/*Enige een*

$$(6{,}63\times10^{-34})(100\times10^{-19}) = (6{,}63\times10^{-34})(43{,}9\times10^{-19}) + \tfrac{1}{2}(9{,}11\times10^{-31})v^2 \quad ✓✓✓$$
$$v^2 = 8{,}17\times10^{-21}$$
$$v = 9{,}04\times10^{-11}\ m\cdot s^{-1} \quad ✓$$

<u>Option 2/*Opsie 2*:</u>

$$E = hf$$
$$E = (6{,}63\times10^{-34})(100\times10^{-19}) \quad ✓$$
$$E = 6{,}63\times10^{-51}\ J$$

$$W_0 = hf_0$$
$$W_0 = (6{,}63\times10^{-34})(43{,}9\times10^{-19}) \quad ✓$$
$$W_0 = 2{,}91\times10^{-51}\ J$$

$$✓ \quad E_K = \tfrac{1}{2}mv^2$$
$$E - W_0 = \tfrac{1}{2}(9{,}11\times10^{-31})v^2 \quad ✓$$
$$6{,}63\times10^{-51} - 2{,}91\times10^{-51} = \tfrac{1}{2}(9{,}11\times10^{-31})v^2$$
$$v^2 = 8{,}17\times10^{-21}$$
$$v = 9{,}04\times10^{-11}\ m\cdot s^{-1} \quad ✓$$
(5)

12.1.4 The data points are not connected directly, an average straight line connecting most of the points are drawn ✓/
Die data punte is nie direk verbind nie, ’n gemiddelde reguitlyn wat deur so veel as moontlik punte gaan word geteken. ✓ (1)

12.2 12.2.1 Emission spectra occurs when a light source gives off light✓ and absorption spectra occurs when white light is observed through a cold gas✓/
Emissiespektra vorm as 'n ligbron lig afgee✓ terwyl absorpsiespektra vorm as die wit lig waargeneem word deur 'n koue gas. ✓ (2)

12.2.2 RED ✓ it has the longest wavelength of all the visible colours✓/
ROOI ✓ Dit het die langste golflengte van al die sigbare kleure. ✓ (2)

[14]

[125]

150

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NASIONALE SENIOR SERTIFIKAAT

GRAAD 12

FISIESE WETENSKAPPE: FISIKA (VR1)

VOORBEREIDINGSEKSAMEN SEPTEMBER 2014

TOTAAL: 150

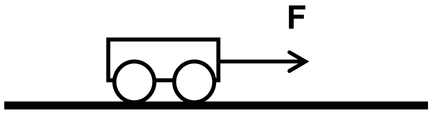
TYD: 3 URE

Hierdie vraestel bestaan uit 16 bladsye en 3 gegewensblaaie.

VRAAG 1: MEERVOUDIGEKEUSE-VRAE

Vier opsies word as moontlike antwoorde vir die volgende vrae gegee. Elke vraag het slegs EEN korrekte antwoord. Skryf slegs die letter (A–D) van die antwoord langs die vraagnommer (1.1–1.10) in die ANTWOORDEBOEK neer.

1.1 ‘n Trollie beweeg op ‘n plat horisontale oppervlak terwyl ‘n konstante krag F daarop toegepas word.



Watter **EEN** van die volgende fisiese hoeveelhede sal **ALTYD** konstant bly terwyl die trollie beweeg?

A momentum
B versnelling
C kinetiese energie
D gravitasie potensiële energie

(2)

1.2 ‘n Voorwerp beweeg vertikaal opwaarts, bereik sy maksimum hoogte en val terug grond toe. Ignoreer lugweerstand. Watter **EEN** van die volgende stellings is **WAAR**? Die voorwerp ondervind ‘n versnelling wat ....

A altyd afwaarts is
B eers opwaarts en dan afwaarts is
C eers afwaarts en dan opwaarts is
D eers afneem en dan toeneem

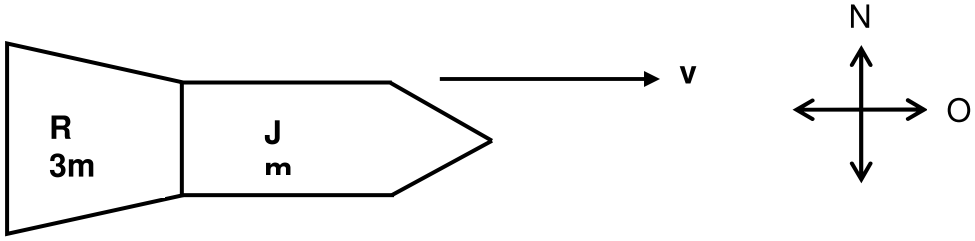
(2)

1.3 ‘n Satelliet ondervind ‘n gravitasiekrag met grootte **F** op die oppervlak van die aarde. Die radius van die aarde is **R**. Die satelliet sirkel nou om die aarde op ‘n onbekende hoogte bo die aarde se oppervlak en ondervind ‘n gravitasiekrag met grootte ¼ **F**. Hierdie onbekende hoogte is ….

A **R**
B 2 **R**
C 3 **R**
D 4 **R**

(2)

1.4 'n Ruimtetuig, wat uit twee modules, R en J, met masses **3m** en **m** respektiewelik bestaan, beweeg horisontaal teen 'n snelheid **v** reg oos. 'n Ontploffing veroorsaak dat die twee modules geskei word.

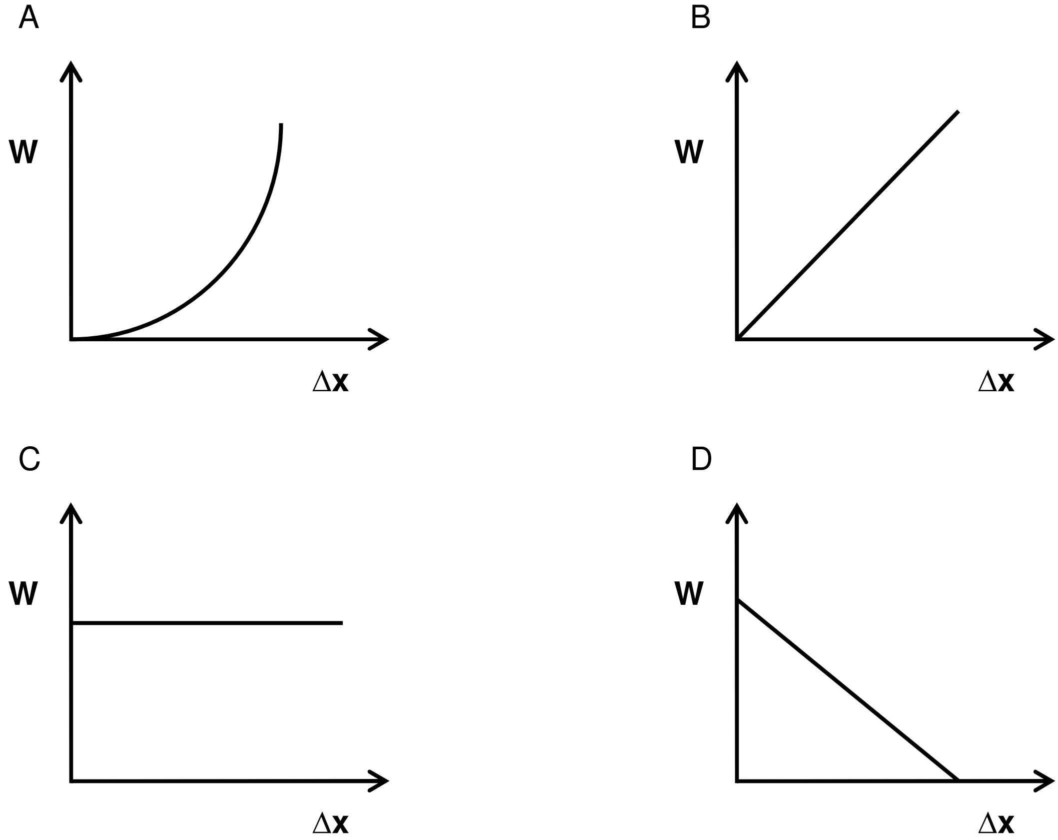


Onmiddelik na die ontploffing beweeg module J in sy oorspronklike rigting teen 'n snelheid 3**v**. Wat sal die **grootte** en **rigting** van module R se snelheid weesonmiddelik na die ontploffing?

	Grootte van R se snelheid	Rigting van R na die ontploffing
A	1 **v**	Oos
B	1 **v**	Wes
C	⅓ **v**	Oos
D	⅓ **v**	Wes

(2)

1.5 'n Motor beweeg vanuit rus in 'n reguit lyn terwyl 'n konstante netto krag daarop inwerk. Watter **EEN** van die volgende grafieke verteenwoordig die netto arbeid (**W**) verrig op die motor in verhouding tot sy verplasing (Δ**x**)?



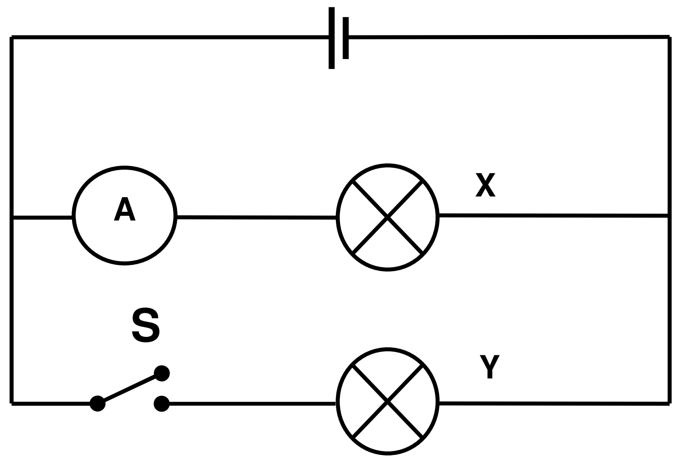
(2)

1.6 In watter rigting sal 'n absorbsiespektrum tydens 'n rooi-skuif skuif?

A na die blou kant van die spektrum.
B na lig met 'n korter golflengte.
C na lig met 'n laer frekwensie.
D. na lig met 'n hoër energie.

(2)

1.7 In die stroombaan hieronder getoon is gloeilampe X en Y identies.

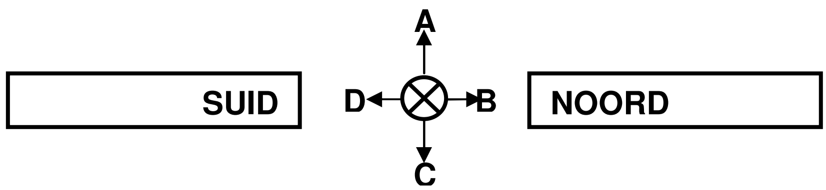


Watter **EEN** van die volgende is die korrekte beskrywing vir die die aanvanklike verandering in die totale weerstand en die lesing op die ammeter wanneer skakelaar S gesluit word?

	R (Totale Weerstand)	I (Ammeterlesing)
A	neem af	onveranderd
B	neem toe	onveranderd
C	neem toe	neem af
D	neem af	neem toe

(2)

1.8 Twee sterk staafmagnete word geplaas met die Noord- en Suidpole wat na mekaar toe wys, soos in die skets hieronder getoon. ‘n Stroomdraende geleier word tussen die pole van die magnete geplaas sodat konvensionele stroom in die vlak van die papier in vloei.

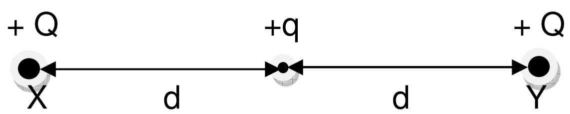


Die geleier sal ‘n krag na .... toe ondervind.

A **A**
B **B**
C **C**
D **D**

(2)

1.9 ‘n Klein toetslading, +q, word presies halfpad tussen twee identiese negatiewe ladings, X en Y elk met ‘n lading van +Q geplaas, soos hieronder getoon.

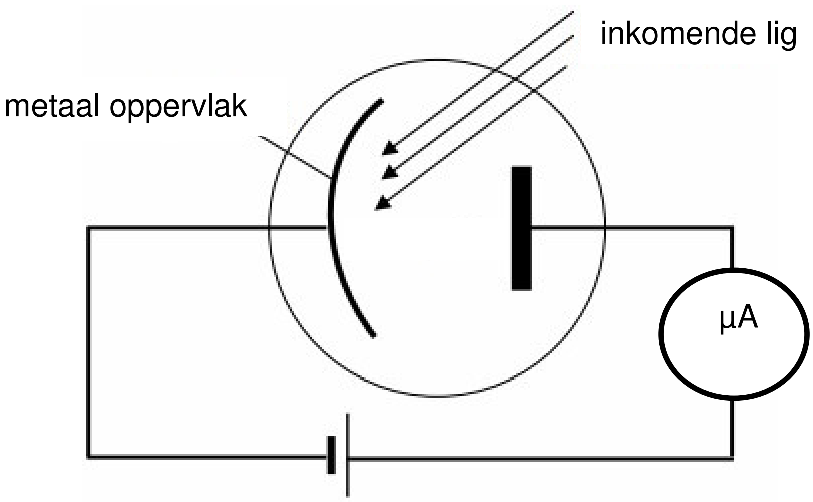


Die toetslading +q sal

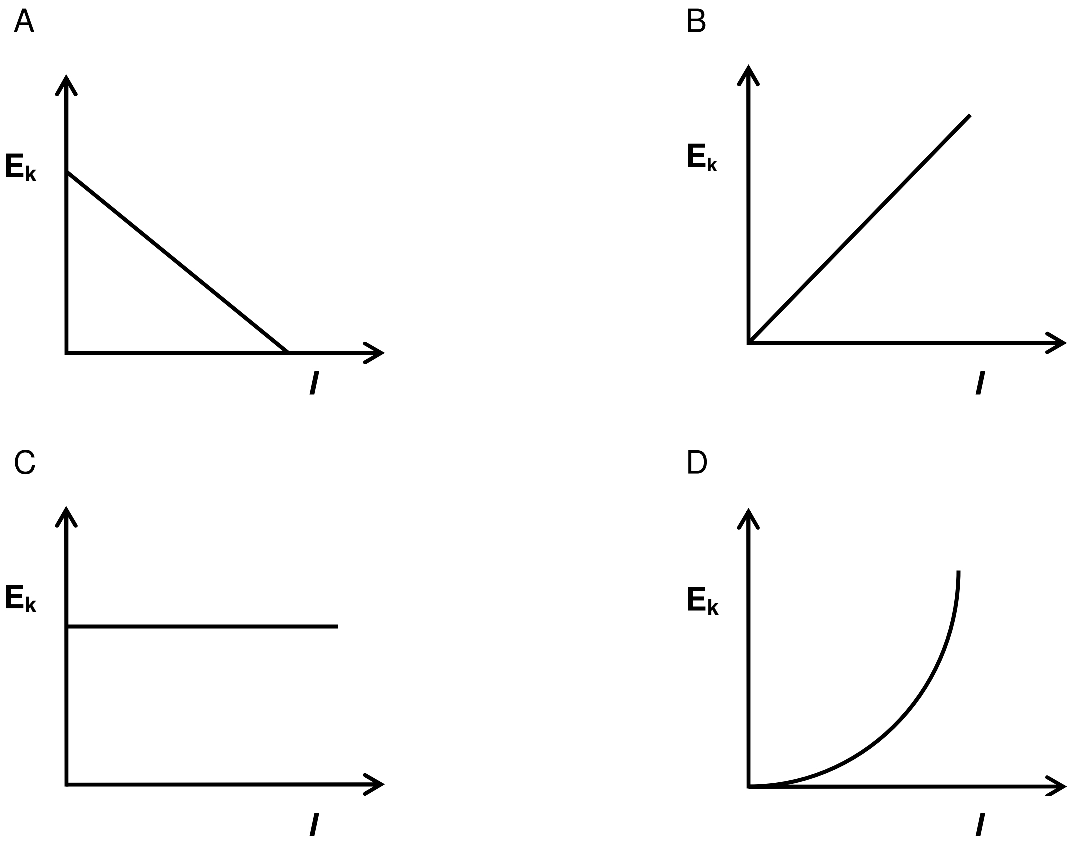
A bly waar dit is
B na X toe beweeg
C na Y toe beweeg
D vertikaal afwaarts beweeg
.

(2)

1.10 Monochromatiese blou lig skyn op ‘n metaaloppervlak soos getoon in die stroombaandiagram hieronder. Die intensiteit, ***I*,** van die inkomende blou lig word geleidelik **VERHOOG.**



Watter **EEN** van die onderstaande grafieke sou die kinetiese energie,, (**E_K)**, van die foto-elektrone wat deur die metaaloppervlak vrygestel word, as ‘n funksie van die intensiteit (***I***) kon voorstel?

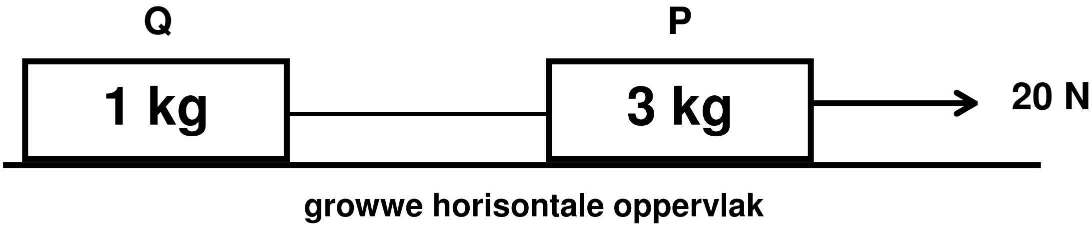


(2)

[20]

VRAAG 2 (Begin op 'n nuwe bladsy.)

Die diagram hieronder toon ‘n 3 kg blok wat met ‘n ligte onrekbare tou aan ‘n 1 kg blok verbind is. ‘n Konstante horisontale krag van 20 N trek die sisteem oor ‘n growwe horisontale oppervlak.



Die wrywingskrag tussen die blokke P en Q en die oppervlak is 2 N en 1 N respektiewelik.

2.1 Stel Newton se Tweede Bewegingswet in woorde. (2)

2.2 Teken ‘n benoemde kragtediagram en toon AL die horisontale kragte wat op die 3 kg blok inwerk. (3)

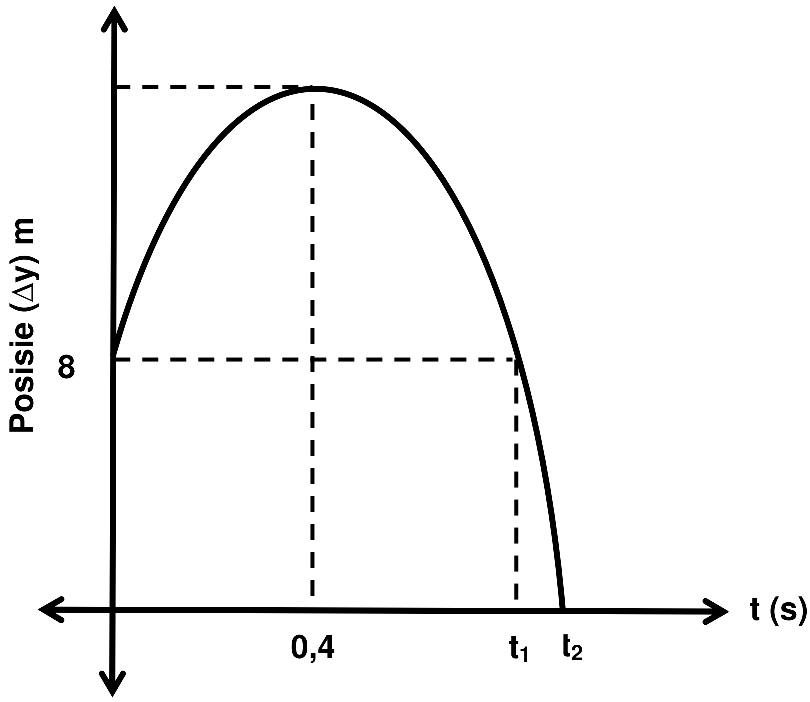
2.3 2.3.1 Bereken die grootte van die versnelling van die 3 kg blok. (5)

2.3.2 Bereken gevolglik die grootte van die spanning in die tou. (2)

[12]

VRAAG 3 (Begin op 'n nuwe bladsy.)

Die onderstaande skets toon die beweging van ‘n bal wat vanaf ‘n balkon vertikaal opwaarts gegooi word. Dit neem 0,4 s om sy hoogste punt te bereik, waarna dit afwaarts val, verby die balkon, en die grond tref. Ignoreer lugweerstand.



3.1 Vanaf die grafiek, hoe hoog is die balkon bokant die grond? (1)

3.2 Sonder berekinge, wat is die numeriese waarde van tyd t_1? (1)

3.3 Bereken die aanvanklike snelheid van die bal. (3)

3.4 Bereken die maksimum hoogte wat die bal bokant die grond bereik. (4)

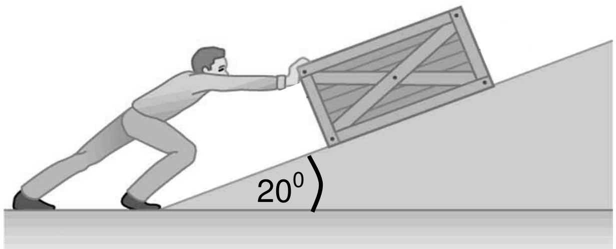
3.5 Bereken die grootte van die finale snelheid van die bal wanneer dit die grond bereik (3)

3.6 Teken ‘n snelheid versus tyd grafiek vir die beweging van die bal. Toon die volgende op jou grafiek aan:
- aanvanklike snelheid
- finale snelheid
- tyd benodig om die maksimum hoogte te bereik (3)

[15]

VRAAG 4 (Begin op 'n nuwe bladsy.)

‘n Man stoot ‘n krat, met massa 10 kg, teen ‘n growwe skuinste, wat ‘n hoek van 20^0 met die horisontaal maak, op. Die man oefen ‘n krag van 100 N parallel tot die skuinste uit.



Die krat word 5 m teen die skuinste op gestoot met ‘n aanvanklike spoed van 1,5 $m.s^{-1}$. Die koëffisient van kinetiese wrywing tussen die krat en die oppervlak is 0,4.

4.1 Teken ‘n benoemde vryliggaamdiagram en toon al die kragte wat op die krat inwerk. (4)

4.2 Bereken die arbeid wat deur gravitasie verrig word. (3)

4.3 Bereken die:

4.3.1 energie verloor as gevolg van wrywing. (6)

4.3.2 arbeid deur die man verrig terwyl hy die krat teen die skuinste opstoot. (1)

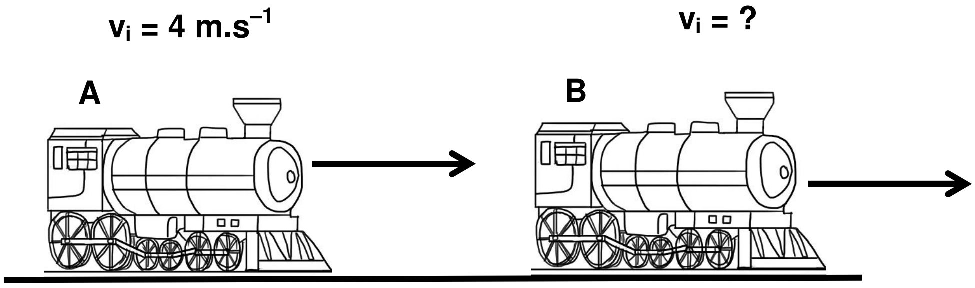
4.4 Stel die Arbeid-Energiestelling in woorde. (2)

4.5 Gebruik die Arbeid-energiestelling en bereken die grootte van die finale snelheid van die krat nadat dit vir 5 m die skuinste opgestoot is. (4)

[20]

VRAAG 5 (Begin op 'n nuwe bladsy.)

Twee spoorweg lokomotiewe, A, massa 6000 kg, en B, massa 5000 kg, beweeg in dieselfde rigting op ‘n reguit horisontale spoor met verskillende konstante spoed soos getoon in die onderstaande skets.



Die twee lokomotiewe bots, hak vas aan mekaar en beweeg teen 3 m.s^{-1} in die oorspronklike rigting onmiddelik na die botsing.

5.1 Is die botsing tussen die twee lokomotiewe elasties of onelasties? Gee ‘n rede vir jou antwoord. (2)

5.2 Bereken die aanvanklike snelheid van lokomotief B voor die botsing. (6)

[8]

VRAAG 6 (Begin op 'n nuwe bladsy.)

Die sirene van ‘n stilstaande brandweerwa gee klankgolwe met ‘n frekwensie van 1800 Hz uit. ‘n Motor, wat op ‘n reguit horisontale pad teen ‘n konstante spoed van 30 m.s^{-1} beweeg, ry verby die brandweerwa en ry verder teen dieselfde konstante spoed.

6.1 Noem die mediese instrument wat gebruik maak van die Dopplereffek. (1)

6.2 Hoe verander die toonhoogte van die sirene wat deur die motor se bestuurder gehoor word (skryf slegs **toeneem**, **afneem** of **bly dieselfde**) wanneer die motor :

6.2.1 na die brandweerwa toe beweeg? (1)

6.2.2 weg van die brandweerwa beweeg? (1)

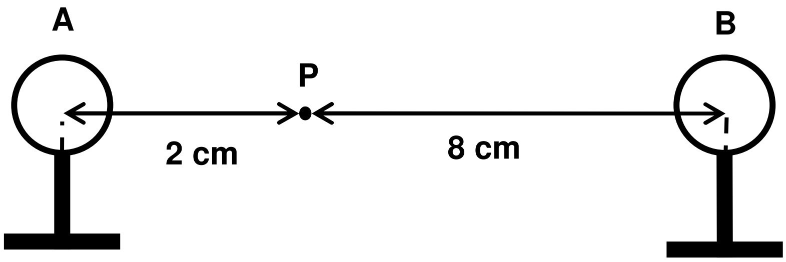
6.3 Bereken die frekwensie wat deur die bestuurder gehoor word wanneer die motor na die brandweerwa toe beweeg. (Neem die spoed van klank in lug as 330 m·s^{-1}) (5)

6.4 Skets ‘n grafiek om te toon hoe die frekwensie van die sirene verander as ‘n funksie van tyd soos die bestuurder nader kom en dan verby die brandweerwa ry (geen numeriese waardes hoef gegee te word nie). (3)

[11]

VRAAG 7 (Begin op 'n nuwe bladsy.)

Twee identiese metaalsfere, A en B, op geisoleerde standers, word geplaas met hulle middelpunte 10 cm van mekaar af, soos in die onderstaande skets getoon. Sfeer A het 'n lading van –15 nC terwyl sfeer B 'n onbekende positiewe lading het. P is 'n punt 2 cm weg vanaf sfeer A se middelpunt, soos getoon in die skets.



Die **NETTO** elektriese veld by punt P is **$3,943 \times 10^5$ $N.C^{-1}$** na links.

7.1 Definieer die term **elektriese veld by 'n punt**. (2)

7.2 Teken die resultante elektriese veldpatroon as gevolg van die ladings op A en B. (2)

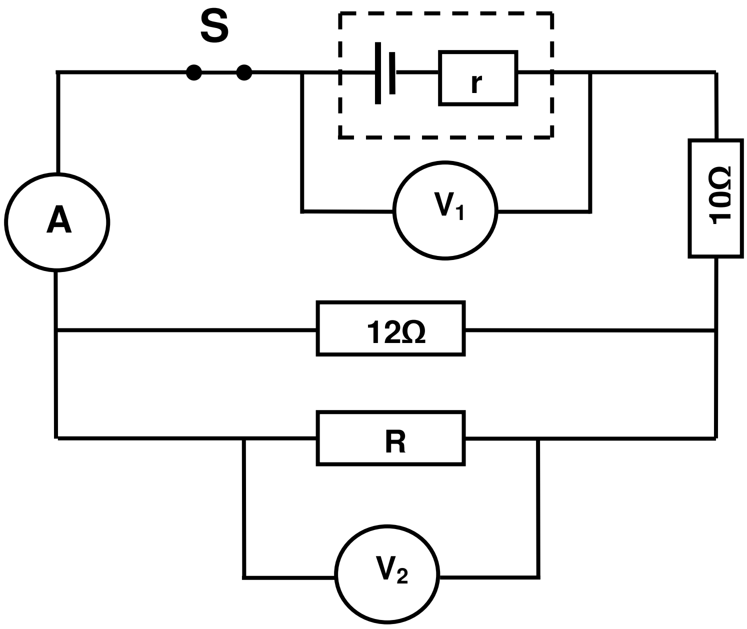
7.3 Bereken die grootte van die onbekende lading op sfeer B. (7)

7.4 Sfeer B word verwyder. Sal die elektriese veld by P as gevolg van die lading op sfeer A, **TOENEEM** , **AFNEEM** of **DIESELFDE BLY**? (1)

[12]

VRAAG 8 (Begin op 'n nuwe bladsy.)

Die battery in die stroombaan, in die diagram hieronder getoon, het ‘n interne weerstand **r**. Wanneer skakelaar **S** gesluit is, is die lesing op voltmeter V_2 18 V en weerstand R verbruik 13,5 W.



8.1 Bereken die weerstand van resistor R. (3)

8.2 Bereken die lesing op die ammeter. (5)

8.3 Verduidelik, in woorde, die betekenis van die term *interne weerstand*. (2)

8.4 Bereken die potensiaalverskil oor die 10 resistor. (3)

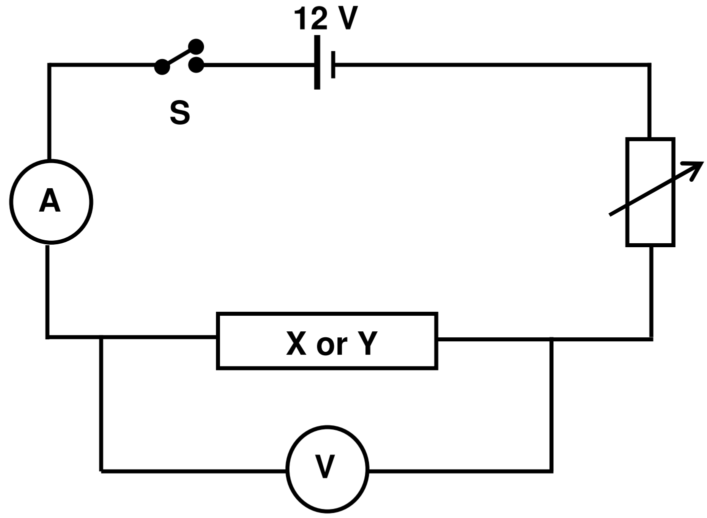
8.5 Wanneer skakelaar S oopgemaak word, verander die lesing op voltmeter V_1 na 45,9 V. Bereken hieruit die interne weerstand van die battery. (5)

8.6 Sal die weerstand van die eksterne stroombaan **TOENEEM**, **AFNEEM** of **DIESELFDE BLY** wanneer Resistor R verwyder word? (1)

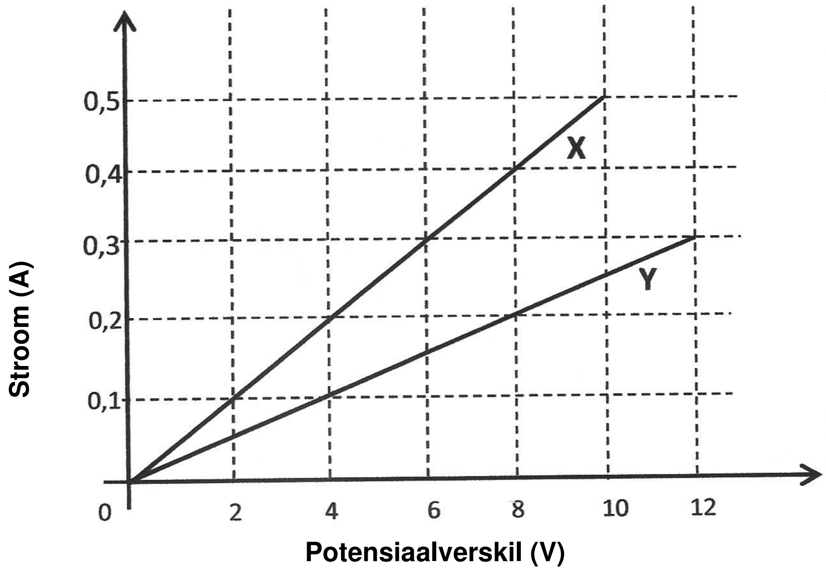
[19]

VRAAG 9 (Begin op 'n nuwe bladsy.)

‘n Leerder stel die stroombaan wat hieronder getoon is, op om die verhouding tussen die potensiaalverskil en stroom vir elk van twee onbekende weerstande, X en Y, te ondersoek. Ignoreer interne weerstande.



Die leerder het die onderstaande grafieke vanaf die ondersoek se uitslae bekom.



9.1 Stel Ohm se Wet in woorde. (2)

9.2 Wat word deur die gradiënt van die bostaande grafiek voorgestel? (1)

9.3 Sonder enige berekeninge, sê watter resistor, X of Y, het die groter weerstand. Gee ‘n rede vir jou antwoord. (2)

9.4 Gebruik die grafiek om die weerstand van resistor X te bepaal. (4)

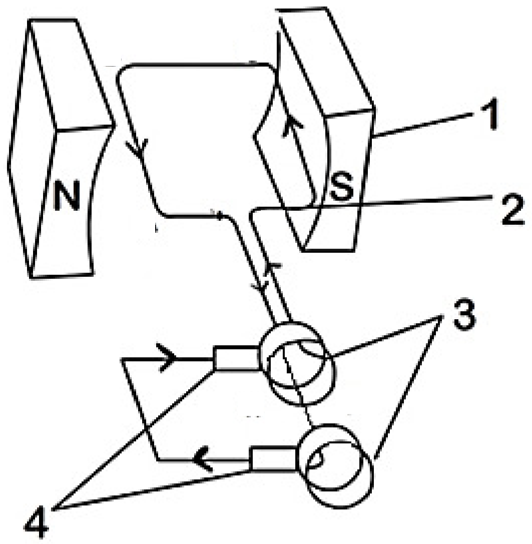
[9]

VRAAG 10 (Begin op 'n nuwe bladsy.)

Elektriese generators word óf as WS óf as GS generators beskryf.

10.1 Watter energieomsetting vind in alle generators plaas? (1)

10.2 Beskou die vereenvoudigde skets van 'n generator hieronder. Die rigting van die aanvanklike geïnduseerde stroom word op die skets aangedui.



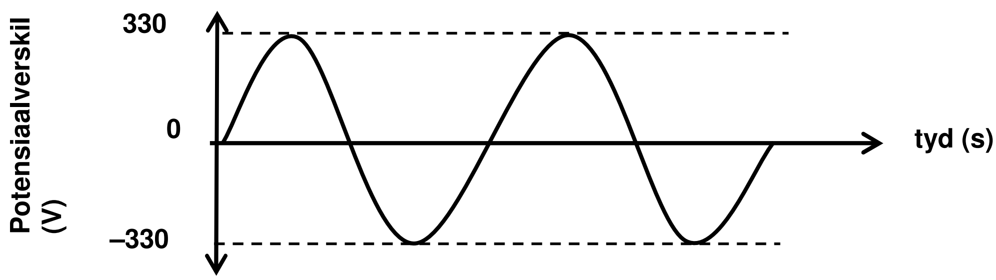
10.2.1 Is die bostaande generator 'n WS of 'n GS generator? (1)

10.2.2 Watter spesifieke gedeelte van die generator in die bostaande skets, **1, 2, 3, of 4** help om hierdie soort generator te identifiseer? (1)

10.2.3 In watter rigting (**kloksgewys of anti-kloksgewys**) word die spoel tussen die magnete gedraai? (1)

10.2.4 Verduidelik kortliks hoekom die geïnduseerde emk 'n maksimum is wanneer die spoel parallel tot die magneetveld is. (2)

10.3 Die grafiek van potensiaalverskil en tyd vir die generator in vraag 10.2 word hieronder getoon.

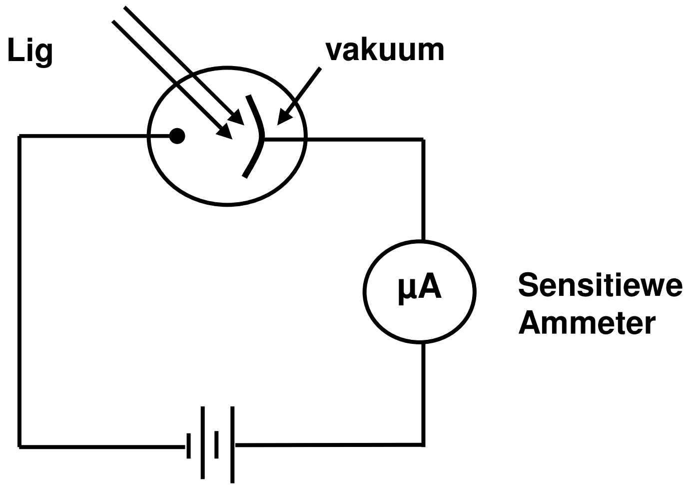


Indien 'n wgk stroom van 15 A geproduseer word, bepaal die tempo waarteen die generator energie sal oordra. (5)

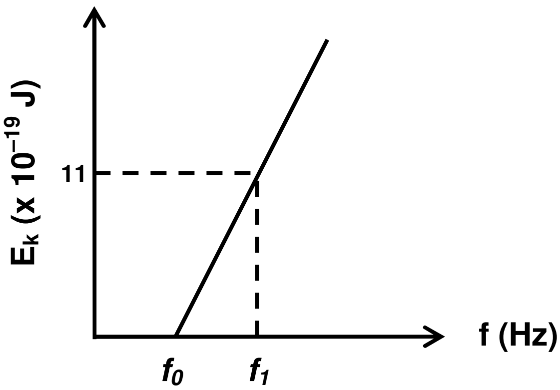
[11]

VRAAG 11 (Begin op 'n nuwe bladsy.)

‘n Leerder ondersoek die verhouding tussen die kinetiese energie van fotoelektrone en die frekwensie van lig wanneer lig invallend is op ‘n metaaloppervlak. Die grafiek wat die leerder geteken het sny die x-as by $f_0 = 5 \times 10^{14}$ Hz.



Grafiek van kinetiese energie versus frekwensie



11.1 Is die metaal waarop die lig skyn die **katode** of die **anode**? (1)

11.2 Watter fisiese hoeveelheid word deur f_0 voorgestel? (1)

11.3 Definieer die term **werksfunksie**. (2)

11.4 Bereken die werksfunksie van die metaal. (3)

11.5 Bereken die frekwensie, f_1, soos getoon op die grafiek. (5)

11.6 Sal f_0 **TOENEEM**, **AFNEEM** of **DIESELFDE BLY** wanneer verskillende frekwensies van lig gebruik word? (1)

[13]

Groot Totaal: 150

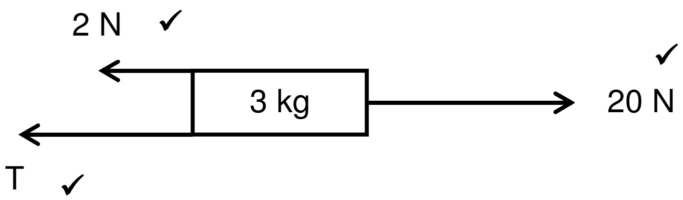
QUESTION/ Vraag 1

1.1	B✓✓	(2)
1.2	A✓✓	(2)
1.3	A✓✓	(2)
1.4	C✓✓	(2)
1.5	B✓✓	(2)
1.6	C✓✓	(2)
1.7	A✓✓	(2)
1.8	A✓✓	(2)
1.9	A✓✓	(2)
1.10	C✓✓	(2)
		[20]

QUESTION/ Vraag 2

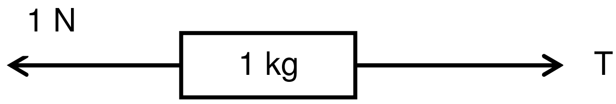
2.1 When a net force is applied to an object, the object accelerates in the direction of the net force. The acceleration is directly proportional to the (net) force and inversely proportional to the mass of the object. ✓✓ //
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die krag teen 'n versnelling direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp. (2)

2.2



(3)

2.3 2.3.1 Consider the 1 kg block:



$F_{net} = ma = T + f$ ✓

$1a = T - 1$ ✓

$T = a + 1$ ……….. equation/vergelyking 1

Consider the 3 kg block:

$F_R = ma = F_{applied} + T + F_f$

$3a = 20 - T - 2$ ✓ ……….. equation/ vergelyking 2

Substituting for T:

$3a = 20 - (a + 1) - 2$ ✓

$4a = 17$

$a = 4{,}25\ m.s^{-2}$ ✓ (5)

OR/ OF

$F_{net} = ma$ ✓

$(F - f) = (M + m)\ a$

✓ ✓

✓

✓

$20 - (2 + 1) = 4a$
$a = 17/4 = 4,25\ ms^{-2}$ (5)

2.3.2 $T = a + 1 = 4,25 + 1 = 5,25$ N (2)

[12]

QUESTION/ VRAAG 3

3.1 8 m ✓ (1)

3.2 0,8 (s) ✓ (1)

3.3 (Take downward motion as NEGATIVE. (Other option: take downwards as positive))

$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (-9,8)(0,4)$
$v_i = 3,92\ m.s^{-1}$, up ✓ ✓ (3)

+ marking 3.3

3.4

OPTION/OPSIE 1 (+ marking 3.3)

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ ✓
$= (3,92)(0,4) + ½(-9,8)(0,4)^2$
$= 0,784$ m ✓
The maximum height = 8 + 0,78
= 8,78 m ✓

OPTION/OPSIE 2

$\Delta U + \Delta K = 0$
$½ mv_i^2 + mgh_i = ½ mv_f^2 + mgh_f$ (Any one) ✓
✓ ✓
$½xm(3,92)^2 + mx9,8x8 = 0 + mx9,8xh$
$h = 8,78$ m ✓

($½xm(3,92)^2 + 0 = 0 + mx9,8xh$
$h = 0,78$ $h_{tot} = 8,78$ m)

OPTION 3 (+ marking 3.3)

$v_f^2 = v_i^2 + 2a\Delta y$
(0)2 = (3,92)2 + 2 (–9,8) Δy ✓
Δy = 0,784 m ✓

The maximum height = 8 + 0,78
= 8,78 m ✓

OPTION 4 (+ marking 3.3)

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ ✓
$= ½(3,92 + 0)(0,4)$
$= 0,78$ m ✓
The maximum height = 8 + 0,78
= 8,78 m ✓

(4)

3.5 from maximum height downwards/ vanaf maksimum hoogte afwaarts
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$= (0)^2 + 2(-9,8)(-8,78)$ ✓ (+ marking from 3.4)
$v_f = 13,12\ m.s^{-1}$ ✓

OR / of

from the balcony upwards/ vanaf balkon opwaarts

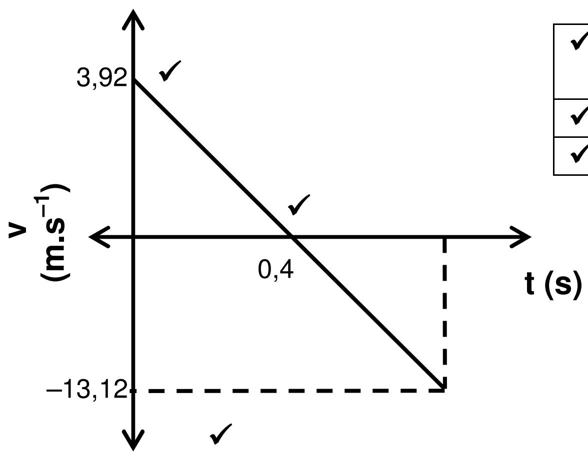
$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$= (0)^2 + 2\ (-9{,}8)\ (-8)$ ✓

$v_f = 13{,}12\ m.s^{-1}$ ✓

(3)

3.6



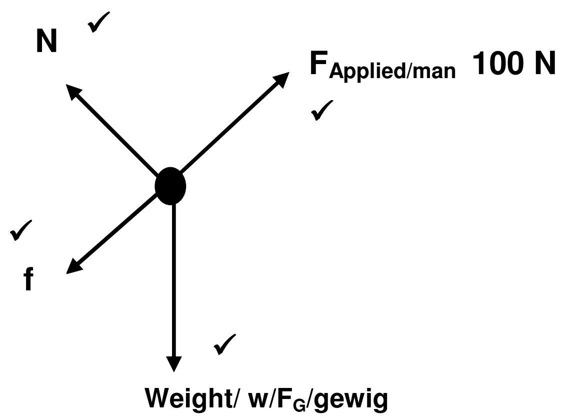
✓	Initial velocity/aanvanklike snelheid
✓	final velocity/finale snelheid
✓	Shape/vorm

(3)

[15]

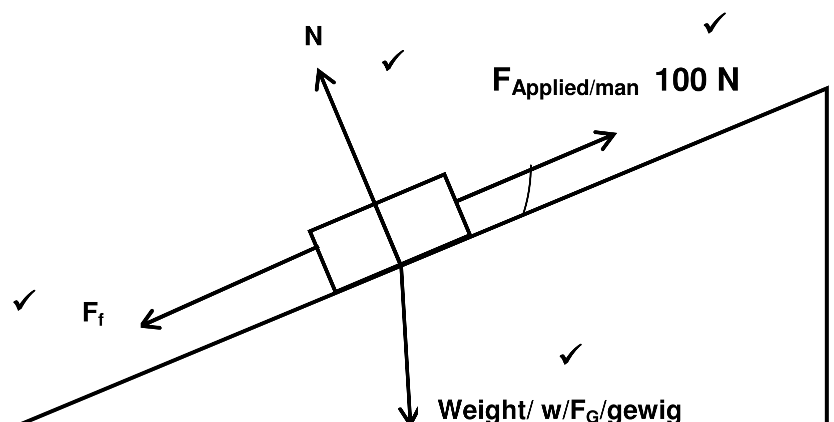
QUESTION/ VRAAG 4

4.1



(4)

OR/OF

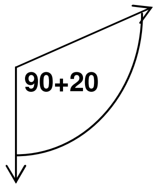


4.2 **OPTION 1**

Work Done by Gravity = $F \Delta x \cos\theta$ ✓

$W_G = (10 \times 9,8)(5) \cos 110^0$ ✓

$= -167,59$ J ✓



OPTION 2 ✓

Work done = ΔE_p =mgh-0 = $mg \Delta x \sin 20^0 = 10 \times 9.8 \times 5 \times \sin 20^0 = 167,59$ J ✓ ✓

(3)

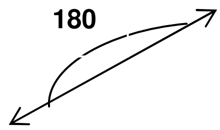
4.3.1 **OPTION 1**

$\Sigma F_y = 0$: $N + F_G \perp = 0$ ✓

$F_N - mg \cos 20^0 = 0$

$F_N = (10)(9,8) \cos 20^0$ ✓

$= 92,1$ N



$f_k = \mu F_N = (0,4)(92,1) = 36,8$ N ✓ ✓

$\therefore$ Work Done by friction = $f_k \Delta x \cos\theta$

$W = (36,8)(5) \cos 180^0$ ✓

$= -184$ J ✓

OPTION 2

$F_k = \mu_k N$ ✓

$= 0,4 \, mg \cos\theta$ ✓

$= 0,4 \times 10 \times 9,8 \cos 20^0$ ✓

$= 36,8$ ✓

$\therefore$ Work Done by friction = $f_k \Delta x \cos\theta$

$W = (36,8)(5) \cos 180^0$ ✓

$= -184$ J ✓

(6)

4..3.2 $W_F = F \Delta x \cos\theta = (100)(5) \cos 0^0 = 500$ N ✓ (1)

4.5 Work Energy theorem states that, the net/total work ✓ done on an object is equal to the change in the object's kinetic energy OR the work done on an object by a resultant/net force is equal to the change in the object's kinetic energy. ✓ (2)

4.6 $W_{NET} = \Delta E_K$ ✓

+ marking 4.2, 4.3.1, 4.3.2, 4.4

✓ ✓

✓

$$W_G + W_f + W_N + W_F = ½ mv_f^2 – ½ mv_i^2$$
$$(–168) + (–184) + (0) + (500) = ½ (10) v_f^2 – ½ (10) ((1,5)^2$$
$$v_f = 5,64 \text{ m.s}^{-1}$$ (4)

[20]

QUESTION/ VRAAG 5

5.1 Inelastic✓ Energy lost due to sound and heat or ✓
The two locomotives move together
Onelasties Lokomotiewe beweeg saam na die botsing (2)

5.2 **(take right a positive)**
$\Sigma p_{before} = \Sigma p_{after}$ ✓ [accept: $m_1v_i + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$ /$p_{before} = p_{after}$]

(6000)(4) ✓ + (5000) (v_B) ✓ = (6000 + 5000) (3) ✓
24000 + 5000 v_B = 33000
v_B = 1,8 m.s^{-1}✓ to the right✓ (6)
<u>Other option</u>: take right as negative
[8]

QUESTION/ VRAAG 6

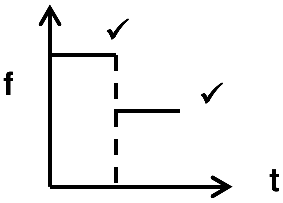
6.1 Blood flow meter / Doppler flow meter ✓ / bloedvloeimeter/Dopplervloeimeter (1)

6.2 6.2.1 Higher pitch ✓/hoër toonhoogte (1)
6.2.2 Lower pitch ✓ / laer toonhoogte (1)

6.3 Use either $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ or $f_L = \frac{v + v_L}{v} f_s$ ✓

$f_L = \frac{330 + 30}{330 - 0}$ ✓✓ x 1800 ✓
f_L = 1 963,6 Hz ✓ (5)

6.4



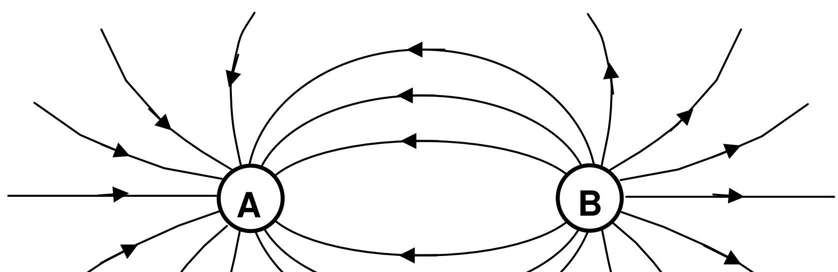
labels ✓

(3)
[11]

QUESTION/ VRAAG 7

7.1 Electric field at a point is the (electrostatic) ✓ force experienced per unit ✓ positive charge placed at that point. // Die elektriese veld by 'n punt is die elektrostatiese krag wat per eenheidspositiewe-lading wat by daardie punt geplaas is ondervind word
(2)

7.2



Curved electric field line important. on outside

Geboë elektriese veld en lyne belangrik op buitekant

1 mark: shape of field between and outside 1 mark direction

(2)

7.3 $E_1 = \frac{kQ}{r^2}$ ✓

$= \frac{9 \times 10^9 (15 \times 10^{-9})}{(2 \times 10^{-2})^2}$ ✓ ✓

$= 337\ 500\ N.C^{-1}$ to the left/ links

$E_2 = \frac{kQ}{r^2}$

$= \frac{9 \times 10^9 (Q_x)}{(8 \times 10^{-2})^2}$ ✓

$= 1{,}40625 \times 10^{12} \times Q_x$ to the left / links

$E_{NET} = E_1 + E_2$

$3{,}943 \times 10^5$ ✓ $= 337\ 500 + 1{,}40625 \times 10^{12}\ Q_X$ ✓

$Q_X = +4{,}04 \times 10^{-8}$ C ✓ (7)

7.4 decrease / ✓ afneem (1)

[12]

QUESTION/VRAAG 8

8.1 $P = \frac{V^2}{R}$ ✓

$13{,}5 = \frac{(18)^2}{R}$ ✓

$R = 24\ \Omega$ ✓

OR $P = VI$ ✓

$I_R = P/V = 13{,}5/18 = 0{,}75$ A ✓

$V = IR$

$R = V/I_R = 18/0{,}75 = 24\ \Omega$ ✓ (3)

8.2 $R = \frac{V}{I}$ ✓

$24 = \frac{18}{I}$ ✓

$I = 0,75\ A$

$R = \frac{V_p}{I_{12}}$

$12 = \frac{18}{I_{12}}$ ✓

$I_{12} = 1,5\ A$ ✓

$I_{Total} = 1,5 + 0,75 = 2,25\ A = I_{10\ \Omega}$ ✓ (5)

OR $\frac{1}{R_p} = \frac{1}{r_1} + \frac{1}{r_2}$ ✓

$\frac{1}{R_p} = \frac{1}{12} + \frac{1}{24}$ ✓

$R_P = 8\Omega$ ✓

$V = IR_P$

$18 = I\ (8)$ ✓

$I = 2,25\ A$ ✓ (5)

8.3 Internal resistance is the opposition to the follow of charge within ✓ a cell (or an ammeter) ✓/ Interne weerstand is die teenstand teen die vloei van stroom binne-in 'n sel (of 'n ammeter) (2)

8.4 When the switch is closed, the pd across the 10 Ω resistor is

$V_{10} = IR_{10}$ ✓ $= 2,25 \times 10$ ✓ $= 22,5\ V$ ✓ (3)

8.5 The pd across the external resistors is given by:

$V_1 = V_{ext} = V_P + V_{10} = 18 + 22,5 = 40,5\ V$ ✓

When the switch is open the total pd (emf) is: Emf $= V_{total} = 45,9\ V$

∴ The 'lost volts' is: $V_L = V_{Total} - V_{ext} = 45,9 - 40,5 = 5,4\ V$ ✓

$r = \frac{V_L}{I}$ ✓

$= \frac{5,4}{2,25}$ ✓

$= 2,4\ \Omega$ ✓ (5)

OR $V_{TOT} = E = I_{TOT} (R_{ext} + R_{int})$ ✓

45,9 ✓ $= (2,25) (R_P + 10 + r)$

$= (2,25) (8 + 10 + r)$ ✓

$r = 2,4\ \Omega$ ✓

$\frac{1}{R_p} = \frac{1}{r_1} + \frac{1}{r_2}$

$\frac{1}{R_p} = \frac{1}{12} + \frac{1}{24}$

$R_P = 8\Omega$ ✓

8.6 Increase / Toeneem (1)

[19]

QUESTION/ VRAAG 9

9.1 Ohm's Law states ✓ that: the potential difference across a conductor is directly proportional to the current in the conductor at constant temperature ✓./
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (2)

9.3 Inverse of resistance or 1/R ✓ / omgekeerde van weerstand (1)

9.2 Y ✓ The inverse of the gradient of graph ✓ Y is greater ✓
Gradient of graph Y smaller. Thus 1/R smaller. Hence, R is greater.
Y; Y se gradient kleiner dus is die omgekeerde van R kleiner, dus R groter (2)

9.4 R_X can be found by finding the gradient of the graph for X

$$\text{gradient} = \frac{\Delta I}{\Delta V}$$

$$m = \frac{0,4 - 0,2}{8 - 4}$$ ✓ ✓

(or other correct values from graph)
(of ander korrekte waardes vanaf grafiek)

$= 0,05$

$$Rx = \frac{1}{0,05}$$ ✓

$= 20\ \Omega$ ✓ (4)

[9]

QUESTION/VRAAG 10

10.1 Mechanical energy is converted to electrical energy. ✓/ meganiese energie na elektriese energie (1)

10.2 10.2.1 AC generator ✓/ WS generator (1)

10.2.2 3 ✓ (slip rings/ sleepringe) (1)

10.2.3 anti-clockwise ✓/ anti-kloksgewys (1)

10.2.4 The (rate of) change in magnetic flux ✓/ magnetic field linkage is at a maximum ✓ // die tempo van verandering van magnetise fluks is maksimum

. (2)

10.3 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $= \frac{330}{\sqrt{2}}$ ✓

$= 233,36$ V

$P_{rms} = V_{rms}I_{rms}$ ✓

$= 233,36 \times 15$ ✓

$= 3500,25$ W ✓ (5)

[11]

QUESTION/VRAAG 11

11.1 Cathode ✓ / katode (1)

11.2 Threshold frequency ✓ /dumpelfrekwensie ✓ (1)

11.3 Work function is the minimum quantity of energy which is required to remove an electron from the surface of a given solid, usually a metal. ✓
die minimum energie benodig om 'n elektron uit die oppervlak van 'n metaal vry te stel. (2)

11.4 $E = W_0 = h f_0$ ✓

$= (6,63 \times 10^{-34})(5 \times 10^{14})$ ✓

$= 3,315 \text{ X } 10^{-19}$ J ✓ (3)

11.5 $hf = W_0 + \frac{1}{2}mv^2$ ✓

$(6,63 \times 10^{-34})$ ✓ $(f_1) = 3,315 \times 10^{-19}$ ✓ $+ 11 \times 10^{-19}$ ✓

$f_1 = 2,15 \times 10^{15}$ Hz ✓ (5)

11.6 same ✓/ dieselfde (1)

[13]

Grand total: 150

education
DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

NATIONAL SENIOR CERTIFICATE EXAM

PHYSICAL SCIENCES: PHYSICS (P1)

GRADE 12

SEPTEMBER 2014

MARKS: 150

TIME: 3 HOURS

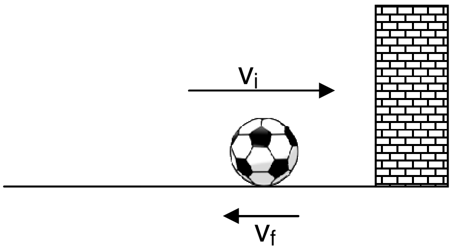
This paper consists of 16 pages and 2 data sheets

SECTION A

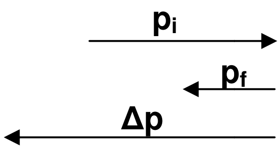
QUESTION 1: MULTIPLE CHOICE QUESTIONS

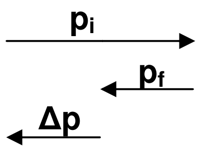
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A-D) next to the question number (1.1-1.10) in the ANSWER BOOK.

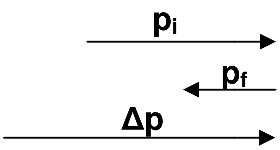
1.1 A ball, mass m, moves towards a wall, collides inelastically with the wall and moves back.

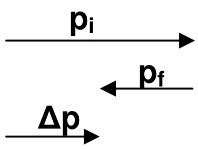


Which one of the following vector diagrams shows the correct relationship between the initial momentum ($\mathbf{p_i}$) of the ball, the final momentum ($\mathbf{p_f}$) of the ball and the change in momentum ($\mathbf{\Delta p}$) the ball experiences?

A


B


C


D


(2)

1.2 Two asteroids, 1 000 km apart, experience an attractive gravitational force **F** between each other**.** If the asteroids move away from each other until a distance of 2 000 km separates them, the magnitude of the new gravitational force will be…

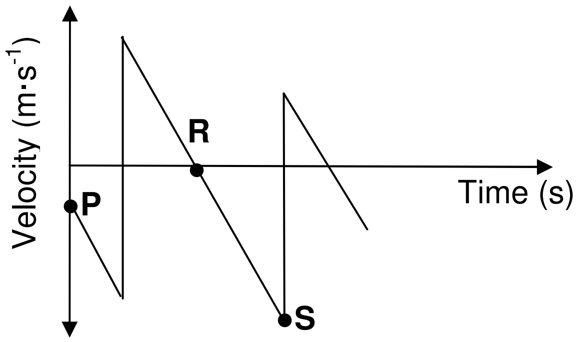
A $\frac{1}{4}\mathbf{F}$

B $\frac{1}{2}\boldsymbol{F}$

C $\sqrt{2\boldsymbol{F}}$

D $4\boldsymbol{F}$ (2)

1.3 A ball is thrown vertically downwards from a certain height above the floor. The ball bounces a few times from the floor. The velocity–time graph below represents the motion of the bouncing ball from the moment it was thrown. Ignore the effects of friction.



Which point (**P**, **Q**, **R** or **S**) on the graph represents the coordinates of the maximum height after the first bounce?

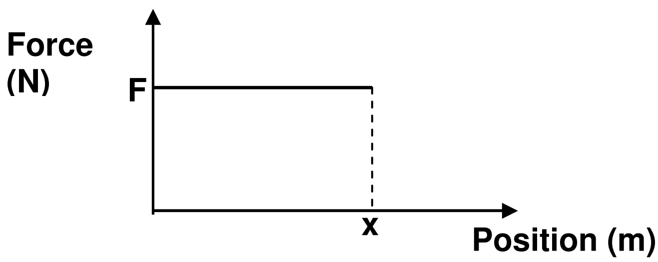
A **P**

B **Q**

C **R**

D **S** (2)

1.4 A constant force **F** applied to an object causes a change in position, **Δx**. The graph of force versus position for the object is given below. Assume that the force **F** and the change in position are in the same direction.



Which ONE of the following statements is correct?

A The gradient of the graph represents the net work done by the force.

B The gradient of the graph represents the change in kinetic energy.

C The area under the graph represents the work done by the force.

D The area under the graph represents the power dissapated by the force. (2)

1.5 The reason why the observed pitch of an ambulance decreases as the ambulance moves away from a stationary observer, is because the

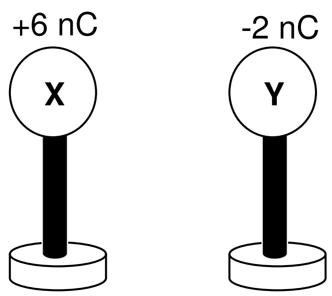
A amplitude of the sound wave decreases.

B amplitude of the sound wave increases.

C wavelength of the sound wave decreases.

D wavelength of the sound wave increases. (2)

1.6 Two identical metal spheres **X** and **Y**, on isolated stands, have charges of +6 nC and -2 nC respectively. **Y** is brought into contact with **X**. **Y** is then placed in its original position again.

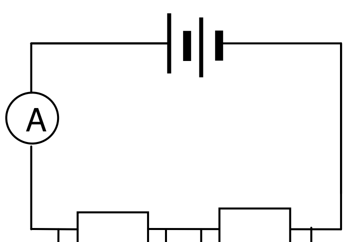


The final charge on each sphere is:

	X	Y
A	0 nC	0 nC
B	3 nC	-1 nC
C	2 nC	2 nC
D	4 nC	4 nC

(2)

1.7 The internal resistance of the battery in the circuit diagram below is negligible.



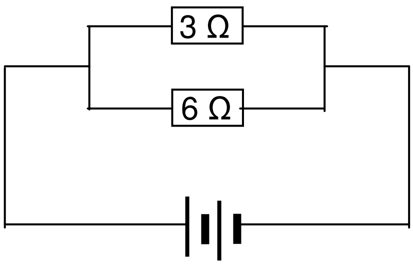
V

Switch S is closed. Which ONE of the following represents the change in the voltmeter and ammeter readings?

	Voltmeter reading	Ammeter reading
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Decreases
D	Decreases	Increases

(2)

1.8 In the circuit diagram below, the power dissipated by the 3 Ω resistor is **P**. The power dissipated by the 6 Ω resistor is…



A $\frac{1}{4}\boldsymbol{P}$

B $\frac{1}{2}\boldsymbol{P}$

C $2\boldsymbol{P}$

D $4\boldsymbol{P}$ (2)

1.9 An electric iron is rated 1 400 W ; 220 V. It takes 3 hours to iron a load of clothes. The cost to iron these clothes, if the cost of electricity is R1,30 per kWh, is…

A R 1,82

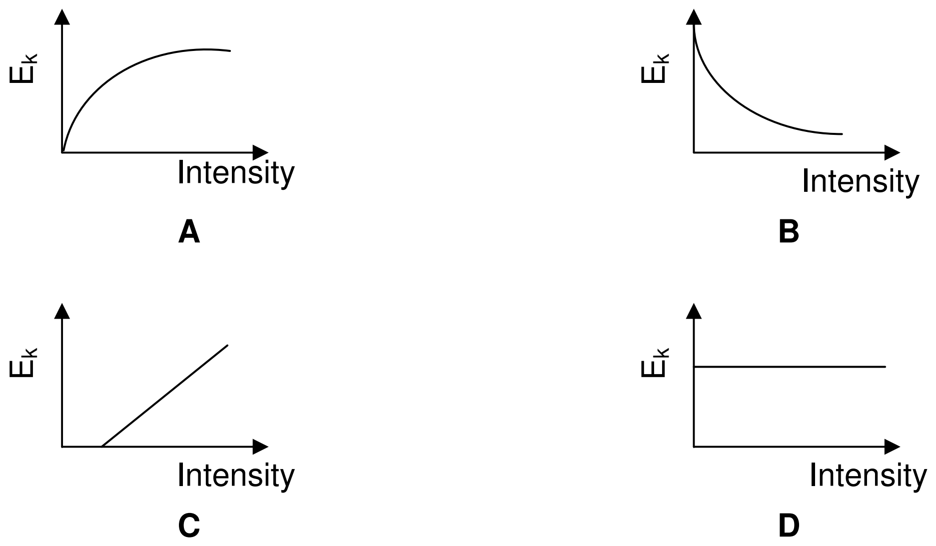
B R 5,46

C R 8,58

D R 18,20 (2)

1.10 Blue light of different intensities is shone onto the cathode of a photo-electric cell. Photo-electrons are emitted from the cathode.

Which ONE of the following graphs represents the correct relationship between the maximum kinetic energy of the emitted photo electrons and the intensity of the incident light?



(2)

TOTAL SECTION A: [20]

SECTION B

INSTRUCTIONS

1. Start each question on a new page.

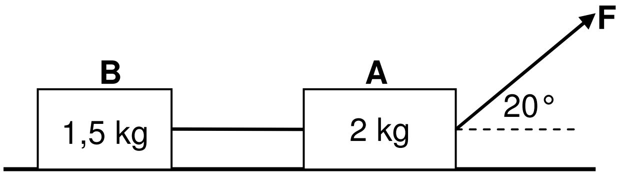
2. Leave one line open between two sub-questions, for example between **QUESTION 2.1** and **2.2.**

3. Show the formulae and substitutions in ALL calculations.

4. ***Round off your final numerical answers to a minimum of two decimal places.***

QUESTION 2 (Start on a new page.)

A light inelastic string connects two blocks of mass 1,5 kg and 2 kg respectively. A force is applied at an angle of 20° on block A.



If a force **F** of 8,25 N is applied on block **A**, the blocks move at a CONSTANT VELOCITY on the rough surface.

2.1 Calculate the horizontal component of the applied force **F**. (2)

2.2 Calculate the magnitude of the normal force acting on block **A**. (3)

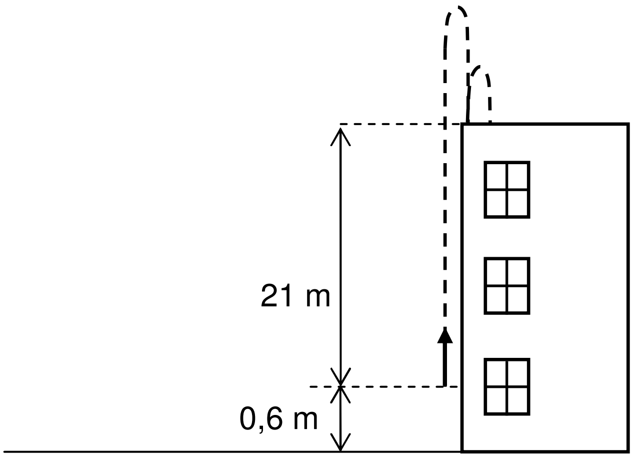
2.3 Calculate the coefficient of kinetic friction between the blocks and the rough surface. (4)

2.4 How will the frictional force on block **A** change if the angle of the force changes to 15°? Write down INCREASES, DECREASES or REMAINS THE SAME. (1)

[10]

QUESTION 3 (Start on a new page.)

A boy kicks a ball vertically upwards from a height of 0,6 m above the ground. The ball moves past the top of a building, 21 m higher than the point from where he kicked the ball. The ball hits the roof of the building 3,1 s after it was kicked. The ball bounces once off the roof of the building and then comes to rest. Ignore all effects of air resistance.



3.1 Write down the magnitude and direction of the acceleration of the ball at point X. (2)

3.2 Calculate the magnitude of the velocity with which the ball was kicked. (4)

3.3 Calculate the maximum height that the ball reaches above the ground. (4)

3.4 Refer to the sketch and state whether the collision of the ball on the roof is ELASTIC or INELASTIC. Give a reason for the answer. (2)

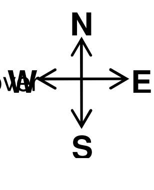
3.5 Sketch a postion versus time graph for the complete motion of the ball, from the moment it was kicked until it comes to rest. Use the roof of the building as the zero of position.
Indicate the following on the graph:

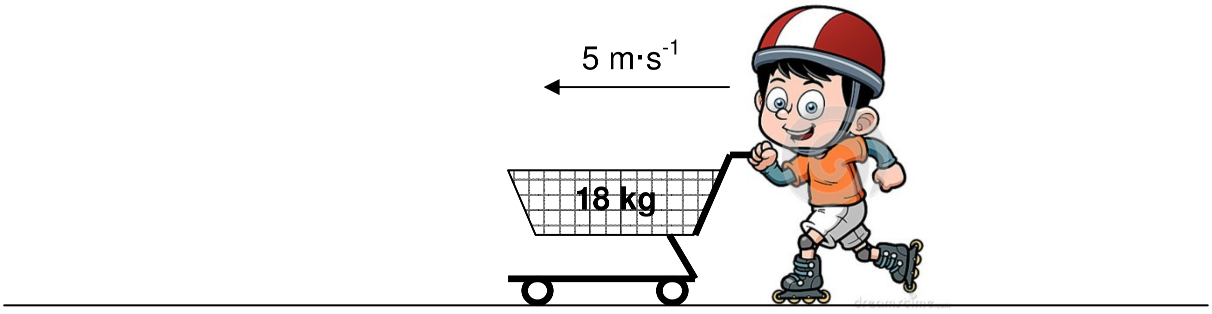
- The position of the ball when the boy kicks it.
- The position at point X.
- The time when the ball hits the roof the first time.

(5)
[17]

QUESTON 4 (Start on a new page)

A boy on roller blades with his hands on a fully loaded trolley, mass 18 kg, moves west at 5 $m \cdot s^{-1}$ over a frictionless surface as shown in the sketch. The boy now pushes the trolley so that he moves at 1 $m \cdot s^{-1}$ east after this push. The mass of the boy and his roller blades is 45 kg.





4.1 State the conservation principle that is applicable during the interaction between the boy and the trolley. (2)

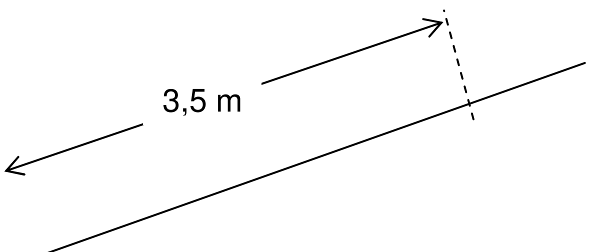
4.2 Calculate the velocity of the trolley directly after the boy pushed it. (4)

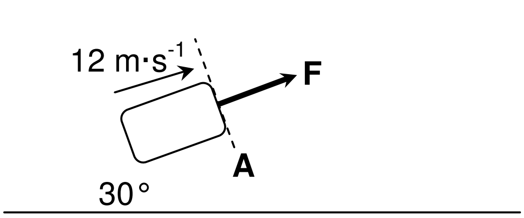
4.3 During the pushing motion of the boy on the trolley, the trolley experiences an impulse. How does the magnitude of the impulse that the boy experiences compare to that of the trolley? Write down INCREASES, DECREASES or REMAINS THE SAME and explain your answer. (3)

4.4 If the force exerted on the trolley lasts 0,4 s, calculate the force that the boy exerts on the trolley. (4)
[13]

QUESTION 5 (Start on a new page)

A constant force **F** is applied to a crate of mass 25 kg to move it upwards along a frictionless inclined plane. When it reaches point **A**, its speed is 12 $m \cdot s^{-1}$ and 10,8 $m \cdot s^{-1}$ when it reaches point **B** which is 3,5 m further up the incline.





5.1 Draw a free force diagram showing ALL the forces acting on the crate while it is moving up the incline. (3)

5.2 Is mechanical energy conserved during this motion? Write down YES or NO and briefly explain the answer. (2)

5.3 Write down the NAME of the conservative force that acts on the crate. (1)

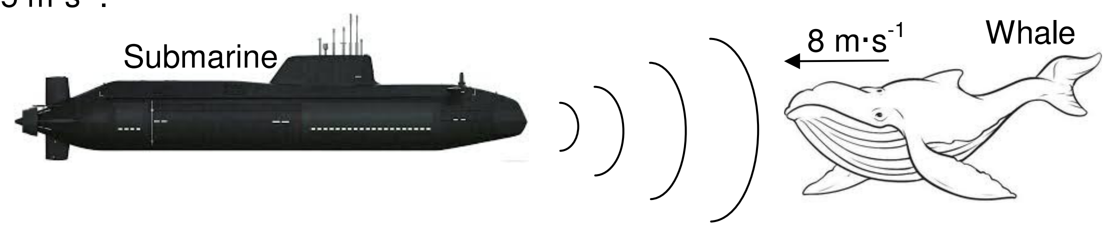
5.4 Give a reason why the normal force does no work on the crate during its motion up the incline. (1)

5.5 In which direction does the net force act on the crate as it moves up the incline? Write only **FROM A TO B** or **FROM B TO A**. (1)

5.6 Use ENERGY PRINCIPLES to calculate the magnitude of the force **F.** (6)
[14]

QUESTION 6 (Start on a new page)

A whale swims directly towards a stationary submarine at 8 $m \cdot s^{-1}$. The sonar system of the submarine has a frequency of 23 000 Hz. Take the speed of the sonar wave in sea water as 1 435 $m \cdot s^{-1}$.



6.1 Define the *Doppler effect*. (2)

6.2 How does the frequency that the whale observes compare to the frequency sent out by the submarine? Write down only HIGHER, LOWER or STAYS THE SAME. (1)

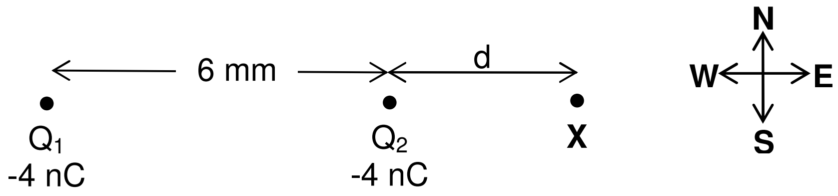
6.3 Calculate the frequency of the sound wave heard by the whale. (4)

The Doppler-effect is also used to monitor the movement of remote stars. During such a study of a star it was observed that the absorption line of red light moved to 688 nm. On the earth the absorption line of red light is observed at 653 nm.

6.4 Is the remote star moving NEARER TO or FURTHER AWAY from the earth? Give a reason for your answer. (4)
[16]

QUESTION 7 (Start on a new page.)

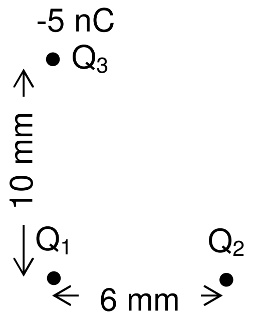
In the diagram below, a point charge, Q_2, with a charge of -4 nC is placed 6 mm east of an identical point charge Q_1. Point **X** is a distance **d** east of Q_2.



7.1 Draw the net electric field pattern due to charges Q_1 and Q_2. (3)

7.2 The electric field at point **X**, due to ONLY Q_1, is $4{,}44 \times 10^5$ $N{\cdot}C^{-1}$ west.
Calculate the distance **d**. (5)

A charge Q_3 of -5 nC is now placed 10 mm due north of charge Q_1.

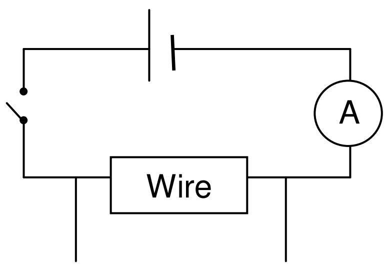


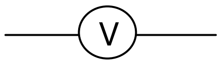
7.3 Write down Coulomb's law in words. (2)

7.4 Calculate the magnitude of the net force that the charge Q_1 will experience due to the charges Q_2 and Q_3.
(6)
[16]

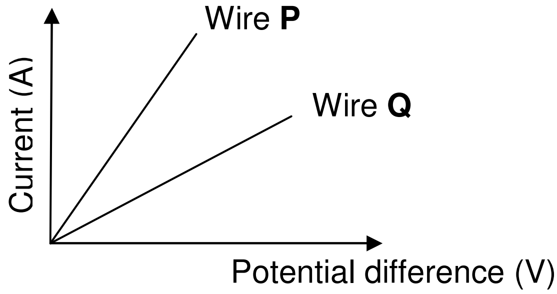
QUESTION 8 (Start on a new page.)

Learners investigate the conductivity of two metal wires **P** and **Q** that are made of different materials. They connect one wire at a time in a circuit diagram as shown below.





The potential difference across each wire is increased by a constant amount and the current is measured accordingly. The learners represent their observations in the following sketch graph.



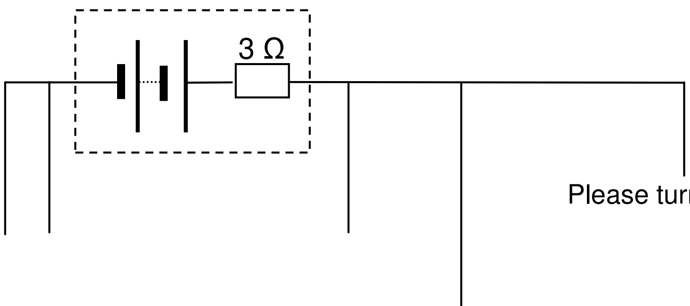
8.1 Write down the investigative question. (2)

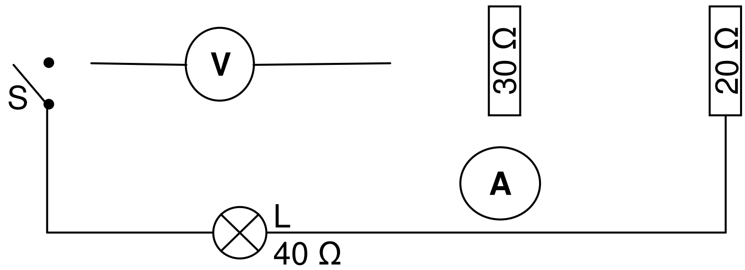
8.2 State TWO variables that the learners had to keep constant in the investigation. (2)

8.3 With reference to the gradients of the graph, determine which one of the wires is the better conductor. Write down **P** or **Q** and explain your answer. (3)
[7]

QUESTION 9 (Start on a new page.)

In the circuit diagram below the light bulb L has a resistance of 40 Ω and the battery has an internal resistance of 3 Ω. The reading on the voltmeter ***decreases*** with 4,5 V when the switch S is closed.





9.1 Explain why there is a decrease in the voltmeter reading when the switch S is closed. (2)

9.2 The switch S is closed. Calculate the:

9.2.1 current in the battery. (3)

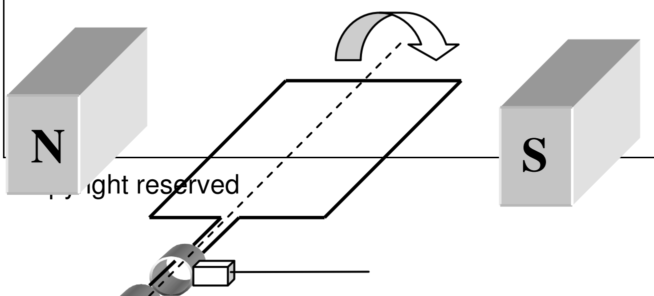
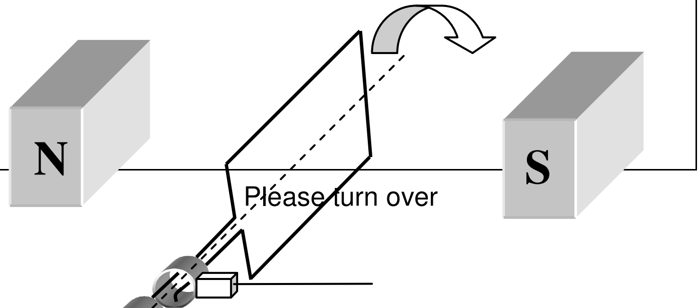
9.2.2 emf of the battery. (5)

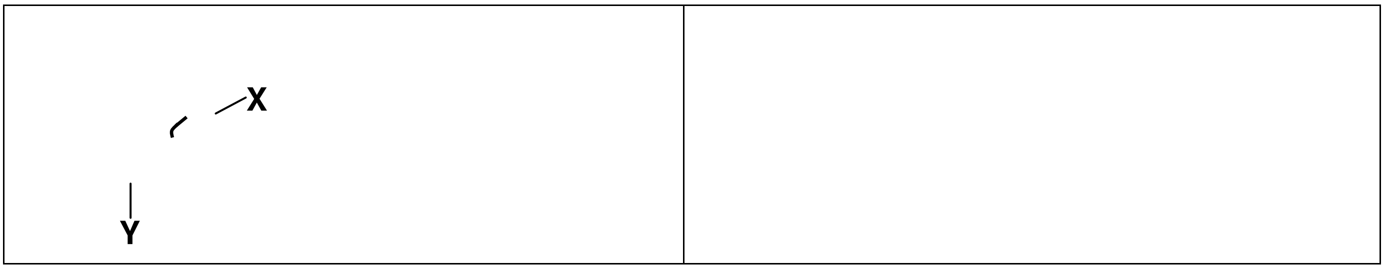
9.2.3 reading on the ammeter. (3)

9.3 The 20 Ω resistor suddenly burns out. How will the power dissipated in the light bulb change?
Write down INCREASES, DECREASES or REMAINS THE SAME and explain the answer fully. (4)
[17]

QUESTION 10 (Start on a new page.)

The following simplified sketches represent an alternating current (AC) generator that is rotated clockwise.

Sketch A	Sketch B
	



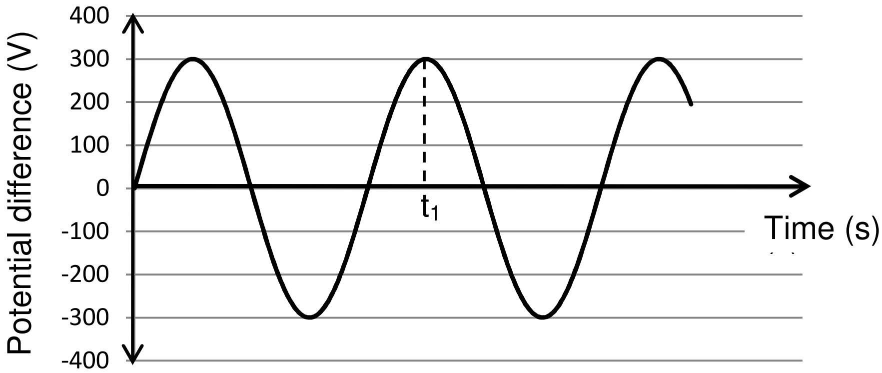
10.1 Write down the energy conversion that takes place in an AC generator. (1)

10.2 Write down the name of the component

10.2.1 labelled **X** (1)

10.2.2 labelled **Y** (1)

10.3 The maximum current output of this AC generator is 21 A. A graph of the potential difference output of the generator against time is shown below.



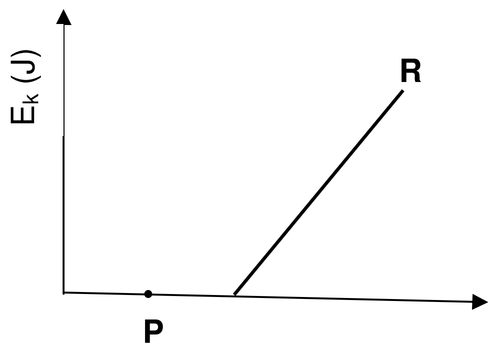
10.3.1 Which ONE of the sketches (**A** or **B**) shows the position of the coil at the time t_1 on the graph? (1)

10.3.2 Calculate the average power generated by the generator. (5)

[9]

QUESTION 11 (Start on a new page.)

Light of different frequencies is irradiated onto the metal cathode **R** of a photo-cell. The kinetic energy of the released photo-electrons is measured and shown in the graph below.



5,79 Frequency ($\times 10^{14}$ Hz)

11.1 Explain why no photo-electrons are released when light of frequency P is used. (2)

11.2 The photo-cell is now replaced with one which contains a metal cathode **S** and is irradiated with light of different frequencies. The metal cathode **S** has a higher work function than metal cathode **R**.

Redraw the above graph in your answer book. Indicate the relationship between the frequency and the kinetic energy of metal cathode **S** on the same axis. Label the graphs very clearly as **R** and **S**. (2)

Ultraviolet light with a frequency of 1,5 × 10^{15} Hz is irradiated on the surface of metal cathode **R.** Photo-electrons are released.

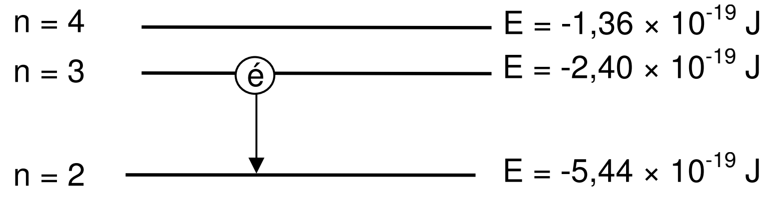
11.3 Calculate the energy of a photon of ultraviolet light. (3)

11.4 Calculate the maximum kinetic energy of the photo-electrons. (4)
[11]

QUESTION 12 (Start on a new page.)

The following table represents the different energy levels of the hydrogen atom as well as the corresponding energy values, in joule (J) of each energy level.

ENERGY LEVEL *ENERGY VALUE*



n = 1 E = $-2,18 \times 10^{-18}$ J

12.1 The colour of light and its corresponding wavelength is given in the table below.

COLOUR	WAVE LENGTH ($\times 10^{-9}$ m)
Red	650
Orange	590
Yellow	570
Green	510
Blue	475
Violet	400

Determine the colour of light emitted when an electron falls back from the third to the second energy level. Show ALL calculations. (6)
[6]

TOTAL SECTION B: [130]
GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9,8\ m \cdot s^{-2}$
Universal gravitational constant	G	$6,67 \times 10^{-11}\ N \cdot m^2 \cdot kg^{-2}$
Radius of Earth	R_E	$6,38 \times 10^6$ m
Mass of Earth	M_E	$5,98 \times 10^{24}$ kg

SECTION A

QUESTION 1 / VRAAG 1

1.1 A ✓✓
1.2 A ✓✓
1.3 C ✓✓
1.4 C ✓✓
1.5 D ✓✓
1.6 C ✓✓
1.7 A ✓✓
1.8 B ✓✓
1.9 B ✓✓
1.10 D ✓✓

[20]

TOTAL SECTION A/TOTAAL AFDELING A: 20

SECTION B/AFDELING B

QUESTION 2 / VRAAG 2

2.1 $F_x = F \cdot \text{Cos}\ \Theta$
$= 8{,}25\ \text{Cos}\ 20°$ ✓
$= 7{,}75\ \text{N}$ ✓ (2)

2.2 $F_N + Fy + Fg = 0$
$F_N + (8{,}25 \times \text{Sin}20°)$✓ $+ (-19{,}6)$✓ $= 0$
$F_N = 16{,}78\ \text{N}$ ✓ (3)

2.3 POSITIVE MARKING FROM QUESTION 2.1 + 2.2
$f = \mu_k \cdot F_N$ ✓
$7{,}75$✓ $= \mu_k(\underline{16{,}78 + 1{,}5 \times 9.8})$ ✓
$\mu_k = 0{,}25$✓ (4)

2.4 Increases ✓ / Toeneem (1)

[10]

QUESTION 3 / VRAAG 3

3.1 9,8 $m\cdot s^{-2}$✓ downwards✓ / afwaarts (2)

3.2

OPTION 1 **upwards positive:** $\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ 21✓ = $v_i(3,1) + \underline{½(-9,8)(3,1)^2}$ ✓ v_i = 21,96 $m\cdot s^{-1}$ ✓ **downwards positive** $\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ -21✓ = $v_i(3,1) + \underline{½(9,8)(3,1)^2}$ ✓ v_i = -21,96 $m\cdot s^{-1}$ v_i = 21,96 $m\cdot s^{-1}$ ✓ (4)	Notes: Accept / Aanvaar: g or/of a $\Delta x = v_i\Delta t + ½a\Delta t^2$

3.3 POSITIVE MARKING FROM 3.2

OPTION 1/OPSIE 1 **Upwards as positive** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{0^2 = 21,96^2 + 2(-9,8)\Delta y}$ ✓ Δy = 24,6 m Max height = 24,6 <u>+ 0,6</u>✓ = 25,2 m ✓ (4) **Downwards as positive** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{0^2 = (-21,96)^2 + 2(9,8)\Delta y}$ ✓ Δy = -24,6 m Max height = 24,6 <u>+ 0,6</u>✓ = 25,2 m ✓ (4)	<u>Notes/Aantekeninge:</u> Accept/Aanvaar: g or/of a $v_f^2 = v_i^2 + 2a\Delta x$ $v^2 = u^2 + 2as$
OPTION 2/OPSIE 2 $(E_p + E_k)_{bottom} = (E_p + E_k)_{top}$ } ✓ $(mgh + ½mv^2)_{bottom} = (mgh + ½mv^2)_{top}$ } $\underline{0 + ½(21,96)^2 = 9,8h + 0^2}$ ✓ h = 24,6 m Max height above the ground = 24,6 <u>+ 0,6</u>✓ = 25,2 m ✓ (4)	

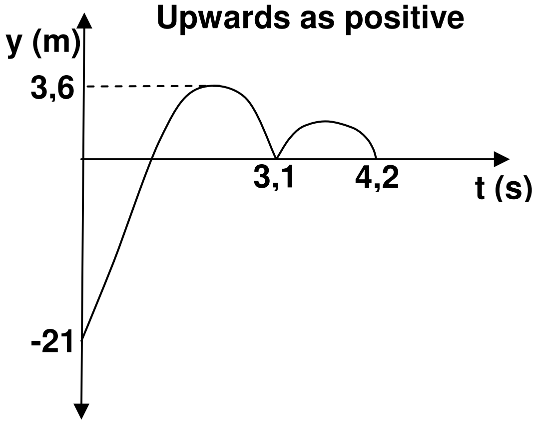
<u>OPTION 3/OPSIE 3</u> **Upwards as positive** $v_f = v_i + a\Delta t$ $0 = 21{,}96 + (-9{,}8)\Delta t$ ✓ $\Delta t = 2{,}24$ s $\Delta y = v_i\Delta t + ½a\Delta t^2$ $= \underline{(21{,}96)(2{,}24) + ½(-9{,}8)(2{,}24)^2}$ ✓ $\Delta y = 24{,}6$ m Max height = 24,6 <u>+ 0,6</u>✓ = 25,2 m ✓ (4) **Downwards as positive** $v_f = v_i + a\Delta t$ $0 = (-21{,}96) + (9{,}8)\Delta t$ ✓ $\Delta t = 2{,}24$ s $\Delta y = v_i\Delta t + ½a\Delta t^2$ $= \underline{(-21{,}96)(2{,}24) + ½(9{,}8)(2{,}24)^2}$ ✓ $\Delta y = -24{,}6$ m Max height = 24,6 <u>+ 0,6</u>✓ = 25,2 m ✓ (4)	<u>Notes/Aantekeninge:</u> Accept/Aanvaar: g or/of a v = u + at $s = ut + ½ at^2$ $\Delta x = v_i\Delta t + ½a\Delta t^2$
<u>OPTION 4/OPSIE 4</u> **Upwards as positive** $v_f = v_i + a\Delta t$ $0 = (21{,}96) + (-9{,}8)\Delta t$ ✓ $\Delta t = 2{,}24$ s $\Delta y = \frac{v_f + v_i}{2}\Delta t$ $= \frac{0+(21{,}96)}{2}(2{,}24)$ ✓ $\Delta y = 24{,}6$ m Max height = 24,6 <u>+ 0,6</u>✓ = 25,2 m ✓ (4) **Downwards as positive** $v_f = v_i + a\Delta t$ $0 = (-21{,}96) + (9{,}8)\Delta t$ ✓ $\Delta t = 2{,}24$ s $\Delta y = \frac{v_f + v_i}{2}\Delta t$ $= \frac{0+(-21{,}96)}{2}(2{,}24)$ ✓ $\Delta y = -24{,}6$ m Max height = 24,6 <u>+ 0,6</u>✓ = 25,2 m ✓ (4)	<u>Notes/Aantekeninge:</u> Accept/Aanvaar: g or/of a v = u + at $s = \frac{v+u}{2}t$ $\Delta x = \frac{v_f + v_i}{2}\Delta t$

3.4 Inelastic✓, the ball bounces lower as the max height before the bounce ✓
Onelasties, die bal hop laer as die maksimum hoogte voor die bons
(2)

OR/OF
Inelastic✓, Max height before bounce > max height after bounce ✓
Onelasties Maksimum hoogte voor bons > maksimum hoogte na bons
(2)

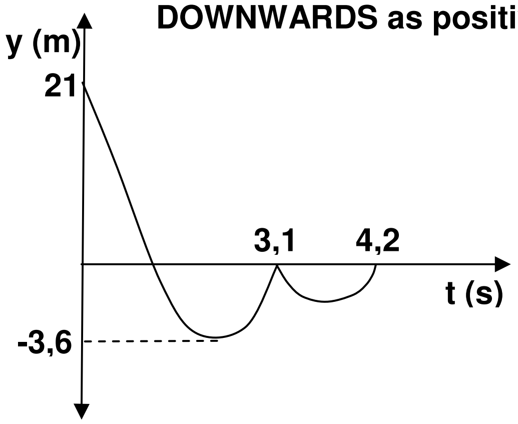
3.5 POSITIVE MARKING FROM QUESTION 3.3

OPTION 1/OPSIE 1



Marking criteria for graph: **Nasienriglyne vir grafiek:**	
Graph starts at -21 m at t = 0 s Grafiek begin by -21 m by t = 0 s	✓
Correct shape as shown up to t = 3,1 s	✓
Maximum height = 3,6 m [(Answer of h in Q3.3) -21]	✓
Time of bounce as t = 3,1 s	✓
Correct shape for second part from t = 3,1 s to t = 4,2 s	✓

DOWNWARDS as positive



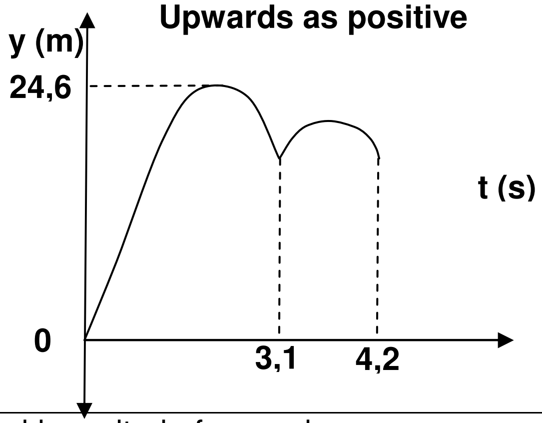
Marking criteria for graph: **Nasienriglyne vir grafiek:**	
Graph starts at 21 m at t = 0 s Grafiek begin by 21 m by t = 0 s	✓
Correct shape as shown up to t = 3,1 s	✓
Maximum height = -3,6 m [(Answer of Δy in Q3.3) +21]	✓
Time of bounce as t = 3,1 s	✓
Correct shape for second part from t = 3,1 s to t = 4,2 s	✓

NOTES/AANTEKENINGE:

OTHER POSSIBILITIES

[Position from where he kicked, as reference point]

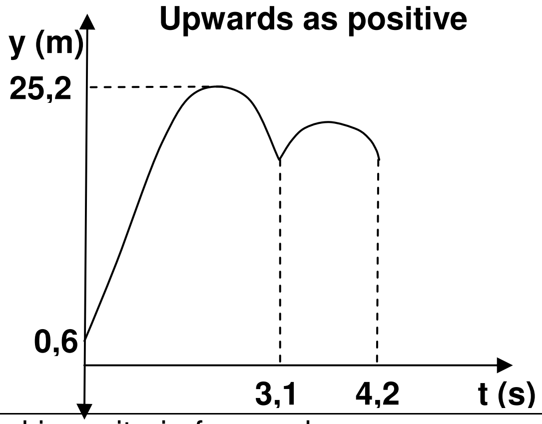
Upwards as positive



Max: $^4/_5$

Marking criteria for graph: Nasienriglyne vir grafiek:	
Graph starts at -21 m at t = 0 s Grafiek begin by -21 m by t = 0 s	×
Correct shape as shown up to t = 3,1 s	✓
Maximum height = 24,6 m	✓
Time of bounce as t = 3,1 s	✓
Correct shape for second part from t = 3,1 s to t = 4,2 s	✓

[Ground as reference point]



Max: $^4/_5$

Marking criteria for graph: Nasienriglyne vir grafiek:	
Graph starts at -21 m at t = 0 s Grafiek begin by -21 m by t = 0 s	×
Correct shape as shown up to t = 3,1 s	✓
Maximum height = 25,2 m	✓
Time of bounce as t = 3,1 s	✓
Correct shape for second part from t = 3,1 s to t = 4,2 s	✓

[22]

QUESTION 4/VRAAG 4

4.1 The total (linear) momentum remains constant ✓ (in magnitude and direction) in a closed system ✓ (2)
Die totale (liniêre) momentum in 'n geslote sisteem bly konstant (in grootte en rigting)

Notes/Aantekeninge:
Allocate mark for "closed system" only in conjunction with momentum

4.2

OPTION 1/OPSIE 1	OPTION 2/OPSIE 2
$\Sigma p_i = \Sigma p_f$ ✓ $45(5) + 18(5)$ ✓ $= 45(-1) + 18v_f$ ✓ v_f = 20 m·s^{-1} west ✓ (4) OR/OF $\Sigma p_i = \Sigma p_f$ ✓ $(45+18)(5)$ ✓ $= 45(-1) + 18v_f$ ✓ v_f = 20 m·s^{-1} west ✓ (4)	$\Delta p_{boy} = -\Delta p_{trolley}$ ✓ $45(-1) - 45(5)$ ✓ $= -(18v_f - 18(5))$ ✓ v_f = 20 m·s^{-1} west ✓ (4)

4.3 Remains the same / Dieselfde ✓
F remains the same ✓ (newton III) and Δt remains the same ✓

OR/OF
Remains the same / Dieselfde ✓
$\Delta p_{trolley} = -\Delta p_{boy}$ ✓ and impuls = Δp: $F\Delta t = \Delta p$ ✓ (3)

4.4 POSITIVE MARKING FROM 4.2

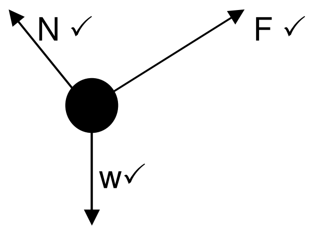
OPTION 1/OPSIE 1	OPTION 2/OPSIE 2
$F_{net} \cdot \Delta t = mv_f - mv_i$ ✓ $F_{trolley}$ (0,4✓) = 18(20) – 18(5)✓ $F_{trolley}$ = 675 N west ✓ (4)	$F_{net} \cdot \Delta t = mv_f - mv_i$ ✓ F_{boy}(0,4✓) = 45(-1) – 45(5)✓ F_{boy} = -675 N F_{boy} = 675 N east $F_{trolley}$ = 675 N west ✓ (4)

[13]

QUESTION 5/VRAAG 5

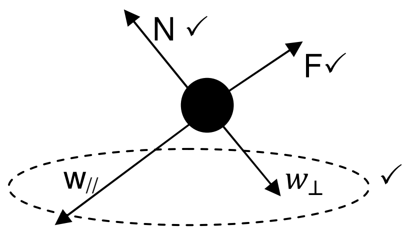
5.1

OPTION 1/OPSIE 1



(3)

OPTION 2/OPSIE 2



(3)

Take note:
DON'T penalise for relative lengths of vectors, although:
[N and $w_\perp$ should be equal in length]
[F should be shorter than $w_{//}$]

Notes/Aantekeninge:

- Any additional forces (like friction) max $^2/_3$
- No arrows: $^0/_3$
- Force(s) not touching object: max $^2/_3$

5.2 No✓, it is not an isolated system✓
Nee, dit is nie 'n geslote sisteem nie
OR/OF
No✓, there is an external force acting on the object✓
Nee, daar is 'n eksterne krag wat op die voorwerp inwerk (2)

5.3 Gravitational force / weight ✓
Gravitasie (aantrekkings) krag / gewig
Note: *NOT* Fg/w/$w_{//}$/parallel component of weight $^0/_1$ (1)

5.4 The force is perpendicular to the displacement ✓
OR/OF
θ = 90º therefore Cosθ = 0 (1)

5.5 B to A ✓

5.6

OPTION 1/OPSIE 1

$W_{net} = \Delta E_k$ ✓
$F_{g//}\cdot\Delta x\cdot\cos\theta + F\cdot\Delta x\cdot\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
(25×9,8×Sin30º) ✓ (3,5)Cos180º ✓+ F(3,5)Cos0º ✓= ½(25)(10,8)^2 – ½(25)(12)^2✓
(63,41)(3,5)(-1) + F(3,5)(1) = 1458 – 1800
F = 24,79 N ✓
(6)

OPTION 2/OPSIE 2

$W_{net} = \Delta E_k$ ✓
$F_g\cdot\Delta x\cdot\cos\theta + F\cdot\Delta x\cdot\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
(25×9,8) ✓ (3,5)Cos120º✓+ F(3,5)Cos0º✓ = ½(25)(10,8)^2 – ½(25)(12)^2✓
(245)(3,5)(-0,5) + F(3,5)(1) = 1458 – 1800
F = 24,79 N✓
(6)

OPTION 3/OPSIE 3
$W_{nc} = \Delta E_k + \Delta E_p$ ✓
$F \cdot \Delta x \cdot \cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$
$F(3,5)\cos 0°$ ✓ $= [\frac{1}{2}(25)(10,8)^2 - \frac{1}{2}(25)(12)^2]$ ✓ $+ [(25)(9,8)$ ✓ $(3,5\sin 30°)$ ✓ $- 0]$
$F = 24,79$ N ✓
(6)

[14]

QUESTION 6/VRAAG 6

6.1 The change in frequency (or pitch) of the sound detected by a listener✓ because the sound source and the listener have different velocities✓ relative to the medium of sound propagation.
Die verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar ✓omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium✓ waarin die klank voortgeplant word, het. (2)

6.2 Higher / Hoër ✓ (1)

6.3 [Boat = S, Whale = L]
$f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ ✓
$= \left(\frac{1435+8}{1435}\right)$ ✓ (23000) ✓
= 23128,223 Hz
(4)

6.4 Futher away✓
λ increases✓ ⇒ If c=constant✓, f will decrease✓ $[f \propto {}^{1}/_{\lambda} \ if \ c = constant]$
Verder weg✓
λ neem toe✓ ⇒ As c=konstant✓ dan sal f afneem✓ $[f \propto {}^{1}/_{\lambda} \ as \ c = konstant]$

OR

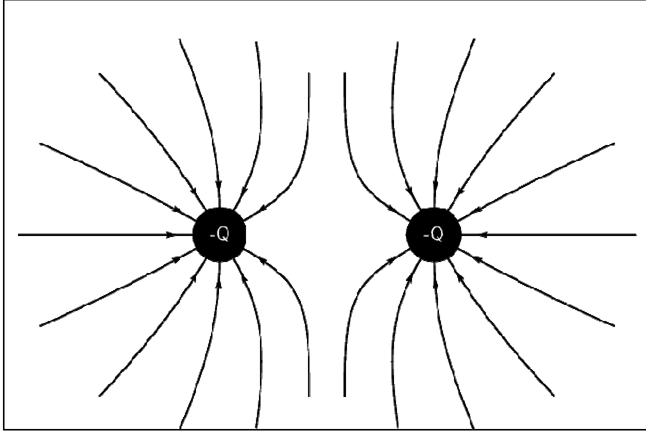
Futher away✓
A shift towards the red end of the spectrum is observed✓ ⇒ If c=constant✓, f will decrease✓

Verder weg✓
'n Verskuiwing na die rooi end van die spektrum word waargeneem✓ ⇒ As c=konstant✓ dan sal f afneem✓

(4)
[11]

QUESTION 7/VRAAG 7

7.1



Marking Criteria :
- Shape✓
- Arrows pointing towards Q✓
- Fieldlines don't touch/cross & perpendicular on charge✓

(3)

7.2

$E = \frac{kQ}{r^2}$ ✓

$4{,}44 \times 10^5$✓ $= \frac{(9\times10^9)(4\times10^{-9})}{r^2}$✓

r = 9×10^{-3}

∴d = 9×10^{-3} - 6×10^{-3}✓

d = 3×10^{-3} m✓ (OR 3 mm)

(5)

7.3 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges✓ and inversely proportional to the square of the distance (r) between them✓.
Die grootte van die elektrostatiese krag wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van die groottes van die ladings✓ en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle✓. (2)

7.4

$F_{Q2} = \frac{kQ_1Q_2}{r^2}$✓

$= \frac{(9\times10^9)(-4\times10^{-9})(-4\times10^{-9})}{(0{,}006)^2}$ ✓

F = 4×10^{-3} N (west or left)

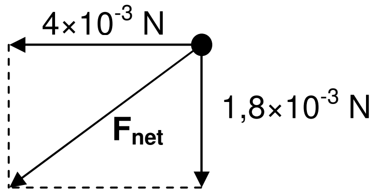
$F_{Q3} = \frac{kQ_1Q_3}{r^2}$

$= \frac{(9\times10^9)(-4\times10^{-9})(-5\times10^{-9})}{(0{,}01)^2}$✓

F = $1{,}8 \times 10^{-3}$ N (south or down)

$F^2 = (4\times10^{-3})^2$✓ + $(1{,}8 \times 10^{-3})^2$✓

∴F = $4{,}39 \times 10^{-3}$ N✓



(6)

[16]

QUESTION 8/VRAAG 8

8.1

Criteria for investigative question/Kriteria vir ondersoekende vraag:	
Dependent and independent variables correctly identified. Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.	✓
Question about the relationship between the independent and dependent variables correctly formulated. Vraag oor die verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek geformuleer.	✓

Example/Voorbeeld:
What is the influence of the type of material of a conductor on the conductivity of the conductor? / Wat is die verband tussen die tipe materiaal van die geleier op die geleidingsvermoë van die geleier

Dependent variable/Afhanklike veranderlike:
- Conductivity of the conductor / Geleidingsvermoë van die geleier

Independent variable/Onafhanklike veranderlike:
- Type of material/metal / Tipe materiaal/metaal

Example/Voorbeeld
How will the conductivity of a conductor change if different types of metarials/metals are used?
Hoe sal die geleidingsvermoë van 'n geleier verander indien verskillende tipe metale gebruik word?

Notes/Aantekeninge:
A question that results in a 'yes' / 'no' answer: max $^1/_2$
'n Vraag wat 'n 'ja' of 'nee' as antwoord het: maks $^1/_2$

Example:
Will the type of metal have an influence on the conductivity of the metal?

8.2 Any TWO: ✓✓
Temperature / Temperatuur
Thickness of conductor / Dikte van die geleier
Length of conductor / lengte van geleier.

(2)

8.3 P✓
Gradient = $\frac{1}{R}$ ✓
Gradient Q < gradient P
$\therefore R_Q > R_P$ ✓

(3)

[7]

QUESTION 9/VRAAG 9

9.1 Due to internal resistance✓ energy is transferred inside the battery✓
As gevolg van interne weerstand✓ word energie binne in die battery oorgedra. ✓
(2)

9.2.1 V=IR✓
4,5 = I(3) ✓
I = 1,5 A ✓ (3)

9.2.2 POSITIVE MARKING FROM QUESTION 9.2.1

ε = I(R+r) ✓ = 1,5✓ ((12✓+40)+3✓) ε = 82,5 V✓ (5)	**OR/OF:** V = IR✓ = 1,5✓ (12✓+40+3✓) V = 82,5 V✓ (5)

9.2.3

OPTION 1/OPSIE 1	**OPTION 2/OPSIE2**
$V_{//}$ = IR = 1,5(12) = 18V V=IR 18✓ = I(30✓) I = 0,6 A ✓	$I = \frac{20}{50}$ ✓(1,5✓) $I = 0{,}6\ A$✓ (3)

9.3 Decreases✓

Total resistance increases ✓
Total current decreases ✓
If R remains constant✓ then P will decrease as well ($P \propto I^2$)

Afneem✓
Totale weerstand neem toe ✓
Totale stroomsterkte neem af ✓
Aangesien R konstant bly✓ sal P dus afneem ($P \propto I^2$)
(4)
[17]

QUESTION 10/VRAAG 10

10.1 Mechanical energy to electric energy ✓
Meganiese energie na elektriese energie ✓

OR/OF

Kinetic energy to electric energy ✓
Kinetiese energie na elektriese energie ✓

(1)

10.2.1 Brush(es) / Carbon brush(es) ✓
Borsel(s) / Koolstofborsel(s) (1)

10.2.2 Slipring(s) / Sleepring(e) ✓ (1)

10.3.1 A ✓ (1)

10.3.2

OPTION 1/OPSIE 1

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$

$= \frac{300}{\sqrt{2}}$ ✓

$V_{rms} = 212,13$ V

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$

$= \frac{21}{\sqrt{2}}$ ✓

$I_{rms} = 14,85$ A

$P_{avg} = V_{rms} \cdot I_{rms}$ ✓

$= \underline{(212,13)(14,85)}$ ✓

$= 3150,13$ W ✓

(5)

OPTION 2/OPSIE 2

$P_{avg} = V_{rms} \cdot I_{rms}$ ✓

$= \frac{V_{max}}{\sqrt{2}} \times \frac{I_{max}}{\sqrt{2}}$

$= \frac{300✓ \times 21✓}{2✓}$

$= 3150$ W ✓

(5)

[8]

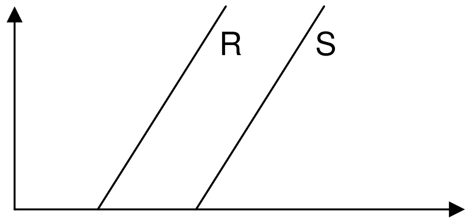
QUESTION 11/VRAAG 11

11.1 Frequency of P < threshold frequency of metal cathode R ✓
Frekwensie van P < drumpelfrekwensie van metaalkatode R

OR/OF

Energy of light P < Workfunction of metal cathodeR ✓
Energie van P < werksfunksie van metaalkatode R (1)

11.2



Criteria for marking:
• X-intercept to the right of R✓
• Graph S parallel to graph R✓

(2)

11.3 E = hf ✓
= $\underline{(6,63\times10^{-34})(1,5\times10^{15})}$ ✓
E = $9,95\times10^{-19}$ J ✓

(3)

11.4 $W = W_o + E_k$ ✓
$9,95\times10^{-19}$✓ = $\underline{(6,63\times10^{-34})(5,79\times10^{14})}$ ✓ + E_k
$E_k = 6,11\times10^{-19}$ J ✓

(4)
[11]

QUESTION 12/VRAAG 12

12.1 $\Delta E = E_f - E_i$
= $-5,44\times10^{-19} - (-2,40\times10^{-19})$ ✓
$\Delta E = 3,04\times10^{-19}$ J

$E = \frac{hc}{\lambda}$ ✓
$3,04\times10^{-19}$ ✓ = $\frac{(6,63\times10^{-34})(3\times10^{8})}{\lambda}$ ✓

$\lambda = 6,54\times10^{-7}$ m ✓
∴ RED/ROOI ✓

(6)
[6]

TOTAL SECTION B/TOTAAL AFDELING B: 130

GRAND TOTAL/GROOTTOTAAL: 150

Western Cape Government
Education

CAPE WINELANDS EDUCATION DISTRICT

CURRICULUM AND ASSESSMENT POLICY STATEMENT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2014

MARKS 150

TIME 3 hours

This question paper consists of 14 pages and 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 John, who is standing in a lift, observes a 20N mass piece suspended from a spring balance fixed to the roof of the lift. He sees that the reading on the spring balance is less than 20N for a short time interval. During this short time interval the lift is …

A. not moving.

B. accelerating upwards.

C. accelerating downwards.

D. moving with constant velocity. (2)

1.2 The gravitational force which the earth exerts on the moon is …..

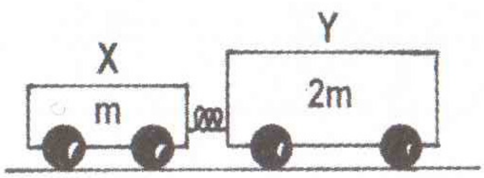
A. directly proportional to the distance between their centres.

B. inversely proportional to the mass of the moon.

C. inversely proportional to the product of the mass of the moon and the mass of the earth.

D. inversely proportional to the square of the distance between their centres. (2)

1.3 Two trolleys, **X** (mass *m*) and **Y** (mass 2m) are stationary on a horizontal plane. There is a compressed spring between the two trolleys as shown in the diagram below.



The spring is now released. How will the momentum of the trolleys compare? The momentum of trolley **X** ……

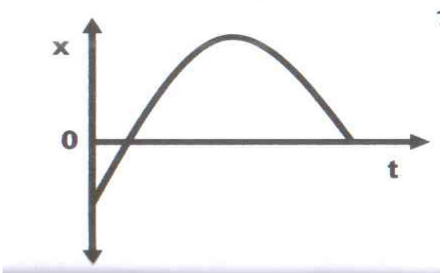
A. Will be greater than the momentum of trolley **Y.**

B. Will be less than the momentum of trolley **Y.**

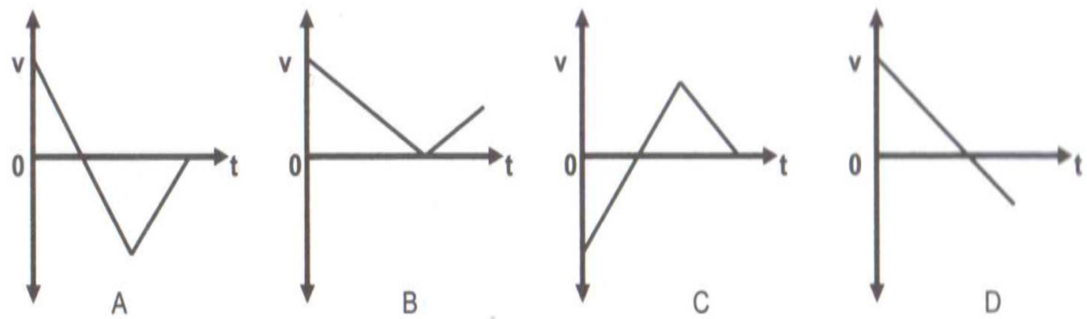
C. Will have the same magnitude as the momentum of trolley **Y.**

D. Will be identical to the momentum of trolley **Y.** (2)

1.4 The graph below shows the position of a particle, with time, moving in a straight line in a vertical plane.



Which ONE of the following velocity – time graphs best represents the motion of the particle?



(2)

1.5 A ball is thrown vertically upwards. Which ONE of the following physical quantities of the ball will be zero when the ball reaches maximum height?

A. Acceleration

B. Kinetic energy

C. Gravitational potential energy

D. Weight (2)

1.6 A vehicle is travelling at a constant speed towards a stationary observer. Its hooter produces sound waves of frequency 400 Hz. Ignore the effects of wind. The sound heard by the observer will most likely have a frequency, in hertz, of …

A. 400

B. 350

C. 380

D. 480 (2)

1.7 The centres of two identical metallic spheres, each carrying a charge Q, are a distance r apart. Which ONE of the following pairs of changes (that are made simultaneously) will double the electrostatic force that one charged sphere exerts on the other?

	Distance between centres of spheres	**Magnitude of charges**
A	decrease distance to $\frac{\mathbf{r}}{2}$	double the charge on each sphere
B	decrease distance to $\frac{\mathbf{r}}{2}$	reduce the charge on one sphere to $\frac{\mathbf{Q}}{2}$
C	decrease distance to $\frac{\mathbf{r}}{\sqrt{2}}$	reduce the charge on each sphere to $\frac{\mathbf{Q}}{2}$
D	decrease distance to $\frac{\mathbf{r}}{\sqrt{2}}$	double the charge on each sphere

(2)

1.8 When electrical energy must be transported over long distances, the energy loss can be minimized if:

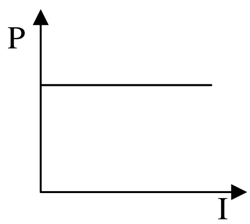
A. the current is high and the voltage is low

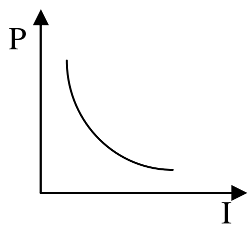
B. the voltage is high and the current is low

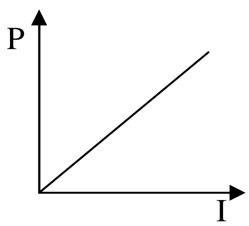
C. both the current and voltage is low

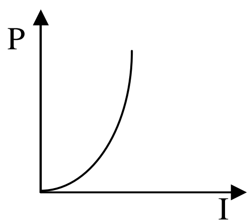
D. both the current and voltage is high (2)

1.9 Which ONE of the following graphs best represents the relationship between the electrical power and the current in a given ohmic conductor?

A


B


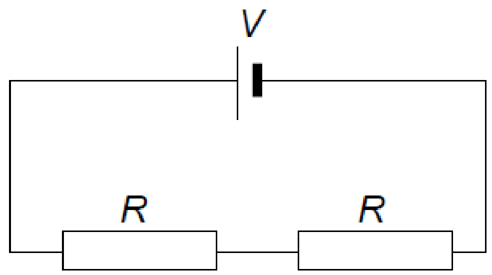
C


D


(2)

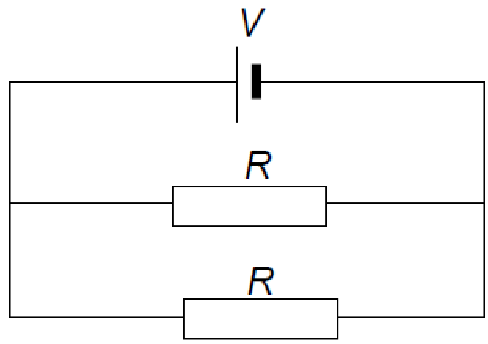
1.10. The two resistors in circuit 1 below are identical. They are connected in series to a cell of emf *V* and negligible internal resistance. The power dissipated by each resistor is *P*.

Circuit 1



The two resistors are now connected in parallel, as shown in circuit 2 below.

Circuit 2



The power dissipated by each resistor in the circuit 2 is …

A 2P

B 4P

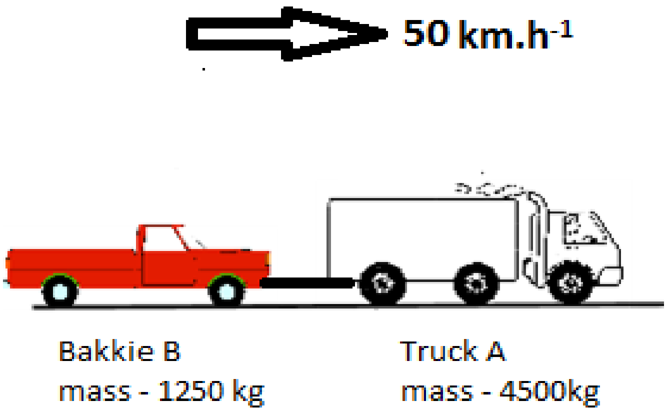
C 8P

D 16P (2)

[20]

QUESTION 2 [START ON A NEW PAGE]

2.1 Truck A, of mass 4 500 kg travels at a CONSTANT VELOCITY OF 50 $km \cdot h^{-1}$ while towing Bakkie B, of mass 1 250 kg. The engine of Truck A produces a force of 11 270 N. The road surface exerts a friction force of 8 820 N on Truck A.



2.1.1 Write down Newton's Second Law of motion in words. (2)

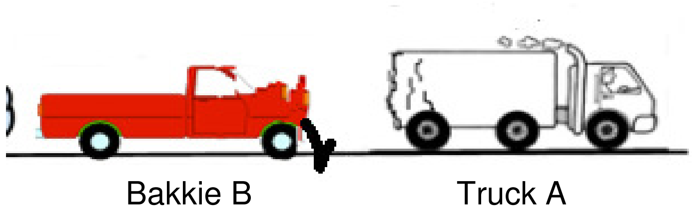
2.1.2 Draw a free-body diagram showing ALL the forces acting on Truck A. The length of the vectors should be an indication of their relative magnitudes. (6)

2.1.3 Calculate the coefficient of kinetic friction for tyre rubber on the road surface. (3)

2.1.4 Calculate the force of friction exerted by the road surface on Bakkie B. (3)

2.1.5 Calculate the tension in the tow rope. (3)

2.2 Truck A suddenly stops. Unfortunately Bakkie B has no brakes and slams into the rear of Truck A and Bakkie B comes to an immediate stop. As a result of the collision, the tow rope breaks



2.2.1 Write down the Law of Conservation of Momentum in words. (2)

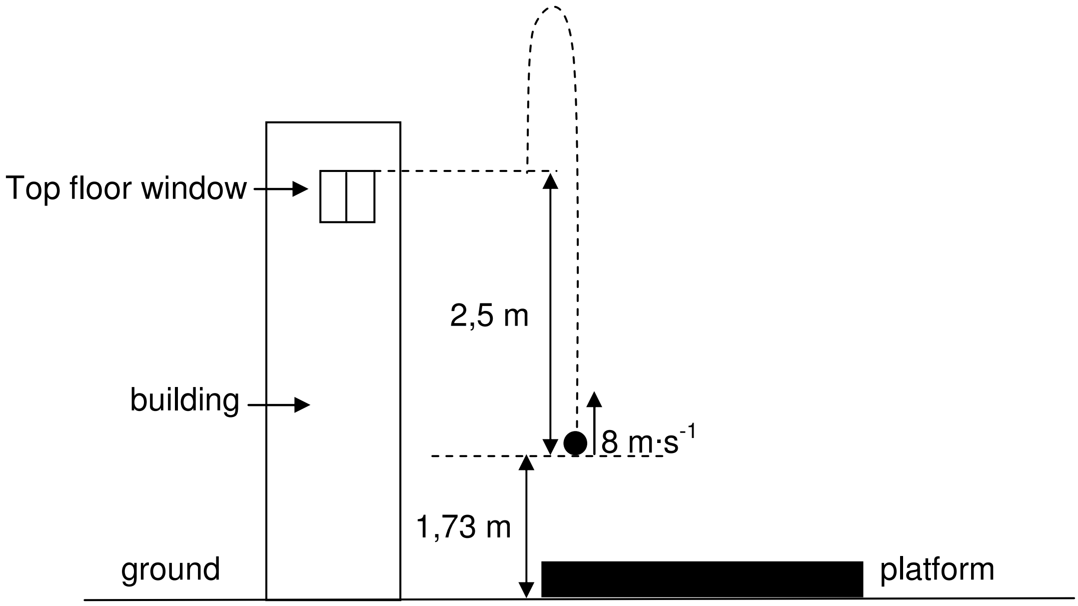
2.2.2 Calculate the speed of Truck A immediately after the collision. (4)

2.2.3 Using Newton's First Law of motion explain why it is always advisable to tow with a solid bar instead of a tow rope. (2)

[25]

QUESTION 3 [BEGIN ON A NEW PAGE]

Sandile, who is standing on a platform, throws a small metal ball vertically upward, from a height of 1,73 m above the ground, into the air at 8 m·s^{-1}. The ball travels pass the top of the building and returns to Sandile's hand which is still at 1,73 m above the ground. Ignore the effects of friction.



3.1 With what speed does the ball strike Sandile's hand? (1)

3.2 Using an equation of motion and NOT energy principles, calculate the maximum height that the ball reaches above the ground. (4)

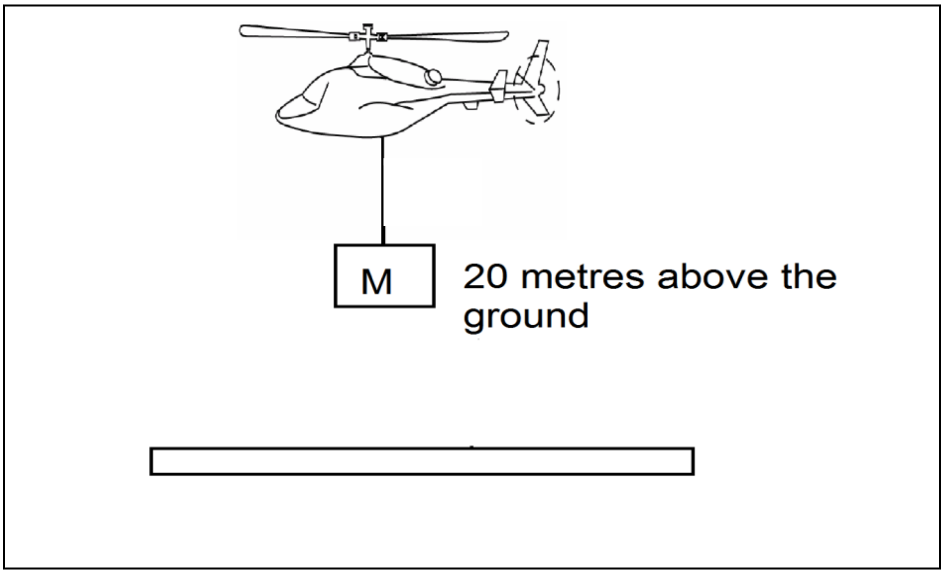
3.3 If a window on the top floor of the building is at a height of 2,5 m above Sandile's hand, calculate the time taken for the ball, from the moment it was thrown, to pass the top of the window <u>on its return</u> to Sandile's hand. (5)

3.4 Taking upward direction as positive, draw a sketch graph of position versus time graph of the ball's motion from the moment it left Sandile's hand until it lands back into his hands. Indicate all relevant position values. Use Sandile's hand as reference. (5)

[15]

QUESTION 4 [BEGIN ON A NEW PAGE]

A rescue helicopter is stationary (hovers) above the ground. It lowers a crate containing medical supplies with a mass 50 kg onto the ground below. When the crate is at a height of 20 m above the ground it has a speed of 2 $m \cdot s^{-1}$. The crate is lowered at a constant acceleration onto the ground with a cable, where it eventually comes to rest. Assume there is no sideways motion during the descent. Air friction is NOT to be ignored.



4.1 Define a *non-conservative force*. (2)

4.2 Identify TWO *non-conservative forces* acting on the crate during its downward descent (motion). (2)

4.3 Draw a free-body diagram showing ALL the forces acting on the crate while it is being lowered to the ground. (3)

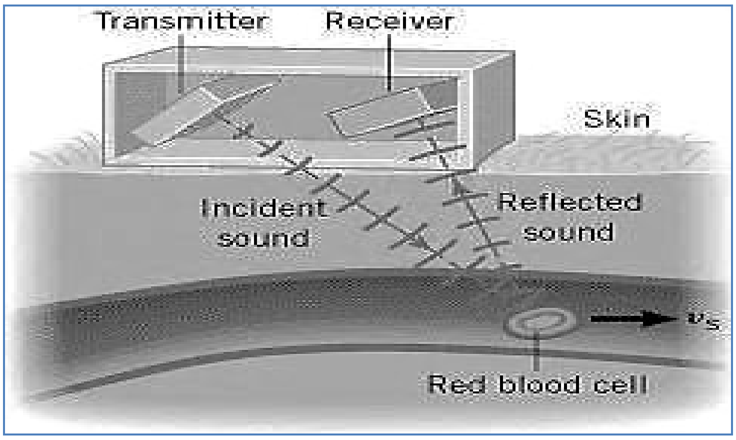
4.4 Write down the work-energy theorem in words. (2)

4.5 Using the work energy theorem, calculate the acceleration of the crate as it is lowered to the ground. (6)

[15]

QUESTION 5 [BEGIN ON A NEW PAGE]

Use the diagram below to answer the following questions.



5.1 Identify the medical device shown in the diagram. (1)

5.2 Explain very briefly how the device functions and what it may be used for. (2)

5.3 A fire truck with its siren on, moves away at constant velocity from a person standing next to the road. The person measures a frequency which is 90% of the frequency of the sound emitted by the siren of the fire truck.

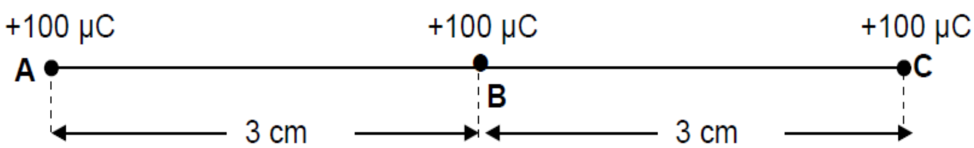
5.3.1 Name the phenomenon observed. (1)

5.3.2 If the speed of sound in air is 340 $m \cdot s^{-1}$, calculate the speed of the fire truck. (4)

[8]

QUESTION 6 [BEGIN ON A NEW PAGE]

Three +100 μC point charges, **A**, **B** and **C**, are equally spaced on a straight line in a vacuum. The charges are a distance of 3 cm from each other as shown in the sketch below.



6.1 Define in words *electric field at a point*. (2)

6.2 Draw the electric field lines associated with charge **A** only. (2)

6.3 Calculate the magnitude of the electric field strength at the position where charge **B** is and due to charge **A** only. (3)

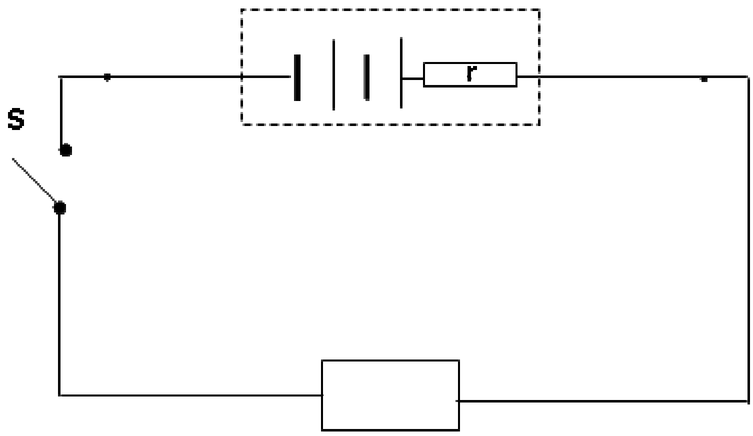
6.4 Write down Coulomb's Law in words. (2)

6.5 Calculate the net electrostatic force experienced by point charge C due to charges **A** and **B**. (8)

[17]

QUESTION 7 [BEGIN ON A NEW PAGE]

Candice and Andisiwe conduct an investigation to determine the emf (ε) and the internal resistance (r) of an unknown battery by experiment using three resistors. They use the circuit below with first one resistor in series, then two resistors in series and then three resistors in series. They also connect a voltmeter and an ammeter in this circuit.



When switch S was closed, they obtained the following results:

Number of resistors	Voltmeter reading (V)	Ammeter reading (A)
3	10,2	1,5
2	9,6	2,0
1	7,8	3,5

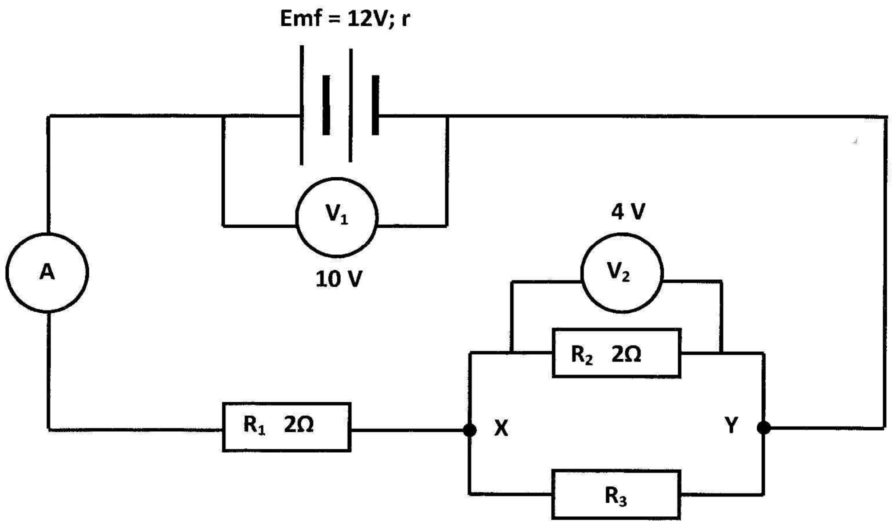
7.1 Sketch this circuit in your answer book. Show in your sketch where the learners connected the ammeter and the voltmeter. (2)

7.2 Calculate the value of ε and r that they obtained in their investigation by using their results. (7)

[9]

QUESTION 8 [BEGIN ON A NEW PAGE]

In the circuit represented below, the battery has an unknown internal resistance and an emf of 12 V. When current flows through the circuit, the voltmeter across the battery reads 10 V and a voltmeter across R_2 reads 4 V



8.1 Explain what is meant by the emf of a cell. (1)

8.2 Calculate the current through R_1. (4)

8.3 Determine the internal resistance of the battery. (3)

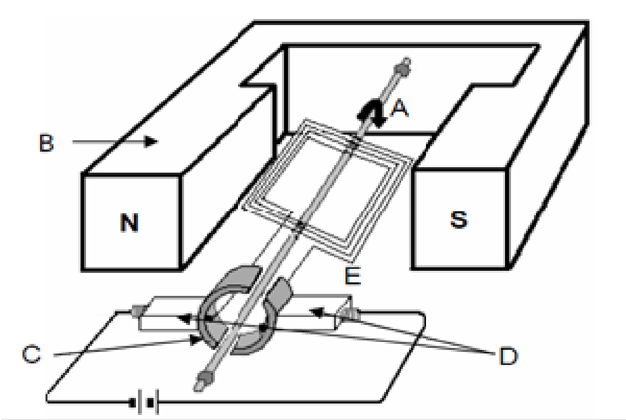
8.4 Determine the resistance of R_3. (4)

8.5 Explain what would happen to the current and resistance in the circuit if R_3 was removed from the circuit and replaced with a wire of negligible resistance. Hence what will happen to the reading on V_1. (4)

[16]

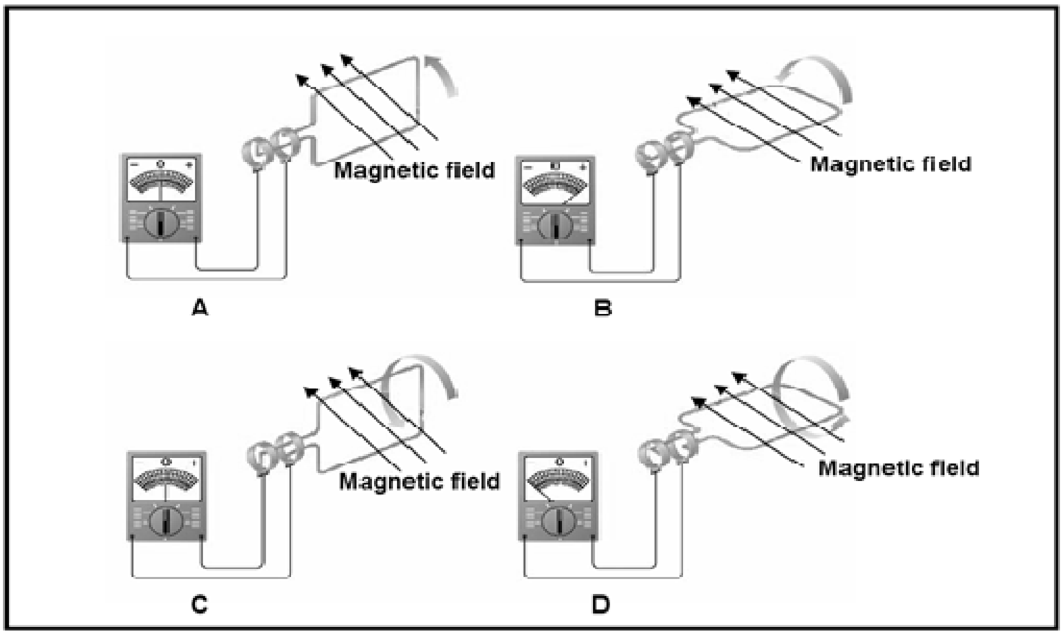
QUESTION 9 **[BEGIN ON A NEW PAGE]**

Electric motors are used in pumps, fans and compressors. Electric motors can be either AC or DC. The diagram below illustrates one of these types of electric motors.



9.1 What type of electric motor (AC or DC) is illustrated in the diagram? Give a reason for your answer. (2)

9.2 The diagrams A to D below show four positions in sequence during the anti-clockwise rotation of the coil of a simple AC generator.



9.2.1 Name the fundamental principle on which generators work. (1)

9.2.2 What is the purpose of the slip rings in an AC generator? (1)

9.2.3 By referring to the relative positions of the coil in positions A to D, draw the corresponding graph of potential difference versus time for one full rotation (A to D to A). Indicate the positions of the coil (by using the letters A to D) on your graph. (3)

9.3 A certain AC generator (alternator) produces a peak current (I_{max}) of 6,43 A when connected to an electrical heater of resistance 48,4 Ω.

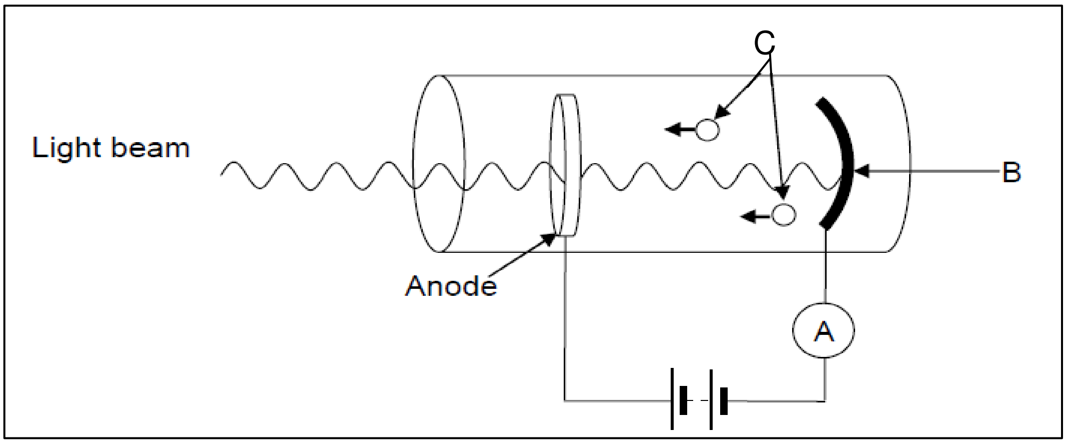
9.3.1 Calculate the rms current (I_{rms}) produced by the generator. (3)

9.3.2 Calculate the peak voltage (V_{max}) output of the generator. (5)

[15]

QUESTION 10 [BEGIN ON A NEW PAGE]

The apparatus below was used to explore the photo-electric effect using a piece of zinc metal and light of a particular frequency. Use the diagram below to answer the following questions.



10.1 Provide labels for B and C. (2)

10.2 Define the term" photo-electric effect" (2)

10.3 The learners observe that when component B is irradiated with light of wavelength of 100 nm, a current is detected in the ammeter. The work function of the metal B is $8,7 \times 10^{-19}$ J. Calculate the speed at which the electrons are emitted. (6)

[10]

GRAND TOTAL: 150

CAPE WINELANDS EDUCATION DISTRICT

MEMORANDUM OF MARKING : September 2014 P.1

QUESTION 1

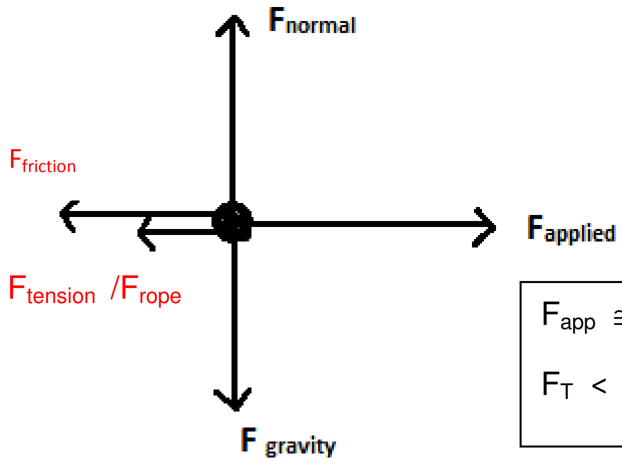
1.1	C	✓✓
1.2	D	✓✓
1.3	C	✓✓
1.4	D	✓✓
1.5	B	✓✓
1.6	D	✓✓
1.7	B	✓✓
1.8	B	✓✓
1.9	D	✓✓
1.10	B	✓✓

[20]

Question 2

2.1.1 When a net force acts on an object, the object will accelerate in the direction of the net force. This acceleration is directly proportional to the net force ✓ and inversely proportional to the mass. ✓ (2)

2.1.2



$F_{app} \cong F_T + F_f$ AND

$F_T < F_f$ ✓

5 forces , correctly labelled and sized ; 1 mark each (6)

2.1.3 **truck** : $N = F_g = mg = (4\,500)(9{,}8) = 44\,100$ N

$F_k = \mu_k N$ ✓

$8\,820 = \mu\,(44\,100)$ ✓

$\mu = 0{,}2$ ✓ (3)

2.1.4 **bakkie**: $N = F_g = mg = (1\,250)(9{,}8) = 12\,250$ N ✓

$F_k = \mu_k N$

$= (0{,}2)(12\,250)$ ✓

$= 2\,450$ N ✓ (3)

2.1.5 Truck: $F_{net} = F_{applied} + F_{friction} + F_{tension}$ ✓

$0 = 11\,270 + (-\,8\,820) + F_{tension}$ ✓

$F_{tension} = 2450$ N ✓ (3)

2.2.1 Total linear momentum in an isolated system✓ is conserved (constant).✓ OR

In an isolated system ✓ the total (linear) momentum before collision equals the total (linear) momentum after collision. ✓ (2)

2.2.2 50 km.h^{-1} = 13,8889 m·s^{-1}

$$\sum p_{before} = \sum p_{after}$$
$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f} \quad ✓$$
$$(1250)(13,8889) + 0 \; ✓ = 0 + (4500)(v_2) \; ✓$$
$$v_2 = 3,86 \text{ m·s}^{-1} \; ✓ \text{ forward}$$
(4)

2.2.3 If the rope snaps the bakkie will according to Newton's First Law, continue to move forward due to inersia ✓ and collide with the truck..
With the solid bar it will remain a fixed distance behind the truck. Also as the truck stops, the bakkie will experience a net force in opposite direction of motion and also stop. ✓ (2)

[25]

QUESTION 3

3.1 $8\ m\cdot s^{-1}$ ✓ (downward) (1)

3.2 $v_f^2 = v_i^2 + 2a\Delta x$ ✓

✓ ✓

$0 = (8)^2 + 2(-9,8)\Delta x$

$\Delta x = 3,27\ m$

✓

$\therefore$ Height above ground $= 3,27 + 1,73 = 5\ m$ (4)

3.3

$v_f^2 = v_i^2 + 2a\Delta y$

$= 8^2 + 2(-9.8)(2,5)$ ✓

$v_f = 3,873\ m\cdot s^{-1}$ ✓ ✓

$v_f = v_i + a\Delta t$ **OR** $\Delta y = \frac{(v_i + v_f)\Delta t}{2}$

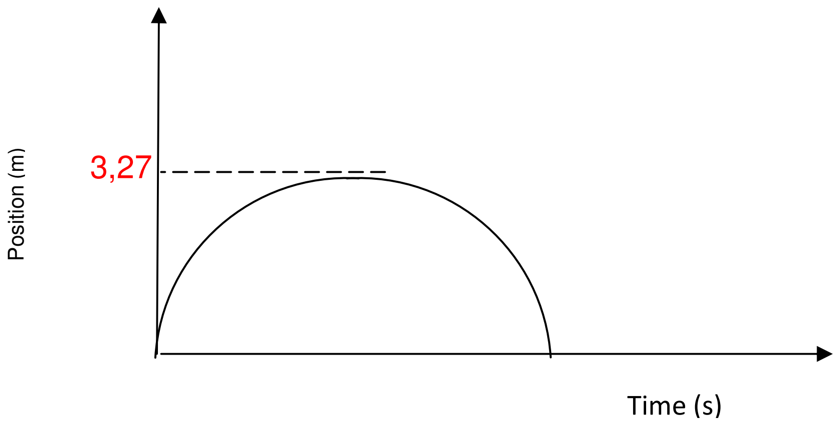
✓ ✓ ✓

$(-3,873) = (8) + (-9,8)\ t$ $2,5 = \frac{(8 - 3,873)\ t}{2}$ ✓

$t = 1,21\ s$ ✓ $t = 1,21\ s$ ✓

(5)

3.4



Correct max value on y-axis ✓
Start and end at zero ✓
Shape ✓✓
Correctly marked x and y axis ✓ (5)

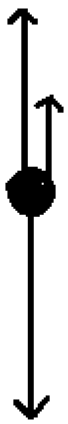
[15]

QUESTION 4

4.1 contact force – work done is dependent on the path taken ✓✓ (2)

4.2 force of air friction ✓
Tension/ Force of rope ✓ (2)

4.3



1 mark for each correct force (3)

4.4 The net work done by an object ✓ is equal to the change in its kinetic energy ✓ **OR**
The work done by the net force ✓ is equal to the change in the objects kinetic energy ✓

(2)

4.5

$W_{net} = \Delta E_k$ ✓

$F_{net}\,\Delta x \cos\varnothing = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓

$F_{net}(20)\cos 180^0 = \frac{1}{2}(50)(0^2) - \frac{1}{2}(50)(2^2)$ ✓

$F_{net}(-20) = -100\ N$

$ma = +5$

$(50)\,a$ ✓ $= 5$

$a = 0{,}1\ m\cdot s^{-2}$ ✓ upwards ✓ (6)

[15]

QUESTION 5

5.1 Doppler flow meter ✓ (1)

5.2 Transmitter sends sound which is reflected off a red blood cell ✓
Reflected sound has different frequency so velocity of blood cells can be measured ✓

(2)

5.3.1 Doppler effect ✓ (1)

5.3.2 $F_l = \frac{v \pm v_l}{v \pm v_s} F_s$ ✓

✓ $0{,}9\ F_s = \frac{(340 - 0)}{(340 + v)} F_s$ ✓

$v = 37{,}78\ m.s^{-1}$ ✓ (4)

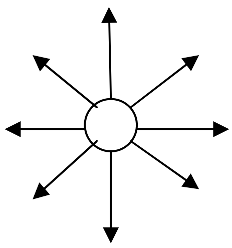
[8]

QUESTION 6

6.1 An *electric field* is a region of space in which an electric charge experiences a force. ✓✓ (The direction of the electric field at a point is the direction that a positive test charge would move if placed at that point).

(2)

6.2



✓ Shape

✓ direction (2)

6.3 $E = \frac{kQ}{r^2}$ ✓

$$E = \frac{(9 \times 10^9)(100 \times 10^{-6})}{(0{,}03)^2} \quad ✓$$

$E = 1 \times 10^9 \ N{\cdot}C^{-1}$ ✓ (3)

6.4 The electrostatic force of attraction or repulsion between two charges is directly proportional to the product of the charges ✓ and inversely proportional to the square of the distance between their centres. ✓

(2)

6.5 force on C due to A :

$F_A = \frac{kQ_1Q_2}{d^2}$ ✓ ✓

$= \frac{(9 \times 10^9)(100 \times 10^{-6})^2}{(0{,}06)^2}$ ✓

$= 25\ 000$ N ✓ ; right

force on C due to B:

$F_B = \frac{kQ_1Q_2}{d^2}$

$= \frac{(9 \times 10^9)(100 \times 10^{-6})^2}{(0{,}03)^2}$ ✓

$= 100\ 000$ N ✓ ; right

OR
Distance is halved
$\therefore F_B = 4 F_A$
$= 4 (25\ 000) = 100\ 000$ N

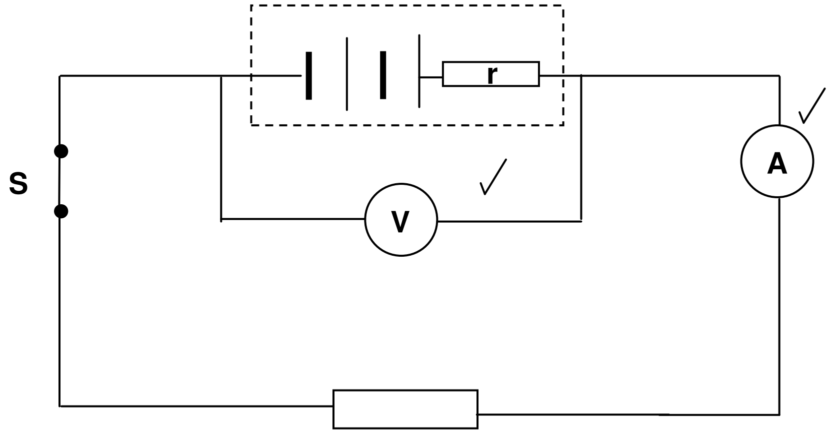
$F_{net} = F_A + F_B$
$= 25\ 000 + 100\ 000$ } ✓
$= 125\ 000$ N; right ✓

(8)

[17]

QUESTION 7

7.1



(2)

7.2 Solve simultaneously for **E** and **r** using any two sets of readings.

$E = IR + Ir$
$E = V + Ir$ ✓

$E = 10,2 + 1,5\,r$ ✓ ... (I)

$E = 9,6 + 2\,r$ ✓ ... (II)

(II) – (I): $0 = -0,6 + 0,5\,r$ ✓ **OR** $10,2 + 1,5\,r = 9,6 + 2\,r$

$r = 1,2\ \Omega$ ✓

Substitute $r = 1,2\ \Omega$ into (II): [OR into equation (I)]

$E = 9,6 + 2(1,2)$ ✓

$= 12\ V$ ✓ (Consider answers where learners use a graph to get to the answer)

(7)

[9]

QUESTION 8

8.1 The emf of a cell is the total energy supplied, per coulomb of charge ✓, by the chemical reaction occurring in the cell. OR
The emf of a cell is the total work done by a cell in moving charges through a circuit. (1)

8.2 For R_1 $V_{R1} = 10\ V - 4\ V = 6\ V$

$$R_{R1} = \frac{V_{R1}}{I_{R1}} \checkmark$$

$$2 \checkmark = \frac{6}{I} \checkmark$$

$$I_{R1} = 3\ A \checkmark$$ (4)

8.3 emf = IR + Ir ✓ OR $V_{lost} = 12 - 10 = 2V$

$12 = 10 + 3r$ ✓ $r_{int} = V_{lost}/I$ ✓
$r = ⅔$ $= 2/3$ ✓
$= 0,67\ \Omega$ ✓ $= 0,67\ \Omega$ ✓ (3)

8.4 Curent through R_2 resistor:

$$R = \frac{V}{I}$$

$$2 = \frac{4}{I} \checkmark$$

$$I = 2\ A \checkmark$$

For R_3 $I = 3 - 2 = 1A$
thus $R = V/I$
$= 4/1$ ✓ $= 4\ \Omega$ ✓ (4)

8.5 R_{cir} will decreases ✓ (as R_3 is replaced with conducting wire)
so current in circuit increases ✓ (R_2 is short-circuited) .

V_{lost} will also increase ✓ (because I increases and r is constant)
∴ V_1 will decrease ✓ [V across wire is 0 V] (less work is done across R_3) (4)

[16]

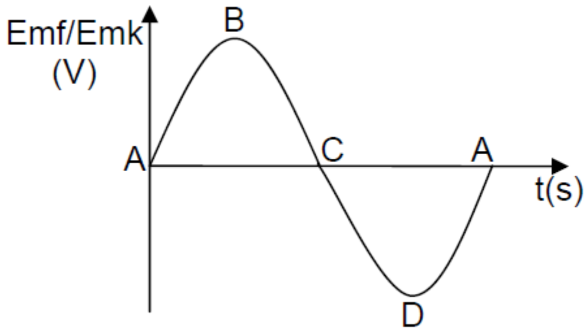
QUESTION 9

9.1 DC Motor ✓. It has a split-ring commutator.✓ (2)

9.2.1 Electromagnetic Induction [ACCEPT: Faradays Law] ✓ (1)

9.2.2 These connect the coil to the brushes (external circuit) –contact or
Allows electrical contact between coil and conducting wires or
Ensures free rotation or
Ensures that AC current is produced in the external circuit. [Any one] (1)

9.2.3



Checklist / *Kontrolelys* Criteria for graph / *Kriteria vir grafiek*	Marks/ *Punte*
Correct shape **with full cycle (ignore if more than one cycle shown** / *Korrekte vorm* ***met volle siklus (ignoreer indien meer as een siklus getoon word)***	✓✓
Points A, B, C and D correctly indicated/Punte A, B, C en D korrek aangedui,	✓

(3)

9.3.1

$$I_{rms} = \frac{I_{max}}{\sqrt{2}} ✓ = \frac{6{,}43}{\sqrt{2}} ✓ = 4{,}55\ A ✓$$

(3)

9.3.2

$$I_{rms} = \frac{V_{rms}}{R} ✓$$

$$\therefore 4{,}55 = \frac{V_{rms}}{48{,}4} ✓$$

$$V_{rms} = 220{,}22\ V$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}} ✓$$

$$220{,}22 = \frac{V_{max}}{\sqrt{2}} ✓$$

$$V_{max} = 311{,}44\ V ✓$$

OR

$$V_{max} = I_{max}R ✓✓$$
$$= (6{,}43) ✓ (48{,}4) ✓$$
$$= 311{,}21\ V ✓$$

(5)

[15]

QUESTION 10

10.1 C – ejected electrons ✓ B – cathode / zinc metal ✓ (2)

10.2 The photoelectric effect is the process whereby electrons are ejected from a metal surface when light of suitable frequency is incident on that surface. ✓✓ (2)

10.3 $E = W_0 + E_k$

$hf = W_o + E_k$ ✓

$$\frac{(6{,}63\times10^{-34})(3\times10^{8})\ ✓}{100\times10^{-9}\ ✓} = 8{,}7\text{x } 10^{-19}\ ✓ + \frac{1}{2}(9{,}1\times10^{-31})v^2\ ✓$$

$\therefore v = 1{,}57 \text{ x } 10^{6} \text{ m·s}^{-1}$ ✓

(6)

[10]

TOTAL 150 MARKS

CAPE WINELANDS EDUCATION DISTRICT

CURRICULUM AND ASSESSMENT POLICY STATEMENT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2015

MARKS 150

TIME 3 hours

This question paper consists of 18 pages including data sheets.

QUESTION 1

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) on your ANSWER PAGE.

1.1 When a spaceship moves at constant velocity, it means that the resultant force acting on the body is zero. This phenomenon is best explained by

A Newton's First Law.

B Newton's Second Law.

C Newton's Third Law.

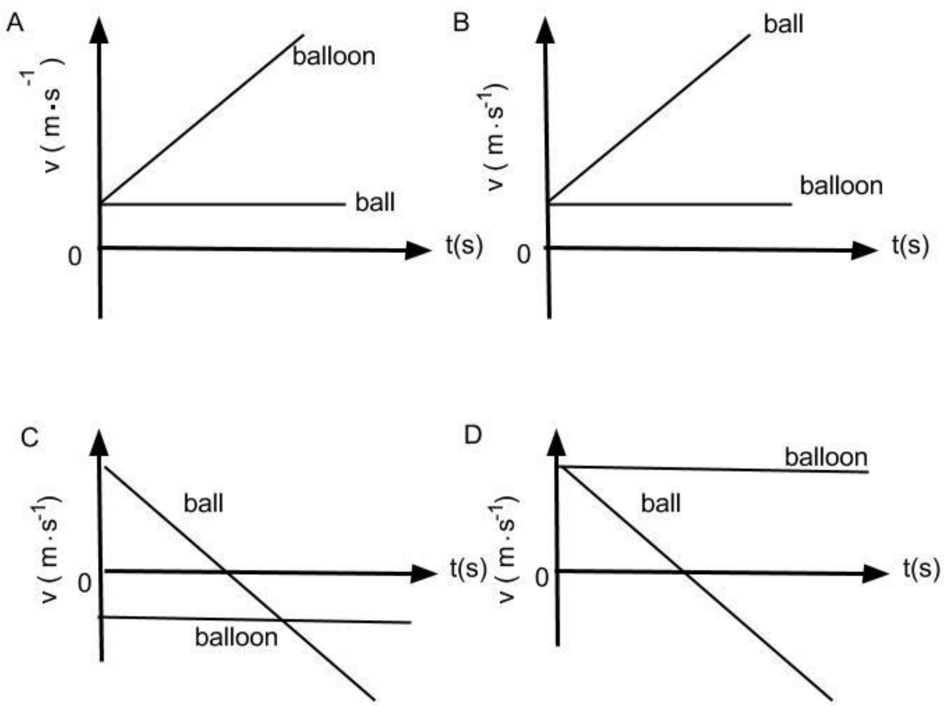
D Newton's Universal Gravitational Law. (2)

1.2 An ELASTIC collision occurs between two bodies in an isolated system. Which ONE of the following combinations of momentum and kinetic energy of the system is CORRECT?

	MOMENTUM	KINETIC ENERGY
A	conserved	conserved
B	conserved	not conserved
C	not conserved	conserved
D	not conserved	not conserved.

(2)

1.3 A ball is dropped from a hot air balloon that is ascending at a constant velocity. Take UPWARDS as the POSITIVE direction. The correct velocity vs time graph for the motion of the ball and the balloon is:

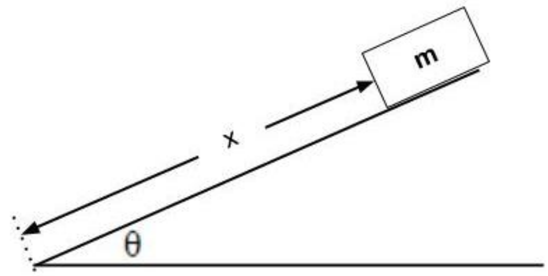


(2)

1.4 An object with mass **m** is lifted at a constant velocity **v** through a height of **h** meter. The magnitude of the net work done on the object is

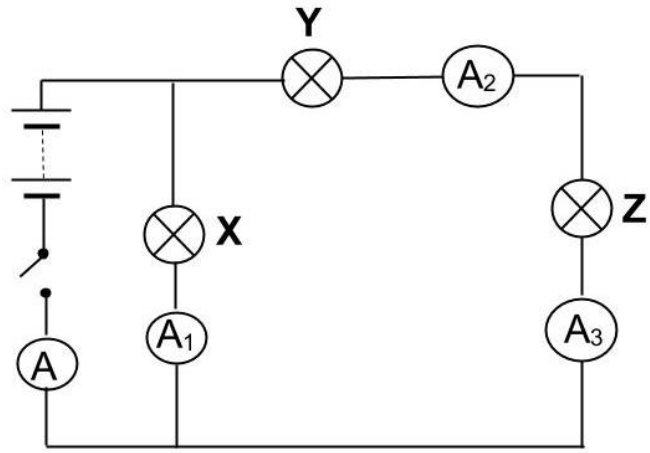
A	0
B	mgh
C	$\frac{1}{2}mv^2$
D	$mgh + \frac{1}{2}mv^2$

(2)

1.5	A block, with mass **m**, is sliding down a rough surface that makes an angle θ with the horizontal, through a distance **x** as indicated in the sketch below. The net work done on the block will increase if... 			
	A	a greater frictional force acts on the block.		
	B	the mass of the block is decreased.		
	C	the distance **x** is decreased.		
	D	the angle θ is increased.		(2)
1.6	Which one of the following can be explained by the *Doppler effect?*			
	A	As a source of sound moves closer to a listener, the sound observed by the listener becomes louder.		
	B	If light shining on a metal has a frequency that is high enough, electrons will be be emitted from the metal.		
	C	A spectrum will be shifted towards shorter wavelengths than expected if the light comes from distant celestial objects moving towards the observer.		
	D	A spectrum of frequencies of electromagnetic radiation is emitted when an atom makes a transition from a high energy state to a lower energy state.		
1.7	An electric field….			
	A	is a region in which a charged particle experiences an electric force.		
	B	is the energy per unit charge experienced by a charged particle.		
	C	is directly proportional to the product of current and resistance in a circuit.		
	D	is the rate of work done by an electrical appliance.		(2)

1.8 Three light bulbs, **X**, **Y** and **Z**, are connected in a circuit as shown below. **X** and **Y** are identical and both has a resistance **R**, while the resistance of **Z** is **2R**. The battery has negligible internal resistance.

When switch **S** is closed, all the bulbs glow. The reading on ammeter **A** is 2,0 A.

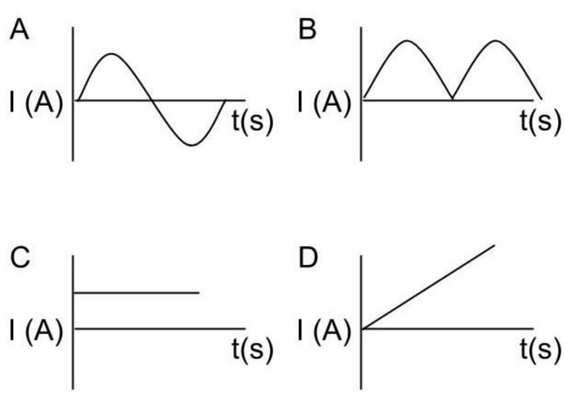


Which ONE of the following correctly describes the readings on the ammeters (in amperes) when bulb **Z** burns out?

	A	**A_1**	**A_2**	**A_3**
A	2	2	0	0
B	1,5	1,5	0	0
C	1	0,5	0,5	0
D	0,6	0,2	0,2	0,2

(2)

1.9 Which one of the following graphs is the correct representation for the current vs time created by a **DC (DIRECT CURRENT)** generator?



(2)

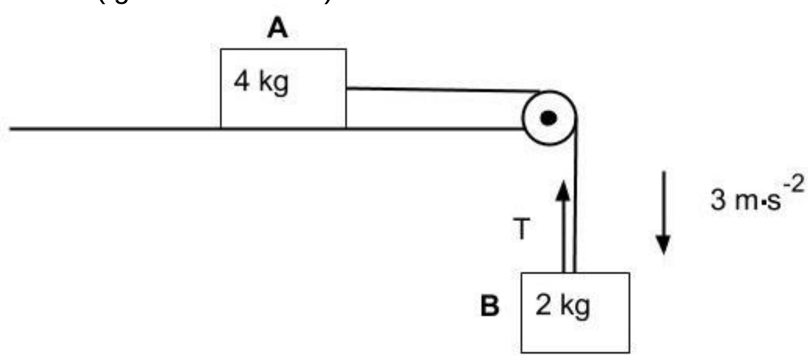
1.10 Light of a certain frequency is incident on a metal surface and photoelectrons are emitted from the surface.

If the INTENSITY of the same light is increased, the ...

A	kinetic energy of the emitted photoelectrons increases.		
B	kinetic energy of the emitted photoelectrons decreases.		
C	number of photoelectrons emitted per second increases.		
D	number of photoelectrons emitted per second decreases.		(2)
			[20]

QUESTION 2 [START ON A NEW PAGE]

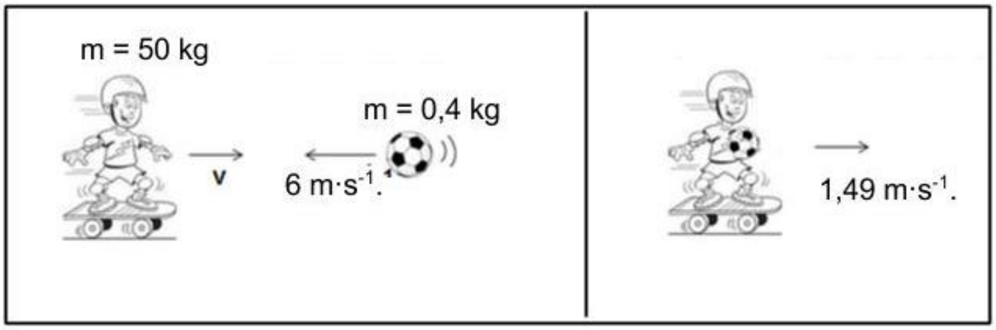
An object A of mass of **4** kg, is connected via a light string of negligible mass over a light, frictionless pulley to object B, with a mass of 2 kg. Object A slides horizontally on a rough surface, while object B accelerates vertically downwards at 3 $m\cdot s^{-2}$ as shown in the diagram below. (Ignore air friction)



2.1	State Newton's Second law of motion in words.	(2)
2.2	Draw a free body diagram of all the forces that acts on object **B.**	(3)
2.3	Calculate the magnitude of the tension **T** in the string between object **A** and **B.**	(3)
2.4	Calculate the magnitude of the kinetic frictional force that is acting on object **A.**	(3)
2.5	Identify one action-reaction force pair that is acting on object **B.**	(2)
		[13]

QUESTION 3 [START ON A NEW PAGE]

A boy on a skateboard moves to the right at constant velocity. The joint mass of the boy and skateboard is 50 kg. He catches a ball with of mass 0,4 kg that is travelling horizontally to the left at a velocity of 6 $m \cdot s^{-1}$. After the boy catches the ball, they both move to the right at 1,49 $m \cdot s^{-1}$.

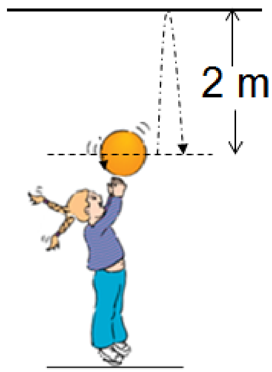


Before boy catches ball After boy catches ball

3.1	Define the term **impulse.**	(2)
3.2	Calculate the magnitude of the average force that the boy exerts on the ball when he catches it, if he and the ball exert a force for a period of 0,1 s on each other.	(3)
3.3	Write down the Principle of Conservation of Momentum.	(2)
3.4	Calculate the magnitude of the velocity **v** of the boy before he catches the ball.	(3)
3.5	Prove with the necessary calculation that this is an *inelastic* collision.	(5)
		[15]

QUESTION 4 [START ON A NEW PAGE]

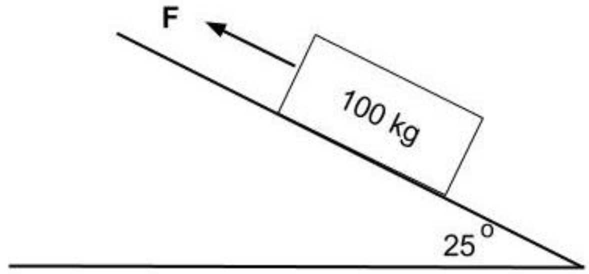
A girl throws a ball vertically upwards with an initial velocity of 8 $m \cdot s^{-1}$. It bounces against the ceiling after travelling 2 m. She catches the ball again 0,65 s after it has left her hand. Assume that the contact time of the ball with the ceiling is negligible. Ignore air friction. Take upwards as positive.



4.1	Calculate the speed of the ball when it reaches the ceiling for the first time.	(3)
4.2	Calculate the speed of the ball immediately after it bounces off the ceiling.	(6)
4.3	Draw a velocity vs time graph for the motion of the ball from the moment it leaves her hand until the moment she catches it again. Indicate the velocity of the ball as it leaves the girl's hand, as well as the velocity of the ball immediately before and after it bounces off the ceiling. Choose upwards as the positive direction.	(5)
		[14]

QUESTION 5 [START ON A NEW PAGE]

The diagram below shows a heavy block of mass 100 kg sliding **down** a rough 25° inclined plane. A constant force **F** is applied on the block parallel to the inclined plane as shown in the diagram below. The block slides down at a **constant velocity**.

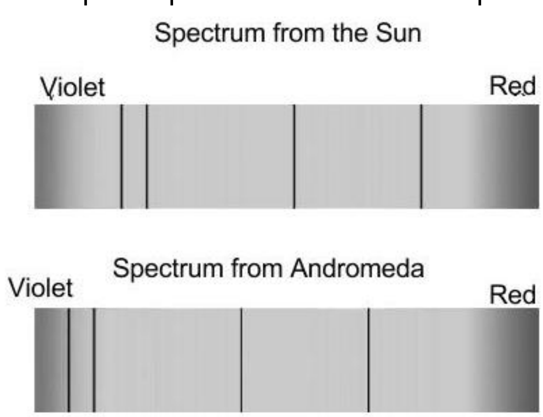


The magnitude of the kinetic frictional force (f_k) between the block and the surface of the inclined plane is **266 N**.

5.1	Friction is a non-conservative force. What is meant by the term *non-conservative force*?	(2)
5.2	Write down the net work done on the block.	(1)
5.3	Calculate the magnitude of the force **F**.	(4)

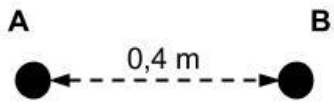
If the block is released from rest without the force **F** being applied, it moves **3 m** down to the bottom of the inclined plane.

5.4	Calculate the speed of the block at the bottom of the inclined plane.	(6)
		[13]

QUESTION 6 [START ON A NEW PAGE]				
6.1	A burglar alarm is wailing with a frequency of 1200 hertz. The speed of sound in air is 340 m•s^{-1}.			
	6.1.1	Explain what is meant by the **Doppler Effect**.		(2)
	6.1.2	If a police officer drives towards the alarm at constant velocity, would he observe an INCREASE, DECREASE or NO CHANGE in the frequency of the sound?		(1)
	6.1.3	Explain the answer in QUESTION 6.1.2 by referring to the WAVELENGTH of the sound observed by the officer.		(2)
	6.1.4	Calculate the frequency the police officer will observe if he is driving towards the alarm at a constant speed of 40 m•s^{-1}.		(4)
6.2	Absorption spectra from the Sun and the Andromeda galaxy is shown below: Study the atomic absorption spectra and answer the question that follows: 			
	6.2.1	Explain the difference between an atomic *absorption spectrum* and an atomic *emission spectrum.*		(4)
	6.2.2	By referring to the frequencies of the absorbed electromagnetic radiation, explain how the spectrum of light from Andromeda differs from the spectrum of light from the Sun.		(1)
	6.2.3	Does the spectrum of Andromeda constitutes a RED SHIFT or a BLUE SHIFT?		(1)
				[15]

QUESTION 7 [START ON A NEW PAGE]

Two identical spheres, **A** and **B,** both negatively charged**,** are placed 0,4 m apart in a vacuum. The charge on sphere **B** is -16 nC. The magnitude of the electrostatic force that one sphere exerts on the other is 7,2 x 10^{-6} N.



7.1	State Coulomb's law in words.	(2)
7.2	Calculate the charge on sphere A.	(3)

Point P is a point 0,3 m to the left of A as shown below:

7.3	Calculate the net electric field at the location of **P** due to **A** and **B**. (Treat the spheres as if they were point charges.)	(6)

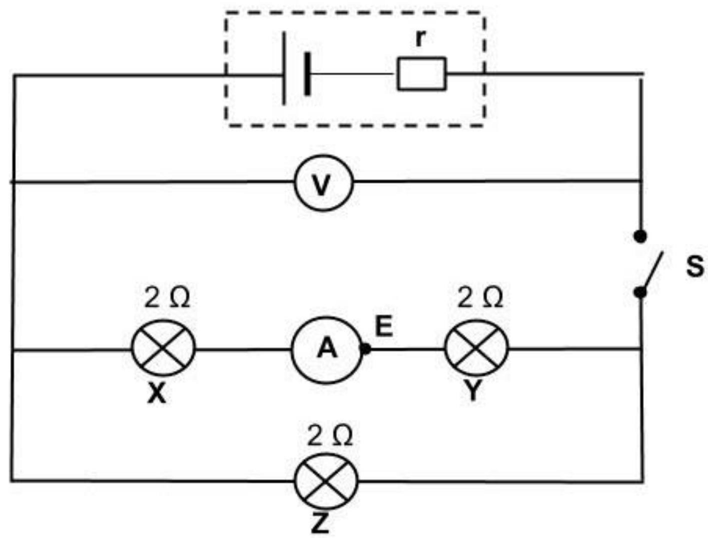
The spheres are brought together, allowed to touch, and then moved back to their original positions, 0,4 m apart.

7.4	When the spheres touch, are electrons transferred from **A to B** or from **B to A?**	(1)
7.5	Calculate the number of electrons transferred from one sphere to the other.	(4)

[16]

QUESTION 8 [START ON A NEW PAGE]

A cell with unknown internal resistance, **r**, is connected to three identical light bulbs, each of resistance 2 Ω, a high resistance voltmeter **V**, a low resistance ammeter **A** and a switch **S** as shown below.

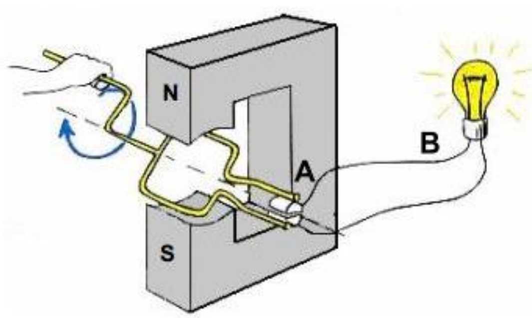


When switch **S** is open, the reading on the voltmeter is **6 V**. When switch **S** is closed, the reading on the voltmeter is **3,9 V**.

8.1	State Ohm's law in words.		(2)
8.2	Which terminal of the ammeter is represented by point **E**? Write down only POSITIVE or NEGATIVE		(1)
8.3	Calculate the total external resistance in the circuit.		(3)
8.4	Calculate the internal resistance, **r**, of the battery.		(6)
8.5	Calculate the reading on **A** when switch **S** is closed.		(2)
8.6	If light bulb **Z** burns out, how will this affect the following values? (Write down INCREASE, DECREASE or STAY THE SAME.)		
	8.6.1	The reading on voltmeter **V**.	(1)
	8.6.2	The total emf of the battery.	(1)
8.7	Calculate the new reading on ammeter **A**, after light bulb **Z** has burnt out.		(3)
			[19]

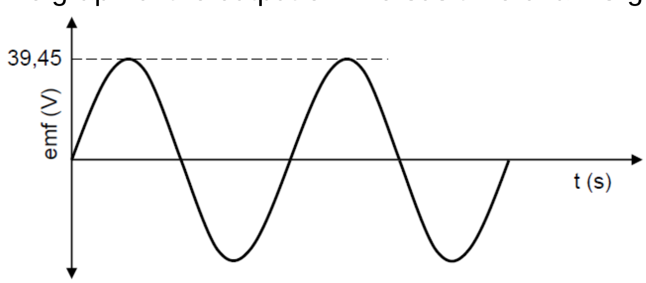
QUESTION 9 [START ON A NEW PAGE]

9.1 A learner is turning a lever connected to a metal coil with a commutator that rotates inside a magnetic field as shown in the diagram below.



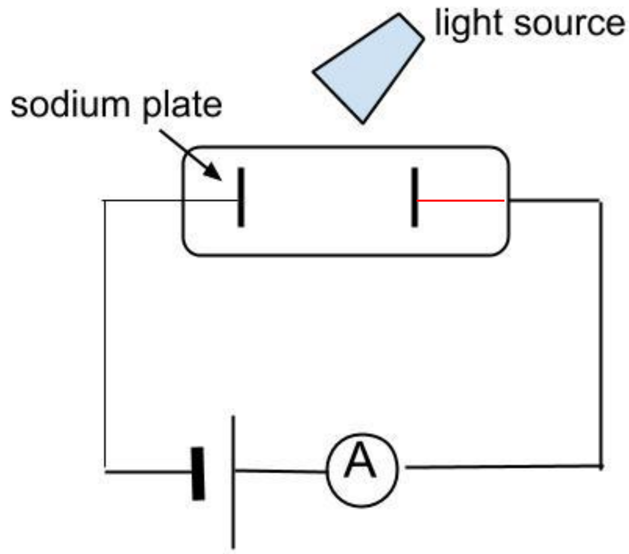
9.1.1	Write down the name of the TYPE of electrical machine represented by the diagram.		(1)
9.1.2	Write down the energy conversion that occurs in the diagram.		(2)
9.1.3	In which direction will the current flow in the wire that is connected to the light bulb? Only write A to B OR B to A.		(1)
9.1.4	What type of current will be generated in the diagram above? Only write DIRECT CURRENT or ALTERNATING CURRENT.		(1)
9.1.5	Explain the answer to QUESTION 9.1.4		(2)
9.1.6	Except for increasing the speed with which the handle is turned, write down two changes that could be made to this setup to increase its output.		(2)

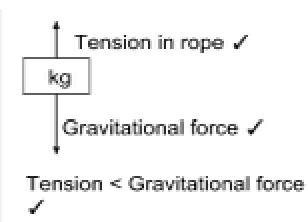
9.2 The graph of the output emf versus time of a AC generator is shown below:



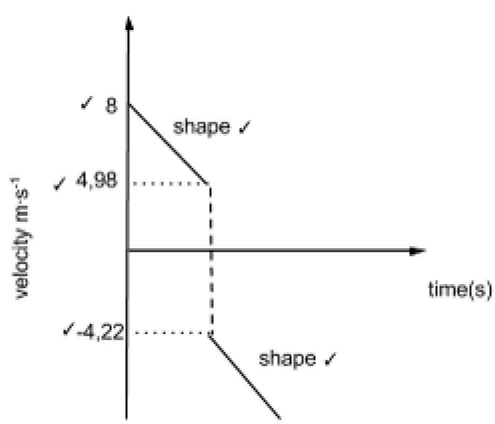
9.2.1	Define the term **root mean square value** (rms) of an AC voltage.		(2)
9.2.2	Calculate the rms voltage for the generator.		(3)

9.3 Give ONE reason why AC voltage is preferred to DC voltage for everyday use. (1)
[15]

QUESTION 10 [START ON A NEW PAGE]				
10.1	A photodiode consisting of a sodium plate and an anode is connected in a circuit diagram as shown below. A learner shines light of different frequencies on the metal plate. He observes that the ammeter connected in the circuit only registers a reading when light with a frequency of 4,389 x 10^{14} Hz or more shines on the sodium plate.			
	 			
	10.1.1	Write down the correct scientific term that describes the phenomenon where electrons are ejected from a metal surface when light of a suitable frequency shines on the metal.		(1)
	10.1.2	Calculate the work function for sodium		(3)
	10.1.3	Calculate the velocity of an **electron** that is ejected from sodium if light with a frequency of 4,83 x 10^{14} Hz shines on the metal.		(4)
10.2	Electrons are ejected from a metal with a velocity **v** when light shines on it**.** Will the velocity INCREASE, DECREASE or STAY THE SAME if:			
	10.2.1	light with a greater frequency is used.		(1)
	10.2.2	a different metal, with a lower work function, is used.		(1)
				[10]
		TOTAL		**[150]**

QUESTION 1		
1.1	A✓✓	(2)
1.2	A✓✓	(2)
1.3	D ✓✓	(2)
1.4	A ✓✓	(2)
1.5	D ✓✓	(2)
1.6	C ✓✓	(2)
1.7	A ✓✓.	(2)
1.8	B ✓✓	(2)
1.9	B ✓✓	(2)
1.10	C ✓✓	(2)
		[20]
QUESTION 2		
2.1	When a resultant/net force acts on an object, the object will accelerate in the direction of the force ✓the acceleration is directly proportional to the force and inversely proportional to the mass of the object.✓	(2)
2.2		(3)
2.3	downward = positive (clockwise) $F_{tension} + F_{gravitation} = F_{resultant}$✓ $F_{tension} + (2)(9,8) = 2(3)$✓	(3)

	$F_{tension}$ = -13,6 N $F_{tension}$ = 13,6 N ✓ upward		
2.4	Right = positive (clockwise) $F_{rope} + F_{friction} = F_{resultant}$✓ 13,6 N + $F_{friction}$ =4(3)✓ $F_{friction}$ = -1,6 N Magnitude of friction force: 1,6 N ✓		(3)
2.5	The force that the rope exerts on the box✓ and the force that the box exerts on the rope.✓ OR the force that the Earth exerts on the box and the force that the box exerts on the Earth.		(2)
			[13]
QUESTION 3			
3.1	The product of the resultant/net force acting on an object and the time the resultant/net force acts on the object.✓✓		(2)
3.2	Right = positive $F\Delta t = m\Delta v = m(v_f - v_i)$✓ (or other correct form of the equation) F(0,1) = 0,4[1,49 - (-6)]✓ F = 29,96 N ✓		(3)
3.3	The total linear momentum of a closed system✓ remains constant (is conserved)✓		(2)
3.4	$m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v$✓(Right = positive) $50v_{1i}$ + (0,4)(-6) = 50,4(1,49)✓ v_{1i} = 1,55 $m\cdot s^{-1}$✓		(3)
3.5	Total kinetic energy before collision: $\frac{1}{2} m_1v_{1i}^2 + \frac{1}{2} m_2v_{2i}^2$ $= (0,5)(50)(1,55)^2 + (0,5)(0,4)(-6)^2$✓ =67,26 J✓ Total kinetic energy after collision: $\frac{1}{2}(m_1 + m_2)v^2$ $= (0,5)(50,4)(1,49)^2$✓ = 55,95 J✓ $E_{k\ before} \neq E_{k\ after}$✓ *inelastic* collision.		(5)
			[15]

QUESTION 4			
4.1	$v_f^2 = v_i^2 + 2g\Delta y$ ✓ (Upwards = positive) $v_f^2 = (8)^2 + 2(-9,8)(2)$ ✓ $v_f = 4,98\ m\cdot s^{-1}$ ✓		(3)
4.2	Time it took to reach the ceiling: $v_f = v_i + gt$ ✓ $4,98 = 8 + (-9,8)t$ ✓ t = 0,31 s. Therefore: time it took for ball to bounce back: 0,65 - 0,31 = 0,34 s ✓ initial velocity of the ball when it bounce back: $\Delta y = v_i t + ½ gt^2$ ✓ $2 = v_i(0,34) + (0,5)(9,8)(0,34)^2$ ✓ $v = 4,22\ m\cdot s^{-1}$ ✓.		(6)
4.3			(5)
			[14]
QUESTION 5			
5.1	A force for which the work done in moving an object between two points depends on the path taken/is not independent of the path taken ✓✓		(2)
5.2	0 J ✓		(1)
5.3	$Fg_{//} - (f + F) = 0$ ✓ (Accept other correct symbols) OR/*OF* $F = mg \sin\theta - f_k$ **OR/*OF*** $F = mg\sin\theta - 266$ $F = [100(9,8) \sin 25^o]$ ✓ $- 266$ ✓		

	414,167- 266 F = 148,17 N ✓ **NOTE/*LET WEL*** No mark for diagram 1 mark for use of any of the three formulae		(4)
5.4	**OPTION 1/*OPSIE 1*** 1 mark for any of the three/ *1 punt vir enige van die drie* $W = F\Delta x \cos\theta$ $W_{net} = W_f + W_g + W_N$ $W_{net} = f_k \Delta x \cos 180^\circ$ ✓ + $mg\sin\theta \Delta x \cos 0^\circ + 0$ $= (266)(3)(-1)$ ✓ + $[100(9,8) \sin 25^\circ (3)(1)]$ ✓ + 0 = 444,5 J $W_{net} = \Delta E_K / \Delta K = ½ m(v_f^2 - v_i^2)$ ✓ $444,5 = ½ (100) (v_f^2 - 0)$ ✓ $v_f = 2,98 \text{ m·s}^{-1}$ ✓ **OPTION 2/*OPSIE 2*** $W_{nc} = \Delta E_p + \Delta E_k$ ✓ $f\Delta x\cos\theta$ ✓ = $(mgh_f - mgh_i) + (½ mv_f^2 - ½ mv_i^2)$ $266\Delta x \cos 180^\circ$ ✓ = $(0 - mg\sin 25^\circ \Delta x \cos 0^\circ) + (½ mv_f^2 - 0)$ $266(3)(-1) = [-100(9,8) \sin 25^\circ (3)(1)]$ ✓ $-½ (100) (v_f^2 - 0)$ ✓ $v_f = 2,98 \text{ m·s}^{-1}$ ✓ **OPTION 3/*OPSIE 3*** **POSITIVE MARKING FROM QUESTION 5.3** ***POSITIEWE NASIEN VANAF VRAAG 5.3*** $W_{net} = \Delta E_k$ ✓ $F_{net}\Delta x\cos\theta$ ✓ = $½ m(v_f^2 - v_i^2)$ (148,17) ✓ $(3)\cos 0^0$ ✓ = $½ (100)(v_f^2 - 0^2)$ $444,51 = 50v_f^2$ ✓ $v_f = 2,98 \text{ m·s}^{-1}$ ✓ **OPTION 4/*OPSIE 4*** **POSITIVE MARKING FROM QUESTION 5.3** ***POSITIEWE NASIEN VANAF VRAAG 5.3*** $F_{net} = ma$ ✓ 148,17 ✓ =100a ✓ $a = 1,48 \text{ m·s}^{-2}$ $v_f^2 = v_i^2 + 2a\Delta x$ ✓ $= 2(1,48)(3)$ ✓ $v_f = 2,98 \text{ m·s}^{-1}$ ✓		(6)

<u>OPTION 5/*OPSIE 5*</u>
POSITIVE MARKING FROM QUESTION 5.3
POSITIEWE NASIEN VANAF VRAAG 5.3

$F_{net} = ma$ ✓
$148{,}17$ ✓ $= 100a$ ✓
$a = 1{,}48\ m \cdot s^{-2}$

$\Delta x = v_i \Delta t + ½ a \Delta t^2$
$3 = 0 + ½(1{,}48)\Delta t^2$
$\Delta t = 2{,}01\ s$ ✓

$v_f = v_i + a\Delta t$
$= 0 + (1{,}48)(2{,}01)$ ✓
$v_f = 2{,}97\ m \cdot s^{-1}$ ✓

<u>OPTION 6/*OPSIE 6*</u>
POSITIVE MARKING FROM QUESTION 5.3
POSITIEWE NASIEN VANAF VRAAG 5.3

$F_{net} = ma$ ✓
$148{,}17$ ✓ $= 100a$ ✓
$a = 1{,}48\ m \cdot s^{-2}$

$\Delta x = v_i \Delta t + ½ a \Delta t^2$
$3 = 0 + ½(1{,}48)\Delta t^2$
$\Delta t = 2{,}01\ s$ ✓

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$3 = \left(\frac{0 + v_f}{2}\right)(2{,}01)$
$v_f = 2{,}99\ m \cdot s^{-1}$ ✓

			[13]
QUESTION 6			
6.1.1	The change in frequency (or pitch) of the sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation ✓ ✓		(2)
6.1.2	increase ✓		(1)
6.1.3	As the police officer move closer to the alarm, he would observe a sound with a shorter wavelength ✓ than was originally omitted. Since the wavelength is inversely proportional to the frequency of the wave, the frequency will increase (become more / higher). ✓		(2)
6.1.4	$f_L = \frac{v + v_L}{v} f_s$ ✓ (OR Formula as on data sheet) $= \frac{340 + 40}{340}$ ✓ (1200) ✓ $= 1\ 341{,}18$ Hz ✓		(4)

6.2.1	An atomic absorption spectrum is formed when certain frequencies of electromagnetic radiation that passes through a medium✓, e.g. a cold gas, is absorbed.✓ An atomic emission spectrum is formed when certain frequencies of electromagnetic radiation are emitted✓ due to an atom's electrons making a transition from a high-energy state to a lower energy state.✓	(4)
6.2.2	The absorbed electromagnetic radiation for the light from Andromeda appear at higher frequencies than the absorbed electromagnetic radiation for light from the Sun.✓	(1)
6.2.3	Blue shift ✓	(1)
		[15]
QUESTION 7		
7.1	The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them:✓✓	(2)
7.2	$F = \frac{kQ_1Q_2}{r^2}$✓ $7,2 \times 10^{-6} = \frac{9\times10^9 \times Q \times 16 \times 10^{-9}}{(0,4)^2}$✓ $Q_A = -8$ nC.✓	(3)
7.3	Electric field at P due to A $E = \frac{kQ}{r^2}$✓ $= \frac{9\times10^9 \times 8 \times 10^{-9}}{(0,3)^2}$✓ $= 800 \text{ N·C}^{-1}$✓ Electric field at P due to B $E = \frac{9\times10^9 \times 16 \times 10^{-9}}{(0,7)^2}$✓ $= 293,88 \text{ N·C}^{-1}$✓ $800 + 293,88 = 1\,093,88 \text{ N·C}^{-1}$✓	(6)
7.4	**B TO A**✓	(1)
7.5	$\frac{8nC + 16nC}{2}$ = 12 nC✓ 4 nC electrons were transferred from B to A✓ $\frac{4\times10^{-9}}{1,6\times10^{-19}}$ ✓= $2,5 \times 10^{10}$ ✓electrons	(4)
		[16]

QUESTION 8			
8.1	The potential difference across a conductor is directly proportional to the current in the conductor✓ at constant temperature.✓		(2)
8.2	Negative✓		(1)
8.3	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$✓ $\frac{1}{R} = \frac{1}{4} + \frac{1}{2}$✓ R = 1,33$\Omega$✓		(3)
8.4	V = IR✓ 3,9 = I x 1,33✓ I = 2,925 A✓ $\varepsilon = IR + Ir$✓ 6 = 3,9 + 2,925 r✓ r = 0,72Ω✓		(6)
8.5	$\frac{2,925}{3}$ ✓= 0,975 A.✓ or V = IR 3,9 = I (4)✓ I = 0,975 A✓		(2)
8.6.1	Increase✓		
8.6.2	Stays the same ✓		(1)
8.7	$\varepsilon = I(R + r)$✓ 6 = I (4 + 0,72)✓ I = 1,27 A✓		(3)
			[19]
QUESTION 9			
9.1.1	Generator ✓		(1)
9.1.2	Kinetic/mechanical energy✓ → electrical energy ✓		(2)
9.1.3	B to A ✓		(1)
9.1.4	DC ✓		(1)

9.1.5	The split ring commutator ensures✓ that the current that passes through to the external circuit is always in the same direction.✓	(2)
9.1.6	Use a coil that consist of more windings ✓ Increase the strengths of the magnets.✓	(2)
9.2.1	The rms value of AC is the DC potential difference which dissipates the same amount of energy as AC✓✓	(2)
9.2.2	$V_{rms} = \frac{V_{max}}{\sqrt{2}}$✓ $= \frac{39,45}{\sqrt{2}}$✓ = 27,9 V ✓	(3)
9.3	It can be stepped up or stepped down / is easier to transmit ✓	(1)
		[15]
QUESTION 10		
10.1.1	Photoelectric effect ✓.	(1)
10.1.2	$W_o = hf_o$✓ $= 6,63 \times 10^{-34} \times 4,389 \times 10^{14}$ ✓ $= 2,91 \times 10^{-19}$ J✓	(3)
10.1.3	E = hf $= 6,63 \times 10^{-34} \times 4,83 \times 10^{14}$ $= 3,2 \times 10^{-19}$J $E = hf_o + ½ mv^2$ ✓ $3,2 \times 10^{-19}$✓ $= 6,63 \times 10^{-34} \times 4,39 \times 10^{14} + (0,5)(9,11 \times 10^{-31}) v^2$✓ $v = 2,5 \times 10^5$ m·s^{-1}✓	(4)
10.2.1	Increase ✓	(1)
10.2.2	increase✓	(1)
		[10]
	TOTAL	**[150]**

Province of the
EASTERN CAPE
EDUCATION

NATIONAL
SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2015

PHYSICAL SCIENCES P1

MARKS: **150**

TIME: **3 hours**

PHSCE1

This question paper consist of 20, pages including 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write the letter (A–D) next to the question number (1.1–1.10) in your ANSWER BOOK for example 1.11 D.

1.1 The front of a modern car is designed to crumble in case of a head-on collision. The chance of serious injuries to the passenger is reduced because the …

A net force acting on the passenger is reduced, since the contact time for the car to stop decreases.

B net force acting on the passenger is reduced, since the rate of change in momentum decreases.

C net force acting on the passenger is reduced, since the change in momentum is reduced.

D net force acting on the passenger is reduced, since the change in momentum is increased. (2)

1.2 An astronaut has a weight of W on earth. He lands on a planet with mass three times greater than the earth and a radius twice that of the earth. What is the weight of the astronaut on this planet? Take the radius of the earth as R.

A $\frac{3}{16}$ W

B $\frac{3}{4}$ W

C $\frac{3}{2}$ W

D 3 W (2)

1.3 $(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$ when only … are present.

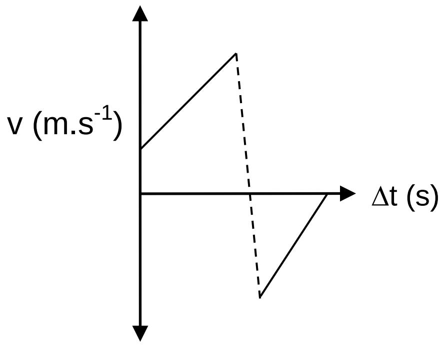
A frictional forces

B tension forces

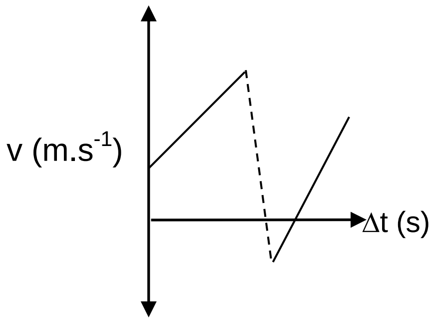
C applied forces

D gravitational forces (2)

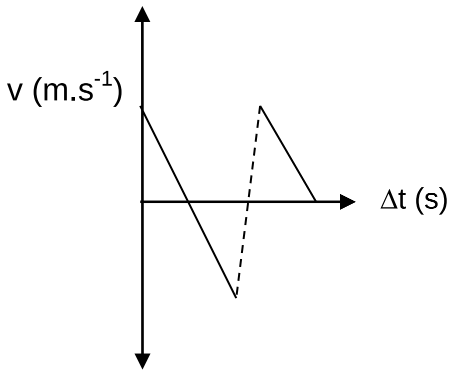
1.4 An object is thrown vertically downwards towards the ground from height *h* with a velocity *v*. The object strikes the ground and bounces upwards. It is caught when it reaches its maximum height after the bounce. Which ONE of the following velocity versus time graphs best represents the motion of the object?



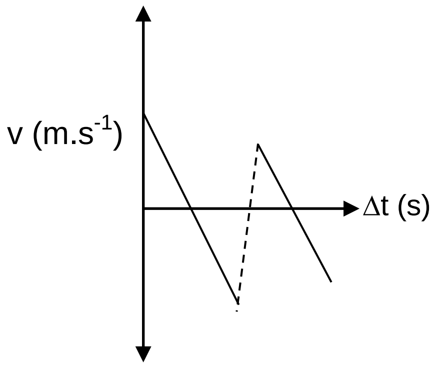
A



B



C

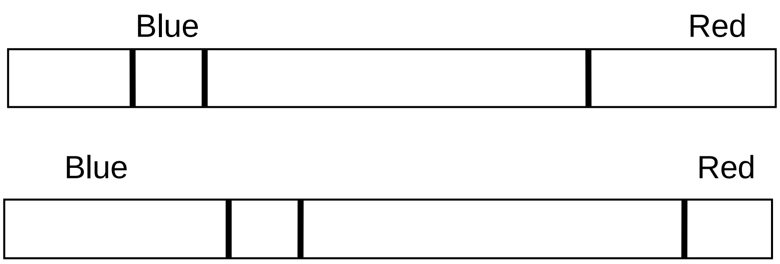


D (2)

1.5 Astronomers obtained the following spectral lines of an element:

Spectrum of element in a laboratory:

Spectrum of element from a distant star:



The observation confirms that the ...

A star is moving closer towards earth.

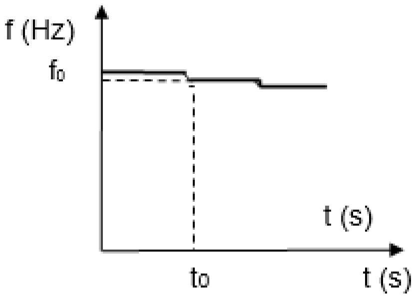
B earth is moving towards the star.

C temperature of earth is increasing.

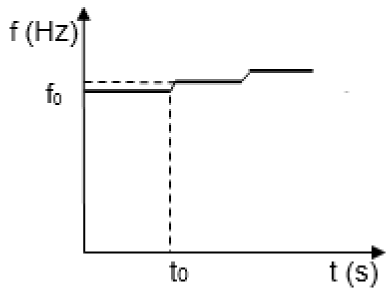
D universe is expanding. (2)

1.6 A stationary fire truck sounds its siren at frequency f_0. A girl walks at a constant velocity towards the fire truck. She passes the fire truck and then walks away from it.

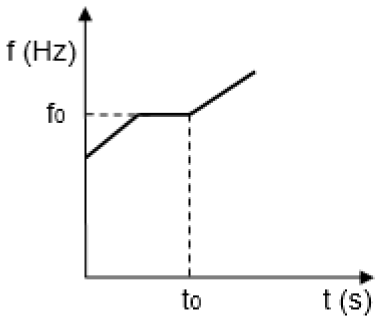
Which ONE of the graphs below shows the changes in frequency heard by the girl over the distance she walks?



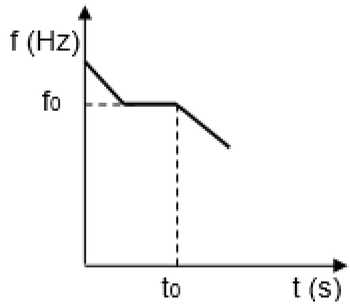
A



B



C



D (2)

1.7 Two spheres, A and B, have charges of +1 C and +2 C respectively. They are brought into contact with each other and then moved to their original positions.

The amount of charge transferred is …

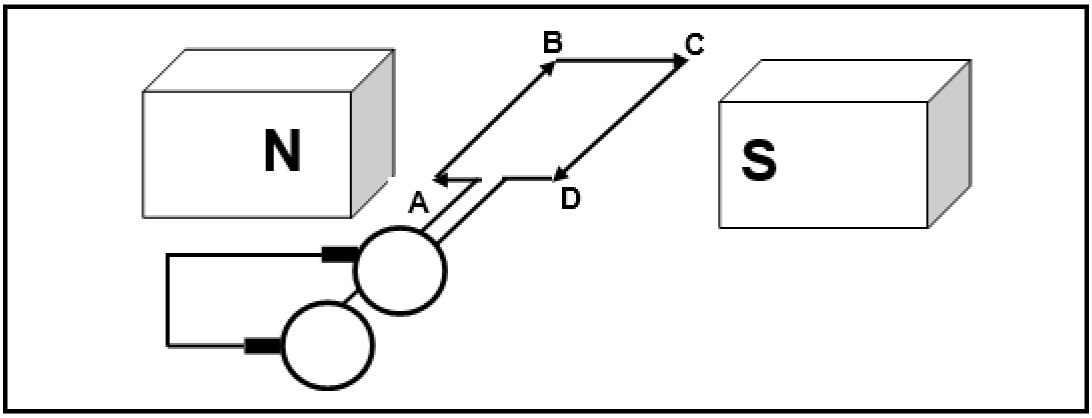
A 0,5 C from B to A.

B 0,5 C from A to B.

C 1,5 C from B to A.

D 1,5 C from A to B. (2)

1.8 A simplified diagram of a generator is shown below.



Coil ABCD rotates …

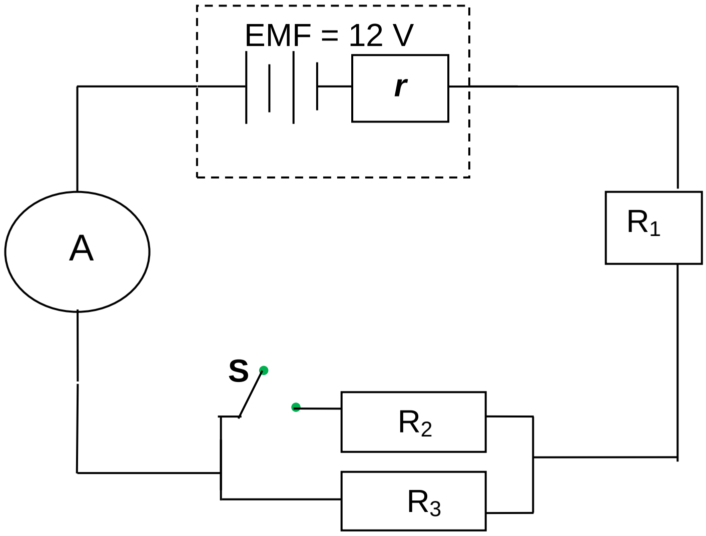
A clockwise.

B anticlockwise.

C clockwise, reaches the vertical position and then reverses its direction.

D anticlockwise, reaches the vertical position and then reverses its direction. (2)

1.9 The circuit diagram below contains a combination of resistors R_1, R_2 and R_3. The battery has an EMF of 12 V and an unknown resistor, ***r***.



Switch S is now CLOSED.

	$R_{external}$	**Reading on ammeter (A)**
A	Decreases	Increases
B	Decreases	Remains constant
C	Decreases	Decreases
D	Increases	Increases

(2)

1.10 A neon tube lights up when a large external voltage is applied across it. Which ONE of the following best describes the type of spectrum observed when the gas inside the tube is observed through a diffraction grating?

A Absorption spectrum

B Continuous emission spectrum

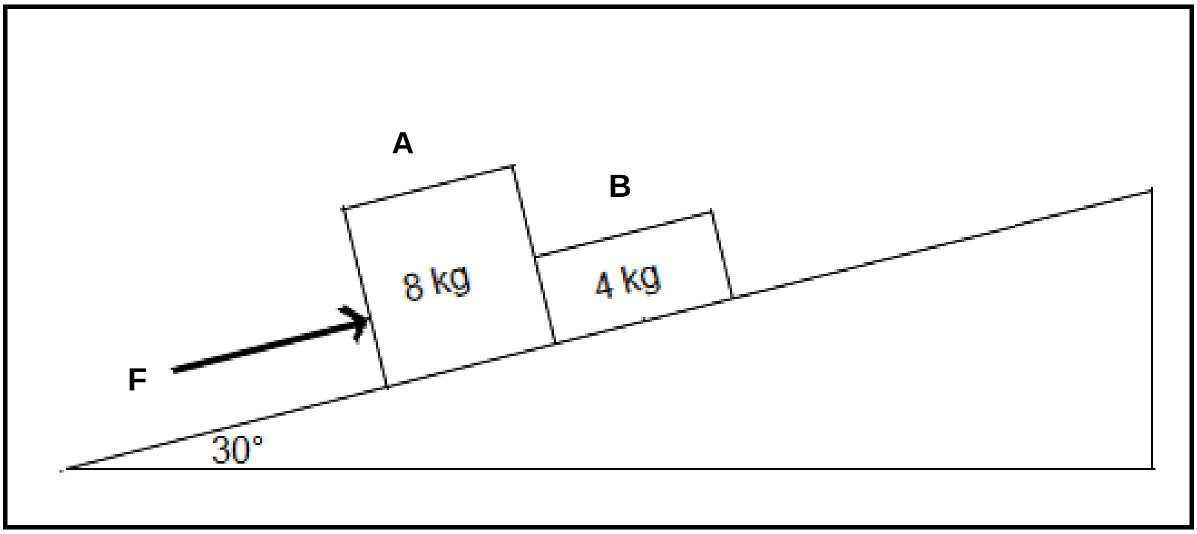
C Line absorption spectrum

D Line emission spectrum (2)

[20]

QUESTION 2 (Start on a new page.)

Two objects, **A** and **B**, of mass 8 kg and 4 kg respectively, are in contact. They lie on a plane inclined at 30° to the horizontal. A force, **F**, applied parallel to the incline, pushes on the objects as shown in the diagram below.



2.1 State *Newton's Second Law of motion* in words. (2)

The magnitude of kinetic frictional force acting on object **A** is 6,8 N and on object **B** is 3,4 N.

2.2 Draw a labelled free-body diagram of the forces acting on **B** as it moves up the inclined plane. (4)

2.3 Calculate the:

2.3.1 Magnitude of **F** if the system moves up the inclined plane at CONSTANT VELOCITY. (5)

2.3.2 Coefficient of kinetic friction for **B**. (3)

2.4 The angle between the incline and the horizontal changes to 35°.

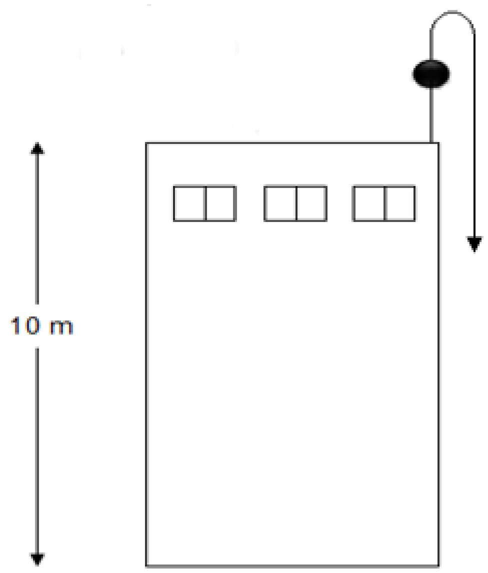
2.4.1 How will the answer in QUESTION 2.3.2 be affected? Write down INCREASES, DECREASES or REMAIN THE SAME. (1)

2.4.2 How will the magnitude of the kinetic frictional force on object **B** be affected? Write INCREASES, DECREASES or REMAIN THE SAME. Explain your answer. (3)

[18]

QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards at a velocity of 4 $m.s^{-1}$ from the roof of a building with a of height 10 m. The ball strikes the ground and rebounds to a height of 3 m.
Ignore the effects of friction.



3.1 Calculate the:

3.1.1 Time taken for the ball to reached its maximum height. (3)

3.1.2 Maximum height the ball reaches above the ground. (4)

3.2 The ball strikes the ground 1,09 s after it was thrown and remains in contact with the ground for 0,2 s before bouncing upwards.

Sketch a graph (not to scale) of position versus time representing the entire motion of the ball.

USE THE GROUND AS ZERO REFERENCE.

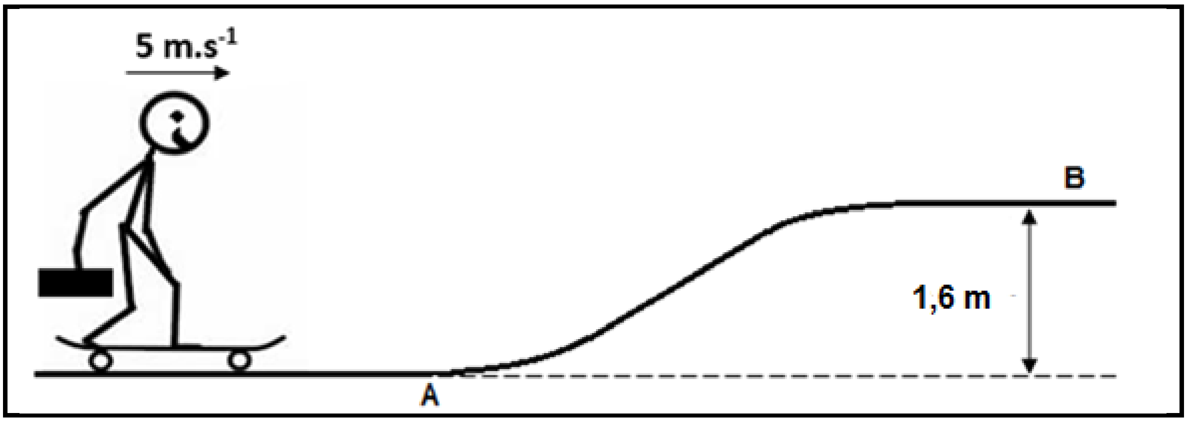
Indicate the following on the graph:

- Height from which the ball was thrown
- Maximum height of the ball from ground
- Height reached by the ball after bouncing
- Time the ball strikes the ground
- Contact time of the ball with the ground

(5)
[13]

QUESTION 4 (Start on a new page.)

A boy on a skateboard moves at 5 $m.s^{-1}$ to the right towards point **A** at the bottom of a slope which is 1,6 m high. He is carrying a 4 kg parcel. The total mass of the boy, his skateboard and the parcel is 70 kg. He needs to increase his speed, in order to reach point **B** at the top of the slope. He decides that if he throws the parcel horizontally, it will increase his forward velocity.
IGNORE ALL FRICTION.



4.1 In which direction must the boy throw the parcel in order to increase his forward velocity? (**TO THE LEFT** or **TO THE RIGHT**) (1)

4.2 Give the name of Newton's law of Motion that you used to obtain your answer in QUESTION 4.1. (1)

4.3 State the *Principle of conservation of mechanical energy.* (2)

4.4 Calculate the velocity of the boy immediately after the parcel leaves his hand in order for him to reach the top of the slope at point **B**. (4)

4.5 Calculate the minimum velocity with which he must throw the parcel in order for him to reach the top of the slope at point **B**. (4)

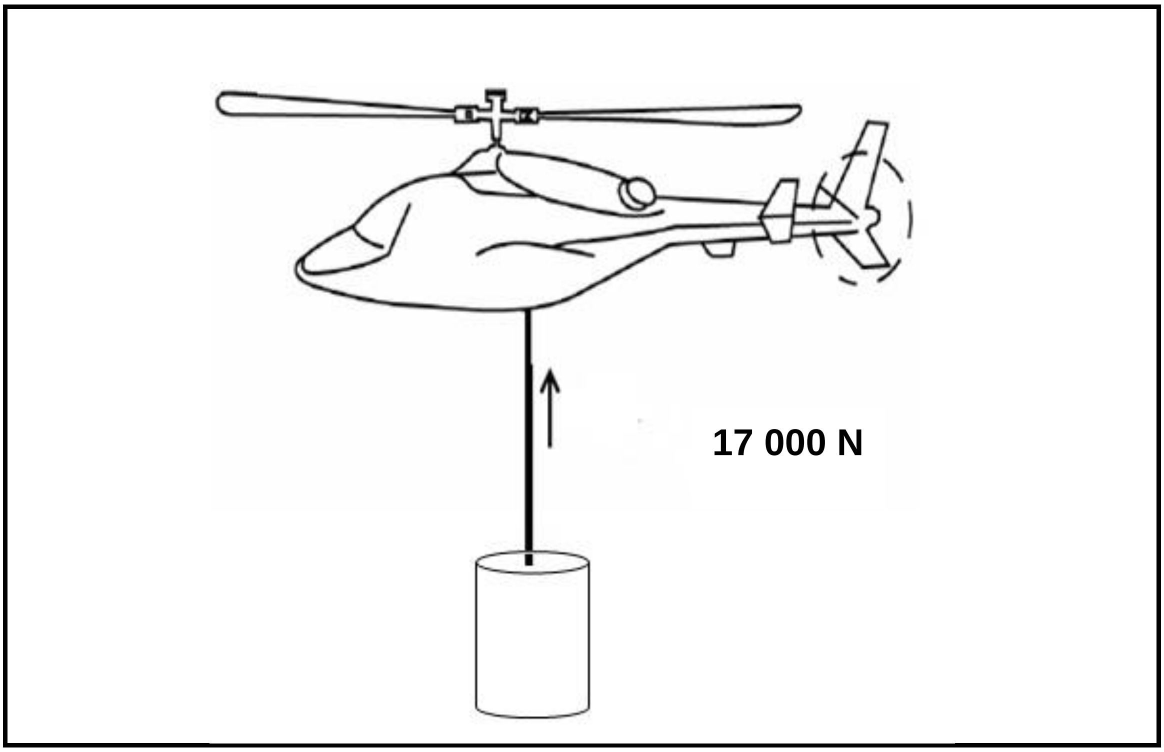
4.6 How will the answer in QUESTION 4.4 be affected, if the boy throws the same parcel with higher velocity in the same direction as indicated in QUESTION 4.1?

Write down INCREASES, DECREASES or REMAIN THE SAME.
Explain your answer. (3)

[15]

QUESTION 5 (Start on a new page.)

During a fire extinguishing operation, a helicopter remains stationary (hovers) above a dam while filling a bucket with water. The bucket, of mass 80 kg, is filled with 1 600 kg of water. It is lifted vertically upwards through a height of 20 m by a cable at a CONSTANT SPEED of 2 $m.s^{-1}$. The tension in the cable is 17 000 N.
Assume there is no sideways motion during the lift.
Air friction is NOT ignored.



5.1 State the *work-energy theorem* in words. (2)

5.2 Draw a labelled free body diagram showing ALL the forces acting on the bucket of water, while being lifted upwards. (3)

5.3 Use the WORK ENERGY THEOREM to calculate the work done by air friction on the bucket of water after moving through the height of 20 m. (5)

[10]

QUESTION 6 (Start on a new page.)

A siren of a stationary ambulance emits sound waves of frequency 280 Hz. A car is moving towards a stationary ambulance at a constant speed that is 310 $m.s^{-1,}$ **lower** than the speed of sound in air.

6.1 Define the *Doppler Effect*. (2)

6.2 Calculate the frequency of sound detected by the driver of the car. Use the speed of sound in air as 340 $m.s^{-1}$. (5)

6.3 How will the answer in QUESTION 6.2 be affected if the car moves away from the ambulance at the same constant speed?

Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

Explain the answer. (3)

6.4 Give ONE use of the Doppler flow meter. (1)

6.5 When a line in a hydrogen spectrum is measured in a laboratory, it has a wavelength of $1,32 \times 10^{-15}$ m. The same line in the light of a star has a wavelength of $1,38 \times 10^{-15}$ m.

Is the star moving TOWARDS, or AWAY from the earth?

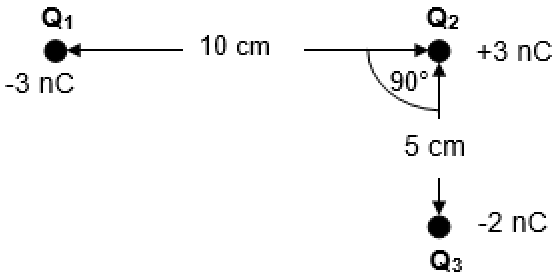
Explain your answer. (2)
[13]

QUESTION 7 (Start on a new page.)

A -3 nC charge Q_1 is placed 10 cm away from a +3 nC Q_2 charge as shown in the diagram below.

7.1 Draw the electric field pattern formed between the two charges. (3)

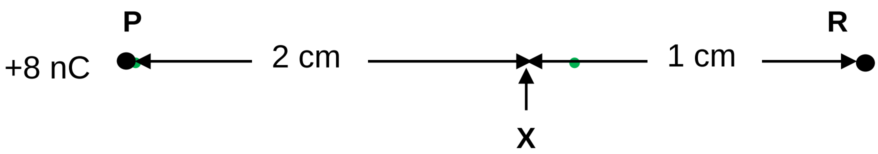
7.2 A -2 nC charge Q_3 is placed 5 cm away from Q_2 as indicated in the diagram below.



Draw a force diagram showing the electrostatic forces exerted on Q_2 by Q_1 and Q_3 respectively. (2)

7.3 Calculate the net force exerted on Q_2 by Q_1 and Q_3 respectively. (8)

7.4 An unknown point charge **R** is placed 3 cm away from point **P** as shown in the sketch below.

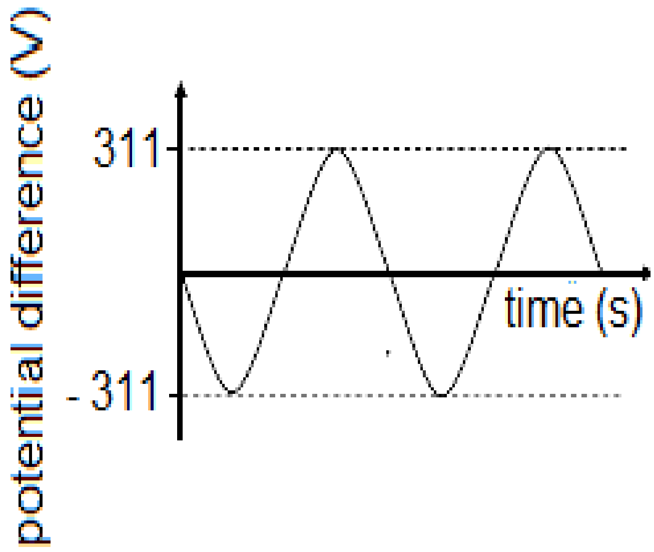


Calculate the charge on **R** if the net electric field strength at point **X** is zero. (5)

[18]

QUESTION 8 (Start on a new page.)

The light bulb shown below is able to operate either with direct current or with alternating current. It displays its optimum operating conditions and the accompanying graph displays the current type that is being used.



8.1 Is the bulb operating with direct current, or alternating current? (1)

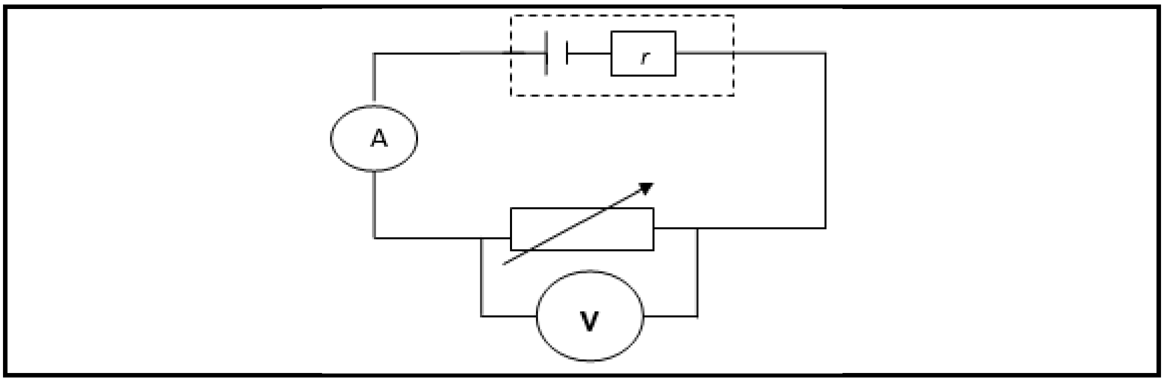
8.2 Explain the meaning of 100 W. (1)

8.3 Calculate the rms current in the bulb when it is connected in a circuit. (4)

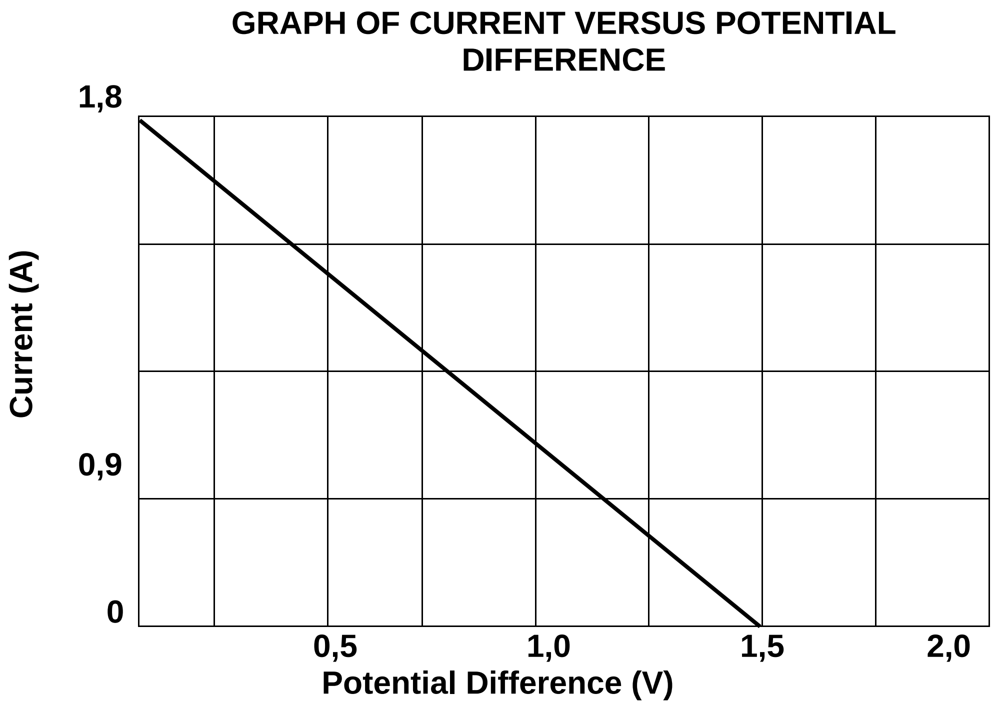
8.4 Explain why ESKOM prefers AC instead of DC for long distance transmission of electricity. (2)
[8]

QUESTION 9 (Start on a new page.)

Learners conduct an experiment as shown in the diagram below.



The results obtained are shown in the graph below.



9.1 Use the graph to determine the following:

9.1.1 Emf (**ε**) of the battery (1)

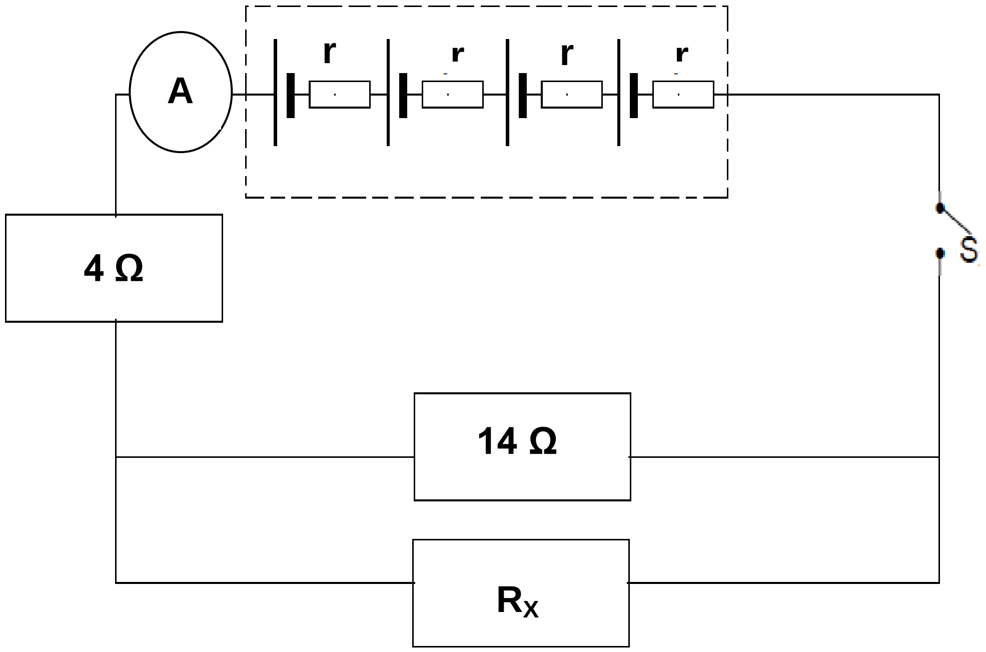
9.1.2 Internal resistance of the battery, WITHOUT USING THE EQUATION **ε** = I(R + r) IN YOUR CALCULATIONS (4)

9.2 The resistance of the rheostat is now increased.

9.2.1 How will this change the voltmeter reading? Write down INCREASES, DECREASES or REMAIN THE SAME. (1)

9.2.2 Explain your answer. (3)

9.3 Four identical cells, EACH with a emf of 1,5 V and an internal resistance of 0,25 Ω are connected in series with each other and to the resistors as shown below.



9.3.1 Write down the potential difference across the cells when the switch is open.

9.3.2 When switch S is closed, the potential difference across the 4 Ω resistor is 2 V.

Calculate the: (2)

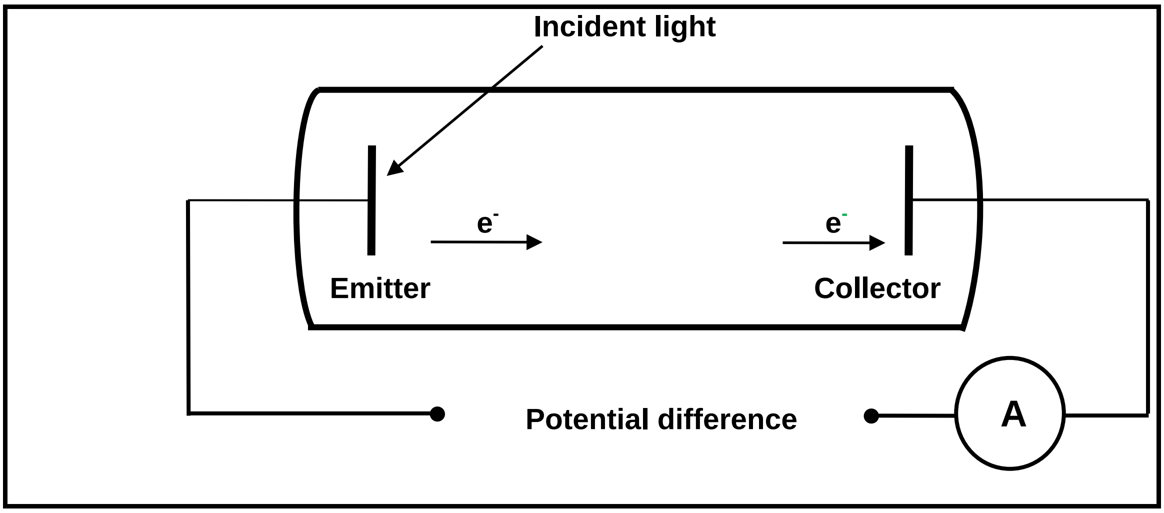
(a) Current in the circuit (3)

(b) R_x (8)

[22]

QUESTION 10 (Start on a new page.)

The simplified diagram below illustrates how an emitter, when light shines on it, emits electrons.



10.1 What phenomenon is displayed in the diagram? (1)

The incident monochromatic light transfers energy to the emitter. The emitter releases 1,01 x 10^9 photo-electrons per second. The threshold frequency of the emitter is 1,21 x 10^{15} Hz.

(**NOTE**: ONE photon releases ONE electron.)

10.2 Define the term *threshold frequency (cut-off frequency).* (2)

10.3 Calculate the current flowing through the ammeter. (5)

10.4 The brightness of the incident light is now decreased.

What effect will this change have on the current strength in QUESTION 10.3?

Write down INCREASES, DECREASES or REMAIN THE SAME. (1)

10.5 The emitter is replaced by another one with a threshold frequency greater than 1,21 x 10^{15} Hz. The same monochromatic light was used.

10.5.1 How does this change have an effect on the kinetic energy of the photoelectrons released?

Write down only GREATER THAN, SMALLER THAN or STAYS THE SAME. (1)

10.5.2 Explain your answer in QUESTION 10.5.1. (2)

10.6 White light shines through a cold diluted gas and photons with specific frequencies are absorbed and appear as black lines in the continuous spectrum.

Differentiate between an absorption spectrum and a line emission spectrum. (2)

[14]

TOTAL: 150

QUESTION/*VRAAG 1*

1.1	B ✓✓	(2)
1.2	B ✓✓	(2)
1.3	D ✓✓	(2)
1.4	A ✓✓	(2)
1.5	D ✓✓	(2)
1.6	A ✓✓	(2)
1.7	B ✓✓	(2)
1.8	A ✓✓	(2)
1.9	A ✓✓	(2)
1.10	D ✓✓	(2)
	(10 x 2)	**[20]**

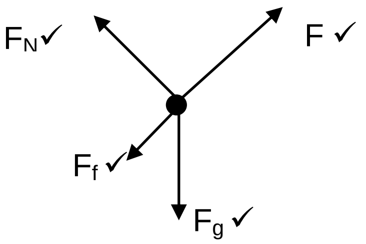
QUESTION 2/*VRAAG 2*

2.1 When a resultant/net force acts on an object, the object accelerates in the direction of the force. This acceleration directly proportional to the force ✓ and inversely proportional to the mass of the object. ✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Hierdie versnelling is direk eweredig aan die krag ✓'n omgekeerd eweredig aan die massa van die voorwerp. ✓

OR/OF

The resultant/net force acting on an object is equal to the rate of change in momentum of the object (in the direction of the force).✓✓ *Die resulterende/netto krag wat op 'n voorwerp inwerk, is gelyk aan die tempo van verandering van momentum van die voorwerp (in die rigting van die resulterende/netto krag.)* ✓✓ (2)

2.2



(4)

2.3 2.3.1 **Up the incline as positive/Teen die skuinste op as positief:**

$F_{net} = ma$
$F + (f_{kA} + f_{kB} + F_{g||}) = ma$
$F + (f_{kA} + f_{kB} + mg\sin 30^0) = (m_A + m_B)a$
} ✓ Any ONE/Enige EEN

$F - \underline{6,8 - 3,4}$ ✓ $- \underline{(12)(9,8)\sin 30^0}$ ✓ $= 0$ ✓
$F = 69$ N ✓ (5)

2.3.2 $f_k = \mu_k F_N$ ✓
$3,40 = \mu_k (4)(9,8)\cos 30^0$ ✓
$\mu_k = 0,10$ ✓ (3)

2.4 2.41 REMAIN THE SAME/*BLY DIESELFDE* ✓ (1)

2.4.2 DECREASES/*NEEM AF* ✓
Since ϴ increases, $F_g\perp$ decreases,✓ therefore F_N decrease*s* ✓/$f_k \;\alpha\; F_N$ ✓ *Omdat ϴ toeneem, sal $F_g\perp$ afneem,* ✓*dus sal F_N afneem* ✓/$f_k \;\alpha\; F_N$. ✓ (3)

[18]

QUESTION 3/*VRAAG 3*

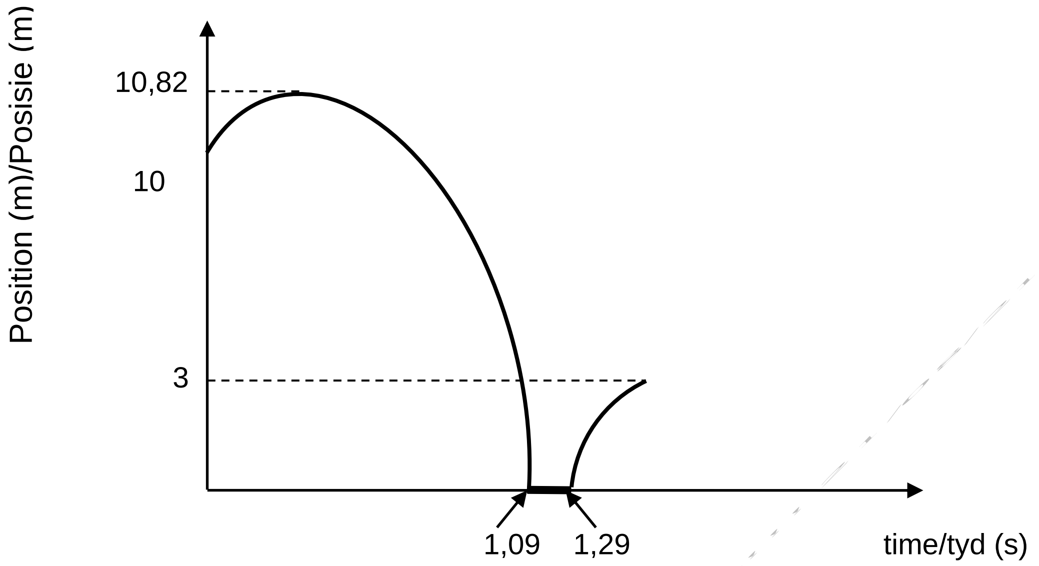
3.1 3.1.1

OPTION1/*OPSIE 1* **Upwards as positive** ***Opwaarts as positief*** $v_f = v_i + a\Delta t$ ✓ $0 = 4 + (-9,8)\Delta t$ ✓ $\Delta t = 0,41$ s ✓ (3)	**Downwards as positive** ***Afwaarts as positief*** $v_f = v_i + a\Delta t$ ✓ $0 = -4 + (9,8)\Delta t$ ✓ $\Delta t = 0,41$ s ✓ (3)
OPTION2/*OPSIE2* **Upwards as positive** ***Opwaarts as positief.*** $v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = 4^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 0,82$s $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $0,82 = \left(\frac{4 + 0}{2}\right)\Delta t$ ✓ $\Delta t = 0,41$ s ✓ (3)	**Downwards as positive** ***Afwaarts as positief*** $v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = (-4^2) + 2(9,8)\Delta y$ ✓ $\Delta y = 0,82$s $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $-0,82 = \left(\frac{-4 + 0}{2}\right)\Delta t$ ✓ $\Delta t = 0,41$ s ✓ (3)
NOTES/*AANTEKENINGE:* Accept/*Aanvaar* $s = \left(\frac{u+v}{2}\right)t$	$v^2 = u^2 + 2as$ g instead of *a* *g* in plaas van *a*

3.1.2

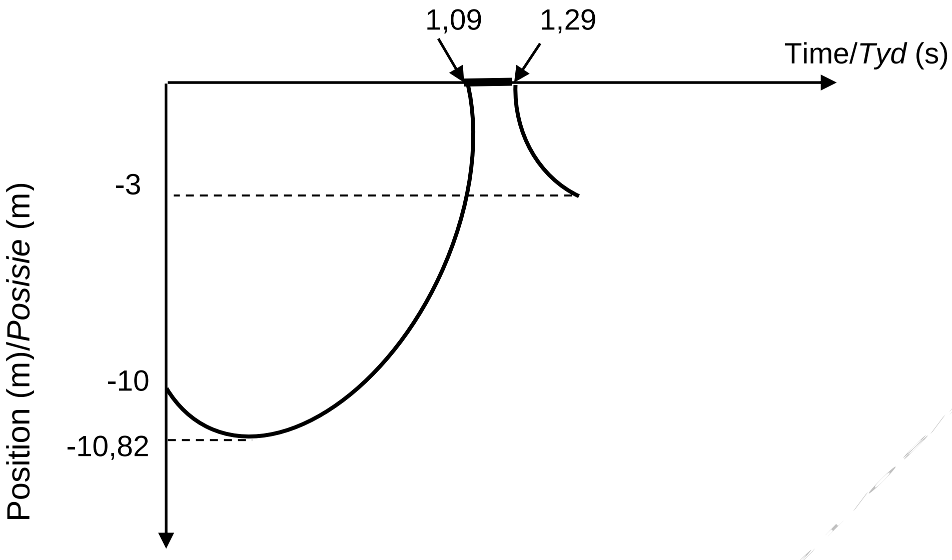
OPTION 1/*OPSIE1* **Upwards as positive** ***Opwaarts as positief*** $\Delta y = v_i\Delta t + ½ a \Delta t^2$ ✓ $= (4)(0,41) + ½ (-9,8)(0,41)^2$ ✓ $= 0,82$ m Maximum height/Maksimum hoogte = <u>10</u> ✓ + 0,82 = 10,82 m ✓ (4)	**OPTION 1/*OPSIE1*** **Downwards as positive** ***Afwaarts as positief*** $\Delta y = v_i\Delta t + ½ a \Delta t^2$ ✓ $= (-4)(0,41) + ½ (9,8)(0,41)^2$ ✓ $= -0,82$ m Maximum height/Maksimum hoogte = <u>10</u> ✓ + 0,82 = 10,82 m ✓ (4)
OPTION 2/*OPSIE 2* **Upwards as positive** ***Opwaarts as positief*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = (4)^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 0,82$m Maximum height/*Maksimum hoogte* = <u>10</u> ✓ + 0,82 = 10,82 m ✓ (4)	**OPTION 2/OPSIE 2** **Downwards as positive** ***Afwaarts as positief*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = (-4)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = 0,82$m Maximum height/*Maksimum hoogte* = <u>10</u> ✓ + 0,82 = 10,82 m ✓ (4)

3.3 **Upwards as positive/*Opwaarts as positief*:**



Criteria for graph/*Kriteria vir grafiek:*	**Marks/*Punte***
Graph starts at 10 m at t = 0. *Grafiek begin by 10 m by t = 10s*.	✓
Positive marking from QUESTION 3.1.2 ***Positiewe nasien vanaf VRAAG 3.1.2*** Maximum height at 10,82 m *Maksimumhoogte by 10,82 m*	✓
Strikes ground at 0 $m.s^{-1}$ at t = 1,09 s *Tref grond by 0* $m.s^{-1}$ *by t = 1,09 s*	✓
Rebounds on ground at 0 $m.s^{-1}$ at t = 1,29 s *Bons van grond af by 0* $m.s^{-1}$ *by t = 1,29 s*	✓
Maximum height after bounce at 3 m. *Maksimumhoogte van bal by 3 m.*	✓

3.3 **Downwards as positive/*Afwaarts as positief***



Criteria for graph/*Kriteria vir grafiek:*	**Marks/*Punte***
Graph starts at -10 m at t = 0s. *Grafiek begin by -10 m by t = 0s.*	✓
Positive marking from QUESTION 3.1.2 ***Positiewe nasien vanaf VRAAG 3.1.2*** Maximum height at -10,82 m *Maksimumhoogte by -10,82 m*	✓
Strike ground at 0 $m.s^{-1}$ at t = 1,09 s. *Tref grond by 0 $m.s^{-1}$ by t = 1,09 s*	✓
Rebounds on ground at 0 $m.s^{-1}$ at t = 1,29 s *Bons van grond af by 0 $m.s^{-1}$ by t = 1,29 s*	✓
Maximum height after bounce at 3 m. *Maksimumhoogte van bal by 3 m.*	✓

(5)
[13]

QUESTION 4/*VRAAG 4*

4.1 TO THE LEFT/*NA LINKS* ✓ (1)

4.2 (Newton's) Third Law (of motion)/(*Newton) se Derde (Bewegingswet*).✓ (1)

4.3 In an isolated/closed system, ✓ the total mechanical energy is conserve remains constant. ✓
In 'n geïsoleerde/geslote sisteem ✓ *bly die totale meganiese energie behoue/bly konstant*. ✓

OR/*OF*

The total mechanical energy of a system remain constant ✓ provided the net work done by external non conservative forces is zero. ✓
Die totale meganiese energie van 'n sisteem bly konstant, ✓ *mits die arbeid verrig deur eksterne nie-konservatiewe kragte, nul is.* ✓

OR/*OF*

In the absence of a non-conservative force, ✓ the total mechanical energy is conserved/remain constant. ✓
In die afwesigheid van 'n nie-konservatiewe krag, ✓ bly die totale meganiese energie behoue/konstant. ✓

OR/*OF*

In an isolated/closed system, ✓ the sum of kinetic and gravitational potential energy is conserved/remains constant. ✓
In 'n geïsoleerde/geslote sisteem, ✓ bly die som van kinetiese en gravitasionele potensiële energie behoue/bly konstant. ✓

Notes/*Aantekeninge*: Allocate ONE mark for 'isolated system" only in conjunction with energy. *Ken EEN punt toe vir "geïsoleerde/geslote sisteem" slegs indien saam met energie gebruik. 1/2*

(2)

4.4

<u>OPTION 1/*OPSIE 1*</u> $E_{\text{mechanical at A}} = E_{\text{mechanical at B}}$ $(E_p + E_k)_A = (E_p + E_k)_B$ $(mgh + \frac{1}{2}mv^2)_A = (mgh + \frac{1}{2}mv^2)_B$ } ✓ Any ONE/*Enige EEN* $66(9,8)(0) + \underline{\frac{1}{2}(66)v^2}$ ✓ $= \underline{66(9,8)(1,6)}$ ✓ $+ \frac{1}{2}(66)(0)^2$ $v = 5,6\ m.s^{-1}$ ✓ (4)
<u>OPTION 2/*OPTION 2*</u> $E_{\text{mechanical at A}} = E_{\text{mechanical at B}}$ $(E_p + E_k)_A = (E_p + E_k)_B$ $(mgh + \frac{1}{2}mv^2)_A = (mgh + \frac{1}{2}mv^2)_B$ } ✓ Any ONE/*Enige EEN* $v^2 = 2gh$ ✓ $= (2)(9,8)(1,6)$ ✓ $v = 5,6\ m.s^{-1}$ ✓ (4)
<u>OPTION 3/*OPSIE 3*</u> $W_{net} = \Delta E_k$ $F_{net}\Delta y.\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$ } ✓ Any ONE/Enige EEN $m(9,8)(1,6)\cos 0^{\circ}$ ✓ $= \frac{1}{2}m(v_f^2 - 0^2)$ ✓ $v_f = 5,6\ m.s^{-1}$ ✓ (4)
<u>NOTES/*AANTEKENINGE*:</u> Accept/*Aanvaar* $(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$ $(U + K)_A = (U + K)_B$ $(U + K)_{top} = (U + K)_{bottom}$ $\Delta E_p + \Delta E_{kA} = 0 / \Delta U + \Delta K = 0$ (4)

4.5 **POSITIVE MARKING FROM QUESTION 4.4**
POSITIEWE NASIEN VAN VRAAG 4.4

OPTION1/*OPSIE1* $\sum p_i = \sum p_f$ $(m_B + m_P)v_{BPi} = m_Bv_f + m_PV_{fP}$ ✓ Any ONE/*Enige EEN* (70)(5)✓ = (66)(5,6) + $4v_{fP}$✓ v_{Pf}= -4,9 $m.s^{-1}$ = 4,9 $m.s^{-1}$ to the left/na links ✓ (4)
OPTION2/*OPSIE2* $\Delta p_{Boy} = -\Delta p_{parcel}$✓ $m_{boy}(v_f - v_i) = -m_p(v_f - v_i)$ (66)(5,6 − 5)✓ = $-4(v_{pf} - 5)$ ✓ v_{Pf} = - 4,9 $m.s^{-1}$ = 4,9 $m.s^{-1}$ to the left/Na links ✓ (4)
OPTION 3/*OPSIE3* $F_{BP} = - F_{PB}$ ✓ $m_Ba_B = - m_Pa_P$ $m_B\left[\frac{v_{Bf} - v_{Bi}}{\Delta t}\right] = - m_P\left[\frac{v_{Pf} - v_{Pi}}{\Delta t}\right]$ $\frac{(66)(5,6 - 5)}{\Delta t}$ ✓ = $\frac{-(4)(v_{Pf} - 4,5)}{\Delta t}$ ✓ V_{pf} = - 4,9 $m.s^{-1}$ = 4,9 $m.s^{-1}$ to the left/na links✓ (4)
Other formulae/*Ander formules*: $m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$ $(m_1 + m_2) v = m_1v_{f1} + m_2v_{f2}$ $m_1v_{iB} + m_2v_{iP} = m_1v_{fB} + m_2v_{fP}$ $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $p_{total\ before} = p_{total\ after}$ Accept/*Aanvaar*: $p_{before} = p_{after}$ or/of $p_i = p_f$ (4)

4.6 INCREASES/VERHOOG ✓

Δp parcel increases, thus Δp boy increases. ✓
For the same mass of boy, v will be greater. ✓

Δp pakkie vermeerder, dus Δp seun vermeerder. ✓
Vir dieselfde massa, van die seun sal v groter wees. ✓

OR/*OF*

If v of parcel increases, the momentum of the boy increases. ✓
For the same mass of boy, the velocity of parcel increases. ✓

Indien v van die pakkie toeneem, neem die momentum van die seun toe. ✓
Vir dieselfde massa van die seun, vermeerder die snelheid van die pakkie. ✓

OR/*OF*

F on parcel increases, therefore F on boy increases. ✓
FΔt(boy) increases, for the same mass of boy, thus v will increase. ✓

F op pakkie neem toe, dus neem F op seun toe. ✓
FΔt(seun) neem toe, dus vir dieselfde massa van seun sal V verhoog. ✓

OR/*OF*

$-m_B v_{Bf} = m_P v_{Pf}$ **AFR**: $-m_S v_{Sf} = m_P v_{Pf}$

$v_B = -\dfrac{m_P v_{Pf}}{m_B}$ ✓ for same m_B, if v_P increases, ✓ then v_B increases.

$v_S = -\dfrac{m_P v_{Pf}}{m_S}$ ✓ *vir dieselfde* m_S, as v_P *toeneem*, ✓ *neem* v_S *toe* (3)

[15]

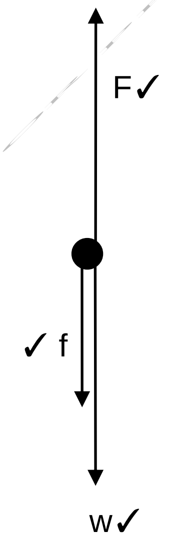
QUESTION 5/VRAAG 5

5.1 The net/total work done ✓ is equal to the change in the object's kinetic energy. ✓
Die netto/totale arbeid verrig ✓ op 'n voorwep is gelyk aan die verandering in kinetiese energie van die voorwerp. ✓

OR/*OF*

The work done on an object by a resultant/net force ✓ is equal to the change in the object's kinetic energy. ✓
Die arbeid verrig op die voorwerp deur 'n resulterende/netto krag ✓ is gelyk aan die verandering in kinetiese energie van die voorwerp. ✓ (2)

5.2



Accepted labels/*Aanvaarde benoemings*	
w	F_g/F_w/mg/gravitational force/weight F_g/F_w/*gravitasiekrag/gewig*
F	$F_{applied}$/F_{cable}/Tension/T/17 000 N $F_{toegepas}$/F_{kabel}/*Spanning*/T/17 000 N
f	F_f/$F_{friction}$/friction/air resistance F_f/$F_{wrywing}$/*wrywing*/*lugweerstand*

(3)

5.3

OPTION 1/*OPSIE1*

$W_{net} = \Delta E_k$
$W_T + W_W + W_f = \Delta E_k$
$F_T \Delta y \cos\theta + F_g \Delta y \cos\theta + W_f = 0$
} ✓ Any ONE/*Enige EEN*

(17000) (20) cos 0° ✓ + (1680)(9,8) (20) cos 180° ✓ + W_f = 0 ✓

W_f = - 10720 J ✓ (5)

OPTION 2/*OPSIE 2*

Downwards as positive

$F_{net} = ma$
-F + f + W = ma
-17000 + f + (1680)(9,8) ✓ = 0 ✓ ✓
f = 536 N

$W_f = f \Delta y \cos\theta$
= (536) (20) cos 180° ✓
= (536).(20).(-1)
= -10 720 J ✓ (5)

Upwards as positive

$F_{net} = ma$
F + f + W = ma
17000 – f - (1680)(9,8) ✓ = 0 ✓ ✓
f = 536 N

$W_f = f \Delta y \cos\theta$
= (536) (20) cos 180° ✓
= (536)(20)(-1)
= -10720 J ✓ (5) **[10]**

QUESTION 6/*VRAAG 6*

6.1 The apparent change in the detected frequency (or pitch)(or wavelength) ✓ as a result of the relative motion between a source and an observer (listener). ✓

Die skynbare verandering in waargenome frekwensie (of toonhoogte)(of golflengte) ✓as gevolg van die relatiewe beweging tussen die bron en waarnemer/luisteraar. ✓ (2)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR/*OF*** $f_L = \frac{v + v_L}{v - v_s} f_s$ ✓

$f_L = \frac{340 + (340-310)}{340}$ 280 ✓ ✓ ✓

= 304,71 Hz ✓ (5)

6.3 SMALLER/KLEINEER ✓
ϴ The listener moves away from the siren, with constant velocity/speed ✓
λ increases and the frequency decreases. ✓
Die luisteraar beweeg weg van die sirene met konstante snelheid/spoed. ✓
λ neem toe en frekwensie neem af. ✓

OR/*OF*

$\lambda \propto \frac{1}{f}$ or/*of* $f \propto \frac{1}{\lambda}$ ✓ At constant velocity (speed) ✓
By kontante snelheid (spoed) ✓

(3)

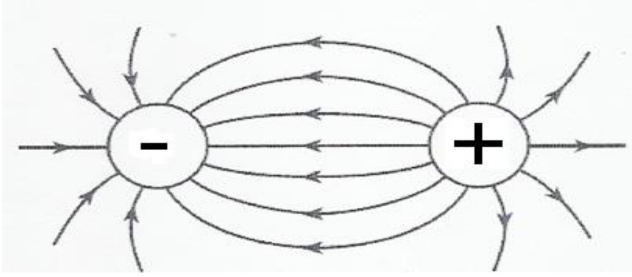
6.4 Determines the rate at which blood flow.
Monitor and measures the heartbeat of a foetus } ✓ Any ONE
Bepaal die tempo waarteen bloed vloei.
Monitor en meet die hartklop van 'n fetus. } ✓ *Enige EEN* (1)

6.5 AWAY/*WEG* ✓
ϴ
Light from a star is shifted towards a longer wavelength/towards the red end of the spectrum. ✓
Die ster se lig word verskuif na 'n langer golflengte/na die rooi kant van die spektrum. ✓ (2)

[13]

QUESTION 7/*VRAAG 7*

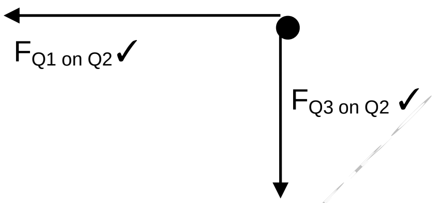
7.1



Criteria for sketch/*Kriteria vir skets:*	Marks/*Punte*
Correct shape *Korrekte vorm*	✓
Correct direction *Korrekte rigting*	✓
Field lines must be perpendicular to surfaces of spheres. (Field lines not touching each other/cross). Field lines start on sphere/NOT entering the spheres. *Veldlyne moet reghoekig wees aan oppervlak van sfere.* *(Veldlyne raak nie mekaar nie/kruis nie.)* *Veldlyne begin op sfere/moet NIE die sfere binnegaan NIE.*	✓

(3)

7.2



(2)

7.3 $F_{Q1\ on\ Q2} = \frac{kQ_1Q_2}{r^2}$ ✓ $= \frac{(9 \times 10^9)(3 \times 10^{-9})(3 \times 10^{-9})}{(10 \times 10^{-2})^2}$ ✓ ✓ $= 8,1 \times 10^{-6}$ N

$F_{Q3\ 0n\ Q2} = \frac{kQ_3Q_2}{r^2} = \frac{(9 \times 10^9)(2 \times 10^{-9})(3 \times 10^{-9})}{(5 \times 10^{-2})^2}$ ✓ $= 2,16 \times 10^{-5}$ N

$F_{net} = \sqrt{(F_{Q1\ on\ Q2})^2 + F_{Q3\ on\ Q2})^2} = \sqrt{(8,1 \times 10^{-6})^2 + (2,16 \times 10^{-5})^2}$ ✓ $= 2,31 \times 10^{-5}$ N

$\tan\theta = \frac{2,16 \times 10^{-5}}{8,1 \times 10^{-6}}$ ✓ $= 2,67$

$\theta = 69,44°$

OR/*OF*

$\theta = \tan^{-1}\left(\frac{2,16 \times 10^{-5}}{8,1 \times 10^{-6}}\right)$ ✓

$\theta = 69,44°$

$F_{net} = 2,31 \times 10^{-5}$ N ✓ 69,44°/On a bearing of 200,56° (Or any appropriate direction) ✓
In 'n rigting van 200,56° (Of enige toepaslike rigting) ✓ (8)

7.4 $E_{net} = 0$
$E_P + E_R = 0$
$\frac{kQ_P}{r_P^2} + \frac{kQ_R}{r_R^2} = 0$
✓ Any ONE/*Enige EEN*

$\frac{(9 \times 10^9)(8 \times 10^{-9})}{(2 \times 10^{-2})^2}$ ✓✓ $- \frac{(9 \times 10^9)Q_R}{(1 \times 10^{-2})^2}$ ✓ $= 0$

$Q_R = +2 \times 10^{-9}$ C (+2 nC)✓ (5)

[18]

QUESTION 8/*VRAAG 8*

8.1 Alternating current/*Wisselstroom* ✓ (1)

8.2 The bulb converts 100 J of energy per second (to heat and light). ✓
Die gloeilamp sit 100 J energie per sekonde om (in hitte en lig). ✓ (1)

8.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$P_{ave} = V_{rms}I_{rms}$ ✓ $100 = \frac{V_{max}}{\sqrt{2}}$ ✓ x I_{rms} $= \frac{311}{\sqrt{2}}$ x I_{rms} ✓ I_{rms} = 0,45 A ✓ (4)	$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $= \frac{311}{\sqrt{2}}$ = 219,91 V $P_{ave} = V_{rms}I_{rms}$ ✓ 100 = 219,91 x I_{rms} ✓ I_{rms} = 0,45 A ✓ (4)

(4)

8.4 AC can be stepped up at power stations. ✓ (AC voltage can be stepped down)
Reduced energy loss during transmission. ✓ /AC can be stepped up of stepped down using transformers at substations.

WS kan by kragstasies verhoog word. ✓ *(WS spanning kan verlaag word)*
Verminderde energieverlies tydens transmissie. ✓ *WS kan met behulp van transformators by substasie verhoog of verlaag word.* (2)

[8]

QUESTION 9/*VRAAG 9*

9.1 9.1.1 1,5 V ✓ (1)

9.1.2 **POSITIVE MARKING FROM QUESTION 9.1.1**
POSITIEWE NASIEN VANAF VRAAG 9.1.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2*** (Or any other gradient)
Gradient = $\frac{\Delta I}{\Delta V}$ $= \frac{0 - 1,8}{1,5 - 0}$ ✓ ✓ = - 1,20 $\frac{1}{r}$ = 1,20 $r = \frac{1}{1,20}$ ✓ = 0,83 Ω ✓ (4)	*Gradient* = $\frac{\Delta I}{\Delta V}$ (*Of enige ander gradient*) $= \frac{0 - 0,9}{1,5 - 0,75}$ ✓ ✓ = - 1,20 $\frac{1}{r}$ = 1,20 $r = \frac{1}{1,20}$ ✓ = 0,83 Ω ✓ (4)

(4)

9.2. 9.2.1 INCREASES/*VERMEERDER* ✓ (1)

9.2.2 ε remains constant/ε *bly konstant* ✓
Ir decreases ✓, V_{ext} Increases ✓
Ir *neem af* ✓, V_{eks} *Neem toe* ✓ (3)

9.3 9.3.1 6 V ✓✓ (2)

9.3.2 (a) $R = \frac{V}{I}$ ✓

$4 = \frac{2}{I}$ ✓

$I = 0,5\ A$ (3)

(b) **POSITIVE MARKING FROM QUESTION 9.3.1**
POSITIEWE NASIEN VAN VRAAG 9.3.1

OPTION 1/*OPSIE 1*

$\varepsilon = I(R + r)$ ✓

6 ✓ $= 0,5\,[R_p + 4$ ✓ $+ 4(0,25)]$ ✓

$R_p = 7\ \Omega$

$\frac{1}{R_p} = \frac{1}{r_1} + \frac{1}{r_2}$ ✓

$\frac{1}{7}$ ✓ $= \frac{1}{14} + \frac{1}{R_x}$ ✓

$R_x = 14\ \Omega$ ✓

(8)

OPTION 2/*OPSIE 2*

$\varepsilon = V_{external} + V_{internal}$
$\varepsilon = V_{external} + Ir$ ✓

6 ✓ $= V_{external} + (0,5)(4)(0,25)$ ✓

$V_{external} = 5,50\ V$

$V_{external} = V_P + V_S$

$5,50 = V_P + 2$ ✓

$V_P = 3,50\ V$

$R_P = \frac{V_P}{I_P}$

$= \frac{3,50}{0,50}$

$= 7\ \Omega$

$\frac{1}{R_P} = \frac{1}{R_{14}} + \frac{1}{R_X}$ ✓

$\frac{1}{7}$ ✓ $= \frac{1}{14} + \frac{1}{R_X}$ ✓

$R_X = 14\ \Omega$ ✓

(8)

OPTION 3/*OPSIE 3*

$\varepsilon = V_{external} + V_{internal}$
$\varepsilon = V_{external} + Ir$ ✓

6 ✓ $= V_{external} + (0,5)(4)(0,25)$ ✓

$V_{external} = 5,50\ V$

$V_{external} = V_P + V_S$

$5,50 = V_P + 2$ ✓

$V_P = 3,50\ V$

$R_{14} = \frac{V_{14}}{I_{14}}$

$14 = \frac{3,50}{I_{14}}$

$I_{14} = 0,25\ A$

$I_P = I_X + I_{14}$

$0,5 = I_X + 0,25$ ✓

$I_X = 0,25\ A$

$R_X = \frac{V_P}{I_X}$ ✓

$= \frac{3,5}{0,25}$ ✓

$= 14\ \Omega$ ✓

(8)

(8)
[20]

QUESTION 10/*VRAAG 10*

10.1 Photo-electric effect/*Fotoëlektriese effek* ✓ (1)

10.2 The minimum frequency of light needed to emit electrons ✓from a metal surface.✓
Die minimum frekwensie van lig benodig om elektrone te verwyder ✓ vanaf die oppervlak van 'n metaal.✓ (2)

10.3 $n = \frac{Q}{e^-}$ OR/OF $n = \frac{Q}{q_{e^-}}$ ✓

$(1{,}01 \times 10^9) = \frac{Q}{(1{,}6 \times 10^{-19})}$ ✓SS

$Q = 1{,}62 \times 10^{-10}$ C ($1{,}616 \times 10^{-10}$ C)

$Q = I\Delta t$ ✓
$1{,}62 \times 10^{-10} = I\,(1)$ ✓

$I = 1{,}62 \times 10^{-10}$ A ✓ (5)

10.4 DECREASES/*NEEM AF* ✓ (1)

10.5

10.5.1 SMALLER/*KLEINER AS*✓ (1)

10.5.2 The wavelength/frequency/energy of the incident light remains constant. ✓
Since the threshold frequency is greater, the work function is greater. ✓
Die golflengte/frekwensie/energie van die inkomende lig bly konstant. ✓
Aangesien die drumpel frekwensie vergroot, is die werksfunksie groter. ✓ (2)

10.6 The wavelengths of light that are absorbed in the absorption spectrum✓ correspond exactly to the wavelength of light that is emitted in the line emission spectrum of the same gas.✓

Die golflengte van lig geabsorbeer in die absorpsie spectrum, ✓*stem presies ooreen met die golflengte van lig wat vrygestel is in die lynemissiespektrum van dieselfde gas.* ✓

OR/*OF*

The dark lines in the absorption spectrum correspond ✓ exactly with the colour lines present in the line emission spectrum of the same gas.✓

Die donkerlyne in die absorpsie spektrum,✓*stem presies ooreen met die kleurlyne in die lynemissie spektrum van dieselfde gas.*✓ (2)

[14]

TOTAL/*TOTAAL*: 150

education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

SEPTEMBER 2015

MARKS: 150

TIME: 3 HOURS

This question paper consists of 13 pages and 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.10) in the ANSWER BOOK.

1.1 An object moving with a constant speed **v** has a kinetic energy **E**. Which one of the following will be true for the kinetic energy if the object has a constant velocity of **2v**?

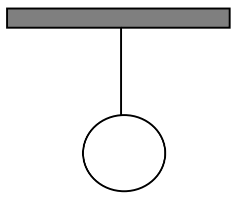
A ½E

B E

C 2E

D 4E

1.2 A sphere is attached to a string, which is suspended from a fixed horisontal bar as shown in the sketch.



The reaction force to the gravitational force exerted by the earth on the sphere is …

A the force of the bar on the sphere.

B the force of the string on the sphere.

C the force of the sphere on the earth.

D the force of the bar on the string. (2)

1.3 A ball is dropped from height **h** above the ground and reaches the ground with kinetic energy **E.** From which height must the ball be dropped to reach the ground with kinetic energy **2E**? (Ignore all effects of friction.)

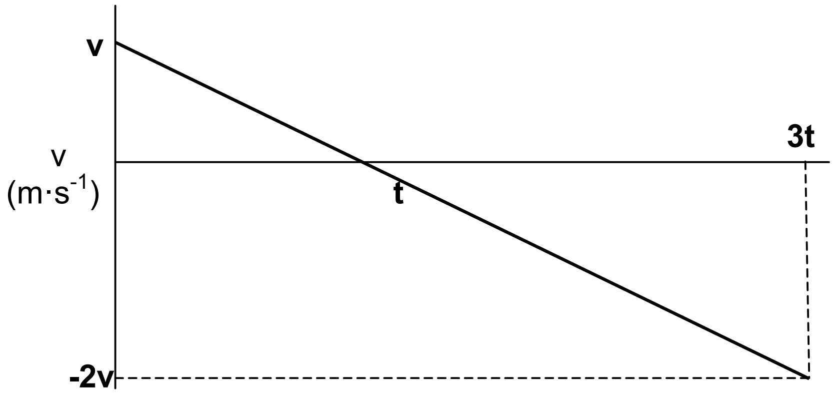
A 2**h**

B 3**h**

C 4**h**

D 8**h** (2)

1.4 The velocity versus time graph below represents the movement of an object under the influence of gravitational force.



The displacement of the object in time **3t** is …

A **vt**.

B zero.

C **-vt**.

D $-\frac{3}{2}$**v t**. (2)

1.5 A net force **F** accelerates two isolated objects, **P** and **Q**, from rest on a straight line for time **t** as shown below. Object **P** experiences an acceleration of **a** and object **Q** an acceleration of **2a.**

If the amount of work done by net force **F** on object **P** equals **W**, the amount of work done on **Q** will be …

A W.

B ½ W.

C 2 W.

D 4 W. (2)

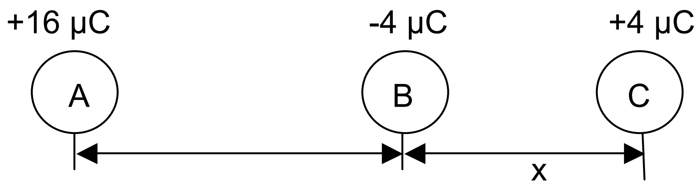
1.6 A block, being pulled by a force **F**, and moving to the left on a rough horizontal surface, is slowing down.

The directions of the resultant force and the acceleration are …

	DIRECTION OF RESULTANT FORCE	**DIRECTION OF ACCELERATION**
A	to the right	to the left
B	to the right	to the right
C	to the left	to the left
D	to the left	to the right

(2)

1.7 Three small identical spheres, **A**, **B** and **C** is charged as shown in the diagram. The distance between sphere **B** and **C** is **x**.



For sphere **B** to experience no resultant electrostatic force, the distance between **A** and **B** must be …

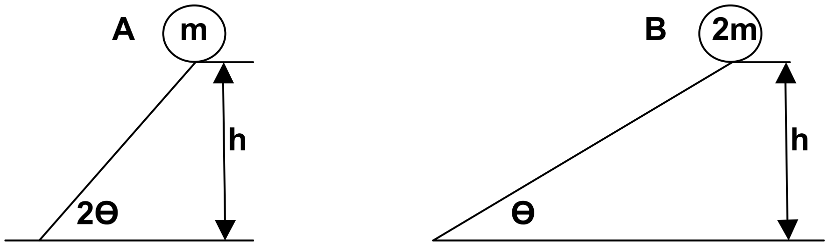
A ¼ x.

B ½ x.

C 2 x.

D 4 x. (2)

1.8 Two metal balls **A** and **B**, mass **m** and **2m** respectively, are allowed to roll down two different frictionless slopes as indicated in the diagram below.

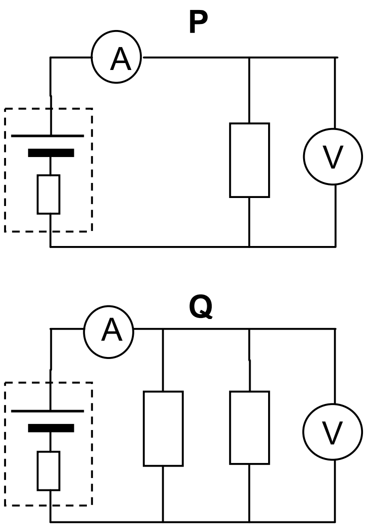


Which ONE of the following is true for the work done and the force acting on balls **A** and **B** respectively?

	MAGNITUDE OF FORCE	WORK DONE
A	$F_A = F_B$	$W_A > W_B$
B	$F_A < F_B$	$W_A < W_B$
C	$F_A > F_B$	$W_A < W_B$
D	$F_A < F_B$	$W_A < W_B$

(2)

1.9 In the circuits shown below all resistors and cells are **identical.**

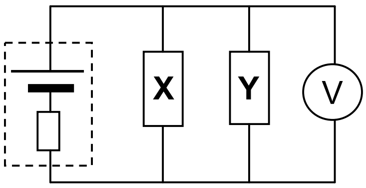


Which ONE of the following gives the correct comparison between the voltmeter and ammeter readings in circuit **P** and **Q.**

	VOLTMETER READING	AMMETER READING
A	$V_P > V_Q$	$A_p > A_Q$
B	$V_P > V_Q$	$A_p < A_Q$
C	$V_P < V_Q$	$A_p = A_Q$
D	$V_P = V_Q$	$A_p < A_Q$

(2)

1.10 In the circuit shown below the resistance of X is **R** and that of Y is **2R**.



If the power dissipated by **X** equals **P**, then the power dissipated by **Y** will be …

A ¼ P.

B ½ P.

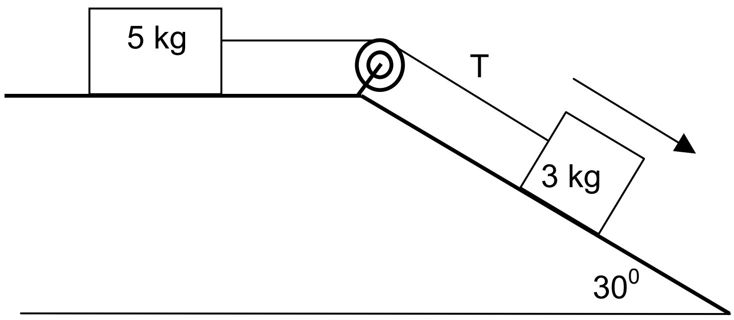
C 2P.

D 4P. (2)

TOTAL SECTION A: 20

QUESTION 2 (Begin on a new page.)

Two blocks of masses 5 kg and 3 kg respectively are connected by a light inextensible string that runs over a light frictionless pulley as shown in the diagram below. The 5 kg block experience a frictional force of 8 N and the coefficient of kinetic friction between the 3 kg block and the surface of the inclined plane is 0,15.



2.1 Define the term *frictional force.* (2)

2.2 Draw a labelled free-body diagram to indicate all the forces acting on the 3 kg block. (3)

2.3 Calculate the:

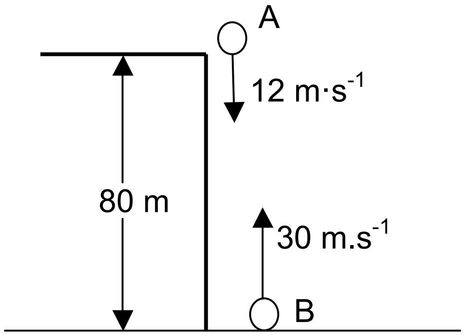
2.3.1 Magnitude of the frictional force acting between the 3 kg block and the surface of the inclined plane (3)

2.3.2 Magnitude of the tension **T** in the string (6)

[14]

QUESTION 3 (Begin on a new page.)

Ball **A** is thrown vertically downwards from the top of a building, 80 m high, at a velocity of 12 m·s^{-1}. At the same instant a second identical ball **B** is thrown upwards at a velocity of 30 m·s^{-1}. Ball **A** and ball **B** pass each other after 2,135 s. Ignore all effects of air friction.



3.1 Give the direction of the acceleration of ball **B** while moving upwards. (1)

3.2 Calculate the velocity of ball **B** the moment it passes ball **A**. (3)

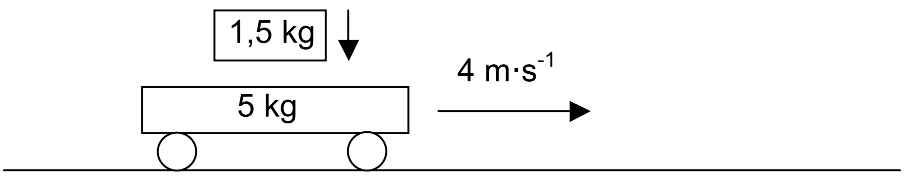
3.3 Calculate the distance between ball **A** and **B** 2,5 s after it was projected. (6)

3.4 Sketch a position-time graph for the motion of ball **A** till it reaches the ground as well as for the motion of ball **B** until it passes ball **A**. Use the ground as zero position. Clearly indicate the time at which the balls pass each other. (3)

[13]

QUESTION 4 (Begin on a new page.)

A trolley, mass 5 kg, moves at 4 m·s^{-1} east across a frictionless horizontal surface. A brick of mass 1,5 kg is dropped onto the trolley.



4.1 Define in words the *Law of Conservation of Momentum*. (2)

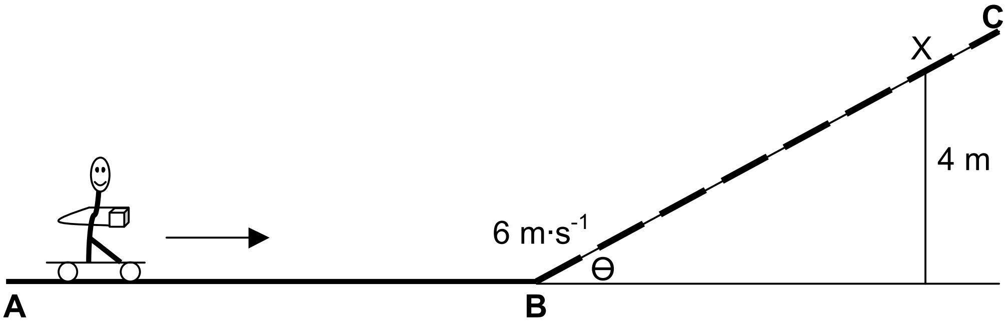
4.2 State the condition for an elastic collision. (1)

4.3 Calculate the change in momentum of the 5 kg trolley. (5)

[8]

QUESTION 5 (Begin on a new page.)

5.1 A boy on roller-skates moves at a constant velocity in an easterly direction along a frictionless horizontal part **AB** of a track carrying a parcel. He decides to increase his velocity by throwing the parcel horizontally away from him.



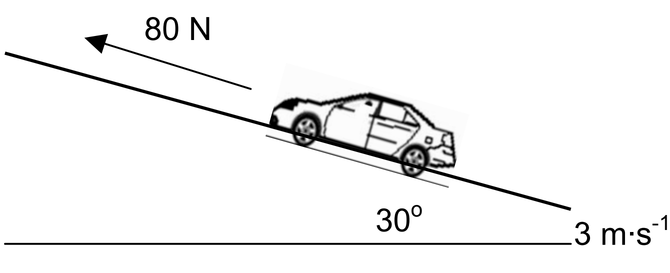
5.1.1 In which direction must the parcel be thrown to cause a maximum increase in the velocity of the boy? (1)

5.1.2 Name and define in words the law in physics that you have applied in QUESTION 5.1.1. (3)

On reaching point **B** at a velocity of 6 $m\cdot s^{-1}$, the boy on the roller-skates, with total mass 57 kg, continues to move up a rough section **BC** of the track and comes to rest at position X, height 4m. The magnitude of the frictional force acting on the roller-skates, is 40 N.

5.1.3 Calculate value Θ of the inclined plane. (6)

5.2 A remote controlled car is driven up an inclined plane at 30^0 to the horizontal as shown below. The car of mass 4 kg, experiences an average forward force of 80 N. A frictional force of 15 N is acting on the car as it moves up the plane. The speed of the car at the bottom of the inclined plane is 3 $m\cdot s^{-1}$.



Use energy principles to calculate the speed of the car after it has travelled 5 m up the inclined plane. (7)
[17]

QUESTION 6 (Begin on a new page.)

Light emitted from distant stars demonstrates the phenomenon known as red shift.

6.1 Explain how the phenomenon known as *red shift* can be used to explain an expanding universe. (2)

6.2 A submarine can use the Doppler effect to detect the speed of ship. A submarine at rest and just below the surface of the water, detects the frequency of a moving ship as 437 Hz, 0,985 times the actual frequency of the sound emitted by the ship. The speed of sound in water is 1470 $m\cdot s^{-1}$.

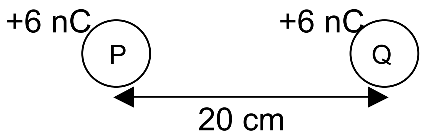
6.2.1 Is the ship moving away from or towards the submarine? Give a reason for your answer. (2)

6.2.2 Calculate the speed of the ship. (5)

6.3 Name two applications of the Doppler effect in Medical Science. (2)
[11]

QUESTION 7 (Begin on a new page.)

The diagram below shows two identical insulated metal spheres. Spheres **P** an **Q** each carry a charge of 6 nC.

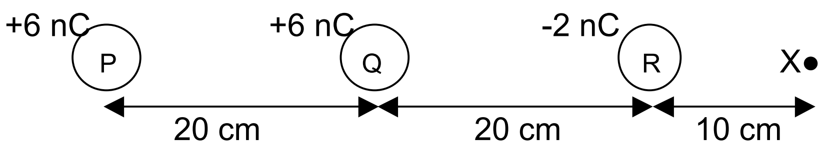


7.1 Define *Coulomb's Law* in words. (2)

7.2 Draw the electric field pattern due to the two spheres **P** and **Q**. (3)

7.3 Calculate the magnitude of the electrostatic force between spheres **P** and **Q**. (4)

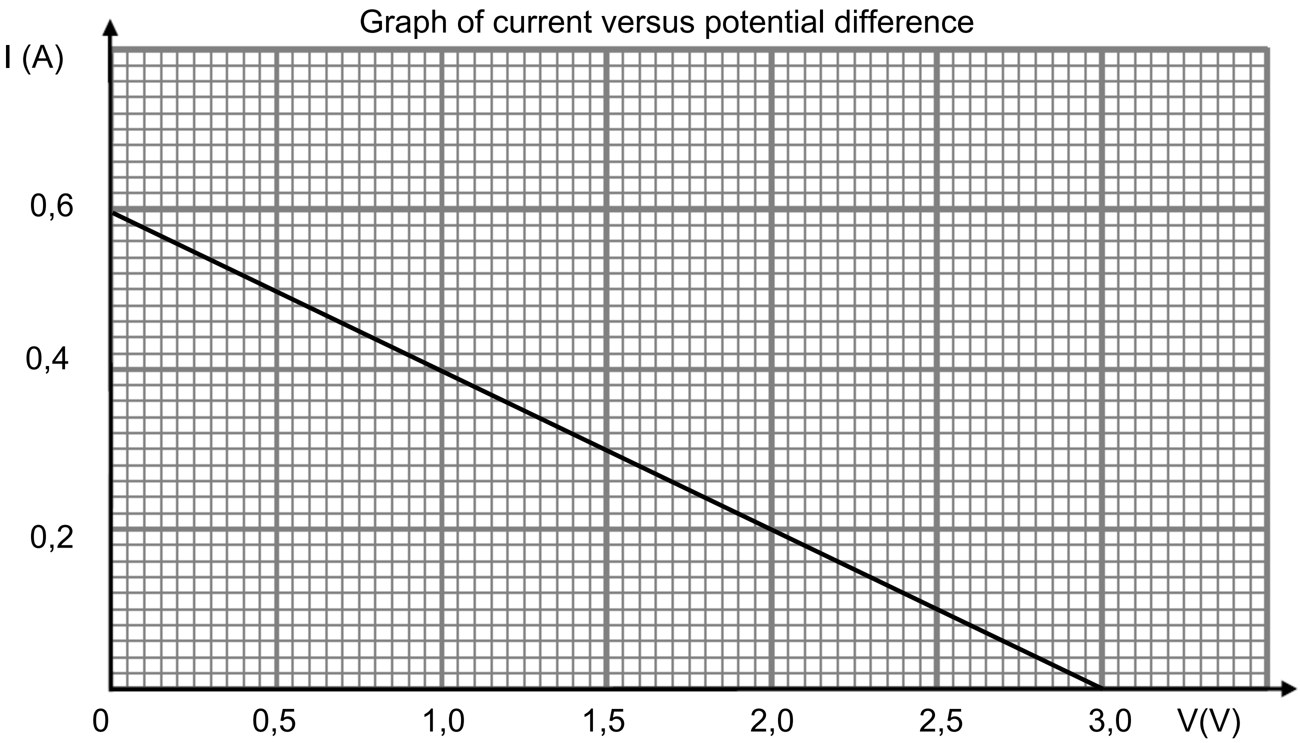
A third sphere, **R**, of charge -2 nC is now placed at a position relative to the other spheres and a chosen point X as shown in the diagram below.



7.4 Calculate the net electric field at point **X** due to spheres **P**, **Q** and **R**. (6)
[15]

QUESTION 8 (Begin on a new page.)

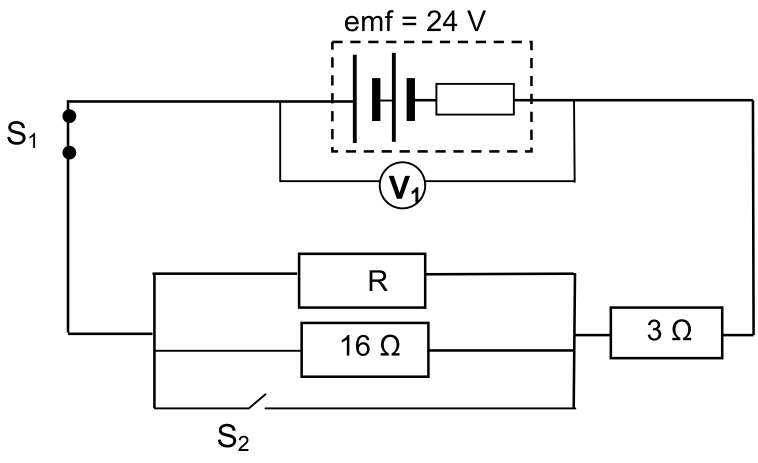
8.1 The graph below is obtained from an experiment to calculate the internal resistance of a battery.



8.1.1 Calculate $V_{internal}$ if the current in the circuit is equal to 0,2 A. (2)

8.1.2 Calculate the internal resistance of the battery. (4)

8.2 A circuit is connected as shown below. When switch S_1 is closed, $V_{external}$ is equal to 22,5 V. The internal resistance of the battery is 0,8 Ω.



8.2.1 Define *Ohm's Law* in words. (2)

8.2.2 Calculate the power dissipated by the 16 Ω resistor. (7)

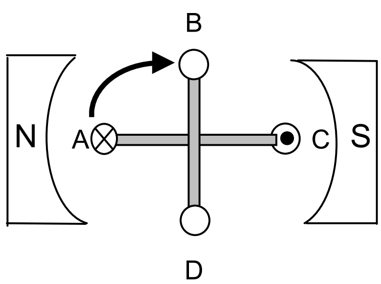
8.2.3 Calculate the resistance of **R**. (5)

8.2.4 Switch S_2 is now closed. How will voltmeter reading V_1 be influenced? (Write down only INCREASE, DECREASE or STAYS THE SAME.) Give an explanation to your answer. (4)

[24]

QUESTION 9 (Begin on a new page.)

9.1 The diagram below shows a coil that is rotated through a magnetic field.



9.1.1 Name the principle demonstrated in the above diagram? (1)

9.1.2 The maximum emf is generated at position **A** of the rotation cycle. Give an explanation for this observation. (2)

9.1.3 Name one structural difference between a DC and AC generator. (2)

9.1.4 Use the positions indicated in the diagram above and sketch a graph of current versus position for one complete rotation of a DC generator. (Indicate the positions **A**, **B**, **C** and **D** on the graph.) (4)

9.2 When an AC supply is connected to a lamp, it lights up with the same brightness as it does when connected to a 18 V battery (DC source). The power dissipated by the lamp is equal to 60 W.

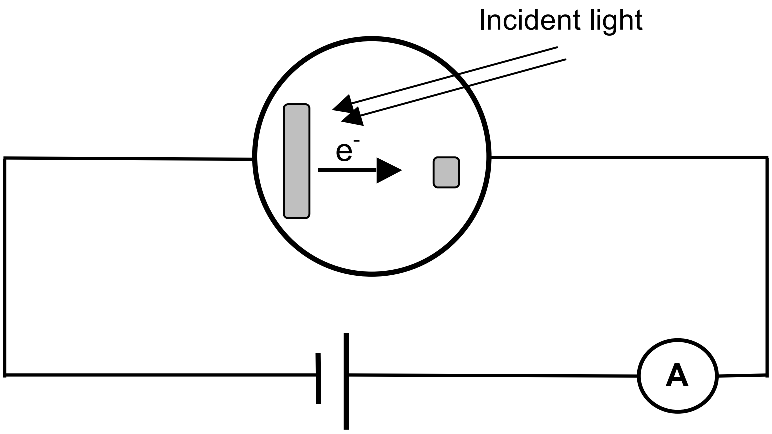
9.2.1 What is the rms voltage of the AC supply? (1)

9.2.2 Calculate the peak current delivered by the AC source. (5)

[15]

QUESTION 10 (Begin on a new page.)

The diagram below shows a circuit in which a photocell is irradiated alternately with red and blue light to demonstrate the photo-electric effect.



10.1 An ammeter reading is recorded when the photocell is irradiated with red light. Give an explanation for this observation. (2)

10.2 Blue light with the same intensity as the red light is now used to irradiate the photocell. How will this influence the following:

10.2.1 The kinetic energy of the photo-electrons (Write down only INCREASE, DECREASE or STAYS THE SAME.) (1)

10.2.2 The ammeter reading. (Write down only INCREASE, DECREASE or STAYS THE SAME.) Give an explanation for your answer. (4)

10.3 The wavelength of the blue light used in the demonstration is $4{,}5 \times 10^{-7}$ m. Calculate the threshold frequency (cut-off frequency) of the metal used in the photo cell if the average speed of an emitted photo-electron is equal to $4{,}78 \times 10^{5}$ $m \cdot s^{-1}$. (6)

[13]

TOTAL SECTION B: 130
GRAND TOTAL: 150

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1	D ✓✓	(2)
1.2	C ✓✓	(2)
1.3	A ✓✓	(2)
1.4	D ✓✓	(2)
1.5	C✓✓	(2)
1.6	B ✓✓	(2)
1.7	C✓✓	(2)
1.8	B ✓✓	(2)
1.9	B ✓✓	(2)
1.10	B ✓✓	(2) **[20]**

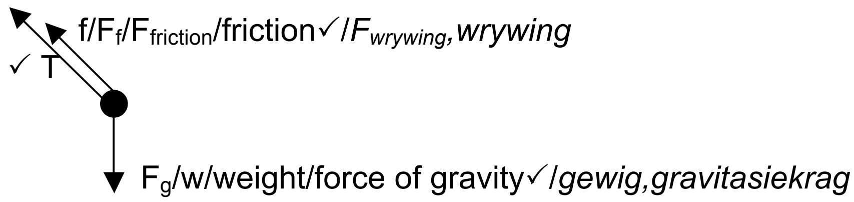
TOTAL SECTION A/*TOTAAL AFDELING A*: 20

SECTION B/*AFDELING B*

QUESTION 2/*VRAAG 2*

2.1 The force that opposes the motion✓ of an object and which act parallel to the surface✓
Die krag wat die beweging van 'n voorwerp teenstaan en parallel aan die oppervlak inwerk. (2)

2.2



(3)

2.3.1 $f_{k(max)} = \mu_k F_N$✓
$= \underline{0,15(3)(9,8)}(\cos 30^0)$✓
$= 3,82$ N✓ (3)

2.3.2 **Positive marking from 2.3.1/ *Positiewe merk van 2.3.1***
Right/downwards as positive:/ *Regs/afwaarts as positief*

5 kg block: $F_{net} = ma$ ✓
$T + f = ma$
$\underline{T - (8) = 5a}$✓ [1]

3 kg block : $T + f + F_{g//} = ma$
$\underline{- T - 3,82 + (3)(9,8)\sin 30^o}$ ✓$= 3a$✓ [2]
$-T + 10,88 = 3a$
Substitute 2 into 1:
$a = 0,36 \text{ m·s}^{-2}$
Substitute a into 1:
$T - 8 = (5)(0,36)$ ✓
$T = 9,8$ N✓ (6)
[14]

QUESTION 3/*VRAAG 3*

3.1 Downwards/*Afwaarts*✓ (1)

3.2

Upwards positive/*Opwaarts positief:*	**Downwards positive/Af*waarts positief:***
$v_f = v_i + a\Delta t$ ✓ = 30✓ + (-9,8)(2,135) = 9,08 m·s^{-1}, upwards✓	$v_f = v_i + a\Delta t$ ✓ = - 30✓ + (9,8)(2,135) = - 9,078 m·s^{-1} = 9,08 m·s^{-1}, upwards ✓

(3)

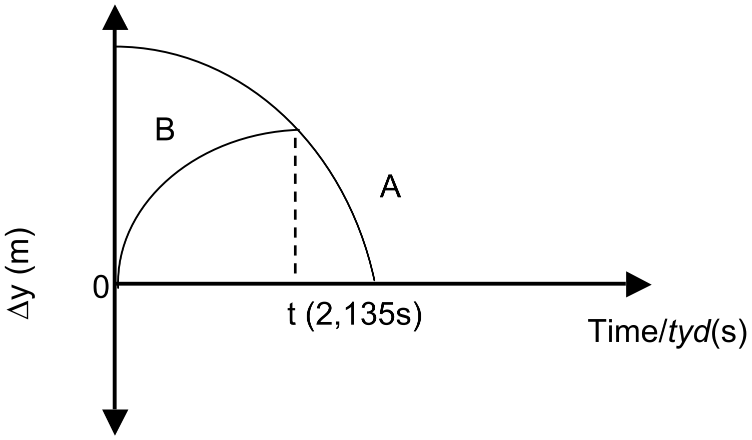
3.3

Upwards positive/*Opwaarts positief:*	**Downwards positive/Af*waarts positief:***
Ball A: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ = -12(2,5) + ½(-9,8)(2,5)^2✓ = - 60,625 m (Height /Hoogte= 19,375 m) Ball B: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ = 30(2,5) ✓ + ½(-9,8)(2,5)^2✓ = 44,375 m Distance = 44,375 - 19,375✓ = 25 m ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ = 12(2,5) + ½(9,8)(2,5)^2✓ = 60,625 m (Height /Hoogte= 19,375 m) Ball B: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ = -30(2,5) ✓ + ½(9,8)(2,5)^2✓ = - 44,375 m Distance = 44,375 - 19,375✓ = 25 m✓

(6)

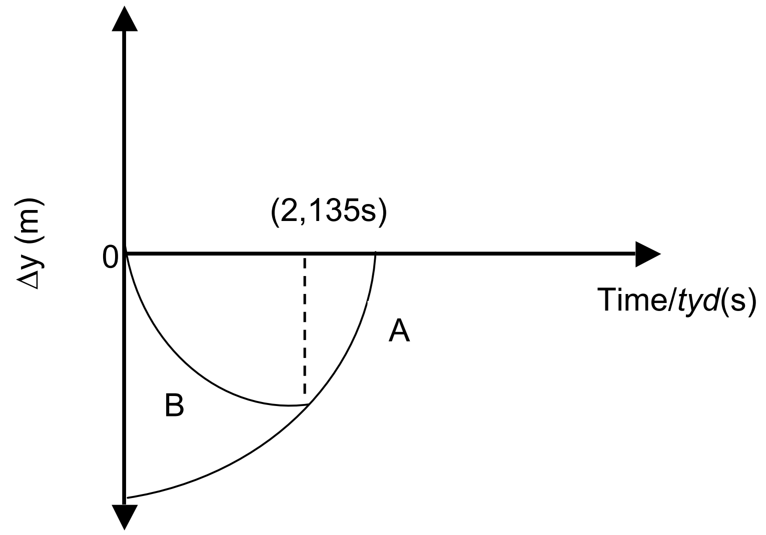
3.4 **OPTION 1/*OPSIE 1***

Upwards positive/*Opwaarts positief:*



Criteria for graph/*Kriteria vir grafiek:*	**Marks/ *Punte***
Shape for ball A up till zero position. *Vorm vir bal A tot zero posisie.*	✓
Shape for ball B up till intersection of lines time. *Vorm vir bal B tot grafieklyne kruis.* 2,135 s.	✓
Indication of time 2,135 s. *Aanduiding van tyd 2,135 s.*	✓
Ground not zero position (provided everything else is correct): $^2/_3$ *Grond nie zero posisie nie (op voorwaarde die res is korrek) :* $^2/_3$	(3)

OPTION 2/*OPSIE 2*
Upwards negative/ *Opwaarts negatief:*



Criteria for graph/*Kriteria vir grafiek:*	**Marks/ *Punte***
Shape for ball A up till zero position. *Vorm vir bal A tot zero posisie.*	✓
Shape for ball B up till intersection of lines time. *Vorm vir bal B tot grafieklyne kruis.* 2,135 s.	✓
Indication of time 2,135 s. *Aanduiding van tyd 2,135 s.*	✓
Ground not zero position (provided everything else is correct): $^2/_3$ *Grond nie zero posisie nie (op voorwaarde die res is korrek) :* $^2/_3$	(3)

[13]

QUESTION 4/*VRAAG 4*

4.1 The total linear momentum of a closed system✓ remains constant ✓

Die totale linieëre momentum in 'n geslote sisteem bly konstant (2)

4.2 The kinetic energy remains constant. ✓ OR
The kinetic energy before the collision equals kinetic energy after the collision.

Die kinetiese energie bly konstant. OF Die kinetiese energie voor botsing is gelyk aan die kinetiese energie na botsing. (1)

4.3 $\Sigma p_{before} = \Sigma p_{after}$ ✓
$(5)(4) = (6,5)v_f$ ✓
$v_f = 3,077 \text{ m·s}^{-1}$
$\Delta p = m(v_f - v_i)$
$= 5(3,077 - 4)$ ✓
$= -4,62 \text{ kg·m·s}^{-1}$
$= 4,62 \text{ kg·m·s}^{-1}$✓, left/west/ opposite to direction of motion ✓
Links/wes/teenoorgesteld aan bewegingsrigting (5)

[8]

QUESTION 5/*VRAAG 5*

5.1.1 Backwards/behind him✓/*Terugwaarts/agter hom.* (1)

5.1.2 Newton's third Law✓of motion: When one body exerts a force on a second body, the second body exerts a force of equal magnitude✓ in the opposite direction on the first body. ✓

Newton se derde bewegingswet: Wanneer een liggaam 'n krag op 'n tweede liggaam uitoefen sal die tweede liggaam 'n krag van gelyke grootte in die teenoorgestelde rigting op die eerste liggaam uitoefen. (3)

5.1.3 **OPTION 1/ *OPSIE 1***

$W_{net} = \Delta K$
$W_g + W_f = \Delta K$ } ✓
$F_g\Delta x\cos\Theta + f\Delta x\cos\Theta = \Delta K$
$(57)(9,8)(4)\cos180^o$ ✓ + $40\Delta x\cos180^o$ ✓ = $0 - ½(57)(6^2)$ ✓
$\Delta x = -30,21$ m
$\sin\Theta = \frac{4}{30,21}$ ✓
$\Theta = 7,61^o$ ✓

OPTION 2/ *OPSIE 2*
$W_{nc} = \Delta U + \Delta K$ ✓/ $W_{nc} = \Delta E_p + \Delta E_k$
$40\Delta x\cos180^o$ ✓ = $(57)(9,8)(4) - (57)(9,8)(0)$ ✓ + $½(57)(0)^2 - ½(57)(6)^2$ ✓
$\Delta x = -30,21$ m
$\sin\Theta = \frac{4}{30,21}$ ✓
$\Theta = 7.61^o$ ✓

(6)

5.2 **OPTION 1/ *OPSIE 1***

$W_{net} = \Delta K$
$W_T + W_g + W_f = \Delta K$ } ✓
$(80)(5)(4)\cos0^o$ ✓ + $(4)(9,8)\sin30^o$ ✓ $(5)\cos180^o$ ✓ + $(15)(5)\cos180^o$ ✓ = $½(4)v_f^2 - ½(4)(3^2)$ ✓
$v_f = 11,07\ m\cdot s^{-1}$ ✓

OPTION 2/ *OPSIE 2*
$W_{nc} = \Delta U + \Delta K$
$W_T + W_f = \Delta U + \Delta K$ } ✓
$(80)(5)(4)\cos0^o$ ✓ + $(15)(5)\cos180^o$ ✓ = $(4)(9,8)(\sin30^o)(5)$ ✓ $- (4)(9,8)(0)$ ✓ + $½(4)v_f^2 - ½(4)(3)^2$ ✓
$v_f = 11,07\ m\cdot s^{-1}$ ✓

(7)
[16]

QUESTION 6/*VRAAG 6*

6.1 Red shift implies that light emitted by stars shows a shift towards the lower frequencies✓ of the spectrum.
According to the Doppler effect this means that the source (star) is moving away from the observer. ✓

Rooiverskuiwing impliseer dat lig vrygestel deur sterre 'n verskuiwing na die laer frekwensies van die spektrum toon.
Volgens die Doppler effek dui dit daarop dat die bron (ster) weg van die waarnemer af beweeg. (2)

6.2.1 Away ✓ (from submarine)
The detected/observed frequency is lower than the actual frequency. ✓ (2)

Weg ✓ (van duikboot)
Die waargenome frekwensie is laer as die werklike frekwensie. ✓

6 2.2

OPTION 1/ *OPSIE 1*	**OPTION 2/ *OPSIE 2***
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$ ✓ $\frac{f_L}{f_S} = \frac{v}{v + v_s}$ $0,985 = \frac{1470}{1470 + v_s}$ ✓ ✓ ✓ $v_s = 22,39 \text{ m·s}^{-1}$ ✓	$f_L = (0,985) f_s$ $437 = (0,985) f_s$ $f_s = 443,655$ Hz $f_L = \frac{v}{v + v_s} f_s$ ✓ $437 = \frac{1470}{1470 + v_s} 443,655$ ✓ ✓ ✓ $v_s = 22,39 \text{ m·s}^{-1}$ ✓

(5)

6.2.2 To measure the velocity of blood flowing through blood vessels.✓
To scan a foetes.✓

Om die snelheid van bloedvloei deur bloedvate te bepaal.
Om 'n fetus te skandeer. (2)

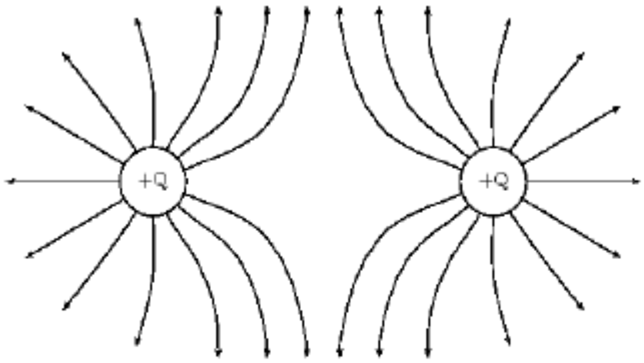
[11]

QUESTION 7/*VRAAG 7*

7.1 The magnitude of the electrostatic force exerted by one point charge on another point charge is directly proportional to the product of the magnitude of the charges✓ and inversely proportional to the square of the distance between them. ✓

Die grootte van die elektrostatiese krag uitgeoefen deur een puntlading op 'n ander puntlading is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen die ladings. (2)

7.2



Criteria for field pattern/*Kriteria vir veldpatroon:*	**Marks/ *Punte***
Correct direction away from the spheres. *Korrekte vorm weg vanaf sphere.*	✓
Correct shape of field pattern. *Korrekte vorm vir veldpatroon.*	✓
Field lines not crossing/ not drawn inside the sphere *Veldlyne kruis nie/ nie binne-in spheer geteken.*	✓
	(3)

7.3
$$F_{ZY} = \frac{kQ_PQ_Q}{r^2} \checkmark$$
$$= \frac{9\times10^9 \times 6\times10^{-9} \times 6\times10^{-9}}{0{,}2^2 \checkmark} \checkmark$$
$= 8{,}1 \times 10^{-6}$ N✓ (4)

7.4
$$E_{net} = \frac{kQ_P}{r^2} \checkmark + \frac{kQ_Q}{r^2} + \frac{kQ_R}{r^2}$$
$$= \frac{9\times10^9 \times 6\times10^{-9}}{0{,}5^2} \checkmark + \frac{9\times10^9 \times 6\times10^{-9}}{0{,}3^2} \checkmark - \frac{9\times10^9 \times 2\times10^{-9}}{0{,}1^2} \checkmark$$
$= -9{,}84 \times 10^2$ N.C^{-1}
$= 9{,}84 \times 10^2$ N.C^{-1}✓, left✓*links* (6)

[15]

QUESTION 8/*VRAAG 8*

8.1.1 $V_i = (3,0 - 2,0) = 1,0\ V$ ✓✓ (2)

8.1.2

$$\text{Gradient} = \frac{\Delta I}{\Delta V} ✓$$
$$= \frac{0,4 - 0,6}{1 - 0} ✓✓$$
$$= -0,2\ \Omega^{-1}$$
$$r_i = 5\ \Omega ✓$$

(4)

8.2.1 The potential difference across a conductor is directly proportional to the current✓ in the conductor at constant temperature✓.

Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom deur die geleier by konstante temperatuur. (2)

8.2.2 $V_i = 24 - 22,5$
$= 1,5\ V$

$$r_i = \frac{V_i}{I} ✓$$
$$0,8 = \frac{1,5}{I} ✓$$
$$I = 1,875\ A$$

$$V_{3\Omega} = IR$$
$$= (1,875)(3) ✓$$
$$= 5,625\ V$$

$$V_{//} = V_{ext} - V_s$$
$$= 22,5 - 5,625 ✓$$
$$= 16,875\ V$$

$$P = \frac{V^2}{R} ✓$$
$$= \frac{16,875^2}{16} ✓$$
$$= 17,80\ W ✓$$

(7)

8.2.3 **Positive marking from 8.2.2/*Positiewe nasien van 8.2.2***

$I = \frac{V_{//}}{R}$

$= \frac{16,875}{16}$ ✓

$= 1,055$ A

$I_R = 1,875 - 1,055$ ✓

$= 0,82$ A

$R = \frac{V}{I}$

$= \frac{16,875}{0,82}$ ✓ ✓

$= 16,06\ \Omega$ ✓ (5)

8.2.4 Decrease✓

Total resistance in circuit decrease and the total current increase. ✓

$V_{internal}$ will increase ✓

Therefore: $V_{external}$ will decrease because emf stays constant. ✓

Afneem

Totale weerstand in stroombaan neem af en die totale stroom neem toe.

V_{intern} sal toeneem.

Dus: *$V_{ekstern}$ sal afneem omdat die emk konstant bly.* (4)

[24]

QUESTION 9/*VRAAG 9*

9.1.1 Electromagnetic Induction✓/*elektromagnetiese induksie* (1)

9.1.2 The rate of change in the magnetic flux✓ is a maximum✓ at position A.

D*ie tempo van verandering in die magnetiese vloed is 'n maksimum by punt A.* (2)

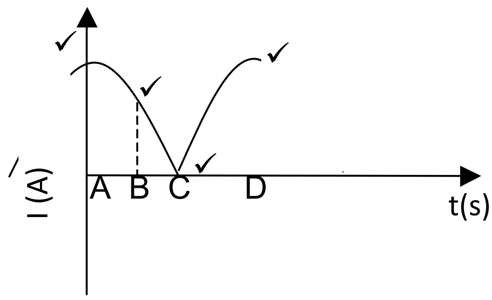
9.1.3 DC generator : split ring commutator✓

AC generator : slip rings✓

GS generator: splitring kommutator

WS generator: sleepringe (2)

9.1.4



(4)

9.2.1 18 V ✓ (1)

9.2.2 $P_{ave} = V_{rms}I_{rms}$ ✓
60 ✓ = $18(I_{rms})$ ✓
$(I_{rms}) = 3{,}33$ A

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$3{,}33 = \frac{I_{max}}{\sqrt{2}}$$ ✓

$I_{max} = 4{,}71$ A✓ (5)

[15]

QUESTION 10/*VRAAG 10*

10.1 The energy of the photons of red light is greater✓ than the work function of the metal in the photocell.✓OR
The frequency of red light is higher than the threshold/cut-off frequency of the metal in the photocell.

Die energie van die fotone van rooi lig is groter as die werksfunksie van die metaal in die fotosel.OF
Die frekwensie van rooi lig is groter as die drumpel/afsnyfrekwensie van die metaal in die fotosel. (2)

10.2.1 Increase✓/ *Neem toe* (1)

10.2.2 Stays the same ✓
The change in colour/frequency only has an influence on the kinetic energy of the photo electrons. ✓
Only the intensity of the light has an influence on the number of photo electrons emitted per time unit. ✓
The intensity of the light stays the same and therefore the number of photo electrons emitted per unit time /current stays the same. ✓ (4)

Bly dieselfde
Die verandering in kleur/frekwensie beïnvloed slegs die kinetiese energie van die foto-elektrone.
Slegs intensitiet van lig het 'n invloed op die aantal foto-elektrone wat per tydeenheid vrygestel word.
Die intensiteit van die lig het dieselfde gebly en daarom het die aantal foto-elektrone per tydeenheid/stroom konstant gebly.

10.3 **OPTION 1/*OPSIE 1***

$$\left.\begin{array}{l} E = W_o + E_{k(max)} \\ h\frac{c}{\lambda} = hf_o + ½mv^2 \end{array}\right\} ✓$$

$$\frac{6,63 \times 10^{-34} \times 3 \times 10^{8}}{4,5 \times 10^{-7}} ✓ ✓ = 6,63 \times 10^{-34}(f_o) ✓ + ½(9,11 \times 10^{-31})(4,78 \times 10^{5})^2 ✓$$

$$f_o = 5,10 \times 10^{14} \text{ Hz } ✓$$

(6)

[13]

TOTAL SECTION B/*TOTAAL AFDELING B*: 130
GRAND TOTAL/*GROOTTOTAAL*: 150

Western Cape Government
Education

METRO SOUTH EDUCATION DISTRICT

CURRICULUM AND ASSESSMENT POLICY STATEMENT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2015

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 3 data sheets.

QUESTION 1 (MULTIPLE CHOICE QUESTIONS)

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A-D) next to the question number (1.1–1.10) in your answer book.

1.1 A constant net force, F, is applied to a crate which moves along a frictionless horizontal surface. Which ONE the following quantities remains constant while force F acts on the crate?

A the rate of change of velocity
B the change in momentum
C the work done on the crate
D the change in kinetic energy (2)

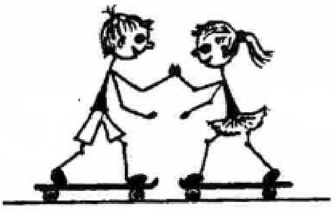
1.2 A satellite experiences a gravitational force of magnitude F on the surface of the earth. The radius of the earth is R. The satellite now circles the earth at an unknown height above the surface of the earth and experiences a gravitational force of magnitude ¼ F. This unknown height above the surface of the earth is ….

A R
B 2R
C 3R
D 4R (2)

1.3 When a light wave from a distant star is analysed it is found that this wave is “red-shifted”. This confirms that the wave experienced a…

A decrease in wavelength and increase in frequency.
B decrease in wavelength and decrease in frequency.
C increase in wavelength and decrease in frequency.
D increase in wavelength and increase in frequency. (2)

1.4 A boy, mass **2m**, and a girl, mass **m**, standing on skateboards are facing each other. They push off against one another. The boy exerts a force on the girl and the boy experiences a change in momentum to the left.



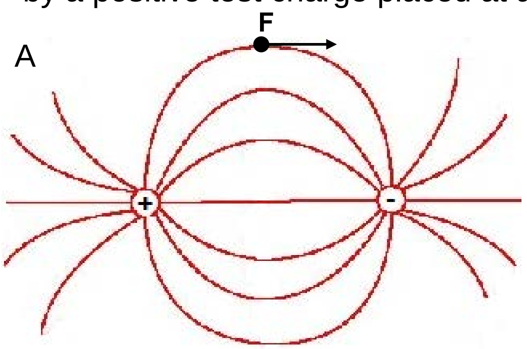
Ignore the effects of friction. Which ONE of the following best describes the magnitudes of the force exerted by the girl and her change in momentum?

	Force exerted by girl	Change in momentum of girl
A	less than the force exerted by the boy	less than the change in momentum of the boy
B	less than the force exerted by the boy	equal to the change in momentum the boy
C	equal to the force exerted by the boy	equal to the change in momentum of the boy
D	equal to the force exerted by the boy	less than the change in momentum of the boy

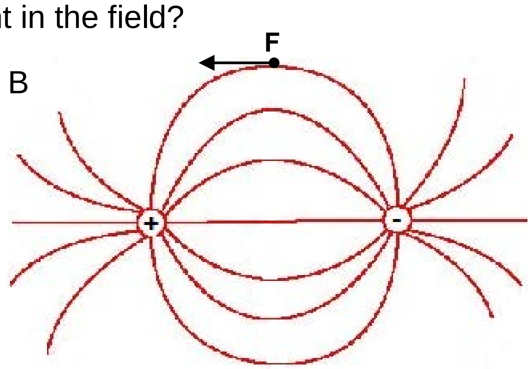
(2)

1.5 The electric field pattern of two small charged objects are shown below. Which one of the following diagrams correctly shows the force experienced by a positive test charge placed at a point in the field?

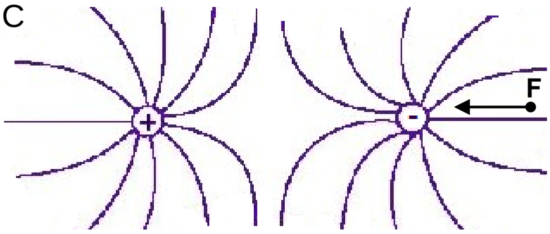
A



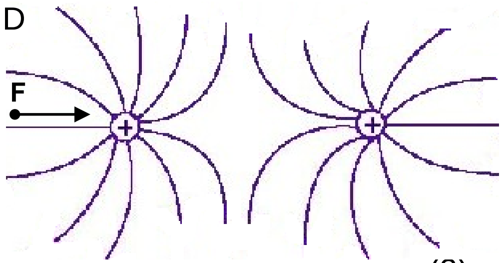
B



C

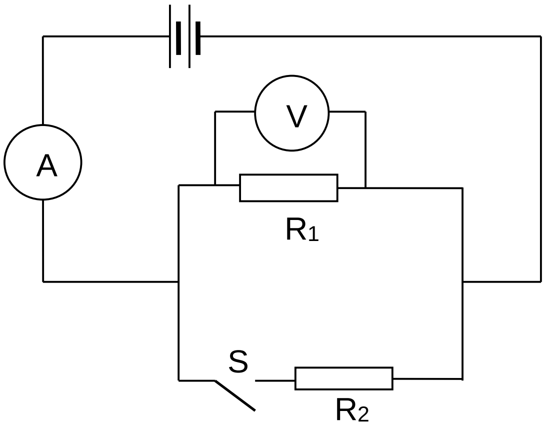


D



(2)

1.6 Consider the following electric circuit, with switch S open.

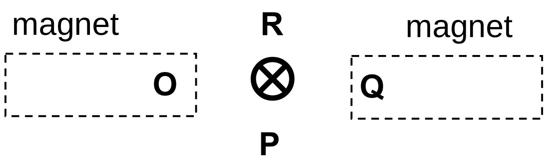


The resistors R_1 and R_2 are identical. The internal resistance of the battery in the circuit is **not** negligible. When switch S is closed, which ONE of the following gives the correct readings on the ammeter (A) and voltmeter (V)?

	READING ON AMMETER	READING ON VOLTMETER
A	decreases	remains the same
B	decreases	increases
C	increases	decreases
D	increases	remains the same

(2)

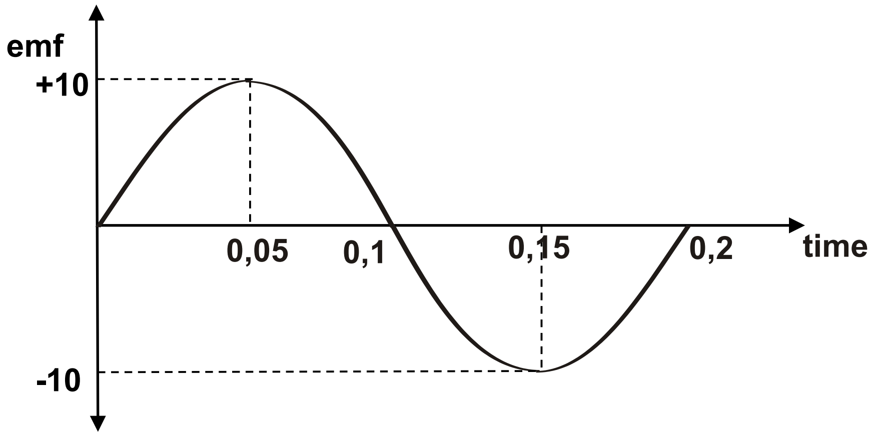
1.7 Two strong bar magnets are arranged with their poles O and Q facing each as shown in the diagram below. A current – carrying conductor carries conventional current into the plane of the paper when placed between the poles of two magnets.



If the force on the conductor is towards R then :-

A O and Q are both north poles.
B Q and O are both south poles.
C Q is a north pole and O is a south pole.
D O is a north pole and Q is a south pole. (2)

1.8 The diagram shows the variation in emf produced by a generator.



If the armature of the generator is rotated at twice the speed how will the emf and the period shown by the graph change?

	Emf	Period
A	Greater than 10 V	0,2 s
B	Greater than 10 V	0,1 s
C	Equal to 10 V	0,1 s
D	Less than 10 V	0,4 s

(2)

1.9 Which ONE of the following provides evidence that light behaves as particles?

A Light can be diffracted.
B Light is refracted by a triangular prism.
C Light ejects electrons from a metal surface.
D The speed of light decreases when it travels from air to glass. (2)

1.10 Which ONE of the following descriptions best explains the formation of a line emission spectrum?

A line emission spectrum is formed when …

A white light passes through a cold gas.
B white light passes through a triangular prism.
C electrons in the ground state move to a higher energy level.
D electrons in the excited state move to a lower energy level.

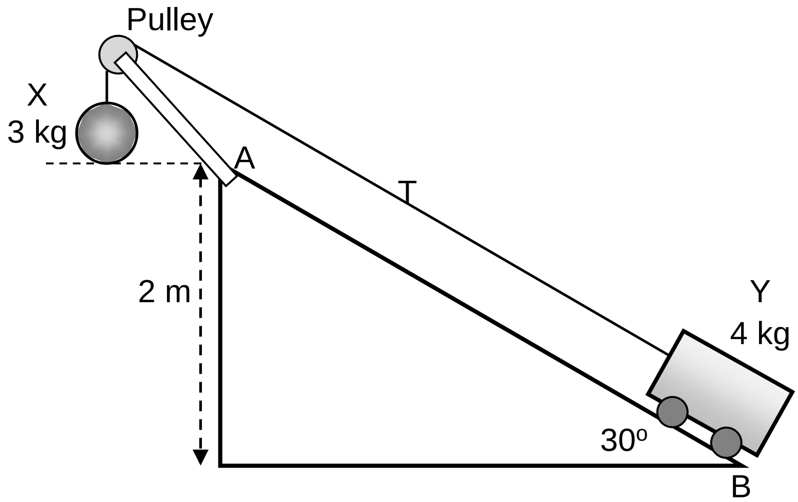
(2)

[20]

QUESTION 2 (Start on a new page)

Ball X of mass 3 kg is attached to trolley Y of mass 4 kg by a light string which passes over a frictionless pulley as shown in the diagram. Initially the trolley is at rest on a slope AB, which makes an angle of 30º with the horizontal. When the ball is released it falls to the ground and the trolley moves 2 m up the slope accelerating at 0,43 $m.s^{-2}$.

The coefficient of kinetic friction along slope AB is μ_k = 0,2. (Ignore the rotation effects of the wheels and air friction.)



2.1 Draw a labelled free body diagram to show ALL the forces acting on the trolley as it moves up the slope. (4)

2.2 Show that a friction force of 6,79 N acts on the trolley as it moves up the slope. (3)

2.3 State Newton's Second Law of motion in words. (2)

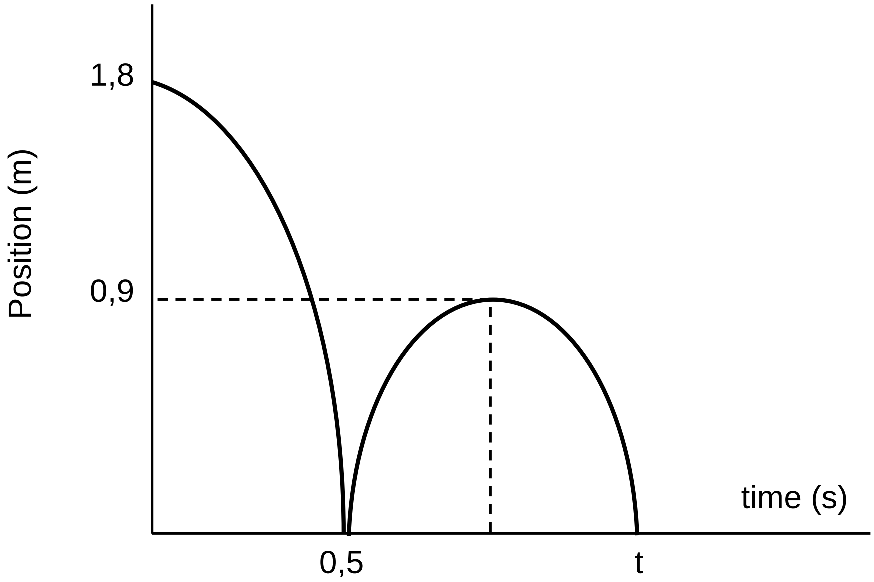
2.5 Calculate the tension T in the string. (5)

2.6 Calculate the speed with which the 3 kg ball strikes the ground. (4)

[18]

QUESTION 3 (Start on a new page)

The position-time graph is given for a ball which is thrown down from a vertical height of 1,8 m and bounces once on reaching the ground. The contact time between the ball and the floor can be ignored.



3.1 Calculate the initial velocity with which the ball was thrown. (3)

3.2 At what speed does the ball strike the ground? (3)

3.3 At what speed did the ball leave the ground after bouncing? (3)

3.4 Calculate the value of time t. (4)

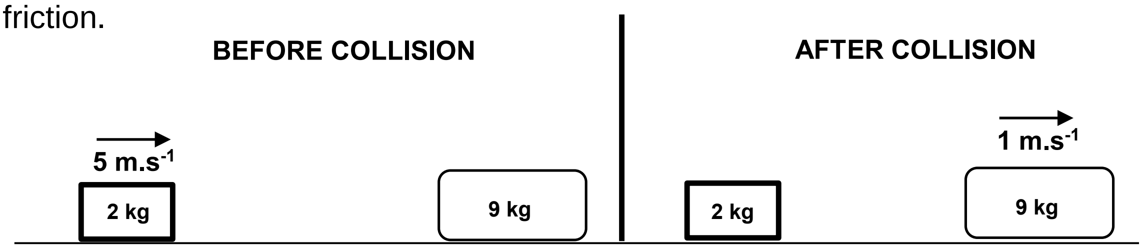
3.5 Sketch a velocity-time graph to represent the motion of the ball. Indicate the following values on the graph:

- The initial velocity at which the object was thrown.
- The velocity at which the ball strikes the ground.
- The velocity at which the ball bounces off the ground.
- The time at which the ball strikes the ground for the first time.
- The time, t, when the ball strikes the ground after the first bounce. (6)

[19]

QUESTION 4 (Start on a new page)

A wooden block of mass 2 kg, moving at a velocity of 5 $m.s^{-1}$, collides with a crate of mass 9 kg resting on a flat horizontal surface as shown in the diagram below. After the collision, the crate moves to the right at 1 $m.s^{-1}$. Ignore the effects of friction.



4.1 Write down the principle of conservation of linear momentum in words. (2)

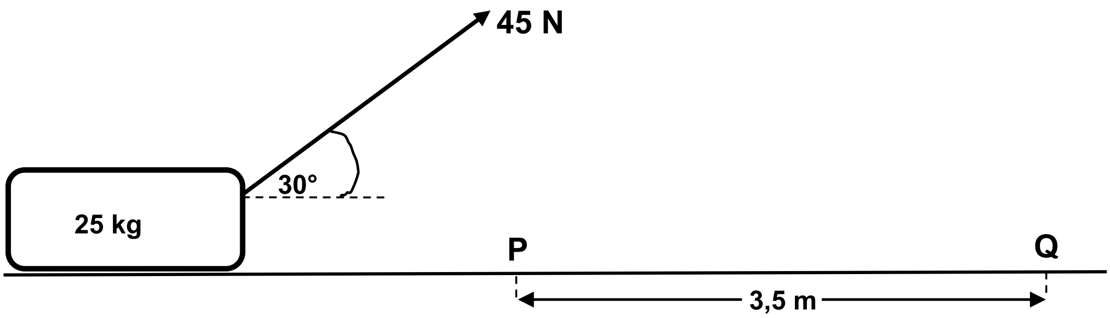
4.2 Calculate the magnitude of the velocity of the wooden block immediately after the collision. (4)

4.3 If the collision lasts 0,6 seconds, calculate the force the wooden block exerts on the crate during the collision. (4)

[10]

QUESTION 5 (Start on a new page)

A worker applies a constant force of 45 N on a crate of mass 25 kg, at an angle of 30° with the horizontal. When the crate reaches point P, its velocity is 12 $m.s^{-1}$ and 3,5 m further it reaches point Q at a velocity of 10,8 $m.s^{-1}$.



5.1 Draw a labelled free-body diagram to show the horizontal forces acting on the crate during its motion. The length of the vectors should be an indication of their relative magnitudes. (3)

5.2 Write down the NAME of the non-conservative force that opposes the forward motion of the crate. (1)

5.3 State the Work-Energy theorem in words. (2)

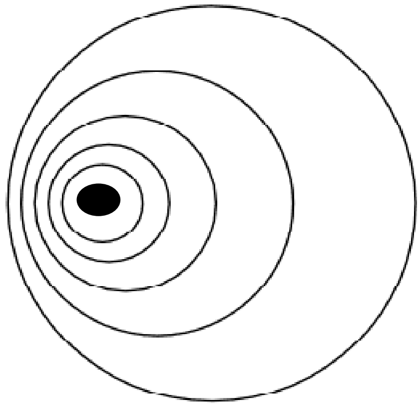
5.4 Use ENERGY PRINCIPLES to calculate the magnitude of the non-conservative force mentioned in QUESTION 5.2. (6)

[12]

QUESTION 6 (Start on a new page)

The diagram shows a moving source of sound wave in air.

It illustrates the Doppler Effect, a phenomenon named after the German scientist, Christian Doppler.



6.1 Explain in words, what is meant by the Doppler Effect. (2)

6.2 In which direction is the source moving, to the left or to the right? (1)

6.3 What happens to the observed frequency of the waves as the source is moving? (1)

6.4 The sound source is moving towards a stationary observer. Answer the following question by stating whether the pitch INCREASES, DECREASES or REAMINS THE SAME. What will the observer hear as the sound source…

6.4.1 moves towards the observer,
6.4.2 moves away from the observer,
6.4.3 slows down and stops. (3)

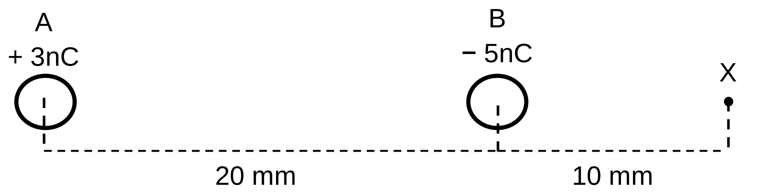
6.5 A submarine is lying motionless under water in the sea. It detects a sound coming from a moving ship. The frequency detected is 1,003 times greater than the actual frequency of the sound emitted by the ship. The speed of sound in salt water is 1 470 $m.s^{-1}$. Ignore the effects of any friction.

Calculate the velocity of the ship. (4)

[11]

QUESTION 7 (Start on a new page)

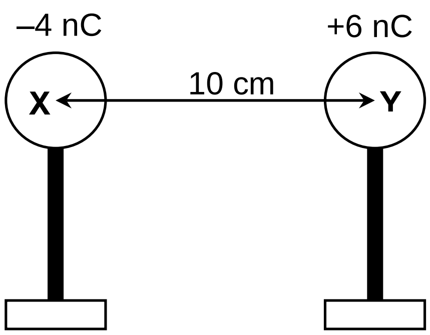
7.1 The diagram shows two point charges which are 20mm apart. A carries a charge of + 3nC and B carries a charge of – 5 nC. X is a point which is situated 10mm to the right of B.



7.1.1 Define the electric field at a point. (2)

7.1.2 Calculate the magnitude and direction of the net electric field at point X due to the presence of both A and B. (6)

7.2 Two small charged spheres, X and Y, on insulated stands are placed 10 cm apart. The charge on X is –4 nC and the charge on Y is +6 nC.



7.2.1 Draw the electric field pattern around charges X and Y. (3)

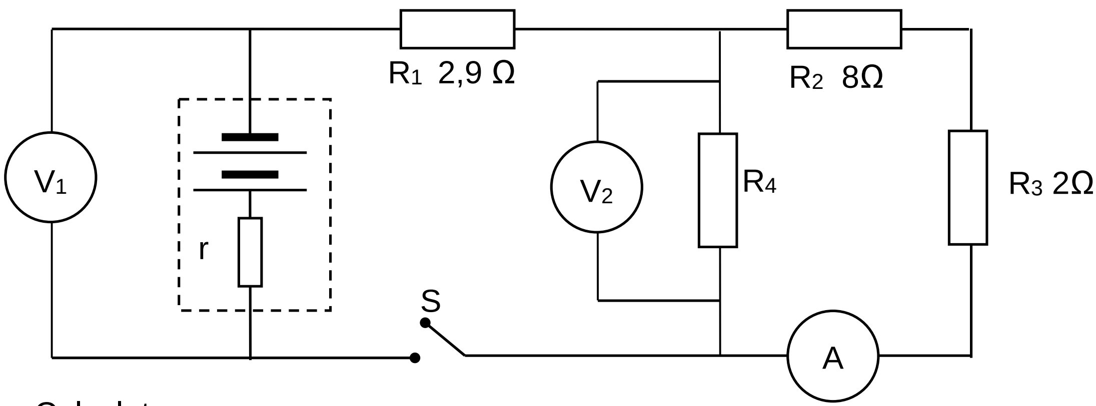
7.2.2 Calculate the magnitude of the force that X exerts on Y. (4)

7.2.3 The charged spheres are now brought into contact with each other and then separated. Calculate the charge on each sphere after separation. (2)

[17]

QUESTION 8 **(Start on a new page)**

In the circuit represented below, voltmeter V_1 reads 12 V when the switch is open and 10,8 V when the switch is closed. The internal resistance of the battery, r, and the resistance of resistor R_4 are unknown. When the switch S is closed, the power dissipated in resistor R_2 is 2 W.
The voltmeters have a very high resistance and the resistance of the ammeter is so small that it can be disregarded.



8.1 Calculate:-

8.1.1 The reading on the ammeter. (3)

8.1.2 The reading on voltmeter V_2. (3)

8.1.3 The current which flows through the battery. (4)

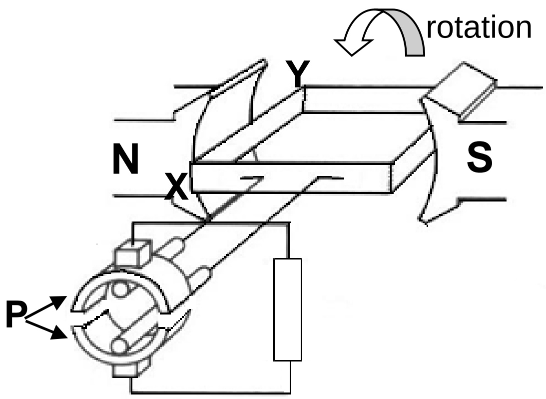
8.1.4 The internal resistance of the battery. (3)

8.2 R_4 is replaced by a conductor with negligible resistance. How will this affect the power of R_2? Write down INCREASE, DECREASE, BECOME ZERO or REMAIN CONSTANT and give a reason for answer. (2)

[15]

QUESTION 9 (Start on a new page)

In a simple generator a coil is rotated anti-clockwise in a uniform magnetic field. The diagram below shows the position at the instant the coil lies parallel to the magnetic field.



9.1 Name the law on which a generator operates. (1)

9.2 Name component P. (1)

9.3 What is the function of component P? (1)

9.4 Determine the direction of the current in segment XY when the coil is in the position shown above. Only write down X to Y OR Y to X. (1)

9.5 Is the induced potential difference in the coil illustrated above about to increase or to decrease? Explain your answer by referring to the change in magnetic flux as the loop rotates from the horizontal to the vertical position. (3)

9.6 Draw a sketch graph of emf in the external circuit against time for one complete rotation of the armature coil, starting with the coil in the position shown. (2)

[9]

QUESTION 10 (Start on a new page)

A certain municipality implements a power decrease in the town. As a result of the power decrease the rms voltage drops from 230 V_{rms} to 210 V_{rms}.

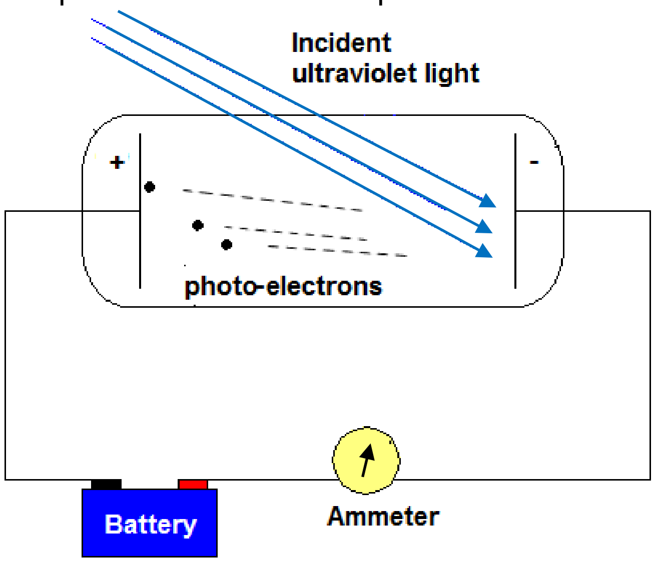
10.1 Calculate the peak voltage during the power decrease. (3)

10.2 A certain electrical appliance dissipates 1 800 W when it is operated at 230 V_{rms}. Calculate the power at which it will operate during the power decrease. (4)

[7]

QUESTION 11 (Start on a new page)

In the diagram below, photons of ultraviolet light with energy 5,6 x 10^{-19} J is incident on the cathode of a photo cell and causes photo-electrons to be emitted from the metal surface.



The threshold (cut-off) frequency of the cathode of the photocell is 7,2 x 10^{14}Hz.

11.1 Which property of light is illustrated by the photo-electric effect (1)

11.2 Define the term *threshold (cut-off) frequency* in words. (2)

11.3 Calculate the maximum kinetic energy of the emitted photo-electrons. (3)

11.4 The brightness of the ultraviolet light is now increased. How will this change affect each following? Only write down INCREASES, DECREASES or REMAINS THE SAME.

11.4.1 The kinetic energy of the emitted photoelectrons. (1)

11.4.2 The reading on the ammeter. (1)

11.5 The ultraviolet light source is now replaced with a light source of wavelength 622 nm. Will this light source be able to eject photo-electrons from the cathode of the photo-cell? Support your answer with a calculation. (4)

[12]

Total: 150 marks

QUESTION 1: MULTIPLE CHOICE QUESTIONS

1.1 A ✓✓

1.2 B ✓✓

1.3 C ✓✓

1.4 C ✓✓

1.5 A ✓✓

1.6 C ✓✓

1.7 C ✓✓

1.8 B ✓✓

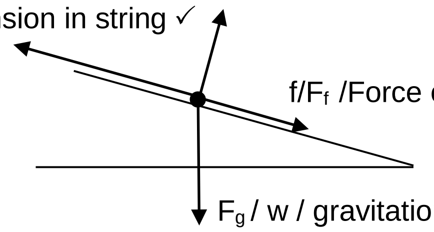
1.9 C ✓✓

1.10 D ✓✓

[20]

QUESTION 2

2.1



(Accept the components of F_g INSTEAD of F_g but not both F_g and the components. No arrows = ¾; forces not touching dots = 3/4) (4)

2.2 F_N = mgcos 30° = 33,95 N ✓

$F_f = \mu_k F_N$ ✓ = 0,2 (33,95) = 6,79 N ✓ (3)

2.3

When a <u>resultant (net) force</u> acts on an object, the object will accelerate in the direction of the force. <u>This acceleration is directly proportional to the force</u>✓ and <u>inversely proportional to the mass of the object</u>.✓

Wanneer 'n resulterende (netto) krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Hierdie versnelling is direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*

The net force acting on an object is equal to the rate of change of momentum ✓✓of the object (in the direction of the force). (2 or 0)

Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering in momentum van die voorwerp (in die rigting van die krag). (2 of 0) (2)

2.4 $F_{g//}$ = mgsin 30° = (4)(9,8)sin 30 = 19,6 N ✓

ma = T − (F_f + $F_{g//}$) ✓

(4)(0,43) ✓ = T − (6,79 + 19,6) ✓

T = 28,11 N ✓ (5)

2.5 $v_f^2 = v_i^2 + 2g\Delta y$ ✓

$v_f^2 = 0^2$✓ $+ 2(0.43)(2)$✓

$\therefore v = 1,31\ m.s^{-1}$✓ (4)

$W_{nc} = \Delta E_p + \Delta E_k$✓

$T\Delta x Cos\theta = mg(h_2 - h_{0)} + \frac{1}{2}m(v_f^2 - v_i^2)$

$(28,11)(2)(1)$✓ $= (2)(9,8)(2-0) + (0,5)(2)\left(v_f^2 - 0^2\right)$✓

$\therefore v = 1,31\ m.s^{-1}$✓

[18]

QUESTION 3

3.1 Take down as positive (If down is taken as negative signs must be consistent)

$\Delta y = v_i\Delta t + \frac{1}{2} g\Delta t^2$ ✓

$\underline{1,8 = v_i(0,5) + \frac{1}{2}(9,8)(0,5)^2}$ ✓

$v_i = 1,15 \text{ m.s}^{-1}$ ✓ (3)

3.2 $v_f = v_i + a\Delta t$ ✓

$v_f = \underline{(1,15) + (9,8)(0,5)}$ ✓

$v_f = 6,05 \text{ m.s}^{-1}$ ✓ (3)

3.3 $v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\underline{0 = v_i^2 + 2(9,8)(-0,9)}$ ✓

$v_i = \pm 4,2$

$v_i = 4,2 \text{ m.s}^{-1}$ upwards✓ (3)

3.4 $v_f = v_i + a\Delta t$ ✓

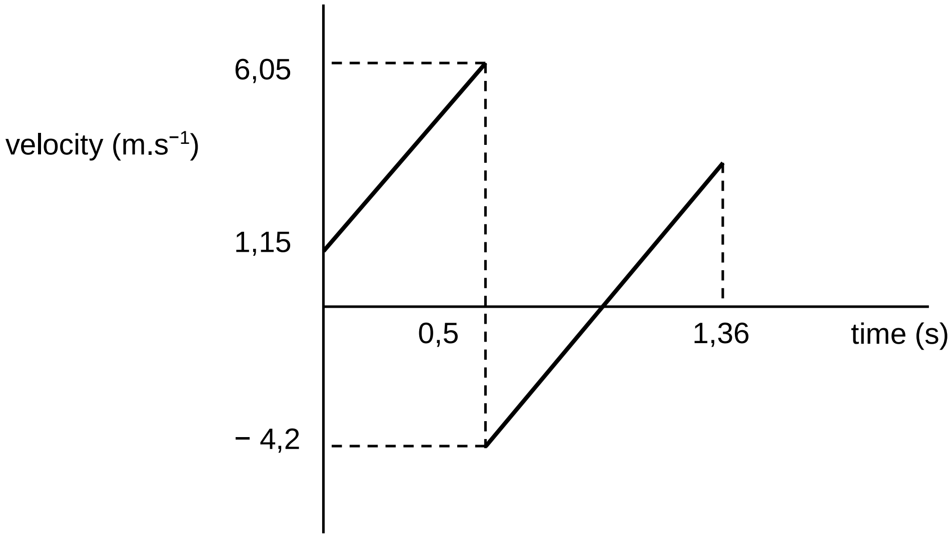
$\underline{0 = (-4,2) + (9,8)(\Delta t)}$ ✓

$\Delta t = 0,43 \text{ s}$ ✓

$t = 0,5 + 2(0,43) = 1,36 \text{ s}$ ✓ (4)

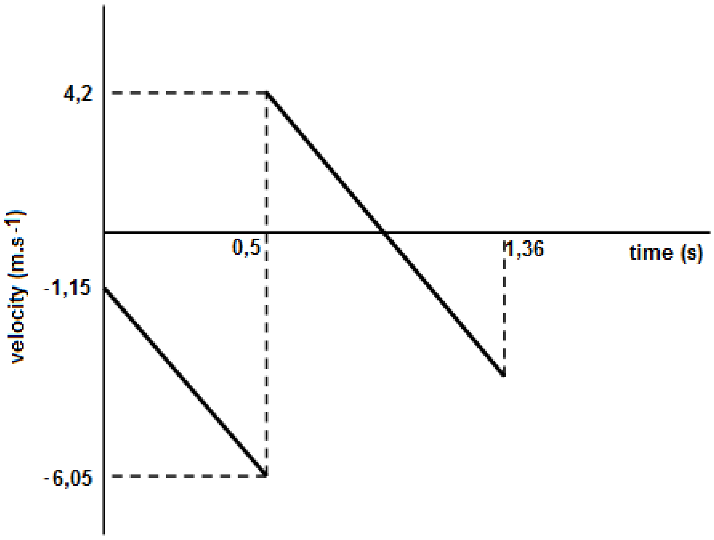
3.5 **DOWN AS POSITIVE:**

- Axes correctly labelled ✓
- Graph correctly drawn ✓ (Lines must be parallel)
- Values of velocities and time t, correctly marked ✓✓✓✓



UPWARD AS POSITIVE:

- Axes correctly labelled ✓
- Graph correctly drawn ✓ (Lines must be parallel)
- Values of velocities and time t, correctly marked ✓✓✓✓



(6)

[19]

QUESTION 4

4.1 The total (linear) momentum remains constant/is conserved ✓in an isolated/a closed system/the absence of external forces. ✓
Die totale lineêre momentum bly konstant/behoue ✓ in 'n geïsoleerde sisteem/geslote sisteem/die afwesigheid van eksterne kragte. ✓ (2)

4.2

To the right as positive/*Na regs as positief:*	To the right as negative/*Na regs as negatief:*
$\Sigma p_{before/voor} = \Sigma p_{after/na}$ ✓ $\underline{(2)(5) + (9)(0)}$ ✓ = $\underline{(2)v_{f1} + (9)(1)}$ ✓ $\therefore v_{f1} = 0{,}5\ m.s^{-1}$ right ✓	$\Sigma p_{before/voor} = \Sigma p_{after/na}$ ✓ $\underline{(2)(-5) + (9)(0)}$✓ = $\underline{(2)v_{f1} + (9)(-1)}$✓ $v_{f1} = -0{,}5\ m.s^{-1}$ $\therefore v_{f1} = 0{,}5\ m.s^{-1}$ right ✓

Other formulae/*Ander formules*:	Notes/*Aantekeninge:*
$m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$ or/*of* $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ or/*of* $m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v_{f2}$	If no formula/principle – Max. $\frac{3}{4}$ *Indien geen formule/beginsel – Maks.* $\frac{3}{4}$

4.3

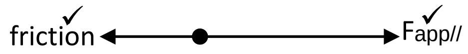
Option 1: (Wooden block)	Option 2: (Wooden block)
$F_{net}\Delta t = m\Delta v$ ✓ OR $F_{net}\Delta t = \Delta p$ $F_{net}(0{,}6)$ ✓ $= 2(0{,}5 - 5)$ ✓ $F_{net} = -15\ N$ $\therefore$ magnitude of $F_{net} = 15\ N$✓	$v_f = v_i + a\Delta t$ $0{,}5 = 5 + a(0{,}6)$ ✓ $a = -7{,}5\ m\cdot s^{-2}$ $F_{net} = ma$ $= (2)(-7{,}5)$ ✓ $= -15\ N$ $\therefore$ magnitude of $F_{net} = 15\ N$✓ ✓For both equations;
OPTION 3: (Crate)	**OPTION 4: (Crate)**
$F_{net}\Delta t = m\Delta v$ ✓ OR $F_{net}\Delta t = \Delta p$ $F_{net}(0{,}6)$ ✓ $= 9(1 - 0)$ ✓ $F_{net} = 15\ N$ $\therefore$ magnitude of $F_{net} = 15\ N$✓	$v_f = v_i + a\Delta t$ $1 = 0 + a(0{,}6)$ ✓ $a = 1{,}67\ m\cdot s^{-2}$ $F_{net} = ma$ $= (9)(1{,}67)$ ✓ $= 15\ N$ $\therefore$ magnitude of $F_{net} = 15\ N$✓ ✓For both equations;

(4)

[10]

QUESTION 5

5.1



✓ = relative size of arrows correct. (3)

5.2 Non-conservative force = FRICTION ✓ (1)

5.3 The <u>net/total work done on an object</u> ✓is <u>equal to the change in the object's kinetic energy</u> ✓OR <u>the work done on an object by a resultant/net force</u> is <u>equal to the change in the object's kinetic energy</u>. (2)

5.4

OPTION 1/*OPSIE 1*

$W_{net} = \Delta E_k$ ✓

$F_{app||}\Delta x\cos\theta + f\Delta x\cos\theta = \frac{1}{2} m(v_f^2 - v_i^2)$

$(45)\cos 30^0$✓ $\underline{(3,5)\cos 0^0}$ ✓+ $\underline{f(3,5)\cos 180^0}$ ✓= $\underline{\frac{1}{2}(25)(10,8^2 - 12^2)}$✓

$f = 136,69$ N ✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta E_k$ ✓

$F_{applied}\Delta x\cos\theta + f\Delta x\cos\theta = \frac{1}{2} m(v_f^2 - v_i^2)$

(45)✓ $\underline{(3,5)\cos 30^0}$ ✓+ $\underline{f(3,5)\cos 180^0}$ ✓= $\underline{\frac{1}{2}(25)(10,8^2 - 12^2)}$✓

$F = 136,69$ N ✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta E_k + \Delta E_p$ ✓

$f\Delta x\cos\theta + F_{app||}\Delta x\cos\theta = \frac{1}{2} m(v_f^2 - v_i^2) + mg(h_f - h_i)$

$\underline{f(3,5)\cos 180^0}$✓+ $\underline{(45)\cos 30^0(3,5)\cos 0^0}$ ✓= $\underline{\frac{1}{2}(25)(10,8^2 - 12^2)}$✓ + 0]✓

$f = 136,69$ N ✓

OPTION 4 (Equations of motion = 4/6 max)

- $a = -3,91$ m.s^{-2}
- $F_{net} = -97.71$ N
- $f = F_{net} - F_{applied//} = 136,68$ N

(6)

[12]

QUESTION 6

6.1 An (apparent) change in observed/detected frequency (pitch), (wavelength) ✓as a result of the relative motion between a source and an observer ✓ (listener). (2)

6.2 To the left. ✓ (1)

6.3 The wavelength is smaller / has decreased. ✓ (**NOT closer together**.) (1)

6.4 The pitch will be higher /increased ✓ as the source approaches and will drop/decrease ✓ suddenly as the source passes and will increase back to the normal frequency as the source slows down and stops. ✓ (3)

6.5 $f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ ✓

$1{,}003 f_S$ ✓ $= \frac{1470 + 0}{1470 - v_S} f_S$ ✓

$\therefore\ v_s = 4{,}4\ m.s^{-1}$ ✓ (4)

[11]

QUESTION 7

7.1.1 The electric field at a point is the electrostatic force experienced ✓per unit positive charge placed at that point. ✓ (2)

7.1.2

$$E_M = \frac{kQ}{r^2} \quad ✓$$

$$E_M = \frac{(9 \times 10^9)(3 \times 10^{-9})}{(30 \times 10^{-3})^2} \quad ✓$$

E_M = 30 000 N.C^{-1} to the right ✓

$$E_N = \frac{(9 \times 10^9)(5 \times 10^{-9})}{(10 \times 10^{-3})^2} \quad ✓$$

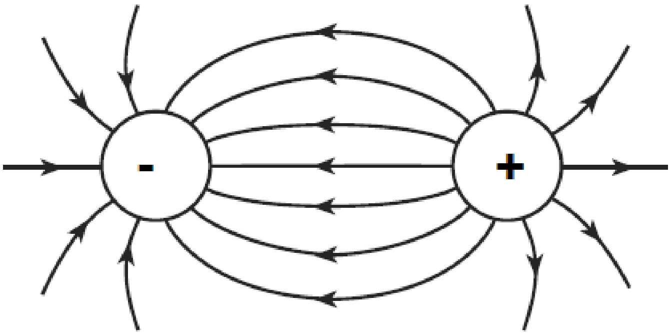
E_N = 450 000 N.C^{-1} to the left ✓

Take right as positive

E_{net} = 30 000 N.C^{-1} − 450 000 N.C^{-1}
E_{net} = − 420 000 N.C^{-1}
E_{net} = 420 000 N.C^{-1} to the left ✓

(6)

7.2.1



Criteria:

Correct shape as shown. ✓
Direction from positive to negative. ✓
Field lines start on spheres and do not cross. ✓

(3)

7.2.2 $$F = \frac{(9x10^9)✓(4x10^{-9})(6x10^{-9})✓}{(0,1)^2✓}$$

$$= 2,16x10^{-5}\ N$$

$$\therefore magnitude\ of\ F = 2,16x10^{-5}\ N✓$$ (4)

7.2.3 $$\frac{Q_1 + Q_2}{2} = \frac{4x10^{-9} + 6x10^{-9}}{2}✓ = 1\ x\ 10^{-9}\ C✓$$ (2)

[17]

QUESTION 8

8.1.1 $P = I^2R$ ✓

$(2) = I^2(8)$ ✓

$I = 0,5$ A ✓ (3)

8.1.2 V across 8 Ω and 2 Ω

$R_{(series)} = 8\ \Omega + 2\ \Omega = 10\ \Omega$ ✓

$V = IR = (0,5)(10)$ ✓

$V = 5V$ = reading on V_2 ✓ (3)

8.1.3 For R_1

$V = (10,8) - (5) = 5,8$ V ✓

$V = IR$

$5,8 = I(2,9)$ ✓

$I = 2A$ = current through battery ✓ (3)

8.1.4 $\mathcal{E} = IR + Ir$ ✓

(12) ✓ = (10,8) ✓ + (2)r

$r = 0,6\ \Omega$ ✓ (4)

8.2 Become zero.✓

All current will flow through the conductor and no current will flow through R_2/R_3 (R_2/R_3 will be short circuited) ✓ (2)

[15]

QUESTION 9

9.1 Electromagnetic induction. ✓ (1)

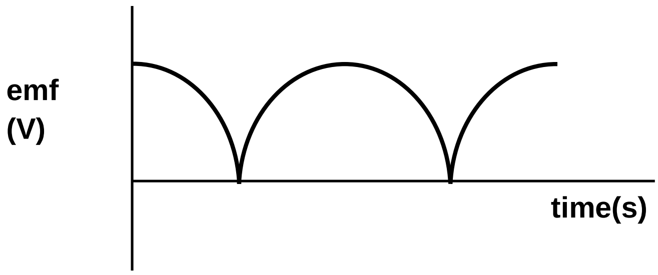
9.2 Split ring commutator .✓ (1)

9.3 The commutator converts the alternating current (AC) from the armature (coil) to direct current (DC) in the external circuit. ✓ (1)

9.4 Y to X ✓ (1)

9.5 Decrease ✓
In the horizontal position the coil cuts the maximum number of field lines per second ie the rate of change of flux is a maximum and the emf is a maximum.✓
In the vertical position the rate of change of flux is a minimum and the emf is a minimum.✓ (3)

9.6 Axes labelled ✓.
Shape of graph✓



(2)

[9]

QUESTION 10

10.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{max} = (210)\sqrt{2}$ ✓

$= 296{,}98 \text{ V}$ ✓ (3)

10.2 $P_{ave} = \frac{V^2_{rms}}{R}$ ✓

$R = \frac{230^2}{1800}$ ✓

$R = 29{,}39\ \Omega$

During cutback

$P_{ave} = \frac{V^2_{rms}}{R}$

$P_{ave} = \frac{210^2}{29{,}39}$ ✓

$P_{ave} = 1500{,}57 \text{ W}$ ✓ (4)

[7]

QUESTION 11

11.1 Photo-electric effect ✓/ *Foto-elektriese effek* (1)

11.2 The minimum frequency of light needed to emit electrons from the surface of a metal ✓✓
Die minimum frekwensie van lig benodig om elektrone vanaf die oppervlakte van 'n metal vry te stel (2)

11.3 $E = W_o + E_{k(max/maks)}$
$5{,}6 \times 10^{-19} = (6{,}63 \times 10^{-34})(7{,}2 \times 10^{14}) + E_{k(max/maks)}$ ✓
$\therefore E_{k(max/maks)} = 8{,}26 \times 10^{-20}$ J ✓ (3)

11.4

11.4.1 Remains the same✓ / *Dieselfde bly* (1)

11.4.2 Increases ✓ / *Toeneem* (1)

11.5

<u>OPTION 1/*OPSIE 1*</u> $c = f.\lambda$ ✓ $3 \times 10^8 = f(6{,}22 \times 10^{-9})$ ✓ $f = 4{,}82 \times 10^{14}$ Hz ✓ No, the frequency of light source is below the threshold frequency of the metal✓ *Nee, die frekwensie van die ligbron is laer as die drumpelfrekwensie van die metal*
<u>OPTION 2/*OPSIE2*</u> $E = \frac{hc}{\lambda}$ ✓ $= \frac{(6{,}63 \times 10^{-34})(3 \times 10^8)}{(622 \times 10^{-9})}$ ✓ $= 3{,}19 \times 10^{-19}$ J $W_0 = hf_o$ $= (6{,}63 \times 10^{-34})(7{,}2 \times 10^{14})$ $= 4{,}77 \times 10^{-19}$ J ✓ No, E light source < W_0 ✓ *Nee. E van ligbron < W_o*

(4)

[12]

GRAND TOTAL/*GROOTTOTAAL*: 150

education

DEPARTMENT: EDUCATION

MPUMALANGA PROVINCE

NATIONAL SENIOR CERTIFICATE EXAMINATION

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2015

MARKS: 150

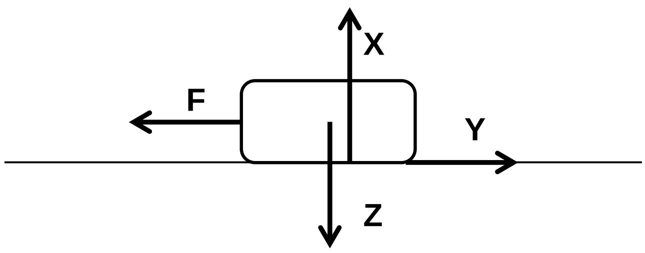
TIME: 3 Hours

This paper consists of 17 pages and 3 data sheets

QUESTION 1: MULTIPLE CHOICE QUESTIONS

Four options are provided as possible answers to the following questions.Each question has only **ONE** correct answer.Write only the letter (A-D) next to the question number (1.1-1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 A learner pulls a block at a CONSTANT SPEED over a rough horizontal surface with a force **F**. The force diagram below shows all the forces acting on the block.



Which ONE of the following relationships between the magnitudes of the forces **F**, **X**, **Y** and **Z** is true?

A **F** > **Y** and **X** = **Z**

B **F** > **Y** and **X** < **Z**

C **F** = **Y** and **X** = **Z**

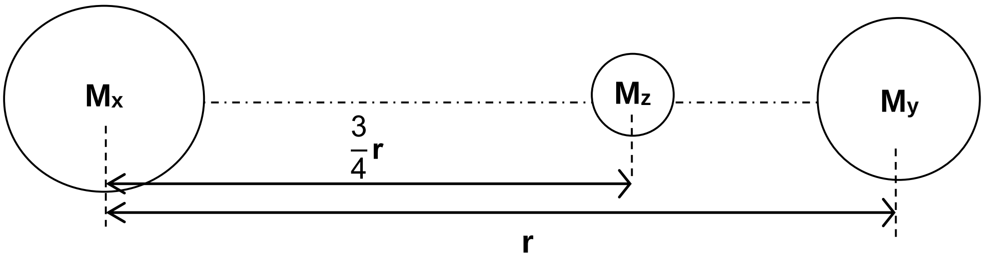
D **F** = **Y** and **X** < **Z** (2)

1.2 A stone is thrown vertically upwards into the air. Which combination in the table below shows the correct change in the momentum and the potential energy of the stone? (Ignore the effects of air friction)

	Momentum	**Potential energy**
A	Increases	Decreases
B	Decreases	Increases
C	Increases	Increases
D	Decreases	Stays constant

(2)

1.3 Two masses M_x and M_y are placed at a distance **r** apart. A third mass M_z experiences a ZERO resultant horizontal gravitational force when it is placed $\frac{3}{4}$**r** from M_x on the line between M_x and M_y.



The ratio of the two masses M_x : M_y is:

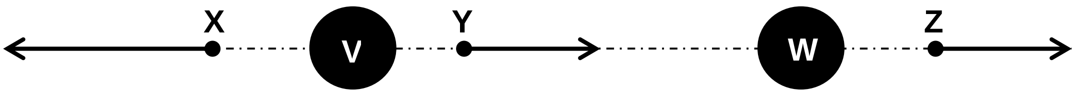
A 3 : 1

B 4 : 3

C 9 : 1

D 16 : 1 (2)

1.4 Two charged spheres **V** and **W** are located on a straight line. **X, Y** and **Z** are three points on the same straight line. The positions of points X, Y and Z are as indicated and the direction of the NET electric field at points **X, Y** and **Z** is shown in the diagram below.

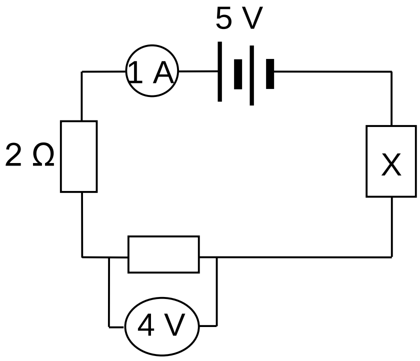


Which ONE of the following combinations represent the charges on each of the spheres **V** and **W**?

	Charge of V	Charge of W
A	Positive	Positive
B	Neutral	Positive
C	Negative	Negative
D	Positive	Negative

(2)

1.5 The battery in the diagram below has negligible internal resistance.
If the current in the circuit is 1 A, the component indicated by X is a/an:



A Light bulb

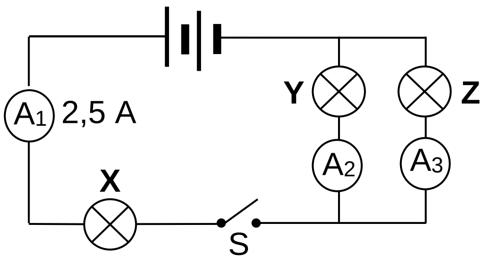
B Cell

C Ammeter

D Switch (2)

1.6 Three identical light bulbs **X**, **Y** and **Z** are connected in a circuit diagram as shown below. The internal resistance of the battery is negligible.

When switch S is closed, the reading on the ammeter A_1 is 2,5 A.

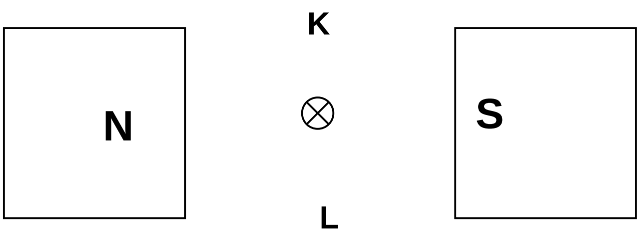


Which ONE of the following options correctly describes the readings on the ammeters (in ampère) if light bulb **Z** burns out?

	A_1	**A_2**	**A_3**
A	3,2	3,2	0
B	2,5	1,25	0
C	1,8	1,8	0
D	1,2	1,1	0,1

(2)

1.7 Two strong bar magnets are arranged with the north and south poles facing each other as shown in the diagram below. A current carrying conductor placed between the two magnets carries conventional current into the plane of the page.



The conductor experiences a force in the direction of…

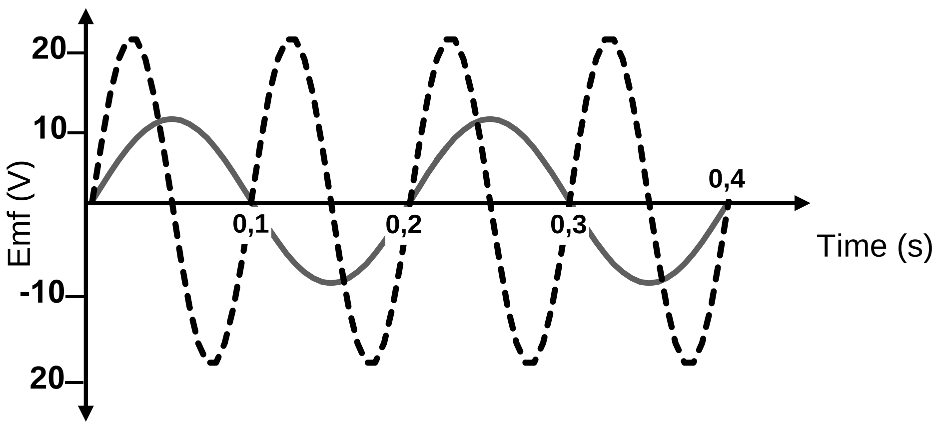
A K

B L

C N

D S (2)

1.8 In the graph below, the solid line represents how the emf, produced by a simple generator, changes with time. The dotted line shows the output of the same generator after a change was made to the generator.



Which change is made to produce the result as shown?

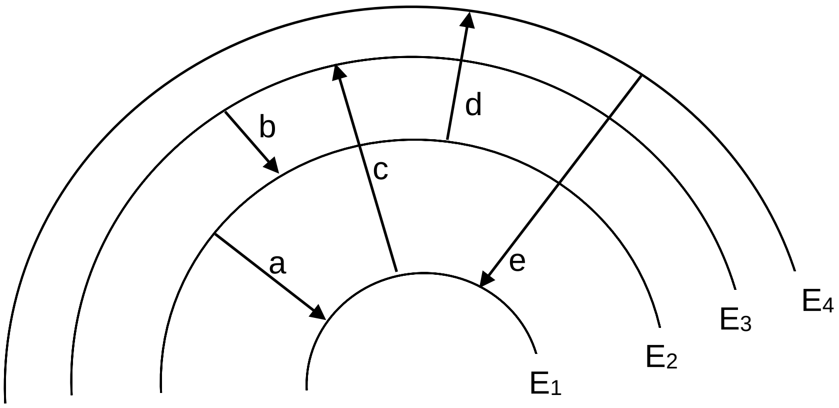
A The amount of turns in the coil is doubled.

B The speed of rotation is doubled.

C A split ring commutator is added.

D The strength of the magnets is doubled. (2)

1.9 The diagram below shows possible transitions of electrons between ENERGY LEVELS (E_1 to E_4) in an atom of a specific element.



Which transition will produce the line of SHORTEST WAVELENGTH on the emission spectra of the element?

A Transition a

B Transition c

C Transition d

D Transition e (2)

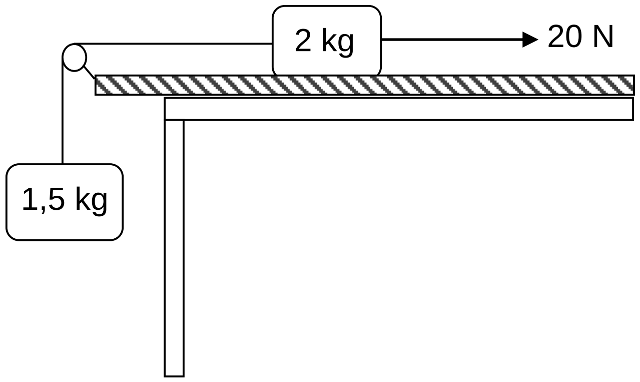
1.10 A bundle of GREEN light is incident on the cathode of a photo-electric cell. The milli-ammeter registers a current in the circuit.The green light is removed and BLUE light with a lower intensity is incident on the same photo-electric cell. How does the amount of photo-electrons released per second and the speed of the photoelectrons compare when BLUE light is used?

	Amount of photoelectrons per second	**Speed of photoelectrons**
A	Decreases	Decreases
B	Increases	Decreases
C	Decreases	Increases
D	Stays the same	Increases

(2)
[20]

QUESTION 2 (Start on a new page)

A block of mass 2 kg is at rest on a rough horizontal suface. The block is connected to another block of mass 1,5 kg by means of a light inextensible string which hangs over a frictionless pulley. The 2 kg block experiences a constant frictional force of 3,1 N when a force of 20 N is applied to the block as shown in the diagram below. Ignore the effects of air friction.



2.1 Define the term *kinetic frictional force*. (2)

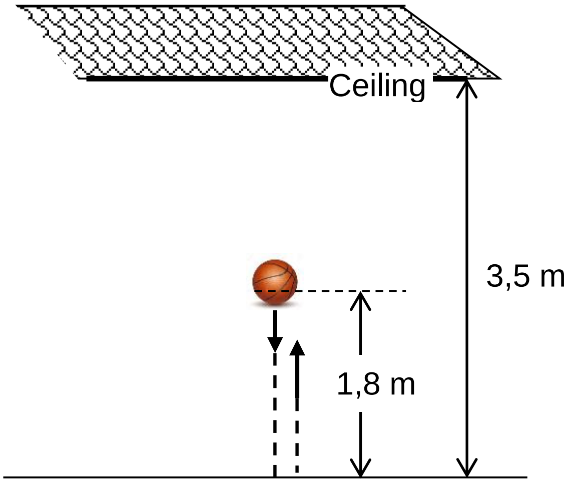
2.2 Draw a labelled free-body diagram indicating ALL the forces acting on the **2 kg block**. (5)

2.3 Apply Newtons' Second Law to each of the blocks and calculate the magnitude of the acceleration of the blocks. (6)

[13]

QUESTION 3 (Start on a new page)

A girl stands on a platform in a classroom. She throws a ball vertically downwards to the floor hoping that the ball, after it bounced on the floor, will hit the ceiling of the classroom. She throws the ball with a speed of 8 $m \cdot s^{-1}$ from a height of 1,8 m above the floor. Ignore the effects of air friction.



3.1 Write down the magnitude and direction of the acceleration of the ball immediately after the ball left her hand. (2)

3.2 Is the motion of the ball, while it is moving downwards towards the floor, *free fall*? Explain the answer. (2)

3.3 Calculate the magnitude of the velocity with which the ball hits the floor. (4)

3.4 How long does it take the ball to hit the floor? (3)

The ball bounces INELASTICALLY on the floor where the speed of the ball DECREASES by 20%. The ball is in contact with the floor for 0,01 s.

3.5 Determine by means of calculations, whether the ball will reach the ceiling after it bounced. (5)

3.6 Sketch a velocity-time graph for the motion of the ball, from the time the ball is thrown until it reaches the maximum height after the bounce.

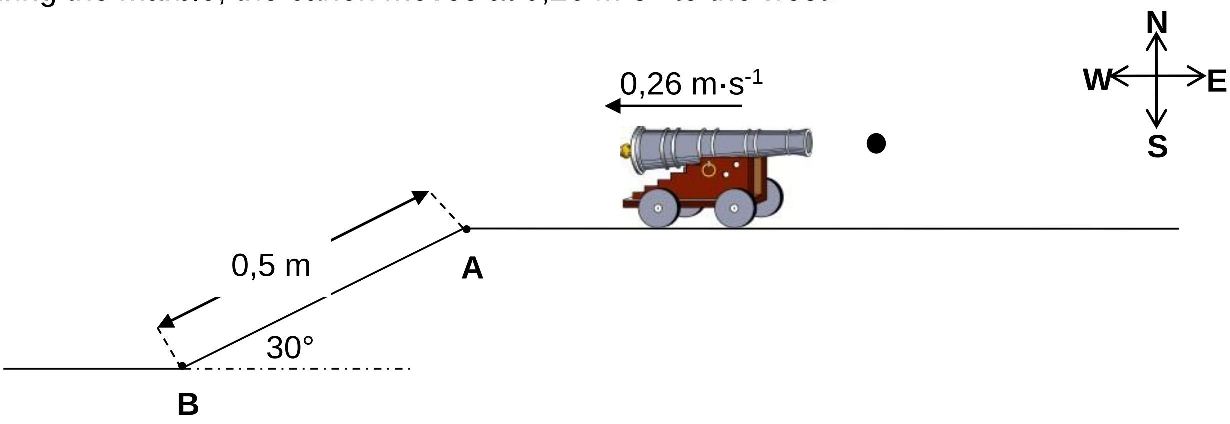
Clearly show the following on the graph:

- The initial velocity of the ball.
- The velocity and time when the ball hits the floor.
- The velocity and time when the ball leaves the floor.

(4)
[20]

QUESTION 4 (Start on a new page)

A toy canon, mass 1,6 kg, is at rest on a rough horizontal surface as shown in the diagram. A steel marble, mass 0,8 kg, is fired horizontally to the east from the canon. Immediately after firing the marble, the canon moves at 0,26 m·s^{-1} to the west.



4.1 Calculate the speed of the steel marble immediately after firing the marble. (4)

4.2 The steel marble experiences a force **F** during the firing. Explain in terms of **F** how the force experienced by the CANON compares with that experienced by the steel marble. (3)

The canon reaches point **A** with a speed of 0,2 m·s^{-1} and then moves down a rough 0,5 m long slope **AB**.

4.3 Explain why this is NOT a closed system. (1)

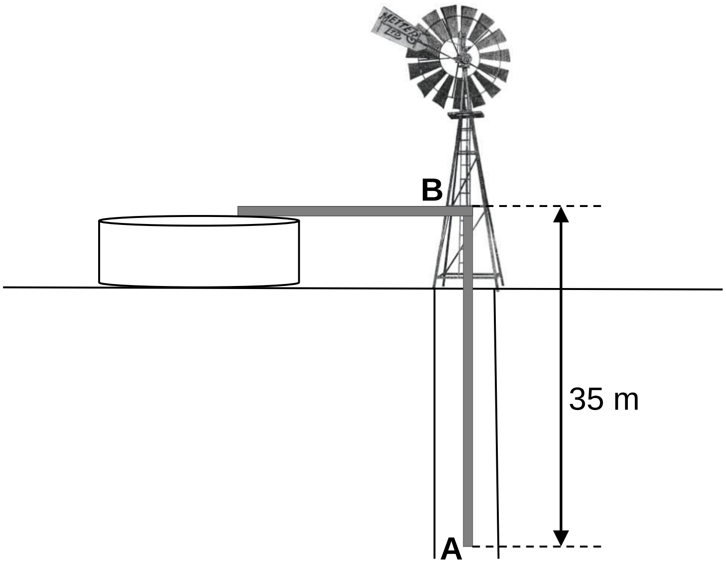
4.4 Calculate the kinetic frictional force experienced by the canon as it moves from **A** to **B** if the coefficient of kinetic friction (μ_k) is 0,12. (3)

4.5 Using ENERGY PRINCIPLES only, calculate the velocity of the canon at point **B**. (5)

[16]

QUESTION 5 (Start on a new page)

A windmill on a farm is used to pump stationary water, from point **A**, in a well. The water flows past point **B**, 35 m above point **A**, at a speed of 2,1 $m \cdot s^{-1}$.



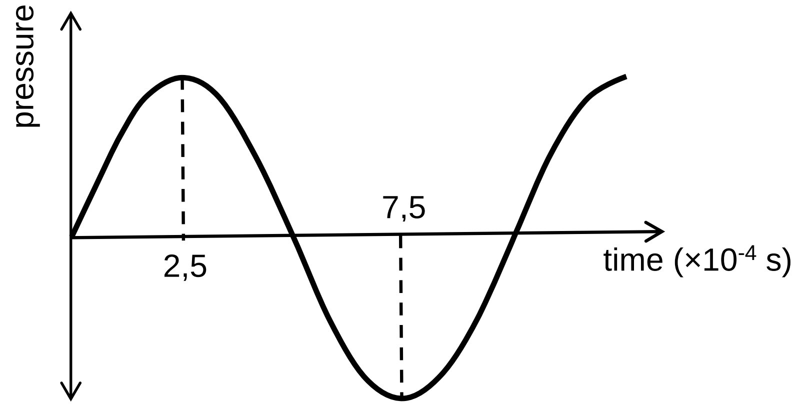
5.1 Define the term *conservative force*. (2)

5.2 Calculate the maximum power delivered by the windmill if 87 kg water is pumped from the well per minute. (5)

[7]

QUESTION 6 (Start on a new page)

A man mounts a siren, which produces a constant frequency of 800 Hz, on the roof of his car. He drives at a constant speed up and down a straight road while a stationary learner measures the observed sound. At a certain stage of the journey, the learner obtains the following pressure-time graph of the sound wave:



6.1 What is the period of the detected sound wave? (1)

6.2 Calculate the frequency of the detected sound wave. (3)

6.3 State the Doppler-effect in words. (2)

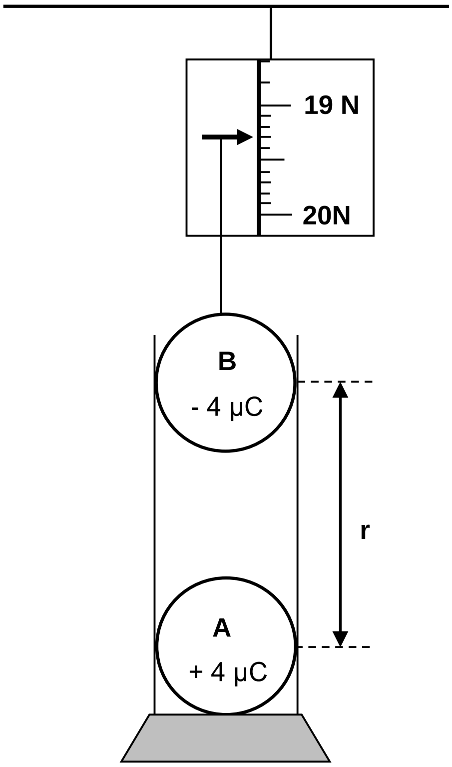
6.4 Calculate the speed of the moving car. Take the speed of sound in air as 340 $m \cdot s^{-1}$. (5)

6.5 While the car is stationary, the frequency of the siren is changed to 900 Hz. Will the wavelength of the detected sound wave INCREASE, DECREASE or REMAIN THE SAME? Explain the answer. (3)

[14]

QUESTION 7 (Start on a new page)

Sphere **A** has a charge of +4 µC and is placed in an insulated cylinder.
A second identical but oppositely charged sphere **B,** mass 500 g,hangs at rest at a distance **r,** directly above **A.** Sphere **B** is attached to a scale as shown below.



7.1 Draw the net electric field pattern due to spheres **A** and **B.** (3)

7.2 State Coulomb's Law in words. (2)

7.3 Draw a labelled force diagram of all the forces acting on sphere **B**. (3)

7.4 What is the magnitude of the net upward force that acts on sphere **B?** (1)

7.5 Calculate the distance **r** between spheres **A** and **B**. (6)

[15]

QUESTION 8 (Start on a new page)

Grade 12 learners conduct an experiment to determine the INTERNAL RESISTANCE of a battery. The learners are divided into two groups and each group receives the following circuit components:

- a battery
- a rheostat
- an ammeter
- a voltmeter
- connecting wires
- a switch

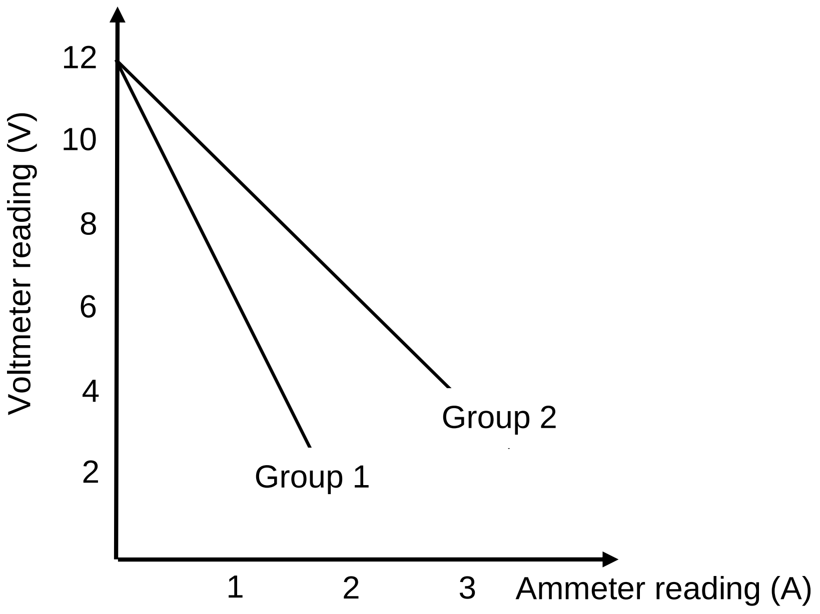
8.1 Explain the term *internal resistance* in words. (2)

8.2 Draw a circuit diagram by making use of the above-mentioned components to show the experimental set-up. (2)

Group 1 uses battery 1 with an internal resistance r_1.

Group 2 uses battery 2 with an internal resistance r_2.

The results of each group are shown in the graph below.



8.3 Refer to the graph and state ONE quantity of the batteries that is the same. (1)

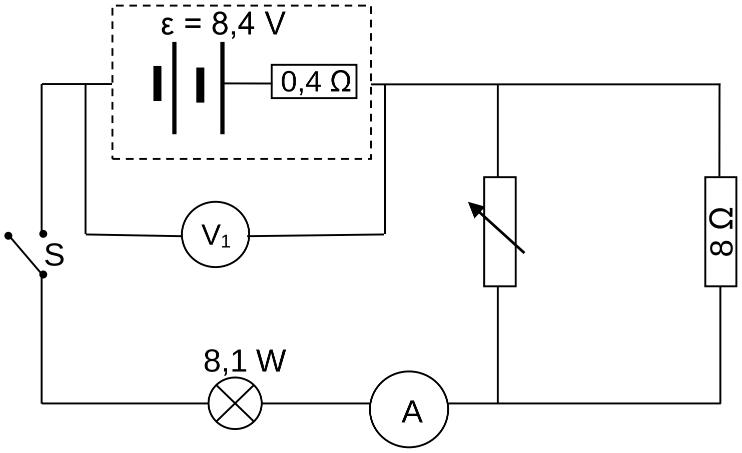
8.4 Explain why the reading on the voltmeters decreases as the current increases. Applicable equations may be used in your explanation. (3)

8.5 Which group, 1 or 2, uses the battery with the highest internal resistance? Explain the answer by referring to the graph. (2)

[10]

QUESTION 9 (Start on a new page)

A 8 Ω resistor, a light bulb and a rheostat are connected to a 8,4 V battery with an internal resistance of 0,4Ω as shown in the circuit diagram below. The power of the light bulb is 8,1 W. The rheostat is changed until the ammeter shows a reading of 1,5 A when the switch is closed.



9.1 Calculate the resistance of the light bulb. (3)

9.2 Calculate the resistance of the rheostat when the reading on the ammeter is 1,5 A. (6)

The rheostat is changed so that the resistance of the rheostat INCREASES dramatically.

9.3 How will the following readings be influenced? Write down only INCREASES, DECREASES or REMAINS THE SAME.

9.3.1 The total resistance in the circuit. (1)

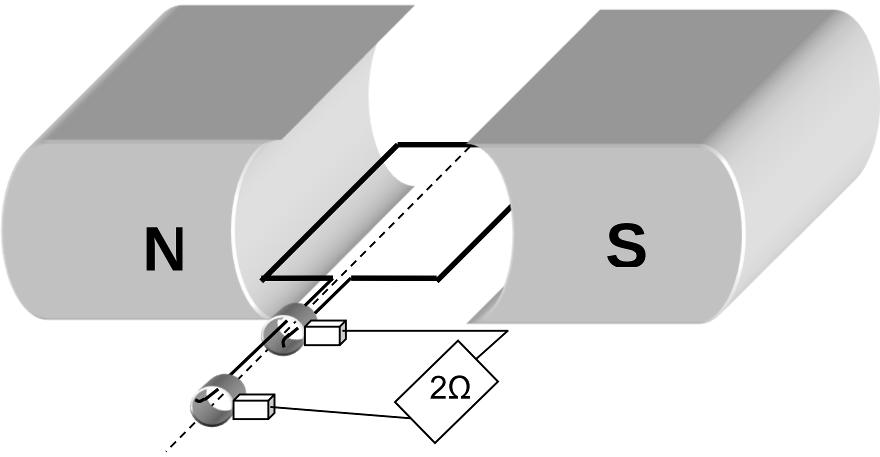
9.3.2 The emf of the battery. (1)

9.3.3 The reading on V_1. (1)

[12]

QUESTION 10 (Start on a new page)

The diagram below represents a simplified alternating current (AC) generator.



10.1 State the energy conversion that takes place in an AC generator. (1)

10.2 A 2 Ω resistor is attached to the AC generator. Calculate the maximum current that flows through the resistor if the resistor dissipates an average power of 80 W. (5)

A television is switched on for an average of 142 hours per month. The television is rated 1 200 W ; 220 V.

10.3 If the ESKOM tariff is R1,25 per unit, calculate the monthly cost of the electricity used by the television. (2)

[8]

QUESTION 11 (Start on a new page)

Learners perform an experiment to investigate the effect of the wavelength of light on the photo-electric effect. They irradiate a metal disc **M** with three light sources of different wavelengths and note the ejection of the photoelectrons from the metal.
The results obtained are shown in the table below:

Light Source	**Wavelength ($\times 10^{-9}$ m)**	**Ejection of photoelectrons**
A	480	Electrons ejected and moving away from the metal
B	620	No electrons ejected
C	570	Electrons ejected and NOT moving away from the metal

11.1 Define *the photo-electric effect* in words. (2)

11.2 Write down an investigative question for this experiment. (2)

11.3 Give a reason why light source A and not light source B will eject electrons from the metal disc **M**. (2)

11.4 Calculate the work function of the metal **M**. (3)

11.5 Calculate the maximum speed with which the electrons will be ejected from the metal disc **M** when it is irradiated with light source **A**. (5)

11.6 Light source **A** is BLUE light and light source **B** is ORANGE light. Which colour is possibly light source **C**? Choose only between VIOLET, GREEN or RED. (1)
[15]

TOTAL: 150

QUESTION 1 / VRAAG 1

1.1 C ✓✓
1.2 B ✓✓
1.3 C ✓✓
1.4 A ✓✓
1.5 B ✓✓
1.6 C✓✓
1.7 B ✓✓
1.8 B ✓✓
1.9 D ✓✓
1.10 C ✓✓

[20]

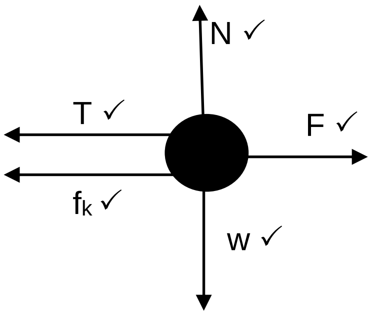
QUESTION 2 / VRAAG 2

2.1 The force that opposes the motion of a moving object ✓✓ relative to a surface

Die krag wat die beweging van 'n bewegende voorwerp relatief tot 'n oppervlak teenwerk (2)

2.2

Accepted labels / Aanvaarde benoemings	
w	Fg / Fw/force of earth on block/weight / 19,6 N / mg / gravitational force
f_k	f/friction/
T	Tension /
F	F_{app} / F_T / $F_{Toegepas}$ /
N	Normal force / F_N / Force of surface on block



(5)

Notes/Aantekeninge:

- Any additional forces: max $^4/_5$
- No arrows: $^0/_5$

Force(s) not touching object: max $^4/_5$

2.3	✓ For either 2a or 1,5a For 2 kg block: $F_{net} = ma$ ✓ F – T – f = 2a 20 – T – 3,1 = 2a ✓ 16,9 – T ✓ = 2a T = 16,9 – 2a	For 1,5 kg block: $F_{net} = ma$ T – 1,5(9,8) = 1,5a T – 14,7 ✓ = 1,5a T = 1,5a + 14,7
	∴16,9 – 2a = 1,5a + 14,7 ✓ 2,2 = 3,5a a = 0,63 m·s^{-2} ✓ **OR** T = 16,9 – 2a T = 1,5a + 14,7 0 = 2,2 – 3,5a (subtract) a = 0,63 m·s^{-2} ✓	(6)

[13]

QUESTION 3 / VRAAG 3

3.1 9,8 m·s^{-2} ✓ downwards ✓ (2)

3.2 Yes✓. Only force of gravity✓ acts on the ball / Ball is moving under the influence of its weight / weight is the only force acting on the ball (2)

3.3	**Downwards positive:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= 8^2$✓ + 2(9,8)(1,8) ✓ v_f = 9,96 m·s^{-1} ✓	**Upwards positive:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= (-8)^2$ ✓ + 2(-9,8)(-1,8) ✓ v_f = 9,96 m·s^{-1} ✓
	OPTION 2 $(mgh + \frac{1}{2}mv^2)_{top} = (mgh + \frac{1}{2}mv^2)_{floor}$ ✓ m(9,8)(1,8) + ½m(8)^2 ✓ = 0 + ½mv^2 ✓ 17,64 + ½(64) = ½v^2 v = 9,96 m·s^{-1} ✓	**OPTION 3** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ 1,8 = 8Δt + ½(9,8)Δt^2✓ Δt = 0,2 s Both Formulae ✓ $v_f = v_i + a\Delta t$ = 8 + (9,8)(0,2) ✓ v_f = 9,96 m·s^{-1} ✓ (4)

3.4

POSITIVE MARKING FROM Q3.3	
OPTION 1 **Downwards positive:** $v_f = v_i + a\Delta t$ ✓ 9,96 = 8 + 9,8Δt ✓ Δt = 0,2 s ✓ **Upwards positive:** $v_f = v_i + a\Delta t$ ✓ -9,96 = -8 + (-9,8)Δt ✓ Δt = 0,2 s ✓	**OPTION 2** **Downwards positive:** $\Delta y = \frac{v_f + v_i}{2}\Delta t$ ✓ $1,8 = \frac{9,96+8}{2}\Delta t$ ✓ Δt = 0,2 s ✓ **Upwards positive:** $\Delta y = \frac{v_f + v_i}{2}\Delta t$ ✓ $-1,8 = \frac{-9,96+(-8)}{2}\Delta t$ ✓ Δt = 0,2 s ✓
OPTION 3 **Downwards positive:** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,8 = 8\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ Δt = 0,2 s ✓ **Upwnwards positive:** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-1,8 = (-8)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ Δt = 0,2 s ✓	

(3)

3.5

POSITIVE MARKING FROM Q3.3	POSITIVE MARKING FROM Q3.3
OPTION 1 80% of 9,96 = 7,97 $m\cdot s^{-1}$ **Upwards positive:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = (7,97)^2$ ✓ + 2(-9,8)Δy ✓ Δy = 3,24 m ✓ No, ball won't reach the ceiling ✓ **Downwards positive:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = (-7,97)^2$ ✓ + 2(9,8)Δy ✓ Δy = -3,24 m Δy = 3,24 m ✓ No, ball won't reach the ceiling ✓	**OPTION 2** 80% of 9,96 = 7,97 $m\cdot s^{-1}$ **Upwards positive** $v_f = v_i + a\Delta t$ 0 = 7,97 + (-9,8)Δt ✓ Δt = 0,81 s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ = (7,97)(0,81) ✓ + ½ $(-9,8)(0,81)^2$ ✓ = 3,24 m ✓ No, ball won't reach the ceiling ✓ **Downwards positive** $v_f = v_i + a\Delta t$ 0 = -7,97 + (9,8)Δt ✓ Δt = 0,81 s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ = (-7,97)(0,81) ✓ + ½ $(9,8)(0,81)^2$ ✓ = -3,24 m = 3,24 m ✓ No, ball won't reach the ceiling ✓

OPTION 3

80% of 9,96 = 7,97 m·s^{-1}

Upwards positive

$v_f = v_i + a\Delta t$

$0 = 7,97 + (-9,8)\Delta t$ ✓

$\Delta t = 0,81$ s

$\Delta y = \frac{v_f + v_i}{2}\Delta t$

$= \frac{0+(7,97)}{2}$ ✓ (0,81) ✓

= 3,23 m✓

No, ball won't reach the ceiling✓

Downwards positive

$v_f = v_i + a\Delta t$

$0 = -7,97 + (9,8)\Delta t$ ✓

$\Delta t = 0,81$ s

$\Delta y = \frac{v_f + v_i}{2}\Delta t$

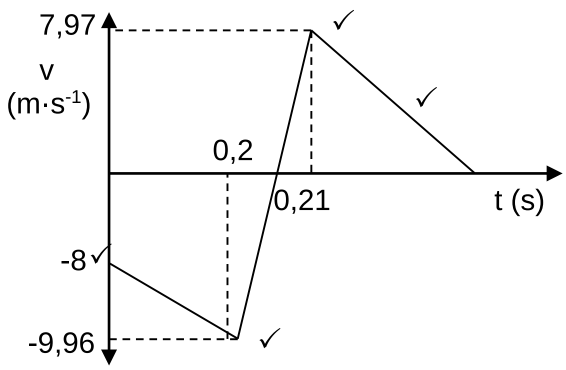
$= \frac{0+(-7,97)}{2}$ ✓ (0,81) ✓

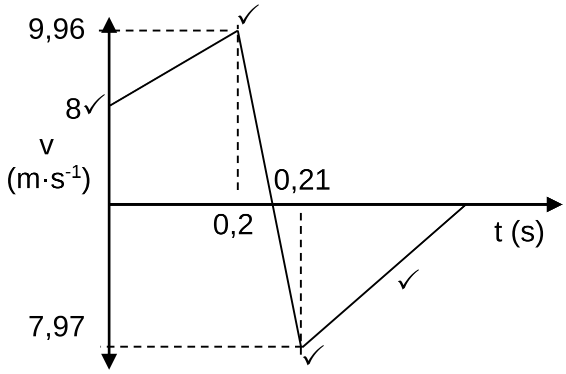
= -3,23

= 3,23 m✓

No, ball won't reach the ceiling✓ (5)

3.6





Criteria / Kriteria	Marks
y-intercept at 8 m·s^{-1} / -8 m·s^{-1}	✓
POSITIVE MARKING FROM Q3.3 & Q3.4 Time and velocity shown with which ball hits the floor (0,2 ; -9,96) or (0,2 ; 9,96)	✓
POSITIVE MARKING FROM Q3.3 and Q3.4 Time and velocity shown with which ball leaves the floor (0,21 ; 7,97) or (0,21 ; -7,97) ***Note:*** *time = answer of Q3.3 + 0,01*	✓
Shape/Vorm: 2 Straight parallel lines ending at v=0	✓

(4)

[20]

QUESTION 4

4.1 $\Sigma p_i = \Sigma p_f$

$(mv_i)_1 + (mv_i)_2 = (mv_f)_1 + (mv_f)_2$ } ✓

0✓= $\underline{1{,}6(0{,}26) + 0{,}8v_f}$ ✓

v_f = -0,52

v_f = 0,52 m·s^{-1} ✓ (4)

4.2 ✓- F✓ / Experiences the <u>same force in magnitude</u>✓, but in <u>opposite direction</u>✓

<u>Newtons Third Law</u>. ✓ (3)

4.3 External forces present ✓/ friction present ✓ (1)

4.4 f = μ_k·N ✓
= $\underline{(0{,}12)(1{,}6\times9{,}8\times\text{Cos } 30°)}$ ✓
= 1,63 N ✓

4.5 **POSITIVE MARKING FROM Q4.4**

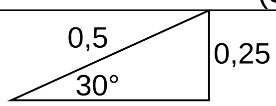
<u>OPTION 1/OPSIE 1</u>

$W_{net} = \Delta E_k$ ✓
$W_{w//} + W_f = ½mv_f^2 – ½mv_i^2$
$\underline{(1{,}6\times9{,}8\times\text{Sin } 30°)(0{,}5)\text{Cos } 0°}$✓ + $\underline{(1{,}63)(0{,}5)\text{Cos } 180°}$✓ = $\underline{½(1{,}6)v_f^2 – ½(1{,}6)(0{,}2)^2}$✓
v_f = 1,98 m·s^{-1} ✓
(5)

<u>OPTION 2/OPSIE 2</u>

$W_{net} = \Delta E_k$ ✓
$W_w + W_f = ½mv_f^2 – ½mv_i^2$
$\underline{(1{,}6\times9{,}8)(0{,}5)\text{Cos } 60°}$✓ + $\underline{(1{,}63)(0{,}5)\text{Cos } 180°}$✓ = $\underline{½(1{,}6)v_f^2 – ½(1{,}6)(0{,}2)^2}$✓
v_f = 1,98 m·s^{-1} ✓
(5)

<u>OPTION 3/OPSIE 3</u>



$W_{net} = \Delta E_k$ ✓
$W_w + W_f = ½mv_f^2 – ½mv_i^2$
$\underline{(1{,}6\times9{,}8)(0{,}25)\text{Cos } 0°}$✓ + $\underline{(1{,}63)(0{,}5)\text{Cos } 180°}$✓ = $\underline{½(1{,}6)v_f^2 – ½(1{,}6)(0{,}2)^2}$✓
v_f = 1,98 m·s^{-1} ✓
(5)

<u>OPTION 4/OPSIE 4</u>

$W_{net} = \Delta E_k$ ✓
$F_{net}\cdot\Delta x\cdot\text{Cos}\Theta = ½mv_f^2 – ½mv_i^2$
$\underline{(1{,}6\times9{,}8\times\text{Sin}30° - 1{,}63)}$ ✓ $\underline{(0{,}5)\text{Cos}0°}$✓ = $\underline{½(1{,}6)v_f^2 – ½(1{,}6)(0{,}2)^2}$✓
v_f = 1,98 m·s^{-1} ✓
(5)

<u>OPTION 5/OPSIE 5</u>

$W_{nc} = \Delta E_k + \Delta E_p$ ✓
$f\cdot\Delta x\cdot\text{Cos}\theta = (½mv_f^2 – ½mv_i^2) + (mgh_f - mgh_i)$
$\underline{(1{,}63)(0{,}5)\text{Cos}180°}$✓= $[\underline{½(1{,}6)(v_f)^2 – ½(1{,}6)(0{,}2)^2}]$ ✓ + [0 - $\underline{(1{,}6)(9{,}8)(0{,}25)}$] ✓
v_f = 1,98 m·s^{-1} ✓
(5)

QUESTION 5

5.1 A force for which the work done in moving an object between two points is independent of the path taken. ✓✓ (2 or 0)

'n Krag waarvoor die arbeid verrig om 'n voorwerp tussen twee punte te beweeg, onafhanklik is van die roete wat gevolg word. ✓✓ (2)

5.2 $P = \frac{W_{nc}}{\Delta t} = \frac{\Delta E_k + \Delta E_p}{\Delta t}$

$= \frac{(\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2) + (mgh_f - mgh_i)}{\Delta t}$ } Any one✓

$= \frac{[\frac{1}{2}(87)(2,1)^2 - 0]✓ + [(87)(9,8)(35) - 0]✓}{60✓}$

= 500,55 W ✓ (5)

[7]

QUESTION 6

6.1 10×10^{-4} s ✓ / 1×10^{-3} s ✓ / 0,001 s ✓ (1)

6.2 **POSITIVE MARKING FROM Q 6.1**

$T = \frac{1}{f}$ ✓

$f = \frac{1}{0,001}$ ✓

= 1000 Hz ✓

OR

$f = \frac{number\ of\ waves}{time}$

$= \frac{0,25}{2,5\times10^{-4}}$

= 1000 Hz

(3)

6.3 The change in frequency (or pitch) of the sound detected by a listener✓ because the sound source and the listener have different velocities✓ relative to the medium of sound propagation.

Die verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar ✓omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium✓ waarin die klank voortgeplant word, het.

(2)

6.4 **POSITIVE MARKING FROM 6.2**

$f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ ✓

1000 ✓ $= \frac{340}{340 - v_s}$ ✓(800)✓

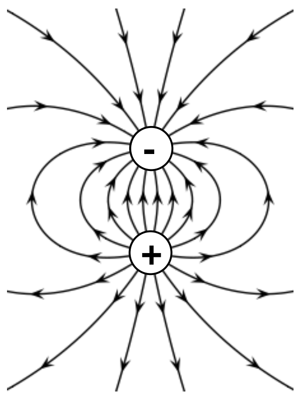
$v_s = 68 \text{ m·s}^{-1}$ ✓ (5)

6.5 Decreases✓. $f \propto \frac{1}{\lambda}$ ✓, if velocity stays constant✓ (v = fλ) (3)

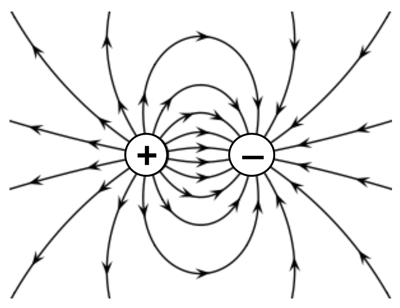
[14]

QUESTION 7

7.1



Don't penalise if drawn horizontally



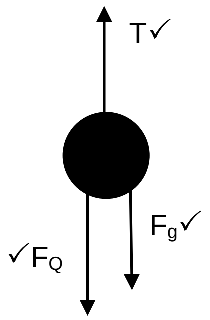
Criteria for sketch:	Marks
Shape of electric field	✓
Correct direction of field lines	✓
No field lines crossing each other / No field lines inside the sferes	✓

(3)

7.2 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges ✓ and inversely proportional to the square of the distance (r) between them ✓

Die grootte van die elektrostatiese krag wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van die groottes van die ladings✓ en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle. ✓ (2)

7.3



T = force of string / scale

F_g = gravitational force /w / mg

F_Q = electrostatic force

(3)

7.4 19,3 N ✓ (1)

7.5 **POSITIVE MARKING FROM Q7.4**

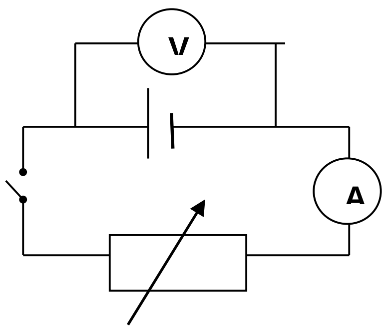
$F_{net} = 0$
$T - mg - F_Q = 0$ ✓
$19,3 - (0,5)(9,8)$ ✓ $= F_Q$
$F_Q = 14,4N$

$F = \frac{kQ_1Q_2}{r^2}$ ✓
$14,4$ ✓ $= \frac{(9\times10^9)(4\times10^{-6})(4\times10^{-6})}{r^2}$ ✓
r = 0,1 m ✓ (6)

QUESTION 8

8.1 The resistance of a battery ✓ that opposes the flow of charge through the battery. ✓
OR
The resistance of a battery✓ that causes a drop in the reading on a voltmeter connected over the battery (p.d) if the switch is closed. ✓ (2)

8.2



- Voltmeter in parallel over battery and ammeter in series ✓
- Rest of components connected so that circuit will work ✓

(2)

8.3 EMF / ε ✓

8.4 If I increases then <u>V_i will increase</u>✓ (V_i= Ir)
As <u>ε will remain constant</u>✓
Therefor <u>V_e (= V_1) will decrease</u> ✓ (ε = V_i + V_e) (3)

8.5 Group 1✓.
The gradient represents the internal resistance and <u>the gradient is steeper</u>✓. (2)
[10]

QUESTION 9

9.1 P = I^2 R✓
<u>8,1 = $(1,5)^2$ R</u> ✓
R = 3,6 Ω ✓

9.2 **POSITIVE MARKING FROM Q9.1**

OPTION 1	**OPTION 2**

ε = I(R+r) ✓
<u>8,4 = 1,5</u>✓ (<u>$R_{//}$ + 3,6 + 0,4</u>✓)
$R_{//}$ = 1,6 Ω
 	
$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2}$ ✓
$\frac{1}{1,6} = \frac{1}{r_1} + \frac{1}{8}$ ✓
R = 2 Ω ✓
	P = VI
	8,1 = V(1,5)
	V = 5,4 V
	
	V_{lost} = Ir = (1,5)(0,4) = 0,6 V✓
	
	$V_{\|\|}$ = 8,4 – 5,4 – 0,6 V = 2,4 V
	
	$I_{8\Omega}$ = V/R = 2,4/8 = 0,3 A✓
	
	$I_{rheostat}$ = 1,5 – 0,3 = 1,2 A
	
	R = V/I✓ = 2,4✓/1,2✓ = 2 Ω✓

(6)

9.3.1 Increases ✓
9.3.2 Remains the same ✓
9.3.3 Increases ✓ (3)
[12]

QUESTION 10

10.1 Mechanical energy to electrical energy ✓
Meganiese energie na elektriese energie ✓

OR/OF

Kinetic energy to electrical energy ✓
Kinetiese energie na elektriese energie ✓

(1)

10.2 $P_{avg} = I_{rms}^2 R$ ✓

$80 = I_{rms}^2(2)$ ✓

$I_{rms} = 6{,}32$ A

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓

$6{,}32 = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{max} = 8{,}94$ A ✓ (5)

10.3 Cost = kWh × tariff
= <u>(1,2 × 142)×R1,25</u>✓
= R213✓ (2)

[8]

QUESTION 11

11.1 <u>The process whereby electrons are ejected from a metal surface</u> ✓ <u>when light of suitable frequency is incident on that surface</u>. ✓

<u>Die proses waardeur elektrone uit 'n metaaloppervlak vrygestel word</u> <u>wanneer lig van geskikte frekwensie invallend op die oppervlak is</u>.

(2)

11.2

Criteria for investigative question/Kriteria vir ondersoekende vraag:	
Dependent and independent variables correctly identified. Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.	✓
Question about the relationship between the independent and dependent variables correctly formulated. Vraag oor die verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek geformuleer.	✓

Dependent variable/Afhanklike veranderlike:

- Ejection of the photoelectrons from the metal

Independent variable/Onafhanklike veranderlike:

- Wavelength

Example/Voorbeeld:

What is the relationship between the wavelength of light incident on the surface of the metal and the ejection of photo-electrons? / Wat is die verband tussen die golflengte van lig wat op die oppervlak van 'n metaal geskyn word en die vrystelling van elektrone daaruit?

Notes/Aantekeninge:
A question that results in a 'yes' / 'no' answer: max $^1/_2$ 'n Vraag wat 'n 'ja' of 'nee' as antwoord het: maks $^1/_2$

(2)

11.3 Frequency of light A is higher than the threshold frequency of the metal ($f_A > f_0$). ✓
Frequency of light B is lower than the threshold frequency of the metal ($f_B < f_0$). ✓
OR
Wavelength of light source A is less than wavelength of light source B

(2)

11.4 $E = \frac{hc}{\lambda}$ ✓

$= \frac{(6,63\times10^{-34})(3\times10^{8})}{(570\times10^{-9})}$ ✓

$= 3,49\times10^{-19}$ J ✓ (3)

11.5 **POSITIVE MARKING FROM Q11.4**

$E = W_o + E_{k(max)}$ ✓

$\frac{hc}{\lambda} = 3,49\times10^{-19} + ½mv^2$

$\frac{(6,63\times10^{-34})(3\times10^{8})}{(480\times10^{-9})}$ ✓ $= 3,49\times10^{-19}$ ✓ $+ ½(9,11\times10^{-31})v^2$ ✓

$v_{max} = 37\ 8845,09\ m\cdot s^{-1}$ ✓ / $3,79\times10^{5}\ m\cdot s^{-1}$

(5)

11.6 Green ✓ (1)

[15]

TOTAL/TOTAAL: 150

NORTHERN CAPE DEPARTMENT OF EDUCATION

TRIAL

EXAMINATION

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2015

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) of the correct answer next to the question number (1.1-1.10).

1.1 The frictional force acting on a sliding object is …

A dependent of the apparent area of contact.

B proportional to the normal force.

C dependent of the velocity of motion.

D independent of the type of surface. (2)

1.2 A conservative force is a force…

A for which the work done in moving an object between two points is dependent of the path taken.

B for which the work done in moving an object between two points is not always constant.

C for which the work done in moving an object between two points is independent of the path taken.

D which is equal in magnitude, but opposite in direction to a non-conservative force. (2)

1.3 Power can be defined as…

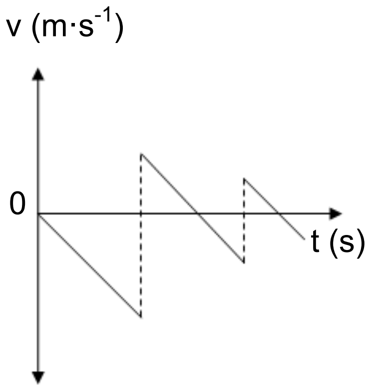
A the net force acting on an object.

B work done by friction.

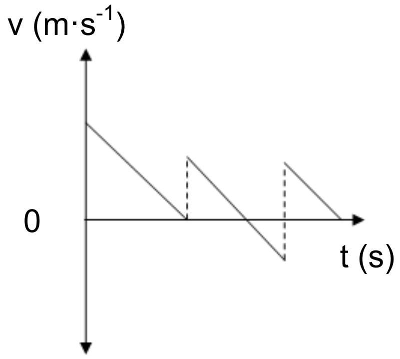
C the total mechanical energy of an object.

D the rate at which work is done. (2)

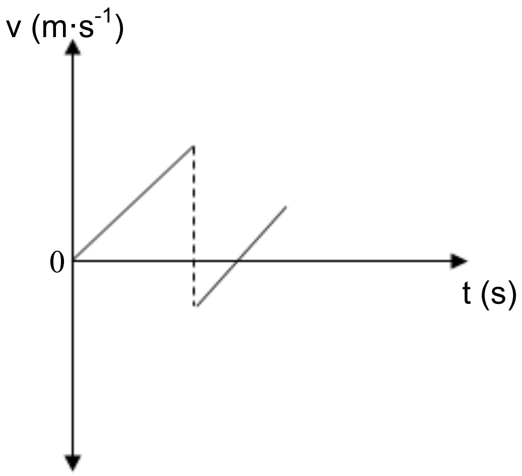
1.4 A ball is dropped from a height. Which ONE of the following velocity vs time graphs best represents the motion of the ball dropped and then bouncing vertically upwards twice?



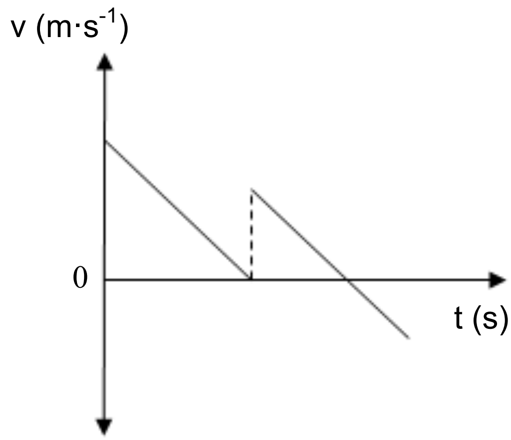
A



B



C



D

(2)

1.5 An object moves in a straight line on a ROUGH horizontal surface. If the net work done on the object is ZERO, then…

A the object has ZERO kinetic energy.

B the object moves at constant speed.

C the object moves with constant acceleration.

D there is no frictional force acting on the object. (2)

1.6 The magnitude of the gravitational force exerted by body *A* on body *B*, separated by a distance *d*, is *F*. What will the magnitude of the gravitational force be, if the distance between the two bodies increases to 4*d* ?

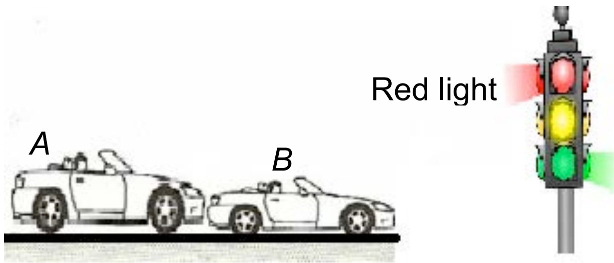
A $\frac{1}{16}F$

B $\frac{1}{4}F$

C F

D $4F$ (2)

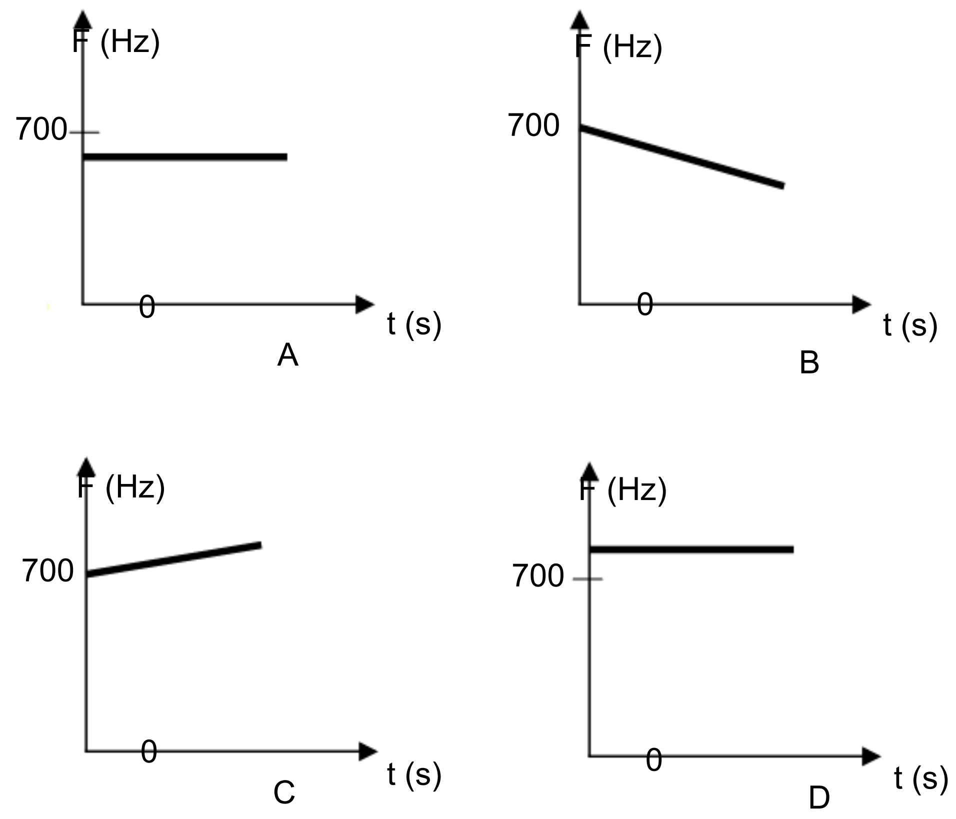
1.7 Car *B* has stopped at an intersection where the lights have gone red. Car *A* which has a greater mass than car *B* does not stop and runs into the back of car *B* as shown in the sketch below.



Which ONE of the following statements is true at the time of collision, about the magnitude of the forces they exert on each other?

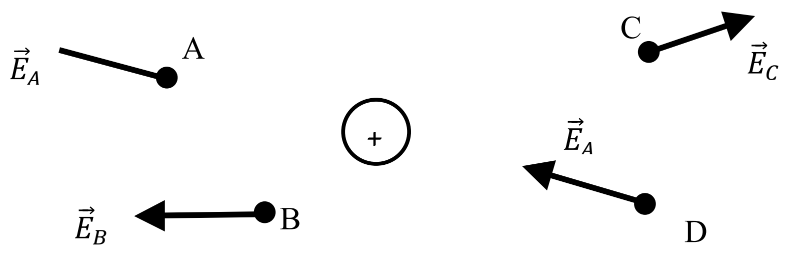
A B exerts a force on A, but A does not exert a force on B.
B The magnitude of the force exerted by B on A is equal to the magnitude of the force by A on B.
C The magnitude of the force exerted by B on A is greater than the magnitude of the force A exerts on B.
D The magnitude of the force exerted by A on B is greater than the magnitude of the force exerted by B on A. (2)

1.8 The siren of an ambulance travelling down a road at constant speed emits sound waves of 700 Hz. A man sitting next to the road notices that the pitch (frequency) of the sound changes as the ambulance moves towards him. Which ONE of the following frequency vs time graphs best shows the frequency of the sound observed (heard) by the man?



(2)

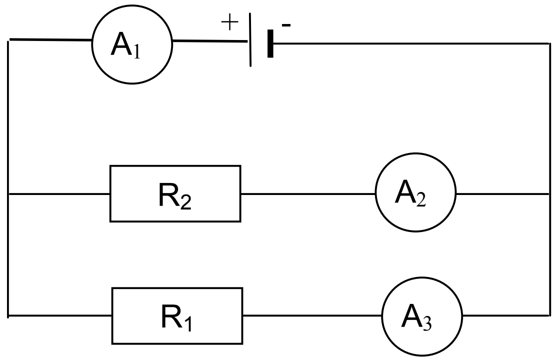
1.9 A learner has represented the electric field $\vec{E}$ at points A, B, C and D due to a positive point charge Q as shown below.



Which ONE is the correct representation?

(2)

1.10 The TWO resistors shown in the circuit diagram below are identical. If the reading on the ammeter A_1 is I what will the reading be on A_2?



A $\frac{1}{3}I$

B $\frac{1}{2}I$

C I

D $2I$ (2)

[20]

QUESTION 2

The picture below shows a boy pushing a lawn mower, of mass 22 kg, across a lawn at constant speed, applying a constant force at 35^0.

clipsahoy.com

2.1 Define *normal force* in words. (2)

2.2 Draw a labelled free body diagram of the lawn mower to show all the forces acting on it. (4)

While the lawn mower is moving, the boy attempts to accelerate it by applying a force of 170 N.
The coefficient of kinetic friction between the mower and lawn is 0,68.

2.3 Calculate the magnitude of the kinetic frictional force between the lawn mower and the lawn. (4)

2.4 Perform a calculation to explain why the boy gets tired pushing on the lawn mower. (3)

[13]

QUESTION 3

A soccer ball of mass 430 g is moving at 20 $m{\cdot}s^{-1}$ horizontally towards the head of a waiting soccer player. The ball is "headed" back, in the opposite direction, along the same straight line, at 25 $m{\cdot}s^{-1}$. Ignore the effects of air resistance.

3.1 Define *impulse of a force* in words. (2)

3.2 Calculate the impulse exerted on the ball while the head is in contact with the ball. (3)

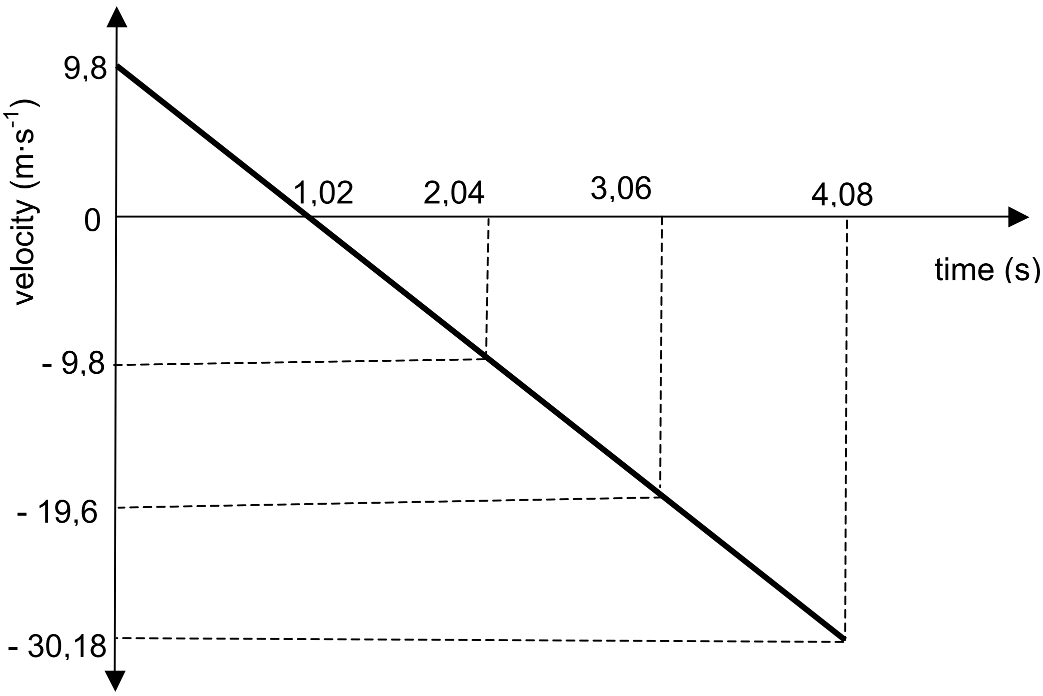
3.3 Using the answer in QUETION 3.2, calculate the time for which the ball must be in contact with the head of the player in order to experience a force of magnitude 300 N. (3)

3.4 Is the collision of the soccer ball with the head of the player elastic or inelastic? Give a reason for the answer. (2)

[10]

QUESTION 4

A boy throws a ball vertically into the air from the top of a building. The ball strikes the ground after 4,08 s. The velocity-time graph below represents the entire motion of the ball. Ignore the effects of air friction.



4.1 Explain what is meant by a *projectile*. (2)

4.2 What is the acceleration of the ball at time 1,02 s? (2)

4.3 Calculate the displacement of the ball. (4)

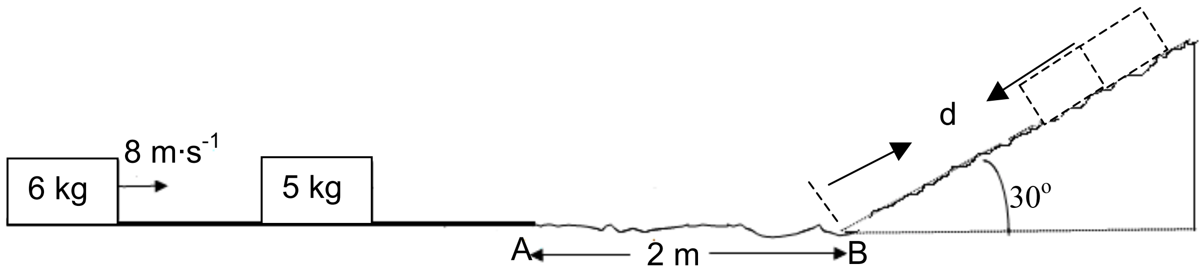
4.4 Sketch a position versus time graph for the entire motion of the ball.
Indicate the following on the graph:

- Initial position
- Maximum height
- Final position
- Time (*t*) values

(4)
[12]

QUESTION 5

A block of mass 6 kg slides to the right with a constant velocity of $8 m{\cdot}s^{-1}$ on a horizontal, frictionless surface. It collides with a stationary block of mass 5 kg. The blocks move together to the right as a single system along the same surface. Refer to the diagram below.



5.1 State the *law of conservation of linear momentum* in words. (2)

5.2 Calculate the velocity of the system of two blocks immediately after the collision. (4)

The block system continues moving with the same common velocity to point **A**, then continues over the rough section **AB,** a distance of 2 m passing point B at $1,5 m{\cdot}s^{-1}$. The system continues up the rough ramp, finally coming to a stop after moving a distance d as shown in the diagram.

5.3 Use energy considerations ONLY to calculate the coefficient of sliding friction between the block system and the surface over the 2 m stretch. (5)

5.4 The system of two blocks slides up the rough ramp with the same coefficient of friction until they come to rest after covering a distance *"d"*.

5.4.1 Use NEWTON'S SECOND LAW of motion to calculate the distance *d*. (7)

5.4.2 How would the answer to QUESTION 5.4.1 change if the angle of inclination is less than 30^{o}? Write only INCREASES, DECREASES or REMAINS THE SAME.
Give a reason for the answer. (2)
[20]

QUESTION 6

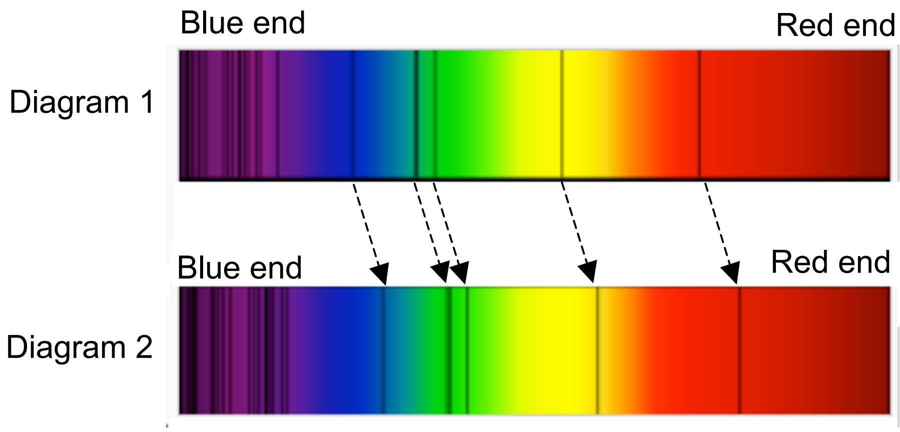
The siren of an ambulance emits sound of frequency 930 Hz as the ambulance approaches a stationary observer. The observer detects a frequency of 1000 Hz. Take the speed of sound in air as 340 $m \cdot s^{-1}$

6.1 State *Doppler effect* in words. (2)

6.2 Calculate the speed with which the ambulance approaches the observer. (5)

6.3 The ambulance is moving away from the observer. What effect will this have on the wavelength of the sound heard by the observer? Write down only INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

6.4 The Doppler effect could be used to explain the motion of stars and other heavenly bodies in our universe.
The two diagrams below represent the absorption spectra of a gas.
Diagram **1** represents the absorption lines in the optical spectrum of the Sun.
Diagram **2** represents the absorption lines in the optical spectrum of a supercluster of distant galaxies.



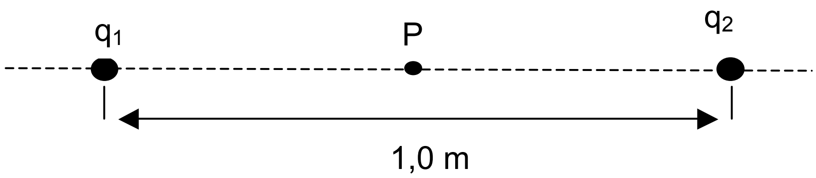
6.4.1 Are the stars moving *towards* or *away from* the Sun? Explain the answer by referring to the shifts in the spectral lines in the two diagrams above. (2)

6.4.2 From the comparison of the two diagrams above, what conclusion can be made about the Universe? (1)

[12]

QUESTION 7

Two point charges q_1= +2,0 μC and q_2= -2,0 μC 1 m apart, are placed in vacuum as shown in the sketch below.

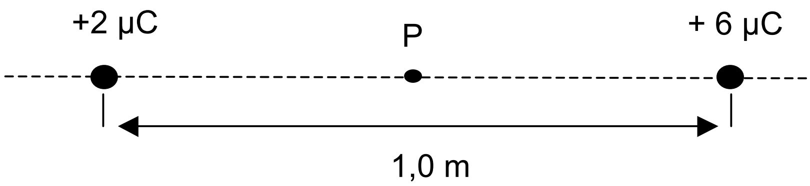


7.1 Define *electric field at a point* in words. (2)

7.2 Draw the electric field pattern due to the two point charges. (2)

7.3 Calculate the electric field at the midpoint between charges q_1 and q_2. (6)

Point charge q_2 is now replaced by a +6 μC charge as shown in the sketch below.

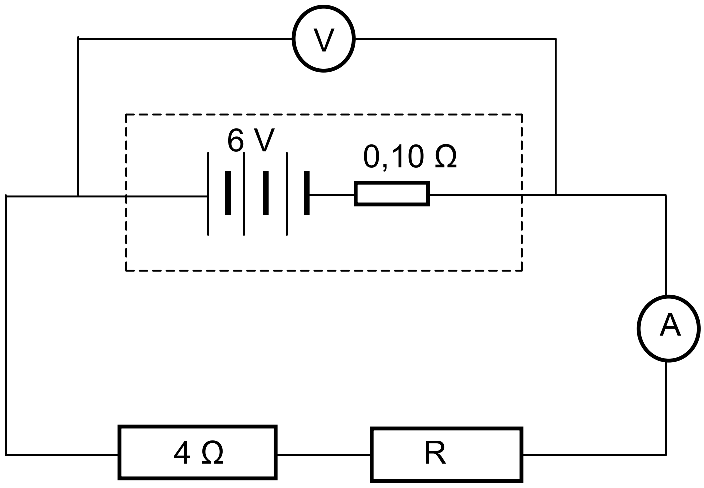


7.4. Determine where a negative point charge ($-q_3$) must be placed so that it experiences a zero net force. (6)

[16]

QUESTION 8

In the circuit diagram below the emf of the battery is 6 V and its internal resistance is 0,10 Ω. The resistance R is UNKNOWN.



8.1 Explain the term *internal resistance.* (2)

8.2 Write down an equation for the terminal potential difference using the values given. (2)

8.3 Draw a sketch graph of terminal potential difference versus current. Indicate the following in the graph: (3)
- The value of the emf
- Current at which terminal potential difference is zero.

8.4 The energy dissipated in 4 Ω resistance is 40 J and the energy dissipated in resistance R is 60 J.

Calculate the:

8.4.1 Resistance R (4)

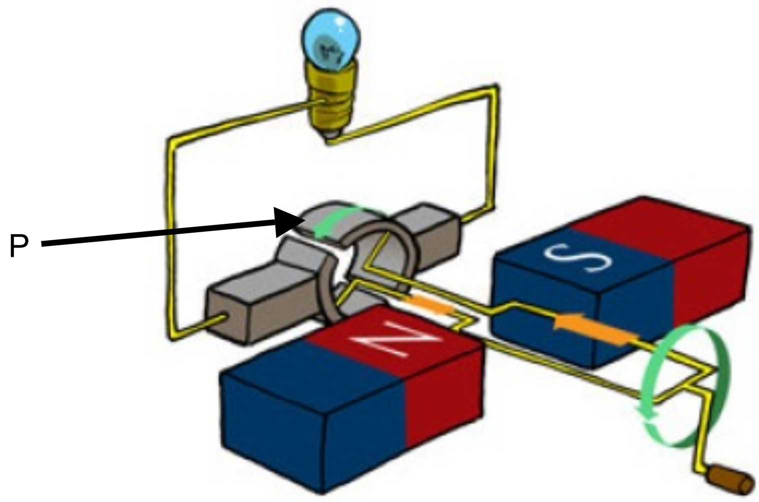
8.4.2 Total current in the circuit (3)

8.4.3 Reading of the voltmeter (3)

8.5 A 7 Ω resistor is now connected in parallel to the 4 Ω resistor. How will this action affect the reading of the voltmeter? Write down only INCREASES, DECREASES or REMAINS THE SAME.
Briefly explain the answer. (4)
[21]

QUESTION 9

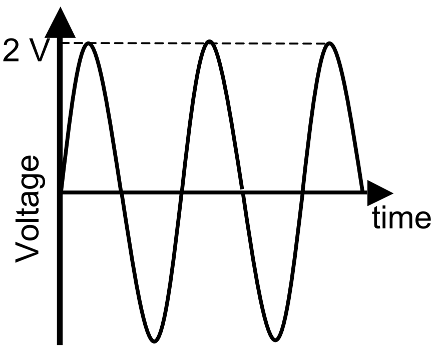
The diagram below represents and electrical machine and P is a split ring commutator.

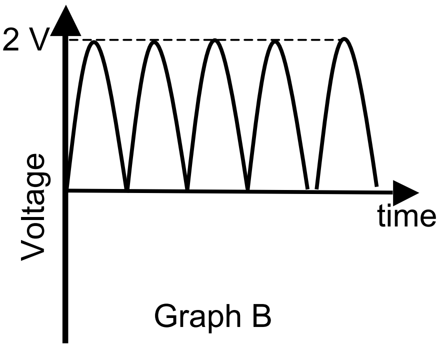


9.1 Identify the type of electrical machine and write down the energy conversion that takes place in this electrical machine. (2)

9.2 Explain the function of the component P. (2)

9.3 The split ring commutator is replaced by slip rings. Which ONE of the following voltage-time graphs (Graph A or Graph B) corresponds with the above change?



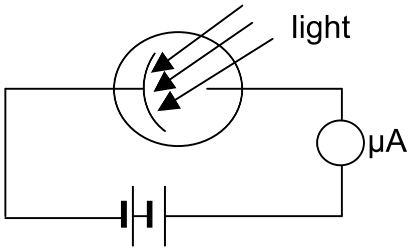


Explain the answer. (3)

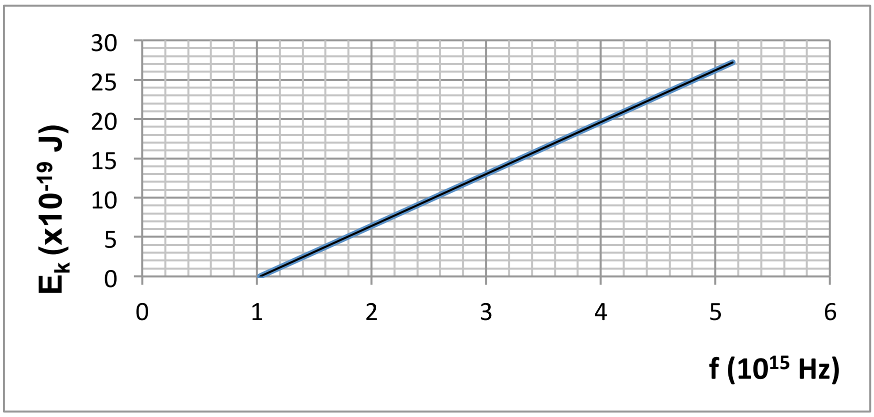
9.4 The light bulb shown in the circuit dissipates energy of 6 J per second. An identical light bulb is connected in parallel to it. Calculate the rms current in the circuit under the new conditions. Assume the emf remains unchange. (5)
[12]

QUESTION 10

The relationship between the maximum kinetic energy of ejected photo-electrons and the frequency of radiation is being investigated.



Light of different frequencies are incident on the aluminium cathode of a photo-cell and the kinetic energy of the ejected photo-electrons are determined. The graph below is drawn according to the data collected from the investigation.



10.1 Write down an investigative question for this investigation. (2)

10.2 Write down the:

10.2.1 independent variable (1)

10.2.2 controlled variable (1)

10.3 Write down a possible conclusion for this investigation. (2)

Aluminium is now replaced by another metal **X** with work function 8 x10 $^{-19}$ J. The incident light has a wavelength of 200 nm.

10.4 Calculate the maximum kinetic energy of the electrons ejected from the surface of the metal. (5)

10.5 The intensity of the incident light is now increased. How will this affect the maximum kinetic energy calculated in QUESTION 10.4? Give a reason for the answer. (2)

10.6 The wavelength of the incident light is now increased keeping the intensity constant. How will this affect the maximum kinetic energy calculated in QUESTION 10.4? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[14]

TOTAL MARKS: 150

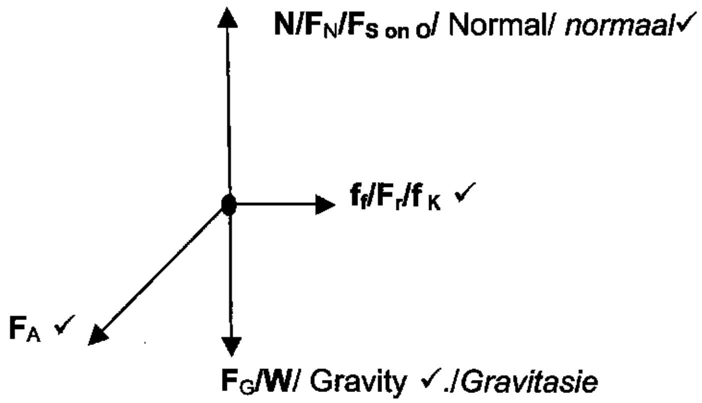
QUESTION 1/ *VRAAG 1*

1.1	B ✓✓	(2)
1.2	C ✓✓	(2)
1.3	D ✓✓	(2)
1.4	A ✓✓	(2)
1.5	B ✓✓	(2)
1.6	A ✓✓	(2)
1.7	B ✓✓	(2)
1.8	D ✓✓	(2)
1.9	C ✓✓	(2)
1.10	B ✓✓	(2)
		[20]

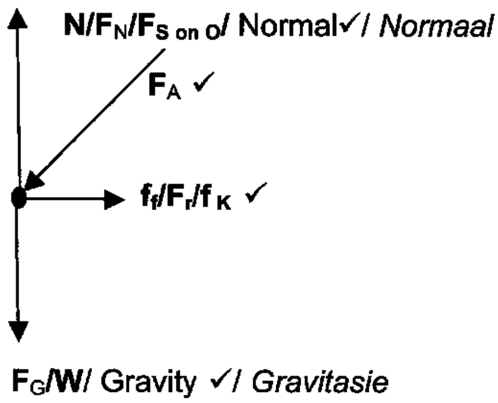
QUESTION 2/ *VRAAG 2*

2.1 Normal force is the force or component of a force which a surface exerts on an object with which it is in contact, ✓and which is perpendicular to the surface. ✓
Normaalkrag is die krag of komponent van 'n krag wat 'n oppervlak op 'n voorwerp waarmee dit in kontak is, uitoefen en wat loodreg op die oppervlak is. (2)

2.2



ACCEPT/ *AANVAAR*



(4)

2.3 **OPTION 1/ *OPSIE 1***

$\sum \vec{F}_y = \vec{0}$ OR/*OF* $F_{net} = 0$ ✓ Any one/*Enige een*

N+(-mg-F$_A$sin35^0=0

N= mg+F$_A$sin35^0

N= 215,16 +97,51✓

$f_k = \mu_k N$ ✓

$f_k = 212.91 N$ ✓

OPTION 2 / *OPSIE 2*

$f_k = \mu_k N$ ✓

$f_k = \mu_k(mg + F_v)$

$f_k = \mu_k(mg + F\sin 35^0)$ ✓ Any one/ *Enige een*

(4)

$f_k = \underline{0.68}\,\underline{(22\times 9{,}8 + 170\times\sin 35^0)}$ ✓
$= 212.91\,N$ ✓

2.4 **POSITIVE MARKING FROM 2.3 /*POSITIEWE NASIEN VANAF 2.3***

OPTION 1/ *OPSIE 1*

$\vec{F}_{net} = \vec{F}_h + \vec{f}_k$ OR/*OF* $F_{net} = F_h - f_k$ OR/*OF* $F_{net} = F\cos 35^0 - f_f$

$F_{net} = 170\cos 35^0 - 212.91$ ✓

$\vec{F}_{net} = -73{,}65\ N$ OR/OF $\vec{F}_{net} = 73{,}65\ N$ backwards✓/ *terugwaarts*

The net force is in the opposite direction of motion/ since the net force is in opposite direction of motion, the mower accelerates backwards.✓
Die netto krag is in die teenoorgestelde rigting van die beweging/ aangesien die netto krag in die teenoorgestelde rigting van beweging is, versnel die grassnyer terugwaarts

OPTION 2/ *OPSIE 2*

$F_x = F\cos 35$ ✓

$F_x = 170\cos 35$ =139.25 N✓

$F_x < f_f$

Under these circumstances the lawn mower will be accelerating in a backward direction/It will slow down in a forward direction. ✓ (3)
Onder hierdie omstandighede sal die grassnyer in 'n terugwaartse rigting versnel/ Dit sal stadiger beweeg in 'n voorwaartse rigting. **[13]**

QUESTION 3/ *VRAAG 3*

3.1 *Impulse* is the product of the force (resultant/net force) acting on an object and the time the force (resultant/net force) acts on the object. (2)
Impuls is die produk van die krag (resultante/ netto krag) wat op 'n voorwerp inwerk en die tyd wat die krag (resultante/ netto krag) op die voorwerp inwerk.

3.2 Impulse (J)=Δ**p**
Impulse (J) $= m(\vec{v}_f - \vec{v}_i)$ } ✓ Anyone/ *Enige een*
Impulse (J) $= 0{,}43(-25 - 20)$ ✓
Impulse (J) $= -19{,}35\ N\cdot s$ ✓ (3)
OR/OF
Impulse (J) $= 19{,}35\ N\cdot s$ ✓ in opposite direction.

3.3 $\vec{F}\Delta t = \Delta\vec{p}$ ✓ OR/*OF* **F**Δt= Δ**p**
(300)Δt= 19,35 ✓ (3)
Δt= 0,065 s ✓ OR/*OF* Δt= 0,07 s

3.4 Inelastic✓/*Onelasties*
Mass is constant but speed changes /Kinetic energy is not conserved.✓ (2)
Massa is konstant maar spoed verander/Kinetiese energie bly nie behoue nie **[10]**

QUESTION 4/*VRAAG 4*

4.1 Projectile is an object upon which the only force acting is the force of gravity.
Projektiel is 'n voorwerp waarop slegs gravitasiekrag inwerk. (2)

4.2 9,8 m·s^{-2} ✓downwards✓/ *afwaarts (theoretical)* (2)
OR/OF
9,6 m·s^{-2} ✓downwards✓ (actual)

4.3 **OPTION 1/ *OPSIE 1***

$\vec{\Delta y} = \vec{v_i}\Delta + \frac{1}{2}\vec{g}(\Delta t)^2$ ✓ OR/*OF* $\Delta y = v_i\Delta t + \frac{1}{2}g(\Delta t)^2$

$\Delta y = 9{,}8(4{,}08)$ ✓ $+ \frac{1}{2}(-9{,}8)(4{,}08)^2$ ✓

Δy= - 41,58 m ✓

OR/ *OF*
Δy= 41,58 m downwards ✓/ *afwaarts*

OPTION 2/*OPSIE 2*

$\vec{\Delta y} = \vec{v_i}\Delta + \frac{1}{2}\vec{g}(\Delta t)^2$ ✓ OR/*OF* $\Delta y = v_i\Delta + \frac{1}{2}g(\Delta t)^2$

$\Delta y = -9{,}8(2.04)$ ✓ $+ \frac{1}{2}(-9{,}8)(2{,}04)^2$ ✓

Δy= - 41,58 m ✓

OR/ *OF*
Δy= 41,58 m downwards ✓/*afwaarts*

OPTION 3/ *OPSIE 3*

$\Delta y = \frac{(v_i + v_f)}{2}\Delta t$ ✓

$\Delta y = \frac{(9{,}8 + (-30{,}18))}{2}$ ✓ $(4{,}08)$ ✓

Δy= - 41,58 m ✓
OR/ *OF*
Δy= 41,58 m downwards ✓/*afwaarts*

OPTION 4/ *OPSIE 4*

$\Delta y = \frac{(v_i + v_f)}{2}\Delta t$ ✓

$\Delta y = \frac{(-9{,}8) + (-30{,}18)}{2}$ ✓ $(2{,}04)$ ✓

Δy= - 40,78 m ✓
OR/ *OF*
Δy= 40,78 m downwards ✓/ *afwaarts*

<u>OPTION 5/ *OPSIE 5*</u>

Δy= Area$_{(trapezium)}$

$$\Delta y = area = \frac{(a+b)}{2}h$$

$$\Delta y = \frac{(-9{,}8)+(-30{,}18)}{2}\checkmark(4{,}08-2{,}04)\checkmark$$

Δy= - 40,78 m ✓

OR *OF*

Δy= 40,78 m downwards ✓/*afwaarts*

<u>OPTION 6/ *OPSIE 6*</u>

Area= Area$_{\Delta 1}$ + Area$_{\Delta 2}$

$$\Delta y = area = \frac{1}{2}b_1h_1 + \frac{1}{2}b_2h_2$$

$$\Delta y = \frac{1}{2}9{,}8(1{,}02)\checkmark + \frac{1}{2}(-30{,}18)(3{,}06)\checkmark$$

Δy=- 41,17 m ✓

OR/ *OF*

Δy= 41,17 m downwards ✓/ *afwaarts* (4)

<u>OPTION 7/ *OPSIE 7*</u>

$$\Delta y = ab + \frac{1}{2}bh$$

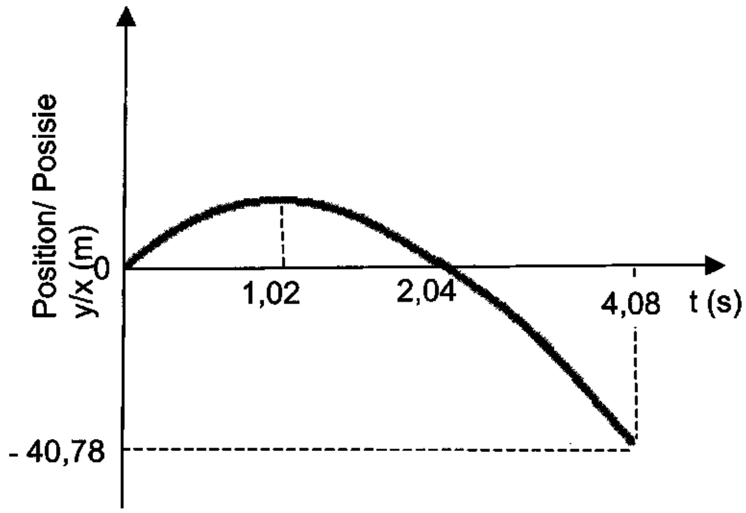
$$\Delta y = -9{,}8(2{,}04)\checkmark + \frac{1}{2}(2{,}04)(-20{,}38)\checkmark$$

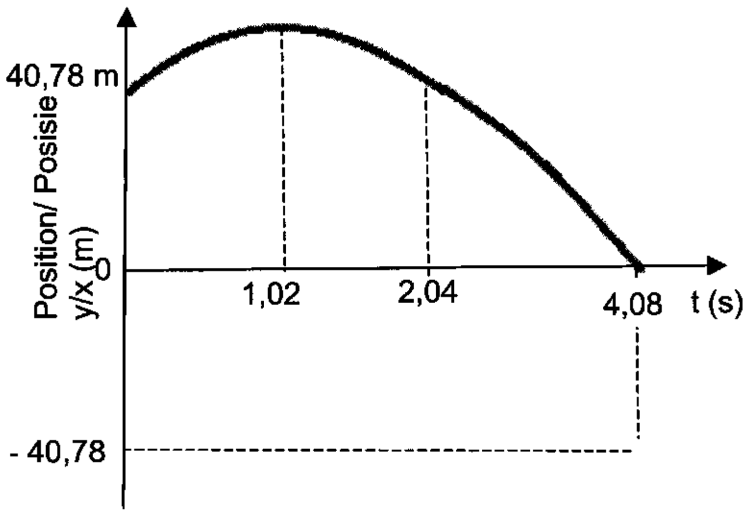
Δy=- 40,78 m ✓

OR/ *OF*

Δy=40,78 m downwards ✓/*afwaarts*

4.4





CRITERIA/ *KRITERIA*	MARKS/*PUNTE*
Graph starting from zero OR 40,78 m/*Grafiek begin by nul OF 40,78m*	✓
Correct shape/ *korrekte vorm*	✓
Position for maximum height (4,9 m or/ *of* 5 m) at 1,02 s *Posisie vir maksimum hoogte* (4,9 m or/ *of* 5 m) by 1,02 s	✓
Final position/ *Finale posisie* (-40.4 m or 40 m) at/ *by* 4,08 s	✓

(4)
[12]

QUESTION 5/ VRAAG 5

5.1. The total linear momentum of an isolated/a closed system✓ remains constant (is conserved). ✓
Die totale linêre momentum van 'n geïsoleerde/ geslote sisteem bly konstant (bly behoue)

OR/ *OF*
In an isolated system✓ the total linear momentum of a system before a collision/interaction is equal to the total linear momentum of the system after the collision. ✓
In 'n geïsoleerde sisteem is die totale liniêre momentum van 'n sisteem voor 'n botsing/ interaksie gelyk aan die totale liniêre momentum van die sisteem na die botsing

OR/ *OF*
If the impulse of the external forces acting on a system is zero✓ the total linear momentum of the system does not change/remains constant. ✓
As die impuls van die eksterne kragte, wat op 'n sisteem inwerk, gelyk is aan nul sal die totale liniêre momentum van die sisteem nie verander nie/ konstant bly.

OR/ *OF*
If there is no external net force acting on a system of particles✓, the total linear momentum of the system is conserved. ✓
As daar geen eksterne netto krag op 'n sisteem van partikels inwerk nie bly die totale liniêre momentum van die sisteem behoue. (2)

5.2 $\sum \vec{p}_{before/voor} = \sum \vec{p}_{after/na}$
OR/OF
$\sum p_{before/voor} = \sum p_{after/na}$
$m_1v_{1(before/voor)} + m_2v_{2(before/voor)} = (m_1 + m_2)v_{syst/sist}$
✓ Anyone/ *Enige een*

$(6\times 8) + (5\times 0)$✓$= (6+5)v_{syst/sist}$✓

$v = 4{,}36\ m\cdot s^{-1}$ to the right ✓/ na regs (4)

5.3. **POSITIVE MARKING FROM QUESTION 5.2**
POSITIEWE NASIEN VANAF VRAAG 5.2

<u>OPTION 1/*OPSIE 1*</u>
$W_{nc} = \Delta E_M$ ✓ Any one/ Enige een

$W_{nc} = \Delta E_K + \Delta E_P$

$f_f \Delta x \cos 180^0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + \Delta E_P$

$\mu_K N \Delta x \cos 180^0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + \Delta E_P$ ✓ Any one/ *Enige een*

$\mu_K mg \Delta x \cos 180^0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + \Delta E_P$

$\mu_K (11 \times 9{,}8 \times 2 \times (-1))$ ✓ $= \frac{1}{2}11(1{,}5)^2 - \frac{1}{2}11(4{,}36)^2$ ✓ $+ 0$

$\mu_k = 0.43$ ✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta E_K$

$W_{net} = E_{Kf} - E_{Ki}$ ✓ Any one/ *Enige een*

$f_f \Delta x \cos 180^0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$\mu_K N \Delta x \cos 180^0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓ Any one/ *Enige een*

$\mu_K mg \Delta x \cos 180^0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$\mu_K (11 \times 9{,}8 \times 2 \times (-1))$ ✓ $= \frac{1}{2}11(1{,}5)^2 - \frac{1}{2}11(4{,}36)$ ✓

$\mu_k = 0.43$ ✓ (5)

5.4.1 **POSITIVE MARKING FROM QUESTION 5.3**
POSITIEWE NASIEN VANAF VRAAG 5.3

$\sum \vec{F}_{net} = m\vec{a}$ /$F_{net} = ma$

$\vec{f}_f + \vec{F}_g + \vec{N} = m\vec{a}$ ✓ Any one / Enige een

$-f_f - F_g = ma$

$-\mu N - F_g = ma$

$-\mu mg \cos 30^0 - mg \sin 30^0 = ma$

$-\mu g \cos 30^0 - g \sin 30^0 = a$ ✓ Any one / Enige een

$-(0{,}43 \times 11 \times 9{,}8 \times \cos 30^0)$ ✓ $- (11 \times 9{,}8 \times \sin 30^0$ ✓ $= 11a$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓

$0^2 = (1{,}5)^2 + 2(-8.55)\Delta x$ ✓

$\Delta x = d = 0{,}26$ m ✓

OR/OF

$\sum \vec{F}_{net} = m\vec{a}$ /F_{net}=ma
$\vec{f}_f + \vec{F}_g + \vec{N} = m\vec{a}$
$-f_f - F_g = ma$
$-\mu N - F_g = ma$
} ✓ Any one / Enige een

$-\mu mg\cos 30^0 - mg\sin 30^0 = ma$
$-\mu g\cos 30^0 - g\sin 30^0 = a$
} ✓ Any one / Enige een

$-(0{,}43 \times 9{,}8 \times \cos 30^0)$ ✓ $-(9{,}8 \times \sin 30^0$ ✓ $= a$

$a = -8{,}55$ m·s^{-2}

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0^2 = (1{,}5)^2 + 2(-8.55)\Delta x$ ✓
Δx=d= 0,26 m✓

(7)

5.4.2 Increases ✓*Toeneem*

Aceleration of the system of blocks decreases✓.
Versnelling van die bloksisteem neem af

(2)
[20]

QUESTION 6/ VRAAG 6

6.1 The Doppler effect is the change in frequency (pitch) of sound detected by a listener✓ because the sound source and the listener have different velocities (relative to the medium of sound propagation). ✓
Die Doppler-effek is die verandering in frekwensie (toonhoogte) van klank soos waargeneem deur die luisteraar omdat die klankbron en die luisteraar verskillende snelhede besit (relatief tot die medium wat die klank voortbring)

OR/ *OF*

The Doppler effect is the change in the observed frequency of a wave✓ when the source or the detector moves relative to the transmitting medium. ✓
Die Doppler-effek is die verandering in die waargenome frekwensie van "n golf wanneer die bron of die waarnemer beweeg relatief tot die medium wat die klank dra. (2)

6.2 **OPTION 1/*OPSIE 1***

$$f_L = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_S \checkmark$$

$$1\,000 \checkmark = \left(\frac{340}{340 - v_s}\right) \checkmark (930) \checkmark$$

V_s= 23,80 m·s^{-1}✓

OPTION 2/ *OPSIE 2*

$$f_L = \left(\frac{v}{v - v_S}\right) f_S \checkmark$$

$$1\,000 \checkmark = \left(\frac{340}{340 - v_s}\right) \checkmark (930) \checkmark$$

V_s= 23,80 m·s^{-1}✓

OPTION 3/ *OPSIE 3*

$$f_L = \frac{f_s}{1 \pm \frac{v_s}{v}} \checkmark \quad \text{OR} \quad f_L = \frac{f_s}{1 - \frac{v_s}{v}}$$

$$\checkmark\ 1000 = \frac{930 \checkmark}{1 - \frac{v_s}{340} \checkmark}$$

V_s= 23,80 m·s^{-1}✓ (5)

6.3. Increases✓/*Toeneem* (2)
The compressions behind the ambulance are further apart than when it was approaching✓.
Die verdunnings agter die ambulans is verder van mekaar as die verdigtings toe die ambulans die luisteraar nader.

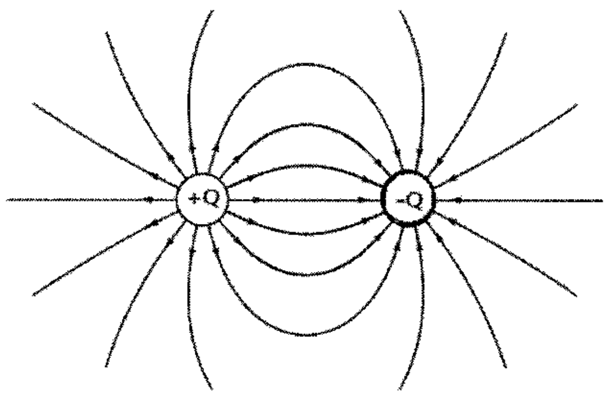
6.4.1. The stars are moving away ✓
Die sterre beweeg weg van die aarde
The spectral lines in the diagrams are shifted towards the red end/red shifted).✓
Die spektrumlyne in die diagramme het verskuif na die rooi ent/rooi verskuiwing. (2)

6.4.2. The Universe is expanding.✓ (1)
Die heelal is besig om uit te sit. **[12]**

QUESTION 7/ VRAAG 7

7.1 The electric field at a point is the (electrostatic) force experienced per unit positive charge at this point. ✓✓
Die elektriese veld by 'n punt is die (elektrostatiese) krag wat 'n positiewe eenheidslading by daardie punt ondervind. (2)

7.2



Criteria for marking
Shape of field lines✓
Direction of field lines. ✓
Nasienkriteria
Vorm van die veldlyne
Rigting van die veldlyne

(2)

7.3 **OPTION 1/ *OPSIE1***

$E_{2\mu C} = \frac{kQ}{r^2}$ ✓

$E_{2\mu C} = \frac{(9x10^9)(2x10^{-6})}{(0,5)^2}$ ✓

$E_{2\mu C} = 7.20x10^4 N \cdot C^{-1}$ right / regs

$E_{-2\mu C} = \frac{kQ}{r^2}$

$E_{-2\mu C} = \frac{kQ}{r^2} = \frac{(9x10^9)(2x10^{-6})}{(0,5)^2}$ ✓

$E_{-2\mu C} = 7,2 \times 10^4 \ N \cdot C^{-1}$ right / regs

$\vec{E}_{net} = \vec{E}_{2\mu C} + \vec{E}_{-2\mu C}$
Positive to the right ✓ Anyone / Enige een
$E_{net} = E_{2\mu C} + E_{2\mu C}$

$E_{netto} = 7.2x10^4 + 7,2 \times 10^4$ ✓

$= +14,4 \times 10^4 N \cdot C^{-1}$ ✓

OR/ *OF*

$= 14,4 \times 10^4 N \cdot C^{-1} right / regs$ ✓

OPTION 2/ *OPSIE 2*

$E_{2\mu C} = \frac{kQ}{r^2}$ ✓

$E_{2\mu C} = \frac{(9x10^9)(2x10^{-6})}{(0,5)^2}$ ✓

$E_{2\mu C} = 7.20x10^4 N \cdot C^{-1}$ right / regs

$E_{-2\mu C} = \frac{kQ}{r^2}$

$E_{-2\mu C} = \frac{kQ}{r^2} = \frac{(9x10^9)(2x10^{-6})}{(0,5)^2}$ ✓

$E_{-2\mu C} = 14,4 \times 10^4$ $N \cdot C^{-1}$ right / regs

$\vec{E}_{net} = \vec{E}_{2\mu C} + \vec{E}_{-2\mu C}$
Positive to the left
$E_{net} = -E_{2\mu C} + (-E_{2\mu C})$
✓ Any one/ *Enige een*

$E_{netto} = -7.2x10^4 - 7,2x10^4$ ✓

$= -14,4 \times 10^4 N \cdot C^{-1}$ ✓

OR/*OF*

$= 14,4 \times 10^4 N \cdot C^{-1}$ *right / regs* ✓

OPTION 3/*OPSIE 3*

$E_{2\mu C} = \frac{kQ}{r^2}$ ✓

$E_{2\mu C} = \frac{(9x10^9)(2x10^{-6})}{(0,5)^2}$ ✓

$E_{2\mu C} = 7.20 \times 10^4 N \cdot C^{-1}$ *right / regs*

$E_{2\mu C} = E_{-2\mu C} = 7.20x10^4 N \cdot C^{-1}$ right / regs ✓

$\vec{E}_{net} = \vec{E}_{2\mu C} + \vec{E}_{-2\mu C}$
Positive to the right
$E_{net} = E_{2\mu C} + E_{2\mu C}$
✓ Any one/ *Enige een*

$E_{netto} = 2 \times (7.2x10^4)$ ✓

$= +14,4 \times 10^4 N \cdot C^{-1}$ ✓

OR/*OF*

$= 14,4 \times 10^4 N \cdot C^{-1}$ *right / regs* ✓

OPTION 4/ OPSIE 4

$E_{2\mu C} = \frac{kQ}{r^2}$ ✓

$E_{2\mu C} = \frac{(9x10^9)(2x10^{-6})}{(0,5)^2}$ ✓

$E_{2\mu C} = 7.20x10^4 N \cdot C^{-1}$ right / regs

$E_{2\mu C} = E_{-2\mu C} = 7.20x10^4 N \cdot C^{-1}$ right / regs ✓

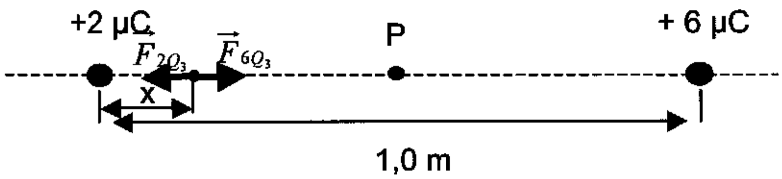
$\vec{E}_{net} = \vec{E}_{2\mu C} + \vec{E}_{-2\mu C}$
Positive to the left
$E_{net} = -E_{2\mu C} + (-E_{2\mu C})$
} ✓ Any one / *Enige een*

$E_{netto} = -7.2x10^4 - 7,2x10^4$ ✓
$= -14,4 \times 10^4 N \cdot C^{-1}$ ✓

OR/OF
$= 14,4 \times 10^4 N \cdot C^{-1}$ *right / regs* ✓ (6)

7.4 **OPSION 1/OPSIE 1**

$\vec{F}_{net} = \vec{F}_{13} + \vec{F}_{23}$ ✓ OR/OF



$F_{net} = \frac{KQ_1Q_3}{r_{13}^2} - \frac{KQ_2Q_3}{r_{23}^2}$

$0 = \frac{KQ_1Q_3}{r_{13}^2} - \frac{KQ_2Q_3}{r_{23}^2}$

$\frac{KQ_1Q_3}{r_{13}^2} = \frac{KQ_2Q_3}{r_{23}^2}$

$\frac{Q_1}{r_{13}^2} = \frac{Q_2}{r_{23}^2}$

} ✓ Any one / *Enige een*

$\frac{2 \times 10^{-6}}{x^2}$ ✓ $= \frac{6 \times 10^{-6}}{(1-x)^2}$ ✓ ✓

$\frac{2}{x^2} = \frac{6}{(1-x)^2}$

$4x^2 + 4x - 2 = 0$ OR/OF

$\frac{\sqrt{2}}{x} = \frac{\sqrt{6}}{(1-x)}$

> OR/OF
> $2(1-x)^2 = 6x^2$
> $2(x^2-2x+1) = 6x^2$
> $2x^2-4x+2 = 6x^2$
> $2x^2-2x+1=0$
>
> $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
>
> $x = \frac{-2 \pm \sqrt{2^2 - 4 \times 2 \times (-1)}}{2(2)}$

x = 0,37 m from charge/ *vanaf lading* 2 μC ✓

OR/OF

x= 0,63 m from charge/ *vanaf lading* 6μC✓

OPSION 2/OPSIE 2

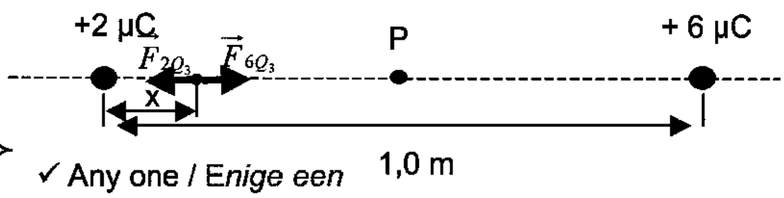
$\vec{F}_{net} = Q_3\vec{E}_{net12}$ ✓

$$F_{net} = Q_3\left(\frac{KQ_1}{r_{13}^2} - \frac{KQ_2}{r_{23}^2}\right)$$

$$0 = \frac{KQ_1Q_3}{r_{13}^2} - \frac{KQ_2Q_3}{r_{23}^2}$$

$$\frac{KQ_1Q_3}{r_{13}^2} = \frac{KQ_2Q_3}{r_{23}^2}$$

✓ Any one / *Enige een*



$$\frac{Q_1}{r_{13}^2} = \frac{Q_2}{r_{23}^2}$$

$$\frac{2\times10^{-6}}{x^2}✓ = \frac{6\times10^{-6}}{(1-x)^2}✓✓$$

$$\frac{2}{x^2} = \frac{6}{(1-x)^2}$$

$4x^2 + 4x - 2 = 0$ OR/OF

$$\frac{\sqrt{2}}{x} = \frac{\sqrt{6}}{(1-x)}$$

OR/OF
$2(1-x)^2 = 6x^2$
$2(x^2-2x+1) = 6x^2$
$2x^2-4x+2 = 6x^2$
$2x^2-2x+1=0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-2 \pm \sqrt{2^2 - 4\times2\times(-1)}}{2(2)}$$

x = 0,37 m from charge/ *vanaf lading* 2 μC ✓

OR/*OF*
x= 0,63 m from charge/ *vanaf lading* 6μC✓ (6)
[16]

QUESTION 8/ VRAAG 8

8.1 When current flows through a voltage source (battery/generator) a resistance to current flow arises✓ due to the resistance of the materials (chemicals/conductors) from which the source is made.✓
Wanneer stroom deur 'n volt-kragbron (battery/generator) vloei, ontstaan 'n weerstand teen stroomvloei as gevolg van die weerstand van die materiaal (chemikaleë/ geleiers) waarvan die bron gemaak is.

OR/OF (2)

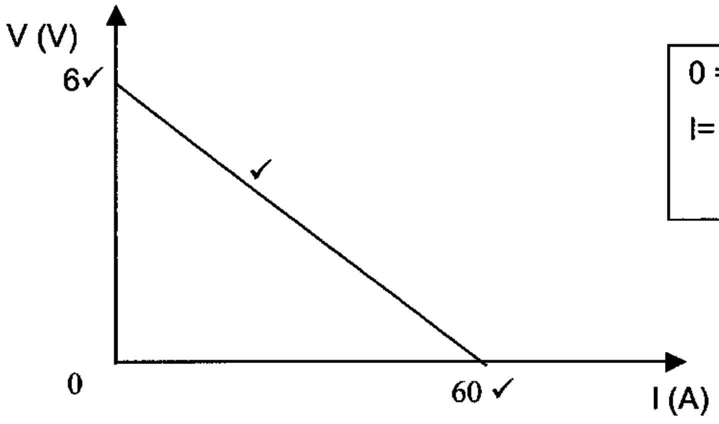
Internal resistance is the resistance offered to the electron flow✓ by the electrolyte/medium of the cell/generator. ✓
Interne weerstand is die weerstand gebied teen die vloei van elektrone deur die elektroliet/ medium van die sel/ generator.

8. 2 $\varepsilon = V_{ext} + Ir$✓

$6 = V_{ext} + I(0,10)$
$V_{ext} = 6 - (0,10)I$ ✓

(2)

8.3



$0 = 6 - (0,10)I$
$I = \frac{6}{0,1} = 60$ A

(3)

8.4

8.4.1 **OPTION 1/ *OPSIE 1***

$W_4 = I^2R\Delta t$ ✓ $= 40$

$I^2(4)\Delta t = 40$ ✓

$W_R = (\frac{10}{\Delta t})R\Delta t = 60$ ✓

$R = 6\ \Omega$ ✓

OPTION 2/ *OPSIE 2*

$W = I^2R\Delta t$ ✓

$\frac{W_4}{W_R} = \frac{I^2 R_4 \Delta t}{I^2 R\ \Delta t^2}$

$\frac{40}{60}$ ✓ $= \frac{I^2(4)\Delta t}{I^2 R\ \Delta t}$ ✓

$R = 6\ \Omega$ ✓

(4)

8.4.2 **POSITIVE MARKING FROM QUESTION 8.4.1**
POSITIEWE NASIEN VANAF VRAAG 8.4.1

OPTION 1/ *OPSIE 1*

$\varepsilon = I(R+r)$ ✓
$6 = I(4+6) + 0,10)$ ✓
$I = 0,59$ A ✓

OPTION 2/ *OPSIE 2*

$\varepsilon = I(R+r)$ ✓
$6 = I(10) + 0,10)$ ✓
$I = 0,59$ A ✓

(3)

8.4.3 **POSITIVE MARKING FROM QUESTION 8.4.1 and 8.4.2**
POSITIEWE NASIEN VANAF VRAAG 8.4.1 en 8.4.2

(3)

OPTION 1/ *OPSIE 1*

$\varepsilon = V_{ext} + Ir$ ✓
$6 = V_{ext} + (0,59)(0,10)$ ✓
$V_{ext} = 5,94$ V ✓

OPTION 2 /*OPSIE 2*

$V = IR_{ext}$ ✓
$= (0,59)(10)$ ✓
$=5,9$ V ✓

8.5 DECREASE✓
Total resistance of the circuit decreases ✓
Current increases✓
$V_{internal\ resistance}$ increases✓
V_{ext} (voltmeter reading) decreases ($V_{ext} = \varepsilon - V_{int}$)

AFNEEM
Totale weerstand van die stroombaan neem af
Stroom neem toe
$V_{interne\ weerstand}$ neem toe
V_{eks}(voltmeterlesing) neem af ($V_{eks} = \varepsilon - V_{int}$) (4)
[21]

QUESTION 9/ VRAAG 9

9.1 DC Generator✓
Mechanical energy to electrical energy✓
GS Generator
Meganiese energie na elektriese energie (2)

9.2 To make the direction of the (induced) current to be the same in every half cycle/half turn✓✓
Om die (geïnduseerde) stroom se rigting dieselfde te hou tydens elke halfsiklus/ halwe rotasie
OR
To keep the (induced) current unidirectional✓✓
Om die *(geïnduseerde) stroom in een rigting te laat vloei* (2)

9.3 Graph A✓
DC generator becomes an AC generator✓
Voltage changes the polarity in every half cycle. ✓
OR
Graph A✓
DC generator becomes an AC generator✓
The voltage is alternating ✓
(3)

9.4 $P_{avg/gem} = \frac{V^2_{rms/wgk}}{R}$ ✓

$P_{avg/gem} = \frac{(\frac{V_{max/maks}}{\sqrt{2}})^2}{R}$

$6 = \frac{(\frac{12}{\sqrt{2}})^2}{R}$ ✓

$R = 12\ \Omega$

$I_{rms/wgk} = \frac{V_{rms/wgk}}{R}$ ✓

$I_{rms/wgk} = \frac{(\frac{V_{max/maks}}{\sqrt{2}})^2}{R}$

$= \frac{(\frac{12}{\sqrt{2}})^2}{12}$

$I_{rms/wgk} = 0{,}71$

$I_{rms\ Total/wgk\ totaal} = 2x(0{,}71)$ ✓

$= 1{,}42$ A ✓

$P_{avg/gem} = \frac{V^2_{rms/wgk}}{R}$ ✓

$P_{avg} = \frac{(\frac{V_{max/maks}}{\sqrt{2}})^2}{R}$

$6 = \frac{(\frac{12}{\sqrt{2}})^2}{R}$ ✓

$R = 12\ \Omega$

$V_{rms/wgk} = I_{rmsTot/wgk\ tot} R_T$ ✓

$\frac{V_{rms/wgk}}{\sqrt{2}} = I_{rms\ Total/wgk\ tot} \cdot (\frac{R}{2})$

$\frac{12}{\sqrt{2}} = I_{rms/wgk} \cdot (\frac{12}{2})$ ✓

$I_{rms\ Total/wgk\ tot} = 1{,}42$ A ✓

(5)
[12]

QUESTION 10/ VRAAG 10

10.1 What is the relationship between frequency of the incident radiation✓ and the maximum kinetic energy of the ejected electrons? ✓ (2)
Wat is die verwantskap tussen frekwensie van die invallende bestraling en die maksimum kinetiese energie van die vrygestelde elektrone?

10.2
10.2.1 frequency✓/ *frekwensie* (1)

10.2.2 ANY ONE✓/ *ENIGE EEN*
Threshold frequency/ *drumpel frekwensie*
Work function of the metal/ *werkfunksie van die metaal*
Potential difference/ *potensiaalverskil*
Intensity of the incident radiation/ *intensiteit van die invallende bestraling* (1)

10.3 As the frequency of the incident radiation increases, the kinetic energy also increases✓✓
Soos die frekwensie van die invallende bestraling toeneem, neem die kinetiese energie ook toe. (2)

10.4 **OPTION 1/ *OPSIE 1***

$E = W_0 + E_{K max/ maks}$
$E = W_0 + \frac{1}{2}mv^2$ } Any one ✓/Enige een

✓ $\frac{hc}{\lambda} = W_0 + E_K$

$\frac{(6{,}63\times10^{-34})(3\times10^{8})}{200\times10^{-9}}$ ✓ $= 8\times10^{-19} + E_K$ ✓

$E_K = 1{,}95 \times 10^{-19}$ J✓

OPTION 2/ *OPSIE 2*

$E = W_0 + E_{K max/ maks}$ ✓

$E = \frac{hc}{\lambda}$ ✓

$E = \frac{(6{,}63\times10^{-34})(3\times10^{8})}{200\times10^{-9}}$ ✓

$E = 9{,}95 \times 10^{-19}$ J

$9{,}95\times10^{-19} = 8\times10^{-19} + E_{K max/ maks}$ ✓

$E_K = 1{,}95 \times 10^{-19}$ J✓ (5)

10.5 Remains the same/ No Change. ✓
Bly dieselfde/ Geen verandering (2)

Kinetic energy is independent of intensity of the incident radiation. ✓
Kinetiese energie is onafhanklik van die intensiteit van die invallende bestraling

106 DECREASES/ *AFNEEM*

(1)
[14]

TOTAL /*TOTAAL*: 150

Education and Sport Development

Department of Education and Sport Development
Departement van Onderwys en Sportontwikkeling
Lefapha la Thuto le Tlhabololo ya Metshameko
NORTH WEST PROVINCE

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2015

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

USE THE INFORMATION BELOW TO ANSWER QUESTION 1.1 AND QUESTION 1.2

An object is thrown upwards with a velocity of 5 $m \cdot s^{-1}$.

1.1 Which ONE of the following gives the magnitude of the velocity of the object at its maximum height?

A 0

B 5

C 4,9

D 9,8 (2)

1.2 The height reached by the object when its velocity is *2* $m \cdot s^{-1}$ can be determined in ONE single step. The equation below that can be used to find this is ...

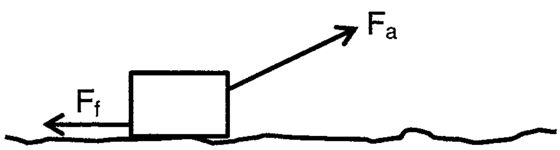
A $v_f = v_i + g\Delta t$

B $v_f^2 = v_i^2 + 2g\Delta y$

C $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$

D $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ (2)

1.3 A constant force F_a acts on an object, causing it to move at a **constant speed** over a rough horizontally surface as shown in the diagram below.



How does the force of friction F_f compare to F_a?

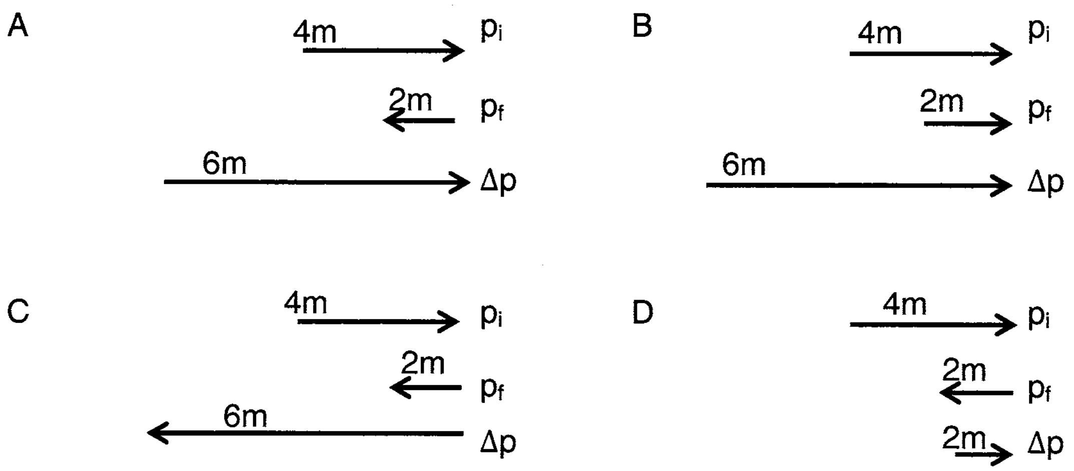
A $F_f = F_a$

B $F_f > F_a$

C $F_f < F_a$

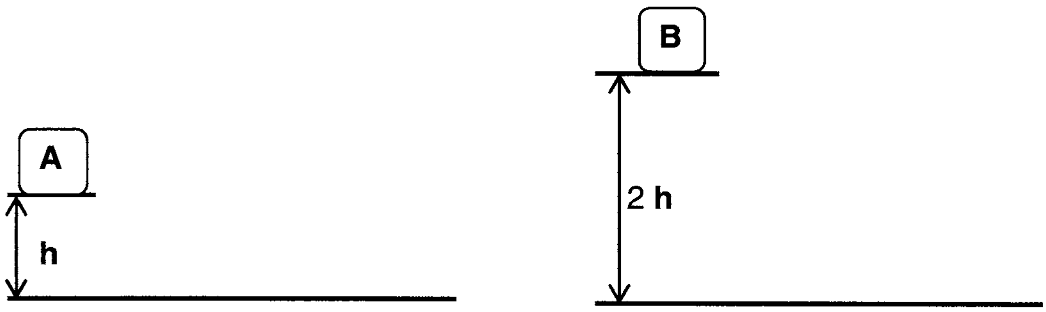
D $F_f = 0$ (2)

1.4 A ball of mass *m,* moving horizontally to the right, strikes the wall with a velocity of 4 m·s^{-1}.The ball rebounds in the opposite direction with a velocity of 2 m·s^{-1}. Which ONE of the options below correctly represents the momentum vectors of the initial momentum (p_i), the final momentum (p_f) and the change in momentum (Δp) of the ball in kg·m·s^{-1}?



(2)

1.5 In the diagram below, two identical blocks **A** and **B**, each with mass *m,* are placed in the positions as shown below.



How does the gravitational potential energy (U) of the blocks compare?

A $U_A = ½ U_B$

B $U_A = U_B$

C $U_A = \sqrt{2}\ U_B$

D $U_A = 2\ U_B$ (2)

1.6 The Doppler effect is observed ...

A only with sound waves.

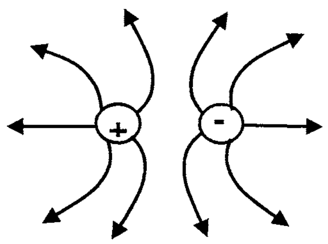
B only with light waves.

C with both sound and light waves.

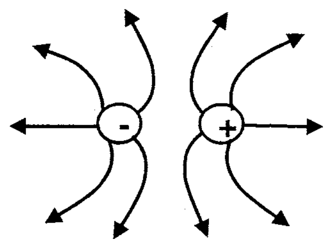
D neither with light nor sound waves. (2)

1.7 Which ONE of the diagrams below shows the correct electric field pattern between two equal, but opposite charges?

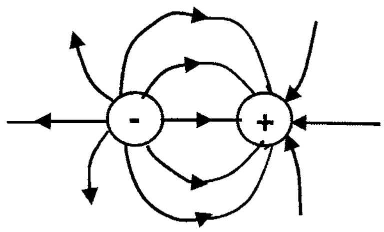
A



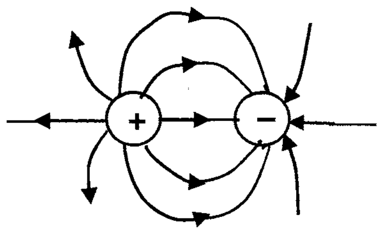
B



C



D

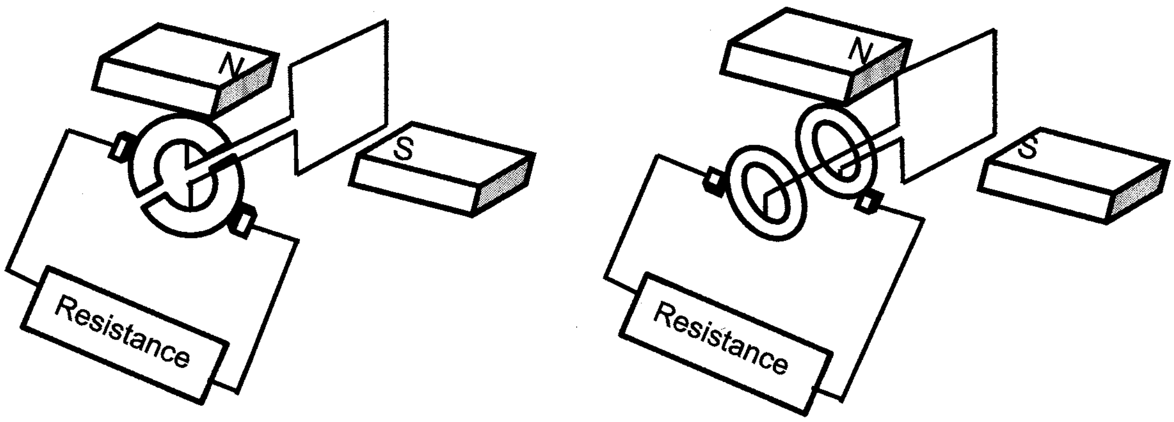


(2)

1.8 Two types of generators are shown in the diagram below:

Generator 1

Generator 2



What type of current is produced by each generator when connected to an external resistance?

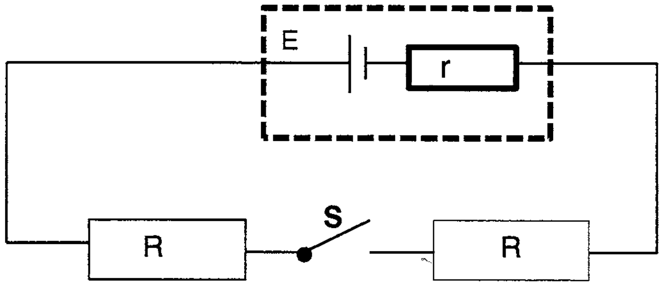
A Both produce direct current.

B Both produce alternating current.

C Generator 1 produces alternating current and Generator 2 produces direct current.

D Generator 1 produces direct current and Generator 2 produces alternating current. (2)

1.9 A battery, with an emf *E* and internal resistance *r*, is connected to a switch *S* and two identical resistors in series. Each resistor has resistance *R*.



Which one of the following statements is CORRECT when the switch **S** is closed?

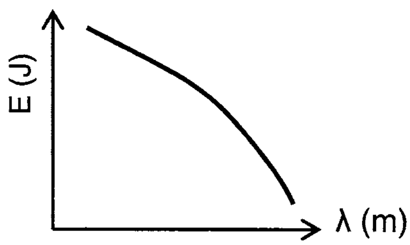
A The voltmeter reading is 0,5*E* when an ideal voltmeter is connected across one resistor.

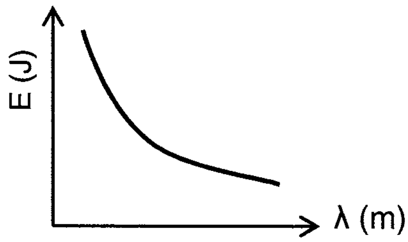
B The voltmeter reading is *E* when an ideal voltmeter is connected across the two resistors.

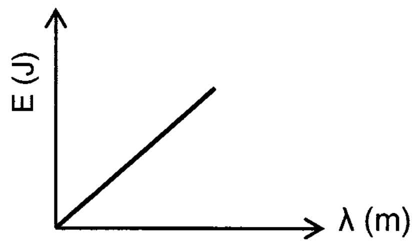
C The voltmeter reading is *E* when an ideal voltmeter is connected across the battery.

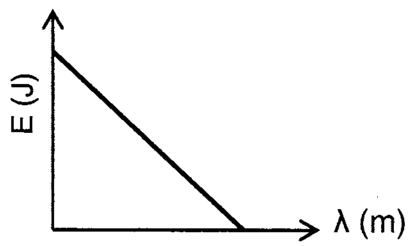
D The voltmeter reading is less than *E* when an ideal voltmeter is connected across the battery. (2)

1.10 Which ONE of the following graphs best shows how photon energy E varies with the wavelength (λ) of the light?

A


B


C


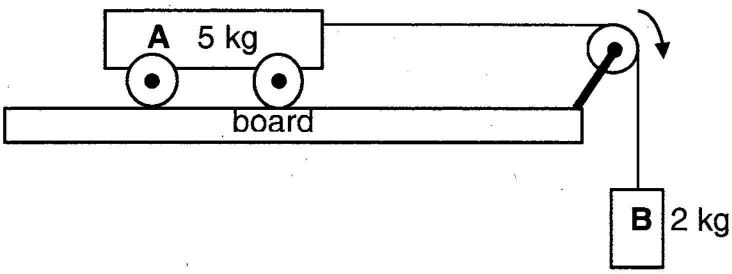
D


(2)

[20]

QUESTION 2 (Start on a new page.)

A dynamics trolley **A** of mass 5 kg is placed on a horizontal board. It is connected to block **B** of mass 2 kg by a light, inextensible string over a frictionless pulley as shown in the diagram below. Ignore any effects of air resistance.



2.1 State *Newton's Second Law of Motion* in words. (2)

2.2 Assuming no frictional force acts between the wheels of the trolley and the surface. Calculate:

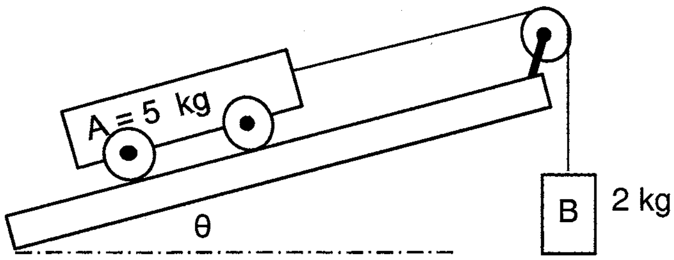
2.2.1 The magnitude of the acceleration of the trolley. (5)

2.2.2 The tension in the string. (2)

Experimental results however showed that the actual acceleration of the trolley was $2\ m{\cdot}s^{-2}$.

2.3 Calculate the magnitude of the frictional force on the trolley. (4)

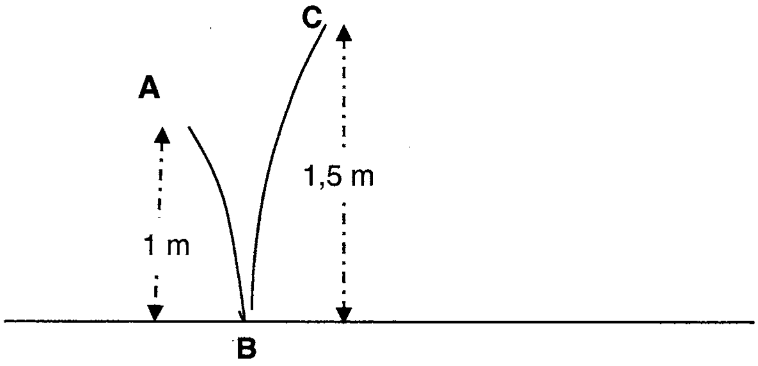
2.4 The trolley is modified to eliminate the effects of friction. The pulley end of the board is now raised so that the board makes an angle θ with the horizontal.



Calculate the value of angle θ so that the trolley remains at rest. (5)
[18]

QUESTION 3 (Start on a new page.)

A ball is thrown vertically downwards from point **A** at a height of 1 m above the ground. It strikes the ground at point **B,** bouncing to point **C,** which is 1,5 m from the ground. See the diagram below. Ignore any effects of friction.



3.1 What is the value of the kinetic energy of the ball at point **C**? (1)

3.2 State the *principle of conservation of mechanical energy* in words. (2)

3.3 Using ENERGY PRINCIPLES ONLY, determine the velocity with which the ball was thrown from point **A**. (5)

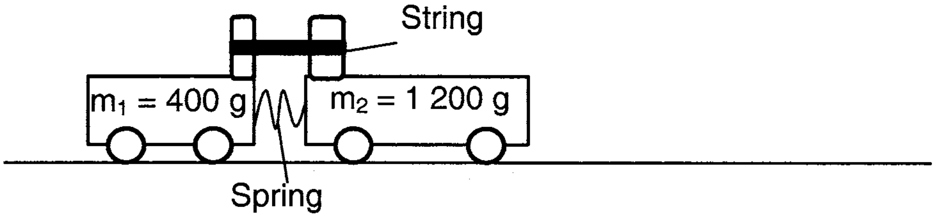
3.4 Determine the time taken by the ball to reach the ground at point **B**. (4)

Assume that the collision with the floor is elastic.

3.5 The ball reaches the height **C** after the first bounce. Compare the height to which the ball will rise after it is allowed to bounce for a second time, to the previous height **C.** Write HIGHER THAN POINT **C**, EQUAL TO POINT **C** or LESS THAN POINT **C.** (1)
[13]

QUESTION 4 (Start on a new page.)

Two carts, m_1 and m_2 of masses 400 g and 1 200 g are free to move on a frictionless horizontal surface. The carts are joined by a compressed spring and tied together by a string. The carts are initially at rest as shown in the figure below.



When the string between them is cut, the spring between them is released. The carts then move away from each other.

4.1 While the spring is expanding:

4.1.1 Compare the magnitudes of the forces acting on carts m_1 and m_2 at any instant.

Write $\mathbf{F_{m1} > F_{m2}}$, $\mathbf{F_{m1} < F_{m2}}$ or $\mathbf{F_{m1} = F_{m2}}$ (1)

4.1.2 Name the law or principle used to obtain the above answer. (1)

4.2 After the spring has expanded:

4.2.1 How do the magnitudes of the velocity of the carts m_1 and m_2 compare?

Write $\mathbf{v_{m1} > v_{m2}}$, $\mathbf{v_{m1} < v_{m2}}$ **or** $\mathbf{v_{m1} = v_{m2}}$ (1)

4.2.2 Name the law or principle applied to obtain the above answer. (1)

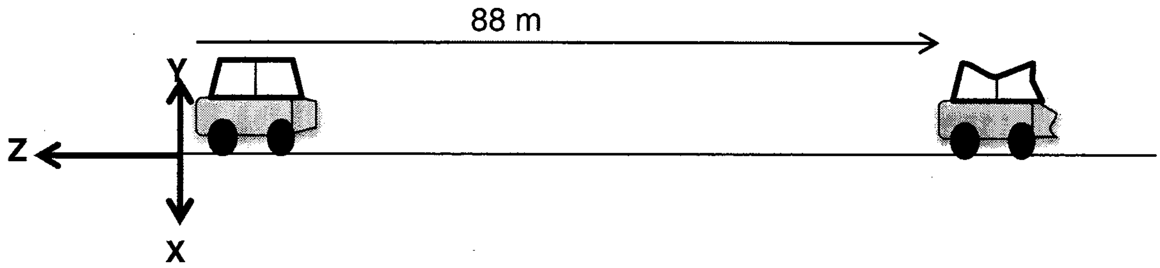
4.3 If 0,225 J of energy is imparted to the carts when the spring between them is released, show that the final speed of m_2 is 0,31 $m \cdot s^{-1}$. Assume that there was no loss of energy. (6)

[10]

QUESTION 5 (Start on a new page.)

During an accident the driver applies the brakes to bring a car to rest. The combined mass of the driver and the car is 800 kg.

The investigators at the accident scene, measure the length of the car's skid marks on the level road to be 88 m. The coefficient of kinetic friction on the road was estimated to be 0,42.



The forces acting on the car while braking, is shown as **X, Y** and **Z** in the figure above.

5.1 Identify and name the force marked **Y**. (1)

5.2 Which ONE of the above forces is a conservative force? (1)

5.3 What is the magnitude of the work done by force **Y**? (1)

5.4 Which ONE of the above forces does negative work on the car? (1)

5.5 State the *work energy theorem* in words. (2)

5.6 Determine the magnitude of the frictional force acting between the wheels of the car and the road surface to bring it to rest. (3)

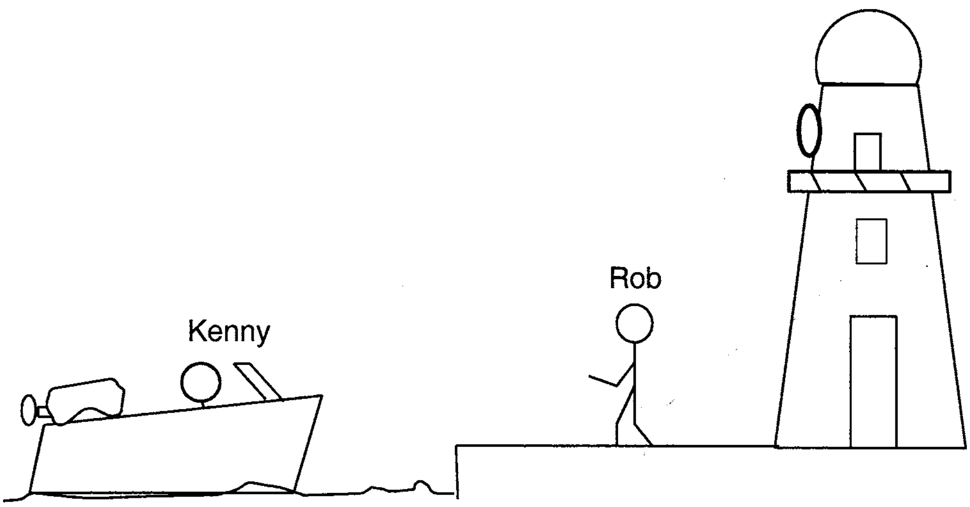
5.7 Using the WORK-ENERGY PRINCIPLE ONLY, determine the speed of the car just before the driver slammed on (and locked) the brakes. (4)

[13]

QUESTION 6 (Start on a new page.)

Kenny is driving his speedboat towards a light house. The fog horn from the light house blows with a frequency of 180 Hz. The apparent frequency of sound received by Kenny is 188 Hz.

Rob his friend, stands in front of the light house, as shown in the diagram below. Use the speed of sound as 340 $m \cdot s^{-1}$.



6.1 State the Doppler effect in words. (2)

6.2 What is the frequency of the sound received by Rob? (1)

6.3 Explain the answer to QUESTION 6.2 above. (2)

6.4 How would the wavelength of the sound wave produced by the fog horn change if the frequency of the wave were lower than 180 Hz? Write down only INCREASES, DECREASES or STAYS THE SAME. (1)

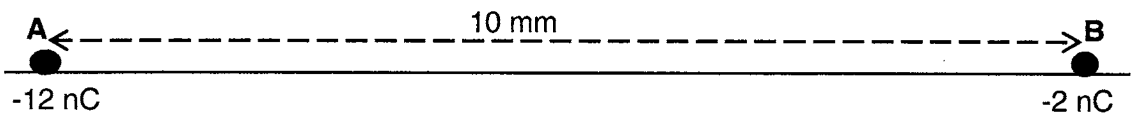
6.5 Give a reason for the answer to QUESTION 6.4. (2)

6.6 Calculate the speed of the boat as it approaches the light house. (5)

[13]

QUESTION 7 (Start on a new page.)

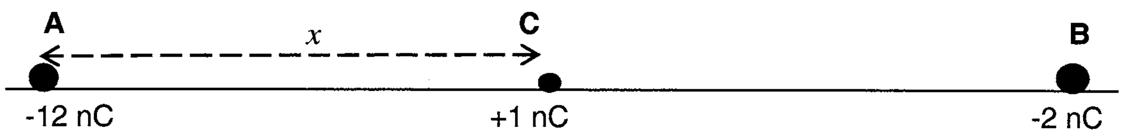
Point charge **A** of -12 nC is 10 mm from point charge **B** of -2 nC along the same straight line.



7.1 State *Coulomb's law* in words. (2)

7.2 Calculate the magnitude of the electrostatic force between **A** and **B**. (4)

A third charge **C** of +1 nC is now placed in between **A** and **B** at a distance of x mm from **A**, as shown in the diagram below.



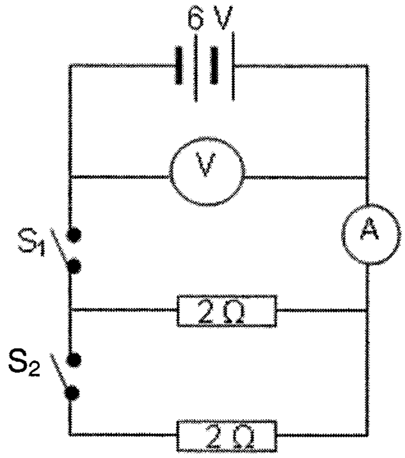
7.3 Calculate the distance x in metres if the resultant electrostatic force experienced by charge **C** due to the presence of **A** and **B**, is zero. (6)

[12]

QUESTION 8 (Start on a new page.)

Two resistors, each of resistance 2 Ω, are connected in parallel to a 6 V battery of negligible internal resistance in circuit 1 below. **S_1** and **S_2** are two switches connected in the circuit as shown below.

Circuit 1

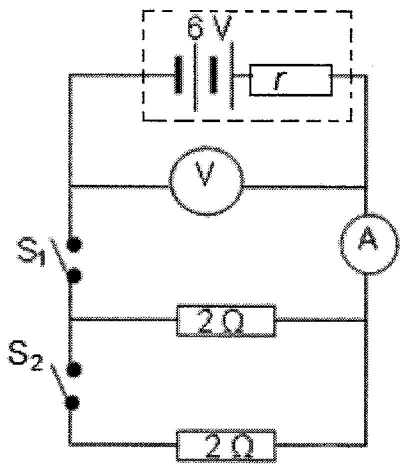


8.1 What is the reading on the voltmeter in circuit **1** when switch **S_1** and **S_2** are both open? (1)

8.2 With switches **S_1** and **S_2 closed** in circuit 1, determine the reading on the ammeter. (5)

Circuit **2** below is identical to circuit **1**, but the 6 V battery has an internal resistance *r*.

Circuit 2



When only switch **S_1** is closed in circuit **1**, its ammeter reading will be the same as the ammeter reading on circuit **2** with both its switches closed.

8.3 Calculate the internal resistance of the battery. (6)

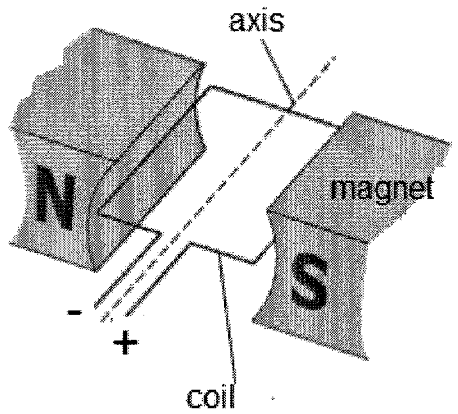
8.4 Consider circuit **2.** How does the voltmeter reading when both **S_1** and **S_2** are closed, compare to when only **S_1** is closed? Write GREATER THAN, SAME AS or SMALLER THAN. (1)

8.5 Explain the answer to QUESTION 8.4 above. (3)

[16]

QUESTION 9 (Start on a new page.)

The diagram shows part of a simple electric motor.

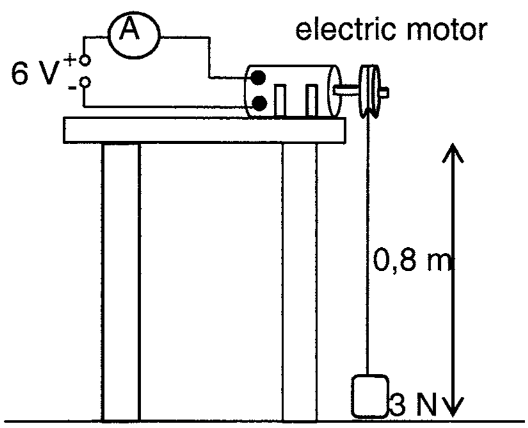


The motor is connected to a DC. power supply.

9.1 When the motor is switched on, the coil rotates. In which direction will the coil rotate? Write down only CLOCKWISE or ANTICLOCKWISE. (1)

9.2 Suggest ONE change which would result in coil turning in the opposite direction. (1)

The electric motor is connected to a power supply of emf 6 V. It lifts a load of 3 N through a height of 0,8 m in 2 s. See the diagram below.



9.3 Determine the reading on the ammeter if 80% of the electrical energy in the motor is converted into lifting the load at a constant speed to a height of 0,8 m. (6)

[8]

QUESTION 10 (Start on a new page.)

Two identical bulbs $\mathbf{B_1}$ and $\mathbf{B_2}$ are connected to two different power sources.

In Figure 1 the bulb $\mathbf{B_1}$ is connected to a 12 V DC power source.
In Figure 2 the bulb $\mathbf{B_2}$ is connected to a 12 V_{max}, 25 Hz AC power source.

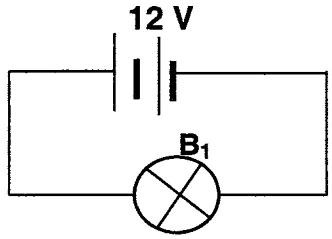


Figure 1

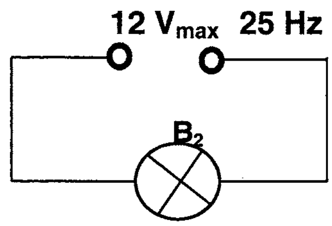


Figure 2

10.1 Which ONE of the bulbs $\mathbf{B_1}$ or $\mathbf{B_2}$ will glow the brightest? (1)

10.2 Perform a calculation to justify the answer to QUESTION 10.1. (3)

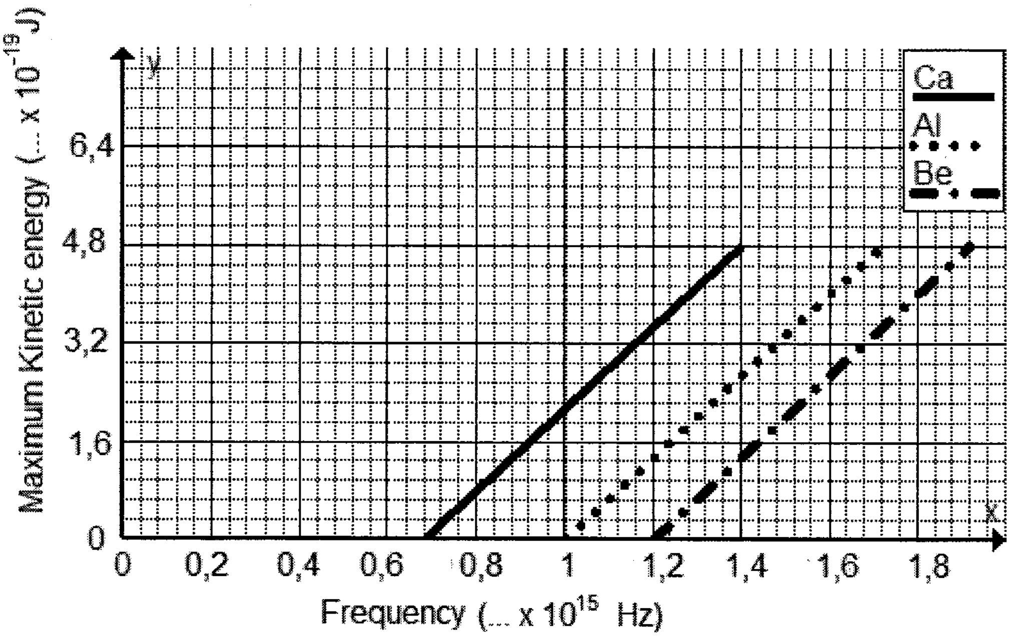
10.3 What is the ratio of the power in bulb $\mathbf{B_1}$ (figure 1) to $\mathbf{B_2}$ (figure 2)? (3)

10.4 Sketch a graph of the voltage output (V) vs time (t) for ONE complete cycle of the AC power source above. Show the maximum value and the time on your axes. (5)

[12]

QUESTION 11 (Start on a new page.)

When electromagnetic radiation shines on metals, electrons may be emitted. The maximum kinetic energy of emitted electrons is plotted against radiation frequency for three metals Calcium (Ca), Aluminium (Al) and Beryllium (Be) is as shown in the graph below.



11.1 Name the phenomenon described above. (1)

11.2 Define in words the term *cut-off frequency.* (2)

11.3 Determine the cut-off frequency for the Beryllium (Be) metal. (1)

11.4 What physical quantity does the gradient of these graphs represent? (1)

11.5 What is the minimum energy the incident light must have in order to emit electrons from the surface of the Calcium (Ca) metal? (3)

11.6 When electromagnetic radiation of wavelength 187 nm shines on one of the metals indicated in the graph, the maximum kinetic energy of the electrons is found to be 4 $\times 10^{-19}$ J.
Use the relevant calculations to identify the metal. (7)
[15]

TOTAL: 150

QUESTION 1 / *VRAAG 1*

1.1	A✓✓	(2)
1.2	B✓✓	(2)
1.3	C✓✓	(2)
1.4	C✓✓	(2)
1.5	A✓✓	(2)
1.6	C✓✓	(2)
1.7	D✓✓	(2)
1.8	D✓✓	(2)
1.9	D✓✓	(2)
1.10	B✓✓	(2)

[20]

QUESTION 2 / *VRAAG 2*

2.1 When a resultant force acts on an object, the object accelerates in the direction of the force. This acceleration is directly proportional to the force ✓ and inversely proportional to the mass of the object. ✓

OR

The resultant/net force acting on an object is equal to ✓ the rate of change of momentum of the object in the direction of the resultant/net force ✓.

Indien 'n resulterende krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Hierdie versnelling is direk eweredig aan die resultante krag ✓ en omgekeerd eweredig aan die massa van die voorwerp. ✓

OF

Die resultante/netto krag wat op 'n voorwerp inwerk is gelyk aan ✓ die tempo van verandering van momentum van die voorwerp, in die rigting van die resultante/netto krag. ✓ (2)

2.2.1 $F_{net} = m \cdot a$ ✓

For 2 kg object / *Vir 2 kg voorwerp*

Subst. (2) into (1):
$\underline{2 \times 9{,}8 - T}$ ✓ = $\underline{2 \times a}$ ✓-----(1)

For 5 kg object
Vir 5 kg voorwerp

✓ $\underline{T = 5 \times a}$ -----(2)

$2 \times 9{,}8 = 5a + 2a$

$a = 2{,}8\ m{\cdot}s^{-2}$ ✓ (5)

2.2.2 $\underline{T = 5 \times 2{,}8}$ ✓

$T = \underline{14\ N}$ ✓

OR/*OF*

$\underline{2 \times 9{,}8 - T} = \underline{2 \times 2{,}8}$ ✓

$T = \underline{14\ N}$ ✓ (2)

2.3 For the 2 kg mass / *Vir die 2 kg massa*:

$\underline{2 \times 9{,}8 - T = 2 \times 2}$ ✓

$19{,}6 - 4 = T$ ……..(1)

For the 5 kg mass / *Vir die 5 kg massa*:

$\underline{T - f}$ ✓= 5×2✓

$T = 10 + f$ …….(2)

Subst. (1) into (2):
$\underline{f = 5{,}6\ N}$ ✓ (4)

2.4 $\underline{F_{net} = 0}$✓

Horizontal forces on the incline/ *Horisontale kragte op die helling*

$\underline{T = F_{//}}$ ⟶ Both equations ✓ ⟵ *Albei vergelykings*

$\underline{19{,}6}$✓ = $\underline{5 \times 9{,}8 \times \sin\theta}$✓

Vertical forces/ *Vertikale kragte*

$\underline{T = m \times g}$

$= 2 \times 9{,}8$

$= 19{,}6\ N$

$\theta = \underline{23{,}58^{\circ}}$ ✓ (5)

[18]

QUESTION 3 / *VRAAG 3*

3.1 0 (J)✓ (1)

3.2 The <u>total mechanical energy</u>✓ (sum of gravitational potential energy and kinetic energy) <u>in an isolated system remains constant.</u>✓ /
<u>Die totale meganiese energie</u>✓ (som van gravitasie potensiële en kinetiese energie) <u>in 'n geslote sisteem bly konstant</u>✓ (2)

3.3 **OPTION 1/ *OPSIE 1***

$E_{mech\ (at\ C)} = E_{mech\ (at\ A)}$ / $E_{meg\ (by\ C)} = E_{meg\ (by\ A)}$

$(mgh + ½ mv^2)_C = (mgh + ½ mv^2)_A$

$m(gh + ½ v^2)_C = m(gh + ½ v^2)_A$

} any equation✓/ *enige vergelyking*

$9,8 \times 1,5$ ✓ $+ 0 = 9,8 \times 1$ ✓ $+ ½ v^2$ ✓

OR write the equation using the mass as m /
OF gebruik m as die massa wanneer die vergelyking geskryf word

$v^2 = 9,8$ $v =$ 3,13 m·s⁻¹ ✓ (5)

OPTION 2/ *OPSIE 2*

$E_{mech\ (at\ C)} = E_{mech\ (at\ B)}$ / $E_{meg\ (by\ C)} = E_{meg\ (by\ A)}$

$(mgh + ½ mv^2)_C = (mgh + ½ mv^2)_B$

$m(gh + ½ v^2)_C = m(gh + ½ v^2)_B$

$m \times 9,8 \times 1,5 = ½ \times m \times v^2$ ✓

} ✓ any equation✓/ *enige vergelyking*

$v = 5,42218$

$E_{mech\ (at\ B)} = E_{mech\ (at\ A)}$ / $E_{meg\ (by\ B)} = E_{meg\ (by\ A)}$

$½ \times m \times (5,42218)^2$ ✓ $= ½ m \times v^2 + m \times 9,8 \times 1$ ✓

OR write the equation without mass /*OF skryf die vergelyking sonder massa*

$v =$ 3,13 m.s⁻¹ ✓

3.4 **OPTION 1/ *OPSIE 1***

(+) $\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓

1 ✓ $= 3,13\,t + ½\, 9,8\, t^2$ ✓

$t = 0,2338$ s ✓

OPTION 2 / *OPSIE 2*

$v_f^2 = v_i^2 + 2a\Delta x$

$v_f^2 = 9,8 + 2 \times 9,8 \times 1$ ✓

$= 5,42218$ m.s⁻¹

$v_f = v_i + g\,\Delta t$

} both equations 1 mark ✓

$5,42218 = 3,13 + 9,8\,t$ ✓

$t = 0,2336$ s ✓ (4)

3.5 Equal to C / *Gelyk aan C* (1)

[13]

QUESTION 4 / *VRAAG 4*

4.1.1 $F_{m1} = F_{m2}$ ✓ (1)

4.1.2 Newton's 3rd law ✓OR (state it in words)/
Newton se 3de wet ✓ *OF (stel in woorde)* (1)

4.2.1 $v_{m1} > v_{m2}$✓ (1)

4.2.2 Newton's 2nd law ✓ OR (state it in words)/
Newton se 2de wet ✓ *OF (stel in woorde)* (1)

4.3

Momentum is conserved/ *Momentum word behou* $\sum p_i = \sum p_f$ or/*of* $(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$ ✓	Energy is conserved/ *Energie word behou* $\frac{1}{2} mv^2_{\text{before/voor}} = \frac{1}{2} mv^2_{\text{after / na}}$

both equations 1 mark/ *albei vergelykings 1 punt*
let velocity of $m_1 = x$ and $m_2 = y$ / *laat snelheid van $m_1 = x$ en $m_2 = y$*

✓ $0 = 0{,}4x + 1{,}2(-y)$ ✓	✓ $0{,}225 = \frac{1}{2}0{,}4x^2 + \frac{1}{2}1{,}2y^2$ ✓
$x = 3y$	
$y = 0{,}306\ m{\cdot}s^{-1}$	$0{,}225 = \frac{1}{2}0{,}4(3y)^2 + \frac{1}{2}1{,}2y^2$ ✓

(6)

[10]

QUESTION 5 / *VRAAG 5*

5.1 Normal force✓ / *Normaalkrag*✓ (1)

5.2 X OR force of gravity OR weight✓ / *X OF gravitasiekrag OF gewig*✓ (1)

5.3 0✓ (1)

5.4 Z OR frictional force✓ / *Z OF wrywingskrag*✓ (1)

5.5 The net/total work done on an object is equal to ✓ the change in the object's kinetic energy ✓OR the work done on an object by a resultant/net force is equal to the change in the object's kinetic energy./
Die netto/totale werk wat op die voorwerp gedoen word, is gelyk aan ✓ *die verandering in die voorwerp se kinetiese energie.* ✓
OF
Die werk gedoen op 'n voorwerp deur 'n resultante/netto krag is gelyk aan die verandering in kinetiese energie van die voorwerp. (2)

5.6 $f_k = \mu_k N$✓
$= 0{,}42 \times 800 \times 9{,}8$✓
$= 3292{,}8\ N$✓

(3)

5.7 $W_{net} = \Delta K$ ✓ OR/*OF* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ OR/*OF* $\Delta E_k = E_{kf} - E_{ki}$

3292,8 x 88 x cos 180° ✓= 0 – ½ 800 x v^2 ✓ OR/*OF*

3292,8 x 88 x -1 = 0 – ½ 800 x v^2

v = 26,915 $m.s^{-1}$ ✓ (4)

[13]

QUESTION 6 / *VRAAG 6*

6.1 Change in frequency (or pitch) of the sound detected by a listener ✓ because the sound source and the listener have different velocities relative to the medium of sound propagation✓/
Die verandering in frekwensie (of toonhoogte) van die klank wat die luisteraar waarneem, ✓ *want die klankbron en die luisteraar het verskillende snelhede relatief tot die medium of klankvoortplanting*✓ (2)

6.2 180 Hz ✓ (1)

6.3 There is no relative motion between the source ✓and the listener✓/.
Daar is geen relatiewe beweging tussen die bron✓ *en die luisteraar nie.* ✓ (2)

6.4` Increases✓ *toeneem* (1)

6.5 For constant velocity /speed of sound ✓
If the frequency decreases λ increases✓/
Vir 'n konstante snelheid/ spoed van klank ✓
As die frekwensie afneem , neem λ toe ✓ (2)
OR/OF
The wave length inversely proportional to the wavelength when v is constant/
Die golflengte is omgekeerd eweredig aan die frekwensie indien v konstant bly.

6.4 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

188 ✓$= \frac{340 + v_L}{340}$ ✓ 180 ✓

v_L = 15,11 $m.s^{-1}$ ✓

(5)

[13]

QUESTION 7 / *VRAAG 7*

7.1 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges ✓
and inversely proportional to the square of the distance (r) between them✓/
Die grootte van die elektrostatiese krag wat uitgeoefen word deur een puntlading (Q_1) op 'n ander puntlading (Q_2) is direk eweredig aan die produk van die groottes van hul lading✓en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle✓

(2)

7.2 $F=\frac{kQ_1Q_2}{r^2}$ ✓

$F=\frac{9\times10^9\times12\times10^{-9}\times2\times10^{-9}}{(10\times10^{-3})^2}$ ✓ ✓

$= 2,16 \times 10^{-3}$ N✓

(4)

7.3 $F_{net} = 0$ OR/*OF* $F_1 + (-F_2) = 0$ OR /*OF* $F_1 = F_2$ ✓

ANY ONE EQUATION / *ENIGE EEN VERGELYKING* 1 mark/*punt*

$F_1=\frac{9\times10^9\times12\times10^{-9}\times1\times10^{-9}}{(x)^2}$ $F_2=\frac{9\times10^9\times1\times10^{-9}\times2\times10^{-9}}{(10\times10^{-3}-x)^2}$

4 marks allocated for substitution/ *4 punte toegeken vir vervanging*

$\frac{9\times10^9\times12\times10^{-9}\times1\times10^{-9}}{(x)^2}$ ✓ ✓ $=$ $\frac{9\times10^9\times1\times10^{-9}\times2\times10^{-9}}{(10\times10^{-3}-x)^2}$ ✓ ✓

$x = 7.1 \times 10^{-3}$ m ✓

(6)

[12]

QUESTION 8 / *VRAAG 8*

8.1 6 V✓ (1)

8.2 $R=\frac{V}{I}$ ✓ $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}$ ✓

$\frac{1}{R}=\frac{1}{2}+\frac{1}{2}$ ✓

$1=\frac{6}{I}$ ✓

R = 1 Ω

$I = 6$ A✓ (5)

8.3 $R=\frac{V}{I}$ $\varepsilon = I\,(R+r)$ ✓

✓ $2=\frac{6}{I}$ ✓ ✓ $6 = 3(1 + r)$ ✓

I = 3 A r = 1Ω ✓ (6)

8.4 Smaller than / *kleiner as*✓ (1)

8.5 With both S_1 and S_2 closed the total resistance decreases, the current increases,✓ ϵ (emf) remain the same✓ and I*r* (lost volts)increases ✓
Met beide S_1 en S_2 gesluit, neem die totale weerstand af/ die stroom verhoog ✓, ε (emk) bly dieselfde ✓ en Ir (verloor volts) verhoog ✓ (3)

[16]

QUESTION 9 / *VRAAG 9*

9.1 clockwise✓/ *kloksgewys* ✓ (1)

9.2 Reverse the direction of the current ✓ OR
Reverse the polarity of the magnet/
Draai die stroomrigting om ✓ OF
Draai die pole van die magneet om (1)

9.3 $W = VI\Delta t$ ✓ $W = F\,\Delta x \cos\theta$ ✓

$= 6 \times I \times 2$ ✓ $= 3 \times 0{,}8 \times 1$ ✓

$= 12\,I$

$\frac{80}{100}\times 12\times I = 3\times 0{,}8\times 1$ ✓

$I = 0{,}25$ A✓

(6)

[8]

QUESTION 10 / *VRAAG 10*

10.1 B_1✓ (1)

10.2

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_{rms} = \frac{12}{\sqrt{2}} = 8{,}485\ V$$ ✓

V_{rms} value in AC is less than the V value in DC✓

Power of bulb B_1 or $\left(\frac{V^2}{R}\right)$ > Power in bulb B_2 ✓

V_{wgk} waarde in AC is minder as die V-waarde in DC ✓

Drywing van gloeilamp B_1 of $\left(\frac{V^2}{R}\right)$ > Drywing in gloeilamp B_2 ✓ (3)

10.3

OPTION 1/ *OPSIE 1*

$$P_1 = \frac{V^2}{R} = \frac{12^2}{R}$$

$$P_2 = \frac{8{,}485^2}{R}$$

$$P_1 : P_2 = ✓\frac{12^2}{R} \div \frac{(8{,}485)^2}{R}✓$$

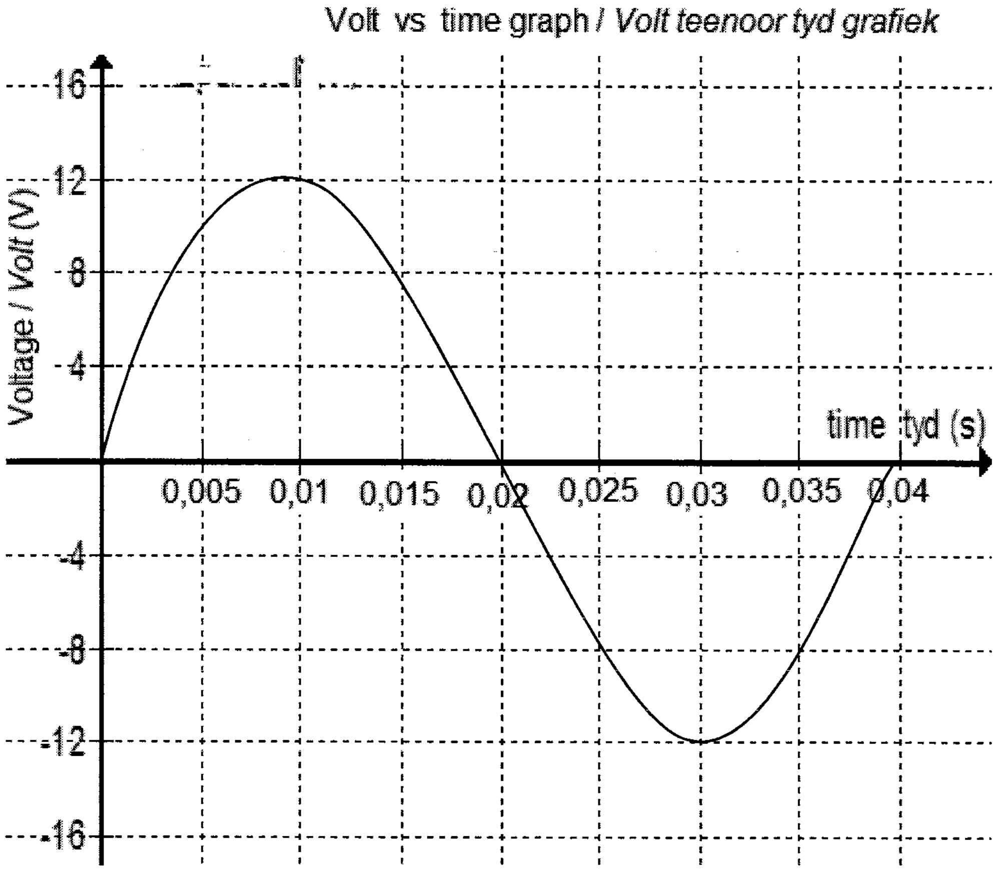
$= \underline{2✓}$ OR / *OF* $\underline{2:1}$

OPTION 2 / *OPSIE 2*

$$P_1 : P_2 = \frac{12^2}{R}✓ \div \frac{\left(\frac{12}{\sqrt{2}}\right)^2}{R}✓$$

$= \underline{2✓}$ OR / *OF* $\underline{2:1}$ (3)

10.4



Sinusoidal curve/ *Sinuskurwe*	Axes marked/ *Asse gemerk*	Peak at 12 &- 12 *Piek by 12 & -12*	Graph changes direction at 0,02/ *Grafiek verander rigting by 0,02*	Ends at 0,04 *Eindig by 0,04*
1	1	1	1	1

(5)

[12]

QUESTION 11 / *VRAAG 11*

11.1 Photoelectric effect / *Fotoëlektriese effek* (1)

11.2 Minimum frequency of light ✓needed to emit electrons from the surface of the metal✓/
Minimum frekwensie van lig ✓wat nodig is om elektrone uit te straal uit die oppervlak van 'n metaal✓ (2)

11.3 $1,2 \times 10^{15}$ Hz ✓ (1)

11.4 Planck's constant OR (h) OR $6,63 \times 10^{-34}$ J·s ✓ (1)
Planck se konstante OF (h) OF $6,63 \times 10^{-34}$ J·s

11.5 $E = hf$ OR/*OF* $W_0 = h f_0$✓

$= 6,63 \times 10^{-34} \times 0,68 \times 10^{15}$✓

$= \underline{4,5084 \times 10^{-19}\ \text{J}}$✓ (3)

11.6 $E = W_0 + E_k$ ✓

$$6,63\times10^{-34}\ \frac{3\times10^{8}\ ✓}{187\times10^{-9}\ ✓} = W_0 + 4\times10^{-19}\ ✓$$

$W_0 = 6,63636 \times 10^{-19}$✓

$W_0 = h f_0$

$f_0 = 1,0009 \times 10^{15}$ Hz✓

<u>Al✓</u> (7)

[15]

GRAND TOTAL / *GROOTTOTAAL*: 150

ANALYSIS GRID PHYSICAL SCIENCE PAPER 1 2015

Question No.		Taxonomy													Knowledge area					
		Knowledge,Recall, Low Demand			COMPREHENSION, Basic Questions			APPLICATION, ANALYSIS, Problem Solving			SYNTHESIS, EVALUATION,Higher Abilities, Hard new problems, Challenge Level			TOTAL	MECHANICS	WAVES, SOUND & LIGHT	ELECTRICITY & MAGNETISM	MATTER & MATERIALS	TOTAL MARKS	Question Totals
	Content	E	M	D	E	M	D	E	M	D	E	M	D		Marks					
1.1	projectile	2												2	2				2	
1.2	projectile		2											2	2				2	
1.3	newton law					2								2	2				2	
1.4	momentum						2							2	2				2	
1.5	energy		2											2	2				2	
1.6	doppler			2										2		2			2	
1.7	electrostatics	2												2			2		2	
1.8	electrodymamics	2												2			2		2	
1.9	circuits									2				2			2		2	
1.10	matter and materials					2								2				2	2	20
2.1	newton law	2												2	2				2	
2.2.1	newton law									5				5	5				5	
2.2.2	newton law							2						2	2				2	
2.3	newton law									4				4	4				4	
2.4	newton law											5		5	5				5	18
3.1	projectile	1												1	1				1	
3.2	projectile	2												2	2				2	
3.3	projectile								5					5	5				5	
3.4	projectile								4					4	4				4	
3.5	projectile				1									1	1				1	13
4.1.1	newton law				1									1	1				1	
4.1.2	newton law		1											1	1				1	
4.2.1	newton law					1								1	1				1	
4.2.2	newton law		1											1	1				1	
4.3	momentum												6	6	6				6	10
5.1	forces	1												1	1				1	
5.2	forces		1											1	1				1	
5.3	forces		1											1	1				1	
5.4	work		1											1	1				1	
5.5	work	2												2	2				2	
5.6	work								3					3	3				3	
5.7	work								4					4	4				4	13
6.1	doppler		2											2		2			2	
6.2	doppler	1												1		1			1	
6.3	doppler						2							2		2			2	

6.4	doppler	1												1						
6.5	doppler					2								2		2			2	
6.6	doppler								5					5		5			5	13
7.1	electrostatics		2											2			2		2	
7.2	electrostatics								4					4			4		4	
7.3	electrostatics												6	6			6		6	12
8.1	circuits	1												1			1		1	
8.2	circuits							5						5			5		5	
8.3	circuits								6					6			6		6	
8.4	circuits					1								1			1		1	
8.5	circuits								3					3			3		3	16
9.1	electrodynamics				1									1			1		1	
9.2	electrodynamics				1									1			1		1	
9.3	electrodynamics												6	6			6		6	8
10.1	electrodynamics						1							1			1		1	
10.2	electrodynamics								3					3			3		3	
10.3	electrodynamics								3					3			3		3	
10.4	electrodynamics										5			5			5		5	12
11.1	photoelectric	1												1				1	1	
11.2	photoelectric	2												2				2	2	
11.3	photoelectric					1								1				1	1	
11.4	photoelectric					1								1				1	1	
11.5	photoelectric							3						3				3	3	
11.6	photoelectric											7		7				7	7	15
		20	**13**	**2**	**4**	**10**	**5**	**10**	**40**	**11**	**5**	**12**	**18**	**150**	**64**	**15**	**49**	**17**	**150**	
		35			19			61			35			150	64	15	49	17		
		15.3%			34.7%			40.0%			10.0%				46%	10.0%	32.7%	11,3%		
		15			35			40			10				45%	8%	36%	10%		

Overall

E	M	D
35	80	35
23%	53%	23 %
30	40	30

150

MOSALA LEBURU.

OTHER OPTIONS FOR PHYSICAL SCIENCES P1

3.4 If used option 2 in 3.3 and uses the value in 3.4 option 2 APPLY positive marking

4.1.2. ~~4.2.1~~ ACCEPT principle of conservation of momemtum

4.2.2 ACCEPT Principle of conservation of

4.3 **OPTION 2**

$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$ ✓ $W_{net} = \Delta E_k$ both equations must be there for a learner to have a tick.

both equations 1 mark

let velocity of $m_1 = x$ and $m_2 = y$

✓ $0 = 0{,}4x + 1{,}2(-y)$ ✓

$x = 3y$

$E_{K\,m1} = ½\, m_1\, (3y)^2$ or $½\; 0{,}4\; (3y)^2$

$E_{K\,m2} = ½\, m_2\, (y)^2$ or $½\; 1{,}2\; y^2$

$E_{Km1} : E_{Km2} = 3{:}1$ ✓

alby vergelykings 1 punt

laat snelheid van $m_1 = x$ en $m_2 = y$

✓

$\frac{1}{4} \times 0{,}225 = \frac{1}{2}(1{,}2)v_f^2 - \frac{1}{2}(1{,}2)0^2$ ✓

$v_f = 0{,}31\ m{\cdot}s^{-1}$

(6)

8.2

$R// = \frac{R_1R_2}{R_1 + R_2}$ ✓

$R// = \frac{2x2}{2+2}$ ✓

$= 1\ \Omega$

9.3 **OPTION 2**

$P = \frac{W}{\Delta t}$ ✓

$P = \frac{3x0{,}8x1}{2} = 1{,}2W$ ✓ ✓

$P = V \times I$ ✓

$V \times I \times \frac{80}{100} = 1{,}2$ ✓

$6 \times I \times \frac{80}{100} = 1{,}2$

$I = 0{,}25$ A ✓

2.4 J

W = V I Δt

1.92 = 6(I)(2)

10.4 Accept cosine graph for 1 cycle

P = 1.2 W

P = W/Δt

W = 2.4

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth *Massa van die Aarde*	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31} \text{ kg}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/*of* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s}f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b}f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf (ε) = $I(R + r)$ emk (ε) = $I(R + r)$
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I \Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{average} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$ $P_{average} = I_{rms}^2R$ / $P_{gemiddeld} = I_{wgk}^2R$ $P_{average} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$

education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

EXEMPLAR 2008

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages, a 3-page data sheet, an answer sheet and graph paper.

SECTION A

Answer this section on the attached ANSWER SHEET.

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for EACH of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) on the attached ANSWER SHEET.

1.1 Change in momentum (1)

1.2 Energy that an object has because of its motion (1)

1.3 The ability of a wave to spread out after it has passed through a small aperture (1)

1.4 The electric potential energy of a point charge situated at a point divided by the charge itself (1)

1.5 The minimum energy needed to eject electrons from a metal using light (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A	COLUMN B
2.1 The energy that an object has due to its height above a reference point	A radio waves
	B primary colours
2.2 Any two colours which, when added together, give white light	C photo-electric effect
	D kinetic energy
2.3 The force per unit charge	E sound waves
2.4 Waves propagated as magnetic and electric fields that oscillate perpendicularly to each other	F gravitational potential energy
	G thermionic effect
2.5 The emission of electrons from a metal surface using light of an appropriate frequency	H potential difference
	I complementary colours
	J electric field

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 No work is done by the earth's gravitational force on a satellite which is moving at a constant speed and constant altitude around the earth. (2)

3.2 When catching a ball, a cricketer pulls his hands back to reduce the change in momentum of the ball. (2)

3.3 When monochromatic light passes through glass its frequency changes. (2)

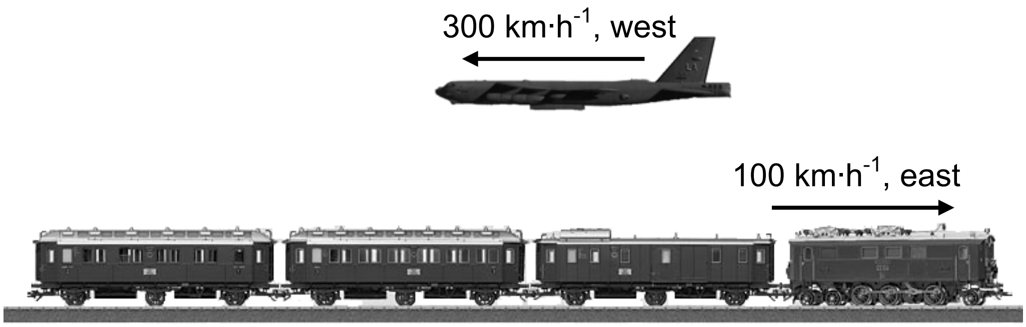
3.4 A filament bulb is an ohmic conductor because it emits heat energy. (2)

3.5 The photo-electric effect is proof that light has a wave nature. (2)
[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 A girl sits in a train travelling east at 100 $km \cdot h^{-1}$. An aeroplane, travelling west at 300 $km \cdot h^{-1}$, passes overhead.



Which ONE of the following is the description of how the aeroplane is moving relative to the girl in the train?

	Magnitude of velocity of aeroplane ($km \cdot h^{-1}$)	**Direction of velocity of aeroplane**
A	400	west
B	200	east
C	200	west
D	400	east

(3)

4.2 An object moving at a constant velocity v has a kinetic energy E. The velocity is changed to 2v. Which ONE of the following is the correct kinetic energy at this velocity?

A ¼E

B ½E

C 2E

D 4E (3)

4.3 Cut glass is used to make ornaments. In light, it shows all the colours of the rainbow. Which ONE of the following is NOT an explanation for this observation?

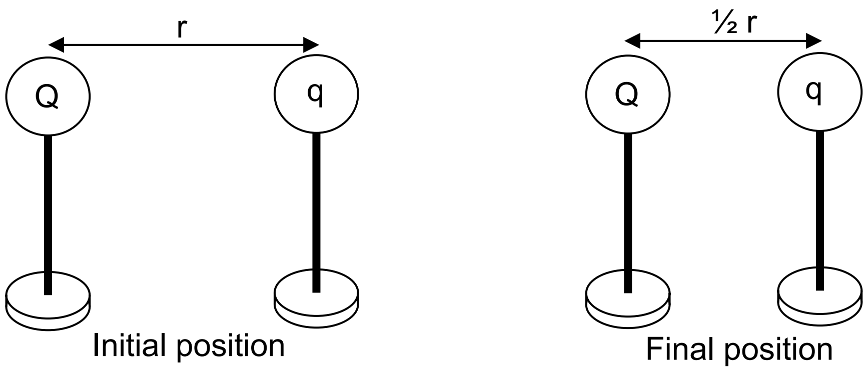
A White light consists of a spectrum of colours.

B Each colour in white light is refracted by different amounts in glass.

C Cut glass has its own characteristic colours.

D White light splits into colours of different frequencies as it passes through glass. (3)

4.4 Two identical metal spheres on insulated stands carry charges of Q and q respectively, as indicated in the diagram. When they are at a distance r from each other, they experience a force F.



The two charges are now moved closer to each other so that the final distance between them is half the original distance, as illustrated. Which ONE of the following correctly describes the new magnitude of the force that the charges experience?

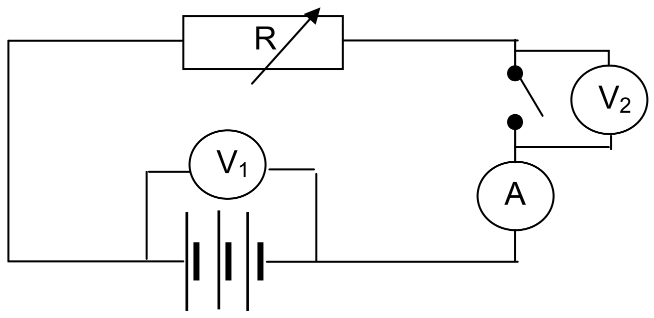
A ¼F

B ½F

C 2F

D 4F (3)

4.5 A variable resistor, an ammeter, a battery of emf 12 V and voltmeters V_1 and V_2 are connected as shown in the diagram below.



When the switch is open, the readings on voltmeters V_1 and V_2 respectively are …

	Reading on V_1	**Reading on V_2**
A	12 V	0 V
B	12 V	12 V
C	0 V	0 V
D	0 V	12 V

(3)
[15]

TOTAL SECTION A: 35

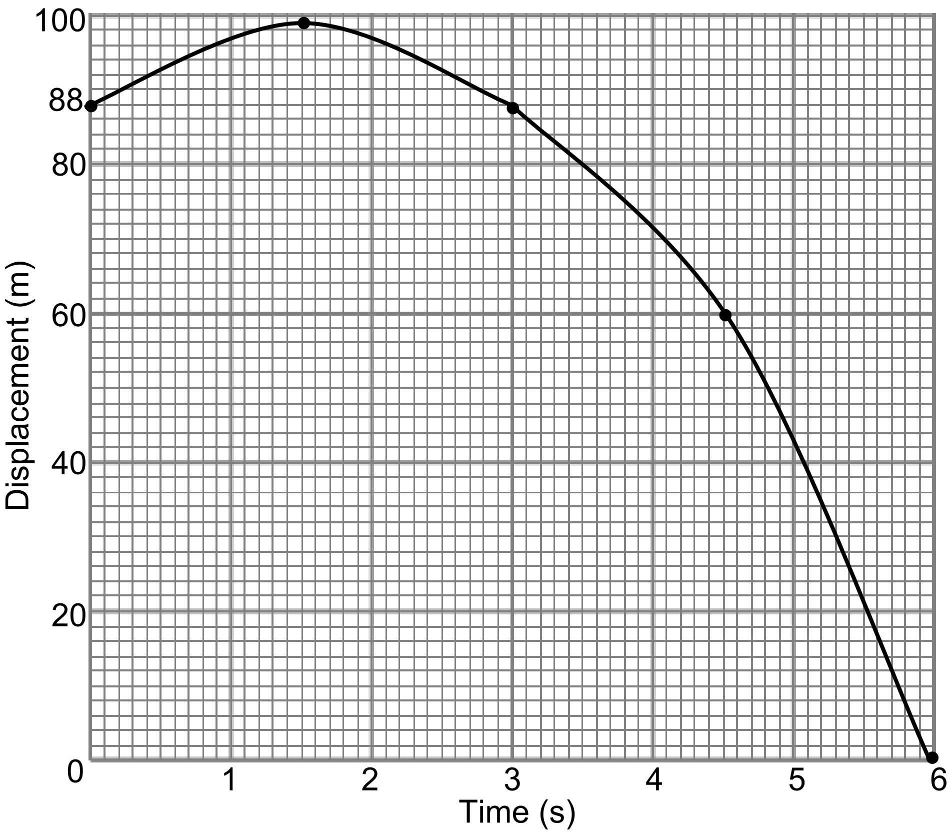
SECTION B

INSTRUCTIONS AND INFORMATION

1. Answer SECTION B in the ANSWER BOOK.
2. The formulae and substitutions must be shown in ALL calculations.
3. Round off your answers to TWO decimal places.

QUESTION 5

A hot-air balloon is rising vertically at constant velocity. When the balloon is at a height of 88 m above the ground, a stone is released from it. The displacement-time graph below represents the motion of the stone from the moment it is released from the balloon until it strikes the ground. Ignore the effect of air resistance.



Use information from the graph to answer the following questions:

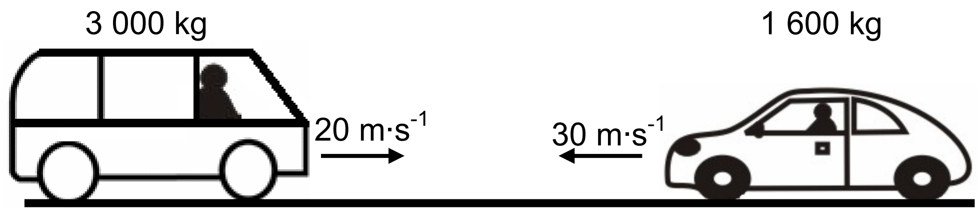
5.1 Calculate the velocity of the hot-air balloon at the instant the stone is released. (6)

5.2 Draw a sketch graph of velocity versus time for the motion of the stone from the moment it is released from the balloon until it strikes the ground. Indicate the respective values of the intercepts on your velocity-time graph. (3)

[9]

QUESTION 6

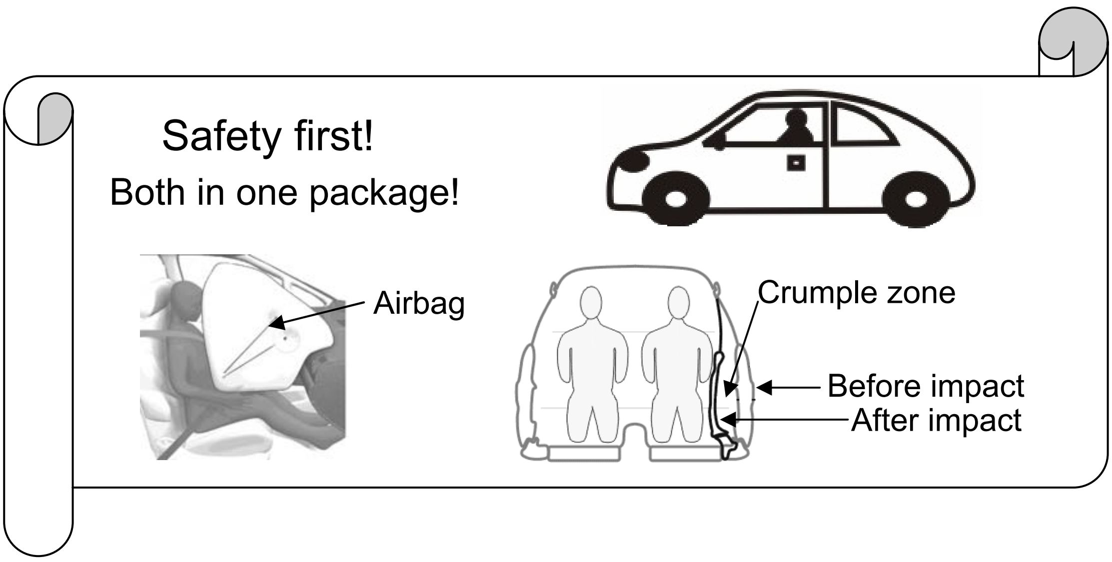
Collisions happen on the roads in our country daily. In one of these collisions, a car of mass 1 600 kg, travelling at a speed of 30 m·s^{-1} to the left, collides head-on with a minibus of mass 3 000 kg, travelling at 20 m·s^{-1} to the right. The two vehicles move together as a unit in a straight line after the collision.



6.1 Calculate the velocity of the two vehicles after the collision. (6)

6.2 Do the necessary calculations to show that the collision was inelastic. (6)

6.3 The billboard below advertises a car from a certain manufacturer.

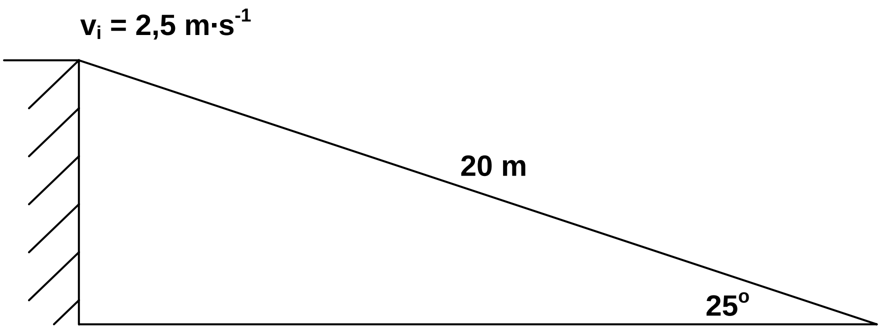


Use your knowledge of momentum and impulse to justify how the safety features mentioned in the advertisement contribute to the safety of passengers. (3)
[15]

QUESTION 7

A person skis down a 20 m long snow slope which makes an angle of 25° with the horizontal.

The total mass of the skier and skis is 50 kg. There is a constant frictional force of 60 N opposing the skier's motion. The speed of the skier as he/she descends from the top of the slope is 2,5 m·s^{-1}.

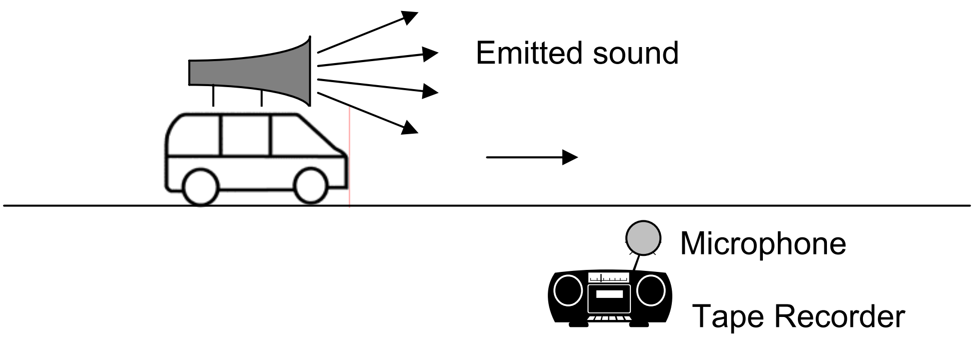


7.1 Calculate the magnitude of the net force parallel to the slope experienced by the person. (5)

7.2 Calculate the maximum speed of the skier at the bottom of the 20 m slope. (6)
[11]

QUESTION 8

During an experiment to determine the speed of sound, learners are given a siren that sounds a single note of frequency 426 Hz. They attach it to a remote controlled car and move it at constant speed past a stationary tape recorder which is mounted in the middle of a runway. Ignore the effects of friction. The tape recorder records the sound of the siren.



The learners make the following observation:
The pitch of the sound from the siren as it moved towards the tape recorder was higher than the pitch as the siren moved away from the recorder.

8.1 Name the effect which explains this observation. (2)

In one of the trials the speed of the remote controlled car was noted as 31 km·h^{-1}*. Two notes from the siren were recorded: one with a frequency of 437* Hz *and the other note with a frequency lower than 426* Hz*.*

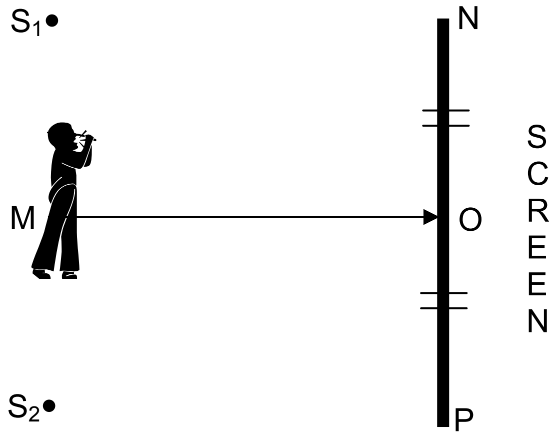
8.2 Convert 31 km·h^{-1} to m·s^{-1}. (2)

8.3 Determine the speed of sound in air. (5)

8.4 Give a reason why the observed frequencies are respectively higher and lower than the frequency of the source (426 Hz). (2)
[11]

QUESTION 9

Red light from two stationary narrow slits, S_1 and S_2, reaches a large white screen PON, indicated in the diagram below.



A dark band is observed at point P on the screen. The brightest band is observed at point O on the screen. Bands are arranged such that the band at point N on the screen is dark.

9.1 State Huygens' principle in words. (2)

9.2 Write down the type of interference that occurs at point O. Write down only DESTRUCTIVE or CONSTRUCTIVE. Briefly explain your answer. (3)

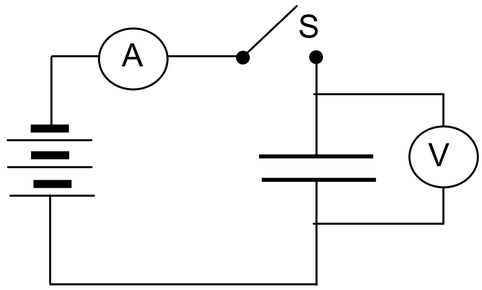
9.3 Describe the change in brightness, if any, of the light bands formed on the screen as you walk closer to the screen from point M to point O. Briefly explain your answer. (3)

The red light is now replaced with a green light.

9.4 How will the new pattern differ from the previous one? (2)
[10]

QUESTION 10

A learner sets up a circuit as illustrated in the circuit diagram below to investigate the change in electric current over time while a capacitor is being charged. Initially there is no charge on the capacitor.



After closing the switch, the learner takes the ammeter readings every 20 seconds. The table below shows the results obtained during the investigation.

I (μ A)	90	66	46	30	20	14	9	6
t (s)	0	20	40	60	80	100	120	140

10.1 Draw a graph of electric current (on the dependent, y-axis) versus time (on the independent, x-axis) on the attached GRAPH PAPER. Draw the axes and choose an appropriate scale. Plot the points and then draw the best fitting line. Supply a suitable heading for your graph. [HINT: The graph is not a straight-line.] (5)

10.2 Use the graph in QUESTION 10.1 to determine the reading on the ammeter after 30 s. (1)

10.3 Consider the change in the ammeter reading and change in the potential difference to explain the shape of the graph. (2)

A capacitor is rated 9 V, 50 μF.

10.4 Calculate the charge on the fully charged capacitor. (3)

10.5 Capacitors are seen as batteries of the future. State ONE advantage that capacitors have over batteries such as torch batteries. (2)

10.6 Appliances such as TVs contain large capacitors. Give a reason why such capacitors are discharged before servicing the appliances. (2)

[15]

QUESTION 11

A group of learners are requested to investigate the relationship between electric current and potential difference. Before conducting the investigation they have to plan and design a suitable experiment.

The learners approach you to assist them with the planning and design of the investigation. Make use of the layout below to help them with the planning and design of the investigation.

11.1 Planning

11.1.1 What is the investigative question for this investigation? (2)

11.1.2 Write down a possible hypothesis for this investigation. (2)

11.1.3 Write down ONE variable that the learners must control during this investigation. (1)

11.2 Design

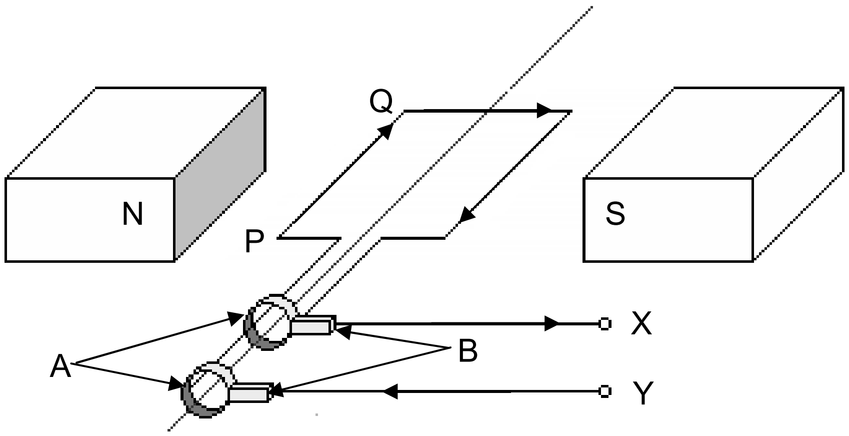
11.2.1 List ALL the apparatus that the learners will need for this investigation. (3)

11.2.2 Draw a circuit diagram that they can use to assemble the apparatus. (3)

11.2.3 Describe, in not more than four lines, how the learners must use this apparatus to take the required measurements. (3)
[14]

QUESTION 12

The simplified sketch below shows the principle of operation of the alternating current (AC) generator.



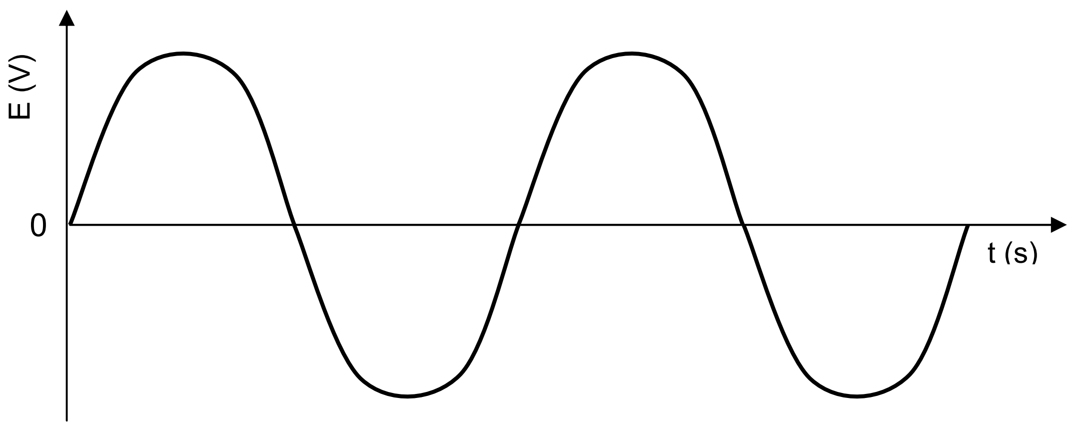
12.1 Name the parts labelled A and B respectively. (2)

12.2 In which direction does segment PQ of the coil have to be rotated in order to cause the current direction as shown in the diagram? Write down only clockwise or anticlockwise. (1)

12.3 Write down TWO changes that can be brought about to improve the output of the generator. (2)

12.4 What changes must be made to the AC generator to make it function as a direct-current (DC) motor? (2)

12.5 The induced emf versus time graph for an AC generator is shown below.



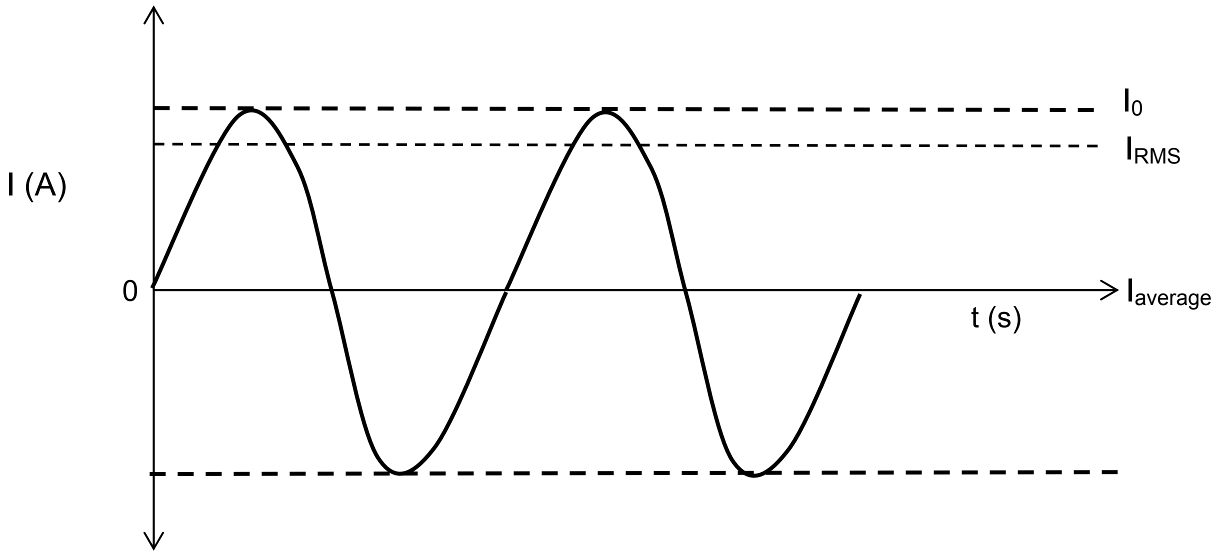
Sketch a graph to show how the above waveform changes, if at all, after changing this generator into a DC generator. (2)

12.6 State TWO advantages of using AC over DC for the long-distance transmission of electrical power. (2)

[11]

QUESTION 13

The sine waveform shown below represents the variation of current (I) with time (t) for a generator used by a man to light his home. The current alternates between a maximum and a minimum.



In the diagram, I_0 = the peak current
I_{RMS} = root mean square current
$I_{average}$ = average value of the current

13.1 Write down an expression for the instantaneous current in terms of the frequency of the source and the time. (2)

13.2 Write down a formula which represents the relationship between the maximum peak current (I_0) and the root mean square current (I_{RMS}). (2)

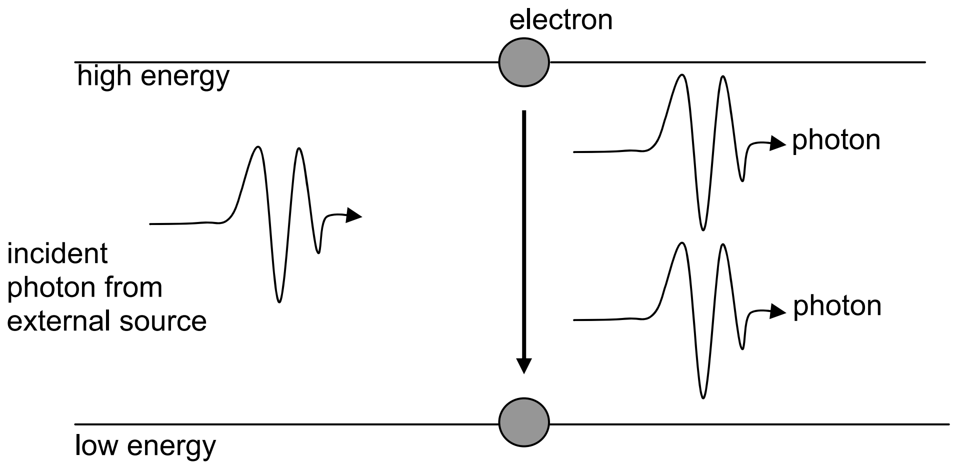
13.3 The frequency of the AC generated by Eskom is 50 Hz. A substation supplies 240 V (RMS) to a house. Calculate the peak voltage at a wall socket. (3)

13.4 Explain why it is of greater value to use RMS current than the average current. (2)
[9]

QUESTION 14

A **laser** is a device that controls the way that energised atoms release photons. 'Laser' is an acronym for **l**ight **a**mplification by **s**timulated **e**mission of **r**adiation, which describes how a laser works.

The diagram below shows how stimulated emission occurs:



Lasers are used in dental drills, compact disk players (CD players), high-speed metal cutting machines, measuring systems, printers and for delicate surgery.

14.1 Describe the process that leads to the emission of the two photons as shown in the diagram. (4)

14.2 Write down TWO properties that distinguish a laser beam from an ordinary light beam. (2)

14.3 Why is a beam from a torch light to illuminate an area preferable to that from a laser when you go on a camping trip? (2)

14.4 Write down TWO advantages of using lasers for eye operations. (2)
[10]

TOTAL SECTION B: 115

GRAND TOTAL: 150

SECTION A / *AFDELING A*

QUESTION 1 / *VRAAG 1*

1.1	Impulse / *Impuls* ✓	[12.2.1]	(1)
1.2	Kinetic / *Kinetiese* ✓	[12.2.1]	(1)
1.3	Diffraction / *Diffraksie* ✓	[12.2.1]	(1)
1.4	Electric-potential / *Elektriesepotensiaal* ✓	[12.2.1]	(1)
1.5	Work-function/*Werkfunksie* ✓	[12.2.1]	(1)
			[5]

QUESTION 2 / *VRAAG 2*

2.1	F ✓	[12.2.1]	(1)
2.2	I ✓	[12.2.1]	(1)
2.3	J ✓	[12.2.1]	(1)
2.4	A ✓	[12.2.1]	(1)
2.5	C ✓	[12.2.1]	(1)
			[5]

QUESTION 3 / *VRAAG 3*

3.1	True / *Waar* ✓✓	[12.2.3]	(2)
3.2	False / *Onwaar* ✓ … to reduce the force ✓ / …verminder die krag	[12.2.3]	(2)
3.3	False / *Onwaar* ✓ Frequency remains constant. ✓ / *Frekwensie bly dieselfde.*	[12.2.3]	(2)
3.4	False / *Onwaar* ✓ Non-ohmic conductor/ *nie-ohmiese geleier*✓	[12.2.1]	(2)
3.5	False / *Onwaar* ✓ Proof of particle nature OR Diffraction/interference is proof of wave nature ✓ *Bewys van deeltjie-aard OF diffraksie/interferensie is bewys van golfaard*	[12.2.1]	(2)
			[10]

QUESTION 4 / *VRAAG 4*

4.1	A ✓✓✓	[12.2.3]	(3)
4.2	D ✓✓✓	[12.2.3]	(3)
4.3	C ✓✓✓	[12.2.3]	(3)
4.4	D ✓✓✓	[12.2.3]	(3)
4.5	B ✓✓✓	[12.2.3]	(3)
			[15]

TOTAL SECTION A = 35
TOTAAL AFDELING A = 35

SECTION B / *AFDELING B*

QUESTION 5 / *VRAAG 5*

5.1 For complete motion of stone/*Vir volledige beweging van klip:*
Upward motion negative / Opwaartse *beweging negatief*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\therefore$ 88 ✓= $v_i(6)$ ✓+ $\frac{1}{2}(9,8)(6)^2$ ✓

v_i = - 14,7 m·s^{-1} $\therefore$ 14,7 m·s^{-1} upwards/*opwaarts* ✓

$v_{balloon} = v_{stone}$✓ = 14,7 m·s^{-1}

OR/*OF*

For complete motion of stone/*Vir volledige beweging van klip:*
Downward motion negative / A*fwaartse beweging negatief*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\therefore$ - 88 ✓= $v_i(6)$ ✓+ $\frac{1}{2}(-9,8)(6)^2$ ✓

v_i = 14,7 m·s^{-1} $\therefore$ 14,7 m·s^{-1} upwards/*opwaarts* ✓

$v_{balloon} = v_{stone}$✓ = 14,7 m·s^{-1}

OR/*OF*

Consider upward motion only/*Beskou slegs opwaartse beweging*:
Upward motion negative / Opwaartse *beweging negatief*

$v_f = v_i + g\Delta t$ ✓ $\therefore$ 0 ✓= v_i + (9,8)(1,5) ✓

$\therefore$ v_i = - 14,7 m·s^{-1} $\therefore$ 14,7 m·s^{-1} ✓upwards/*opwaarts* ✓

$v_{balloon} = v_{stone}$✓ = 14,7 m·s^{-1}

OR/*OF*

Consider upward motion only/*Beskou slegs opwaartse beweging*:
Downward motion negative / A*fwaartse beweging negatief*

$v_f = v_i + g\Delta t$ ✓ $\therefore$ 0 ✓= v_i + (- 9,8)(1,5) ✓

$\therefore$ v_i = 14,7 m·s^{-1} $\therefore$ 14,7 m·s^{-1} ✓upwards/*opwaarts* ✓

$v_{balloon} = v_{stone}$✓ = 14,7 m·s^{-1}

OR/*OF*

Consider upward motion only/*Beskou slegs opwaartse beweging*:
Upward motion negative / Opwaartse *beweging negatief*

$v_f^2 = v_i^2 + 2g\Delta y$ ✓ $\therefore$ 0^2 ✓= v_i^2 + 2(9,8)(99 - 88) ✓

$\therefore$ v_i = - 14,7 m·s^{-1} $\therefore$ 14,7 m·s^{-1} ✓upwards/*opwaarts* ✓

$v_{balloon} = v_{stone}$✓ = 14,7 m·s^{-1}

OR/*OF*

Consider upward motion only/*Beskou slegs opwaartse beweging*:
Downward motion negative / A*fwaartse beweging negatief*

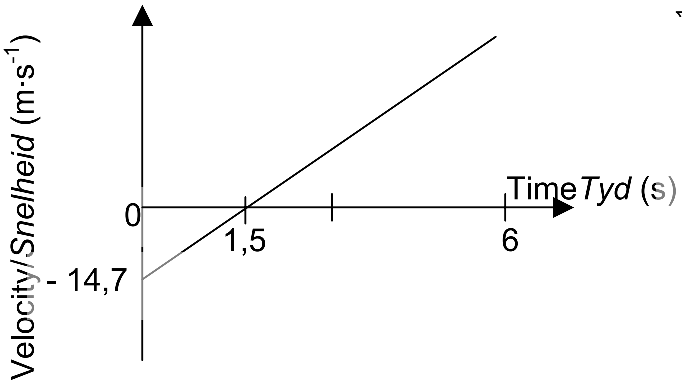
$v_f^2 = v_i^2 + 2g\Delta y$ ✓ $\therefore$ 0^2 ✓= v_i^2 + 2(- 9,8)(99 - 88) ✓

$\therefore$ v_i = 14,7 m·s^{-1} $\therefore$ 14,7 m·s^{-1} ✓upwards/*opwaarts* ✓

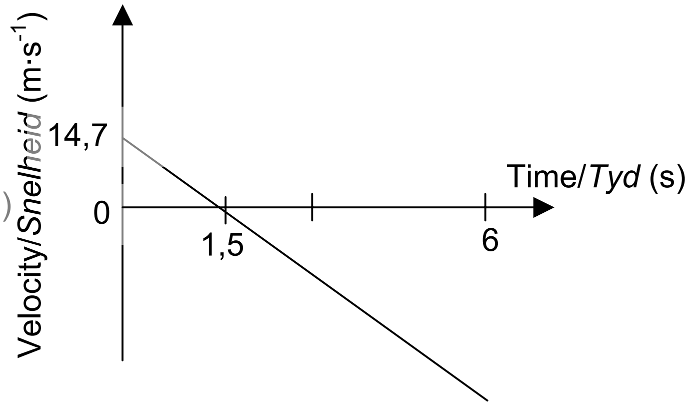
$v_{balloon} = v_{stone}$✓ = 14,7 m·s^{-1} [12.1.2] (6)

5.2

Upward motion as negative:
Opwaartse beweging negatief:



Downward motion as negative:
Afwaartse beweging negatief:



Checklist/*Kontrolelys* Criteria for graph/ *Kriteria vir grafiek*	Marks/ *Punte*
Graph is a straight line that intercepts x-axis at 1,5 s *Grafiek is 'n reguit lyn wat die x-as by 1,5 s sny*	✓
Maximum velocity after 6 s/ Maksimum snelheid na 6 s.	✓
Initial velocity indicated as 14,7 $m{\cdot}s^{-1}$/ Beginsnelheid aangedui as 14,7 $m{\cdot}s^{-1}$	✓

(3)
[12.1.2] **[9]**

QUESTION 6 / *VRAAG 6*

6.1 Consider motion to the right as positive:/*Beskou beweging na regs as positief:*

$p_{before} = p_{after}$ ✓

$m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v_f$

(1 600)(30) ✓+ (3 000)(-20) ✓ = (1 600 + 3 000) v_f✓

48 000 – 60 000 = (4 600)v_f

$v_f = -2{,}6\ m{\cdot}s^{-1}$ ∴ $v_f = 2{,}6\ m{\cdot}s^{-1}$ ✓ to the right/*na regs*✓ [12.2.3] (6)

6.2 Before collision/*voor botsing*:

$E_k = \frac{1}{2}m_1v_{i1}^2 + \frac{1}{2}m_2v_{i2}^2$ ✓= $\frac{1}{2}$ (1 600)(30)^2 + $\frac{1}{2}$(3 000)(16)^2 ✓

= 720 000 + 384 000 = 1,104 x 10^6 J✓

After collision/*na botsing*:

$E_k = \frac{1}{2}m_1v_{f1}^2 + \frac{1}{2}m_2v_{f2}^2$ = $\frac{1}{2}$ (1 600 + 3 000)(2,6)^2 ✓= 384 000

= 5 980 J ✓

E_k before collision not equal to E_k after collision – thus the collision is inelastic ✓

/*E_k voor botsing nie gelyk aan E_k na botsing – dus is die botsing nie-elasties* [12.1.3] (6)

6.3 During a collision, the crumple zone/ airbag **increases the time** during which momentum changes ✓ and according to the equation

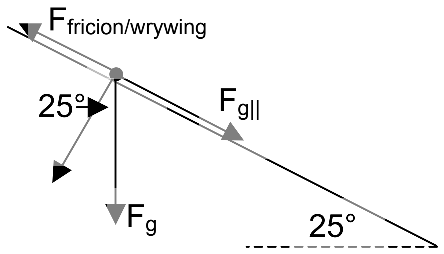
$F_{net} = \frac{\Delta p}{\Delta t}$ ✓ the **force during impact will decrease**. ✓

[12.3.2]

*Tydens 'n botsing sal die frommelsone/lugsak die **tyd** waartydens die momentum verander **verhoog** en volgens die vergelyking $F_{net} = \frac{\Delta p}{\Delta t}$ sal die **krag tydens impak verlaag.*** (3)

QUESTION 7 / *VRAAG 7*

7.1 Net force causing motion along the ramp:/ *Netto krag wat beweging langs die skuinsvlak veroorsaak.*



$F_{net} = F_{g||} - F_{friction/wrywing}$ ✓
$= mg \sin 25^o$ ✓✓ $- F_{friction/wrywing}$
$= (50)(9,8)(\sin 25°) - 60$ ✓ $= 147,08$ N✓

[12.1.3] (5)

7.2 Work done by net force: / *Arbeid verrig deur netto krag*:
$W = F\Delta x$ ✓ $= 147,08 \times 20$ ✓ $= 2941,66$ J

$W = E_{kf} - E_{ki}$✓
$E_{kf} = W + E_{ki\ i} = 2941,66 + ½\ 50(2,5)^2$ ✓ $= 3097,91$ J

$E_{kf} = ½\ mv^2\ \therefore 3097,91 = ½\ (50)v^2$ ✓ $\therefore v = \sqrt{\frac{3097,91}{25}} = 11,13\ m{\cdot}s^{-1}$✓

[12.1.3] (6)
[11]

QUESTION 8 / *VRAAG 8*

8.1 Doppler Effect / *Doppler effek*✓✓ [12.2.3] (2)

8.2 $31\ km{\cdot}h^{-1} = \frac{31\,000}{3\,600}$ ✓ $= 8,61\ m{\cdot}s^{-1}$ ✓ [12.2.3] (2)

8.3 $f_L = \frac{v}{v - v_S} f_S$ ✓

437 ✓ $= \frac{v}{v - 8,61}(426)$ ✓✓

$v = 342,05\ m{\cdot}s^{-1}$ ✓ [12.2.3] (5)

8.4 Higher frequency: source is moving towards observer. ✓
Lower frequency: source is moving away from observer. ✓

Hoër frekwensie bron beweeg na die waarnemer.
Laer frekwensie bron beweeg weg vanaf die waarnemer. (2)

[12.2.2] **[10]**

QUESTION 9 / *VRAAG 9*

9.1 Every point on a wavefront acts as a source of secondary waves. ✓✓

Elke punt op 'n golffront reageer soos 'n bron van sekondêre golwe. [12.2.1] (2)

9.2 CONSTRUCTIVE ✓ - waves are interfering constructively to increase the amplitude of the wave. ✓✓

KONSTRUKTIEF - gGolwe interfereer konstruktief om die amplitude van die golf te verhoog. [12.2.3] (3)

9.3 Brightness of red light remains the same. ✓ The distance from each source to line MO is the same. (The difference in path length is zero) ✓✓

Die helderheid van rooi lig bly dieselfde. Die afstand vanaf elke bron na lyn MO is dieselfde. (Die padlengte verskil is nul) [12.2.3] (3)

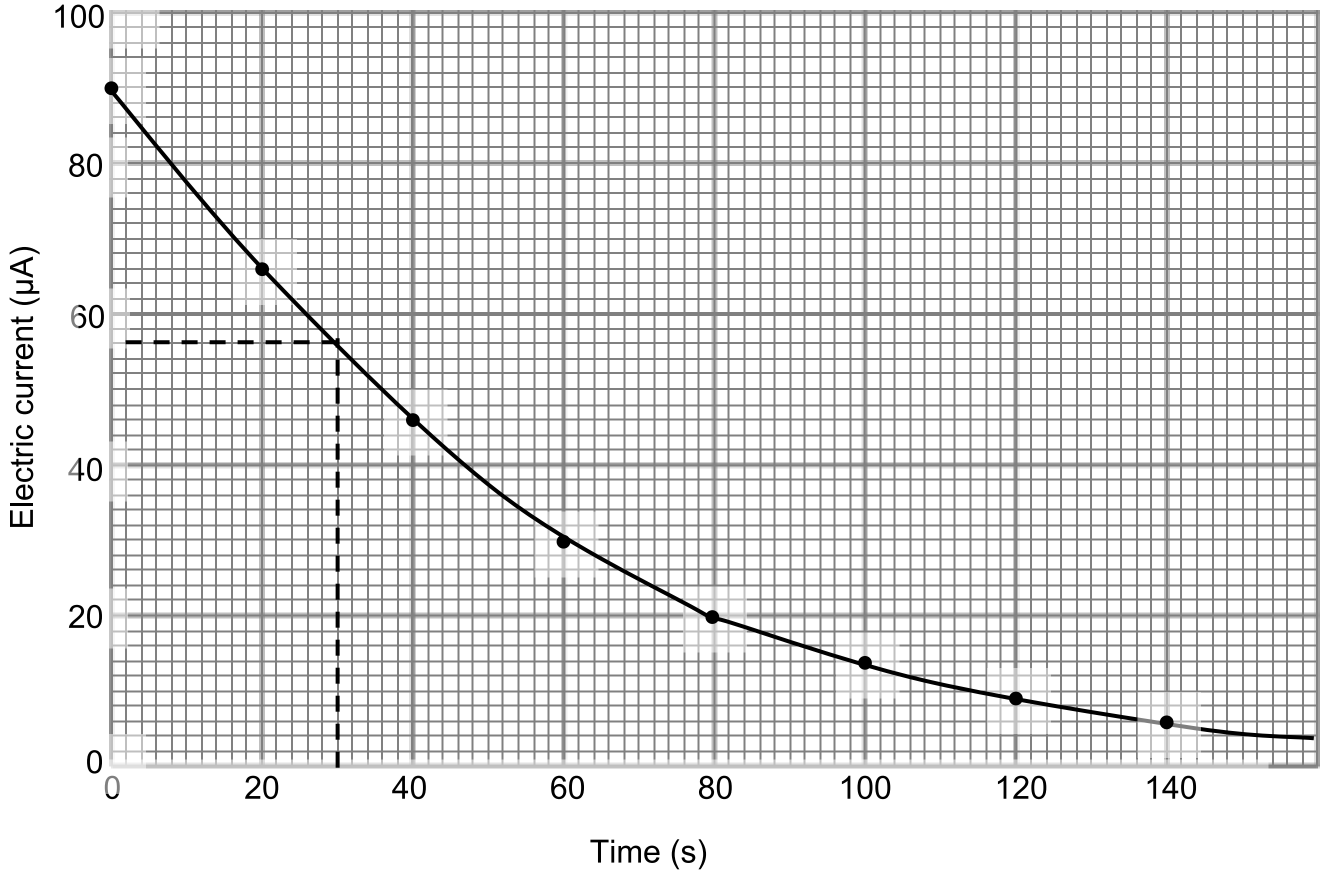
9.4 Green and dark bands are narrower. ✓✓

Groen en donker bande is smaller [12.2.2] (2)
[10]

QUESTION 10 / *VRAAG 10*

10.1

Graph of electric current versus time/*Grafiek van elektriese stroom teenoor tyd*



Checklist/*Kontrolelys* Criteria for graph/ *Kriteria vir grafiek*	Marks/ *Punte*
Suitable heading / Geskikte opskrif	✓
Correct scale on both axes/ Korrekte skaal op beide asse	✓
Correct labels on both axes/ *Korrekte byskrifte op beide asse*	✓
Points plotted correctly/*Punte korrek gestip.*	✓
Curve drawn through points/*Kurwe deur punte getrek.*	✓

[12.1.2] (5)

10.2 56 μA ✓ [12.1.2] (1)

10.3 As the **potential difference across the plates of the capacitor increases** during charging, the **potential difference of the battery is opposed**, ✓causing the current in the circuit to gradually decrease. ✓ [12.1.2] (2)

10.4 $C = \frac{Q}{V}$ ✓ $\therefore$ $50 \times 10^{-6} = \frac{Q}{9}$ ✓ $\therefore$ $Q = 4{,}5 \times 10^{-4}$ C✓

[12.2.3] (3)

10.5 Any one/ *Enige een:*
Supply electrical energy faster ✓
Can be recharged almost indefinitely
No spilling of dangerous chemicals

Verskaf elektriese energie vinniger
Kan feitlik onbeperk herlaai word
Geen mors van gevaarlike chemikalieë nie.

[12.3.2] (2)

10.6 The high voltage across plates can cause electric shock or even death when the capacitor discharges.

Die hoë potensiaalverskil oor die plate kan 'n elektriese skok of selfs die dood veroorsaak wanneer die kapasitor ontlaai.

[12.3.2] (2)
[15]

QUESTION 11 / *VRAAG 11*

11.1 11.1.1 Examples/*Voorbeelde:*
What is the relationship between the electric current and the potential difference?
OR
How does the electric current change when the potential difference changes?

Wat is die verwantskap tussen elektriese stroom en potensiaalverskil?
OF
Hoe verander die elektriese stroom indien die potensiaalverskil verander?

Checklist/*Kontrolelys* Criteria for investigative question/ *Kriteria vir ondersoekende vraag*	Marks/ *Punte*
Question that refers to dependent variable/ *Vraag wat na afhanklike veranderlike verwys*	✓
Question that refers to independent variable/ *Vraag wat na onafhanklike veranderlike verwys*	✓

[12.1.1] (2)

11.1.2 Any prediction that answers the investigative question / *Enige voorspelling what die ondersoekende vraag beantwoord:*

Checklist/*Kontrolelys* Criteria for hypothesis/ *Kriteria vir hipotese*	Marks/ *Punte*
Statement that can be proved true or false (not an aim) *Stelling wat reg of verkeerd bewys kan word (nie 'n doel nie)*	✓
Question refers to dependent and independent variables *Stelling verwys na afhanklike en onafhanklike veranderlikes*	✓

Examples/Voorbeelde

Electric current is directly proportional to potential difference/*Elektriese stroom is direk eweredig aan potensiaalverskil*
OR/*OF*
Electric current increases as the potential difference increases./*Elektriese stroom neem toe soos wat die potensiaalverskil toeneem.*
OR/*OF* (2)
Electric current increases as the potential difference decreases./*Elektriese stroom neem toe soos wat die potensiaalverskil afneem.* [12.1.1]

11.1.3 Temperature/*Temperatuur* ✓ [12.1.1] (1)

11.2 11.2.1 Method 1/*Metode 1:*
Torch batteries, ammeter, voltmeter, resistor e.g. nichrome wire (not a bulb), connecting wires/
Flitsbatterye, ammeter, voltmeter, weerstand bv. nichroomdraad (nie 'n gloeilamp nie), verbindingsdrade

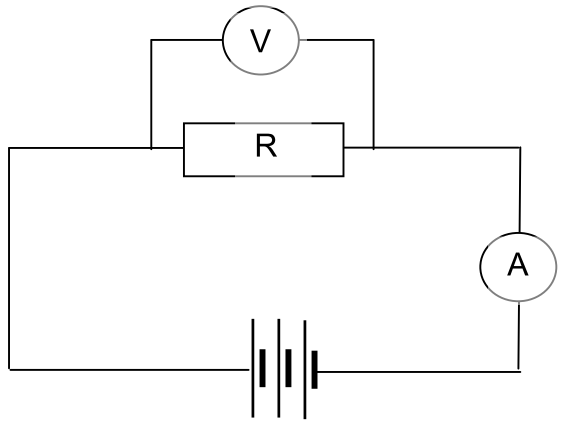
OR
Method 2/*Metode 2:*
Power source, rheostat, ammeter, voltmeter, resistor e.g. nichrome wire (not a bulb), connecting wires/
Kragbron, verstelbare weerstand, ammeter, voltmeter, weerstand bv. nichroomdraad (nie 'n gloeilamp nie), verbindingsdrade

Checklist/Kontrolelys **Criteria for keuse van apparaat/*Kriteria vir keuse van apparaat***	Marks/ *Punte*
Any source of electricity of which potential difference can be changed *Enige verstelbare bron van potensiaalverskil*	✓
Ammeter and/*en* voltmeter	✓
Resistor/Weerstand	✓

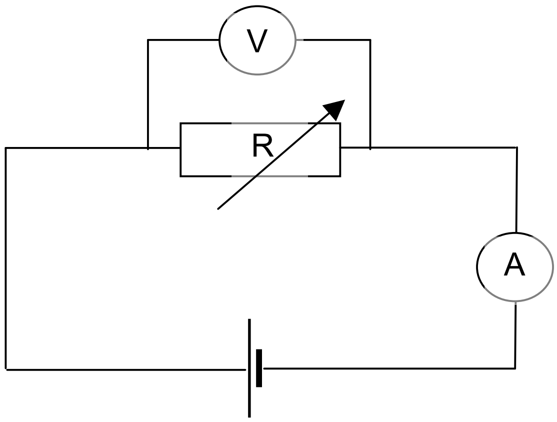
[12.1.1] (3)

11.2.2

Method 1/*Metode 1*



Method 2/*Metode 2*



Checklist/Kontrolelys **Criteria for circuit diagram/*Kriteria vir stroombaandiagram***	Marks/ *Punte*
Source of electricity correctly indicated/*Bron van elektrisiteit korrek aangedui*	✓
Resistor with voltmeter connected in parallel across resistor correctly indicated/*Weerstand met voltmeter in parallel oor weerstand korrek aangedui*	✓
Ammenter connected in series to measure current in resistor/*Ammeter in serie geskakel om stroom deur resistor the meet*	✓

[12.1.1] (3)

11.2.3 With one battery, measure the voltmeter reading and the ammeter reading.
Add another battery in series with the first and repeat the measurements.
Add a third battery in series with the first two and repeat the measurements.

Met een battery, meet die voltmeterlesing en die ammeterlesing.
Voeg 'n tweede battery in serie met die eerste en herhaal die metings.
Voeg 'n derde battery in serie met die eerste twee en herhaal die metings.

OR/*OF*

Adjust the rheostat connected in series to the power source and take the readings on the ammeter and voltmeter.
Increase/decrease the resistance of the rheostat and take a second set of readings.
Increase/decrease the resistance of the rheostat to take a third set of readings.

Verstel die verstelbare weerstand wat in serie met die kragbron geskakel is en neem die lesings op die ammeter en die voltmeter.
Verhoog/verlaag die weerstand en neem 'n tweede stel lesings.
Verhoog/verlaag die weerstand en neem 'n derde stel lesings.

Checklist/Kontrolelys **Criteria for method/*Kriteria vir metode:***	Marks/ *Punte*
Indicates that potential difference must be adjusted. / *Dui aan dat potensiaalverskil verstel moet word.*	✓
Indicates that voltmeter reading must be taken. / *Dui aan dat voltmeterlesing geneem moet word.*	✓
Indicates that ammeter reading must be taken. / *Dui aan dat ammeterlesing geneem moet word.*	✓

(3)
[12.1.1] **[14]**

QUESTION 12 / *VRAAG 12*

12.1 A: Slip rings ✓ B: Brushes ✓

A: Sleepringe B: Borsels [12.2.1] (2)

12.2 Anticlockwise ✓
Antikloksgewys [12.2.3] (1)

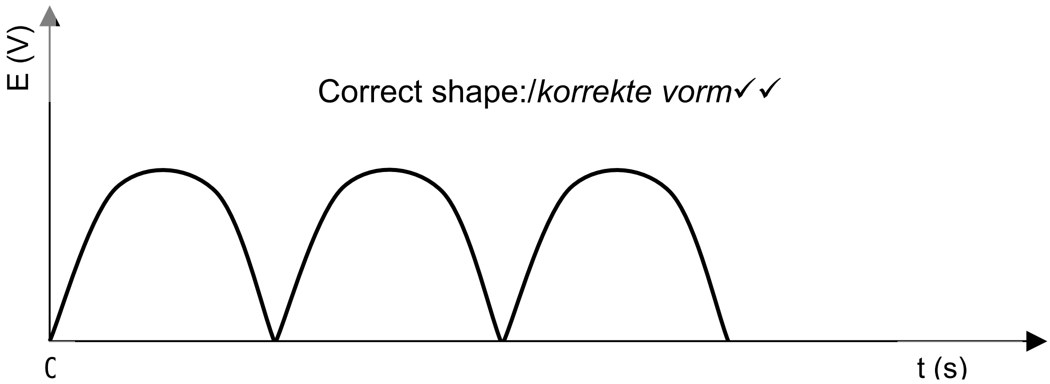
12.3 Any two:
Increase number of turns of coil ✓
Increase magnetic field strength (stronger magnets) ✓
Increase speed of rotation
Use horse-shoe magnet (to concentrate field)

Enige twee:
Verhoog die aantal windings op die spoel
Verhoog die sterkte van die magneetveld
Verhoog die rotasiespoed
Gebruik 'n hoefystermagneet (om veld te konsentreer) [12.2.1] (2)

12.4 Use split ring commutators instead of slip rings ✓
Add a battery to provide electrical energy to drive motor. ✓

Gebruik 'n splitring kommutator in plaas van sleepringe
Voeg 'n battery by om elektriese energie te verskaf om die motor aan te dryf [12.2.3] (2)

12.5



[12.1.2] (2)

12.6 Any two:
(i) easier to generate and transmit from place to place ✓
(ii) easier to convert from a.c. to d.c. than the reverse ✓
(iii) voltage can be easily changed by stepping it up or down
(iv) high frequency used in a.c. make it more suitable for electric motors

Enige twee
(i) makliker om op te wek en van een plak na 'n ander oor te dra
(ii) makliker om vanaf ws na gs om te skakel as die omgekeerde
(iii) potensiaalverksil kan maklik verander word deur dit te verhoog of te verlaag
(iv) hoë frekwensie gebruik in ws maak dit meer geskik vir elektriese motors [12.3.2] (2)
[12]

QUESTION 13 / *VRAAG 13*

13.1 $I = I_0 \sin\omega t$ ✓✓ or $I = I_0 \sin 2\pi ft$ [12.1.2] (2)

13.2 $I_{rms} = \frac{I_0}{\sqrt{2}}$ ✓✓ [12.2.1] (2)

13.3 $V_0 = \sqrt{2}\, V_{rms}$ ✓= 1,414 x 240 ✓ = 339, 36 V ✓ [12.2.3] (3)

13.4 The average value of the current over the cycle is zero and no useful power is delivered.✓✓
Die gemiddelde waarde van die stroom oor die siklus is nul en geen bruikbare drywing word gelewer nie. [12.1.2] (2)
[9]

QUESTION 14 / *VRAAG 14*

14.1 Incoming incident photon collides with electron. ✓
Electron is excited to a higher energy level. ✓
The unstable electron returns to the lower energy level, ✓ emitting two photons. ✓

Invallende foton bots met die electron. ✓
Elektron word opgewek na hoër energievlak. ✓
Die onstabiele elektron keer na laer energievlak terug ✓ *en stel twee fotone vry.* ✓ [12.1.2] (4)

14.2 *Any two*:/ *Enige twee*:
Laser beam is: / *Laser straal is*:
Monochromatic / *Monochromaties* ✓
Coherent / *Koherent* ✓
Unidirectional / *In een rigting gekonsentreer* [12.2.1] (2)

14.3 A flash light gives a broad beam that sweeps a wider area. ✓
A laser beam is narrow. ✓

'n Flitslig verskaf 'n breë straal lig wat 'n groter area dek
'n Laserstraal is nou [12.3.2] (2)

14.4 Less damage to eye tissue✓
Less scarring/ More precision cut ✓

Minder skade aan die oogweefsel
Minder littekens/Meer akkurate snit [12.3.2] (2)
[11]

GRAND TOTAL = 150
GROOTTOTAAL = 150

education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

ADDITIONAL EXEMPLAR 2008

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages, 3 data sheets and 1 answer sheet.

SECTION A

Answer this section on the attached ANSWER SHEET.

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) on the attached ANSWER SHEET.

1.1 The product of the magnitude of a force on an object and the magnitude of the distance that the object moves in the direction of the force (1)

1.2 The rate at which work is done (1)

1.3 The pattern observed on a screen when red light passes through a double slit (1)

1.4 Force per unit charge (1)

1.5 The process by which an atom moves to its ground state emitting a photon of energy without any outside influence (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A		COLUMN B	
2.1	The product of force and velocity	A	potential dividers
2.2	Complementary colours	B	impulse
2.3	The colour model used to produce colour on a television screen	C	subtractive
		D	cyan light and green light
2.4	Resistors in series	E	power
2.5	The condition in a laser where more atoms are in the excited state than in the ground state	F	population inversion
		G	current dividers
		H	additive
		I	stimulated emission
		J	blue light and yellow light

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 A long cannon will impart a greater impulse to a cannonball than a short cannon because the force acts over a longer time. (2)

3.2 The light bands produced by red light through a double slit is narrower than the bands produced by blue light. (2)

3.3 Halving the distance between two stationary charges doubles the electrostatic force that the charges exert on each other. (2)

3.4 A DC generator produces a constant direct current similar to that produced by a battery. (2)

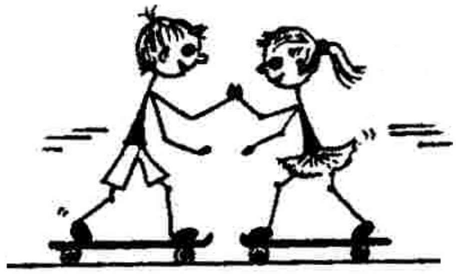
3.5 Laser light is coherent, monochromatic, sharply focussed and highly directional. (2)

[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 A boy, mass *2m*, and a girl, mass *m*, are facing each other on roller skates. With their hands, they push off against one another. The boy experiences a force *F* and an acceleration *a* to the left.



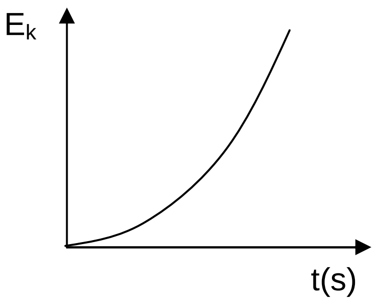
Which ONE of the following best describes the magnitudes of the force and acceleration experienced by the girl? Ignore the effects of friction.

	FORCE	ACCELERATION
A	$\frac{1}{2}F$	2a
B	F	2a
C	F	$\frac{1}{2}a$
D	2F	$\frac{1}{2}a$

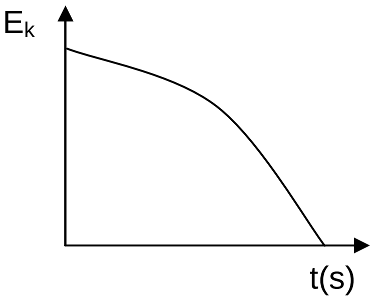
(3)

4.2 A stone is dropped from the edge of a cliff. Which ONE of the following graphs best represents the change in kinetic energy of the stone during its fall?

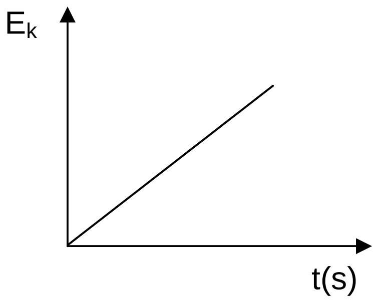
A



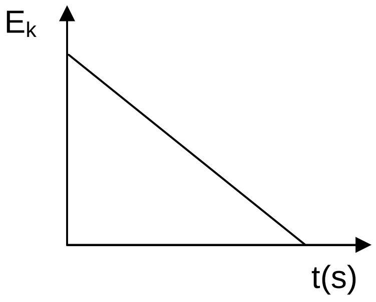
B



C



D



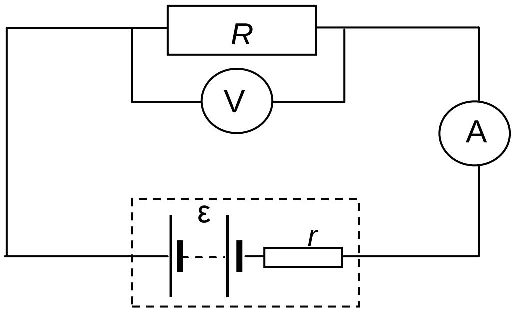
(3)

4.3 A circus clown wears a yellow jacket and a red nose. Which ONE of the following correctly describes the colour of the jacket and the nose of the clown when illuminated with cyan light?

	JACKET	**NOSE**
A	blue	red
B	green	black
C	cyan	black
D	green	cyan

(3)

4.4 A battery with emf ε and internal resistance *r* is connected to a resistor *R* as shown in the circuit diagram below.



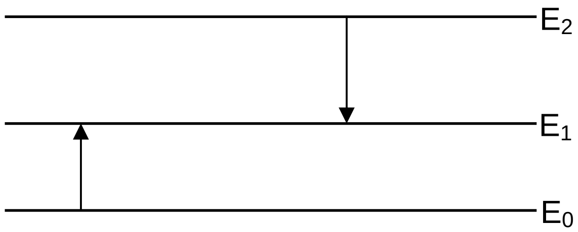
A second resistor of the SAME RESISTANCE is now connected in parallel with resistor *R*.

How will the voltmeter and ammeter readings change when the second resistor is connected in the circuit?

	VOLTMETER READING	**AMMETER READING**
A	stays the same	decreases
B	increases	stays the same
C	decreases	increases
D	increases	increases

(3)

4.5 The energy level diagram for an element is shown below. E_0 represents the ground state. The energy change from E_0 to E_1 is smaller than that for E_2 to E_1.



The electron transition from E_2 to E_1 corresponds to a green line in the element's spectrum. The transition E_0 to E_1 corresponds to ...

A absorption of green light.

B emission of green light.

C emission of red light.

D absorption of red light. (3)

[15]

TOTAL SECTION A: 35

SECTION B

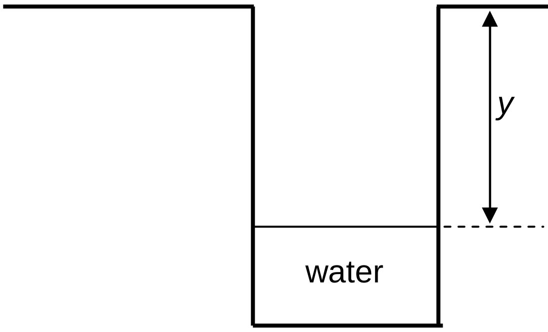
INSTRUCTIONS AND INFORMATION

1. Answer SECTION B in the ANSWER BOOK.
2. The formulae and substitutions must be shown in ALL calculations.
3. Round off your answers to TWO decimal places where applicable.

QUESTION 5

Any falling object which is being acted upon only by the force of gravity is said to be in a state of *free fall*.

5.1 Briefly describe how you can make use of a small free-falling stone to determine how deep the water level is in a well (represented by *y* in the diagram below).

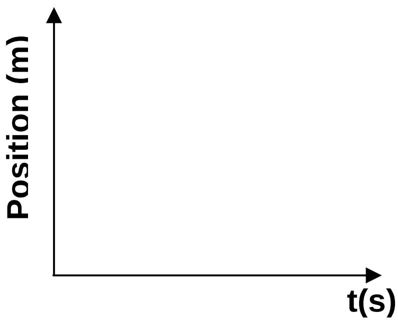


(3)

5.2 Give ONE reason why the concept of free fall might not give a correct answer. (1)

5.3 A student is at the top of a building of height *h.* He throws a stone, X, upward with a speed *v*. He then throws a second identical stone, Y, downward at the same speed *v*.

5.3.1 Redraw the following set of axes in the ANSWER BOOK and sketch the graphs of position versus time for each of the stones X and Y. Use the ground as the point of zero position.



(4)

5.3.2 How will the velocities of the two stones, X and Y, compare when they reach the ground? Explain your answer. (4)

5.4 A mountain climber stands at the top of a 50 m cliff that overhangs a calm pool. She throws two stones vertically downward 1 s apart and observes that the two stones reach the water simultaneously after a while. The first stone was thrown at an initial speed of 2 $m \cdot s^{-1}$.

Calculate the initial speed at which she threw the second stone. Ignore the effects of friction. (6)

[18]

QUESTION 6

New cars have a crumple zone to help minimise injuries during accidents. In addition seat belts, air bags and padded interiors can reduce the chance of death or serious injury.

6.1 Use principles in Physics to explain how air bags can reduce the chance of death or injury. (3)

6.2 In a crash test, a car of mass 1,2 x 10^3 kg collides with a wall and rebounds as illustrated below. The initial and final velocities of the car are 12 $m \cdot s^{-1}$ to the left and 2 $m \cdot s^{-1}$ to the right respectively. The collision lasts 0,1 s.

Calculate the:

6.2.1 Impulse of the car during the accident (4)

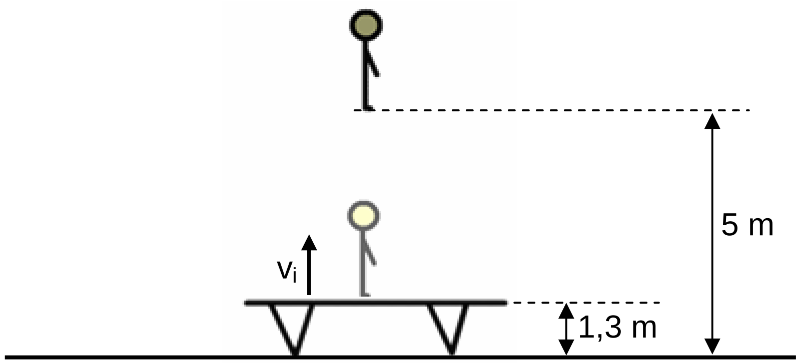
6.2.2 Average force exerted on the car (3)

6.3 How will the magnitude of the force exerted on the car be affected if the time interval of the collision remains 0,1 s, but the car does not bounce off the wall? Write down only INCREASES, DECREASES or REMAINS THE SAME. Explain your answer. (2)

[12]

QUESTION 7

A gymnast jumps vertically upward from a trampoline as illustrated below.



The gymnast leaves the trampoline at a height of 1,3 m and reaches a maximum height of 5 m. Ignore the effects of friction.

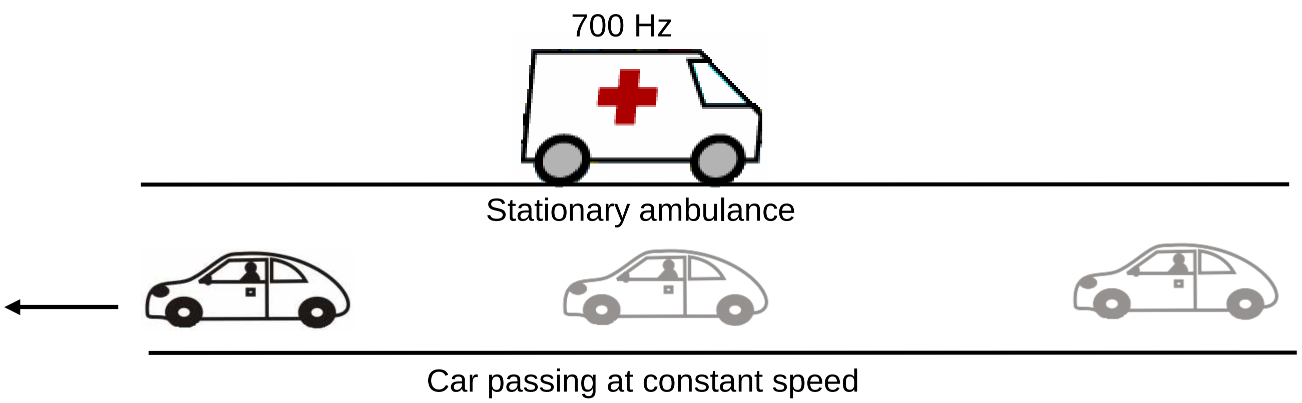
7.1 Write down the work-energy theorem. (2)

7.2 Use energy principles to calculate the initial speed v_i with which the gymnast leaves the trampoline. (5)
[7]

QUESTION 8

The sketch below shows a stationary ambulance. The siren of the ambulance emits sound waves of frequency 700 Hz.

The driver of a car approaching the ambulance and passing it at constant speed, observes the frequency of the emitted sound waves to change by 80 Hz.

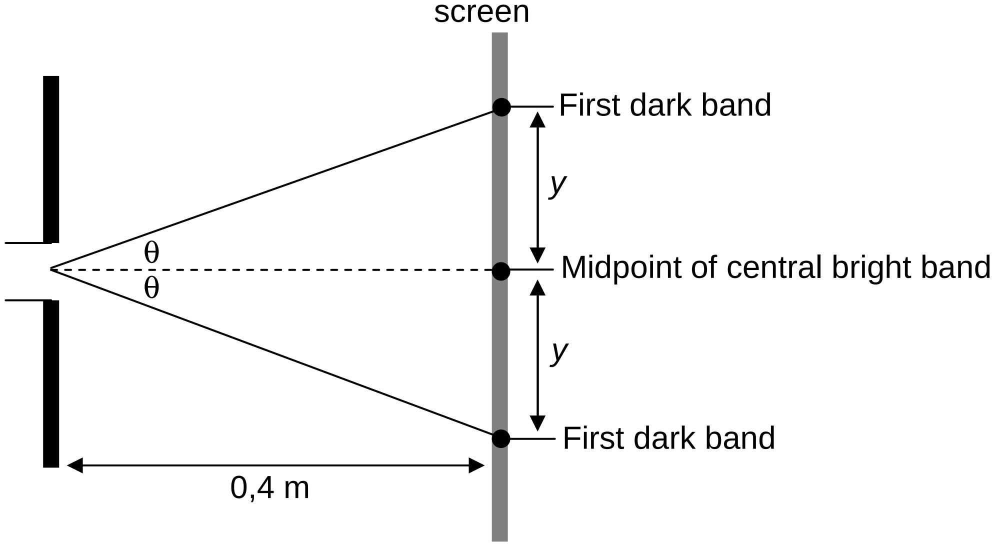


8.1 Name and state the wave phenomenon illustrated above. (3)

8.2 Take the speed of sound in air as 340 $m \cdot s^{-1}$ and calculate the speed at which the car passes the ambulance. (5)
[8]

QUESTION 9

During a demonstration of a wave phenomenon, monochromatic red light passes through a slit of width 1,8 x 10^{-4} m and shines on a flat screen a distance of 0,4 m away from the slit. The wavelength of the light is 675 nm.



9.1 Name the phenomenon demonstrated above. (1)

9.2 Briefly explain how the dark bands in the observed pattern are formed. (2)

9.3 Calculate the width 2*y* of the central bright band. (6)

9.4 How will your answer to QUESTION 9.3 change if the width of the slit is changed to 1,8 x 10^{-6} m? Write only INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for your choice. (3)

9.5 The red light incident on the slit now passes through a yellow filter and then through a magenta filter before reaching the slit.

What colour will now be observed for the central bright band? Explain your answer. (3)
[15]

QUESTION 10

A capacitor's function is to store charge or electrical energy. Capacitors also function as filters, passing alternating current (AC) and blocking direct current (DC).

10.1 Briefly explain how a capacitor can block direct current (DC). (2)

10.2 You are requested to design a parallel plate capacitor with a capacitance of 200 pF using the following materials:

- Two connecting wires
- A whole sheet of aluminium foil of area 0,2 m^2

Use the following steps as guidance in your design:

10.2.1 Calculate the distance between the plates of the capacitor. (4)

10.2.2 Make a sketch of your design and indicate the dimensions of the capacitor on the sketch. (4)

10.2.3 What change will you make to your design, still using all the supplied materials, to change the capacitance of the capacitor to 100 pF? (1)

10.3 Supercapacitors (capacitors of 1 farad and more) are well suited to replace batteries in many applications. This is because their scale is comparable to that of batteries at the moment, from small ones used in cellular phones to large ones that can be found in cars. Even though supercapacitors have a lower energy density compared to batteries, they avoid many of the disadvantages of batteries.

10.3.1 Compare the way in which capacitors and batteries store energy. (2)

10.3.2 Name ONE disadvantage of batteries when disposed of in the environment. (1)

10.3.3 The following statement appears in an advertisement of a certain type of battery:

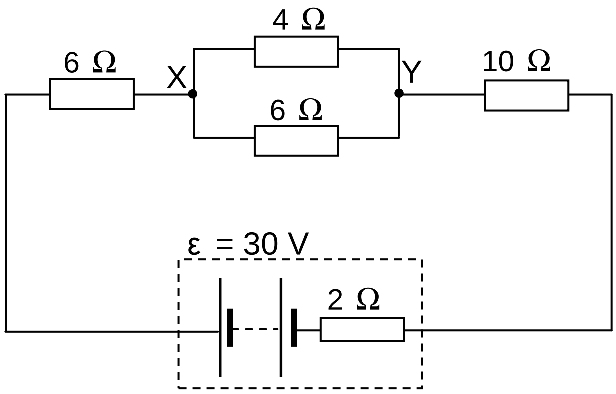
'Capacitors cannot function without batteries – they need a source of energy. On the other hand, batteries don't need capacitors.'

Briefly explain why this is a valid statement. (2)

[16]

QUESTION 11

Four resistors of different resistances are connected in a circuit as shown below. The battery has an emf of 30 V and an internal resistance of 2 Ω. The resistance of the connecting wires is negligible.

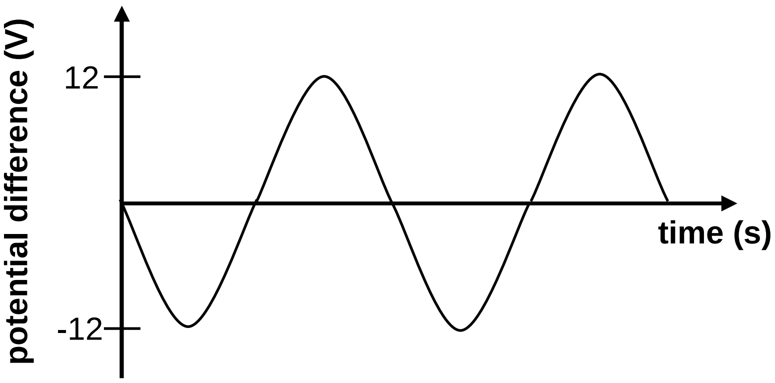


11.1 Define the concept *emf* of a battery. (2)

11.2 Calculate the potential difference between points X and Y. (7)
[9]

QUESTION 12

The average power of a lamp is 15 W. The lamp can be used with either an AC supply or a DC supply. The graph below shows the AC potential difference.



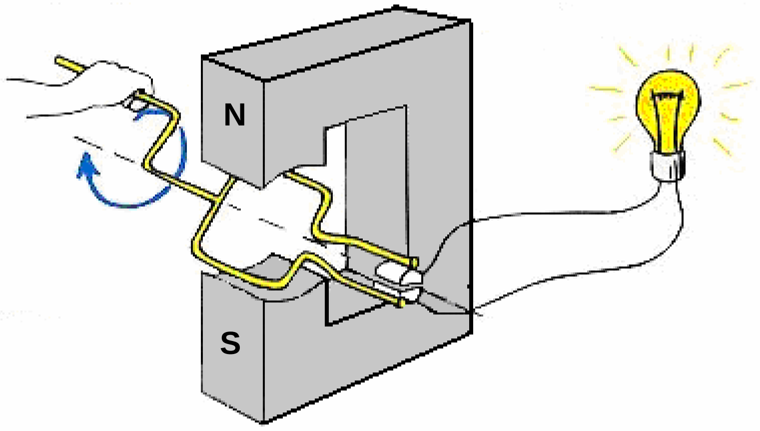
12.1 Calculate the potential difference of a DC supply that will produce the same brightness of the lamp. (3)

12.2 Calculate the peak current through the lamp when connected to a 12 V AC supply. (4)

12.3 Draw a sketch graph of current through the lamp against time when connected to the AC supply. Indicate the value of the peak current on the graph. (3)
[10]

QUESTION 13

The diagram below shows a basic electric generator.



13.1 What type of generator (AC or DC) is illustrated above? Give a reason for your answer. (2)

13.2 Is the induced potential difference in the coil illustrated above about to increase or to decrease? Refer to the change in magnetic flux as the loop rotates from the vertical to the horizontal position, and explain your answer. (5)

13.3 State ONE change that can be made to the above generator to increase the output potential difference. (1)
[8]

QUESTION 14

A learner wants to demonstrate the photoelectric effect. He uses a disk of zinc placed on an electroscope. The work function of zinc is 6,9 x 10^{-19} J.

14.1 Define the concept *work function*. (2)

14.2 Calculate the maximum wavelength of light that will eject electrons from the zinc. (4)

14.3 The electroscope is negatively charged and then exposed to ultraviolet light from a mercury discharge lamp. One of the wavelengths of the light is 260 nm.

Calculate the kinetic energy of an electron emitted from the zinc disk by a photon of this light. (4)

14.4 When the student attempts the experiment with a positively charged electroscope, he finds that the ultraviolet light has no apparent effect. Explain this observation. (2)
[12]

TOTAL SECTION B: 115

GRAND TOTAL: 150

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1	Work done/*Arbeid of werk verrig* ✓	[12.2.1]	(1)
1.2	Power/*Drywing* ✓	[12.2.1]	(1)
1.3	InterferenceI*Interferensie* ✓	[12.2.1]	(1)
1.4	Electric field (strength)/*Elektriese veld(sterkte)* ✓	[12.2.1]	(1)
1.5	Spontaneous emission/*Spontane uitstraling* ✓	[12.2.1]	(1)
			[5]

QUESTION 2/*VRAAG 2*

2.1	E ✓	[12.2.1]	(1)
2.2	J ✓	[12.2.3]	(1)
2.3	H ✓	[12.2.1]	(1)
2.4	A ✓	[12.2.1]	(1)
2.5	F ✓	[12.2.1]	(1)
			[5]

QUESTION 3/*VRAAG 3*

3.1	True/*Waar* ✓✓	[12.2.2]	(2)
3.2	False/*Onwaar* ✓ … is broader …✓ /*… is breër …*	[12.2.2]	(2)
3.3	False/*Onwaar* ✓ … increase the electrostatic force four times/.. *verhoog die elektrostatiese krag vier keer …* ✓	[12.2.2]	(2)
3.4	False/*Onwaar* ✓ … a DC generator produces a <u>pulsating</u> direct current/ … *'n GS-generator lewer 'n pulserende direkte stroom* ✓	[12.2.1]	(2)
3.5	True/*Waar* ✓✓	[12.2.1]	(2)
			[10]

QUESTION 4/*VRAAG 4*

4.1	B ✓✓✓	[12.2.2]	(3)
4.2	A ✓✓✓	[12.1.2]	(3)
4.3	B ✓✓✓	[12.2.3]	(3)
4.4	C ✓✓✓	[12.1.3]	(3)
4.5	D ✓✓✓	[12.1.2]	(3)
			[15]

TOTAL SECTION A:/*TOTAAL AFDELING A:* **35**

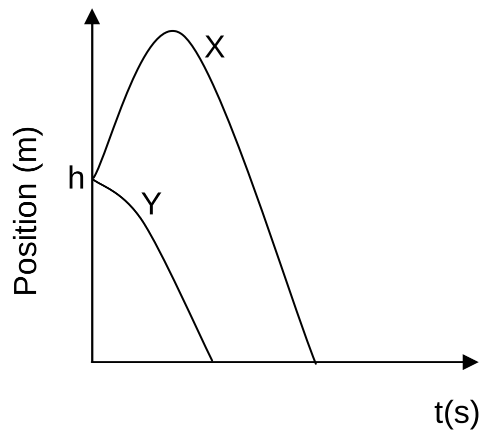
SECTION B/*AFDELING B*

QUESTION 5/*VRAAG 5*

5.1
- Release a stone from the top of the well and let it fall straight down into the well./*Laat val 'n klip vanaf die bopunt van die put reguit in die put in.* ✓
- Take the time from it was released until it splashes in the water./*Neem die tyd vandat die klip laat val is totdat dit die water tref.* ✓
- Use the equation $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓with v_i = 0 to calculate the depth of the water level./*Gebruik die vergelyking* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ *met* v_i *= 0 om die diepte van die watervlak te bereken.* [12.1.1] (3)

5.2 Due to air friction gravity is not the only force acting on the object./*Weens lugweerstand is gravitasie nie die enigste krag wat op die voorwerp inwerk nie.* ✓ [12.2.3] (1)

5.3.1



Checklist/*Kontrolelys* Criteria for graph/*Kriteria vir grafiek:*	Marks/ *Punte*
Both graphs starts at height h or same height/*Beide grafieke begin by hoogte h of by dieselfde hoogte*	✓
Shape of graph X as indicated/*Vorm van grafiek X korrek aangedui*	✓
Shape of graph Y as indicated/ *Vorm van grafiek Y korrek aangedui*	✓
Time on x-axis for X longer than for Y/*Tyd op x-as vir X langer as vir Y*	✓

[12.1.2] (4)

5.3.2 Velocities will be the same/*Snelhede sal dieselfde wees.* ✓

Both X and Y experience the same displacement ✓and same acceleration.✓ On its downward flight X has same velocity as Y at a height of h. ✓
Using $v_f^2 = v_i^2 + 2a\Delta y$ will thus give the same final velocity for both.

Beide X en Y ondergaan dieselfde verplasing.✓ en ondervind dieselfde versnelling. .✓ Op sy afwaarste vlug het X dieselfde snelheid as Y op hoogte h. ✓ Deur gebruik te maak van $v_f^2 = v_i^2 + 2a\Delta y$ *sal beide dus dieselfde eindsnelheid hê.* [12.1.4] (4)

5.4 For X - upward as negative/*Vir X - opwaarts as negatief*:

$v_f^2 = v_i^2 + 2a\Delta y$ = $(2)^2 + 2(9,8)(50) = 31,37\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$ ✓

$\therefore 31,37 = 2 + 9,8\Delta t$ ✓

$\therefore \Delta t = 2,997 = 3\ s$

For/*Vir* Y:

$\Delta t = 3 - 1 = 2\ s$ ✓

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\therefore 50 = v_i(2) + 0,5(9,8)(2)^2$ ✓

$\therefore v_i = 15,2\ m\cdot s^{-1}$ downward/*afwaarts* ✓

OR/*OF*

For X - upward as negative/*Vir X - opwaarts as negatief*:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$50 = 2\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\therefore 4,9\Delta t^2 + 2\Delta t - 50 = 0$

$$\Delta t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-2 \pm \sqrt{2^2 - 4(4,9)(-50)}}{2(4,9)}$$

$\therefore \Delta t = 2,997\ s = 3\ s$

For/*Vir* Y:

$\Delta t = 3 - 1 = 2\ s$ ✓

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ [12.1.3]

$\therefore 50 = v_i(2) + 0,5(9,8)(2)^2$ ✓ (6)

$\therefore v_i = 15,2\ m\cdot s^{-1}$ downward/*afwaarts* ✓ **[18]**

QUESTION 6/*VRAAG 6*

6.1 When the airbag inflates during a collision, the contact time of a passenger/driver with an air bag is longer than without an airbag ✓and thus the force on the passenger/driver is reduced ✓ according to $F_{net} = \frac{\Delta p}{\Delta t}$ ✓.

Wanneer die lugsak opblaas tydens 'n botsing, is die kontaktyd van die passasier/bestuurder met 'n lugsak langer as sonder 'n lugsak ✓en dus is die krag op die passasier/bestuurder kleiner ✓volgens $F_{net} = \frac{\Delta p}{\Delta t}$ ✓. [12.3.2] (3)

6.2.1 Take to the right as negative/*Neem na regs as negatief*:

$F_{net}\Delta t = \Delta p = mv_f - mv_i$ ✓

$\therefore F_{net}\Delta t = 1{,}2 \times 10^3 (-2 - 12)$ ✓ $= -1{,}68 \times 10^4$

$\therefore$ Impulse = $1{,}68 \times 10^4$ N·s ✓ to the right/*na regs* or/*of* away from wall/*weg vanaf muur* ✓

OR/*OF*

$v_f = v_i + a\Delta t$
$\therefore -2 = 12 + a(0{,}1)$
$\therefore a = -140$ m·s^{-2}
$\therefore = 140$ m·s^{-2} to the right/*na regs*

$\therefore F_{net} = ma = (1{,}2 \times 10^3)(-140)$ ✓ $= -1{,}68 \times 10^5$
$\therefore F_{net} = 1{,}68 \times 10^5$ N to the right/*na regs* or/*of* away from wall/*weg vanaf muur*

Impulse = $F_{net}\Delta t$ ✓= $(1{,}68 \times 10^5)(0{,}1)$ ✓
= $1{,}68 \times 10^4$ N·s ✓ to the right/*na regs* or/*of* away from wall/*weg vanaf muur* ✓ [12.2.3] (4)

6.2.2 $F_{net}\Delta t = \Delta p = -1{,}68 \times 10^4$
$\therefore F_{net}(0{,}1) = -1{,}68 \times 10^4$ ✓
$\therefore F_{net} = -1{,}68 \times 10^5$ N
$\therefore F_{net} = 1{,}68 \times 10^5$ N ✓to the right/*na regs*✓

OR/*OF*

Take to the right as negative:
$v_f = v_i + a\Delta t$
$\therefore -2 = 12 + a(0{,}1)$ $\therefore a = -140$ m·s^{-2}
$\therefore F_{net} = ma = (1{,}2 \times 10^3)(-140)$ ✓ $= -1{,}68 \times 10^5$
$\therefore F_{net} = 1{,}68 \times 10^5$ N ✓to the right/*na regs* ✓ or/*of* away from the wall/*weg van die muur af* [12.2.3] (3)

6.3 Decreases/*Neem af* ✓
The final velocity of the car is zero and thus Δp decreases ✓
Die finale snelheid van die motor is nul en dus neem Δp *af.* ✓ [12.2.2] (2)

[12]

QUESTION 7/*VRAAG 7*

7.1 The net work done on an object is equal to the change in the object's kinetic energy./*Die netto arbeid verrig op 'n voorwerp is gelyk aan die verandering in kinetiese energie van die voorwerp.* ✓✓

OR/*OF*

The work done on an object by a net force is equal to the change in the object's kinetic energy./*Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in kinetiese energie van die voorwerp.* [12.2.1] (2)

7.2 $(E_p + E_k)_f = (E_p + E_k)_i$

$mgh_f + \frac{1}{2}mv_f^2 = mgh_i + \frac{1}{2}mv_i^2$ ✓

$m(9,8)(5)$ ✓ $+ 0$ ✓$= m(9,8)(1,3)$ ✓ $+ \frac{1}{2}mv_i^2$

$v_i = 8,52\ m\cdot s^{-1}$ ✓

OR/*OF*

$W_{net} = \Delta E_k = E_{kf} - E_{ki}$ ✓

(Work done is only due to gravity/*arbeid verrig slegs deur gravitasie*)

$W_{net} = F\cos\theta\,\Delta y = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$\therefore mg\cos 180°(h_f - h_i)$ ✓ $= 0 - \frac{1}{2}mv_i^2$ ✓

[$E_{kf} = 0$, v_f at highest point is zero/*by hoogste punt is nul*]

$\therefore m(9,8)\cos 180°(5 - 1,3) = -\frac{1}{2}mv_i^2$ ✓

$\therefore m(9,8)(-1)(3,7) = -\frac{1}{2}mv_i^2$

$\therefore v_i = 8,52\ m\cdot s^{-1}$ ✓

OR/*OF*

W(external forces/*eksterne kragte*) $= \Delta E_p + \Delta E_k$ ✓

0 ✓$= mg(h_f - h_i) + (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2)$ ✓

$\therefore -mg(h_f - h_i) = -\frac{1}{2}mv_i^2$

$\therefore -m(9,8)(5 - 1,3) = -\frac{1}{2}mv_i^2$ ✓

$v_i = 8,52\ m\cdot s^{-1}$ ✓

[12.1.3] (5)
[7]

QUESTION 8/*VRAAG 8*

8.1 Doppler effect/*Doppler-effek* ✓

A change in observed frequency (pitch) due to relative motion between observer and sound source./*'n Verandering in waargenome frekwensie (toonhoogte) wanneer daar relatiewe beweging tussen 'n klankbron en 'n waarnemer is.* ✓✓

OR/*OF*

A change in observed frequency (pitch) because the sound source and observer have different velocities with respect to the medium./ *'n Verandering in waargenome frekwensie (toonhoogte) omdat die bron en die waarnemer verskillende snelhede ten opsigte van die medium het.* ✓✓ [12.2.1] (3)

8.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

When car approaches/*Wanneer motor nader beweeg:*

$f_L(\text{approach}/\textit{nader}) = (\frac{340 + v_L}{340 \pm 0})700$ ✓

When car moves away/*Wanneer motor weg beweeg:*

$f_L(\text{away}/\textit{weg}) = (\frac{340 - v_L}{340 \pm 0})700$ ✓

$(\frac{340 + v_L}{340 \pm 0})700 - (\frac{340 - v_L}{340 \pm 0})700 = 80$ ✓

$\therefore \frac{700}{340}(340 + v_L - 340 + v_L) = 80$

$\therefore v_L = 19{,}43 \text{ m·s}^{-1}$ ✓

OR/*OF*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$f_L(\text{approach}/\textit{nader}) = (\frac{v + v_L}{v \pm 0})f_s$ ✓

$f_L(\text{away}/\textit{weg}) = (\frac{v - v_L}{v \pm 0})f_s$ ✓

$f_L(\text{approach}/\textit{nader}) - f_L(\text{away}/\textit{weg}) = (\frac{v + v_L}{v \pm 0})f_s - (\frac{v - v_L}{v \pm 0})f_s = 80$ ✓

$\therefore 80 = \frac{2f_s v_L}{v} = \frac{2(700)v_L}{340}$ [12.1.3] (5)

$\therefore v_L = 19{,}43 \text{ m·s}^{-1}$ ✓ **[8]**

QUESTION 9/*VRAAG 9*

9.1 Diffraction/*Diffraksie* ✓ [12.1.2] (1)

9.2 Wavelets originating from different points in the slit ✓reach the screen out of phase and interfere destructively ✓on the screen.

Golffronte wat vanaf verskillende punte in die spleet ontstaan✓ bereik die skerm uit fase en ondergaan destruktiewe interferensie. ✓ [12.2.3] (2)

9.3

$$\sin\theta = \frac{m\lambda}{a} \checkmark$$
$$= \frac{(1)(675 \times 10^{-9})}{1{,}8 \times 10^{-4}} \checkmark$$
$$= 3{,}75 \times 10^{-3}$$
$$\therefore \theta = 0{,}21° \checkmark$$

$$\tan 0{,}21° = \frac{y}{0{,}4} \checkmark$$
$$\therefore y = 1{,}47 \times 10^{-3} \text{ m } (1{,}47 \text{ mm}) \checkmark$$

Width of central bright band/*Breedte van sentrale helder band:*
$2y = 2(1{,}47 \times 10^{-3}) = 2{,}93 \times 10^{-3}$ m (2,93 mm) ✓ [12.1.3] (6)

9.4 Increases/*Toeneem* ✓

Diffraction is inversely proportional to the width of the slit. ✓✓
Diffraksie is omgekeerd eweredig aan die breedte van die spleet. ✓✓ [12.2.2]

OR/*OF*

Amount of diffraction is determined by the ratio $\frac{\lambda}{a}$ ✓. If *a* decreases, $\frac{\lambda}{a}$ will increase. ✓/*Hoeveelheid diffraksie word bepaal deur die verhouding* $\frac{\lambda}{a}$ ✓. *Indien a afneem, sal* $\frac{\lambda}{a}$ *toeneem*✓. (3)

9.5 Red/*Rooi* ✓

The <u>yellow filter transmits red light.</u> ✓– yellow only transmit red and green light. When the <u>red light reaches the magenta filter it will be transmitted</u> ✓– magenta only transmits red and blue light.

<u>Die geel filter laat rooi lig deur</u> ✓ – geel laat slegs rooi en groen lig deur. Wanneer die <u>rooi lig die magenta filter bereik, word dit deurgelaat</u> ✓ – magenta laat slegs rooi en blou lig deur. [12.2.3] (3)

[15]

QUESTION 10/*VRAAG 10*

10.1 As the capacitor charges the direct current decreases ✓and eventually becomes zero when the capacitor is fully charged. ✓
Soos wat die kapasitor laai, verminder die direkte stroom ✓en word uiteindelik nul wanneer die kapasitor ten volle gelaai is. ✓ [12.2.3] (2)

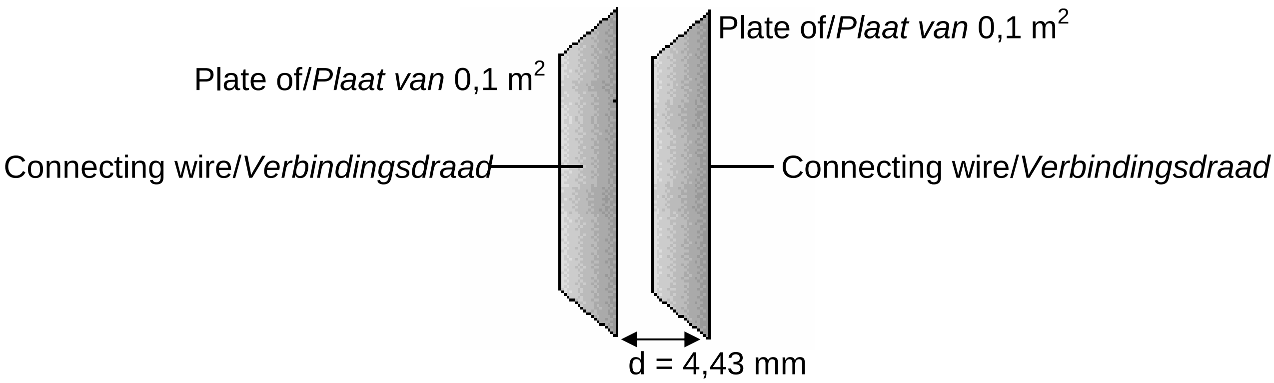
10.2.1 Plate area/*Plaatoppervlakte* = $\frac{0,2}{2}$ = 0,1 m^2 ✓

$C = \frac{\varepsilon_0 A}{d}$ ✓

$\therefore 200 \times 10^{-12} = 8,85 \times 10^{-12} \frac{0,1}{d}$ ✓

$\therefore d = 4,43 \times 10^{-3}$ m (4,43 mm) ✓ [12.1.3] (4)

10.2.2



Checklist/*Kontrolelys* Criteria for diagram/*Kriteria vir diagram:*	Marks/ *Punte*
Plates drawn parallel/*Plate parallel geteken*	✓
Area of plates indicated/*Oppervlakte van plate aangedui*	✓
Connecting wires indicated and labelled/Verbindingsdrade aangedui en benoem	✓
Distance between plates indicated/*Afstand tussen plate aangedui*	✓

[12.1.1] (4)

10.2.3 Double the distance between the plates/Increase the distance between the plates to 8,86 mm ✓
Verdubbel die afstand tussen die plate/Vermeerder die afstand tussen die plate na 8,86 mm ✓ [12.2.2] (1)

10.3.1 Batteries store energy in chemical reactions/*Batterye stoor energie in chemiese reaksies* ✓
Capacitors store energy in electric fields/*Kapasitors stoor energie in elektriese velde* ✓ [12.2.1] (2)

10.3.2 Any one/*Enigeen:*
Chemicals e.g. acid or heavy metals can leach into soil and groundwater./*Chemikalieë bv. suur of swaar metale kan in grondwater en grond inbeweeg.* ✓
Plastic casing can pollute environment./*Plastiekomhulsels kan die omgewing besoedel.* [12.3.3] (1)

10.3.3 Capacitors need a source of energy e.g. batteries to obtain charge. ✓ Batteries produce their own energy/electricity from chemical reactions inside the battery. ✓
Kapasitors benodig 'n bron van energie bv. batterye om lading te verkry. ✓ *Batterye produseer hulle eie energie/elektristeit uit chemiese reaksies binne-in die battery*. ✓ [12.1.4] (2)
[16]

QUESTION 11/*VRAAG 11*

11.1 The maximum work done per unit charge/*Maksimum arbeid verrig per eenheidslading* ✓✓ [12.2.1] (2)

11.2 $\frac{1}{R_P} = \frac{1}{4} + \frac{1}{6}$ ✓ $\therefore R_p = 2{,}4\ \Omega$ ✓

R(total/*totaal*) = 2,4 + 6 + 10 + 2 = 20,4 Ω ✓

$I = \frac{V}{R}$ ✓ $= \frac{30}{20{,}4}$ ✓ $= 1{,}47$ A

$V_p = IR_p = (1{,}47)(2{,}4)$ ✓ $= 3{,}53$ V ✓ [12.1.3] (7)
[9]

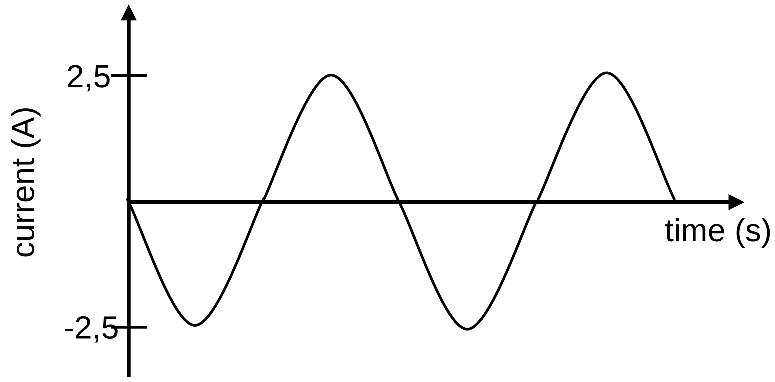
QUESTION 12/*VRAAG 12*

12.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $= \frac{12}{\sqrt{2}}$ ✓ $= 8{,}49$ V ✓ [12.2.3] (3)

12.2 $P_{ave} = V_{rms}I_{rms}$ ✓ $\therefore$ $15 = 8{,}49I_{rms}$ ✓ $\therefore$ $I_{rms} = 1{,}77$ A

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ $\therefore I_{max} = 1{,}77\sqrt{2}$ ✓ $= 2{,}5$ A ✓ [12.2.3] (4)

12.3



Checklist/*Kontrolelys* Criteria for graph/*Kriteria vir grafiek:*	Marks/ *Punte*
Axes drawn and correctly labelled./*Asse geteken en korrek benoem.*	✓
Shape of graph as indicated./*Vorm van grafiek soos getoon.*	✓
Peak current correctly indicated on y-axis/*Kruinstroom korrek op y-as aangedui.*	✓

[12.1.2] (3)
[10]

QUESTION 13/*VRAAG 13*

13.1 DC generator/GS-generator ✓
Split-ring commutator ✓present/*Splitringkommutator teenwoordig* [12.1.2] (2)

13.2 Decrease/*afneem* ✓ as the coil rotates clockwise from the vertical to the horizontal position/*soos wat spoel kloksgewys vanaf die vertikale na horisontale posisie roteer.*

When the coil is in the vertical position in the diagram, the magnetic flux linkage is a minimum, ✓but the change in flux linkage with time is a maximum and thus the induced potential difference in the coil is a maximum. ✓

In the horizontal position the magnetic flux linkage is maximum, ✓but the change in magnetic flux linkage with time is now a minimum, thus the induced potential difference in the coil is a minimum. ✓

Wanneer die spoel in die *vertikale posisie* in die diagram is, is die *magneetvloedkoppeling 'n minimum,* ✓ maar die verandering in vloedkoppeling met tyd is 'n maksimum en dus is die geïnduseerde potensiaalverskil in die spoel 'n maksimum. ✓

Sodra die spoel die horisontale posisie in die diagram bereik, is die magneetvloedkoppeling 'n maksimum, ✓ maar die verandering in vloedkoppeling met tyd is 'n minimum en dus is die geïnduseerde potensiaalverskil in die spoel 'n minimum. ✓ [12.1.2] [12.2.3] (5)

13.3 Any ONE/*Enige EEN:*
Increase the number of wire loops in the coil/*Verhoog aantal windinge in spoel.* ✓
Use a stronger magnet/*Gebruik 'n sterker magneet* [12.2.3] (1)
Rotate the coil faster/*Roteer die spoel vinniger* **[8]**

QUESTION 14/*VRAAG 14*

14.1 Minimum energy needed to eject electrons from a certain material/metal. ✓✓

Minimum energie benodig om elektrone uit 'n spesifieke metaal/materiaal vry te stel. ✓✓ [12.2.1] (2)

14.2 $E = \frac{hc}{\lambda}$ ✓

$\therefore 6,9 \times 10^{-19}$ ✓ $= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{\lambda}$ ✓

$\therefore \lambda = 288,26 \times 10^{-9}$ m ✓ $= 288,26$ nm [12.2.3] (4)

14.3 $E_k = \frac{hc}{\lambda} - W$ ✓

$= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{260 \times 10^{-9}}$ ✓ $- 6,9 \times 10^{-19}$ ✓

$= 7,65 \times 10^{-19} - 6,9 \times 10^{-19}$

$= 7,5 \times 10^{-20}$ J ✓ [12.1.3] (4)

14.4 The positively charged zinc plate will attract electrons ✓preventing them from being emitted. ✓

Die positief gelaaide sinkplaat sal elektrone aantrek ✓*en vrystelling verhoed.* ✓ [12.2.3] (2)

[12]

GRAND TOTAL/*GROOTTOTAAL:* **150**

education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS P1

PREPARATORY EXAMINATION 2008

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages, a 3-page data sheet and 1 answer sheet.

SECTION A

Answer this section on the attached ANSWER SHEET.

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) on the attached ANSWER SHEET.

1.1 The force that acts on a body in free fall (1)

1.2 The physical quantity that is equivalent to the change in the momentum of a body (1)

1.3 A change in the observed pitch of a sound produced by a moving object (1)

1.4 A current that changes direction every half cycle (1)

1.5 A device that produces monochromatic, coherent and collimated light (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

	COLUMN A		COLUMN B
2.1	The net (resultant) force is equal to the rate of change in momentum	A	red
		B	DC motor
2.2	Visible light with the highest frequency	C	cyan, magenta and yellow
2.3	A motor that makes use of a split-ring commutator	D	Newton's Second Law
		E	conservation of momentum
2.4	An electronic circuit component that can store electric charge	F	blue, green and red
2.5	Three primary colours of paint	G	violet
		H	capacitor
		I	AC motor
		J	diode

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 If an object has momentum it must have kinetic energy. (2)

3.2 A passenger, walking at 1 $m \cdot s^{-1}$ west in a train that is travelling at 2 $m \cdot s^{-1}$ west, has a velocity of 3 $m \cdot s^{-1}$ west relative to the train. (2)

3.3 A yellow filter will transmit green and blue light and absorb red light. (2)

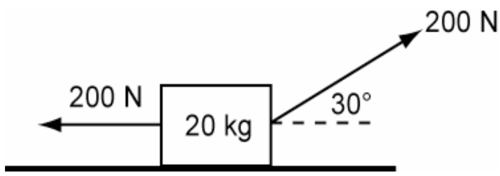
3.4 2 A rms alternating current is equivalent to 2 A direct current. (2)

3.5 Scattering is when light is re-emitted in all directions by an object with the same frequency at which it was absorbed. (2)
[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 Two forces, each of magnitude 200 N, are simultaneously applied to a crate at rest on a horizontal surface as shown in the diagram below. Ignore the effects of friction.



Work will be done by the net force on the crate because the crate will …

A be lifted off the surface.

B accelerate to the left.

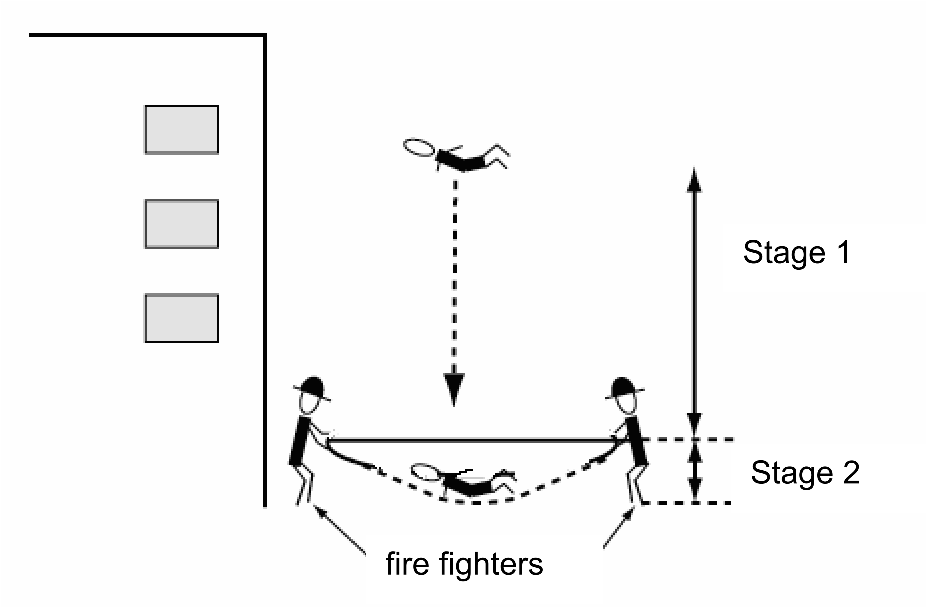
C accelerate to the right.

D remain at rest. (3)

4.2 A man jumps from a window of a multiple-storey building at a certain height above a fire fighters' safety net.

- **Stage 1:** It takes 0,3 seconds to reach the net.
- **Stage 2:** The net stretches by 1 m on impact before the man comes to rest after 0,2 seconds.

Air resistance can be ignored.



Which ONE of the following statements regarding the mechanical energy and momentum of the man is TRUE?

	STAGE 1	**STAGE 2**
A	Mechanical energy and momentum remain constant.	Mechanical energy and momentum remain constant.
B	Mechanical energy and momentum remain constant.	Mechanical energy and momentum change.
C	Mechanical energy remains constant and momentum changes.	Mechanical energy remains constant and momentum changes.
D	Mechanical energy remains constant and momentum changes.	Mechanical energy and momentum change.

(3)

4.3 Which ONE of the following statements describing the condition for single-slit diffraction is CORRECT?

A The slit width is equal to the wavelength of the waves.

B The slit width is greater than the wavelength of the waves.

C The slit width is less than the wavelength of the waves.

D The wavelength of the waves is less than the distance to the screen. (3)

4.4 Which ONE of the statements below best explains the term *population inversion* in LASERS?

A Photons are emitted spontaneously in a random direction.

B Photons induce or stimulate electrons to change energy levels.

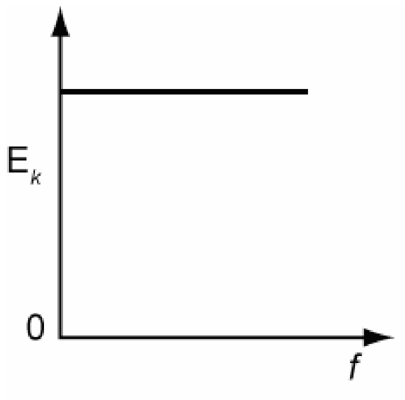
C High-energy electrons pass through a narrow slit.

D More electrons are excited than what will remain in the ground state. (3)

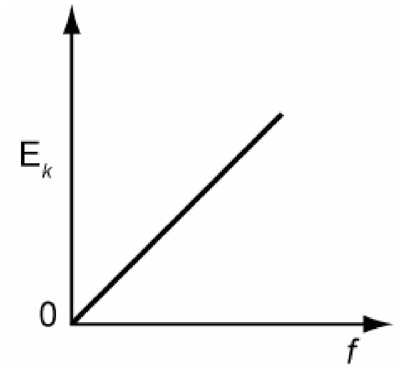
4.5 A metal is illuminated with light of frequency *f* and the electrons emitted have a maximum kinetic energy of E_k.

Which ONE of the following graphs best illustrates the relationship between kinetic energy (E_k) of the emitted electrons and frequency (*f*) of the incident light?

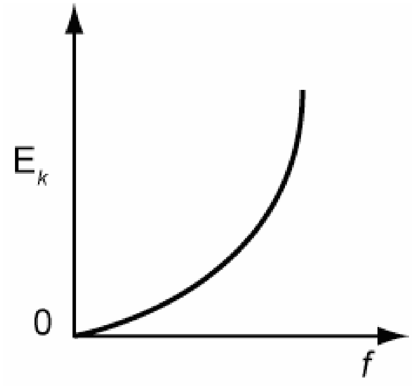
A



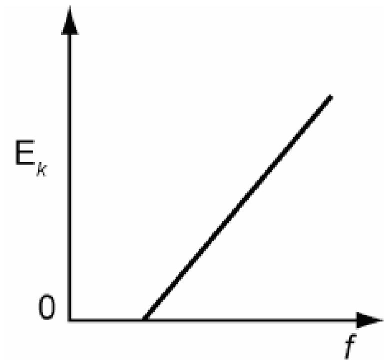
B



C



D



(3)
[15]

TOTAL SECTION A: 35

SECTION B

INSTRUCTIONS AND INFORMATION

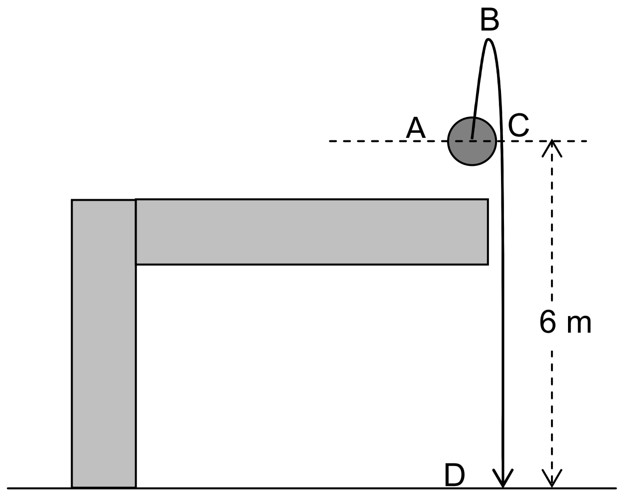
1. Answer this section in the ANSWER BOOK.

2. The formulae and substitutions must be shown in ALL calculations.

3. Round off your answers to TWO decimal places.

QUESTION 5

5.1 Marshall stands on a platform and kicks a soccer ball from 6 m above the ground (position A) vertically upwards into the air with an initial velocity of 4 m·s^{-1}. The ball hits the ground (position D) after 1,6 seconds. The motion of the ball is represented in the diagram below. Ignore the effects of air resistance.



5.1 Calculate the maximum height (position B) the ball reaches above the ground. (5)

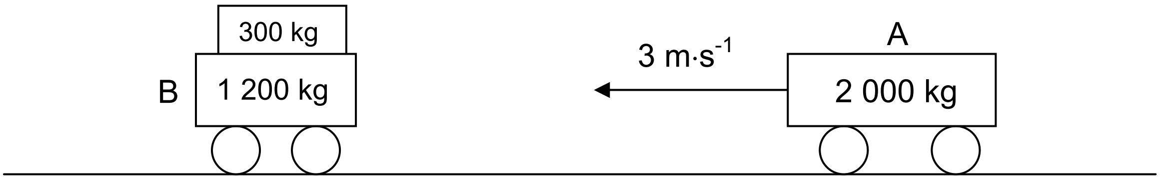
5.2 Calculate the time taken for the ball to reach maximum height (position B). (3)

5.3 Draw a sketch graph of position versus time for the motion of the ball from the moment it was kicked until it hits the ground. Use point A as the reference point (zero-position). Indicate ALL relevant position and time values at positions A, B, C and D. (5)

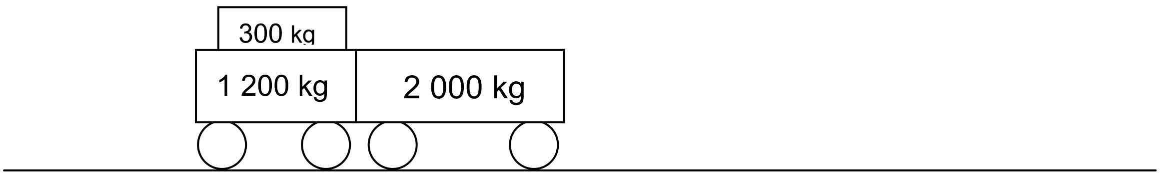
[13]

QUESTION 6

A railway truck A of mass 2 000 kg moves westwards with a velocity of 3 $m \cdot s^{-1}$. It collides with a stationary truck B of mass 1 200 kg, loaded with electronic equipment of mass 300 kg. The two trucks combined after the collision. Ignore the effects of friction.



BEFORE COLLISION



AFTER COLLISION

6.1 Write down magnitude and direction of the 'reaction force' to the weight of truck A. (2)

6.2 Calculate the velocity of truck B after the collision. (5)

6.3 Calculate the magnitude of the force that truck A exerts on truck B if the collision lasts for 0,5 s. (4)

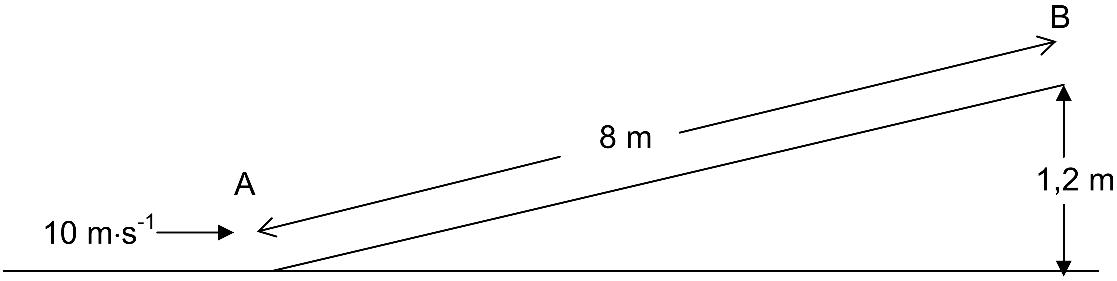
6.4 The electronic equipment on the stationary truck is wrapped in bubble plastic (plastic filled with air bubbles).

Use physics principles to explain why bubble plastic is preferred to ordinary plastic. (3)

[14]

QUESTION 7

Nthabiseng, a cyclist, is free-wheeling (moving without peddling) along a horizontal surface at a constant speed of 10 m·s^{-1}. She reaches the bottom of a ramp (position A) that has a height of 1,2 m and a length of 8 m. While free-wheeling up the ramp, she experiences a frictional force of 18 N. The total mass of the cyclist and cycle is 55 kg.



7.1 Explain whether her mechanical energy is conserved or not as Nthabiseng moves from position A to position B. (2)

7.2 Calculate the kinetic energy of the cyclist at position A. (3)

7.3 Calculate the kinetic energy at the top of the ramp (position B). (8)
[13]

QUESTION 8

An ambulance moving at 40 m·s^{-1} approaches a traffic light where a blind man and his dog wait to cross the road. The siren of the ambulance emits sound waves at a frequency of 350 Hz. The pitch of the sound that the man hears gets higher as the ambulance moves towards him and decreases as the ambulance passes him and moves away.

8.1 Use a sketch of wave fronts to show why the pitch of the sound that the blind man hears is:

8.1.1 Higher as the ambulance approaches him (2)

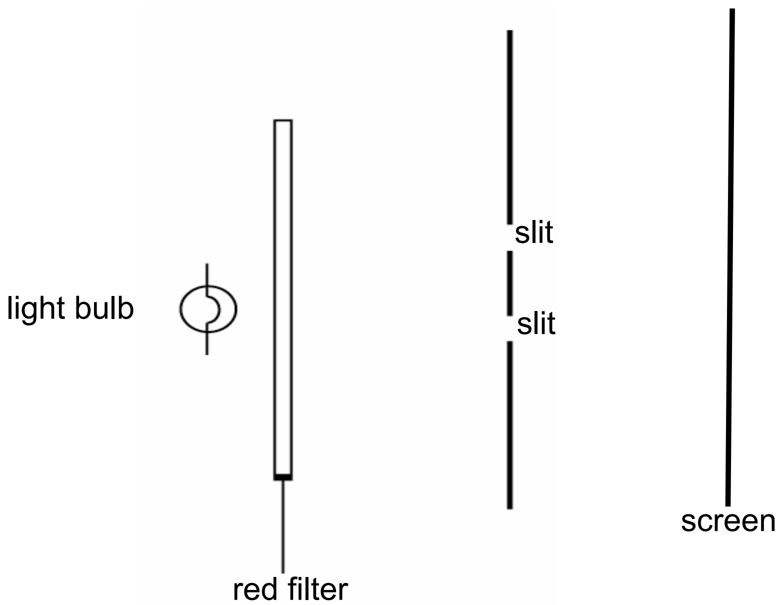
8.1.2 Lower as the ambulance moves away from him (2)

8.2 If the speed of sound in air is accepted as 340 m·s^{-1}, determine the apparent frequency of the sound waves that the man hears while the ambulance approaches him. (5)

8.3 Explain how this effect can benefit a blind person. (2)
[11]

QUESTION 9

In a set-up to illustrate Young's double slit experiment, Renzo placed a red filter that allows only monochromatic red light to reach the slits between a light bulb and a double slit.



9.1 Define the term *monochromatic*. (2)

9.2 Describe the pattern that is observed on the screen with the naked eye once the red light has passed through the double slits. (2)

9.3 Explain the observation made in QUESTION 9.2. (2)

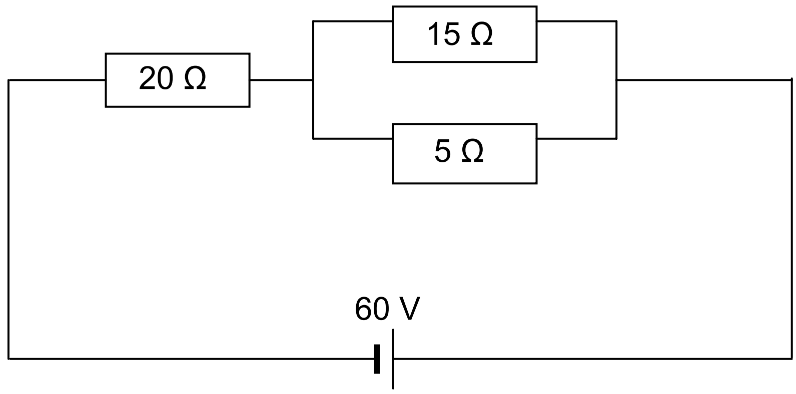
9.4 Describe and explain how the observed pattern will differ if the red filter is replaced by a blue one. (4)

9.5 How will the pattern observed be affected if the distance between the two slits is increased? (2)

[12]

QUESTION 10

Consider the electric circuit below and answer the questions that follow.



10.1 Calculate the magnitude of the current. (6)

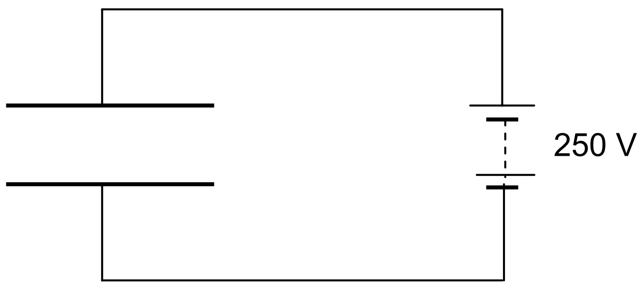
10.2 Calculate the potential difference across the 15 Ω resistor. (3)
[9]

QUESTION 11

Two parallel plates are arranged to form a capacitor. The area of each plate is 0,04 m^2. The plates are separated by a 0,002 m air gap.

11.1 Calculate the capacitance of the capacitor. (4)

This capacitor is connected across a 250 V source as shown below.



11.2 Calculate the charge that accumulates on each plate. (3)

11.3 State how the amount of the charge stored on each plate can be increased without altering the design of the capacitor. (2)

11.4 Write down the general name for the insulating material that is used to fill the space between the plates of a capacitor. (1)

11.5 Use your knowledge of capacitors to explain why it is dangerous to open an amplifier while it is in operation. (2)
[12]

QUESTION 12

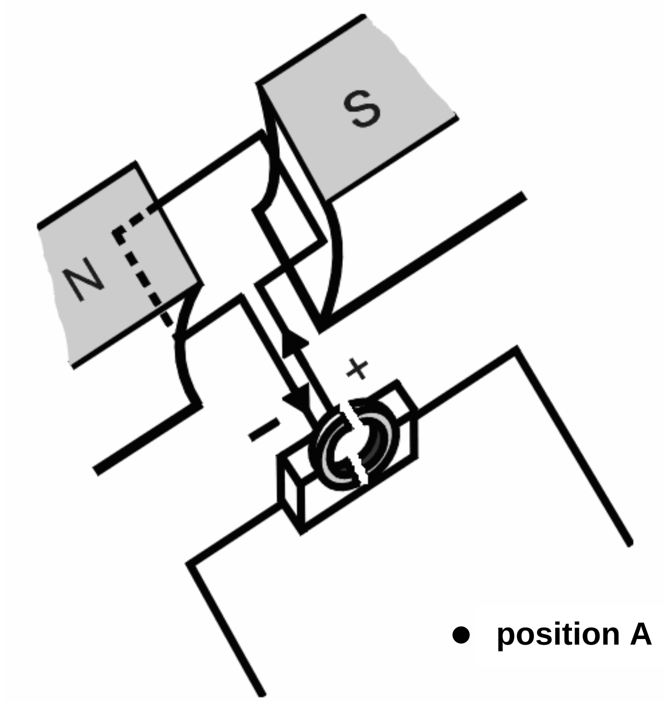
Electric motors are important components of many modern electrical appliances. AC motors are used in washing machines and vacuum cleaners, and DC motors are used in toys and tools.

12.1 What energy conversion takes place in electric motors? (2)

12.2 What is the essential difference in the design between DC motors and AC motors? (2)

12.3 List THREE ways in which the efficiency of the motor can be improved. (3)

12.4 Consider the diagram below. The conventional current flows in the direction indicated by the arrows.



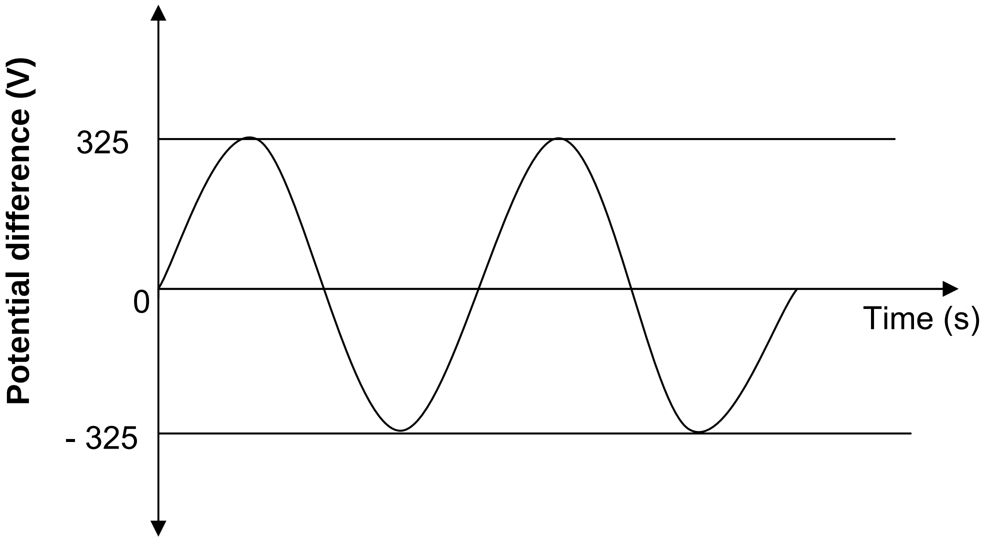
12.4.1 In which direction (clockwise or anti-clockwise), as seen from position A, will the coiled armature rotate if the switch is closed? (1)

12.4.2 Why does the armature continue moving in the same direction once it has reached the vertical position? (2)

[10]

QUESTION 13

The waveform below is a graphical representation of the variation of voltage (V) versus time (t) for an alternating current generator.

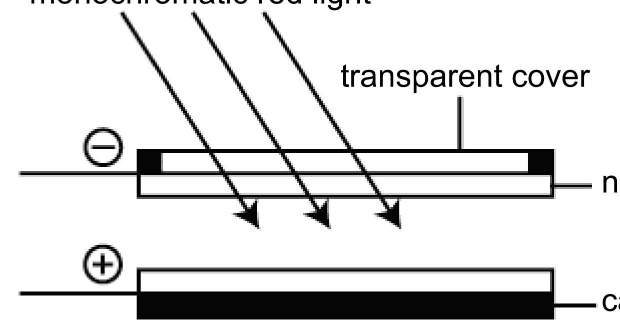


13.1 Explain the advantage of using alternating current at power stations. (2)

13.2 Calculate the average power dissipated by this generator if the rms current produced is 13 A. (5)
[7]

QUESTION 14

14.1 The sketch below shows the components of a photocell used in a camera light meter.



The photocell consists of a caesium cathode with a small work function. When monochromatic red light from a 50 W light bulb strikes the cathode in the photocell, the light meter registers a small current.

14.1.1 What name is given to the effect described above? (1)

14.1.2 What will the effect on the current be when the 50 W bulb is replaced by a 100 W bulb? Give a reason for your answer. (2)

14.1.3 What will be the effect on the kinetic energy of the emitted photo electrons when the 50 W red light is replaced with a 50 W blue light bulb. Give a reason for your answer. (3)

14.2 Ultraviolet lamps are often used in butcheries, even though they are potentially harmful.

14.2.1 Which property of UV light makes it harmful? (1)

14.2.2 Explain why UV light is used in butcheries. (1)

14.2.3 A photon of ultraviolet light carrying 2,95 x 10^{-20} J of energy is shone onto a metal with a work function of 1 x 10^{-20} J. Calculate the speed of the ejected photo electron. (5)

[13]

TOTAL SECTION B: 115

GRAND TOTAL: 150

SECTION A / *AFDELING A*

QUESTION 1/*VRAAG 1*

1.1 Gravitational force/*gravitasiekrag* ✓
or/*of*
weight/*gewig* [12.2.1] (1)

1.2 Impulse/*impuls* ✓ [12.2.1] (1)

1.3 Doppler Effect/*Doppler effek* ✓ [12.2.1] (1)

1.4 Alternating current/*wisselstroom* ✓ [12.2.1] (1)

1.5 Laser/*Laser* ✓ [12.2.1] (1)
[5]

QUESTION 2 / *VRAAG 2*

2.1 D✓ [12.2.1] (1)

2.2 G✓ [12.2.1] (1)

2.3 B✓ [12.2.1] (1)

2.4 H✓ [12.2.1] (1)

2.5 C✓ [12.2.1] (1)
[5]

QUESTION 3 / *VRAAG 3*

3.1 True / *Waar* ✓✓ [12.2.3] (2)

3.2 False / *Onwaar*:
……….velocity relative to the train is 1 $m \cdot s^{-1}$✓.
………..snelheid relatief tot trein is 1 $m \cdot s^{-1}$. ✓ [12.2.3] (2)

3.3 False: ✓ Onwaar ✓
… transmit green and red light and absorb blue light ✓ OR
A cyan filter …
… laat groen en rooilig deur and absorbeer bloulig OF
'n Siaanfilter … [12.2.3] (2)

3.4 True / *Waar* ✓✓ [12.2.1] (2)

3.5 True / *Waar* ✓✓ [12.2.1] (2)
[10]

QUESTION 4 / *VRAAG 4*

4.1 B ✓✓✓ [12.2.3] (3)

4.2 D ✓✓✓ [12.1.3] (3)

4.3 C ✓✓✓ [12.2.3] (3)

4.4 D ✓✓✓ [12.2.1] (3)

4.5 D ✓✓✓ [12.1.2] (3)
[15]

TOTAL SECTION A = 35
TOTAAL AFDELING A = 35

SECTION B / *AFDELING B*

QUESTION 5/*VRAAG 5*

5.1 Consider downward motion as positive

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(0)^2$ ✓ = $(-4)^2 + 2(9,8)\Delta y$ ✓ [Note: v_i & a → opposite signs]

Δy = - 0,82 m

= 0,82 m upwards ✓

$\therefore \Delta y_{above\ ground}$ = 6 + 0,82 = 6,82 m ✓

OR

E_t(top) = E_t(bottom)

$E_p + E_k = E_p + E_k$ ✓

$mgh + \frac{1}{2}mv_i^2 = mgh + \frac{1}{2}mv_f^2$

(m)(9,8)(6) ✓ + ½ m$(-4)^2$ ✓= m(9,8)h + 0 ✓

h = 6,82 m ✓ [12.2.3] (5)

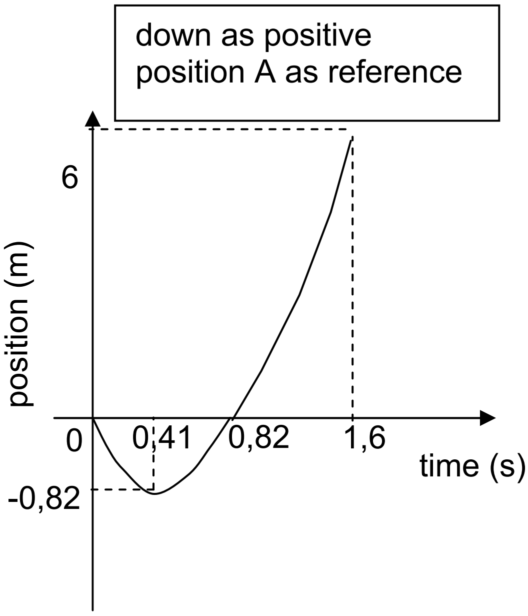
5.2 Consider downward motion as positive:

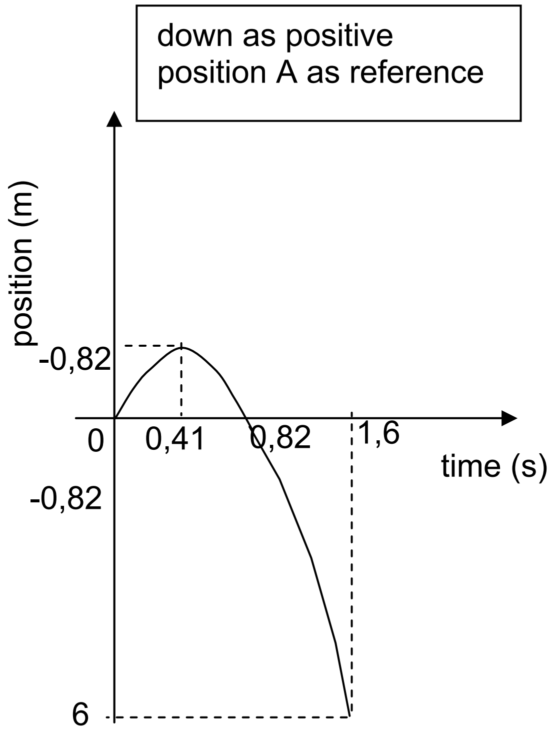
$v_f = v_i + a\Delta t$ ✓

0 = (-4) + (9,8) Δt✓ [Note: v_i & a → opposite signs]

Δt = 0,41 s ✓ [12.2.3] (3)

5.3





Checklist/*Kontrolelys* Criteria for graph/ *Kriteria vir grafiek*	Marks/ *Punte*
Correct shape of graph 0 – 0,41 s / *Korrekte vorm van grafiek 0 – 0,41 s*	✓
Correct shape of graph 0,41s – 1,6 s / *Korrekte vorm van grafiek 0,41s- 1,6 s*	✓
Coordinates 0,41 s ; 0,82 m for highest position indicated / *Ko-ordinate 0,41 s; 0,82 m vir hoogste punt aangedui*	✓
Coordinates 0,s ; 0,82 m indicated / *Ko-ordinate 0 s; 0,82 m aangedui*	✓
Coordinates 1,6s ; 6 m indicated / *Ko-ordinate 0,41 s; 0,82 m aangedui*	✓

(5)
[12.1.2] **[13]**

QUESTION 6/*VRAAG 6*

6.1 $1{,}96 \times 10^4$ N ✓, upward /opwaarts✓ [12.2.3] (2)

6.2 $p_{before} = p_{after}$

$m_1v_{i1} + m_2v_{i2} = (m_1+m_2)v_f$ ✓

(0) ✓ + (2 000)(3) ✓ = (1 500 + 2 000)v_f ✓

$v_f = 1{,}71 \text{m.s}^{-1}$ ✓ westwards✓ [12.2.3] (6)

6.3 $F_{net}\Delta t = \Delta p$

$F_{net} = \frac{m(v-u)}{\Delta t}$ / $\frac{m(v_{fB} - v_{iB})}{\Delta t}$ ✓

$= \frac{2000(1{,}71-3)}{0{,}5}$ ✓✓

$= -5\ 160$ N

$\therefore$ Magnitude of F = 5 160 N ✓ [12.2.3] (4)

6.4 The air bubbles will increase the time of impact ✓ and thus reduce the Force. ✓ This may minimize damage to the equipment. ✓

Die lugborrels verleng die impaktyd ✓en verminder dus die krag wat die vertraging veroorsaak.✓ Hierdie effek kan verhoed dat die voorraad beskadig word.✓ [12.3.2] (3)

[15]

QUESTION 7/*VRAAG 7*

7.1 E_{mech} is not conserved. ✓ This is not an isolated system / there is friction✓
E_{meg} bly nie behoue. ✓ Is nie 'n geisoleerde sisteem / daar is wrywing. ✓ [12.2.3] (2)

7.2
$E_k = K = \frac{1}{2}mv^2$✓
$= \frac{1}{2}(55)(10)^2$✓
$= 2\ 750$ J✓ [12.2.3] (3)

7.3 $W_{nc} = \Delta E_k + \Delta E_p$

$F\cos\theta\Delta x = E_{kf} - E_{ki} + E_{pf} - E_{pi}$ ✓

$(18)\cos180^o(8)$ ✓ $= (½\ mv_f^2 - ½\ mv_i^2)$ ✓+ $(mgh_f - mgh_i)$ ✓
-144✓ $= E_{kf} - ½\ (55)(10)^2$✓ $+ (55)(9,8)(1,2)$ ✓ $- 0$
$E_{kf} = 1\ 959,2$ J ✓

OR

$E_p = U = mgh$ (gained)
$= (55)(9,8)(1,2)$ ✓
$= 646,8$ J✓

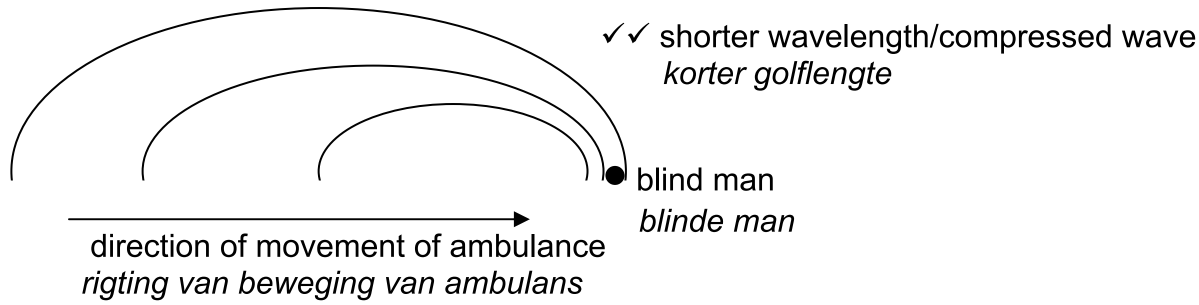
Work done against friction / Werk gedoen teen wrywing.
$W = F\cdot\cos\theta\ \Delta x = (18)(\cos180^o)(8)$
$= (18)(-1)(8)$ ✓
$= -144$ J ✓ (lost)

$\therefore (E_p + E_k)_{bottom} = (E_p + E_k)_{top} + W$✓
$(0 + 2\ 750)$ ✓$= 646,8$✓ $+ E_k + 144$
$E_k)_{top} = 1\ 959,2$ J ✓

OR
$W_{net} = \Delta E_k$✓
$F_{net}\cos\theta\Delta x = \Delta E_k$
$(mg\sin\theta + f)$ ✓✓$\cos\theta\Delta x = E_{kf} - E_{ki}$
$[(55)(9,8)(\frac{1,2}{8})$ ✓ $+ 18$✓$](\cos180^o)(8)$ ✓ $= E_{kf} - 2750$✓
$E_{ki} = 1959,2$ J✓ [12.1.3] (8)
[13]

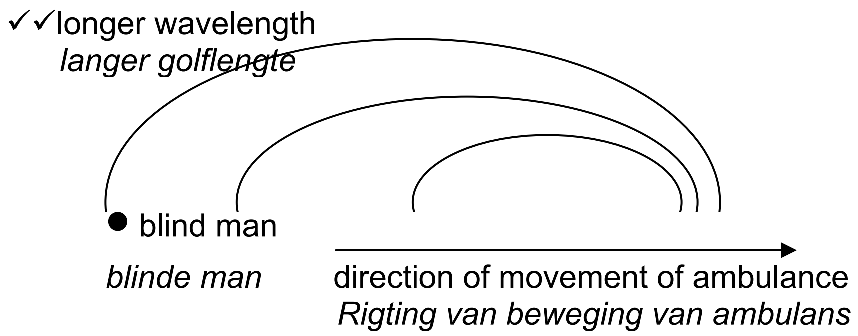
QUESTION 8/*VRAAG 8*

8.1.1



[12.1.2] (2)

8.1.2



[12.1.2] (2)

8.2 $f_L = (\frac{v \pm v_L}{v \pm v_s})f_s$ ✓

$= (\frac{340 \pm 0}{340 - 40})350$ ✓ ✓ ✓

$= 396{,}7$ Hz ✓ [12.2.3] (1)

8.3 When crossing a street , a blind person can determine whether a car is moving towards✓ or away✓ from him
Wanneer 'n blinde persoon 'n straat oorsteek kan bepaal word of die motor kar na✓ of weg✓ van die person beweeg [12.3.2] (2)

[11]

QUESTION 9/*VRAAG 9*

9.1 Light consisting of a single frequency. ✓✓ (or one wavelength)
Lig wat net uit'n enkele frekwensie bestaan. ✓✓(of een golflengte) [12.2.1] (2)

9.2 Alternate red✓ and dark bands✓ are observed.
Afwisselende rooi✓ en donker stroke✓ is waargeneem [12.2.3] (2)

9.3 Red bands as result of constructive and dark bands as result of destructive interference.
Rooibande as gevolg van konstruktiewe en donkerbande as gevolg van destruktiewe interferensie [12.2.3] (2)

9.4 The coloured bands are narrower ✓✓/ A greater number of dark bands, closer together are seen.
The wavelength of blue light is shorter than red✓✓, resulting in more points of interference.
Die gekleurede bande is nouer✓✓ / 'n Groter aantal donker en rooi stroke nader aan mekaar.
Die golflengte van blou lig is korter as rooi, ✓✓ en veroorsaak meer interferensie. [12.2.2] (4)

9.5 More dark and light bands are seen. ✓✓
Meer donker en lig stroke word waargeneem.✓✓ [12.2.2] (2)

[12]

QUESTION 10/*VRAAG 10*

10.1
$$R_{||} = \frac{R_1R_2}{R_1 + R_2} \checkmark$$
$$= \frac{(5)(15)}{(5+15)}$$
$$= 3{,}75\ \Omega \checkmark$$

$$R_T = 20 + 3{,}75 = 23{,}75\Omega \checkmark$$

$$I_T = \frac{V}{R_T} \checkmark$$
$$= \frac{60}{23{,}75} \checkmark$$
$$= 2{,}53\ A \checkmark$$
[12.1.3] (6)

10.2
$$V_{20\Omega} = IR_{20\Omega}$$
$$= (2{,}53)(20) \checkmark$$
$$= 50{,}6\ V \checkmark$$

$$V_{||} = (60 - 50{,}6)$$
$$= 9{,}4\ V \checkmark$$
[12.2.3] (3)

[9]

QUESTION 11/*VRAAG 11*

11.1 $C= \frac{\varepsilon_0 A}{d}$ ✓

$= \frac{8,85\times10^{-12}\cdot 0,04}{0,002}$ ✓✓

$= 1,77\times10^{-10}$ F✓ [12.2.3] (4)

11.2 $C = \frac{Q}{V}$ ✓

$1,77\times10^{-10} = \frac{Q}{250}$ ✓

$1,77\times10^{-10}\cdot250 = Q$

$Q = 4,425\times 10^{-8}$C✓ [12.2.3] (3)

11.3 Increase the potential difference ✓✓
Verhoog die potensiaalverskil ✓✓ [12.2.2] (2)

11.4 dielectric / *diëlektriikum* ✓ [12.2.1] (1)

11.5 It stores charge. ✓ This large amount of charge can cause shock to the body.
Dit berg lading. ✓ *Die groot hoeveelheid gebergde lading kan skok veroorsaak*✓ [12.3.2] (2)
[13]

QUESTION 12/*VRAAG 12*

12.1 Electric energy ✓converted to (rotational) mechanical energy. ✓
Elektriese energie✓ word omgesit in meganiese energie [12.2.1] (2)

12.2.1 A DC motor reverses current direction with the aid of the commutator whenever the coil is in the vertical ✓position to ensure continuous rotation.
An AC motor, with alternating current as input, works without commutators since the current alternates. ✓

‘n Gelykstroom motor verander die stroomrigting sodra die spoel in ‘n vertikale posisie is, om die rotasie te volhou.
‘n Wisselstroommotor , wat deur ‘n wisselstroom gevoer word, werk sonder kommutators want die stroom wissel. [12.2.1] (2)

12.3 Increase the number of turns on each coil/increased number of coils ✓
Stronger magnets ✓ Bigger current ✓
Verhoog die aantal windings op elke spoel/meer spoele ✓ / Sterker magnete ✓/ groter stroom✓ [12.2.2] (3)

12.4.1 Clockwise ✓/*Kloksgewys* [12.2.3] (1)

12.4.2 Its own momentum ✓/ split ring commutator changes direction✓ of current, every time the coil reaches the vertical position.
Eie momentum✓ / Die kommutator verander die stroomrigting✓sodra die spoel die vertikale posisie bereik [12.2.3] (2)

[10]

QUESTION 13/*VRAAG 13*

13.1 The voltage can change using transformers✓. Electrical energy can be transmitted over long distances at low current✓, and experience low energy loss.
Die elektriese spanning kan verander word deur transformators. ✓ Elekriese energie kan gelei oor langafstande word een lae stroomsterkte✓, en beperk dus energie verlies [12.3.2] (2)

13.2

$$\Delta V_{rms} = \frac{\Delta V_{max}}{\sqrt{2}} ✓$$

$$= \frac{325}{\sqrt{2}} ✓$$

$$= 0,707\ (325)$$

$$= 230\ V$$

$$P = V_{rms} I_{rms} ✓$$

$$= (230)(13) ✓$$

$$= 2\ 990\ W ✓$$

[12.1.3] (5)

[7]

QUESTION 14/*VRAAG 14*

14.1.1 Photo electric effect ✓
Foto elektriese effek✓ [12.2.1] (1)

14.1.2 increases /*verhoog* ✓
The higher intensity more photo-electrons emitted per second✓/ intensity is proportional to the photo-current
Hoe hoër intensiteit, hoe meer foto-elektrone per sekonde vrygestel ✓/ *intensiteit is eweredig aan foto-elektrone* [12.2.2] (2)

14.1.3 Increases / *toeneem*✓
Blue light has a higher frequency✓ than red light therefore a higher energy✓
Blou lig het hoër frekwensie ✓*as rooi lig en dus hoër energie*✓ [12.2.2] (3)

14.2.1 High frequency / High energy ✓
Hoë frekwensie / hoë energie✓ [12.3.2] (1)

14.2.2 High frequency UV light kills microbes and sterilises food. ✓
Hoe frekwensie UV lig maak mikro organisme dood✓ *en steriliseer voedsel.* ✓ [12.3.2] (1)

14.2.3 $E = W_o + E_k$ ✓
$(2{,}95 \times 10^{-19})$ ✓ = (1×10^{-20}) ✓ + $\frac{1}{2}mv^2$
$\frac{1}{2}(9{,}11 \times 10^{-31})v^2$✓ = $(2{,}95 \times 10^{-20}) - (1 \times 10^{-20})$
$v = 2{,}069 \times 10^5\ m{\cdot}s^{-1}$ ✓ [12.2.3] (5)

[13]

TOTAL = 150
TOTAAL = 150

education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2008

MARKS: 150

TIME: 3 hours

PHYSICAL SCIENCE P1
PHSC

108 4 1E

This question paper consists of 16 pages, a 3-page data sheet and an answer sheet.

X25

7

GAUTENG

SECTION A

Answer this section on the attached ANSWER SHEET.

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for EACH of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) on the attached ANSWER SHEET.

1.1 The product of force and velocity (1)

1.2 The type of collision in which kinetic energy is conserved (1)

1.3 The coloured bands produced when white light passes through a triangular prism (1)

1.4 A device used to store charge in an electric circuit (1)

1.5 A phenomenon that occurs in a LASER when there are more electrons in a high-energy state than in a lower energy state (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A		COLUMN B	
2.1	A unit of measure equal to $kg{\cdot}m^2{\cdot}s^{-2}$	A	opaque
		B	electric field
2.2	The rate of change of momentum	C	net force
2.3	Objects that absorb some light while reflecting others	D	joule
2.4	Electric potential energy per unit charge	E	light bulb
		F	newton
2.5	A source of monochromatic light	G	laser
		H	electric potential
		I	transparent
		J	impulse

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Write only 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 When work is done by a net force on an object moving along a horizontal plane, the kinetic energy of the object is constant. (2)

3.2 When car A, travelling at 20 $m \cdot s^{-1}$, approaches car B, travelling at 18 $m \cdot s^{-1}$ in the opposite direction, its speed relative to car B is 38 $m \cdot s^{-1}$. (2)

3.3 The degree of diffraction of a wave is directly proportional to its frequency. (2)

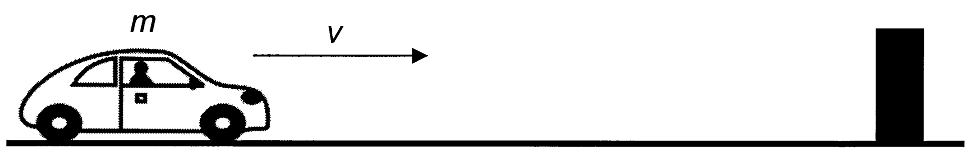
3.4 In a parallel plate capacitor, a dielectric increases capacitance by increasing the net electric field between the plates. (2)

3.5 In a laser, an incident photon leads to the creation of an identical photon travelling in the same direction as the incident photon. (2)
[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 A car of mass *m* moves along a straight line with a velocity of magnitude *v*. The driver sees an obstruction and immediately applies the brakes. The car stops uniformly in *t* seconds from the moment that the brakes are applied. The car does not hit the obstruction.



Which ONE of the following represents the MAGNITUDE of the average force exerted on the car during the braking period of *t* seconds?

A $\frac{v}{t}$

B mv

C $\frac{mv}{t}$

D mvt (3)

4.2 Consider the statements below:

I Work is done on an object when a force displaces the object in the direction of the force.

II Mechanical energy of a system is conserved when an external force does no work on the system.

III The work done on an object by a net force is equal to the kinetic energy of the object.

Which of the above statements is/are TRUE?

A Only I

B I and II only

C II and III only

D I, II and III (3)

4.3 Which ONE of the statements is CORRECT for the pigment cyan?

Cyan absorbs …

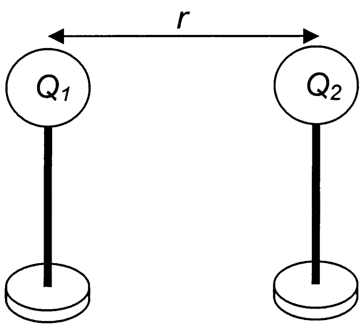
A red light while reflecting green and blue light.

B green light while reflecting red and blue light.

C blue light while reflecting green and red light.

D yellow light while reflecting green and blue light. (3)

4.4 The centres of two identical spheres are a distance r apart. They carry charges of Q_1 and Q_2 respectively as shown in the diagram below. Each sphere exerts an electrostatic force of magnitude F on the other.



The distance between the charges is now **halved** and the charge on Q_1 is **doubled.** The magnitude of the new force between the charges is …

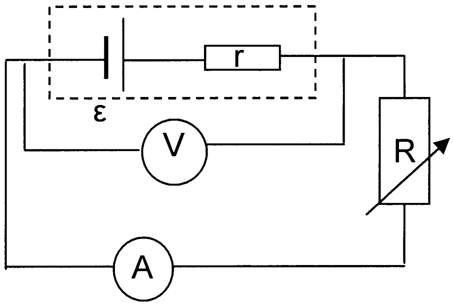
A F

B $2F$

C $4F$

D $8F$ (3)

4.5 In the circuit represented below, the resistance of the variable resistor is decreased.



How would this decrease affect the readings on the voltmeter and ammeter?

	Voltmeter reading	Ammeter reading
A	unchanged	unchanged
B	decreases	increases
C	decreases	unchanged
D	increases	increases

(3)
[15]

TOTAL SECTION A: 35

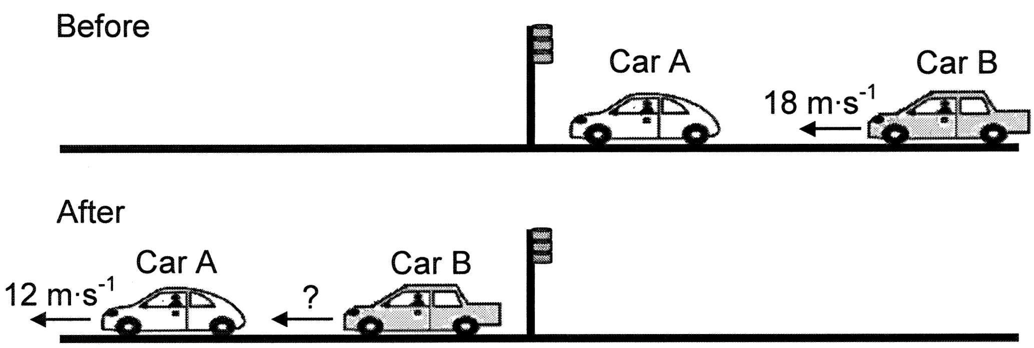
SECTION B

INSTRUCTIONS AND INFORMATION

1. Answer SECTION B in the ANSWER BOOK.
2. The formulae and substitutions must be shown in ALL calculations.
3. Round off your answers to TWO decimal places.

QUESTION 5

The most common reasons for rear-end collisions are too short a following distance, speeding and failing brakes. The sketch below represents one such collision. Car A of mass 1 000 kg, stationary at a traffic light, is hit from behind by Car B of mass 1 200 kg, travelling at 18 $m \cdot s^{-1}$. Immediately after the collision Car A moves forward at 12 $m \cdot s^{-1}$.



5.1 Assume that linear momentum is conserved during this collision. Calculate the speed of Car B immediately after the collision. (4)

5.2 Modern cars are designed to crumple partially on impact. Explain why the assumption made in QUESTION 5.1 may NOT be valid in this case. (2)

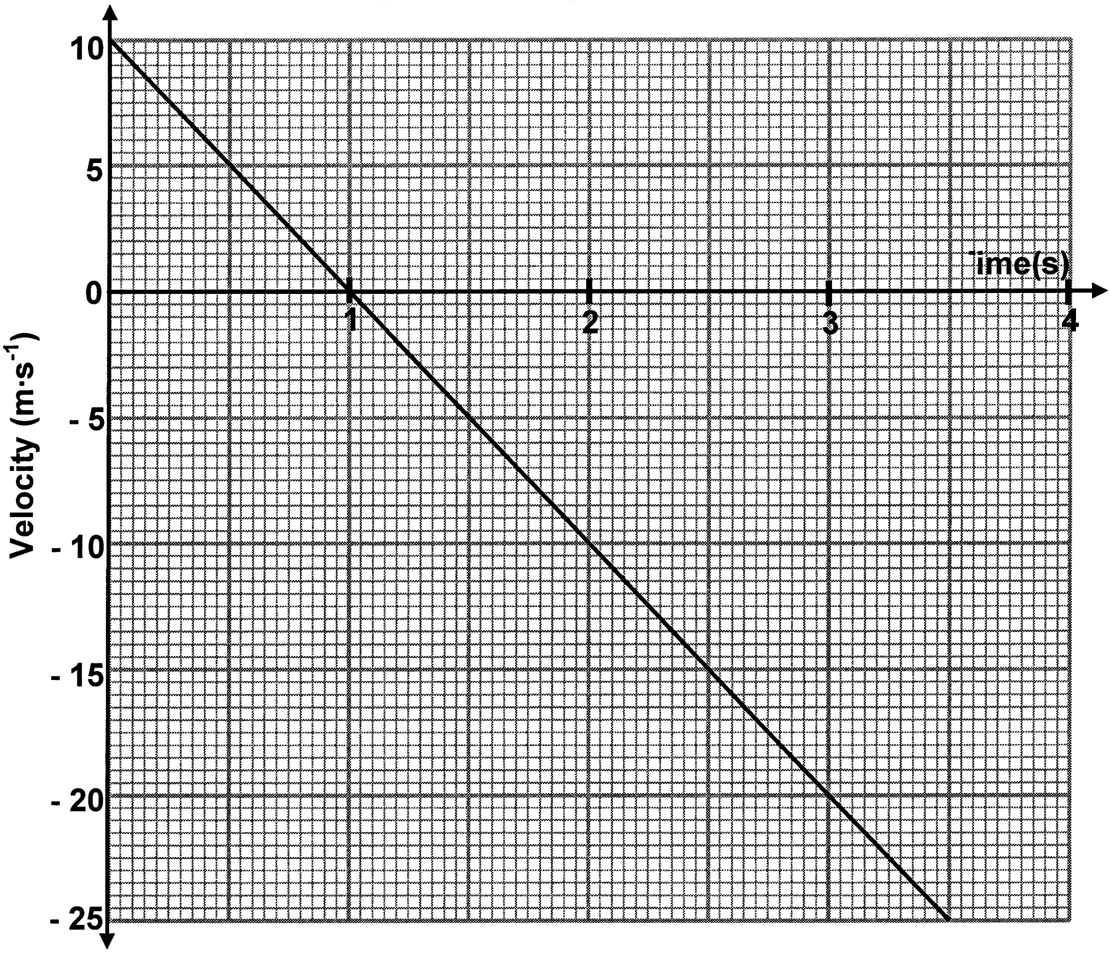
5.3 A traffic officer appears at the scene of the accident and mentions the dangers of a head-on collision. He mentions that for cars involved in a head-on collision, the risk of injury for passengers in a heavier car would be less than for passengers in a lighter car.

Use principles of Physics to explain why the statement made by the traffic officer is correct. (3)
[9]

QUESTION 6

A boy stands at the edge of a high cliff. He throws a stone vertically upwards with an initial velocity of 10 m·s^{-1}. The stone strikes the ground at a point below the cliff after 3,5 s. The velocity-time graph below was obtained from *measurements* made during the motion of the stone.

Graph of velocity versus time



Use the information on the graph to answer the following questions:

6.1 Calculate the acceleration of the stone between times t = 2 s and t = 3 s. (3)

6.2 At which time(s) is the stone moving at a speed of 5 m·s^{-1}? (2)

6.3 After how many seconds does the stone reach its highest point? (1)

6.4 Determine the height of the cliff from which the stone was thrown. (4)

6.5 Using the top of the cliff as the initial position of the stone, sketch the position-time graph (displacement-time graph) for the motion of the stone **from its highest point until it reaches the ground**. Only indicate relevant time values on the x-axis. (3)

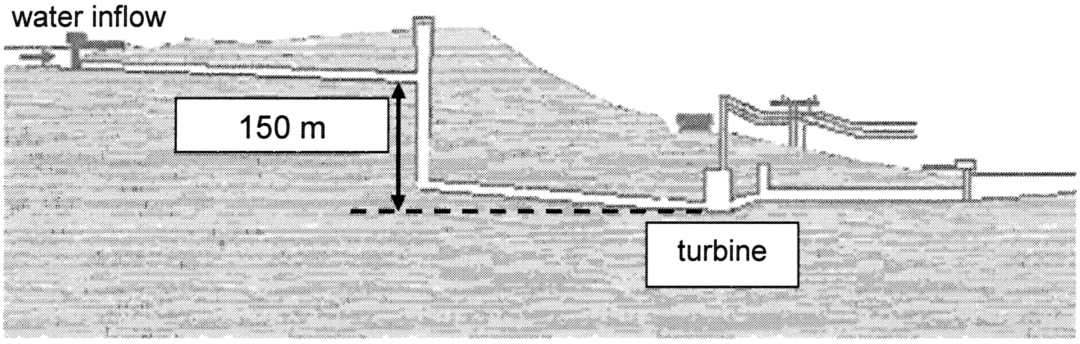
[13]

QUESTION 7

The diagram below represents how water is funnelled into a pipe and directed to a turbine at a hydro-electric power plant. The force of the falling water rotates the turbine.

Each second, 200 m^3 of water is funnelled down a vertical shaft to the turbine below. The vertical height through which the water falls upon reaching the turbine is 150 m. Ignore the effects of friction.

NOTE: One m^3 of water has a mass of 1 000 kg.



7.1 Calculate the mass of water that enters the turbine each second. (1)

7.2 Calculate the kinetic energy of this mass of water when entering the turbine. Use energy principles. (4)

7.3 Calculate the maximum speed at which this mass of water enters the turbine. (3)

7.4 Assume that a generator converts 85% of this maximum kinetic energy gained by the water into hydro-electricity. Calculate the electrical power output of the generator. (2)

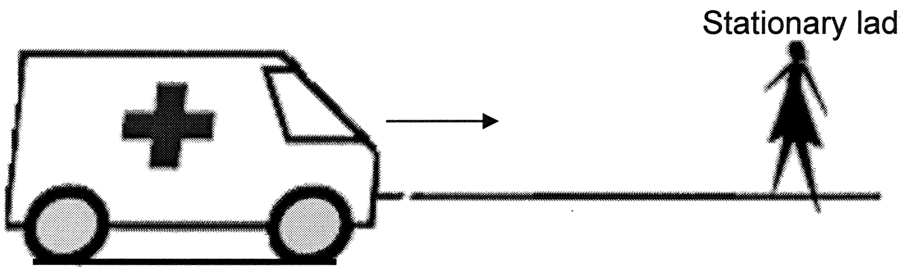
7.5 Explain what happens to the 15% of the kinetic energy that is NOT converted into electrical energy. (1)

[11]

QUESTION 8

An ambulance travelling down a road at constant speed emits sound waves from its siren. A lady stands on the side of the road with a detector which registers sound waves at a frequency of 445 Hz as the ambulance approaches her.

After passing her, and moving away at the same constant speed, sound waves of frequency 380 Hz are registered.



Assume that the speed of sound in air is 343 $m \cdot s^{-1}$.

8.1 Name the phenomenon that describes the change in the frequency observed by the lady. (1)

8.2 Calculate:

8.2.1 The speed at which the ambulance is moving (7)

8.2.2 The frequency at which the siren emits the sound waves (3)
[11]

QUESTION 9

A helium-neon laser emits red light that passes through a single slit. A diffraction pattern is observed on a screen some distance away from the slit.

9.1 Define the term *diffraction.* (2)

9.2 If the wavelength of red light is 644,4 nm and the slit width is 3 437 nm, calculate the angle at which the third minimum occurs. (3)

9.3 Briefly describe the diffraction pattern that will be observed on the screen. (2)

The single slit is replaced with a double slit.

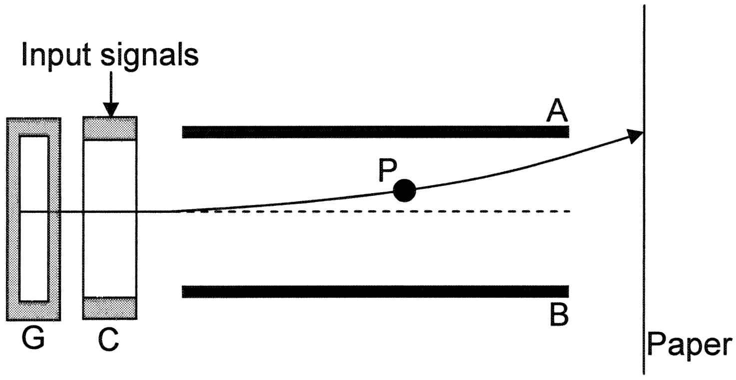
9.4 Name ONE similarity and ONE difference in the pattern observed when the single slit is replaced with a double slit. (2)

9.5 Will this pattern be observed if the laser is replaced with a light bulb? Give a reason for your answer. (2)
[11]

QUESTION 10

An ink-jet printer makes use of the electric field between two oppositely charged parallel plates to control the position of an ink drop on paper.

In the diagram below, the generator (G) of the printer shoots out ink drops that are charged in the charging unit C. The input signal from a computer controls the charge given to each ink drop. **P is a negatively charged ink drop.**



10.1 Define the electric field at a point in space. (2)

10.2 Is plate B negatively or positively charged? Give a reason for your answer. (2)

10.3 Sketch the electric field pattern between plates A and B. (2)

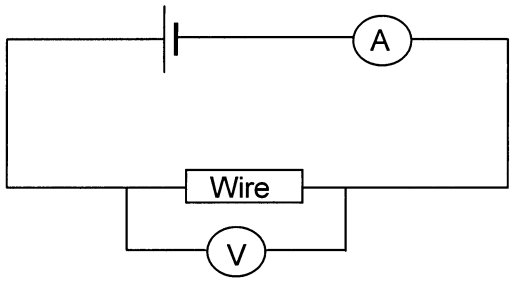
The plates A and B are $6{,}4 \times 10^{-4}$ m apart and ink drop P has a charge of magnitude $1{,}5 \times 10^{-13}$ C. When the ink drop enters the field it experiences an electrical force of $2{,}1 \times 10^{-7}$ N.

10.4 Calculate the potential difference across the parallel plates. (5)

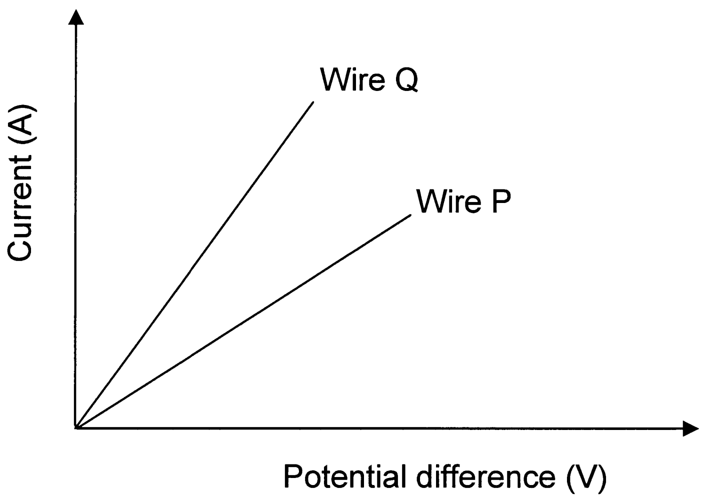
[11]

QUESTION 11

Learners investigate the conducting ability of two metal wires P and Q, made of different materials. They connect ONE wire at a time in a circuit as shown below.



The potential difference across each wire is increased in equal increments, and the resulting current through these wires is measured. Using the measurements, the learners obtained the following sketch graphs for each of the wires.

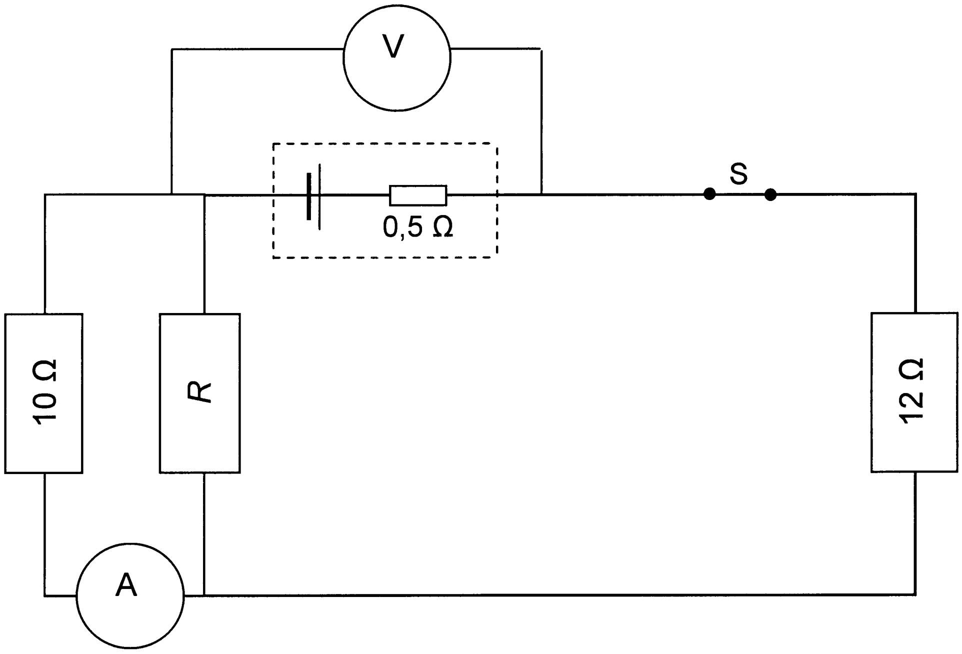


11.1 Name TWO variables that the learners would have controlled in each of the experiments. (2)

11.2 Which one (P or Q) is the better conductor? Explain your answer. (4)
[6]

QUESTION 12

A circuit is connected as shown below. The resistance of *R*, which is connected in parallel with the 10 Ω resistor, is unknown. With switch S closed, the reading on voltmeter V decreases from 45 V to 43,5 V. The internal resistance of the battery is 0,5 Ω.



12.1 Calculate the reading on ammeter A. Show ALL your calculations. (8)

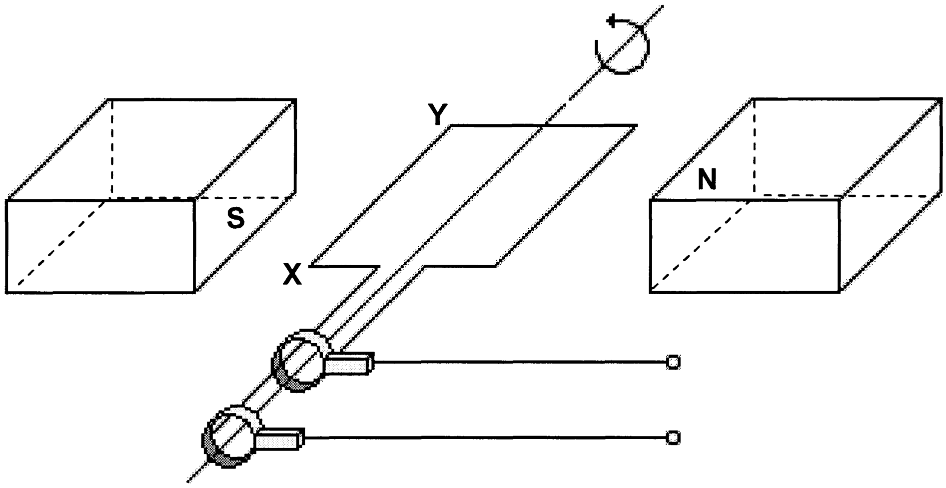
12.2 Determine the resistance of resistor *R*. (3)

12.3 How will the reading on voltmeter V change if resistor *R* burns out? Give a reason for your answer. (4)

[15]

QUESTION 13

A coil is rotated anti-clockwise in a uniform magnetic field. The diagram below shows the position at the instant the coil lies parallel to the magnetic field.



13.1 What type of generator is illustrated in the diagram? Give a reason for your answer. (2)

13.2 Determine the direction of the current in segment XY when the coil is in the position shown above. Only write down X to Y OR Y to X. (2)

13.3 Assume that the speed and direction of rotation are constant. Draw a sketch graph of potential difference against time that represents the output of this device. (2)
[6]

QUESTION 14

The municipality of Dinaledin implements a power cutback in the town. As a result of the cutback the rms voltage drops from 220 V_{rms} to 200 V_{rms}.

14.1 Calculate the peak voltage during cutback. (3)

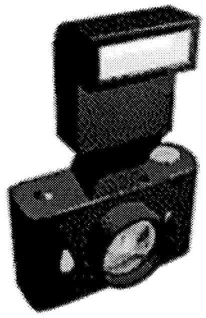
14.2 A certain electrical appliance dissipates 1 200 W when it is operated at 220 V_{rms}. Calculate the power at which it will operate during the cutback. (4)

14.3 It is common practice to connect many appliances to a multi-plug. Modern types of multi-plugs have a cut-off switch built in.

Using principles in Physics, explain clearly why this cut-off switch is important. (4)
[11]

QUESTION 15

A fully automatic camera has a built-in light meter. When light enters the light meter, it strikes a metal object that releases electrons and creates a current.



15.1 What phenomenon is described by the underlined sentence? (1)

15.2 A metal plate is irradiated with electromagnetic radiation of wavelength 200 nm. The metal has a work function of $7,57 \times 10^{-19}$ J.

Show by calculation that the metal plate will emit photo-electrons when irradiated with radiation of this wavelength. (6)

15.3 The intensity of the incident radiation on the metal plate is increased whilst maintaining a constant wavelength of 200 nm. State and explain what effect this change has on the following:

15.3.1 Energy of the emitted photo-electrons (2)

15.3.2 Number of emitted photo-electrons (2)
[11]

TOTAL SECTION B: 115

GRAND TOTAL: 150

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1 Power/ rate of work /*drywing/arbeidstempo* ✓
instantaneous power/*oombliklike drywing*
average power/*gemiddelde drywing* [12.2.1] (1)

1.2 elastic/*elastiese* ✓ [12.2.1] (1)

1.3 (continuous/light) spectrum/*(aaneenlopende/lig) spektrum* ✓ (1)
Continuous emission spectrum/*aaneenlopende emissiespektrum*

No marks for/*Geen punte vir*:
Line spectrum/*lynspektrum*
Emission spectrum/*emissiespektrum*
EM spectrum/*spektrum*
Rainbow/reënboog [12.2.1]

1.4 capacitor/*kapasitor* ✓ [12.2.1] (1)

1.5 population inversion/*besettingsomkering* ✓

Accept/*Aanvaar:*
Inverted population/*omgekeerde besetting/populasie of bevolkingsomkering/populasie inversie* [12.2.1] (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 D ✓ [12.2.2] (1)

2.2 C ✓
Accept/*Aanvaar* F [12.2.1] (1)

2.3 A✓ [12.2.1] (1)

2.4 H✓ [12.2.1] (1)

2.5 G ✓ [12.2.3] (1)
[5]

QUESTION 3/*VRAAG 3*

3.1 False/Onwaar ✓
... the kinetic energy changes/decreases/increases/does not remain the same ✓
... die kinetiese energie verander/neem toe/neem af /bly nie dieselfde nie

OR/OF
.... the velocity changes /*die snelheid verander*

OR/*OF*
... the potential energy remains the same/... d*ie potensiële energie bly konstant.*

OR/*OF*
... work is done by a zero net force, the kinetic energy does not change/*... arbeid word verrig deur 'n netto krag van nul, bly die kinetiese energie konstant.* [12.2.3] (2)

3.2 True/*Waar* ✓✓ [12.2.3] (2)

3.3 False/Onwaar ✓
... is inversely proportional/*is omgekeerd eweredig*✓
...is directly proportional to wavelength/*is direkt eweredig aan golflengte*
The degree of refraction .../*Die mate van breking/refraksie ...* [12.2.2] (2)

3.4 False/*Onwaar* ✓
... by decreasing the net electric field/opposing electric field set up by the voltage source✓
...deur die netto elektriese veld te verlaag/deur die elektriese veld wat deur die battery(spanningsbron) opgewek word, teen te werk

No other factors accepted/*geen ander faktore word aanvaar nie*. [12.2.3] (2)

3.5 True/*Waar* ✓✓ [12.2.1] (2)

[10]

QUESTION 4/*VRAAG 4*

4.1	C ✓✓✓	[12.2.3]	(3)
4.2	B ✓✓✓	[12.2.3]	(3)
4.3	A ✓✓✓	[12.2.3]	(3)
4.4	D ✓✓✓	[12.2.2]	(3)
4.5	B ✓✓✓	[12.1.3]	(3)
			[15]

TOTAL SECTION A: 35
***TOTAAL AFDELING A:* 35**

SECTION B/*AFDELING B*

QUESTION 5 / *VRAAG 5*

5.1 Consider to the left as positive/*Beskou na links as positief*

$\Sigma m_i v_i = \Sigma m_f v_f$

$p_{before} = p_{after}$ /$p_{voor} = p_{na}$ OR $m_A v_{iA} + m_B v_{iB} = m_A v_{fA} + m_B v_{fB}$

OR $m_A u_A + m_B u_B = m_A v_A + m_B v_B$ ✓

(1 000)(0) + (1 200)(18) ✓= (1000)(12) + (1 200)v_{fB}✓

9 600 = (1 200)v_{i2}

$V_{fB} = 8\ m\cdot s^{-1}$ ✓

> OR calculation using to the left as negative
> Answer given as – 8 $m\cdot s^{-1}$ ✓ (all velocities substituted must be negative) OF *berekening met links as negatief: Antwoord – 8 $m.s^{-1}$ (alle snelhede vervang moet negatief wees)*

> Do NOT penalise for zero value not shown if equation is correct./*Moenie vir nulwaarde wat nie getoon is penaliseer nie as vergelyking korrek is.*

[12.2.3] (4)

> 1. Wrong formula / Verkeerde *formule:* $\frac{0}{4}$
> 2. No formula, but all substitutions correct / *geen formule, maar alle vervangings korrek:* $\frac{3}{4}$
> 3. No formula, correct substitution, but zero values omitted / *geen formule, korrekte vervangings maar nulwaardes nie getoon* toon: $\frac{0}{4}$

5.2 Not an isolated system / external forces present / frictional forces present / driver in front car has his foot on the brake. ✓✓
Nie 'n geïsoleerde sisteem nie/ eksterne kragte is teenwoordig/ wrywingskragte teenwoordig / bestuurder van voorste motor het sy voet op die rem. [12.2.3] (2)

5.3

During the collision, both cars experience a force of equal magnitude ✓
This net force on the car with larger mass causes it to experience a smaller acceleration✓
therefore the passenger will experience a smaller change in velocity and will be less injured. ✓

Tydens die botsing ondervind beide motors 'n krag van gelyke grootte.
Hierdie netto krag op die motor met groter massa veroorsaak 'n kleiner versnelling
en dus ondergaan die passasier 'n kleiner verandering in snelheid en word minder beseer. .

For a specific/*Vir spesifieke* $F_{net}\Delta t$:
Δp(heavy car) = Δp(light car) ✓
$m_H(v_f - v_i)_H = m_L(v_f - v_i)_L$
but $m_H > m_L$
$(v_f - v_i)_H < (v_f - v_i)_L$ ✓
Therefore a passenger will experience a smaller change in velocity ✓and gets injured less/*Dus sal 'n passasier 'n kleiner verandering in snelheid ondervind en minder beseer word.*

[12.3.2] (3)
[9]

QUESTION 6/*VRAAG 6*

6.1 [12.1.2] (3)

Gradient/*gradient* = $\frac{\Delta v}{\Delta t}$ ✓= $\frac{-20-(-10)}{3-2}$ ✓= $\frac{-10}{1}$ = -10 m·s^{-2}✓ or 10 m·s^{-2} downwards

Accept / Aanvaar $\frac{\Delta y}{\Delta x}$

(+)

Upwards/*Opwaarts*+
$v_f = v_i + a\Delta t$ ✓
$-20 = -10 + a(1)$ ✓
$a = -10$ m·s^{-2}✓

Downwards/Afwaarts +
$v_f = v_i + a\Delta t$ ✓
$20 = 10 + a(1)$ ✓
$a = 10$ m·s^{-2} ✓

If only answer = -10 m.s^{-2} $(\frac{0}{3})$

Do NOT penalise for other sets of values FROM THE GRAPH giving the correct answer/ *Moenie penaliseer vir ander stele waardes vanaf die grafiek wat die korrekte antwoord gee nie.*

[12.1.2] (3)

6.2 0,5 s ✓ and/*en* 1,5 s ✓ Accept /*Aanvaar* sec /*sek* [12.1.2] (2)

6.3 1 s ✓ [12.1.2] (1)

6.4

6.4

DETERMINING AREAS/ *BEPALING VAN OPPERVLAKTE*

Option 1 / *Opsie 1* :Area of trapezium / *Oppervlakte van trapesium*

Height of cliff/ *Hoogte van krans* = area of trapezium/area of trapezium
= ½ (sum of parallel sides/som van ewewydige sye)h ✓
= ½ (10 + 25) ✓ (1,5) ✓
= 26,25 m✓

> One mark for the area formula in words or symbols / *Een punt vir area formule in woorde of simbole*

If negative values for velocities – final answer must be given as positive: ✓
= ½ (sum of parallel sides/som van ewewydige sye)h
= ½ (- 10 - 25) ✓ (1,5) ✓
= - 26.25 m

Option 2 / *Opsie 2* :Difference between areas of two triangles / *Verskil tussen die oppervlaktes van twee driehoeke*

Height of cliff /Hoogte van krans
= area of larger triangle/van groter driehoek – area of smaller triangle/van kleiner driehoek
= ½ bh – ½ bh✓
= ½ (2,5)(25) ✓– ½ (1)(10) ✓ = 31,25 - 5
= 26,25 m✓

> One mark for the area formula in words or symbols / *Een punt vir area formule in woorde of simbole*

OR/OF
area of larger triangle/van groter driehoek = ½ bh ✓= ½ (2,5)(25) ✓= 31,25 m
area of smaller triangle/van kleiner driehoek = ½ bh = ½ (1)(10) ✓ = 5 m
Height of cliff /Hoogte van krans= 31,25 – 5 = 26,25 m ✓

If negative values for velocities – final answer must be given as positive:
As negatiewe snelheidswaardes – finale antwoord moet positief wees:
= ½ bh – ½ bh✓
= ½ (2,5)(- 25) ✓– ½ (1)(- 10) ✓ = - 31,25 + 5
= - 26,25 m
Thus height/*dus hoogte* is 26,25 m ✓

Option 3 / *Opsie 3* :The sum of areas of rectangle and triangle / *Die som van die oppervlaktes van reghoek en driehoek*

Height of cliff */Hoogte van krans*
= area of rectangle/van reghoek + area of triangle/van driehoek
= (l x b) + ½ bh ✓
=(1,5)(10) ✓ + ½ (1,5)(15) ✓ = 15 + 11,25
= 26,25 m✓

> One mark for the area formula in words or symbols / *Een punt vir area formule in woorde of simbole*

If negative values for velocities – final answer must be given as positive:
(l x b) + ½ bh ✓
=(1,5)(-10) ✓ + ½ (1,5)(-15) ✓ = - 15 - 11,25
= - 26,25 m
Thus height/*dus hoogte* is 26,25 m ✓

USING EQUATIONS OF MOTION / GEBRUIK VAN BEWEGINGSVERGLYKINGS

Option 1 / *Opsie 1*: Initial velocity 10 $m\cdot s^{-1}$ upwards and total time 3,5 s / *Beginsnelheid 10 $m\cdot s^{-1}$ opwaarts en totale tyd 3,5 s*

Consider upward motion as positive / *Beskou opwaartse beweging as positief:*

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓

$\therefore\ \Delta y = (10)(3,5)$ ✓ $+ \frac{1}{2}(-10)(3,5)^2$ ✓

$\Delta y = -26,25$ m

Height of cliff/*hoogte van krans* = 26,25 m ✓ (If a = 9,8 $m\cdot s^{-2}$; Δy = 25,03 m)

> -1 if a = 9,8 $m\cdot s^{-2}$
>
> Accept y or Δx in the place of Δy
> *Aanvaar y of Δx in die plek van Δy*

Consider upward motion negative/*Beskou opwaartse beweging as negatief*

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $\therefore\ \Delta y = (-10)(3,5)$ ✓ $+ \frac{1}{2}(10)(3,5)^2$ ✓ $\therefore\ \Delta y = 26,25$ m

Height of cliff/*hoogte van krans* = 26,25 m ✓ (If a = 9,8 $m\cdot s^{-2}$; Δy = 25,03 m)

Option 2 / *Opsie 2*: Initial velocity 10 $m\cdot s^{-1}$ upwards and final velocity of 25 $m\cdot s^{-1}$ downwards / *Beginsnelheid 10 $m\cdot s^{-1}$ opwaarts en eindsnelheid 25 $m\cdot s^{-1}$ afwaarts*

Consider upward motion as positive/*Beskou opwaartse beweging as positief*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\therefore\ (-25)^2$ ✓ $= (10)^2 + 2(-10)\ \Delta y$ ✓

$\therefore\ \Delta y = -26,25$ m

Height of cliff/*hoogte van krans* = 26,25 m ✓

(If a = 9,8 $m\cdot s^{-2}$; Δy = 26,79 m)

> -1 if a = 9,8 $m\cdot s^{-2}$
>
> Accept y or Δx in the place of Δy
> *Aanvaar y of Δx in die plek van Δy*

Consider upward motion as negative/*Beskou opwaartse beweging as negatief*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\therefore\ (25)^2$ ✓ $= (-10)^2 + 2(10)\ \Delta y$ ✓

$\therefore\ \Delta y = 26,25$ m

Height of cliff/*Hoogte van krans* = 26,25 m ✓ (If a = 9,8 $m\cdot s^{-2}$; Δy = 26,79 m)

Option 3 / *Opsie 3*: Initial velocity 10 $m\cdot s^{-1}$ upwards and final velocity of 25 $m\cdot s^{-1}$ downwards / *Beginsnelheid 10 $m\cdot s^{-1}$ opwaarts en eindsnelheid 25 $m\cdot s^{-1}$ afwaarts*

Consider upward motion as positive/*Beskou opwaartse beweging as positief*

$\Delta y = \frac{(v_i + v_f)}{2} \Delta t$ ✓

$= \frac{(-10 - 25)}{2}(1,5)$ ✓

$= -26,25$ m

Height of cliff/*hoogte van krans* = 26,25 m ✓

> -1 if a = 9,8 $m\cdot s^{-2}$
>
> Accept y or Δx in the place of Δy
> *Aanvaar y of Δx in die plek van Δy*

Consider upward motion as negative/*Beskou opwaartse beweging as negatief*

$\Delta y = \frac{(v_i + v_f)}{2} \Delta t$ ✓ $= \frac{(10 + 25)}{2}(1,5)$ ✓ $= 26,25$ m ✓

Option 4 / *Opsie 4*: Initial velocity 10 m·s^{-1} downwards and total time of 1,5 s / *Beginsnelheid 10 m·s^{-1} en totale tyd van 1,5 s*

Consider upward motion as positive/*Beskou opwaartse beweging as positief:*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\therefore\ \Delta y = (-10)(1,5)$ ✓ $+ \frac{1}{2}(-10)(1,5)^2$ ✓ $= -15 - 11,25$

$\Delta y = -26,25$ m

Height of cliff/*hoogte van krans* = 26,25 m ✓ (If a = 9,8 m·s^{-2} ; Δy = 25,03 m)

Consider upward motion negative/*Beskou opwaartse beweging as negatief*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\therefore\ \Delta y = (10)(1,5)$ ✓ $+ \frac{1}{2}(10)(1,5)^2$ ✓

$\Delta y = 26,25$ m ✓

Height of cliff/*hoogte van krans* = 26,25 m (If a = 9,8 m·s^{-2}; Δy = 25,03 m)

> -1 if a = 9,8 m·s^{-2}
>
> Accept y or Δx in the place of Δy
> *Aanvaar y of Δx in die plek van Δy*

Option 5 / *Opsie 5*: Initial velocity 0 m·s^{-1} and total time of 2,5 s / *Beginsnelheid 0 m·s^{-1} en totale tyd van 2,5 s*

Consider upward motion as positive/*Beskou opwaartse beweging as positief:*
Maximum height above the ground/*Maksimum hoogte bokant grond:*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\therefore\ \Delta y = (0)(2,5) + \frac{1}{2}(-10)(2,5)^2$ ✓ $= -31,25$ m

(If a = 9,8 m·s^{-2}; Δy = 30,63 m)

$\Delta y = 31,25$ m

> -1 if a = 9,8 m·s^{-2}
>
> Accept y or Δx in the place of Δy
> *Aanvaar y of Δx in die plek van Δy*

From cliff to maximum height/*vanaf rots tot maksimum hoogte*:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$\Delta y = (10)(1) + \frac{1}{2}(-10)(1)^2$ ✓ = 5 m (If a = 9,8 m·s^{-2}; Δy = 5,1 m)

Height of cliff/*hoogte van rots* = = 31,25 – 5 = 26,25 m ✓ (If a = 9,8 m·s^{-2}; Δy = 25,53 m)

Consider upward motion negative/*Beskou opwaartse beweging as negatief*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\therefore\ \Delta y = (0)(2,5)$ ✓ $+ \frac{1}{2}(10)(2,5)^2$ ✓ $= 31,25$ m

From cliff to maximum height/*vanaf rots tot maksimum hoogte*:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\Delta y = (-10)(1)$ ✓ $+ \frac{1}{2}(10)(1)^2$ ✓ $= -5$ m $\therefore\ \Delta y = 5$ m

Height of cliff/*hoogte van rots* = 31, 25 – 5 = 26,25 m

Option 6 / *Opsie 6*: Initial velocity 0 m·s^{-1} and final velocity 25 m·s^{-1} downwards / *Beginsnelheid 0 m·s^{-1} en eindsnelheid van 25 m·s^{-1} afwaarts*

Consider upward motion as positive/*Beskou opwaartse beweging as positief:*
Maximum height above the ground/*Maksimum hoogte bokant grond:*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(-25)^2 = (0)^2 + 2(-10)\Delta y$ ✓
$\therefore \Delta y = -31{,}25$ m
(If a = 9,8 m·s^{-2}; $\Delta y = 30{,}63$ m)
$\Delta y = 31{,}25$ m

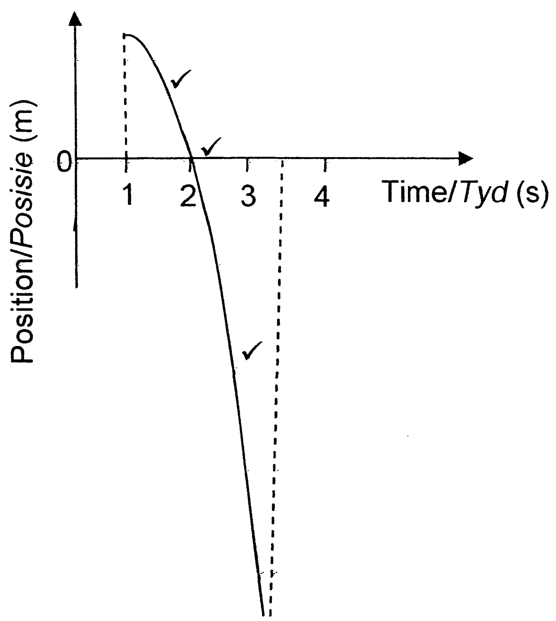
From cliff to maximum height/*vanaf rots tot maksimum hoogte*:
$v_f^2 = v_i^2 + 2a\Delta y$
$0^2 = (-10)^2 + 2(-10)\Delta y$ ✓
$\therefore \Delta y = 5$ m (If a = 9,8 m·s^{-2}; $\Delta y = 5{,}1$ m)
Height of cliff/*hoogte van rots* = = 31,25 – 5 = 26,25 m ✓

Consider upward motion negative/*Beskou opwaartse beweging as negatief*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(25)^2 = (0)^2 + 2(10)\Delta y$ ✓
$\therefore \Delta y = 31{,}25$ m

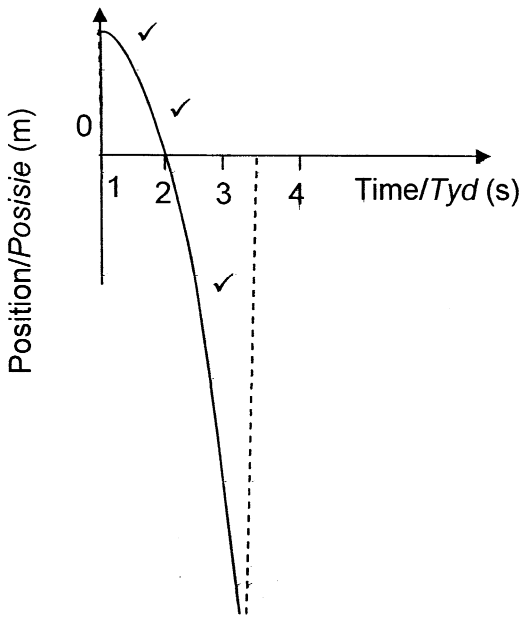
From cliff to maximum height/*vanaf rots tot maksimum hoogte*:
$v_f^2 = v_i^2 + 2a\Delta y$
$0^2 = (10)^2 + 2(10)\Delta y$ ✓
$\therefore \Delta y = 5$ m (If a = 9,8 m·s^{-2}; $\Delta y = 5{,}1$ m)
Height of cliff/*hoogte van rots* = = 31,25 – 5 = 26,25 m ✓

[12.1.2] (4)

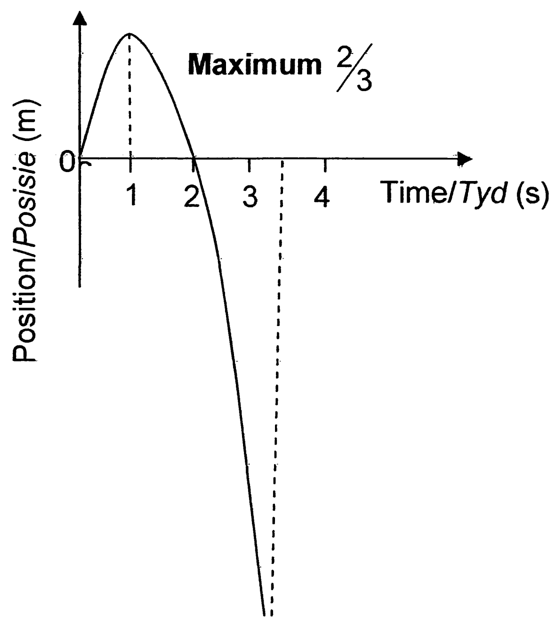
6.5



Height of cliff as zero position
Hoogte van krans as nulposisie

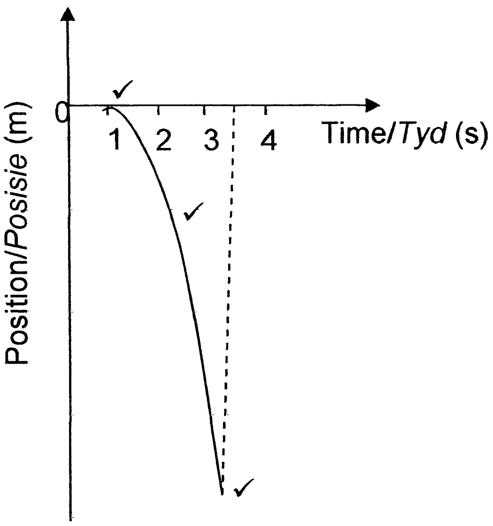


Height of cliff as zero position
Hoogte van krans as nulposisie

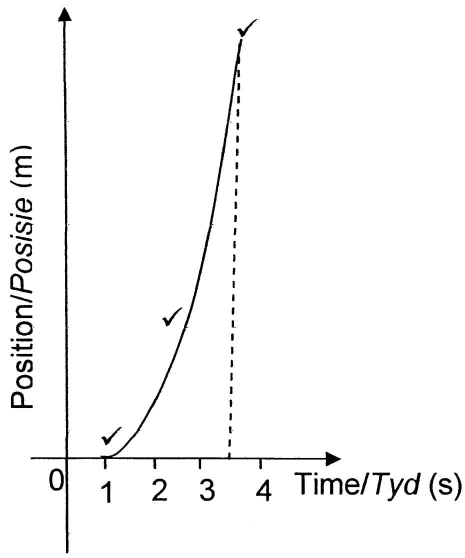


Checklist/*Kontrolelys* Criteria for graph/*Kriteria vir grafiek*	Marks/ *Punte*
t = 1s – 3,5 s: shape of curve representing constant acceleration / *Verplasing neem af (kurwe stel konstante versnelling voor)*	✓
At 2 s: Displacement is 0 (intersects time axis) / *Verplasing is 0 (sny tydas)*	✓
Curve stops at 3,5 s/ **Kurwe** *eindig by 3,5 s*	✓

NOTE: Reflection of these graphs for opposite sign convention (downwards as positive) / *Spieëlbeelde van hierdie grafieke vir teenoorgestelde teken konvensie (afwaarts as positief)*

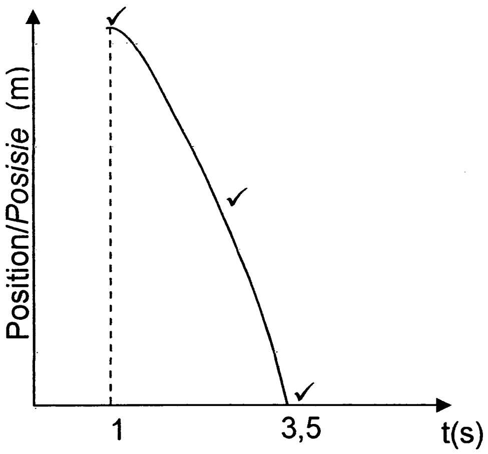


Maximum position zero, upward positive
Maksimum posisie nul , opwaarts positief

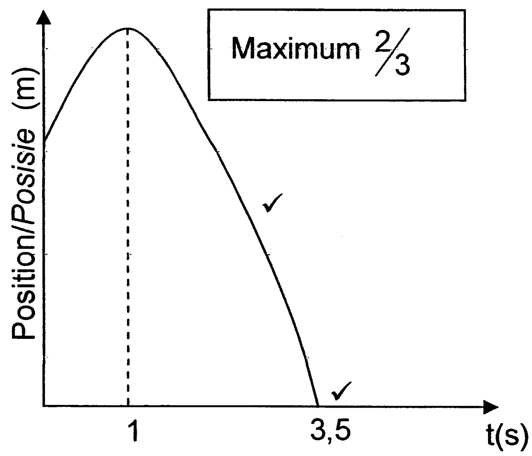


Maximum position zero, upward negative
Maksimum posisie nul, opwaarts negatief

Checklist/*Kontrolelys* Criteria for graph/*Kriteria vir grafiek*	Marks/ *Punte*
t = 1s Displacement is 0 (intersects with x-axis)/ *Verplasing is 0 (sny x-as)*	✓
From 1 – 3,5 s: Curve representing constant acceleration / *kurwe stel konstante versnelling voor*	✓
Graph stops at 3,5 s/ *Grafiek eindig by 3,5 s*	✓



Height of cliff at t = 0 s



Height of cliff at t = 0 s

Checklist/*Kontrolelys* Criteria for graph/*Kriteria vir grafiek*	Marks/ *Punte*
t = 1s: maximum displacement/*maksimum verplasing*	✓
t = 1 s – 3,5 s: curve representing constant acceleration/ *kurwe stel konstante versnelling voor*	✓
t = 3,5 s: Displacement is zero/*Verplasing is nul*	✓

[12.1.2] (3)
[13]

QUESTION 7/*VRAAG 7*

7.1 $200 \times 1\,000 = 2 \times 10^5$ kg ✓ [12.2.3] (1)

7.2 $E_{ki} + E_{pi} = E_{kf} + E_{pf}$ ✓ or/of $E_{mech\,i} = E_{mech\,f}$ or/*of* $\Delta E_p = \Delta E_k$

$0 + mgh_i = E_{kf} + 0$

$0 + (2 \times 10^5)(9,8)(150)$ ✓ $= E_{kf} + 0$ ✓

$\therefore E_{kf} = 2,94 \times 10^8$ J ✓

-1 if $g = 10\ m{\cdot}s^{-2}$

$E_p(top) = E_k(bottom)$ 0/4
$mgh = E_k(bottom)$
$(2 \times 10^5)(9,8)(150) = E_k(bottom)$
$E_k(bottom) = 2,94 \times 10^8$ J

OR/*OF*

$W_{net} = \Delta E_k$

$F\cos\theta\,\Delta y = E_{kf} - E_{ki}$ ✓

$(200\,000)(9,8)(\cos 0^o)(150)$ ✓ $= E_{kf} - 0$ ✓

$\therefore E_{kf} = 2,94 \times 10^8$ J ✓

Do not penalise when zero values are omitted after principle statement /*Moenie penaliseer wanneer nulwaardes uitgelaat word na beginselstelling nie.*

[12.2.3] (4)

7.3 $E_{kf} = \frac{1}{2}mv_f^2$ ✓
$2,94 \times 10^8 \text{ J} = \frac{1}{2}(2 \times 10^5)v_f^2$ ✓
$v_f = 54,22\ m{\cdot}s^{-1}$ ✓ [12.2.3] (3)

7.4 $P = \frac{85}{100} \times \frac{W}{\Delta t} = \frac{85}{100} \times \frac{2,94 \times 10^8}{1}$ ✓
$= 2,499 \times 10^8$ W ✓ Accept/*Aanvaar* $2,5 \times 10^8$ W

OR/*OF*

$E_k(\text{effective}/\textit{effektief}) = \frac{85}{100} \times 2,94 \times 10^8$ ✓ $= 2,499 \times 10^8$ J

$P = \frac{W}{\Delta t} = 2,499 \times 10^8$ W ✓ Accept/*Aanvaar* $2,5 \times 10^8$ W [12.2.3] (2)

7.5 Converted to sound / heat in turbine / other forms of energy. ✓
Omgeskakel na klank / hitte in die turbine / ander vorms van energie [12.2.3] (1)
[11]

QUESTION 8/*VRAAG 8*

8.1 Doppler effect/*Dopplereffek* ✓ [12.2.1] (1)

8.2.1 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓OR/*OF* $f_s = \frac{v \pm v_s}{v \pm v_L} f_L$ OR/OF

approach/*nader*: $f_L = \frac{v \pm v_L}{v - v_s} f_s$ OR/*OF* $f_L = \frac{v}{v - v_s} f_s$

move away/*beweeg weg:* $f_L = \frac{v \pm v_L}{v + v_s} f_s$ OR/OF $f_L = \frac{v}{v + v_s} f_s$

Ambulance approaching/*Ambulans nader dame:*

$445 = f_s \frac{343}{343 - v_s}$ ✓ ✓ $\therefore 445(343 - v_s) = 343 f_s$ .... (i)

Ambulance moving away/*Ambulans beweeg weg*:

$380 = f_s \frac{343}{343 + v_s}$ ✓ ✓ $\therefore 380(343 + v_s) = 343 f_s$ ....(ii)

$445(343 - v_s) = 380(343 + v_s)$ ✓

1 mark for equalising equations/dividing two equations/*1 punt vir gelykstelling van vergelykings/deling van vergelykings*

$v_s = 27{,}02\ m{\cdot}s^{-1}$ ✓

[12.1.3] (7)

8.2.2 $445 = f_s \frac{343 \pm 0}{343 - v_s}$ OR/*OF* $445(343 - v_s) = 343 f_s$

$\therefore 445(343 - 27{,}02)$ ✓ $= 343 f_s$ ✓

$f_s = 409{,}94$ Hz ✓

OR/*OF*

$380 = f_s \frac{343 \pm 0}{343 + v_s}$ OR/*OF* $380(343 + v_s) = 343 f_s$

$380(343 + 27{,}02)$ ✓ $= 343 f_s$ ✓

$f_s = 409{,}94$ Hz ✓

Accept answers/*Aanvaar antwoorde* from / *vanaf* 408 to / *tot* 410 Hz

If 340 m.s^{-1} is used as speed of sound minus 1 mark / *As 340 m.s^{-1} vir spoed van klank gebruik word – minus 1 punt* [12.2.3] (3)

[11]

QUESTION 9/*VRAAG 9*

9.1 The spreading (or bending) of a wave passing through a small aperture/slit/around a sharp edge/obstacle ✓✓/*Die verspreiding (of buiging) van 'n golf as dit deur 'n nou spleet/om 'n skerp hoek beweeg/versperring.* (2 or/*of* 0) [12.2.1] (2)

9.2 $\sin\theta = m\frac{\lambda}{a}$ ✓ $= 3 \times \frac{644,4 \times 10^{-9}}{3437 \times 10^{-9}}$ ✓ $\therefore \theta = 34,23°$ ✓

Accept: $3 \times \frac{644}{3437}$ ✓ (units in nm)

OR

Using radians: $\theta = m\frac{\lambda}{a}$ ✓ $= 3 \times \frac{644,4 \times 10^{-9}}{3437 \times 10^{-9}}$ ✓

$\therefore \theta = (0,597)(57,3) = 34,23°$ ✓ [12.2.3] (3)

9.3 A broad central red / bright/ light fringe (bands) ✓followed by alternate dark and red (bright) fringes (bands) on either side ✓/*'n Breë sentrale rooi (helder) band gevolg deur alternatiewe donker en rooi (helder) bande aan beide kante* [12.2.3] (2)

9.4 Similarity/*Ooreenkoms:*

Alternate red and dark bands✓
Afwisselende rooi en donker bande

(Must be an observation ; reference to frequency or wavelength – no marks/*Moet 'n waarneming wees; verwysing na frekwensie of golflengte – geen punte*)

Difference/*Verskil:*

The red bands are of equal width / no broad central band is observed✓
Die rooi bande is van dieselfde wydte/ geen sentrale breë band word waargeneem nie.

OR/OF

The red bands are of equal intensity (brightness)
Die rooi bande is van gelyke intensiteit (helderheid)

(Must be an observation ; reference to frequency or wavelength – no marks/*Moet 'n waarneming wees; verwysing na frekwensie of golflengte – geen punte*) [12.1.2] (2)

9.5 No✓, it is not a coherent source / not monochromatic /bands of different colours✓
Nee, dit is nie 'n koherente bron nie / nie monochromaties nie / bande van verskillende kleure

OR/*OF*

Yes✓, if the light bulb is coloured it's light will also be monochromatic✓
Ja, as die gloeilamp gekleurd is, is die lig ook monochromaties

OR/*OF*

Yes✓ , light from a white light bulb consists of colours of different frequencies which will produce <u>bands of the different colours</u>✓ [12.2.3]
Ja, lig van 'n wit gloeilamp bestaan uit kleure van verskillende frekwensies wat <u>bande van verskillende kleure</u> vorm (2)
[11]

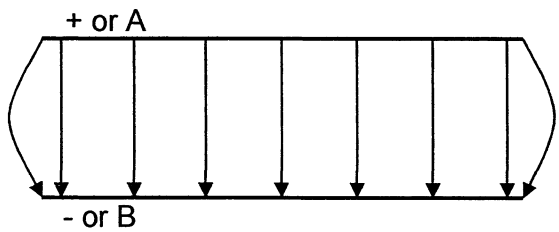
QUESTION 10/*VRAAG 10*

10.1 (Electric) force experienced per (positive) charge placed at the point.✓✓
(Elektriese) krag ondervind per (positiewe) lading geplaas by die punt

OR/*OF*
A point /space where a charge will experience an (electric) force ✓ ✓
'n Punt / ruimte waar 'n lading 'n (elektriese) krag sal ondervind. [12.2.1] (2)

10.2 Negative/*Negatief* ✓
Negative ink droplets deflect away from B / are attracted towards A / repels P / like charges repel✓
Negatiewe inkdruppels word vanaf B gedeflekteer / word deur A aangetrek / stoot P af / gelyksoortige ladings stoot mekaar af [12.1.2] (2)

10.3



Checklist/Kontrolelys Criteria for sketch vir diagram/*Kriteria vir diagram*	Marks/ *Punte*
Field lines parallel and evenly spaced between plates, slightly bent at sides. *Veldlyne parallel en eweredig tussen die plate gespasieer, effens gebuig by die ente*	✓
Direction of field lines from A to B (+ to – or top to bottom for diagram in paper)./*Rigting van veldlyne van A na B (+ na – of bo na onder vir diagram in vraestel)*	✓

10.4 $E = \frac{F}{q}$ ✓ $= \frac{2,1 \times 10^{-7}}{1,5 \times 10^{-13}}$ ✓ $= 1,4 \times 10^{6}$ NC^{-1}

(carry answer/*gebruik antwoord*)
(loses mark for final answer/ *verloor punt vir finale antwoord*)

$E = \frac{V}{d}$ ✓ $\therefore$ $1,4 \times 10^{6} = \frac{V}{6,4 \times 10^{-4}}$ ✓

$V = 8,96 \times 10^{2}$ V✓

OR/*OF*

$V = \frac{Fd}{q}$ ✓✓ $= \frac{(2,1 \times 10^{-7})(6,4 \times 10^{-4})}{1,5 \times 10^{-13}}$ ✓ ✓ $= 8,96 \times 10^{2}$ V✓

[12.1.3] (5)
[11]

QUESTION 11/*VRAAG 11*

11.1 Any two/*Enige twee*:
Temperature / *Temperatuur*✓
Cross sectional area (thickness) of material / *Deursnitoppervlak (dikte) van materiaal.* ✓
Length/*Lengte* [12.1.1] (2)

11.2

Option 1 / Opsie 1

Conductor Q✓/*Geleier Q* ✓

For the same potential difference, ✓ wire Q has a higher current than wire P. ✓ Therefore wire Q has a lower resistance than wire P. ✓
Vir dieselfde potensiaalverskil, het draad Q 'n hoër stroom as draad P. Dus het draad Q 'n laer weerstand as draad P

Option 2 / Opsie 2

Conductor Q✓/*Geleier Q*
The gradient of the graph for wire Q is bigger than that for wire P. ✓
Die gradiënt van die grafiek vir draad Q is groter as dié vir draad P
Gradient = $\frac{I}{V}$ is bigger ✓, thus $\frac{V}{I}$ = R is smaller. ✓
Gradiënt = $\frac{I}{V}$ *is groter, dus* $\frac{V}{I}$ = *R is kleiner*

Option 3 / Opsie 3

Conductor Q✓/*Geleier Q* ✓

The gradient of the graph for wire Q is bigger than that for wire P. ✓
Die gradiënt van die grafiek vir draad Q is groter as dié vir draad P
Gradient = $\frac{1}{R}$ is bigger ✓, thus R is smaller. ✓
Gradiënt = $\frac{1}{R}$ *is groter, dus R is kleiner*

Option 4 / Opsie 4

Conductor Q✓/*Geleier Q* ✓
Gradient / Gradiënt = $\frac{I}{V}$ = conductance ✓✓ / konduktansie (geleidings vermoë)
Wire Q has a higher conductance than wire P✓/*Draad Q het 'n hoër konduktansie (geleidingsvermoë) as draad P*

[12.1.2] (4)
[6]

QUESTION 12/*VRAAG 12*

12.1 $V_{int} = 45 - 43{,}5 = 1{,}5\text{ V}$ ✓

$I = \frac{V}{R}$ ✓ $= \frac{1{,}5}{0{,}5}$✓ $= 3\text{ A}$ OR/OF

emf/*emk* = $V_{ext} + V_{int}$ ✓ 45 = 43,5 ✓ + I(0,5) ✓ I = 3 A

$V_{12\,\Omega} = IR_{12\,\Omega} = 3 \times 12$ ✓ $= 36\text{ V}$ OR/OF

$V_{//} = 43{,}5 - 36 = 7{,}5\text{ V}$ ✓✓

(If only $V_{//} = 7{,}5$ V: 2 marks)
(*Indien $V_{//} = 7{,}5$ V: 2 punte*)

$I = \frac{V_{//}}{R} = \frac{7{,}5}{10}$✓ $= 0{,}75\text{ A}$ ✓

emf/emk = I(R+r) 45 = 3(R + 0,5) ✓ R = 14,5 Ω	OR/*OF* V = IR 45 = 3R✓ R = 15 Ω
$R_p = 14{,}5 - 12 = 2{,}5\ \Omega$ ✓	$R_p = 15 - 12 - 0{,}5 = 2{,}5\ \Omega$ ✓

$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2}$

$\frac{1}{2{,}5} = \frac{1}{10} + \frac{1}{r}$

$R = 3{,}33\ \Omega$ ✓

Current divides in ratio 3:1

$\frac{1}{4} \times 3$ ✓ $= 0{,}75\text{ A}$ ✓

Use answers of steps/*gebruik antwoorde van stappe*) Loses mark for final answer/*verloor punt vir finale antwoord*)

[12.1.3] (8)

12.2 $I_R = 3 - 0{,}75 = 2{,}25\text{ A}$ ✓

$R = \frac{V_{//}}{I} = \frac{7{,}5}{2{,}25}$✓ $= 3{,}33\ \Omega$ ✓ OR/OF

emf/*emk* = I(R+r) 45 = 3(R + 0,5) ✓ R = 14,5 Ω $R_p = 14{,}5 - 12 = 2{,}5\ \Omega$ ✓ $\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2}$ ∴ $\frac{1}{2{,}5} = \frac{1}{10} + \frac{1}{r}$ ∴ $R = 3{,}33\ \Omega$ ✓

[12.1.3] (3)

12.3 Increases/*Toeneem* ✓

The total resistance increases, ✓
therefore the current decreases✓ therefore $V_{internal}$ decrease ✓ therefore reading on V increases
Die totale weerstand neem toe Stroom neem af, V_{intern} neem af en dus neem V toe (4)

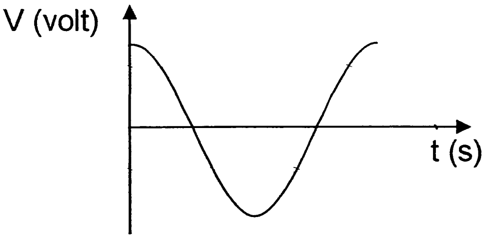
[12.2.3] **[15]**

QUESTION 13/*VRAAG 13*

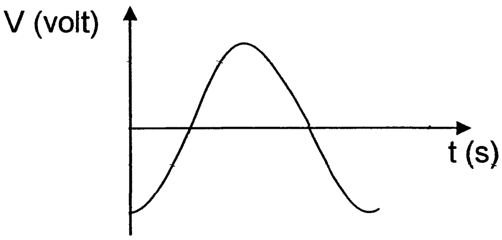
13.1 AC (generator) / *WS (generator)*✓
OR/OF Alternator/*Alternator*✓
(Separate) slipring ✓ (for each side of the loop).
(*Aparte*) *sleepring*✓ *(vir elke kant van die winding).* [12.1.2] (2)

13.2 X to/*na* Y ✓✓ [12.1.2] (2)

13.3

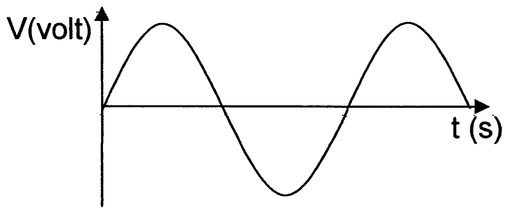


OR/OF



Checklist/Kontrolelys Criteria for sketch graph *Kriteria vir sketsgrafiek*	Marks/ *Punte*
Correct labelling of axes *Korrekte benoeming van asse*	✓
Shape of graph – at least one cycle *Vorm van grafiek- ten minste een siklus*	✓

Accept / *Aanvaar*



[12.1.2] (2)
[6]

QUESTION 14/*VRAAG 14*

14.1 $V_{rms/wgk} = \frac{V_{max}}{\sqrt{2}}$ ✓ ∴ 200 ✓= $\frac{V_{max}}{\sqrt{2}}$ = ∴ $V_{max/maks}$ = 282,84 V✓ [12.2.3] (3)

14.2 $P_{ave} = \frac{V^2_{rms}}{R}$ ✓∴ 1 200 = $\frac{220^2}{R}$ ✓∴ R = 40,33 Ω OR/*OF*

$P_{ave} = V_{rms}I_{rms}$ 1200 = (220)I_{rms} I_{rms} = 5,45 A ✓ V = IR 220 = (5,45)R ✓ R = 40,33 Ω

At 200 V: $P_{ave} = \frac{V_{rms}^2}{R} = \frac{200^2}{40,33}$ ✓ = 991,82 W ✓

(991,74 W if previous answer is not rounded/ *as vorige antwoord afgerond is*)

OR/OF

$P_{ave} = V_{rms}I_{rms}$ ∴ 1200 = (220)I_{rms} ∴ I_{rms} = 5,45 A ✓

Accept answers from: 990 to 992 W

Using ratio's: 220 V uses current of 5,45 A
∴ 200 V uses current of 4,95 A } ✓

$P_{ave} = V_{rms}I_{rms}$ ∴ = (200)(4,95) ✓ ∴ = 990,91 W✓ [12.1.3] (4)

14.3 V stays constant ✓
As more appliances are connected to the multi-plug the total resistance decreases✓
causing the main current drawn by the multi-plug to increase.✓
Due to the high current the heating effect will increase ✓and can cause damage/trips the main switch
V bly konstant✓
Soos wat meer meer toestelle aan die meervoudige kragprop geskakel word, neem die totale weerstand af
En gevolglik neem die hoofstroom wat deur die meervoudige kragprop getrek word toe
As gevolg van die hoë stroom neem die verhittingseffek toe wat skade kan veroorsaak/die hoofskakelaar kan afskop.

OR/OF

V remains constant ✓; $P_{ave} = V_{rms}I_{rms}$ ∴ $I_{rms} = \frac{P_{ave}}{V_{rms}}$ ✓

As the number of appliances increase, the current drawn will increase✓Due to the high current the heating effect will increase ✓and can cause damage/trips the main switch

V bly konstant; $P_{gem} = V_{wgk}I_{wgk}$ ∴ $I_{wgk} = \frac{P_{gem}}{V_{wgk}}$

Soos die aantal toesetelle toeneem, sal die totale stroom toeneem
As gevolg van die hoë stroom neem die verhittingseffek toe wat skade kan veroorsaak/die hoofskakelaar kan afskop. [12.3.2] (4)
[11]

QUESTION 15/*VRAAG 15*

15.1 Photo-electric effect/*Foto-elektriese effek* ✓ [12.2.1] (1)

15.2
Option 1 / *Opsie 1*

$c = f\lambda$ ✓ ∴ $3 \times 10^8 = f(200 \times 10^{-9})$ ✓ ∴ $f = 1,5 \times 10^{15}$ Hz

$f_0 = \dfrac{W_0}{h}$ ✓ $= \dfrac{7,57 \times 10^{-19}}{6,63 \times 10^{-34}}$ ✓ $= 1,14 \times 10^{15}$ Hz ✓

Frequency ($1,5 \times 10^{15}$ Hz) greater than threshold frequency ($1,14 \times 10^{15}$ Hz) ✓ – photo-electrons will be emitted./ *Frekwensie groter as drumpelfrekwensie – foto-elektrone word vrygestel.*

Option 2 / Opsie 2

$c = f\lambda$ ✓ ∴ $3 \times 10^8 = f(200 \times 10^{-9})$ ✓ ∴ $f = 1,5 \times 10^{15}$ Hz

E(photon/*foton*) = hf✓ = $(6,63 \times 10^{-34})(1,5 \times 10^{15})$ ✓= $9,95 \times 10^{-19}$ J ✓
E(photon/*foton*) > work function/*werkfunksie* ✓– photo-electrons will be emitted/*foto-elektrone sal vrygestel word.*

Option 3 / *Opsie 3*

$E = h\dfrac{c}{\lambda}$ ✓✓$= \dfrac{(6,63 \times 10^{-34})\checkmark(3 \times 10^{8})}{(200 \times 10^{-9})\checkmark} = 9,95 \times 10^{-19}$ J ✓

E(photon/*foton*) > work function/*werkfunksie* ✓– photo-electrons will be emitted/*foto-elektrone sal vrygestel word*

Option 4 / *Opsie 4*

$hf = W_o + E_k$ ✓ ∴ $h\dfrac{c}{\lambda} = W_o + E_k$

$\dfrac{(6,63 \times 10^{-34})\checkmark(3 \times 10^{8})}{(200 \times 10^{-9})\checkmark} = 7,57\checkmark \times 10^{-19} + E_k$ ∴ $E_k = 2,375 \times 10^{-19}$J ✓

∴ will emit electrons as the electrons have a kinetic energy ✓∴ *sal elektrone vrystel aangesien die elektrone kinetiese energie het*

[12.1.3] (6)

15.3.1 The energy of the photo-electrons remains unchanged ✓ as the frequency / wavelength of the photons did not change. ✓ *Die energie van die foto-elektrone bly dieselfde, omdat die frekwensie /golflengte van die fotone nie verander het nie.* [12.2.2] (2)

15.3.2 Number of photo-electrons (per second) is increased✓ When the intensity is increased the number of photons will increase, releasing an increased number of electrons. ✓ *Aantal foto-elektrone vrygestel (per sekonde) vermeerder. Verhoging van intensiteit vermeerder die aantal fotone wat meer elektrone vrystel.* [12.2.2] (2) **[11]**

TOTAL SECTION B/*TOTAAL AFDELING B*: 115
GRAND TOTAL/*GROOTTOTAAL*: 150

education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2009

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages, 3 data sheets and 1 answer sheet.

SECTION A

Answer this section on the attached ANSWER SHEET.

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) on the attached ANSWER SHEET.

1.1 The force that acts on a body in free fall (1)

1.2 The ability to do work (1)

1.3 The phenomenon observed when a wave bends around the edges of an obstacle (1)

1.4 The law that describes the interaction between two point charges at rest (1)

1.5 Electromagnetic radiation with the shortest wavelength (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A		COLUMN B	
2.1	A collision during which the kinetic energy changes	A	elastic
		B	wavefront
2.2	A unit of measure equal to the watt	C	low frequency electromagnetic waves
2.3	The imaginary line joining points in phase on a wave	D	$N \cdot m \cdot s^{-1}$
2.4	Energy of a charge due to its location in an electric field	E	inelastic
		F	amplitude
2.5	Radio waves	G	electric potential energy
		H	sound waves
		I	$J \cdot s$
		J	potential difference

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 When a child exerts a horizontal force on a heavy crate, the crate does not move because the crate exerts an equal but opposite force on the child. (2)

3.2 The net (total) work done on a body that travels at constant speed is zero. (2)

3.3 As a source moves towards a stationary observer, the frequency of the source and the observed frequency changes. (2)

3.4 Current in a given conductor at constant temperature is inversely proportional to the potential difference across its ends. (2)

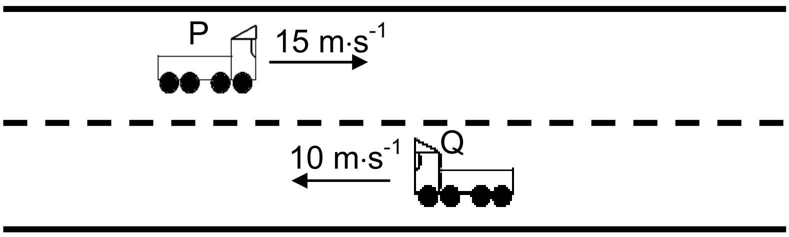
3.5 Sodium produces an emission spectrum that is different from its absorption spectrum. (2)

[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 The diagram below shows two trucks, P and Q, travelling in opposite directions along a straight level road. Truck P travels at 15 $m{\cdot}s^{-1}$ and truck Q travels at 10 $m{\cdot}s^{-1}$.



A passenger on truck P will observe truck Q travelling at …

A 5 $m{\cdot}s^{-1}$

B 10 $m{\cdot}s^{-1}$

C 15 $m{\cdot}s^{-1}$

D 25 $m{\cdot}s^{-1}$ (3)

4.2 The engine of a car does work, *W,* to increase the velocity of the car from 0 to *v*. The work done by the engine to increase the velocity from ***v* to 2*v***, is:

A *W*

B 2*W*

C 3*W*

D 4*W* (3)

4.3 The siren of a police car, travelling at a speed *v*, emits sound waves of frequency *f*.

Which ONE of the following best describes the frequency that will be observed by a passenger in a car following right behind the police car at a speed *v*?

A Zero

B Smaller than *f*

C Equal to *f*

D Greater than *f* (3)

4.4 A negatively charged plastic comb is brought close to, but does not touch, a small piece of paper. If the comb and the paper are now attracted to each other, the original charge on the paper was …

A negative.

B positive.

C negative or neutral.

D positive or neutral. (3)

4.5 Which ONE of the following best describes the difference between laser light and fluorescent light?

A Laser light consists of more frequencies than fluorescent light.

B Laser light is coherent, monochromatic and collimated, while fluorescent light has none of these properties.

C Laser light is coherent and collimated, while fluorescent light is monochromatic.

D Fluorescent light is coherent and laser light is not. (3)
[15]

TOTAL SECTION A: 35

SECTION B

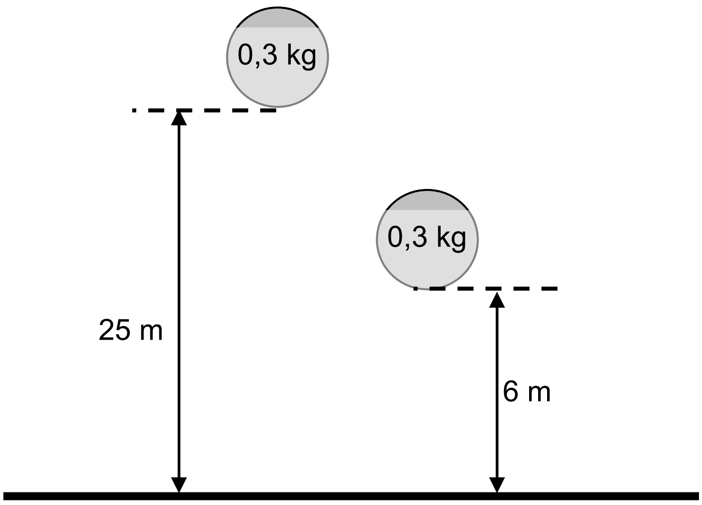
INSTRUCTIONS AND INFORMATION

1. Answer this section in the ANSWER BOOK.
2. The formulae and substitutions must be shown in ALL calculations.
3. Round off your answers to TWO decimal places where applicable.

QUESTION 5

The roof of a tall building is 25 m above the ground. A rigid ball of mass 0,3 kg falls freely when dropped from the roof. It strikes the concrete floor on the ground with velocity v_1. It bounces to a maximum vertical height of 6 m.

The ball was in contact with the floor for 0,9 s. Ignore the effects of friction.



5.1 Calculate the velocity v_1 when the ball first hits the floor. (3)

5.2 Calculate the impulse of the ball as a result of the collision. (7)

5.3 Calculate the magnitude of the net force exerted on the ball. (3)

5.4 Using the ground as zero reference, draw a sketch graph of position (displacement) versus time for the motion of the ball from its original height until it reaches its second maximum height. Indicate the relevant position values on the y-axis. (4)

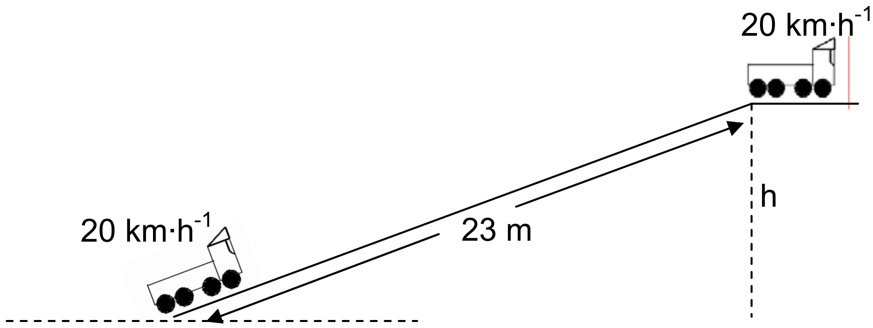
5.5 The rigid ball is now replaced with a softer ball of the same mass and volume as the rigid ball. It is then dropped from the same height onto the concrete floor.

Will the ball reach the SAME, GREATER or LESSER height compared to the previous ball? Use principles of physics to explain your answer. (3)
[20]

QUESTION 6

In South Africa the transportation of goods by trucks adds to the traffic problems on our roads.

A 10 000 kg truck travels up a straight inclined road of length 23 m at a constant speed of 20 km·h^{-1}. The total work done by the engine of the truck to get there is 7 x 10^5 J. The work done to overcome friction is 8,5 x 10^4 J.



6.1 Calculate:

6.1.1 The height, h, reached by the truck at the top of the road (6)

6.1.2 The instantaneous power delivered by the engine of truck (6)

6.2 Arrestor beds are constructed as a safety measure to allow trucks to come to rest when their brakes fail whilst going downhill. Write down TWO design features of such arrestor beds. (2)

[14]

QUESTION 7

Dolphins use ultrasound to scan their environment.

When a dolphin is 100 m from a rock, it emits ultrasound waves of frequency 250 kHz whilst swimming at 20 $m \cdot s^{-1}$ towards the rock. Assume that the speed of sound in water is 1 500 $m \cdot s^{-1}$.

7.1 Calculate the frequency of the sound waves detected by a detector on the rock. (4)

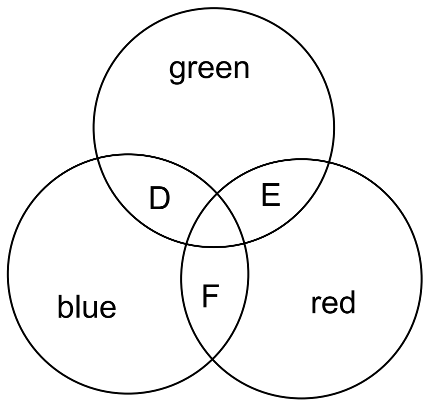
7.2 When the dolphin is 50 m from the rock, another ultrasound wave of 250 kHz is emitted.

How will the frequency of the detected sound waves compare with the answer calculated in QUESTION 7.1? Write down only HIGHER, LOWER or REMAINS THE SAME. Explain your answer. (2)

[6]

QUESTION 8

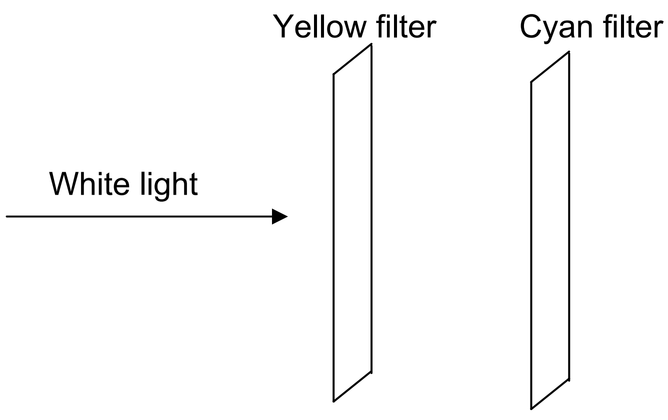
8.1 The diagram below shows the three primary colours of light. Each of D, E and F in the diagram below is obtained by adding a pair of primary colours. This is the basis of how technology may use colour to produce desired colour effects as is done in the television.



8.1.1 Which THREE colours are represented by the letters D, E and F respectively? (3)

8.1.2 Why are the colours red, blue and green referred to as primary colours? (2)

8.2 White light passes through a yellow filter, which is in turn followed by a cyan filter as shown in the diagram below.



8.2.1 Identify the colour that emerges from the cyan filter. (1)

8.2.2 Explain your answer to QUESTION 8.2.1. (4)

8.2.3 The cyan filter is now replaced with a magenta filter. What colour will emerge from the magenta filter? (1)

[11]

QUESTION 9

Huygens's principle is used to explain the wave phenomena, interference and diffraction.

9.1 State Huygens's principle. (2)

9.2 Use Huygens's principle to explain the diffraction of water waves in a ripple tank as they pass through a narrow opening in a barrier. (3)

9.3 A single slit of unknown width is illuminated with red light of wavelength 650 nm.

Calculate the width of the slit for which the first dark band will appear at 15^{o}. (3)
[8]

QUESTION 10

Each plate of a parallel plate capacitor has an area of 40 cm^2. The plates are 1 cm apart. The capacitor is connected to a 12 V DC supply.

10.1 Calculate the magnitude of the charge on each plate. (5)

10.2 By which factor will the charge calculated in QUESTION 10.1 change if the area of each parallel plate is changed to 20 cm^2?

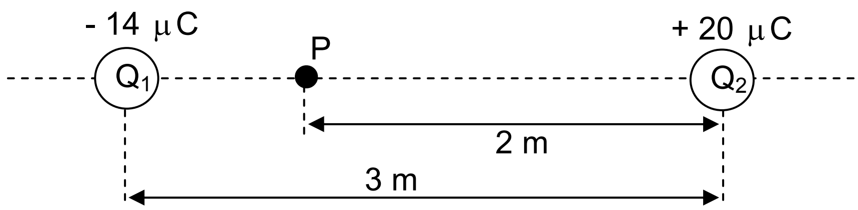
Explain your answer in terms of physics principles and the charge stored in the capacitor. (NO calculations needed.) (3)

10.3 What is the net charge on the capacitor? (1)

10.4 Capacitors are used in flash cameras. Give a reason for this use. (1)
[10]

QUESTION 11

Two point charges, Q_1 and Q_2, a distance 3 m apart, are shown below. The charge on Q_1 is - 14 μC and the charge on Q_2 is + 20 μC.



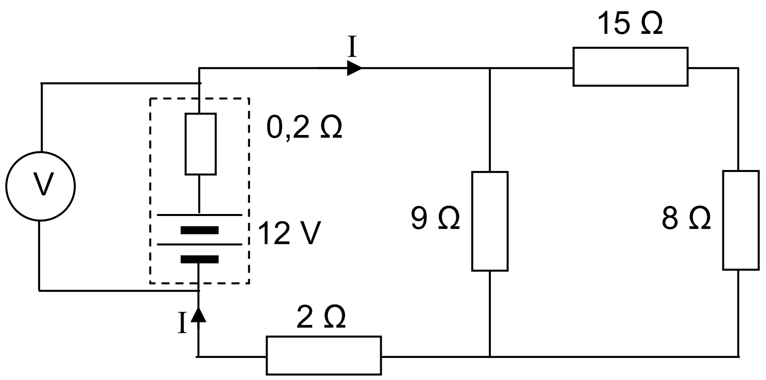
11.1 Define the *electric field* at a point in space. (2)

11.2 Draw the electric field pattern due to these two charges. (3)

11.3 Calculate the net electric field at point P situated 2 m from Q_2. (5)
[10]

QUESTION 12

The battery in the circuit below has an emf of 12 V and an internal resistance of 0,2 Ω. The resistance of the connecting wires can be ignored.

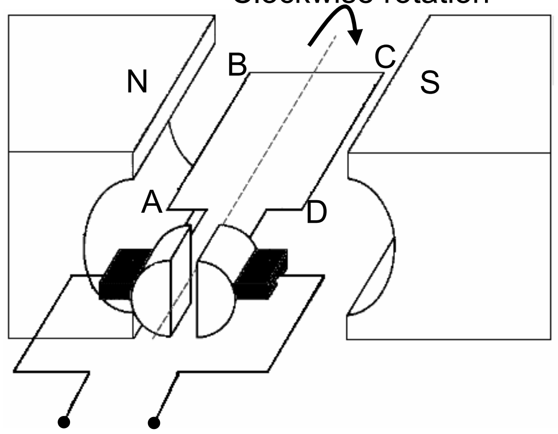


12.1 Calculate the current, I, that flows through the battery. (6)

12.2 How will the reading on the voltmeter be affected if the 9 Ω resistor is removed and replaced with a conducting wire of negligible resistance? Explain your answer. (4)
[10]

QUESTION 13

13.1 Electric motors are used in pumps, fans and compressors. Electric motors can be either AC or DC. The diagram below illustrates one of these types of electric motors.



13.1.1 What type of electric motor (AC or DC) is illustrated in the diagram?

Give a reason for your answer. (2)

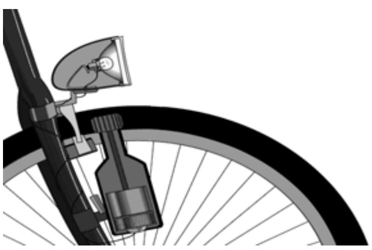
13.1.2 If the loop turns in a clockwise direction, in what direction is the current in section AB of the loop flowing in the above diagram? Write down from A to B, or from B to A only. (1)

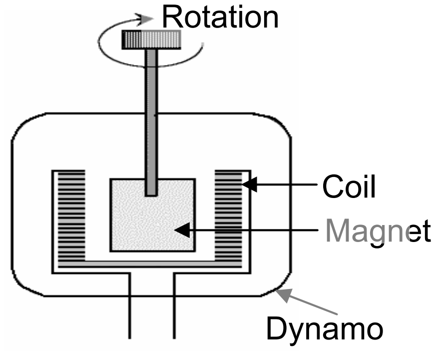
The motor in the diagram is now changed to operate as a generator.

13.1.3 On what principle does a generator operate? (1)

13.1.4 Draw a sketch graph of the potential difference versus time for this generator while it is functioning. (2)

13.2 The diagram below shows a dynamo attached to the wheel of a bicycle. When riding a bicycle, the wheel rotates a magnet near a coil.

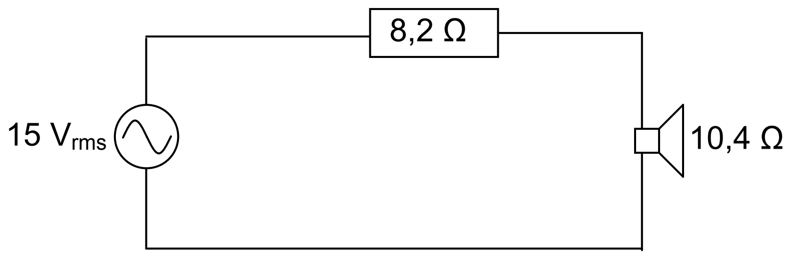




Explain how a current is induced in the coil. (2)
[8]

QUESTION 14

14.1 In the circuit below the AC source delivers alternating voltages at audio frequency to the speaker.



14.1.1 What is the peak voltage that the source can deliver? (2)

14.1.2 Calculate the average power delivered to the speaker. (6)

14.2 Alternating current is generated at power stations.

Name TWO advantages of AC transmission over long distances. (2)
[10]

QUESTION 15

The work function of three metals is shown in the table below.

METAL	WORK FUNCTION (W_0) in J
Aluminium	$6,54 \times 10^{-19}$
Zinc	$6,89 \times 10^{-19}$
Silver	$7,58 \times 10^{-19}$

15.1 Give a reason why different metals have different work functions. (1)

15.2 Light of wavelength $2,3 \times 10^{-7}$ m is shone onto a metal X. The average speed of the emitted electrons is $4,78 \times 10^{5}$ m·s^{-1}.

Identify metal X by performing a relevant calculation. (6)

15.3 What conclusion about the nature of light is drawn from the photo-electric effect? (1)
[8]

TOTAL SECTION B: 115

GRAND TOTAL: 150

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1	Gravitational force/*gravitasiekrag* ✓ or/*of* weight/*gewig*	[12.2.1]	(1)
1.2	Energy/*energie* ✓	[12.2.1]	(1)
1.3	Diffraction/*diffraksie* ✓	[12.2.1]	(1)
1.4	Coulomb's law/*Coulomb se wet* ✓	[12.2.1]	(1)
1.5	Gamma rays/*Gammastrale* ✓	[12.2.1]	(1) **[5]**

QUESTION 2/*VRAAG 2*

2.1	E✓	[12.2.1]	(1)
2.2	D✓	[12.2.1]	(1)
2.3	B✓	[12.2.1]	(1)
2.4	G✓	[12.2.1]	(1)
2.5	C✓	[12.2.1]	(1) **[5]**

QUESTION 3/*VRAAG 3*

3.1 False/Onwaar ✓
… the force applied by the child is too small to overcome the inertia of the crate/frictional forces.
… die krag uitgeoefen deur die kind is te klein om die traagheid van die krat/wrywingskragte te oorkom.✓

OR/OF

… the net force on the crate is zero. ✓
…die nettokrag op die krat is nul. ✓ [12.2.3] (2)

3.2 True/*Waar* ✓✓ [12.2.2] (2)

3.3 False/*Onwaar* ✓
…frequency of the source remains the same …✓
… frekwensie van die bron bly dieselfde …✓ [12.2.2] (2)

3.4 False/*Onwaar*✓
directly proportional to the potential difference across its ends✓/ *direk eweredig aan die potensiaalverskil en omgekeerd eweredig aan die weerstand* [12.2.2] (2)

3.5 True/*Waar* ✓✓ [12.2.3] (2)
[10]

QUESTION 4/*VRAAG 4*

4.1 D ✓✓✓ [12.2.3] (3)

4.2 C ✓✓✓ [12.1.3] (3)

4.3 C ✓✓✓ [12.2.3] (3)

4.4 D ✓✓✓ [12.2.3] (3)

4.5 B ✓✓✓ [12.2.3] (3)
[15]

TOTAL SECTION A: 35
***TOTAAL AFDELING A:* 35**

SECTION B/*AFDELING B*

QUESTION 5/*VRAAG 5*

5.1 $v_f^2 = v_i^2 + 2a\Delta x$ ✓
$v_f^2 = (0)^2 + 2(-9,8)(25)$ ✓
v_f = - 22,13 or 22,13 m·s^{-1} down/*afwaarts*✓

OR/OF

E_t(top/*bo*) = E_t(bottom/*onder*)
$E_p + E_k = E_p + E_k$
$mgh + 0 = 0 + \frac{1}{2}mv_f^2$ ✓
$(0,3)(9,8)(25) + 0 = 0 + \frac{1}{2}(0,3)v_f^2$ ✓
v_f = 22,13 m·s^{-1} downward/*afwaarts*✓ [12.2.3] (3)

5.2 Consider upward motion as positive:/ *Beskou opwaartse beweging as positief:*
$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0 = v_i^2 + 2(-9,8)(6)^2$ ✓
v_i = 10,84 m·s^{-1} ✓

Impulse/*Impuls* = Δp ✓
= [(0,3)(10,84) – (0,3)(- 22,13)]✓
= + 9,89 N·s ✓ i.e. 9,89 N·s upward/*opwaarts*✓

OR/OF

Consider upward motion as negative:/*Beskou opwaartse beweging as negatief*
$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0 = v_i^2 + 2(9,8)(-6)^2$ ✓
v_i = - 10,84 m·s^{-1} ✓

Impulse/*Impuls* = Δp ✓
= [(0,3)(- 10,84) – (0,3)(22,13)]✓
= - 9,89 N·s✓ i.e. 9,89 N·s upward/*opwaarts* ✓

OR/OF

E_t(top/*bo*) = E_t(bottom/*onder*)
$E_p + E_k = E_p + E_k$
$mgh + 0 = 0 + \frac{1}{2}mv_f^2$ ✓
$(0,3)(9,8)(6) + 0 = 0 + \frac{1}{2}(0,3)v_f^2$ ✓
v_f = 10,84 m·s^{-1} upward/*opwaarts*✓

Impulse/*Impuls* = Δp ✓
= [(0,3)(10,84) – (0,3)(- 22,13)]✓
= + 9,89 N·s ✓ i.e. 9,89 N·s upward/*opwaarts*✓ [12.1.3] (7)

5.3 Take upward as positive:/*Neem opwaarts as positief:*

$F_{net}\Delta t = \Delta p$ ✓

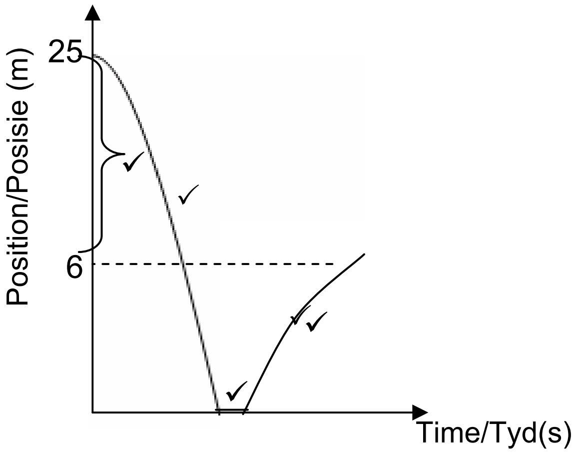
$F_{net} = \frac{\Delta p}{\Delta t} = \frac{+9{,}89}{0{,}9}$ ✓ =+ 10,99 N✓i.e.10,99 N (11 N) upward/*opwaarts*

Take upward as negative:/*Neem opwaarts as negatief:*

$F_{net}\Delta t = \Delta p$ ✓

$F_{net} = \frac{\Delta p}{\Delta t} = \frac{-9{,}89}{0{,}9}$ ✓ = - 10,99 N ✓i.e. 10,99 N (11 N)
upward/*opwaarts* [12.2.3] (3)

5.4



Checklist/*Kontrolelys* Criteria for graph/*Kriteria vir grafiek*	Marks/ *Punte*
Maximum original height indicated as 25 m and height of 2nd bounce as 6 m *Maksimum oorspronklike hoogte aangedui as 25 m en hoogte van tweede hop as 6 m*	✓
Correct shape between 25 m and 0 m *Korrekte vorm tussen 25 m en 0 m*	✓
Graph on x-axis between first reaching the floor and 2nd bounce *Grafiek op x-as wanneer dit die vloer tref en die 2de hop*	✓
Correct shape between 0 m and 6 m. *Korrekte vorm van grafiek tussen 0 m en 6 m.*	✓

[12.1.2] (4)

5.5 Smaller ✓

Contact time for softer ball is longer ✓than for rigid ball

According to $F_{net}\Delta t = \Delta p$, the force exerted by floor on softer ball is smaller than on the rigid ball. ✓.

Kleiner

Kontak tyd vir sagter bal is langer ✓ as vir stewige bal

Volgens $F_{net}\Delta t = \Delta p$, is die krag deur die vloer op sagter bal uitgeoefen kleiner as die op die stewige bal. ✓. [12.3.2] (3)

[20]

QUESTION 6/*VRAAG 6*

6.1.1 $W_{net} = \Delta E_p + \Delta E_k$ ✓
$\therefore W_{net} = (mgh_f - mgh_i) + (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2)$
$\therefore 7 \times 10^5$ ✓ $- 8,5 \times 10^4$ ✓ $= 10\,000(9,8)(h_f - 0)$ ✓ + 0 ✓
$\therefore 6,15 \times 10^5 = 10\,000(9,8)h_f$
$\therefore h_f = 6,28$ m ✓

OR/*OF*

Useful work done = gain in Ep ✓ = mgh ✓
Bruikbare arbeid verrig = wins aan Ep ✓ = mgh ✓
$\therefore 7 \times 10^5$ ✓ $- 8,5 \times 10^4$ ✓ $= 10\,000(9,8)h$ ✓
$\therefore 6,15 \times 10^5 = 10\,000(9,8)h_f$
$\therefore h = 6,28$ m ✓ [12.1.3] (6)

6.1.2 $W = F\Delta x \cos\theta$ ✓
$\therefore 7 \times 10^5 = F(23)(1)$ ✓
$\therefore F = 3,04 \times 10^4$ N ✓

$P = Fv$ ✓
$= (3,04 \times 10^4)(\frac{20\,000}{60 \times 60})$ ✓
$= 1,6 \times 10^5$ W ✓ [12.1.3] (6)

6.2 Any TWO/*Enige TWEE:*
Surface must provide sufficient friction like sand ✓
Must be long enough for vehicle to stop. ✓
Oppervlak moet genoeg wrywing lewer soos sand ✓ (2)
Moet lank genoeg wees om die voertuig tot stilstand te bring✓ [12.3.2] **[14]**

QUESTION 7/*VRAAG 7*

7.1 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$= (\frac{1500 \pm 0}{1500 - 20})$ ✓ (250×10^3) ✓

$= 253,38 \times 10^3$ Hz (253,38 kHz) ✓ [12.2.3] (4)

7.2 Remains the same ✓
The detected frequency is independent of the distance between the source and observer. ✓
Bly dieselfde ✓
Die waargenome frekwensie is onafhanklik van die afstand tussen die bron en die waarnemer✓ (2)
[12.2.2] **[6]**

QUESTION 8/*VRAAG 8*

8.1.1 D: cyan ✓/*siaan*✓
E: yellow ✓/*geel* ✓
F: magenta ✓/ *magenta*✓ [12.2.3] (3)

8.1.2 All other colours can be obtained by mixing of these three colours ✓✓ / *Al die ander kleure kan verkry word deur hierdie drie kleure te meng*✓✓ [12.2.1] (2)

8.2.1 Green ✓/*Groen* ✓ [12.2.3] (1)

8.2.2 The yellow filter transmits red and green ✓and absorbs blue light. ✓
The cyan filter transmits the green light ✓and absorbs the red light. ✓
Die geel filter laat rooi en groen lig deur✓ *en absorbeer blou lig*✓
Die siaanfilter laat groen lig deur ✓*en absorbeer rooi lig*✓ [12.2.3] (4)

8.2.3 Red ✓/*rooi* ✓ [12.2.3] (1)
[11]

QUESTION 9/*VRAAG 9*

9.1 Each point on the wavefront acts as a source of spherical secondary waves or wavelets travelling away from source. ✓✓
Elke punt of die golffront dien as 'n bron van sferiese sekondêre golwe of golfies wat weg vanaf die bron beweeg ✓✓ [12.2.1] (2)

9.2 Each point on the initial plane wavefront entering the slit acts as a source of secondary wavelets. ✓ The wavelets propagate in all directions ✓ beyond the slit causing the wave to spread into regions beyond those in line with the slit. ✓
Elke punt op die aanvanklike vlakgolffront wat die spleet binnegaan dien as 'n bron van sekondêre golfies. ✓ *Die golfies word in alle rigtings* ✓*aan die anderkant van die spleet propageer wat veroorsaak dat die golf in gebiede verder as dié in lyn met die van die spleet, sprei* ✓ [12.2.3] (3)

9.3 $\sin\theta = m\frac{\lambda}{a}$ ✓ $\therefore$ $\sin 15° = 1 \times \frac{650 \times 10^{-9}}{a}$ ✓ $\therefore$ $a = 2{,}7 \times 10^{-6}$ m ✓ [12.2.3] (3)
[8]

QUESTION 10/*VRAAG 10*

10.1 $C = \frac{\varepsilon_o A}{d}$ ✓ = $\frac{(8,85\times10^{-12})(40\times10^{-4})}{(0,01)}$ ✓ = 3,54 x 10^{-12} F

Q = CV✓
= (3,54 x 10^{-12})(12) ✓
= 4,25 x 10^{-11} C✓ [12.1.3] (5)

10.2 half ✓
Half the area will store half the amount of charge OR C α A ✓
and C α Q, thus C is halved ✓
Helfte✓
Helfte die oppervlak (area) sal die helfte van die aantal lading stoor OF
C α A ✓ en C α Q, dus is C halveer ✓ [12.2.2] (3)

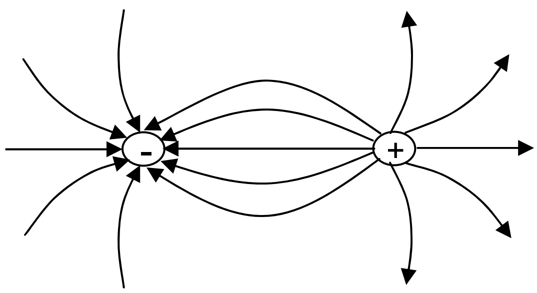
10.3 net charge = 0 C ✓/ *netto lading = 0 C* ✓ [12.2.3] (1)

10.4 Discharges almost instantly to deliver flash light ✓/ *Ontlaai amper onmiddellik om 'n flits te lewer*✓ [12.3.2] (1)
[10]

QUESTION 11/*VRAAG 11*

11.1 (Electric) Force experienced per (positive) charge placed at the point.✓✓
(Elektriese) Krag ondervind per (positiewe) lading geplaas by die punt✓✓ [12.2.1] (2)

11.2



Checklist/*Kontrolelys* Criteria for electric field/*Kriteria vir elektriese veld*	Marks/ *Punte*
Direction *Rigting*	✓
Shape *Vorm*	✓
Field lines not touching each other or entering the spheres *Veldlyne raak nie mekaar nie of wat die sfere binnegaan*	✓

[12.1.2] (3)

11.3 Electric field at P due to Q_1:/*Elektriese veld by P as gevolg van Q_1*

$E = \frac{kQ}{r^2}$ ✓ = $\frac{9\times10^9\times14\times10^{-6}}{1^2}$ ✓= 1,26 x 10^5 N·C^{-1} to the left/*na links*

Electric field at P due to Q_2: *Elektriese veld by P as gevolg van Q_2*

$E = \frac{kQ}{r^2}$ = $\frac{9\times10^9\times20\times10^{-6}}{2^2}$ ✓= 4,5 x 10^4 N·C^{-1} to the left/*na links*

E_{net} = 1,26 x 10^5 + 4,5 x 10^4 N·C^{-1} ✓= 1,71 x 10^5 N·C^{-1} to the left/*na links*✓ [12.1.3] (5)

[10]

QUESTION 12/*VRAAG 12*

12.1 $\frac{1}{R_e} = \frac{1}{r_1} + \frac{1}{r_2}$ = $\frac{1}{9}$ ✓ + $\frac{1}{23}$ ✓

R = 6,47 Ω ✓

R_{tot} = 6,47 + 2 + 0,2 = 8,67 Ω ✓

$I = \frac{V}{R}$ = $\frac{12}{8,67}$ ✓ = 1,41 A✓ [12.1.3] (6)

12.2 Decreases ✓/*Afneem*

Effective resistance of circuit decreases ✓ (No current through 15 Ω and 8 Ω resistances)
Current increases ✓
Ir (lost volts) increases ✓
$V_{external}$ decreases

Effektiewe weerstand van die stroombaan neem af ✓ (Geen stroom deur die 15 Ω- en 8 Ω-weerstande)
Stroom neem toe ✓
Ir (verlore volts) neem toe ✓
$V_{ekstern}$ neem af [12.2.2] (4)

[10]

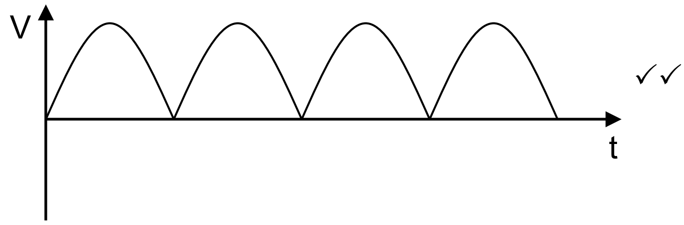
QUESTION 13/*VRAAG 13*

13.1.1 DC ✓ A splitring-commutator ✓ is used to ensure that the current in the loop remains in the same direction through the complete cycle. / *GS✓ / 'n Spitringkommutator✓ word gebruik om te verseker dat die stroom in die spoel in dieselfde rigting bly tydens die volledige siklus.* [12.1.2] (2)

13.1.2 B to A ✓/ *B na A*✓ [12.1.2] (1)

13.1.3 Electromagnetic induction ✓/*Elektromagnetiese induksie*✓ [12.2.1] (1)

13.1.4



[12.1.2] (2)

13.2 When the magnet rotates the <u>changing magnetic flux</u>✓<u>cuts through the windings of the coil</u> ✓and induces a current in the coil. / *Wanneer die magnet roteer sny die <u>veranderende magnetiese vloed</u> ✓deur die <u>windings van die spoel</u>✓ en induseer 'n stroom in die spoel.* [12.2.3] (2)
[8]

QUESTION 14/*VRAAG 14*

14.1.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $\therefore$ $V_{max} = 15(\sqrt{2}) = 21{,}21$ V ✓ [12.2.3] (2)

14.1.2 $R_{total} = 8{,}2 + 10{,}4 = 18{,}6\ \Omega$ ✓

$I = \frac{V}{R}$ ✓ $= \frac{15}{18{,}6}$ ✓$= 0{,}81$ A

$P = I^2R$ ✓$= (0{,}81)^2(10{,}4)$ ✓$= 6{,}76$ W ✓ [12.1.3] (6)

14.2
- With alternating current long distance transmission may be at high voltage and low current, less loss in energy and therefore more energy available for use. ✓/ *Met wisselstroom mag langafstand geleiding teen hoë spanning and lae stroom geskied, minder verlies in energie en daarom meer energie vir verbruik beskikbaar.*✓
- AC allows power stations to be relatively remote from users, so users are isolated from environmental affects of the stations. This remote delivery may save energy elsewhere (e.g. goods transport and commuting). ✓/ *WS maak dit moontlik vir kragstasies om relatief afgeleë van verbruikers te wees, sodoende word verbruikers geïsoleer van die omgewingseffekte van die kragstasies. Hierdie afgeleë lewering mag energie elders bespaar (bv. goederevervoer en pendel)* ✓ [12.3.2] (2)

[10]

QUESTION 15/*VRAAG 15*

15.1 Different metals have different ionisation energies/Different metals attract electrons with different forces. ✓
Verskillende metale het verskillende ionisasie energieë / Verskillende metale trek elektrone aan met verskillende kragte✓ [12.2.1] (1)

15.2 $hf = W_0 + ½mv^2$ ✓ and/*en* $c = f\lambda$ ✓

$$\frac{hc}{\lambda} = W_0 + \frac{1}{2}mv^2$$

$$\frac{(6{,}63 \times 10^{-34})(3 \times 10^8)}{(2{,}3 \times 10^{-7})} ✓ = W_o + ½\,(9{,}11 \times 10^{-31})(4{,}78 \times 10^5)^2 ✓$$

$W_0 = 7{,}58 \times 10^{-19}$ J✓

Metal X is silver ✓/*Metaal X is silwer*✓ [12.1.3] (6)

15.3 (Establish) particle nature of light ✓/(*Bevestig)die deeltjieaard van lig*✓ [12.2.1] (1)
[8]

TOTAL SECTION B/*TOTAAL AFDELING B:* *115*

GRAND TOTAL/*GROOTTOTAAL:* *150*

education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2009(1)

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

1.1 The energy of a stationary object due to its position above the surface of the earth (1)

1.2 The unit of measurement equal to one joule per second (1)

1.3 The term used to describe two light sources that emit waves that maintain the same phase relationship with each other (1)

1.4 Electromagnetic waves with the highest penetrating ability (1)

1.5 The 'packets of energy' making up electromagnetic radiation (1)
[5]

QUESTION 2: FALSE ITEMS

Each of the five statements below is FALSE. Correct each statement so that it is TRUE. Write only the correct statement next to the question number (2.1 – 2.5) in the ANSWER BOOK.

NOTE: Correction by using the negative of the statement, for example "… IS NOT …", will not be accepted.

2.1 The magnitude of the acceleration of an object projected vertically upwards from the ground is zero at its maximum height. (2)

2.2 When a bullet is fired from a gun, the momentum of the bullet is the same as the momentum of the gun. (2)

2.3 Dispersion of white light by the parallel tracks on the surface of a CD is the result of refraction. (2)

2.4 Non-identical resistors connected in series have the same current in them and the same potential difference across each of them. (2)

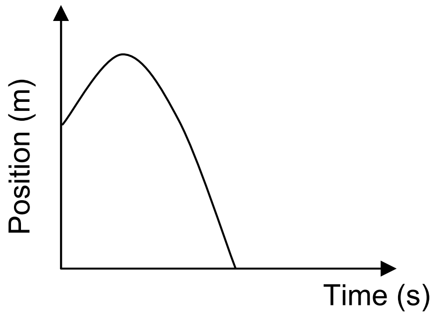
2.5 A line emission spectrum is formed when electrons in an atom move from lower to higher energy levels. (2)
[10]

QUESTION 3: MULTIPLE-CHOICE QUESTIONS

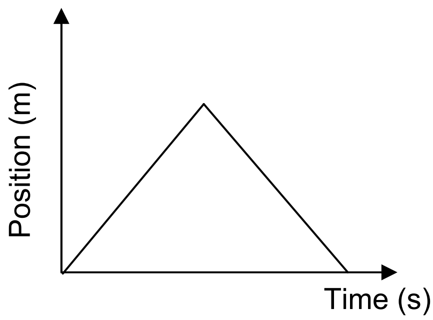
Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (3.1 – 3.5) in the ANSWER BOOK.

3.1 A stone is thrown vertically upwards and returns to the thrower's hand after a while. Which ONE of the following position-versus-time graphs best represents the motion of the stone?

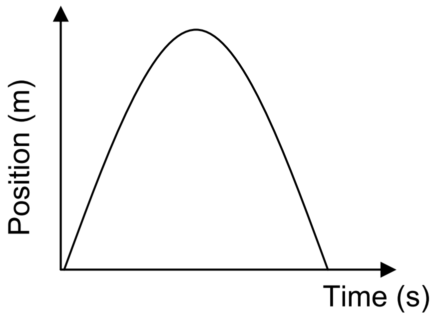
A



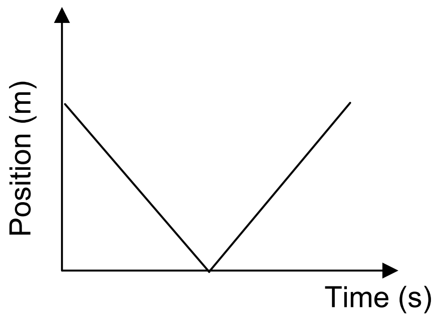
B



C



D



(2)

3.2 Car A moves west at speed *v*. Car B moves east at speed 2*v* along the same straight road. The velocity of Car A relative to Car B is:

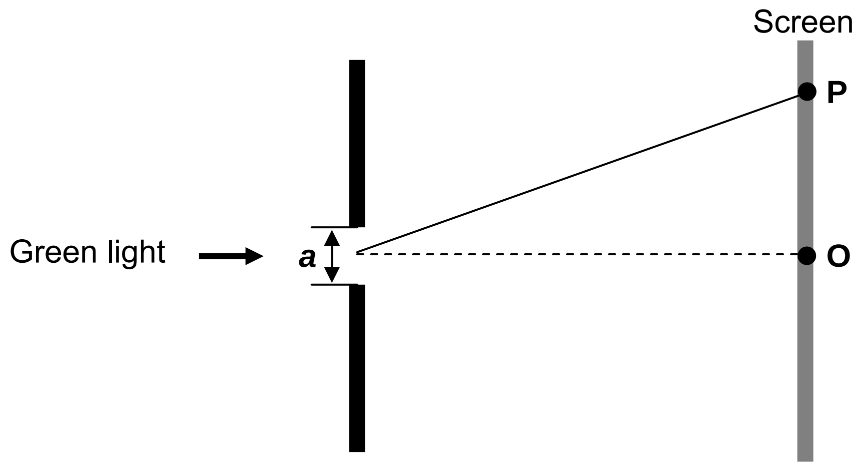
A 3*v* west

B 3*v* east

C *v* east

D *v* west (2)

3.3 Green light passes through a narrow slit of width *a*. The first minimum is observed at point P on a screen as shown in the diagram below.

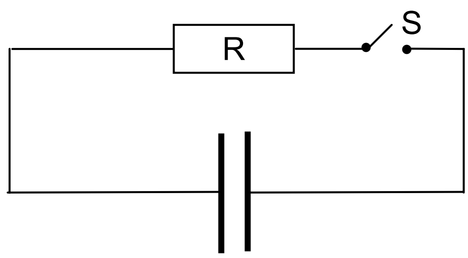


Which ONE of the following changes regarding the colour of the incident light and the width of the slit will cause the GREATEST increase in the distance OP?

	Colour of light	**Width of slit**
A	Red	2*a*
B	Red	½*a*
C	Blue	2*a*
D	Blue	½*a*

(2)

3.4 A fully charged capacitor is connected to a resistor *R* in a circuit, as shown below.

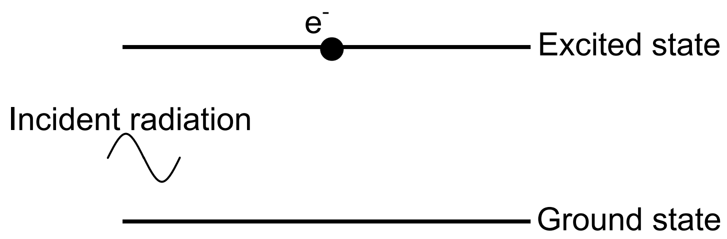


Which ONE of the following correctly describes the changes in the current, *I*, in the circuit and the potential difference, *V*, across the capacitor when the switch S is closed?

	I	***V***
A	Decreases	Increases
B	Increases	Decreases
C	Decreases	Decreases
D	Increases	Increases

(2)

3.5 The diagram below represents part of the process of stimulated emission in a laser. An electron in an atom of the lasing material is shown in the excited state, with radiation incident on the lasing material.



The radiation emitted by the electron when dropping to the ground state will be …

A in phase and in the same direction as the incident radiation.

B in phase and opposite in direction to the incident radiation.

C out of phase and in the same direction as the incident radiation.

D out of phase and opposite in direction to the incident radiation. (2)

[10]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start each question on a NEW page.

2. Leave one line between two subquestions, for example between QUESTION 4.1 and QUESTION 4.2.

3. The formulae and substitutions must be shown in ALL calculations.

4. Round off your answers to TWO decimal places where applicable.

QUESTION 4 (Start on a new page.)

The following extract comes from an article in a school newspaper.

THE LAWS OF PHYSICS ARE ACCURATE!

Two construction workers, Alex and Pete, were arguing about whether a smaller brick would hit the ground quicker than a larger brick when both are released from the same height.

Alex said that the larger brick should hit the ground first. Pete argued that the smaller brick would hit the ground first.

4.1 Are their statements correct? Give a reason for your answer. (3)

4.2 A group of Physical Sciences learners decide to test Alex's and Pete's hypotheses. They drop two bricks, one small and the other much larger, from one of the floors of the school building.

4.2.1 Write down TWO precautions they should take to ensure that the result is reliable. (2)

4.2.2 Give a reason why, despite all the necessary precautions, they might not get the correct result. (1)

4.3 In another experiment, the learners **drop** a brick A from a height of 8 m. After 0,6 s, they **throw** a second brick B downwards from the same height. Both bricks, A and B, hit the ground at the same time.

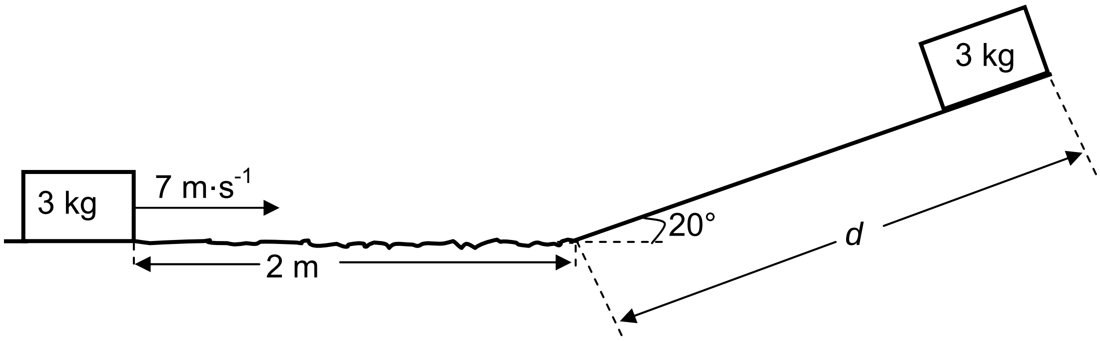
Ignore the effects of friction and calculate the speed at which brick B was thrown. (7)

[13]

QUESTION 5 (Start on a new page.)

A 3 kg block slides at a constant velocity of 7 m·s^{-1} along a horizontal surface. It then strikes a rough surface, causing it to experience a constant frictional force of 30 N. The block slides 2 m under the influence of this frictional force before it moves up a frictionless ramp inclined at an angle of 20° to the horizontal, as shown in the diagram below.

The block moves a distance *d* up the ramp, before it comes to rest.



5.1 Show by calculation that the speed of the block at the bottom of the ramp is 3 m·s^{-1}. (5)

5.2 Draw a free-body diagram to show all the forces acting on the block in a direction parallel to the incline, whilst the block is sliding up the ramp. (2)

5.3 Calculate the distance, *d*, the block slides up the ramp. (5)
[12]

QUESTION 6 (Start on a new page.)

A man of mass 87 kg on roller skates, moving horizontally at constant speed in a straight line, sees a boy of mass 22 kg standing directly in his path. The man grabs the boy and they both continue in a straight line at 2,4 m·s^{-1}.

6.1 Calculate the man's speed just before he grabs the boy. Ignore the effects of friction. (4)

6.2 Is the collision elastic? Use a calculation to support your answer. (6)

6.3 After grabbing the boy, they both continue at a velocity of 2,4 m·s^{-1} along a straight line until they arrive at a loose gravel surface near the end of the path. They now move at constant acceleration in a straight line through the loose gravel for 2 m before coming to rest.

Calculate the magnitude of the force exerted by the gravel surface on the man and the boy. (5)
[15]

QUESTION 7 (Start on a new page.)

A fire truck, with its siren on, is moving at 20 $m.s^{-1}$ towards a burning building. A person standing next to the road with a detector, measures the frequency of the sound emitted by the siren to be 450 Hz. The measured frequency is HIGHER than the frequency of the sound emitted by the siren.

7.1 Is the fire truck moving toward or away from the person? (1)

7.2 Explain why the registered frequency is higher. (2)

7.3 Calculate the frequency of the siren if the speed of sound in air is 340 $m{\cdot}s^{-1}$. (4)
[7]

QUESTION 8 (Start on a new page.)

Before the Industrial Revolution, the range of colours available for art and decorative uses was limited. Pigments were harvested from natural sources such as plants, animal waste, insects and minerals.

Blue and purple, derived from a pigment in a scarce stone, came to be associated with royalty, because only the rich could afford it. Carmine, a red pigment, was produced from harvested, dried and crushed insects in Mexico. It became one of the region's most valuable export products, providing jobs for many of the local inhabitants.

However, the discovery and production of chemical pigments made clothes and paints in colours such as red, blue and purple accessible and affordable to everybody.

[Adapted from: *Wikipedia*]

8.1 Define the term *pigment.* (2)

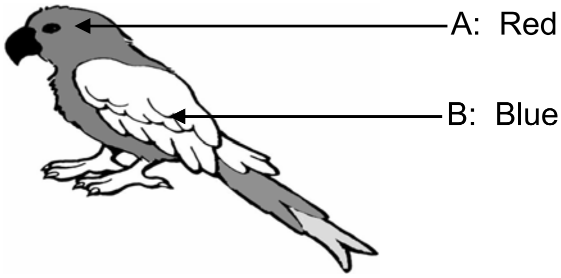
8.2 The production of chemical pigments was beneficial to some people, but not to others. Explain this statement by referring to information from the passage. (2)

8.3 Which colour model, ADDITIVE or SUBTRACTIVE, explains the mixing of pigments? (1)

8.4 An artist has only the following three different colours of paint:

MAGENTA, YELLOW, CYAN

A picture of a parrot is to be painted in the colours shown below.



Suggest how the artist can mix the above THREE colours to paint the various parts of the parrot. Only write down the letters (A and B) and next to each the colour(s) that she must mix. (2)

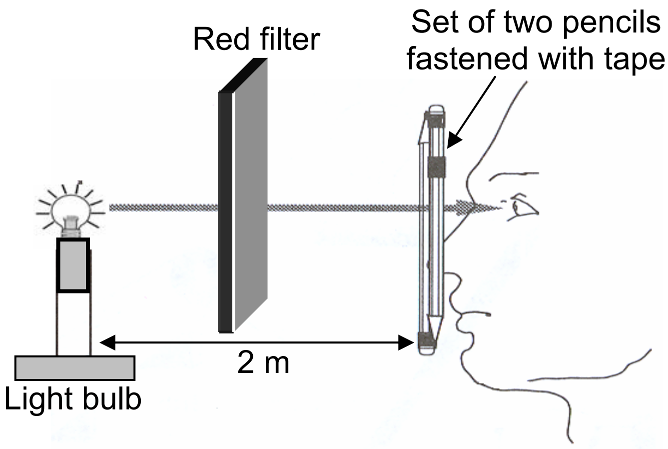
8.5 A car owner requested a panel beater to paint the door of her car the same green colour as the rest of the car. On receiving her car, she left the workshop satisfied that the colour of the paint used on the door is exactly the same as the colour of the paint used on the rest of the car. However, when she viewed the car outside in the sunlight, she observed that the door was not painted green, but cyan.

What colour of lighting was used in the workshop to have made her perceive the door as green in the workshop? Explain how you arrived at your answer. (3)
[10]

QUESTION 9 (Start on a new page.)

A learner uses a white light bulb, two pencils and a red filter to investigate a wave phenomenon.

He places the red filter in front of the light bulb and fastens the two pencils together with tape. He then observes the light bulb through the narrow gap between the two pencils from a distance of 2 m, as shown below.



9.1 Name the wave phenomenon investigated by the learner. (1)

9.2 The learner notes the following observations in his practical book:

Observation 1:
Red and dark bands of different widths are observed on either side of the central red band.

Observation 2:
When the two pencils are brought closer together, the red lines become broader.

Observation 3:
When the red filter is removed, spectral colours are observed on either side of the central band.

9.2.1 Write down Huygens's principle. (2)

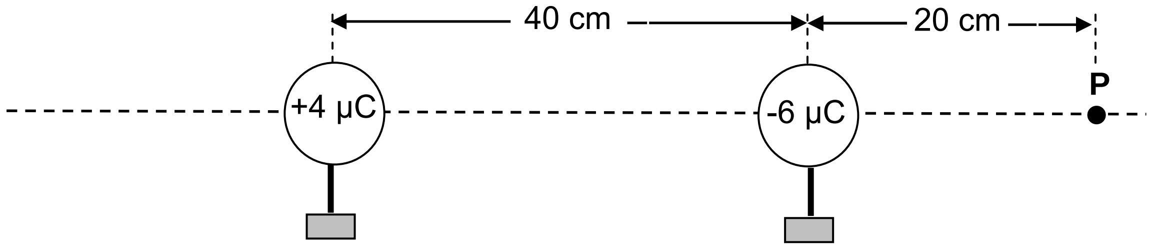
9.2.2 Use Huygens's principle to explain the occurrence of red and dark bands in Observation 1. (2)

9.2.3 Give a reason for Observation 2. (2)

9.2.4 Explain the formation of the spectral colours in Observation 3. (2)
[9]

QUESTION 10 (Start on a new page.)

Two metal spheres on insulated stands carry charges of +4 µC and -6 µC respectively. The spheres are arranged with their centres 40 cm apart, as shown below.



10.1 Calculate the magnitude of the force exerted by each sphere on the other. (4)

10.2 By what factor will the magnitude of the force in QUESTION 10.1 change if the distance between the spheres is halved? (Do not calculate the new value of the force.) (1)

10.3 Calculate the net electric field at point P as shown in the diagram above. (6)

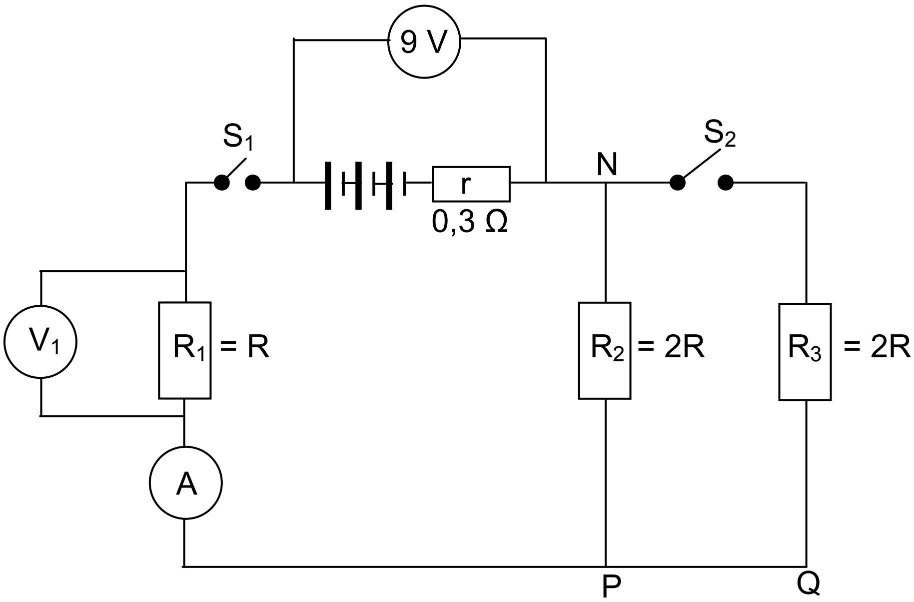
10.4 The spheres are now brought into contact with each other and then returned to their original positions. Now calculate the potential energy of the system of two charges. (5)

[16]

QUESTION 11 (Start on a new page.)

Three resistors, R_1, R_2 and R_3, are connected to a battery, as shown in the circuit diagram below. The internal resistance of the battery is 0,3 Ω. The resistance of R_2 and R_3 is equal. The resistance of R_1 is half that of R_2.

When both switches are open, the voltmeter across the battery reads 9 V.



11.1 What is the value of the emf of the battery? Give a reason for your answer. (2)

11.2 When **only switch S_1 is closed**, the reading on the ammeter is 3 A. Calculate the resistance of R_1. (5)

11.3 Both switches S_1 and S_2 are now closed.

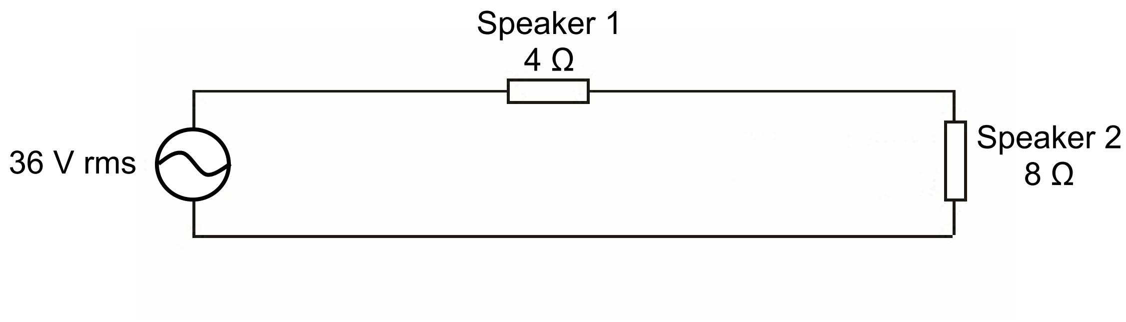
11.3.1 How will the resistance of the circuit change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

11.3.2 A conducting wire of negligible resistance is connected between points Q and N. What effect will this have on the 'lost volts'? Explain the answer. (3)

[11]

QUESTION 12 (Start on a new page.)

A source provides an rms potential difference of 36 V to a 4 Ω and an 8 Ω speaker connected in series, as shown in the diagram below.



12.1 Calculate the following:

12.1.1 rms current through the 4 Ω speaker (3)

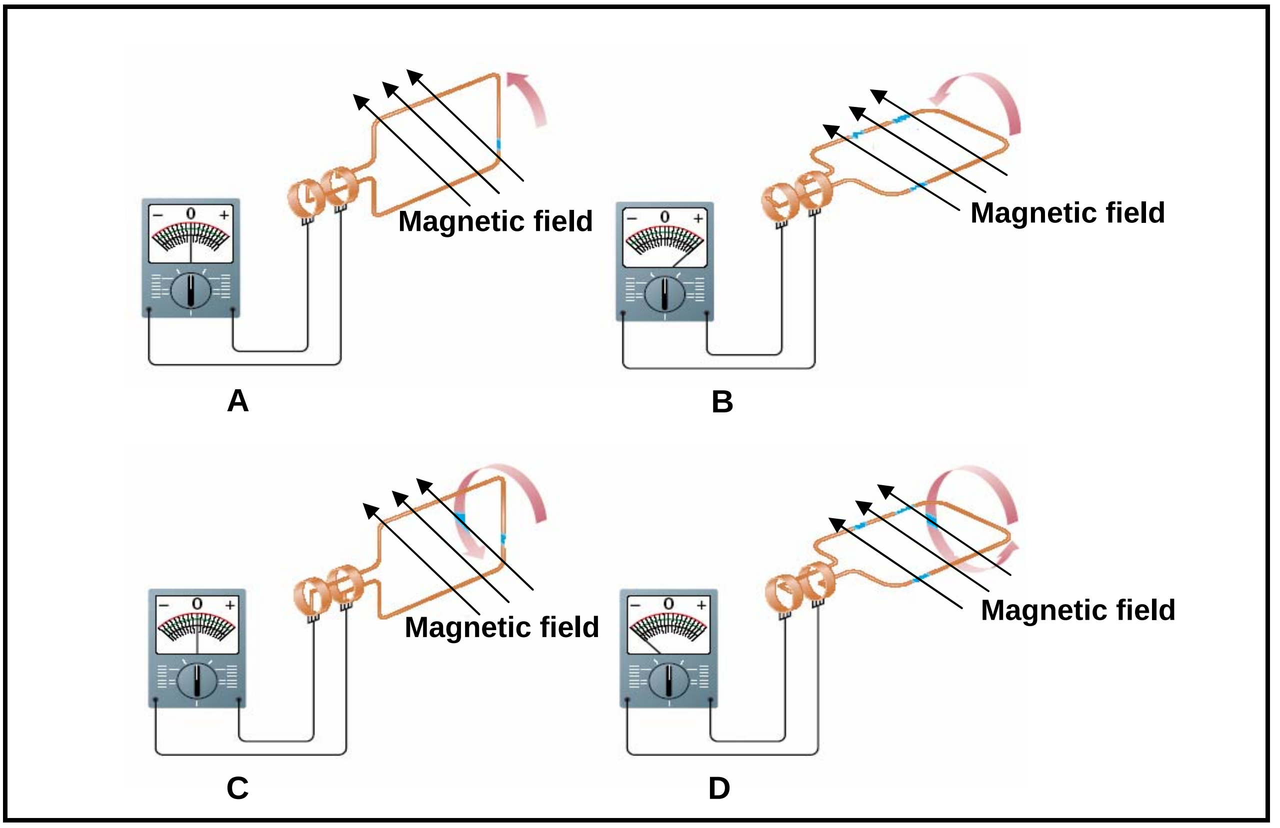
12.1.2 Peak current through each speaker (3)

12.1.3 Average power dissipated by the 4 Ω speaker (3)

12.2 Without using a calculation, state how the average power dissipated by the 4 Ω speaker compares with the power dissipated by the 8 Ω speaker. Give a reason for the answer. (3)
[12]

QUESTION 13 (Start on a new page.)

The diagrams A to D below show four positions in sequence during the anti-clockwise rotation of the coil of a simple AC generator.



13.1 Name the fundamental principle on which generators work. (1)

13.2 What is the purpose of the slip rings in an AC generator? (1)

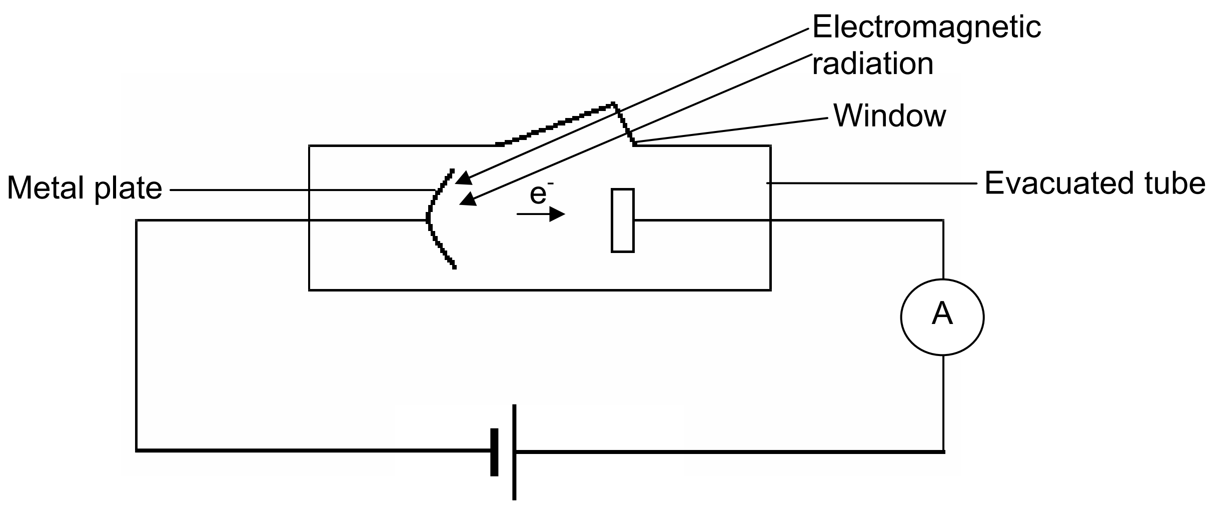
13.3 By referring to the relative positions of the coil in positions A to D, draw the corresponding graph of potential difference versus time for one full rotation (A to D to A). Indicate the positions of the coil (by using the letters A to D) on your graph. (3)

13.4 Name ONE way in which the induced emf of a specific generator can be increased. (1)

13.5 Which component in a DC generator makes it different from an AC generator? (1)
[7]

QUESTION 14 (Start on a new page.)

The diagram below shows a metal plate that emits electrons when a certain frequency of electromagnetic radiation is incident on it. The plate is connected to a source of potential difference and an ammeter as shown in the circuit below.



14.1 Name the phenomenon described above. (1)

When radiation of wavelength 555 nm is incident on the metal plate, electrons are released with zero kinetic energy.

14.2 Define the term *work function* of a metal. (2)

14.3 Calculate the work function of this metal. (6)

14.4 How will the reading on the ammeter change if the intensity of the electromagnetic radiation is increased? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for your answer. (3)

14.5 Incident radiation with a longer wavelength is now used. How will the reading on the ammeter change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[13]

TOTAL SECTION B: 125

GRAND TOTAL: 150

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1 (gravitational) potential (energy) ✓
(gravitasionele) potensiële (energie) [12.2.1] (1)

1.2 watt / W ✓ [12.2.1] (1)

1.3 Coherent / coherence ✓
Koherent [12.2.1] (1)

1.4 gamma rays /*-strale* ✓

OR/*OF*
γ rays /γ*-strale* [12.2.1] (1)

1.5 Photons / *fotone* ✓

OR/*OF*
Quanta / *kwanta* [12.2.1] (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 … is 9,8 m·s^{-2} at its maximum height. ✓✓
… is 9,8 m·s^{-2} by sy maksimum hoogte.

OR/*OF*
… the velocity is zero at its maximum height./… *die snelheid is nul by sy maksimum hoogte*. [12.2.1] (2)

2.2 … the **magnitude of the MOMENTUM** of the bullet is equal (opposite in direction) to the magnitude of the momentum of the gun. ✓✓
… die **grootte van die MOMENTUM** van die *koeël is gelyk (teenoorgesteld in rigting) aan die grootte van die momentum van die geweer.*

OR/OF
...the **MOMENTUM** of the bullet is **opposite in direction** to the momentum of the gun
... *die **MOMENTUM** van die koeël is **teenoorgesteld in rigting** aan die momentum van die geweer*

OR/OF
… the **MOMENTUM** of the bullet is equal to, but opposite in direction to the momentum of the gun.
*… die **MOMENTUM** van die koeël is gelyk aan, maar teenoorgesteld in rigting aan die momentum van die geweer.*

OR/*OF*
…. the **CHANGE in MOMENTUM (impulse**) of the bullet is equal in magnitude (opposite in direction) to the change in momentum of the gun.
… die verandering in MOMENTUM van die koeël is gelyk in grootte (teenoorgesteld in rigting) aan die verandering in momentum van die geweer.

OR/*OF*
…. the **CHANGE in MOMENTUM (impulse**) of the bullet is equal to, but opposite in direction to the change in momentum of the gun.
*… die **VERANDERING in MOMENTUM (impuls)** van die koeël is gelyk aan, maar teenoorgesteld in rigting aan die verandering in momentum van die geweer.*

OR/*OF*
... the **magnitude of the FORCE** that the bullet exerts on the gun is **equal** (opposite in direction) to the force that the gun exerts on the bullet.
*… die **grootte van die KRAG** wat die koeël op die geweer uitoefen is **gelyk** (teenoorgesteld in rigting) aan die krag wat die geweer op die koeël uitoefen.*

OR/*OF*
... the **FORCE** that the bullet exerts on the gun is **equal to, but opposite in direction** to the force that the gun exerts on the bullet.
*… die **KRAG** wat die koeël op die geweer uitoefen is **gelyk aan, maar teenoorgesteld in rigting,** aan die krag wat die geweer op die koeël uitoefen.* [12.2.3] (2)

2.3 … result of diffraction / interference ✓✓
… gevolg van diffraksie / interferensie

OR/*OF*
… by a triangular prism …
… deur 'n driehoekige prisma … [12.2.3] (2)

2.4 … different potential differences … ✓✓
… verskillende potensiaalverskille …

OR/*OF*
Identical resistors …
Identiese resistors …

OR/OF
Identical resistors …connected in parallel
Identiese resistors …in parallel geskakel

OR/OF
Non-identical resistors .....in parallel ....different current
Nie identiese resistors ... in parallel ... verskillende stroom [12.2.2] (2)

2.5 A line absorption spectrum … ✓✓
'n Lynabsorpsiespektrum …

OR/*OF*
… when electrons move from higher to lower energy levels.
… wanneer elektrone van hoër na laer energievlakke beweeg. [12.2.1] (2)
[10]

QUESTION 3/*VRAAG 3*

3.1 C ✓✓ [12.1.2] (2)

3.2 A ✓✓ [12.2.3] (2)

3.3 B ✓✓ [12.1.2] (2)

3.4 C ✓✓ [12.2.3] (2)

3.5 A ✓✓ [12.2.1] (2)
[10]

TOTAL SECTION A/*TOTAAL AFDELING A*: 25

SECTION B/*AFDELING B*

QUESTION 4/*VRAAG 4*

4.1

Option 1/*Opsie 1*
Statements not correct (or no) / *Stellings nie reg nie (of nee)* ✓

The bricks will experience the same (gravitational) acceleration / free fall ✓ and thus reach the ground at the same time. ✓

Die bakstene ondervind dieselfde (gravitasie) versnelling /vryval ✓en bereik dus die grond gelyktydig. ✓

Option 2/*Opsie 2*
Pete is correct or Alex is wrong / *Pete is reg of Alex is verkeerd* ✓

The smaller brick experiences less air resistance, thus larger acceleration ✓
and reaches the ground first. ✓

Die kleiner baksteen ondervind minder lugweerstand, dus groter versnelling ✓
en tref die grond eerste. ✓

Option 3/*Opsie 3*
Alex is correct or Pete is wrong / *Alex is reg of Pete is verkeerd* ✓

In the presence of air resistance, the larger brick, with larger mass, experiences a larger net force downwards, thus largest acceleration ✓
and reaches the ground first ✓

In die aanwesigheid van lugweerstand, ondervind die groter baksteen met groter massa 'n groter netto afwaartse krag, dus grootste versnelling ✓
en *tref die grond eerste.* ✓

Option 4/*Opsie 4*
Both are correct / *Beide is reg* ✓

Pete correct: The smaller brick experiences less air resistance, thus larger acceleration and reaches the ground first. ✓
Die kleiner baksteen ondervind minder lugweerstand, dus groter versnelling en tref die grond eerste ✓

Alex correct: In the presence of air resistance, the larger brick, with larger mass, experiences a larger net force downwards, thus largest acceleration and reaches the ground first ✓
In die aanwesigheid van lugweerstand, ondervind die groter baksteen met groter massa, 'n groter netto afwaartse krag, dus grootste versnelling en tref grond eerste. ✓

[12.2.3] (3)

4.2.1 Any two / *Enige twee:*

- Ensure that both bricks are dropped from same height
  Maak seker dat beide bakstene vanaf dieselfde hoogte laat val word

- Ensure that both bricks are dropped at the same time
  Maak seker dat beide bakstene gelyktydig laat val word

  OR/*OF*
  Ensure that the stopwatch starts at instant that each brick is released and stopped at the instant that each brick reaches the ground
  Maak seker dat die stophorlosie begin die oomblik as elk van die bakstene gelos word, en gestop word die oomblik as elke baksteen die grond bereik

- Repeat the experiment several times and use the average of the results
  Herhaal die eksperiment verskeie kere en gebruik die gemiddelde van die resultate

- Make sure that $v_i = 0$ for both bricks
  Maak seker dat $v_i = 0$ vir beide bakstene

- Make sure that there is no strong wind
  Maak seker dat daar geen sterk wind is nie

- Use bricks made of the same material / of same density
  Gebruik bakstene gemaak van dieselfde materiaal / met dieselfde digtheid [12.1.1] (2)

4.2.2 External force(s) may be present e.g. friction/air resistance / strong wind blowing
Eksterne krag(te) kan teenwoordig wees bv. wrywing / lugweerstand / sterk wind wat waai [12.1.1] (1)

4.3

Option 1/*Opsie 1*:
Downward direction positive / *Afwaartse rigting positief:*
A:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
8 ✓ $= (0)\Delta t + \frac{1}{2}(9{,}8)\Delta t^2$ ✓
$\therefore \Delta t = 1{,}28$ s

B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
8 ✓ $= v_{iB}(1{,}28 - 0{,}6)$ ✓ $+ \frac{1}{2}(9{,}8)(1{,}28 - 0{,}6)^2$ ✓
$\therefore v_{iB} = 8{,}43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Downward motion negative / *Afwaartse beweging negatief:*
A:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
-8 ✓ $= (0)\Delta t + \frac{1}{2}(-9{,}8)\Delta t^2$ ✓ $\therefore \Delta t = 1{,}28$ s
B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
-8 ✓ $= v_{iB}(1{,}28 - 0{,}6)$ ✓ $+ \frac{1}{2}(-9{,}8)(1{,}28 - 0{,}6)^2$ ✓
$\therefore v_{iB} = -8{,}43\ m\cdot s^{-1}$
$\therefore v_{iB} = 8{,}43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Option 2/*Opsie 2*:
Downward direction positive / *Afwaartse rigting positief:*
A:
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= 0^2 + 2(9{,}8)(8)$ ✓ $\therefore v_f = 12{,}52\ m\cdot s^{-1}$
$v_f = v_i + a\Delta t$ $\therefore 12{,}52 = 0 + (9{,}8)\Delta t$ ✓ $\therefore \Delta t = 1{,}28$ s
B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
8 ✓ $= v_{iB}(1{,}28 - 0{,}6)$ ✓ $+ \frac{1}{2}(9{,}8)(1{,}28 - 0{,}6)^2$ ✓
$\therefore v_{iB} = 8{,}43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Downward direction negative / *Afwaartse rigting negatief:*
A:
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= 0^2 + 2(-9{,}8)(-8)$ ✓ $\therefore v_f = -12{,}52\ m\cdot s^{-1}$
$v_f = v_i + a\Delta t$ $\therefore -12{,}52 = 0 + (-9{,}8)\Delta t$ ✓ $\therefore \Delta t = 1{,}28$ s
B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
-8 ✓ $= v_{iB}(1{,}28 - 0{,}6)$ ✓ $+ \frac{1}{2}(-9{,}8)(1{,}28 - 0{,}6)^2$ ✓
$\therefore v_{iB} = -8{,}43\ m\cdot s^{-1}$
$\therefore v_{iB} = 8{,}43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Option 3/*Opsie 3*:

Downward direction positive / *Afwaartse rigting positief:*

A:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= 0^2 + 2(9,8)(8)$ ✓ $\therefore v_f = 12,52 \text{ m·s}^{-1}$

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t \therefore 8 = \frac{(0 + 12,52)}{2}\Delta t$ ✓ $\therefore \Delta t = 1,28 \text{ s}$

B:

$\Delta y = v_i\Delta t + ½a\Delta t^2$

8 ✓ $= v_{iB}(1,28 – 0,6)$ ✓ $+ ½(9,8)(1,28 – 0,6)^2$ ✓

$\therefore v_{iB} = 8,43 \text{ m·s}^{-1}$ ✓ (8,43 to/*tot* 8,48 m·s^{-1})

Downward direction negative / *Afwaartse rigting negatief:*

A:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= 0^2 + 2(- 9,8)(- 8)$ ✓ $\therefore v_f = - 12,52 \text{ m·s}^{-1}$

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t \therefore 8 = \frac{(0 - 12,52)}{2}\Delta t$ ✓ $\therefore \Delta t = 1,28 \text{ s}$

B:

$\Delta y = v_i\Delta t + ½a\Delta t^2$

8 ✓ $= v_{iB}(1,28 – 0,6)$ ✓ $+ ½(- 9,8)(1,28 – 0,6)^2$ ✓

$\therefore v_{iB} = - 8,43 \text{ m·s}^{-1}$

$\therefore v_{iB} = 8,43 \text{ m·s}^{-1}$ ✓ (8,43 to/*tot* 8,48 m·s^{-1})

Option 4/*Opsie 4*:

A:

$W_{net} = \Delta K$

$mgh = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$m(9,8)(8) = \frac{1}{2}mv_f^2 - 0$ ✓

$\therefore v_f = 12,52 \text{ m·s}^{-1}$

A:

$(U + K)_i = (U + K)_f$

$mgh + 0 = 0 + \frac{1}{2}mv_f^2$

$m(9,8)(8) + 0 = 0 + \frac{1}{2}mv_f^2$ ✓

$\therefore v_f = 12,52 \text{ m·s}^{-1}$

✓ $v_f = v_i + a\Delta t \therefore 12,52 = 0 + (9,8)\Delta t$ ✓

$\therefore \Delta t = 1,28 \text{ s}$

B:

$\Delta y = v_i\Delta t + ½a\Delta t^2$

8 ✓ $= v_{iB}(1,28 – 0,6)$ ✓ $+ ½(9,8)(1,28 – 0,6)^2$ ✓

$\therefore v_{iB} = 8,43 \text{ m·s}^{-1}$ ✓ (8,43 to/*tot* 8,48 m·s^{-1})

[12.1.3] (7)

[13]

QUESTION 5/*VRAAG 5*

5.1

Option 1/*Opsie 1*:
Direction of motion as positive / *Rigting van beweging as positief:*

$F_{net} = ma$ ✓
$-30 = (3)a$ ✓
$\therefore a = -10\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$= (7)^2$ ✓ $+ 2(-10)(2)$ ✓
$\therefore v_f = 3\ m\cdot s^{-1}$

Option 2/*Opsie 2*:

$W_{net} = \Delta K$ ✓ or/*of* ΔE_k
$F\Delta x\cos\theta$ ✓ $= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(30)(2)\cos180°$ ✓ $= \frac{1}{2}(3)v_f^2$ ✓ $- \frac{1}{2}(3)(7)^2$ ✓
$-60 = 1{,}5v_f^2 - 73{,}5 \therefore v_f = 3\ m\cdot s^{-1}$

Option 3/*Opsie 3*:

$W_{appl} = \Delta U + \Delta K - W_f$ **Max./*Maks.*:** $4/5$
$0 = 0 + (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2) - F\Delta x\cos\theta$ ✓
$0 = 0 + \frac{1}{2}(3)v_f^2$ ✓ $- \frac{1}{2}(3)(7)^2$ ✓ $- (30)(2)\cos180°$ ✓
$0 = 1{,}5v_f^2 - 73{,}5 + 60 \therefore v_f = 3\ m\cdot s^{-1}$

$W_{appl} = \Delta U + \Delta K + W_f$ $0/5$

Option 4 / *Opsie 4*:

$(U + K)_i + W_f = (U + K)_f$ **Max./*Maks.*:** $4/5$
$(0 + \frac{1}{2}mv_i^2) + F\Delta x\cos\theta$ ✓ $= 0 + \frac{1}{2}mv_f^2$
$0 + \frac{1}{2}(3)(7)^2$ ✓ $+ 30(2)\cos180°$ ✓ $= 0 + \frac{1}{2}(3)v_f^2$ ✓
$73{,}5 - 60 = 1{,}5v_f^2 \therefore v_f = 3\ m\cdot s^{-1}$

$(U + K)_i - W_f = (U + K)_f$ $0/5$

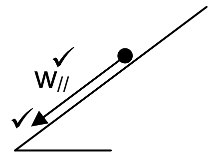
Option 5 / *Opsie 5*:

$(U + K)_i = (U + K)_f - W_f$ **Max./*Maks.*:** $4/5$
$(0 + \frac{1}{2}mv_i^2) = 0 + \frac{1}{2}mv_f^2 - F\Delta x\cos\theta$ ✓
$0 + \frac{1}{2}(3)(7)^2$ ✓ $= 0 + \frac{1}{2}(3)v_f^2$ ✓ $- 30(2)\cos180°$ ✓
$73{,}5 = 1{,}5v_f^2 + 60 \therefore v_f = 3\ m\cdot s^{-1}$

$(U + K)_i = (U + K)_f + W_f$ $0/5$

[12.1.3] (5)

5.2



Any one of the following labels / *Enige een van volgende benoemings:*

- $w_{parallel}$ or/of $w_{//}$
- $F_{g(parallel)}$ or/of $F_{g//}$
- mgsin20°
- Component of weight parallel to incline / *komponent van gewig parallel aan skuinste*

Checklist / *kontrolelys* Free-body diagram / *vrye kragtediagram*	
Direction of force indicated as parallel to and down incline (not needed to show incline) *Rigting van krag getoon as parallel aan en afwaarts teen skuinste (skuinste hoef nie getoon te word nie)*	✓
Correct label / korrekte benoeming	✓

[12.1.2] (2)

5.3

<u>Option 1/*Opsie 1*:</u>

$(U + K)_i = (U + K)_f$ ✓

$0 + \frac{1}{2}mv_i^2 = mgh + 0$

$0 + \frac{1}{2}(3)(3)^2$ ✓ $= (3)(9,8)h + 0$ ✓

$\therefore$ h = 0,46 m

$\sin 20° = \frac{h}{d}$ ✓ $= \frac{0,46}{d}$ $\therefore$ d = 1,34 m ✓

As single step/*As een stap:*

$(U + K)_i = (U + K)_f$ ✓

$0 + \frac{1}{2}(3)(3)^2$ ✓ $= (3)(9,8)h + 0$ ✓

$\frac{1}{2}(3)(3)^2 = (3)(9,8)(d\sin 20°)$ ✓

$\therefore$ d = 1,34 m ✓

<u>Option 2/*Opsie 2*:</u>

$W_{net} = \Delta K$ ✓ (or/*of* ΔEk)

$F_{g//}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$(3)(9,8)\sin 20°$ ✓ $(d)\cos 180°$ ✓ $= 0 - \frac{1}{2}(3)(3)^2$ ✓

$-10,06d = -13,5$ $\therefore$ d = 1,34 m ✓

<u>Option 3/*Opsie 3*:</u>

$W_{net} = \Delta K$ ✓ (or/*of* ΔEk)

$W_{gravity} = K_f - K_i$

$mgh\cos 180°$ ✓ $= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$(3)(9,8)h(-1)$ ✓ $= 0 - \frac{1}{2}(3)(3)^2$ ✓ $\therefore$ h = 0,46 m

$\sin 20° = \frac{h}{d}$ ✓ $= \frac{0,46}{d}$ $\therefore$ d = 1,34 m ✓

Option 4 / *Opsie 4*:
Direction of motion as positive / *Rigting van beweging as positief:*

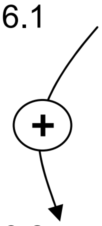
$F_{net} = ma$ ✓
$mg\sin 20° = ma$
$-(3)(9,8)\sin 20° = 3a$ ✓ $\therefore a = -3,35\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0^2 = (3)^2 + 2(-3,35)(d)$ ✓

$\therefore d = 1,34\ m$ ✓

[12.1.3] (5)
[12]

QUESTION 6 / *VRAAG 6*



6.1 $m_m v_{im} + m_b v_{bi} = (m_m + m_b)v_f$ ✓

$(87)v_{im} + 0$ ✓ $= (87 + 22)(2,4)$ ✓

$v_{im} = 3,01\ m\cdot s^{-1}$ ✓ [12.2.3] (4)

6.2

Option 1/*Opsie 1:*
K(before/*voor*) $= ½mv^2$ ✓
$= ½(87)(3,01)^2 + 0$ ✓
$= 394,11$ J ✓
$= (391,5$ if $3\ m\cdot s^{-1})$

K(after/*na*) $= ½mv^2$
$= ½(109)(2,4)^2$ ✓
$= 313,92$ J ✓

Collision is inelastic / No ✓
Botsing is nie-elasties / Nee

Option 2/*Opsie 2:*
ΔK = K(after/*na*) - K(before/*voor*)
$= ½mv^2$(after/*na*) - $½mv^2$(before/*voor*) ✓
$= ½(109)(2,4)^2$ ✓ – $(½(87)(3,01)^2 + 0)$ ✓
$= 313,92 - 394,11$
$= -80,19$ J ✓✓

Collision is inelastic / No ✓
Botsing is nie-elasties / Nee

[12.2.3] (6)

6.3

Option 1 / *Opsie 1*:

$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta$ ✓= ½m($v_f^2 - v_i^2$)
F_{net}(2)(-1) ✓= ½(87 + 22)(0^2 - $2,4^2$) ✓

$\therefore$ F_{net} = 156,96 N ✓
If/*indien* – 156,96 N: minus 1

Option 2 / *Opsie 2*:

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
0^2 = $2,4^2$ + 2a(2) ✓ $\therefore$ a = - 1,44 m·s^{-2}

F_{net} = ma ✓= (87 + 22)(- 1,44) ✓= - 156,96 N

$\therefore$ F_{net} = 156,96 N ✓

Option 3 / *Opsie 3*:

$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $\therefore$ $2 = (\frac{0 + 2,4}{2})\Delta t$ ✓ $\therefore$ Δt = 1,67 s
$F_{net}\Delta t = \Delta p = mv_f - mv_i$ ✓
F_{net}(1,67) = (87 + 22)(0 – 2,4) ✓

$\therefore$ F_{net} = - 156,65 N $\therefore$ F_{net} = 156,65 N ✓

Option 4 / *Opsie 4*:

$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $\therefore$ $2 = (\frac{0 + 2,4}{2})\Delta t$ ✓ $\therefore$ Δt = 1,67 s

$v_f = v_i + a\Delta t$ $\therefore$ 0 = 2,4 + a(1,67) $\therefore$ a = - 1,44 m·s^{-2}

F_{net} = ma ✓= (87 + 22)(-1,44) ✓ = - 156,96 N

$\therefore$ F_{net} = 156,96 N ✓

[12.2.3] (5)
[15]

QUESTION 7/*VRAAG 7*

7.1 Towards the person / *Na die persoon toe* ✓ [12.1.2] (1)

7.2 When the source moves towards a stationary observer
waves in front of the source is compressed ✓
resulting in a shorter wavelength ✓, resulting in a higher frequency
(speed of sound constant)

Wanneer die bron 'n stilstaande waarnemer nader,
word golwe voor die bron saamgepers ✓
wat 'n korter golflengte tot gevolg het ✓ *wat 'n hoër frekwensie tot*
gevolg het (spoed van klank konstant) [12.2.2] (2)

7.3 Formulae accepted / *Formules aanvaar:*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$\therefore\ 450$ ✓ $= (\frac{340}{340 - 20})f_s$ ✓ [12.2.3] (4)

$\therefore f_s = 423{,}53$ Hz ✓ **[7]**

QUESTION 8/*VRAAG 8*

8.1 A (chemical) substance that (selectively) absorb light of certain frequencies / colours and (selectively) transmits / reflects others. ✓✓

'*n (Chemiese) stof wat (selektief) lig van sekere frekwensies / kleure absorbeer en ander (selektief) deurlaat / weerkaats.* [12.2.1] (2)

8.2 The manufacturing of pigments made all colours affordable for all people./ *Vervaardiging van pigmente het alle kleure vir alle mense bekostigbaar gemaak.* ✓

At the same time people, e.g. the Mexicans, could have lost their jobs and only income. / *Terselfdertyd het mense, bv. die Meksikane, hulle werk en enigste inkomste verloor.* ✓ [12.3.1] (2)

8.3 Subtractive / *Subtraktief* ✓ [12.2.1] (1)

8.4 A: magenta + yellow / *geel* ✓
B: magenta + cyan / *siaan* ✓ [12.2.3] (2)

8.5 **Option 1/*Opsie 1:***
Yellow light / *Geel lig* ✓

Cyan paint reflects blue and green light ✓
(Yellow light contains green light and red light)
Only green light (in yellow light) will be reflected ✓and it appears green

Siaanverf weerkaats blou en groen lig ✓
(Geel lig bevat groen en rooi lig)
Slegs groen lig (in geel lig) sal weerkaats word ✓en dit kom groen voor

Option 2/*Opsie 2:*
Green light / *Groen lig* ✓

Cyan paint reflects blue and green light ✓
When green light shines onto it, only green light will be reflected ✓and it appears green

Siaanverf weerkaats blou en groen lig ✓
Wanneer groen lig daarop skyn, word slegs groen lig weerkaats ✓en dit kom groen voor. [12.2.3] (3)
[10]

QUESTION 9 / *VRAAG 9*

9.1 Diffraction / *Diffraksie* ✓ [12.1.2] (1)

9.2.1 Each point on a wave front acts as a source of (spherical) secondary wave fronts / wavelets (that propagates in the forward direction). ✓✓
Elke punt op 'n golffront dien as 'n bron van (sferiese) sekondêre golffronte / golfies (wat in 'n voorwaartse rigting voortplant). [12.2.1] (2)

9.2.2 Dark bands form where **wave fronts / wavelets** interfere destructively.✓
Red/bright bands form where **wave fronts / wavelets** interfere constructively. ✓

Donker bande vorm waar ***golffronte / golwe*** *destruktiewe interferensie ondergaan.* ✓
Rooi/helder bande vorm waar ***golffronte / golwe*** *konstruktiewe interferensie ondergaan.* ✓ [12.1.4] (2)

9.2.3 Diffraction is inversely proportional to the slit width / Diffraction $\alpha \frac{1}{a}$ ✓✓

Diffraksie is omgekeerd eweredig aan die spleetwydte /
Diffraksie $\alpha \frac{1}{a}$ ✓✓

OR/*OF*
The degree of diffraction / Angle at which minima occurs
increases with decreasing slit width
Mate van diffraksie / Hoek waar minima voorkom
neem toe met afname in spleetwydte [12.1.4] (2)

9.2.4 *White light* consists of different colours with <u>different wavelengths</u> ✓
Amount of diffraction differs for different colours / different
wavelengths. ✓

Wit lig bestaan uit verskillende kleure met <u>verskillende golflengtes</u>. ✓
Mate van diffraksie verskil vir verskillende kleure / golflengtes. ✓ [12.1.4] (2)

[9]

QUESTION 10 / *VRAAG 10*

10.1

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\times10^9)(4\times10^{-6})(6\times10^{-6})}{(0,4)^2}$ ✓ ✓

F = 1,35 N ✓

OR/*OF*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\times10^9)(4\times10^{-6})(-6\times10^{-6})}{(0,4)^2}$ ✓ ✓

F = -1,35 N
Magnitude of / *Grootte van* F = 1,35 N ✓ [12.2.3] (4)

10.2 four / *vier (4)* ✓ [12.2.2] (1)

10.3 $E(6\ \mu C) = \dfrac{kQ}{r^2}$ ✓

$= \dfrac{(9\times10^9)(6\times10^{-6})}{(0,2)^2}$ ✓ ✓

$= 1,35 \times 10^6\ N{\cdot}C^{-1}$ to the left/*na links*

$E(4\ \mu C) = \dfrac{kQ}{r^2}$

$= \dfrac{(9\times10^9)(4\times10^{-6})}{(0,6)^2}$ ✓ ✓

$= 1 \times 10^5\ N{\cdot}C^{-1}$ (to the right / *na regs)*

To the right as positive/*Na regs as positief:*

$E_{net/netto} = -1,35 \times 10^6 + 1 \times 10^5 = -1,25 \times 10^6\ N{\cdot}C^{-1}$ ✓

$E_{net/netto} = 1,25 \times 10^6\ N{\cdot}C^{-1}$ to the left / *na links* ✓

OR/*OF*

$E_{net} = \dfrac{kQ}{r^2}$ ✓ $= 9 \times 10^9\left(\dfrac{-6\times10^{-6}}{(0,2)^2} + \dfrac{(4\times10^{-6})}{(0,6)^2}\right)$ ✓ ✓ ✓

$= -1,35 \times 10^6 + 1 \times 10^5 = -1,25 \times 10^6$

$E_{net/netto}$ = 1,25 x 10^6 N·C^{-1} in the direction of the field of the 6 μC charge/*in die rigting van veld van die 6 μC lading* ✓ [12.1.3] (6)

10.4 New charge/*Nuwe lading* $= \dfrac{(+4\times10^{-6}) + (-6\times10^{-6})}{2}$ ✓

$= -1 \times 10^{-6}$ C or/*of* – 1 μ*C*

$U = \dfrac{kQ_1Q_2}{r}$ ✓

$= \dfrac{(9\times10^9)(-1\times10^{-6})(-1\times10^{-6})}{(0,4)}$ ✓ ✓

$\therefore$ U = 2,25 x 10^{-2} J ✓ (0,02 J) [12.1.3] (5)

[16]

QUESTION 11 / *VRAAG 11*

11.1 9 V ✓

Potential difference measured when:
switch is open / no current flows / circuit is open/no work done is in external circuit ✓

Potensiaalverskil gemeet wanneer:
die skakelaar oop is / geen stroom vloei nie / stroombaan oop is / geen arbeid verrig word in die eksterne stroombaan nie [12.2.2] (2)

11.2

<u>Option 1 / *Opsie 1*:</u>

Emf = $IR + Ir$ ✓
9 ✓= 3(3R) ✓ + 3(0,3) ✓

$\therefore R = R_1 = \frac{9-0,9}{9} = 0,9\ \Omega$ ✓

<u>Option 2 / *Opsie 2*:</u>

Emf = $IR + Ir$ ✓
9 ✓= V_{ext} + (3)(0,3) ✓ $\therefore V_{ext}$ = 8,1 V
$V_{ext} = I(R_1 + R_2)$
8,1 = 3(3R) ✓ $\therefore R_1 = 0,9\ \Omega$ ✓

<u>Option 3 / *Opsie 3*:</u>

emf = $IR + Ir$ ✓
9 ✓= V_{ext} + (3)(0,3) ✓ $\therefore V_{ext}$ = 8,1 V

$\therefore V_1 = \frac{8,1}{3} = 2,7$ V (R₁ + R₂ = 3R)

$R_1 = \frac{V_1}{I} = \frac{2,7}{3}$ ✓ $= 0,9\ \Omega$ ✓

<u>Option 4 / *Opsie 4*:</u>

$R_t = \frac{V}{I}$ ✓ $= \frac{9}{3}$ ✓ $= 3\ \Omega$

$R_2 + R_1$ = 3 – 0,3 ✓ = 2,7 Ω = 3R

$\therefore R_1 = R = \frac{2,7}{3}$ ✓ $= 0,9\ \Omega$ ✓

<u>Option 5 / *Opsie 5*:</u>

$V_{int} = Ir$ ✓ = (3)(0,3) ✓ = 0,9 V

V_{ext} = 9✓ – 0,9 = = 8,1 V

$V_1 = IR_1 \therefore V_1 = 3R$
$V_{R2} = IR_2 \therefore V_{R2} = 3(2R) = 6R$.

$V_1 + V_{R2} = 3R + 6R = 9R$
$\therefore$ 8,1 = 9R ✓ $\therefore R = 0,9\ \Omega$ ✓

[12.1.3] (5)

11.3.1 Decreases / *Verminder* ✓ [12.2.2] (1)

11.3.2 Increases / *Vermeerder* ✓
Resistance decreases / *Weerstand verminder* ✓
<u>Current increases / *Stroom vermeerder*</u> ✓
<u>Ir increases / *Ir vermeerder*</u>

OR/*OF*
Increases / *Vermeerder* ✓
Current passes through wire QN / wire QN shorts the parallel combination of resistors R_2 and R_3 ✓
All the current passes through R_1 and also through battery, thus Ir increases ✓
Die stroom gaan deur draad QN / draad QN veroorsaak 'n kortsluiting van die parallelle kombinasie resistors R_2 en R_3
Al die stroom gaan deur R_1 en deur die battery, dus verhoog Ir [12.2.2] (3)

[11]

QUESTION 12/*VRAAG 12*

12.1.1 $I_{rms} = \frac{V_{rms}}{R}$ ✓ = $\frac{36}{12}$ ✓ = 3 A✓

OR/*OF*
$V_{4\,\Omega} + V_{8\,\Omega}$ = 36 V and/en $V_{4\,\Omega}:V_{8\,\Omega}$ = 1:2
$\therefore V_{4\,\Omega}$ = 12 V
$I_{4\,\Omega} = \frac{V}{R}$ ✓ = $\frac{12}{4}$ ✓ = 3 A ✓

[12.2..3] (3)

12.1.2 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓
$\therefore 3 = \frac{I_{max}}{\sqrt{2}}$ ✓ $\therefore I_{max}$ = 4,24 A ✓

[12.2.3] (3)

12.1.3 $P_{ave} = I^2_{rms}R$ ✓ = $(3)^2(4)$ ✓ = 36 W✓

OR/*OF*
V_{rms} (speaker/luidspreker 1) = $I_{rms}R$ = (3)(4) = 12 V
$P_{ave} = V_{rms}I_{rms}$ ✓ = (12)(3) ✓ = 36 W ✓

OR/*OF*
V_{rms} (speaker/luidspreker 1) = $I_{rms}R$ = (3)(4) = 12 V
$P_{ave} = \frac{V^2_{rms}}{R}$ ✓ = $\frac{12^2}{4}$ ✓ = 36 W ✓

[12.2.3] (3)

12.2 $P_{4\Omega}$ = ½ P_8 or $P_{8\Omega}$ = 2 $P_{4\Omega}$ or /*of*
Smaller / *Kleiner* ✓($P_{4\Omega} < P_{8\Omega}$) or/*of* $P_{8\Omega} > P_{4\Omega}$)

$P_{ave} = I^2_{rms}R$, but since
<u>I_{rms} is constant / *omdat I_{wgk}*</u> *konstant is*✓
$P \propto R$ ✓

OR/*OF*
$P_{4\Omega}$ = ½ P_8 or $P_{8\Omega}$ = 2 $P_{4\Omega}$ or /*of*
Smaller / *Kleiner* ✓

$P_{ave} = V_{rms}I_{rms}$, since
<u>I_{rms} is constant / *omdat I_{wgk}*</u> *konstant is* ✓
$P_{ave} \propto V$ ✓

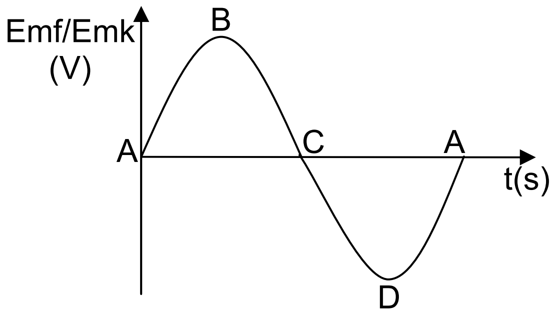
[12.2.2] (3)
[12]

QUESTION 13 / *VRAAG 13*

13.1 Electromagnetic induction / Faraday's law ✓
Elektromagnetiese induksie / Faraday se wet [12.2.1] (1)

13.2 Provides a (sliding) contact (between coil and conducting wires) ✓/ Ensures free rotation
Verskaf 'n (glyende) kontak (tussen die spoel en die geleidende drade)/ Verseker dat spoel vrylik roteer [12.2.1] (1)

13.3



Checklist / *Kontrolelys* Criteria for graph / *Kriteria vir grafiek*	Marks/ *Punte*
Correct shape **with full cycle (ignore if more than one cycle shown** / *Korrekte vorm* ***met volle siklus (ignoreer indien meer as een siklus getoon word)***	✓✓
Points A, B, C and D correctly indicated/Punte A, B, C en D korrek aangedui,	✓

[12.1.2] (3)

13.4 Increase the speed at which the coil rotates ✓
Verhoog die spoed waarteen die spoel roteer [12.2.3] (1)

13.5 (Splitring) commutator ✓
(Splitring)kommutator [12.2.3] (1)
[7]

QUESTION 14/*VRAAG 14*

14.1 Photoelectric effect / *Foto-elektriese effek* ✓ [12.2.1] (1)

14.2 The minimum energy of light needed to emit (photo)electrons from a metal ✓✓
Die minimum energie benodig deur lig om (foto-)elektrone uit 'n metaal vry te stel [12.2.1] (2)

14.3

Option 1 / *Opsie 1*:

E/hf = $\frac{hc}{\lambda}$ ✓ = $\frac{(6{,}63\times10^{-34})(3\times10^{8})}{555\times10^{-9}}$ ✓ ✓ = 3,58 x 10^{-19} J

$hf = W_0 + \frac{1}{2}mv^2$ ✓ ∴ 3,58 x 10^{-19} = W_0 + 0 ✓

∴ W_0 = 3,58 x 10^{-19} J ✓

Option 2 / *Opsie 2*:

$hf = W_0 + \frac{1}{2}mv^2$ ✓

$\frac{hc}{\lambda}$ ✓ = $W_0 + \frac{1}{2}mv^2$

$\frac{(6{,}63\times10^{-34})(3\times10^{8})}{555\times10^{-9}}$ ✓ ✓ = W_0 + 0 ✓

∴ W_0 = 3,58 x 10^{-19} J ✓

Option 3 / *Opsie 3*:

f = $\frac{c}{\lambda}$ = $\frac{3\times10^{8}}{555\times10^{-9}}$ ✓ = 5,41 x 10^{14} Hz

E = hf = (6,63 x 10^{-34})(5,41 x 10^{14}) ✓ = 3,59 x 10^{-19} J

$hf = W_0 + \frac{1}{2}mv^2$ ✓ ∴ 3,59 x 10^{-19} = W_0 + 0 ✓

∴ W_0 = 3,59 x 10^{-19} J ✓

Option 4 / *Opsie 4*:

$W_0 = hf_0$ ✓✓ = $\frac{(6{,}63\times10^{-34})(3\times10^{8})}{555\times10^{-9}}$ ✓ ✓ ✓ = 3,58 x 10^{-19} J ✓

[12.1.3] (6)

14.4 Increases / *Vermeerder* ✓

With light of higher intensity more photons strikes the metal surface per second / *Met lig van hoër intensiteit tref meer fotone die metaaloppervlak per sekonde* ✓

Thus more (photo)electrons are emitted per second, ✓resulting in a bigger current./ *Dus word meer (foto-)elektrone per sekonde vrygestel wat 'n hoër stroom tot gevolg het.* [12.2.2] (3)

14.5 Decreases / *Verminder* ✓ [12.2.2] (1)

[13]

TOTAL SECTION B / *TOTAAL AFDELING B:* 125

GRAND TOTAL / *GROOTTOTAAL:* 150

education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2009

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

SECTION A

Answer this section in the ANSWER BOOK.

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

1.1 The rate of change of momentum (1)

1.2 Motion of an object near the surface of the earth under the influence of the earth's gravitational force alone (1)

1.3 The phenomenon that causes dispersion of white light when it passes through a triangular prism (1)

1.4 The law which relates the current in a resistor, maintained at constant temperature, to the potential difference across its ends (1)

1.5 The source of an intense narrow beam of coherent monochromatic light (1)
[5]

QUESTION 2: FALSE ITEMS

Each of the five statements below is FALSE. Correct each statement so that it is TRUE. Write only the correct statement next to the question number (2.1 – 2.5) in the ANSWER BOOK.

NOTE: Correction by using the negative of the statement, for example, "… IS NOT …", will not be accepted.

2.1 The work done by a non-zero net (resultant) force on an object, moving on a horizontal plane, is equal to the change in the potential energy of the object. (2)

2.2 When a bird, flying at a velocity of 10 $m \cdot s^{-1}$ east, encounters a wind blowing at 8 $m \cdot s^{-1}$ west, its velocity relative to an observer on the ground is 18 $m \cdot s^{-1}$ west. (2)

2.3 The number of bright bands per unit length observed in an interference pattern on a screen, will increase when the wavelength of the waves passing through a double slit increases. (2)

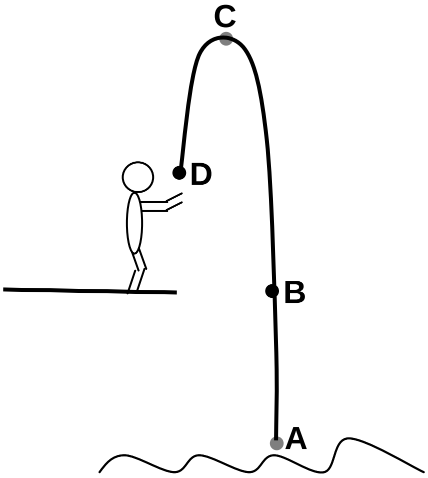
2.4 A lamp functioning at peak voltage (AC) will glow with the same brightness when connected to a battery of the same voltage (DC). (2)

2.5 Monochromatic light has photons of different energies. (2)
[10]

QUESTION 3: MULTIPLE-CHOICE QUESTIONS

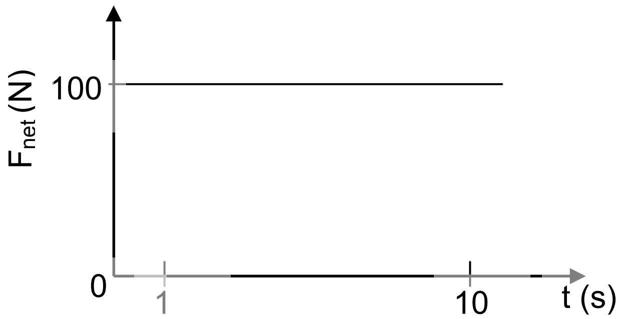
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (3.1 – 3.5) in the ANSWER BOOK.

3.1 A person dives from a high platform into a pool. At which ONE of the positions A, B, C or D will the magnitude of his momentum be a maximum?



A Position A
B Position B
C Position C
D Position D (2)

3.2 The sketch graph below may be used to calculate the impulse of a constant net force of 100 N that acts on an object over a period of time.



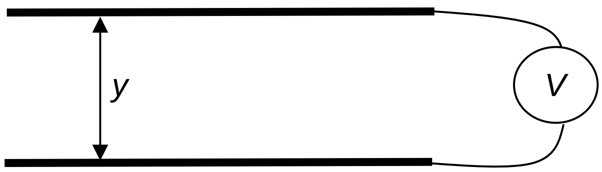
Which ONE of the following can be used to calculate the impulse (in $kg \cdot m \cdot s^{-1}$) of the force for the time interval t = 1 s to t = 10 s?

A 100 x 1
B 100 x 10
C 100 x 9
D 10 x 9 (2)

3.3 A listener moves at constant velocity towards a stationary source of sound. The frequency of sound heard by the listener is higher than the frequency of the sound emitted by the source, because …

A the wavelength observed by the listener becomes shorter.
B the wavelength observed by the listener becomes longer.
C more wave fronts reach the listener per second.
D less wave fronts reach the listener per second. (2)

3.4 A potential difference *V* is applied across two identical, parallel plates a distance *y* apart, as shown in the diagram below. The magnitude of the electric field between the plates is *E*.



Which ONE of the following changes to the above arrangement will result in an electric field of magnitude *2E*?

	Potential difference	**Distance between plates**
A	$2V$	$2y$
B	$2V$	$\frac{1}{2}y$
C	V	$2y$
D	V	$\frac{1}{2}y$

(2)

3.5 A line emission spectrum is formed when electrons in an atom, that moves from …

A higher to lower energy levels, emit energy as light.
B higher to lower energy levels, absorb light energy.
C lower to higher energy levels, emit energy as light.
D lower to higher energy levels, absorb light energy. (2)
[10]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Answer this section in the ANSWER BOOK.

2. Start each question on a NEW page.

3. Leave one line between two subquestions, for example between QUESTION 4.1 and QUESTION 4.2.

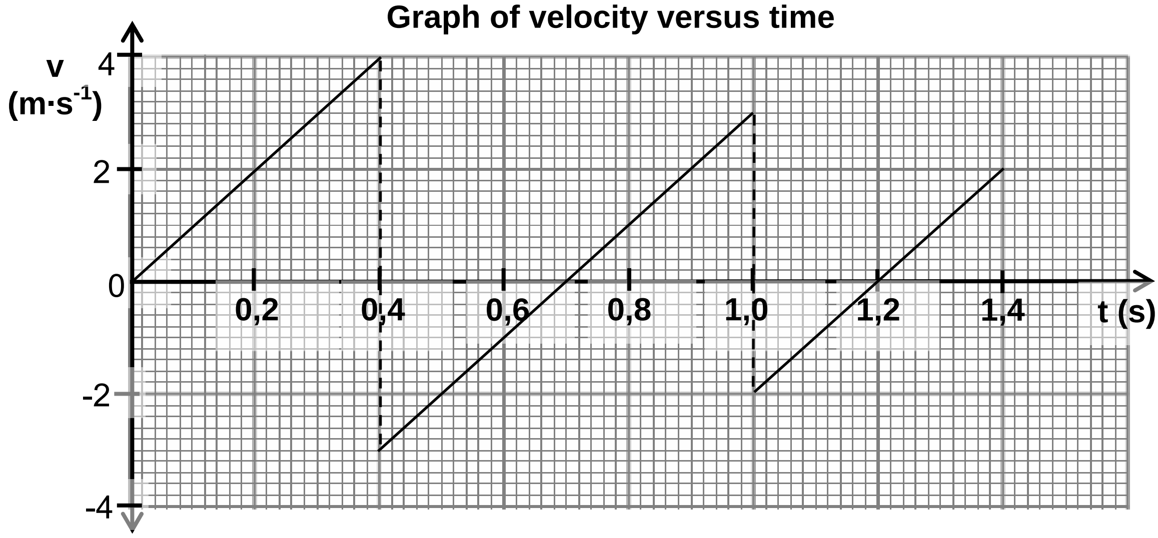
4. The formulae and substitutions must be shown in ALL calculations.

5. Round off your answers to TWO decimal places, where applicable.

QUESTION 4 (Start on a new page.)

A ball is released from a certain height. The velocity-time graph below represents the motion of the ball as it bounces vertically on a concrete floor. The interaction time of the ball with the floor is negligibly small and is thus ignored.

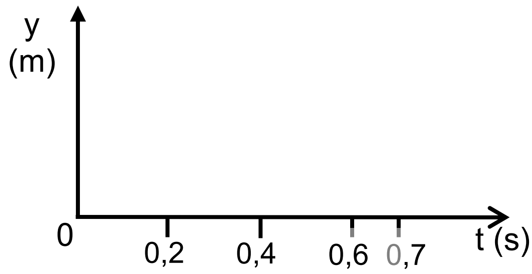
Graph of velocity versus time



4.1 Describe the changes, if any, in velocity and acceleration of the ball from t = 0 s to t = 0,4 s. (4)

4.2 Without using the equations of motion, calculate the height from which the ball has been dropped initially. (4)

4.3 Copy the set of axes below into your ANSWER BOOK.



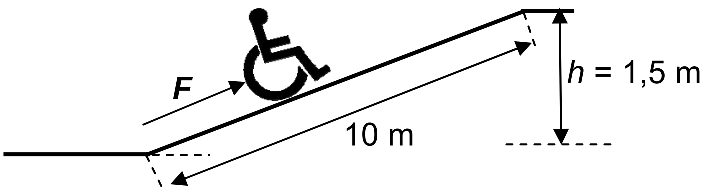
Use the given velocity versus time graph for the motion of the ball to sketch the corresponding position-time graph for the time interval 0 s to 0,7 s. (3)

4.4 Is the first collision of the ball with the floor elastic or inelastic? Give a reason for your answer. (2)
[13]

QUESTION 5 (Start on a new page.)

John applies a force *F* to help his friend in a wheelchair to move up a ramp of length 10 m and a vertical height of 1,5 m, as shown in the diagram below. The combined mass of his friend and the wheelchair is 120 kg. The frictional force between the wheels of the wheelchair and the surface of the ramp is 50 N. The rotational effects of the wheels of the wheelchair may be ignored.

The wheelchair moves up the ramp at constant velocity.



5.1 What is the magnitude of the net force acting on the wheelchair as it moves up the ramp? Give a reason for your answer. (2)

5.2 What is the magnitude of the net work done on the wheelchair on reaching the top of the ramp? (1)

5.3 Calculate the following:

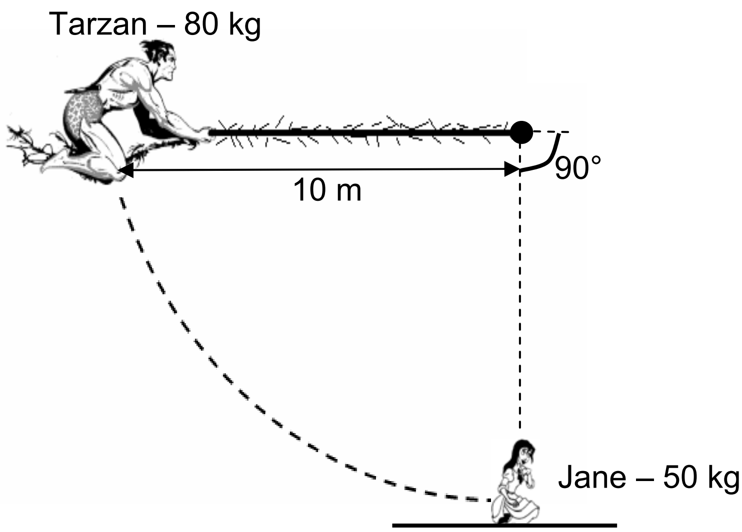
5.3.1 Work done on the wheelchair by force *F* (5)

5.3.2 The magnitude of force *F* exerted on the wheelchair by John (4)
[12]

QUESTION 6 (Start on a new page.)

Tarzan, of mass 80 kg, swings from rest on a rope of length 10 m that is horizontal when he starts, as shown in the diagram below. At the bottom of his swing, he picks up Jane, sitting on the ground, in an inelastic collision. Jane has a mass of 50 kg. They then swing upwards as one unit.

The mass of the rope and the effects of air friction may be ignored.



6.1 State the principle of conservation of linear momentum in words. (2)

6.2 Calculate the combined speed of Tarzan and Jane just after he picks her up. (8)

6.3 Will Tarzan and Jane reach a height of 10 m on their upward swing? Give a reason for your answer. (2)

6.4 If Jane is holding on to a bag of bananas at the time when Tarzan picks her up, how will their combined speed compare to that obtained in QUESTION 6.2? Write only GREATER THAN, SMALLER THAN or EQUAL TO. (2)

[14]

QUESTION 7 (Start on a new page.)

The siren of a police car produces a sound of frequency 420 Hz. A man sitting next to the road notices that the pitch of the sound changes as the car moves towards and then away from him.

7.1 Write down the name of the above phenomenon. (1)

7.2 Assume that the speed of sound in air is 340 $m \cdot s^{-1}$. Calculate the frequency of the sound of the siren observed by the man, when the car is moving towards him at a speed of 16 $m \cdot s^{-1}$. (4)

7.3 The police car moves away from the man at constant velocity, then slows down and finally comes to rest.

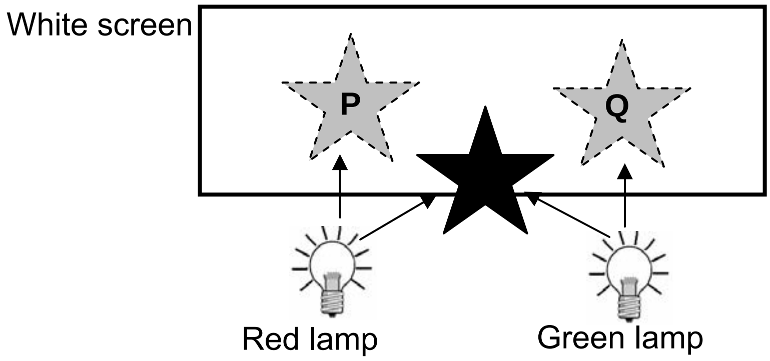
7.3.1 How will the observed frequency **compare** with the original frequency of the siren when the police car moves away from the man at constant velocity? Write only GREATER THAN, SMALLER THAN or EQUAL TO. (2)

7.3.2 How will the observed frequency **change** as the car slows down whilst moving away? Write only INCREASES, DECREASES or REMAINS THE SAME. (2)

[9]

QUESTION 8 (Start on a new page.)

8.1 During a practical investigation, a learner shines light from a red lamp and a green lamp onto a wooden star. Coloured shadows of the star, P and Q, appear on a white screen behind the star as shown below.



8.1.1 What colour is observed for each of the coloured shadows P and Q? (2)

8.1.2 What colour is observed on the rest of the screen? (1)

The learner adds a third lamp to the above arrangement. He observes a third coloured shadow right behind the wooden star. The background on the screen appears white.

8.1.3 What is the colour of the third lamp? Give a reason for your answer. (2)

8.2 With repeated washing, white fabrics become yellowish. A manufacturer of a certain detergent adds blue dye to the detergent and claims that it makes your fabric whiter by removing these yellow stains.

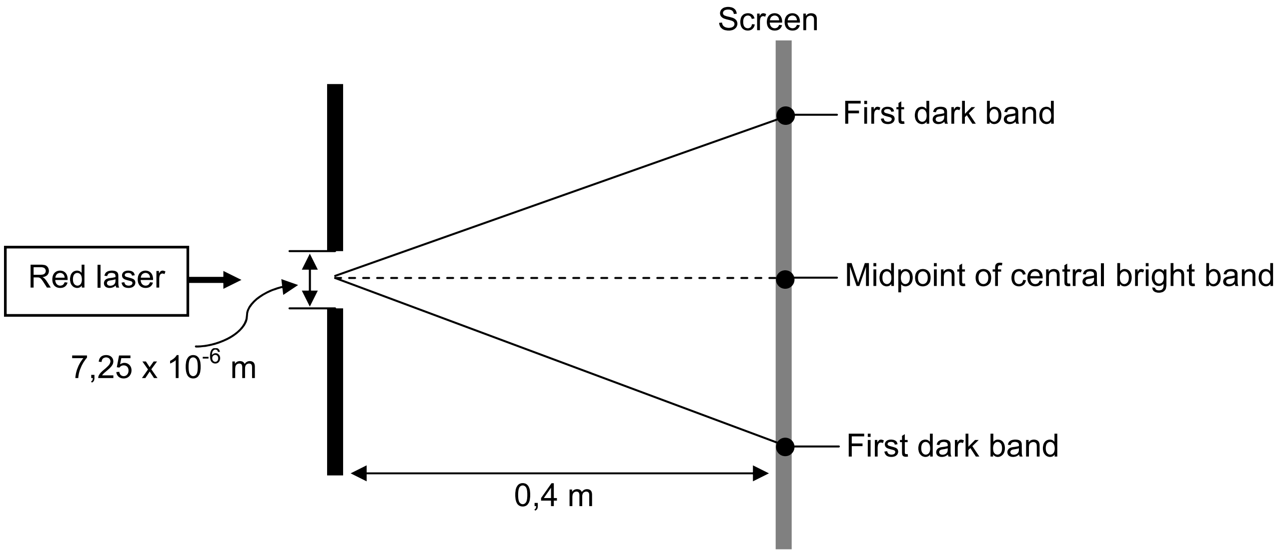
8.2.1 Define the term *complementary colours*. (2)

8.2.2 It is possible that the dye does not really remove the yellow stains, although it makes the fabric end up looking whiter. Explain how this may be the case. (3)

[10]

QUESTION 9 (Start on a new page.)

A learner uses a single slit to determine the wavelength of a red laser light. He sets up the slit and screen as shown below and shines the laser through the single slit of width 7,25 x 10^{-6} m. The distance between the screen and the slit is 0,4 m.



9.1 Name the type of pattern observed on the screen. (1)

9.2 State ONE safety precaution that the learner must take when using the above apparatus. (1)

9.3 The learner measures the distance between the midpoint of the central bright band and the first dark band as 3,5 cm.

Calculate the wavelength of the red laser light. (5)

9.4 The learner wants to decrease the distance between the midpoint of the central bright band and the first dark band.

What change can the learner make to the above arrangement to achieve this? Assume that the same laser is used. (1)
[8]

QUESTION 10 (Start on a new page.)

The ability of capacitors to store charge makes them essential components in electrical appliances. Users are often warned of the dangers associated with capacitors inside appliances.

10.1 Briefly explain why it can be dangerous to touch a charged capacitor. (2)

10.2 A certain parallel plate capacitor consists of two identical aluminium plates, each of area 2×10^{-4} m^2. The plates are separated by a distance of 0,03 mm, with air occupying the space between the plates.

10.2.1 Calculate the capacitance of the capacitor. (4)

10.2.2 Calculate the charge stored on the plates of the capacitor when connected to a 6 V battery. (3)

10.3 How will the capacitance of the capacitor in QUESTION 10.2 change (INCREASES, DECREASES or REMAINS THE SAME) if:

10.3.1 Paper is used to fill the gap between the plates instead of air (1)

10.3.2 The distance between the plates is increased (1)
[11]

QUESTION 11 (Start on a new page.)

Deaths associated with lightning in South Africa are about four times higher than the global average. A typical thundercloud may be at a potential of $1{,}2 \times 10^8$ V and the thunder strike may result in a charge transfer of 20 C.

11.1 Define *electric current*. (2)

11.2 Calculate the current generated during the above thunder strike if the charge transfer takes place in $1{,}1 \times 10^{-4}$ s. (3)

11.3 Calculate the amount of energy transferred during the strike. (3)

Injuries caused by lightning can be reduced if the necessary precautions are taken. The following is an example of such a precaution:

If you are far from a shelter during lightning, crouch with your feet together.

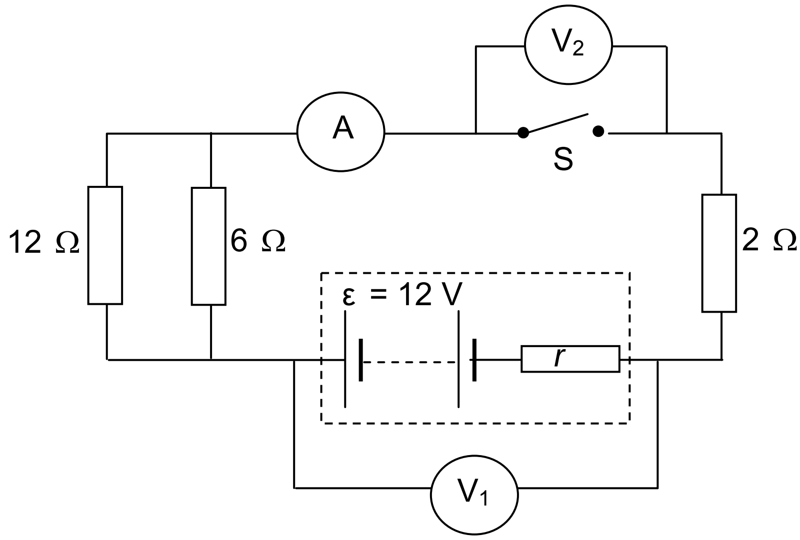
11.4 Give a reason why you must do the following:

11.4.1 Crouch (1)

11.4.2 Keep your feet together (1)
[10]

QUESTION 12 (Start on a new page.)

12.1 The battery in the circuit diagram below has an EMF of 12 V and an unknown internal resistance *r*. Voltmeter V_1 is connected across the battery and voltmeter V_2 is connected across the switch S. The resistance of the connecting wires and the ammeter is negligible.



12.1.1 Write down the respective readings on voltmeters V_1 and V_2 when switch S is open. (2)

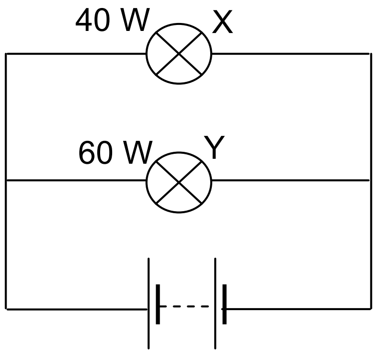
Switch S is now closed. The reading on voltmeter V_1 changes to 9 V.

12.1.2 What will the new reading on V_2 be? (1)

12.1.3 Calculate the total **external** resistance of the circuit. (4)

12.1.4 Calculate the internal resistance, *r*, of the battery. (5)

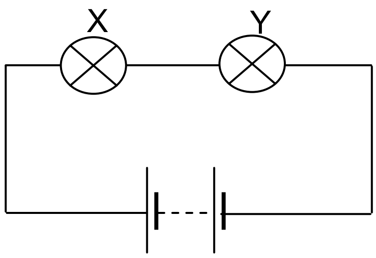
12.2 The circuit below shows two light bulbs, X and Y, connected in parallel to a battery with negligible internal resistance.



The bulbs are marked 40 W and 60 W respectively. Bulb Y glows brighter than bulb X.

12.2.1 How does the resistance of bulb Y compare to that of bulb X? Use an appropriate equation (or relationship) to explain your answer. (3)

During an experiment a learner connects these two bulbs in series to the same power supply as shown below. He observes that bulb X now glows brighter than bulb Y.

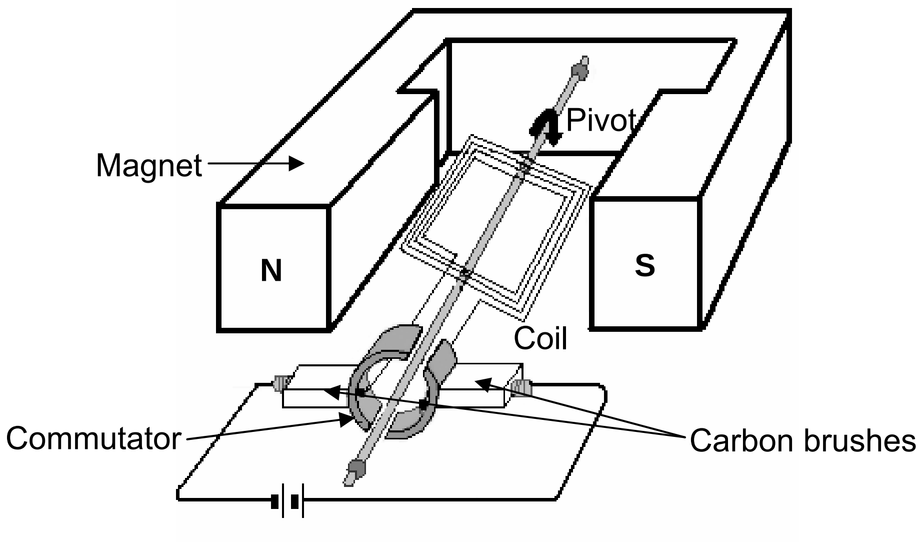


12.2.2 Use an appropriate equation (or relationship) to explain why bulb X now glows brighter than bulb Y. (3)

[18]

QUESTION 13 (Start on a new page.)

The diagram below represents a simplified sketch of an electric DC motor.



13.1 Name the component which ensures continuous rotation of the coil of this electric motor. (1)

13.2 Name the part of the motor which becomes an electromagnet when the current flows in the motor. (1)

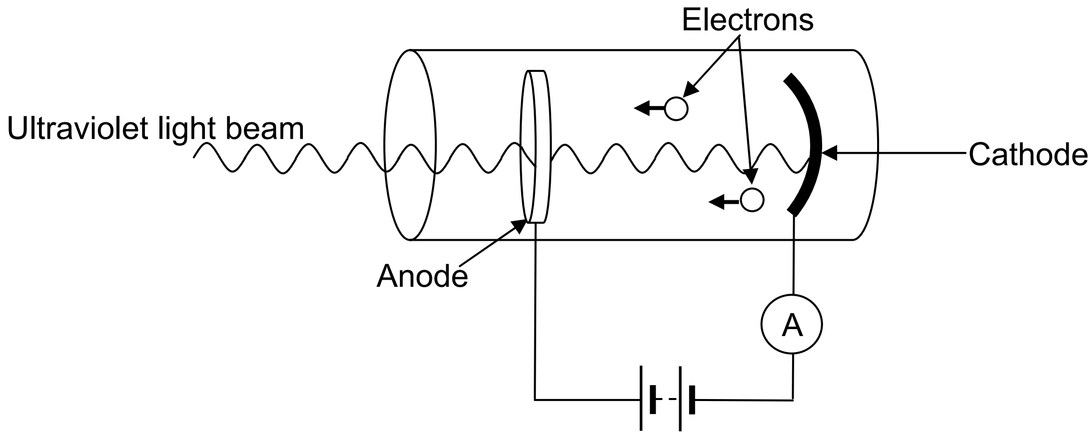
13.3 When the electric motor is connected to a 12 V DC supply, it draws a current of 1,2 A. The motor is now used to lift an object of mass 1,6 kg through a vertical height of 0,8 m at constant speed in 3 s.

Is all the electrical energy converted to the gain in potential energy of the object? Support your answer with relevant calculations. (7)

[9]

QUESTION 14 (Start on a new page.)

The photo-electric effect has many practical applications. A photocell, such as the one below used in burglar alarm systems, is one such application.



Ultraviolet light of wavelength 100 nm is used to illuminate the photocell. When a person interrupts the ultraviolet beam, the sudden drop in current activates a switch, which sets off the alarm.

14.1 Define the term *threshold frequency*. (2)

14.2 How will an increase in intensity of the ultraviolet light influence the ammeter reading? Write only INCREASES, DECREASES or REMAINS THE SAME. Explain your answer. (3)

14.3 The work function of the metal used as a cathode in the photocell is $8{,}7 \times 10^{-19}$ J. Calculate the velocity at which the electrons are emitted. (6)
[11]

TOTAL SECTION B: 125

GRAND TOTAL: 150

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1 Net (resultant) force/*Netto (resulterende) krag* ✓ [12.2.1] (1)

1.2 Free fall/*Vryval* ✓ [12.2.1] (1)

1.3 Refraction/*Breking* ✓ [12.2.1] (1)

1.4 Ohm's law/*Ohm se wet* ✓ [12.2.1] (1)

1.5 Laser ✓ [12.2.1] (1)

[5]

QUESTION 2/*VRAAG 2*

2.1 … is equal to the change in kinetic energy ... ✓✓
… is gelyk aan die verandering in kinetiese energie ... [12.2.2] (2)

2.2 … is 2 $m \cdot s^{-1}$ east./… *is 2* $m \cdot s^{-1}$ *oos.* ✓✓ [12.2.3] (2)

2.3 The number of bright bands per unit length observed in an interference pattern on a screen will decrease …✓✓
Die aantal helder bande per eenheidslengte wat in 'n interferensiepatroon waargeneem word, sal afneem ...

OR/*OF*
… when the wavelength of the waves passing through a double slit decreases.
… wanneer die golflengte van die golwe wat deur die dubbelspleet beweeg, afneem.

OR/*OF*
… when the frequency of the waves passing through a double slit increases.
… wanneer die frekwensie van die golwe wat deur die dubbelspleet beweeg, toeneem. [12.2.2] (2)

2.4 A lamp functioning at RMS voltage …/*'n Lamp wat teen WGK-potensiaalverskil ...* ✓ ✓

OR/*OF*
… glow dimmer than when connected to the same voltage (DC). ✓ ✓
… dowwer gloei as wanneer dit gekoppel is aan dieselfde potensiaalverskil (GS). [12.2.3] (2)

2.5 … of the same energy./ … *van dieselfde energie.* ✓ ✓

OR/*OF*
White light has .../*Wit lig het ...* [12.2.2] (2)

[10]

QUESTION 3/*VRAAG 3*

3.1 A ✓✓ [12.1.2] (2)

3.2 C ✓✓ [12.1.2] (2)

3.3 C ✓✓ [12.2.2] (2)

3.4 D ✓ ✓ [12.2.2] (2)

3.5 A ✓ ✓ [12.2.1] (2)
[10]

TOTAL SECTION A/*TOTAAL AFDELING A:* 25

SECTION B/*AFDELING B*

QUESTION 4/*VRAAG 4*

4.1 t = 0 s:
ball starts from rest/*bal begin uit rus* ✓
OR/*OF*
ball starts at 0 ($m \cdot s^{-1}$)/*bal begin teen 0* ($m \cdot s^{-1}$)

t = 0 s – 0,4 s:
Falls at constant acceleration/*val teen konstante versnelling* ✓

OR/*OF*
no change in acceleration/*geen verandering in versnelling* nie

OR/*OF*
constant increase in velocity/*konstante toename in snelheid*

t = 0,4 s: Reaches the floor at 4 $m \cdot s^{-1}$ (or 4 $m \cdot s^{-1}$ downwards)/*bereik die vloer teen 4* $m \cdot s^{-1}$ *(of 4* $m \cdot s^{-1}$ *afwaarts)* ✓

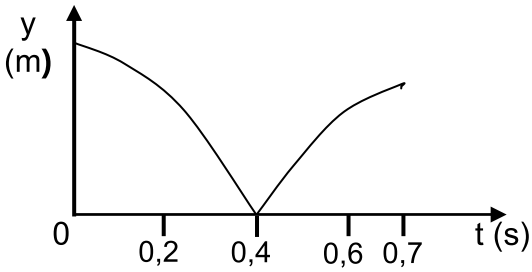
t = 0,4 s: Bounces back at -3 $m \cdot s^{-1}$ (or 3 $m \cdot s^{-1}$ upwards)/*Bons terug teen -3* $m \cdot s^{-1}$ *(of 3* $m \cdot s^{-1}$*opwaarts)* ✓ [12.1.2] (4)

4.2 Δy = area of triangle =/*oppervlakte van driehoek* = $\frac{1}{2}bh$ ✓

$= \frac{1}{2}(0,4)$ ✓ (4) ✓

= 0,8 m✓ [12.1.2] (4)

4.3



Checklist/*Kontrolelys* Criteria for graph/*Kriteria vir grafiek*	**Marks/*Punte***
Correct shape (as shown on graph) *Korrekte vorm (soos op grafiek aangetoon)*	✓
Zero position at 0,4 s *Nulposisie by 0,4 s*	✓
Maximum position of 2nd bounce smaller than that of 1st bounce *Maksimum posisie van 2de bons is kleiner as dié van 1ste bons*	✓

[12.1.2] (3)

4.4 Inelastic/*Onelasties* ✓
Decrease/change in speed (from 4 m·s^{-1} to 3 m·s^{-1}) ✓
Afname/verandering in spoed (vanaf 4 m·s^{-1} tot 3 m·s^{-1})

OR/*OF*
Decrease/change in kinetic energy during collision
Afname/verandering in kinetiese energie tydens botsing [12.1.2] (2)

[13]

QUESTION 5/*VRAAG 5*

5.1 0 (N)/Zero/*nul* ✓
no acceleration/constant velocity ✓
geen versnelling/konstante snelheid [12.2.3] (2)

5.2 0 (J)/Zero/*nul* ✓ [12.2.3] (1)

5.3.1

Accept/*Aanvaar*: E_k, E_p

Option 1/*Opsie 1*:
$U_i + K_i + W_{friction/wrywing} + W_{applied/toegepas} = U_f + K_f$ ✓
$0 + f\Delta x \cos\theta + W_{applied/toegepas} = mgh \quad (K_i = K_f)$
$0 + (50)(10)(-1)$ ✓ $+ W_{applied/toegepas} = (120)(9,8)(1,5)$ ✓ ✓
$\therefore W_{applied/toegepas} = 2\ 264$ J ✓ ($2,26 \times 10^3$ J)

Option 2/*Opsie 2*:
For equilibrium:/*Vir ewewig:*
$F = f + w_{parallel\ to\ incline/parallel\ met\ helling} = f + mg\sin\alpha$ (α - angle of incline with horizontal/*hoek van helling met horisontaal*)
$F = 50$ ✓ $+ (120)(9,8)(\frac{1,5}{10})$ ✓
$\therefore F = 226,4$ N
$W_{applied/toegepas} = F\Delta x\cos\theta$ ✓
$= (226,4)(10)(\cos 0°)$ ✓ OR $(226,4)(10)$
$= 2\ 264$ J ✓ ($2,26 \times 10^3$ J)

Option 3/*Opsie 3*:
$W_{net/netto} = \Delta K$ ✓
$W_{applied/toegepas} + W_{friction/wrywing} + W_{gravity/gravitasie} = \Delta K$
$W_{applied/toegepas} + (50)(10)(-1)$ ✓ $- (120)(9,8)(1,5)$ ✓ $= 0$ ✓
$\therefore W_{applied/toegepas} = 2\ 264$ J ✓ ($2,26 \times 10^3$ J)

Option 4/*Opsie 4*:
W(external forces/*eksterne kragte*) $= \Delta U + \Delta K$ ✓
OR/*OF*
$W_{applied/toegepas} + W_{friction/wrywing} = (U_f - U_i) + (K_f - K_i)/\Delta U + \Delta K$

$W_{applied/toegepas} + (50)(10)(-1)$ ✓ $= (120)(9,8)(1,5) - 0)$ ✓ $+ 0$ ✓
$\therefore W_{applied/toegepas} = 2\ 264$ J ✓ ($2,26 \times 10^3$ J)

[12.1.3] (5)

5.3.2 $W_{applied/toegepas} = F\Delta x\cos\theta$ ✓
2 264 J ✓ $= F(10)(1)$ ✓
$\therefore F = 226,4$ N ✓ ($2,26 \times 10^2$ N)

OR/*OF*
$F = f + w_{par\ to\ incline/par\ met\ helling} = f + mg\sin\beta$ ✓ (α - angle of incline with horizontal/*hoek van helling met horisontaal*)
$F = 50$ ✓ $+ (120)(9,8)(\frac{1,5}{10})$ ✓
$\therefore F = 226,4$ N ✓ ($2,26 \times 10^2$ N) [12.2.3] (4)

[12]

QUESTION 6/*VRAAG 6*

6.1 The total linear momentum in a closed/isolated system is conserved in magnitude and direction. ✓✓
Die totale lineêre momentum in 'n geslote/geïsoleerde sisteem bly behoue in grootte en rigting.

Only/*Slegs* $\frac{2}{2}$ or/*of* $\frac{0}{2}$

[12.2.1] (2)

6.2

(U + K)top/*bo* = (U + K)bottom/*onder* ✓
$mgh + 0 = 0 + \frac{1}{2}mv_f^2$
$(80)(9,8)(10)$ ✓ $+ 0 = 0 + \frac{1}{2}(80)v_f^2$ ✓
$\therefore v_f = 14\ m\cdot s^{-1}$ ✓

Accept/*Aanvaar*: E_k, E_p

When using/*Indien gebruik*:
$v_f^2 = v_i^2 + 2a\Delta y$ $\frac{0}{4}$

U(top) = K(bottom) $\frac{0}{4}$
$mgh = \frac{1}{2}mv_f^2$
$(80)(9,8)(10) = \frac{1}{2}(80)v_f^2 \therefore v_f = 14\ m\cdot s^{-1}$

+

$m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$ ✓

$(80)(14) + (50)(0)$ ✓ $= (80 + 50)v_f$ ✓

$v_f = 8,62\ m\cdot s^{-1}$ ✓

Do NOT penalise for zero value not shown if equation is correct./*Moenie vir nulwaarde wat nie getoon is nie, penaliseer indien vergelyking korrek is.*

Alternative formulae/*Alternatiewe formules*:
$\Sigma m_i v_i = \Sigma m_f v_f$
$m_A v_{iA} + m_B v_{iB} = m_A v_{fA} + m_B v_{fB}$
$m_A u_A + m_B u_B = m_A v_A + m_B v_B$
Total p_{before}/*Totale* p_{voor} = Total p_{after}/*Totale* p_{na}
Accept/*Aanvaar*: $p_{before} = p_{after}$ /$p_{voor} = p_{na}$
$p_i = p_f$

[12.1.3] (8)

6.3 No ✓
Collision is inelastic/total kinetic energy after collision is less than before collision ✓
Nee
Botsing is onelasties/totale kinetiese energie na botsing is minder as voor die botsing [12.2.3] (2)

6.4 Smaller than ✓✓
Kleiner as [12.2.2] (2)

[14]

QUESTION 7/*VRAAG 7*

7.1 Doppler effect/*Doppler-effek* [12.2.1] (1)

7.2 Car approaching/*Motor kom nader*:

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark \text{ OR/OF } f_L = \frac{v}{v - v_s} f_s$$

$$= \left(\frac{340}{340 - 16}\right) \checkmark (420) \checkmark$$

$\therefore f_L$ = 440,74 Hz ✓ [12.2.3] (4)

7.3.1 Smaller than/*Kleiner as* ✓ [12.2.2] (2)

7.3.2 Increases/*Toeneem* ✓ [12.2.2] (1)
[9]

QUESTION 8/*VRAAG 8*

8.1.1 P: red/*rooi* ✓
Q: green/*groen* ✓ [12.1.2] (2)

8.1.2 Yellow/*geel* ✓ [12.1.2] (1)

8.1.3 Blue/*blou* ✓

Red + blue + green = white light ✓
Rooi + blou + groen = wit lig [12.1.2] (2)

8.2.1 Any two colours that together will give white light. ✓✓
Enige twee kleure wat saam wit lig sal gee.

Only/*Slegs* $^2/_2$ or/*of* $^0/_2$

[12.2.1] (2)

8.2.2 Reflected blue light (from blue dye in detergent) ✓ + reflected yellow light (from stains) ✓ = white light (and garment appears whiter) ✓

Weerkaatste blou lig (vanaf kleurstof in seep) + weerkaatste geel lig (vanaf vlekke) = wit lig (en kledingstuk kom witter voor)

OR/*OF*
Red light + green light (reflected by stains) ✓+ blue light (reflected by dye) ✓= white (and garment appears white) ✓

Rooi lig + groen lig (weerkaats deur vlekke) + blou lig (weerkaats deur kleurstof) = wit lig (en die kledingstuk kom witter voor) [12.3.2] (3)
[10]

QUESTION 9/*VRAAG 9*

9.1 diffraction (pattern) ✓
diffraksie (patroon)

OR/*OF*
Interference/*interferensie* [12.2.1] (1)

9.2 Do not look directly into the laser ✓
Moenie direk in die laser kyk nie

OR/*OF*
Do not shine the laser in the direction of other people
Moenie die laser in die rigting van ander mense skyn nie [12.1.1] (1)

9.3 $\tan\theta = \frac{0,035}{0,4}$ ✓ $\therefore \theta = 5°$

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 5°$ ✓ $= \frac{(1)\lambda}{7,25 \times 10^{-6}}$ ✓

$= 6,31 \times 10^{-7}$ m ✓ = 631 nm

$\tan\theta \approx \sin\theta = \frac{m\lambda}{a}$ ✓ $\frac{0,035}{0,4}$ ✓✓ $= \frac{(1)\lambda}{7,25 \times 10^{-6}}$ ✓ $= 6,31 \times 10^{-7}$ m ✓ = 631 nm

[12.1.3] (5)

9.4 Increase the slit width ✓
Vergroot die spleetwydte

OR/*OF*
Move the screen closer to the slit/decrease distance between screen and slit
Beweeg die skerm nader aan die spleet/verminder die afstand tussen die skerm en die spleet [12.2.2] (1)
[8]

QUESTION 10/*VRAAG 10*

10.1 Discharges very fast ✓when touched and can cause electric shock (that can be fatal) ✓
Ontlaai baie vinnig wanneer aangeraak word en kan 'n (dodelike) elektriese skok tot gevolg hê [12.3.2] (2)

10.2.1 $C = \frac{\varepsilon_o A}{d}$ ✓

$= \frac{(8{,}85 \times 10^{-12})(2 \times 10^{-4})}{(0{,}03 \times 10^{-3})}$ ✓ ✓

$\therefore$ C = 5,9 x 10^{-11} F ✓ [12.2.3] (4)

10.2.2 $C = \frac{Q}{V}$ ✓

$\therefore$ Q = 5,9 x 10^{-11} x 6 ✓

$\therefore$ Q = 3,54 x 10^{-10} C ✓ [12.2.3] (3)

10.3.1 Increases/*Toeneem*✓ [12.2.2] (1)

10.3.2 Decreases/*Afneem* ✓ [12.2.2] (1)
[11]

QUESTION 11/*VRAAG 11*

11.1 Amount of charge that passes a cross-section of a conductor per unit time. ✓✓
Aantal lading wat deur die deursnit van 'n geleier per eenheid tyd beweeg

Only/*Slegs* $2/2$ or/*of* $0/2$

OR/*OF*
Rate of flow of charge/*Tempo van vloei van lading* [12.2.1] (2)

11.2 $q = I \Delta t$ ✓
20 = I(1,1 x 10^{-4}) ✓
$\therefore$ I = 1,82 x 10^{5} A ✓ [12.2.3] (3)

11.3 W = VQ ✓
= (1,2 x 10^{8})(20) ✓
= 2,4 x 10^{9} J ✓ [12.2.3] (3)

11.4.1 Lightning tends to strike the highest points ✓
Weerlig is ge neig om die hoogste punte te tref [12.3.1] (1)

11.4.2 To prevent a potential difference from building up ✓ (between your feet)
Om te verhoed dat 'n potensiaalverskil (tussen jou voete) opbou [12.3.1] (1)
[10]

QUESTION 12/*VRAAG 12*

12.1.1 V_1 = 12 V ✓
V_2 = 12 V ✓ [12.1.2] (2)

12.1.2 V_2 = 0 V ✓ [12.1.2] (1)

12.1.3 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\therefore \frac{1}{R_p} = \frac{1}{12} + \frac{1}{6}$ ✓ $\therefore R_p = 4\ \Omega$

R(total/*totaal*) = 4 + 2 ✓ = 6 Ω ✓ [12.2.3] (4)

12.1.4 $R = \frac{V}{I}$ ✓ $\therefore 6 = \frac{9}{I}$ ✓ $\therefore I = 1,5$ A

EMF/*EMK* = IR + Ir ✓

12 = 9 ✓ + (1,5)r

$\therefore$ r = 2 Ω ✓ [12.1.3] (5)

12.2.1 In parallel:
$P_Y > P_X$ (given/*gegee*)

$V_Y = V_X$ ✓ (V is constant – parallel/*V is konstant – parallel*)
$\therefore \frac{V^2}{R_Y} > \frac{V^2}{R_X}$ ✓
$\therefore R_Y < R_X$ ✓ [12.1.3] (3)

12.2.2 In series/*In serie*
$I_Y = I_X$ / I is the same/*is dieselfde* ✓
$I^2R_Y < I^2R_X$ ✓
P α R ✓ (I constant/*konstant*) OR/OF $P_Y < P_X$ [12.2.2] (3)
[18]

QUESTION 13/*VRAAG 13*

13.1 (Splitring) commutator/*kommutator* ✓ [12.2.1] (1)

13.2 Coil/*Spoel* ✓ [12.2.1] (1)

13.3 No/*Nee* ✓

OR/OF
E(electrical) > E(mechanical)
E(elektries) > E(meganies)

W(electrical/*elektries*) = VIΔt ✓ = (12)(1,2)(3) ✓ = 43,2 J ✓

$E_p = mg\Delta y$ ✓ = (1,6)(9,8)(0,8) ✓ = 12,544 J ✓ [12.1.3] (7)
[9]

QUESTION 14/*VRAAG 14*

14.1 The minimum frequency of light needed to emit electrons from a certain metal. ✓✓
Die minimum frekwensie van lig wat benodig word om elektrone uit 'n sekere metaal vry te stel [12.2.1] (2)

14.2 Increases/*Toeneem* ✓
Higher intensity, more photons strike metal plate per second ✓
More photo-electrons emitted per second ✓
Hoër intensiteit, meer fotone tref die metaalplaat per sekonde
Meer fotoëlektrone vrygestel per sekonde [12.2.3] (3)

14.4 $hf = W_o + E_k$ ✓

$$\frac{(6{,}63\times10^{-34})(3\times10^{8})}{100\times10^{-9}} \checkmark = 8{,}7\times 10^{-19} \checkmark + \frac{1}{2}(9{,}1\times10^{-31})v^2 \checkmark$$

$\therefore v = 1{,}57 \times 10^{6}\ m{\cdot}s^{-1}$ ✓ [12.2.3] (6)

[11]

TOTAL SECTION B/*TOTAAL AFDELING B*: 125

GRAND TOTAL/*GROOTTOTAAL*: *150*

education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2010

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages, 3 data sheets and 1 page of graph paper.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

1.1 The rate at which energy is transferred (1)

1.2 The term used to describe light of a single frequency (1)

1.3 The work done per unit charge moved between two points in an electric field (1)

1.4 The fundamental principle on which electric generators operate (1)

1.5 The excited state in a laser medium where electrons remain for a longer period of time than normal (1)
[5]

QUESTION 2: FALSE ITEMS

Each of the five statements below is FALSE. Write down the correct statement next to the question number (2.1 – 2.5) in the ANSWER BOOK.

NOTE: Correction by using the negative of the statement, for example "… IS NOT …", will not be accepted.

2.1 The rate of change of momentum is equal to the impulse. (2)

2.2 If the net work done on a moving object is zero, the velocity of the object decreases. (2)

2.3 The nodal lines in the interference pattern of blue light are the result of constructive interference. (2)

2.4 Radio waves are sound waves that can travel through a vacuum. (2)

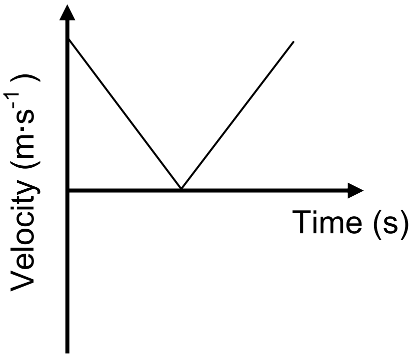
2.5 When a spectrum consists of discrete lines, it is a continuous spectrum. (2)
[10]

QUESTION 3: MULTIPLE-CHOICE QUESTIONS

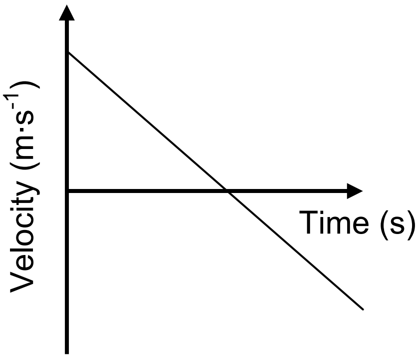
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A – D) next to the question number (3.1 – 3.5) in the ANSWER BOOK.

3.1 A stone is thrown vertically upwards and returns to the thrower's hand after a while. Which ONE of the following velocity-time graphs best represents the motion of the stone?

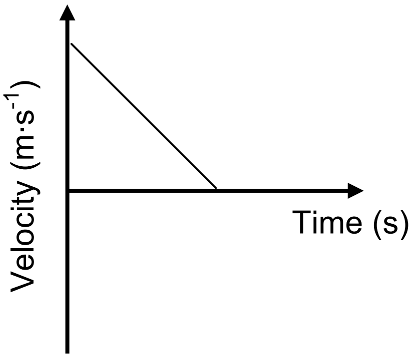
A



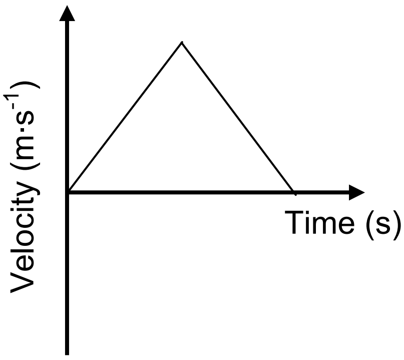
B



C

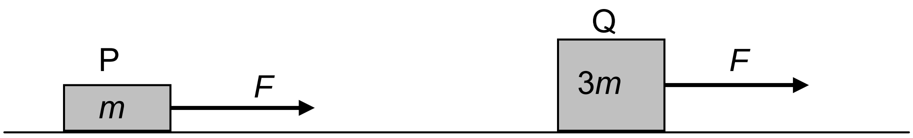


D



(2)

3.2 A net force *F* acts on each of two isolated objects, P and Q, as shown below. The mass of Q is three times that of P. (Ignore the effects of friction.)



If the rate of change of momentum of object Q is x, then the rate of change of momentum of object P is as follows:

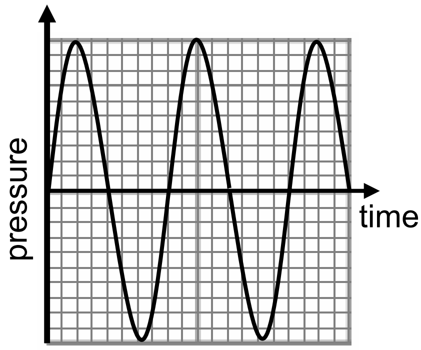
A $\frac{1}{9}x$

B $\frac{1}{3}x$

C x

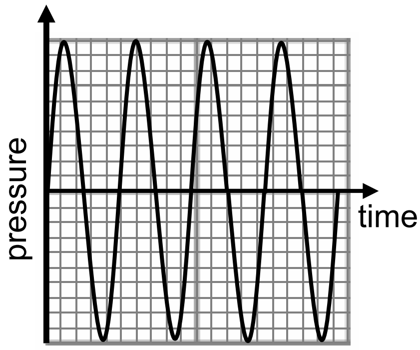
D $3x$ (2)

3.3 The pressure versus time graph below represents a sound wave in air emitted by a stationary source.

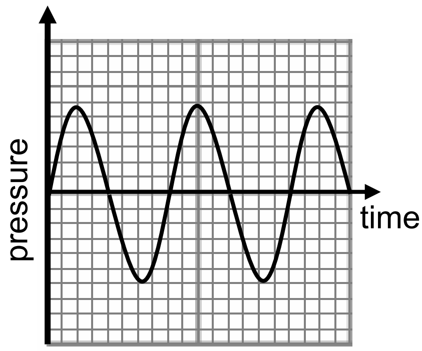


Which ONE of the following graphs best represents the sound wave, as observed by a stationary observer, if the source is moving towards the observer?

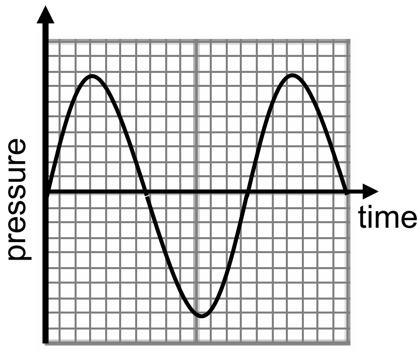
A



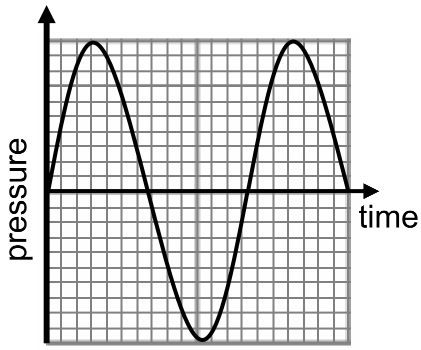
B



C

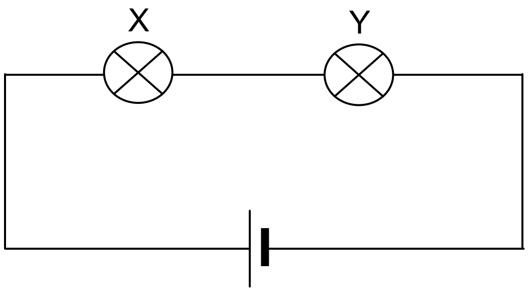


D



(2)

3.4 The diagram below shows two light bulbs, X and Y, connected in series to a battery with negligible internal resistance.



If bulb X glows brighter than bulb Y, then the …

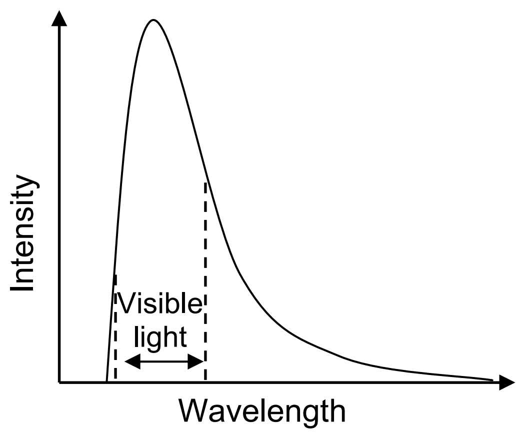
A current through bulb X is smaller than that through bulb Y.

B resistance of bulb X is smaller than that of bulb Y.

C resistance of bulb X is greater than that of bulb Y.

D current through bulb X is greater than that through bulb Y. (2)

3.5 Sunlight is composed of various intensities of the different wavelengths of light. The graph below represents the relationship between the intensity and wavelength of sunlight. The region between the dashed lines indicates the range of wavelengths of the visible portion of the spectrum.



Which colour of the visible part of sunlight has the lowest intensity?

A Red

B Green

C Blue

D Violet (2)

[10]

TOTAL SECTION A: 25

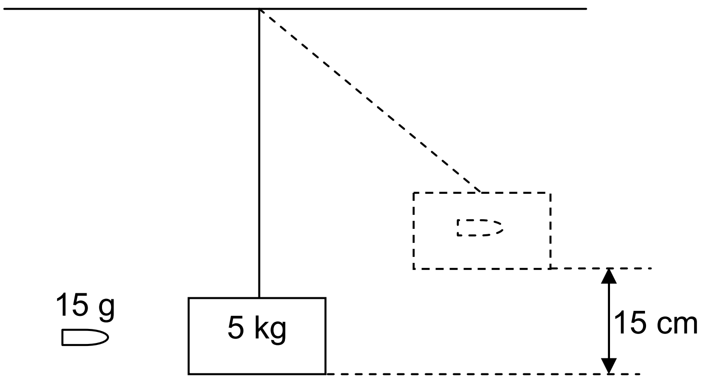
SECTION B

INSTRUCTIONS AND INFORMATION

1. Start each question on a NEW page.
2. Leave a line between two subquestions, for example between QUESTION 4.1 and QUESTION 4.2.
3. The formulae and substitutions must be shown in ALL calculations.
4. Round off your answers to TWO decimal places where applicable.

QUESTION 4 (Start on a new page.)

During an investigation a police officer fires a bullet of mass 15 g into a stationary wooden block, of mass 5 kg, suspended from a long, strong cord. The bullet remains stuck in the block and the block-bullet system swings to a height of 15 cm above the equilibrium position, as shown below. (Effects of friction and the mass of the cord may be ignored.)



4.1 State the law of conservation of momentum in words. (2)

4.2 Use energy principles to show that the magnitude of the velocity of the block-bullet system is 1,71 $m \cdot s^{-1}$ immediately after the bullet struck the block. (3)

4.3 Calculate the magnitude of the velocity of the bullet just before it strikes the block. (4)

4.4 The police officer is pushed slightly backwards by the butt of the rifle, which he is holding against his shoulder, whilst firing the rifle. Use the relevant law of motion to explain why this happens. (3)

[12]

QUESTION 5 (Start on a new page.)

A supervisor, 1,8 m tall, visits a construction site. A brick resting at the edge of a roof 50 m above the ground suddenly falls. At the instant when the brick has fallen 30 m the supervisor sees the brick coming down directly towards him from above.

Ignore the effects of friction and take the downwards motion as positive.

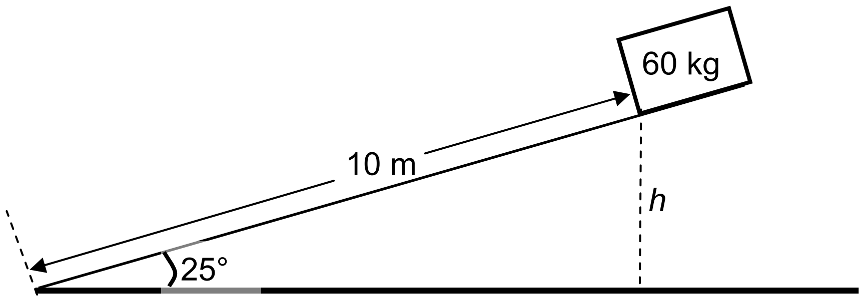
5.1 Calculate the speed of the brick after it has fallen 30 m. (3)

5.2 The average reaction time of a human being is 0,4 s. With the aid of a suitable calculation, determine whether the supervisor will be able to avoid being hit by the brick. (6)

[9]

QUESTION 6 (Start on a new page.)

A box of mass 60 kg starts from rest at height *h* and slides down a rough slope of length 10 m, which makes an angle of 25° with the horizontal. It undergoes a constant acceleration of magnitude 2 $m \cdot s^{-2}$ while sliding down the slope.



6.1 State the work-energy theorem in words. (2)

6.2 Draw a free-body diagram to show ALL the forces acting on the cardboard box **while it slides down the slope.** (3)

6.3 **The box reaches the bottom of the slope.**

Calculate the following:

6.3.1 The kinetic energy of the box, using the equations of motion (5)

6.3.2 The work done on the box by the gravitational force (4)

6.3.3 The work done on the box by the frictional force, using the work-energy theorem (4)

6.3.4 The magnitude of the frictional force acting on the box (3)

[21]

QUESTION 7 (Start on a new page.)

An ambulance with its siren on, moves **away** at constant velocity from a person standing next to the road. The person measures a frequency which is 90% of the frequency of the sound emitted by the siren of the ambulance.

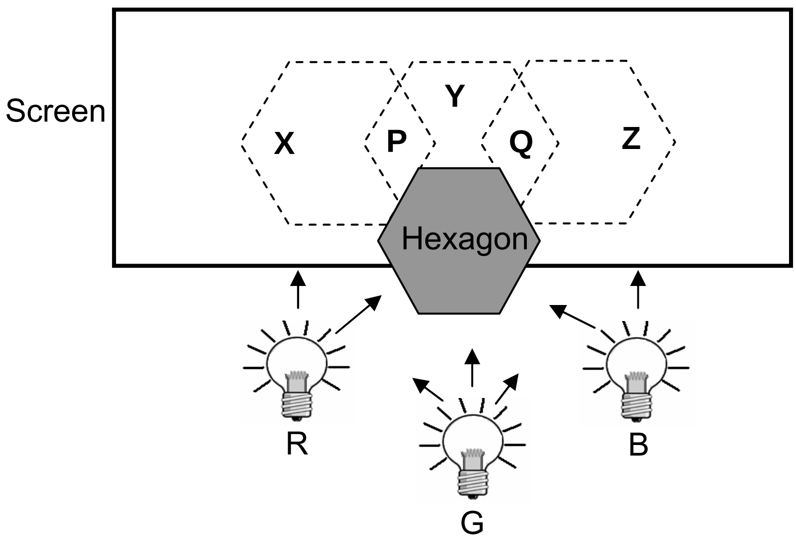
7.1 Name the phenomenon observed. (1)

7.2 If the speed of sound in air is 340 $m \cdot s^{-1}$, calculate the speed of the ambulance. (5)

[6]

QUESTION 8 (Start on a new page.)

8.1 A technician shines light from a red (R), a green (G) and a blue (B) lamp onto a hexagon cut from cardboard. Coloured shadows X, Y and Z, of the hexagon, appear on a white screen behind the hexagon, as shown below. The coloured shadows overlap in regions P and Q.



8.1.1 Which colour model is used to explain colour mixing of light? (1)

8.1.2 Write down the letters X, Y and Z in your ANSWER BOOK and next to each the colour of the shadow observed on the screen.

(HINT: No red light reaches shadow Z, no green light reaches shadow Y and no blue light reaches shadow X.) (3)

8.1.3 Write down the letters P and Q in your ANSWER BOOK and next to each the colour observed on the screen for each region. (2)

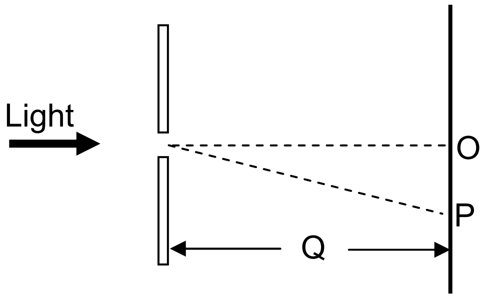
8.2 Your school uses a green light to illuminate an indoor garden in the office block. The gardener finds that, despite correct watering and fertilising, the plants are in a poor state. He blames the light for the problem.

Briefly explain why the green light might be the problem. (2)

[8]

QUESTION 9 (Start on a new page.)

Light of a single frequency pass through a single slit. The first minimum is observed at point P on a screen, as shown in the diagram below. Point O is the midpoint of the central bright band. The distance OP is 2,5 cm and the slit width is $3{,}2 \times 10^{-5}$ m.



9.1 What can be deduced about the nature of light from this observation? (1)

9.2 Explain how the minimum is formed at point P. (2)

9.3 If the wavelength of the incident light is 600 nm, calculate the distance Q between the screen and the slit. (5)

9.4 The original slit is now replaced by a second slit of different width, while the distance Q and the wavelength of the incident light remain the same. Distance OP changes to 4 cm.

9.4.1 How does the slit width of the second slit compare to that of the first slit? Only write down GREATER THAN, SMALLER THAN or EQUAL TO. (1)

9.4.2 Explain your answer to QUESTION 9.4.1 without performing a calculation. (2)

[11]

QUESTION 10 (Start on a new page.)

Capacitors are circuit devices used to store electrical energy. The capacitance of capacitors depends, amongst other factors, on the plate area. The larger the plate area, the more the energy that can be stored.

10.1 Apart from plate area, state TWO other factors that can influence the capacitance of a capacitor. (2)

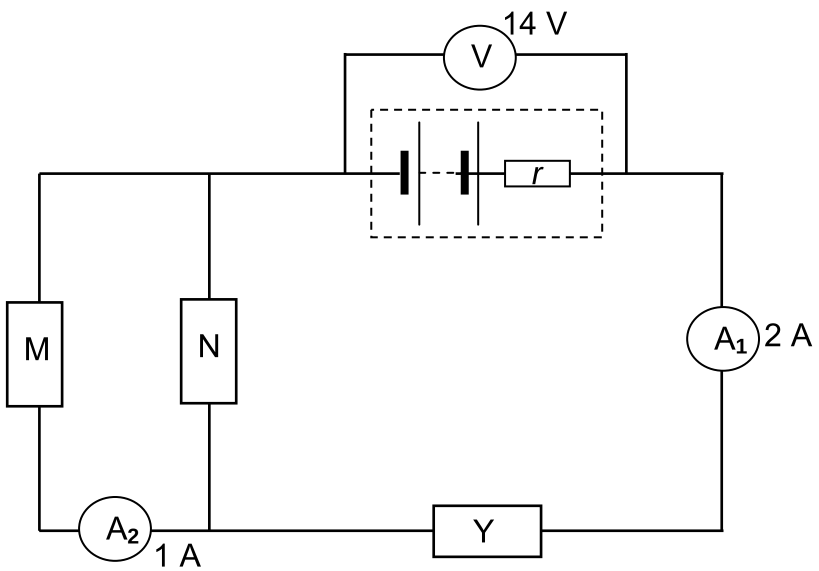
10.2 A certain parallel plate capacitor consists of two plates, each having dimensions of 2 cm by 10 cm. The plates are 0,2 mm apart and are held at a potential difference of 20 V. The space between the plates is filled with air.

10.2.1 Sketch the electric field pattern between the two oppositely charged parallel plates of the capacitor. (3)

10.2.2 Calculate the capacitance of this capacitor. (5)
[10]

QUESTION 11 (Start on a new page.)

The circuit diagram below shows a battery, with an internal resistance *r*, connected to three resistors, M, N, and Y. The resistance of N is 2 Ω and the reading on voltmeter V is 14 V. The reading on ammeter A_1 is 2 A and the reading on ammeter A_2 is 1 A. (The resistance of the ammeters and the connecting wires may be ignored.)



11.1 State Ohm's law in words. (2)

11.2 How does the resistance of M compare with that of N? Explain how you arrived at the answer. (2)

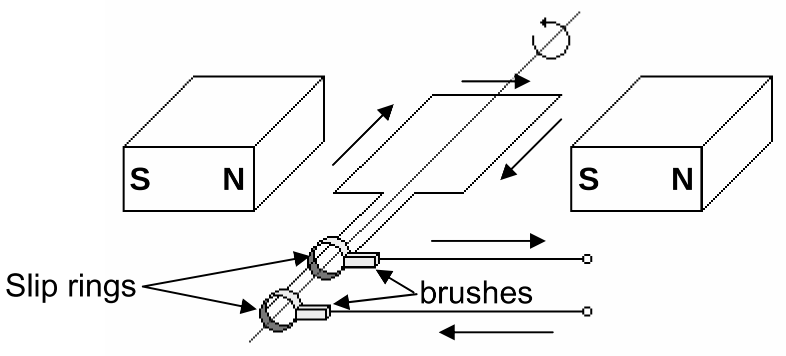
11.3 If the emf of the battery is 17 V, calculate the internal resistance of the battery. (5)

11.4 Calculate the potential difference across resistor N. (3)

11.5 Calculate the resistance of Y. (4)
[16]

QUESTION 12 (Start on a new page.)

12.1 A simplified sketch of a generator is shown below.



12.1.1 Is the output voltage AC or DC? Give a reason for your answer. (2)

12.1.2 State TWO effects on the output voltage if the coil is made to turn faster. (2)

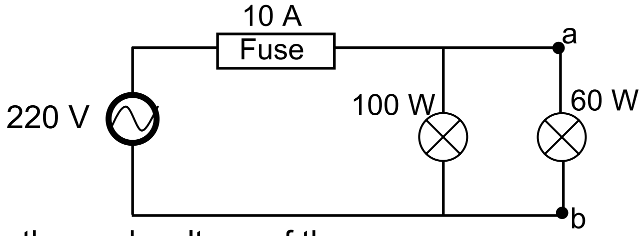
12.1.3 What is the position of the coil relative to the magnetic field when the output voltage is a maximum? (1)

12.2 In South Africa, the major source of electricity is coal-driven generators. Recently society has become concerned about fossil fuels (like coal) as the primary source of electrical energy. Some business people have proposed that government should invest in windmills as an alternative source of energy.

State ONE advantage and ONE disadvantage of using windmills over coal-driven generators in supplying energy. (2)
[7]

QUESTION 13 (Start on a new page.)

Lights in most households are connected in parallel, as shown in the simplified circuit below. Two light bulbs rated at 100 W; 220 V and 60 W; 220 V respectively are connected to an AC source of rms value 220 V. The fuse in the circuit can allow a maximum current of 10 A.



13.1 Calculate the peak voltage of the source. (3)

13.2 Calculate the resistance of the 100 W light bulb, when operating at optimal conditions. (3)

13.3 An electric iron, with a power rating of 2 200 W, is now connected across points a and b. Explain, with the aid of a calculation, why this is not advisable. (5)
[11]

QUESTION 14 (Start on a new page.)

During an experiment to determine the work function of a certain metal light of different frequencies was shone on the metal surface and the corresponding kinetic energies of the photoelectrons were recorded as shown in the table below.

Frequency of incident light (x 10^{14} Hz)	Kinetic energy of photoelectrons (x 10^{-19} J)
6,6	0,7
8,2	1,6
9,2	2,2
10,6	3,0
12,0	3,8

14.1 Define the term *work function*. (2)

14.2 Use the data in the table above to draw a graph of kinetic energy versus frequency on the graph paper provided. (6)

14.3 Extrapolate your graph to cut the X-axis.

14.3.1 What is the frequency at the point of intercept? (2)

14.3.2 What term is used to describe this frequency? (1)

14.4 Use your graph to determine the work function of the metal. (3)
[14]

TOTAL SECTION B: 125

GRAND TOTAL: 150

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1 Power / *drywing* ✓ [12.2.1] (1)

1.2 Monochromatic / *monochromaties* ✓ [12.2.1] (1)

1.3 Potential difference / *potensiaalverskil* ✓ [12.2.1] (1)

1.4 Electromagnetic induction / *elektromagnetiese induksie* ✓
OR/*OF*
Faraday's law / *Faraday se wet* [12.2.1] (1)

1.5 Metastable (state) / *metastabiele (toestand)* ✓ [12.2.1] (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 .. equal to the net force. / … *gelyk aan die netto krag.* ✓✓

OR/*OF*
The change in momentum is equal to … / *Die verandering in momentum is gelyk aan …* [12.2.2] (2)

2.2 …remains constant. / … bly constant. ✓✓ [12.2.2] (2)

2.3 The light/bright/blue lines in the interference pattern … / Die ligte/helder/ blou lyne in die interferensiepatroon … ✓✓

OR/*OF*
… are the result of destructive interference. / … is die gevolg van destruktiewe interferensie. [12.2.2] (2)

2.4 … are electromagnetic waves. / … *is elektromagnetiese golwe.* ✓✓ [12.2.3] (2)

2 .5 … line spectrum. / *lynspektrum.* ✓✓
… line emission spectrum. / *lynemissiespektrum.*
… line absorption spectrum. / *lynabsorpsiespektrum.* [12.2.3] (2)
[10]

QUESTION 3/*VRAAG 3*

3.1 B ✓✓ [12.1.2] (2)

3.2 C ✓✓ [12.2.2] (2)

3.3 A ✓✓ [12.1.2] (2)

3.4 C ✓✓ [12.2.2] (2)

3.5 D ✓✓ [12.1.2] (2)
[10]

TOTAL SECTION A/*TOTAAL AFDELING A*: 25

SECTION B/*AFDELING B*

QUESTION 4/*VRAAG 4*

4.1 The total linear momentum in an isolated system is conserved. ✓✓
Die totale liniêre momentum in'n geslote sisteem bly behoue.
OR/*OF*
If no net external force acts on a system of particles, the total linear momentum of the system cannot change. / *Indien geen netto eksterne krag op'n sisteem van deeltjies inwerk nie, kan die totale liniêre momentum nie verander nie.*

Only/*Slegs* $\frac{2}{2}$ or/*of* $\frac{0}{2}$

[12.2.1] (2)

4.2 $(U + K)_{bottom} = (U + K)_{top}$ ✓
$0 + \frac{1}{2}(m_1 + m_2)v^2 = mgh + 0$
$\frac{1}{2}(0{,}015 + 5)(v_f^2)$ ✓ $= (0{,}015 + 5)(9{,}8)(0{,}15)$ ✓
$\therefore v_f = 1{,}71\ m\cdot s^{-1}$

Other formulae / *Ander formules:*
$E_{mech(i)} = E_{mech(f)}$
$(E_p + E_k)_i = (E_p + E_k)_f$
$(E_p + E_k)_{bottom} = (E_p + E_k)_{top}$
$(U + K)_{bottom} = (U + K)_{top}$
$mgh_i + \frac{1}{2}mv_i^2 = mgh_f + \frac{1}{2}mv_f^2$

[12.2.3] (3)

4.3 p_t(before/*voor*) = p_t(after/*na*) ✓
$m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v_f$
$(0{,}015)v_{i1} + 0$ ✓ $= (0{,}015 + 5)(1{,}71)$ ✓
$\therefore v_{i1} = 571{,}71\ m\cdot s^{-1}$ ✓

Any one as formula / *Enige een as formule:*
$\Sigma p_{before/voor} = \Sigma p_{after/na}$
$p_t(before) = p_t(after)$
$m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$
$m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v_f$
Accept symbols v and u
Accept / *Aanvaar:* $p_{before} = p_{after}$
$p_i = p_f$

[12.2.3] (4)

4.4 According to Newton's third law,
the gun will exert a force on the bullet ✓
and the bullet will exert an equal but opposite force on the gun. ✓
The force of the gun on the officer pushes him slightly backwards. ✓

Volgens Newton se derde wet
oefen die geweer 'n krag op die koeël uit ✓
en die koeël oefen 'n gelyke, maar teenoorgestelde krag op die geweer uit. ✓
Die krag van die geweer op die polisieman druk hom effens terugwaarts. ✓

[12.2.3] (3)
[12]

QUESTION 5/*VRAAG 5*

5.1 Velocity after / *snelheid na* 30 m:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$= 0 + 2(9,8)(50 - 20)$ ✓

$v_f = 24,25\ m\cdot s^{-1}$ ✓

> **Accept / *Aanvaar:***
> $v^2 = u^2 + 2as$/$v = u + at$/$s = ut + ½at^2$
> A mixture of the two allowed formulae is not accepted. / *'n Mengsel van die twee erkende formules word nie aanvaar nie.*

OR/*OF*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$30 = (0)\Delta t + ½(9,8)\Delta t^2$

$\therefore\ \Delta t = 2,47\ s$

$v_f = v_i + a\Delta t = 0 + (9,8)(2,47)$ ✓ $= 24,25\ m\cdot s^{-1}$ ✓ [12.2.3] (3)

5.2 Velocity after a further / *snelheid na 'n verdere* 18,2 m:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$= 24,25^2 + 2(9,8)(20 – 1,8)$ ✓

$\therefore v_f = 30,74\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$ ✓

$30,74 = 24,25 + 9,8t$ ✓

$\therefore t = 0,66\ s$ ✓

> **Accept / *Aanvaar:***
> $v^2 = u^2 + 2as$/ $v = u + at$
> A mixture of the two allowed formulae is not accepted.
> *'n Mengsel van die twee erkende formules word nie aanvaar nie.*

He will not be struck – reaction time is shorter than the time for the brick to reach his head. / *Hy sal nie getref word nie – reaksietyd is korter as die tyd wat dit die baksteen neem om sy kop te bereik.* ✓

OR/*OF*

Distance fallen in 0,4 s / *Afstand geval in 0,4 s*:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $= (24,25)(0,4) + ½(9,8)(0,4)^2$ ✓ $= 10,45\ m$ ✓

Distance above head of supervisor after 0,4 s / *Afstand bo kop van toesighouer na 0,4 s*: 20 – 1,8 – 10,45 = 7,75 m ✓✓

He will not be struck – the brick is still 7,75 m above his head./*Hy sal nie getref word nie – die baksteen is steeds 7,75 m bokant sy kop*. ✓ [12.1.3] (6)

[9]

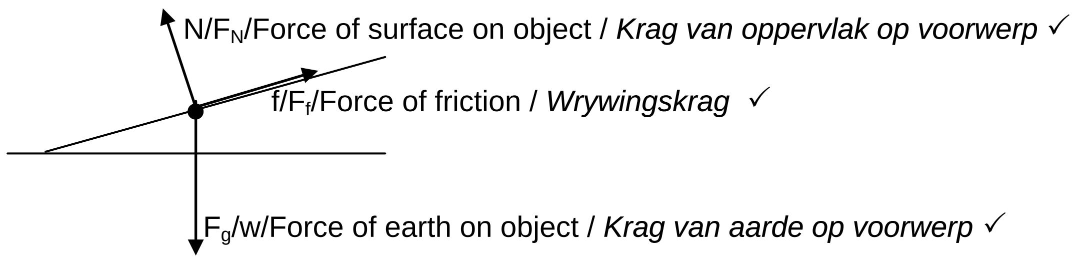
QUESTION 6/*VRAAG 6*

6.1 The net work done on an object is equal to the change in the object's kinetic energy. ✓✓
Die netto arbeid verrig op 'n voorwerp is gelyk aan die verandering in kinetiese energie *van die voorwerp.*

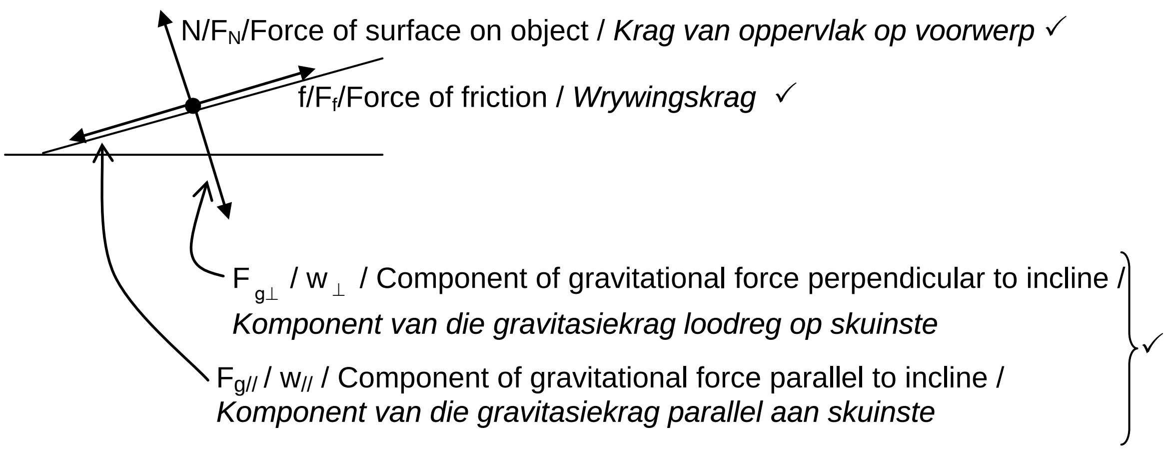
Only/*Slegs* $\frac{2}{2}$ or/*of* $\frac{0}{2}$

OR/*OF*
The work done on an object by a net force is equal to the change in the object's kinetic energy. / *Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in kinetiese energie van die voorwerp.* [12.2.1] (2)

6.2



OR/*OF*



[12.1.2] (3)

6.3.1 $v_f^2 = v_i^2 + 2a\Delta x$ ✓
$= (0)^2 + (2)(2)(10)$ ✓
$= 40\ m^2 \cdot s^{-2}$

$E_{kf} = ½m v_f^2$ ✓
$= ½(60)(40)$ ✓
$= 1\ 200\ J$ ✓

Accept/*Aanvaar:*
E_k / K
$v^2 = u^2 + 2as$ / $s = ut + ½at^2$/ $v = u + at$
A mixture of the two allowed formulae is not accepted. / *'n Mengsel van die twee erkende formules word nie aanvaar nie.*

OR/*OF*

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$10 = (0)\Delta t\ \ ½(2)\ \Delta t^2$
$\therefore\ \Delta t = 3{,}16\ s$
$v_f = v_i + a\Delta t = 0 + (2)(3{,}16)$ ✓ $= 6{,}32\ m \cdot s^{-1}$

$E_{kf} = ½m v_f^2$ ✓
$= ½(60)(6{,}32)^2$ ✓
$= 1\ 200\ J$ ✓ [12.1.3] (5)

6.3.2 $W_g = w_{//}\ \Delta x\cos\theta$ ✓
$= mg\sin 25°$ ✓ $(10)(\cos 0°)$ ✓
$= (60)(9{,}8)\sin 25° 10(1)$
$= 2\ 485\ J$ ✓

OR/*OF*

$W_g = w\Delta x\cos\theta$ ✓
$= mgh\cos 0°$
$= (60)(9{,}8)$ ✓ $(10)\sin 25°(1)$ ✓
$= 2\ 485\ J$ ✓

OR/*OF*

$W_g = -\Delta U$ ✓
$= -\ (0 – mgh)$ ✓
$= -\ (0 – (60)(9{,}8)(10)\sin 25°$ ✓
$= 2\ 485\ J$ ✓ [12.2.3] (4)

6.3.3

OPTION 1/*OPSIE 1:*

Marking rule 1.6
Nasienreël 1.6

$W_{net} = \Delta E_k$ ✓

$W_{g(\text{parallel to slope/}\textit{parallel aan helling})} + W_f = \Delta E_k$ ✓

$2\,485 + W_f = 1\,200$ ✓

$W_f = -1\,285$ J ✓ (If/*Indien* + 1 285 J deduct 1 mark/*trek 1 punt af*)

OPTION 2/*OPSIE 2:*

Marking rule 1.6
Nasienreël 1.6

$W_{net} = W_g + W_f$ ✓

$ma\Delta x = W_{\mathbf{g}} + W_f$

$(60)(2)(10)$ ✓ $= 2\,485$ ✓ $+ W_f$

$\therefore W_f = -1\,285$ J ✓ (If/*Indien* + 1 285 J deduct 1 mark/*trek 1 punt af*)

OPTION 3/*OPSIE 3*:

$W_{appl/toegep} = \Delta U + \Delta K + W_f$ $\quad {}^{0}/_{4}$

Marking rule 1.6
Nasienreël 1.6

$W_{(\text{applied/}\textit{toegepas})} = \Delta E_k + \Delta E_p - W_f$

$0 = (\tfrac{1}{2}m v_f^2 - 0) + (0 - mgh) - W_f$ **Max./*Maks.*:** $^{3}/_{4}$

$0 = \tfrac{1}{2}m v_f^2 - mgh - W_f$ ✓

$0 = 1\,200 - 2\,485 - W_f$ ✓

$\therefore W_f = -1\,285$ J ✓

OPTION 4 / *OPSIE 4*:

$(U + K)_i - W_f = (U + K)_f$ $\quad {}^{0}/_{4}$

Marking rule 1.6
Nasienreël 1.6

$(U + K)_i + W_f = (U + K)_f$ **Max./*Maks.*:** $^{3}/_{4}$

$mgh + 0 + W_f = 0 + \tfrac{1}{2}m v_f^2$ ✓

$2\,485 + W_f = 1\,200$ ✓

$W_f = -1\,285$ J ✓ (If/*Indien* + 1 285 J deduct 1 mark/*trek 1 punt af*)

OPTION 5/*OPSIE 5:*

Marking rule 1.6
Nasienreël 1.6

$W_{nc} = \Delta E_k + \Delta E_p$ ✓

$= (\tfrac{1}{2}m v_f^2 - 0) + (0 - mgh)$

$= \tfrac{1}{2}m v_f^2 - mgh$ ✓

$= 1\,200 - 2\,485$ ✓

$\therefore W_{nc} = W_f = -1\,285$ J ✓ (If/*Indien* + 1 285 J deduct 1 mark/*trek 1 punt af*)

(4)

[12.2.3]

6.3.3

OPTION 1/*OPSIE 1*
$W_f = F_f \Delta x \cos\theta$ ✓
$- 1\ 285 = f(10)\cos 180°$ ✓
$F_f = 128{,}5$ N ✓

OPTION 2/*OPSIE 2*
$F_{net} = F_{g(\text{parallel to slope/}\textit{parallel aan helling})} - F_f$ ✓
$ma = mg\sin 25° - F_f$
$(60)(2) = (60)(9{,}8)\sin 25° - F_f$ ✓
$F_f = 128{,}5$ N ✓

[12.2.3] (3)
[21]

QUESTION 7/*VRAAG 7*

7.1 Doppler effect / *Doppler-effek* ✓ [12.2.1] (1)

7.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ / $f_L = \frac{v}{v + v_s} f_s$

$\frac{90}{100} f_s$ ✓ $= \left(\frac{340}{340 + v_s}\right)$ ✓ f_s ✓ $\quad \left(f_L = \frac{90}{100} f_s\right)$

$v_s = 37{,}78\ \text{m·s}^{-1}$ ✓

Any other formula / *Enige ander formule* $^0\!/_5$

[12.1.3] (5)
[6]

QUESTION 8/*VRAAG 8*

8.1.1 Additive / *additief* ✓ [12.2.1] (1)

8.1.2 X: yellow / *geel* ✓
Y: magenta ✓
Z: cyan / *siaan* ✓ [12.2.3] (3)

8.1.3 P: red / *rooi* ✓
Q: blue / *blou* ✓ [12.2.3] (2)

8.2 Green plants will reflect green light ✓and very little light will be available ✓for (photosynthesis) food production in the plant.

Groen plante weerkaats groen lig ✓ en baie min lig is beskikbaar ✓ vir (fotosintese) produksie van voedsel in die plante. [12.3.2] (2)
[8]

QUESTION 9/*VRAAG 9*

9.1 Wave nature / *Golfaard* ✓
OR/*OF*
Light has wave properties. / *Lig het golfeienskappe*. [12.2.1] (1)

9.2 Wavefronts from the slit arrive at point P out of phase and <u>interfere destructively</u>. ✓✓
Goffronte vanaf die spleet kom uit fase by punt P aan en ondergaan <u>destruktiewe interferensie</u>. ✓✓
OR/OF
A crest meets a trough at P and <u>destructive interference</u> takes place. ✓✓ / 'n *Kruin ontmoet 'n trog by P en <u>destruktiewe interferensie</u> vind plaas.* [12.2.3] (2)

9.3 $\sin\theta = \frac{m\lambda}{a}$ ✓ $= \frac{(1)(600\times10^{-9})}{3{,}2\times10^{-5}}$ ✓ ✓ $\therefore\ \theta = 1{,}07°$

$\tan\theta = \frac{OP}{Q}$

$\therefore\ \tan 1{,}07° = \frac{2{,}5\times10^{-2}}{Q}$ ✓

$\therefore$ Q = 1,34 m ✓ [12.1.3] (5)

9.4.1 Smaller than / *Kleiner as* ✓ [12.2.2] (1)

9.4.2 If OP increases:

$\sin\theta$ increases ✓ OR degree of diffraction increases

$\sin\theta\ \alpha\ \frac{1}{a}$ ✓ (and thus *a* decreases)

Indien OP toeneem:
$\sin\theta$ neem toe ✓ *OF mate van diffraksie vermeerder*

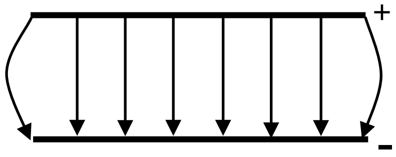
$\sin\theta\ \alpha\ \frac{1}{a}$ ✓ *(en dus neem* a *af)* [12.2.2] (2)

[11]

QUESTION 10/*VRAAG 10*

10.1 Dielectric / Diëlektrikum ✓
Distance between plates / Afstand tussen plate ✓ [12.2.1] (2)

10.2.1



Checklist / *Kontrolelys*	**Mark / *Punt***
Evenly spaced field lines. / *Eweredig gespasieerde veldlyne.*	✓
Direction of field lines from positive to negative. / *Rigting van veldlyne vanaf positief na negatief*.	✓
Field lines curved at the ends. / *Veldlyne gekrom by die ente.*	✓

NOTE: If charges on plates not indicated, maximum $\frac{2}{3}$ (no mark for direction)

LET WEL: Indien ladings op plate nie aangedui is nie, maksimum $\frac{2}{3}$ (geen punt vir rigting)

[12.1.2] (3)

10.2.2 $C = \frac{\varepsilon_0 A}{d}$ ✓ $= \frac{(8,85\times10^{-12})(2\times10^{-2})(10\times10^{-2})}{0,2\times10^{-3}}$ ✓ ✓ ✓

$= 8,85 \times 10^{-11}$ F ✓

(5)

[12.1.3] **[9]**

QUESTION 11/*VRAAG 11*

Only/*Slegs* $\frac{2}{2}$ or/*of* $\frac{0}{2}$

11.1 The current through a conductor is directly proportional to the potential difference across its ends at constant temperature. ✓✓

Die stroom in'n geleier is direk eweredig aan die potetsiaal-verskil oor sy ente by konstante temperatuur. [12.2.1] (2)

11.2 Equal / *gelyk* ✓
<u>2 A divides equally at T</u> (and since I_M = 1 A it follows that I_N = 1 A) ✓
<u>2 A verdeel gelyk by T</u> en omdat I_M = 1 A volg dit dat I_N = 1 A)

OR/*OF*

$I \propto \frac{1}{R}$, $\therefore R_M = R_N$ [12.2.2] (2)

11.3 emf = IR + Ir ✓$\therefore$ 17 = 14 + Ir ✓$\therefore$ Ir = 3 V

$r = \frac{V_{lost}}{I}$ ✓$= \frac{3}{2}$ ✓ = 1,5 Ω ✓ [12.1.3] (5)

11.4 $V_N = IR_N$ ✓= (1)(2) ✓= 2 V ✓ [12.2.3] (3)

11.5 V_Y = 14 – 2 = 12 V ✓

$V_Y = IR_Y$ ✓$\therefore$ 12 = (2)R_Y ✓
$\therefore R_Y$ = 6 Ω ✓ [12.1.3] (4)
[16]

QUESTION 12/*VRAAG 12*

12.1.1 AC / *WS* – alternating current / *wisselstroom* ✓
A separate slip ring connected to each wire. / *'n Aparte sleepring is aan elke draad geskakel.* ✓ [12.2.1] (2)

12.1.2 Increase in peak (or rms) voltage / *Toename in piekspanning (of wgk-spanning)* ✓
Increase in frequency / *Toename in frekwensie* ✓ [12.2.2] (2)

12.1.3 The plane of the coil is parallel to the magnetic field. ✓
Die vlak van die spoel is parallel aan die magneetveld. [12.2.2] (1)

12.2 <u>Advantage / *Voordeel:*</u>
Less environmental pollution ✓ (noise, gases, etc.) *Minder omgewingbesoedeling (geraas, gasse, ens.)*

<u>Disadvantage / *Nadeel*:</u>
- Will not operate in absence of wind. / *Sal nie in afwesigheid van wind werk nie.* ✓
- Many windmills needed to generate sufficient electricity – unsightly appearance in environment. / *Baie windlaaiers benodig om genoeg elektrisiteit op te wek – is onooglik in omgewing.* [12.3.2] [12.3.3] (2)

[7]

QUESTION 13/*VRAAG 13*

13.1 $V_{rms} = \frac{V_{max/maks}}{\sqrt{2}}$ ✓

$\therefore\ 220 = \frac{V_{max/maks}}{\sqrt{2}}$ ✓

$\therefore\ V_{max/maks} = 311{,}13\ V$ ✓ [12.2.3] (3)

13.2 $P_{average/gemid} = \frac{V_{rms}^2}{R}$ ✓

$\therefore 100 = \frac{(220)^2}{R}$ ✓

$\therefore R = 484\ \Omega$ ✓ [12.2.3] (3)

13.3 $P_{ave} = V_{rms}I_{rms}$ ✓
$2\ 200 = (220)I_{rms}$ ✓
$I_{rms} = 10\ A$ ✓

The iron draws a current of 10 A. Therefore together with the lights the total current will exceed 10 A ✓and the fuse wire will blow and the current will stop. ✓

Die yster trek'n stroom van 10 A. Dus sal dit, tesame met die ligte,'n groter stroom as 10 A trek en die smeltdraad sal brand en geen stroom sal vloei nie. [12.3.2] (5)

[11]

QUESTION 14/*VRAAG 14*

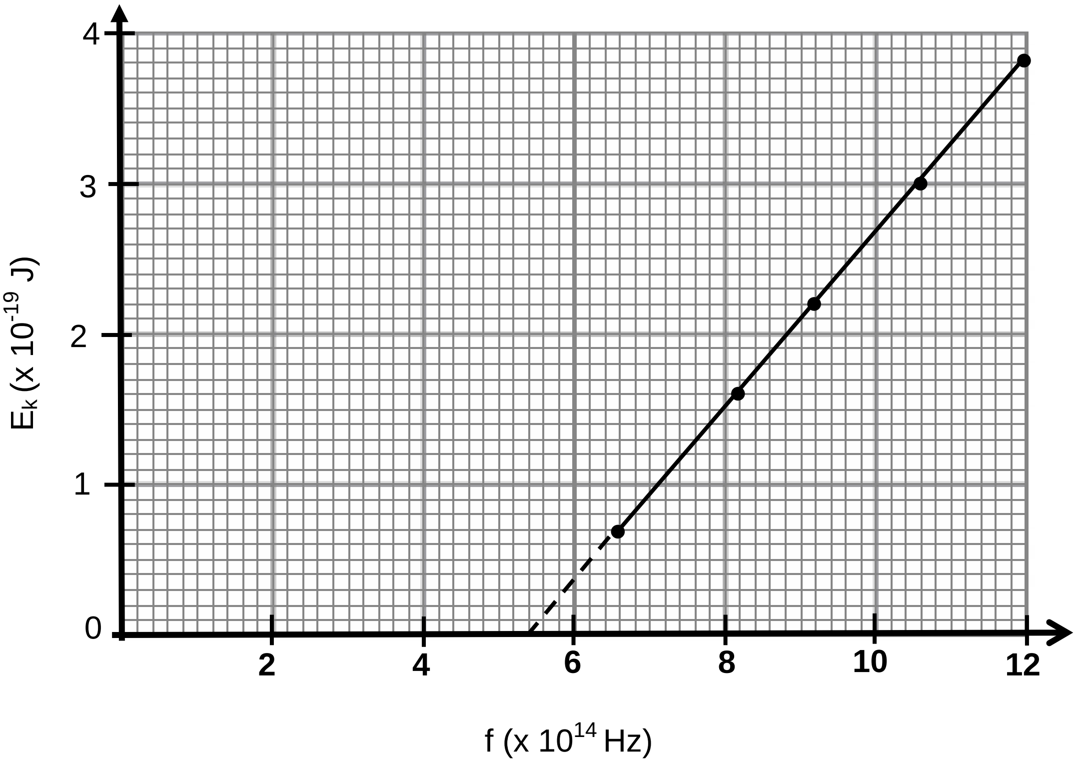
14.1 Minimum amount of energy needed to remove an electron from the surface of a metal/conducting material. ✓✓

Only/*Slegs* $\frac{2}{2}$ or/*of* $\frac{0}{2}$

Minimum energie benodig om'n elektron vanaf die oppervlak van'n metaal/geleidende materiaal te verwyder. [12.2.1] (2)

14.2

Graph of kinetic energy versus frequency
Grafiek van kinetiese energie teenoor frekwensie



Checklist/*Kontrolelys* Criteria for graph / *Kriteria vir grafiek*	**Marks / *Punte***
Relevant heading / *Geskikte opskrif*	✓
Axes labelled correctly with units. / *Asse korrek benoem met eenhede.*	✓
Appropriate scale. / *Geskikte skaal.*	✓
Plotting all the points. / *Alle punte gestip.*	✓✓
Line of best fit. / *Beste paslyn getrek.*	✓

[12.1.2] (6)

14.3

14.3.1 $f_o = 5,4 \times 10^{14}$ Hz ✓✓ [12.1.2] (2)

14.3.2 Threshold frequency / Drumpelfrekwensie ✓ [12.2.1] (1)

14.3 $W_o = hf_o$ ✓
$= (6,63 \times 10^{-34})(5,4 \times 10^{14})$ ✓
$= 3,58 \times 10^{-19}$ J ✓ [12.1.2] (3)

[14]

TOTAL SECTION B/TOTAAL AFDELING B: 125
GRAND TOTAL/GROOT*TOTAAL*: 150

10841

PHYSICAL SCIENCES

First Paper

17 pages

MARKS: 150
TIME: 3 HOURS

PLEASE TURN OVER

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

1.1 The motion of an object near the surface of the earth under the influence of the earth's gravitational force only (1)

1.2 The term used to describe two light sources emitting waves that maintain the same phase relationship with each other (1)

1.3 A continuous spectrum from which certain colours or frequencies of light are missing (1)

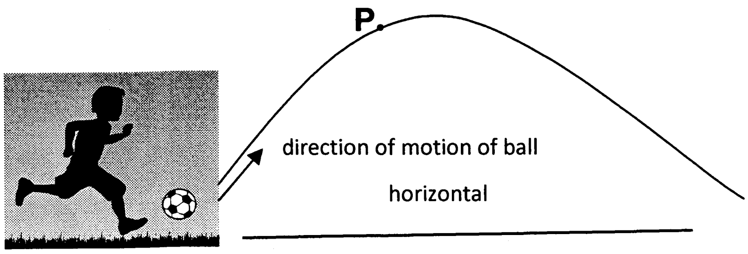
1.4 The minimum frequency of light needed to emit photoelectrons from the surface of a metal (1)

1.5 The circuit device that can store charge on two parallel plates separated by a dielectric (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

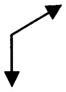
Four options are provided as possible answers to the questions. Each question has only ONE correct answer. Choose the correct answer for each of the following:

2.1 A boy kicks a soccer ball as shown in the diagram below. Ignore the effects of friction.

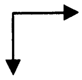


Which ONE of the following shows the correct direction(s) of the force(s) acting on the ball at point **P**?

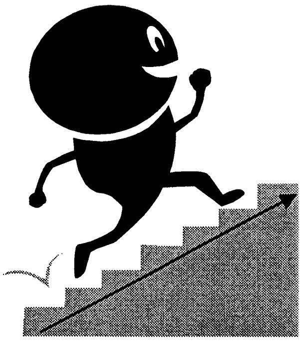
A. 

B. 

C. 

D.  (2)

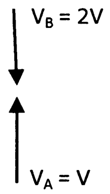
2.2 A boy starts running from rest up a staircase as shown below. He reaches a velocity *v* at the top of the staircase.



Which ONE of the following statements is TRUE whilst the boy runs up the stairs?

A. Work is done by gravity.
B. No work is done by gravity.
C. Mechanical energy is conserved.
D. Potential energy is converted into kinetic energy. (2)

2.3 Car A moves north at speed v. Car B moves south at speed 2 v along the same straight road. The velocity of Car A relative to Car B is:



A 3 v north
B 3 v south
C v south
D v north (2)

2.4 Consider the four statements below about electromagnetic waves.

I. They obey the wave equation $c = f\lambda$.
II. They transfer energy from one place to another.
III. They cannot propagate in a vacuum.
IV. They can undergo diffraction but not interference.

Which of this/these statement(s) is/are FALSE?

A. I only
B. II and III only
C. III and IV only
D. IV only (2)

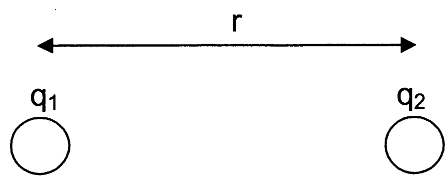
2.5 Magnetic field on a current-carrying conductor can be … by accelerating a negatively charged particle in that conductor.

A increased
B decreased
C maintained constant
D eliminated (2)

2.6 The work done by the net force acting on an object is equal to the change in …

A kinetic energy.
B momentum.
C gravitational potential energy.
D none of the above. (2)

2.7 The centres of two identical spheres are a distance r apart. They carry charges q_1 and q_2 respectively. Each sphere exerts an electrostatic force of magnitude F on each other as shown below



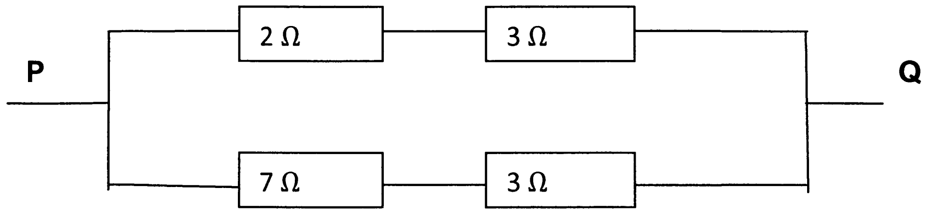
The distance between the charges is now **halved** and the charge on q_1 is **doubled**. The magnitude of the new forces between the charges is …

A F
B 2F
C 4F
D 8F (2)

2.8 What kind of waves are used by cellular phones to transmit and receive signals?

A Gamma rays
B Microwaves
C Ultraviolet rays
D Infrared rays (2)

2.9 In a section of a circuit represented below, a potential difference V is applied across **PQ**.



Which ONE of the following gives the current on the 7 Ω resistor?

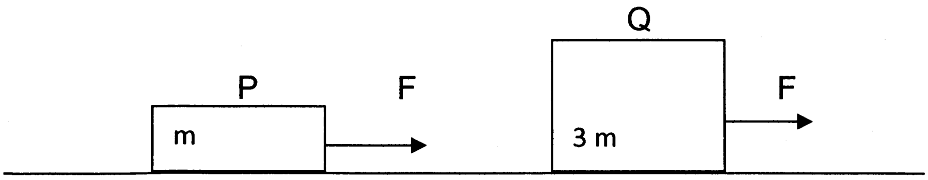
A $\frac{V}{3}$

B $\frac{V}{5}$

C $\frac{V}{7}$

D $\frac{V}{10}$ (2)

2.10 A net force F acts on each of two isolated objects, P and Q, as shown below. The mass of Q is three times that of P. (Ignore the effect of friction.)



If the rate of change of momentum of object Q is x, then the rate of change of momentum of object P is as follows:

A $\frac{1}{9}x$

B $\frac{1}{3}x$

C x

D 3x

(2)
(10 x 2) [20]
TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start each question on a NEW page.
2. Leave one line between two sub-questions, for example between QUESTION 3.1 and QUESTION 3.2.
3. The formulae and substitutions must be shown in ALL calculations.
4. Round off your answers to TWO decimal places.

QUESTION 3 (Start on a new page)

A small brick of mass 700 g is projected vertically downwards at a velocity of 1,25 $m \cdot s^{-1}$ from the top of a building of height 25 m. Ignore the effects of air resistance.

3.1 Calculate the magnitude of the velocity at which the brick hits the ground. (4)

On reaching the ground, the brick penetrates 10 cm into the ground before it comes to rest. Calculate the:

3.2 Net work done on the brick whilst penetrating the ground. (3)

3.3 Magnitude of the frictional force exerted by the ground on the brick. (6)

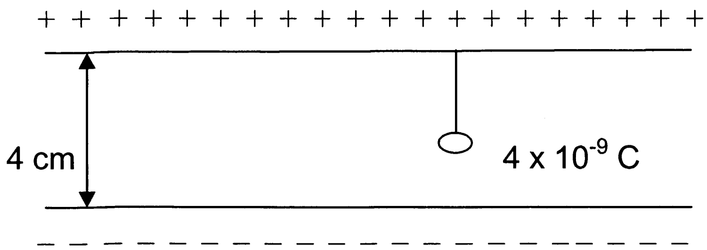
3.4 Change in momentum of the brick from the moment it hits the ground until it comes to rest. (3)

3.5 Time it takes the brick from the moment it strikes the ground until it comes to rest. (3)

[19]

QUESTION 4 (Start on a new page)

Peter suspends a small ball of mass 2 x 10^{-4} kg between two oppositely charged parallel metal plates using a light inelastic thread. The plates are 4 cm apart. The ball has a positive charge of 4 x 10^{-9} C.



When a potential difference of 1,4 x 10^4 V is applied across the plates, the thread breaks.

4.1 Draw a diagram showing the electric field pattern between the plates. (4)

4.2 Draw a labelled force diagram showing all forces acting on the ball before the thread breaks. (3)
[7]

QUESTION 5 (Start on a new page)

Physical Sciences learners drop objects of different masses from the same height above the ground. Their hypothesis is as follows:

Objects of different masses dropped from the same height will reach the ground at different times. (Ignore the effects of air resistance)

5.1 Formulate an investigative question for this investigation. (2)

5.2 For this investigation, name ...

5.2.1 the dependent variable mentioned in the hypothesis. (1)
5.2.2 the independent variable mentioned in the hypothesis. (1)

5.3 Sketch a possible velocity versus time graph for the above investigation (2)
[6]

QUESTION 6 (Start on a new page)

A space shuttle consisting of a rocket motor with a mass of 600 kg and a capsule with a mass of 280 kg, while travelling in space at 6 800 $m.s^{-1}$ relative to the earth, releases its rocket motor. As a result, the capsule is projected in the opposite direction at 7 300 $m.s^{-1}$ relative to the earth.

6.1 State the principle of conservation of momentum. (2)

6.2 Calculate the speed of the rocket motor immediately after it is released from the capsule. (4)

6.3 Is the collision in QUESTION 6.2 elastic or inelastic? Support your answer with a calculation. (5)

[11]

QUESTION 7 (Start on a new page)

A stationary ship transmits sound waves at a frequency of 30 kHz. A submarine moving at 24 $m{\cdot}s^{-1}$ in the water, receives the sound waves at a LOWER frequency than 30 kHz. (Assume that the speed of the sound waves in water is 1 480 $m{\cdot}s^{-1}$.)

7.1 Name the phenomenon that explains the change in observed frequency. (1)

7.2 Define the term *frequency*. (2)

7.3 Calculate the frequency of the sound waves received by the submarine. (4)

7.4 A SOUND DETECTOR ON THE SHIP measures the frequency of the sound waves reflected from the submarine. Calculate the frequency of these reflected sound waves. (3)

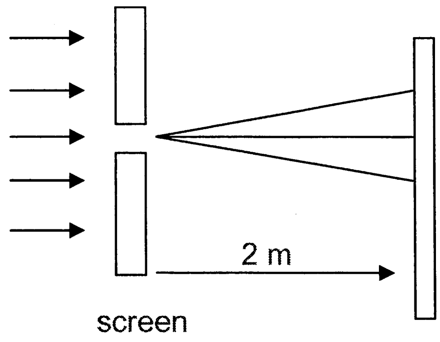
[10]

QUESTION 8 (Start on a new page)

8.1 Define *diffraction*. (2)

8.2 Write down Huygen's principle. (2)

8.3 Monochromatic light of wavelength 633 nm passes through a slit 0,1 mm wide. A diffraction pattern is seen on a screen 2 m away as shown below. How wide is the central maximum on the screen?



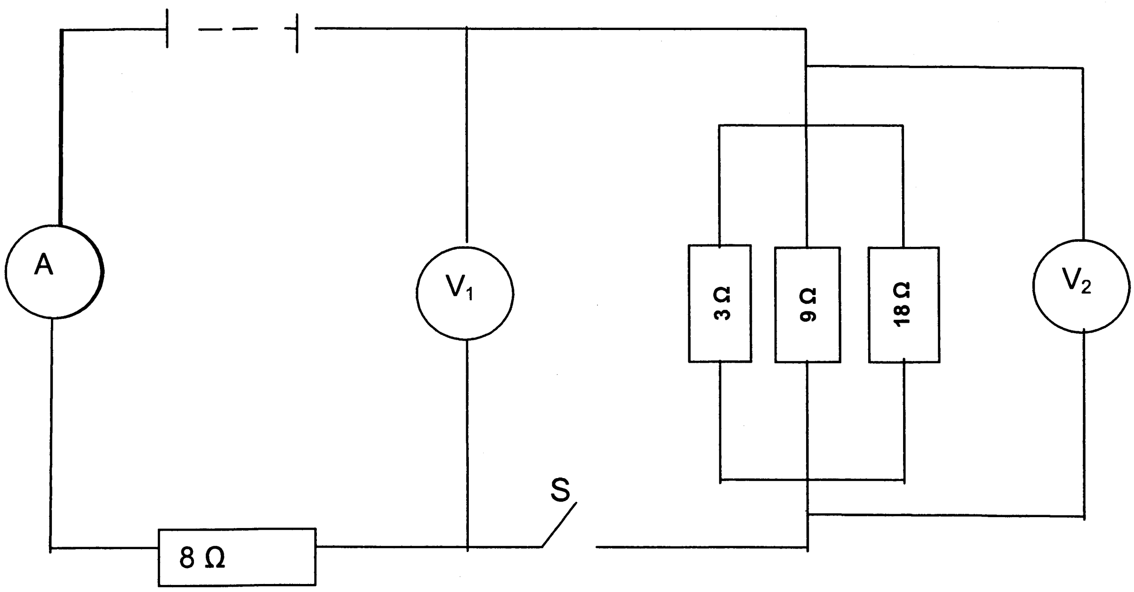
(5)

8.4 What happens to the central maximum on the screen if the width of the slit is increased? (2)
[11]

QUESTION 9 (Start on a new page)

In the circuit shown below, the battery has an emf of 24 V and an internal resistance of 2 Ω. Voltmeter V_1 is connected as shown and V_2 is connected across the three parallel resistors. The resistance of the connecting wires and the ammeter can be ignored.

emf = 24 V ; r = 2 Ω



9.1 Explain the term emf when referring to an electrical cell. (2)

9.2 With switch S open, calculate the reading on

9.2.1 V_1 (2)

9.2.2 V_2 (2)

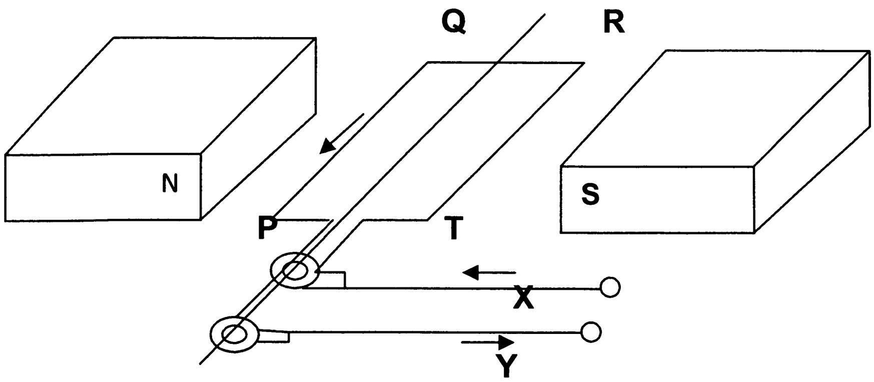
9.3 With switch S closed, calculate the …

9.3.1 total resistance of the entire circuit. (4)

9.3.2 charge moving past a cross section of the 8 Ω resistor in one minute. (5)
[15]

QUESTION 10 (Start on a new page)

The sketch below shows the position of a coil of a generator that lies parallel to a magnetic field.



10.1 In what direction must PQ of the coil be rotated in order to cause the current direction as shown? Write clockwise or anticlockwise. (1)

10.2 Is this generator AC or DC? Give reason for your answer. (3)

10.3 What energy conversion takes place in the generator represented above? (2)

10.4 Can the above generator be used in a car? Explain your answer. (3)

10.5 Draw the induced emf- versus-time graph for the above generator. (2)

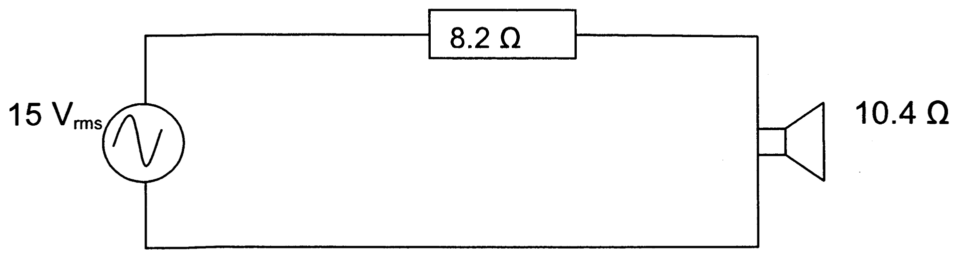
10.6 Name ONE way in which the induced emf of a specific generator can be increased. (1)

10.7 A 1 000 μF capacitor is charged by connecting it to a 12 V battery. Determine how much energy is stored in this capacitor. (3)

10. 8 A certain capacitor consists of two parallel metal plates, each having dimensions of 20 mm by 100 mm. The plates are 0,2 mm apart and are held at a potential difference of 15 V. The space between them is filled with air. Calculate the capacitance of this capacitor. (5)
[20]

QUESTION 11 (Start on a new page)

In the circuit below, the AC source delivers alternating voltage at audio frequency to the speaker. Assume that only resistance influence the performance of the speaker.



11.1 Calculate the peak voltage that the source can deliver. (2)

11.2 Calculate the average power delivered to the speaker. (6)

11.3 Alternating current is generated at power stations. Give ONE advantage of AC transmission over long distances. (2)
[10]

QUESTION 12 (Start on a new page)

12.1 What is the photoelectric effect ? (2)

12.2 Calculate the energy of a red photon with a wavelength of $7,5 \times 10^{-7}$m. (3)

12.3 The work function of a particular metal is $1,6 \times 10^{-19}$J.
Define work function. (2)

12.4 During an experiment to determine the work function of a certain metal, light of different frequencies was shone on the metal surface and the corresponding kinetic energies of the photoelectrons were recorded as shown in the table below.

Frequency of incident light (Hz)	**Kinetic energy of photoelectrons (J)**
$6,6 \times 10^{14}$	$0,7 \times 10^{-19}$
$8,2 \times 10^{14}$	$1,6 \times 10^{-19}$
$9,2 \times 10^{14}$	$2,2 \times 10^{-19}$
$9,2 \times 10^{14}$	$3,0 \times 10^{-19}$
$12,0 \times 10^{14}$	$3,8 \times 10^{-19}$

12.4.1 Use the data in the table above to draw a graph of kinetic energy versus frequency. Use the graph paper provided on page 14. (4)

12.4.2 What is the value of the frequency when the graph intercepts the x-axis? (2)

12.5 Calculate the kinetic energy of an electron ejected from the metal when it is illuminated by red light. (3)

[16]

TOTAL SECTION B: 125

GRAND TOTAL: 150

MEMO

QUESTION 1 / *VRAAG 1*

1.1 Free fall / *Vryval* ✓	[12.2.1]	(1)
1.2 Coherent or Coherence / *Koherent* ✓	[12.2.1]	(1)
1.3 Absorption Spectrum / *Absorpsiespektrum* ✓	[12.2.1]	(1)
1.4 Threshold frequency / *Drumpelfrekwensie* ✓	12.2.1]	(1)
1.5 Capacitor / *Kapasitor* ✓	[12.2.1]	(1)
		[5]

QUESTION 2 / *VRAAG 3*

2.1	A ✓✓	[12.2.3]	(2)
2.2	B ✓✓	[12.2.3]	(2)
2.3	A ✓✓	[12.2.2]	(2)
2.4	C ✓✓	[12.2.1]	(2)
2.5	A ✓✓	[12.2.3]	(2)
2.6	A ✓✓	[12.2.3]	(2)
2.7	D ✓✓	[12.2.2]	(2)
2.8	B ✓✓	[12.3.3]	(2)
2.9	D ✓✓	[12.2.3]	(2)
2.10	C ✓✓	[12.2.3]	(2)
			[20]

TOTAL SECTION A / *TOTAAL AFDELING A*: 25

QUESTION 3 / *VRAAG 3*

Positive marking from/
Positiewe nasien van
3.1 - 3.5

3.1 $v^2_f = v^2_i + 2a\triangle y$ ✓

$= (1,25)^2\ 3 + (2)(9,8)(25)$ ✓

$v_f = 22,17\ m.s^{-1}$ ✓

OR/OF

$E_m(top/bo) = E_m(bottom/onder)$ ✓

$(E_k + E_p)_{top/\ bo} = (E_k + E_p)_{bottom/\ onder}$

$(\frac{1}{2}mv^2 + mgh)_{top/\ bo} = (\frac{1}{2}mv^2 + mgh)_{bottom/\ onder}$

$(\frac{1}{2}v^2 + gh)_{top/\ bo} = (\frac{1}{2}v^2 + 0)_{bottom/\ onder}$

$\frac{1}{2}x\ 1,25^2 + 9,8x\ 25 = \frac{1}{2}v^2$ ✓

$v = 22,17\ m.s^{-1}$ ✓

[12.2.3] (4)

3.2 $W_{net} = \triangle E_k$ or/of $W_{net} = \triangle K$

$= E_{kf} - E_{ki}$ ✓

$= \frac{1}{2}mv^2_f - \frac{1}{2}mv^2_i$

$= 0 - \frac{1}{2}mv^2_i \quad ; \ v_f = 0$

$= -½ \times 0,7 \times 22,17^2$ ✓

$= -172\ J$ ✓

[12.2.3] (3)

3.3 $W = F\triangle x\cos\theta$ ✓

$172 = F(0,1)\cos(180)$ ✓ $F_{res} = -1720$ N

$F_{res} = 1720$ N opposite to direction of motion/ *teenoorgestelde rigting van beweging* ✓

$F_{res} = -F_g + F_f$ ✓

∴ $-1720 = -mg + F_f$

$F_f = 1720 + mg$ ✓

$= 1720 + 0{,}7x9{,}8$

$= 1726{,}86$ N ✓

[12.2.3] (6)

3.4 $\triangle p = m\triangle v$ ✓

$= m(v_f - v_i)$

$= 0{,}7(0 - (-22{,}17))$ ✓

$= 15{,}52$ kg.m.s^{-1} ✓

[12.2.3] (3)

3.5 $F_{net.} \triangle t = \triangle p$ ✓

$1720 . \triangle t = 15{,}52$ ✓

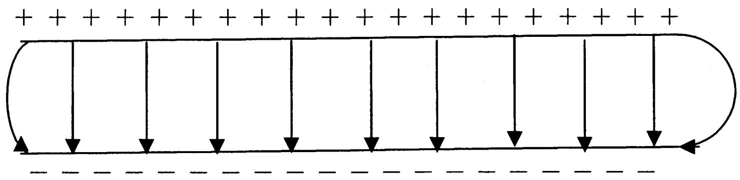
$\triangle t = 15{,}52/1720$

$\triangle t = 9 \times 10^{-3}$s ✓ [12.2.3] (3)

[19]

QUESTION 4/ *VRAAG 4*

4.1



Lines parallel and evenly spaced / *lyne parallel en eweredig gespasieër* ✓

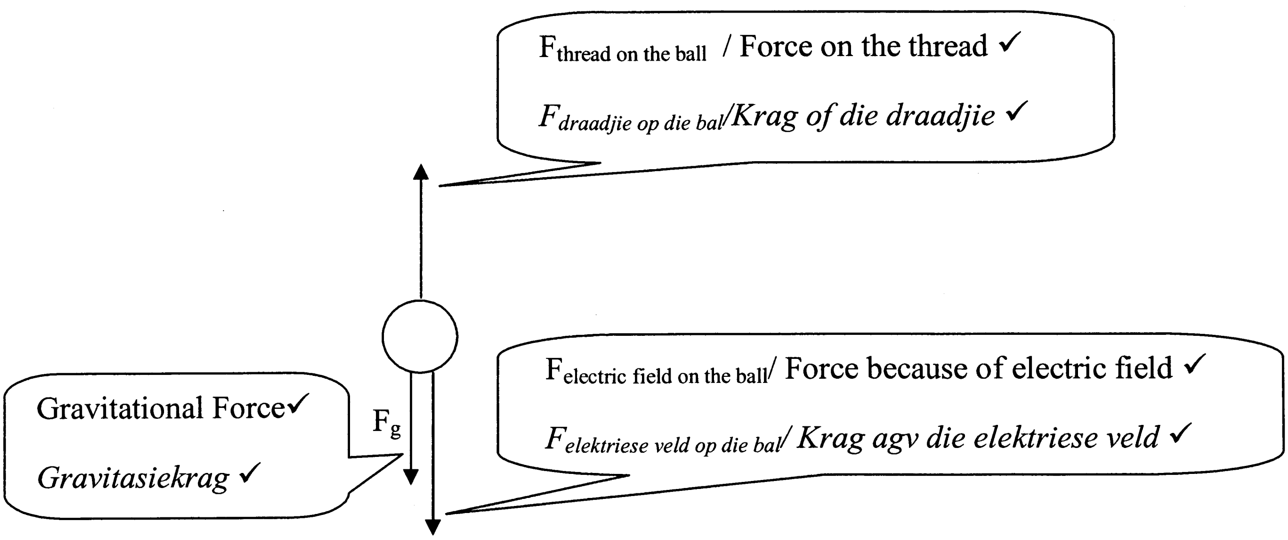
Direction of field lines / *rigting van veldlyne* ✓

Starting and ending on plate/*begin en eindig op plate* ✓

Effect at side plates/ *effek by kante van plate* ✓

[12.1.2] (4)

4.2



[12.1.2] (3)

[7]

QUESTION 5 / *VRAAG 5*

5.1 Is gravitational acceleration of falling bodies independent of their masses? ✓✓

Is vallende voorwerpe se versnelling onafhanklik van hul massas?

[12.2.3] (2)

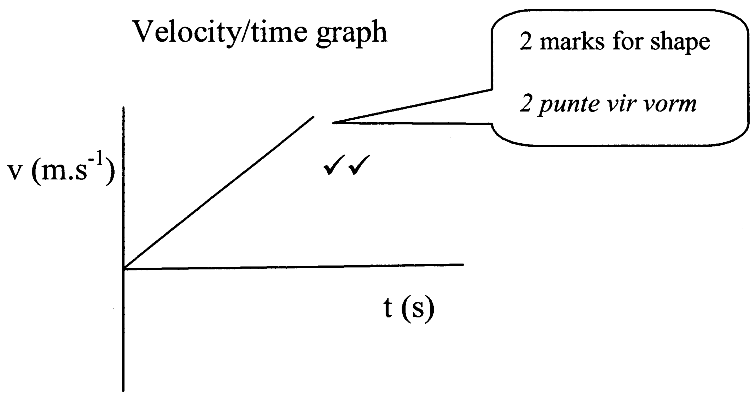
5.2.1 dependent Variable: time ✓

Afhanklike veranderlike: Tyd [12.2.3] (1)

5.2.2 Independent Variable: Mass ✓

Onafhanklike veranderlike: massas [12.2.3] (1)

5.3



[12.1.2] (2)

[6]

QUESTION 6 / *VRAAG 6*

6.1 The total linear momentum in a closed system remains constant. ✓✓

Die totale liniêre momentum in 'n geslote sisteem bly konstant. [12.2.1] (2)

6.2 M_R = mass of rocket; M_C = mass of capsule

p before = p after

$(M_R + M_C)\ V_i = M_R\ V_f + M_C\ V_f$ ✓

$(600 + 280)\ 6\ 800$ ✓ $= 600 \times 7\ 300$ ✓ $+ 280\ V_f$

$160\ 4000 = 280\ V_f$

$\frac{160\ 4000}{280} = V_f$

V_f capsule = 5728,57 ✓ $m.s^{-1}$ [12.2.3] (4)

6.3 E_k (before/*voor*) $= (\frac{1}{2}m_1v^2_i + \frac{1}{2}m_2v^2_f)_{before/\ voor}$ ✓

$= ½.\ (600 + 280)6800^2$

$= 2{,}03 \times 10^{10}$ J ✓

E_k (after/ *na*) $= (\frac{1}{2}mv^2_i + \frac{1}{2}mv^2_f)_{after/\ na}$

$= ½ . \times 600 \times 7300^2 + ½ \times 280 \times 572{,}57^2$

$= 2{,}03 \times 10^{10}$ J ✓

E_k (before/*voor*) = E_k (after/*na*) ✓

∴ separation was elastic / ∴ *skeiding was elasties.* ✓

[12.1.2] (5)

[11]

QUESTION/ *VRAAG 7*

7.1 Doppler effect / *Doppler effek.* ✓ [12.2.1] (1)

7.2 Number of vibrations per second / *Getal vibrasies per sekonde.* ✓✓ [12.2.1] (2)

7.3 $F_s = 30kHz$, $F_L = ?$, $V_L = 24m.s^{-1}$, $V_s = 0$, $V=1480m.s^{-1}$

$F_L = (\frac{V \pm V_L}{V \pm V_s}) F_s$ ✓

$= (\frac{1480-24}{1480+0})30$ ✓✓

$= 29,5$ kHz ✓ [12.1.3] (4)

Positive marking/
***Positiewe nasien* 7.4**

7.4 $F_s = 29,5$ kHz, $F_L = ?$, $V_L = 0$, $V_s = -24m.s^{-1}$, $V=1480m.s^{-1}$

$F_L = (\frac{V \pm V_L}{V \pm V_s}) F_s$

$= (\frac{1480+0}{1480+24})29,5$ ✓✓

$= 29,0$ kHz ✓ [12.2.3] (3)

[10]

QUESTION 8 / *VRAAG 8*

8.1 Diffraction is the bending of waves around the edges of an opening or obstacle. ✓✓

Diffraksie is die buiging van golwe om die randte van 'n opening of 'n versperring

[12.2.1] (2)

8.2 Every point on a wavefront acts as the source of secondary wavelets that spread out in all directions with the same speed as the wave. ✓✓

Elke punt op 'n golffront tree op as 'n bron van sekondêre golfies wat in alle rigtings uitsprei teen dieselfde spoed as die golf. [12.2.1] (2)

8.3 $\lambda = 633 \text{ nm} = 633 \times 10^{-9} \text{ m}$

$a = 0{,}1 \text{ mm} = 0{,}1 \times 10^{-3} \text{ m}$

$\text{Sin}\theta = \frac{m\lambda}{a}$ ✓

$\text{Sin}\theta = (1)\ 633\text{x}10^{-9}) / (0{,}1\text{x } 10^{-3})$

$\theta = \text{Sin}^{-1}(0{,}00633)$

$\theta = 0{,}36^0$ ✓

The width of the central maximum is 2*x*. Use trigonometric function to find *x*.

Die wydte van die sentrale helder band op skerm is 2x. Vind x deur die gebruik van trig-funksies.

$\tan\theta = \frac{x}{2}$ ✓

$x = \tan\theta(2)$

$= \tan (0{,}36)(2)$

$= 0{,}013 \text{ m}$ ✓

The width of the central maximum is / *Die wydte van die sentrale helder band is*

$2x = (2)(0{,}013)$

$= 0{,}026 \text{ m}$ ✓ $= 26 \text{ mm}$ [12.2.3] (5)

8.4 Decreases / *Afneem* ✓✓ [12.1.2] (2)

[11]

QUESTION 9 / *VRAAG 9*

9.1 emf is the rate of supply of energy per unit current **OR** ✓✓

The rate of work done in moving an ampere of current **OR**

The work done (maximum energy) to move 1coulomb of charge through the whole circuit in a second

emk is die tempo van energievoorsiening per eenheidstroom ***OF***

die tempo van arbeid om 1 ampere stroom te beweeg ***OF***

die arbeid verrig (maksimum energie) om 1 coulomb lading deur die hele stroombaan te beweeg [12.2.1] (2)

9.2.1 24 V ✓✓ [12.1.2] (2)

9.2.2 0 V ✓✓ [12.1.2] (2)

9.3.1

Parallel section **<u>NO Positive Marking</u>** [12.1.2] (4)

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$ ✓ ***<u>Geen Positiewe Nasien</u>***

$$= \frac{1}{3} + \frac{1}{9} + \frac{1}{18} = \frac{9}{18}$$ ✓

$\therefore R_p = 2\ \Omega$

$\therefore R_T = R_p + 8 + r$ ✓

$= 2 + 8 + 2$

$= 12\ \Omega$ ✓

9.3.2

$I_{cir} = \frac{V}{R_T}$ ✓

$= \frac{24}{12}$ ✓

$= 2$ A ✓

$q = I\Delta t$ ✓

$= 2 \times 60$

$= 120$ C ✓

NO Positive Marking

Geen Positiewe Nasien

[12.1.2] (5)

[15]

QUESTION 10 / *VRAAG 10*

10.1 Anticlockwise / *Anti-kloksgewys.* ✓ [12.1.2] (1)

10.2 AC generator: Has two separate slip rings ✓✓

WS generator: Het twee afsonderlike sleepringe ✓✓ [12.1.2] (3)

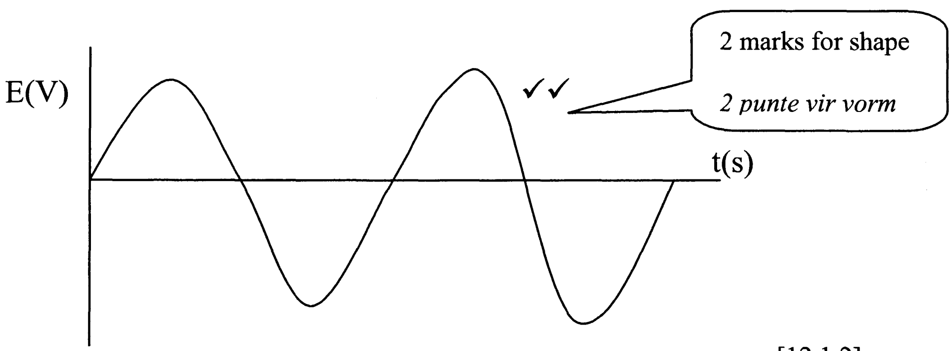
10.3 Mechanical energy is converted into electrical energy. ✓

Meganiese energie word omgesit in elektriese energie. ✓ [12.2.3] (2)

10.4 Yes, ✓ because they convert mechanical energy into electrical energy which is used for lights, indicators and other components which need electrical energy. ✓✓

Ja, ✓ *om dat hulle meganiese energie in elektriese energie verander wat gebruik word vir ligte, flikkerligte en ander komponente wat eletriese energie benodig.* ✓ ✓
[12.1.4] (3)

10.5



[12.1.2] (2)

10.6 Increase the speed at which the coil rotate. ✓

Verhoog die spoed waarteen die spoel roteer. ✓ [12.2.3] (1)

10.7 $W = \frac{1}{2} CV^2$ ✓

$= (\frac{1}{2})(1000 \times 10^{-6}F)(12V)^2$ ✓

$= 0{,}072$ J ✓ [12.2.2] (3)

10.8 $C = \varepsilon_0 \frac{A}{d}$ ✓

$$= \frac{(8{,}85 \times 10^{-12})\left(\frac{20}{1000}\right)\left(\frac{100}{1000}\right)}{(1000)}$$ ✓ ✓

$= 8{,}85 \times 10^{-11}$ F ✓ [12.2.2] (5)

[20]

QUESTION 11 / *VRAAG 11*

11.1 $V_{rms/wgk} = V_{max/maks} / \sqrt{2}$ ✓

$V_{max/maks} = V_{rms/wgk} \cdot \sqrt{2}$

$= 15V \times \sqrt{2}$ ✓

$= 21,2\ V$ ✓ [12.1.3] (3)

11.2 $P = V_{rms} I_{rms}$

$R_T = R_1 + R_2$ ✓

$= 8,2 + 10,4$ ✓

$= 18,6\ \Omega$ ✓

$P = \dfrac{V^2 (rms/wgk)}{R}$ ✓

$= (15^2/18,6)$ ✓

$= 12,09\ W$ ✓ [12.1.3] (5)

11.3. •Transformers can step-up the voltage resulting in a smaller current. ✓✓

Being transmitted ✓and less energy is lost✓

Transformators verhoog spanning wat veroorsaak dat die stroom verlaag ✓✓

Kan oorgedra word✓ *en energie gaan verlore*✓

[12.1.4] (2)

[10]

QUESTION/ *VRAAG 12*

12.1 Photoelectric effect is the emission of electrons from the surface of a metal when light, having a frequency greater than the threshold frequency of the metal, is radiated(shone) onto the metal surface. ✓✓

Die Foto-elektriese effek is die uitstraal van elektrone vanaf die oppervlakte van 'n metaal wanneer die metaal met lig met 'n frekwensie groter as die drumpelfrekwensie van die metaaoppervlak, bestraal word. ✓✓

[12.2.1] (2)

12.2 $E = hf$

$E = \frac{hc}{\lambda}$ ✓

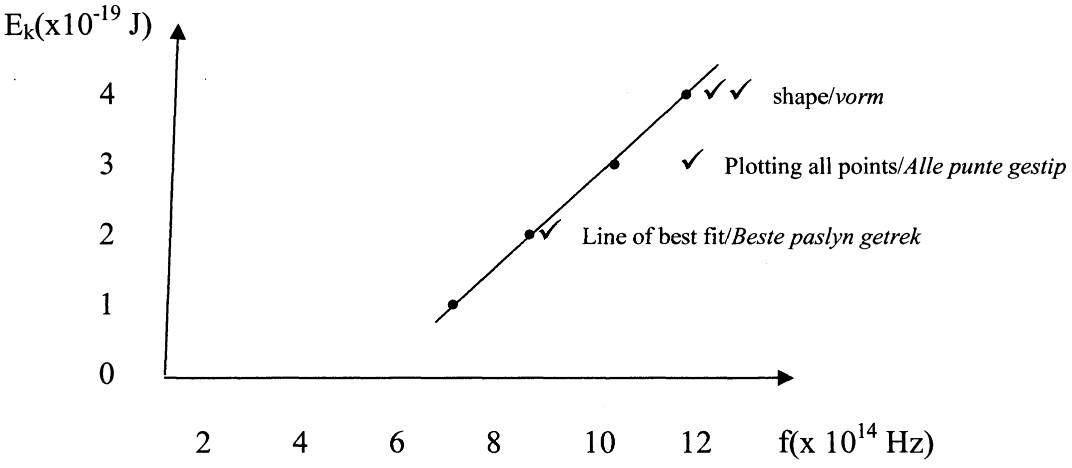
$= (6,6 \times 10^{-34})(3 \times 10^{8}) / (7,5 \times 10^{-7})$ ✓

$= 2,64 \times 10^{-19}$ J ✓ [12.1.3] (3)

12.3 Work function is the minimum energy needed to remove an electron from the surface of a metal. ✓✓

Werkfunksie is die minimum energie wat nodig is om 'n elektron vanaf die oppervlakte van die metaal te verwyder. ✓✓ [12.2.1] (2)

12.4.1



[12.1.2] (4)

12.4.2 $f_o = 5,4 \times 10^{14}$ Hz ✓✓ [12.1.2] (2)

12.5 $E = W_o + E_k$ ✓ ($E_k = \frac{1}{2}m_2v^2$; $E = hf$)

$E_k = E - W_o$

$= 2{,}64 \times 10^{-19} - 1{,}6 \times 10^{-19}$ ✓

$= 1{,}05 \times 10^{-19}$ J ✓ [12.1.3] (3)

[16]

TOTAL SECTION B / *TOTAAL AFDELING B*: 115

GRAND TOTAL / *GROOTTOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2010

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)

3. Answer ALL the questions in the ANSWER BOOK.

4. You may use a non-programmable calculator.

5. You may use appropriate mathematical instruments.

6. Number the answers correctly according to the numbering system used in this question paper.

7. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.

8. Give brief motivations, discussions, et cetera where required.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

1.1 The type of collision in which kinetic energy is conserved (1)

1.2 The principle which states that each point on a wave front acts as a source of secondary wavelets (1)

1.3 The unit of measure equivalent to one volt per ampere (1)

1.4 The component in a DC electric motor that ensures continuous rotation in one direction by reversing the direction of the current every half-cycle (1)

1.5 The minimum energy needed to eject an electron from a metal surface (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (2.1 – 2.10) in the ANSWER BOOK.

2.1 An object projected vertically upwards reaches its maximum height and returns to its original point of projection. Ignoring the effects of friction, the direction of the acceleration of the object during its motion is …

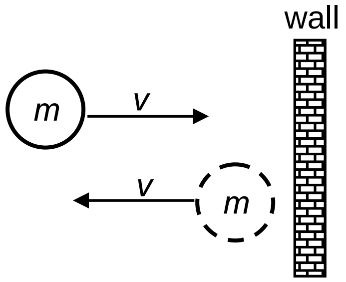
A always vertically downwards.

B first vertically upwards and then vertically downwards.

C first vertically downwards and then vertically upwards.

D always vertically upwards. (2)

2.2 A ball of mass *m* strikes a wall perpendicularly at a speed *v*. Immediately after the collision the ball moves in the opposite direction at the same speed *v*, as shown in the diagram below.



Which ONE of the following represents the magnitude of the change in momentum of the ball?

A 0

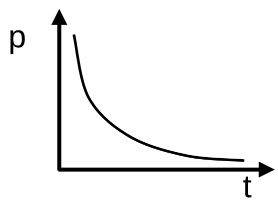
B *mv*

C 2*mv*

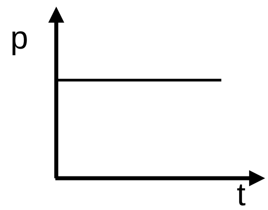
D 3*mv* (2)

2.3 Which ONE of the following momentum versus time graphs best represents the motion of an object that starts from rest and moves in a straight line under the influence of a constant net force?

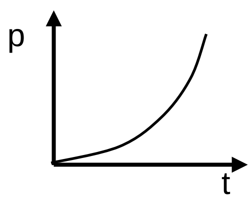
A



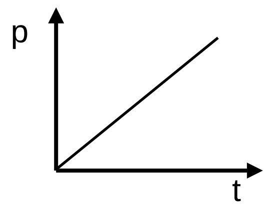
B



C



D



(2)

2.4 Which ONE of the following correctly represents the given types of electromagnetic radiation in order of INCREASING WAVELENGTH?

A Microwaves; infrared; ultraviolet

B Infrared; ultraviolet; X-rays

C Radio waves; infrared; gamma rays

D Ultraviolet; infrared; microwaves (2)

2.5 Which ONE of the following phenomena provides the most conclusive evidence for the wave nature of light?

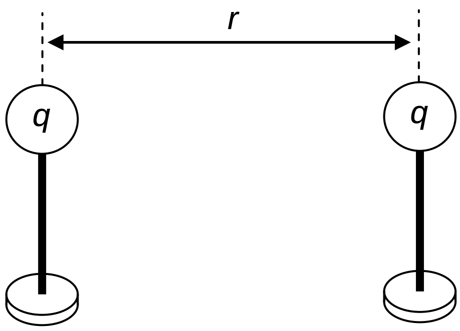
A Photoelectric effect

B Refraction

C Reflection

D Diffraction (2)

2.6 The diagram below represents two small spheres on insulated stands. Each sphere carries a positive charge of magnitude *q* and is separated by a distance *r*, as shown. The total electrical potential energy of the system of two charges is *U*.



The distance between the centres of the spheres is now HALVED.

Which ONE of the following now represents the magnitude of the electrical potential energy of the system of two charges?

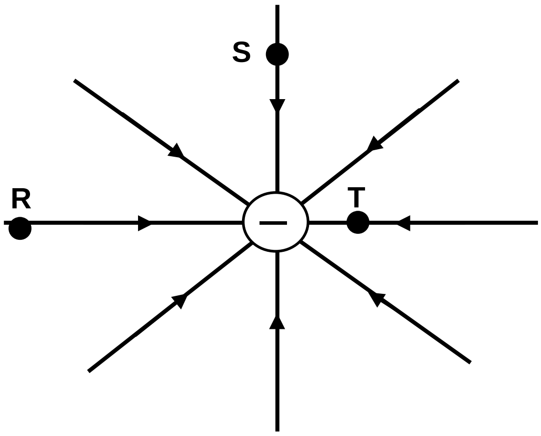
A $\frac{1}{4}U$

B $\frac{1}{2}U$

C $2U$

D $4U$ (2)

2.7 The diagram below represents the electric field pattern around a negative point charge. R, S and T are points at different distances from the negative point charge.



The magnitude of the electric field of the point charge is ...

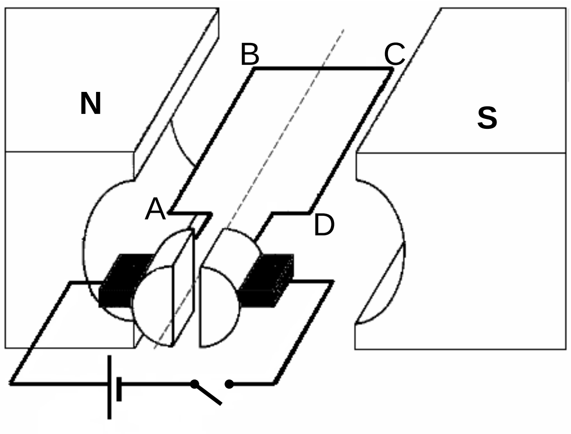
A greatest at point R.

B greatest at point S.

C greatest at point T.

D the same at points R, S and T. (2)

2.8 The simplified diagram of an electric motor is shown below.



When the switch is closed, coil ABCD rotates …

A clockwise.

B anticlockwise.

C clockwise until it reaches the vertical position and then reverses its direction.

D anticlockwise until it reaches the vertical position and then reverses its direction. (2)

2.9 A neon tube lights up when a large external voltage is applied across it.

Which ONE of the following best describes the type of spectrum observed when the gas inside the tube is viewed through a diffraction grating?

A Continuous

B Absorption

C Line emission

D Line absorption (2)

2.10 When a clean metal plate is irradiated with light of sufficient energy, photoelectrons are emitted. The INTENSITY of the light is now increased. This change will …

A increase the number of photoelectrons emitted per second.

B decrease the number of photoelectrons emitted per second.

C increase the kinetic energy of the emitted photoelectrons.

D decrease the kinetic energy of the emitted photoelectrons. (2)
[20]

TOTAL SECTION A: 25

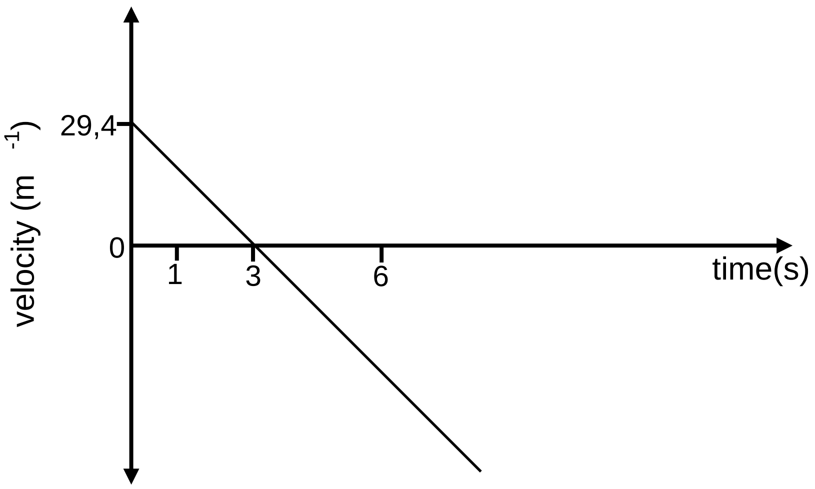
SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your numerical answers to TWO decimal places.

QUESTION 3 (Start on a new page.)

A man fires a projectile **X** vertically upwards at a velocity of 29,4 $m \cdot s^{-1}$ from the EDGE of a cliff of height 100 m. After some time the projectile lands on the ground below the cliff. The velocity-time graph below (NOT DRAWN TO SCALE) represents the motion of projectile **X**. (Ignore the effects of friction.)



3.1 Use the graph to determine the time that the projectile takes to reach its maximum height. (A calculation is not required.) (1)

3.2 Calculate the maximum height that projectile **X** reaches above the ground. (4)

3.3 Sketch the position-time graph for projectile **X** for the period t = 0 s to t = 6 s. USE THE EDGE OF THE CLIFF AS ZERO OF POSITION.

Indicate the following on the graph:

- The time when projectile **X** reaches its maximum height
- The time when projectile **X** reaches the edge of the cliff (4)

3.4 One second (1 s) after projectile **X** is fired, the man's friend fires a second projectile **Y** upwards at a velocity of 49 $m{\cdot}s^{-1}$ FROM THE GROUND BELOW THE CLIFF.

The first projectile, **X**, passes projectile **Y** 5,23 s after projectile **X** is fired. (Ignore the effects of friction.)

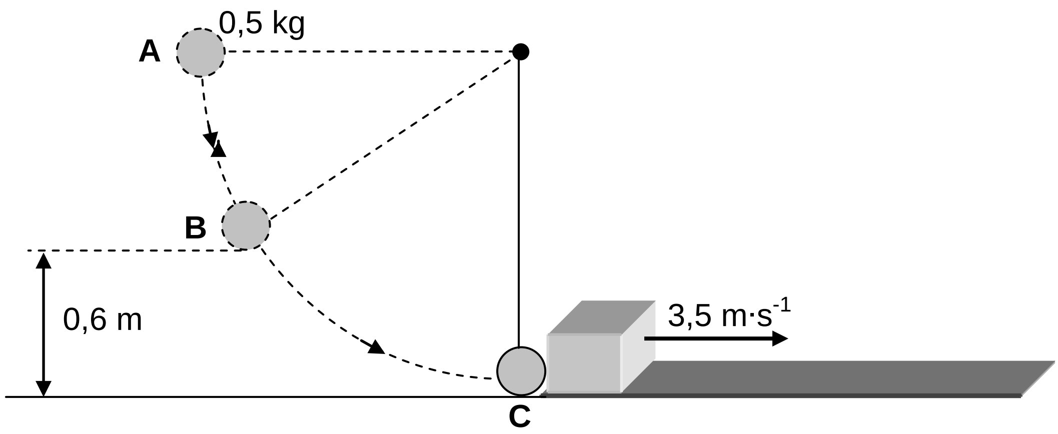
Calculate the following:

3.4.1 The velocity of projectile **X** at the instant it passes projectile **Y** (5)

3.4.2 The velocity of projectile **X** RELATIVE to projectile **Y** at the instant it passes projectile **Y** (5)
[19]

QUESTION 4 (Start on a new page.)

A steel ball of mass 0,5 kg is suspended from a string of negligible mass. It is released from rest at point **A**, as shown in the sketch below. As it passes through point **B**, which is 0,6 m above the ground, the magnitude of its velocity is 3 $m{\cdot}s^{-1}$. (Ignore the effects of friction.)



4.1 Write down the principle of the conservation of mechanical energy in words. (2)

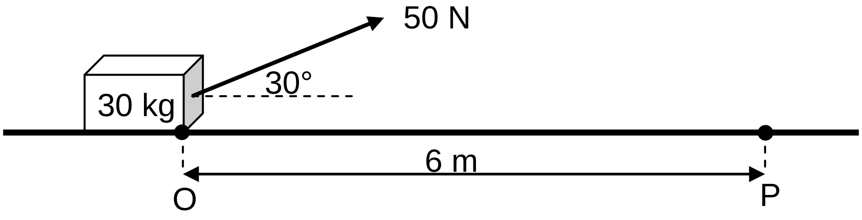
4.2 Calculate the mechanical energy of the steel ball at point **B**. (4)

As the steel ball swings through its lowest position at point **C**, it collides with a stationary crate of mass 0,1 kg. Immediately after the collision, the crate moves at a velocity of 3,5 $m{\cdot}s^{-1}$ to the right.

4.3 Calculate the velocity of the steel ball immediately after the collision. (7)
[13]

QUESTION 5 (Start on a new page.)

A worker pulls a crate of mass 30 kg from rest along a horizontal floor by applying a constant force of magnitude 50 N at an angle of 30° to the horizontal. A frictional force of magnitude 20 N acts on the crate whilst moving along the floor.



5.1 Draw a labelled free-body diagram to show ALL the forces acting on the crate during its motion. (4)

5.2 Give a reason why each of the vertical forces acting on the crate do NO WORK on the crate. (2)

5.3 Calculate the net work done on the crate as it reaches point P, 6 m from the starting point O. (4)

5.4 Use the work-energy theorem to calculate the speed of the crate at the instant it reaches point P. (3)

5.5 The worker now applies a force of the same magnitude, but at a SMALLER ANGLE to the horizontal, on the crate.

How does the work done by the worker now compare to the work done by the worker in QUESTION 5.3? Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (No calculations are required.) (2)

[15]

QUESTION 6 (Start on a new page.)

The siren of a burglar alarm system has a frequency of 960 Hz. During a patrol, a security officer, travelling in his car, hears the siren of the alarm of a house and approaches the house at constant velocity. A detector in his car registers the frequency of the sound as 1 000 Hz.

6.1 Name the phenomenon that explains the change in the observed frequency. (1)

6.2 Calculate the speed at which the patrol car approaches the house. Use the speed of sound in air as 340 $m \cdot s^{-1}$. (4)

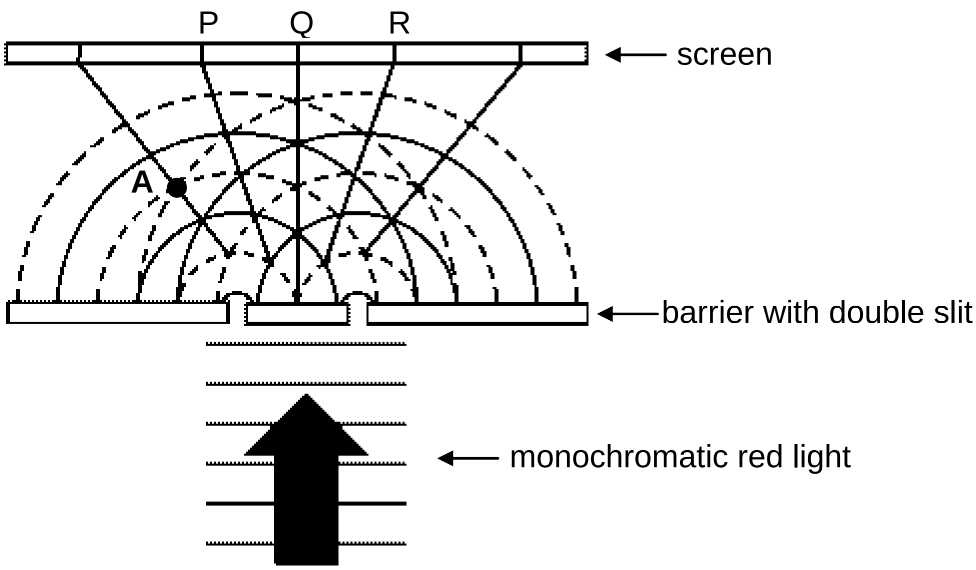
6.3 If the patrol car had approached the house at a higher speed, how would the detected frequency have compared to the first observed frequency of 1 000 Hz? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

[6]

QUESTION 7 (Start on a new page.)

Monochromatic red light passes through a double slit, as shown in the diagram below. Circular wave fronts, advancing towards the screen, are shown between the slits and the screen as dotted lines and solid lines. The solid lines represent crests and the dotted lines troughs.

Interference of the circular wave fronts results in an interference pattern observed on the screen. **P**, **Q** and **R** represent the centres of different bands in the interference pattern.



7.1 Define the term *interference*. (2)

7.2 What type of interference takes place at point **A**? Give a reason for the answer. (2)

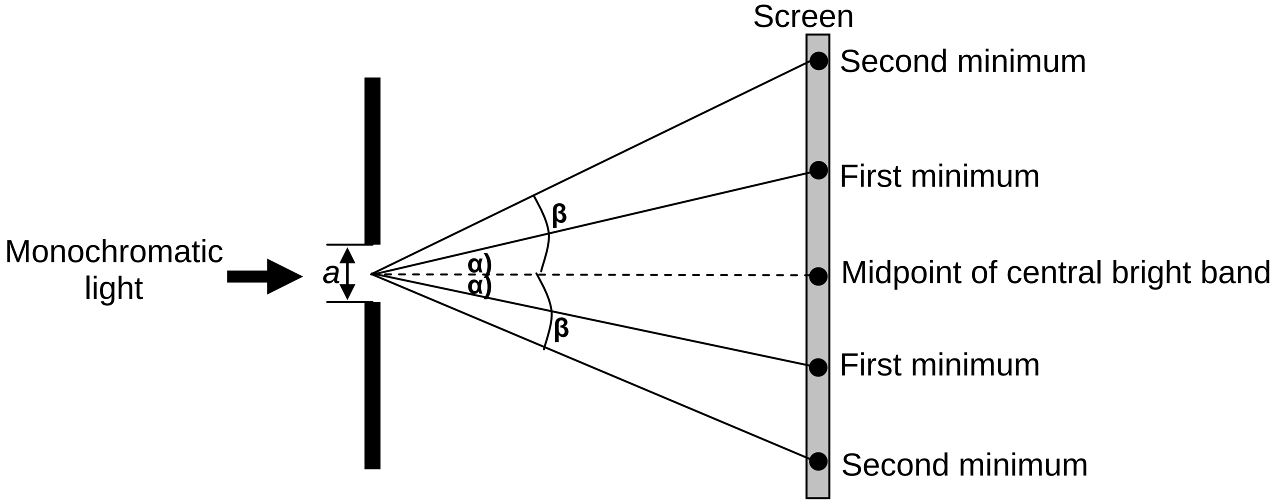
7.3 Is band **P** a dark band or a red band? Refer to the type of interference involved to explain how you arrived at the answer. (3)

[7]

QUESTION 8 (Start on a new page.)

The relationship between the degree of diffraction of light and slit width is investigated.

Monochromatic light of wavelength 410 nm is passed through a single slit at a *fixed distance* from a screen. The angles at which the first minimum (α) and the second minimum (β) occur are measured.



The experiment is repeated using the same light source but a slit of different width.

The results obtained from the two experiments are represented in the table below.

	ANGLE OF 1ST MINIMUM (α)	**ANGLE OF 2ND MINIMUM (β)**
Slit 1	10°	20°
Slit 2	5°	10°

8.1 Define the term *diffraction*. (2)

8.2 For this investigation, name the following:

8.2.1 Dependent variable (1)

8.2.2 Independent variable (1)

8.3 Which ONE of **Slit 1** or **Slit 2** is the narrower slit? Explain the answer. (2)

8.4 Use the data in the table to calculate the width of **Slit 2**. (4)
[10]

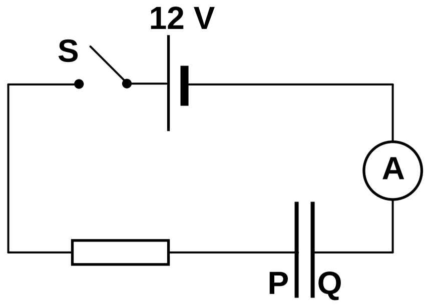
QUESTION 9 (Start on a new page.)

A certain parallel plate capacitor consists of two plates, each of dimension 15 mm by 20 mm, separated by a distance of 1,5 mm. The space between the plates is occupied by air.

9.1 Define the term *capacitance*, in words. (2)

9.2 Calculate the capacitance of this capacitor. (5)

The circuit diagram below shows the ABOVE CAPACITOR, initially uncharged, connected in series to a resistor, an ammeter of negligible resistance and a source with an emf of 12 V. The internal resistance of the battery is negligible.



Switch **S** is now closed.

9.3 Draw a sketch graph of current versus time to show how the ammeter reading changes with time as the capacitor charges. (2)

The capacitor is now fully charged.

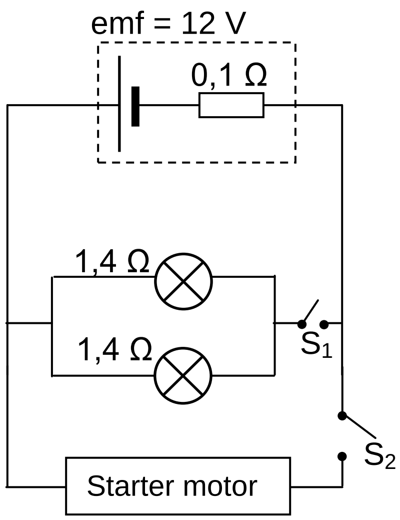
9.4 Calculate the magnitude of the charge on each plate of the capacitor. (3)

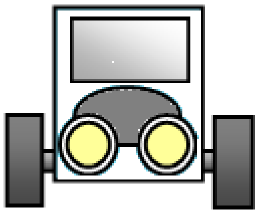
9.5 One of the molecules in the air between the plates of the capacitor becomes ionised. This ion carries a charge of $+3,2 \times 10^{-19}$ C. Calculate the magnitude of the electrostatic force experienced by this ion between the plates. (5)

[17]

QUESTION 10 (Start on a new page.)

The headlights of a car are connected in parallel to a 12 V battery, as shown in the simplified circuit diagram below. The internal resistance of the battery is 0,1 Ω and each headlight has a resistance of 1,4 Ω. The starter motor is connected in parallel with the headlights and controlled by the ignition switch, $\mathbf{S_2}$. The resistance of the connecting wires may be ignored.





10.1 State Ohm's law in words. (2)

10.2 With only switch $\mathbf{S_1}$ closed, calculate the following:

10.2.1 Effective resistance of the two headlights (3)

10.2.2 Potential difference across the two headlights (4)

10.2.3 Power dissipated by one of the headlights (3)

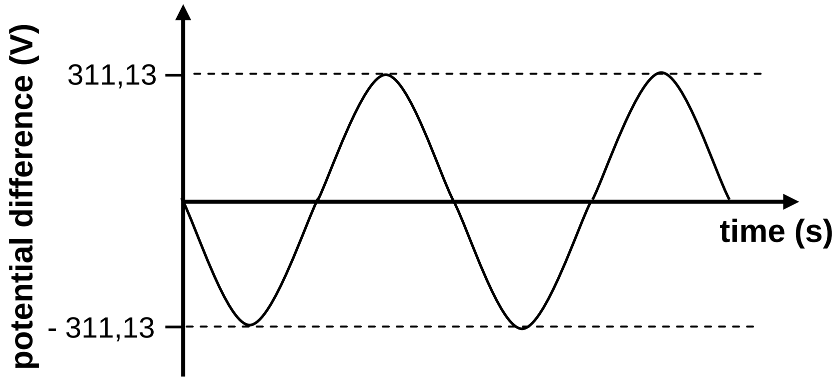
10.3 Ignition switch $\mathbf{S_2}$ is now closed (whilst $\mathbf{S_1}$ is also closed) for a short time and the starter motor, with VERY LOW RESISTANCE, rotates.

How will the brightness of the headlights be affected while switch $\mathbf{S_2}$ is closed? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Fully explain how you arrived at the answer. (4)
[16]

QUESTION 11 (Start on a new page.)

The output of an AC generator is shown in the graph below.



A light bulb with an average power rating of 100 W is connected to this generator.

11.1 Calculate the following:

11.1.1 rms potential difference across the light bulb (3)

11.1.2 Peak current (I_{max}) through the light bulb (5)

11.2 The AC generator is replaced with a DC generator. Draw the graph of potential difference versus time for the output of the DC generator. (No numerical values are expected on the axes.) (2)

[10]

QUESTION 12 (Start on a new page.)

Sunlight is a major source of ultraviolet light.

12.1 Overexposure to ultraviolet light could have harmful effects on humans. State ONE of these harmful effects on humans. (1)

12.2 Medical practitioners expose surgery equipment to ultraviolet light. Give a reason for doing this. (1)

A certain metal has a work function of $3,84 \times 10^{-19}$ J. The surface of the metal is irradiated with ultraviolet light of wavelength 200 nm causing photoelectrons to be emitted.

12.3 Calculate the energy of a photon of ultraviolet light. (4)

12.4 Calculate the maximum velocity of the emitted photoelectrons. (4)

12.5 Will photoelectrons be emitted from the surface of this metal if it is irradiated with X-rays? Give a reason for the answer. (2)

[12]

TOTAL SECTION B: 125
GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m \cdot s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}\ m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J \cdot s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}\ N \cdot m^{2} \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	$8,85 \times 10^{-12}\ F \cdot m^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/*of* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x \cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ $E = h\frac{c}{\lambda}$
$\sin\theta = \frac{m\lambda}{a}$	$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F=\frac{kQ_1Q_2}{r^2}$	$E=\frac{kQ}{r^2}$
$E=\frac{V}{d}$	$E=\frac{F}{q}$
$U=\frac{kQ_1Q_2}{r}$	$V=\frac{W}{q}$
$C=\frac{Q}{V}$	$C=\frac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R=\frac{V}{I}$	emf (ε) = $I(R + r)$/ emk (ε) = $I(R + r)$
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p}=\frac{1}{R_1}+\frac{1}{R_2}+...$	$q = I\,\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P=\frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P=\frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms}=\frac{I_{max}}{\sqrt{2}}$ / $I_{wgk}=\frac{I_{maks}}{\sqrt{2}}$ $V_{rms}=\frac{V_{max}}{\sqrt{2}}$ / $V_{wgk}=\frac{V_{maks}}{\sqrt{2}}$	$P_{average}=V_{rms}I_{rms}$ / $P_{gemiddeld}=V_{wgk}I_{wgk}$ $P_{average}=I_{rms}^2R$ / $P_{gemiddeld}=I_{wgk}^2R$ $P_{average}=\frac{V_{rms}^2}{R}$ / $P_{gemiddeld}=\frac{V_{wgk}^2}{R}$

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2010

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

1.1 The type of collision in which kinetic energy is conserved (1)

1.2 The principle which states that each point on a wave front acts as a source of secondary wavelets (1)

1.3 The unit of measure equivalent to one volt per ampere (1)

1.4 The component in a DC electric motor that ensures continuous rotation in one direction by reversing the direction of the current every half-cycle (1)

1.5 The minimum energy needed to eject an electron from a metal surface (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (2.1 – 2.10) in the ANSWER BOOK.

2.1 An object projected vertically upwards reaches its maximum height and returns to its original point of projection. Ignoring the effects of friction, the direction of the acceleration of the object during its motion is …

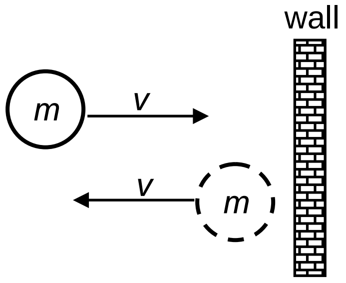
A always vertically downwards.

B first vertically upwards and then vertically downwards.

C first vertically downwards and then vertically upwards.

D always vertically upwards. (2)

2.2 A ball of mass *m* strikes a wall perpendicularly at a speed *v*. Immediately after the collision the ball moves in the opposite direction at the same speed *v*, as shown in the diagram below.



Which ONE of the following represents the magnitude of the change in momentum of the ball?

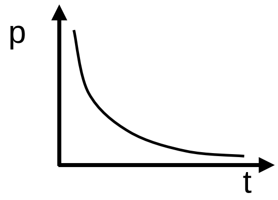
A 0

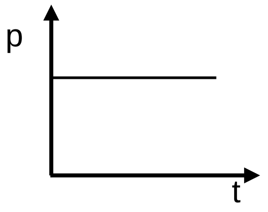
B *mv*

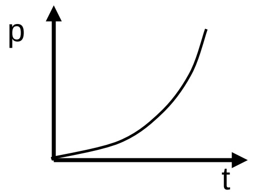
C 2*mv*

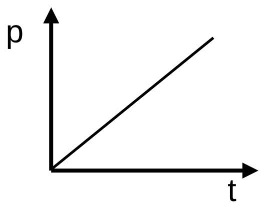
D 3*mv* (2)

2.3 Which ONE of the following momentum versus time graphs best represents the motion of an object that starts from rest and moves in a straight line under the influence of a constant net force?

A


B


C


D


(2)

2.4 Which ONE of the following correctly represents the given types of electromagnetic radiation in order of INCREASING WAVELENGTH?

A Microwaves; infrared; ultraviolet

B Infrared; ultraviolet; X-rays

C Radio waves; infrared; gamma rays

D Ultraviolet; infrared; microwaves (2)

2.5 Which ONE of the following phenomena provides the most conclusive evidence for the wave nature of light?

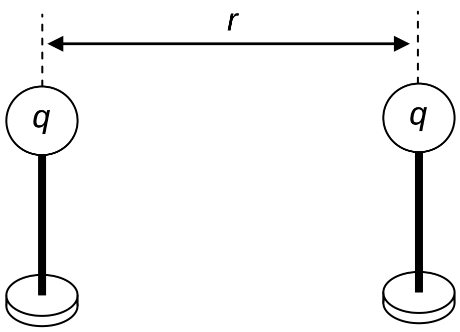
A Photoelectric effect

B Refraction

C Reflection

D Diffraction (2)

2.6 The diagram below represents two small spheres on insulated stands. Each sphere carries a positive charge of magnitude *q* and is separated by a distance *r*, as shown. The total electrical potential energy of the system of two charges is *U*.



The distance between the centres of the spheres is now HALVED.

Which ONE of the following now represents the magnitude of the electrical potential energy of the system of two charges?

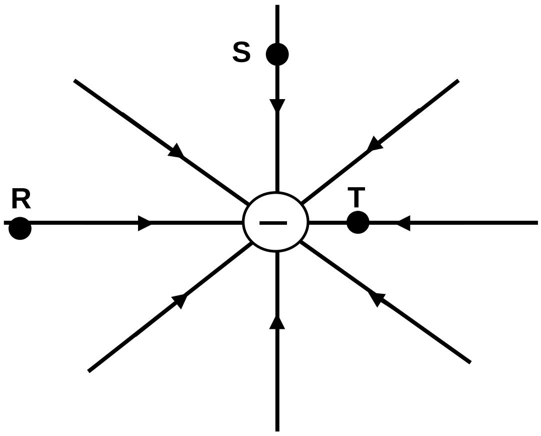
A $\frac{1}{4}U$

B $\frac{1}{2}U$

C $2U$

D $4U$ (2)

2.7 The diagram below represents the electric field pattern around a negative point charge. R, S and T are points at different distances from the negative point charge.



The magnitude of the electric field of the point charge is ...

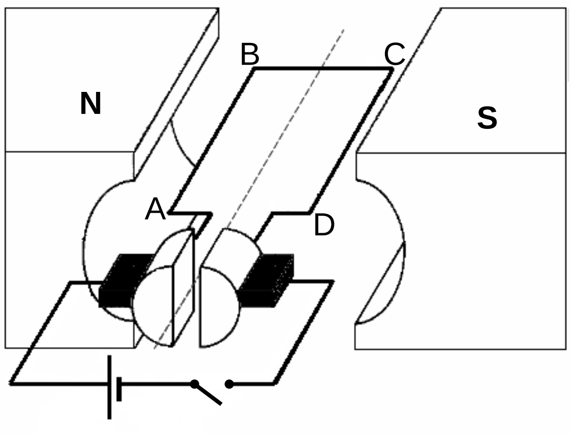
A greatest at point R.

B greatest at point S.

C greatest at point T.

D the same at points R, S and T. (2)

2.8 The simplified diagram of an electric motor is shown below.



When the switch is closed, coil ABCD rotates …

A clockwise.

B anticlockwise.

C clockwise until it reaches the vertical position and then reverses its direction.

D anticlockwise until it reaches the vertical position and then reverses its direction. (2)

2.9 A neon tube lights up when a large external voltage is applied across it.

Which ONE of the following best describes the type of spectrum observed when the gas inside the tube is viewed through a diffraction grating?

A Continuous

B Absorption

C Line emission

D Line absorption (2)

2.10 When a clean metal plate is irradiated with light of sufficient energy, photoelectrons are emitted. The INTENSITY of the light is now increased. This change will …

A increase the number of photoelectrons emitted per second.

B decrease the number of photoelectrons emitted per second.

C increase the kinetic energy of the emitted photoelectrons.

D decrease the kinetic energy of the emitted photoelectrons. (2)
[20]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.

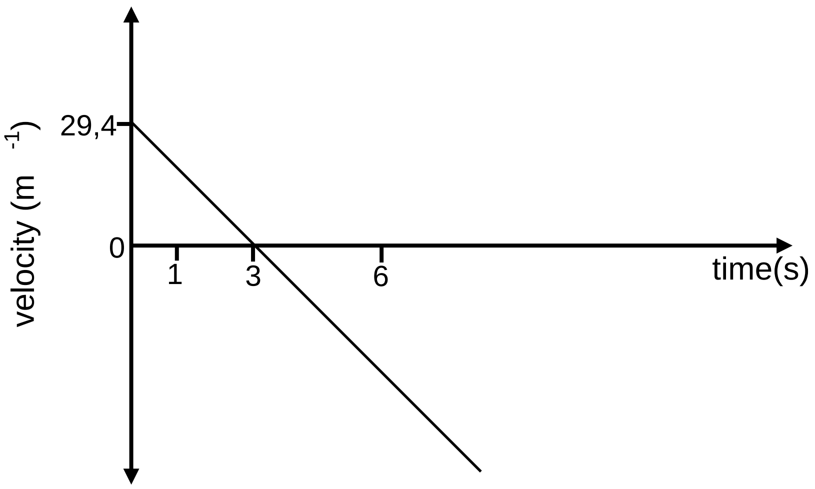
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

3. Show the formulae and substitutions in ALL calculations.

4. Round off your numerical answers to TWO decimal places.

QUESTION 3 (Start on a new page.)

A man fires a projectile **X** vertically upwards at a velocity of 29,4 $m \cdot s^{-1}$ from the EDGE of a cliff of height 100 m. After some time the projectile lands on the ground below the cliff. The velocity-time graph below (NOT DRAWN TO SCALE) represents the motion of projectile **X**. (Ignore the effects of friction.)



3.1 Use the graph to determine the time that the projectile takes to reach its maximum height. (A calculation is not required.) (1)

3.2 Calculate the maximum height that projectile **X** reaches above the ground. (4)

3.3 Sketch the position-time graph for projectile **X** for the period t = 0 s to t = 6 s. USE THE EDGE OF THE CLIFF AS ZERO OF POSITION.

Indicate the following on the graph:

- The time when projectile **X** reaches its maximum height
- The time when projectile **X** reaches the edge of the cliff (4)

3.4 One second (1 s) after projectile **X** is fired, the man's friend fires a second projectile **Y** upwards at a velocity of 49 $m\cdot s^{-1}$ FROM THE GROUND BELOW THE CLIFF.

The first projectile, **X**, passes projectile **Y** 5,23 s after projectile **X** is fired. (Ignore the effects of friction.)

Calculate the following:

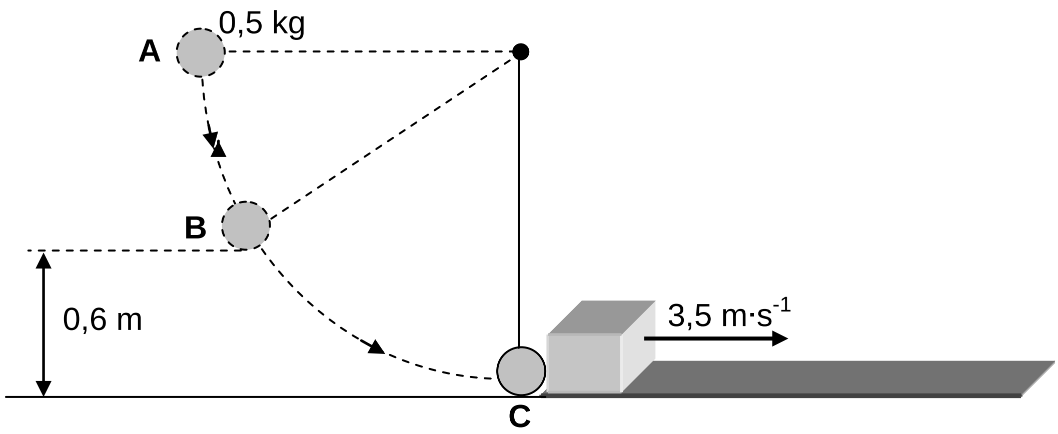
3.4.1 The velocity of projectile **X** at the instant it passes projectile **Y** (5)

3.4.2 The velocity of projectile **X** RELATIVE to projectile **Y** at the instant it passes projectile **Y** (5)

[19]

QUESTION 4 (Start on a new page.)

A steel ball of mass 0,5 kg is suspended from a string of negligible mass. It is released from rest at point **A**, as shown in the sketch below. As it passes through point **B**, which is 0,6 m above the ground, the magnitude of its velocity is 3 $m\cdot s^{-1}$. (Ignore the effects of friction.)



4.1 Write down the principle of the conservation of mechanical energy in words. (2)

4.2 Calculate the mechanical energy of the steel ball at point **B**. (4)

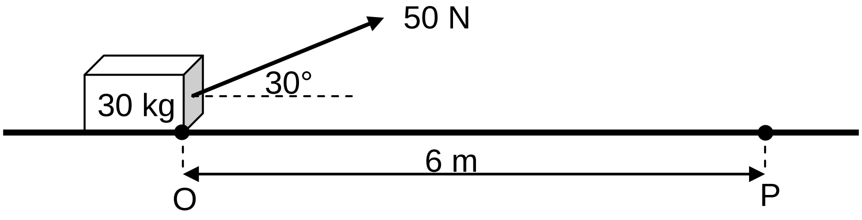
As the steel ball swings through its lowest position at point **C**, it collides with a stationary crate of mass 0,1 kg. Immediately after the collision, the crate moves at a velocity of 3,5 $m\cdot s^{-1}$ to the right.

4.3 Calculate the velocity of the steel ball immediately after the collision. (7)

[13]

QUESTION 5 (Start on a new page.)

A worker pulls a crate of mass 30 kg from rest along a horizontal floor by applying a constant force of magnitude 50 N at an angle of 30° to the horizontal. A frictional force of magnitude 20 N acts on the crate whilst moving along the floor.



5.1 Draw a labelled free-body diagram to show ALL the forces acting on the crate during its motion. (4)

5.2 Give a reason why each of the vertical forces acting on the crate do NO WORK on the crate. (2)

5.3 Calculate the net work done on the crate as it reaches point P, 6 m from the starting point O. (4)

5.4 Use the work-energy theorem to calculate the speed of the crate at the instant it reaches point P. (3)

5.5 The worker now applies a force of the same magnitude, but at a SMALLER ANGLE to the horizontal, on the crate.

How does the work done by the worker now compare to the work done by the worker in QUESTION 5.3? Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (No calculations are required.) (2)

[15]

QUESTION 6 (Start on a new page.)

The siren of a burglar alarm system has a frequency of 960 Hz. During a patrol, a security officer, travelling in his car, hears the siren of the alarm of a house and approaches the house at constant velocity. A detector in his car registers the frequency of the sound as 1 000 Hz.

6.1 Name the phenomenon that explains the change in the observed frequency. (1)

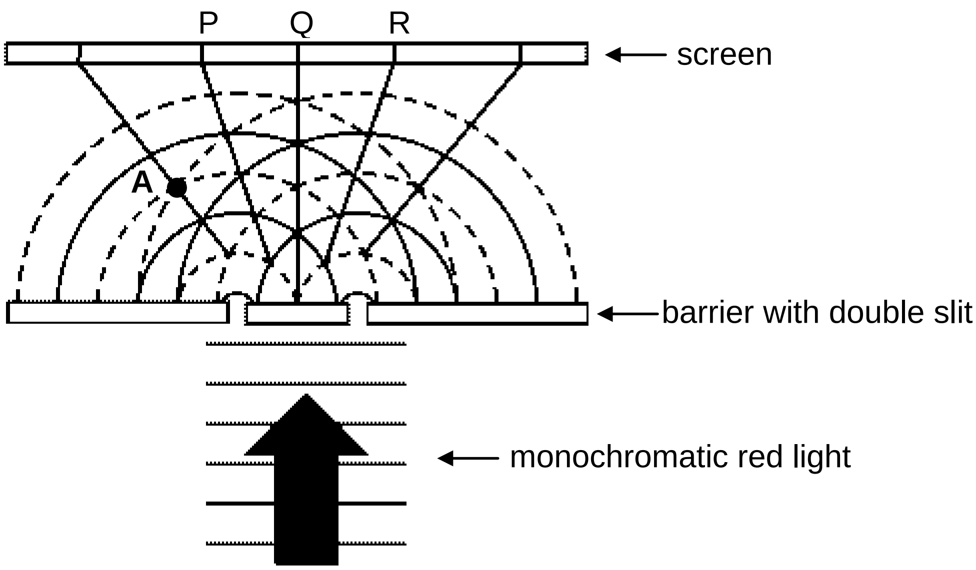
6.2 Calculate the speed at which the patrol car approaches the house. Use the speed of sound in air as 340 $m \cdot s^{-1}$. (4)

6.3 If the patrol car had approached the house at a higher speed, how would the detected frequency have compared to the first observed frequency of 1 000 Hz? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)
[6]

QUESTION 7 (Start on a new page.)

Monochromatic red light passes through a double slit, as shown in the diagram below. Circular wave fronts, advancing towards the screen, are shown between the slits and the screen as dotted lines and solid lines. The solid lines represent crests and the dotted lines troughs.

Interference of the circular wave fronts results in an interference pattern observed on the screen. **P**, **Q** and **R** represent the centres of different bands in the interference pattern.



7.1 Define the term *interference*. (2)

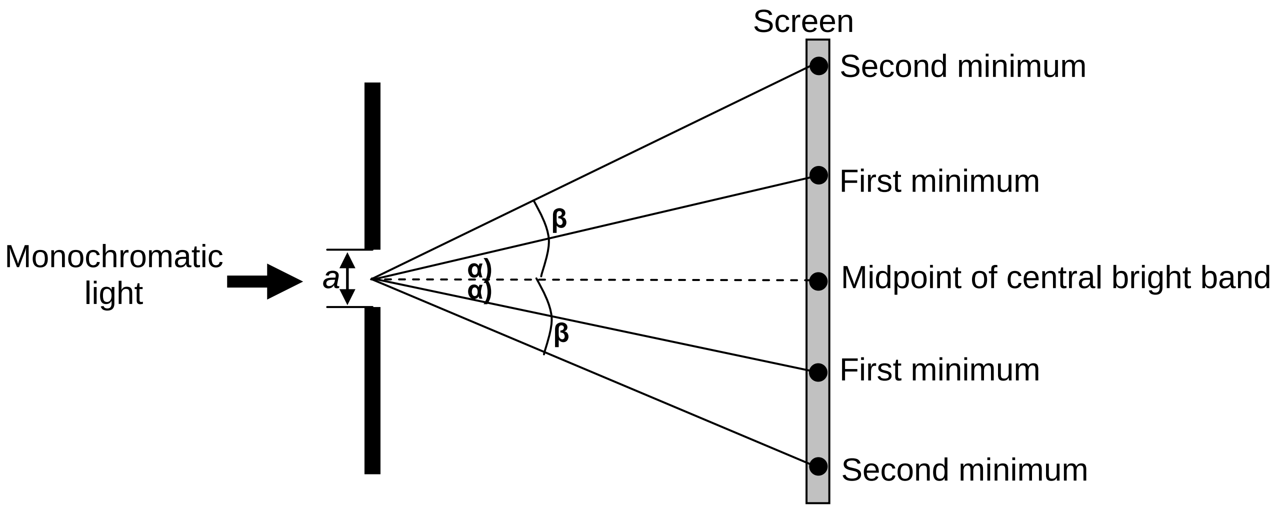
7.2 What type of interference takes place at point **A**? Give a reason for the answer. (2)

7.3 Is band **P** a dark band or a red band? Refer to the type of interference involved to explain how you arrived at the answer. (3)
[7]

QUESTION 8 (Start on a new page.)

The relationship between the degree of diffraction of light and slit width is investigated.

Monochromatic light of wavelength 410 nm is passed through a single slit at a *fixed distance* from a screen. The angles at which the first minimum (α) and the second minimum (β) occur are measured.



The experiment is repeated using the same light source but a slit of different width.

The results obtained from the two experiments are represented in the table below.

	ANGLE OF 1ST MINIMUM (α)	ANGLE OF 2ND MINIMUM (β)
Slit 1	10°	20°
Slit 2	5°	10°

8.1 Define the term *diffraction*. (2)

8.2 For this investigation, name the following:

8.2.1 Dependent variable (1)

8.2.2 Independent variable (1)

8.3 Which ONE of **Slit 1** or **Slit 2** is the narrower slit? Explain the answer. (2)

8.4 Use the data in the table to calculate the width of **Slit 2**. (4)
[10]

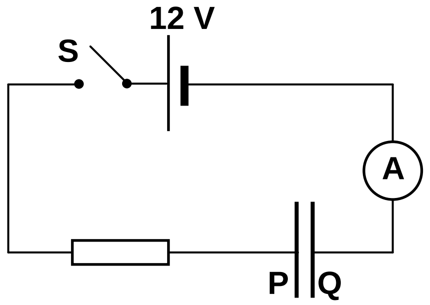
QUESTION 9 (Start on a new page.)

A certain parallel plate capacitor consists of two plates, each of dimension 15 mm by 20 mm, separated by a distance of 1,5 mm. The space between the plates is occupied by air.

9.1 Define the term *capacitance*, in words. (2)

9.2 Calculate the capacitance of this capacitor. (5)

The circuit diagram below shows the ABOVE CAPACITOR, initially uncharged, connected in series to a resistor, an ammeter of negligible resistance and a source with an emf of 12 V. The internal resistance of the battery is negligible.



Switch **S** is now closed.

9.3 Draw a sketch graph of current versus time to show how the ammeter reading changes with time as the capacitor charges. (2)

The capacitor is now fully charged.

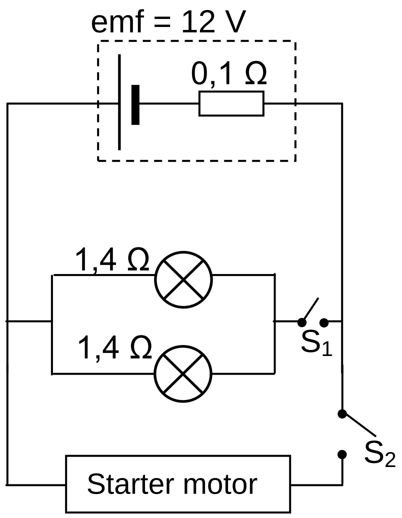
9.4 Calculate the magnitude of the charge on each plate of the capacitor. (3)

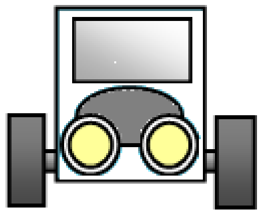
9.5 One of the molecules in the air between the plates of the capacitor becomes ionised. This ion carries a charge of $+3,2 \times 10^{-19}$ C. Calculate the magnitude of the electrostatic force experienced by this ion between the plates. (5)

[17]

QUESTION 10 (Start on a new page.)

The headlights of a car are connected in parallel to a 12 V battery, as shown in the simplified circuit diagram below. The internal resistance of the battery is 0,1 Ω and each headlight has a resistance of 1,4 Ω. The starter motor is connected in parallel with the headlights and controlled by the ignition switch, $\mathbf{S_2}$. The resistance of the connecting wires may be ignored.





10.1 State Ohm's law in words. (2)

10.2 With only switch $\mathbf{S_1}$ closed, calculate the following:

10.2.1 Effective resistance of the two headlights (3)

10.2.2 Potential difference across the two headlights (4)

10.2.3 Power dissipated by one of the headlights (3)

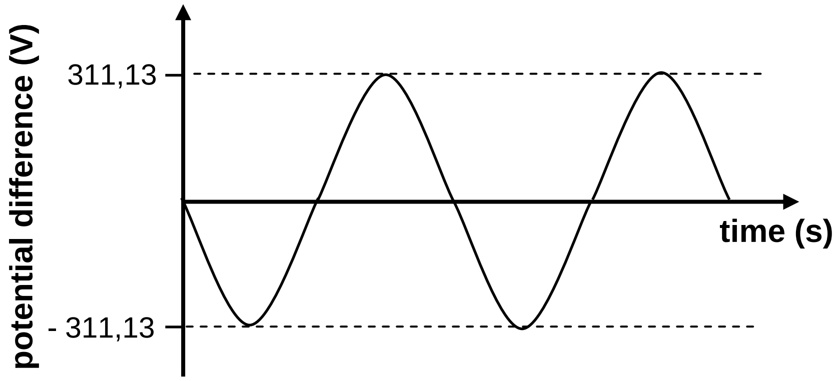
10.3 Ignition switch $\mathbf{S_2}$ is now closed (whilst $\mathbf{S_1}$ is also closed) for a short time and the starter motor, with VERY LOW RESISTANCE, rotates.

How will the brightness of the headlights be affected while switch $\mathbf{S_2}$ is closed? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Fully explain how you arrived at the answer. (4)
[16]

QUESTION 11 (Start on a new page.)

The output of an AC generator is shown in the graph below.



A light bulb with an average power rating of 100 W is connected to this generator.

11.1 Calculate the following:

11.1.1 rms potential difference across the light bulb (3)

11.1.2 Peak current (I_{max}) through the light bulb (5)

11.2 The AC generator is replaced with a DC generator. Draw the graph of potential difference versus time for the output of the DC generator. (No numerical values are expected on the axes.) (2)

[10]

QUESTION 12 (Start on a new page.)

Sunlight is a major source of ultraviolet light.

12.1 Overexposure to ultraviolet light could have harmful effects on humans. State ONE of these harmful effects on humans. (1)

12.2 Medical practitioners expose surgery equipment to ultraviolet light. Give a reason for doing this. (1)

A certain metal has a work function of $3,84 \times 10^{-19}$ J. The surface of the metal is irradiated with ultraviolet light of wavelength 200 nm causing photoelectrons to be emitted.

12.3 Calculate the energy of a photon of ultraviolet light. (4)

12.4 Calculate the maximum velocity of the emitted photoelectrons. (4)

12.5 Will photoelectrons be emitted from the surface of this metal if it is irradiated with X-rays? Give a reason for the answer. (2)

[12]

TOTAL SECTION B: 125
GRAND TOTAL: 150

SECTION A

QUESTION 1

1.1	Elastic ✓	[12.2.1]	(1)
1.2	Huygens' (principle) ✓	[12.2.1]	(1)
1.3	ohm / Ω ✓	[12.2.1]	(1)
1.4	(Split-ring) commutator ✓	[12.2.1]	(1)
1.5	Work function ✓	[12.2.1]	(1)
			[5]

QUESTION 2

2.1	A ✓✓	[12.2.3]	(2)
2.2	C ✓✓	[12.1.2]	(2)
2.3	D ✓✓	[12.2.3]	(2)
2.4	D ✓✓	[12.2.2]	(2)
2.5	D ✓✓	[12.2.1]	(2)
2.6	C ✓✓	[12.2.2]	(2)
2.7	C ✓✓	[12.2.2]	(2)
2.8	B ✓✓	[12.1.2]	(2)
2.9	C ✓✓	[12.2.1]	(2)
2.10	A ✓✓	[12.2.2]	(2)
			[20]

TOTAL SECTION A: 25

SECTION B

QUESTION 3

3.1 3 seconds / 3 s ✓ [12.1.2] (1)

3.2

Accept the equations:	
v = u + at	$s = ut + \frac{1}{2}at^2$
$s = \left(\frac{v + u}{2}\right)t$	$v^2 = u^2 + 2as$

OPTION 1
Area between graph and time axis
Δy = (area of triangle)/ ½ bh ✓
= <u>½ (3)(29,4)</u> ✓
= 44,1 m

Maximum height above ground:
<u>100 +✓</u> 44,1 = 144,1 m ✓

OPTION 2
$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ OR $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$= \left(\frac{0 + 29,4}{2}\right)3$ ✓ $= \left(\frac{29,4 + 0}{2}\right)3$

= 44,1 m (43,22m)

Maximum height above ground:
<u>100 +✓</u> 44,1 = 144,1 m ✓(143,22m)

OPTION 3
From edge of cliff to max height
(Upward positive)
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
∴ <u>$0^2 = 29,4^2 + 2(-9,8)\Delta y$</u> ✓
∴ Δy = 44,1 m

Maximum height above ground:
<u>100 +</u>✓ 44,1 = 144,1 m✓

From edge of cliff to max height)
(Downward positive)
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
∴ <u>$0^2 = (-29,4)^2 + 2(9,8)\Delta y$</u> ✓
∴ Δy = - 44,1 m

Maximum height above ground:
<u>100 +</u>✓ 44,1 = 144,1 m✓

OPTION 4
From edge of cliff to max height
(Upward positive)
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
= (29,4)(3) + ½(-9,8)(3)^2 ✓
= 44,1 m

Maximum height above ground:
100 +✓ 44,1 = 144,1 m ✓(143,2 m)

From edge of cliff to max height)
(Downward positive)
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
= (-29,4)(3) + ½(9,8)(3)^2 ✓
= - 44,1 m

Maximum height above ground:
100 +✓ 44,1 = 144,1 m ✓

OPTION 5
From max height to edge of cliff
Downward positive
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
(29,4)^2 = 0^2 + 2(9,8)Δy ✓
∴ Δy = 44,1 m

Maximum height above ground:
100 +✓ 44,1 = 144,1 m✓

OPTION 6
From max height to edge of cliff
Downward positive
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
= (0)(3) + ½(9,8)(3)^2 ✓
= 44,1 m

Maximum height above ground:
100 +✓ 44,1 = 144,1 m ✓

OPTION 7
$E_{mech\ (edge\ of\ cliff)} = E_{mech\ (max\ height)}$
$(mgh + ½ mv^2)_A = (mgh + ½ mv^2)_B$ } ✓ any equation
$m(gh + ½ v^2)_A = m(gh + ½ v^2)_B$

(9,8)(100)+ ½ (29,4)^2 ✓= (9,8)h + 0 ✓
h = 144,1 m ✓

OPTION 8
$W_{net} = \Delta E_k$
$mgh\cos\theta = ½ m(v_f^2 – v_i^2)$ } ✓any equation
$m(gh\cos\theta) = ½m(v_f^2 - v_i^2)$

(9,8)hcos180^o = ½ (0^2 - (29,4)^2) ✓
h = 44,1 m (43,22m)

Maximum height above ground:
100 +✓ 44,1 = 144,1 m ✓

OPTION 9
$E_{mech\ (edge\ of\ cliff)} = E_{mech\ (max\ height)}$
$(mgh + ½ mv^2)_A = (mgh + ½ mv^2)_B$ } any equation
$m(gh + ½ v^2)_A = m(gh + ½ v^2)_B$

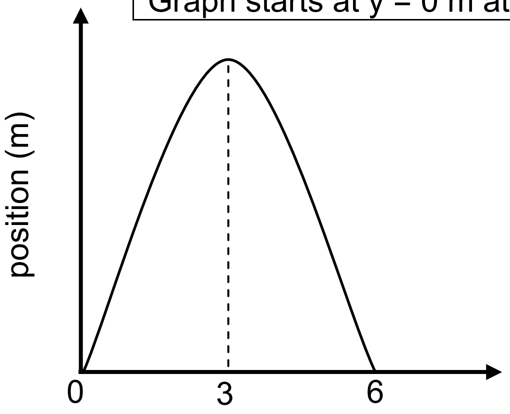
0 + ½ (29,4)^2 = (9,8)h + 0 ✓
h = 44,1 m

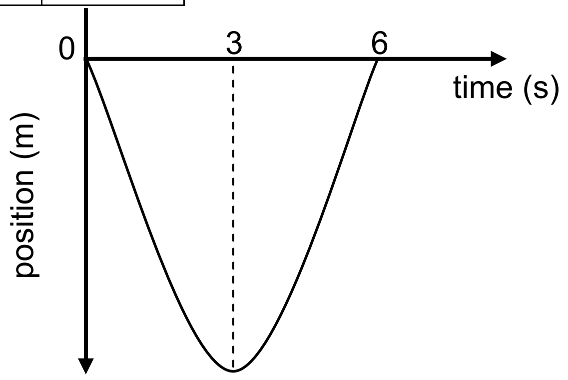
Maximum height above ground:
100 +✓ 44,1 = 144,1 m ✓

[12.1.2]
[12.2.3] (4)

3.3

Checklist: Criteria for graph	Marks
Correct shape	✓
t = 3 s at maximum height	✓
t = 6 s at y = 0 m	✓
Graph starts at y = 0 m at t = 0 s	✓





[12.1.2] (4)

3.4.1

OPTION 1:

Upward positive:

$v_f = v_i + a\Delta t$ ✓

$= \underline{29,4}$✓ $+ \underline{(-9,8)(5,23)}$ ✓

$= -21,85\ m\cdot s^{-1}$ ✓downwards ✓

OR

$v_f = 21,85\ m\cdot s^{-1}$ ✓downwards✓

Downward positive:

$v_f = v_i + a\Delta t$ ✓

$= \underline{-29,4}$ ✓+ $\underline{(9,8)(5,23)}$ ✓

$= 21,85\ m\cdot s^{-1}$ ✓downwards ✓

OPTION 2

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$= 29,4\ (5,23) + ½\ (-9,8)(5,23)^2$

$= 19,73\ m$

✓(for both formulae)

$v_f^2 = v_i^2 + 2a\Delta y$

$= \underline{29,4^2}$ ✓+ $\underline{2(-9,8)(19,73)}$ ✓

$\therefore v_f = 21,85\ m\cdot s^{-1}$ ✓downwards ✓

Downward positive:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$= (-29,4)(5,23) + ½\ (9,8)(5,23)^2$

$= -19,73\ m$

✓(for both formulae)

$v_f^2 = v_i^2 + 2a\Delta y$

$= \underline{(-29,4)^2}$ ✓+ $\underline{2(9,8)(-19,73)}$ ✓

$\therefore v_f = 21,85\ m\cdot s^{-1}$ ✓downwards ✓

POSITIVE MARKING FROM 3.1

OPTION 3 (Downward motion only)

Downward positive:

Time for downward motion:

(5,23 – 3)✓ = 2,23 s

$v_f = v_i + a\Delta t$ ✓

$= \underline{0 + (9,8)(2,23)}$ ✓

$= 21,85\ m\cdot s^{-1}$ ✓downwards ✓

OPTION 4

Downward positive:

Time for downward motion:

(5,23 – 3)✓ = 2,23 s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$= \underline{(0)(2,23) + ½\ (9,8)(2,23)^2}$

$= 24,36721\ m$

✓(for both formulae)

$v_f^2 = v_i^2 + 2a\Delta y$

$= \underline{(0)^2 + 2(9,8)(24,36721)}$ ✓

$\therefore v_f = 21,85\ m\cdot s^{-1}$ ✓downwards ✓

[12.2.3] (5)

3.4.2 **POSITIVE MARKING FROM QUESTION 3.4.1**

OPTION 1

Upward positive:

$\Delta t = (5,23 – 1)$ ✓ = 4,23 s

$v_f = v_i + a\Delta t$ ✓

$= \underline{49 + (-9,8)(4,23)}$ ✓

$v_f = 7,55\ m\cdot s^{-1}$ upwards

$\Delta v_{XY} = v_X - v_Y$ (vector difference)

$= -21,85 - 7,55$

$= -29,40\ m\cdot s^{-1}$ ✓downwards✓

OR

$v_{XY} = 29,40\ m\cdot s^{-1}$✓ downwards✓

$v_{XY} = v_{XG} + v_{GY}$

$= -21,85 + (-7,55)$

$= -29,40\ m\cdot s^{-1}$ ✓downwards✓

OR

$v_{XY} = 29,40\ m\cdot s^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$

$-21,85 = v_{XY} + (7,55)$

$= -29,40\ m\cdot s^{-1}$ ✓downwards✓

OR

$v_{XY} = 29,40\ m\cdot s^{-1}$ ✓downwards✓

Downward positive:

$\Delta t = (5,23 - 1)$ ✓ $= 4,23$ s

$v_f = v_i + a\Delta t$ ✓
$= \underline{-49 + (9,8)(4,23)}$ ✓
$= -7,55 \text{ m·s}^{-1}$
$v_f = 7,55 \text{ m·s}^{-1}$ upwards

$v_{XY} = v_{XG} + v_{GY}$
$= 21,85 + (7,55)$
$v_{XY} = 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XY} = v_X - v_Y$ (vector difference)
$= 21,85 - (-7,55)$
$= 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$21,85 = v_{XY} + (-7,55)$
$= 29,40 \text{ m·s}^{-1}$ ✓downwards✓

OPTION 2

Upward positive:

$\Delta t = (5,23 - 1)$ ✓ $= 4,23$ s
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= 49(4,23) + ½ (-9,8)(4,23)^2$
$= 119,59$ m (upwards)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ (for both equations)
$= \underline{(49)^2 + 2(-9,8)(119,59)}$ ✓
$\therefore v_f = 7,55 \text{ m·s}^{-1}$ upwards

$v_{XY} = v_{XG} + v_{GY}$
$= -21,85 + (-7,55)$
$= -29,40 \text{ m·s}^{-1}$ ✓downwards✓
OR
$v_{XY} = 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XY} = v_X - v_Y$ (vector difference)
$= -21,85 - 7,55$
$= -29,40 \text{ m·s}^{-1}$ ✓downwards✓
OR
$v_{XY} = 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$-21,85 = v_{XY} + (7,55)$
$= -29,40 \text{ m·s}^{-1}$ ✓downwards✓
OR
$v_{XY} = 29,40 \text{ m·s}^{-1}$ ✓downwards✓

Downward positive:

$\Delta t = (5,23 - 1)$ ✓ $= 4,23$ s
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (-49)(4,23) + ½ (9,8)(4,23)^2$
$= -119,59$ m (upwards)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ (for both equations)
$= \underline{(-49)^2 + 2(9,8)(-119,59)}$ ✓
$\therefore v_f = 7,55 \text{ m·s}^{-1}$ upwards

$v_{XY} = v_{XG} + v_{GY}$
$= 21,85 + (7,55)$
$= 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XY} = v_X - v_Y$ (vector difference)
$= 21,85 - (-7,55)$
$= 29,40 \text{ m·s}^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$21,85 = v_{XY} + (-7,55)$
$= 29,40 \text{ m·s}^{-1}$ ✓downwards✓

[12.1.3] (5)
[19]

QUESTION 4

.1 The sum of the kinetic and (gravitational) potential energy is conserved / constant / remains the same / does not change✓
in an isolated / closed / system / no external work done / only conservative forces act on the system.✓

OR
The (total) mechanical energy is conserved/ constant✓
in an isolated system.✓

[12.2.1] (2)

4.2

OPTION 1

$E_{mech} = U + K$ or $E_p + E_k$
$= mgh + ½ mv^2$ ✓(any formulae)
$= (0,5)(9,8)(0,6)$ ✓ $+ ½ (0,5)(3)^2$ ✓
$= 5,19$ J ✓ (5,25 J)

OPTION 2

$E_p = mgh = (0,5)(9,8)(0,6)$ ✓ $= 2,94$ J (3 J)
$E_k = ½ mv^2 = ½ (0,5)(3)^2$ ✓ $= 2,25$ J
$E_{mech} = E_p + E_k$ ✓ $= 2,94 + 2,25$
$= 5,19$ J✓

[12.2.3] (4)

4.3

Accepted formulae

$E_{mech(A)} = E_{mech(B)}$ / $E_{mech(i)} = E_{mech(f)}$ / $E_{mech(top)} = E_{mech(bottom)}$
$(E_p + E_k)_A = (E_p + E_k)_B$ / $(E_p + E_k)_{bottom} = (E_p + E_k)_{top}$
$(E_p + E_k)_i = (E_p + E_k)_f$ /$(U + K)_{bottom} = (U + K)_{top}$
$(U + K)_i = (U + K)_f$ / $(U + K)_A = (U + K)_B$ / $mgh_i + \frac{1}{2}mv_i^2 = mgh_f + \frac{1}{2}mv_f^2$

OPTION 1

$(U + K)_B = (U + K)_C$ ✓
$mgh_B + ½ m v_B^2 = mgh_C + ½ m v_C^2$
$5,19$ ✓ $= 0 + ½ (0,5)v^2$ ✓
$\therefore v = 4,56 \text{ m·s}^{-1}$

OPTION 2

$W_{net} = \Delta E_k$ ✓
$mg\Delta y\cos\theta = ½ m(v_f^2 – v_i^2)$
$(0,5)(9,8)(0,6)(1)$✓$= ½ (0,5)(v_f^2 – 3^2)$ ✓
$\therefore v_f = 4,56 \text{ m·s}^{-1}$

$\Sigma p_{before} = \Sigma p_{after}$ ✓
$(0,5)(4,56) + 0$ ✓ $= (0,5)v_{f2} + (0,1)(3,5)$ ✓
$\therefore v_{f2} = 3,86 \text{ m·s}^{-1}$ ✓(to the right) ($3,88 \text{ m·s}^{-1}$)

Other formulae:

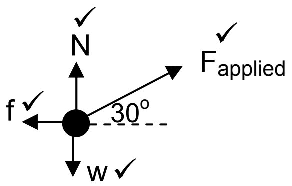
$p_{t\ before} = p_{t\ after}$ or $m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$
or $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

[12.1.3] (7)
[12.2.3] **[13]**

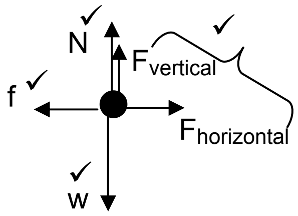
QUESTION 5

Accepted Labels	
N	Normal / Force of surface on crate / F_N / 269 N / 275 N
w	F_g / force of Earth on crate / weight / 294 N /300 N mg / gravitational force
$F_{applied}$	F / force of worker on crate / 50 N / F_A
f	$F_{friction}$ / 20 N / F_f / friction
$F_{horizontal}$ / F_x / $F_{//}$	43,30 N
$F_{vertical}$ / F_y / $F_\perp$	25 N

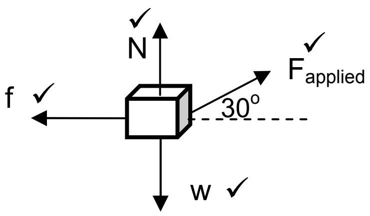
5.1



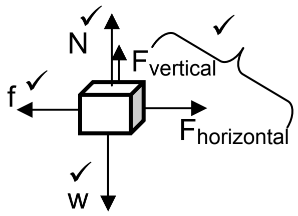
OR



Accept: Force diagram



OR



[12.1.2] (4)

5.2 $W = F\Delta x \cos 90^o$ ✓✓ = 0

OR

They (normal force and the gravitational force) are <u>perpendicular</u> /at 90^o to the (direction of the) <u>displacement / motion / Δx</u> ✓✓ of the crate.

OR

The angle between the force and <u>displacement / motion / Δx</u> is 90^o.✓✓

OR

The crate moves horizontally and the forces act vertically.✓✓ [12.2.2] (2)

5.3

Accepted symbols for applied force: F_{appl} / F / F_A
Accepted symbols for frictional force: f / F_f / $F_{friction}$
Accepted symbols for gravitational force: w / F_g / $F_{force\ of\ Earth\ on\ crate}$ / gravitational force

OPTION 1

$W_{net} = W_{appl} + W_f$
$= F_{app}\Delta x\cos\theta + f\Delta x\cos\theta$ ✓ For either formula
$= \underline{(50)(6)(\cos 30°)}$ ✓ $+ \underline{(20)(6)(\cos 180°)}$ ✓
$= 259,81 + (-120)$
$W_{net} = 139,81$ J ✓

OPTION 2

$W_{applied} = F_{app}\Delta x\cos\theta$
$= \underline{(50)(6)(\cos 30°)}$ ✓
$= 259,81$ J
$W_f = f\Delta x\cos\theta$
$= \underline{(20)(6)(\cos 180°)}$ ✓
$= -120$ J

$W_{net} = W_{applied} + W_f$ ✓ OR $F_{app}\Delta x\cos\theta + F\Delta x\cos\theta$
$= 139,81$ J ✓

OPTION 3

$W_{net} = W_{appl\,//} + W_f$
$= F_{app//}\Delta x\cos\theta + f\Delta x\cos\theta$ ✓ For either formula
$= \underline{(50)(\cos 30°)(6)\cos 0°}$ ✓ $+ \underline{(20)(6)(\cos 180°)}$ ✓
$= 259,81 + (-120)$
$W_{net} = 139,81$ J ✓

OPTION 4

$F_{net} = F_{horizontal} + f$
$= \underline{(50)(\cos 30°) + (-20)}$ ✓
$= 23,30$ N

$W_{net} = F_{net}\Delta x\cos\theta$ ✓
$= \underline{(23,30)(6)(\cos 0°)}$ ✓
$= 139,81$ J ✓

OPTION 5

$F_{net} = F_{horizontal} + f$
$ma = \underline{(50)(\cos 30°) + (-20)}$ ✓
$(30)a = (50)(\cos 30^{\circ}) + (-20)$
$a = 0,776...\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$
$= (0)^2 + 2(0,78...)(6)$
$v_f = 3,052...\ m\cdot s^{-1}$

✓one mark for all three formulas

$W_{net} = \Delta K = ½\, m(v_f^2 - v_i^2)$
$= \underline{½\,(30)(3,052...^2 - 0^2)}$ ✓
$= 139,81$ J ✓

[12.1.3] (4)

5.4

$W_{net} = \Delta K$ / $W_{net} = \Delta E_k$ ✓
$= ½ mv_f^2 - ½ mv_i^2$
$139,81 = ½ (30)v_f^2 – 0$ ✓
$v_f = 3,05$ m·s^{-1} ✓

If: W instead of W_{net} max($\frac{2}{3}$)
No marks for any other method

[12.2.3] (3)

5.5 Greater than ✓

The horizontal component (of the force) / force in direction of motion will now be greater / F_{net} will now be greater.✓

OR
As θ decreases cos θ increases✓

OR
For θ smaller than 30°, cos θ > cos 30°.✓ (2)
[12.3.2] **[15]**

QUESTION 6

6.1 Doppler effect ✓ [12.2.1] (1)

6.2

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ / $f_L = \frac{v + v_L}{v} f_s$ ✓

$\therefore$ 1 000 ✓$= \left(\frac{340 + v_L}{340}\right)(960)$ ✓

$\therefore v_L = 14,17$ m·s^{-1} ✓

[12.2.3] (4)

6.3 Higher than ✓ [12.2.2] (1)
[6]

QUESTION 7

7.1 When two waves pass through the same region of space at the same time✓,
resulting in the superposition of waves. ✓ [12.2.1] (2)

7.2 Constructive (interference)✓

The waves crossing each other are in phase. ✓/ Two troughs meet./
The path difference is an integer number of λ. [12.1.2] (2)

7.3 Dark band ✓

It lies on the line combining all the points where crests and troughs overlap ✓ resulting in destructive interference. ✓

OR
It lies on the (nodal) line✓ where destructive interference occurs. ✓ (3)
[12.1.2] **[7]**

QUESTION 8

8.1 The ability of a wave to bend / spread out (in wave fronts)✓ as they pass through a (small) aperture / opening or around a (sharp) edge/ points /corners / barrier. ✓ (2)

8.2 8.2.1 Angle of / (Degree of) diffraction ✓
Position of minima
α or β [12.1.1] (1)

8.2.2 (Slit) width / a ✓ [12.1.1] (1)

8.3 (Slit) 1 ✓
Slit 1 represents the <u>most diffraction</u>. ✓

OR
Diffraction /Angle / sin θ / θ is inversely proportional to slit width. ✓

OR
$\sin\theta \ \alpha \frac{1}{a}$ or $\theta \ \alpha \frac{1}{a}$ ✓

OR
Larger angle at which first minimum for slit 1 is obtained. ✓

OR
Smaller angle at which first minimum for slit 2 is obtained.✓

OR
Actual calculations showing slit 1 is narrower than slit 2. ✓ [12.1.2] [12.2.2] (2)

8.4

<u>OPTION 1</u>

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 5° = \frac{(1)(410 \times 10^{-9})}{a}$ ✓ ✓

$\therefore$ a = $4,70 \times 10^{-6}$ m ✓ (0,0000047 m / 4,7 μm)

<u>OPTION 2</u>

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 10° = \frac{(2)(410 \times 10^{-9})}{a}$ ✓ ✓

$\therefore$ a = $4,72 \times 10^{-6}$ m ✓ (0,00000472 m / 4,72 μm)

<u>OPTION 3</u>

Allocated full marks if calculation shown correctly in QUESTION 8.3. [12.1.3] (4)

[10]

QUESTION 9

9.1 The <u>ratio of the (amount of) charge (transferred)</u> ✓ to the (resulting) potential difference. ✓

[12.2.1] (2)

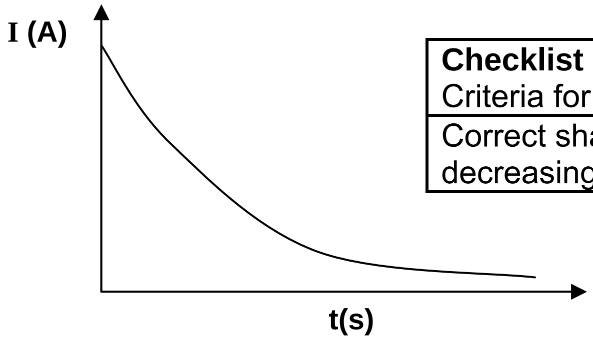
9.2 $C = \frac{\varepsilon_0 A}{d}$ ✓ or $C = \frac{K\varepsilon_0 A}{d}$ ✓ where $K = 1$

$= \frac{(8{,}85\times10^{-12})(2\times10^{-2})(1{,}5\times10^{-2})}{1{,}5\times10^{-3}}$ ✓ ✓ (the circled $(2\times10^{-2})(1{,}5\times10^{-2})$ → 3 x 10^{-4})

$\therefore C = 1{,}77 \times 10^{-12}$ F ✓ (1,77 pF)

[12.2.3] (5)

9.3



Checklist Criteria for graph:	Mark/ *Punt*
Correct shape of graph showing decreasing current with time.	✓✓

[12.1.2] (2)

9.4 $C = \frac{Q}{V}$ ✓

$\therefore 1{,}77 \times 10^{-12} = \frac{Q}{12}$ ✓

$\therefore Q = 2{,}12 \times 10^{-11}$ C ✓

[12.2.3] (3)

9.5

OPTION 1	**OPTION 2**
$F = \frac{Vq}{d}$ ✓✓ $= \frac{(12)(3{,}2\times10^{-19})}{1{,}5\times10^{-3}}$ ✓ ✓ $= 2{,}56 \times 10^{-15}$ N ✓	$E = \frac{V}{d}$ ✓ $= \frac{12}{1{,}5\times10^{-3}}$ ✓ $= 8 \times 10^3$ V·m^{-1} $E = \frac{F}{q}$ ✓ $8 \times 10^3 = \frac{F}{3{,}2\times10^{-19}}$ ✓ $\therefore F = 2{,}56 \times 10^{-15}$ N ✓

(5)

[12.1.3] **[17]**

QUESTION 10

10.1 The current in a conductor is directly proportional to the potential difference ✓
across its ends at constant temperature. ✓

OR
The ratio of potential difference to current is constant✓
at constant temperature ✓ [12.2.1] (2)

10.2.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ = $\frac{1}{1,4} + \frac{1}{1,4}$ ✓ ∴ R_p = 0,7 Ω ✓

OR
$R_p = \frac{R_1R_2}{R_1 + R_2}$ ✓ = $\frac{1,4 \times 1,4}{1,4 + 1,4}$ ✓= 0,7 Ω ✓ [12.2.3] (3)

10.2.2

OPTION 1:
emf = I(R + r) ✓
∴ 12 = I(0,7 + 0, 1) ✓
∴ I = 15 A

$R = \frac{V}{I}$

$0,7 = \frac{V}{15}$ ✓
∴V = 10,5 V ✓

OPTION 2:
$I = \frac{V}{R}$ ✓ = $\frac{12}{0,8}$ ✓ = 15 A

V = IR
= (15)(0,7) ✓
= 10,5 V ✓

emf = I(R + r)
12 = $V_{external}$ + (15)(0,1) ✓
$V_{external}$ = 12 – (15)(0,1)
= 10,5 V ✓

$V_{\text{"lost"}}$ = Ir = (15)(0,1) ✓= 1,5 V
$V_{external}$ = 12 – 1,5 V = 10,5 V✓

$I_{headlight} = \frac{15}{2}$ = 7,5 A✓
V = IR = (7,5)(1,4) = 10,5 V✓

OPTION 3
Voltage divides 0,7: 0,1 / 7:1
∴$V_{headlight} = \frac{7}{8}$ ✓✓x 12 ✓
= 10,5 V ✓

[12.2.3] (4)

10.2.3

OPTION 1	OPTION 2	OPTION 3
$P = \frac{V^2}{R}$ ✓ $= \frac{10,5^2}{1,4}$ ✓ = 78,75 W ✓	I(light) = 7,5 A P = VI ✓ = (10,5)(7,5) ✓ = 78,75 W ✓	I(light) = 7,5 A $P = I^2R$ ✓ $= (7,5)^2(1,4)$ ✓ = 78,75 W ✓

OPTIONS ACCEPTED ONLY BECAUSE BULBS ARE IDENTICAL:

$P_{total} = \frac{V^2}{R}$ ✓ $= \frac{(10,5)^2}{0,7}$ = 157,5 W $P_{headlight} = \frac{157,5}{2}$ ✓ = 78,75 W ✓	P_{total} = VI ✓ = (10,5)(15) = 157,5 W $P_{headlight} = \frac{157,5}{2}$ ✓ = 78,75 W ✓	$P_{total} = I^2R$ ✓ $= (15)^2(0,7)$ = 157,5 W $P_{headlight} = \frac{157,5}{2}$ ✓ = 78,75 W ✓

[12.2.3] (3)

10.3 Decreases ✓

-

(Effective/ total) resistance decreases. ✓
(Total) current increases. ✓
"Lost volts" / $V_{internal}$ / Ir increases, thus potential difference / V (across headlights) decreases.✓
$P = \frac{V^2}{R}$ decreases.

[12.1.3] (4)
[16]

QUESTION 11

11.1 11.1.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $= \frac{311,13}{\sqrt{2}}$ ✓ $= 220$ V ✓

[12.2.3] (3)

11.1.2

OPTION 1

$P_{ave} = V_{rms}I_{rms}$ ✓ $\therefore$ $100 = (220)I_{rms}$ ✓ $\therefore$ $I_{rms} = 0,45$ A

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ $\therefore I_{max} = 0,45\sqrt{2}$ ✓ $= 0,64$ A ✓

OPTION 2

$P_{ave} = \frac{V_{rms}^2}{R}$ ✓

$100 = \frac{(220)^2}{R}$ ✓ $\therefore R = 484\ \Omega$

$R = \frac{V_{max}}{I_{max}}$ ✓

$484 = \frac{311,13}{I_{max}}$ ✓

$I_{max} = 0,64$ A ✓

OPTION 3

$P_{ave} = V_{rms}I_{rms}$ ✓

$= \frac{V_{max}}{\sqrt{2}} \times \frac{I_{max}}{\sqrt{2}} = \frac{V_{max}I_{max}}{2}$ ✓

100 ✓ $= \frac{311,13 \times I_{max}}{2}$ ✓

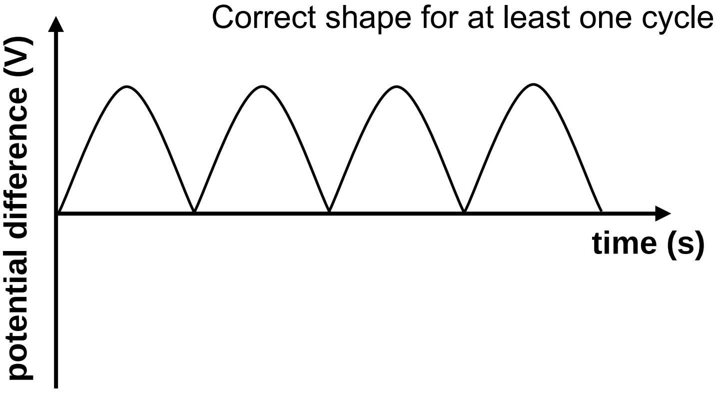
$I_{max} = 0,64$ A ✓

[12.1.3]

(5)

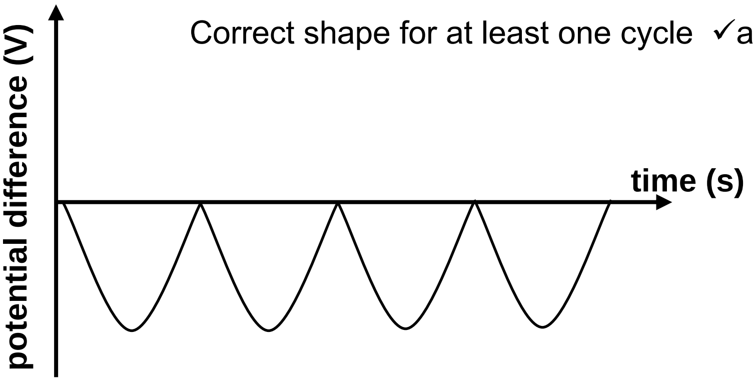
11.2

Correct shape for at least one cycle✓ and loops of equal height. ✓



OR

Correct shape for at least one cycle ✓and loops of equal height. ✓



[12.1.2] (2)
[10]

QUESTION 12

12.1 Any ONE: ✓
Damage to skin./Causes (skin) cancer.
Damage to eyes./Increased occurrence of cataracts.
Damage to crops resulting in food shortages. [12.3.2] (1)

12.2 Kills bacteria / germs / Sterilises/ sanitises / disinfects equipment.✓ [12.3.2] (1)

12.3

OPTION 1

$E = \frac{hc}{\lambda}$ ✓

$= \frac{(6,63\times10^{-34})(3\times10^{8})}{200\times10^{-9}}$ ✓ ✓

$= 9,95 \times 10^{-19}$ J ✓

OPTION 2

$c = f\lambda$

$3 \times 10^{8} = f(200 \times 10^{-9})$ ✓

$f = 1,5 \times 10^{15}$ Hz

$E = hf$

$= (6,63 \times 10^{-34})(1,5 \times 10^{15})$ ✓

$= 9,95 \times 10^{-19}$ J ✓

✓ for both formulae

[12.2.3] (4)

12.4

OPTION 1

$E = W_o + E_k$
$hf = hf_o + ½ mv^2$
} ✓ For either formula

$9,95 \times 10^{-19}$ ✓ $= 3,84 \times 10^{-19} + ½ (9,11 \times 10^{-31})v^2$ ✓

$\therefore v = 1,16 \times 10^{6}$ m·s^{-1} ✓ (1157583,69 - 1158180,94 m·s^{-1})

OPTION 2

$E = W_o + E_k$ ✓

$E_k = 9,95 \times 10^{-19} – 3,84 \times 10^{-19}$ ✓

$= 6,11 \times 10^{-19}$ J

$E_k = ½ mv^2$

$6,11 \times 10^{-19} = ½ (9,11 \times 10^{-31})v^2$ ✓

$\therefore v = 1,16 \times 10^{6}$ m·s^{-1} ✓ (1157583,69 - 1158180,94 m·s^{-1})

Other symbols:

E: hf
W_o: hf_o
K: E_k: ½ mv^2

[12.2.3] (4)

12.5 Yes✓
(Photons of) X rays have a higher frequency / shorter wavelength / energy (than ultraviolet radiation). ✓

-

OR
UV light has lower frequency than X-rays. [12.2.2] (2)

[12]

TOTAL SECTION B: 125
GRAND TOTAL: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2011

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for EACH of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) in the ANSWER BOOK.

1.1 The product of the mass and velocity of a body (1)

1.2 The term used to describe two sources that emit waves which maintain a constant phase relation with each other (1)

1.3 The type of spectrum formed when light is passed through a cold gas at low pressure (1)

1.4 The property of a conductor given by the ratio of the applied potential difference to the current through the conductor (1)

1.5 The 'packets of energy' (quanta) of which light consists (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A – D) next to the question number (2.1 – 2.10) in the ANSWER BOOK.

2.1 Which ONE of the following physical quantities represents the RATE OF CHANGE OF MOMENTUM of an object?

A Force

B Kinetic energy

C Impulse

D Acceleration (2)

2.2 The kinetic energy of a car moving at constant velocity ***v*** is *K*. The velocity of the car changes to ***2v***. What is the new kinetic energy of the car?

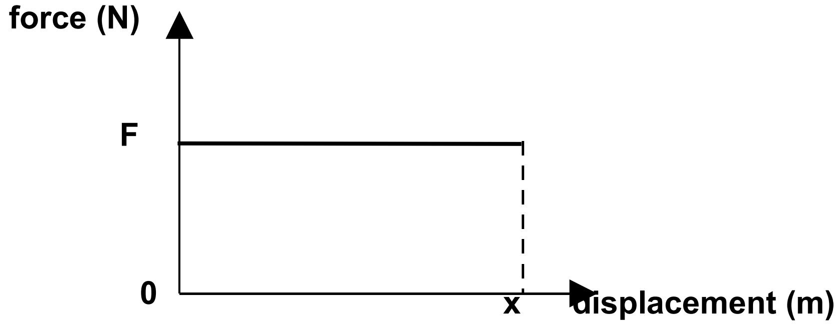
A $\frac{1}{4}K$

B $\frac{1}{2}K$

C $2K$

D $4K$ (2)

2.3 The graph below represents a constant force *F* acting on an object over a displacement *x.* The force and displacement are in the same direction.



Which ONE of the following statements can be deduced from the graph?

A The gradient of the graph represents the work done by the force.

B The gradient of the graph represents the change in kinetic energy of the object.

C The area under the graph represents the net work done by the force.

D The area under the graph represents the power dissipated by the force. (2)

2.4 Which ONE of the following is the main principle applied when measuring the rate of blood flow or the heartbeat of a foetus in the womb?

A Doppler effect

B Photoelectric effect

C Huygens' principle

D Diffraction (2)

2.5 The pattern observed in single-slit diffraction is best explained by ...

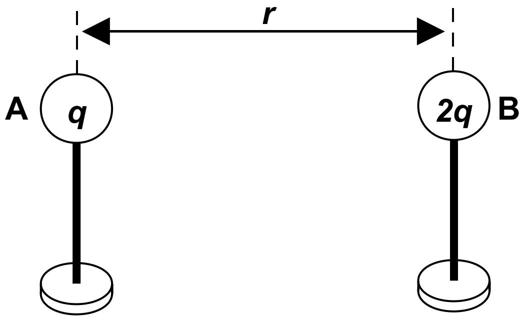
A reflection.

B Huygens' principle.

C scattering.

D refraction. (2)

2.6 The sketch below shows two small metal spheres, A and B, on insulated stands carrying charges of magnitude *q* and *2q* respectively. The distance between the centres of the two spheres is *r*.



Sphere A exerts a force of magnitude *F* on sphere B. What is the magnitude of the force that sphere B exerts on sphere A?

A $\frac{1}{2}F$

B *F*

C *2F*

D *4F* (2)

2.7 Which ONE of the following is the unit of measurement for the rate of flow of charge?

A watt

B coulomb

C volt

D ampere (2)

2.8 Which ONE of the following changes to the design of an AC generator will increase its maximum emf?

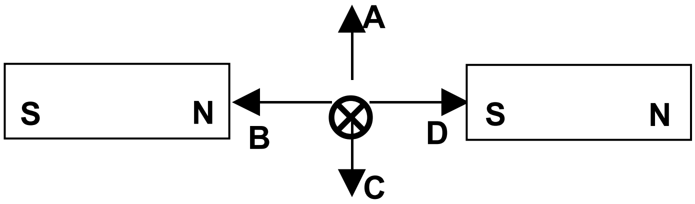
A Change the polarity of the magnets

B Use larger slip rings

C Use larger brushes

D Increase the number of turns on the coil (2)

2.9 The cross (⊗) in the diagram below represents a conductor carrying conventional current INTO THE PAGE in the uniform field between the two bar magnets. The conductor is placed between the north (N) pole and south (S) pole of the magnets, as shown.



In which ONE of the directions **A**, **B**, **C** or **D** (all lying in the plane of the page) will this conductor experience a force?

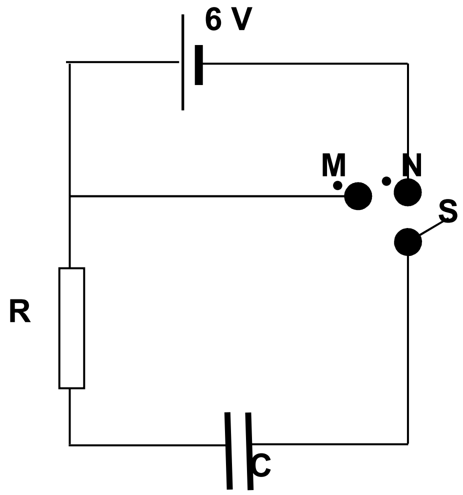
A A

B B

C C

D D (2)

2.10 A 6 V battery, a resistor, a capacitor and a switch S are connected in a circuit as shown in the diagram below. Switch S can be closed at either position M or position N.



Switch **S** is initially at position N. After a while it is moved to position M.

Which ONE of the following statements is correct when the switch is moved to position M?

A The capacitor discharges.

B The capacitor charges.

C The battery discharges.

D The battery charges. (2)

[20]

TOTAL SECTION A: 25

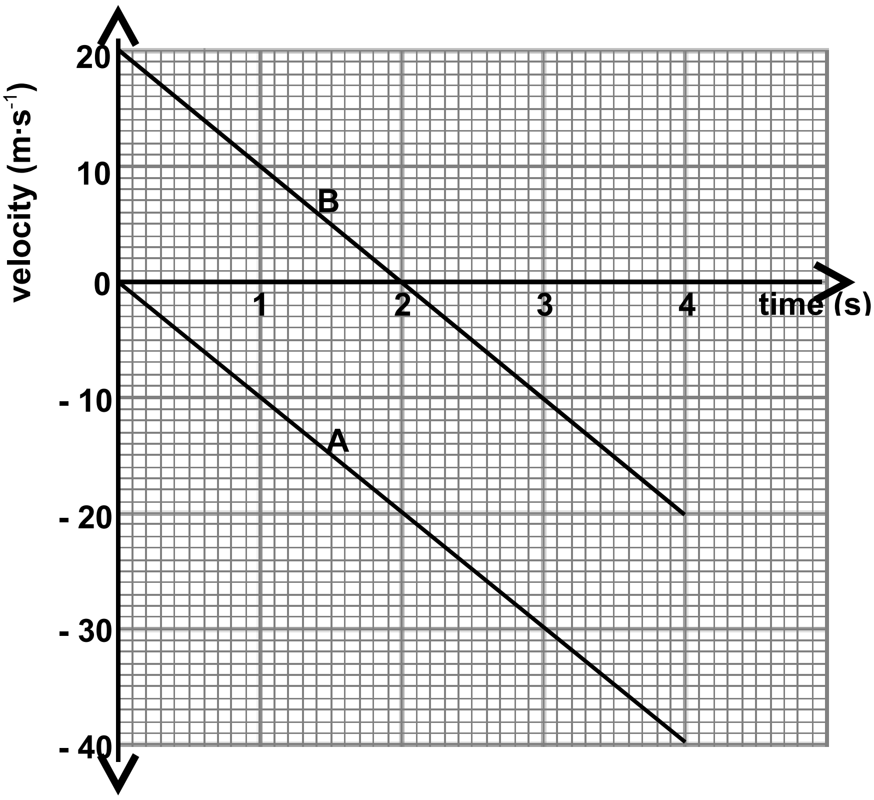
SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your numerical answers to TWO decimal places.

QUESTION 3 (Start on a new page.)

The velocity-time graph shown below represents the motion of two objects, **A** and **B**, released from the same height. Object **A** is released from REST and at the same instant object **B** is PROJECTED vertically upwards. (Ignore the effects of friction.)



3.1 *Object A undergoes a constant acceleration*. Give a reason for this statement by referring to the graph. (No calculations are required.) (2)

3.2 At what time/times is the SPEED of object **B** equal to 10 $m \cdot s^{-1}$? (2)

3.3 What is the velocity of object **A** relative to object **B** at t = 1 s? (3)

3.4 Object **A** strikes the ground after 4 s. USE EQUATIONS OF MOTION to calculate the height from which the objects were released. (3)

3.5 What physical quantity is represented by the area between the graph and the time axis for each of the graphs **A** and **B**? (2)

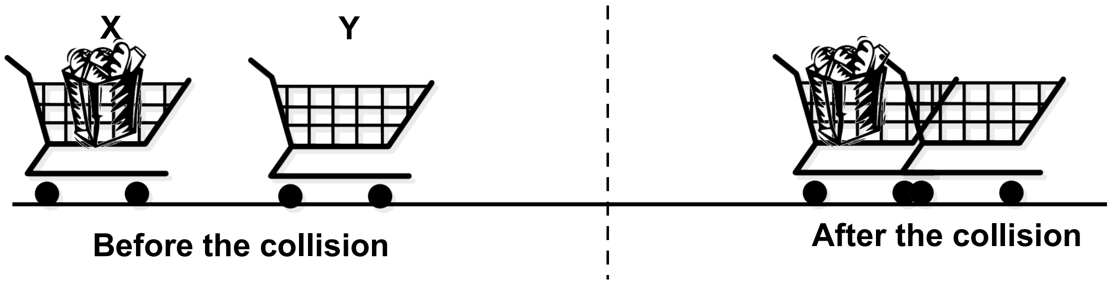
3.6 Calculate, WITHOUT USING EQUATIONS OF MOTION, the distance between objects **A** and **B** at t = 1 s. (5)
[17]

QUESTION 4 (Start on a new page.)

Two shopping trolleys, **X** and **Y**, are both moving to the right along the same straight line. The mass of trolley **Y** is 12 kg and its kinetic energy is 37,5 J.

4.1 Calculate the speed of trolley **Y**. (3)

Trolley **X** of mass 30 kg collides with trolley **Y** and they stick together on impact. After the collision, the combined speed of the trolleys is 3,2 $m \cdot s^{-1}$. (Ignore the effects of friction.)



4.2 Write down the principle of conservation of linear momentum in words. (2)

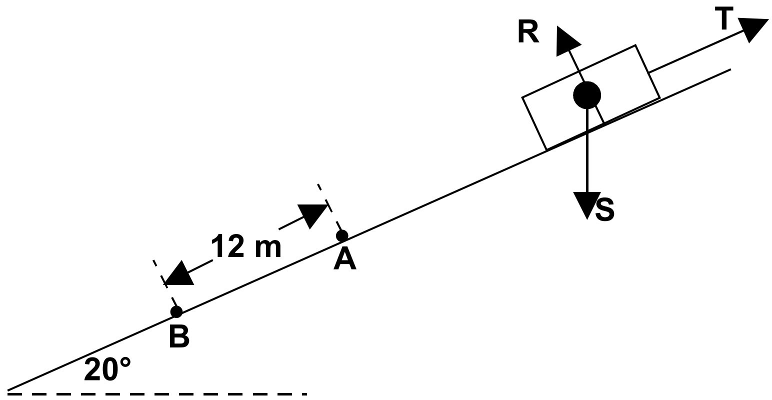
4.3 Calculate the speed of trolley **X** before the collision. (5)

During the collision, trolley **X** exerts a force on trolley **Y**. The collision time is 0,2 s.

4.4 Calculate the magnitude of the force that trolley **X** exerts on trolley **Y**. (4)
[14]

QUESTION 5 (Start on a new page.)

A crate of mass 70 kg slides down a rough incline that makes an angle of 20° with the horizontal, as shown in the diagram below. The crate experiences a constant frictional force of magnitude 190 N during its motion down the incline. The forces acting on the crate are represented by **R**, **S** and **T**.



5.1 Label the forces **R**, **S** and **T**. (3)

5.2 Give a reason why force **R** does no work on the crate. (2)

The crate passes point **A** at a speed of 2 $m \cdot s^{-1}$ and moves a distance of 12 m before reaching point **B** lower down on the incline.

5.3 Calculate the net work done on the crate during its motion from point **A** to point **B**. (5)

5.4 Write down the work-energy theorem in words. (2)

5.5 Use the work-energy theorem to calculate the speed of the crate at point **B**. (4)
[16]

QUESTION 6 (Start on a new page.)

The whistle of a train emits sound waves of frequency 2 000 Hz. A stationary listener measures the frequency of these emitted sound waves as 2 080 Hz. The speed of sound in air is 340 $m \cdot s^{-1}$.

6.1 Name the phenomenon responsible for the observed change in frequency. (1)

6.2 Is the train moving AWAY FROM or TOWARDS the stationary listener? (1)

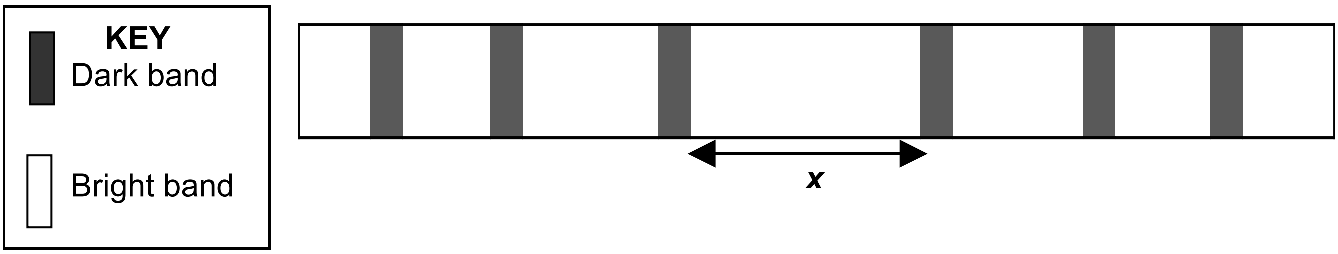
6.3 Calculate the speed of the train. (4)

6.4 Will the frequency observed by a passenger, sitting in the train, be GREATER THAN, EQUAL TO or SMALLER THAN 2 000 Hz? Explain the answer. (2)
[8]

QUESTION 7 (Start on a new page.)

Learners perform an experiment with monochromatic light. They pass the light through a single slit. The distance between the screen and the slit is kept constant.

The diagram below represents the pattern observed during the experiment.



The slit has a width of 0,02 mm and the SECOND dark band is formed on the screen at an angle of 3° from the centre of the slit.

7.1 Define the term *diffraction*. (2)

7.2 Calculate the wavelength of this light. (4)

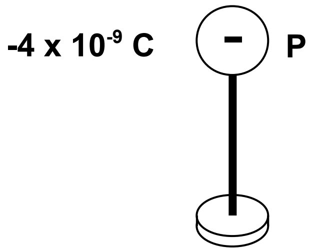
7.3 The light used is either green or red. Given that yellow light has a wavelength of 577 nm, which colour is used? Give a reason for your answer. (2)

7.4 Using the same light as in QUESTION 7.2, write down TWO experimental changes that can be made to decrease the distance *x* in the diagram above. (2)

7.5 Describe the pattern that will be observed if the single slit is now replaced with a double slit. (2)
[12]

QUESTION 8 (Start on a new page.)

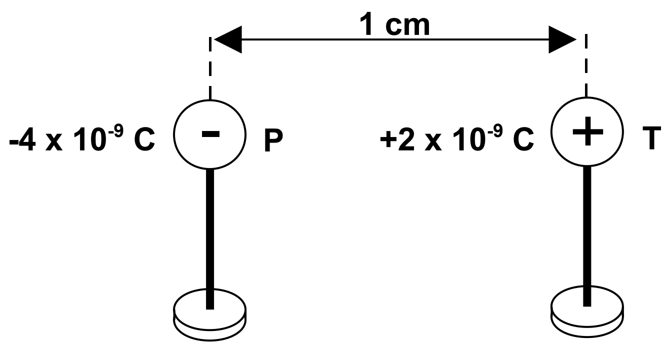
The diagram below shows a small metal sphere **P** on an insulated stand. The sphere carries a charge of -4 x 10^{-9} C, as shown in the diagram.



8.1 Draw the electric field pattern around sphere **P**. Assume that no other charges affect this pattern. (2)

8.2 Calculate the number of electrons in excess on sphere **P**. (2)

A second metal sphere **T** carrying a charge of +2 x 10^{-9} C is placed 1 cm from sphere **P**, as shown in the diagram below.



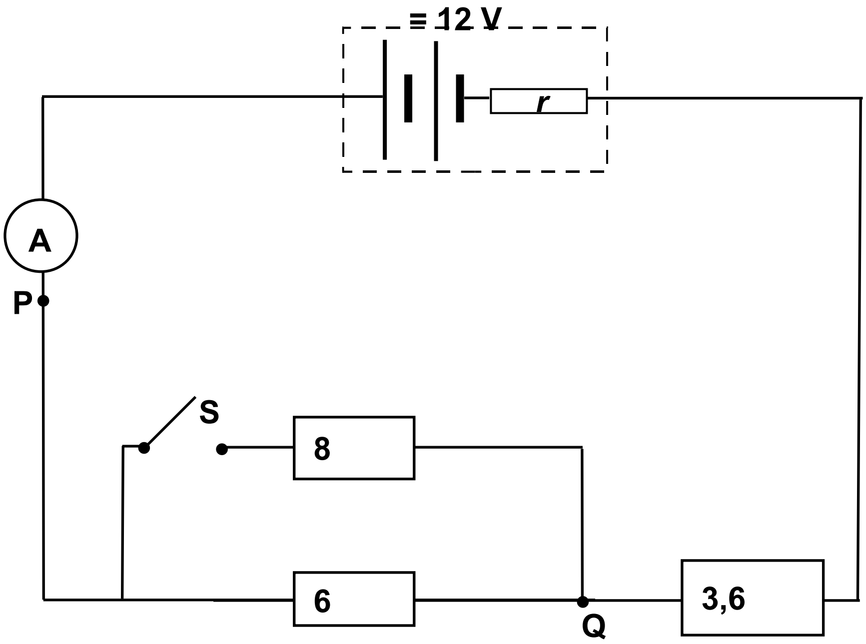
8.3 Calculate the magnitude of the electrostatic force that sphere **P** exerts on sphere **T**. (4)

The spheres are now brought into contact with each other and returned to their original positions.

8.4 Calculate the electric potential energy of the system of two charges. (6)
[14]

QUESTION 9 (Start on a new page.)

The circuit diagram below represents a combination of resistors in series and parallel. The battery has an emf of 12 V and an unknown internal resistance *r*.



With switch **S** OPEN, ammeter A gives a reading of 1,2 A.

9.1 Calculate the total resistance of the circuit. (3)

9.2 Calculate the internal resistance of the battery. (4)

9.3 Calculate the energy dissipated in the 6 Ω resistor in 3 minutes. (3)

Switch **S** is now CLOSED.

9.4 How will EACH of the following be affected? Write down only INCREASES, DECREASES or REMAINS THE SAME.

9.4.1 The total resistance of the circuit (1)

9.4.2 The reading on ammeter A (1)

9.5 A conducting wire of negligible resistance is now connected between points **P** and **Q**. What effect will this have on the temperature of the battery?

Write down only INCREASES, DECREASES or REMAINS THE SAME. Explain how you arrived at the answer. (4)

[16]

QUESTION 10 (Start on a new page.)

AC generators at coal-fired power stations supply most of the electrical energy needed in our country.

10.1 State ONE structural difference between an AC and a DC generator. (2)

A certain AC generator (alternator) produces a peak current (I_{max}) of 6,43 A when connected to an electrical heater of resistance 48,4 Ω.

10.2 Calculate the rms current (I_{rms}) produced by the generator. (3)

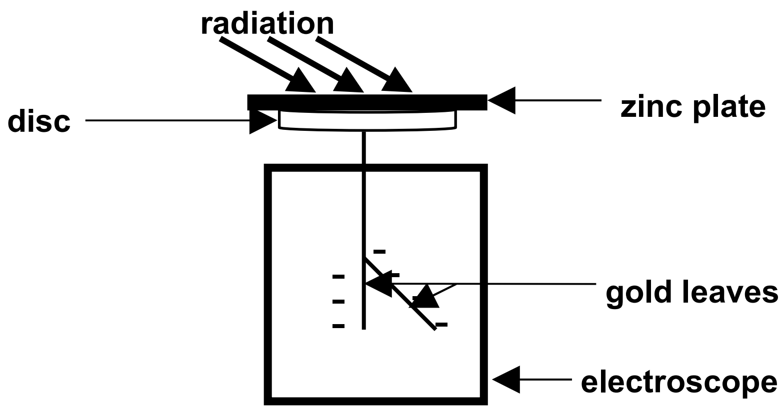
10.3 Calculate the peak voltage (V_{max}) output of the generator. (5)

10.4 Draw a sketch graph of potential difference versus time for this AC generator. Clearly label the axes and indicate V_{max} on the potential difference axis. (2)

10.5 To meet energy demands in the country, the government plans building nuclear power stations. State ONE environmental advantage of the generation of electricity in nuclear power stations over coal-fired power stations. (1)
[13]

QUESTION 11 (Start on a new page.)

11.1 A group of learners performs an investigation to compare the effect of two types of radiation on the emission of photoelectrons from zinc. They place a zinc plate on top of the disc of a negatively charged electroscope. Ultraviolet and red light are shone alternately onto the zinc plate as shown below, with the electroscope fully charged in each case.



They record the following observations:

RADIATION	OBSERVATION
Ultraviolet light	Gold leaves collapse
Red light	No effect on the deflection of gold leaves

11.1.1 Write down an INVESTIGATIVE QUESTION for this investigation. (2)

11.1.2 Explain the observation made for ultraviolet light. (3)

11.1.3 What conclusion can be drawn from this investigation? (2)

11.1.4 The following safety precaution is printed on the ultraviolet light source:

OVEREXPOSURE TO ULTRAVIOLET LIGHT IS A HEALTH RISK

Name ONE health risk associated with overexposure to ultraviolet light. (1)

11.2 The learners have access to the following information:

Work function of zinc	$6,88 \times 10^{-19}$ J
Frequency of ultraviolet light	$7,89 \times 10^{14}$ Hz
Frequency of red light	$4,29 \times 10^{14}$ Hz

11.2.1 Define the term *work function* of a metal. (2)

11.2.2 Name ONE type of electromagnetic radiation with a higher frequency than that of ultraviolet light. (1)

11.2.3 Use a calculation to explain why red light fails to emit photoelectrons from the surface of the zinc plate. (4)
[15]

TOTAL SECTION B: 125
GRAND TOTAL: 150

SECTION A

QUESTION 1

1.1	Momentum ✓	[12.2.1]	(1)
1.2	Coherent (sources) ✓	[12.2.1]	(1)
1.3	(Line) absorption ✓	[12.2.1]	(1)
1.4	Resistance ✓	[12.2.1]	(1)
1.5	Photons ✓	[12.2.1]	(1)
			[5]

QUESTION 2

2.1	A ✓✓	[12.2.1]	(2)
2.2	D ✓✓	[12.2.2]	(2)
2.3	C ✓✓	[12.1.2]	(2)
2.4	A ✓✓	[12.2.1]	(2)
2.5	B ✓✓	[12.2.1]	(2)
2.6	B ✓✓	[12.2.3]	(2)
2.7	D ✓✓	[12.2.1]	(2)
2.8	D ✓✓	[12.2.1]	(2)
2.9	C ✓✓	[12.1.2]	(2)
2.10	A ✓✓	[12.1.2]	(2)
			[20]

TOTAL SECTION A: 25

SECTION B

QUESTION 3

- **PENALISE ONLY ONCE FOR NOT ROUNDING OFF FINAL ANSWERS TO TWO DECIMAL PLACES.**

3.1 Gradient of the graph is constant. ✓✓ [12.1.2] (2)

3.2 At t = 1 s ✓ and t = 3 s✓ [12.1.2] (2)

3.3 $V_{AB} = V_{AC} + V_{CB}$
$= -10 + (-10)$
$= -20\ m\cdot s^{-1}$
$= 20\ m\cdot s^{-1}$ ✓✓downwards ✓

OR

$V_{AB} = V_{AC} – V_{BC}$
$= -10 - 10$
$= -20\ m\cdot s^{-1}$
$= 20\ m\cdot s^{-1}$ ✓✓downwards ✓

OR

$V_{AB} = V_A – V_B$ (vector difference)
$= -10 – (10)$
$= -20\ m\cdot s^{-1}$
$= 20\ m\cdot s^{-1}$ ✓✓downwards ✓

[12.1.2] (3)

3.4

OPTION 1

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (0)(4) + ½ (10)(4)^2$✓
$= 80$ m✓ (78,4 m if a = 9,8 $m\cdot s^{-2}$)

OPTION 2

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(40)^2 = (0)^2 + 2(10)\Delta y$✓
$\Delta y = 80$ m ✓ (81,63 m if a = 9,8 $m\cdot s^{-2}$)

OPTION 3

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓
$= \left(\frac{40 + 0}{2}\right)(4)$ ✓
$= 80$ m✓

Accept:
$s = ut + ½ at^2$
$v = u + at$
$v^2 = u^2 + 2as$
$s = \left(\frac{v + u}{2}\right)t$
Accept formulae if *a* is replaced with *g*

[12.2.3] (3)

3.5 Displacement ✓✓ / Change in position
Accept: distance [12.2.1] (2)

3.6

(Accept: y / Δx / x for distance)

<u>Distance covered by object B</u>

$\Delta y = \frac{1}{2}bh + lb$ ✓

= ½ (1)(10) + (10)(1)✓

= 15 m

<u>Distance covered by object A</u>

$\Delta y = \frac{1}{2}bh$ ✓

= ½ (1)(-10) ✓ Accept: ½ (1)(10)

= - 5 m = 5 m

Distance between A and B = 15 – (-5) = 20 m ✓

Accept:
Distance between A and B = 15 + (5) = 20 m ✓

[12.1.3] (5)
[17]

QUESTION 4

4.1 K / E_k = ½ mv^2 ✓
37,5 = ½ $(12)v^2$ ✓
v = 2,5 $m \cdot s^{-1}$ ✓ [12.2.3] (3)

4.2 The <u>total linear momentum remains constant / is conserved</u> (in magnitude and direction) ✓<u>in a closed system</u>. ✓

OR

In a <u>closed system</u>, ✓ the <u>total linear momentum before collision is equal to the total linear momentum after collision</u>. ✓ [12.2.1] (2)

4.3 Σ p(before) = Σ p(after) ✓
$(30)v_i$ ✓+ (12)(2,5) ✓= (30 + 12) (3,2) ✓
∴ v_i = 3,48 $m \cdot s^{-1}$ ✓

Other formulae:
p_t(before) = p_t(after)
$m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
Accept: $p_{before} = p_{after}$
$p_i = p_f$

If no subscripts:
e.g. mv + mv = mv + mv Max. $\frac{4}{5}$

[12.2.3] (5)

4.4

OPTION 1 **Trolley X:** $F_{net}\Delta t = m\Delta v$ ✓ OR $F_{net}\Delta t = \Delta p$ $F_{net}(0,2)$ ✓ = 30(3,2 – 3,48) ✓ F_{net} = -42 N ∴ magnitude of F_{net} = 42 N✓	**OPTION 2** **Trolley X:** $v_f = v_i + a\Delta t$ 3,2 = 3,48 + a(0,2) ✓ a = -1,4 $m \cdot s^{-2}$ $F_{net} = ma$ = (30)(-1,4) ✓ = -42 N Magnitude of F_{net} = 42 N ✓ ✓ for both formulae
OPTION 3 **Trolley Y:** $F_{net}\Delta t = m\Delta v$ ✓ OR $F_{net}\Delta t = \Delta p$ $F_{net}(0,2)$ ✓ = 12(3,2 – 2,5) ✓ F_{net} = 42 N✓	**OPTION 4** **Trolley Y:** $v_f = v_i + a\Delta t$ 3,2 = 2,5 + a(0,2) ✓ a = 3,5 $m \cdot s^{-2}$ $F_{net} = ma$ = (12)(3,5) ✓ = 42 N✓ ✓ for both formulae

[12.2.3] (4)
[14]

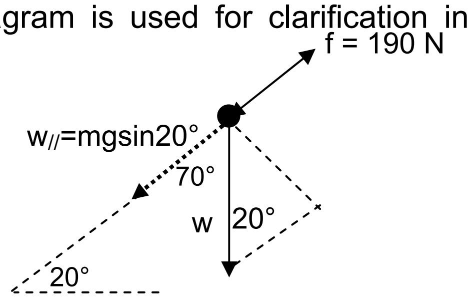
QUESTION 5

5.1 R: Force of incline (surface) on crate / N / Normal (force) / F_N ✓
S: Gravitational force / Gravity / force of Earth on crate / F_g / w / $F_{Earth\ on\ crate}$ ✓
T: Frictional force/F_f/$F_{friction}$/f✓ [12.1.2] (3)

5.2 The force is perpendicular to ✓ the displacement ✓of the crate.

OR
W = F Δx cos 90° ✓ = 0 ✓ [12.2.1] (2)

5.3 The following diagram is used for clarification in the solutions below.



OPTION 1 $W_{net} = W_w + W_f$ ✓ = mgΔxcos70° + fΔxcos180° = (70)(9,8) ✓ (12)(cos70°)✓ + (190)(12)(-1) ✓ W_{net} = 535,51 J ✓	Accept: cos180° or -1

5.3

OPTION 2

$F_{net} = w_{//} + f$
$= mg\sin 20° + (-190)$
$= (70)(9,8)\sin 20°$ ✓ – 190 ✓
$= 44,63$ N

$\therefore W_{net} = F_{net}\Delta x\cos\theta$ ✓
$= (44,63)(12)(\cos 0°)$ ✓
$W_{net} = 535,51$ ✓

Accept:
cos0° or 1

OPTION 3

$W_{net} = W_{w//} + W_f$ ✓
$= mg\sin 20°\Delta x\cos 0° + f\Delta x\cos 180°$
$= (70)(9,8)\sin 20°$ ✓ $(12)\cos 0°$ ✓ + $(190)(12)\cos 180°$ ✓
$W_{net} = 535,51$ J ✓

Accept:
cos0° or 1
cos180° or -1

OPTION 4

$W_{net} = W_w + W_f$ ✓
$= mgh\cos 0° + f\Delta x\cos 180°$
$= (70)(9,8)$ ✓ $(12\sin 20°)\cos 0°$ ✓ + $(190)(12)\cos 180°$ ✓
$W_{net} = 535,51$ J ✓

Accept:
cos0° or 1
cos180° or -1

[12.1.3] (5)

5.4 The net work done (on an object) ✓is equal to the change in (the object's) kinetic energy. ✓

OR

The work done (on an object) by a net force is equal to the change in (the object's) kinetic energy. [12.2.1] (2)

5.5 $W_{net} = \Delta K$ ✓ (OR $W_{net} = \Delta E_k$)

$535,51 = ½\, m(v_f^2 - v_i^2)$

$535,51$ ✓ $= ½\,(70)(v_f^2 - 4)$ ✓

$v_f = 4,39\ m\cdot s^{-1}$ ✓

[12.2.3] (4)

[16]

QUESTION 6

6.1 Doppler effect ✓ [12.2.1] (1)

6.2 Towards ✓ [12.2.2] (1)

6.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ / $f_L = \frac{v}{v - v_s} f_s$

$v_L = \frac{v + v_L}{v - v_s} f_s$ / $v_L = \frac{v - v_L}{v - v_s} f_s$ Max. $\frac{3}{4}$

$\therefore$ 2 080 ✓= $(\frac{340 \pm 0}{340 - v_s}) 2\,000$ ✓

$\therefore v_s$ = 13,08 m·s^{-1} ✓ [12.2.3] (4)

6.4 Equal to (2 000 Hz) ✓
The passenger moves at the same velocity as the train. / There is no difference in velocity of the passenger relative to the train. ✓ [12.2.2] (2)
[8]

QUESTION 7

7.1 The ability of a wave to bend / spread out (in wave fronts). ✓ as they pass through a small aperture / around a sharp edge. ✓ [12.2.1] (2)

7.2 $\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 3°$ ✓= $\frac{2\lambda}{0{,}02 \times 10^{-3}}$ ✓

$\lambda = \frac{(\sin 3)(0{,}02 \times 10^{-3})}{2}$

= 5,23 x 10^{-7} m ✓ (523 nm) [12.2.3] (4)

7.3 Green ✓
It has a shorter wavelength than yellow light. ✓

OR

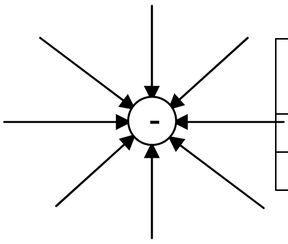
λ(yellow) > 5,23 x 10^{-7} m / 523 nm [12.2.2] (2)

7.4 Increase the slit width. ✓
Decrease the distance between the screen and the slit. ✓ [12.1.1] (2)

7.5 A central band of alternate bright and dark bands ✓of equal width. ✓ [12.1.4] (2)
[12]

QUESTION 8

8.1



Checklist: Criteria for electric field	Marks
Direction of field (towards charge)	✓
Shape (Field radially symmetrical)	✓

[12.1.2] (2)

8.2

$$n_{electrons} = \frac{Q}{q_e}$$

$$= \frac{-4\times10^{-9}}{-1{,}6\times10^{-19}} \checkmark \text{OR } \frac{4\times10^{-9}}{1{,}6\times10^{-19}}$$

$= 2{,}5 \times 10^{10}$ ✓ (electrons)

[12.2.3] (2)

8.3

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$= \frac{(9\times10^{9})(4\times10^{-9})(2\times10^{-9})}{(1\times10^{-2})^2} \checkmark \checkmark$$

$= 7{,}2 \times 10^{-4}$ N ✓

OR

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$= \frac{(9\times10^{9})(-4\times10^{-9})(+2\times10^{-9})}{(1\times10^{-2})^2} \checkmark \checkmark$$

$= -7{,}2 \times 10^{-4}$ N

$= 7{,}2 \times 10^{-4}$ N ✓

[12.2.3] (4)

8.4

$$\text{New charge} = \frac{(-4\times10^{-9}) + (2\times10^{-9})}{2} \checkmark$$

$= -1 \times 10^{-9}$ C ✓

$$U = \frac{kQ_1Q_2}{r} \checkmark$$

$$= \frac{(9\times10^{9})(-1\times10^{-9})(-1\times10^{-9})}{(1\times10^{-2})} \checkmark \checkmark$$

$= 9 \times 10^{-7}$ J ✓

[12.1.3] (6)

[14]

QUESTION 9

9.1 $R = \frac{V}{I}$ ✓

$= \frac{12}{1,2}$ ✓

$= 10\ \Omega$ ✓ [12.2.3] (3)

9.2 $R_{total} = R + r$ ✓

10✓ = (6 + 3,6)✓ + r

r = 0,4 Ω ✓ [12.2.3] (4)

9.3 $W = I^2Rt$ ✓

$= (1,2)^2(6)(180)$ ✓ OR $(1,2)^2(6)(3 \times 60)$

$= 1\ 555,2$ J ✓/$1,56 \times 10^3$ J [12.2.3] (3)

9.4 9.4.1 Decreases ✓ (or any equivalent word) [12.2.2] (1)

9.4.2 Increases ✓ (or any equivalent word) [12.2.2] (1)

9.5 Increases ✓

R_{ext} decreases ✓ (significantly).

I through battery increases ✓ (significantly).

$\underline{W = I^2rt}$/ Energy transfer to the battery / work done by battery <u>increases</u> (substantial). ✓

OR

$\underline{W = \frac{V^2}{r}t}$ / Energy transfer to the battery / work done by battery <u>increases</u> (substantial). [12.1.3] (4)

[16]

QUESTION 10

10.1 AC generator – slip rings✓
DC generator – (split ring) commutator✓ (2)

IF: The one has a slip ring and the other one has a (split ring) commutator. ½

[12.2.1]

10.2 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ = $\frac{6,43}{\sqrt{2}}$ ✓ = 4,55 A✓

[12.2.3] (3)

10.3 $I_{rms} = \frac{V_{rms}}{R}$ ✓

$\therefore 4,55 = \frac{V_{rms}}{48,4}$ ✓

V_{rms}= 220,22 V

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$220,22 = \frac{V_{max}}{\sqrt{2}}$ ✓

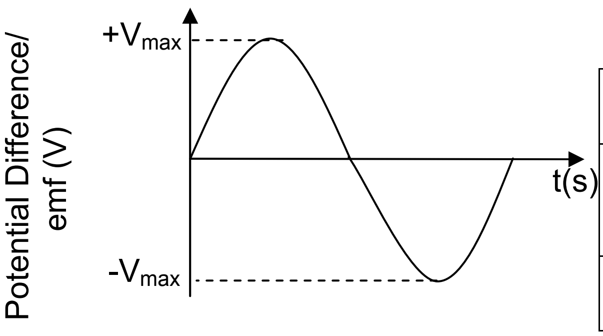
V_{max} = 311,44 V ✓

OR

$V_{max} = I_{max}R$✓✓
= (6,43) ✓ (48,4) ✓
= 311,21 V✓

[12.1.3] (5)

10.4



Checklist Criteria for Graph	Marks
V_{max} correctly shown : $-V_{max}$ and $+V_{max}$/-311,44 V and =311,44 V	✓
Correct shape for at least one complete cycle.	✓

[12.1.2] (2)

10.5 Less air pollution ✓ [12.3.2] (1)

[13]

QUESTION 11

11.1 11.1.2

Checklist **Criteria for investigative question**	Mark
The dependent and independent variables are stated.	✓
Asks a question about the relationship between the dependent and independent variable.	✓

Examples:
Which type of radiation will emit (photo)electrons from zinc?
OR
Which one of red light or ultraviolet light will emit (photo) electrons from zinc? [12.1.1] (2)

11.1.2 Ultraviolet light emits photoelectrons (from the zinc plate). ✓
Electrons in the gold leaves move upward (into the disc of the electroscope due to the shortage of electrons). ✓
Less negative charges in gold leaves. / less repulsion between the gold leaves. ✓ [12.1.4] (3)

11.1.3 Only ultra violet light/radiation will eject (photo) electrons (from the surface of zinc). ✓✓
OR
Red light does not eject (photo) electrons from zinc. ✓✓ [12.1.2] (2)

11.1.4 Any ONE
It causes damage to the skin / skin cancer.✓
It cause damage to the eye / cataracts. [12.3.2] (1)

11.2 11.2.1 The minimum energy needed ✓by an electron (in a metal) to be emitted from the metal's surface. ✓ [12.2.1] (2)

11.2.2 X-rays ✓
OR
Gamma-rays [12.2.1] (1)

11.2.3

OPTION 1
$E = hf$ ✓
$= (6,63 \times 10^{-34})(4,29 \times 10^{14})$ ✓
$= 2,84 \times 10^{-19}$ J ✓
$E < W_o$ ✓ - no electrons are emitted.

OPTION 2
$hf = W_0 + \frac{1}{2}mv^2$ ✓
$(6,63 \times 10^{-34})(4,29 \times 10^{14}) = 6,88 \times 10^{-19} + \frac{1}{2}mv^2$ ✓
$\frac{1}{2}mv^2 = -4,04 \times 10^{-19}$ J ✓
Kinetic energy of photo-electrons < 0 ✓ ∴ no electrons are emitted

[12.2.3] (4)
[15]

TOTAL SECTION B: 125
GRAND TOTAL: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2011

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)

3. Answer ALL the questions in the ANSWER BOOK.

4. You may use a non-programmable calculator.

5. You may use appropriate mathematical instruments.

6. Number the answers correctly according to the numbering system used in this question paper.

7. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.

8. Give brief motivations, discussions, et cetera where required.

9. Round off your final numerical answers to a minimum of TWO decimal places.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The rate at which work is done (1)

1.2 The term that describes two sources that produce waves that have a constant phase relationship to each other (1)

1.3 The general name given to the insulating material between the plates of capacitors (1)

1.4 The type of current produced by an electric generator which has slip rings (1)

1.5 The unit of measurement of electric field (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (2.1–2.10) in the ANSWER BOOK.

2.1 Impulse is equal to the …

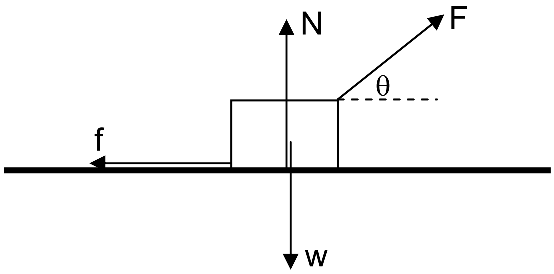
A initial momentum of a body.

B final momentum of a body.

C change in momentum of a body.

D rate of change in momentum of a body. (2)

2.2 An object is pulled along a straight horizontal road to the right without being lifted. The force diagram below shows all the forces acting on the object.



Which ONE of the above forces does POSITIVE WORK on the object?

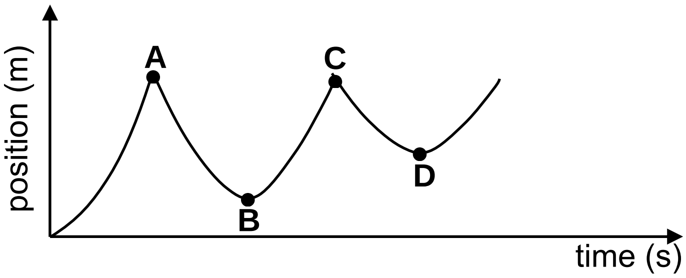
A w

B N

C f

D F (2)

2.3 A ball is released from rest from a certain height above the floor and bounces off the floor a number of times. The position-time graph below represents the motion of the bouncing ball from the instant it is released from rest.



Neglecting air resistance, which point (**A**, **B**, **C** or **D**) on the graph represents the position-time coordinates of the maximum height reached by the ball after the SECOND bounce?

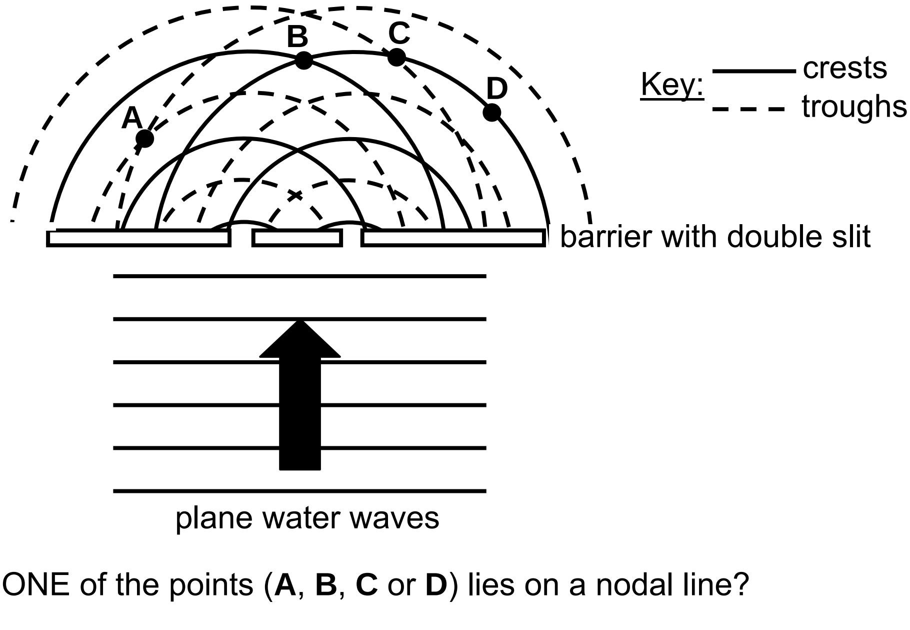
A A

B B

C C

D D (2)

2.4 Water waves pass through a double slit. The resulting circular wavefronts produced are shown as dotted and solid lines in the diagram below.



Which ONE of the points (**A**, **B**, **C** or **D**) lies on a nodal line?

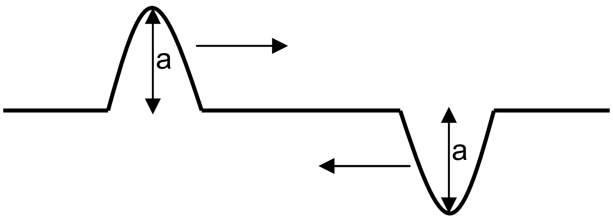
A A

B B

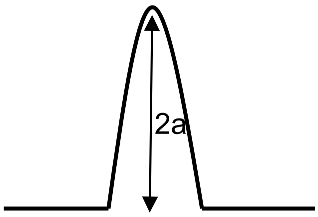
C C

D D (2)

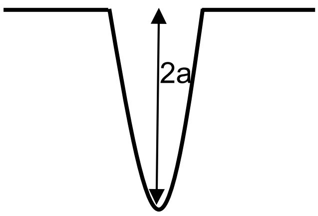
2.5 The diagram below represents two pulses, each of amplitude *a*, travelling in opposite directions along a slinky coil.

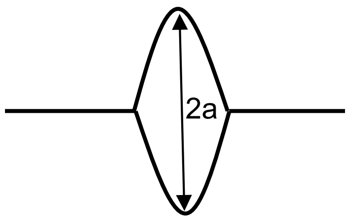


Which ONE of the following represents the resultant amplitude at the instant that these two pulses meet?

A


B

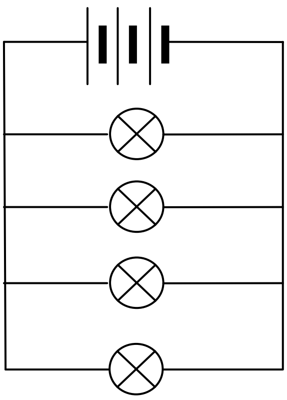
C


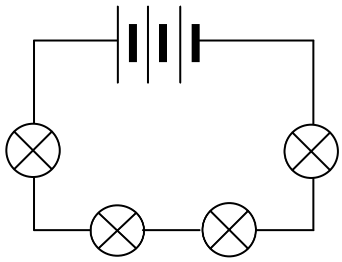
D


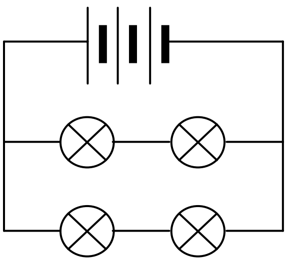
(2)

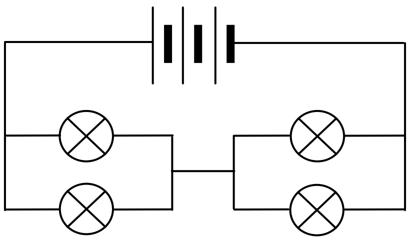
2.6 A set of identical light bulbs are connected as shown in the circuit diagrams below. The internal resistance of the battery is negligible.

In which ONE of these circuits will the light bulbs glow the brightest?

A


B


C


D


(2)

2.7 The unit of measurement of THE RATE OF FLOW OF CHARGE in a conductor is …

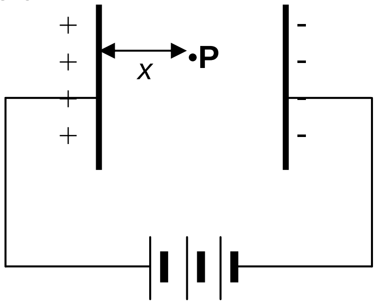
A watt.

B volt.

C ampere.

D coulomb. (2)

2.8 Point **P** is a distance *x* from the positive plate of a parallel-plate capacitor as shown in the diagram below.



The magnitude of the electric field at **P** is *E*. At a distance $\frac{1}{2}x$ from the positive plate, the magnitude of the electric field will be …

A $\frac{1}{4}E$

B $\frac{1}{2}E$

C *E*

D 2*E* (2)

2.9 Which ONE of the following descriptions best explains the formation of a line emission spectrum?

A line emission spectrum is formed when …

A white light passes through a cold gas.

B white light passes through a triangular prism.

C electrons in the ground state move to a higher energy level.

D electrons in the excited state move to a lower energy level. (2)

2.10 Which ONE of the following electromagnetic waves has the shortest wavelength?

A Radio waves

B Gamma rays

C Infrared rays

D Ultraviolet rays (2)

[20]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.

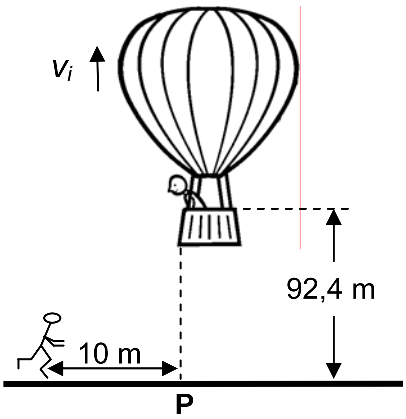
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

3. Show the formulae and substitutions in ALL calculations.

4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A hot-air balloon is moving vertically upwards at a constant speed. A camera is accidentally dropped from the balloon at a height of 92,4 m as shown in the diagram below. The camera strikes the ground after 6 s. Ignore the effects of friction.



3.1 At the instant the camera is dropped, it moves upwards. Give a reason for this observation. (1)

3.2 Calculate the speed v_i at which the balloon is rising when the camera is dropped. (4)

3.3 Draw a sketch graph of velocity versus time for the entire motion of the camera.

Indicate the following on the graph:

- Initial velocity
- Time at which it reaches the ground (4)

3.4 If a jogger, 10 m away from point **P** as shown in the above diagram and running at a constant speed of 2 $m \cdot s^{-1}$, sees the camera at the same instant it starts falling from the balloon, will he be able to catch the camera before it strikes the ground?

Use a calculation to show how you arrived at the answer. (5)

[14]

QUESTION 4 (Start on a new page.)

A patrol car is moving on a straight horizontal road at a velocity of 10 m·s^{-1} east. At the same time a thief in a car ahead of him is driving at a velocity of 40 m·s^{-1} in the same direction.

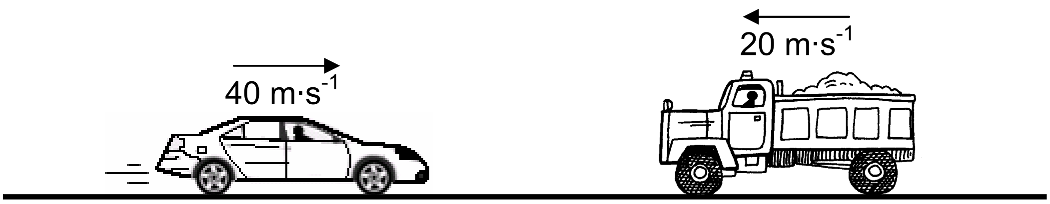
v_{PG}: velocity of the **p**atrol car relative to the **g**round
v_{TG}: velocity of the **t**hief's car relative to the **g**round

4.1 Write down the velocity of the thief's car relative to the patrol car. (2)

A person in the patrol car fires a bullet at the thief's car. The bullet leaves the gun with an initial horizontal velocity of 100 m·s^{-1} relative to the patrol car. Ignore the effects of friction.

4.2 Write down the initial velocity of the **b**ullet relative to the **t**hief's car. (2)

While travelling at 40 m·s^{-1}, the thief's car of mass 1 000 kg, collides head-on with a truck of mass 5 000 kg moving at 20 m·s^{-1}. After the collision, the car and the truck move together. Ignore the effects of friction.



4.3 State the *law of conservation of linear momentum* in words. (2)

4.4 Calculate the velocity of the thief's car immediately after the collision. (6)

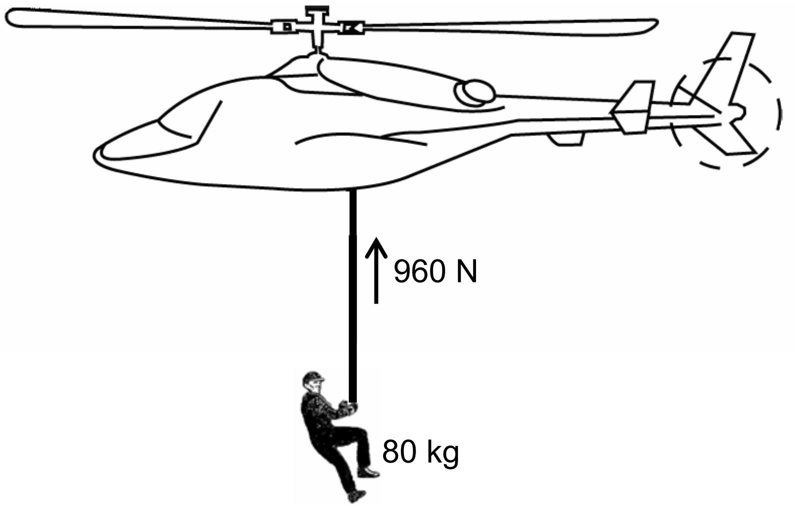
4.5 Research has shown that forces greater than 85 000 N during collisions may cause fatal injuries. The collision described above lasts for 0,5 s.

Determine, by means of a calculation, whether the collision above could result in a fatal injury. (5)

[17]

QUESTION 5 (Start on a new page.)

A rescue helicopter is stationary (hovers) above a soldier. The soldier of mass 80 kg is lifted vertically upwards through a height of 20 m by a cable at a CONSTANT SPEED of 4 $m \cdot s^{-1}$. The tension in the cable is 960 N. Assume that there is no sideways motion during the lift. Air friction is not to be ignored.



5.1 State the work-energy theorem in words. (2)

5.2 Draw a labelled free-body diagram showing ALL the forces acting on the soldier while being lifted upwards. (3)

5.3 Write down the name of a non-contact force that acts on the soldier during the upward lift. (1)

5.4 Use the WORK-ENERGY THEOREM to calculate the work done on the soldier by friction after moving through the height of 20 m. (5)

[11]

QUESTION 6 (Start on a new page.)

A train approaches a station at a constant speed of 20 $m \cdot s^{-1}$ with its whistle blowing at a frequency of 458 Hz. An observer, standing on the platform, hears a change in pitch as the train approaches him, passes him and moves away from him.

6.1 Name the phenomenon that explains the change in pitch heard by the observer. (1)

6.2 Calculate the frequency of the sound that the observer hears while the train is approaching him. Use the speed of sound in air as 340 $m \cdot s^{-1}$. (4)

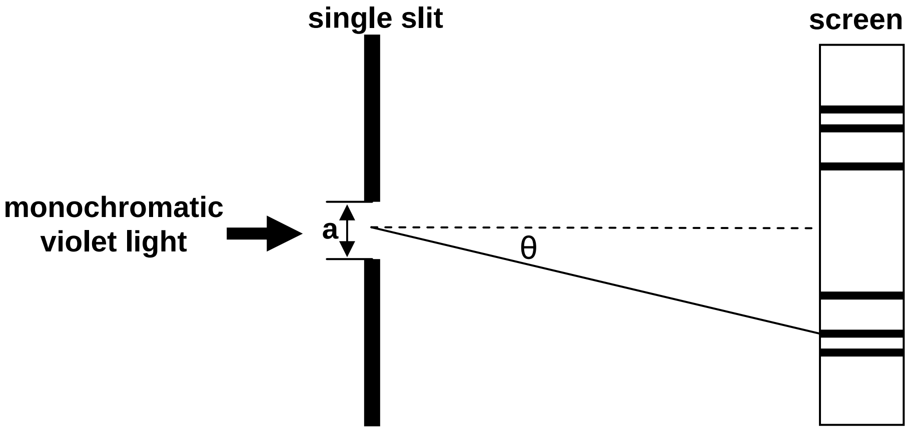
6.3 How will the observed frequency change as the train passes and moves away from the observer? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

6.4 How will the frequency observed by the train driver compare to that of the sound waves emitted by the whistle? Write down only GREATER THAN, EQUAL TO or LESS THAN. Give a reason for the answer. (2)

[8]

QUESTION 7 (Start on a new page.)

A learner investigates the change in broadness of the central bright band in a diffraction pattern when light passes through single slits of different widths. She uses monochromatic violet light of wavelength 4 x 10^{-7} m. The apparatus is set up as shown in the diagram below.



7.1 Define the term *monochromatic light*. (2)

7.2 Write down the investigative question for this investigation. (2)

7.3 Write down TWO variables that are kept constant during this investigation. (2)

7.4 The learner now uses a narrower slit.

How will the broadness of the central bright band change? Write down only INCREASES, DECREASES or REMAINS THE SAME.

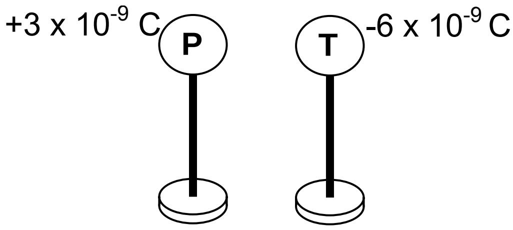
Give an explanation. (2)

7.5 Calculate the angle θ at which the second minimum is formed if a slit of width 2,2 x 10^{-6} m is used. (5)

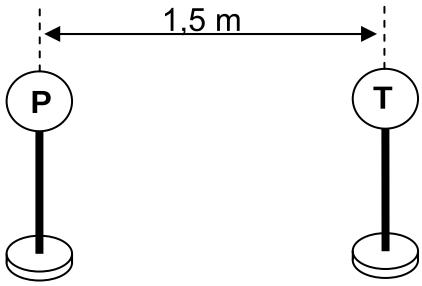
[13]

QUESTION 8 (Start on a new page.)

Two metal spheres, **P** and **T**, on insulated stands, carry charges of +3 x 10^{-9} C and -6 x 10^{-9} C respectively.



The spheres are allowed to touch each other and are then placed 1,5 m apart as shown below.



8.1 In which direction will electrons flow while spheres **P** and **T** are in contact? Write down only FROM **P** TO **T** or FROM **T** TO **P**. (1)

8.2 Calculate the net charge gained or lost by sphere **P** after the spheres have been in contact. (3)

8.3 Calculate the number of electrons transferred during the process in QUESTION 8.2. (2)

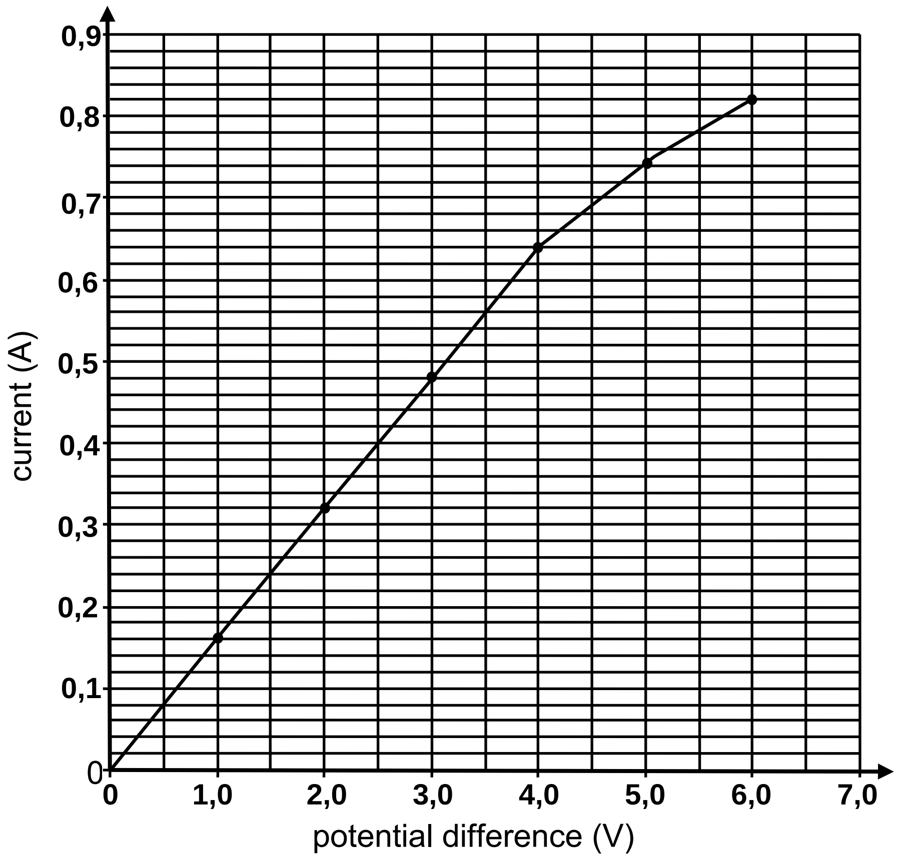
8.4 A third sphere **R,** carrying a charge of -3 x 10^{-9} C, is NOW placed between **P** and **T** at a distance of 1 m from **T**.

Calculate the net force experienced by sphere **R** as a result of its interaction with **P** and **T**. (6)

[12]

QUESTION 9 (Start on a new page.)

Learners conduct an investigation to verify Ohm's law. They measure the current through a conducting wire for different potential differences across its ends. The results obtained are shown in the graph below.



9.1 Which ONE of the measured quantities is the dependent variable? (1)

9.2 The graph deviates from Ohm's law at some point.

9.2.1 Write down the coordinates of the plotted point on the graph beyond which Ohm's law is not obeyed. (2)

9.2.2 Give a possible reason for the deviation from Ohm's law as shown in the graph. Assume that all measurements are correct. (2)

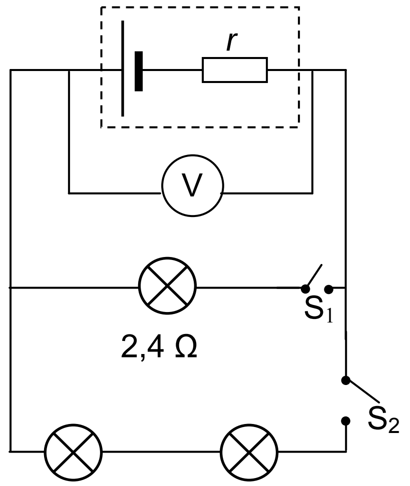
9.3 Calculate the gradient of the graph for the section where Ohm's law is obeyed.

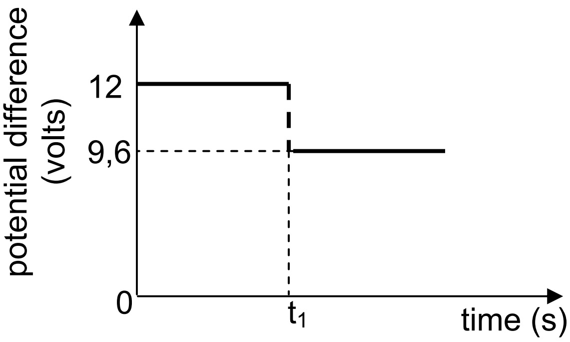
Use this to calculate the resistance of the conducting wire. (4)
[9]

QUESTION 10 (Start on a new page.)

The headlamp and two IDENTICAL tail lamps of a scooter are connected in parallel to a battery with unknown internal resistance as shown in the simplified circuit diagram below. The headlamp has a resistance of 2,4 Ω and is controlled by switch $\mathbf{S_1}$. The tail lamps are controlled by switch $\mathbf{S_2}$. The resistance of the connecting wires may be ignored.

The graph alongside shows the potential difference across the terminals of the battery before and after switch $\mathbf{S_1}$ is closed (whilst switch $\mathbf{S_2}$ is open). Switch $\mathbf{S_1}$ is closed at time t_1.





10.1 Use the graph to determine the emf of the battery. (1)

10.2 WITH ONLY SWITCH $\mathbf{S_1}$ CLOSED, calculate the following:

10.2.1 Current through the headlamp (3)

10.2.2 Internal resistance, *r*, of the battery (3)

10.3 BOTH SWITCHES $\mathbf{S_1}$ AND $\mathbf{S_2}$ ARE NOW CLOSED. The battery delivers a current of 6 A during this period.

Calculate the resistance of each tail lamp. (5)

10.4 How will the reading on the voltmeter be affected if the headlamp burns out? (Both switches $\mathbf{S_1}$ and $\mathbf{S_2}$ are still closed.)

Write down only INCREASES, DECREASES or REMAINS THE SAME.

Give an explanation. (3)
[15]

QUESTION 11 (Start on a new page.)

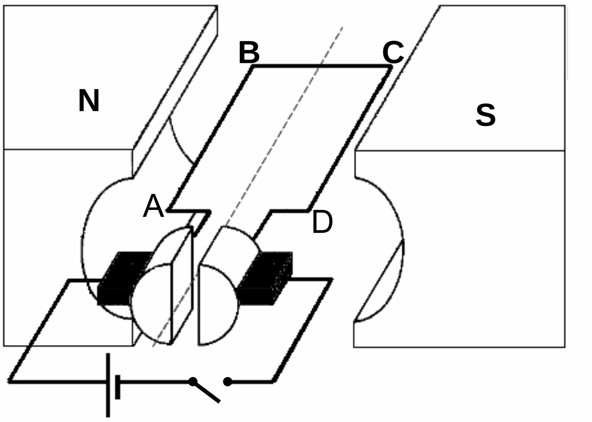
Diesel-electric trains make use of electric motors as well as generators.

11.1 The table below compares a motor and a generator in terms of the type of energy conversion and the underlying principle on which each operates. Complete the table by writing down only the question number (11.1.1–11.1.4) in the ANSWER BOOK and next to each number the answer.

	TYPE OF ENERGY CONVERSION	**PRINCIPLE OF OPERATION**
Motor	11.1.1	11.1.3
Generator	11.1.2	11.1.4

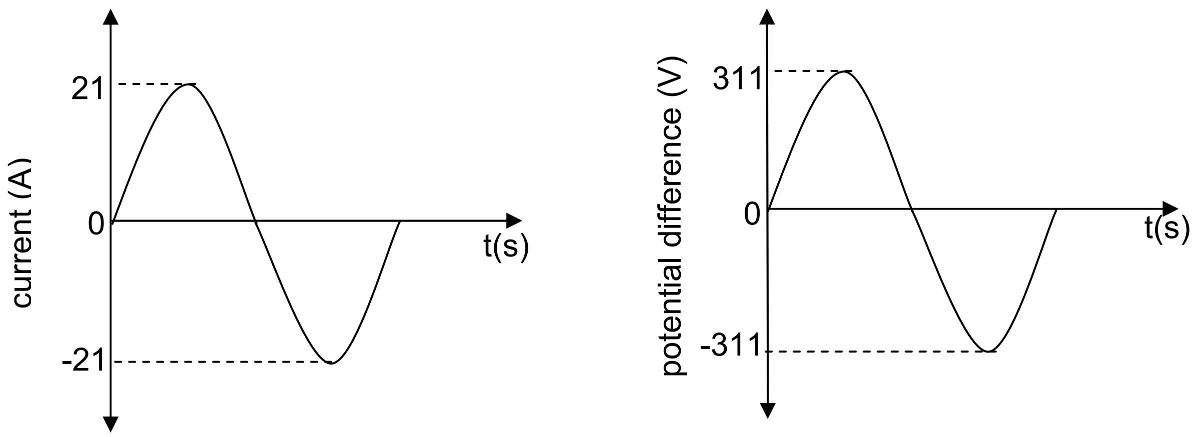
(4)

The simplified diagram below represents an electric motor.



11.2 Give a reason why the section of the coil labelled **BC** in the above diagram does not experience a magnetic force whilst the coil is in the position as shown. (2)

11.3 Graphs of the current and potential difference outputs of an AC generator are shown below.

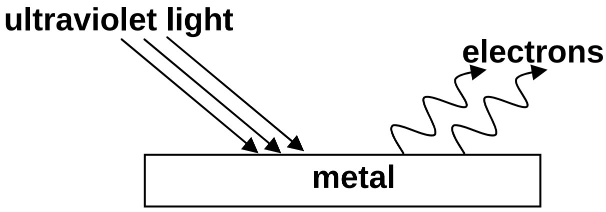


Calculate the average power output of this generator. (6)
[12]

QUESTION 12 (Start on a new page.)

A metal surface is illuminated with ultraviolet light of wavelength 330 nm. Electrons are emitted from the metal surface.

<u>The minimum amount of energy required to emit an electron from the surface of this metal</u> is 3,5 x 10^{-19} J.



12.1 Name the phenomenon illustrated above. (1)

12.2 Give ONE word or term for the underlined sentence in the above paragraph. (1)

12.3 Calculate the frequency of the ultraviolet light. (4)

12.4 Calculate the kinetic energy of a photoelectron emitted from the surface of the metal when the ultraviolet light shines on it. (4)

12.5 The intensity of the ultraviolet light illuminating the metal is now increased. What effect will this change have on the following:

12.5.1 Kinetic energy of the emitted photoelectrons (Write down only INCREASES, DECREASES or REMAINS THE SAME.) (1)

12.5.2 Number of photoelectrons emitted per second (Write down only INCREASES, DECREASES or REMAINS THE SAME.) (1)

12.6 Overexposure to sunlight causes damage to skin cells.

12.6.1 Which type of radiation in sunlight is said to be primarily responsible for this damage? (1)

12.6.2 Name the property of this radiation responsible for the damage. (1)
[14]

TOTAL SECTION B: 125
GRAND TOTAL: 150

SECTION A

QUESTION 1 / *VRAAG 1*

1.1 Power ✓
Drywing / Arbeidstempo ✓ (1)

1.2 Coherent / *Koherent* ✓ (1)

1.3 Dielectric / *Diëlektrikum* ✓ (1)

1.4 Alternating (current) / AC / ac ✓
Wissel(stroom) / WS / ws ✓ (1)

1.5 $N \cdot C^{-1}$ / $V \cdot m^{-1}$ / newton per coulomb / volt per meter ✓ (1)
[5]

QUESTION 2 / *VRAAG 2*

2.1 C ✓✓ (2)

2.2 D ✓✓ (2)

2.3 D ✓✓ (2)

2.4 C ✓✓ (2)

2.5 B ✓✓ (2)

2.6 A ✓✓ (2)

2.7 C ✓✓ (2)

2.8 C ✓✓ (2)

2.9 D ✓✓ (2)

2.10 B ✓✓ (2)
[20]

TOTAL SECTION A / *TOTAAL AFDELING A*: 25

SECTION B / *AFDELING B*

QUESTION 3 / *VRAAG 3*

3.1 The initial <u>velocity / speed of the camera is the same</u> ✓ (as that of the balloon).
Die begin<u>snelheid / spoed van die kamera</u> is <u>dieselfde</u> ✓(as dié van die ballon). (1)

3.2 **Downward positive:**
Afwaarts positief:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\therefore 92{,}4$ ✓ $= v_i(6) + \frac{1}{2}(9{,}8)(6)^2$ ✓

$\therefore v_i = -14\ m\cdot s^{-1}$

$\therefore v_i = 14\ m\cdot s^{-1}$ ✓

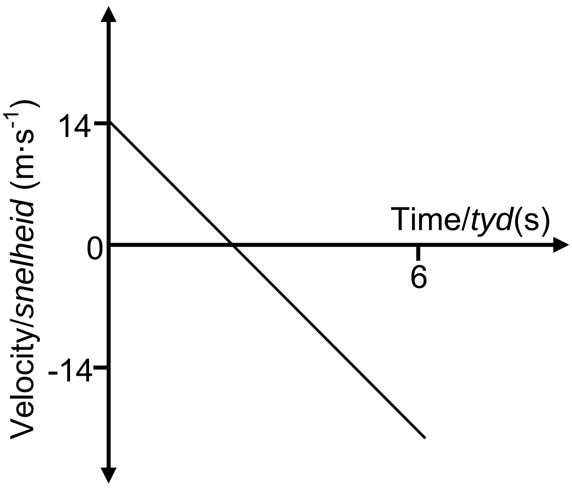
Downward negative:
Afwaarts negatief:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\therefore -92{,}4$ ✓ $= v_i(6) + \frac{1}{2}(-9{,}8)(6)^2$ ✓

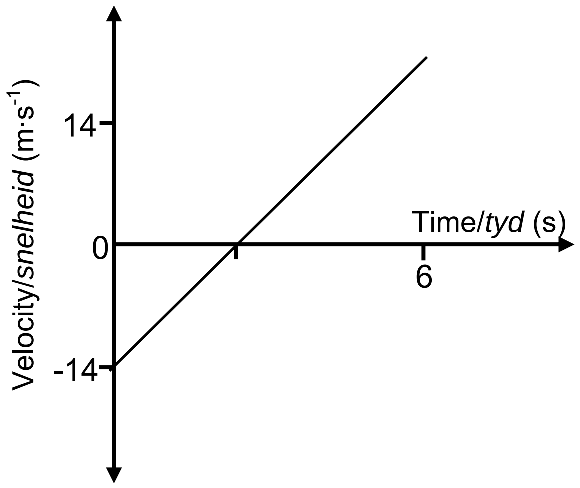
$\therefore v_i = 14\ m\cdot s^{-1}$ ✓ (4)

3.3 Upward positive/*Opwaarts positief*:



Criteria for graph/*Kriteria vir grafiek:*	Marks/ *Punte*
Correct shape as shown.(straight line with gradient) Korrekte *vorm soos getoon.(reguitlyn met gradient)*	✓
Graph starts at v = 14 $m\cdot s^{-1}$ / v_i at t = 0 s. *Grafiek begin by v = 14 $m\cdot s^{-1}$ / v_i by t = 0 s.*	✓
Graph extends below t axis until t = 6 s. *Grafiek verleng onder t-as tot t = 6 s.*	✓
Section of graph below t axis longer than section above t axis. *Gedeelte van grafiek onderkant t-as langer as gedeelte bokant t-as.*	✓

Upward negative / *Opwaarts negatief:*



Criteria for graph/*Kriteria vir grafiek:*	Marks/ *Punte*
Correct shape as shown. Korrekte *vorm soos getoon.*	✓
Graph starts at v / v_i = -14 m·s^{-1} at t = 0 s. *Grafiek begin by v/v_i = -14 m·s^{-1} by t = 0 s.*	✓
Graph extends above t axis until t = 6 s. *Grafiek verleng bokant t-as tot t = 6 s.*	✓
Section of graph above t axis longer than section below t axis. *Gedeelte van grafiek bokant t-as langer as gedeelte onderkant t-as.*	✓

(4)

3.4

Option 1 / *Opsie 1*:

$\Delta x = v\Delta t$ ✓

$\therefore 10$ ✓ $= (2)\Delta t$ ✓

$\therefore \Delta t = 5$ s ✓

Yes/ Will catch the camera, time is less than 6 s. ✓

Ja / Sal die kamera vang, tyd is kleiner as 6 s. ✓

Option 2/*Opsie 2*:

$\Delta x = v\Delta t$ ✓

$= (2)$ ✓ (6) ✓

$= 12$ m ✓

Yes / Will catch the camera, distance covered is greater than 10 m. ✓

Ja / Sal die kamera vang , afstand afgelê is groter as 10 m. ✓

Option 3 / *Opsie 3*:

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\therefore 10$ ✓ $= (2)\Delta t$ ✓ $+ ½(0)\Delta t$

$\therefore \Delta t = 5$ s ✓

Yes/ will catch the camera, time is less than 6 s✓.

Ja / Sal die kamera vang, tyd is kleiner as 6 s. ✓

Option 4 / *Opsie 4*:

$\Delta x = (\frac{v_i + v_f}{2})\Delta t$ ✓ $\therefore 10$ ✓ $= (\frac{2+2}{2})\Delta t$ ✓ $\therefore \Delta t = 5$ s ✓

Yes / Will catch the camera, time is less than 6 s.✓

Ja / Sal die kamera vang, tyd is kleiner as 6 s. ✓

Option 5 / *Opsie 5*:

$\Delta x = (\frac{v_i + v_f}{2})\Delta t$ ✓ $= (\frac{2+2}{2})$ ✓ 6 ✓ $= 12$ m· ✓

Yes / Will catch the camera, distance covered is greater than 10 m. ✓

Ja / Sal die kamera vang , afstand afgelê is groter as 10 m. ✓

(5)
[14]

QUESTION 4 / *VRAAG 4*

4.1 30 m·s^{-1} ✓east / *oos* ✓

Notes / *Aantekeninge*:
$v_{TP} = v_{TG} - v_{PG} = 40 - 10 = 30$ $\therefore v_{TP} = 30$ m·s^{-1} east/*oos* OR/*OF* $v_{TP} = v_{TG} + v_{GP} = 40 + (-10) = 30$ $\therefore v_{TP} = 30$ m·s^{-1} east/*oos*

(2)

4.2 70 m·s^{-1} ✓ east / *oos* ✓

Notes / *Aantekeninge*:	
Solution 1 / *Oplossing 1*: $v_{BT} = v_{BP} - v_{TP}$ $= 100 - 30 = 70$ $\therefore v_{BT} = 70$ m·s^{-1} east / *oos* **Solution 2 / *Oplossing 2*** $v_{BT} = v_{BP} + v_{PT}$ $= 100 + (-30) = 70$ $\therefore v_{BT} = 70$ m·s^{-1} east/*oos* **OR / OF** $v_{BT} = v_{BP} + v_{PG} + v_{GT}$ $= 100 + 10 + (-40)$ $= 70$ $\therefore v_{BT} = 70$ m·s^{-1} east / *oos*	**Solution 3 / *Oplossing 3*** $v_{BT} = v_{BP} + v_{PG} + v_{GT}$ $= 100 + 10 + (-40)$ $= 70$ $\therefore v_{BT} = 70$ m·s^{-1} east / *oos* **Solution 4 / *Oplossing 4*** $v_{BG} = v_{BP} + v_{PG}$ $= 100 + 10 = 110$ $\therefore v_{BG} = 110$ m·s^{-1} $v_{BT} = v_{BG} + v_{GT}$ $= 110 + (-40) = 70$ $\therefore v_{BT} = 70$ m·s^{-1} east / *oos*

(2)

4.3 The total (linear) momentum remains constant/is conserved / does not change. ✓
in an isolated/a closed system/the absence of external forces. ✓

Die totale (liniêre) momentum bly konstant / behoue / verander nie ✓
in 'n geïsoleerde sisteem / geslote sisteem / die afwesigheid van eksterne kragte. ✓ (2)

4.4

Option 1 / *Opsie 1*:

To the right as positive / *Na regs as positief:*

$\Sigma p_{before/\ voor} = \Sigma p_{after/\ na}$ ✓

$\underline{(1\ 000)(40)}$ ✓+ $\underline{(5\ 000)(-20)}$ ✓ = $\underline{(1\ 000 + 5\ 000)v_f}$ ✓

$\therefore v_f = -10\ m{\cdot}s^{-1}$ ✓

$\therefore v_f = 10\ m{\cdot}s^{-1}$ left / *na links* ✓ **OR / *OF*** west / *wes*

Option 2 / *Opsie 2*:

To the right as positive / *Na regs as positief:*

$\Delta p_{car} = -\Delta p_{truck}$ ✓

$m(v_f – v_i) = -m(v_f – v_i)$

$\underline{(1000)(v_f} – (40))$ ✓= $\underline{-(5\ 000)(v_f}$ ✓– (-20)) ✓

$6\ 000v_f = -60\ 000$

$\therefore v_f = -10\ m{\cdot}s^{-1}$ ✓

$\therefore v_f = 10\ m{\cdot}s^{-1}$ left / *na links* ✓ **OR/*OF*** west / *wes* (6)

4.5

Option 1 / *Opsie 1:* Force on car / *Krag op motor:* To the right as positive / *Na regs as positief:* $F_{net}\Delta t = \Delta p$ ✓$= mv_f - mv_i$ $F_{net}(0,5)$ ✓ = $\underline{1\ 000(-10 – 40)}$ ✓ $\therefore F_{net} = -1 \times 10^5$ N ✓ OR/*OF* $\therefore F_{net} = 1 \times 10^5$ N (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal. / *Ja botsing is fataal.* ✓	Force on car / *Krag op motor:* To the left as positive / *Na links as positief:* $F_{net}\Delta t = \Delta p$ ✓$= mv_f - mv_i$ $F_{net}(0,5)$ ✓ = $\underline{1\ 000(10 – (- 40))}$ ✓ $\therefore F_{net} = 1 \times 10^5$ N ✓ (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal. / *Ja, botsing is fatal.* ✓
Option 2 / *Opsie 2:* Force on truck / *Krag op vragmotor:* To the right as positive / *Na regs as positief:* $F_{net}\Delta t = \Delta p$ ✓$= mv_f - mv_i$ $F_{net}(0,5)$ ✓ = $\underline{5\ 000(-10 – (-20))}$ ✓ $\therefore F_{net} = 1 \times 10^5$ N ✓ (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal. / *Ja, botsing is fataal.* ✓	Force on truck / *Krag op vragmotor:* To the left as positive / *Na links as positief:* $F_{net}\Delta t = \Delta p$ ✓$= mv_f - mv_i$ $F_{net}(0,5)$ ✓ = $\underline{5\ 000(10 – 20)}$ ✓ $\therefore F_{net} = -1 \times 10^5$ N ✓ $\therefore F_{net} = 1 \times 10^5$ N (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal / *Ja, botsing is fataal.* ✓
Option 3 / *Opsie 3:* Force on car / *Krag op motor:* To the right as positive / *Na regs as positief:* $v_f = v_i + a\Delta t$ $\therefore -10 \underline{= 40 + a(0,5)}$ ✓ $\therefore a = -100$ (✓ Both formulae/ *Beide formules*) $F_{net} = ma = (1\ 000)(-100)$ ✓ $\therefore F_{net} = -1 \times 10^5$ N ✓ (-100 000 N) $\therefore F_{net} = 1 \times 10^5$ N (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal. / *Ja, botsing is fataal.* ✓	Force on car / *Krag op motor:* To the left as positive / *Na links as positief:* $v_f = v_i + a\Delta t$ $\therefore 10 \underline{= - 40 + a(0,5)}$ ✓ $\therefore a = 100$ (✓ Both formulae/ *Beide formules*) $F_{net} = ma = (1\ 000)(100)$ ✓ $\therefore F_{net} = 1 \times 10^5$ N ✓ (100 000 N) $\therefore F_{net} > 85\ 000$ N Yes, collision is fatal. / *Ja, botsing is fataal.* ✓

Option 4 / *Opsie 4*: Force on truck / *Krag op vragmotor:* To the right as positive / *Na regs as positief:* $v_f = v_i + a\Delta t$ $\therefore$ -10 = -20 + a(0,5) ✓ $\therefore$ a = 20 ✓ Both formulae/ *Beide formules* F_{net} = ma = (5 000)(20) ✓ $\therefore$ $F_{net} = 1 \times 10^5$ N ✓ (100 000 N) $\therefore F_{net}$ > 85 000 N Yes, collision is fatal. / *Ja, botsing is fataal.* ✓	Force on truck / *Krag op vragmotor:* To the left as positive / *Na links as positief:* $v_f = v_i + a\Delta t$ $\therefore$ 10 = 20 + a(0,5) ✓ $\therefore$ a = -20 ✓ Both formulae/ *Beide formules* F_{net} = ma = (5 000)(-20) ✓ $\therefore$ $F_{net} = -1 \times 10^5$ N ✓ (-100 000 N) $\therefore$ $F_{net} = 1 \times 10^5$ N (100 000 N) $\therefore F_{net}$ > 85 000 N Yes, collision is fatal. / *Ja, botsing is fataal.* ✓

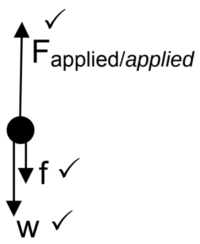
(5)
[17]

QUESTION 5 / *VRAAG 5*

5.1 The net (total) work (done on an object) ✓
is equal to the change in kinetic energy (of the object.) ✓
Die netto (totale) arbeid (verrig op 'n voorwerp) ✓
is gelyk aan die verandering in kinetiese energie (van die voorwerp) ✓

OR / *OF*
The work done (on an object) by a net (resultant) force ✓
is equal to the change in (the object's) kinetic energy. ✓
Die arbeid verrig (op 'n voorwerp) deur 'n netto (resulterende) krag ✓
is gelyk aan die verandering in kinetiese energie (van die voorwerp.) ✓ (2)

5.2



(3)

5.3 Gravitational force/weight (of soldier) ✓
Gravitasiekrag/gewig (van soldaat) (1)

5.4 $W_{net} = \Delta K$ ✓

$F\Delta y\cos\theta + F_w\Delta y\cos\theta + W_f = \Delta K$

(960)(20)cos0° ✓+ (80)(9,8)(20)cos180° ✓ + W_f = 0 ✓

19 200 – 15 680 + W_f = 0

W_f = - 3 520 J ✓ (5)
[11]

QUESTION 6 / *VRAAG 6*

6.1 Doppler effect / *Doppler-effek* ✓ (1)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$\therefore f_L = \frac{340 \pm 0}{340 - 20}$ ✓ (458) ✓

$\therefore f_L$ = 486,63 Hz ✓ (4)

6.3 Decreases/*Verlaag* ✓ (1)

6.4 Equal to/*Gelyk aan* ✓

Velocity of train driver relative to the whistle is zero. ✓
Snelheid van treindrywer relatief tot fluitjie is nul.

OR / *OF*
Train driver has same velocity as whistle.
Treindrywer het dieselfde snelheid as die fluitjie.

OR / *OF*
There is no relative motion between source and observer.
Daar is geen relatiewe beweging tussen bron en waarnemer. (2)
[8]

QUESTION 7 / *VRAAG 7*

7.1 Light of a single wavelength **OR** single frequency. ✓✓
*Lig van 'n enkele golflengte **OF** enkele frekwensie.* ✓✓ (2)

7.2

Criteria for investigative question: ***Kriteria vir ondersoekende vraag:***	**Mark/** ***Punt***
The dependent and independent variables are stated. *Die afhanklike en onafhanklike veranderlikes is genoem.*	✓
Asks a question about the relationship between dependent and independent variables. *Vra 'n vraag oor die verwantskap tussen die afhanklike en onafhanklike veranderlikes.*	✓

Examples/*Voorbeelde:*

- How will the broadness / width of the central band change / differ when slit width changes / is increased / is decreased?
Hoe sal die breedte / wydte van die sentrale helderband verander / verskil wanneer die spleetwydte verander / toeneem / afneem?

- What is the relationship between the broadness of the central bright band and slit width?
Wat is die verwantskap tussen die breedte van die sentrale helderband en spleetwydte? (2)

7.3 Wavelength (of light) / Frequency (of light) / Colour of light/ Light source ✓
<u>Distance between slit and screen.</u> ✓

Golflengte (van lig) / Frekwensie (van lig) / Kleur van lig / Ligbron ✓
<u>Afstand tussen spleet en skerm</u>. ✓ (2)

7.4 Increases / *Vermeerder* ✓
Diffraction is inversely proportional to slit width. ✓
Diffraksie is omgekeerd eweredig aan spleetwydte. ✓

OR/*OF*
Increases / *Vermeerder* ✓
Diffraction / *Diffraksie* OR/*OF* sinθ $\alpha \ \frac{1}{a}$ ✓ (2)

7.5 **<u>Option 1 / *Opsie 1:*</u>**

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin\theta = \frac{(2)(4\times10^{-7})}{2{,}2\times10^{-6}}$ ✓✓

$\therefore\ \theta$ = 21,32° ✓

<u>Option 2 / *Opsie 2:*</u>

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin\theta = \frac{(-2)(4\times10^{-7})}{2{,}2\times10^{-6}}$ ✓✓

$\therefore\ \theta$ = -21,32° ✓ (5)

[13]

QUESTION 8 / *VRAAG 8*

8.1 T to/*na* P ✓ (1)

8.2 $Q = \frac{3\times10^{-9} + (-6\times10^{-9})}{2}$ ✓ = -1,5 x 10^{-9} C

$\Delta Q_P = Q_P(\text{final}) - Q_P(\text{initial})$
= -1,5 x 10^{-9} – 3 x 10^{-9} ✓
= -4,5 x 10^{-9} C ✓

OR / *OF*
$\Delta Q_T = Q_T(\text{final}) - Q_T(\text{initial})$
= -1,5 x 10^{-9} – (-6 x 10^{-9}) ✓
= 4,5 x 10^{-9} C ✓ (3)

8.3 Number of electrons / *Getal elektrone* = $\frac{-4{,}5\times10^{-9}}{-1{,}6\times10^{-19}}$ ✓
= 2,81 x 10^{10} ✓ (2)

8.4

Option 1 / *Opsie 1*

$F_{TR} = \frac{kQ_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^9)(1,5\times10^{-9})(3\times10^{-9})}{1^2}$ ✓

= 4,05 x 10^{-8} N to the left/towards P
na links/na P toe

$F_{PR} = \frac{kQ_1Q_2}{r^2}$

$= \frac{(9\times10^9)(1,5\times10^{-9})(3\times10^{-9})}{0,5^2}$ ✓

= 1,62 x 10^{-7} N to the right/towards T
na regs/na T toe

✓Any one / *Enige een* (for the circled substitutions)

To the right / towards T as positive: / *Na regs / na T toe as positief*
F_{net} = 1,62 x 10^{-7} - 4,05 x 10^{-8}
= 1,22 x 10^{-7} N (1,215 x 10^{-7} N)
= 1,22 x 10^{-7} N ✓ to the right / towards T / *na regs / na T toe* ✓ (6)

[12]

QUESTION 9 / *VRAAG 9*

9.1 Current / I / *stroom* ✓ (1)

9.2

9.2.1 (4,0 ✓ ; 0,64) ✓ (2)

9.2.2 Temperature was not kept constant. ✓✓
Temperatuur is nie konstant gehou nie. ✓✓ (2)

9.3 Gradient/m = $\frac{\Delta y}{\Delta x} = \frac{0,64-0}{4-0}$ ✓✓ = 0,16

R = $\frac{1}{0,16}$ = 6,25 Ω ✓✓ (4)

[9]

QUESTION 10 / *VRAAG 10*

10.1 12 V ✓ (1)

10.2.1

Option 1 / *Opsie 1:*	**Option 2 / *Opsie 2:***
I = $\frac{V}{R}$ ✓ = $\frac{9,6}{2,4}$ ✓ = 4 A	emf = IR + Ir✓ 12 = I(2,4) + 2,4✓ ∴ I = 4 A✓

(3)

10.2.2

Option 1 / *Opsie 1*:	**Option 2 / *Opsie 2*:**
emf/*emk* = IR + Ir ✓ 12 = 9,6 + 4r ✓ $\therefore$ r = 0,6 Ω ✓	$V_{lost/verlore}$ = Ir ✓ 2,4 = 4r ✓ $\therefore$ r = 0,6 Ω ✓
Option 3 / *Opsie 3*: emf/*emk* = I(R + r) ✓ 12 = 4(2,4 + r) ✓ $\therefore$ r = 0,6 Ω ✓	

(3)

10.3

Option 1 / *Opsie 1*:	**Option 2 / *Opsie 2*:**
emf/*emk* = I(R + r) ✓ 12 = 6(R + 0,6) ✓ $R_{ext/eks}$ = 1,4 Ω $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\frac{1}{1,4} = \frac{1}{2,4} + \frac{1}{R}$ ✓ $\therefore$ R = 3,36 Ω Each tail lamp/*Elke agterlig:* : R = 1,68 Ω ✓	Emf = $V_{terminal}$ + Ir ✓ 12 = $V_{terminal}$ + 6(0,6) ✓ $\therefore$ $V_{terminal}$ = 8,4 V $I_{2,4\ \Omega} = \frac{V}{R} = \frac{8,4}{2,4}$ = 3,5 A $I_{tail\ lamps/agterligte}$ = 6 – 3,5 = 2,5 A $R_{tail\ lamps/agterligte} = \frac{V}{I}$ ✓ $= \frac{8,4}{2,5}$ ✓ = 3,36 Ω $R_{tail\ lamp/agterlig}$ = 1,68 Ω ✓
Option 3 / *Opsie 3:*	**Option 4 / *Opsie 4:***
V = IR ✓ 12 = (6)R ✓ R_{ext} = 2 Ω $\therefore R_{parallel}$ = 2 – 0,6 = 1,4 Ω $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\frac{1}{1,4} = \frac{1}{2,4} + \frac{1}{R}$ ✓ $\therefore$ R = 3,36 Ω Each tail lamp/*Elke agterlig*: R = 1,68 Ω ✓	For parallel combination: $I_1 + I_2$ = 6 A *Vir parallelle kombinasie: $I_1 + I_2$ = 6 A* $\therefore \frac{V}{2,4} + \frac{V}{R_{taillamps}}$ ✓ = 6 ✓ 8,4✓ $(\frac{1}{2,4} + \frac{1}{R_{taillamps}})$✓ = 6 $\therefore$ $R_{tail\ lamps/agterligte}$ = 3,36 $R_{tail\ lamp/agterligte}$ = 1,68 Ω ✓

(5)

10.4 Increases / *Vermeerder* ✓
Resistance increases, current decreases ✓
Ir (lost volts) decreases ✓

Vermeerder ✓
Weerstand verhoog, stroom verlaag ✓
Ir (verlore volts) verminder / neem af. ✓

(3)
[15]

QUESTION 11 / *VRAAG 11*

11.1.1 Electrical (energy) to mechanical / kinetic (energy) ✓
Elektriese (energie) na meganiese / kinetiese (energie) ✓ (1)

11.1.2 Mechanical / kinetic (energy) to electrical (energy) ✓
Meganiese / kinetiese (energie) na elektriese (energie) ✓ (1)

11.1.3 Motor effect / *Motor-effek* ✓ (1)

11.1.4 Electromagnetic induction ✓
Elektromagnetiese induksie ✓ (1)

11.2 BC / conductor is parallel ✓ to the magnetic field. ✓
BC / geleier is parallel ✓ aan die magneetveld. ✓

OR / *OF*
Open switch ✓, no current. ✓
Oop skakelaar ✓, geen stroom. ✓ (2)

11.3

Option 1 / *Opsie 1*:	**Option 2 / *Opsie 2*:**
$P_{ave} = V_{rms}I_{rms}$ ✓ $= \frac{V_{max}}{\sqrt{2}}$ ✓ $\cdot \frac{I_{max}}{\sqrt{2}}$ ✓ $= \frac{(311)(21)}{2}$ ✓✓ $= 3\ 265,5$ W ✓ **OR / OF** $P_{max} = V_{max}I_{max}$ ✓ $= (311)$ ✓ (21) ✓ $= 6531$ W $\therefore P_{ave} = \frac{P_{max}}{2}$ ✓✓ $= \frac{6531}{2}$ $= 3\ 265,5$ W ✓	$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $= \frac{311}{\sqrt{2}}$ ✓ $= 219,91$ V $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ $= \frac{21}{\sqrt{2}}$ ✓ $= 14,85$ A $P_{ave} = V_{rms}I_{rms}$ ✓ $= (219,91)(14,85)$ $= 3\ 265,66$ W ✓
Option 3 / *Opsie 3*	**Option 4 / *Opsie 4***
$R = \frac{V}{I}$ ✓ $= \frac{311}{21}$ ✓ $= 14,81\ \Omega$ $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ $= \frac{21}{\sqrt{2}}$ ✓ $= 14,85$ A $P_{ave} = I^2_{rms}R$ ✓ $= (14,85)^2(14,81)$ $= 3\ 265,83$ W ✓	$R = \frac{V}{I}$ ✓ $= \frac{311}{21}$ ✓ $= 14,81\ \Omega$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $= \frac{311}{\sqrt{2}}$ ✓ $= 219,91$ V $P_{ave} = \frac{V^2_{rms}}{R}$ ✓ $= \frac{219,41^2}{14,81}$ $= 3\ 265,83$ W ✓

(6)
[12]

QUESTION 12 / *VRAAG 12*

12.1 Photo-electric effect / *Foto-elektriese effek* ✓ (1)

12.2 Work function / *Werkfunksie / Arbeidsfunksie* ✓ (1)

12.3 $c = f\lambda$ ✓
3×10^8 ✓ $= f(330 \times 10^{-9})$ ✓
$\therefore f = 9,09 \times 10^{14}$ Hz ✓

OR/*OF*

$E = \frac{hc}{\lambda} = \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{330 \times 10^{-9}}$ ✓ $= 6,03 \times 10^{-19}$ J
$E = hf$
$6,03 \times 10^{-19} = (6,63 \times 10^{-34})f$ ✓
$\therefore f = 9,09 \times 10^{14}$ Hz ✓ (4)

✓ for both equations
vir beide vergelykings

12.4

<u>Option 1 / *Opsie 1*:</u>

$E = W_o + K$
$\frac{hc}{\lambda} = W_o + K$
✓ Any one / *Enige een*

$\therefore \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{330 \times 10^{-9}}$ ✓ $= 3,5 \times 10^{-19} + K$ ✓
$\therefore K = 2,53 \times 10^{-19}$ J ✓

<u>Option 2 / *Opsie 2*:</u>

$E = W_o + K$
$hf = W_o + K$
✓ Any one / *Enige een*

$\therefore (6,63 \times 10^{-34})(9,09 \times 10^{14})$ ✓ $= 3,5 \times 10^{-19} + K$ ✓
$\therefore K = 2,53 \times 10^{-19}$ J ✓

(4)

12.5
12.5.1 Remains the same / *Bly dieselfde* ✓ (1)

12.5.2 Increases / *Vermeerder* ✓ (1)

12.6
12.6.1 Ultraviolet radiation / *Ultraviolet-straling* ✓ (1)

12.6.2 <u>High energy</u> / <u>high frequency</u> ✓
<u>Hoë</u> energie / <u>hoë</u> frekwensie (1)

[14]

TOTAL SECTION B/TOTAAL AFDELING B: 125
GRAND TOTAL/*GROOTTOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2012

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The type of energy an object has due to its motion (1)

1.2 The phenomenon which occurs when two light waves meet at a given point (1)

1.3 The unit of measurement of electrical resistance (1)

1.4 The basic principle on which electric generators function (1)

1.5 The type of line spectrum observed when electrons in an atom move from the excited state to the ground state (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (2.1–2.10) in the ANSWER BOOK.

2.1 A car of mass *m* collides head-on with a truck of mass 2*m*. If the car exerts a force of magnitude *F* on the truck during the collision, the magnitude of the force that the truck exerts on the car is …

A $\frac{1}{2}F$

B F

C $2F$

D $4F$ (2)

2.2 An object moves in a straight line on a ROUGH horizontal surface. If the net work done on the object is zero, then …

A the object has zero kinetic energy.

B the object moves at constant speed.

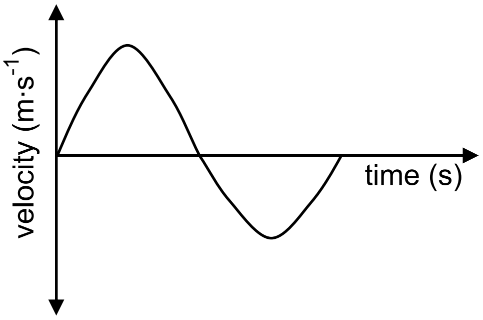
C the object moves at constant acceleration.

D there is no frictional force acting on the object. (2)

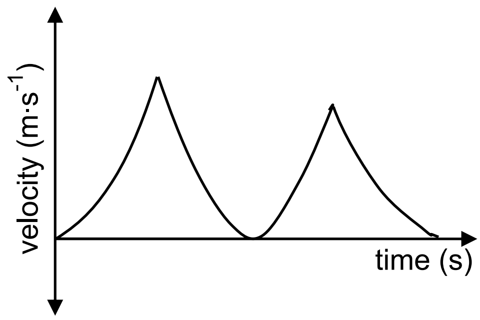
2.3 A ball is released from rest from a certain height above the floor and bounces off the floor a number of times. Ignore the effects of air resistance.

Which ONE of the following velocity-time graphs best represents the motion of the ball?

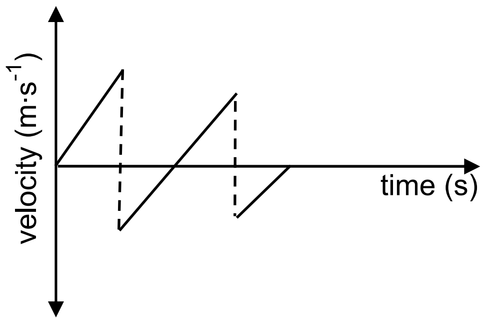
A



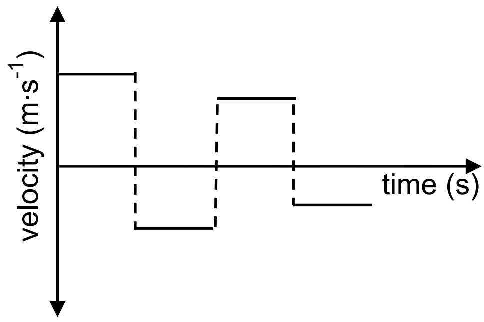
B



C

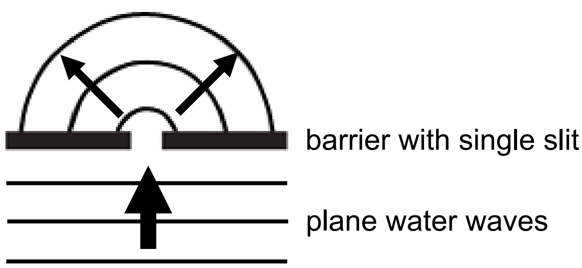


D



(2)

2.4 The diagram below shows plane water waves that spread out after passing through a single slit.



The wave phenomenon observed after the water waves pass through the slit is …

A reflection.

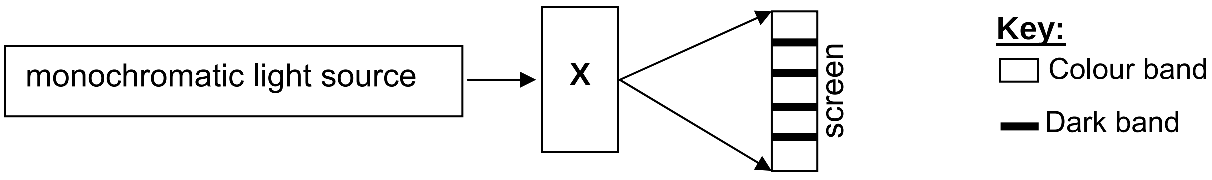
B diffraction.

C refraction.

D photoelectric effect. (2)

2.5 Monochromatic light from a point source passes through a device **X**.

A pattern is observed on a screen, as shown in the diagram below.



From the observation on the screen, it can be concluded that device **X** is a …

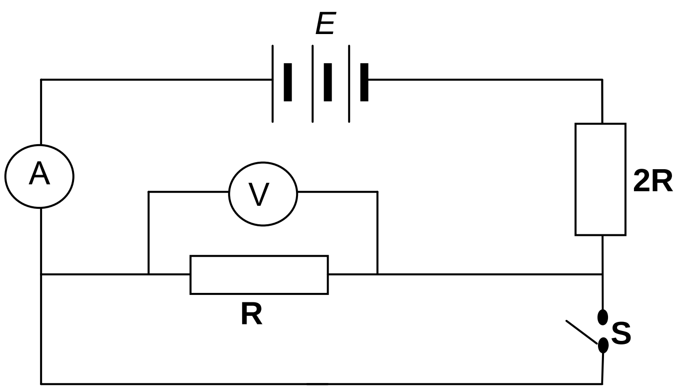
A prism.

B single slit.

C double slit.

D concave lens. (2)

2.6 In the circuit diagram below, the internal resistance of the battery and the resistance of the conducting wires are negligible. The emf of the battery is *E*.



When switch **S** is closed, the reading on voltmeter V, in volts, is ...

A 0

B $\frac{1}{3}E$

C $\frac{2}{3}E$

D E (2)

2.7 Two identical small metal spheres on insulated stands carry equal charges and are a distance *d* apart. Each sphere experiences an electrostatic force of magnitude *F*.

The spheres are now placed a distance $\frac{1}{2}d$ apart.

The magnitude of the electrostatic force each sphere now experiences is …

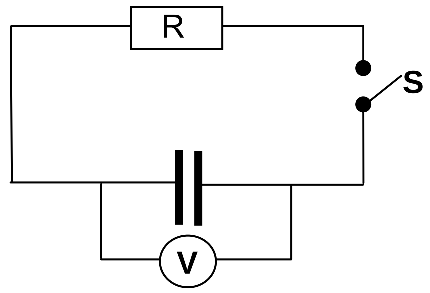
A $\frac{1}{2}F$

B F

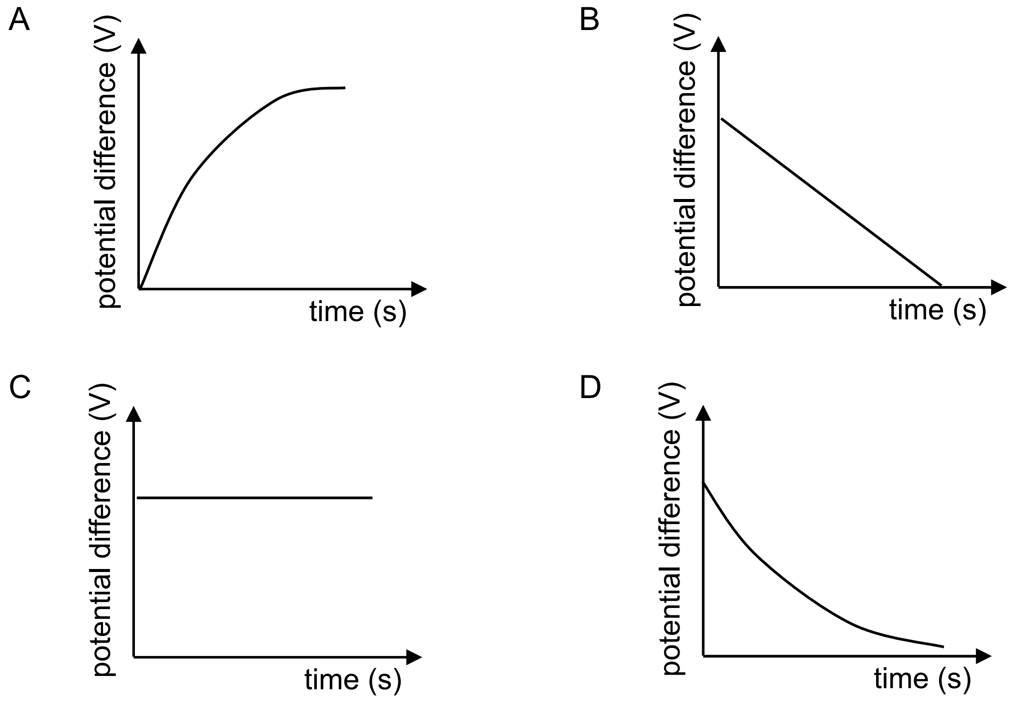
C $2F$

D $4F$ (2)

2.8 A fully charged capacitor is connected in a circuit, as shown below. The capacitor discharges when switch **S** is closed.

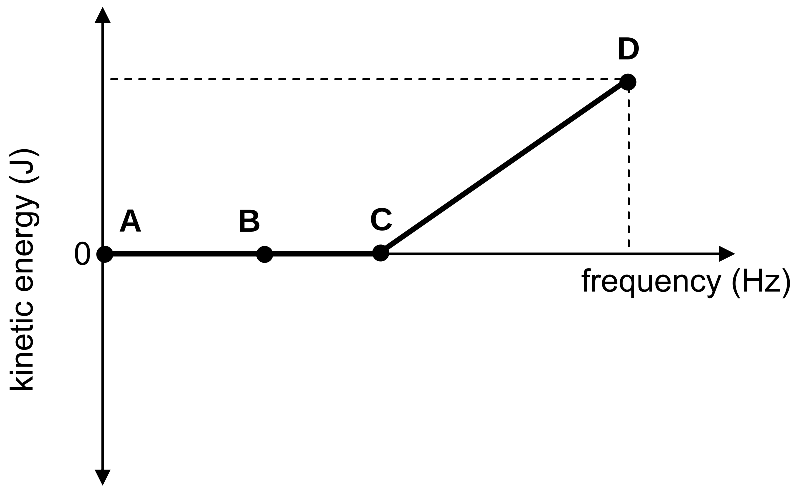


Which ONE of the following graphs correctly shows the change in the voltmeter reading with time when switch **S** is closed?



(2)

2.9 When light shines on a metal plate in a photocell, electrons are emitted. The graph below shows the relationship between the kinetic energy of the emitted photoelectrons and the frequency of the incoming light.



Which ONE of the points (**A**, **B**, **C** or **D**) on the graph represents the threshold frequency?

A A

B B

C C

D D (2)

2.10 Overexposure to sunlight causes damage to plants and crops.

Which ONE of the following types of electromagnetic radiation is responsible for this damage?

A Ultraviolet rays

B Radio waves

C Visible light

D X-rays (2)
[20]

TOTAL SECTION A: 25

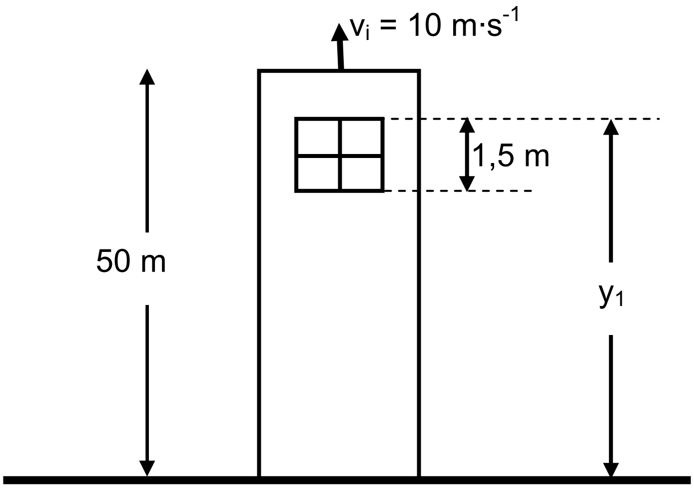
SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A stone is thrown vertically upward at a velocity of 10 m·s^{-1} from the top of a tower of height 50 m. After some time the stone passes the edge of the tower and strikes the ground below the tower. Ignore the effects of friction.



3.1 Draw a labelled free-body diagram showing the force(s) acting on the stone during its motion. (1)

3.2 Calculate the:

3.2.1 Time taken by the stone to reach its maximum height above the ground (4)

3.2.2 Maximum height that the stone reaches above the ground (4)

3.3 USING THE GROUND AS REFERENCE (zero position), sketch a position-time graph for the entire motion of the stone. (3)

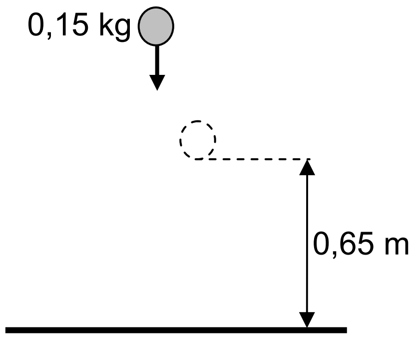
3.4 On its way down, the stone takes 0,1 s to pass a window of length 1,5 m, as shown in the diagram above.

Calculate the distance (y_1) from the top of the window to the ground. (7)
[19]

QUESTION 4 (Start on a new page.)

The bounce of a cricket ball is tested before it is used. The standard test is to drop a ball from a certain height onto a hard surface and then measure how high it bounces.

During such a test, a cricket ball of mass 0,15 kg is dropped from rest from a certain height and it strikes the floor at a speed of 6,2 $m \cdot s^{-1}$. The ball bounces straight upwards at a velocity of 3,62 $m \cdot s^{-1}$ to a height of 0,65 m, as shown in the diagram below. The effects of air friction may be ignored.



4.1 Define the term *impulse* in words. (2)

4.2 Calculate the magnitude of the impulse of the net force applied to the ball during its collision with the floor. (3)

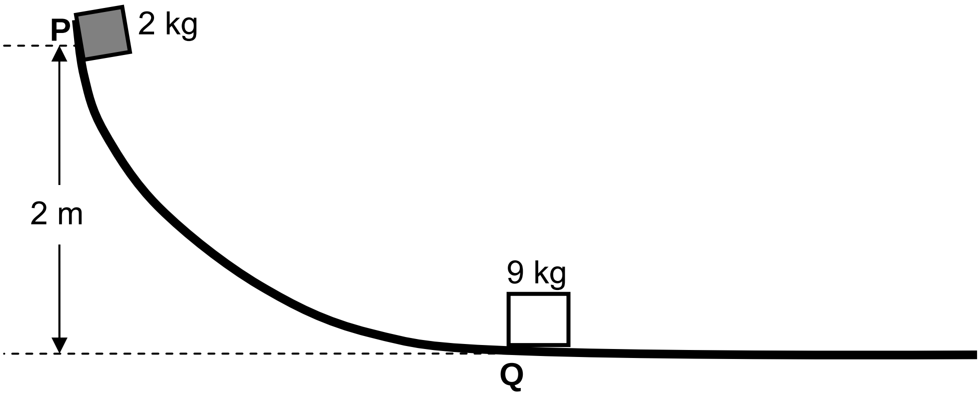
4.3 To meet the requirements, a cricket ball must bounce to one third of the height that it is initially dropped from.

Use ENERGY PRINCIPLES to determine whether this ball meets the minimum requirements. (5)

[10]

QUESTION 5 (Start on a new page.)

A wooden block of mass 2 kg is released from rest at point **P** and slides down a curved slope from a vertical height of 2 m, as shown in the diagram below. It reaches its lowest position, point **Q**, at a speed of 5 m·s^{-1}.



5.1 Define the term *gravitational potential energy*. (2)

5.2 Use the work-energy theorem to calculate the work done by the average frictional force on the wooden block when it reaches point **Q**. (6)

5.3 Is mechanical energy conserved while the wooden block slides down the slope? Give a reason for the answer. (2)

5.4 The wooden block collides with a stationary crate of mass 9 kg at point **Q**. After the collision, the crate moves to the right at 1 m·s^{-1}.

5.4.1 Calculate the magnitude of the velocity of the wooden block immediately after the collision. (4)

5.4.2 The total kinetic energy of the system before the collision is 25 J. Use a calculation to show that the collision between the wooden block and the crate is inelastic. (5)

[19]

QUESTION 6 (Start on a new page.)

An ambulance approaches an accident scene at constant velocity. The siren of the ambulance emits sound waves at a frequency of 980 Hz. A detector at the scene measures the frequency of the emitted sound waves as 1 050 Hz.

6.1 Calculate the speed at which the ambulance approaches the accident scene. Use the speed of sound in air as 340 m·s^{-1}. (4)

6.2 Explain why the measured frequency is higher than the frequency of the source. (2)

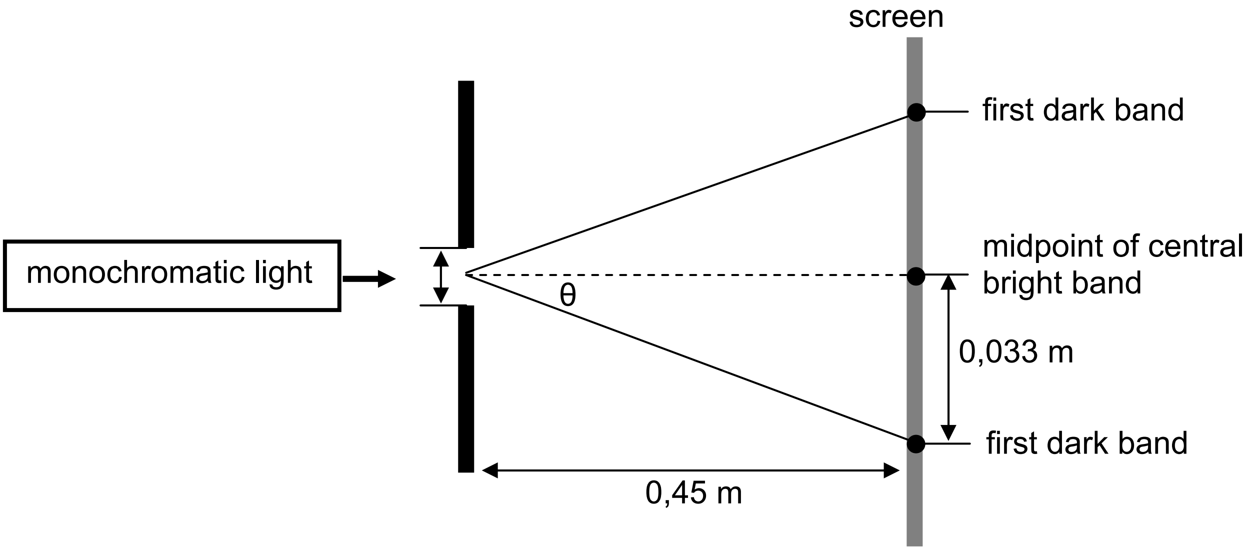
6.3 The principle of the Doppler effect is applied in the Doppler flow meter. State ONE positive impact of the use of the Doppler flow meter on humans. (2)

[8]

QUESTION 7 (Start on a new page.)

Learners investigate the change in the broadness of the central bright band formed when monochromatic light of different wavelengths passes through a single slit.

They set up the apparatus, as shown in diagram below, and measure the broadness of the central bright band in the pattern observed on the screen. The width of the slit is $5,6 \times 10^{-7}$ m.



7.1 Write down an investigative question. (2)

7.2 Which TWO variables are kept constant? (2)

7.3 In one of their experiments, the distance from the midpoint of the central bright band to the first dark band is measured to be 0,033 m.

Calculate the wavelength of the light used in this experiment. (5)

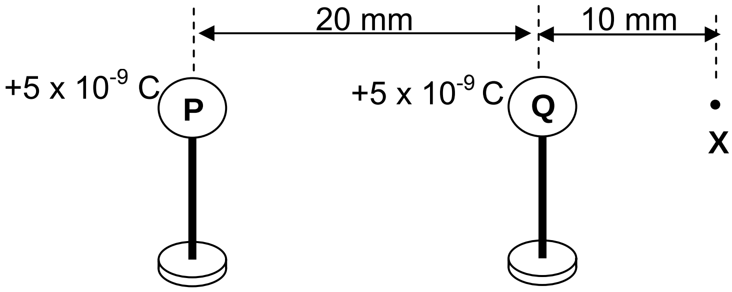
7.4 How will the broadness of the central bright band of red light compare with that of blue light? Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (2)

[11]

QUESTION 8 (Start on a new page.)

Two metal spheres, **P** and **Q**, on insulated stands, carrying charges of $+5 \times 10^{-9}$ C and $+5 \times 10^{-9}$ C respectively, are placed with their centres 20 mm apart. **X** is a point at a distance of 10 mm from sphere **Q**, as shown below.



8.1 Define the term *electric field.* (2)

8.2 Sketch the net electric field pattern for the two charges. (3)

8.3 Calculate the net electric field at point **X** due to the presence of **P** and **Q**. (6)

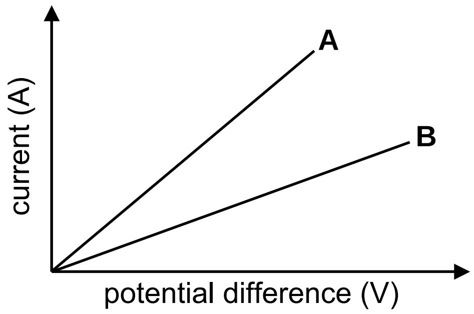
8.4 Use your answer to QUESTION 8.3 to calculate the magnitude of the electrostatic force that an electron will experience when placed at point **X**. (3)

[14]

QUESTION 9 (Start on a new page.)

9.1 Learners use Ohm's law to determine which ONE of two resistors **A** and **B** has the greater resistance.

For each resistor, they measure the current through the resistor for different potential differences across its ends. The graph below shows the results obtained in their investigation.



9.1.1 The learners are supplied with the following apparatus:

6 V battery
Voltmeter
Ammeter
Rheostat
Resistors **A** and **B**
Conducting wires

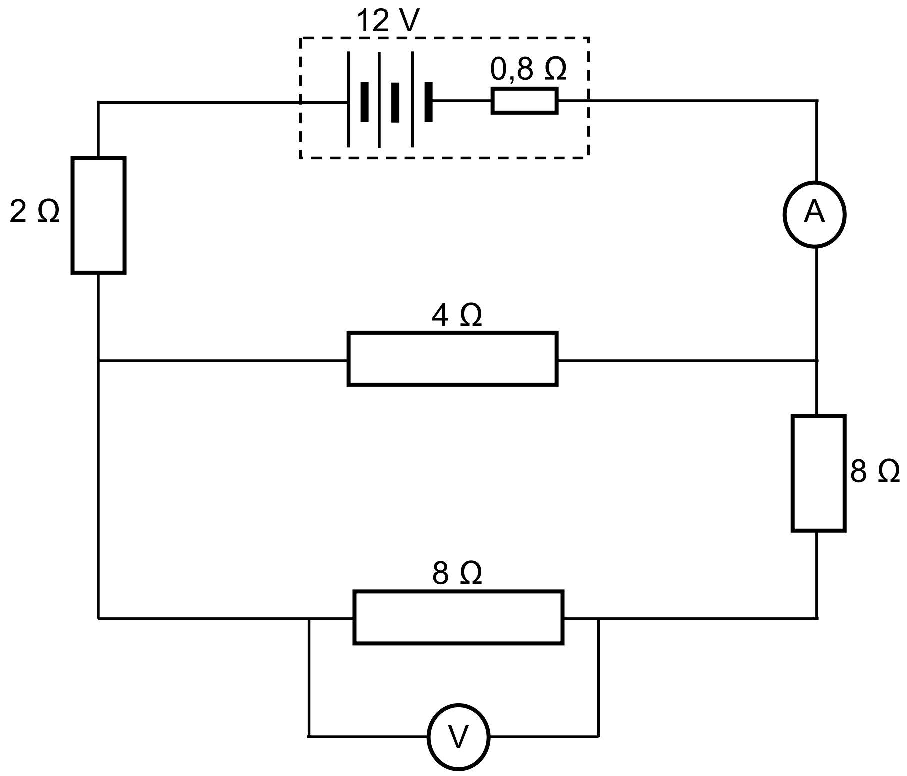
Draw a circuit diagram to show how the learners must use the above apparatus to obtain each of the graphs shown above. (4)

9.1.2 Write down ONE variable that must be kept constant during this investigation. (1)

9.1.3 Which ONE of **A** or **B** has the higher resistance?

Give an explanation for the answer. (3)

9.2 In the circuit diagram below, the battery has an emf of 12 V and an internal resistance of 0,8 Ω. The resistance of the ammeter and connecting wires may be ignored.



Calculate the:

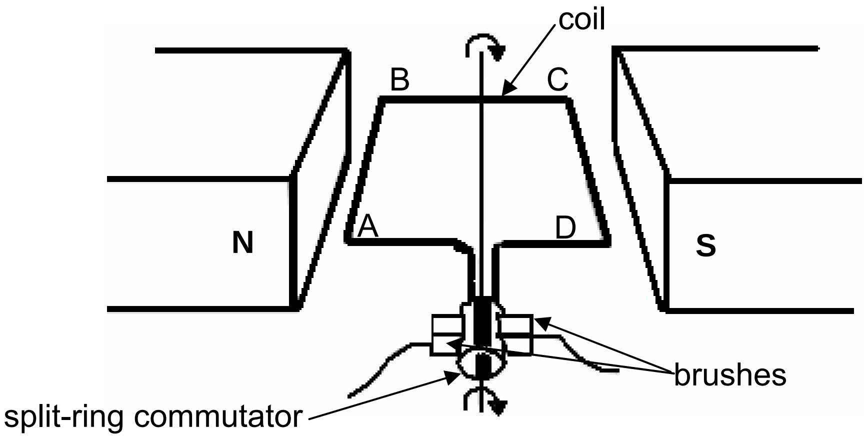
9.2.1 Effective resistance of the circuit (4)

9.2.2 Reading on the ammeter (3)

9.2.3 Reading on the voltmeter (4)
[19]

QUESTION 10 (Start on a new page.)

10.1 The essential components of a simplified DC motor are shown in the diagram below.



When the motor is functioning, the coil rotates in a clockwise direction, as shown.

10.1.1 Write down the function of each of the following components:

(a) Split-ring commutator (1)

(b) Brushes (1)

10.1.2 What is the direction of the conventional current in the part of the coil labelled **AB**? Write down only FROM A TO B or FROM B TO A. (1)

10.1.3 Will the coil experience a maximum or minimum turning effect (torque) if the coil is in the position as shown in the diagram above? (1)

10.1.4 State ONE way in which this turning effect (torque) can be increased. (1)

10.2 Alternating current (AC) is used for the long-distance transmission of electricity.

10.2.1 Give a reason why AC is preferred over DC for long-distance transmission of electricity. (1)

10.2.2 An electric appliance with a power rating of 2 000 W is connected to a 230 V rms household mains supply.

Calculate the:

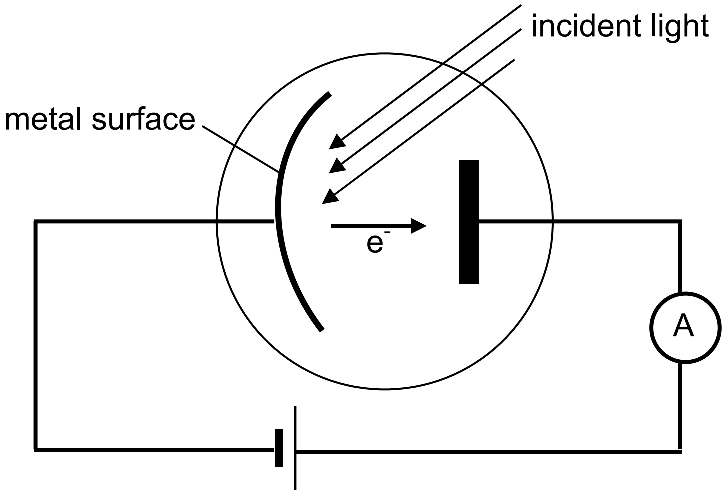
(a) Peak (maximum) voltage (3)

(b) rms current passing through the appliance (3)

[12]

QUESTION 11 (Start on a new page.)

In the diagram shown below, electrons are released from a metal plate when light of a certain frequency is shone on its surface.



11.1 Name the phenomenon described above. (1)

11.2 The frequency of the incident light on the metal plate is $6{,}16 \times 10^{14}$ Hz and electrons are released with a kinetic energy of $5{,}6 \times 10^{-20}$ J.

Calculate the:

11.2.1 Energy of the incident photons (3)

11.2.2 Threshold frequency of the metal plate (5)

11.3 The brightness of the incident light is now increased. What effect will this change have on the following: (Write down only INCREASES, DECREASES or REMAINS THE SAME.)

11.3.1 The reading on the ammeter
Explain the answer. (2)

11.3.2 The kinetic energy of the released photoelectrons
Explain the answer. (2)
[13]

TOTAL SECTION B: 125
GRAND TOTAL: 150

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1	Kinetic energy/*Kinetiese energie* ✓	(1)
1.2	Interference/*Interferensie* ✓	(1)
1.3	Ohm ✓	(1)
1.4	Electromagnetic induction/*Elektromagnetiese induksie* ✓ **OR/*OF*** Faraday's law/*Faraday se wet*	(1)
1.5	(Line) emission (spectrum) ✓ *(Lyn)emissie(spektrum)*	(1) **[5]**

QUESTION 2/*VRAAG 2*

2.1	B ✓✓	(2)
2.2	B ✓✓	(2)
2.3	C ✓✓	(2)
2.4	B ✓✓	(2)
2.5	C ✓✓	(2)
2.6	A ✓✓	(2)
2.7	D ✓✓	(2)
2.8	D ✓✓	(2)
2.9	C ✓✓	(2)
2.10	A ✓✓	(2) **[20]**

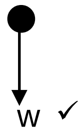
TOTAL SECTION A /*TOTAAL AFDELING A*: 25

SECTION B/*AFDELING B*

QUESTION 3/*VRAAG 3*

3.1

Accepted Labels/*Aanvaarde benoemings*	
w	F_g / F_w / force of Earth on stone/weight/mg/gravitational force *F_g / F_w / krag van Aarde op klip/gewig/mg/gravitasiekrag*



(1)

3.2.1

Option 1/*Opsie 1*: Upward positive/*Opwaarts positief*: $v_f = v_i + a\Delta t$ ✓ 0 = 10 ✓+(-9,8) Δt ✓ $\therefore \Delta t$ = 1,02 s ✓	Upward negative/*Opwaarts negatief*: $v_f = v_i + a\Delta t$ ✓ 0 = -10 ✓+ 9,8 Δt ✓ $\therefore \Delta t$ = 1,02 s ✓
Option 2/*Opsie 2*: Upward positive/*Opwaarts positief*: $v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = 10^2 + 2(-9,8)\Delta y$ ✓ $\therefore$ y = 5,1 m $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓Both formulae/*Beide formules* 5,1 = $(\frac{10+0}{2})\Delta t$ ✓ $\therefore \Delta t$ = 1,02 s ✓	Upward negative/*Opwaarts negatief*: $v_f^2 = v_i^2 + 2a\Delta y$ $0^2 = (-10)^2 + 2(9,8)\Delta y$ ✓ $\therefore$ y = -5,1 m $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ Both formulae/*Beide formules* -5,1 = $(\frac{-10+0}{2})\Delta t$ ✓ $\therefore \Delta t$ = 1,02 s ✓

(4)

3.2.2 **POSITIVE MARKING FROM QUESTION 3.2.1 TO QUESTION 3.2.2**
POSITIEWE NASIEN VAN VRAAG 3.2.1 NA VRAAG 3.2.2

Option 1/*Opsie 1:* **Upward positive/*Opwaarts positief*:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = 10^2 + 2(-9,8)\Delta y$ ✓ $\therefore \Delta y$ = 5,1 m Height/*Hoogte* = 50 + ✓ 5,1 = 55,1 m ✓	**Upward negative/*Opwaarts negatief*:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $0^2 = (-10)^2 + 2(9,8)\Delta y$ ✓ $\therefore \Delta y$ = -5,1 m Height/*Hoogte* = 50 + ✓ 5,1 = 55,1 m ✓

<u>Option 2/*Opsie 2:*</u>

Upward positive/*Opwaarts positief*:

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = (\frac{10+0}{2})1{,}02$ ✓

$\therefore$ = 5,1 m

Height = 50 + ✓ 5,1
= 55,1 m ✓

Upward negative/*Opwaarts negatief*:

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = (\frac{-10+0}{2})1{,}02$ ✓

$\therefore \therefore \Delta y$ = - 5,1 m

Height/*Hoogte* = 50 + ✓ 5,1
= 55,1 m ✓

<u>Option 3/*Opsie 3*:</u>

Consider downward motion/*Beskou afwaartse beweging*:

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = (\frac{-10+0}{2})1{,}02$ ✓

$\therefore$ = -5,1 m

Height = 50 + ✓ 5,1
= 55,1 m ✓

Upward negative/*Opwaarts negatief*:

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = (\frac{-10+0}{2})1{,}02$ ✓

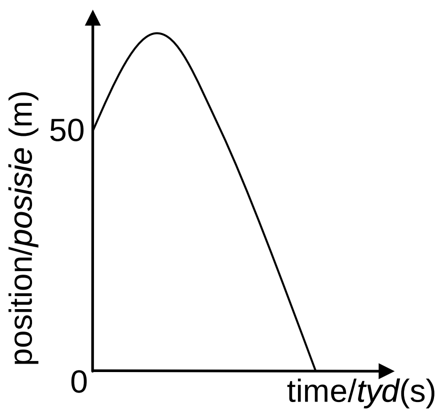
$\therefore$ = - 5,1 m

Height/*Hoogte* = 50 +✓ 5,1
= 55,1 m✓ (4)

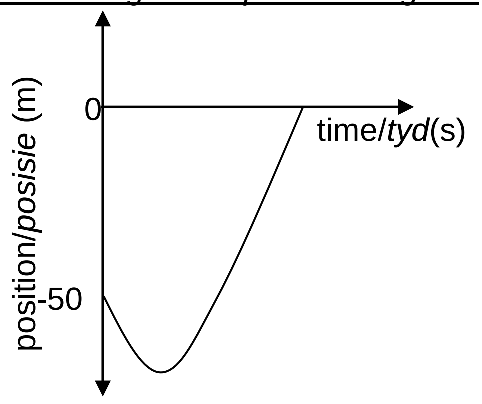
3.3

Criteria for graph/Kriteria vir grafiek	Marks/ *Punte*
Correct shape/*Korrekte vorm*	✓
Final position lower than initial position.	✓
Graph ends on x axis./*Grafiek eindig op x-as*.	✓

<u>Upward positive/*Opwaarts positief*</u>



<u>Upward negative/*Opwaarts negatief*</u>



3.4

Option 1/*Opsie 1* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,5$ ✓ $= v_i(0,1) + \frac{1}{2}(9,8)(0,1)^2$ ✓ $\therefore v_i = 14,51\ m\cdot s^{-1}$ From maximum height/*Van maksimum hoogte:* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $14,51^2$ ✓ $= (0)^2 + 2(9,8)\Delta y$ ✓ $\therefore \Delta y = 10,74$ m Height/*Hoogte* = 55,1 –10,74 = 44,36 m ✓	
Option 2/*Opsie 2* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,5$ ✓ $= v_i(0,1) + \frac{1}{2}(9,8)(0,1)^2$ ✓ $\therefore v_i = 14,51\ m\cdot s^{-1}$ Downwards from top of tower to top of window:/*Afwaarts van bopunt van toring tot bopunt van venster* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $14,51^2$ ✓ $= (10)^2 + 2(9,8)\Delta y$ ✓ $\therefore \Delta y = 5,64$ m Height/*Hoogte* = 50 – 5,64 = 44,36 m ✓	**Option 3/*Opsie 3*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $1,5$ ✓ $= v_i(0,1) + \frac{1}{2}(9,8)(0,1)^2$ ✓ $\therefore v_i = 14,51\ m\cdot s^{-1}$ From original point of projection:/*Van oorspronklike punt van projeksie* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $14,51^2$ ✓ $= (-10)^2 + 2(9,8)\Delta y$ ✓ $\therefore \Delta y = 5,64$ m Height/*Hoogte* = 50 – 5,64 = 44,36 m ✓
Option 4/*Opsie 4* $\bar{v} = \frac{\Delta y}{\Delta t} = \frac{1,5}{0,1} = 15\ m\cdot s^{-1}$ $\bar{v} = \frac{v_i + v_f}{2} = \underline{15}$ $\therefore v_i + v_f = 30\ m\cdot s^{-1}$ $\therefore v_f = 30 - v_i$ $v_f = v_i + a\Delta t$ ✓ $\underline{30 - v_i}$ ✓ $\underline{= v_i + 9,8(0,1)}$ ✓ $\therefore v_i = 14,51\ m\cdot s^{-1}$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $14,51^2$ ✓ $= (0)^2 + 2(9,8)\Delta y$ ✓ $\therefore \Delta y = 10,74$ m Height/*Hoogte* = 55,1 – 10,74 = 44,36 m ✓	

(7)
[19]

QUESTION 4/*VRAAG 4*

4.1 Impulse is the <u>product</u> of the (net/average) <u>force</u> and the <u>time</u> during which the force acts. ✓✓
Impuls is die <u>produk</u> van die (netto/gemiddelde) <u>krag</u> en die <u>tyd</u> waartydens die krag inwerk. ✓✓

OR/*OF*
Impulse is the <u>change in momentum</u>. ✓✓
Impuls is gelyk aan <u>verandering in momentum</u>. ✓✓ (2)

4.2

<u>Option 1/*Opsie 1:*</u> Upward positive:/*Opwaarts positief*	**<u>Option 2/*Opsie 2:*</u>** Upward negative:/*Opwaarts negatief*
$F_{net}\Delta t = \Delta p$ ✓ $= m(v_f - v_i)$ $= 0{,}15(3{,}62 - (-6{,}2))$ ✓ $= 1{,}473\ N\cdot s\ /\ kg\cdot m\cdot s^{-1}$ ✓ upward/*opwaarts*	$F_{net}\Delta t = \Delta p$ ✓ $= m(v_f - v_i)$ $= 0{,}15[(-3{,}62 - (6.2))$ ✓ $= -1{,}473\ N\cdot s\ /kg\cdot m\cdot s^{-1}$ $F_{net}\Delta t = 1{,}473\ N\cdot s\ /kg\cdot m\cdot s^{-1}$ ✓ upward/*opwaarts*
<u>Option 3/*Opsie 3:*</u> Upward positive: /*Opwaarts positief*	**<u>Option 4/*Opsie 4:*</u>** Upward negative: /*Opwaarts negatief*
$F_{net}\Delta t = \Delta p$ ✓ $= mv_f - mv_i$ $= (0{,}15)(3{,}62) - (0{,}15)(-6{,}2)$ ✓ $= 1{,}473\ N\cdot s\ /\ kg\cdot m\cdot s^{-1}$ ✓ upward/*opwaarts*	$F_{net}\Delta t = \Delta p$ ✓ $= mv_f - mv_i)$ $= (0{,}15)(-3{,}62) - (0{,}15)(6{,}2)$ ✓ $= -1{,}473\ N\cdot s\ /kg\cdot m\cdot s^{-1}$ $F_{net}\Delta t = 1{,}473\ N\cdot s\ /kg\cdot m\cdot s^{-1}$ ✓ upward/*opwaarts*

(3)

4.3 $(U + K)_{top/bo} = (U + K)_{bottom/onder}$ ✓
$mgh_f + ½\, m v_f^2 = mgh_i + ½\, m v_i^2$
$(0{,}15)(9{,}8)h + 0$ ✓ $= 0 + ½(0{,}15)(6{,}2)^2$ ✓
$\therefore\ h = 1{,}96$ m ✓

$\frac{1{,}96}{3} = 0{,}65$ m
Yes/Meets requirements ✓

Ja/Voldoen aan vereistes. ✓

K(bottom/*onder*) = U(top/*bo*)
Max.: $0/4$
<u>Other formulae/*Ander formules*</u>: $E_{mech(A)} = E_{mech(B)}$ / $E_{mech(i)} = E_{mech(f)}$ $E_{mech(top)} = E_{mech(bottom)}$ $(E_p + E_k)_A = (E_p + E_k)_B$ $(E_p + E_k)_{bottom} = (E_p + E_k)_{top}$ $E_p + E_k)_i = (E_p + E_k)_f$ $(U + K)_i = (U + K)_f$ $(U + K)_A = (U + K)_B$ $mgh_B + \frac{1}{2}mv_i^2 = mgh_B + \frac{1}{2}mv_f^2$

(5)
[10]

QUESTION 5/*VRAAG 5*

5.1 The energy of an object due to its position ✓ above the surface of the earth. ✓

Die energie van 'n voorwerp as gevolg sy posisie ✓ bokant die oppervlak van die aarde. ✓ (2)

5.2

Option 1/*Opsie 1:* $W_{net} = \Delta K$ ✓ $mg\Delta y\cos\theta + W_f = ½mv_f^2 - ½mv_i^2$ $(2)(9,8)(2)\cos0°$ ✓ $+ W_f$ ✓ $= ½(2)(5)^2$ ✓ $- 0$ ✓ $\therefore W_f = -14,2$ J ✓
Option 2/*Opsie 2:* $W_{net} = \Delta K$ ✓ $-\Delta U + W_f = ½mv_f^2 - ½mv_i^2$ $mgh + W_f = ½mv_f^2 - ½mv_i^2$ $(2)(9,8)(2)$ ✓ $+ W_f$ ✓ $= ½(2)(5)^2$ ✓ $- 0$ ✓ $\therefore W_f = -14,2$ J ✓

(6)

5.3 No/Nee ✓
Friction is present/*Wrywing is aanwesig*. ✓ (2)

5.4.1 $\Sigma p_{before} = \Sigma p_{after}$ ✓
$(2)(5) + (9)(0)$ ✓ $= 2v_{f2} + (9)(1)$ ✓

$\therefore v_{f2} = 0,5\ m\cdot s^{-1}$ ✓

Notes/*Aantekeninge:*
Other formulae/*Ander formules*: $m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$ $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

(4)

5.4.2 K(total after/*total na*) $= ½m_1v_f^2 + ½m_2v_f^2$ ✓
$= ½(2)(0,5)^2$ ✓ $+ ½(9)(1)^2$ ✓
$= 4,75$ J ✓
K(total before) $\neq$ K(total after) ✓
$\therefore$ inelastic

K(totaal na) $\neq$ *K(totaal voor)* ✓
$\therefore$ *onelasties* (5)

[19]

QUESTION 6/*VRAAG 6*

6.1 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ OR $f_L = \frac{v}{v - v_s} f_s$ ✓

$\therefore 1\ 050$ ✓ $= \frac{340 + 0}{340 - v_s}(980)$ ✓

$\therefore\ v_s = 22{,}67\ m{\cdot}s^{-1}$ ✓ (4)

6.2 Waves in front of the moving source are compressed.
The observed <u>wavelength decreases</u>. ✓
For the <u>same speed of sound</u>, ✓a higher frequency will be observed.

Golwe voor die bewegende bron word saamgepers.
Die waargenome <u>golflengte verminder</u>. ✓
Vir <u>dieselfde spoed van klank</u> ✓sal 'n hoër frekwensie waargeneem word. (2)

6.3 Any ONE/*Enige EEN*:

- Determine whether <u>arteries are clogged</u>/narrowed ✓
  so that <u>precautions can be taken in advance/to prevent heart attack /stroke.</u> ✓
  Bepaal of <u>are verstop/vernou is</u>, ✓✓
  sodat <u>voorsorg getref kan word/om hartaanvalle/beroerte te voorkom</u>. ✓

- Determine <u>heartbeat of foetus</u>
  to assure that <u>child is alive</u>/does not have a heart defect.
  Bepaal die <u>hartklop</u> van 'n <u>fetus</u>
  om seker te maak of <u>baba leef</u>/geen hartdefekte het nie. (2)

[8]

QUESTION 7/*VRAAG 7*

7.1

Criteria for investigative question/*Kriteria vir ondersoekende vraag:*	**Mark/*Punt***
The dependent and independent variables are stated. *Die afhanklike en onafhanklike veranderlikes is genoem*.	✓
Asks a question about the relationship between dependent and independent variables. *Vra 'n vraag oor die verwantskap tussen die afhanklike en onafhanklike veranderlikes.*	✓

Dependent variable:
***Afhanklike veranderlike*:**
Broadness of central (bright) band/degree of diffraction
Breedte van sentrale (helder) band/mate van diffraksie
Independent variable:
Onafhanklike veranderlike:
Wavelength (of light)/Golflengte (van lig)

Example/*Voorbeeld:*
How will the width of the central band change/differ when the wavelength (of the light) changes/is increased/is decreased?
Hoe sal die breedte van die sentrale helder band verander wanneer die golflengte (van die lig) toeneem/afneem? (2)

7.2 Slit width/*Spleetwydte* ✓
Distance between slit and screen/*Afstand tussen spleet en skerm.* ✓ (2)

7.3 $\tan\theta = \frac{0,033}{0,45}$ ✓ $\therefore\ \theta = 4,19(4)°$

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 4,19°$ ✓ $= \frac{(1)\lambda}{5,6\times10^{-7}}$ ✓

$\therefore\ \lambda = 4,1 \times 10^{-8}$ m ✓ (5)

7.4 Greater than/*Groter as* ✓
Red light has a longer wavelength (and is diffracted more.) ✓
Rooilig het 'n langer golflengte (en word meer diffrakteer.)

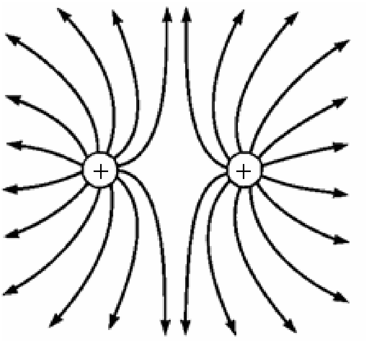
OR/*OF* (2)
Diffraction/*Diffraksie* $\alpha\ \lambda$ ✓ **[11]**

QUESTION 8/*VRAAG 8*

8.1 The (electrostatic) force experienced at a point ✓
per unit charge at that point. ✓
Die elektrostatiese krag ondervind by 'n punt ✓
per eenheidslading by daardie punt. ✓

OR/*OF*
The (electrostatic) force experienced ✓
by a charge placed at that point divided by the charge itself. ✓
Die (elektrostatiese) krag ondervind ✓
deur 'n lading geplaas by daardie punt gedeel deur die lading self. ✓ (2)

8.2



Criteria for sketch/*Kriteria vir skets*	Marks/ *Punte*
Correct shape as shown. *Korrekte vorm soos getoon*	✓
Direction from positive to negative. *Rigting van positief na negatief.*	✓
Field lines start on spheres and do not cross. *Veldlyne begin op elke sfeer en kruis nie.*	✓

(3)

8.3 $E_P = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^9)(5\times10^{-9})}{(30\times10^{-3})^2}$ ✓ ✓

$= 5 \times 10^4\ N{\cdot}C^{-1}$ to the right/*na regs*

$E_Q = \frac{kQ}{r^2}$

$= \frac{(9\times10^9)(5\times10^{-9})}{(10\times10^{-3})^2}$ ✓ ✓

$= 4{,}5 \times 10^5\ N{\cdot}C^{-1}$ to the right/*na regs*

$E_{net} = 5 \times 10^4 + 4{,}5 \times 10^5$
$= 5 \times 10^5\ N{\cdot}C^{-1}$ to the right/*na regs* ✓ (6)

8.4 **POSITIVE MARKING FROM QUESTION 8.3 TO QUESTION 8.4/**
POSITIEWE NASIEN VAN VRAAG 8.3 NA VRAAG 8.4

$E = \frac{F}{q}$ ✓

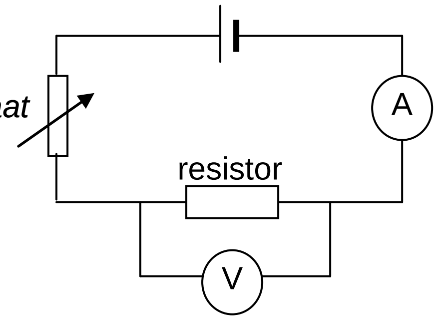
$5 \times 10^5 = \frac{F}{1{,}6\times10^{-19}}$ ✓

$F = 8 \times 10^{-14}$ N ✓ (3)

[14]

QUESTION 9/*VRAAG 9*

9.1
9.1.1



Criteria for circuit diagram/*Kriteria vir stroombaandiagram*	**Mark/*Punt***
Battery connected to the resistor as shown – correct symbols used. *Battery aan resistor geskakel soos getoon – korrekte simbole is gebruik.*	✓
Rheostat connected in series with resistor – correct symbols used. *Reostaat in serie geskakel met resistor – korrekte simbole is gebruik.*	✓
Ammeter connected in series so that it measures the current through resistor – correct symbols used. *Ammeter in serie geskakel sodat dit die stroom deur die resistor meet – korrekte simbole is gebruik.*	✓
Voltmeter connected in parallel across resistor – correct symbols used. *Voltmeter in parallel geskakel oor resistor – korrekte simbole is gebruik.*	✓

(4)

9.1.2 Temperature/*Temperatuur* ✓ (1)

9.1.3 B ✓

The ratio $\frac{V}{I}$ is greater than that of A. ✓✓

B ✓

Die verhouding $\frac{V}{I}$ *is groter as die van A.* ✓✓

OR/*OF*

B ✓

The ratio $\frac{I}{V}$ is smaller than that of A. ✓✓

B ✓

Die verhouding $\frac{I}{V}$ *is kleiner as die van A.* ✓✓

(3)

9.2

9.2.1 $\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2}$ ✓ $= \frac{1}{4} + \frac{1}{16}$ ✓

$\therefore R = 3,2\ \Omega$

$R_{effective/effektief} = 3,2\ \Omega + 2\ \Omega + 0,8\ \Omega$ ✓

$= 6\ \Omega$ ✓ (4)

9.2.2

Option 1/*Opsie 1:*	**Option 2/*Opsie 2*:**
V = IR ✓ 12 = I(6) ✓ I = 2 A ✓	emf = I(R + r) ✓ 12 = I(5,2 + 0,8) ✓ I = 2 A ✓

(3)

9.2.3

Option 1/*Opsie 1*:	**Option 2/*Opsie 2*:**
$V_{parallel}$ = IR ✓ =(2)(3,2) ✓ = 6,4 V $V_{8\Omega} = \frac{6,4}{2}$ ✓= 3,2 V ✓	$Vp = \frac{R_p}{R} \times V$ ✓ $= \frac{3,2}{6}$ ✓ x 12 ✓ = 6,4 V $\therefore V_{8\Omega}$ = 3,2 V ✓
Option 3/*Opsie 3*:	**Option 4/*Opsie 4*:**
$I_{8\Omega} = \frac{4}{20}(2)$ ✓ = 0,4 A $V_{8\Omega}$ = IR ✓ = (0,4)(8) ✓ = 3,2 V ✓	emf = I(R + r) ✓ $12 = IR_{2\ \Omega} + V_p + Ir$ $12 = (2)(2) + V_p + (2)(0,8)$ ✓ Vp = 6,4 V $V_{8\Omega} = \frac{6,4}{2}$ ✓= 3,2 V ✓

(4)

[19]

QUESTION 10/*VRAAG 10*

10.1
10.1.1
(a) Reverses the direction of the current in the coil each half cycle. ✓
Keer die stroomrigting in die spoel elke halwe siklus. ✓

OR/*OF*
Maintains constant direction of rotation of the coil.
Onderhou die konstante rigting van rotasie van die spoel. (1)

10.1.1 (b) Makes electrical contact (with the commutator). ✓
Maak elektriese kontak (met kommutator). ✓

OR/*OF*
Allows split-ring commutator to rotate freely.
Laat splitringkommutator toe om vry te roteer.

OR/*OF*
Allows charges to flow/current in and out of the coil.
Laat vloei van lading/stroom in en uit spoel toe. (1)

10.1.2 B to/*na* A ✓ (1)

10.1.3 Maximum/*Maksimum* ✓ (1)

10.1.4 Any ONE/*Enige EEN*:

- Increase the current in the coil. ✓
  Verhoog die stroom in die spoel. ✓
- Increase the magnitude of the magnetic field./Use a stronger magnet.
  Vergroot die grootte van die magneetveld./Gebruik 'n sterker magneet.
- Increase the number of turns in the coil.
  Verhoog die aantal windinge in die spoel.
- Use a soft iron core as the core of the *coil.*
  Gebruik 'n sagte ysterkern in die spoel.

(1)

10.2
10.2.1 Any ONE/*Enige EEN:*

- Can be transmitted over long distances without major energy loss. ✓
  Kan oor groot afstande oorgedra word sonder groot energieverlies. ✓
- The potential difference can be increased or decreased.
  Die potensiaalverskil kan verhoog of verlaag word. (1)

10.2.2
(a) $V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$ ✓

$230 = \frac{V_{max/maks}}{\sqrt{2}}$ ✓

$V_{max/maks} = 325,27$ V ✓

(3)

10.2.2
(b) $P_{ave} = V_{rms/wgk} I_{rms/wgk}$ ✓

$2\,000 = (230)I_{rms/wgk}$ ✓
$I_{rms/wgk} = 8,70$ A ✓ (8,696 A) (3)
[12]

QUESTION 11/*VRAAG 11*

11.1 Photoelectric effect/*Foto-elektriese effek* ✓ (1)

11.2
11.2.1 $E = hf$ ✓
$= (6,63 \times 10^{-34})(6,16 \times 10^{14})$ ✓
$= 4,08 \times 10^{-19}$ J ✓ (3)

11.2.2 $E = W_0 + K$ ✓

$4,08 \times 10^{-19}$ ✓ $= (6,63 \times 10^{-34})f_0$ ✓ $+ 5,6 \times 10^{-20}$ ✓

$f_0 = 5,31 \times 10^{14}$ Hz ✓ (5)

11.3
11.3.1 Increases ✓
<u>More photoelectrons emitted per second</u> ✓

Vermeerder ✓
<u>Meer foto-elektrone vrygestel per sekonde</u> ✓ (2)

11.3.2 Remains the same ✓
Intensity does not affect energy. ✓
Bly dieselfde ✓
Intensiteit het geen effek op energie nie. ✓

OR/*OF*
Remains the same ✓
The frequency of light remains the same. ✓
Bly dieselfde ✓
Die frekwensie van die lig bly dieselfde. ✓ (2)
[13]

TOTAL SECTION B/*TOTAAL AFDELING B*: 125
GRAND TOTAL/*GROOTTOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2012

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages and 3 data sheets.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The number of complete waves that pass a point in one second (1)

1.2 A circuit component which stores electric charge and releases it instantly (1)

1.3 The component in a generator needed to change it from an AC to a DC generator (1)

1.4 The tiny 'packets' (quanta) of energy that light consists of (1)

1.5 The vector difference of two velocities measured from the same frame of reference (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (2.1–2.10) in the ANSWER BOOK.

2.1 The net force acting on an object is equal to the ...

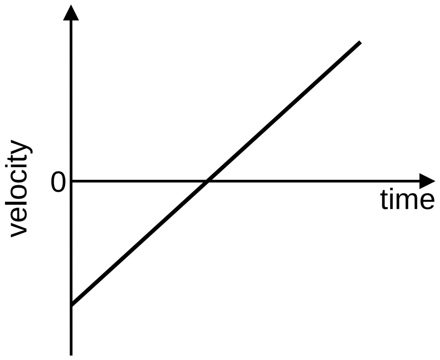
A mass of the object.

B acceleration of the object.

C change in momentum of the object.

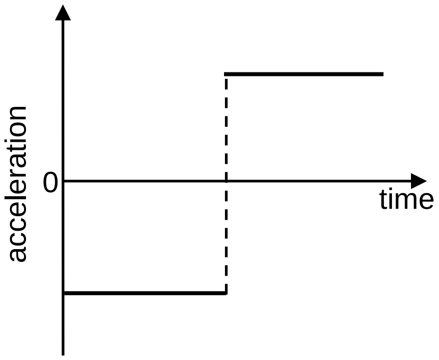
D rate of change in momentum of the object. (2)

2.2 The velocity-time graph below represents the motion of an object.

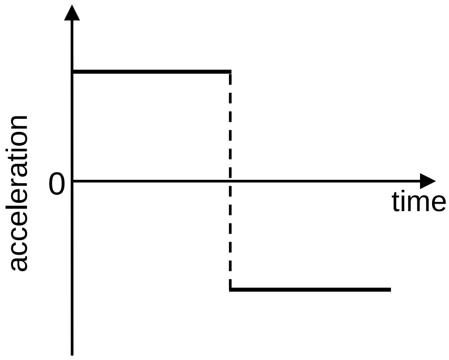


Which ONE of the following graphs represents the corresponding acceleration-time graph for the motion of this object?

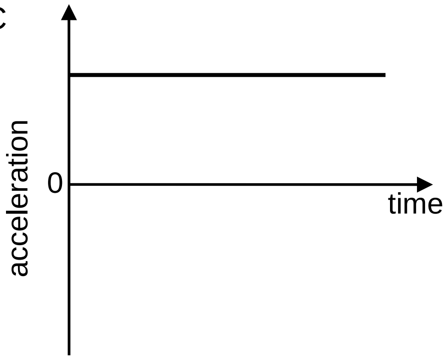
A



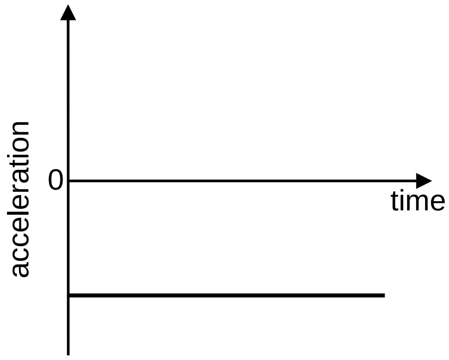
B



C



D



(2)

2.3 A car moves up a hill at CONSTANT speed. Which ONE of the following represents the work done by the weight of the car as it moves up the hill?

A ΔE_k

B ΔE_p

C $-\Delta E_k$

D $-\Delta E_p$ (2)

2.4 A central bright band is observed when light of wavelength λ passes through a single slit of width *a*.

Light of wavelength 2λ is now used. Which ONE of the following slit widths would produce a central bright band of the SAME broadness?

A $\frac{1}{4}a$

B $\frac{1}{2}a$

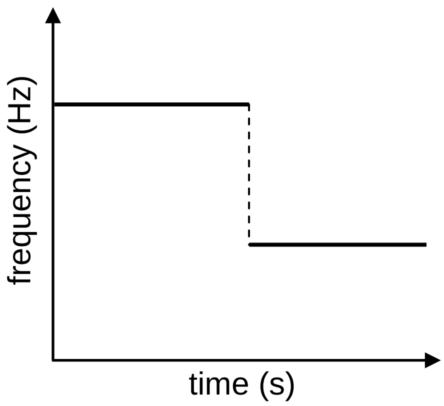
C a

D $2a$ (2)

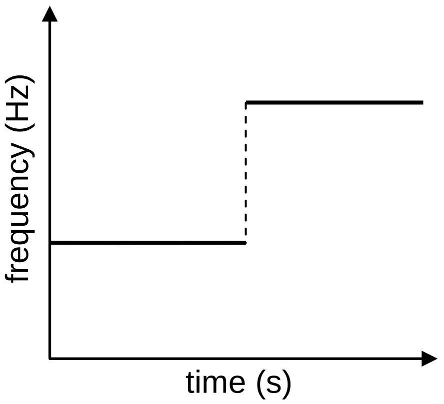
2.5 A source of sound approaches a stationary listener in a straight line at constant velocity. It passes the listener and moves away from him in the same straight line at the same constant velocity.

Which ONE of the following graphs best represents the change in observed frequency against time?

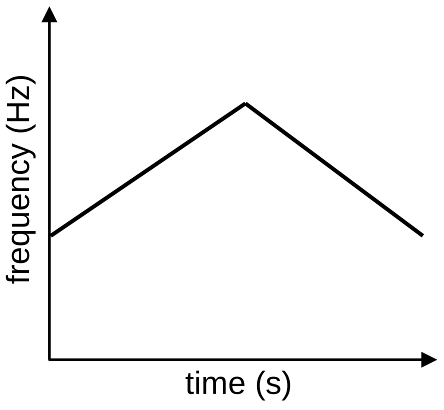
A



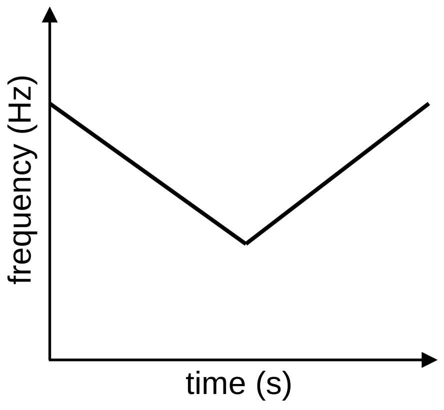
B



C

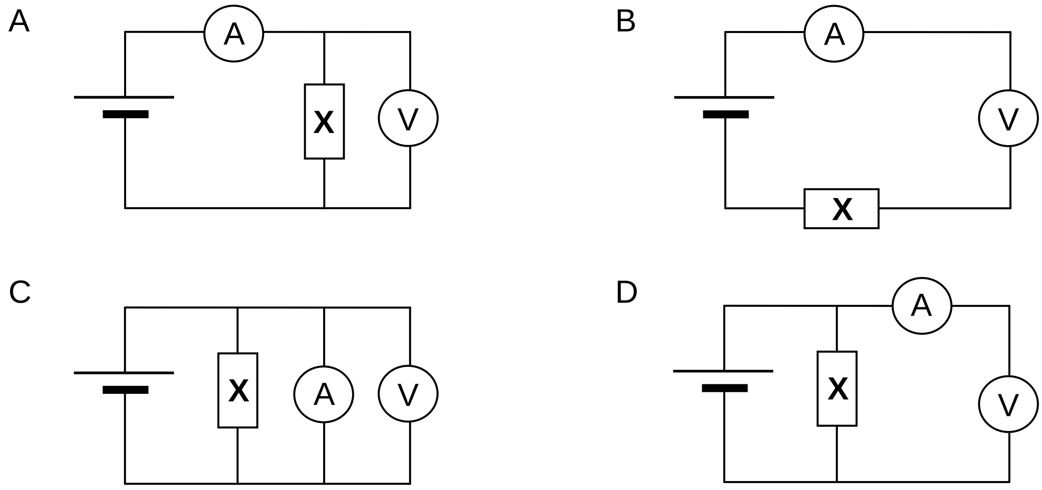


D



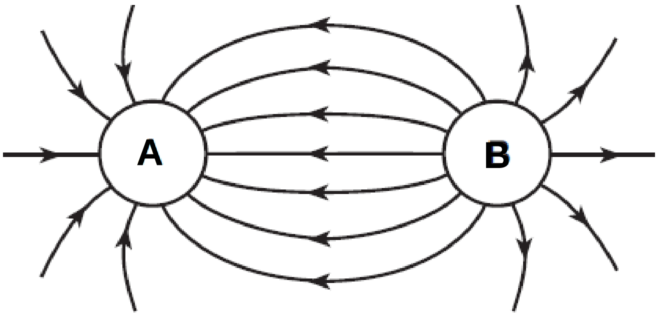
(2)

2.6 Which ONE of the circuits below can be used to measure the current in a conductor **X** and the potential difference across its ends?



(2)

2.7 The electric field pattern between two charged spheres, **A** and **B**, is shown below.



Which ONE of the following statements regarding the charge on spheres **A** and **B** is CORRECT?

A Spheres **A** and **B** are both positively charged.

B Spheres **A** and **B** are both negatively charged.

C Sphere **A** is positively charged and sphere **B** is negatively charged.

D Sphere **A** is negatively charged and sphere **B** is positively charged. (2)

2.8 Which ONE of the following shows the different types of electromagnetic radiation in order of increasing frequency?

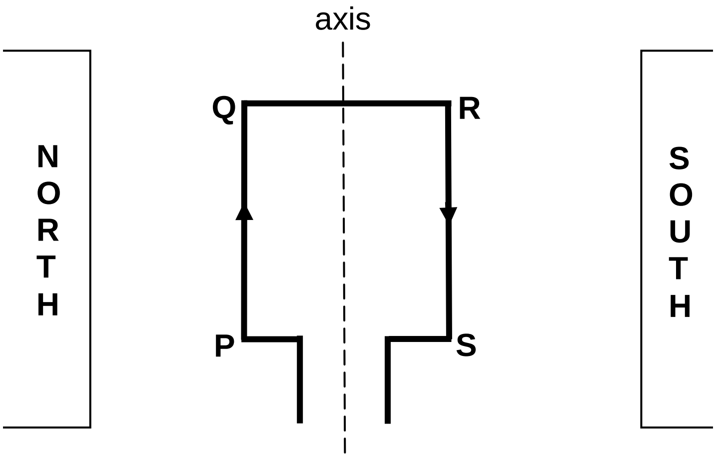
A X-rays; ultraviolet rays; infrared rays; visible light

B Infrared rays; X-rays; visible light; ultraviolet rays

C Infrared rays; visible light; ultraviolet rays; X-rays

D X-rays; ultraviolet rays; visible light; infrared rays (2)

2.9 A rectangular current-carrying coil, **PQRS**, is placed in a uniform magnetic field with its plane parallel to the field as shown below. The arrows indicate the direction of the conventional current.



The coil will ...

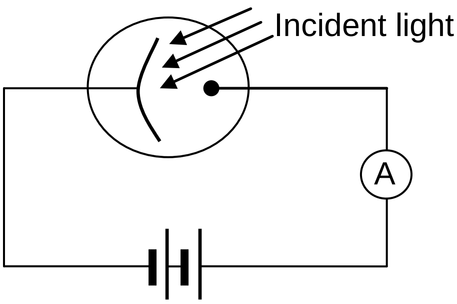
A rotate clockwise.

B remain stationary.

C rotate anticlockwise.

D rotate clockwise and then anticlockwise. (2)

2.10 The diagram below shows light incident on the cathode of a photocell. The ammeter registers a reading.



Which ONE of the following correctly describes the relationship between the intensity of the incident light and the ammeter reading?

	INTENSITY	**AMMETER READING**
A	Increases	Increases
B	Increases	Remains the same
C	Increases	Decreases
D	Decreases	Increases

(2)
[20]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.

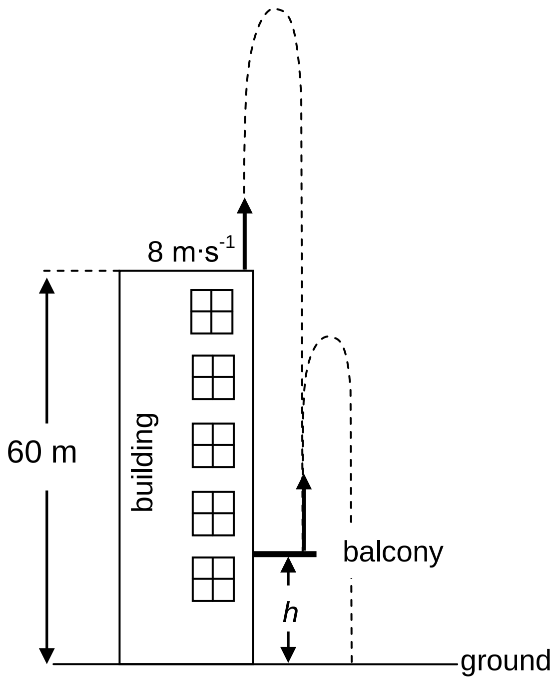
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

3. Show the formulae and substitutions in ALL calculations.

4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

An object is projected vertically upwards at 8 m·s^{-1} from the roof of a building which is 60 m high. It strikes the balcony below after 4 s. The object then bounces off the balcony and strikes the ground as illustrated below. Ignore the effects of friction.



3.1 Is the object's acceleration at its maximum height UPWARD, DOWNWARD or ZERO? (1)

3.2 Calculate the:

3.2.1 Magnitude of the velocity at which the object strikes the balcony (4)

3.2.2 Height, *h*, of the balcony above the ground (5)

The object bounces off the balcony at a velocity of 27,13 m·s^{-1} and strikes the ground 6 s after leaving the balcony.

3.3 Sketch a velocity-time graph to represent the motion of the object from the moment it is projected from the ROOF of the building until it strikes the GROUND. Indicate the following velocity and time values on the graph:

- The initial velocity at which the object was projected from the roof of the building
- The velocity at which the object strikes the balcony
- The time when the object strikes the balcony
- The velocity at which the object bounces off the balcony
- The time when the object strikes the ground (6)

[16]

QUESTION 4 (Start on a new page.)

The diagram below shows a car of mass *m* travelling at a velocity of 20 m·s^{-1} east on a straight level road and a truck of mass 2*m* travelling at 20 m·s^{-1} west on the same road. Ignore the effects of friction.

4.1 Calculate the velocity of the car relative to the truck. (2)

The vehicles collide head-on and stick together during the collision.

4.2 State the *principle of conservation of linear momentum* in words. (2)

4.3 Calculate the velocity of the truck-car system immediately after the collision. (6)

4.4 On impact the car exerts a force of magnitude *F* on the truck and experiences an acceleration of magnitude *a.*

4.4.1 Determine, in terms of *F*, the magnitude of the force that the truck exerts on the car on impact. Give a reason for the answer. (2)

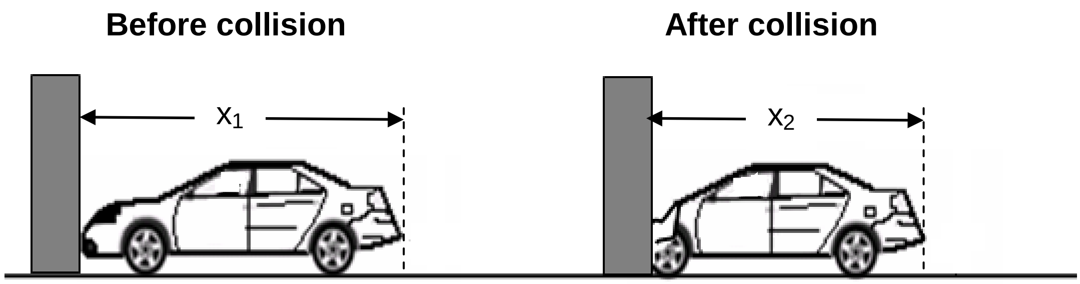
4.4.2 Determine, in terms of *a*, the acceleration that the truck experiences on impact. Give a reason for the answer. (2)

4.4.3 Both drivers are wearing identical seat belts. Which driver is likely to be more severely injured on impact? Explain the answer by referring to acceleration and velocity. (3)

[17]

QUESTION 5 (Start on a new page.)

In order to measure the net force involved during a collision, a car is allowed to collide head-on with a flat, rigid barrier. The resulting crumple distance is measured. The crumple distance is the length by which the car becomes shorter in coming to rest.



In one of the tests, a car of mass 1 200 kg strikes the barrier at a speed of 20 $m \cdot s^{-1}$. The crumple distance, ($x_1 - x_2$), is measured as 1,02 m. (Ignore the effects of frictional forces during crumpling.)

5.1 Draw a labelled free-body diagram showing ALL the forces acting on the car during the collision. (3)

5.2 State the *work-energy theorem* in words. (2)

5.3 Assume that the net force is constant during crumpling.

5.3.1 USE THE WORK-ENERGY THEOREM to calculate the magnitude of the net force exerted on the car as it is brought to rest during crumpling. (4)

5.3.2 Calculate the time it takes the car to come to rest during crumpling. (4)
[13]

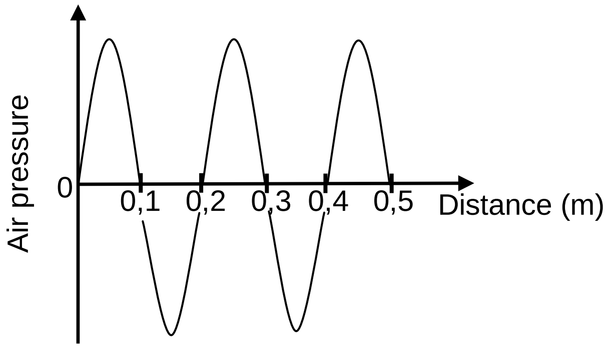
QUESTION 6 (Start on a new page.)

A bird flies directly towards a stationary birdwatcher at constant velocity. The bird constantly emits sound waves at a frequency of 1 650 Hz. The birdwatcher hears a change in pitch as the bird comes closer to him.

6.1 Write down the property of sound that is related to pitch. (1)

6.2 Give a reason why the birdwatcher observes a change in pitch as the bird approaches him. (1)

The air pressure versus distance graph below represents the waves detected by the birdwatcher as the bird comes closer to him. The speed of sound in air is 340 m·s^{-1}.



6.3 From the graph, write down the wavelength of the detected waves. (1)

6.4 Calculate the:

6.4.1 Frequency of the waves detected by the birdwatcher (3)

6.4.2 Magnitude of the velocity at which the bird flies (5)

[11]

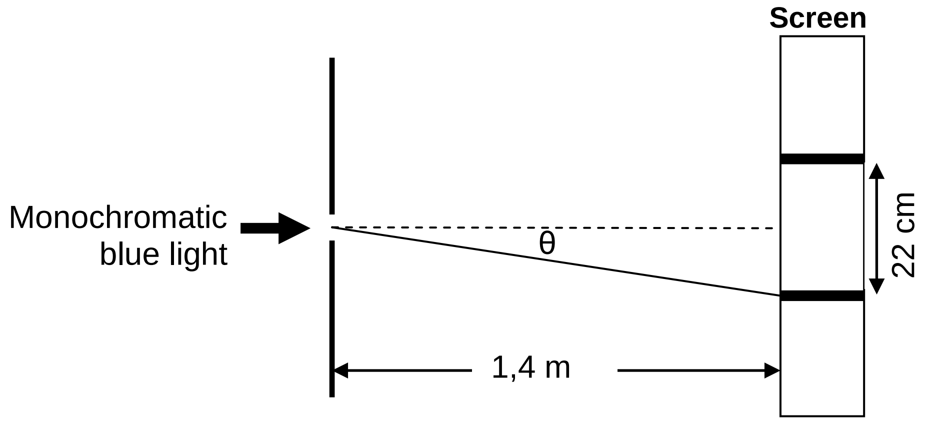
QUESTION 7 (Start on a new page.)

Learners use monochromatic blue light to investigate the difference between an interference pattern and a diffraction pattern.

7.1 Apart from the blue light and a screen, write down the name of ONE item that the learners will need to obtain an interference pattern. (1)

7.2 Briefly describe the interference pattern that will be observed on the screen. (2)

7.3 In one of their experiments they place the screen at a distance of 1,4 m from a single slit and observe a pattern on the screen. The width of the central bright band is measured as 22 cm.



Calculate the:

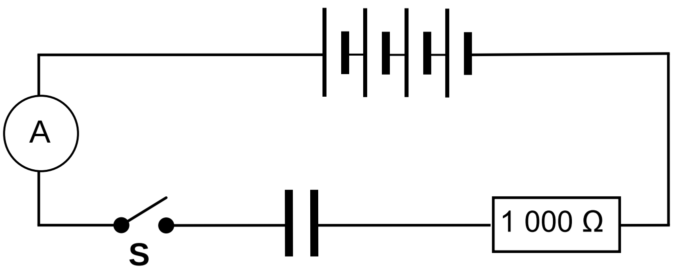
7.3.1 Angle θ at which the first minimum will be observed on the screen (3)

7.3.2 The width of the slit used if the wavelength of the blue light is 470 nm (5)

7.4 The width of the central band INCREASES when the blue light is replaced with monochromatic red light. Explain this observation. (2)
[13]

QUESTION 8 (Start on a new page.)

In the circuit represented below, an uncharged capacitor is connected in series with a 1 000 Ω resistor. The emf of the battery is 12 V. Ignore the internal resistance of the battery and the ammeter.



8.1 Calculate the initial current in the circuit when switch **S** is closed. (3)

8.2 Write down the potential difference across the plates of the capacitor when it is fully charged. (1)

The capacitor has a capacitance of 120 μF and the space between its plates is filled with air.

8.3 Calculate the charge stored on the plates of the capacitor when it is fully charged. (3)

After discharging the capacitor, it is connected in the same circuit to a resistor of HIGHER resistance and switch **S** is closed again.

8.4 How would this change affect each of the following:
(Write down INCREASES, DECREASES or REMAINS THE SAME.)

8.4.1 The initial charging current (1)

8.4.2 The time it takes for the capacitor to become fully charged (1)

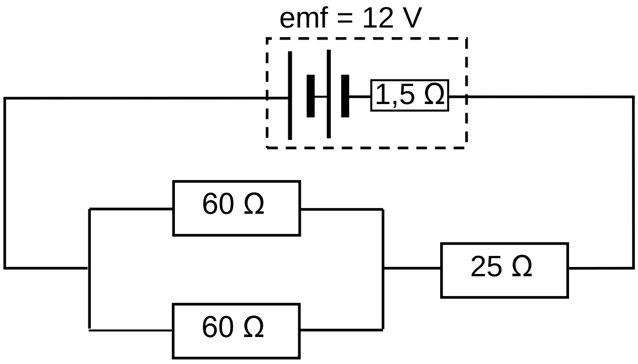
8.5 The two parallel plates of the fully charged capacitor are 12 mm apart.

8.5.1 Sketch the electric field pattern between the parallel plates. (3)

8.5.2 Calculate the magnitude of the electric field at a point midway between the plates. (3)
[15]

QUESTION 9 (Start on a new page.)

9.1 In the circuit represented below, two 60 Ω resistors connected in parallel are connected in series with a 25 Ω resistor. The battery has an emf of 12 V and an internal resistance of 1,5 Ω.



Calculate the:

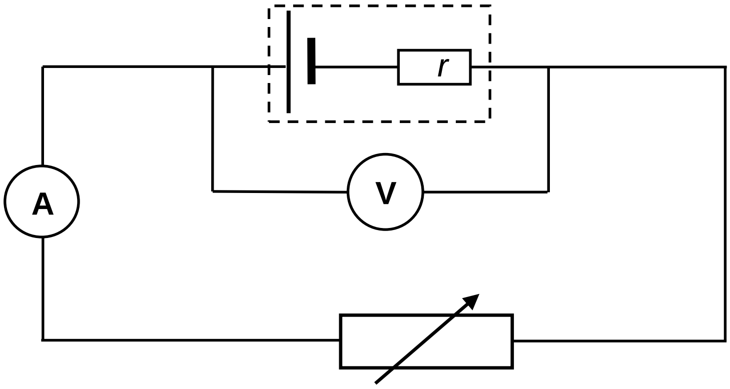
9.1.1 Equivalent resistance of the parallel combination (3)

9.1.2 Total current in the circuit (5)

9.1.3 Potential difference across the parallel resistors (3)

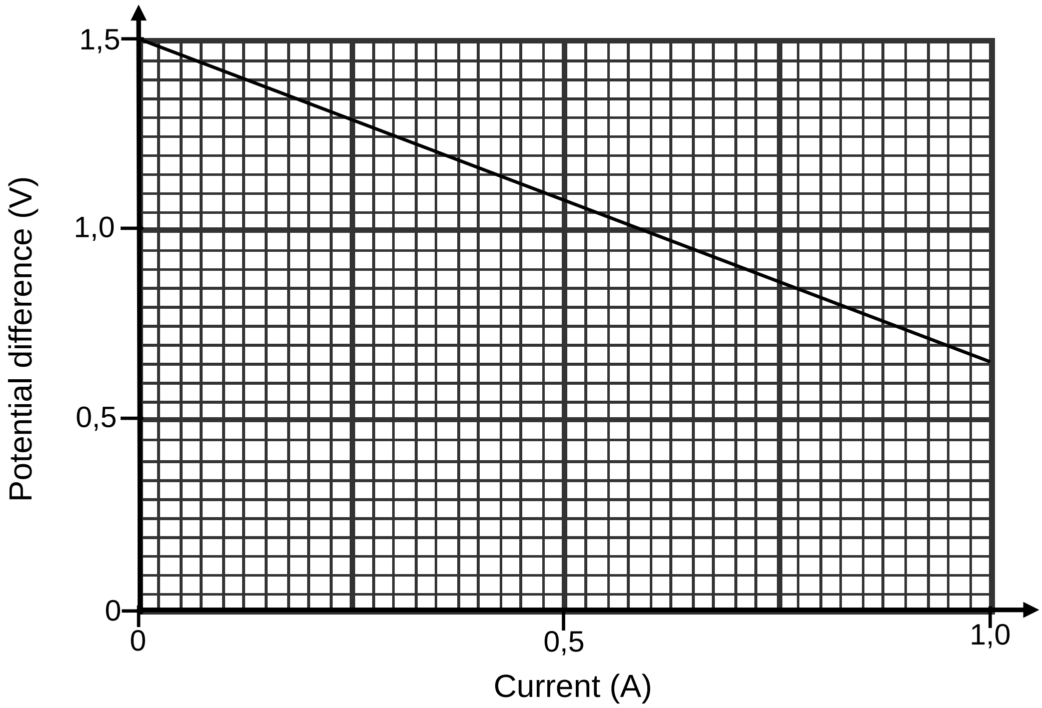
9.2 Learners conduct an investigation to determine the emf and internal resistance (r) of a battery.

They set up a circuit as shown in the diagram below and measure the potential difference using the voltmeter for different currents in the circuit.



The results obtained are shown in the graph below.

Graph of potential difference versus current



9.2.1 Use the graph to determine the emf of the battery. (1)

9.2.2 Calculate the gradient of the graph. (3)

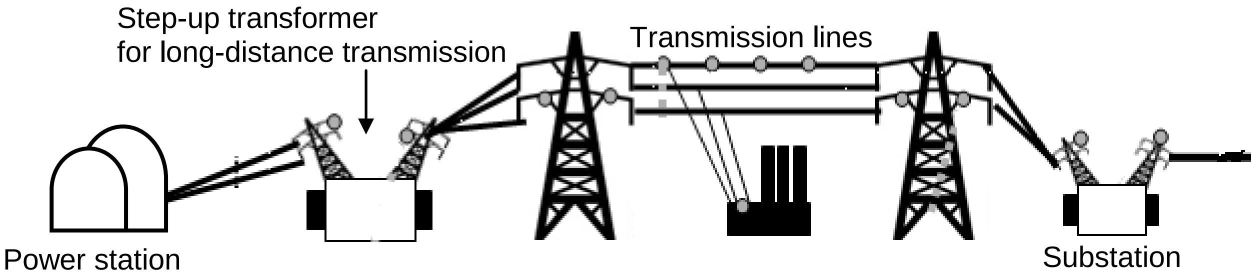
9.2.3 Which physical quantity is represented by the magnitude of the gradient of the graph? (2)

9.2.4 How does the voltmeter reading change as the ammeter reading increases? Write down INCREASES, DECREASES or REMAINS THE SAME. Use the formula emf = IR + Ir to explain the answer. (3)

[20]

QUESTION 10 (Start on a new page.)

The diagram below illustrates how electricity generated at a power station is transmitted to a substation.



10.1 Does the power station use an AC or a DC generator? (1)

10.2 Sketch a graph of the potential difference generated at the power station versus time. (2)

10.3 The average power produced at the power station is $4,45 \times 10^{9}$ W.

Calculate the rms current in the transmission lines if the power is transmitted at a maximum voltage of 30 000 V. (5)

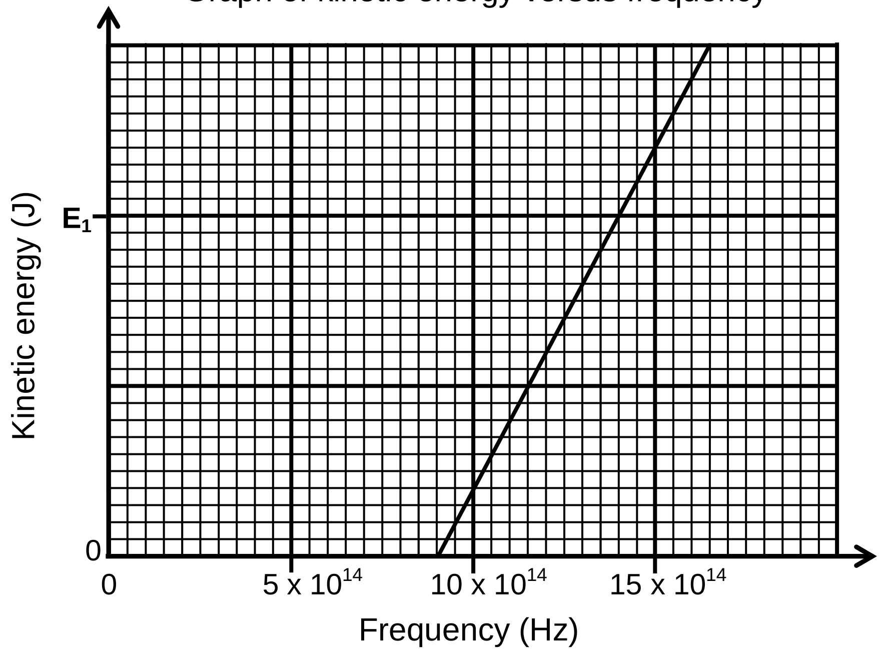
10.4 Give a reason why electricity should be transmitted at high voltage and low current. (1)

[9]

QUESTION 11 (Start on a new page.)

During an investigation, light of different frequencies is shone onto the metal cathode of a photocell. The kinetic energy of the emitted photoelectrons is measured. The graph below shows the results obtained.

Graph of kinetic energy versus frequency



11.1 For this investigation, write down the following:

11.1.1 Dependent variable (1)

11.1.2 Independent variable (1)

11.1.3 Controlled variable (1)

11.2 Define the term *threshold frequency*. (2)

11.3 Use the graph to obtain the threshold frequency of the metal used as cathode in the photocell. (1)

11.4 Calculate the kinetic energy at E_1 shown on the graph. (4)

11.5 How would the kinetic energy calculated in QUESTION 11.4 be affected if light of higher intensity is used? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

[11]

TOTAL SECTION B: 125

GRAND TOTAL: 150

SECTION A

QUESTION 1/*VRAAG 1*

1.1	Frequency/*Frekwensie* ✓	(1)
1.2	Capacitor/*Kapasitor* ✓	(1)
1.3	Split ring commutator ✓ *Splitringkommutator*	(1)
1.4	Photons/*Fotone* ✓	(1)
1.5	Relative velocity/*Relatiewe snelheid* ✓	(1) **[5]**

QUESTION 2/*VRAAG 2*

2.1	D ✓✓	(2)
2.2	C ✓✓	(2)
2.3	D ✓✓	(2)
2.4	D ✓✓	(2)
2.5	A ✓✓	(2)
2.6	A ✓✓	(2)
2.7	D ✓✓	(2)
2.8	C ✓✓	(2)
2.9	C ✓✓	(2)
2.10	A ✓✓	(2) **[20]**

TOTAL SECTION A/*TOTAAL AFDELING A*: 25

SECTION B/*AFDELING B*

QUESTION 3/*VRAAG 3*

3.1 Downward/*afwaarts* ✓ (1)

3.2

3.2.1 **Upwards positive/*Opwaarts positief:***

$v_f = v_i + a\Delta t$ ✓
$= 8$ ✓ $+ (-9,8)(4)$ ✓
$= -31,2\ m \cdot s^{-1}$
$\therefore v_f = 31,2\ m \cdot s^{-1}$ ✓

Downwards positive/*Afwaarts positief:*

$v_f = v_i + a\Delta t$ ✓
$= -8$ ✓ $+ (9,8)(4)$ ✓
$\therefore v_f = 31,2\ m \cdot s^{-1}$ ✓ (4)

3.2.2

OPTION 1/*OPSIE 1*

Upwards positive/*Opwaarts positief*:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (8)(4)$ ✓ $+ \frac{1}{2}(-9,8)(4)^2$ ✓
$= -46,4\ m$

Height of balcony/*Hoogte van balkon:*
<u>60 –</u> 46,4 ✓ = 13,6 m ✓

Downwards positive/*Afwaarts positief:*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (-8)(4)$ ✓ $+ \frac{1}{2}(9,8)(4)^2$ ✓
$= 46,4\ m$

Height of balcony/*Hoogte van balkon:*
<u>60 –</u> 46,4 ✓ = 13,6 m ✓

OPTION 2/*OPSIE 2*

Upwards positive/*Opwaarts positief:*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (27,13)$ ✓ (6) ✓ $+ \frac{1}{2}(-9,8)(6)^2$ ✓
$= -13,62\ m$

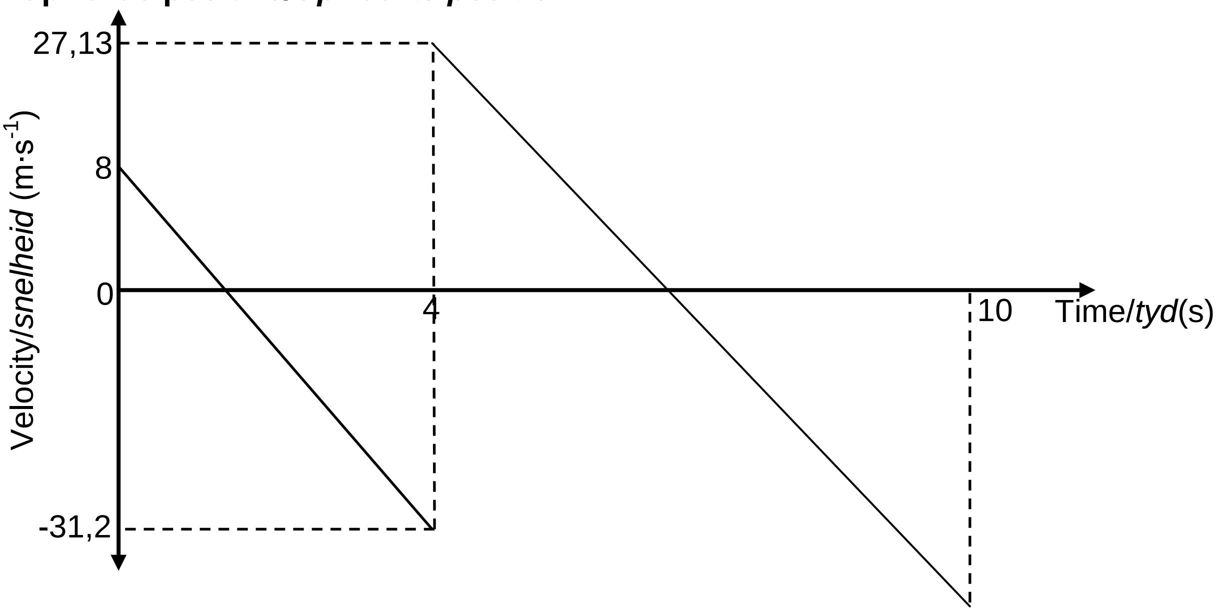
Height of balcony/*Hoogte van balkon:*
= 13,62 m ✓

Downwards positive/*Afwaarts positief:*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (-27,13)$ ✓ (6) ✓ $+ \frac{1}{2}(9,8)(6)^2$ ✓
$= 13,62\ m$

Height of balcony/*Hoogte van balkon:*
= 13,62 m ✓ (5)

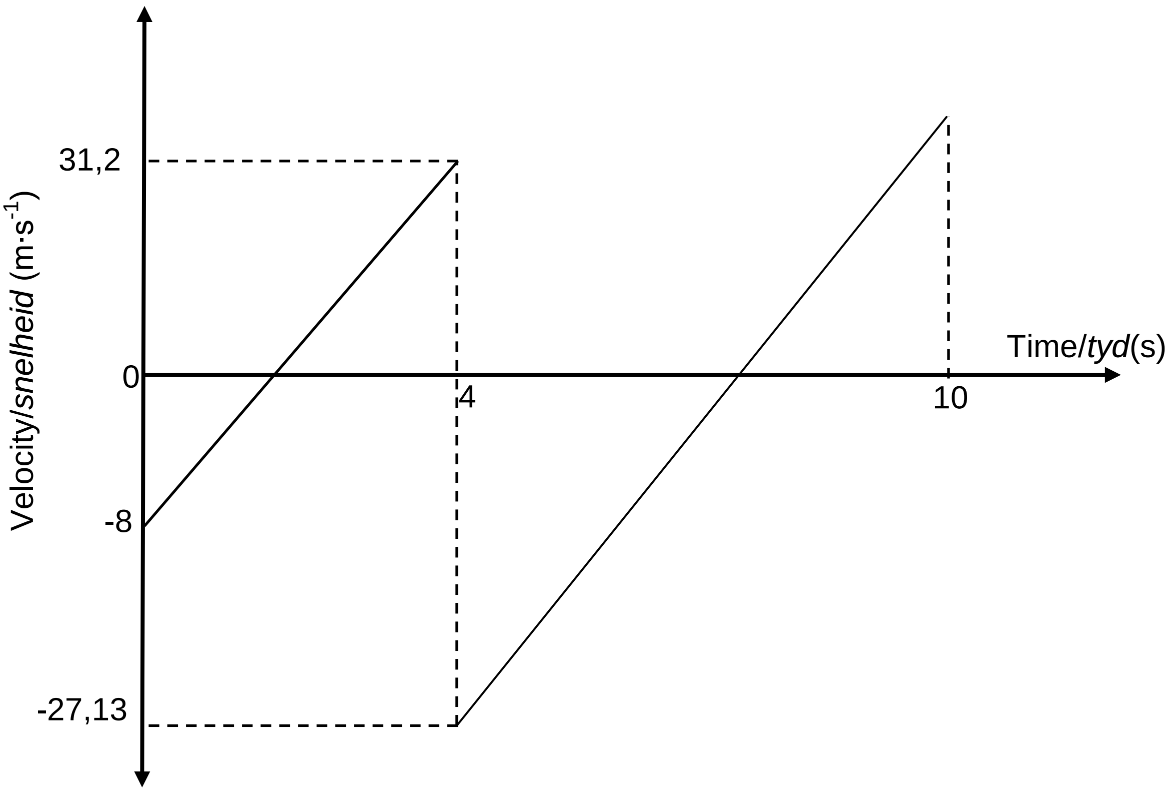
3.3 **<u>OPTION 1/*OPSIE 1*</u>**
Upwards positive/*Opwaarts positief:*



Criteria for graph/*Kriteria vir grafiek:*	**Marks/ *Punte***
Shape has two parallel lines with a gradient. *Vorm het twee ewewydige lyne met gradient.*	✓
First part of graph starts at v = 8 m·s^{-1} at t = 0 s *Eerste deel van grafiek begin by v = 8 m·s^{-1} by t = 0 s.*	✓
Positive marking from QUESTION 3.2.1: ***Positiewe nasien vanaf VRAAG 3.2.1:*** First part of the graph extends below the x axis until v = -31,2 m·s^{-1} at t = 4 s. *Eerste deel van die grafiek verleng onder x-as tot* v = -31,2 m·s^{-1} by *t = 4 s.*	✓
Graph is discontinuous and object changes direction at 4 s. *Grafiek is nie kontinu nie en voorwerp verander van rigting by 4 s.*	✓
Second part of graph starts at v = 27,13 m·s^{-1} at t = 4 s. *Tweede deel van grafiek begin by v = 27,13 m·s^{-1} by t = 4 s.*	✓
Second part of graph extends below the x axis until t = 10 s. *Tweede deel van grafiek verleng onder x-as tot t =10 s.*	✓

<u>OPTION 2/*OPSIE 2*</u>

Upwards negative/*Opwaarts negatief:*



Criteria for graph/*Kriteria vir grafiek:*	**Marks *Punte***
Correct shape as shown (two parallel lines). *Korrekte vorm soos aangetoon (twee ewewydige lyne).*	✓
First part of graph starts at v = -8 $m{\cdot}s^{-1}$ at t = 0 s *Eerste deel van grafiek begin by v = -8 $m{\cdot}s^{-1}$ by t = 0 s*	✓
Positive marking from QUESTION 3.2.1. ***Positiewe nasien vanaf VRAAG 3.2.1.*** First part of the graph extends above the x axis until v = 31,2 $m{\cdot}s^{-1}$ at t = 4 s. *Eerste deel van die grafiek verleng bokant x-as tot* v = 31,2 $m{\cdot}s^{-1}$ by *t = 4 s.*	✓
Graph is discontinuous and object changes direction at 4 s. *Grafiek is nie kontinu en voorwerp verander van rigting by 4 s.*	✓
Second part of graph starts at v = -27,13 $m{\cdot}s^{-1}$ at t = 4 s. *Tweede deel van grafiek begin by v = -27,13 $m{\cdot}s^{-1}$ by t = 4 s.*	✓
Second part of graph extends above the x axis until t = 10 s. *Tweede deel van grafiek verleng bokant x-as tot t = 10 s.*	✓

(6)
[16]

QUESTION 4/*VRAAG 4*

4.1 40 m·s^{-1} ✓east/*oos* ✓ (2)

4.2 The <u>total (linear) momentum remains constant</u>/is conserved ✓
in <u>an isolated</u>/a closed system/the absence of external forces/ if the impulse of external forces is zero. ✓

Die <u>totale (liniêre) momentum bly konstant/</u>behoue ✓
in 'n <u>geïsoleerde sisteem</u>/geslote sisteem/ die afwesigheid van eksterne kragte./ indien die impuls van eksterne kragte nul is.✓ (2)

4.3 **<u>East positive/*Oos positief:*</u>**
$\Sigma p_i = \Sigma p_f$ ✓
$m(20)$ ✓+ $2m(-20)$ ✓ = $(m + 2m)v_f$ ✓
$\therefore v_f = -6{,}67 \text{ m·s}^{-1}$
$\therefore v_f = 6{,}67 \text{ m·s}^{-1}$ ✓ west /wes ✓
<u>East negative/*Oos negatief:*</u>
$\Sigma p_i = \Sigma p_f$ ✓
$m(-20)$ ✓+ $2m(+20)$ ✓ = $(m + 2m)v_f$ ✓
$\therefore v_f = 6{,}67 \text{ m·s}^{-1}$ ✓ west /*wes* ✓ (6)

4.4
4.4.1 F✓
Newton's Third Law of motion/*Newton se Derde Bewegingswet* ✓ (2)

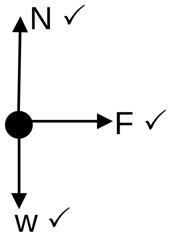
4.4.2 -½ a / ½ a✓
(Same/*Dieselfe* F_{net}), <u>$a \propto \frac{1}{m}$</u> ✓ (2)

4.4.3 Car driver ✓
(Car - driver system) have <u>greater acceleration</u>. ✓
(Car - driver system) have <u>greater change in velocity /greater Δv</u>.✓

Motorbestuurder ✓
(Motor -bestuurder sisteem) het groter versnelling. ✓
(Motor -bestuurder sisteem) het groter verandering in snelheid / groter <u>Δv</u>.✓ (3)
[17]

QUESTION 5/*VRAAG 5*

5.1



(3)

5.2 The <u>net (total) work</u> (done on an object) is <u>equal to</u> ✓
the <u>change in kinetic energy</u> (of the object.) ✓
Die <u>netto</u> (totale) <u>arbeid verrig</u> (op 'n voorwerp) is <u>gelyk aan</u> ✓
die <u>verandering in kinetiese energie</u> (van die voorwerp). ✓ (2)

5.3

5.3.1 $W_{net} = \Delta E_k/\Delta K$ ✓ **OR/*OF*** $F_{net}\Delta x\cos\theta = ½\, m(v_f^2 - v_i^2)$

$\underline{F_{net}(1{,}02)\cos 180°}$ ✓ = $\underline{½\,(1\,200)(0 - 20^2)}$ ✓

F_{net} = 235 294,12 N ✓ (2,35 x 10^5 N) (4)

5.3.2

<u>OPTION 1 /*OPSIE 1*</u>	**<u>OPTION 2/*OPSIE 1*</u>**
$F_{net}\Delta t = m\Delta v$ ✓ $\therefore$ (-235 294,12)Δt ✓= (1 200)(0 - 20) ✓ $\therefore$ Δt = 0,1 s ✓(0,102 s)	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ 1,02 ✓= $\left(\frac{20 + 0}{2}\right)\Delta t$ ✓ Δt = 0,1 s✓

(4)
[13]

QUESTION 6/*VRAAG 6*

6.1 Frequency/*Frekwensie* ✓ (1)

6.2 There is relative motion between the bird and the bird watcher. ✓
Daar is relatiewe beweging tussen die voël en die voëlkyker nie. ✓ (1)

6.3 0,2 m ✓ (1)

6.4

6.4.1 $v = f\lambda$ ✓
340 = f(0,2) ✓
$\therefore$ f = 1 700 Hz ✓ (3)

6.4.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

$\therefore 1\,700$ ✓ = $\frac{340}{340 - v_s}$ ✓ (1 650) ✓

$\therefore$ v_s = 10 m·s^{-1} ✓ (5)
[11]

QUESTION 7/*VRAAG 7*

7.1 Double slit/*Dubbelspleet* ✓ (1)

7.2 (Alternate) dark and bright/blue bands. ✓
Bright / blue bands of equal broadness (width). ✓

(Afwisselende) donker en helder/blou bande. ✓
Helder / blou bande van gelyke breedte. ✓ (2)

7.3

7.3.1 $\tan\theta = \frac{\frac{1}{2}\text{central band}}{\text{screen distance}}$ / $\frac{\frac{1}{2}\textit{sentraleband}}{\textit{skermafstand}}$

$\therefore \tan\theta = \frac{\frac{1}{2}(0{,}22)}{1{,}4}$ ✓ ✓

$\therefore \theta = 4{,}49°$ ✓ (3)

7.3.2

OPTION 1/*OPSIE 1:*	**OPTION 2/*OPSIE 2:***
$\sin\theta = \frac{m\lambda}{a}$ ✓	$\sin\theta = \frac{m\lambda}{a}$ ✓
$\sin 4{,}49 = \frac{(1)(470\times10^{-9})}{a}$ ✓ ✓ ✓	$\sin(-4{,}49°) = \frac{(-1)(470\times10^{-9})}{a}$ ✓ ✓ ✓
$\therefore$ a = 6×10^{-6} m ✓(6 003,67 nm)	$\therefore$ a = 6×10^{-6} m ✓ (6 003,67 nm)

(5)

7.4 $\lambda_{\text{red light}} > \lambda_{\text{blue light}}$ ✓
(Degree of) diffraction/sin θ / $\theta \propto$ wavelength (λ) ✓

$\lambda_{\textit{rooilig}} > \lambda_{\textit{bloulig}}$ ✓
Diffraksie $\propto$ *golflengte* (λ) ✓ (2)

[13]

QUESTION 8/*VRAAG 8*

8.1 $R = \frac{V}{I}$ ✓

$1\,000 = \frac{12}{I}$ ✓

$\therefore I = 0{,}01$ A ✓ (3)

8.2 12 V ✓ (1)

8.3 $C = \frac{Q}{V}$ ✓

$120 \times 10^{-6} = \frac{Q}{12}$ ✓

$\therefore Q = 1{,}44 \times 10^{-3}$ C ✓ (3)

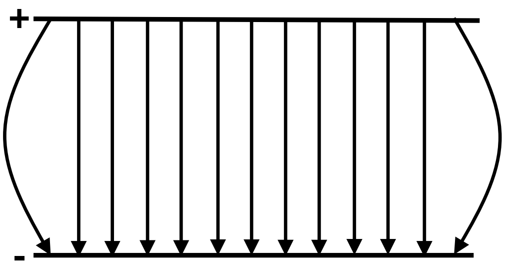
8.4

8.4.1 Decreases/*Verminder* ✓ (1)

8.4.2 Increases/*Vermeerder* ✓ (1)

8.5

8.5.1



Criteria for sketch:/*Kriteria vir skets:*	Marks/ *Punte*
Parallel lines equally spaced. *Parallelle lyne eweredig gespasieer.*	✓
Direction from positive plate towards negative plate.(Polarity of plates must be indicated) *Rigting vanaf positiewe plaat na negatiewe plaat.(Polariteit van plate moet aangedui word)*	✓
Field curved at the ends of the plates. *Veld gekrom aan einde van die plate.*	✓

(3)

8.5.2

$E = \frac{V}{d}$ ✓

$= \frac{12}{12 \times 10^{-3}}$ ✓

$\therefore E = 1\,000\ V{\cdot}m^{-1}$ ✓ (3)

[15]

QUESTION 9/*VRAAG 9*

9.1

9.1.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$= \frac{1}{60} + \frac{1}{60}$ ✓

$\therefore R_p = 30\ \Omega$ ✓ (3)

9.1.2

OPTION 1 / *OPSIE 1*	**OPTION 2 / *OPSIE 2:***
$R_{ext} = 30 + 25 = 55\ \Omega$ ✓	$R_{tot} = (30 + 25)$ ✓ $+1,5 = 56,5\ \Omega$
Emf/*emk* = I(R + r) ✓	V = IR✓
$\therefore$ 12 ✓= I(55 + 1,5) ✓	12✓ = I(56,5) ✓
$\therefore$ I = 0,21 A ✓	$\therefore$ I = 0,21 A ✓

(5)

9.1.3

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
V = IR ✓	V = IR ✓
= (0,21)(30) ✓	= (0,105)(60) ✓
= 6,3 V ✓	= 6,3 V ✓

(3)

9.2

9.2.1 1,5 V ✓ (1)

9.2.2 gradient/m = $\frac{\Delta V}{\Delta I}$

$= \frac{0,65 - 1,5}{1,0 - 0}$ ✓✓

= - 0,85 Ω ✓ (3)

9.2.3 Internal resistance ✓✓
Interne weerstand (2)

9.2.4 Decreases/*Verminder* ✓

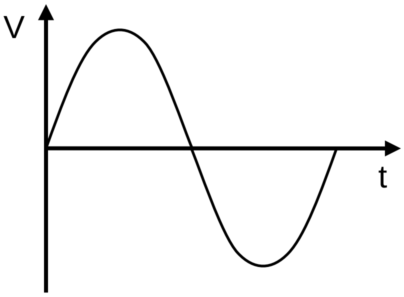
When I increases/*Wanneer I toeneem:*
"Lost volts"/ Ir increases./*"Verlore volts"/Ir neem toe.* ✓
V_{ext} = emf – Ir decreases. ✓/V_{ext} = *emk – Ir neem af.* (3)

[20]

QUESTION 10/*VRAAG 10*

10.1 AC /*WS* ✓ (1)

10.2



Criteria for graph/*Kriteria vir grafiek:*	**Marks** ***Punte***
Correct shape as shown; accept more than one cycle. *Korrekte vorm soos aangetoon; aanvaar meer as een siklus.*	✓✓
If no/wrong labels: minus 1 mark *Indien geen/verkeerde byskifte: minus 1 punt*	

(2)

10.3

<u>OPTION 1/*OPSIE 1*</u>	**<u>OPTION 2 / *OPSIE 2*</u>**
$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$ ✓ $= \frac{30\times10^3}{\sqrt{2}}$ ✓ $= 2,12 \times 10^4$ V $P_{ave} = V_{rms}I_{rms}/P_{gem.} = V_{wgk}I_{wgk}$ ✓ $4,45 \times 10^9$ ✓ $= (2,12 \times 10^4)I_{rms/wgk}$ $\therefore I_{rms/wgk} = 2,10 \times 10^5$ A ✓	$P_{ave} = V_{rms}I_{rms}/P_{gem.} = V_{wgk}I_{wgk}$ $P_{ave/gem.} = \frac{V_{max}I_{rms}}{\sqrt{2}} / \frac{V_{maks}I_{wgk}}{\sqrt{2}}$ ✓✓ $4,45 \times 10^9$ ✓ $= \frac{(30\times10^3)I_{rms/wgk}}{\sqrt{2}}$ ✓ $\therefore I_{rms/wgk} = 2,10 \times 10^5$ A ✓

(5)

10.4 <u>Less loss in (electrical) energy</u> (as heat). ✓
<u>Minder verlies aan (elektriese) energie</u> (as hitte). ✓ (1)

[9]

QUESTION 11/*VRAAG 11*

11.1

11.1.1 Kinetic energy /*Kinetiese energie* (E_k)✓ (1)

11.1.2 Frequency /*Frekwensie*✓(f) (1)

11.1.3 (Type of) metal✓
(Soort) metaal ✓ (1)

11.2 The minimum frequency needed to emit electrons ✓ from (the surface of) a metal. ✓
Die minimum frekwensie benodig om elektrone vry te stel vanaf (die oppervlak van) 'n metaal. (2)

11.3 9×10^{14} Hz ✓ (1)

11.4

$E = W_0 + E_k$
$hf = hf_0 + E_k$
✓ Any one /*Enige een*

$(6,63 \times 10^{-34})(14 \times 10^{14})$ ✓ $= (6,63 \times 10^{-34})(9 \times 10^{14})$ ✓ $+ E_k$

$\therefore\ E_k = 3,32 \times 10^{-19}$ J ✓ ($3,31 \times 10^{-19}$ J) (4)

11.5 Remains the same/*Bly dieselfde* ✓ (1)

[11]

TOTAL SECTION B/*TOTAAL AFDELING B*: 125
GRAND TOTAL/*GROOTTOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2013

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The type of electromagnetic radiation that is used to take pictures of the human skeleton (1)

1.2 The product of mass and velocity (1)

1.3 The principle which states that each point on a wave front acts as a source of secondary waves (1)

1.4 The unit of measurement equivalent to a coulomb per second (1)

1.5 The general term used to describe a system on which no external forces act (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (2.1–2.10) in the ANSWER BOOK.

2.1 Power is defined as the rate …

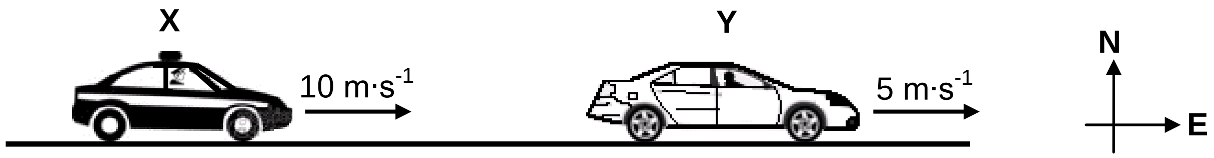
A of change of velocity.

B at which work is done.

C of change of momentum.

D of change of displacement. (2)

2.2 Two cars, **X** and **Y**, are travelling in an easterly direction along a straight level road as shown in the diagram below. The velocity of car **X** is 10 $m{\cdot}s^{-1}$ relative to the ground and the velocity of car **Y** is 5 $m{\cdot}s^{-1}$ relative to the ground.



The velocity of car **X** relative to car **Y** is …

A 5 $m{\cdot}s^{-1}$ east.

B 5 $m{\cdot}s^{-1}$ west.

C 15 $m{\cdot}s^{-1}$ east.

D 15 $m{\cdot}s^{-1}$ west. (2)

2.3 Which ONE of the following is an example of a contact force?

A Frictional force

B Magnetic force

C Electrostatic force

D Gravitational force (2)

2.4 A sound source approaches a stationary observer at constant velocity. Which ONE of the following describes how the observed frequency and wavelength differ from that of the sound source?

	Observed wavelength	**Observed frequency**
A	Greater than	Greater than
B	Less than	Less than
C	Greater than	Less than
D	Less than	Greater than

(2)

2.5 Two light sources of the same frequency maintain the same phase relationship with each other. This is an example of …

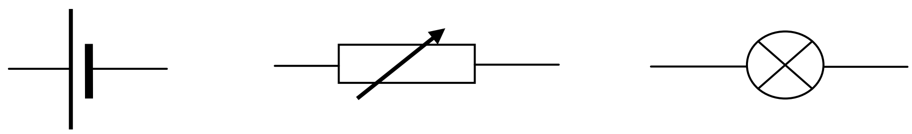
A coherence.

B Huygens' principle.

C destructive interference.

D constructive interference. (2)

2.6 Consider the three circuit components represented below.



Which ONE of the options below best represents the names of the components in the correct sequence, from left to right?

A Light bulb, resistor, cell

B Resistor, light bulb, cell

C Cell, light bulb, variable resistor

D Cell, variable resistor, light bulb (2)

2.7 A positively charged metal sphere **X** on an insulated stand is brought into contact with an identical neutral metal sphere **Y** on an insulated stand. The two spheres are then separated.

Which ONE of the following describes the charge on each sphere after they have been separated?

	Sphere X	Sphere Y
A	Positive	Neutral
B	Positive	Positive
C	Neutral	Positive
D	Neutral	Neutral

(2)

2.8 When the distance between the plates of a parallel plate capacitor is decreased, its capacitance …

A increases.

B decreases.

C becomes zero.

D remains unchanged. (2)

2.9 Consider the types of electromagnetic radiation below:

(i) Gamma rays
(ii) X-rays
(iii) Infrared rays

Which of the above radiations have wavelengths shorter than that of visible light?

A (i), (ii) and (iii)

B (i) and (ii) only

C (i) and (iii) only

D (ii) and (iii) only (2)

2.10 Which ONE of the following provides evidence that light behaves as particles?

A Light can be diffracted.

B Light is refracted by a triangular prism.

C Light ejects electrons from a metal surface.

D The speed of light decreases when it travels from air to glass. (2)
[20]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.

2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

3. Show the formulae and substitutions in ALL calculations.

4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A ball of mass 0,2 kg is dropped from a height of 0,8 m onto a hard floor. It bounces to a maximum height of 0,6 m. The floor exerts a force of 50 N on the ball. Ignore the effects of friction.

3.1 Write down the magnitude and direction of the force that the ball exerts on the floor. (2)

3.2 Calculate the:

3.2.1 Velocity at which the ball strikes the floor (4)

3.2.2 Time that the ball is in contact with the floor if it bounces off the floor at a speed of 3,43 $m \cdot s^{-1}$ (4)

3.3 The ball takes 0,404 s from the moment it is dropped until it strikes the floor.

Sketch a graph (not to scale) of position versus time representing the entire motion of the ball. USE THE GROUND AS ZERO REFERENCE.

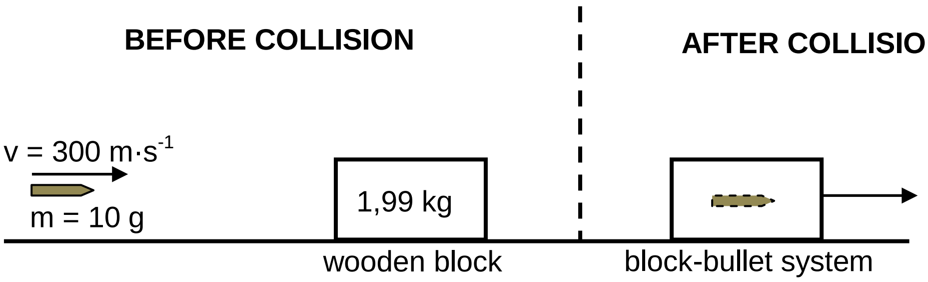
Indicate the following on the graph:

- Height from which the ball is dropped
- Height reached by the ball after the bounce
- Time at which the ball bounces off the floor (5)

[15]

QUESTION 4 (Start on a new page.)

A bullet of mass 10 g, moving at a velocity of 300 $m \cdot s^{-1}$, strikes a wooden block of mass 1,99 kg resting on a flat horizontal surface as shown in the diagram below. The bullet becomes embedded in the block. Ignore the effects of air friction.



4.1 Write down in words the *principle of conservation of linear momentum*. (2)

4.2 Calculate the speed of the block-bullet system immediately after the collision. (4)

4.3 Is this collision elastic or inelastic? Give a reason for the answer. (2)

The floor exerts a constant frictional force of 8 N on the block-bullet system as it comes to rest.

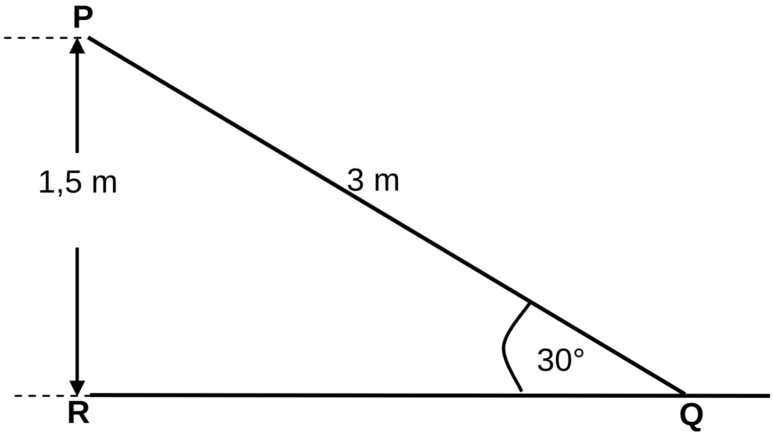
4.4 Calculate the distance that the block-bullet system moves after the collision. (4)
[12]

QUESTION 5 (Start on a new page.)

The simplified diagram below shows a slide **PQ** at a playground. The slide is 3 m long and 1,5 m high. A boy of mass 40 kg and a girl of mass 22 kg stand at the top of the slide at **P**.

The girl accelerates uniformly from rest down the slide. She experiences a constant frictional force of 1,9 N.

The boy falls vertically down from the top of the slide through the height **PR** of 1,5 m. Ignore the effects of air friction.



5.1 Write down the *principle of conservation of mechanical energy* in words. (2)

5.2 Draw a labelled free-body diagram to show ALL the forces acting on the:

5.2.1 Boy while falling vertically downwards (1)

5.2.2 Girl as she slides down the slide (3)

5.3 Use the principle of CONSERVATION OF MECHANICAL ENERGY to calculate the speed of the boy when he reaches the ground at **R**. (4)

5.4 Use the WORK-ENERGY THEOREM to calculate the speed of the girl when she reaches the end of the slide at **Q**. (5)

5.5 How would the velocity of the girl at **Q** compare to that of the boy at **R** if the slide exerts no frictional force on the girl? Write down only GREATER THAN, LESS THAN or EQUAL TO. (1)

[16]

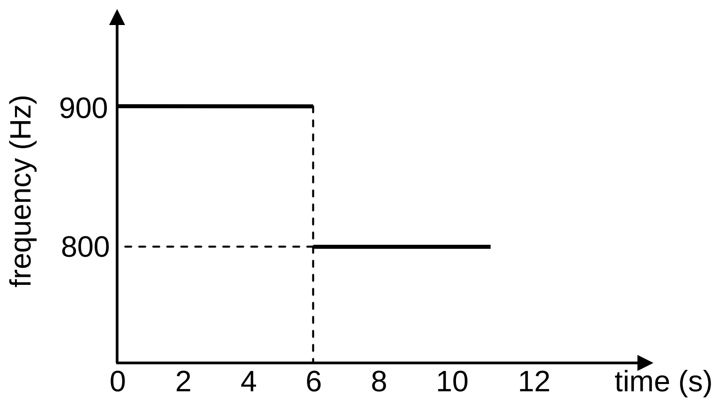
QUESTION 6 (Start on a new page.)

The siren of a stationary ambulance emits sound waves at a frequency of 850 Hz.

An observer, travelling in a car at a constant speed in a straight line, begins measuring the frequency of the sound waves emitted by the siren when he is at a distance *x* from the ambulance.

The observer continues measuring the frequency as he approaches, passes and moves away from the ambulance.

The results obtained are shown in the graph below.



6.1 The observed frequency suddenly changes at t = 6 s. Give a reason for this sudden change in observed frequency. (1)

6.2 Calculate the:

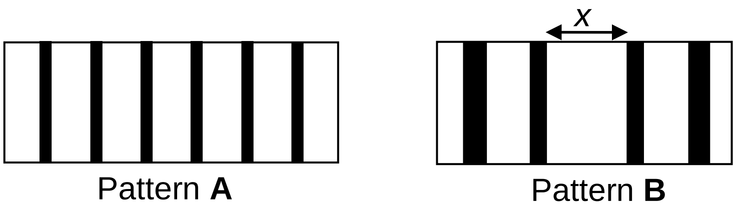
6.2.1 Speed of the car
(Take the speed of sound in air as 340 $m \cdot s^{-1}$.) (5)

6.2.2 Distance *x* between the car and the ambulance when the observer BEGINS measuring the frequency (3)
[9]

QUESTION 7 (Start on a new page.)

A learner investigates the difference in patterns obtained on a screen when monochromatic red light passes through a single slit and through a double slit.

The diagram below shows two patterns obtained during the investigation.



Shaded area: dark

Unshaded area: red

7.1 Which pattern, **A** or **B**, is a diffraction pattern? (1)

7.2 Write down the name of the phenomenon that explains the formation of the red lines (unshaded area) in pattern **A**. (2)

7.3 The monochromatic red light used to obtain pattern **B** has a frequency of $4{,}54 \times 10^{14}$ Hz. The broadness of the central band, *x*, is measured as 20 cm when the distance between the screen and the slit is 1,5 m.

Calculate the:

7.3.1 Wavelength of the red light (3)

7.3.2 Width of the slit used (6)

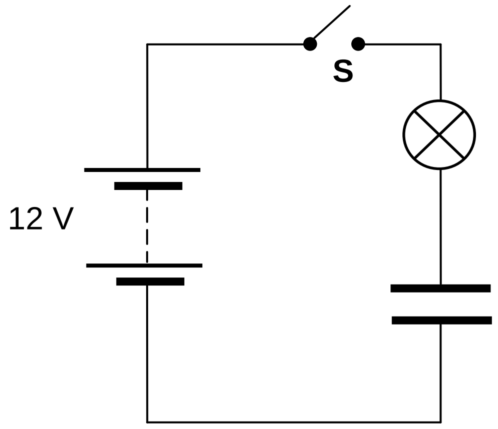
7.4 How will the broadness of the central band, *x*, change if the monochromatic red light is replaced with monochromatic blue light? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

[13]

QUESTION 8 (Start on a new page.)

8.1 Write down the main function of a capacitor in a circuit. (1)

A high-resistance light bulb and an uncharged parallel plate capacitor are connected in series with a 12 V battery and a switch **S**, as shown below. The internal resistance of the battery and the resistance of the connecting wires should be ignored.



Switch **S** is now closed and the capacitor charges.

8.2 Describe how the brightness of the light bulb changes during the charging process. (1)

The capacitor is NOW fully charged.

8.3 Write down the potential difference across the:

8.3.1 Light bulb (1)

8.3.2 Capacitor (1)

8.4 The distance between the plates of the capacitor is 5,4 mm.

For the fully charged capacitor, calculate the magnitude of the:

8.4.1 Electric field between the plates (3)

8.4.2 Electrostatic force exerted on an electron between the plates (3)

8.5 An electron is positioned 3,8 mm from the positive plate of the capacitor.

Calculate the:

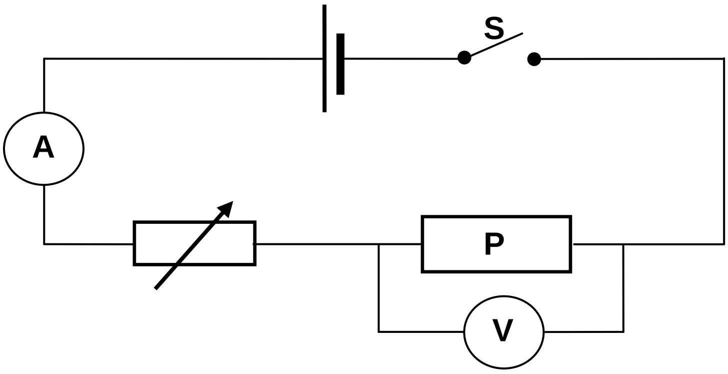
8.5.1 Distance (in mm) between the electron and the negative plate (1)

8.5.2 Work that must be done to move the electron to the negative plate (Ignore the effects of gravitational force.) (4)

[15]

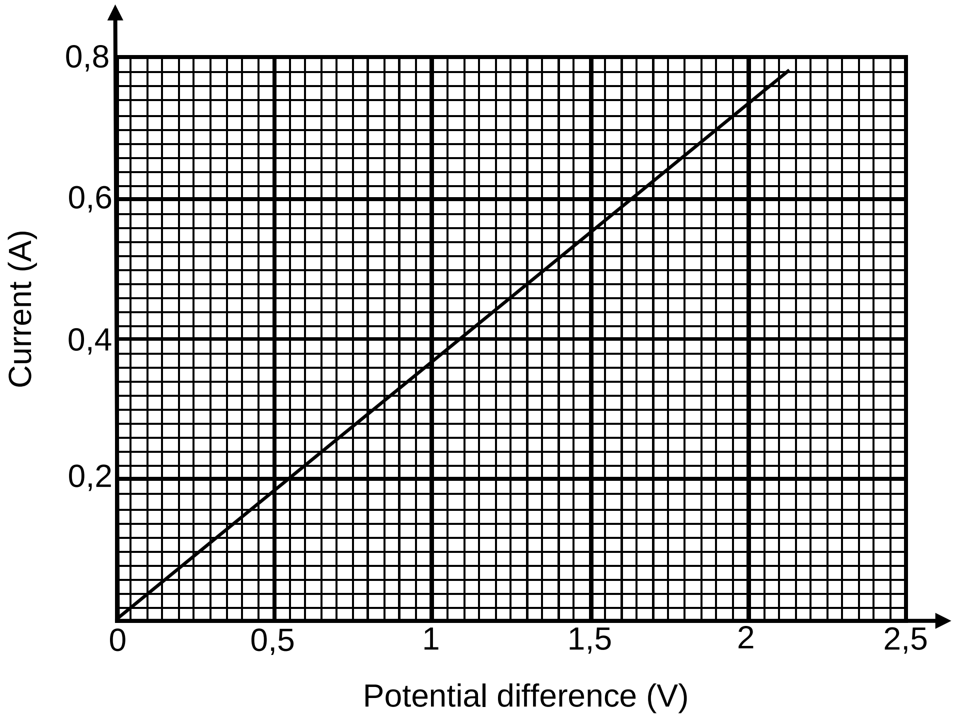
QUESTION 9 (Start on a new page.)

9.1 The circuit represented below is used to investigate the relationship between the current passing through and the potential difference across resistor **P**.



The results obtained are used to draw the graph below.

Graph of current versus potential difference



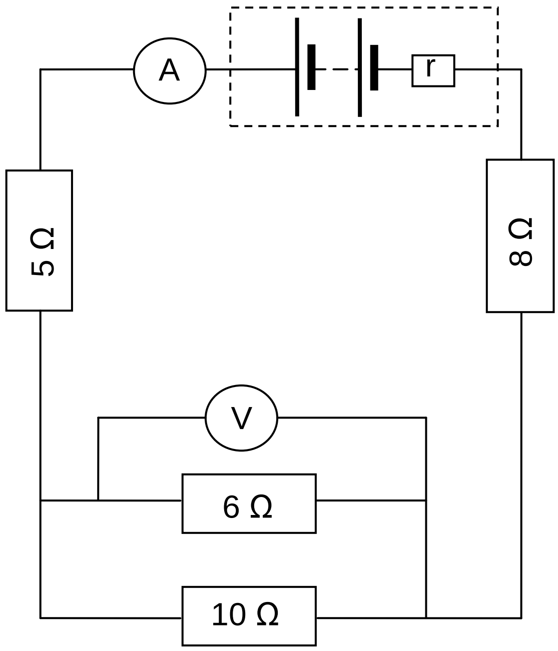
9.1.1 Write down the independent variable. (1)

9.1.2 Write down the variable that must be controlled. (1)

9.1.3 Write down the conclusion that can be obtained from the graph. (2)

9.1.4 Using the gradient of the graph, calculate the resistance of resistor **P**. (4)

9.2 In the circuit represented below, a battery of emf 30 V and unknown internal resistance *r* are connected to resistors, as shown. Ignore the resistance of the ammeter and the connecting wires.



The current passing through the 10 Ω resistor is 0,6 A.

Calculate the:

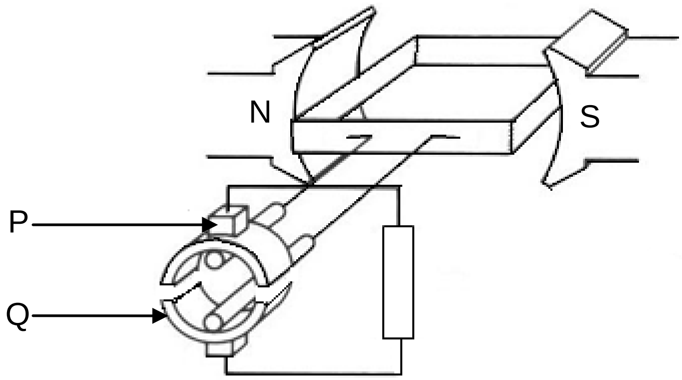
9.2.1 Equivalent resistance of the two resistors in parallel (3)

9.2.2 Current through the 8 Ω resistor (4)

9.2.3 Internal resistance of the battery (4)
[19]

QUESTION 10 (Start on a new page.)

AC generators and DC generators differ in their construction and the type of current they deliver. The simplified sketch below represents a DC generator.



10.1 Which component (**P** or **Q**) enables this generator to produce DC? (1)

10.2 What structural change must be made to this generator to change it to an AC generator? (1)

10.3 Briefly explain why Eskom prefers using AC instead of DC for the long-distance transmission of electricity. (2)

10.4 An AC generator delivers 240 V_{rms} to a 60 W light bulb. The peak current in the light bulb is 0,35 A.

Calculate the:

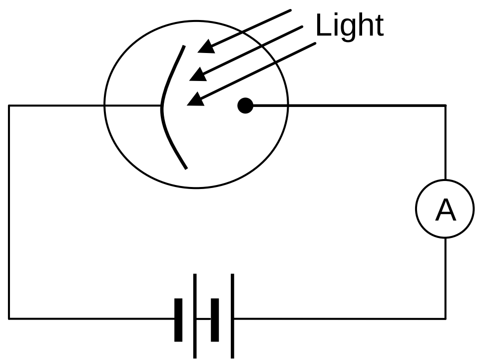
10.4.1 rms current in the light bulb (3)

10.4.2 Resistance of the light bulb (3)

[10]

QUESTION 11 (Start on a new page.)

Light shines onto the cathode of a photocell as shown below. The ammeter registers a reading.



11.1 Define the term *photon*. (2)

11.2 Each photon of light has an energy of 6,9 x 10^{-19} J. The cathode has a work function of 6,4 x 10^{-19} J.

Calculate the:

11.2.1 Wavelength of the light (5)

11.2.2 Kinetic energy of the photoelectrons (3)

11.3 How will the reading on the ammeter change if:

11.3.1 Light of the same frequency, but of higher intensity, is used

Write down INCREASES, DECREASES or REMAINS THE SAME. Fully explain the answer. (3)

11.3.2 Light of the same intensity, but of higher frequency, is used

Write down INCREASES, DECREASES or REMAINS THE SAME. Fully explain the answer. (3)
[16]

TOTAL SECTION B: 125
GRAND TOTAL: 150

SECTION A

QUESTION 1/*VRAAG 1*

1.1	X-rays/*X-strale*✓	(1)
1.2	Momentum ✓	(1)
1.3	Huygens (principle)/*Huygens (se beginsel)*✓	(1)
1.4	ampere/*ampère* ✓	(1)
1.5	Isolated/closed ✓ *Geïsoleerde/geslote*	(1) **[5]**

QUESTION 2/*VRAAG 2*

2.1	B ✓✓	(2)
2.2	A ✓✓	(2)
2.3	A ✓✓	(2)
2.4	D ✓✓	(2)
2.5	A ✓✓	(2)
2.6	D ✓✓	(2)
2.7	B ✓✓	(2)
2.8	A ✓✓	(2)
2.9	B ✓✓	(2)
2.10	C ✓✓	(2) **[20]**

TOTAL SECTION A/*TOTAAL AFDELING A*: 25

SECTION B/*AFDELING B*

QUESTION 3/*VRAAG 3*

3.1 50 N ✓downwards/*afwaarts*✓ (2)

3.2

3.2.1

OPTION 1/*OPSIE 1*	**Notes/*Aantekeninge***
Downward positive: ***Afwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\therefore v_f^2 = 0^2 + \underline{2(9,8)(0,8)}$ ✓ $\therefore v_f = 3,96\ m\cdot s^{-1}$ ✓ downward /*afwaarts*✓ **Downward negative:** ***Afwaarts negatief:*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\therefore v_f^2 = 0^2 + \underline{2(-9,8)(-0,8)}$ ✓ $\therefore v_f = -3,96\ m\cdot s^{-1}$ $\therefore v_f = 3,96\ m\cdot s^{-1}$ ✓ downward /*afwaarts*✓	Accept/*Aanvaar:* g or/*of* a Accept/*Aanvaar*: $v_f^2 = v_i^2 + 2a\Delta x$ $v^2 = u^2 + 2as$
OPTION 2/*OPSIE 2*	**Notes/*Aantekeninge***
$(E_p + E_k)_{top/bo} = (E_p + Ek)_{bottom/onder}$ ✓ $mgh + 0 = 0 + ½mv^2$ $(9,8)(0,8)$ ✓$= ½\ v^2$ $v = 3,96\ m\cdot s^{-1}$ ✓ downward/*afwaarts*✓	Accept/*Aanvaar*: $(U + K)_{top/bo} = (U + K)_{bottom/onder}$

(4)

3.2.2

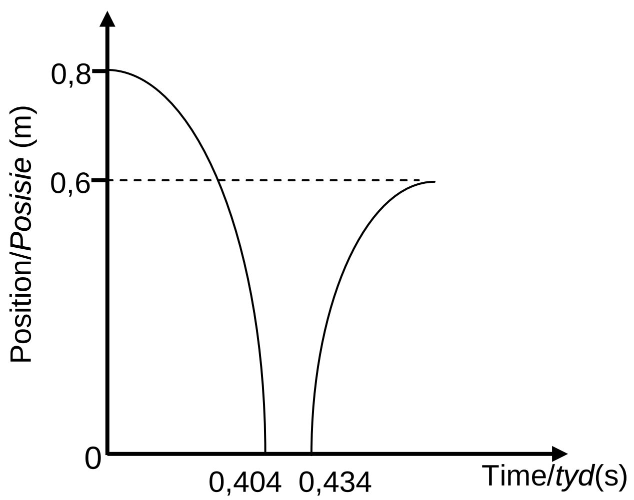
<u>POSITIVE MARKING FROM QUESTION 3.2.1</u> ***<u>POSITIEWE NASIEN VAN VRAAG 3.2.1</u>*** **<u>OPTION 1/*OPSIE 1*</u>** **Downward positive/*Afwaarts positief:*** $F_{net}\Delta t = \Delta p$ OR $F_{net}\Delta t = m(v_f - v_i)$ ✓ $(F_{app} + mg)\Delta t = \Delta p$ $(-50 + (0,2)(9,8)\Delta t$ ✓ $= 0,2(-3,43 - 3,96)$ ✓ $\therefore\ \Delta t = 0,03$ s ✓ (3×10^{-2} s) **Downward negative/*Afwaarts negatief:*** $F_{net}\Delta t = \Delta p$ OR $F_{net}\Delta t = m(v_f - v_i)$ ✓ $(F_{app} + mg)\Delta t = \Delta p$ $(50 - (0,2)(9,8)\Delta t$✓ $= 0,2[3,43 - (-3,96)]$ ✓ $\therefore\ \Delta t = 0,03$ s ✓ (3×10^{-2} s)	**<u>Notes/*Aantekeninge:*</u>** Substitution: F_{app} and v_f must have the same sign. *Substitusie: F_{app} en v_f moet dieselfde tekens hê.*
<u>OPTION 2/*OPSIE 2*</u> **Downward positive/*Afwaarts positief:*** $F_{net} = ma$ $F_{app} + mg = ma$ $(-50 + (0,2)(9,8) = 0,2a$ ✓ $\therefore\ a = -240,2\ m{\cdot}s^{-2}$ $v_f = v_i + a\Delta t$ ✓both formulae / *beide formules* $-3,43 = 3,96 + (-240,2)\Delta t$ ✓ $\therefore\ \Delta t = 0,03$ s ✓ (3×10^{-2} s) **Downward negative/*Afwaarts negatief:*** $F_{net} = ma$ $F_{app} + mg = ma$ $(50 - (0,2)(9,8) = 0,2a$ ✓ $\therefore\ a = 240,2\ m{\cdot}s^{-2}$ $v_f = v_i + a\Delta t$ ✓both formulae / *beide formules* $3,43 = -3,96 + (240,2)\Delta t$ ✓ $\therefore\ \Delta t = 0,03$ s ✓ (3×10^{-2} s)	**<u>Notes/*Aantekeninge*</u>** Accept/*Aanvaar*: $v = u + at$ $v_f = v_i + a\Delta t$

(4)

3.3 **POSITIVE MARKING FROM QUESTION 3.2.**
POSITIEWE NASIEN VAN VRAAG 3.2.

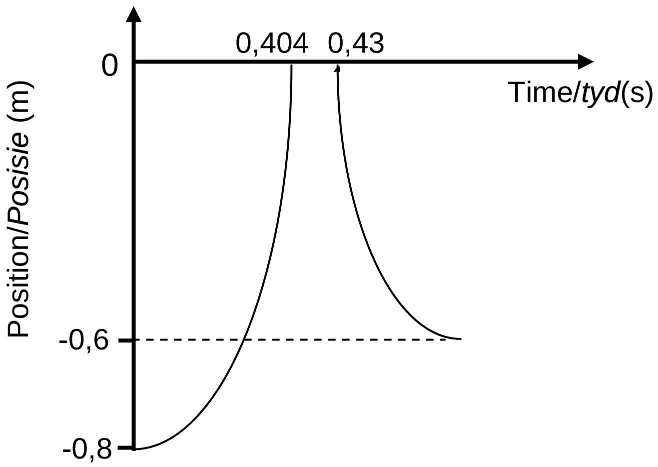
OPTION/*OPSIE 1*
Ground as zero reference and downward negative:
Grond as nulverwysing en afwaarts negatief:

Criteria for graph/*Kriteria vir grafiek:*	Marks/ *Punte*
Correct shape (both curves) *Korrekte vorm (beide krommes)*	✓
Graph starts at y = 0,8 m at t = 0 s *Grafiek begin by y* = 0,8 m at t = 0 s	✓
Second maximum height at y = 0,6 m *Tweede maksimum by y = 0,6 m s*	✓
Contact time shown as space on x axis between two curves. *Kontaktyd aangetoon as spasie op x-as tussen twee krommes.*	✓
Time at which ball leaves the floor shown as t = 0,434 s. *Tyd wanneer die bal die vloer verlaat getoon as t = 0,434 s.*	✓



<u>OPTION/*OPSIE* 2</u>
Ground as zero reference and downward positive:
Grond as nulverwysing en afwaarts positief:

Criteria for graph/*Kriteria vir grafiek:*	Marks/ *Punte*
Correct shape (both curves) *Korrekte vorm (beide krommes)*	✓
Graph starts at y = -0,8 m at t = 0 s *Grafiek begin by y* = -0,8 m at t = 0 s	✓
Second maximum height at y = -0,6 m *Tweede maksimum by y = -0,6 m s*	✓
Contact time shown as space on x axis between two curves. *Kontaktyd aangetoon as spasie op x-as tussen twee krommes.*	✓
Time at which ball leaves the floor shown as t = 0,434 s. *Tyd wanneer die bal die vloer verlaat getoon as t = 0,434 s.*	✓



(5)
[15]

QUESTION 4/*VRAAG 4*

4.1 The total (linear) momentum remains constant/is conserved ✓ in an isolated/a closed system/the absence of external forces. ✓

Die totale lineêre momentum bly konstant/behoue ✓ in 'n geïsoleerde sisteem/geslote sisteem/die afwesigheid van eksterne kragte. ✓

> **Notes/*Aantekeninge:***
> The mark for 'closed/isolated system' is only awarded if used in conjunction with momentum.
> *Die punt vir 'geslote/geïsoleerde sisteem' word slegs toegeken indien saam met momentum gebruik.*
>
> **Accept:** The total momentum before a collision equals the total momentum after a collision in a closed system.
> ***Aanvaar:*** *Die totale momentum voor 'n botsing is gelyk aan die totale momentum na 'n botsing in 'n geslote sisteem.*

(2)

4.2 **To the right as positive/*Na regs as positief:***

$\Sigma p_{before/voor} = \Sigma p_{after/na}$ ✓
$(0,01)(300)$ ✓ $+ (1,99)(0) = (0,01 + 1,99)v_{f2}$ ✓
$\therefore v_{f2} = 1,5\ m\cdot s^{-1}$ ✓

To the right as negative/*Na regs as negatief:*

$\Sigma p_{before/voor} = \Sigma p_{after/na}$ ✓
$(0,01)(-300)$ ✓ $+ (1,99)(0) = (0,01 + 1,99)v_{f2}$ ✓
$\therefore v_{f2} = -1,5\ m\cdot s^{-1}$
$\therefore v_{f2} = 1,5\ m\cdot s^{-1}$ ✓

Other formulae/*Ander formules*:	**Notes/*Aantekeninge:***
$m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$ or/*of* $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ or/*of* $m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v_{f2}$	If no formula/principle – Max. $\frac{3}{4}$ *Indien geen formule/beginsel – Maks.* $\frac{3}{4}$

(4)

4.3 Inelastic/*Onelasties* ✓
Kinetic energy is not conserved./*Kinetiese energie bly nie behoue nie*.✓

OR/*OF*
Inelastic/*Onelasties*✓
Objects stick together/*Voorwerpe heg aan mekaar*. ✓

OR/*OF*
Inelastic/*Onelasties*✓
Structural damage to the block./*Strukturele skade aan blok*. ✓

OR/*OF*
Inelastic/*Onelasties*✓
There is deformation to the block/bullet./*Daar is vervorming van die blok.*✓

OR/*OF*
Inelastic/*Onelasties* ✓
Energy converted to other forms such as sound and heat./*Energie word omgeskakel na ander vorms soos klank en hitte.*✓

(2)

4.4 **POSITIVE MARKING FROM QUESTION 4.2.**
POSITIEF NASIEN VAN VRAAG 4.2.

Option 1/*Opsie 1*:	Notes/*Aantekeninge:*
$W_{net} = \Delta K$ ✓ **OR /*OF*** $F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(8)\Delta x\cos180°$ ✓ $= \frac{1}{2}(2)(0^2 - 1{,}5^2)$ ✓ $\therefore \Delta x = 0{,}28$ m ✓	Accept/*Aanvaar*: E_k
Option 2/*Opsie 2*: $F_{net} = ma$ $\therefore (-8) = 2a$ ✓ $\therefore a = -4\ m\cdot s^{-2}$ $v_f^2 = v_i^2 + 2a\Delta x$ $0^2 = (1{,}5)^2 + 2(-4)\Delta x$ ✓ $\therefore \Delta x = 0{,}28$ m ✓ ✓Both formulae / *Beide formules*	Accept/*Aanvaar*: $v_f^2 = v_i^2 + 2a\Delta y$ $v^2 = u^2 + 2as$

(4)
[12]

QUESTION 5/*VRAAG 5*

5.1 The total mechanical energy remains constant/is conserved✓ in an isolated/closed system. ✓
Die totale meganiese energie bly konstant/bly behoue in 'n geïsoleerde/geslote sisteem

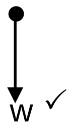
OR/*OF*
The sum of the potential and kinetic energy remains constant ✓ in an isolated/closed system. ✓
Die som van die potensiële en kinetiese energies bly konstant in 'n geïsoleerde/geslote sisteem

Notes/*Aantekeninge:*
The mark for 'closed/isolated system' is only awarded if used in conjunction with energy. *Die punt vir 'geslote/geïsoleerde sisteem' word slegs toegeken indien saam met energie gebruik.*

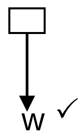
(2)

5.2

5.2.1 **Free-body diagram**
Vrye kragtediagram



Accept/*Aanvaar*: Force diagram/*kragtediagram*

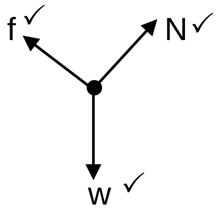


Accepted labels/*Aanvaarde benoemings*	
w	F_g/F_w/force of Earth on boy/weight/392 N/mg/gravitational force *F_g/F_w/krag van Aarde op seun/gewig/392 N/mg/gravitasiekrag*

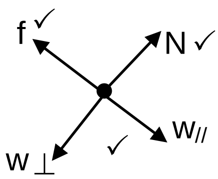
(1)

5.2.2

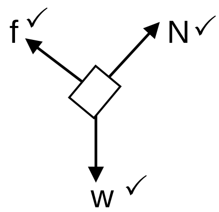
Free-body diagram
Vrye kragtediagram



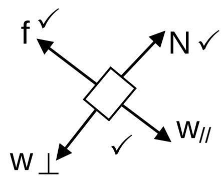
OR/*OF*



Accept: <u>Force diagram</u>
Aanvaar: Kragtediagram



OR/*OF*



Accepted labels/*Aanvaarde benoemings*	
w	F_g/F_w/force of Earth on girl/weight/215,6 N/mg/gravitational force *F_g/F_w/krag van Aarde op meisie/gewig/215,6 N/mg/gravitasiekrag*
f	$F_{friction}$/F_f/friction *$F_{wrywing}$/F_f/F_w/wrywing*
N	F_N/F_{normal}/normal force/force of slide or surface on girl

(3)

5.3

$K_i + U_i = K_f + U_f$ ✓ OR $\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$

$0 + (40)(9,8)(1,5)$ ✓ $= \frac{1}{2}(40)v_f^2 + 0$ ✓

$\therefore v_f = 5,42 \text{ m·s}^{-1}$ ✓

<u>Notes/*Aantekeninge*</u>:
Accept/*Aanvaar* E_p & E_k

(4)

5.4

Option 1/*Opsie 1* $W_{net} = \Delta K$ ✓ $w\Delta x\cos\theta + f\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $mg\Delta x\cos\theta + f\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(22)(9,8)(3)\cos60°$ ✓ + $(1,9)(3)\cos180°$ ✓= $\frac{1}{2}(22)(v_f^2 - 0^2)$ ✓ $\therefore v_f = 5,37\ m\cdot s^{-1}$ ✓	**Accept/ *Aanvaar:*** $\Delta y/\Delta x$
Option 2/*Opsie 2* $W_{net} = \Delta K$ ✓ $w_{//}\Delta x\cos\theta + f\Delta x\cos\theta = ½\ mv_f^2 – ½\ mv_i^2$ $mg\sin\theta\, x\cos\theta + f\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(22)(9,8)\sin30°(3)\cos0°$ ✓ + $(1,9)(3)\cos180°$ ✓= $\frac{1}{2}(22)(v_f^2 - 0^2)$ ✓ $\therefore v_f = 5,37\ m\cdot s^{-1}$ ✓	**Accept/ *Aanvaar*:** $\Delta y/\Delta x$
Option 3/*Opsie 3* $W_{net} = \Delta K$ ✓ $mgh\cos\theta + f\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(22)(9,8)(1,5)\cos0°$ ✓ + $(1,9)(3)\cos180°$ ✓= $\frac{1}{2}(22)(v_f^2 - 0^2)$ ✓ $\therefore v_f = 5,37\ m\cdot s^{-1}$ ✓	**Accept/ *Aanvaar*** $h/\Delta y/\Delta x$
Option 4/*Opsie 4* $W_{net} = \Delta K$ ✓ $- \Delta U + W_f = \Delta K$ $- (mgh_f – mgh_i) + W_f = \Delta K$ $- (0 – (22)(9,8)(1,5)$ ✓ + $(1,9)(3)\cos180°$✓ = $\frac{1}{2}(22)(v_f^2 - 0^2)$ ✓ $\therefore v_f = 5,37\ m\cdot s^{-1}$ ✓	**Accept/ *Aanvaar*** $h/\Delta y/\Delta x$

(5)

5.5 Equal to/*Gelyk aan*✓ (1)

[16]

QUESTION 6/*VRAAG 6*

6.1 The approaching observer (higher f) passes the source at t = 6 s and moves away (lower f) from the source. ✓
Die naderende waarnemer (hoër f) beweeg verby die bron by t = 6 s en beweeg weg (laer f) van die bron af. (1)

6.2

6.2.1

OPTION 1/*OPSIE 1* Approaching observer: *Naderende waarnemer:* $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v + v_L}{v} f_s$ ✓ $\therefore 900$ ✓ = $\frac{340 + v_L}{340}$ ✓(850) ✓ $\therefore v_L = 20\ m{\cdot}s^{-1}$ ✓	**Notes:** • Any other Doppler formula, e.g. $f_L = \frac{v - v_L}{v - v_s}$ - Max. $\frac{3}{4}$ ***Aantekeninge:*** • *Enige ander Dopplerformule, bv.* $f_L = \frac{v - v_L}{v - v_s}$ - *Maks.* $\frac{3}{4}$
OPTION 2 / *OPSIE 2* Observer moving away: *Waarnemer beweeg weg:* $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v - v_L}{v} f_s$ ✓ $\therefore 800$ ✓ = $\frac{340 - v_L}{340}$ ✓(850) ✓ $\therefore v_L = 20\ m{\cdot}s^{-1}$ ✓	

(5)

6.2.2 **POSITIVE MARKING FROM QUESTION 6.2.1**
POSITIEWE NASIEN van VRAAG 6.2.1

Option 1/*Opsie 1*: $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ = (20)(6) ✓+ ½(0) Δ t ∴ Δ x = 120 m ✓	**Notes/Aantekeninge** Accept/*Aanvaar*: s = ut / s = vt $s = ut + \frac{1}{2} at^2$ $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
Option 2/*Opsie 2*: $\Delta x = v \Delta t$ ✓ = (20)(6) ✓ ∴ Δ x = 120 m ✓	

(3)
[9]

QUESTION 7/*VRAAG 7*

7.1 B ✓ (1)

7.2 Constructive ✓ interference ✓
Konstruktiewe interferensie (2)

7.3

7.3.1

$c = f\lambda$ ✓ $3 \times 10^8 = 4{,}54 \times 10^{14}\lambda$ ✓ $\therefore \lambda = 6{,}61 \times 10^{-7}$ m ✓	**Notes/*Aantekeninge*** Accept/*Aanvaar* $v = f\lambda$

(3)

7.3.2 **POSITIVE MARKING FROM QUESTION 7.3.1**
POSITIEWE NASIEN VAN VRAAG 7.3.1

OPTION 1/*OPSIE 1* $\tan\theta = \dfrac{\frac{1}{2}\text{central band}}{\text{screen distance}}$ $\therefore \tan\theta = \dfrac{\frac{1}{2}(0{,}2)}{1{,}5}$ ✓ ✓ $\therefore \theta = 3{,}81°$ $\sin\theta = \dfrac{m\lambda}{a}$ ✓ $\sin 3{,}81°$ ✓ $= \dfrac{(1)(6{,}61\times10^{-7})}{a}$ ✓ $\therefore a = 9{,}95 \times 10^{-6}$ m ✓	**Notes/*Aantekeninge*** Accept final answer in range: $9{,}94 \times 10^{-6}$ to $9{,}95 \times 10^{-6}$ m *Aanvaar finale antwoorde in die gebied:* $9{,}94 \times 10^{-6}$ to $9{,}95 \times 10^{-6}$ m IF distance is not half of central band: Max $\frac{4}{6}$ *INDIEN afstand nie helfte van sentrale band is nie: Maks* $\frac{4}{6}$
OPTION 2/*OPSIE 2* $\tan\theta = \dfrac{\frac{1}{2}\text{central band}}{\text{screen distance}}$ $\therefore \tan\theta = \dfrac{\frac{1}{2}(0{,}2)}{1{,}5}$ ✓ ✓ $\therefore \theta = 3{,}81°$ $\sin\theta = \dfrac{m\lambda}{a}$ ✓ $\sin(-3{,}81°)$ ✓ $= \dfrac{(-1)(6{,}61\times10^{-7})}{a}$ ✓ $\therefore a = 9{,}95 \times 10^{-6}$ m ✓	**Notes/*Aantekeninge*** Accept final answer in range: $9{,}94 \times 10^{-6}$ to $9{,}95 \times 10^{-6}$ m *Aanvaar finale antwoorde in die gebied:* $9{,}94 \times 10^{-6}$ to $9{,}95 \times 10^{-6}$ m IF distance is not half of central band: Max $\frac{4}{6}$ *INDIEN afstand nie helfte van sentrale band is nie: Maks* $\frac{4}{6}$

(6)

7.4 Decreases/*Verminder* ✓ (1)
[13]

QUESTION 8/*VRAAG 8*

8.1 Stores (electric) charge/energy. ✓
Stoor (elektriese) lading/energie.

OR/*OF*
Releases (stored) charge instantly/very fast. ✓
Stel (gestoorde) lading onmiddellik vry/baie vinnig vry. (1)

8.2 The brightness of the bulb decreases (gradually) ✓
until it stops glowing/dies.
Die helderheid van die gloeilamp verminder (geleidelik).

OR/*OF*
The bulb glows dimmer ✓
until it stops glowing/dies.
Die gloeilamp gloei flouer totdat dit ophou gloei/uitbrand. (1)

8.3
8.3.1 0 (V) ✓ (1)

8.3.2 12 V ✓ (1)

8.4 **POSITIVE MARKING FROM QUESTION 8.3.2.**
POSITIEWE NASIEN VAN VRAAG 8.3.2.

8.4.1 $E = \frac{V}{d}$ ✓

$= \frac{12}{5,4 \times 10^{-3}}$ ✓

$= 2,22 \times 10^{3}\ V{\cdot}m^{-1}$ ✓ $(2\ 222,22\ V{\cdot}m^{-1})$ (3)

8.4.2 **POSITIVE MARKING FROM QUESTION 8.4.1.**
POSITIEWE NASIEN VAN VRAAG 8.4.1.

$E = \frac{F}{q}$ ✓

$\therefore 2,22 \times 10^{3} = \frac{F}{1,6 \times 10^{-19}}$ ✓

$\therefore F = 3,56 \times 10^{-16}\ N$ ✓ (3)

8.5
8.5.1 5,4 mm – 3,8 mm = 1,6 mm ✓ (1)

8.5.2 **POSITIVE MARKING FROM QUESTION 8.4.2 & 8.5.1.**
POSITIEWE NASIEN VAN VRAAG 8.4.2 & 8.5.1.

$W = F\Delta x\cos\theta$ ✓
$= (3,56 \times 10^{-16})(1,6 \times 10^{-3})$ ✓ $\cos 0°$ ✓
$= 5,69 \times 10^{-19}$ J ✓

(4)
[15]

QUESTION 9/*VRAAG 9*

9.1

9.1.1 Potential difference/*Potensiaalverskil* ✓ (1)

9.1.2 Temperature/*Temperatuur* ✓
Resistance/*Weerstand* (1)

9.1.3 Current is directly proportional to potential difference. ✓✓
Stroom is direk eweredig aan potensiaalverskil

OR/*OF*
The ratio of potential difference to current is constant. ✓✓
Die verhouding van potensiaalverskil tot stroom is konstant.

IF/*INDIEN*: Current is proportional to potential difference. ✓ *Stroom is eweredig aan potensiaalverskil.*

(2)

9.1.4 Gradient/m = $\frac{0{,}18 - 0 ✓}{0{,}5 - 0 ✓} = 0{,}36$

$R = \frac{1}{0{,}36} = 2{,}78\ \Omega$ ✓✓

<u>Notes/*Aantekeninge:*</u> Accept any set of correct values from the graph. *Aanvaar enige stel waardes vanaf die grafiek.*

(4)

9.2

9.2.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$= \frac{1}{6} + \frac{1}{10}$ ✓

$\therefore R_p = 3{,}75\ \Omega$ ✓ (3)

9.2.2 **POSITIVE MARKING FROM QUESTION 9.2.1.**
POSITIEWE NASIEN VAN VRAAG 9.2.1.

OPTION 2 / *OPSIE 2*	**Notes/*Aantekeninge***
$V_p = I_{10\,\Omega}R$ ✓ Any one / *Enige een* $= 0{,}6 \times 10$ ✓ $= 6$ V $I_p = \frac{V_p}{R_p}$ ✓ Any one / *Enige een* $= \frac{6}{3{,}75}$ ✓ $= 1{,}6$ A ✓	Do not penalise for subscripts. *Moenie penaliseer indien onderskrifte weggelaat is nie.*

OPTION 1/*OPSIE 2*	**Notes/*Aantekeninge***
$V_{10\,\Omega} = I_{10\,\Omega}R$ ✓ Any one / *Enige een* $= 0{,}6 \times 10$ ✓ $= 6$ V $I_{6\Omega} = \frac{V}{R}$ ✓ Any one / *Enige een* $= \frac{6}{6}$ ✓ $= 1$ A $I_{tot} = 1 + 0{,}6 = 1{,}6$ A ✓	Do not penalise for subscripts. *Moenie penaliseer indien onderskrifte weggelaat is nie.*

(4)

9.2.3 **POSITIVE MARKING FROM QUESTION 9.2.1.**
POSITIEWE NASIEN VAN VRAAG 9.2.1.

$E = I(R + r)$ ✓
30 ✓ $= 1{,}6(3{,}75 + 5 + 8 + r)$ ✓
$\therefore\ r = 2\ \Omega$ ✓ (4)

[19]

QUESTION 10/*VRAAG 10*

10.1 Q/split ring commutator/commutator ✓
Q/splitringkommutator/kommutator (1)

10.2 Replace Q/split ring commutator with slip rings. ✓
Vervang Q/splitringkommutator met sleepringe. (1)

10.3 AC can be stepped-up at power stations/*WS kan by die kragstasie verhoog word* ✓
to reduce energy loss during transmission./*om energieverlies tydens transmissie te verminder.* ✓ (2)

10.4

10.4.1

$$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}} ✓$$

$$= \frac{0,35}{\sqrt{2}} ✓$$

$$\therefore I_{rms/wgk} = 0,25 \text{ A} ✓$$

Notes/*Aantekeninge*
If subscripts omitted: no mark for formula
Indien onderskifte weggelaat is: geen punt vir formule

(3)

10.4.2

OPTION	Notes/*Aantekeninge*
OPTION 1/*OPSIE 1* $P_{ave/gemid} = \frac{V^2_{rms/wgk}}{R}$ ✓ $60 = \frac{240^2}{R}$ ✓ $\therefore R = 960\ \Omega$ ✓	Do not penalise if subscripts are omitted. *Moenie penaliseer indien onderskrifte weggelaat is nie*
OPTION 2/*OPSIE 2* $P_{ave/gemid} = I^2_{rms/wgk}R$ ✓ $60 = (0,25)^2R$ ✓ $\therefore R = 960\ \Omega$ ✓	
OPTION 3/*OPSIE 3* $R = \frac{V_{rms/wgk}}{I_{rms/wgk}}$ ✓ $= \frac{240}{0,25}$ ✓ $= 960\ \Omega$ ✓	**Notes/*Aantekeninge*** **Accept/*Aanvaar:*** $R = \frac{V}{I}$ as formula/*formule*

(3)
[10]

QUESTION 11/*VRAAG 11*

11.1 Quantum/packet of energy/*Kwantum/pakkie energie* ✓
found in light/*In lig gevind* ✓ (2)

11.2

11.2.1

OPTION 1/*OPSIE 1*

$E = \frac{hc}{\lambda}$ ✓

$6,9 \times 10^{-19}$ ✓ $= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{\lambda}$ ✓ ✓

$\therefore \lambda = 2,9 \times 10^{-7}$ m ✓

OPTION 2 / *OPSIE 2*

E = hf

$6,9 \times 10^{-19}$ ✓ $= 6,63 \times 10^{-34}$f ✓

$\therefore$ f = $1,04 \times 10^{15}$ Hz

c = fλ

$3 \times 10^{8} = 1,04 \times 10^{15}\lambda$ ✓

$\therefore \lambda = 2,88 \times 10^{-7}$ m ✓

✓ Both formulae/*Beide formules*

Notes/*Aantekeninge*
Accept/*Aanvaar:* v = fλ

(5)

11.2.2 $E = W_o + E_k$ ✓
$6,9 \times 10^{-19} = 6,4 \times 10^{-19} + E_k$ ✓
$\therefore E_k = 5 \times 10^{-20}$ J ✓ (3)

11.3

11.3.1 Increases/*Vermeerder* ✓

- More photons (packets of energy) strike the surface of the metal per unit time./*Meer fotone (pakkies energie) tref die oppervlakte van die metaal per eenheid tyd.* ✓
- More (photo)electrons ejected per unit time./*Meer (foto)elektrone vrygestel per eenheid tyd*. ✓ (3)

11.3.2 Increases/*Vermeerder* ✓

- (Photo)electrons are emitted with higher kinetic energy/move faster./*(Foto)elektrone word vrygestel met hoër kinetiese energie/beweeg vinniger.* ✓
- Increase in rate of flow of charge./Same number of charges pass a point in a shorter time./*Toename in tempo van vloei van lading/dieselfde aantal lading beweeg verby 'n punt in 'n korter tyd.* ✓ (3)

[16]

TOTAL SECTION B/*TOTAAL AFDELING B:* 125
GRAND TOTAL/*GROOTTOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2013

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The rate of change of velocity (1)

1.2 The distance between two consecutive points in phase on a wave (1)

1.3 A region of space in which an electric charge experiences an electrostatic force (1)

1.4 The type of electromagnetic wave with the shortest wavelength (1)

1.5 The minimum frequency of light needed to remove an electron from the surface of a metal (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (2.1–2.10) in the ANSWER BOOK.

2.1 Which ONE of the following physical quantities is equal to the product of force and constant velocity?

A Work

B Power

C Energy

D Acceleration (2)

2.2 A 30 kg iron sphere and a 10 kg aluminium sphere with the same diameter fall freely from the roof of a tall building. Ignore the effects of friction.

When the spheres are 5 m above the ground, they have the same ...

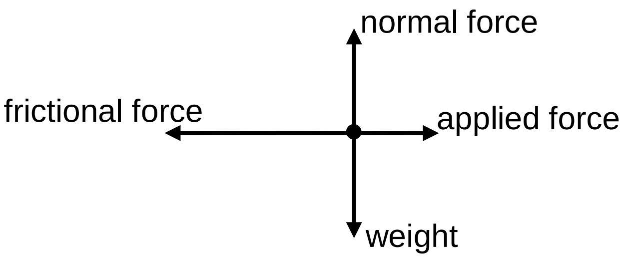
A momentum.

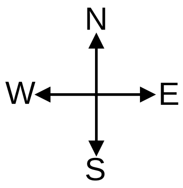
B acceleration.

C kinetic energy.

D potential energy. (2)

2.3 The free-body diagram below shows the relative magnitudes and directions of all the forces acting on an object moving horizontally in an easterly direction.





The kinetic energy of the object ...

A is zero.

B increases.

C decreases.

D remains constant. (2)

2.4 The hooter of a vehicle travelling at constant speed towards a stationary observer, produces sound waves of frequency 400 Hz. Ignore the effects of wind.

Which ONE of the following frequencies, in hertz, is most likely to be heard by the observer?

A 400

B 350

C 380

D 480 (2)

2.5 When two waves meet at a point, the amplitude of the resultant wave is the algebraic sum of the amplitudes of the individual waves.

This principle is known as …

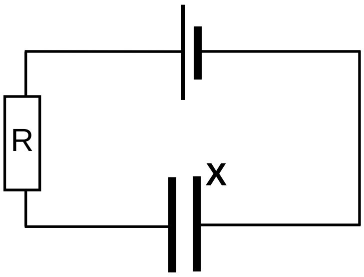
A dispersion.

B the Doppler effect.

C superposition.

D Huygens' principle. (2)

2.6 A parallel plate capacitor, **X**, with a vacuum between its plates is connected in a circuit as shown below. When fully charged, the charge stored on its plates is equal to Q.



Capacitor **X** is now replaced with a similar capacitor, **Y**, with the same dimensions but with paper between its plates. When fully charged, the charge stored on the plates of capacitor **Y** is …

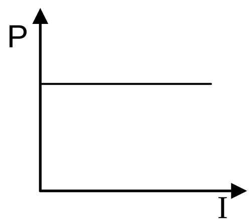
A zero.

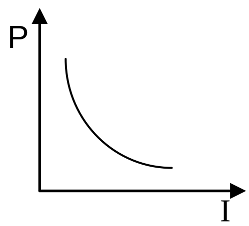
B equal to Q.

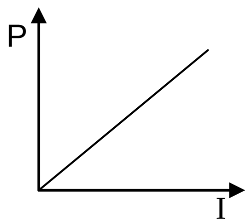
C larger than Q.

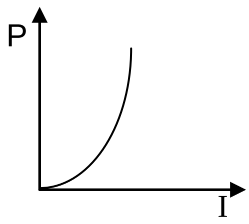
D smaller than Q. (2)

2.7 Which ONE of the following graphs best represents the relationship between the electrical power and the current in a given ohmic conductor?

A


B


C


D


(2)

2.8 In a vacuum, all electromagnetic waves have the same …

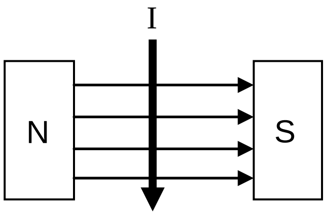
A energy.

B speed.

C frequency.

D wavelength. (2)

2.9 In the sketch below, a conductor carrying conventional current, I, is placed in a magnetic field.



Which ONE of the following best describes the direction of the magnetic force experienced by the conductor?

A Parallel to the direction of the magnetic field

B Opposite to the direction of the magnetic field

C Into the page perpendicular to the direction of the magnetic field

D Out of the page perpendicular to the direction of the magnetic field (2)

2.10 An atom in its ground state absorbs energy *E* and is excited to a higher energy state. When the atom returns to the ground state, a photon with energy ...

A *E* is absorbed.

B *E* is released.

C less than *E* is released.

D less than *E* is absorbed. (2)
[20]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.

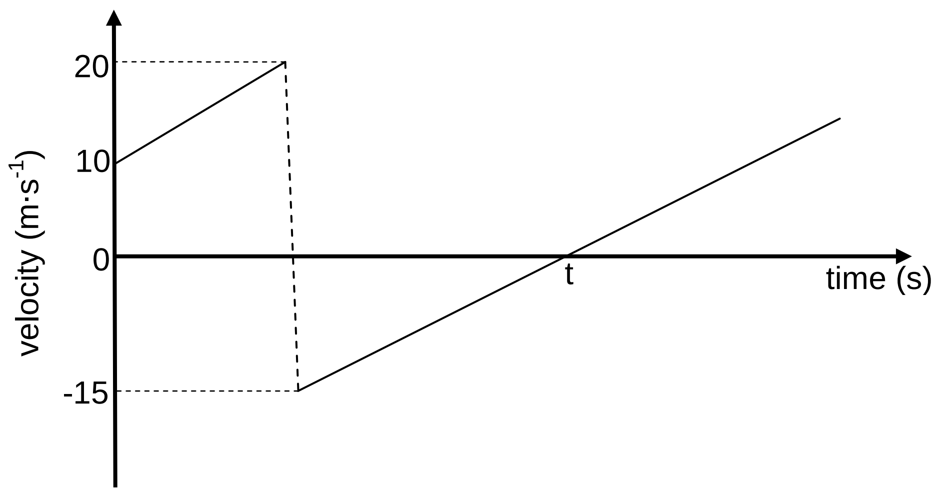
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

3. Show the formulae and substitutions in ALL calculations.

4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A ball of mass 0,15 kg is thrown vertically downwards from the top of a building to a concrete floor below. The ball bounces off the floor. The velocity versus time graph below shows the motion of the ball. Ignore the effects of air friction. TAKE DOWNWARD MOTION AS POSITIVE.



3.1 From the graph, write down the magnitude of the velocity at which the ball bounces off the floor. (1)

3.2 Is the collision of the ball with the floor ELASTIC or INELASTIC? Refer to the data on the graph to explain the answer. (3)

3.3 Calculate the:

3.3.1 Height from which the ball is thrown (4)

3.3.2 Magnitude of the impulse imparted by the floor on the ball (3)

3.3.3 Magnitude of the displacement of the ball from the moment it is thrown until time *t* (4)

3.4 Sketch a position versus time graph for the motion of the ball from the moment it is thrown until it reaches its maximum height after the bounce. USE THE FLOOR AS THE ZERO POSITION.

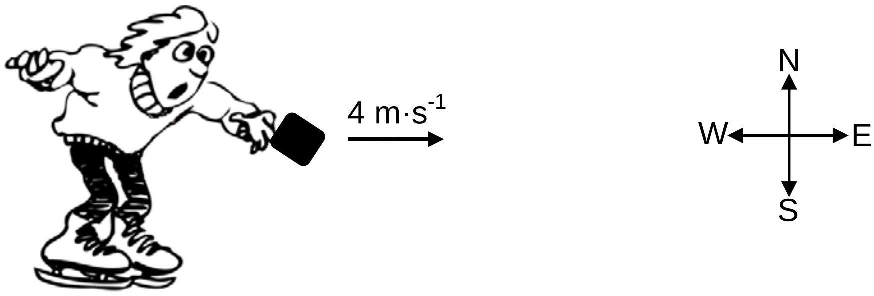
Indicate the following on the graph:

- The height from which the ball is thrown
- Time *t* (4)

[19]

QUESTION 4 (Start on a new page.)

A boy on ice skates is stationary on a frozen lake (no friction). He throws a package of mass 5 kg at 4 m·s^{-1} horizontally east as shown below. The mass of the boy is 60 kg.



At the instant the package leaves the boy's hand, the boy starts moving.

4.1 In which direction does the boy move? Write down only EAST or WEST. (1)

4.2 Which ONE of Newton's laws of motion explains the direction in which the boy experiences a force when he throws the package? Name and state this law in words. (3)

4.3 Calculate the magnitude of the velocity of the boy immediately after the package leaves his hand. Ignore the effects of friction. (5)

4.4 How will the answer to QUESTION 4.3 be affected if:

(Write down INCREASES, DECREASES or REMAINS THE SAME.)

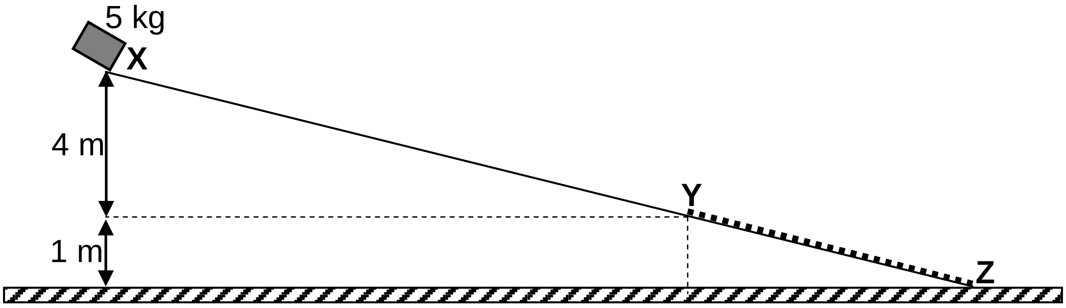
4.4.1 The boy throws the same package at a higher velocity in the same direction (1)

4.4.2 The boy throws a package of double the mass at the same velocity as in QUESTION 4.3. Explain the answer. (3)

[13]

QUESTION 5 (Start on a new page.)

A 5 kg rigid crate moves from rest down path **XYZ** as shown below (diagram not drawn to scale). Section **XY** of the path is frictionless. Assume that the crate moves in a straight line down the path.



5.1 State, in words, the *principle of the conservation of mechanical energy*. (2)

5.2 Use the principle of the conservation of mechanical energy to calculate the speed of the crate when it reaches point **Y**. (4)

On reaching point **Y**, the crate continues to move down section **YZ** of the path. It experiences an average frictional force of 10 N and reaches point **Z** at a speed of 4 $m \cdot s^{-1}$.

5.3 APART FROM FRICTION, write down the names of TWO other forces that act on the crate while it moves down section **YZ**. (2)

5.4 In which direction does the net force act on the crate as it moves down section **YZ**? Write down only from '**Y** to **Z**' or from '**Z** to **Y**'. (1)

5.5 Use the WORK-ENERGY THEOREM to calculate the length of section **YZ**. (5)

Another crate of mass 10 kg now moves from point **X** down path **XYZ**.

5.6 How will the velocity of this 10 kg crate at point **Y** compare to that of the 5 kg crate at **Y**? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

[15]

QUESTION 6 (Start on a new page.)

An ambulance approaches a stationary observer at a constant speed of 10,6 $m \cdot s^{-1}$, while its siren produces sound at a constant frequency of 954,3 Hz. The stationary observer measures the frequency of the sound as 985 Hz.

6.1 Name the medical instrument that makes use of the Doppler effect. (1)

6.2 Calculate the velocity of sound. (5)

6.3 How would the wavelength of the sound wave produced by the siren of the ambulance change if the frequency of the wave were higher than 954,3 Hz? Write down only INCREASES, DECREASES or STAYS THE SAME. (1)

6.4 Give a reason for the answer to QUESTION 6.3. (2)

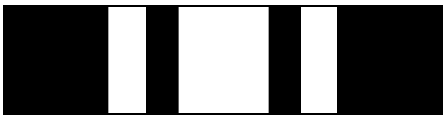
[9]

QUESTION 7 (Start on a new page.)

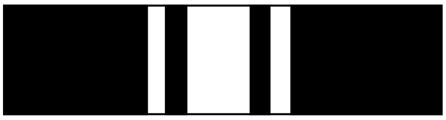
Learners investigate how the broadness of the central bright band in a diffraction pattern changes as the wavelength of light changes. During the investigation, they perform two experiments. The slit width and the distance between the slit and the screen are kept constant.

In the first experiment, they pass light from a monochromatic source through a single slit and obtain pattern **P** on a screen. In the second experiment, they pass light from a different monochromatic source through the single slit and obtain pattern **Q** on the screen.

Pattern P



Pattern Q



7.1 Define the term *diffraction*. (2)

7.2 Which ONE of the two patterns (**P** or **Q**) was obtained using the monochromatic light of a longer wavelength? (1)

7.3 For this investigation, write down the:

7.3.1 Dependent variable (1)

7.3.2 Investigative question (2)

In ONE of their experiments, they use light of wavelength 410 nm and a slit width of 5×10^{-6} m.

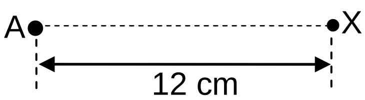
7.4 Calculate the angle at which the SECOND MINIMUM will be observed on the screen. (5)

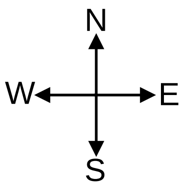
7.5 The single slit is now replaced with a double slit. Describe the pattern that will be observed on the screen. (2)

[13]

QUESTION 8 (Start on a new page.)

In the diagram below, point charge **A** has a charge of +16 μC. **X** is a point 12 cm from point charge **A**.



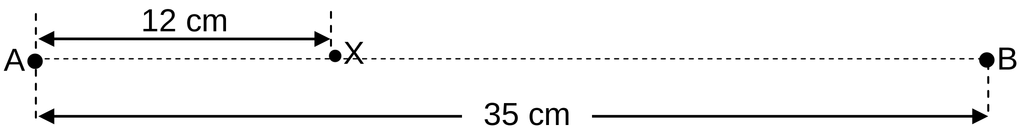


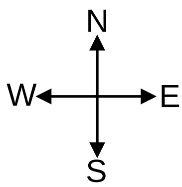
8.1 Draw the electric field pattern produced by point charge **A**. (2)

8.2 Is the electric field in QUESTION 8.1 UNIFORM or NON-UNIFORM? (1)

8.3 Calculate the magnitude and direction of the electric field at point **X** due to point charge **A**. (5)

Another point charge **B** is now placed at a distance of 35 cm from point charge **A** as shown below. The NET electric field at point **X** due to point charges **A** and **B** is 1×10^{7} $N \cdot C^{-1}$ west.





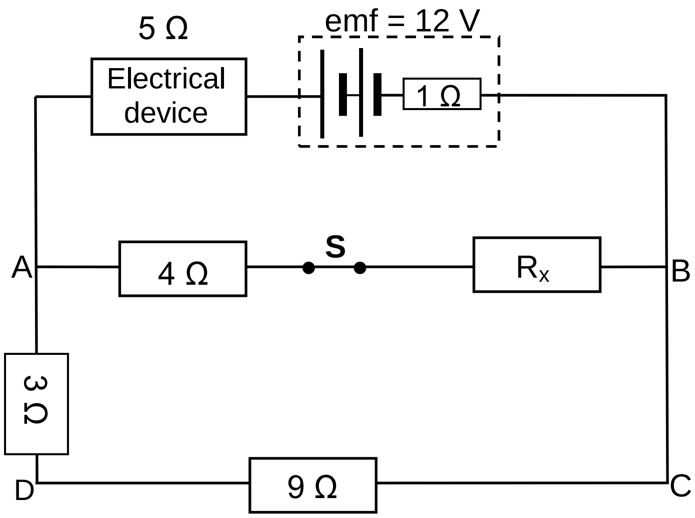
8.4 Is point charge **B** POSITIVE or NEGATIVE? (1)

8.5 Calculate the magnitude of point charge **B**. (5)
[14]

QUESTION 9 (Start on a new page.)

A learner wants to use a 12 V battery with an internal resistance of 1 Ω to operate an electrical device. He uses the circuit below to obtain the desired potential difference for the device to function. The resistance of the device is 5 Ω.

When switch **S** is **closed** as shown, the device functions at its maximum power of 5 W.



9.1 Explain, in words, the meaning of *an emf of 12 V*. (2)

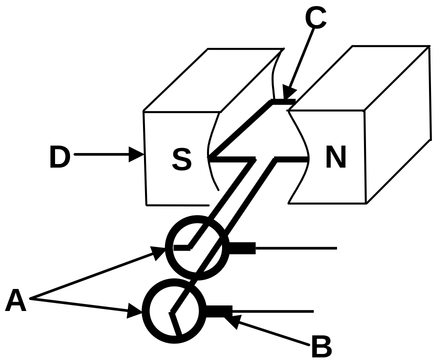
9.2 Calculate the current that passes through the electrical device. (3)

9.3 Calculate the resistance of resistor $\mathbf{R_x}$. (7)

9.4 Switch **S** is now **opened**. Will the device still function at maximum power? Write down YES or NO. Explain the answer without doing any calculations. (4)
[16]

QUESTION 10 (Start on a new page.)

The simplified sketch represents an AC generator. The main components are labelled **A**, **B**, **C** and **D**.



10.1 Write down the name of component:

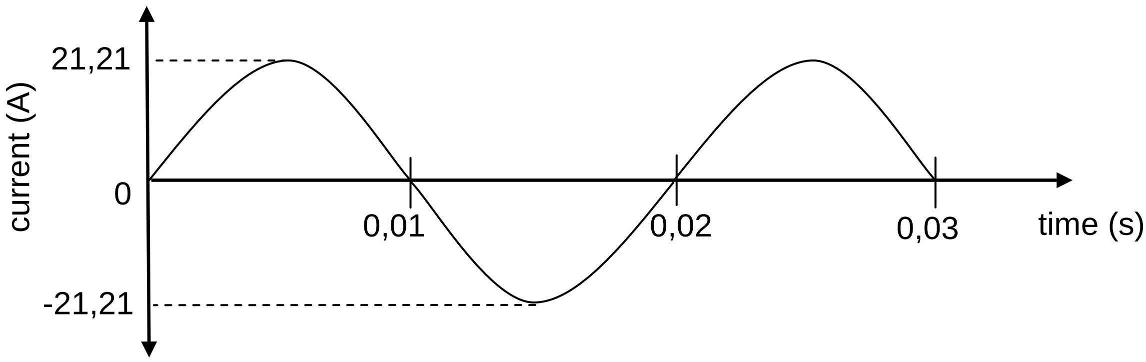
10.1.1 **A** (1)

10.1.2 **B** (1)

10.2 Write down the function of component **B**. (1)

10.3 State the energy conversion which takes place in an AC generator. (1)

A similar coil is rotated in a magnetic field. The graph below shows how the alternating current produced by the AC generator varies with time.



10.4 How many rotations are made by the coil in 0,03 seconds? (1)

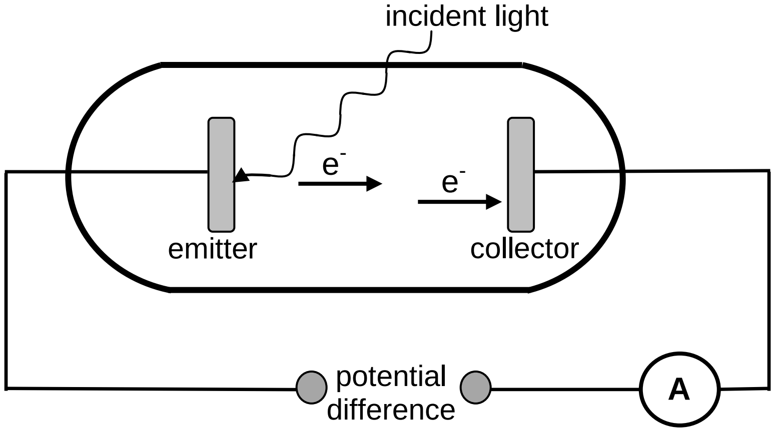
10.5 Calculate the frequency of the alternating current. (3)

10.6 Will the plane of the coil be PERPENDICULAR TO or PARALLEL TO the magnetic field at t = 0,015 s? (1)

10.7 If the generator produces a maximum potential difference of 311 V, calculate its average power output. (5)
[14]

QUESTION 11 (Start on a new page.)

11.1 In the simplified diagram below, light is incident on the emitter of a photocell. The emitted photoelectrons move towards the collector and the ammeter registers a reading.



11.1.1 Name the phenomenon illustrated above. (1)

11.1.2 The work function of the metal used as emitter is $8,0 \times 10^{-19}$ J. The incident light has a wavelength of 200 nm.

Calculate the maximum speed at which an electron can be emitted. (5)

11.1.3 Incident light of a higher frequency is now used.

How will this change affect the maximum kinetic energy of the electron emitted in QUESTION 11.1.2? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

11.1.4 The intensity of the incident light is now increased.

How will this change affect the speed of the electron calculated in QUESTION 11.1.2? Write down INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

11.2 A metal worker places two iron rods, **A** and **B**, in a furnace. After a while he observes that **A** glows deep red while **B** glows orange.

Which ONE of the rods (**A** or **B**) radiates more energy? Give a reason for the answer. (2)

11.3 Neon signs illuminate many buildings. What type of spectrum is produced by neon signs? (1)
[12]

TOTAL SECTION B: 125
GRAND TOTAL: 150

SECTION A

QUESTION 1/*VRAAG 1*

1.1	Acceleration / *Versnelling* ✓	(1)
1.2	Wavelength / *Golflengte* ✓	(1)
1.3	Electric field / *Elektriese veld* ✓	(1)
1.4	Gamma / γ (rays) / *Gamma* / γ (*strale*) ✓	(1)
1.5	Threshold (frequency) / *Drumpel(frekwensie)* ✓	(1)
		[5]

QUESTION 2/*VRAAG 2*

2.1	B ✓✓	(2)
2.2	B ✓✓	(2)
2.3	C ✓✓	(2)
2.4	D ✓✓	(2)
2.5	C ✓✓	(2)
2.6	C ✓✓	(2)
2.7	D ✓✓	(2)
2.8	B ✓✓	(2)
2.9	D ✓✓	(2)
2.10	B ✓✓	(2)
		[20]

TOTAL SECTION A/*TOTAAL AFDELING A*: 25

SECTION B/*AFDELING B*

QUESTION 3/*VRAAG 3*

3.1 15 m·s^{-1} ✓ (1)

3.2

OPTION 1/*OPSIE 1*

Inelastic ✓

The speed/velocity at which the ball leaves the floor is less / different than that at which it strikes the floor. OR The speed/velocity of the ball changes during the collision. ✓

Therefore the kinetic energy changes/is not conserved. ✓

Onelasties

Die spoed/snelheid waarteen die bal die vloer verlaat is kleiner / verskillend as dit waarteen dit die vloer tref. OF Die spoed / snelheid van die bal verander gedurende die botsing.

Die kinetiese energie verander/bly nie behoue nie.

OPTION 2/*OPSIE 2*

Collision is inelastic. ✓

Botsing is onelasties

$\Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$= \frac{1}{2}(0,15)(\underline{15})^2 - \frac{1}{2}(0,15)(\underline{20})^2$ ✓

$= -13,13$ J

$K_i \neq K_f$ / $\Delta K \neq 0$ ✓

OPTION 3/*OPSIE 3*

Collision is inelastic.

Botsing is onelasties. ✓

$K_f = \frac{1}{2}mv_f^2$

$= \frac{1}{2}(0,15)(\underline{15})^2$

$= 16,88$ J

$K_i = \frac{1}{2}mv_i^2$

$= \frac{1}{2}(0,15)(\underline{20})^2$

$= 30$ J

✓ (for K_f and K_i calculations)

$K_f \neq K_1$ / $\Delta K \neq 0$ ✓ (3)

3.3

OPTION 1/*OPSIE 1*

$v_f^2 = vi^2 + 2a\Delta y$ ✓

$(20)^2$ ✓ $= \underline{(10)^2 + 2(9,8)\Delta y}$ ✓

$\therefore \Delta y = 15,31$ m ✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta K$ ✓

$F_{net}\Delta y\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$

$m(9,8)\Delta y\cos 0°$ ✓ $= \frac{1}{2}m(20^2 - 10^2)$ ✓

$\Delta y = 15,31$ m ✓

OPTION 3/*OPSIE 3*

$(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$
$(mgh + \frac{1}{2}mv^2)_{top} = (mgh + \frac{1}{2}mv^2)_{bottom}$
} ✓any one/*enige een*

$m(9,8)h + \frac{1}{2}m(10)^2$ ✓ $= m(9,8)(0) + \frac{1}{2}m(20)^2$ ✓

$h = 15,31$ m ✓

OPTION 4/*OPSIE 4*

$v_f = v_i + a\Delta t$

$20 = 10 + (9,8)(\Delta t)$

$\therefore \Delta t = 1,02$ s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

✓ (for both formulae)

$= (10)(1,02)$ ✓ $+ \frac{1}{2}(9,8)(1,02)^2$ ✓

$\therefore \Delta y = 15,3$ m ✓

OPTION 5/*OPSIE 5*

$v_f = v_i + a\Delta t$ ✓
$20 = 10 + (9,8)(\Delta t)$
$\therefore\ \Delta t = 1,02$ s

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

$\Delta y = \left(\frac{10+20}{2}\right)$ ✓(1,02) ✓

$\therefore\ \Delta y = 15,3$ m ✓

OPTION 6/*OPSIE 6*

$v_f = v_i + a\Delta t$ ✓
$20 = 10 + (9,8)(\Delta t)$
$\therefore\ \Delta t = 1,02$ s

Height = area between graph & *t* axis
Hoogte = opperv. tussen grafiek & t-as
= ½(sum ‖ sides)$h_\perp$
= ½(10 + 20) ✓1,02 ✓
= 15,3 m✓
= 15,3 m ✓

OPTION 7/*OPSIE 7*

$v_f = v_i + a\Delta t$ ✓
$20 = 10 + (9,8)(\Delta t)$
$\therefore\ \Delta t = 1,02$ s

Height = area between graph & *t* axis
Hoogte = opperv. tussen grafiek & t-as
= lb + ½bh = ½(10 + 20)1,02
= (1,02)(10) ✓ + ½(1,02)(10) ✓
= 15,3 m ✓

OPTION 8/*OPSIE 8*

$F_{net} = ma$

$mg = m\left(\frac{v_f^2 - v_i^2}{2\Delta x}\right)$ ✓

$(0,15)(9,8)$ ✓ $=(0,15)\left(\frac{20^2 - 10^2}{2\Delta x}\right)$ ✓

$\Delta x = 15,31$ m✓ (4)

3.3.2

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = mv_f - mv_i$ ✓Any one/*Enige een*
$\Delta p = mv_f - mv_i$
$= 0,15(-15 - 20)$ ✓
$= -5,25$ N·s (or $-5,25$ kg·m·s^{-1})
Magnitude/*Grootte* = 5,25 N·s or 5,25 kg·m·s^{-1}✓ (3)

3.3.3

OPTION 1 / *OPSIE 1*

Displacement from floor to max. height/ *Verplasing van vloer na maks. hoogte*:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$\underline{(0)^2 = (-15)^2 + 2(9,8)\Delta y}$ ✓
$\therefore\ \Delta y = -11,48$ m

Total displacement / *Totale verplasing*
= - 11,48 + 15,3 ✓
= 3,82 m ✓ / 3,83 m

OPTION 2 / *OPSIE 2*

$v_f = v_i + a\Delta t$
$0 = -15 + (9,8)\Delta t$
$\Delta t = 1,53$ s ✓

$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$= \underline{(-15)(1,53) + ½ (9,8)(1,53)^2}$ ✓
$= -11,48$ m

Total displacement / *Totale verplasing*
= - 11,48 + 15,3 ✓
= 3,82 m ✓

OPTION 3 / *OPSIE 3*

$v_f = v_i + a\Delta t$
$0 = -15 + (9,8)\Delta t$
$\Delta t = 1,53$ s ✓

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$
$= \underline{\left(\frac{0 + (-15)}{2}\right)(1,53)}$ ✓
$= -11,48$ m

Total displacement / *Totale verplasing*
= - 11,48 + 15,3 ✓
= 3,82 m ✓

OPTION 4 / *OPSIE 4*

$v_f = v_i + a\Delta t$
$0 = -15 + (9,8)\Delta t$
$\Delta t = 1,53$ s ✓

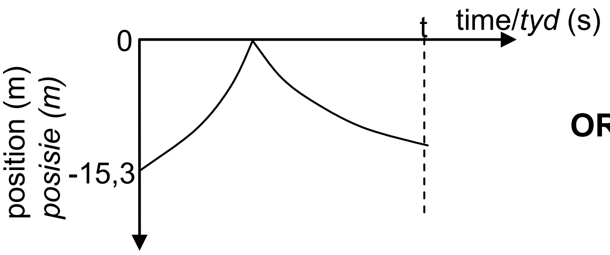
Area = ½ bh
$= \underline{½ (1,53)(-15)}$ ✓
$= -11,48$ m

Total displacement / *Totale verplasing*
= - 11,48 + 15,3 ✓
= 3,82 m ✓

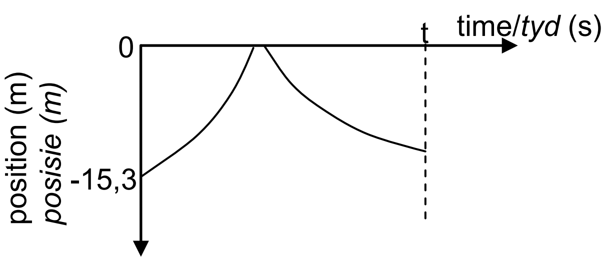
OPTION 5 / *OPSIE 5* $E_{M(initial)} = E_{M(final)}$ $(E_p + E_k)_{initial} = (E_p + E_k)_{final}$ $(mgh + ½ mv^2)_{initial} = (mgh + ½ mv^2)_{final}$ } ✓Any one /*Enige een* $(0,15)(9,8)(0) + ½ (0,15)(15)^2 = (0,15)(9,8)h + ½ (0,15)(0)^2$ ✓ h = 11,48 m Total displacement / *Totale verplasing* = 15,31 - 11,48 ✓ = 3,83 m ✓
OPTION 6/*OPSIE 6* $W_{net} = \Delta K$ ✓ $F_{net}\Delta y\cos\theta = ½ m(v_f^2 – v_i^2)$ $m(9,8)\Delta y\cos 180° = ½ m(0^2 – 15^2)$ ✓ Δy = 11,48 m Total displacement / *Totale verplasing* = 15,31 - 11,48 ✓ = 3,83 m ✓
OPTION 7/*OPSIE 7* $F_{net} = ma$ $mg = m\left(\frac{v_f^2 - v_i^2}{2\Delta x}\right)$ ✓ $(0,15)(9,8) = (0,15)\left(\frac{0^2 - (-15)^2}{2\Delta x}\right)$ ✓ Δx = -11,48 m Total displacement / *Totale verplasing* = 15,31 - 11,48 ✓ = 3,83 m ✓

(4)

3.4



OR/*OF*



Marking criteria for graph:/*Nasienriglyne vir grafiek:*	
Correct shape as shown for first part./*Korrekte vorm soos aangetoon vir eerste deel.*	✓
Correct shape as shown for the second part up to t / 2,55 s. *Korrekte vorm soos aangetoon vir tweede deel t / 2,55 s.*	✓
Graph starts at -15,3 m at t = 0 s./*Grafiek begin by -15,3 m by t = 0 s.*	✓
Maximum height after bounce at time *t* / 2,55 s./*Maksimum hoogte na bons by tyd t./ 2,55 s.* Maximum height after bounce less than 15,3 m./*Maksimum hoogte na bons kleiner as 15,3 m.*	✓

(4)
[19]

QUESTION 4/*VRAAG 4*

4.1 West / *Wes* ✓ (1)

4.2 (Newton's) Third Law (of Motion) ✓
<u>When object A exerts a force on object B,</u>
<u>object B exerts a force equal in magnitude on object A</u>✓, <u>but opposite in direction.</u> ✓

(Newton) se Derde (Bewegings)wet
<u>Wanneer voorwerp A 'n krag op voorwerp B uitoefen,</u>
<u>oefen voorwerp B 'n krag van gelyke grootte op voorwerp A</u>, <u>maar in die teenoorgestelde rigting.</u> (3)

4.3

<u>OPTION 1/ *OPSIE 1*</u> **<u>East as positive/Oos *as positief:*</u>** $\Sigma p_i = \Sigma p_f$ ✓ 0 ✓ $= (60)v_f + (5)(4)$ ✓ $\therefore v_f = -0{,}33$✓ $\therefore v_f = 0{,}33\ m\cdot s^{-1}$✓	**<u>OPTION 2/*OPSIE 2*</u>** **<u>East as positive/*Oos as positief:*</u>** $\Delta p_A = -\Delta p_B$ ✓ $(60)v_f$ ✓ $- 0 = -[(5)(4) - 0]$ ✓ $\therefore v_f = -0{,}33$ ✓ $\therefore v_f = 0{,}33\ m\cdot s^{-1}$✓
<u>West as positive/*Wes as positief:*</u> $\Sigma p_i = \Sigma p_f$ ✓ 0 ✓ $= (60)v_f + (5)(-4)$ ✓ $\therefore v_f = 0{,}33\ m\cdot s^{-1}$✓✓	**<u>West as positive/*Wes as positief:*</u>** $\Delta p_A = -\Delta p_B$ ✓ $(60)v_f$ ✓ $- 0 = -[(5)(-4) - 0]$ ✓ $\therefore v_f = 0{,}33\ m\cdot s^{-1}$✓✓
<u>OPTION 3/ *OPSIE 3*</u> **<u>East as positive/Oos *as positief*</u>** $F_{BP} = -F_{PB}$✓ $m_Ba_B = -m_Pa_P$ $m_B\left(\frac{v_{Bf}-v_{Bi}}{\Delta t}\right) = -m_P\left(\frac{v_{Pf}-v_{Pi}}{\Delta t}\right)$ $(60)\left(\frac{v_{Bf}-0}{\Delta t}\right)$ ✓ $= -(5)\left(\frac{4-0}{\Delta t}\right)$ ✓ $v_{Bi} = -0{,}33\ m\cdot s^{-1}$✓ $= 0{,}33\ m\cdot s^{-1}$✓	**<u>OPTION 4/ *OPSIE 4*</u>** **<u>West as positive/*Wes as positief*</u>** $F_{BP} = -F_{PB}$✓ $m_Ba_B = -m_Pa_P$ $m_B\left(\frac{v_{Bf}-v_{Bi}}{\Delta t}\right) = -m_P\left(\frac{v_{Pf}-v_{Pi}}{\Delta t}\right)$ $(60)\left(\frac{v_{Bf}-0}{\Delta t}\right)$ ✓ $= -(5)\left(\frac{-4-0}{\Delta t}\right)$ ✓ $v_{Bi} = 0{,}33\ m\cdot s^{-1}$✓✓

(5)

4.4
4.4.1 Increases / *Verhoog* ✓ (1)

4.4.2 Increases / *Verhoog* ✓

- Δp package increases, thus Δp boy increases. ✓
  Δp pakkie vermeerder, dus Δp seun vermeerder.
- For the same mass of boy, v will be greater. ✓
  Vir dieselfde massa van die seun sal v groter wees.

OR/*OF*

Increases / *Verhoog* ✓

From the equation in QUESTION 4.3: $-m_A v_{Af} = m_B v_{Bf}$

Vanaf die vegelyking in VRAAG 4.3: $-m_A v_{Af} = m_B v_{Bf}$

- If mass of package/B doubles/increases, the momentum of the boy / A doubles / increases. ✓
  Indien die massa van pakkie / B verdubbel / toeneem, verdubbel / vermeerder die momentum van die seun / A
- For same mass of boy / A, the velocity of boy / A doubles/increases. ✓
  Vir dieselfde massa van die seun / A, verdubbel/vermeerder die snelheid van die seun /A.

OR/*OF*

Increases / *Verhoog* ✓

$-m_B v_{Bf} = m_p v_{pf}$

$v_B = \frac{-m_p v_{pf}}{m_B}$ ✓ for same m_B, if m_P doubles, ✓ then v_B doubles (3)

[13]

QUESTION 5/*VRAAG 5*

5.1 The total mechanical energy remains constant / is conserved ✓ in a closed / isolated system / in absence of external forces /non-conservative forces. ✓

Die totale meganiese energie in bly konstant / bly behoue in 'n geslote / geïsoleerde sisteem /in afwesigheid van eksterne kragte /nie-konserwatiewe kragte.

OR/*OF*

The sum of the potential and kinetic energy of a system remains constant ✓ in a closed/isolated system. ✓

Die som van die potensiële en kinetiese energie van *'n sisteem bly konstant in 'n geslote / geïsoleerde sisteem.*

OR/*OF*

When the work done on an object by the non-conservative forces is zero ✓, the total mechanical energy is conserved. ✓

Wanneer die arbeid deur die nie-konserwatiewe kragte op 'n voorwerp verrig nul is, bly die totale meganiese energie behoue. (2)

5.2

OPTION 1/*OPSIE 1*

$E_{mechanical\ at\ X} = E_{mechanical\ at\ Y}$
$(E_p + E_k)_X = (E_p + E_k)_Y$
$(mgh + ½ mv^2)_X = (mgh + ½ mv^2)_Y$
✓Any one/*Enige een*

$5(9,8)(5) + ½(5)(0^2)$✓$= (5)(9,8)(1) + ½(5)v_f^2$ ✓
$v = 8,85\ m·s^{-1}$ ✓

OPTION 2/*OPSIE 2*

$E_{mechanical\ at\ X} = E_{mechanical\ at\ Y}$
$(E_p + E_k)_X = (E_p + E_k)_Y$
$(mgh + ½ mv^2)_X = (mgh + ½ mv^2)_Y$
✓ Any one/*Enige een*

$5(9,8)(4) + ½(5)(0^2)$✓$= (5)(9,8)(0) + ½(5)v_f^2$ ✓
$v = 8,85\ m·s^{-1}$ ✓

(4)

5.3 Weight / gravitational (force) / (force of) gravity ✓
Gewig / Gravitasie(krag)
Normal force / *Normaalkrag* ✓ (2)

5.4 Z to/*na* Y ✓ (1)

5.5

OPTION 1/*OPSIE 1*

$W_{net} = \Delta K$ ✓
$W_w + W_f = ½m(v_f^2 – v_i^2)$
$mg\Delta y\cos 0° + f\Delta x\cos 180° = ½ m(v_f^2 – v_i^2)$
$(5)(9,8)(1)(1)$ ✓ $+ (10)\Delta x(-1)$ ✓ $= ½(5)(4^2 – 8,85^2)$ ✓
$\Delta x = 20,48$ m ✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta K$ ✓
$W_w + W_f = ½m(v_f^2 – v_i^2)$
$-\Delta E_p + W_f = ½m(v_f^2 – v_i^2)$
$-(0 – mgh) + f\Delta x\cos 180° = ½ m(v_f^2 – v_i^2)$
$(5)(9,8)(1)$ ✓ $+ (10)\Delta x(-1)$ ✓ $= ½(5)(4^2 – 8,85^2)$ ✓
$\Delta x = 20,48$ m ✓

OPTION 3/*OPSIE 3*

$W_{net} = \Delta K$ ✓
$W_w + W_f = ½m(v_f^2 – v_i^2)$
$-\Delta E_p + W_f = ½m(v_f^2 – v_i^2)$
$-(0 – mgh) + f\Delta x\cos 180° = ½ m(v_f^2 – v_i^2)$
$(5)(9,8)(5)$ ✓ $+ (10)\Delta x(-1)$ ✓ $= ½(5)(4^2 – 0^2)$ ✓
$\Delta x = 20,48$ m ✓

OPTION 4/*OPSIE 4*

$W_{net} = \Delta K$ ✓
$W_w + W_f = ½m(v_f^2 – v_i^2)$
$mg\Delta x\cos(90° – \theta) + f\Delta x\cos 180° = ½ m(v_f^2 – v_i^2)$
$mg\Delta x\sin\theta + f\Delta x\cos 180° = ½ m(v_f^2 – v_i^2)$
$mg\Delta x\left(\frac{1}{\Delta x}\right) + f\Delta x\cos 180° = ½ m(v_f^2 – v_i^2)$
$(5)(9,8)$ ✓ $+ (10)\Delta x(-1)$ ✓ $= ½(5)(4^2 – 8,85^2)$ ✓
$\Delta x = 20,48$ m ✓

<u>OPTION 5/*OPSIE 5*</u> $W_{net} = \Delta K$ ✓ $W_{w\|\|} + W_f = ½m(v_f^2 – v_i^2)$ $mg\sin\theta\Delta x\cos\theta + f\Delta x\cos\theta = ½\ m(v_f^2 – v_i^2)$ $mg\left(\frac{1}{\Delta x}\right)\Delta x\cos0° + f\Delta x\cos180° = ½\ m(v_f^2 – v_i^2)$ $(5)(9,8)$ ✓ + $(10)\Delta x(-1)$ ✓ = $½(5)(4^2 – 8,85^2)$ ✓ $\Delta x = 20,48$ m ✓
<u>OPTION 6/*OPSIE 6*</u> $W_{net} = \Delta K$ ✓ $F_{net}\Delta x\cos\theta = ½m(v_f^2 – v_i^2)$ $(10 - 49\sin\theta)\Delta x\cos180° = ½\ m(v_f^2 – v_i^2)$ $(10 - 49\left(\frac{1}{\Delta x}\right))$✓$\Delta x\cos180° = ½\ m(v_f^2 – v_i^2)$ $(10\Delta x – 49)(-1)$✓ = $½(5)(4^2 – 8,85^2)$ ✓ $\Delta x = 20,48$ m
<u>OPTION 7/*OPSIE 7*</u> $W_{nc} = \Delta E_p + \Delta E_k$✓ $f\Delta x\cos\theta = (mgh_f – mgh_i) + (½\ mv_f^2 – ½\ mv_i^2)$ $(10)\Delta x\cos180°$ ✓= $[0 – (5)(9,8)(1)]$ ✓ + $[½\ (5)(4)^4 – ½\ (5)(8,85)^2$✓ $\Delta x = 20,48$ m✓

(5)

5.6 Equal to / *Gelyk aan* ✓ (1)

[15]

QUESTION 6/*VRAAG 6*

6.1 Doppler flow meter / *Dopplervloeimeter* ✓ (1)

6.2

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \ ✓$$

$$985\ ✓ = \frac{v}{(v - 10,6)}\ ✓(954,3)\ ✓$$

$v = 340,1\ m\cdot s^{-1}$ ✓ (5)

6.3 Decreases / *Afneem* ✓ (1)

6.4 <u>For a constant velocity of sound / speed</u> ✓
<u>if the frequency increases,</u> λ decreases. ✓
<u>Vir 'n konstante snelheid van klank /spoed,</u>
<u>as die frekwensie toeneem</u> neem λ af.

OR/*OF*

$\lambda \propto \frac{1}{f}$ or $f \propto \frac{1}{\lambda}$ ✓ at constant velocity/speed / *by konstante snelheid/spoed..* ✓ (2)

[9]

QUESTION 7/*VRAAG 7*

7.1 The bending of waves around obstacles / corners / through an opening / aperture ✓✓
Die buiging van golwe om versperrings / hoeke / deur 'n opening.

OR/*OF*
The spreading of waves around the edge of a barrier/through an opening/aperture.
Die uitspreiding van golwe om die kant van 'n versperring/deur 'n opening. (2)

7.2 P ✓ (1)

7.3

7.3.1 Broadness of the central bright band / diffraction pattern / angle of diffraction / degree of diffraction / sin θ / position of the first minimum ✓
Breedte van die sentrale helderband / diffraksiepatroon/hoek van diffraksie / mate van diffraksie / sin θ / posisie van die eerste minimum (1)

7.3.2

Criteria for investigative question/K*riteria vir ondersoekende vraag*:	
Dependent and independent variables correctly identified. *Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.*	✓
Question about the relationship between the independent and dependent variables correctly formulated. Vraag oor die verwantskap tussen die *afhanklike en onafhanklike veranderlikes korrek geformuleer.*	✓

Example/*Voorbeeld*:
What is the relationship between the broadness of the central band and the wavelength (of light used)?
Wat is die verwantskap tussen die breedte van die sentrale band en die golflengte (van die lig)? (2)

7.4

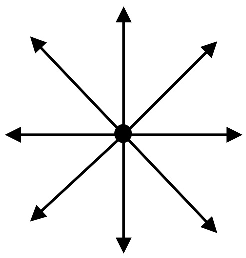
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\sin\theta = \frac{m\lambda}{a}$ ✓ $\sin\theta = \frac{(2)(410\times10^{-9})}{5\times10^{-6}}$ ✓✓✓ $\therefore \theta = 9{,}44°$ ✓ or $9{,}21°$	$\sin\theta = \frac{m\lambda}{a}$ ✓ $\sin\theta = \frac{(-2)(410\times10^{-9})}{5\times10^{-6}}$ ✓✓✓ $\therefore \theta = -9{,}44°$ ✓ or $-9{,}21°$

(5)

7.5 Light (bright) and dark bands.✓
Light /dark bands of equal width. ✓
Lig (helder) en donker bande eweredig gespasieer.
Helder / donker bande van gelyke breedte /wydte. (2)
[13]

QUESTION 8/*VRAAG 8*

8.1



Criteria for sketch:/*Kriteria vir skets:*	
Correct shape - field lines radially around charge. *Korrekte vorm – veldlyne radiaal uitwaarts.*	✓
Direction of field lines away from charge. *Rigting van veldlyne weg van lading af.*	✓

(2)

8.2 Non-uniform / *Nie-uniform* ✓ (1)

8.3 $E = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^9)(16\times10^{-6})}{(0{,}12)^2}$ ✓

$= 1 \times 10^7\ N{\cdot}C^{-1}$ ✓ east/*oos* ✓ (5)

8.4 Positive / *Positief* ✓ (1)

8.5

West: positive	**West: negative**
$E_A + E_B = E_{net}$ $-1 \times 10^7 + E_B$ ✓ $= 1 \times 10^7$ ✓ $\therefore E_B = 2 \times 10^7\ N{\cdot}C^{-1}$ $E_B = \frac{kQ_B}{r^2}$ $\therefore 2 \times 10^7$ ✓ $= \frac{(9\times10^9)Q_B}{(0{,}23)^2}$ ✓ $\therefore Q_B = 1{,}18 \times 10^{-4}\ C$ ✓ (5)	$E_A + E_B = E_{net}$ $1 \times 10^7 + E_B$ ✓ $= -1 \times 10^7$ ✓ $\therefore E_B = -2 \times 10^7\ N{\cdot}C^{-1}$ $= 2 \times 10^7\ N{\cdot}C^{-1}$ $E_B = \frac{kQ_B}{r^2}$ $\therefore 2 \times 10^7$ ✓ $= \frac{(9\times10^9)Q_B}{(0{,}23)^2}$ ✓ $\therefore Q_B = 1{,}18 \times 10^{-4}\ C$ ✓ (5)

(5)
[14]

QUESTION 9/*VRAAG 9*

9.1 12 J of energy are transferred to / work done on ✓
each coulomb (of charge) / per C charge ✓ passing through the battery.

12 J energie word oorgedra aan / arbeid word verrig op
elke coulomb (lading) / per C lading wat deur die battery beweeg. (2)

9.2

OPTION 1/*OPSIE 1*

$P = I^2R$ ✓
$5 = I^2(5)$ ✓
$\therefore I = 1$ A ✓

OPTION 2/*OPSIE 2*	**OPTION 3/*OPSIE 3***
$P = \frac{V^2}{R}$ $5 = \frac{V^2}{5}$ V = 5 V P = VI ✓ 5 = (5)I ✓ I = 1 A✓	$P = \frac{V^2}{R}$ $5 = \frac{V^2}{5}$ V = 5 V V = IR ✓ 5 = I(5) ✓ I = 1 A✓

(3)

9.3

OPTION 1 / *OPSIE 1*	**OPTION 2 / *OPSIE 2***	**OPTION 3/OPSIE 3**
Emf = I(R + r) ✓ 12 ✓= (1)(R + 1) R = 11 Ω R_p = 11 – 5✓ = 6 Ω	Emf = I(R + r) ✓ 12 ✓= (1)(R_p + 5 + 1)✓ ∴ R_p = 6 Ω	V = I R_T ✓ 12✓ = (1)R R_T = 12 Ω R_p = R_T – (5 + 1) = 12 – 6 ✓ = 6 Ω

$\frac{1}{R_p} = \frac{1}{R_{12}} + \frac{1}{R}$ ∴ $\frac{1}{6}$✓ $= \frac{1}{12}$✓ $+ \frac{1}{4 + R_X}$✓ ∴ $\frac{1}{12} = \frac{1}{4 + R_X}$ ∴ 12 = 4 + R_x ∴ R_x = 8 Ω✓

OR/*OF*

$R_p = \frac{(4 + R_X)(12)}{4 + R_X + 12}$ ✓✓ ∴ $R_p = \frac{(4 + R_X)(12)}{4 + R_X + 12}$ ∴ 6 ✓ $= \frac{(4 + R_X)(12)}{4 + R_X + 12}$ ∴ R_x = 8 Ω ✓

OPTION 4/*OPSIE 4*

$V_{5Ω}$ = IR ✓
= (1)(5)
= 5 V

$V_{internal}$ = Ir
= (1)(1)
= 1 V

$V_{parallel}$ = 12✓– (1 + 5) ✓
= 6 V

$V_{parallel}$ = IR
6 = I(12) ✓
∴I = 0,5 A

I_{Rx} = 1 – 0,5
= 0,5 A

V = IR
6✓ = (0,5)(4 + R_x) ✓
∴R_x = 8 Ω ✓

(7)

9.4 No / *Nee* ✓

Total resistance (R) increases. / *Totale weerstand (R) neem toe*.✓
Current (I) decreases / *Stroom (I) neem af.* ✓
(For a constant R) power ($P = I^2R$) decreases.✓
(Vir konstante R) drywing ($P = I^2R$) verminder. (4)

[16]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 slip rings / *sleepringe* ✓ (1)

10.1.2 brush(es) / *borsel(s)* ✓ (1)

10.2 Maintains electrical contact with the slip rings.
Handhaaf elektriese kontak met die sleepringe.

OR/*OF*
To take current out/in of the coil.
Om die stroom uit/in die spoel te neem. (1)

10.3 Mechanical /kinetic energy to electrical energy. ✓
Meganiese / kinetiese energie na elektriese energie. (1)

10.4 1½ ✓ (1)

10.5

OPTION 1/ *OPSIE 1*

$f = \frac{1}{T}$ ✓

$= \frac{1}{0,02}$ ✓

= 50 Hz ✓

(3)

OPTION 2/ *OPSIE 2*

$f = \frac{\text{number of cycles}}{\text{time}}$ ✓

$= \frac{1,5}{0,03}$ or/of $\frac{1}{0,02}$ or/of $\frac{0,5}{0,01}$ ✓

= 50 Hz ✓

(3)

(3)

10.6 Parallel to / *Parallel aan* ✓ (1)

10.7

OPTION 1/ *OPSIE 1* $P_{ave} = V_{rms}I_{rms}$ ✓ $= \left(\frac{V_{max}}{\sqrt{2}}\right)\left(\frac{I_{max}}{\sqrt{2}}\right)$ ✓ (1 mark for both formulae / *1 punt vir beide formules*) $= \left(\frac{311}{\sqrt{2}}\right)$ ✓ $\left(\frac{21{,}21}{\sqrt{2}}\right)$ ✓ = 3 298,16 W ✓ (Accept range / *Aanvaar gebied*: 3298,13 – 3299,18 W)	
OPTION 2/ *OPSIE 2* $P_{ave} = \frac{V_{max}I_{max}}{2}$ ✓✓ $= \frac{(311)(21.21)}{2}$ ✓✓ = 3298,16 W ✓	**OPTION 3 / *OPSIE 3*** $V_{rms} = \frac{V_{max}}{\sqrt{2}} = \frac{311}{\sqrt{2}}$ ✓ = 219,91 V ✓ $I_{rms} = \frac{I_{max}}{\sqrt{2}} = \frac{21{,}21}{\sqrt{2}}$ ✓ = 14,998 A $P_{ave} = V_{rms}I_{rms}$ ✓ = (219,91)(14,998) = 3 298,21 W ✓
OPTION 4/ *OPSIE 4* $R = \frac{V_{max}}{I_{max}}$ $= \frac{311}{21{,}21}$ ✓ = 14,66 Ω $V_{rms} = \frac{V_{max}}{\sqrt{2}} = \frac{311}{\sqrt{2}}$ ✓ = 219,91 V $P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{(219{,}91)^2}{14{,}66}$ ✓ = 3 298,8 W ✓	**OPTION 6/*OPSIE 6*** $R = \frac{V_{max}}{I_{max}}$ $= \frac{311}{21{,}21}$ ✓ = 14,66 Ω $I_{rms} = \frac{I_{max}}{\sqrt{2}} = \frac{21{,}21}{\sqrt{2}}$ ✓ = 14,998 A $P_{ave} = I_{rms}^2 R$ ✓ $= (14{,}998)^2(14{,}66)$ ✓ = 3 297,62 W ✓

(5)
[14]

QUESTION 11/*VRAAG 11*

11.1
11.1.1 Photo-electric effect / *Foto-elektriese effek* ✓ (1)

11.1.2

OPTION 1/*OPSIE 1*

$E = W_0 + E_k$

$hf = hf_0 + E_k$ ✓ Any one/*Enige een*

$\frac{hc}{\lambda} = W_0 + \frac{1}{2}mv^2$

$\frac{(6,63 \times 10^{-34})(3 \times 10^8)}{200 \times 10^{-9}}$ ✓ $= 8 \times 10^{-19}$ ✓ $+ \frac{1}{2}(9,11 \times 10^{-31})v^2$ ✓

$v = 6,53 \times 10^5\ m \cdot s^{-1}$ ✓ ($653454,89\ m \cdot s^{-1}$)

OPTION 2 / *OPSIE 2*

$c = f\lambda$
$3 \times 10^8 = f(200 \times 10^{-9})$
$f = 1,5 \times 10^{15}$ Hz

$hf = hf_0 + E_k$ ✓

$(6,63 \times 10^{-34})(1,5 \times 10^{15})$ ✓ $= 8 \times 10^{-19}$ ✓ $+ \frac{1}{2}(9,11 \times 10^{-31})v^2$ ✓

$v = 6,53 \times 10^5\ m \cdot s^{-1}$ ✓ (5)

11.1.3 Increases / *Vermeerder* ✓ (1)

11.1.4 Remains the same / *Bly dieselfde* ✓
Intensity only affects number of photoelectrons emitted per second. ✓
Intensiteit beïnvloed slegs die getal foto-elektrone vrygestel per sekonde.

OR/*OF*
Remains the same / *Bly dieselfde* ✓
The kinetic energy of the emitted photoelectrons remains the same.
Die kinetiese energie van die vrygestelde foto-elektrone bly dieselfde.

OR/*OF*
Remains the same / *Bly dieselfde* ✓
Only the frequency/wavelength of the incident light affects the maximum kinetic energy.
Slegs the frekwensie/golflengte van die invallende lig beïnvloed die maksimum kinetiese energie. (2)

11.2 B ✓
Orange light has a <u>higher frequency</u> than red light. ✓
Oranje lig het 'n <u>hoër frekwensie</u> as rooi lig.

OR/*OF*
Orange light has <u>smaller wavelength</u> than red light.
Oranje lig het 'n <u>kleiner golflengte</u> as rooi lig. (2)

11.3 Line emission (spectra) / *Lyn emissie(spektrum)* ✓ (1)
[12]

TOTAL SECTION B/*TOTAAL AFDELING B*: 125
GRAND TOTAL/*GROOTTOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2014

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The sum of the kinetic energy and gravitational potential energy of an object (1)

1.2 The law of motion that can be used to explain why all persons in moving vehicles should wear safety belts (1)

1.3 The energy a charge possesses as a result of its position relative to other charges that it interacts with (1)

1.4 The bending of waves around corners or obstacles (1)

1.5 The minimum energy needed to remove an electron from the surface of a metal (1)
[5]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (2.1–2.10) in the ANSWER BOOK.

2.1 Net force is a measure of the …

A change in energy.

B rate of change in energy.

C change in momentum.

D rate of change in momentum. (2)

2.2 If air resistance is negligible, the total mechanical energy of a free-falling body …

A remains constant.

B becomes zero.

C increases.

D decreases. (2)

2.3 If the momentum of an object is doubled, then its kinetic energy is ...

A halved.

B doubled.

C three times greater.

D four times greater. (2)

2.4 The degree of diffraction depends on a wave's ...

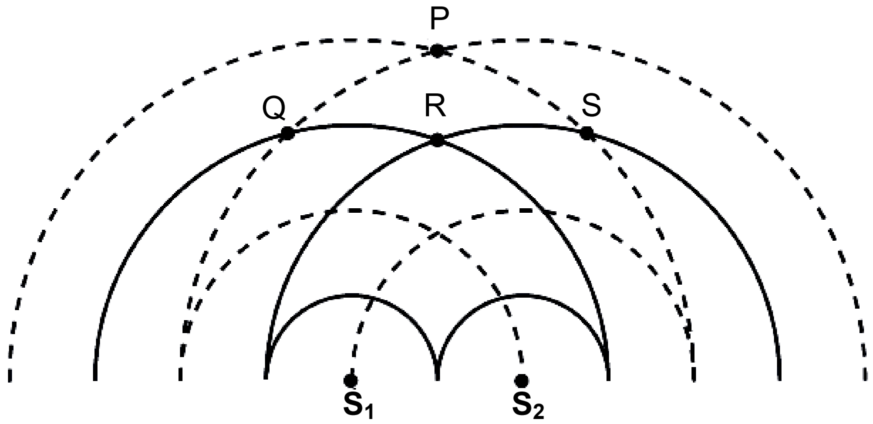
A phase.

B velocity.

C amplitude.

D wavelength. (2)

2.5 The diagram below shows waves generated by two coherent sources, $\mathbf{S_1}$ and $\mathbf{S_2}$. The solid lines represent CRESTS and the broken (dashed) lines represent TROUGHS.



Destructive interference occurs at points ...

A Q and R.

B Q and P.

C Q and S.

D R and S. (2)

2.6 Two small identical metal spheres, each carrying equal charges Q, are brought into contact and then separated.

The charge on each sphere will now be …

A zero.

B $\frac{Q}{2}$.

C Q.

D $2Q$. (2)

2.7 Two resistors of equal resistance are connected in SERIES to a battery with negligible internal resistance. The current through the battery is I.

When the two resistors are connected in PARALLEL to the same battery, the current through the battery will be …

A $\frac{1}{2}I$.

B I.

C $2I$.

D $4I$. (2)

2.8 Which ONE of the following statements is INCORRECT?
Electromagnetic waves …

A can undergo reflection and refraction.

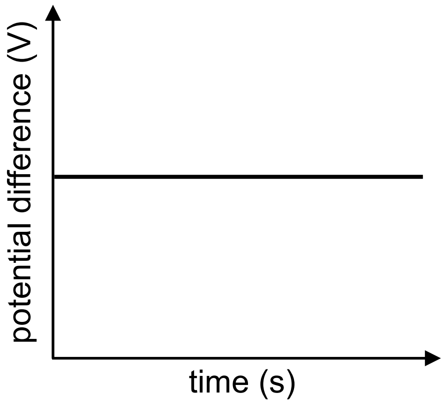
B are longitudinal waves.

C can travel through a vacuum.

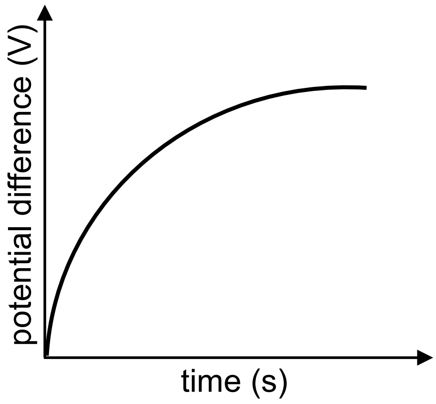
D can undergo diffraction and interference. (2)

2.9 Which ONE of the following graphs represents the change in potential difference across a capacitor as it charges?

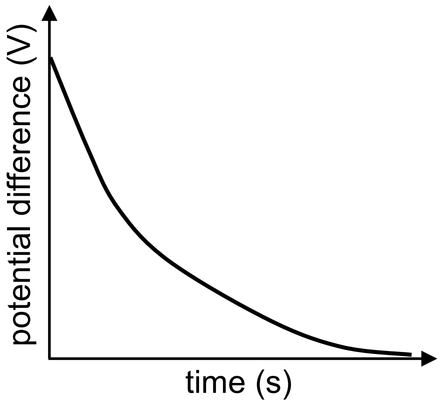
A



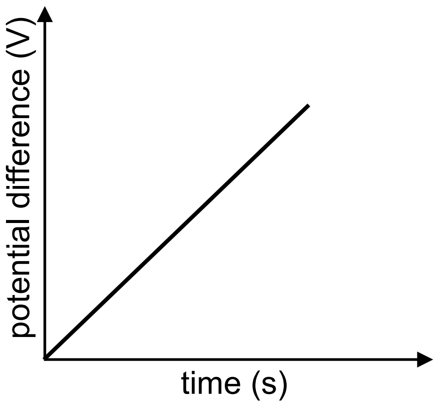
B



C

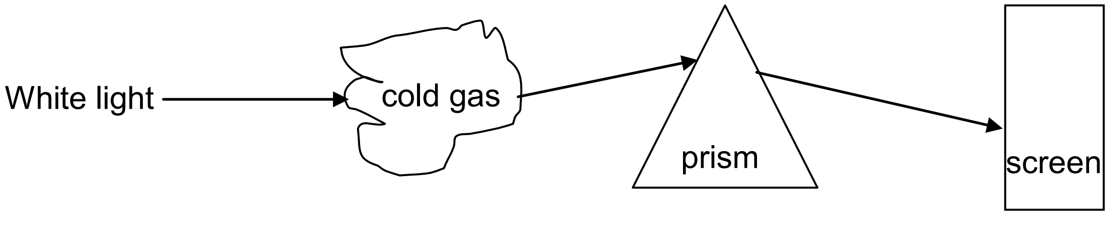


D



(2)

2.10 Light spectra help to identify elements. White light is passed through a cold gas and then through a prism as shown in the sketch below.



What type of spectrum is observed on the screen?

A Line absorption spectrum

B Line emission spectrum

C Continuous absorption spectrum

D Continuous emission spectrum (2)

[20]

TOTAL SECTION A: 25

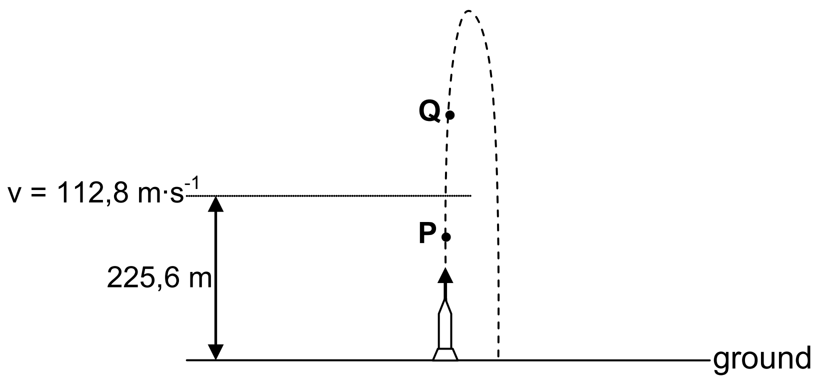
SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A stationary rocket on the ground is launched vertically upwards. After 4 s, the rocket's fuel is used up and it is 225,6 m above the ground. At this instant the velocity of the rocket is 112,8 $m \cdot s^{-1}$. The diagram below shows the path followed by the rocket. Ignore the effects of air friction. Assume that g does not change during the entire motion of the rocket.



3.1 Write down the direction of the acceleration of the rocket at point:

3.1.1 **P** (1)

3.1.2 **Q** (1)

3.2 At which point (**P** or **Q**) is the rocket in free fall? Give a reason for the answer. (2)

3.3 TAKING UPWARD MOTION AS POSITIVE, USE EQUATIONS OF MOTION to calculate the time taken from the moment the rocket is launched until it strikes the ground. (6)

3.4 Sketch a velocity versus time graph for the motion of the rocket from the moment it runs out of fuel until it strikes the ground. Take the time when the rocket runs out of fuel as t = 0 s.

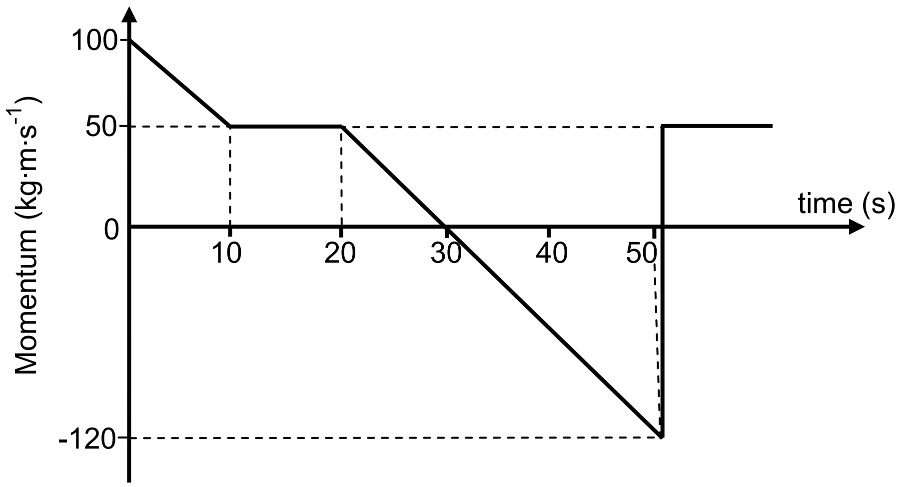
Indicate the following values on the graph:

- Velocity of the rocket when it runs out of fuel
- Time at which the rocket strikes the ground (5)

[15]

QUESTION 4 (Start on a new page.)

The momentum versus time graph of object **A**, originally moving horizontally EAST, is shown below.



4.1 Write down the definition of *momentum* in words. (2)

4.2 *The net force acting on object **A** is zero between t = 10 s and t = 20 s.*

Use the graph and a relevant equation to explain why this statement is TRUE. (2)

4.3 Calculate the magnitude of the impulse that object **A** experiences between t = 20 s and t = 50 s. (3)

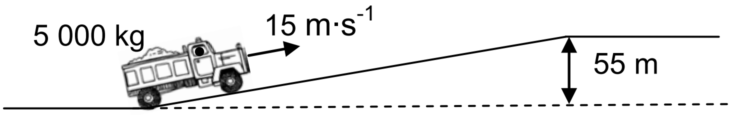
4.4 At t = 50 s, object **A** collides with another object, **B**, which has a momentum of 70 $kg \cdot m \cdot s^{-1}$ EAST.

Use the information from the graph and the relevant principle to calculate the momentum of object **B** after the collision. (5)

[12]

QUESTION 5 (Start on a new page.)

A loaded truck with a total mass of 5 000 kg travels up a straight incline at a constant velocity of 15 $m \cdot s^{-1}$. At the top of the incline, the truck is at a height of 55 m above its starting point. The work done by frictional forces is 8,5 x 10^4 J. (Ignore the rotational effects of the wheels of the truck.)



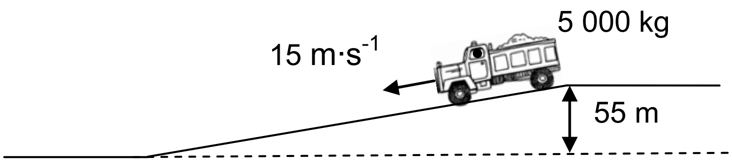
5.1 Define *power* in words. (2)

5.2 Draw a labelled free-body diagram showing ALL the forces acting on the truck as it moves up the incline. (4)

5.3 Use the WORK-ENERGY THEOREM to calculate the work done by the engine of the truck to get it to the top of the incline. (5)

5.4 Calculate the average power delivered by the engine of the truck if the truck takes 60 s to reach the top of the incline. (3)

The truck now returns down the same incline with a constant velocity of 15 $m \cdot s^{-1}$.



5.5 How will the work done by the engine of the truck on reaching the bottom of the incline compare to that calculated in QUESTION 5.3? Write down GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (2)
[16]

QUESTION 6 (Start on a new page.)

A sound source on a car produces sound waves of frequency 850 Hz. A stationary observer measures the emitted frequency using a detector which can measure a maximum frequency of 800 Hz. He finds that the detector only registers a reading whilst the car is moving. (Ignore the effects of wind.)

6.1 Must the car move TOWARDS or AWAY from the observer for the detector to register a reading?

Explain the answer by referring to frequency or wavelength. (3)

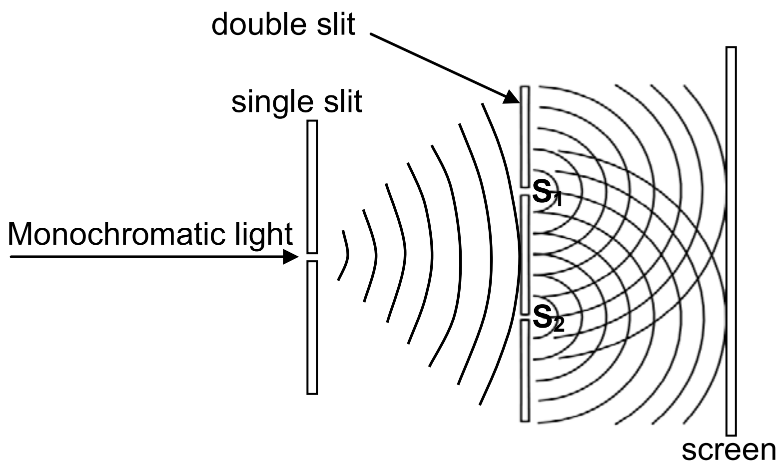
6.2 Calculate the minimum speed at which the car must move for the detector to register the maximum reading. Take the speed of sound in air as 340 $m \cdot s^{-1}$. (5)

6.3 State ONE use of the Doppler effect in medicine. (1)

[9]

QUESTION 7 (Start on a new page.)

The diagram below shows monochromatic light that first passes through a single slit and then through a double slit. An interference pattern is observed on the screen.



7.1 What is the function of the double slit in the above arrangement? (1)

7.2 The width of the two slits $\mathbf{S_1}$ and $\mathbf{S_2}$ and the distance between the slits are kept constant. How will the width of the bands in the interference pattern change if:
(Write down only INCREASES, DECREASES or REMAINS THE SAME.)

7.2.1 Light of longer wavelength is used (1)

7.2.2 Light of higher frequency is used (1)

7.2.3 The distance between the slits and screen is increased for a given frequency of light (1)

The double slit is now removed and the light passes through the single slit only.

7.3 Describe the pattern that will be observed on the screen when the light passes through the single slit. (2)

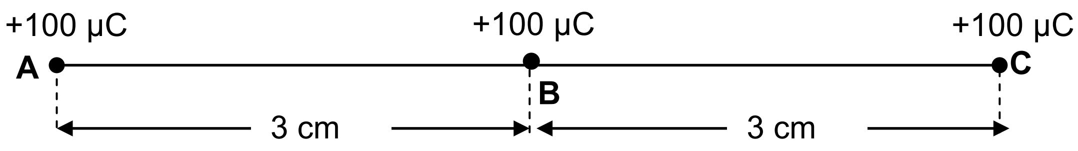
7.4 When light of wavelength 450 nm passes through the single slit, the FOURTH minimum occurs at an angle of 25°. Calculate the width of the single slit. (5)

One can hear sounds around the corners of a doorway, but cannot see around the corners.

7.5 Use your knowledge of diffraction to explain this observation. (2)
[13]

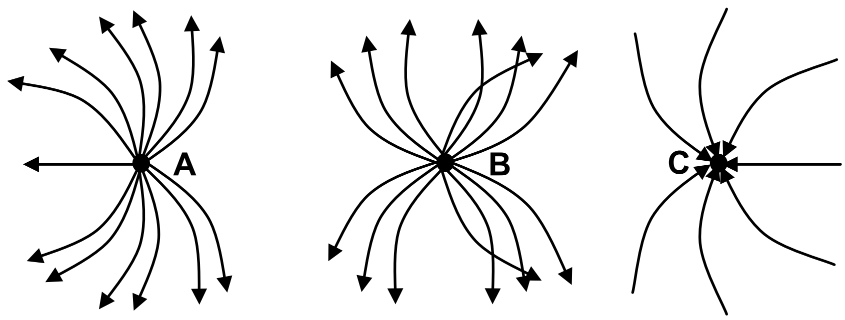
QUESTION 8 (Start on a new page.)

Three +100 μC point charges, **A**, **B** and **C**, are equally spaced on a straight line in a vacuum. The charges are a distance of 3 cm from each other as shown in the sketch below.



8.1 Name the law that describes the electrostatic force exerted by one point charge on another. (1)

8.2 A learner sketches the electric field pattern produced by the three charges as shown below.



Write down THREE mistakes the learner made. (3)

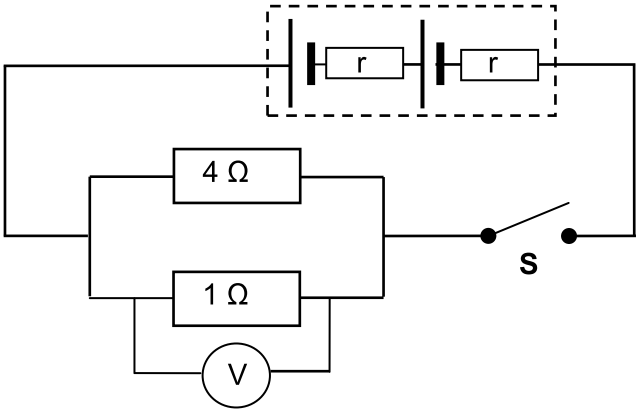
8.3 Calculate the net electrostatic force experienced by point charge **C**. (6)

8.4 Write down the net electrostatic force experienced by point charge **B**. Give a reason for the answer. (2)

[12]

QUESTION 9 (Start on a new page.)

Two identical cells, EACH with an emf of 1,5 V and an internal resistance *r*, are connected in series with each other and to the resistors as shown below.



9.1 Define, in words, the term *electromotive force* (emf). (2)

9.2 Write down the total emf of the circuit. (1)

When switch **S** is closed, the potential difference across the 4 Ω resistor is 2,8 V.

9.3 Calculate the total current in the circuit. (5)

9.4 Calculate the internal resistance *r* of EACH cell. (5)

9.5 An unknown resistor is now connected in parallel with the 4 Ω and 1 Ω resistors. How will this change affect the magnitude of:

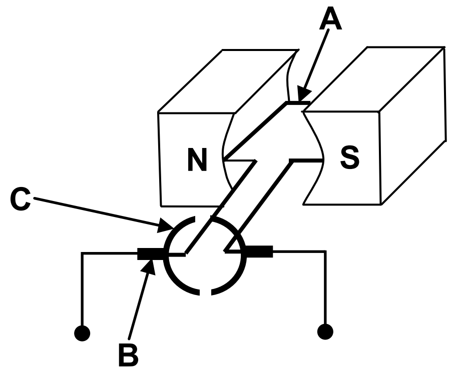
9.5.1 The internal resistance of the battery
Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

9.5.2 The reading on the voltmeter
Write down INCREASES, DECREASES or REMAINS THE SAME.
Explain the answer by referring to resistance, current and 'lost volts'. (4)

[18]

QUESTION 10 (Start on a new page.)

10.1 A simplified diagram of an electric motor is shown below.



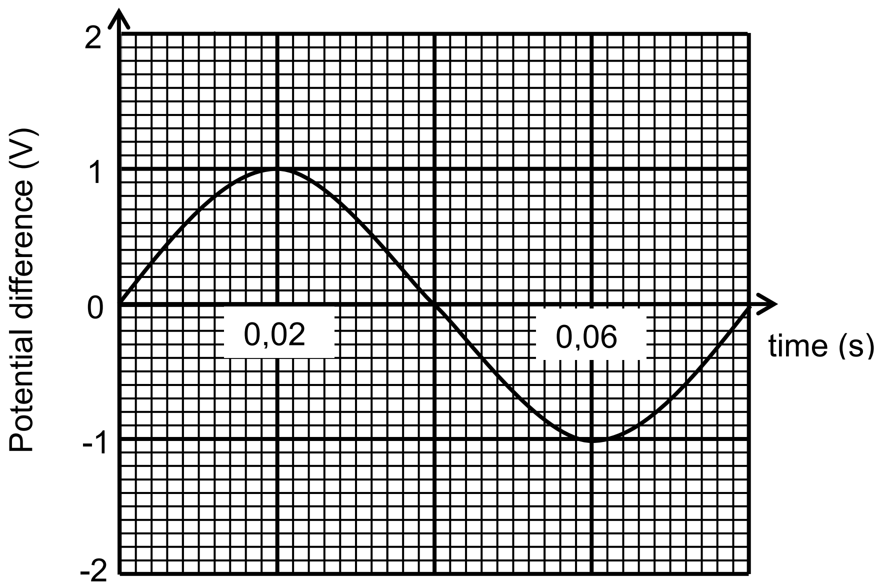
10.1.1 Name the components labelled **A**, **B** and **C**. Write down only the name of the component next to the letter (A–C). (3)

10.1.2 Write down the function of the component labelled **B**. (1)

10.1.3 Is this motor an AC motor or a DC motor? (1)

10.1.4 Give a reason why component **A** experiences a magnetic force when a current passes through it. (2)

10.2 A coil is rotated in a magnetic field. The varying induced emf obtained is represented in the graph below.



10.2.1 Calculate the induced rms potential difference. (3)

10.2.2 The coil is now rotated at TWICE the original speed.

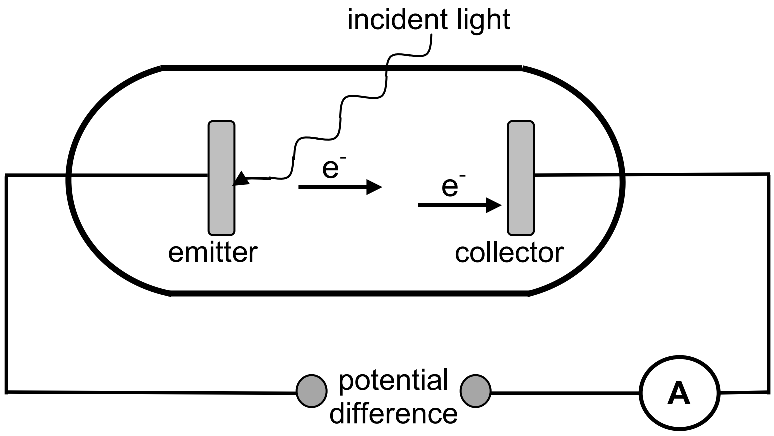
Write down the period of the new wave. (2)

10.2.3 Calculate the average power generated if the generator produces a maximum current of 2 A. (4)

[16]

QUESTION 11 (Start on a new page.)

11.1 The apparatus below is used to demonstrate the photoelectric effect.



11.1.1 Define, in words, the *photoelectric effect*. (2)

The incident monochromatic light transfers $1,8 \times 10^{-9}$ J of energy in one second to a certain area of the emitter. The wavelength of a photon in the incident light is 260 nm.

If one photon releases one electron, calculate the:

11.1.2 Number of electrons released from the surface of that area of the emitter in one second (5)

11.1.3 Current produced, in amperes (4)

11.2 The sketch below shows an example of a line emission spectrum.

11.2.1 Briefly explain how this type of spectrum is formed by referring to electron transitions in atoms. (2)

11.2.2 Write down ONE important use of line emission spectra. (1)
[14]

TOTAL SECTION B: 125
GRAND TOTAL: 150

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1	Mechanical energy / *Meganiese energie* ✓	(1)
1.2	Newton's first law / *Newton se eerste wet* ✓	(1)
1.3	(Electrical) potential energy / *(Elektriese) potensiële energie* ✓	(1)
1.4	Diffraction / *Diffraksie* ✓	(1)
1.5	Work function / *Arbeidsfunksie (Werkfunksie)* ✓	(1)
		[5]

QUESTION 2/*VRAAG 2*

2.1	D ✓✓	(2)
2.2	A ✓✓	(2)
2.3	D ✓✓	(2)
2.4	D ✓✓	(2)
2.5	C ✓✓	(2)
2.6	C ✓✓	(2)
2.7	D ✓✓	(2)
2.8	B ✓✓	(2)
2.9	B ✓✓	(2)
2.10	A ✓✓	(2)
		[20]

TOTAL SECTION A/*TOTAAL AFDELING A*: 25

SECTION B/*AFDELING B*

QUESTION 3/*VRAAG 3*

3.1

3.1.1 Upwards / *Opwaarts* ✓ (1)

3.1.2 Downwards / *Afwaarts*✓ (1)

3.2 Q ✓
Weight is the only force acting on the rocket. ✓
Gewig is die enigste krag wat op die vuurpyl inwerk. (2)

3.3

<u>OPTION 1/*OPSIE 1*</u> **Upwards positive/*Opwaarts positief*:** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\therefore$ -225,6 ✓ = (112,8)Δt ✓ + ½(-9,8)Δt^2 ✓ $\therefore$ Δt = 24,87 s Total time/*Totale tyd*: <u>4 +</u> ✓ 24,87 = 28,87 s ✓ **Downwards positive/*Afwaarts positief:*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\therefore$ 225,6 ✓ = (-112,8)Δt ✓ + ½(9,8)Δt^2 ✓ $\therefore$ Δt = 24,87 s Total time/*Totale tyd*: <u>4 +</u> ✓ 24,87 = 28,87 s ✓	**<u>Notes/*Aantekeninge:*</u>** Accept/*Aanvaar:* g or/*of* a $s = ut + \frac{1}{2}at^2$ $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$
<u>OPTION 2/*OPSIE 2*</u> **Upwards positive/*Opwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ $\therefore v_f^2 = (112,8)^2 + 2(-9,8)(-225,6)$ ✓ $\therefore$ v_f = 130,94 m·s^{-1} $\Delta y = (\frac{v_i + v_f}{2})\Delta t$ ✓ -225,6 ✓ = $(\frac{112,8 - 130,94}{2})\Delta t$ ✓ $\therefore$ Δt = 24,87 s Total time/*Totale tyd* : <u>4 +</u> ✓ 24,87 = 28,87 s ✓ **Downwards positive/*Afwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ $\therefore v_f^2 = \underline{(-112,8)^2 + 2(9,8)(225,6)}$ ✓ $\therefore$ v_f = 130,94 m·s^{-1} $\Delta y = (\frac{v_i + v_f}{2})\Delta t$ ✓	**<u>Notes/*Aantekeninge:*</u>** Accept/*Aanvaar:* g or/*of* a $v_f^2 = vi^2 + 2a\Delta x$ $v^2 = u^2 + 2as$ $\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $s = \left(\frac{u+v}{2}\right)t$

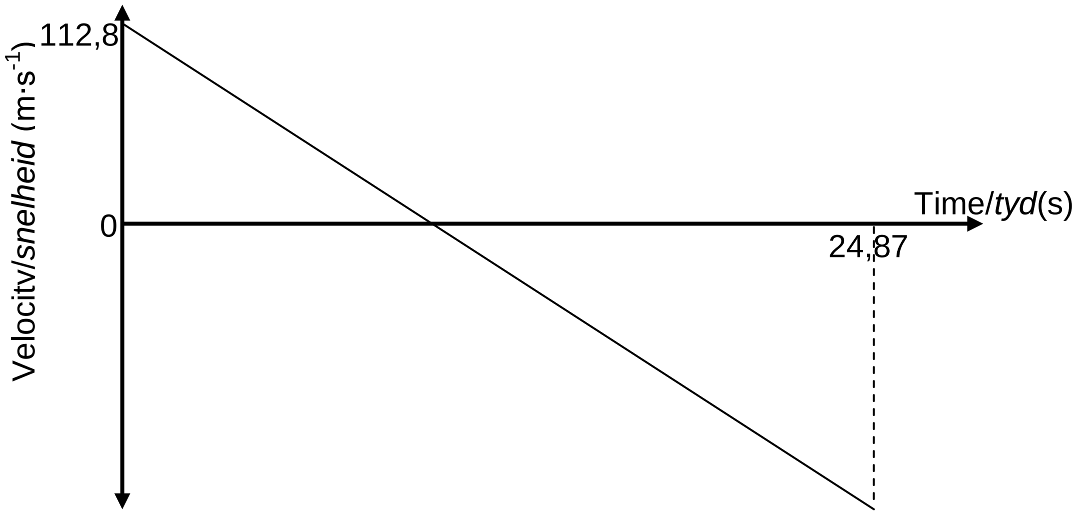
$225,6$ ✓ $= \left(\frac{-112,8 + 130,94}{2}\right)\Delta t$ ✓ $\therefore \Delta t = 24,87$ s Total time/*Totale tyd*: 4 + ✓ 24,87 = 28,87 s ✓	

OPTION 3/*OPSIE 3* **Upwards positive/*Opwaarts positief*:** Time from point where fuel is used up to maximum height /*Tyd vanaf punt waar brandstof opgebruik is tot maksimum hoogte* : $v_f = v_i + a\Delta t$ ✓ $\therefore 0 = 112,8 + (-9,8)\Delta t$ ✓ $\therefore \Delta t = 11,51$ s Time from maximum height to ground / *Tyd vanaf maksimum hoogte tot die grond*: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= (112,8)(11,51) + ½(-9,8)(11,51)^2$ $\therefore \Delta y = 649,18$ m Maximum height/*Maksimum hoogte*: 225,6 + 649,18 = 874,78 m $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\therefore -874,78 = (0)\Delta t + ½(-9,8)\Delta t^2$ ✓ $\therefore \Delta t = 13,36$ s Total time / *Totale tyd*: 4 + ✓ 11,51 + 13,36 = 28,87 s ✓	**Notes/*Aantekeninge:*** Accept/*Aanvaar:* g or/*of* a $v = u + at$ $v_f^2 = vi^2 + 2a\Delta x$ $v^2 = u^2 + 2as$ $s = ut + \frac{1}{2}at^2$ $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$
Downwards positive/Afwaarts *positief:* Time from point where fuel is used up to maximum height/ *Tyd vanaf punt waar brandstof opgebruik is tot maksimum hoogte*: $v_f = v_i + a\Delta t$ ✓ $\therefore 0 = -112,8 + (9,8)\Delta t$ ✓ $\therefore \Delta t = 11,51$ s Time from maximum height to ground: *Tyd vanaf maksimum hoogte tot die grond*: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $= (-112,8)(11,51) + ½(9,8)(11,51)^2$ $\therefore \Delta y = -649,18$ m Maximum height/ *Maksimum hoogte*: 225,6 + 649,18 = 874,78 m $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\therefore 874,78 = (0)\Delta t + ½(9,8)\Delta t^2$ ✓ $\therefore \Delta t = 13,36$ s Total time/*Totale tyd* 4 + ✓ 11,51 + 13,36 = 28,87 s ✓	**Notes/*Aantekeninge:*** Accept/*Aanvaar:* g or/*of* a $v = u + at$ $v_f^2 = vi^2 + 2a\Delta x$ $v^2 = u^2 + 2as$ $s = ut + \frac{1}{2}at^2$ $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$

(6)

3.4 **OPTION 1/*OPSIE 1***

Upwards positive/*Opwaarts positief:*



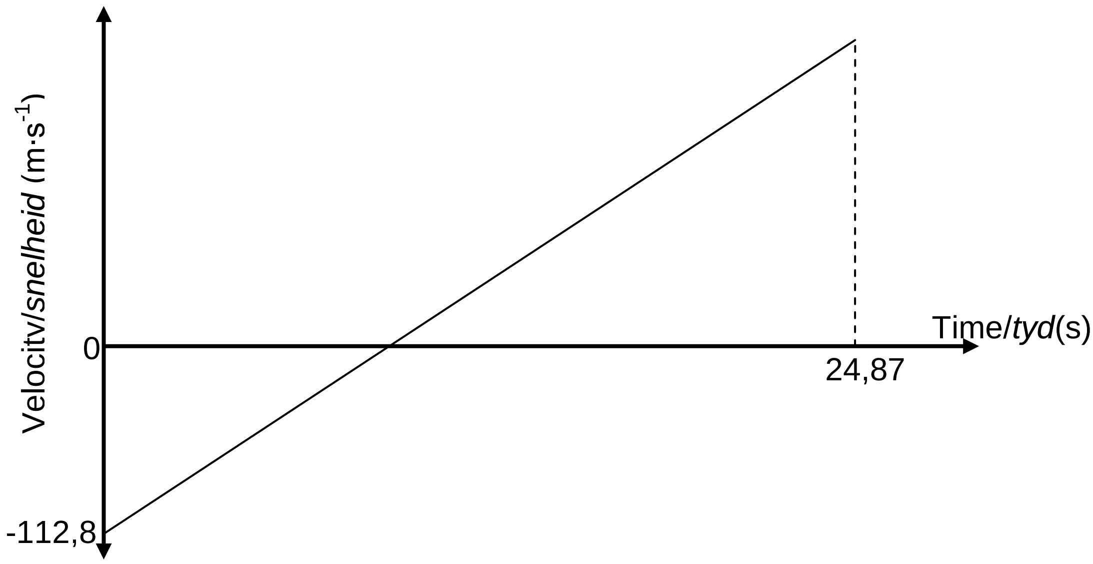
Criteria for graph/*Kriteria vir grafiek:*	**Marks/ *Punte***
Graph starts at (0; 112,8)./ *Grafiek begin by (0; 112,8).*	✓
Graph is a straight line with a gradient. /G*rafiek is 'n reguitlyn met 'n gradiënt.*	✓
Graph has a negative gradient./*Grafiek het 'n negatiewe gradiënt.*	✓
POSITIVE MARKING FROM QUESTION 3.3./*POSITIEWE NASIEN VANAF VRAAG 3.3.* Graph extends below x-axis until t = 24,87 s. *Grafiek verleng onder x-as tot t = 24,87s.*	✓
Graph extends below the x-axis to a magnitude of the velocity greater than (112,8 $m \cdot s^{-1}$). / *Tweede deel van grafiek verleng onder die x-as tot 'n grootte van die snelheid groter as (112,8* $m \cdot s^{-1}$*).*	✓

Notes/*Aantekeninge:*
If wrong labels/*Indien verkeerde byskrifte*: Max./*Maks.* $\frac{3}{4}$

<u>OPTION 2/*OPSIE 2*</u>

If upwards taken as negative: Max $\frac{4}{5}$/

Indien opwaarts as negatief geneem: Maks. $\frac{4}{5}$



Criteria for graph/*Kriteria vir grafiek:*	**Marks/ *Punte***
Graph starts at (0; -112,8)./ *Grafiek begin by (0; -112,8).*	✓
Graph is a straight line with a gradient. /G*rafiek is 'n reguitlyn met 'n gradiënt.*	✓
Graph has a positive gradient./*Grafiek het 'n positiewe gradiënt.*	✓
POSITIVE MARKING FROM QUESTION 3.3./*POSITIEWE NASIEN VANAF VRAAG 3.3.* Graph extends above x-axis until t = 24,87 s. *Grafiek verleng bo x-as tot t = 24,87s.*	✓
Graph extends above the x-axis to a magnitude of the velocity greater than (112,8 $m \cdot s^{-1}$). / *Tweede deel van grafiek verleng bo die x-as tot 'n grootte van die snelheid groter as (112.8 $m \cdot s^{-1}$).*	✓

<u>Notes/*Aantekeninge:*</u>
If wrong labels/*Indien verkeerde byskrifte*: Max./*Maks.* $\frac{3}{4}$

(5)
[15]

QUESTION 4/*VRAAG 4*

4.1 Momentum is the <u>product of the mass and velocity</u> of an object. ✓✓
Momentum is die <u>produk van die massa en snelheid</u> van 'n voorwerp. (2)

4.2 $\Delta p = 0$ ✓

$F_{net} = \frac{\Delta p}{\Delta t} = 0$ ✓

OR/*OF*

$\Delta p = 0$ ✓

$\Delta v = 0 \therefore a = 0 \therefore F_{net} = ma$ ✓

OR/*OF*

Gradient of graph/ *Gradiënt van grafiek* = $\frac{\Delta p}{\Delta t} = F_{net}$ ✓

Gradient of graph between/*Gradient van grafiek tussen*:
t = 10 s and/*en* 20 s = 0 ✓ (2)

4.3

<u>OPTION 1</u>	**<u>OPTION 2</u>**
$F_{net}\Delta t = \Delta p$ ✓ $= -120 - 50$ ✓ $= -170$ $\therefore F_{net}\Delta t = 170$ N·s / kg·m·s^{-1} ✓	$F_{net} = \frac{\Delta p}{\Delta t}$ ✓ $= \frac{-120 - 50}{50 - 20}$ $\therefore F_{net} = -5{,}67$ $F_{net}\Delta t = (-5{,}67)(30)$ ✓ $= -170$ $\therefore F_{net}\Delta t = 170$ N·s / kg·m·s^{-1} ✓

(3)

4.4

<u>OPTION 1/ *OPSIE 1*</u>	**<u>OPTION 2/*OPSIE 2*</u>**
$\Sigma p_i = \Sigma p_f$ ✓ $-120 + 70$ ✓ $= 50 + p_{Bf}$ ✓ $\therefore p_{Bf} = -100$ $\therefore p_{Bf} = 100$ kg·m·s^{-1}✓ west / *wes* ✓	$\Delta p_A = -\Delta p_B$ ✓ $50 - (-120)$ ✓ $= -(p_{Bf} - 70)$ ✓ $\therefore p_{Bf} = -100$ $\therefore p_{Bf} = 100$ kg·m·s^{-1}✓ west / *wes* ✓
<u>Other formulae/*Ander formules*:</u> $m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$ or $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ or $m_Av_{iA} + m_Bv_{iB} = m_Av_{fA} + m_Bv_{fB}$ $p_{total\ before} = p_{total\ after}$ Accept /*Aanvaar:* $p_{before} = p_{after}$ $p_i = p_f$	**<u>Notes/*Aantekeninge:*</u>** • If no formula/principle – Max. $\frac{4}{5}$ *Indien geen formule/beginsel – Maks.* $\frac{4}{5}$ • Mark direction independently. *Sien rigting onafhanklik na.*

(5)
[12]

QUESTION 5/*VRAAG 5*

5.1 The rate at which work is done. / Work done per unit time. ✓✓
Die tempo waarteen arbeid verrig word. / Arbeid verrig per eenheidstyd.

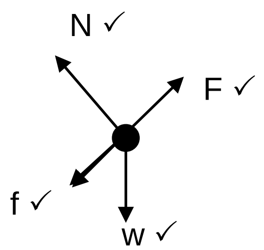
OR/*OF*
The rate at which energy is transferred. / Energy transferred per unit time.
Die tempo waarteen energie oorgedra word. / Energie oorgedra per eenheidstyd.

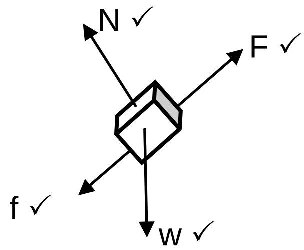
Notes/*Aantekeninge:*
- No part marking /*Geen gedeelte nasien*- 2 marks or 0./*Twee punte of nul*
- **Accept/*Aanvaar*:**
  The product of force and average / instantaneous velocity. ✓✓
  Die produk van krag en gemiddelde / oombliklike snelheid
- **IF/INDIEN:**
  The product of force and velocity / *Die produk van krag en snelheid*.
  Max/*Maks*. $\frac{1}{2}$

(2)

5.2

Accept/*Aanvaar*: Force diagram/*kragtediagram*





Accepted labels/*Aanvaarde benoemings*	
w	F_g/F_w/force of Earth on truck/weight/12 000 N/mg/gravitational force *F_g/F_w/krag van Aarde op vragmotor/gewig/12 000 N/mg/gravitasiekrag*
N	F_N/normal *F_N/normaal*
F	Force of engine /F_{net}/$F_{applied}$ *Krag van enjin op vragmotor/F_{net}/$F_{toegepas}$*
f	F_f / friction

(4)

5.3

OPTION 1/*OPSIE 1*	**Notes/*Aantekeninge:***
$W_{net} = \Delta K$ ✓ $W_F + W_f + W_w = K_f - K_i$ $W_F - 8,5 \times 10^4$ ✓ $+ (5\ 000)(9,8)(55)\cos 180°$ ✓ $= 0$ ✓ $\therefore W_F = 2,78 \times 10^6$ J ✓	Accept/*Aanvaar:* $W_{net} = \Delta E_k$ $W_{net} = E_{kf} - E_{ki}$
OPTION 2/*OPSIE 2*	**Notes/*Aantekeninge:***
$W_{net} = \Delta K$ ✓ $W_F + W_f - \Delta E_p = K_f - K_i$ $W_F - 8,5 \times 10^4$ ✓ $- (5\ 000)(9,8)(55)$ ✓ $= 0$ ✓ $\therefore W_F = 2,78 \times 10^6$ J ✓	Accept/*Aanvaar:* $W_{net} = \Delta E_k$ $W_{net} = E_{kf} - E_{ki}$

(5)

POSITIVE MARKING FROM 5.3/*POSITIEWE NASIEN VANAF VRAAG 5.3*

5.4 $P = \frac{W}{\Delta t}$ ✓

$= \frac{2,78 \times 10^6}{60}$ ✓

$= 4,63 \times 10^4$ W ✓ (3)

5.5 Smaller than /*Kleiner as*✓
Weight / gravitational force does positive work on the truck. ✓
Gewig / gravitasiekrag verrig positiewe arbeid op die trok. (2)
[16]

QUESTION 6/*VRAAG 6*

6.1 Away (from the observer) ✓

Detected frequency must be less than or equal to 800 Hz. ✓
If the car moves away from the observer, <u>less waves reaches her per unit time</u>. ✓

OR/OF
Away (from the observer) ✓
The apparent wavelength increases. ✓
For the same speed of sound, the apparent frequency decreases. ✓ (3)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

800 ✓ $= \frac{340}{340 + v_s}$ ✓ (850) ✓

$\therefore\ v_s = 21,25\ m \cdot s^{-1}$ ✓

(5)

6.3 **ANY ONE:**
Measurement of foetal heart beat. ✓
Measurement and monitoring blood flow./ Doppler flow meter (1)
[9]

QUESTION 7/*VRAAG 7*

7.1 To produce coherent waves. / Act as coherent source. ✓

OR/*OF*
To produce waves with a constant phase relationship.

Accept: To create an interference pattern./
Aanvaar: Om 'n interferensiepatroon te vorm. (1)

7.2.1 Increases ✓ (1)

7.2.2 Decreases ✓ (1)

7.2.3 Increases ✓ (1)

7.3 A bright broad central band. ✓
On either side alternating bright and dark bands ✓ (of different widths and intensity). (2)

7.4
$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 25^o$ ✓ $= \frac{(4)✓(450 \times 10^{-9})✓}{a}$

$a = 4{,}26 \times 10^{-6}$ m ✓ (5)

7.5 $\lambda_{sound} > \lambda_{light}$ ✓
diffraction of sound waves > diffraction light waves ✓

OR
Sound waves have wavelength larger than the opening and therefore are effectively diffracted. ✓
Light waves have wavelength much smaller than the opening and there is virtually no diffraction. ✓

OR
For diffraction to occur, the wavelength must be comparable to the size of the opening. ✓
Since wavelengths of light waves are much smaller than sound waves, ✓ diffraction effects are more visible with sound than with light. (2)

[13]

QUESTION 8/*VRAAG 8*

8.1 Coulomb's law / *Coulomb se wet* ✓ (1)

8.2 A: Field lines too dense in relation to C/ Number of field lines differ. /*A: Veldlyne te dig in vergelyking met C/ Aantal veldlyne verskil.* ✓
B: Field lines are crossing each other. /*B: Veldlyne kruis mekaar.* ✓
C: Direction of field lines should be away from C/ *C: Rigting van veldlyne moet weg van C af wees.* ✓ (3)

8.3

<u>OPTION 1/*OPSIE 1*</u>

$F_{AC} = \frac{kQ_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^9)(100\times10^{-6})(100\times10^{-6})}{(0,06)^2}$ ✓

$= 2,5 \times 10^4$ N to the right/*na regs*

$F_{BC} = \frac{kQ_1Q_2}{r^2}$

$= \frac{(9\times10^9)(100\times10^{-6})(100\times10^{-6})}{(0,03)^2}$ ✓

$= 1 \times 10^5$ N to the right/*na regs*

✓Any one (substitution of $(9\times10^9)(100\times10^{-6})(100\times10^{-6})$ in either calculation)

$F_{net} = F_{AC} + F_{BC}$
$= 2,5 \times 10^4 + 1 \times 10^5$
$= 1,25 \times 10^5$ N ✓ to the right/*na regs* ✓

<u>OPTION 2/*OPSIE 2*</u>

$F_{AC} = \frac{kQ_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^9)(100\times10^{-6})(100\times10^{-6})}{(0,06)^2}$ ✓ ✓

$= 2,5 \times 10^4$ N to the right/*na regs*

$r_{BC} = ½\ r_{AC}$
$F_{BC} = 4\ F_{BC}$ ✓ $= 4(2,5 \times 10^4) = 1 \times 10^5$ N to the right

$F_{net} = F_{AC} + F_{BC}$
$= 2,5 \times 10^4 + 1 \times 10^5$
$= 1,25 \times 10^5$ N ✓ to the right/*na regs* ✓

(6)

8.4 Net force acting on charge at B = 0 N/
Netto krag wat op lading inwerk by B = 0 N ✓
$F_{AB} = - F_{CB}$ ✓ (2)

[12]

QUESTION 9/*VRAAG 9*

9.1 The amount of energy ✓ given to each coulomb of charge ✓passing through the battery./*Die hoeveelheid energie ✓ oorgedra aan elke coulomb lading ✓ wat deur die battery beweeg.*

OR/*OF*
The maximum ability of a cell to do work./*Die maksimum vermoë van 'n sel om arbeid te verrig.* (2)

9.2 3 V ✓ (1)

9.3

OPTION 1 / *OPSIE 1*	OPTION 2 / *OPSIE 2*
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $= \frac{1}{4} + \frac{1}{1}$ ✓ $= \frac{5}{4}$ $\therefore R_p = 0,8\ \Omega$ V = IR✓ 2,8 = I(0,8) ✓ I = 3,5 A✓	Current through 4 Ω resistor/*Stroom deur 4 Ω-weerstand*: V = IR✓ 2,8 = I(4) ✓ ∴ I = 0,7 A Current through 1 Ω resistor/ *Stroom deur 1 Ω-weerstand*: V = IR 2,8 = I(1) ✓ ∴ I = 2,8 A Total current through battery/*Totale stroom deur battery*: $I_T = I_1 + I_2$ = 0,7 + 2,8 ✓= 3,5 A ✓

(5)

9.4 **POSITIVE MARKING FROM QUESTION 9.3./*POSITIEWE NASIEN VAN VRAAG 9.3.***

OPTION 1 / *OPSIE 1*
Emf = I(R + r) ✓
3 ✓= 3,5(0,8 + 2r) ✓
2r = 0,06 Ω (0,057 Ω) ✓
∴ r = 0,03 Ω✓

OPTION 2 / *OPSIE 2*

$V_{\text{"lost"}}$ = 3 – 2,8 ✓= 0,2 V
$V_{\text{"lost"}} = Ir_{total}$ ✓
0,2 = 3,5r ✓
r_{total} = 0,057 Ω✓
∴ $r_{internal}$ of each cell = 0,03 Ω✓ (5)

9.5
9.5.1 Remains the same/*Bly dieselfde* ✓ (1)

9.5.2 Decreases/*Neem af* ✓
Total resistance decreases./*Totale weerstand verminder.* ✓
Current (through battery) increases./*Stroom (deur die battery) verhoog* ✓
'Lost volts' increases./*'Verlore volts' neem toe*. ✓ (4)
[18]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 A: coil / rotor / armature / *spoel* ✓
B: brushes / *borsels*✓
C: commutator / *kommutator* OR/*OF*
split-ring (commutator) / *(split-ring)kommutator* ✓ (3)

10.1.2 **ANY ONE/*ENIGE EEN*:**
Takes current into the coil./ *Neem stroom in spoel* in. ✓
Maintains contact with the commutator / *Bly in kontak met kommutator.* (1)

10.1.3 DC motor /*GS Motor* ✓ (1)

10.1.4 Due to the motor effect / *As gevolg van die motoreffek* ✓✓

OR / OF
There is an <u>interaction between the external magnetic field</u> ✓and the <u>magnetic field produced by the current in the conductor.</u> ✓
Daar is 'n <u>wisselwerking tussen die eksterne magneetveld en die magneetveld veroorsaak deur die stroom in die geleier.</u> (2)

10.2

10.2.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$= \frac{1}{\sqrt{2}}$ ✓

$= 0,707$ V ✓ (3)

10.2.2 0,04 s ✓✓

(v doubles $\therefore$ emf doubles $\therefore$ f doubles $\therefore$ period halves)
(v verdubbel $\therefore$ emk verdubbel $\therefore$ f verdubbel $\therefore$ periode halveer)

Notes/*Aantekeninge:*
IF/*INDIEN:* 0,04 - Max/*Maks*. $\frac{1}{2}$

(2)

10.2.3 **POSITIVE MARKING FROM QUESTION 10.2.1.**
POSITIEWE NASIEN VANAF VRAAG 10.2.1.

<u>OPTION 1 / OPSIE 1</u>

$P_{ave} = V_{rms}I_{rms}$ ✓

$= \left(\frac{V_{max}}{\sqrt{2}}\right)\left(\frac{I_{max}}{\sqrt{2}}\right)$ ✓ (1 mark for formula/*1 punt vir formule*)

$= \left(\frac{1}{\sqrt{2}}\right)$ ✓ $\left(\frac{2}{\sqrt{2}}\right)$

$= 1\ W$ ✓

<u>OPTION 2 / *OPSIE 2*</u>

$P_{ave} = V_{rms}I_{rms}$ ✓

$= \left(\frac{1}{\sqrt{2}}\right)\left(\frac{I_{max}}{\sqrt{2}}\right)$ ✓

$= \left(\frac{1}{\sqrt{2}}\right)\left(\frac{2}{\sqrt{2}}\right)$ ✓

$= 1\ W$ ✓ (4)

[16]

QUESTION 11/*VRAAG 11*

11.1.1 The <u>emission of electrons from the surface of a metal</u> ✓ <u>by light</u> of an appropriate frequency. ✓/*Die <u>vrystelling van elektrone vanaf die oppervlak van 'n metaal/Deur lig</u> van 'n toepaslike frekwensie* (2)

11.1.2 Total energy transferred per second = 1,8 x 10^{-9} J
Totale energie oorgedra per sekonde = 1,8 x 10^{-9} J
Energy of one photon/*Energie van een foton*:

$E_{photon/foton} = hf = \frac{hc}{\lambda}$ (any one/*enige een*) ✓

$= \frac{(6,63\times10^{-34})(3\times10^{8})}{260\times10^{-9}}$ ✓

$= 7,65 \times 10^{-19}$ J

Number of electrons in one second = $\frac{1,8\times10^{-9}}{7,65\times10^{-19}}$ ✓ ✓ = 2,35 x 10^{9} ✓

OR/OF

Total energy transferred per second = 1,8 x 10^{-9} J
Totale energie oorgedra per sekonde = 1,8 x 10^{-9} J
Energy of one photon/*Energie van een foton*

$E_{photon/foton} = hf = \frac{hc}{\lambda}$ ✓any one /*enige een*

Number of electrons /*Aantal elektrone* = $\frac{1,8\times10^{-9}}{hf}$ ✓ $= \frac{1,8\times10^{-9}\times\lambda}{hc}$

Number of electrons ejected/*Aantal elektrone vrygestel* = $\frac{1,8\times10^{-9}\times2,6\times10^{-7}}{6,63\times10^{-34}\times3\times10^{8}}$ ✓ ✓

$\therefore N_e = 2,35 \times 10^{9}$ (electrons per second) ✓ (5)

11.1.3 **POSITIVE MARKING FROM QUESTION 11.1.2.**
POSITIEWE NASIEN VANAF VRAAG 11.1.2.

$q = N_e \times e$
$= (2,35 \times 10^{9})(1,6 \times 10^{-19})$ ✓ $= 3,76 \times 10^{-10}$ C
$q = I\Delta t$ ✓

$\therefore I = \frac{q}{\Delta t} = \frac{3,76\times10^{-10}}{1}$ ✓

$I = 3,76 \times 10^{-10}$ A ✓ (4)

11.2.1 Electrons in excited state fall back to ground state/ lower energy state. ✓
Elektrone in opgewekte toestand val terug na grondtoestand /laer energietoestand
Energy radiated as light. /*Energie uitgestraal as lig.* ✓ (2)

11.2.2 To identify elements. */Om elemente te identifiseer.* ✓
<u>Accept / *Aanvaar:*</u>
To determine the temperature of stars/ Fluorescent lights/ Neon signs./ (1)
Om die temperatuur van sterre te bepaal/ Fluoreserende ligte/ Neontekens **[14]**

TOTAL SECTION B/*TOTAAL AFDELING B*: 125
GRAND TOTAL/*GROOTTOTAAL*: 150

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Paper 1

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 to 1.5) in the ANSWER BOOK.

1.1 The product of the net force and the time during which the force is applied on an object. (1)

1.2 The law that states that: The sum of the potential energy and kinetic energy before – is equal to the sum of the potential energy and kinetic energy after –. (1)

1.3 The splitting of white light into separate colours. (1)

1.4 Radiation which is commonly associated with heat or thermal radiation. (1)

1.5 The law that states that: The EMF induced in a conductor is proportional to the rate at which the conductor cuts through the magnetic field lines. (1)

[5]

QUESTION 2: FALSE ITEMS

Each of the five statements below is FALSE. Correct each statement so that it is TRUE. Write only the correct statement next to the question number (2.1 to 2.5) in the ANSWER BOOK.

NOTE: Correction by using the negative of the statement, for example "… IS NOT …", will not be accepted.

2.1 When a ball is thrown vertically upwards, at its highest point it experiences no force. (2)

2.2 When the speed of an object doubles, the kinetic energy of the object also doubles. (2)

2.3 When white light passes through the cool vapour of an element and is observed through a diffraction grating, an emission spectrum is observed. (2)

2.4 The largest potential difference would be across the resistor that has the smallest electrical resistance. (2)

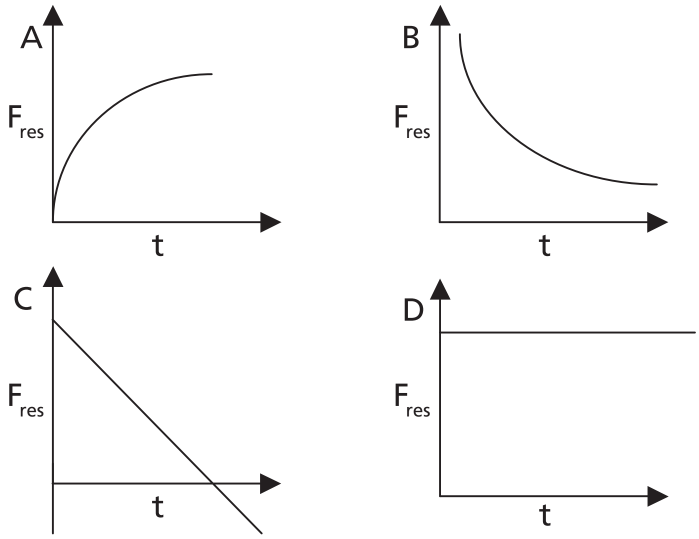
2.5 The rms current is the peak current that will flow in a coil of a generator during one cycle. (2)

[10]

QUESTION 3: MULTIPLE-CHOICE QUESTIONS

Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A to D) next to the question number (3.1 to 3.5) in the ANSWER BOOK.

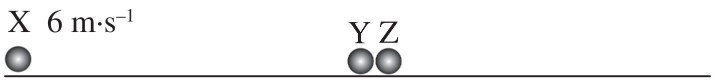
3.1 Which of the following force/time graphs represent the resultant force experienced by an object that falls from a great height and reaches terminal velocity before striking the ground. **Take down as positive.**



3.2 An astronaut with mass m has a weight W on earth. What will his or her mass and weight be on Jupiter if the gravitational acceleration of Jupiter is 24 times that of the earth?

	Mass	**Weight**
A	M	24W
B	24m	$\frac{W}{24}$
C	$\frac{m}{24}$	W
D	M	$\frac{W}{24}$

3.3 Snooker ball X initially moves with a horizontal velocity of 6 m·s^{-1} to the right and collides with two identical snooker balls Y and Z, which are stationary.



If both momentum and kinetic energy are conserved in the collision, indicate which answer correctly gives the horizontal velocity in m·s^{-1} for the three snooker balls after the collision:

	X	Y	Z
A	0	0	0
B	0	2	4
C	2	2	2
D	0	0	6

3.4 Two metal spheres X and Y on insulated stands are placed 10 cm apart. A charge of 4 μC is placed at X and a charge of –6 μC is placed at Y. Z is 5 cm away from Y. The electric field strength at point Z due to the charge on Y only is …

X Y Z

O 10 cm O 5 cm.

4 μC –6 μC

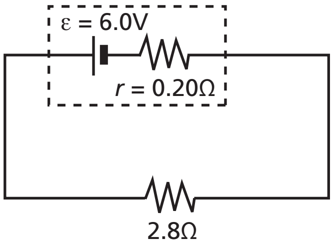
A $2{,}16 \times 10^7$ NC^{-1} towards Y

B $2{,}16 \times 10^7$ NC^{-1} towards X

C $0{,}16 \times 10^7$ NC^{-1} towards Y

D $0{,}16 \times 10^7$ NC^{-1} towards X

3.5 What is the current flowing in the circuit below?



A 1,96 A

B 2,00 A

C 2,14 A

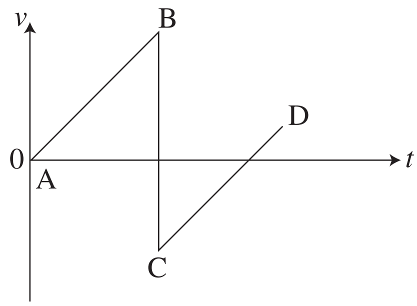
D 4,00 A **[5 × 2 = 10]**

SECTION A TOTAL = [25]

SECTION B

QUESTION 4

4.1 Thembi decides to investigate the motion of a ping-pong ball when it bounces on the ground. Thembi plots the graph of the ping-pong ball's motion. The graph below shows the velocity-time graph for a vertically bouncing ping-pong ball, which is released above the ground at A and strikes the floor at B. The effects of air resistance have been neglected.



4.1.1 State what the gradient of a velocity-time graph represents. (1)

4.1.2 Explain why the gradient of the line AB is the same as line CD. (2)

4.1.3 State what the area between the line AB and the time axis represents. (2)

4.1.4 State why the velocity at C is negative. (1)

4.1.5 State why the speed at C is less than the speed at B. (2)

4.2 The ping-pong ball has a mass of 0.15 kg and is dropped from an initial height of 1.2 m. After impact the ping-pong ball rebounds to a height of 0.75 m. Calculate:

4.2.1 the speed of the ping-pong ball immediately before impact with the ground. (3)

4.2.2 the speed of the ping-pong ball immediately after impact with the ground. (2)

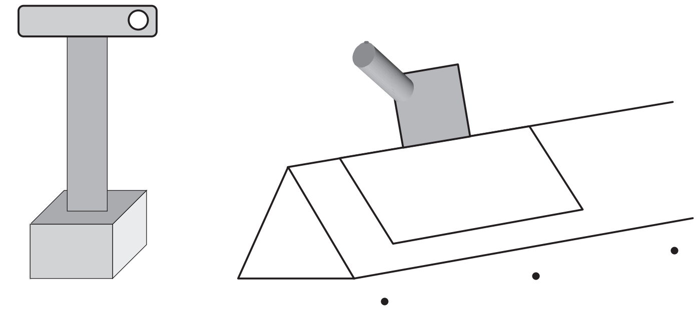
4.2.3 the change in momentum of the ping-pong ball as a result of the impact. (3)

4.2.4 the resultant average force acting on the ping-pong ball during impact if it is in contact with the floor for 0.10 s. (3)

[19]

QUESTION 5

A ball with a mass of 20 g is fired horizontally into a catcher mounted on top of a vehicle. The vehicle is resting on an air track.



The vehicle and the catcher have a combined mass of 0.38 kg and move along the air track at a steady speed of 1.2 $m \cdot s^{-1}$ after the ball has entered the catcher.

5.1 State the law of conservation of momentum. (2)

5.2 The figure above shows the type of apparatus which could be used to investigate this interaction in the laboratory. Explain why the air track is used. (3)

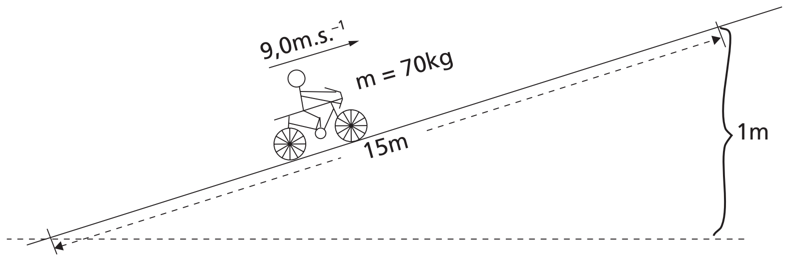
5.3 What is the total momentum of the ball, catcher and vehicle when they are moving along the runway? (3)

5.4 Calculate the speed of the ball before it entered the catcher. (3)

[11]

QUESTION 6

6.1 Nonnie, a cyclist rides along an uphill road at a constant speed of 9.0 $m \cdot s^{-1}$. The combined mass of Nonnie and the bicycle is 70 kg. For every 15 m that she travels along the uphill road, she gains 1.0 m in height. **Neglect energy loss due to frictional forces.**



6.1.1 Calculate the component of the weight of the bicycle and Nonnie that acts along the incline. (4)

6.1.2 Calculate the power developed by Nonnie in riding up the slope. (3)

6.2 Nonnie stops pedalling and the bicycle freewheels up the incline for a short time.

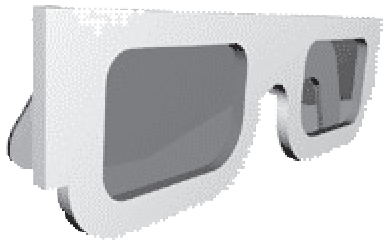
6.2.1 State the energy change taking place as the bicycle freewheels up the slope. (1)

6.2.2 Calculate the distance travelled along the slope from where Nonnie stopped pedalling to where the bicycle comes to rest. (5)

[13]

QUESTION 7

7.1 3-D motion pictures are made in such a way that it must be viewed through special glasses with one red and one blue lens to produce a 3-dimensional effect.



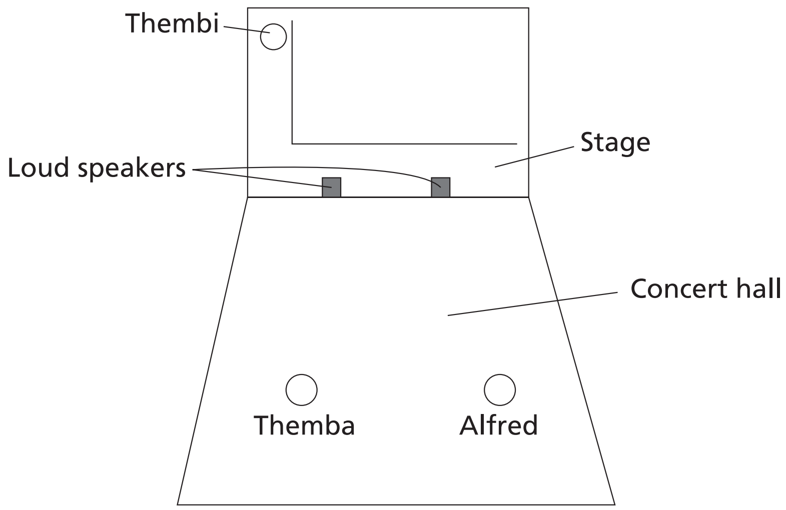
One of the systems how this is done is the following: Two images are displayed on the screen, one in red and the other in blue. The coloured filters on the lenses only allow light from the image which is the same colour as the lens to enter each eye, and your brain does the rest.

7.1.1 Which subtractive primary colours should be used to make a red lens? (2)

7.1.2 What is the complementary colour of red? (1)

7.1.3 Explain why magenta and cyan lenses cannot be used in place of red and blue lenses when the projected images are in red and blue. In answering the question, ensure that you refer to how the colour of these lenses would be made. (3)

7.2 The sound-crew technicians John, Themba and Alfred are setting up the sound system for a large outdoor concert. John positions two loudspeakers, one on each side of the stage and both facing directly out into the area where the audience will stand. In order to test loudness settings, he broadcasts a sound of a **single frequency** simultaneously from each speaker. Themba and Alfred are standing in the audience area in order to gauge if the loudness settings are suitable. Themba hears an extremely loud sound and says that the volume should be reduced. Alfred hears almost nothing at all and says that the volume should be increased.



7.2.1 Sketch a diagram to illustrate the wavefronts emanating from the two speakers. Include a heavy dot to indicate a position where Themba might be standing. (4)

7.2.2 Name the wave phenomenon that causes Alfred to not hear almost any sound. (2)

After discovering that Themba and Alfred are hearing two different things, the three technicians assume that their sound equipment must have been damaged during transport. They begin to pace around the audience area, trying to decide what to do next. As they walk from one side of the audience area to the other (parallel to the stage) they discover that there are alternating regions of loud and quiet. The technicians are perplexed. They obviously don't remember their Grade 12 Physics lessons!

7.2.3 List two changes which will cause the width of the alternating regions to **decrease**. (2)

7.2.4 Thembi standing in a corridor at the back of the concert hall, about 10 metres from an open doorway leading to the stage, hears the sounds coming from the hall, despite the fact that the walls are sound-proof. Name the phenomenon that allows her to hear these sounds. (1)

7.2.5 Briefly explain why the pattern of loud and soft regions is not detected by the audience during the actual rock concert. (2)

[17]

QUESTION 8

Two boats (A and B) are stationary at **different** ends of the harbour. The boatmen in each boat hear the sound of a dolphin but cannot see the dolphin. The men on boat A hear the pitch of the dolphin decreasing while the men on boat B hear the pitch of the dolphin increasing.

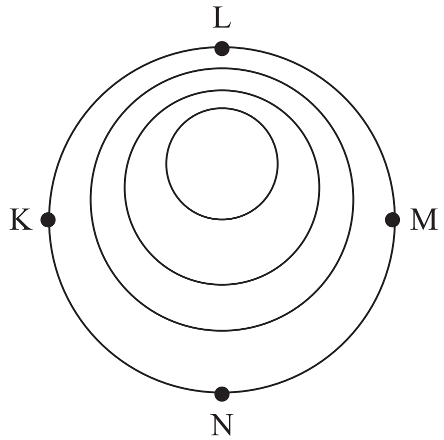
Boat A Boat B

X Y Z

8.1 What effect is responsible for the changing pitch of the dolphin for the men in each boat? (1)

8.2 What is the most likely position of the dolphin? Choose from positions X, Y or Z on the diagram above. (1)

8.3 The following diagram shows the sound-wave pattern produced by the dolphin.



8.3.1 Which position is Boat A likely to be in? Select from K, L, M or N. (1)

8.3.2 If the dolphin has a frequency of 520 Hz, and the dolphin is moving at 24 $m \cdot s^{-1}$, determine the frequency of sound that a boatman in position L will hear. (3)

8.3.3 For a boat in position N, state how each of the following will change or remain the same if the dolphin speeds up.

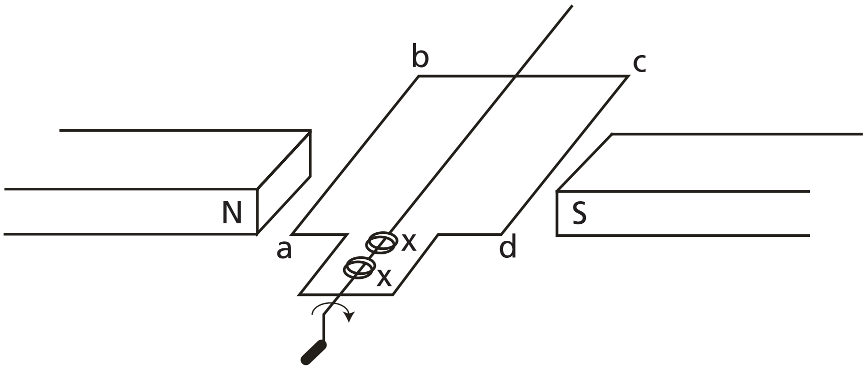
(a) Wavelength of the received sound.

(b) Frequency of the dolphin's call. (2)

[8]

QUESTION 9

The following figure shows the basic parts of an AC-generator:

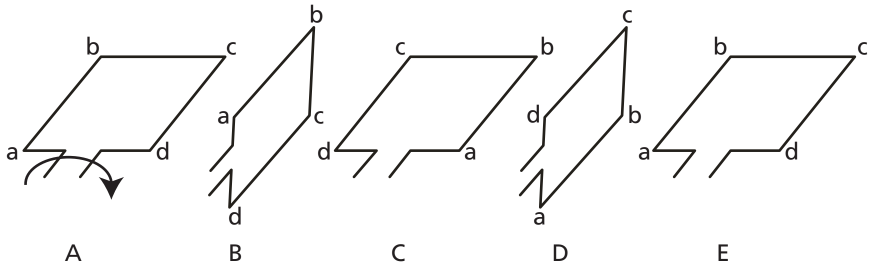


9.1 Give the name for the parts labelled X. (2)

9.2 What is the energy conversion taking place in this generator? (1)

9.3 Use Fleming's Right Hand Dynamo Rule to determine the direction of the induced current in the coil. Give your answer as either c to d, or d to c. (1)

9.4 The figures below show the position of the coil during a full rotation. Draw a sketch graph of emf vs. time for one full rotation of the coil. Clearly mark positions A to E on your graph. (4)



John has made a simple generator similar to that shown in the sketch and he decides to investigate the factors that influence the size of the induced emf.

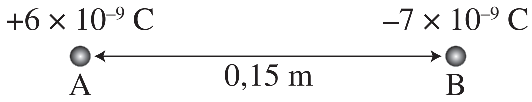
9.5 Give **2** different variables that he could investigate and state how he should change each of them in order to **increase** the induced emf. (4)

9.6 What structural difference is there between a D.C. generator and an A.C. generator? (2)

[14]

QUESTION 10

Two objects, A and B, carrying charges of + 6×10^{-9} C and -7×10^{-9} C respectively, are placed 0,15 m apart.



10.1 State *Coulomb's* law in words. (2)

10.2 Sketch the electric field pattern for the two objects. (3)

10.3 Calculate the magnitude of the force the two charges exert on each other. (3)

10.4 Are these forces attractive or repulsive? (1)

10.5 What will happen to the force if:

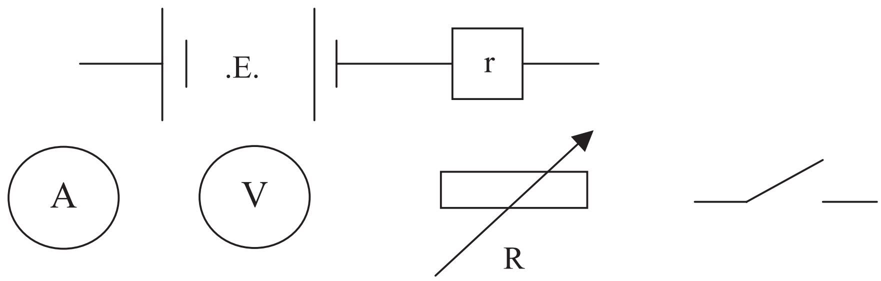
10.5.1 The distance is doubled?

10.5.2 Both charges are halved? (2)

[11]

QUESTION 11

The apparatus below can be used in an experiment to determine the internal resistance of a battery.



11.1 Draw the circuit diagram required to allow you to take the readings necessary to determine the internal resistance of the battery. (3)

11.2 In one experiment the potential difference across the battery and the current is measured and recorded for a number of different values of resistor connected across the battery. The results are recorded in the table.

Potential difference (v)	0,3	0,5	0,7	0,9	1,1	1,3	1,5
Current (A)	0,75	0,68	0,55	0,45	0,35	0,25	0,15

11.2.1 Give the dependent and independent variables for the experiment. (2)

11.2.2 Which variable must be controlled during the experiment? (1)

11.2.3 Draw a graph of voltage versus current for the readings shown in the table on the graph paper. (6)

11.3 Use your graph to determine:

11.3.1 The emf of the battery. (1)

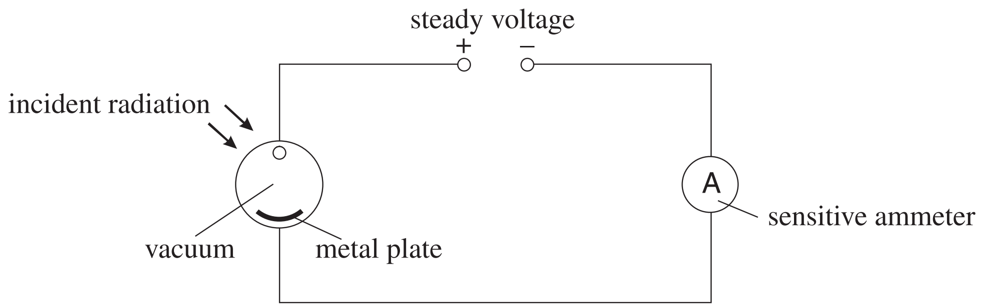
11.3.2 The maximum current the battery can supply. (1)

11.3.3 The internal resistance of the battery. (3)

[17]

QUESTION 12

The diagram below shows an experimental arrangement used to demonstrate aspects of the photo-electric effect. A photo-electric cell is coupled in series with a voltage source and an ammeter. When photoelectrons from the photo-electric cell are emitted, the ammeter registers a current.

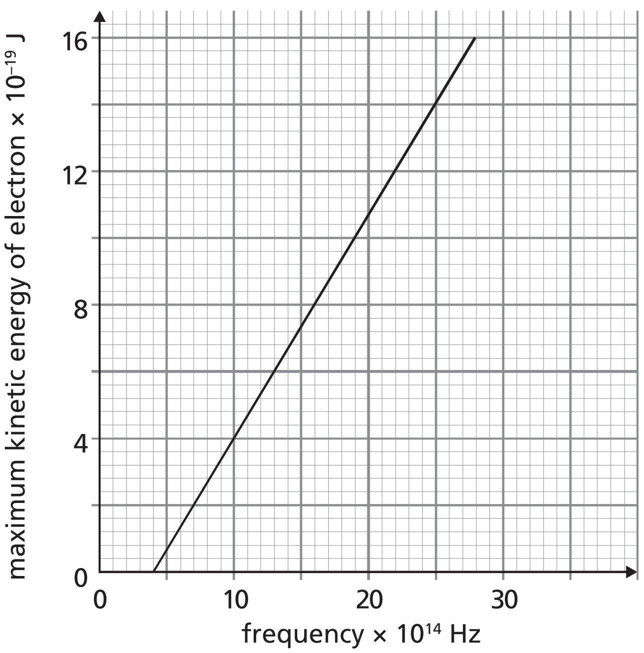


12.1 The metal plate is illuminated with radiation of a particular frequency, but **does not emit photo-electrons**. If the intensity of the radiation is increased, state and explain what effect this increase will have on the observed current. (2)

12.2 The metal plate is illuminated with radiation such that **photo-electrons are emitted**. The intensity of the radiation is increased. State and explain what effect this increase in intensity has on the observed current. (3)

12. 3 The metal plate is illuminated with radiation such that photo-electrons are emitted. Air is allowed to enter the photo-electric cell and the vacuum is destroyed. State and explain what effect the air will have on the observed current. (2)

The diagram alongside shows how the maximum kinetic energy of electrons emitted from the cathode of a photo-electric cell varies with the frequency of the incident radiation.



12.4 Write an equation that shows the relation between the energy of an incident light photon on a metal surface and the emission of photo-electrons from that surface. Briefly state the meaning of each term in the equation. (5)

12.5 Use the graph to calculate the maximum wavelength of electro-magnetic radiation that can release photoelectrons from the cathode surface. (3)

[15]

End Section B = 125 marks

SECTION A

QUESTION 1

1.1 Impulse ✓ (1)

1.2 Conservation of mechanical energy ✓ (1)

1.3 Dispersion ✓ (1)

1.4 Infra red radiation ✓ (1)

1.5 Faraday's law ✓ (1)

[5]

QUESTION 2

2.1 At its highest point, the ball experiences only the gravitational force of the earth. ✓ ✓ (2)

2.2 If the speed doubles, the kinetic energy is 4 times greater. ✓ ✓ (2)

2.3 When white light passes through the cool vapour of an element and is observed through a diffraction grating, an absorption spectrum is observed. ✓ ✓ (2)

2.4 The largest potential difference would be across the resistor that has the largest electrical resistance. ✓ ✓ (2)

2.5 The rms current is the effective current that will flow in a coil of a generator during one cycle. ✓ ✓ (2)

[10]

QUESTION 3

3.1 B ✓ ✓

3.2 A ✓ ✓

3.3 D ✓ ✓

3.4 A ✓ ✓

3.5 B ✓ ✓ **[10]**

SECTION A TOTAL = [25]

SECTION B

QUESTION 4

4.1 4.1.1 Acceleration ✓ (1)

4.1.2 Acceleration due to gravity ✓is the same for the falling ball as for the bouncing ball, which means that the velocity-time gradients must be the same. ✓ (2)

4.1.3 The height that the ball was dropped from ✓✓ OR the displacement of the ball as it travels to the ground. (2)

4.1.4 A to B is +, which implies that its velocity downwards is positive. At C the ball starts moving upwards, which means that its velocity is negative. (1)

4.1.5 The collision between ball and ground was not elastic and some kinetic energy has been "lost" during the bounce ✓, hence the ball leaves the ground with less kinetic energy and therefore less speed. ✓ (2)

4.2 4.2.1 Total mechanical energy of the ball at the top = Total mechanical energy of the ball at the bottom.

$PE_{top} + KE_{top} = PE_{bottom-} + KE_{bottom}$ (&)

$mgh + 0 = 0 + \frac{1}{2}mv^2$

$v^2 = 2(9,8)(1,2)$(&)

$v = 4,85\ m.s^{-1}$ downwards ✓ (3)

Since the ball is travelling in a straight line downwards the following equation may also be used:

$V_f^2 = v_i^2 + 2g\Delta y$

$= 0 + 2(9,8)(1,2)$

$V_f = 4,85\ m.,s^{-1}$ downwards.

4.2.2 $PE_{bottom} + KE_{bottom} = PE_{top} + KE_{top}$

$0 + \frac{1}{2}mv^2 = mgh + 0$ ✓

$v^2 = 2(9,8)(0,75)$

$v = 3,83\ m.s^{-1}$ upwards. ✓ (2)

The equation $v_f^2 = v_i^2 + 2g\Delta y$ could also be used here.

4.2.3 $\boldsymbol{\Delta p = m(v_f - v_i)}$ ✓

$\Delta p = 0,15(-3,83 - 4,85)$ ✓

$\Delta p = -1,30\ kg.m.s^{-1}$ upwards ✓ (3)

4.2.4 $\boldsymbol{F\Delta t = \Delta p}$

$F(0,10) = -1,30$ ✓

$F = -13,00N$ ✓ OR

$F = 13,00N$ upwards ✓ (3)

[19]

QUESTION 5

5.1 The total linear momentum in a closed system remains constant in magnitude and direction (✓) unless it is acted on by a net external force. (✓)

OR

In a closed system, the total momentum before a collision is equal to the total momentum after collision in magnitude and direction. (2)

5.2 The law of conservation of momentum only applies in a closed system. ✓ In the system being considered friction is an external force and is not part of the system under investigation. ✓ So the air tract is used to make the frictional force as small as possible. ✓ (3)

5.3 $p = mv$ ✓

$= (0.38 + 0.02)$ ✓ $\times 1.2$

$= 0.48\ kgms^{-1}$ ✓ in original direction of motion (3)

5.4 p before = p after

$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2)v_f$ ✓

$0.02 \times v_{1i} + 0 = 0.48$ ✓

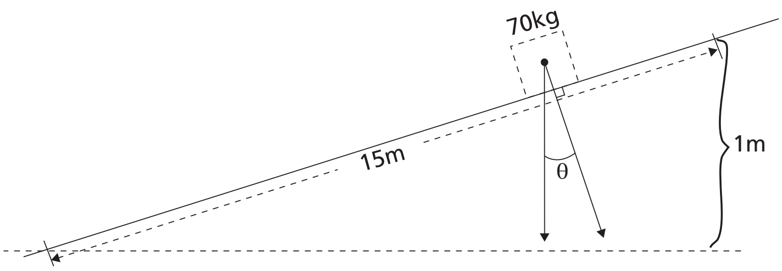
$V_{1i} = 24\ ms^{-1}$ ✓

The ball had a velocity of $24 ms^{-1}$ before it entered the catcher. (3)

[11]

QUESTION 6

6.1



6.1.1 $\sin\theta = \frac{1}{15}$ ✓

$\theta = 3.82^{o}$ ✓

component down slope = W sin θ ✓

$= (70)(9,8) \sin (3.82)$

$= 45.70$ N ✓ (4)

6.1.2 $P = F v$ ✓

$P = (45.70)(9.0)$ ✓

$P = 411.3$ W ✓ (3)

6.2.1 Because the friction force between the bicycle wheels and the ground is neglected, we can say that:

Kinetic energy → Potential energy ✓ (1)

6.2.2 $KE_{bottom} + PE_{bottom} = KE_{top} + PE_{top}$ ✓

$$\frac{1}{2}mv^2 + 0 = 0 + mgh$$

$$h = \frac{v^2}{2g}$$

$$h = \frac{(9.0)^2}{(2(9,8))}$$

$$h = 4.13 \text{ m} ✓ ✓$$

$$\sin\theta = \frac{h}{distance}$$

$$distance = \frac{4,13}{\sin 3,82^o} = 62.44 \text{ m} ✓ ✓$$ (5)

[13]

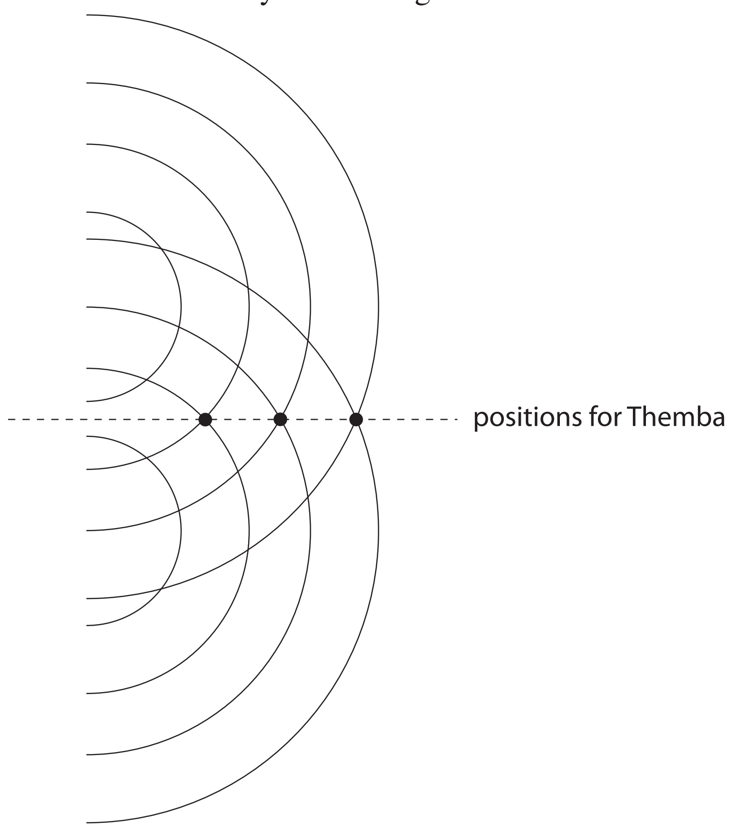
QUESTION 7

7.1 7.1.1 Magenta and yellow ✓ (all correct or no marks) (2)

7.1.2 Cyan ✓ (1)

7.1.3 A cyan lens is made from <u>blue</u> and <u>green</u> so lets through the blue ✓ image. A magenta lens is made from <u>blue</u> and <u>red</u> – letting through both ✓ blue and red images, meaning that the images are not separated for each eye. [✓ for colours of lenses – all must be correct.] (3)

7.2 7.2.1 Themba can be anywhere along the dotted line. (4)



7.2.2 Destructive interference. (2)

7.2.3 Higher frequency or shorter wavelength. Sources further apart. (2)

7.2.4 Diffraction. (1)

7.2.5 The music will involve many frequencies and so no clear interference pattern will result. (2)

QUESTION 8

8.1 8.3 Doppler effect ✓. (1)

8.3 Y ✓ (1)

8.3 N ✓ (1)

8.3.2 $f_o = \frac{v_s}{v_s - v_A} f_S = \frac{340}{340 - 24}$ ✓(bottom subs) (520 ✓) f_o = 559,5 Hz ✓ (3)

8.3.3 (a) Wavelength increases ✓.

(b) Frequency of the dolphin's call remains the same ✓ (2)

[17]

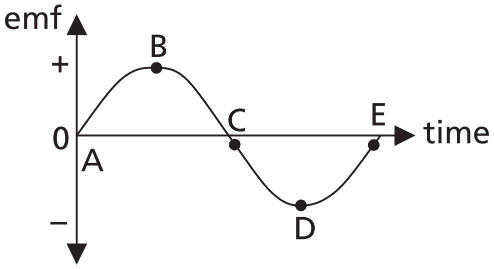
QUESTION 9

9.1 X – slip rings ✓ (2)

9.2 Mechanical to electrical ✓. (1)

9.3 c to d ✓ (1)

9.4



Sine curve (AE) ✓ ✓

Labels ✓ ✓ (4)

9.5
- Speed of rotation – faster ⇒ bigger emf
- Magnet strength – stronger ⇒ bigger emf
- Number of coils – more coils ⇒ bigger emf
- Curved magnets – field lines at 90° for longer

Two variables for 2 marks each. (4)

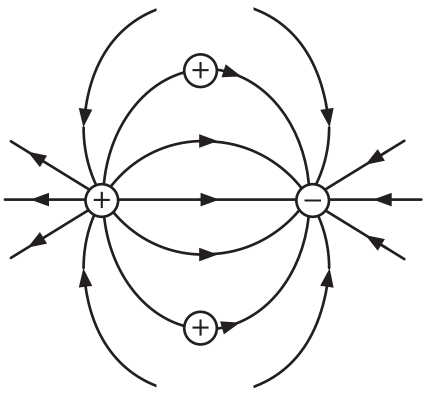
9.6 A DC generator has a split ring commutator ✓while an AC generator has slip rings. ✓ (2)

[14]

QUESTION 10

10.1 The electrostatic force between two point charges is directly proportional ✓ to the product of the charges and inversely proportional to the square distance between them. ✓ (2)

10.2



Correct diagram

Lines perpendicular to charge

Arrows (3)

10.3 $F = \frac{kQ1Q2}{r^2}$ ✓

$= \frac{9 \times 10^9 \times 6 \times 10^{-9} \times 7 \times 10^{-9}}{(0.15)^2}$ ✓

$= 1.68 \times 10^{-5}$N ✓ (3)

10.4 Attractive ✓ (1)

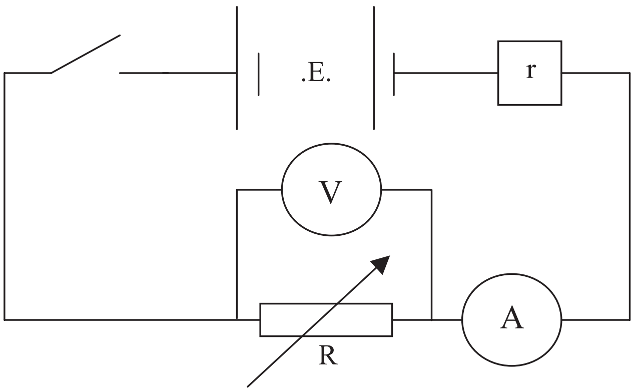
10.5 10.5.1 F is a quarter of the original size. ✓

10.5.2 F is a quarter of the original size. ✓ (2)

[11]

QUESTION 11

11.1



Correct position of ammeter ✓

Correct position of voltmeter ✓

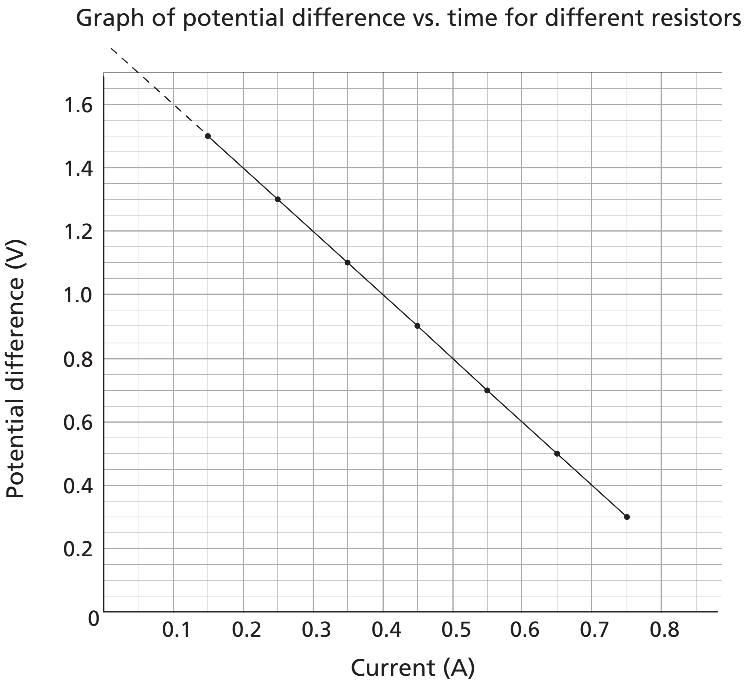
All connections in place ✓ (3)

11.2 11.2.1 Dependent variable – voltage ✓

Independent variable – current ✓ (2)

11.2.2 temperature ✓ (1)

11.2.3



Scale ✓ Accuracy ✓ Labels ✓ ✓ Best fit line ✓ Heading ✓ (6)

11.3 11.3.1 The emf of a cell can be obtained when the cell is not delivering any current. Therefore: where the current = 0A on the graph, the emf = 1.8 V. ✓ (1)

11.3.2 The maximum current that can flow is when the potential difference across the resistor is zero, which means that there is no resistance in the external circuit. Therefore where the potential difference is zero, the line cuts the current axis at (maximum current) = 0.9A. ✓ (1)

11.3.3 $r = \frac{E}{I}$ ✓ $= \frac{1.8}{0.9}$ ✓ $= 2\ \Omega$ ✓ (3)

[17]

QUESTION 12

12.1 No effect ✓ as frequency of incoming radiation must be above threshold ✓ (2)

12.2 Intensity increased therefore more photons ✓ 1 photon releases 1 electron; therefore ✓ current increases ✓ (3)

12.3 Electrons collide with air particles ✓, electrons slow down, less current ✓ (2)

12.4 $hf = W_0 + KE_{max}$ ✓ ✓

hf = energy of incoming photon ✓

W_0 = work function OR min energy needed to free electron ✓

KE_{max} = max kinetic energy of ejected electron ✓ (5)

12.5 From graph, $f_0 = 4 \times 10^{14}$ Hz ✓

$c = f_0\lambda$

$3 \times 10^8 = 4 \times 10^{14}\ \lambda$ ✓

$\lambda = 7.50 \times 10^{-7}$ m ✓ (3)

[15]

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

EXEMPLAR 2014

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 The net force acting on an object is directly proportional to the ...

A mass of the object.

B acceleration of the object.

C change in momentum of the object.

D rate of change in momentum of the object. (2)

1.2 An astronomer, viewing light from distant galaxies, observes a shift of spectral lines toward the red end of the visible spectrum. This shift provides evidence that …

A the universe is expanding.

B the galaxies are moving closer towards Earth.

C Earth is moving towards the distant galaxies.

D the temperature of Earth's atmosphere is increasing. (2)

1.3 A ball is thrown vertically upwards. Which ONE of the following physical quantities has a non-zero value at the instant the ball changes direction?

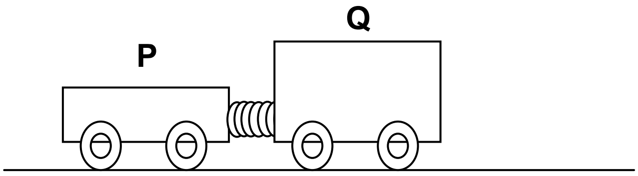
A Acceleration

B Kinetic energy

C Momentum

D Velocity (2)

1.4 Two trolleys, **P** and **Q**, of mass *m* and 2*m* respectively are at rest on a frictionless horizontal surface. The trolleys have a compressed spring between them.



The spring is released and the trolleys move apart. Which ONE of the following statements is TRUE?

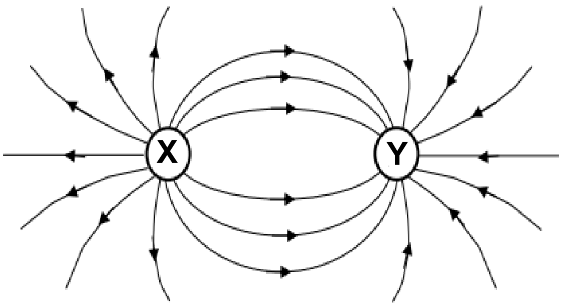
A **P** and **Q** have equal kinetic energies.

B The speed of **P** is less than the speed of **Q**.

C The sum of the final kinetic energies of **P** and **Q** is zero.

D The sum of the final momentum of **P** and **Q** is zero. (2)

1.5 The diagram below shows the electric field pattern due to two point charges **X** and **Y**.



Which ONE of the following represents the charge on **X** and **Y** respectively?

	POINT CHARGE X	**POINT CHARGE Y**
A	Negative	Negative
B	Positive	Positive
C	Positive	Negative
D	Negative	Positive

(2)

1.6 Two identical metal spheres, each of mass *m* and separated by a distance *r*, exert a gravitational force of magnitude *F* on each other. The distance between the spheres is now HALVED.

The magnitude of the force the spheres now exerts on each other is:

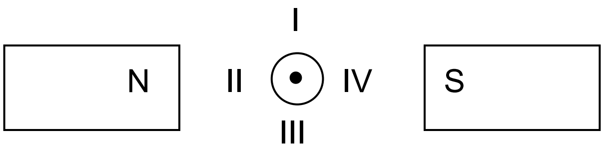
A ½*F*

B *F*

C 2*F*

D 4*F* (2)

1.7 In the diagram below, a conductor placed between two magnets is carrying current out of the page.



The direction of the force exerted on the conductor is towards:

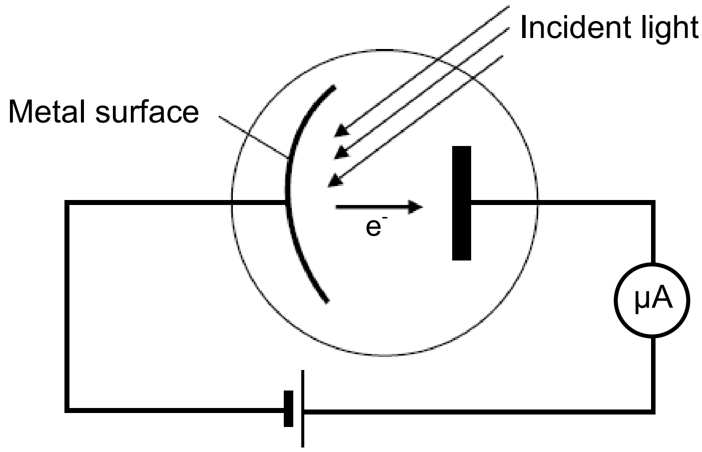
A I

B II

C III

D IV (2)

1.8 When light of a certain frequency is incident on the cathode of a photocell, the ammeter in the circuit registers a reading.

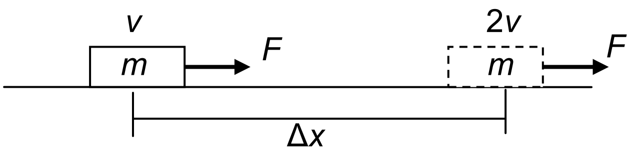


The frequency of the incident light is now increased while keeping the intensity constant. Which ONE of the following correctly describes the reading on the ammeter and the reason for this reading?

	AMMETER READING	**REASON**
A	Increases	More photoelectrons are emitted per second.
B	Increases	The speed of the photoelectrons increases.
C	Remains the same	The number of photoelectrons remains the same.
D	Remains the same	The speed of the photoelectrons remains the same.

(2)

1.9 An applied force F accelerates an object of mass m on a horizontal frictionless surface from a velocity v to a velocity $2v$.



The net work done on the object is equal to ...

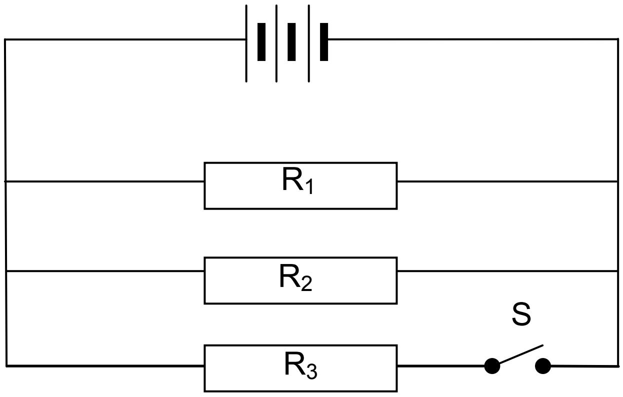
A $\frac{1}{2}mv^2$.

B mv^2.

C $\frac{3}{2}mv^2$.

D $2mv^2$. (2)

1.10 Consider the circuit diagram below.



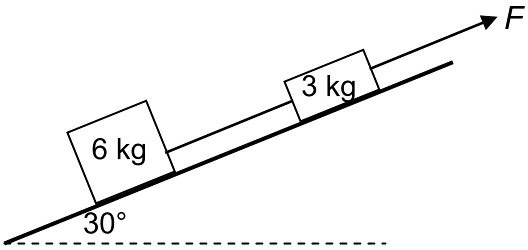
Which ONE of the following correctly describes the change in total resistance and total current when switch **S** is closed?

	TOTAL RESISTANCE	**TOTAL CURRENT**
A	Decreases	Decreases
B	Increases	Increases
C	Decreases	Increases
D	Increases	Decreases

(2)
[20]

QUESTION 2 (Start on a new page.)

A light inelastic string connects two objects of mass 6 kg and 3 kg respectively. They are pulled up an inclined plane that makes an angle of 30° with the horizontal, with a force of magnitude *F*. Ignore the mass of the string.



The coefficient of kinetic friction for the 3 kg object and the 6 kg object is 0,1 and 0,2 respectively.

2.1 State Newton's Second Law of Motion in words. (2)

2.2 How will the coefficient of kinetic friction be affected if the angle between the incline and the horizontal increases? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

2.3 Draw a labelled free-body diagram indicating all the forces acting on the 6 kg object as it moves up the inclined plane. (4)

2.4 Calculate the:

2.4.1 Tension in the string if the system accelerates up the inclined plane at 4 $m \cdot s^{-2}$ (5)

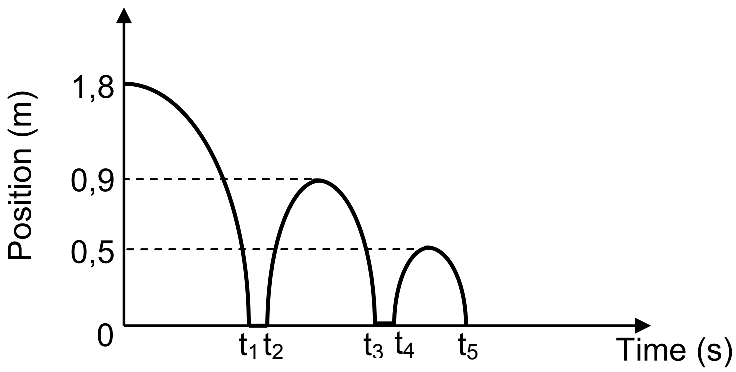
2.4.2 Magnitude of *F* if the system moves up the inclined plane at CONSTANT VELOCITY (6)

2.5 How would the tension in the string, calculated in QUESTION 2.4.1, be affected if the system accelerates up a FRICTIONLESS inclined plane at 4 $m \cdot s^{-2}$? Write down only INCREASES, DECREASES OR REMAINS THE SAME. (1)

[19]

QUESTION 3 (Start on a new page.)

A ball of mass 0,5 kg is projected vertically downwards towards the ground from a height of 1,8 m at a velocity of 2 m·s^{-1}. The position-time graph for the motion of the ball is shown below.



3.1 What is the maximum vertical height reached by the ball after the second bounce? (1)

Calculate the:

3.2 Magnitude of the time t_1 indicated on the graph (5)

3.3 Velocity with which the ball rebounds from the ground during the first bounce (4)

The ball is in contact with the ground for 0,2 s during the first bounce.

3.4 Calculate the magnitude of the force exerted by the ground on the ball during the first bounce if the ball strikes the ground at 6,27 m·s^{-1}. (4)

3.5 Draw a velocity-time graph for the motion of the ball from the time that it is projected to the time when it rebounds to a height of 0,9 m.

Clearly show the following on your graph:

- The time when the ball hits the ground
- The velocity of the ball when it hits the ground
- The velocity of the ball when it rebounds from the ground (3)

[17]

QUESTION 4 (Start on a new page.)

Two boys, each of mass m, are standing at the back of a flatbed trolley of mass 4 m. The trolley is at rest on a frictionless horizontal surface.

The boys jump off simultaneously at one end of the trolley with a horizontal velocity of 2 $m \cdot s^{-1}$. The trolley moves in the opposite direction.

4.1 Write down the *principle of conservation of linear momentum* in words. (2)

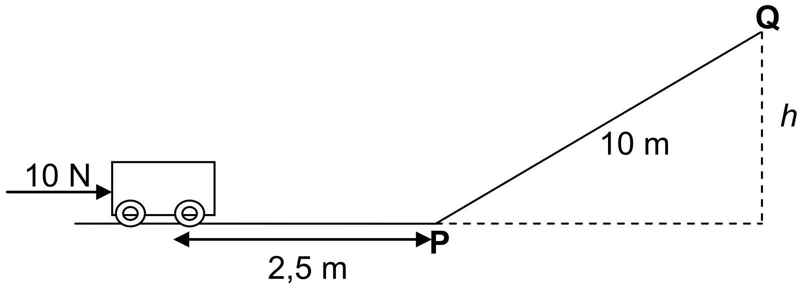
4.2 Calculate the final velocity of the trolley. (5)

4.3 The two boys jump off the trolley one at a time. How will the velocity of the trolley compare to that calculated in QUESTION 4.2? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

[8]

QUESTION 5 (Start on a new page.)

A 3 kg trolley is at rest on a horizontal frictionless surface. A constant horizontal force of 10 N is applied to the trolley over a distance of 2,5 m.



When the force is removed at point **P**, the trolley moves a distance of 10 m up the incline until it reaches the maximum height at point **Q**. While the trolley moves up the incline, there is a constant frictional force of 2 N acting on it.

5.1 Write down the name of a non-conservative force acting on the trolley as it moves up the incline. (1)

5.2 Draw a labelled free-body diagram showing all the forces acting on the trolley as it moves along the horizontal surface. (3)

5.3 State the WORK-ENERGY THEOREM in words. (2)

5.4 Use the work-energy theorem to calculate the speed of the trolley when it reaches point **P**. (4)

5.5 Calculate the height, *h*, that the trolley reaches at point **Q**. (5)

[15]

QUESTION 6 (Start on a new page.)

The siren of a stationary police car emits sound waves of wavelength 0,55 m.

With its siren on, the police car now approaches a stationary listener at constant velocity on a straight road. Assume that the speed of sound in air is 345 $m \cdot s^{-1}$.

6.1 Will the wavelength of the sound waves observed by the listener be GREATER THAN, SMALLER THAN or EQUAL TO 0,55 m? (1)

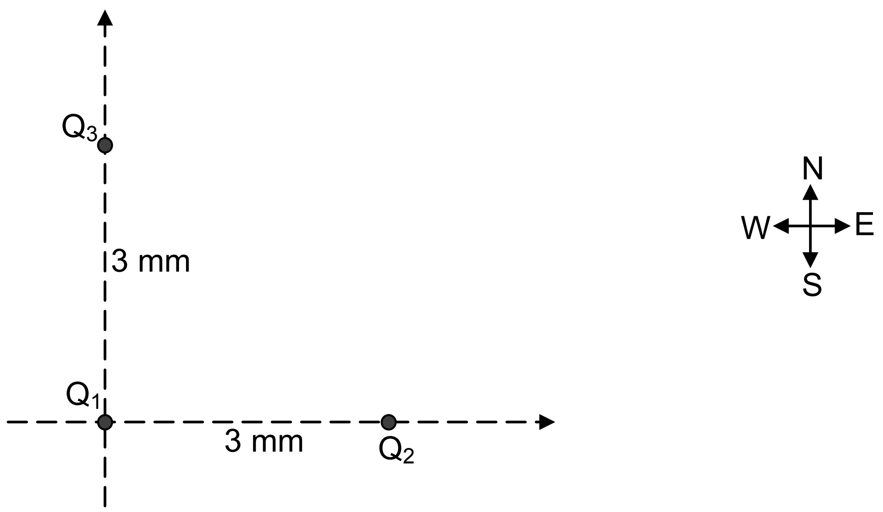
6.2 Name the phenomenon observed in QUESTION 6.1. (1)

6.3 Calculate the frequency of the sound waves observed by the listener if the car approaches him at a speed of 120 $km \cdot h^{-1}$. (7)

6.4 How will the answer in QUESTION 6.3 change if the police car moves away from the listener at 120 $km \cdot h^{-1}$? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[10]

QUESTION 7 (Start on a new page.)

Three small, identical metal spheres, Q_1, Q_2 and Q_3, are placed in a vacuum. Each sphere carries a charge of – 4 μC. The spheres are arranged such that Q_2 and Q_3 are each 3 mm from Q_1 as shown in the diagram below.



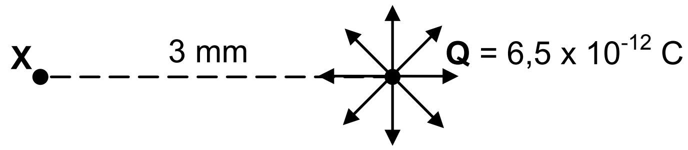
7.1 State Coulomb's law in words. (2)

7.2 Draw a force diagram showing the electrostatic forces exerted on Q_1 by Q_2 and Q_3. (2)

7.3 Calculate the net force exerted on Q_1 by Q_2 and Q_3. (8)
[12]

QUESTION 8 (Start on a new page.)

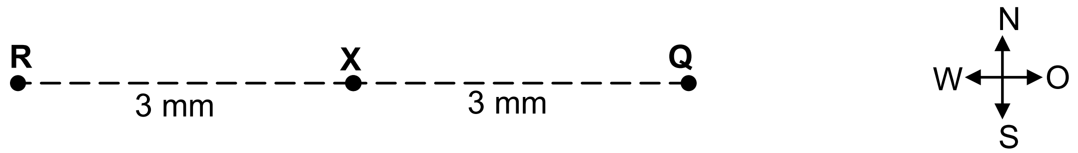
An isolated point charge **Q** is located in space as shown in the diagram below. Point charge **Q** contributes to an electric field as shown. Point **X** is located 3 mm away from point charge **Q**.



8.1 Define the term *electric field* at a point. (2)

8.2 Calculate the magnitude of the electric field at point **X**. (3)

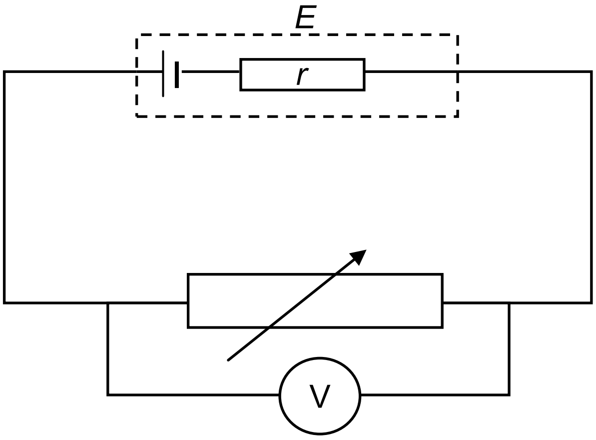
8.3 Point charge **R** carrying a charge of + 6,5 x 10^{-12} C is placed 3 mm away from point **X** as shown in the diagram below.



Calculate the net electric field at point **X**. (4)
[9]

QUESTION 9 (Start on a new page.)

9.1 In an experiment, learners use the circuit below to determine the internal resistance of a cell.

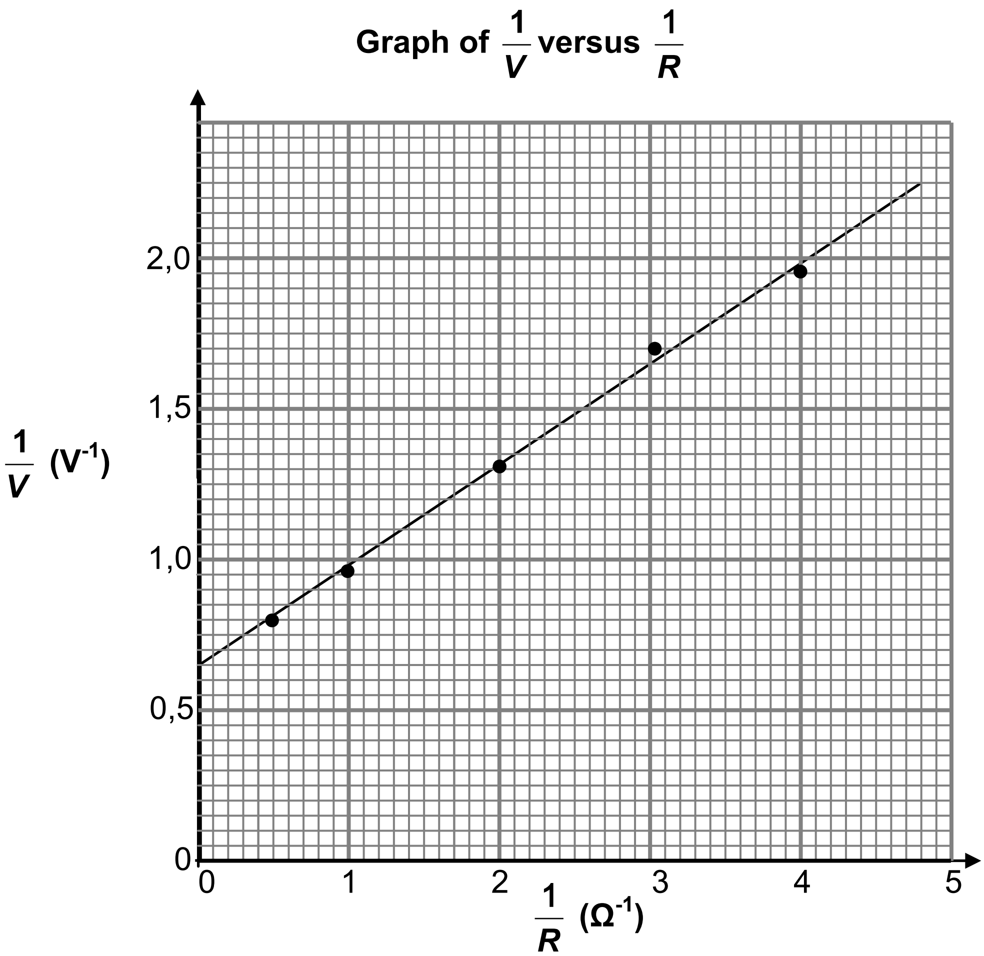


The circuit consists of a cell of emf E and internal resistance r. A voltmeter is placed across a variable resistor which can be set to *known values* R.

The equation used by the learners is:

$$\frac{1}{V} = \frac{r}{ER} + \frac{1}{E}$$

They obtain the graph below.



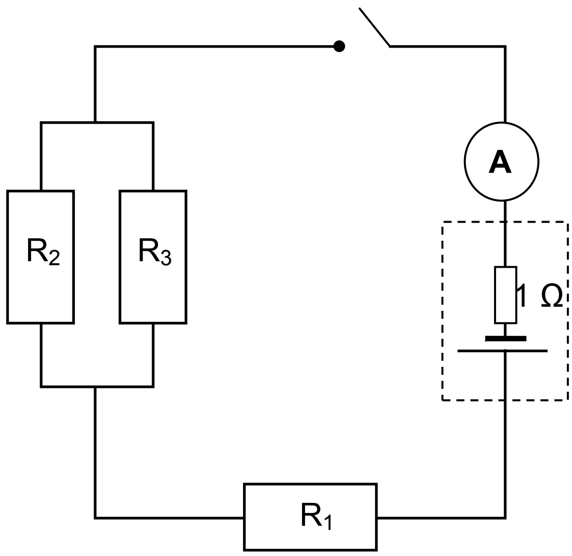
9.1.1 Write down a mathematical relationship for the slope of the graph. (1)

Use the information in the graph and calculate the:

9.1.2 Emf of the cell (2)

9.1.3 Internal resistance of the cell (3)

9.2 In the electrical circuit shown below, the battery has an emf of 6 V and an internal resistance of 1 Ω. The total external resistance of the circuit is 9 Ω.



9.2.1 Calculate the current in R_1 when the switch is closed. (3)

The power dissipated in resistor R_1 is 1,8 W. The resistance of resistor R_3 is 4 times that of resistor R_2. ($R_3 = 4R_2$)

9.2.2 Calculate the resistance of resistor R_2. (5)

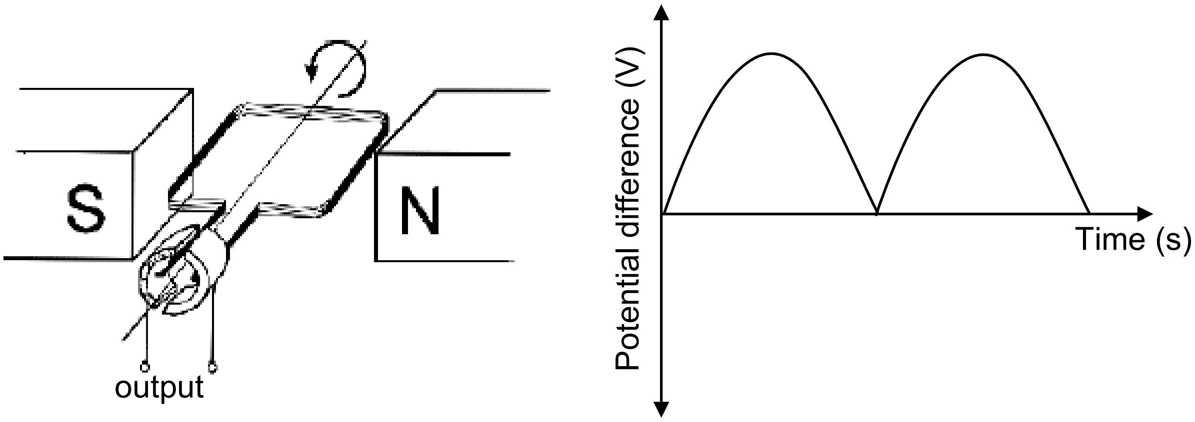
9.3 A hair dryer operates at a potential difference of 240 V and a current of 9,5 A.

It takes a learner 12 minutes to completely dry her hair. Eskom charges energy usage at R1,47 per unit. Calculate the cost of operating the hairdryer for the 12 minutes. (1 unit = 1 kW·h) (4)

[18]

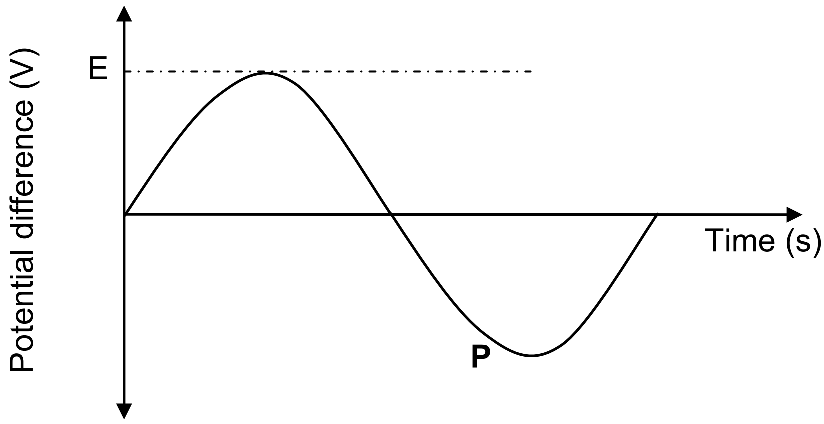
QUESTION 10 (Start on a new page.)

A simplified diagram of a DC generator and a graph of its output potential difference for one cycle is shown below.



10.1 Write down ONE way in which the output of this generator can be increased. (1)

A specific change is made to the structure of the DC generator in QUESTION 10.1. The output potential difference obtained as a result of this change is shown below.



10.2 Write down the change that was made to the DC generator. (1)

10.3 Copy graph **P** into your ANSWER BOOK.

On the same set of axes, sketch the graph of the output potential difference that will be obtained when the new generator is rotated at TWICE its original speed.

Label this graph as **Q**. (2)

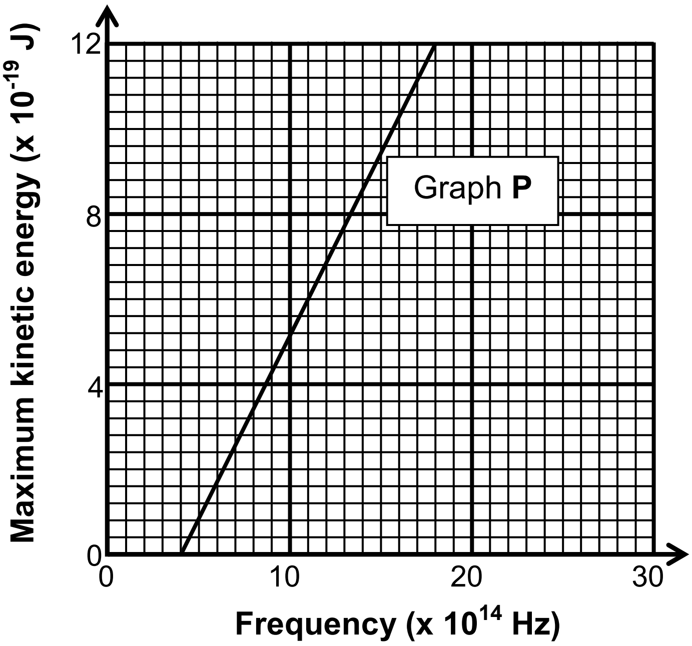
10.4 A certain generator operates at a maximum voltage of 340 V. A 120 W appliance is connected to the generator. Calculate the resistance of the appliance. (4)

[8]

QUESTION 11 (Start on a new page.)

Graph **P** below shows how the maximum kinetic energy of electrons emitted from the cathode of a photoelectric cell varies with the frequency of the incident radiation.

Graph of maximum kinetic energy versus frequency



11.1 Define the term *work function*. (2)

11.2 Calculate the:

11.2.1 Work function of the metal used as cathode in the photocell (3)

11.2.2 Velocity of photoelectrons emitted when the frequency of the incident light is 8 x 10^{14} Hz (5)

11.3 The photocell is now replaced with another one in which the work function of the cathode is TWICE that of the metal in the first cell.

The maximum kinetic energy versus frequency graph, **Q**, for this cathode is now drawn on the same set of axes as graph **P**.

11.3.1 How will the gradient of graph **Q** compare to that of graph **P**? Write down GREATER THAN, SMALLER THAN or EQUAL TO. Explain the answer. (2)

11.3.2 What will the value of the x-intercept of graph **Q** be? Explain how you arrived at the answer. (2)

[14]

TOTAL: 150

QUESTION 1/*VRAAG 1*

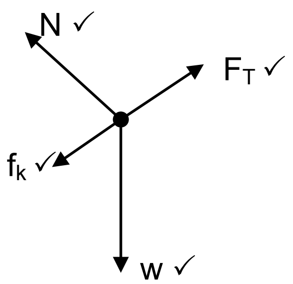
1.1	B ✓✓	(2)
1.2	A ✓✓	(2)
1.3	A ✓✓	(2)
1.4	D ✓✓	(2)
1.5	C ✓✓	(2)
1.6	D ✓✓	(2)
1.7	A ✓✓	(2)
1.8	B ✓✓	(2)
1.9	C ✓✓	(2)
1.10	C ✓✓	(2)
		[20]

QUESTION 2/*VRAAG 2*

2.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force. This acceleration is directly proportional to the force ✓and inversely proportional to the mass of the object. ✓
Wanneer 'n resulterende/netto krag op 'n liggaam inwerk, sal die liggaam in die rigting van die krag versnel. Hierdie versnelling is direk eweredig aan die krag en omgekeerd eweredig aan die massa van die liggaam. (2)

2.2 Remains the same / *Bly dieselfde* ✓ (1)

2.3



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg / gravitational force *F_g / F_w / gewig / mg / gravitasiekrag*
f	$F_{friction}$ / F_f / friction *$F_{wrywing}$ / F_w / wrywing*
N	F_N / F_{normal} / normal force F_N / $F_{normaal}$ / *normaalkrag*
F_T	F_t / T / tension F_t / T / *spanning*

(4)

2.4

2.4.1 Up the incline as positive/*Teen die skuinste op as positief:*

$F_{net} = ma$
$F_T + f_k + w_{//} = ma$
$F_T + \mu_k N + w\sin30° = ma$
$F_T + \mu_k mg\cos30° + mg\sin30° = ma$
✓ Any one/*Enige een*

$F_T - (0,2)(6)(9,8)\cos30°$✓ $- (6)(9,8)\sin30°$✓ $= (6)(4)$ ✓
$\therefore F_T = 63,58$ N ✓ (5)

2.4.2 Up the incline as positive/*Teen die skuinste op as positief:*

$F_{net} = ma$
$F + f_{k(6\ kg)} + f_{k(3\ kg)} + w_{//} = ma$
$F + \mu_k N_{(6\ kg)} + \mu_k N_{(3\ kg)} + mg\sin30° = ma$
✓ Any one/*Enige een*

$F - (0,2)(6)(9,8)\cos30°$✓ $- (0,1)(3)(9,8)\cos30°$✓ $- (9)(9,8)\sin30°$✓ $= 0$ ✓
$\therefore F = 56,83$ N ✓ (6)

2.5 Decreases / *Afneem* ✓ (1)

[19]

QUESTION 3/*VRAAG 3*

3.1 0,5 m ✓ (1)

3.2 **<u>OPTION 1/*OPSIE 1*</u>**

Upwards positive/*Opwaarts positief*:

$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = (-2)^2 + 2(-9,8)(-1,8)$ ✓
$v_f = -6,27\ m\cdot s^{-1}$ ✓

$v_f = v_i + a\Delta t$
$-6,27 = -2 + (-9,8)\Delta t$ ✓
$\Delta t = 0,44\ s$ ✓

✓Both equations/*Beide vergelykings*

Downwards positive/*Afwaarts positief:*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (2)^2 + 2(9,8)(1,89)$ ✓
$v_f = 6,27\ m\cdot s^{-1}$ ✓

$v_f = v_i + a\Delta t$
$6,27 = 2 + (9,8)\Delta t$ ✓
$\Delta t = 0,44\ s$ ✓

✓Both equations/*Beide vergelykings*

<u>OPTION 2/*OPSIE 2*</u>

Upwards positive/*Opwaarts positief:*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$-1,8$ ✓ $= (-2)\Delta t$ ✓ $+ \frac{1}{2}(-9,8)\Delta t^2$ ✓

$$\Delta t = \frac{-2 \pm \sqrt{(2)^2 - 4(4,9)(-1,8)}}{2(4,9)}$$

$= 0,44\ s$ ✓

Downwards positive/*Afwaarts positief:*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$1,8$ ✓ $= (2)\Delta t$ ✓ $+ \frac{1}{2}(9,8)\Delta t^2$ ✓

$$\Delta t = \frac{-2 \pm \sqrt{(-2)^2 - 4(4,9)(-1,8)}}{2(4,9)} = 0,44\ s$$ ✓

(5)

3.3 **Upwards positive/*Opwaarts positief:***

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0^2 = v_i^2 + 2(-9,8)(0,9)$ ✓
$v_i = 4,2\ m\cdot s^{-1}$ ✓ upwards/*opwaarts* ✓

Downwards positive/*Afwaarts positief:*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0^2 = v_i^2 + 2(9,8)(0,9)$ ✓
$v_i = 4,2\ m\cdot s^{-1}$ ✓ upwards/*opwaarts* ✓ (4)

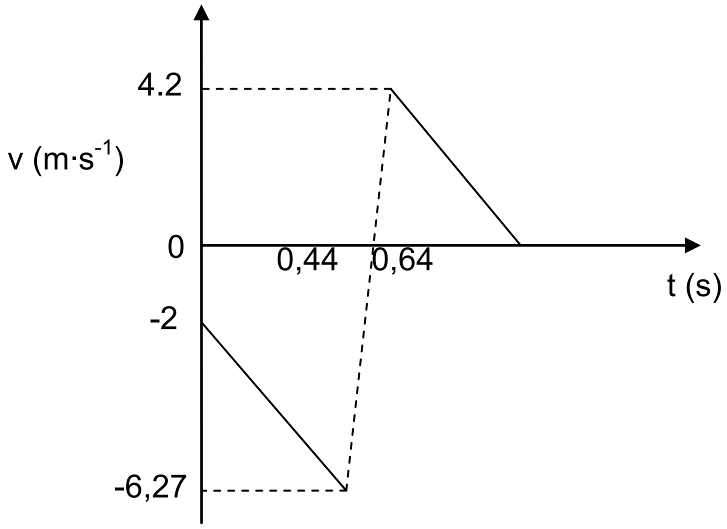
3.4 **Upwards positive/*Opwaarts positief:***

$F_{net}\Delta t = m\Delta v$ ✓
F_{net} (0,2) ✓= (0,5)[(4,2 – (-6,27)] ✓
F_{net} = 26,175 N ✓

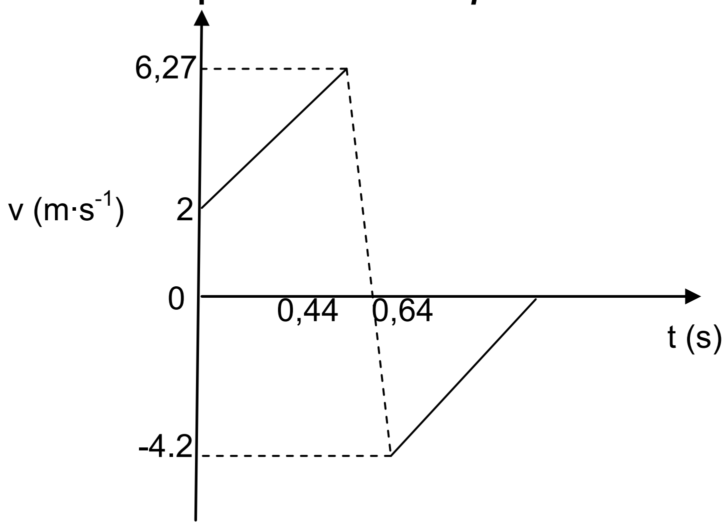
Downwards positive/*Afwaarts positief:*

$F_{net}\Delta t = m\Delta v$ ✓
F_{net} (0,2) ✓ = (0,5)[(-4,2 – (6,27)] ✓
F_{net} = -26,175 N
F_{net} = 26,175 N ✓ (4)

3.5 **Upwards positive/*Opwaarts positief:***



Downwards positive/*Afwaarts positief:*



(3)

Criteria for graph/*Kriteria vir grafiek:*	**Marks/ *Punte***
First part of the graph starts at v = 2 $m\cdot s^{-1}$ at t = 0 s and extends until v = 6,27 $m\cdot s^{-1}$ at t = 0,44 s. *Eerste deel van die grafiek begin by v = 2* $m\cdot s^{-1}$ *by t = 0 s en verleng tot* v = 6,27 $m\cdot s^{-1}$ by *t = 0,44 s.*	✓
Graph is discontinuous and object changes direction at 0,64 s. *Grafiek is nie kontinu nie en voorwerp verander van rigting by 0,64 s.*	✓
Second part of graph starts at v = 4,2 $m\cdot s^{-1}$ at t = 0,64 s until v = 0 $m\cdot s^{-1}$. *Tweede deel van grafiek begin by v = 4,2* $m\cdot s^{-1}$ *by t = 0,64 s tot* v = 0 $m\cdot s^{-1}$.	✓

[17]

QUESTION 4/*VRAAG 4*

4.1 The total linear momentum in a closed system ✓ remains constant. / is conserved. ✓
Die totale lineêre momentum in 'n geslote sisteem bly konstant / bly behoue.

OR/*OF*
In a closed system ✓ the total linear momentum before collision is equal to the total linear momentum after collision. ✓
In 'n geslote sisteem is die totale lineêre momentum voor botsing gelyk aan die totale lineêre momentum na botsing. (2)

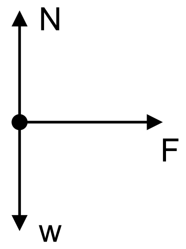
4.2 $\sum p_i = \sum p_f$
$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$ } ✓ Any one/*Enige een*
$(2m + 4m)(0)$ ✓ $= 2m(2) + 4m(v_{2f})$ ✓
$-4m = 4mv_f$
$\therefore v_f = -1\ m\cdot s^{-1}$
$\therefore v_f = 1\ m\cdot s^{-1}$ ✓ in the opposite direction to that of the boys ✓
in die teenoorgestelde rigting as dié van die seuns (5)

4.3 Greater than / *Groter as* ✓ (1)
[8]

QUESTION 5/*VRAAG 5*

5.1 Frictional force / *Wrywingkrag* ✓ (1)

5.2 F_N / Normal force / *Normaalkrag* ✓
F_g / Gravitational force / Weight / *Gravitasiekrag* / *Gewig* ✓
F_{app}/ 10 N / Horizontal applied force / *Horisontale toegepaste krag* ✓



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg / gravitational force *F_g / F_w / gewig / mg / gravitasiekrag*
N	F_N / F_{normal} / normal force F_N / $F_{normaal}$ / *normaalkrag*
F	F_{app} / applied force / 10 N F_{toeg} / *toegepaste krag/ 10 N*

(3)

5.3 The <u>net work done</u> ✓on an object is <u>equal to the change in kinetic energy</u> ✓of the object.
Die <u>netto arbeid verrig</u> op 'n voorwerp is <u>gelyk aan die verandering in kinetiese energie</u> van die voorwerp. (2)

5.4 $W_{net} = \Delta E_K$ ✓
$W_F + W_w + W_{FN} = ½\, m(v_f^2 - v_i^2)$
$(10)(2,5)\cos0^o + 0 + 0$ ✓$= ½\,(3)(v_f^2 - 0^2)$ ✓
$v_f = 4,08\ m{\cdot}s^{-1}$ ✓ (4)

5.5 **<u>OPTION 1/*OPSIE 1*</u>**
$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$f\Delta x\cos\theta = (mgh_f - mgh^i) + (½\, mv_f^2 - ½\, mv_i^2)$
$(2)(10)\cos180^o$ ✓$= (3)(9,8)h_f - 0$ ✓ $+ 0 - ½\,(3)(4,08)^2$ ✓
$\therefore h = 0,17$ m ✓

<u>OPTION 2/*OPSIE 2*</u>
$W_{net} = \Delta E_K$ ✓
$W_f + W_w = ½\, m(v_f^2 - v_i^2)$
$(2)(10)\cos180^o$ ✓$+ (3)(9,8)h\cos 180^o$ ✓$= ½\,(3)(0^2 - 4,08^2)$ ✓
$\therefore h = 0,17$ m ✓

<u>OPTION 3/*OPSIE 3*</u>
$W_{net} = \Delta E_k$ ✓
$mg\sin\alpha\, \Delta x\cos\theta + f\Delta x\cos\theta = ½\, m(v_f^2 - v_i^2)$
$(3)(9,8)(\frac{h}{10})(10)\cos180^o$ ✓$+ (2)(10)\cos180^o$ ✓$= ½\,(3)(0^2 - 4,08^2)$ ✓
$\therefore h = 0,17$ m ✓ (5)
[15]

QUESTION 6/*VRAAG 6*

6.1 Smaller than / *Kleiner as* ✓ (1)

6.2 Doppler effect / *Doppler-effek* ✓ (1)

6.3 $v = f\lambda$ ✓
$345 = f(0{,}55)$ ✓
$\therefore f = 627{,}27\ \text{Hz}$

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

$= \frac{345}{345 - 33{,}33}(627{,}27)$ ✓ ✓ ✓

$= 694{,}35\ \text{Hz}$ ✓ (7)

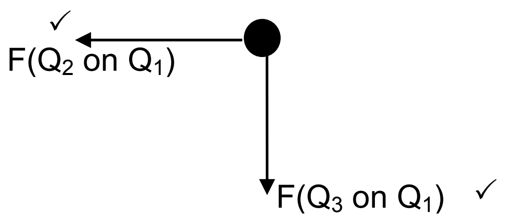
6.4 Decreases / *Verlaag* ✓ (1)

[10]

QUESTION 7/*VRAAG 7*

7.1 The (magnitude) of the electrostatic force exerted by one charge on another is directly proportional to the (magnitudes of the) charges ✓ and inversely proportional to the square of the distance between their centres. ✓
Die (grootte) van die elektrostatiese krag wat een lading op 'n ander uitoefen, is direk eweredig aan die (groottes van die) ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hul middelpunte. (2)

7.2



(2)

7.3 $F = k\frac{Q_1Q_2}{r^2}$ ✓

$F(Q_2 \text{ on } Q_1) = (9 \times 10^9)\frac{(4\times10^{-6})(4\times10^{-6})}{(3\times10^{-3})^2}$ ✓ ✓ $= 1{,}6 \times 10^4$ N (to left/*na links*)

$F(Q_3 \text{ on } Q_1) = (9 \times 10^9)\frac{(4\times10^{-6})(4\times10^{-6})}{(3\times10^{-3})^2}$ ✓ $= 1{,}6 \times 10^4$ N

(downwards/*afwaarts*)

$F_{net} = \sqrt{(F_{Q2\text{ on }Q1})^2 + (F_{Q3\text{ on }Q1})^2}$

$= \sqrt{(1{,}6 \times 10^4)^2 + (1{,}6\times10^4)^2}$ ✓

$= 2{,}26 \times 10^4$ N

$\tan\theta = \left(\frac{F_{Q3\text{ on }Q1}}{F_{Q2\text{ on }Q1}}\right)$

$\tan\theta = \left(\frac{1{,}6\times10^4}{1{,}6\times10^4}\right)$ ✓

$\therefore \theta = 45°$

$F_{net} = 2{,}26 \times 10^3$ N ✓ SW / 225° / 45° south of west / *suid van wes* ✓ (8)

[12]

QUESTION 8/*VRAAG 8*

8.1 <u>The force</u> ✓<u>per unit charge</u> ✓ at that point.
<u>Die krag</u> <u>per eenheidslading</u> by daardie punt. (2)

8.2 $E = \frac{kQ}{r^2}$ ✓

$= \frac{(9\times10^9)(6{,}5\times10^{-12})}{(0{,}003)^2}$ ✓

$= 6{,}5 \times 10^3$ N·C^{-1} ✓ (3)

8.3 **At point X/*By punt X***

$E_Q = 6{,}5 \times 10^3$ N·C^{-1} west/*wes* ✓

$E_R = \frac{kQ}{r^2}$

$= \frac{(9\times10^9)(6{,}5\times10^{-12})}{(0{,}003)^2}$

$= 6{,}5 \times 10^3$ N·C^{-1} east/*oos* ✓

$E_{net} = E_Q + E_R$ ✓

$= 6{,}5 \times 10^3 + (-6{,}5 \times 10^3)$

$= 0$ N·C^{-1} ✓ (4)

[9]

QUESTION 9/*VRAAG 9*

9.1

9.1.1 From graph/*Van grafiek:* $\frac{R}{V}$ ✓

OR/*OF*

From equation/*Van vergelyking*: $\frac{r}{E}$ (1)

9.1.2 $\frac{1}{E} = 0,65$ ✓

$\therefore E = 1,54\ V$ ✓ (2)

9.1.3 $\frac{r}{E} = \frac{2 - 1}{4 - 1}$ ✓✓

$\therefore r = 0,51\ \Omega$ ✓

(Any set of values from the graph can be used to calculate the gradient./*Enige stel waardes van die grafiek kan gebruik word om die gradiënt te bereken.)* (3)

9.2

9.2.1 Emf/*emk* = $I(R + r)$ ✓

$6 = I(9 + 1)$ ✓

$\therefore I = 0,6\ A$ ✓ (3)

9.2.2 $P = I^2R$ ✓

$1,8 = (0,6)^2R_1$ ✓

$R_1 = 5\ \Omega$

$R_p = 9 – 5 = 4\ \Omega$ ✓

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{4} = \frac{1}{R_2} + \frac{1}{4R_2}$$ ✓

$\therefore R_2 = 5\ \Omega$ ✓ (5)

9.3 $W = VI\Delta t$ ✓

$= (240)(9,5)(12)(60)$ ✓

$= 1,64 \times 10^6\ J$

Cost/*Koste* = $\frac{1,64 \times 10^6}{3,6 \times 10^6} \times 1,47$ ✓

= R0,67 or/*of* 67 cents/*sent* ✓ (4)

[18]

QUESTION 10/*VRAAG10*

10.1 Increase the speed of rotation. / *Verhoog spoed van rotasie.* ✓

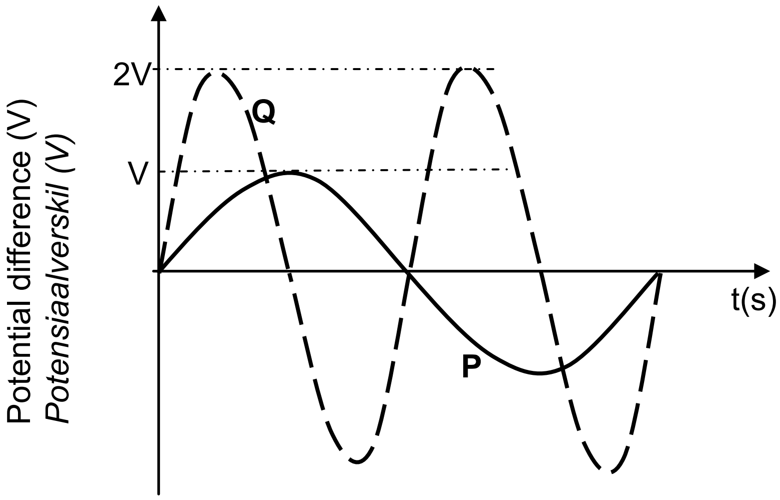
OR/*OF*
Increase the number of coils. / *Verhoog getal windings/spoele.*

OR/*OF*
Increase the strength of the magnetic field. / *Verhoog magetiese veldsterkte.* (1)

10.2 Commutators replaced by slip rings./ *Kommutators vervang met sleepringe.* ✓

OR/*OF*
Slip rings were used. /*Sleepringe is gebruik.* ✓ (1)

10.3



Criteria for graph/*Kriteria vir grafiek:*	Marks *Punte*
Correct shape with higher amplitude as shown (accept more than one cycle) *Korrekte vorm met hoër amplitude soos aangetoon (aanvaar meer as een siklus)*	✓
Correct shape with higher frequency as shown (accept more than one cycle) *Korrekte vorm met hoër frekwensie soos aangetoon (aanvaar meer as een siklus)*	✓

(2)

10.4

$$P_{ave} = \frac{V_{rms}^2}{R} ✓ = \frac{\left(\frac{V_{max}}{\sqrt{2}}\right)^2}{R} ✓$$

$$120 = \frac{\left(\frac{340}{\sqrt{2}}\right)^2}{R} ✓$$

R = 481,67 Ω ✓ (4)

[8]

QUESTION 11/*VRAAG 11*

11.1 The minimum energy needed to remove an electron ✓
from the surface of a metal. ✓
Die minimum energie benodig om 'n elektron
vanaf die oppervlak van 'n metaal te verwyder. (2)

11.2

11.2.1 $W_0 = hf_0$ ✓
$= (6,63 \times 10^{-34})(4 \times 10^{14})$ ✓
$= 2,65 \times 10^{-19}$ J ✓ (3)

11.2.2 $E = W_0 + E_k$
$hf = hf_0 + ½mv^2$
✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(8 \times 10^{14})$ ✓ $= 2,65 \times 10^{-19}$ ✓ $+ ½(9,11 \times 10^{-31})v^2$ ✓

$\therefore$ $v = 7,63 \times 10^5\ m{\cdot}s^{-1}$ ✓ (5)

11.3

11.3.1 Equal to /*Gelyk aan* ✓
The gradient is Planck's constant./ *Die gradiënt is Planck se konstante.* ✓ (2)

11.3.2 8×10^{14} Hz ✓
f_0 is directly proportional to W_0. / *f_0 is direk eweredig aan W_0.* ✓ (2)
[14]

TOTAL/*TOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2014

MARKS: 150

TIME: 3 hours

PHYSICAL SCIENCES: Paper 1
1084E

10841E

This question paper consists of 18 pages, 3 data sheets and 1 graph sheet.

X25

2

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following physical quantities is a measure of the inertia of a body?

A Mass

B Energy

C Velocity

D Acceleration (2)

1.2 The magnitude of the gravitational force exerted by one body on another body is ***F***. When the distance between the centres of the two bodies is doubled, the magnitude of the gravitational force, in terms of ***F***, will now be …

A $\frac{1}{4}\boldsymbol{F}$

B $\frac{1}{2}\boldsymbol{F}$

C 2***F***

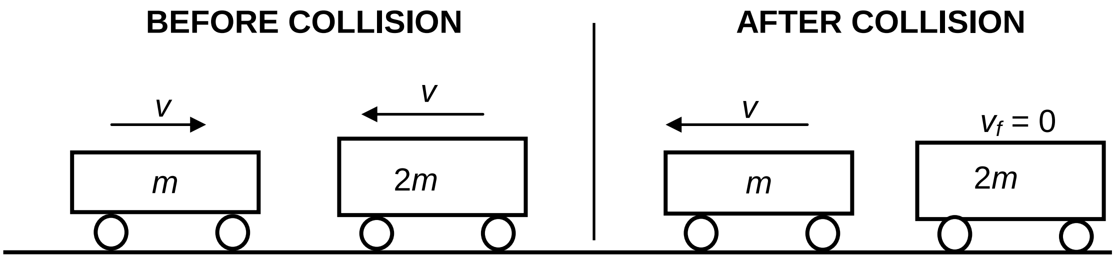
D 4***F*** (2)

1.3 An object is thrown vertically upwards. Which ONE of the following regarding the object's velocity and acceleration at the highest point of its motion is CORRECT? Ignore the effects of friction.

	VELOCITY	ACCELERATION
A	Zero	Zero
B	Zero	Upwards
C	Maximum	Zero
D	Zero	Downwards

(2)

1.4 An object of mass m moving at velocity v collides head-on with an object of mass $2m$ moving in the opposite direction at velocity v. Immediately after the collision the smaller mass moves at velocity v in the opposite direction and the larger mass is brought to rest. Refer to the diagram below.



Ignore the effects of friction.

Which ONE of the following is CORRECT?

	MOMENTUM	MECHANICAL ENERGY
A	Conserved	Conserved
B	Not conserved	Conserved
C	Conserved	Not conserved
D	Not conserved	Not conserved

(2)

1.5 Two balls, **P** and **Q**, are dropped simultaneously from the same height. Ball **P** has TWICE the mass of ball **Q**. Ignore the effects of air friction.

Just before the balls hit the ground, the kinetic energy of ball **P** is x. The kinetic energy of ball **Q**, in terms of x, will be …

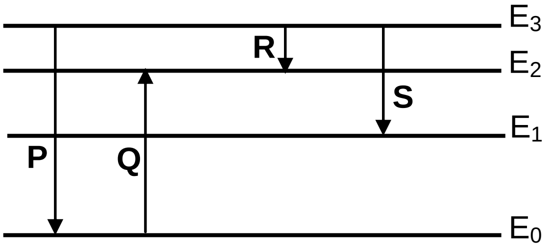
A $\frac{1}{4}x$

B $\frac{1}{2}x$

C x

D $2x$ (2)

1.6 The diagram below shows the electron transitions **P**, **Q**, **R** and **S** between different energy levels in an atom.



Which ONE of the transitions will result in an emission of a radiation with the longest wavelength?

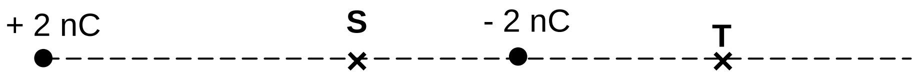
A **P**

B **Q**

C **R**

D **S** (2)

1.7 Two charges of + 2 nC and - 2 nC are located on a straight line. **S** and **T** are two points that lie on the same straight line as shown in the diagram below.



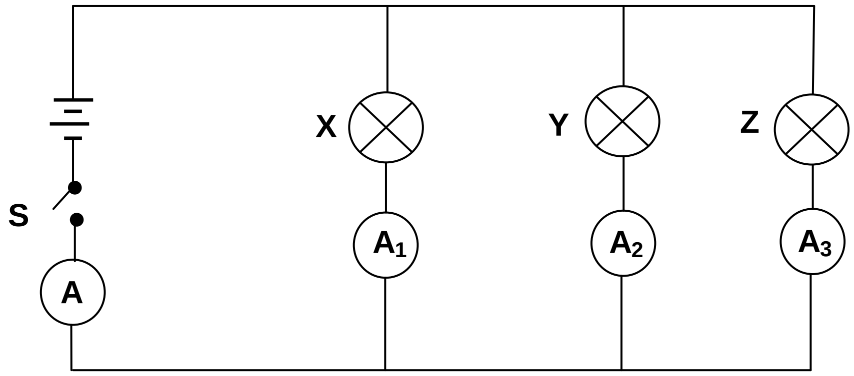
Which ONE of the following correctly represents the directions of the RESULTANT electric fields at **S** and at **T**?

	DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT S	DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT T
A	Right	Left
B	Left	Left
C	Right	Right
D	Left	Right

(2)

1.8 Three light bulbs, **X**, **Y** and **Z** with resistances *R*, 2*R* and *R* respectively, are connected in a circuit as shown below. The battery has negligible internal resistance.

When switch **S is closed**, all the bulbs light up. The reading on ammeter **A** is 2,5 A.

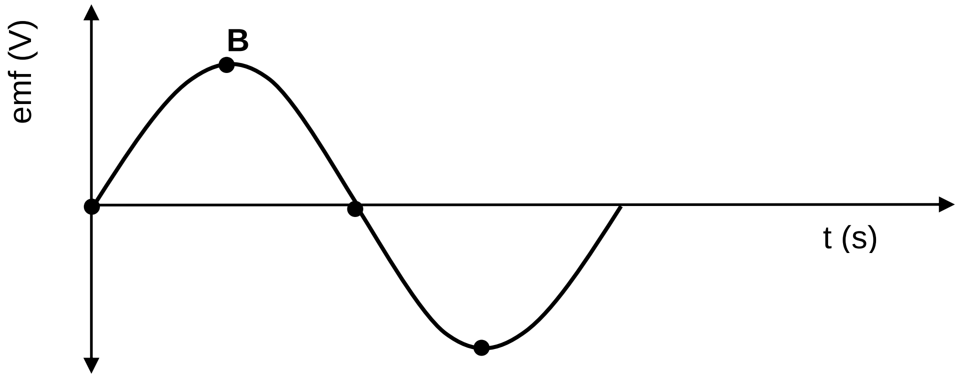


Which ONE of the following correctly describes the readings on the ammeters (in amperes) when bulb **Z** burns out?

	A_1	A_2	A_3	A
A	1,25	1,25	0	2,5
B	1,6	0,8	0,1	2,5
C	0,75	0,75	0	1,5
D	1	0,5	0	1,5

(2)

1.9 The coils of an AC generator make one complete rotation. The resulting graph for the output emf is shown below.



The position **B** on the graph is obtained when the plane of the coil is at an angle of … to the magnetic field.

A 0º

B 60º

C 90º

D 120º (2)

1.10 A learner makes the observations below after conducting an experiment using a photocell with frequencies of the incident light being above the threshold frequency (cut-off frequency).

(i) The photocurrent increases as the intensity of the incident light increases.

(ii) The ammeter in the circuit registers a current immediately after the incident light is radiated on the cathode.

(iii) The photocurrent increases as the frequency of the incident light increases.

Which of the observation(s) is/are CORRECT?

A (i) only

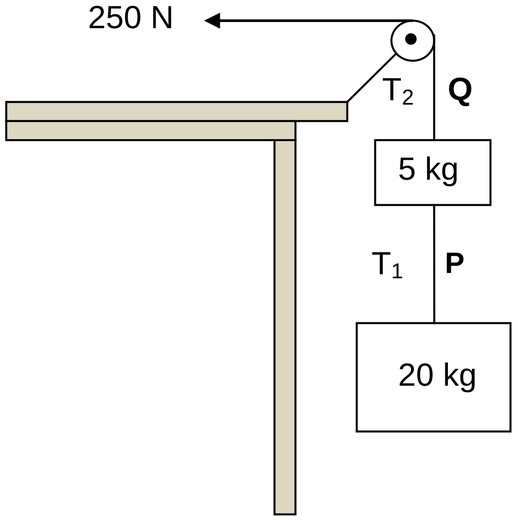
B (ii) only

C (i) and (ii) only

D (ii) and (iii) only (2)
[20]

QUESTION 2 (Start on a new page.)

Two blocks of masses 20 kg and 5 kg respectively are connected by a light inextensible string, **P**. A second light inextensible string, **Q**, attached to the 5 kg block, runs over a light frictionless pulley. A constant horizontal force of 250 N pulls the second string as shown in the diagram below. The magnitudes of the tensions in **P** and **Q** are T_1 and T_2 respectively. Ignore the effects of air friction.



2.1 State Newton's Second Law of Motion in words. (2)

2.2 Draw a labelled free-body diagram indicating ALL the forces acting on the **5 kg block**. (3)

2.3 Calculate the magnitude of the tension T_1 in string **P**. (6)

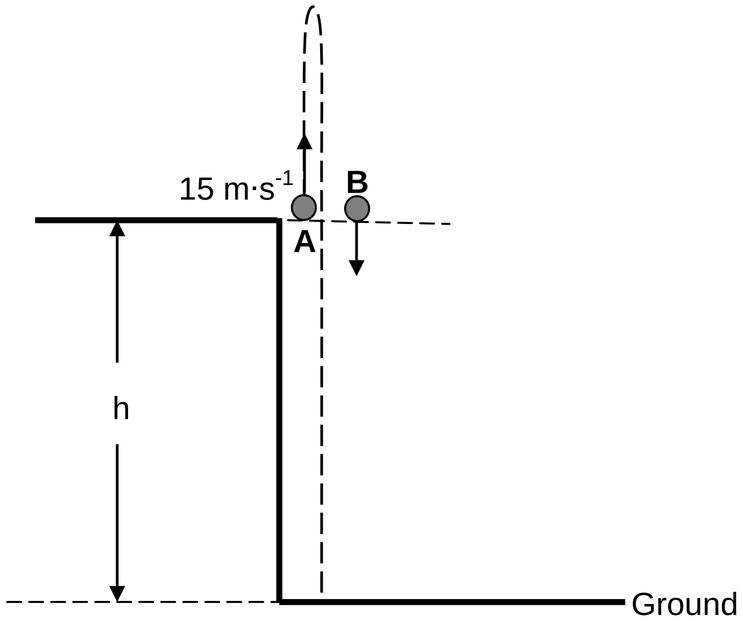
2.4 When the 250 N force is replaced by a sharp pull on the string, one of the two strings break.

Which ONE of the two strings, **P** or **Q**, will break? (1)
[12]

QUESTION 3 (Start on a new page.)

A ball, **A**, is thrown vertically upward from a height, h, with a speed of 15 m·s^{-1}. AT THE SAME INSTANT, a second identical ball, **B**, is dropped from the same height as ball **A** as shown in the diagram below.

Both balls undergo free fall and eventually hit the ground.



3.1 Explain the term *free fall.* (2)

3.2 Calculate the time it takes for ball **A** to return to its starting point. (4)

3.3 Calculate the distance between ball **A** and ball **B** when ball **A** is at its maximum height. (7)

3.4 Sketch a velocity-time graph in the ANSWER BOOK for the motion of ball **A** from the time it is projected until it hits the ground.

Clearly show the following on your graph:

- The initial velocity
- The time it takes to reach its maximum height
- The time it takes to return to its starting point (4)

[17]

QUESTION 4 (Start on a new page.)

Dancers have to learn many skills, including how to land correctly. A dancer of mass 50 kg leaps into the air and lands feet first on the ground. She lands on the ground with a velocity of 5 $m \cdot s^{-1}$. As she lands, she bends her knees and comes to a complete stop in 0,2 seconds.

4.1 Calculate the momentum with which the dancer reaches the ground. (3)

4.2 Define the term *impulse* of a force. (2)

4.3 Calculate the magnitude of the net force acting on the dancer as she lands. (3)

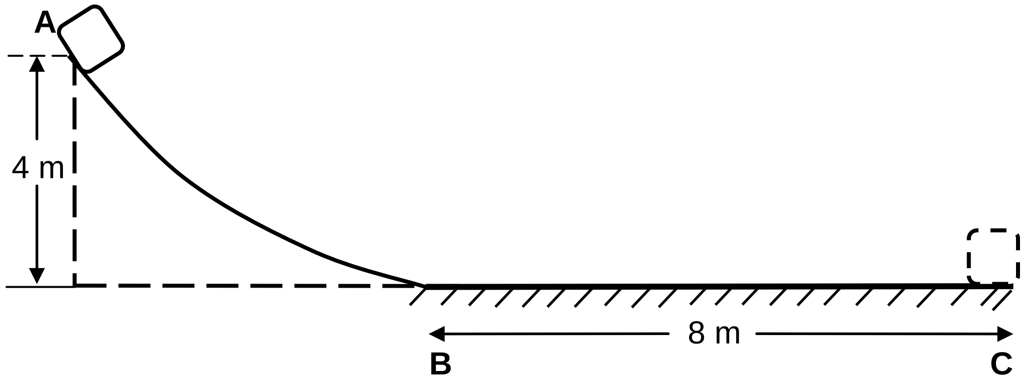
Assume that the dancer performs the same jump as before but lands without bending her knees.

4.4 Will the force now be GREATER THAN, SMALLER THAN or EQUAL TO the force calculated in QUESTION 4.3? (1)

4.5 Give a reason for the answer to QUESTION 4.4. (3)
[12]

QUESTION 5 (Start on a new page.)

5.1 The diagram below shows a track, **ABC**. The curved section, **AB**, is frictionless. The rough horizontal section, **BC**, is 8 m long.



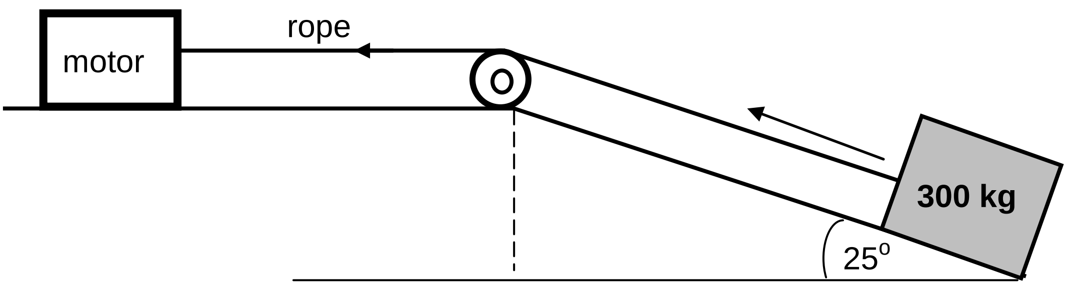
An object of mass 10 kg is released from point **A** which is 4 m above the ground. It slides down the track and comes to rest at point **C**.

5.1.1 State the *principle of conservation of mechanical energy* in words. (2)

5.1.2 Is mechanical energy conserved as the object slides from **A** to **C**? Write only YES or NO. (1)

5.1.3 Using ENERGY PRINCIPLES only, calculate the magnitude of the frictional force exerted on the object as it moves along **BC**. (6)

5.2 A motor pulls a crate of mass 300 kg with a constant force by means of a light inextensible rope running over a light frictionless pulley as shown below. The coefficient of kinetic friction between the crate and the surface of the inclined plane is 0,19.



5.2.1 Calculate the magnitude of the frictional force acting between the crate and the surface of the inclined plane. (3)

The crate moves up the incline at a constant speed of 0,5 $m \cdot s^{-1}$.

5.2.2 Calculate the average power delivered by the motor while pulling the crate up the incline. (6)
[18]

QUESTION 6 (Start on a new page.)

6.1 The siren of a stationary ambulance emits a note of frequency 1 130 Hz. When the ambulance moves at a constant speed, a stationary observer detects a frequency that is 70 Hz **higher** than that emitted by the siren.

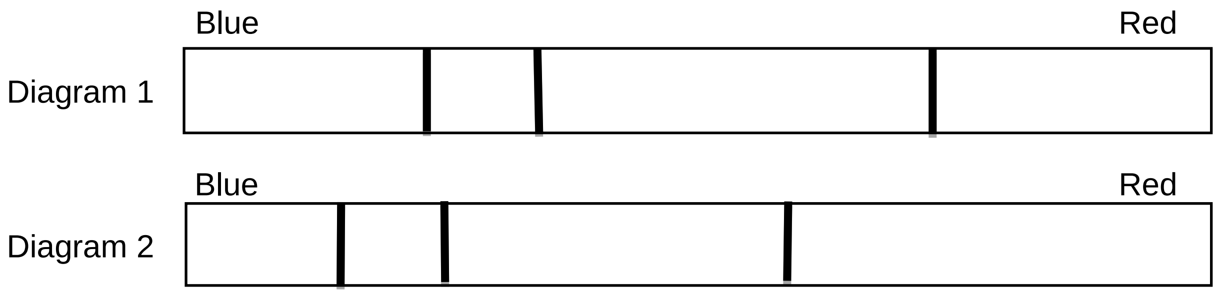
6.1.1 State the Doppler effect in words. (2)

6.1.2 Is the ambulance moving *towards* or *away from* the observer? Give a reason for the answer. (2)

6.1.3 Calculate the speed at which the ambulance is travelling. Take the speed of sound in air as 343 $m \cdot s^{-1}$. (5)

6.2 A study of spectral lines obtained from various stars can provide valuable information about the movement of the stars.

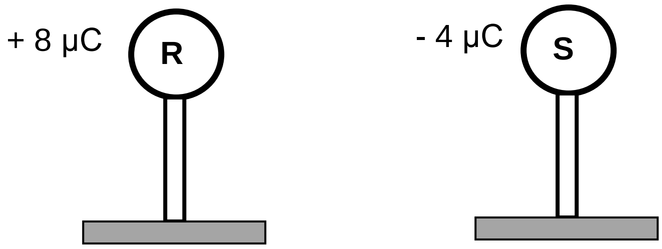
The two diagrams below represent different spectral lines of an element. Diagram **1** represents the spectrum of the element in a laboratory on Earth. Diagram **2** represents the spectrum of the same element from a distant star.



Is the star moving *towards* or *away from* the Earth? Explain the answer by referring to the shifts in the spectral lines in the two diagrams above. (2)
[11]

QUESTION 7 (Start on a new page.)

The diagram below shows two small identical metal spheres, **R** and **S**, each placed on a wooden stand. Spheres **R** and **S** carry charges of + 8 μC and **-** 4 μC respectively. Ignore the effects of air.



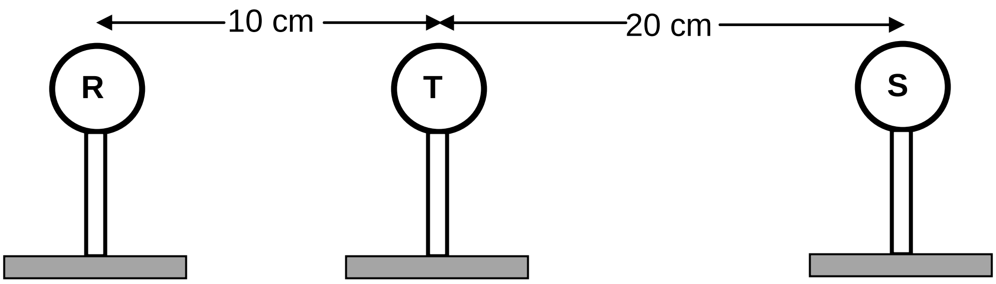
7.1 Explain why the spheres were placed on wooden stands. (1)

Spheres **R** and **S** are brought into contact for a while and then separated by a small distance.

7.2 Calculate the net charge on each of the spheres. (2)

7.3 Draw the electric field pattern due to the two spheres **R** and **S**. (3)

After **R** and **S** have been in contact and separated, a third sphere, **T**, of charge + 1 μC is now placed between them as shown in the diagram below.



7.4 Draw a free-body diagram showing the electrostatic forces experienced by sphere **T** due to spheres **R** and **S**. (2)

7.5 Calculate the net electrostatic force experienced by **T** due to **R** and **S**. (6)

7.6 Define the *electric field at a point*. (2)

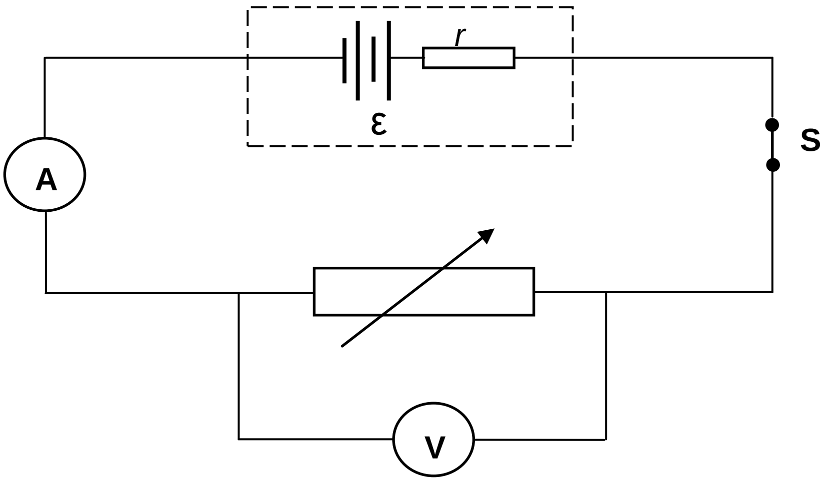
7.7 Calculate the magnitude of the net electric field at the location of **T** due to **R** and **S**. (Treat the spheres as if they were point charges.) (3)

[19]

QUESTION 8 (Start on a new page.)

NOTE: The graph for QUESTION 8.1.2 must be drawn on the GRAPH SHEET attached at the end of the QUESTION PAPER.

8.1 A group of learners conduct an experiment to determine the emf (ε) and internal resistance (r) of a battery. They connect a battery to a rheostat (variable resistor), a low-resistance ammeter and a high-resistance voltmeter as shown in the diagram below.



The data obtained from the experiment is displayed in the table below.

READING ON VOLTMETER (V)	READING ON AMMETER (A)
2	0,58
3	0,46
4	0,36
5	0,24
6	0,14

8.1.1 State ONE factor which must be kept constant during the experiment. (1)

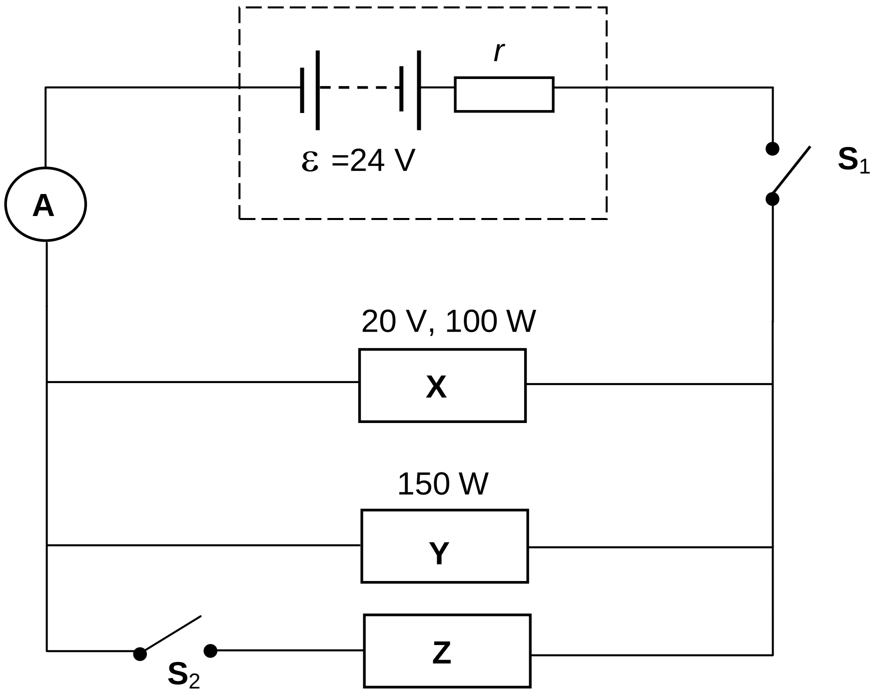
8.1.2 Using the information in the table above, plot the points and draw the line of best fit on the attached GRAPH SHEET. (3)

Use the graph drawn in QUESTION 8.1.2 to determine the following:

8.1.3 Emf (ε) of the battery (1)

8.1.4 Internal resistance of the battery, WITHOUT USING ANY FORM OF THE EQUATION $\varepsilon = I(R + r)$ (3)

8.2 Three electrical devices, **X**, **Y** and **Z**, are connected to a 24 V battery with internal resistance *r* as shown in the circuit diagram below. The power rating of each of the devices **X** and **Y** are indicated in the diagram.



With switch $\mathbf{S_1}$ closed and $\mathbf{S_2}$ open, the devices function as rated.

Calculate the:

8.2.1 Current in **X** (3)

8.2.2 Resistance of **Y** (3)

8.2.3 Internal resistance of the battery (5)

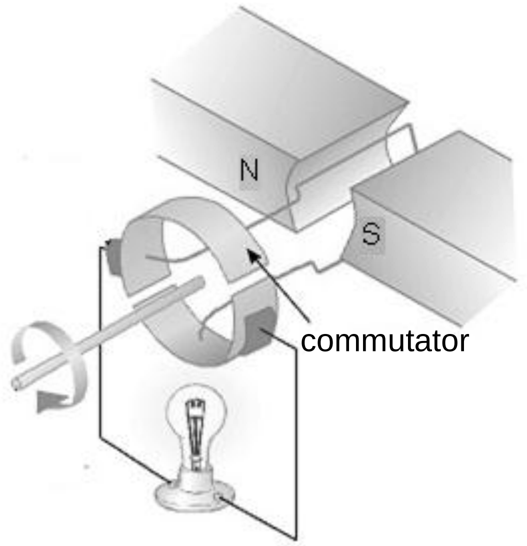
Now switch $\mathbf{S_2}$ is also closed.

8.2.4 Identify device **Z** which, when placed in the position shown, can still enable **X** and **Y** to operate as rated. Assume that the resistances of all the devices remain unchanged. (1)

8.2.5 Explain how you arrived at the answer to QUESTION 8.2.4. (2)
[22]

QUESTION 9 (Start on a new page.)

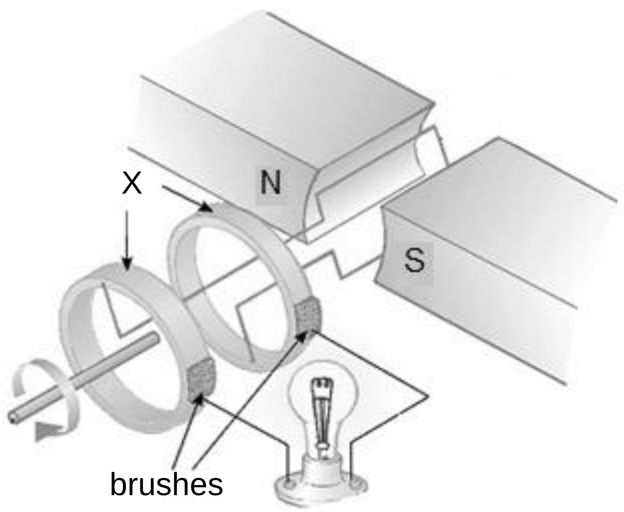
The diagram below represents a simplified version of an electrical machine used to light up a bulb.



9.1 Name the principle on which the machine operates. (1)

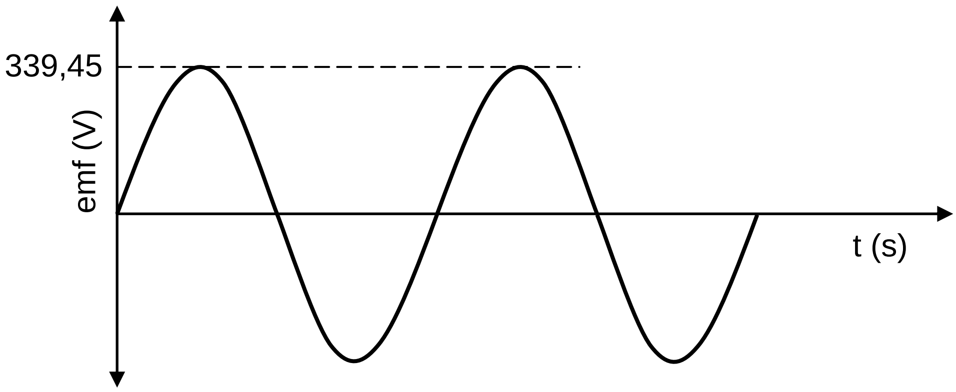
9.2 State ONE way in which to make this bulb burn brighter. (1)

Some changes have been made to the machine and a new device is obtained as shown below.



9.3 Name part **X** in the new device. (1)

9.4 The graph of output emf versus time obtained using the device in QUESTION 9.3 is shown below.

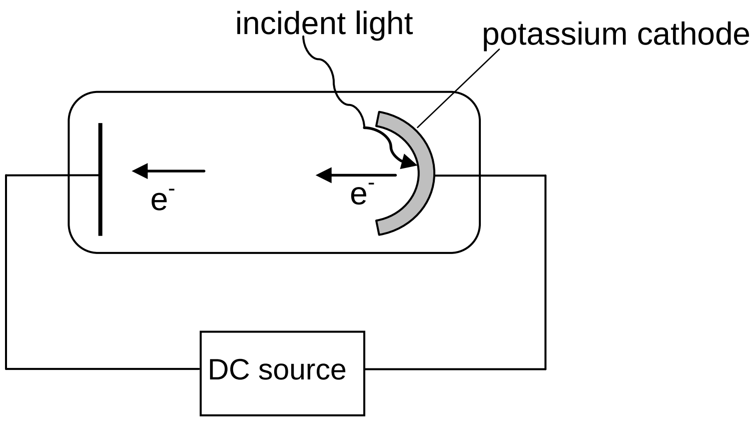


9.4.1 Define the term *root mean square value* of an AC voltage. (2)

9.4.2 Calculate the rms voltage. (3)
[8]

QUESTION 10 (Start on a new page.)

Ultraviolet light is incident onto a photocell with a potassium cathode as shown below. The threshold frequency of potassium is 5,548 x 10^{14} Hz.



10.1 Define the term *threshold frequency (cut-off frequency)*. (2)

The maximum speed of an ejected photoelectron is 5,33 x 10^5 m·s^{-1}.

10.2 Calculate the wavelength of the ultraviolet light used. (5)

The photocell is now replaced by another photocell with a rubidium cathode. The maximum speed of the ejected photoelectron is 6,10 x 10^5 m·s^{-1} when the same ultraviolet light source is used.

10.3 How does the work function of rubidium compare to that of potassium? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

10.4 Explain the answer to QUESTION 10.3. (3)
[11]

TOTAL: 150

QUESTION 1/*VRAAG 1*

1.1	A ✓✓	(2)
1.2	A ✓✓	(2)
1.3	D ✓✓	(2)
1.4	C ✓✓	(2)
1.5	B ✓✓	(2)
1.6	C ✓✓ (Accept/ *Aanvaar* R)	(2)
1.7	A ✓✓	(2)
1.8	D ✓✓	(2)
1.9	A ✓✓	(2)
1.10	C ✓✓	(2) **[20]**

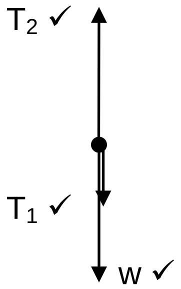
QUESTION 2/*VRAAG 2*

2.1 When a resultant (net) force acts on an object, the object will accelerate in the direction of the force. This acceleration is directly proportional to the force✓ and inversely proportional to the mass of the object.✓

Wanneer 'n resulterende (netto) krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Hierdie versnelling is direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*
The net force acting on an object is equal to the rate of change of momentum ✓✓ of the object (in the direction of the force). (2 or 0)
Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering in momentum van die voorwerp (in die rigting van die krag).(2 of 0) (2)

2.2



(3)

2.3

OPTION 1/*OPSIE 1*

$F_{net} = ma$ ✓

For 5 kg block/*Vir 5 kg-blok*

$T_2 + (-mg) + (-T_1) = ma$

$250 - (5)(9,8) - T_1$ ✓ $= 5a$ ✓

$201 - T_1 = 5a$

$T_1 = 201 - 5a$........(1)

For 20 kg block/*Vir 20 kg-blok*

$T_1 + (-mg) = ma$.......(2)

$T_1 + [-20(9,8)]$ ✓ $= 20a$

$5 = 25a$

$a = 0,2\ m\cdot s^{-2}$ upwards/*opwaarts*

$\therefore T_1 = 201 - 5(0,2)$ ✓

$= 200$ N ✓

OR/*OF* $T_1 = 20(9,8) + 20(0,2)$ ✓

$= 200$ N ✓

(6)

OPTION 2 /*OPSIE 2*

$F_{net} = ma$ ✓

For 5 kg block/*Vir 5 kg-blok*

$T_2 + (-mg) + (-T_1) = ma$

$250 - (5)(9,8) - T_1$ ✓ $= 5a$ ✓

$201 - T_1 = 5a$

$T_1 = 201 - 5a$........(1)

For 20 kg block/*Vir 20 kg-blok* ,

$T_1 + (-mg) = ma$.......(2)

$T_1 + [-20(9,8)]$ ✓ $= 20a$

(1) x 4 : $4T_1 = 804 - 20a$

$\therefore T_1 - 196 = 804 - 4T_1$ ✓

$\therefore 5T_1 = 1\,000$

$\therefore T_1 = 200$ N ✓

(6)

OPTION 3/*OPSIE 3*
$F_{net} = ma$✓
For 5 kg block/*Vir 5 kg-blok*
$T_2 + (-mg) + (-T_1) = ma$
$250 - (5)(9,8) - T_1$✓$= 5a$ ✓

$201 - T_1 = 5a$
$T_1 = 201 - 5a$........(1)
$\therefore a = \frac{201 - T_1}{5}$
For 20 kg block/*Vir 20 kg-blok* ,
$T_1 + (-mg) = ma$.......(2)
$T_1 + [-(20)(9,8)]$ ✓ $= 20a$

$\therefore T_1 - 196 = 20\left(\frac{201 - T_1}{5}\right)$✓
$\therefore T_1 = 200$ N✓ (6)

2.4 **Q** ✓ (1)
[12]

QUESTION 3/*VRAAG 3*

3.1 An object moving / Motion under the influence of gravity / weight / gravitational force only (and there are no other forces such as friction).✓✓ (2 or/*of* 0)
('n Voorwerp wat / Beweging slegs onder die invloed van swaartekrag / gewig / gravitasiekrag (en daar is geen ander kragte soos wrywing nie). (2)

3.2

OPTION 1/*OPSIE 1* Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ 0 ✓$= 15\,\Delta t + \frac{1}{2}(-9,8)\,\Delta t^2$✓ $\Delta t = 3,06$ s It takes/*Dit neem* 3,06 s✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ 0✓ $= -15\,\Delta t + \frac{1}{2}(9,8)\,\Delta t^2$✓ $\Delta t = 3,06$ s It takes/*Dit neem* 3,06 s✓

(4)

OPTION 2/*OPSIE 2* Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$v_f = v_i + a\Delta t$✓ 0✓ $= 15 + (-9,8)\Delta t$✓ $\Delta t = 1,53$ s It takes (2)(1,53) = 3,06 s✓	$v_f = v_i + a\Delta t$✓ 0✓ $= -15 + (9,8)\Delta t$✓ $\Delta t = 1,53$ s It takes/*Dit neem* 3,06 s✓

(4)

OPTION 3 / *OPSIE 3* Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$v_f = v_i + a\Delta t$✓ -15 ✓$= 15 + (-9,8)\Delta t$✓ $\Delta t = 3,06$ s✓	$v_f = v_i + a\Delta t$✓ 15 ✓$= -15 + (9,8)\Delta t$✓ $\Delta t = 3,06$ s✓

(4)

<u>OPTION 4/*OPSIE 4*</u> **Upwards positive/*Opwaarts positief:*** $F_{net}\ \Delta t = \Delta p$ ✓ $mg\ \Delta t = m\ (v_f - v_i)$ $\Delta t = \frac{(0-15)}{-9,8}$ ✓ ✓ $\Delta t = 1,53$ s It takes/*Dit neem* (2)(1,53s) = 3,06 s ✓	**Downwards positive /*Afwaarts positief:*** $F_{net}\ \Delta t = \Delta p$ ✓ $mg\ \Delta t = m\ (v_f - v_i)$ $\Delta t = \frac{0-(-15)}{9,8}$ ✓ ✓ $\Delta t = 1,53$ s It takes/*Dit neem* (2)(1,53s) = 3,06 s ✓

(4)

<u>OPTION 5/*OPSIE 5*</u> **Upwards positive/*Opwaarts positief:*** $F_{net}\ \Delta t = \Delta p$ ✓ $mg\ \Delta t = m\ (v_f - v_i)$ $\Delta t = \frac{-15-(15)}{-9,8}$ ✓ ✓ = 3,06 s ✓	**Downwards positive/*Afwaarts positief:*** $F_{net}\ \Delta t = \Delta p$ ✓ $mg\ \Delta t = m\ (v_f - v_i)$ $\Delta t = \frac{15-(-15)}{9,8}$ ✓ ✓ $\Delta t = 3,06$ s ✓

(4)

<u>OPTION 5/*OPSIE 6*</u> **Upwards positive/*Opwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ For ball A/*Vir bal A* $0 = (15)^2 + 2\ (-9,8)\Delta y$ ✓ $\Delta y_A = 11,48$ m $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ $11,48 = \left(\frac{15+0}{2}\right)\Delta t$ ✓ $\Delta t = 1,53$ s It takes/*Dit neem* (2)(1,53s) = 3,06 s ✓	**Downwards positive/*Afwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ For ball A/*Vir bal A* $0 = (-15)^2 + 2\ (9,8)\Delta y$ ✓ $\Delta y_A = -11,48$ m $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ $-11,48 = \left(\frac{-15+0}{2}\right)\Delta t$ ✓ $\Delta t = 1,53$ s It takes/*Dit neem* (2)(1,53s) = 3,06 s ✓

3.3

OPTION 1/*OPSIE 1*	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
For ball A/*Vir bal A*	For ball A/*Vir bal A*
$0 = (15)^2$ ✓ $+ 2(-9,8)\Delta y$ ✓	$0 = (-15)^2$ ✓ $+ 2(9,8)\Delta y$ ✓
$\Delta y_A = 11,48$ m	$\Delta y_A = -11,48$ m
<u>When A is at highest point</u>	<u>When A is at highest point</u>
<u>*Wanneer A op hoogste punt is*</u>	<u>*Wanneer A op hoogste punt is*</u>
$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$	$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$
$= 0 + \underline{½(-9,8)(1,53)^2}$ ✓✓	$= 0 + \underline{½(9,8)(1,53)^2}$ ✓✓
$\Delta y_B = -11,47$ m	$\Delta y_B = 11,47$ m
$\Delta y_B = 11,47$ m downward/*afwaarts*	$\Delta y_B = 11,47$ m downward/*afwaarts*
Distance/*Afstand* $= y_A + y_B$	Distance/*Afstand* $= y_A + y_B$
$= 11,47 + 11,48$ ✓	$= 11,48 + 11,47$ ✓
$= 22,95$ m ✓	$= 22,95$ m ✓

OPTION 2/*OPSIE 2*	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
<u>At maximum height $v_f = 0$:</u>	<u>At maximum height $v_f = 0$:</u>
<u>*By maksimum hoogte $v_f = 0$:*</u>	<u>*By maksimum hoogte $v_f = 0$:*</u>
Ball/*Bal* A	Ball/*Bal* A
$\Delta y_A = v_i\Delta t + ½ a\Delta t^2$ ✓	$\Delta y_A = v_i\Delta t + ½ a\Delta t^2$ ✓
$= 15(1,53)$ ✓ $+ ½(-9,8)(1,53)^2$ ✓	$= (-15)(1,53)$ ✓ $+ ½(9,8)(1,53)^2$ ✓
$= 11,48$ m	$= -11,48$ m
<u>When A is at highest/point</u>	When A is at highest point
<u>*Wanneer A op hoogste punt is*</u>	*Wanneer A by hoogste punt is*
$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$	$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$
$= 0 + \underline{½(-9,8)(1,53)^2}$ ✓✓	$= 0 + \underline{½(-9,8)(1,53)^2}$ ✓✓
$\Delta y_B = -11,47$ m	$\Delta y_B = -11,47$ m
$\Delta y_B = 11,47$ m downward/*afwaarts*	$\Delta y_B = 11,47$ m downward/*afwaarts*
Distance/*Afstand* $= y_A + y_B$	Distance/*Afstand* $= (y_A + y_B)$
$= 11,48 + 11,47$ ✓	$= 11,48 + 11,47$ ✓
$= 22,95$ m ✓	$= 22,95$ m ✓

(7)

<u>OPTION 3/*OPSIE 3*</u>	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
Ball A/*Bal A* $\Delta y_A = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $\Delta y_A = 15(1,53)$ ✓ $+ \frac{1}{2}(-9,8)(1,53)^2$ ✓ $= 11,48$ m	Ball A/*Bal A* $y_A = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ $\Delta y_A = -15(1,53)$ ✓ $+ \frac{1}{2}(9,8)(1,53)^2$ ✓ $= -11,48$ (m) $=$ 11,48 m upward/*opwaarts*
For ball B/*Vir bal B* $v_f = v_i + a\Delta t$ $v_f = 0 + (-9,8)(1,53)$ $v_f = 14,99\ m\cdot s^{-1}$	For ball B/*Vir bal B* $v_f = v_i + a\Delta t$ $v_f = 0 + (9,8)(1,53)$ $v_f = 14,99\ m\cdot s^{-1}$
$v_f^2 = v_i^2 + 2a\Delta x$ $14,99^2$ ✓ $= 0 + 2(-9,8)\Delta y_B$ ✓ $\Delta y_B = -11,47$ (m) $=$ 11,47 m downward/*afwaarts*	$v_f^2 = v_i^2 + 2a\Delta x$ $14,99^2$ ✓ $= 0 + 2(9,8)\Delta y_B$ ✓ $\Delta y_B = 11,47$ (m)
Distance/*Afstand* $= (y_A + y_B)$ $= 11,48 + 11,47$ ✓ $= 22,95$ m ✓	Distance/*Afstand* $= (y_A + y_B)$ $= 11,48 + 11,47$ ✓ $= 22,95$ m ✓

(7)

<u>OPTION 4/*OPSIE 4*</u>	
Upwards positive/*Opwaarts positief:*	**Downwards positive/*Afwaarts positief:***
Ball A/*Bal A* $\Delta y_A = \frac{v_i + v_f}{2}\Delta t$ ✓ $= \frac{(15+0)}{2}(1,53)$ ✓ ✓ $= 11,48$ m	Ball A/*Bal A* $\Delta y_A = \frac{v_i + v_f}{2}\Delta t$ ✓ $= \frac{(-15+0)}{2}(1,53)$ ✓ ✓ $= -11,48$ (m) $=$ 11,48 m upwards/*opwaarts*
For ball B/*Vir bal B* $v_f = v_i + a\Delta t$ $= 0 + (-9,8)(1,53)$ $= -15\ m\cdot s^{-1}$ $\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0-15)\times 1,53}{2}$ ✓ ✓ $= -11,47$ m $=$ 11,47 m downward/*afwaarts* Distance/*Afstand* $= (y_A + y_B)$ $= 11,48 + 11,47$ ✓ $= 22,95$ m ✓	$v_f = v_i\Delta t + a\Delta t$ $= 0 + (9,8)(1,53)$ $= 15\ m\cdot s^{-1}$ $\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0+15)\times 1,53}{2}$ ✓ ✓ $= 11,47$m Distance/*Afstand* $= y_A + y_B$ $= 11,48 + 11,47$ ✓ $= 22,95$ m ✓

(7)

<table>
<tr><td>

<u>OPTION 5/*OPSIE 5*</u>

Upwards positive/*Opwaarts positief:*

Ball A/*Bal A*
$W_{net} = \Delta K$ ✓

OR/*OF*
$½ m(v^2_f - v^2_i) = mg(h_f – h_i)\cos\theta$
$½ m(0 - 15^2)$ ✓ $= m(9,8)h_f\cos 180^o$ ✓
h = 11,48 m

OR/*OF*
For Ball B when A is at highest point./ *Vir Bal B wanneer A by sy hoogste punt is.*

$v_f = v_i + a\Delta t$
$= 0 + (-9,8) (1,53) = -15\ m\cdot s^{-1}$ ✓
$\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0 - 15)\times 1,53}{2}$ ✓
=-11,48 m
= 11,48 m downward/*afwaarts*

Distance/*Afstand* = $y_A + y_B$
= 11,48 + 11,48 ✓
= 22,96 m ✓

</td><td>

Downwards positive/*Afwaarts positief:*

Ball A/*Bal A*
$W_{net} = \Delta K$ ✓

OR/*OF*
$½ m(v^2_f - v^2_i) = mg(h_f – h_i)\cos\theta$
$½ m(0 - 15^2)$ ✓ $= m(9,8)h_f\cos 180^o$ ✓
h = 11,48 m

OR/*OF*
For Ball B when A is at highest point./ *Vir Bal B wanneer A by sy hoogste punt is.*

$v_f = v_i + a\Delta t$
$= 0 + (9,8) (1,53) = 15\ m\cdot s^{-1}$ ✓
$\Delta y = \frac{v_i + v_f}{2}\Delta t = \frac{(0 + 15)(1,53)}{2}$ ✓
= 11,48 m downward/*afwaarts*

Distance/*Afstand* = $y_A + y_B$
= 11,48 + 11,48 ✓
= 22,96 m ✓

</td></tr>
</table>

(7)

<table>
<tr><td>

<u>OPTION 7/*OPSIE 7*</u>

Upwards positive/*Opwaarts positief:*
Ball A
$½ m v^2_i + mgh_i = ½ m v^2_f + mgh_f$ ✓
$½ m(15^2)$ ✓ $+0 = ½ m(0) + m(9,8)h$ ✓
h = 11,48 m

OR/*OF*
For Ball B when A is at highest point. *Vir Bal B wanneer A by sy hoogste punt is.*

$v_f = v_i + a\Delta t$
$= 0 + (-9,8) (1,53)$
$= -15\ m\cdot s^{-1}$
$\Delta y = \frac{v_i + v_f}{2}\Delta t$ ✓
$= \frac{(0 - 15)(1,53)}{2}$ ✓
=-11,48 m
= 11,48 m downward/*afwaarts*
Distance/*Afstand* = $y_A + y_B$
= 11,48 + 11,48 ✓
= 22,96 m ✓

</td><td>

Downwards positive/*Afwaarts positief:*
Ball A
$½ m v^2_i + mgh_i = ½ m v^2_f + mgh_f$ ✓
$½ m(15^2)$ ✓ $+0 = ½ m(0) + m(9,8)h$ ✓
h = 11,48 m

OR/*OF*
For Ball B when A is at highest point. *Vir Bal B wanneer A by sy hoogste punt is.*

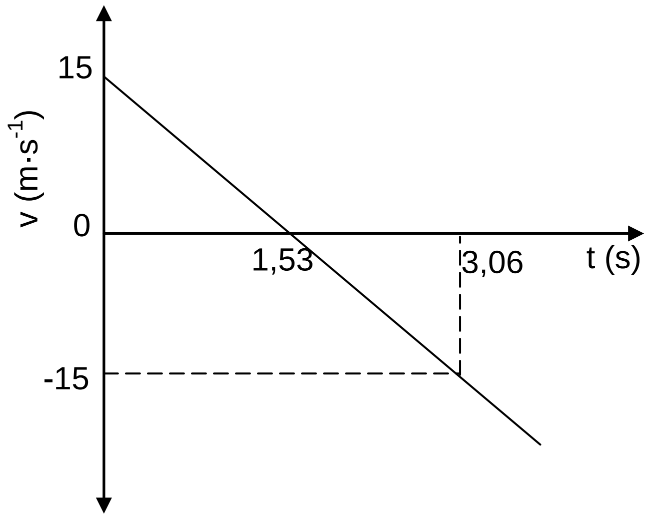
$v_f = v_i + a\Delta t$
$= 0 + (9,8) (1,53)$
$= 15\ m\cdot s^{-1}$
$\Delta y = \frac{v_i + v_f}{2}\Delta t$ ✓
$= \frac{(0 + 15)(1,53)}{2}$ ✓
= 11,48 m downward/*afwaarts*

Distance/*Afstand* = $y_A + y_B$
= 11,48 + 11,48 ✓
= 22,96 m ✓

</td></tr>
</table>

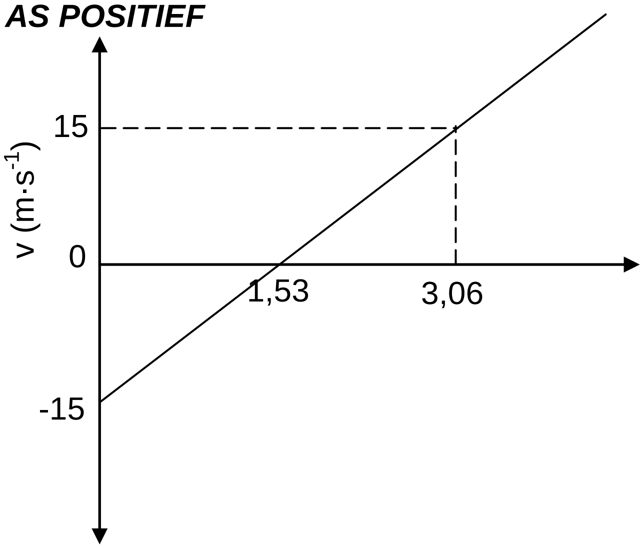
(7)

3.4



(4)
[17]

CONSIDER MOTION DOWNWARD AS POSITIVE/*BESKOU BEWEGING AFWAARTS AS POSITIEF*



Criteria/*Kriteria*	**Marks/*Punte***
Graph starts at correct Initial velocity shown./*Grafiek begin by korrekte beginsnelheid aangetoon.*	✓
Time for maximum height shown (1,53 s)./*Tyd vir maksimum hoogte aangetoon.(1,53 s)*	✓
Time for return shown (3,06 s) /*Tyd om terug te keer (3,06) aangetoon.*	✓
Shape/*Vorm*: Straight line extending beyond 3,06 s/ *Reguitlyn wat verby 3,06 s strek.*	✓

(4)
[17]

QUESTION 4/*VRAAG 4*

4.1 p = mv✓
= 50(5)✓
= 250 kg·m·s^{-1}✓ (downward/*afwaarts)*

OR/*OF*
p = mv✓
= 50(-5)✓
= - 250 kg·m·s^{-1}
= 250 kg·m·s^{-1}✓ (downward/*afwaarts)* (3)

4.2 The product of the (net) force and the time interval (during which the force acts)✓✓ (2 or 0)
Die produk van die (netto) krag en die tydinterval (waartydens die krag inwerk) (2 of 0). (2)

4.3

<u>OPTION 1/*OPSIE 1*</u> $\Delta p = F_{net}\Delta t$✓ 0 - 250 ✓= F_{net}(0,2) F_{net} = -1 250 N = 1 250 N ✓	$\Delta p = F_{net}\Delta t$✓ 250 - 0 ✓= F_{net}(0,2) F_{net} = 1 250 N ✓	$\Delta p = F_{net}\Delta t$✓ 50(0 – (-5))✓= F_{net}(0,2) F_{net} = 1 250 N ✓

(3)

<u>OPTION 2/*OPSIE 2*</u> $m(v_f – v_i) = F_{net}\Delta t$✓ 50 (0 - 5) ✓= F_{net} (0,2) F_{net} = -1 250 N = 1 250 N ✓	$m(v_f – v_i) = F_{net}\Delta t$✓ 50 (5 - 0) ✓= F_{net} (0,2) F_{net} = 1 250 N ✓

(3)

<u>OPTION 3 /*OPSIE 3*</u> $v_f = v_i + a\Delta t$ 0 = 5 + a(0,2) ✓ a = -25 m·s^{-2} F_{net} = ma✓ = 50 (-25) = - 1 250 N = 1 250 N✓	$v_f = v_i + a\Delta t$ 5 = 0 + a(0,2) ✓ a = 25 m·s^{-2} F_{net} = ma✓ = 50 (25) = 1 250 N✓

(3)

4.4 Greater than/*Groter as*✓ (1)

4.5 For the same momentum change, ✓
the stopping time (contact time) ✓will be smaller (less) ✓
∴ the (upward) force exerted (on her) is greater.
Vir dieselfde verandering in momentum,
sal die stilhoutyd (kontaktyd) kleiner wees
∴ die (opwaartse)krag wat (op haar) uitgeoefen word, sal groter wees. (3)
[12]

QUESTION 5/*VRAAG 5*

5.1.1 In an isolated/closed system, ✓ the total mechanical energy is conserved / remains constant ✓
In 'n geïsoleerde/geslote sisteem bly die totale meganiese energie behoue / bly konstant.

OR/*OF*
The total mechanical energy of a system is conserved/ remains constant ✓ in the absence of friction.✓
Die totale meganiese energie van 'n sisteem bly behoue/bly konstant in die afwesigheid van wrywing.

OR/*OF*
The total mechanical energy of a system remains constant ✓provided the net work done by external non conservative forces is zero.✓
Die totale meganiese energie van 'n sisteem bly konstant, mits die arbeid verrig deur eksterne nie-konserwatiewe kragte, nul is.

OR/*OF*
In the absence of a non-conservative force, the total mechanical energy is conserved/remains constant
In die afwesigheid van 'n nie-konserwatiewe krag, bly die totale meganiese energie behoue / konstant

OR/*OF*
In an isolated/closed system, ✓ the sum of kinetic and gravitational potential energy is conserved / remains constant ✓
In 'n geïsoleerde/geslote sisteem bly som van kinetiese en gravitasionele potensiële energie behoue / bly konstant.

5.1.2 No/*Nee*✓ (1)

5.1.3

OPTION 1/*OPSIE 1*	
Along **AB**/*Langs* **AB** $E_{\text{mechanical at A}} = E_{\text{mechanical at B}}$ $(E_p + E_k)_A = (E_p + E_k)_B$ ✓ $(mgh + ½ mv^2)_A = (mgh + ½ mv^2)_B$ $(10)(9,8)(4) + 0 = 0 + ½ (10) v_f^2$ ✓ $v_f = 8,85\ m·s^{-1}$	Along **AB**/*Langs* **AB** $W_{net} = ΔE_k$ ✓ $F_gΔh\cosθ = ½ m(v_f^2 – v_i^2)$ $(10)(9,8)(4)\cos0^o = ½ (10)(v_f^2 – 0)$ ✓ $v_f = 8,85\ m·s^{-1}$

(6)

<table>
<tr><td colspan="2">Along AB/Langs AB

$W_{nc} = \Delta K + \Delta U$ ✓
$0 = ½\ (10)(v_f^2 – 0) + 10(9,8)(4 – 0)$ ✓
$v_f = 8,85\ m·s^{-1}$</td></tr>
<tr><td colspan="2">Substitute 8,85 m·s⁻¹ in one of the following options
Vervang 8,85 m·s⁻¹ in een van die volgende opsies</td></tr>
<tr><td>Along BC/Langs BC

$W_{net} = \Delta K$✓
$f\Delta x \cos\theta = \Delta K$
$\underline{f(8)\cos 180^o}$ ✓= $\underline{½\ (10)(0 – 8,85^2)}$ ✓
f = 48,95 N✓</td><td>Along BC/Langs BC

$W_{nc} = \Delta K + \Delta U$ ✓
$f\ \Delta x\cos\theta = \Delta K + \Delta U$
$\underline{f(8)\cos 180}$ ✓= $\underline{½\ (10)(0 - 8,85^2) + 0}$✓
f = 48,95 N✓ (Accept/ Aanvaar 49 N)</td></tr>
</table>

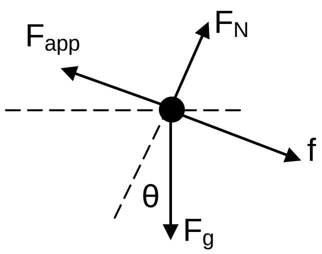
OPTION 2/*OPSIE 2*
Along **AC**/*Langs* **AC**

$W_{nc} = \Delta K + \Delta U$✓
$f\Delta x\cos\theta = \Delta K + \Delta U$
$(f)(8)$✓$(\cos180^o)$✓ = (0 - 0) ✓ + 10 (9,8)(0 - 4) ✓
f = 49 N ✓ (6)

5.2.1 $f_k = \mu_k N$✓
$= \mu_k mg\cos\theta$
$= \underline{(0,19)(300)(9,8)\cos 25^o}$✓
= 506,26 N✓ (3)

5.2.2

OPTION 1/*OPSIE 1*



$F_{net} = 0$
$\underline{F_{app} + (-F_g\sin\theta) + (-f) = 0}$ ✓
F_{app} - (300)(9,8)sin 25°✓ - 506,26✓ = 0
F_{app} = 1 748,76 N

$P_{ave} = Fv_{ave}$ ✓
= 1748,76 x 0,5✓
= 874,38 W ✓ (6)

OPTION 2/*OPSIE 2*
$W_f + W_{app} + W_N + W_g = 0$ ✓
$F\Delta x\cos\theta + F_{app}\Delta x\cos\theta + 0 + F_g\Delta x\cos\theta = 0$
$(506{,}26\Delta x\cos 180^o)$✓ + $(F_{app}\Delta x\cos 0) + 300(9{,}8)\Delta x\cos 115^o$✓= 0
$F_{app} = 1748{,}76$ N
$P_{ave} = Fv_{ave}$✓
= (1748,76) (0,5)✓
= 874,38 W✓

(6)

OPTION 3/*OPSIE 3*
$W_f + W_{app} + W_N + W_g = 0$✓
$F\Delta x\cos\theta + F_{app}\Delta x\cos\theta + 0 + F_g\sin\theta\Delta x\cos\theta = 0$
$(506{,}26\Delta x\cos 0)$ ✓ + $(F_{ap}\Delta x\cos 0) + 300\ (9{,}8)\sin 25^o\ \Delta x\cos 180)$ ✓= 0
$F_{app} = 1\ 748{,}76$ N
$P_{ave} = Fv_{ave}$✓
= (1 748,76)(0,5)✓
= 874,38 W✓

(6)
[18]

QUESTION 6/*VRAAG 6*

6.1.1 An (apparent) change in observed/detected frequency (pitch), (wavelength) ✓as a result of the relative motion between a source and an observer ✓(listener).
'n Skynbare verandering in waargenome frekwensie (toonhoogte),(golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. (2)

6.1.2 Towards/*Na*✓

Observed/detected frequency is greater than the actual frequency.✓
Waargenome frekwensie is groter as die werklike frekwensie. (2)

6.1.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

(1200)✓$= \frac{343}{343 - v_s}$✓1130 ✓

$v_s = 20{,}01\ m\cdot s^{-1}$✓
Accept/*Aanvaar:* (19,42 – 20,01 $m\cdot s^{-1}$) (5)

6.2 The star is approaching the earth. ✓
Die ster nader die aarde.
OR/*OF*
The earth and the star are approaching (moving towards) each other.✓
Die aarde en die ster nader mekaar.

The spectral lines in diagram 2 are shifted towards the blue end/blue shifted.✓ (2)
Die spektrumlyne in diagram 2 het verskuif na die blou ent/blou verskuiwing **[11]**

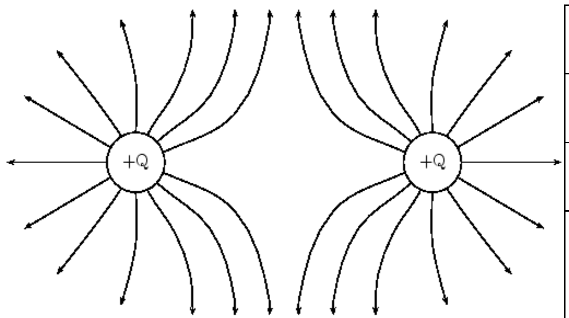
QUESTION 7/*VRAAG 7*

7.1 To ensure that charge does not leak to the ground/insulated. ✓
Om te verseker dat die lading nie na die grond toe lek nie/isoleer. (1)

<u>Notes/*Aantekeninge*</u>
Accept/*Aanvaar* In order retain original charge✓/To insulate the charges./ *Om oorspronklike lading te behou/ Om lading te isoleer.*

7.2 Net charge/*Netto lading* = $\frac{Q_R + Q_S}{2} = \frac{+8+(-4)}{2}$ ✓= 2 μC✓ (2)

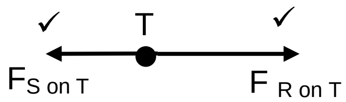
7.3



Criteria for sketch:/*Kriteria vir skets:*	Marks/ *Punte*
Correct direction of field lines *Korrekte rigting van veldlyne*	✓
Shape of the electric field *Vorm van elektrieseveld*	✓
No field line crossing each other / No field lines inside the spheres/ *Geen veldlyne wat maekaar kruis nie / Geen veldlyne binne sfeer nie*	✓

(3)

7.4



(2)

7.5

<u>OPTION 1/*OPSIE 1*</u>

$F = k\frac{Q_1Q_2}{r^2}$ ✓

$F_{ST} = (9\times10^9)\frac{(1\times10^{-6})(2\times10^{-6})}{(0,2)^2}$ ✓ ✓ = 0,45 N / 4,5 x 10^{-1} N left/*links*

OR/*OF*

$F_{TS} = \frac{1}{4}F_{RT} = \frac{1}{4}(1,8) = 0,45$ N

$F_{RT} = 9\times10^9\times\frac{(2\times10^{-6})(1\times10^{-6})}{(0,1)^2}$ ✓ = 1,8 N right/*regs*

OR/*OF*

$F_{RT} = 4F_{ST} = 4(0,45) = 1,8$ N right /*regs*

$F_{net} = F_{ST} + F_{RT} = \underline{1,8 + (-0,45)}$ ✓

= <u>1,35 N</u> or towards sphere S / *na sfeer* or/*of* <u>right/*regs*</u> *S*✓ (6)

OPTION 2/*OPSIE 2*	
$E_R = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,1)^2}$ ✓= 1,8 x 10^6 $N.C^{-1}$ right/*regs* $E_s = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,2)^2}$ ✓= 4,5 x 10^5 $N.C^{-1}$ left/*links* E_{net} = 1,8 x 10^6 - 4,5 x 10^5 ✓= 1,35 x 10^6 $N.C^{-1}$right/*regs* F = EQ ✓= (1,35 x 10^6)(1 x 10^{-6}) ✓ = <u>1,35 N towards sphere S / na sfeer S right/*regs*</u> ✓	(6)

7.6 <u>Force experienced</u> ✓<u>per unit positive charge</u> ✓placed at that point.
Krag ondervind per eenheid positiewe lading by daardie punt. (2)

7.7

OPTION 1/*OPSIE 1*	
$E = \frac{F}{q}$ ✓ = $\frac{1,35}{1\times10^{-6}}$ ✓= 1,35 x 10^6 $N\cdot C^{-1}$ ✓	(3)

OPTION 2/*OPSIE 2*	
$E_R = \frac{kQ}{r^2}$ ✓ = $\frac{(9\times10^9)(2\times10^{-6})}{(0,1)^2}$ ✓= 1,8 x 10^6 $N\cdot C^{-1}$ right/*regs* $E_s = \frac{kQ}{r^2} = \frac{(9\times10^9)(2\times10^{-6})}{(0,2)^2}$ = 4,5 x 10^5 $N\cdot C^{-1}$ left/*links* E_{net} = 1,8 x 10^6 - 4,5 x 10^5 = 1,35 x 10^6 $N\cdot C^{-1}$ ✓	(3)
OPTION 3/*OPSIE 3* $E = \frac{F}{q}$ ✓ = $\frac{1,8}{1\times10^{-6}}$ ✓= 1,8 x 10^6 $N\cdot C^{-1}$ $E = \frac{F}{q} = \frac{0,45}{1\times10^{-6}}$ = 4,5 x 10^5 $N\cdot C^{-1}$ E_{net} = 1,8 x 10^6 - 4,5 x 10^5 = 1,35 x 10^6 $N\cdot C^{-1}$ ✓	(3)

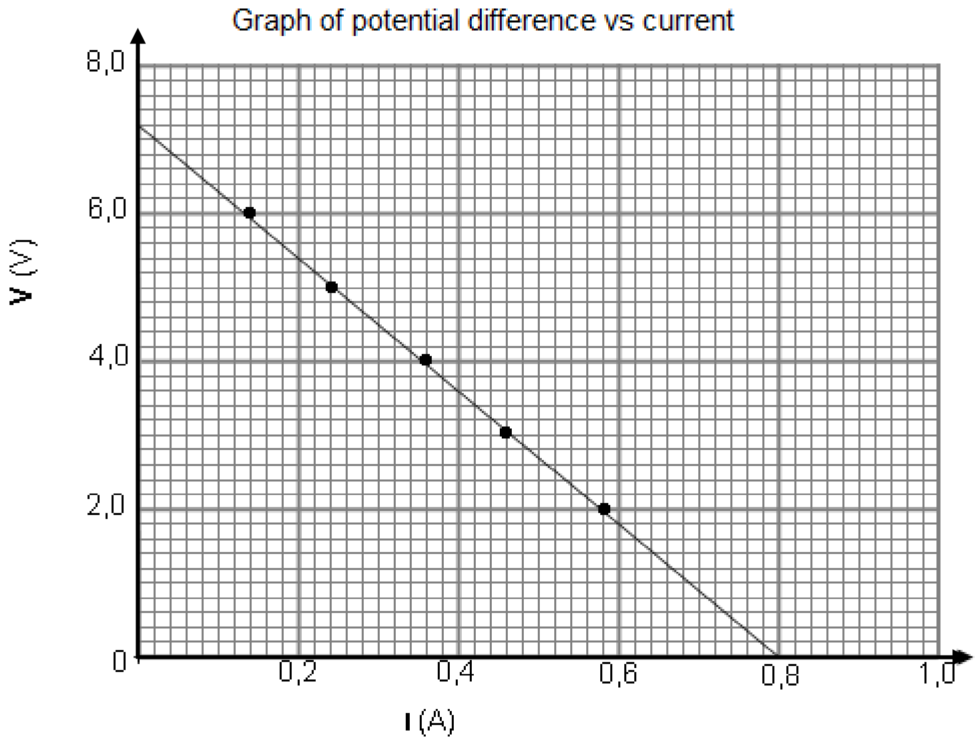
[19]

QUESTION 8/*VRAAG 8*

8.1.1 Keep the temperature (of battery) constant.
Hou die temperatuur (van battery) konstant (1)

8.1.2

Grafiek van potensiaalverskil teenoor stroom



Criteria for drawing line of best fit:/*Kriteria vir teken van lyn van beste pas:*	Marks/ *Punte*
ALL points correctly plotted (at least 4 points) *ALLE punte korrek gestip (ten minste 4 punte)*	✓✓
Correct line of best fit if all plotted points are used (at least 3 point) *Korrekte lyn van beste pas indien alle punte gebruik word (ten minste 3 punte)*	✓

(3)

8.1.3 7,2 V✓
(Accept any readings between 7,0 V and 7,4 V or the value of the y-intercept
/*Aanvaar enige lesing tussen 7,0 V en 7,4 V of die waarde van die y-afsnit* (1)

8.1.4

Slope/*Helling* $= \frac{\Delta V}{\Delta I}$

$= \frac{0 - 7,2}{0,8 - 0}$ ✓✓ $= -9$

r = 9 Ω✓ (3)

8.2.1

OPTION 1/*OPSIE 1*

$P = VI$ ✓
$100 = 20(I)$ ✓
$I = 5\ A$ ✓

(3)

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$ ✓
$100 = \frac{(20)^2}{R}$
$R = 4\ \Omega$

$V = IR$
$20 = I(4)$ ✓
$I = 5\ A$ ✓

(3)

OPTION 3/*OPSIE 3*

$P = \frac{V^2}{R}$ ✓
$100 = \frac{(20)^2}{R}$
$R = 4\ \Omega$

$P = I^2R$
$100 = I^2(4)$ ✓
$I = 5\ A$ ✓

8.2.2

OPTION 1/*OPSIE 1*

$P = \frac{V^2}{R}$ ✓
$R = \frac{(20)^2}{150}$ ✓
$= 2,67\ \Omega$ ✓

(3)

OPTION 2/OPSIE 2

$P = VI$ ✓
$150 = (20)I$
$I = 7,5\ A$

$V = IR$
$20 = (7,5)R$ ✓
$R = 2,67\ \Omega$ ✓

OR/*OF*

$P = I^2R$
$150 = (7,5)^2R$ ✓
$R = 2,67\ \Omega$ ✓

(3)

OPTION 3/*OPSIE 3*

I_X : I_Y
5 : 7,5
1 : 1,5

R_X : R_Y
1,5 : 1✓
4 ✓: 2,67 Ω✓

(3)

8.2.3

OPTION 1/*OPSIE 1*

P = VI **OR/*OF*** $P = I^2R$

$I_{150W} = \frac{150}{20}$ ✓ = 7,5 A $I_{150W} = \sqrt{\frac{150}{2,67}}$ ✓ = 7,5 A

I_{tot} = (5 + 7,5) ✓
ε = I(R + r) ✓
24 = 12,5(R + r)
24 = V_{ext} + V_{ir}
24 = 20 + 12,5(r) ✓
r = 0,32 Ω ✓

(5)

OPTION 2/*OPSIE 2*

V = Ir✓
I_{tot} = (5 + 7,5) ✓
(24 - 20) ✓= 12,5 r✓
$\therefore r = \frac{4}{12,5}$
r = 0,32 Ω✓

(5)

OPTION 3/*OPSIE 3*

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_{//}} = \frac{1}{4} + \frac{1}{2,67}$ ✓ OR/*OF* $R_{//} = \frac{(4)(2,67)}{4+2,67}$

$\therefore R_{||}$ =1,6 Ω

$I_{tot} = \frac{20}{1,6}$ = 12,5 A✓

ε = I(R + r) ✓

24 = 12,5(R + r)
24 = V_{ext} + V_{ir}
24 = 20 + 12,5(r) ✓
r = 0,32 Ω ✓

(5)

<u>OPTION 4/*OPSIE 4*</u>
P = VI✓
250 = (20)I✓
I = 12,5 A

V = Ir✓
4 = (12,5)r✓
r = 0,32 Ω ✓ (5)

8.2.4 Device Z is a voltmeter ✓.
Toestel Z is 'n voltmeter (1)

8.2.5 Device **Z** should be a voltmeter (or a device with very high resistance) because <u>it has a very high resistance</u>✓ <u>and will draw very little current.</u> ✓
The current through **X** and **Y** will remain the same hence the device can operate as rated.
*Toestel **Z** moet 'n voltmeter wees (of 'n toestel met 'n baie hoë weerstand) omdat dit 'n baie hoë weerstand het en baie min sal stroom trek*
*Die stroom deur **X** en **Y** sal dieselfde bly, gevolglik kan die toestel werk soos ontwerp.* (2)
[22]

QUESTION 9/*VRAAG 9*

9.1 Electromagnetic induction / *Elektromagnetiese induksie*✓ (1)

9.2 Rotate the coil faster/Increase the number of coils/ Increase the strength of the magnetic field.
Roteer die spoel vinniger/Verhoog die aantal spoele / Verhoog die sterkte van die magneetveld. (1)

9.3 Slip rings/*Sleepringe*✓ (1)

9.4.1 It is the <u>value of the voltage in a DC circuit</u>✓ that will have the <u>same heating effect as an AC circuit</u>. ✓
Dit is die <u>waarde van die potensiaalverskil in 'n GS-stroombaan</u>✓ wat dieselfde verhittingseffek het as 'n WS-stroombaan✓ (2)

9.4.2
$$V_{rms} = \frac{V_{max}}{\sqrt{2}} \checkmark$$
$$= \frac{339,45}{\sqrt{2}} \checkmark$$
V_{rms} = 240,03 V ✓ (3)
[8]

QUESTION 10/*VRAAG 10*

10.1 The minimum frequency (of a photon/light) needed to emit electrons ✓ from (the surface of) a metal. (substance) ✓
Die minimum frekwensie (van 'n foton/lig) benodig om elektrone vanaf die (oppervlakte van)'n metaal (stof) vry te stel. (2)

10.2 **OPTION 1/*OPSIE 1***

$$E = W_o + E_{k(max)}$$
$$E = W_o + \frac{1}{2}mv^2_{max}$$
$$h\frac{c}{\lambda} = hf_0 + \frac{1}{2}mv^2_{max}$$

✓Any one / *Enige een*

$$\frac{(6,63 \times 10^{-34})(3 \times 10^8)}{\lambda} ✓ = (6,63 \times 10^{-34})(5,548 \times 10^{14}) ✓ + \frac{1}{2}(9,11 \times 10^{-31})(5,33 \times 10^5)^2 ✓$$

$\lambda = 4 \times 10^{-7}$ m✓ (5)

OPTION 2/*OPSIE 2*

$$E = W_o + E_{k(max)}$$
$$E = W_o + \frac{1}{2}mv^2_{max}$$
$$hf = hf_0 + \frac{1}{2}mv^2_{max}$$

✓Any one / *Enige een*

$$(6,63 \times 10^{-34})f = (6,63 \times 10^{-34})(5,548 \times 10^{14}) ✓ + \frac{1}{2}(9,11 \times 10^{-31})(5,33 \times 10^5)^2 ✓$$

$f = 7,5 \times 10^{14}$ Hz

$c = f\lambda$
$3 \times 10^8 = (7,5 \times 10^{14})\lambda$✓
$\lambda = 4 \times 10^{-7}$ m ✓ (5)

10.3 Smaller (less) than ✓
Kleiner (minder) as (1)

10.4 The wavelength/frequency/energy of the incident light (photon/hf) is constant✓.
Die golflengte/frekwensie/energie van die invallende lig (foton/hf) is konstant

Since the speed is larger, the kinetic energy is larger ✓ the work function/W_0/threshold frequency smaller. ✓

Aangesien die spoed vergroot, is die kinetiese energie groter, is die arbeidsfunksie / W_0 / drumpel frekwensie kleiner (3)
[11]

GRAND TOTAL/*GROOTTOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2015

MARKS: 150

TIME: 3 hours

PHYSICAL SCIENCES: Paper 1
1084E

10841E

This question paper consists of 17 pages and 3 data sheets.

X05

12

GAUTENG

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following forces always acts perpendicular to the surface on which a body is placed?

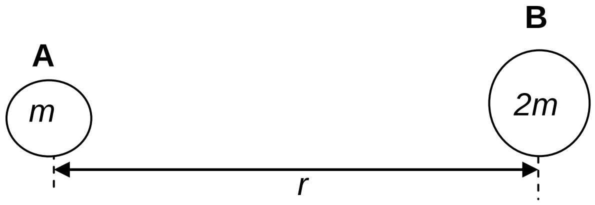
A Normal force

B Frictional force

C Gravitational force

D Tension force (2)

1.2 Two isolated bodies, **A** and **B**, having masses *m* and 2*m* respectively, are placed a distance *r* apart.



Consider the following statements regarding the gravitational force exerted by the bodies on each other.

(i) The force exerted by **B** on body **A** is half that exerted by **A** on body **B**.

(ii) The force exerted on the bodies is independent of the masses of the bodies.

(iii) The force exerted on body **A** by **B** is equal but opposite to that exerted on body **B** by **A**.

(iv) The forces will always be attractive.

Which of the statements above is/are TRUE?

A (i), (ii) and (iv) only

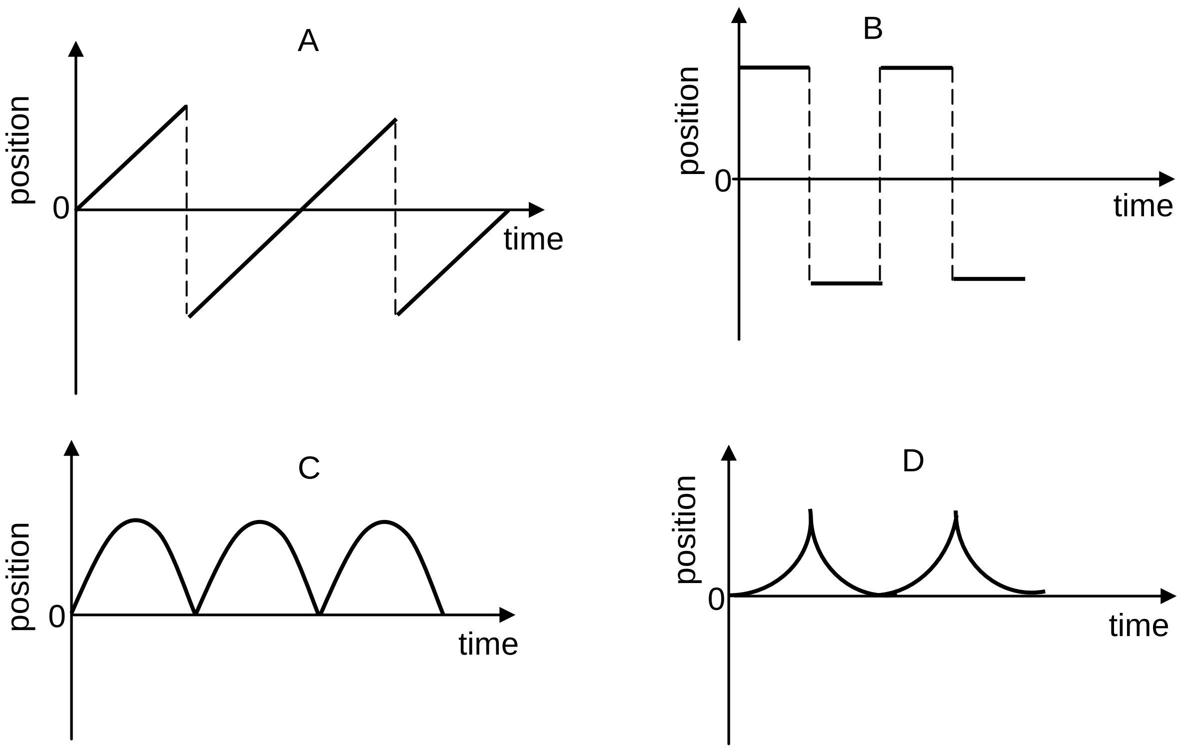
B (ii), (iii) and (iv) only

C (iii) and (iv) only

D (iv) only (2)

1.3 A ball is released from a height above the floor. The ball falls vertically and bounces off the floor a number of times. Ignore the effects of friction and assume that the collision of the ball with the floor is elastic. Take the point of release of the ball as the reference point and downward direction as positive.

Which ONE of the following is a CORRECT representation of the position-time graph for the motion of the ball?



(2)

1.4 Two bodies undergo an INELASTIC collision in the absence of friction. Which ONE of the following combinations of momentum and kinetic energy of the system is CORRECT?

	MOMENTUM	KINETIC ENERGY
A	Not conserved	Conserved
B	Conserved	Not conserved
C	Not conserved	Not conserved
D	Conserved	Conserved

(2)

1.5 The speed of a bicycle increases from 2 $m \cdot s^{-1}$ to 8 $m \cdot s^{-1}$. Its kinetic energy increases by a factor of …

A 4.

B 6.

C 8.

D 16. (2)

1.6 Which ONE of the following CANNOT be explained using the Doppler effect?

A Emission of electrons from a metal surface

B 'Flow meters' used in hospitals

C Red spectral lines from distant stars being shifted

D Observed frequency of light from moving bodies being higher than expected (2)

1.7 The magnitude of an electric field, a distance *r* from a point charge is ***E***. The magnitude of an electric field, a distance 2*r* from the same point charge will be …

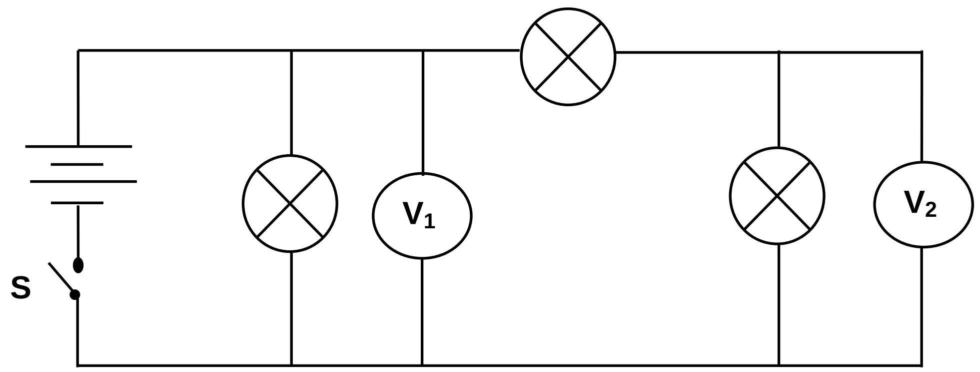
A $\frac{1}{4}\boldsymbol{E}$

B $\frac{1}{2}\boldsymbol{E}$

C 2***E***

D 4***E*** (2)

1.8 Three identical light bulbs are connected in a circuit as shown below. The resistances of the battery and connecting wires can be ignored.



Which ONE of the following statements is CORRECT when switch **S** is closed?

The reading on $\mathbf{V_1}$ is …

A half that on $\mathbf{V_2}$.

B equal to that on $\mathbf{V_2}$.

C twice that on $\mathbf{V_2}$.

D three times that on $\mathbf{V_2}$. (2)

1.9 The speed of rotation of the coils in an AC generator is increased. Which ONE of the following combinations of frequency and output voltage for the generator will occur as a result of the change?

	FREQUENCY	**OUTPUT VOLTAGE**
A	Increases	Increases
B	No change	Increases
C	Decreases	Decreases
D	Increases	No change

(2)

1.10 The spectrum of an element from a star shows some absorption lines. These lines are produced because …

A atoms absorb energy when moving from an excited state to a lower energy state.

B a cold gas absorbs certain frequencies of light passing through it.

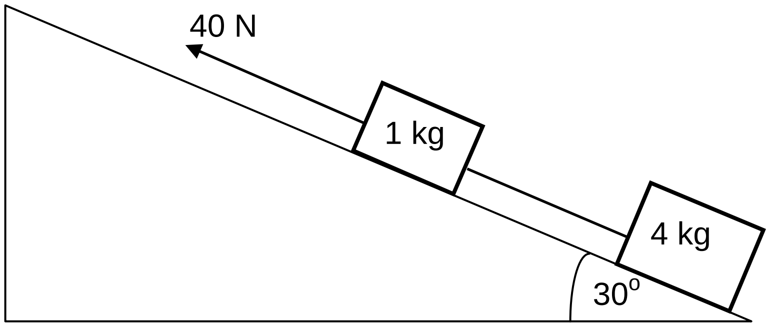
C a hot gas absorbs certain frequencies of light passing through it.

D atoms release energy when moving from an excited state to a lower energy state. (2)

[20]

QUESTION 2 (Start on a new page.)

A block of mass 1 kg is connected to another block of mass 4 kg by a light inextensible string. The system is pulled up a rough plane inclined at 30° to the horizontal, by means of a constant 40 N force parallel to the plane as shown in the diagram below.



The magnitude of the kinetic frictional force between the surface and the 4 kg block is 10 N. The coefficient of kinetic friction between the 1 kg block and the surface is 0,29.

2.1 State Newton's third law in words. (2)

2.2 Draw a labelled free-body diagram showing ALL the forces acting on the **1 kg block** as it moves up the incline. (5)

2.3 Calculate the magnitude of the:

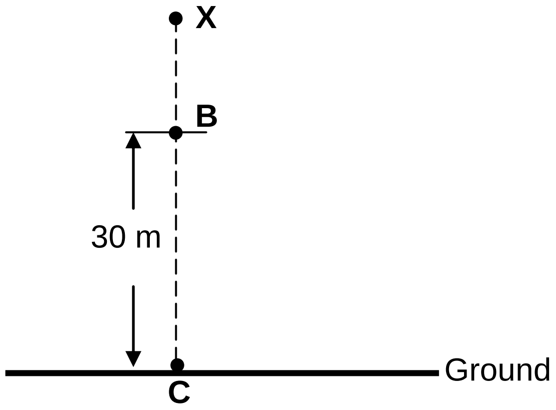
2.3.1 Kinetic frictional force between the 1 kg block and the surface (3)

2.3.2 Tension in the string connecting the two blocks (6)

[16]

QUESTION 3 (Start on a new page.)

An object is released from rest from a point **X,** above the ground as shown in the diagram below. It travels the last 30 m (**BC**) in 1,5 s before hitting the ground. Ignore the effects of air friction.



3.1 Name the type of motion described above. (1)

3.2 Calculate the:

3.2.1 Magnitude of the velocity of the object at point **B** (4)

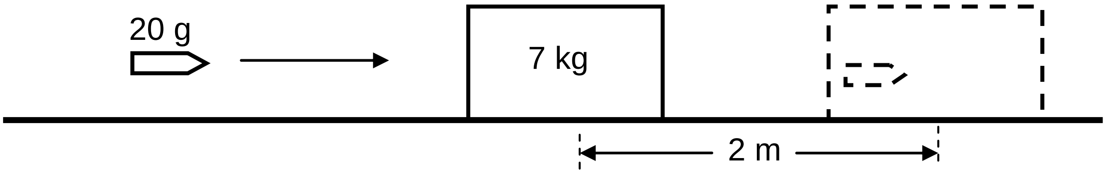
3.2.2 Height of point **X** above the ground (5)

After hitting the ground, the object bounces once and then comes to rest on the ground.

3.3 Sketch an acceleration-time graph for the entire motion of the object. (3)
[13]

QUESTION 4 (Start on a new page.)

The diagram below shows a bullet of mass 20 g that is travelling horizontally. The bullet strikes a stationary 7 kg block and becomes embedded in it. The bullet and block together travel on a rough horizontal surface a distance of 2 m before coming to a stop.



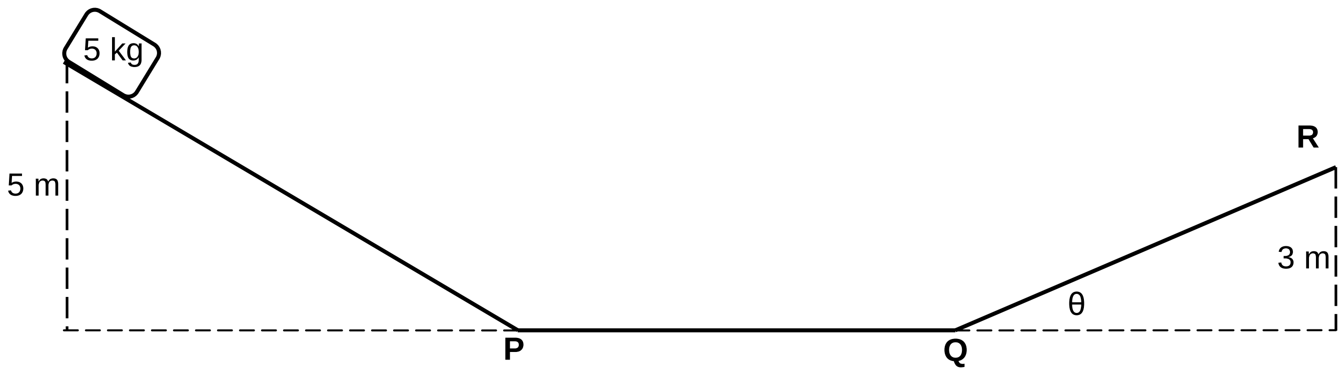
4.1 Use the work-energy theorem to calculate the magnitude of the velocity of the bullet-block system immediately after the bullet strikes the block, given that the frictional force between the block and surface is 10 N. (5)

4.2 State the *principle of conservation of linear momentum* in words. (2)

4.3 Calculate the magnitude of the velocity with which the bullet hits the block. (4)
[11]

QUESTION 5 (Start on a new page.)

A 5 kg block is released from rest from a height of 5 m and slides down a frictionless incline to point **P** as shown in the diagram below. It then moves along a frictionless horizontal portion **PQ** and finally moves up a second rough inclined plane. It comes to a stop at point **R** which is 3 m above the horizontal.



The frictional force, which is a non-conservative force, between the surface and the block is 18 N.

5.1 Using ENERGY PRINCIPLES only, calculate the speed of the block at point **P**. (4)

5.2 Explain why the kinetic energy at point **P** is the same as that at point **Q**. (2)

5.3 Explain the term *non-conservative force.* (2)

5.4 Calculate the angle (θ) of the slope **QR**. (7)

[15]

QUESTION 6 (Start on a new page.)

The Doppler effect is applicable to both sound and light waves. It also has very important applications in our everyday lives.

6.1 A hooter on a stationary train emits sound with a frequency of 520 Hz, as detected by a person standing on the platform. Assume that the speed of sound is 340 $m \cdot s^{-1}$ in still air.

Calculate the:

6.1.1 Wavelength of the sound detected by the person (2)

6.1.2 Wavelength of the sound detected by the person when the train moves towards him/her at a constant speed of 15 $m \cdot s^{-1}$ with the hooter still emitting sound (6)

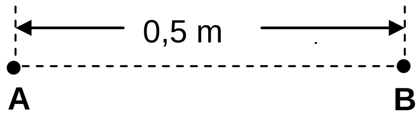
6.2 Explain why the wavelength calculated in QUESTION 6.1.1 differs from that obtained in QUESTION 6.1.2. (2)

6.3 Use your knowledge of the Doppler effect to explain *red shifts.* (2)

[12]

QUESTION 7 (Start on a new page.)

Two identical negatively charged spheres, **A** and **B**, having charges of the **same magnitude**, are placed 0,5 m apart in vacuum. The magnitude of the electrostatic force that one sphere exerts on the other is $1,44 \times 10^{-1}$ N.



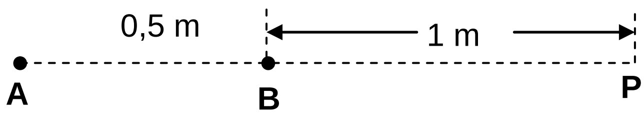
7.1 State Coulomb's law in words. (2)

7.2 Calculate the:

7.2.1 Magnitude of the charge on each sphere (4)

7.2.2 Excess number of electrons on sphere **B** (3)

7.3 **P** is a point at a distance of 1 m from sphere **B**.



7.3.1 What is the direction of the net electric field at point **P**? (1)

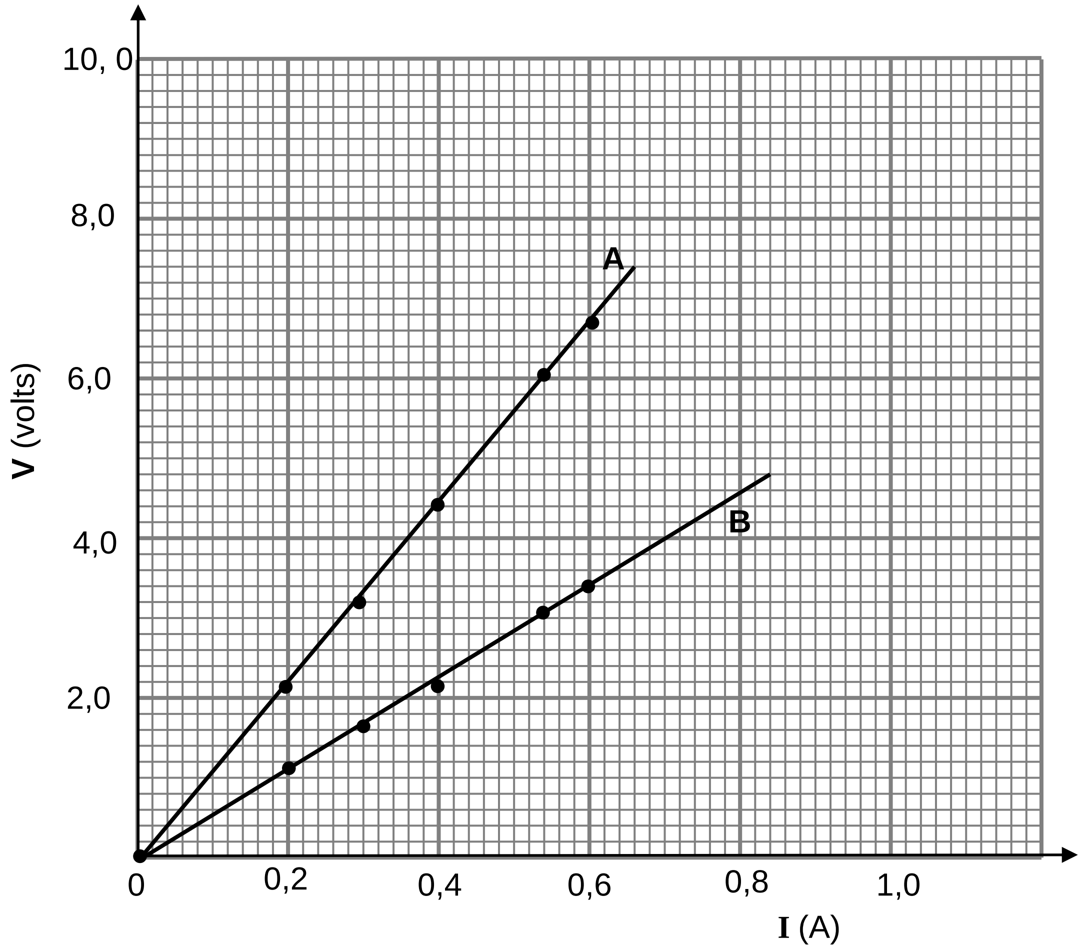
7.3.2 Calculate the number of electrons that should be removed from sphere **B** so that the net electric field at point **P** is 3×10^4 N·C^{-1} to the right. (8)

[18]

QUESTION 8 (Start on a new page.)

8.1 Learners want to construct an electric heater using one of two wires, **A** and **B**, of different resistances. They conduct experiments and draw the graphs as shown below.

Graph of V versus I for resistors A and B

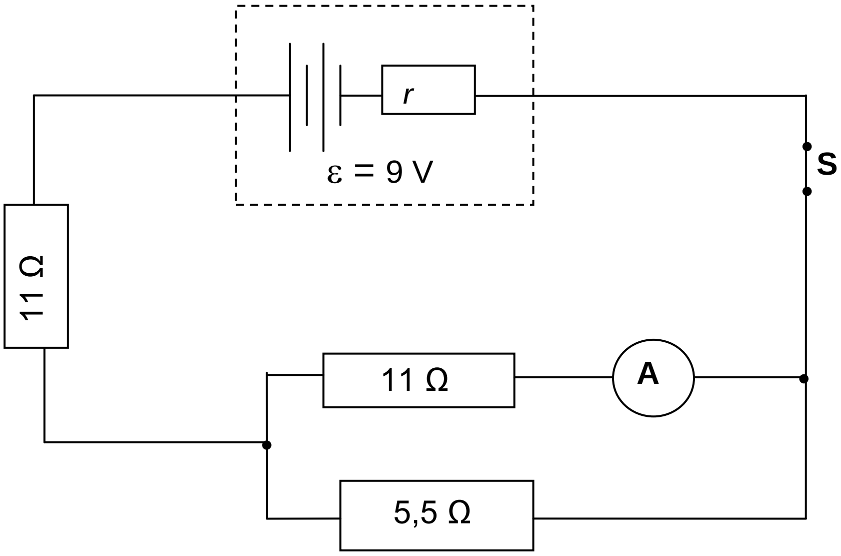


8.1.1 Apart from temperature, write down TWO other factors that the learners should consider to ensure a fair test when choosing which wire to use. (2)

8.1.2 Assuming all other factors are kept constant, state which ONE of the two wires will be the most suitable to use in the heater.

Use suitable calculations to show clearly how you arrive at the answer. (8)

8.2 In the circuit below the reading on ammeter **A** is 0,2 A. The battery has an emf of 9 V and internal resistance *r*.



8.2.1 Calculate the current through the 5,5 Ω resistor. (3)

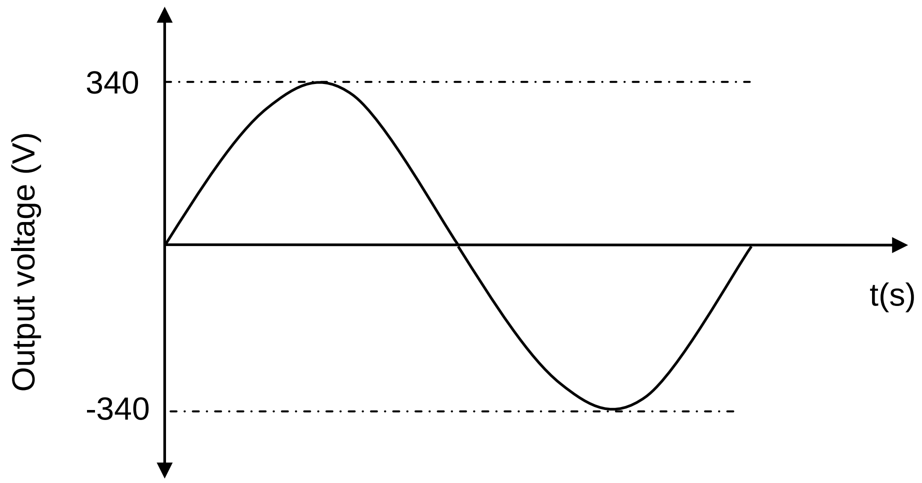
8.2.2 Calculate the internal resistance of the battery. (7)

8.2.3 Will the ammeter reading INCREASE, DECREASE or REMAIN THE SAME if the 5,5 Ω resistor is removed from the circuit? Give a reason for the answer. (2)

[22]

QUESTION 9 (Start on a new page.)

The graph below shows the output voltage from a household AC generator for one cycle of rotation of the coils.



9.1 A 100 W light bulb is connected to this generator and it glows at its maximum brightness. Use the information from the graph to calculate the:

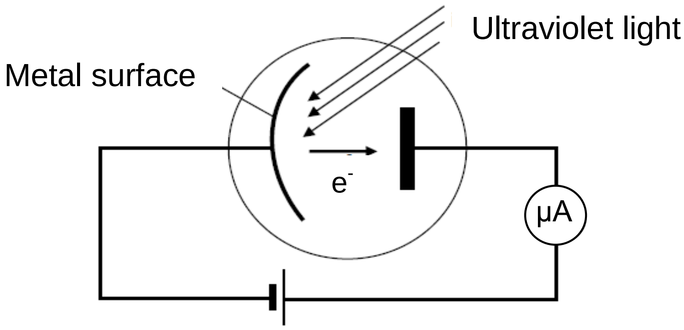
9.1.1 Resistance of the bulb (5)

9.1.2 rms current through the bulb (3)

9.2 Give ONE reason why AC voltage is preferred to DC voltage for everyday use. (1)
[9]

QUESTION 10 (Start on a new page.)

A learner uses photocells to determine the maximum kinetic energy of ejected photoelectrons. One photocell has a caesium cathode and the other has a sodium cathode. Each photocell is radiated by ultraviolet light from the same source as shown below.



The incomplete results obtained are shown in the table below.

NAME OF THE METAL	WORK FUNCTION OF THE METAL (J)	MAXIMUM KINETIC ENERGY OF PHOTOELECTRONS (J)
Caesium	$3,36 \times 10^{-19}$	$2,32 \times 10^{-19}$
Sodium	$3,65 \times 10^{-19}$	$\mathbf{E_K}$

10.1 Define the term *work function of a metal*. (2)

10.2 Use the information in the table to calculate the wavelength of the ultraviolet light used in the experiment. (4)

10.3 Calculate the maximum kinetic energy, E_K, of an electron ejected from the sodium metal. (4)

10.4 The intensity of the incident ultraviolet light was then increased.

10.4.1 Give a reason why this change does NOT affect the maximum kinetic energy of the ejected photoelectrons. (1)

10.4.2 How does the increased intensity affect the reading on the ammeter? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

10.4.3 Explain the answer to QUESTION 10.4.2. (2)
[14]

TOTAL: 150

QUESTION 1/*VRAAG 1*

1.1	A ✓✓	(2)
1.2	C✓✓	(2)
1.3	D ✓✓	(2)
1.4	B✓✓	(2)
1.5	D✓✓	(2)
1.6	A✓✓	(2)
1.7	A✓✓	(2)
1.8	C✓✓	(2)
1.9	A✓✓	(2)
1.10	B✓✓	(2)
		[20]

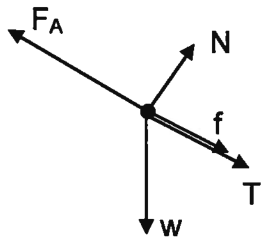
QUESTION 2/*VRAAG 2*

2.1 When one body exerts a force on a second body, the second body exerts a force of equal magnitude in the opposite direction on the first body.
Wanneer een liggaam 'n krag op 'n tweede liggaam uitoefen, oefen die tweede liggaam 'n krag van gelyke grootte in die teenoorgestelde rigting op die eerste liggaam.

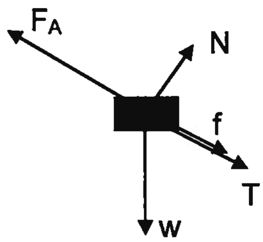
OR/*OF*:
When body A exerts a force on body B, body B will exert a force of equal magnitude but opposite in direction on body A.
Indien liggaam A 'n krag uitoefen op liggaam B, sal B 'n krag van gelyke grootte maar teenoorgesteld in rigting op liggaam A uitoefen.

ACCEPT/*AANVAAR* (for 1 mark only/*vir slegs 1 punt*)
Action and reaction are equal and opposite.
Aksie en reaksie is gelyk en teenoorgesteld (2)

2.2



Accept/Aanvaar	**Notes/*Aantekeninge***

Force diagram
Kragtediagram

	Do not penalise for length of arrows
	Moenie vir die lengte van die pyltjies penaliseer nie
	If w is not shown but $F_{//}$ and $F_{\perp}$ are shown give 1 mark for both.
	Indien w nie aangetoon is nie maar $F_{//}$ en $F_{\perp}$ is getoon, ken 1 punt toe vir beide.

Accept the following symbols/*Aanvaar die volgende simbole.*	
N	F_N; Normal;/*Normaal* ✓
F_A	40 N✓
f	F_f,f_k ✓
w	F_G Weight/*Gewig*; Gravitational force/*Gravitasiekrag*✓
T	Tension/*Spanning*; F_T ; ✓

(5)

2.3.1 **OPTION 1/*OPSIE 1***

For the 1 kg block/*Vir die 1 kg blok*;

$f_k = \mu_k N$

$= \mu_k\ mg\cos\theta$ ✓

$= 0,29\ (1 \times 9,8 \cos 30^\circ)$ ✓

$= 2,46$ N ✓

OPTION 2/*OPSIE 2*

BY PROPORTION:/*DEUR EWEREDIGHEID*

The smaller mass = ¼ of the larger mass ✓

Die kleiner massa = ¼ die groter massa

∴ frictional force/*wrywingskrag* = ¼ (10) ✓

= 2,5 N ✓ (3)

2.3.2 **POSITIVE MARKING FROM QUESTION 2.2**
POSITIEWE NASIEN VANAF VRAAG 2.2

OPTION 1/*OPSIE 1*

$F_{net} = ma$ ✓

For 1 kg block/*Vir 1 kg blok*

$F_A - \{(T+f_k) + mg\sin\theta\} = ma$

$40 - \{T + 2,46 + 1(9,8)(\sin 30^\circ)\}$ ✓ $= (1 \times)\ a$ ✓

$40 - T - 7,36 = a$

$32,64 - T = a$........(1)

For 4 kg block/*Vir 4 kg blok*

$T - (mg\sin\theta + f_k) = 4a$

$T - (4 \times 9,8 \sin 30^\circ + 10) = 4a$ ✓

$T - 29,6 = 4a$.........(2)

From (1) and (2)/*Vanaf (1) en (2)*

$a = 0,61\ m\cdot s^{-2}$

$T = 29,6 + (4(0,61)$ ✓

$T = 32,04$ N ✓

OPTION 2/*OPSIE 2*

Consider the blocks as a single system.
Beskou die blokke as 'n enkele sisteem.

$F_A - [\ (f_{tot}) - \{(4+1)\ g\sin 30^\circ\}] = (4+1)a$

$40 - (10 - 2,46) - (5(9,8)\sin 30^\circ)$ ✓ $= 5a$ ✓

$\therefore a = 0,61\ m\cdot s^{-2}$

For 1 kg block/*Vir 1 kg blok*

$F_{net} = ma$ ✓

$F_A - \{(T+f_k) + mg\sin\theta\} = ma$

$40 - \{T + 2,46 + 1(9,8)(\sin 30^\circ)\} = (1\ x)\ a$ ✓

$40 - T - 7,36 = a$

$32,64 - T = 0,61$ ✓

$T = 32,04$ N ✓

Notes/*Aantekeninge*

Learners need not show how (1) and (2) were combined
Leerders hoef nie aan te toon hoe (1) en (2) gekombineer is nie.

The first correct substitution for equation (1) should carry 2 marks.
The second substitution must carry 1 mark.
Die eerste korrekte vervanging vir vergelyking (1) moet 2 punte tel.
Die tweede vervanging tel 1 punt.

OR/*OF*

For 4 kg block/*Vir 4 kg blok*
Fnet - ma
$T - (mg \sin\theta + f_k) = 4a$
$T - (4 \times 9{,}8 \sin 30^{\circ} + 10) = 4a$✓
$T - 29{,}6 = 4a$
$T = 29{,}6 + (4)(0{,}61)$ ✓
$= 32{,}04$ N✓ (6)

[16]

QUESTION 3/*VRAAG 3*

3.1 Free fall/*Vrye val*

ACCEPT/*AANVAAR*
Vertically accelerated motion/projectile motion.
Vertikale versnelde beweging /projektielbeweging (1)

3.2.1 **Downward motion as positive**
Afwaartse beweging as positief

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓
30✓ $= v_i(1{,}5) + \frac{1}{2}(9{,}8)(1{,}5)^2$ ✓
$v_i = 12{,}65\ m\cdot s^{-1}$✓

Upward motion as positive
Opwaartse beweging as positief

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓
-30✓ $= v_i(1{,}5) + \frac{1}{2}(-9{,}8)(1{,}5)^2$ ✓
$v_i = 12{,}65\ m\cdot s^{-1}$✓

Notes / *Aantekeninge*
Accept/*Aanvaar*
g or/*of* a
$\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓
$s = ut + \frac{1}{2} at^2$

(4)

3.2.2

OPTION 1/*OPSIE 1*	Notes / *Aantekeninge*
Positive marking from QUESTION 3.2.1 ***Positiewe nasien vanaf VRAAG 3.2.1*** **Downward motion as positive** ***Afwaartse beweging as positief*** $v_f^2 = v_i^2 + 2a\Delta y$✓ $12{,}65^2$ ✓$= 0 + 2(9{,}8)\Delta y$✓ $\Delta y = 8{,}16$ m✓ Height/*Hoogte* **XC** = **XB** + **BC** (30 + 8,16) = 38,16 m Height is/*Hoogte is* 38,16 m✓	For/*Vir* **XB** Accept/*Aanvaar* g or/*of* a $v^2 = u^2 + 2as$ The height must be written down in order to score the final mark. *Die hoogte moet neergeskryf word om die finale punt te kry.*

Upward motion as positive ***Opwaartse beweging as positief*** $v_f^2 = v_i^2 + 2a\Delta y$✓ $(-12,65)^2$ ✓= $\underline{0 + 2(-9,8)\ \Delta y}$✓ $\Delta y = -8,16$ m✓ Height/*Hoogte* **XC** = **XB + BC** (-30) +(- 8,16) = -38,16 m Height is /*Hoogte is* 38,16 m) ✓

(5)

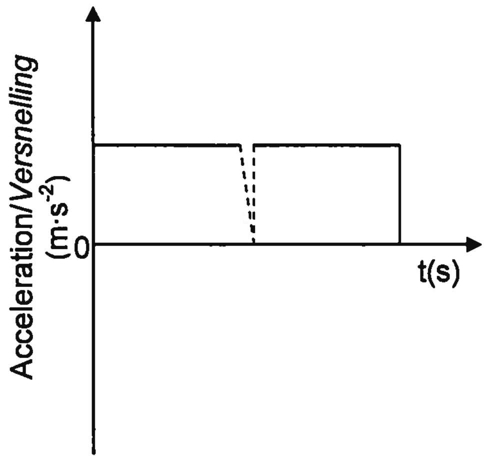
<u>OPTION /*OPSIE 2*</u> **Positive marking from QUESTION 3.2.1** ***Positiewe nasien vanaf VRAAG 3.2.1*** **Downward motion as positive** ***Afwaartse beweging as positief*** $v_B = v_X + a\Delta t$✓ $\underline{12,65 = 0 + 9,8\Delta t}$✓ $\Delta t = 1,29$ s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $= \underline{0 + \frac{1}{2}(9,8(1,29)^2}$✓ $\Delta y = 8,15$ m Height/*Hoogte* **XC** = **XB + BC** (30 + 8,15) = 38,15 m✓ **Upward motion as positive** ***Opwaartse beweging as positief*** $v_B = v_X + a\Delta t$✓ $\underline{-12,65 = 0 + (-)9,8\Delta t}$✓ $\Delta t = 1,29$ s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $= \underline{0 + \frac{1}{2}(-9,8(1,29)^2}$✓ $\Delta y = -8,15$ m Height/*Hoogte* **XC** = **XB + BC** (-30) + (-8,15) = 38,15 m✓	<u>Notes / *Aantekeninge*</u> **Start with time for XB** ***Begin met tyd vir XB*** Accept/*Aanvaar* g or/*of* a v=u+at $v^2 = u^2 + 2as$ $s = ut + \frac{1}{2}at^2$

(5)

OPTION 3/*OPSIE 3*	**Notes / *Aantekeninge***	
Positive marking from QUESTION 3.2.1 ***Positiewe nasien vanaf VRAAG 3.2.1*** **Downward motion as positive** ***Afwaartse beweging as positief*** $v_C = v_B + a\Delta t$✓ $= 12{,}65 + 9{,}8\ (1{,}5)$ ✓ $= 27{,}35\ m \cdot s^{-1}$ $v_C^2 = v_X^2 + 2a\Delta y$✓ $(27{,}35)^2 = 0 + 2(9{,}8)\ \Delta y$✓ $\therefore \Delta y = 38{,}16$ m Height is /*Hoogte is* 38,16 m✓ **Upward motion as positive** ***Opwaartse beweging as positief*** $v_C = v_B + a\Delta t$✓ $= -12{,}65 + (-9{,}8)\ (1{,}5)$ ✓ $= -27{,}35\ m \cdot s^{-1}$ $v_C^2 = v_X^2 + 2a\Delta y$✓ $(-27{,}35)^2 = 0 + 2(-9{,}8)\ \Delta y$✓ $\therefore \Delta y = -38{,}16$ m Height/*Hoogte* = 38,16m✓	start with velocity at C Accept/*Aanvaar* g or/*of* a $v = u+at$ $v^2 = u^2 + 2as$ The height must be written down in order to score the final mark. *Die hoogte moet neergeskryf word om die finale punt te kry.*	(5)

OPTION 4/*OPSIE 4*	**Notes / *Aantekeninge***	
Positive marking from QUESTION 3.2.1 ***Positiewe nasien vanaf VRAAG 3.2.1*** $\Delta U + \Delta K = 0$✓ $(mgh + 0)$ ✓ $= 0 + (\frac{1}{2} m(12{,}65)^2)$✓ $h = 8{,}16$ m✓ $XC = h + 30$ $= (30 + 8{,}16)$ $= 38{,}16$ m✓	Accept/*Aanvaar* $mgh_i + \frac{1}{2} mv_i^2 = mgh_f + \frac{1}{2} mv_f^2$ Take point B as the zero position and XH = h *Neem punt B is nul posisie en XH = h*	(5)

3.3 **OPTION 1/*OPSIE 1***

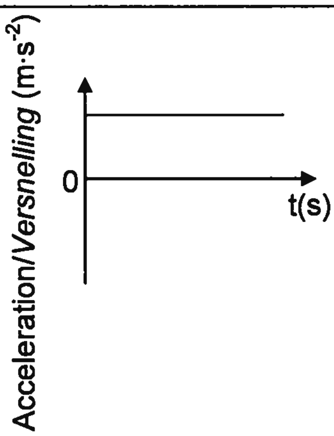


Notes / *Aantekeninge*

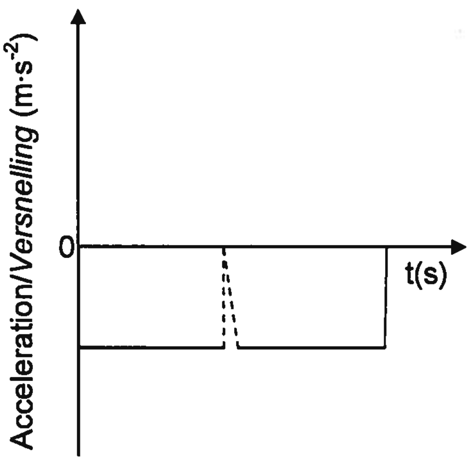
Criteria/*Kriteria*	**Mark/Punt**
For **each** line correctly drawn as shown *Vir **elke** lyn korrek geteken soos getoon*	✓✓
Both axes correctly labelled *Beide asse korrek benoem*	✓

Accept/*Aanvaar*

Only 2 marks for this answer/Slegs 2 punte vir hierdie antwoord



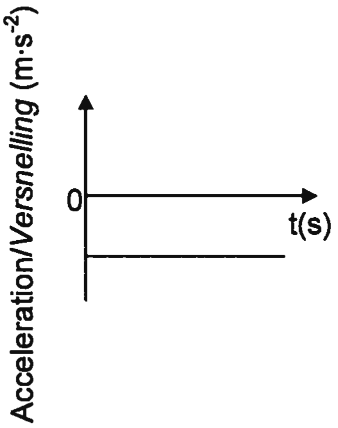
OPTION 2/*OPSIE 2*



Notes / *Aantekeninge*

Criteria/*Kriteria*	Mark/*Punt*
For **each** line correctly drawn as shown *Vir **elke** lyn korrek geteken soos getoon*	✓✓
Both axes correctly labelled *Beide asse korrek benoem*	✓

Only 2 marks for this answer/Slegs 2 punte vir hierdie antwoord



(3)
[13]

QUESTION 4/*VRAAG 4*

4.1

	Notes / ***Aantekeninge***
$W_{net} = \Delta K$ ✓ $W_{net} = ½ (M + m)(v_f^2 - v_i^2)$ $W_{fr} = f\Delta x\cos\theta$ ✓$= ½ (M + m)(v_f^2 - v_i^2)$ $10 \times 2 \cos180$✓$= ½ (7,02)(0 - v^2)$ ✓ $v_{bb} = 2,39\ m\cdot s^{-1}$✓ $(2,387)\ m\cdot s^{-1}$	1 mark for either of the formulae indicated *1 punt vir enige van die formule aangedui* **Accept/*Aanvaar*** $W_{nc} = \Delta K + \Delta U$ with $\Delta U = 0$

(5)

4.2

	Notes/***Aantekeninge***
The total linear momentum of an (isolated) closed system remains constant. *Die totale lineêre momentum in 'n geslote (geïsoleerde) sisteem bly konstant* **ACCEPT/*AANVAAR*** In an isolated system the total momentum before collision equals the total momentum after collision. *In 'n (geïsoleerde) geslote sisteem is die totale momentum voor botsing gelyk aan die totale momentum na botsing.*	2 or/*of* 0

(2)

4.3.

	Notes / ***Aantekeninge***
Positive marking from QUESTION 4.1 **Positiewe nasien vanaf VRAAG 4.1** $\Sigma p_i = \Sigma p_f$ ✓ $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$ $0,02v_i + (7)(0) = (7,02)(2,39)$ $0,02v_i$✓ $= 7,02\ (2,39)$✓ $v_i = 838,89\ m\cdot s^{-1}$ ✓	Accept/*Aanvaar* $(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$ $837,84\ m\cdot s^{-1}$ (for learners working with $2,387\ m\cdot s^{-1}$/*vir leerders wat met* $2,387\ m\cdot s^{-1}$ *werk*)

(4)
[11]

QUESTION 5/*VRAAG 5*

5.1

$\Delta U + \Delta K = 0$✓
$(5)(9,8)(5) + 0$✓ $+ (0 + ½(5v_f^2))$✓ $= 0$
$v_f = \sqrt{2 \times 9,8 \times 5}$
$= 9,90\ m \cdot s^{-1}$✓ $(9,899\ m \cdot s^{-1})$

Notes / *Aantekeninge*
Accept/*Aanvaar*
$Mgh_i + ½Mv_i^2 = Mgh_f + ½Mv_f^2$

(4)

5.2 No friction/zero resultant force ✓so there is no loss in energy.✓/Only conservative forces present./Mechanical energy is conserved
Geen wrywing/nul resulterende krag dus is daar geen verlies in energie nie/ Slegs konserwatiewe kragte is teenwoordig./Meganiese energie bly behoue (2)

5.3 A force for which the work done is path dependent.✓✓
'n Krag waarvoor arbeid verrig afhanklik van die pad gevolg is

Notes / *Aantekeninge*
Accept/*Aanvaar*
A force which does not conserve mechanical energy./*'n Krag wat nie meganiese energie behoue laat bly nie.*

(2)

5.4

OPTION 1/*OPSIE 1*

$W_{nc} = \Delta U + \Delta K$ ✓
$F \Delta x \cos\theta = \Delta U + \Delta K$
$(18 \Delta x \cos 180$✓$) = (5)(9,8)(3 - 0)$✓ $+ ½(5)(0 - 9,90^2)$✓
$\Delta x = 5,4458m$✓
$\theta = \sin^{-1}\frac{3}{5,4458}$✓
$\theta = 33,43°$✓

OPTION 2/*OPSIE 2*

$W_{net} = W_f + W_G$✓
$W_{net} = f \Delta x \cos\theta + mg\sin\theta \Delta x \cos\theta$
$= [(18)\Delta x \cos 180°) + 5(9,8)\frac{3}{\Delta x}(\Delta x)\cos 180°]$✓
$= -18\Delta x - 147$
$W_{net} = \Delta K$✓
$\Delta K = ½(5)(0 - 9,90^2)$✓
$= -245,025$
$-18\Delta x - 147 = -245,025$
$\Delta x = 5,4458\ m$✓
$\theta = \sin^{-1}\frac{3}{5,4458}$✓
$\theta = 39,43°$✓

(7)
[15]

QUESTION 6/*VRAAG 6*

6.1.1 $v = f\lambda$ ✓

$\lambda = \frac{340}{520}$

$= 0,65$ m ✓ (2)

6.1.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$f_L = \frac{340 ✓}{(340 - 15) ✓}(520)$ ✓

$f_L = 544$ Hz

$v = f\lambda$

$\lambda = \frac{340}{544}$ ✓

$= 0,63$m ✓

Notes / *Aantekeninge*
Accept/*Aanvaar*

$f_L = \frac{v}{v - v_s} f_s$

(6)

6.2 The wavelength in QUESTION 6.1.2 is shorter because the waves are compressed as they approach the observer. ✓ ✓
Die golflengte in VRAAG 6.1.2 is korter omdat die golwe saamgedruk word soos hulle die waarnemer nader. (2)

6.3 The red shift occurs when the spectrum of a distant star moving away from the earth is shifted toward the red end of the spectrum. ✓ ✓
Rooi verskuiwings vind plaas wanneer die spektrum van 'n vêr afgeleë ster wat vanaf die aarde wegbeweeg na die rooi ent van die spektrum skuif. (2)

[12]

QUESTION 7/*VRAAG 7*

7.1 The net electrostatic force on a charged particle due to the presence of another charged particle is directly proportional to the product of the charges✓and inversely proportional to the square of the distance between them (their centres) ✓
Die netto elektrostatiese krag op 'n gelaaide deeltjies as gevolg van die teenwoordigheid van 'n ander gelaaide deeltjie is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle (hul middelpunte)

OR/*OF*
The force of attraction or repulsion between two point charges is directly proportional to the product of the charges ✓and inversely proportional to the square of the distance between them. ✓
Die aantrekkings- of afstotingskrag tussen twee puntladings is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.

OR/*OF*
Any two charged particles will exert an electrostatic force on each other where the force is directly proportional to the product of the charges and inversely proportional to the square of the distance between the charged particles. (their centres)
Enige twee gelaaide deeltjies sal 'n elektrostatiese krag op mekaar uitoefen waar die krag direk eweredig is aan die produk van die ladings en omgekeerd eweredig is aan die kwadraat van die afstand tussen hulle (tussen hul middelpunte) (2)

7.2
7.2.1 $F = \frac{KQ_1Q_2}{r^2}$ ✓

$1{,}44 \times 10^{-1} = \frac{(9 \times 10^9)Q^2}{(0{,}5)^2}$ ✓ ✓

$Q = 2 \times 10^{-6}$ C✓ (4)

7.2.2 **Positive marking from QUESTION 7.2.1**
Positiewe nasien vanaf VRAAG 7.2.1
Q = ne✓
$2 \times 10^{-6} = n(1{,}6 \times 10^{-19})$ ✓
$n = 1{,}25 \times 10^{13}$ electrons/*elektrone*✓ (3)

7.3

7.3.1 Left /*Links* (west/*wes*) ✓ (1)

7.3.2 Take right as positive/*Neem regs as positief*

$E_{net} = E_A + E_B$ ✓

$$(3\times10^4) = -\frac{(9\times10^9)(2\times10^{-6})}{(1,5)^2}\checkmark + \frac{(9\times10^9)Q_{final}}{(1)^2}\checkmark$$

$Q_{final} = 4,22 \times 10^{-6}$ C ✓

Q = ne

$4,22 \times 10^{-6} = n(1,6\times10^{-19})$ ✓

$n_f = 2,64 \times 10^{13}$ electrons/*elektrone* ✓

electrons removed/*elektrone verwyder*

$= (2,64 \times 10^{13} + 1,25 \times 10^{13})$ ✓

$= 3,89 \times 10^{13}$ electrons/*elektrone* ✓ (8)

Notes / *Aantekeninge*

No. electrons should be removed $= n_f - n_i$
allocate the 1 mark for the subtraction

Aantal elektrone wat verwyder moet word $= n_f - n_i$
Ken 1 punt toe vir aftrekking

[18]

QUESTION 8/*VRAAG 8*

8.1.1 Ensure that the wires have:/*Maak seker dat die drade*
The same length/*dieselfde lengte het.* ✓
The same thickness/cross-sectional area/*dieselfde dikte/deursnit-area/ oppervlakte het* ✓ (2)

8.1.2 Wire **A** (Resistor A)/*Draad A* ✓

$R = \frac{\Delta V}{\Delta I}$ ✓

$R_A = \frac{4,4}{0,4}$ ✓ $= 11\ \Omega$ ✓

$R_B = \frac{2,2}{0,4}$ ✓ $= 5,5\ \Omega$ ✓

$E = I^2 R\Delta t$ ✓

Accept any correct coordinates chosen from the graph
Aanvaar enige korrekte koördinate van die grafiek gekies.

For the same time and current, the heating in A will be higher because its resistance is higher than that of B. ✓
Vir dieselfde tyd en stroom, sal die verwarming in A hoër wees omdat sy weerstand groter is as die van B.

ACCEPT/*AANVAAR*: $P = I^2R$
For the same current, the heat produced per unit time in A will be higher because its resistance is higher than that of B. ✓
Vir dieselfde stroom, sal die hitte vrygestel per eenheidstyd in A hoër wees omdat sy weerstand groter is as die van B. (8)

8.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$I_{5,5\Omega} : I_{11\Omega}$ 2 : 1 $I_{5,5\Omega} = (0,2)(2)$ ✓✓ $= 0,4$ A✓	$V = IR$ $V_{11\ \Omega} = 0,2 \times 11$ $=2,2$ V✓ $V_{5,5} = V_{11} = 2,2$ V✓ $I_{5,5} = \frac{2,2}{5,5}$ $= 0,4$ A✓

(3)

8.2.2

OPTION 1/OPSIE 1	**Notes / *Aantekeninge***
$V = IR$ $I_{tot} = (0,4 + 0,2)$ ✓ $= 0,6$ A $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ ✓ $\frac{1}{R_p} = \frac{1}{11} + \frac{1}{5,5}$ ✓ $R_P = 3,67\ \Omega$ $R_T = R_P + R_A$ $= 3,67 + 11$✓ $=14,67\Omega$ $\varepsilon = I(R + r)$ ✓ $9 = 0,6(14,67 + r)$ ✓ $r = 0,33\ \Omega$ ✓	Accept/*Aanvaar* $R_P = \frac{R_1R_2}{R_1 + R_2}$ ✓ $= \frac{11 \times 5,5}{11 + 5,5}$ ✓ $= 3,67\ \Omega$

(7)

OPTION 2/*OPSIE 2*
$I_{tot} = (0,4 + 0,2)$ ✓ $= 0,6$ A $V_{ext} = V_{11\ \Omega} + V_{//}$ ✓ $= [I_{tot}(R_{11}) + 2,2]$ $= 0,6\ (11)$ ✓ $+ 2,2$ $= 8,8$V✓ $\varepsilon = V_{ext} + I_{tot}(r)$ ✓ $9 = 8,8 + 0,6r$✓ $r = 0,33\ \Omega$✓

(7)

8.2.3 Decrease/*Afneem* ✓
The total resistance increases ✓/ *Die totale weerstand neem toe* (2)
[22]

QUESTION 9/*VRAAG 9*

9.1.1

OPTION 1/*OPSIE 1*	Notes / *Aantekeninge*
$P_{av} = \frac{V^2_{rms}}{R}$ ✓ $100✓ = \frac{\left(\frac{340}{\sqrt{2}}\right)^2}{R}$ ✓ ✓ $R = 578\ \Omega$ ✓	Assume correct formula for V_{rms} and give a mark if the substitution is correct1 mark *Aanvaar die korrekte formule vir V_{wgk} en ken 'n punt toe indien die vervanging korrek is.*
OPTION 2/*OPSIE 2* $V_{rms} = \frac{V_{max}}{\sqrt{2}} = \frac{340}{\sqrt{2}}$ ✓= 240,04 $P_{ave} = \frac{V^2_{rms}}{R}$ ✓ $100✓ = \frac{240{,}04^2}{R}$ ✓ $R = 578\ \Omega$ ✓	

(5)

9.1.2

OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*
$P_{av} = I_{rms}V_{rms}$ ✓ $100 = I_{rms}\frac{340}{\sqrt{2}}$ ✓ $I_{rms} = \frac{100}{\frac{340}{\sqrt{2}}}$ $= 0{,}417$ A ✓	$V_{rms} = I_{rms}R$ ✓ $\frac{340}{\sqrt{2}} = I_{rms}(578)$ ✓ $I_{rms} = 0{,}417$ A ✓

(3)

9.2 Can be stepped up or down/ can be transmitted with less power loss.
Kan verhoog of verlaag word/ kan versend word met minder energie verlies. (1)

[9]

QUESTION 10/*VRAAG 10*

10.1 The minimum energy needed to emit an electron ✓ from (the surface of) a metal. ✓
Die minimum energie benodig om 'n elektron uit die (oppervlak van) 'n metaal vry te stel. (2)

10.2 $E = W_0 + \frac{1}{2}mv^2_{max}$
$h\frac{c}{\lambda} = W_0 + \frac{1}{2}mv^2_{max}$
} Any ONE OF/*ENIGE EEN van*✓

$\frac{(6{,}63\times10^{-34})(3\times10^8)}{(\lambda)} = (3{,}36\times10^{-19}) + 2{,}32\times10^{-19}$ ✓ ✓

λ = 3,50 x 10^{-7} m✓ (4)

10.3 **POSITIVE MARKING FROM QUESTION 10.2**
POSITIEWE NASIEN VANAF VRAAG 10.2

$E = W_0 + \frac{1}{2}mv^2_{max}$
OR/*OF*
$h\frac{c}{\lambda} = W_0 + \frac{1}{2}mv^2_{max}$

$\frac{(6{,}63\times10^{-34})(3\times10^8)}{(3{,}50\times10^{-7})} = (3{,}65\times10^{-19}) + E_k$ ✓ ✓

E = 2,03 x 10^{-19} J✓ (4)

10.4.1 Increasing the intensity does not change the energy/ frequency/wavelength of the incident photons✓/The energy of a photon remains unchanged (for the same frequency).
Verhoging van die intensiteit, verander nie die energie/frekwensie/golflengte van die invallende fotone nie/Die energie van die foton bly onveranderd (vir dieselfde frekwensie). (1)

10.4.2 Increases./*Neem toe*✓ (1)

10.4.3 More photons (packets of energy) strike the surface of the metal per unit time✓ hence more (photo) electrons ejected per unit time ✓(leading to increased current).
Meer fotone (energie pakkies) tref die oppervlakte van die metaal per eenheidstyd, gevolglik word meer (foto)elektrone per eenheidstyd vrygestel (wat lei tot 'n verhoogde stroom). (2)
[14]

TOTAL/*TOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATION

PHYSICAL SCIENCES P1

PHYSICS

2015

MARKS: 150

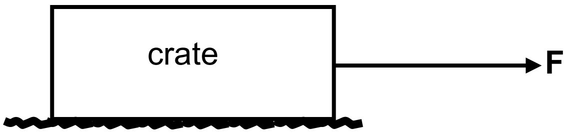
TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 A horizontal force **F** is applied to a crate, causing it to move over a rough, horizontal surface as shown below.



The kinetic frictional force between the crate and the surface on which it is moving depends on …

A the applied force **F**.

B the surface area of the crate in contact with the floor.

C how fast the crate moves on the surface.

D the upward force exerted by the surface on the crate. (2)

1.2 An object is placed on a bathroom scale in a lift which is stationary on the third floor of a building. The reading on the scale will be greatest when the lift ...

A accelerates downward.

B accelerates upward.

C moves upward at constant speed.

D moves downward at constant speed. (2)

1.3 A ball is thrown vertically upwards into the air. Ignore the effects of friction. The NET FORCE acting on the ball when the ball is at its highest point is ...

A zero.

B equal to the weight of the ball.

C less than the weight of the ball.

D greater than the weight of the ball. (2)

1.4 During a collision an inflated air bag in a car decreases the net force that would have acted on the driver of the car. This is because the time interval over which the net force acts on the driver … for the same momentum change.

A is zero

B decreases

C increases

D remains constant (2)

1.5 An object moving horizontally at a constant velocity suddenly encounters a rough horizontal surface. The object continues to move over this rough surface. Which ONE of the following statements is CORRECT?

The net work done on the object during the motion over the rough surface is …

A zero.

B positive.

C negative.

D constant. (2)

1.6 The hooter of a car emits sound of constant frequency as the car moves away from a stationary listener.

Which ONE of the following properties of the sound heard by the listener will **NOT** change?

A Velocity

B Frequency

C Both wavelength and frequency

D Both frequency and loudness (2)

1.7 Two identical positively charged spheres, which are free to move, are placed near each other on a frictionless surface.

Which ONE of the following CORRECTLY describes the motion of the two spheres?

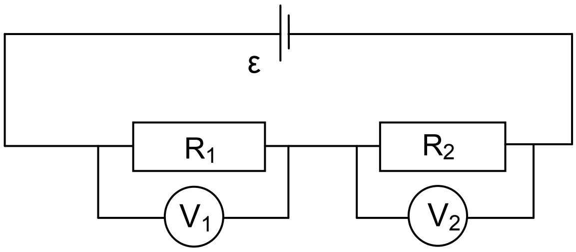
A They move away from each other with increasing acceleration.

B They move away from each other with decreasing acceleration.

C They move away from each other with constant acceleration.

D They move away from each other with zero acceleration. (2)

1.8 The diagram below shows a cell of emf (ε), and two resistors, R_1 and R_2, in series, with $R_1 < R_2$. The cell has negligible internal resistance and the voltmeters have very high resistances.



Which ONE of the following is CORRECT?

A $V_1 = V_2 = \varepsilon$

B $V_1 > V_2$

C $\frac{V_1}{R_1} = \frac{V_2}{R_2}$

D $\frac{V_1^2}{R_1} > \frac{V_2^2}{R_2}$ (2)

1.9 A DC generator operates at 80 Hz. The number of times the output voltage reaches a maximum in 1 second is ...

A 40.

B 80.

C 120.

D 160. (2)

1.10 Light of a certain frequency is incident on a metal surface and photoelectrons are emitted from the surface.

If the INTENSITY of the same light is increased, the ...

A kinetic energy of the emitted photoelectrons increases.

B kinetic energy of the emitted photoelectrons decreases.

C number of photoelectrons emitted per second increases.

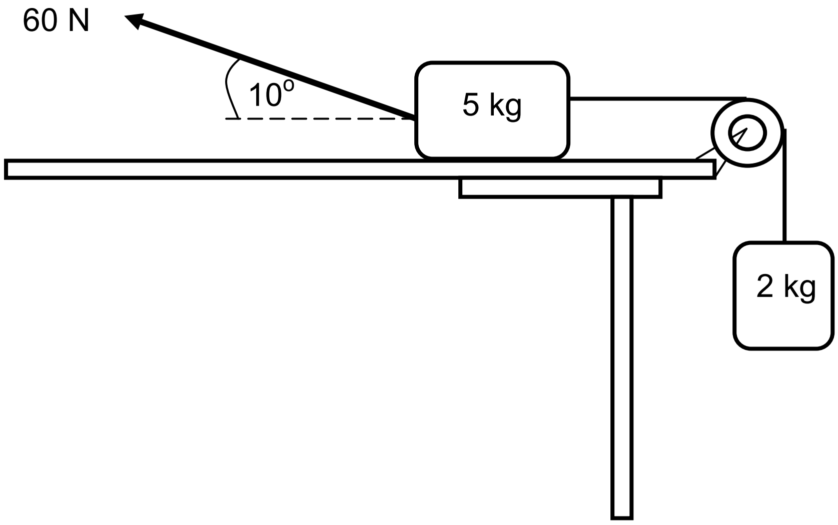
D number of photoelectrons emitted per second decreases. (2)

[20]

QUESTION 2 (Start on a new page.)

A 5 kg block, resting on a rough horizontal table, is connected by a light inextensible string passing over a light frictionless pulley to another block of mass 2 kg. The 2 kg block hangs vertically as shown in the diagram below.

A force of 60 N is applied to the 5 kg block at an angle of 10^{o} to the horizontal, causing the block to accelerate to the left.



The coefficient of kinetic friction between the 5 kg block and the surface of the table is 0,5. Ignore the effects of air friction.

2.1 Draw a labelled free-body diagram showing ALL the forces acting on the 5 kg block. (5)

2.2 Calculate the magnitude of the:

2.2.1 Vertical component of the 60 N force (2)

2.2.2 Horizontal component of the 60 N force (2)

2.3 State Newton's Second Law of Motion in words. (2)

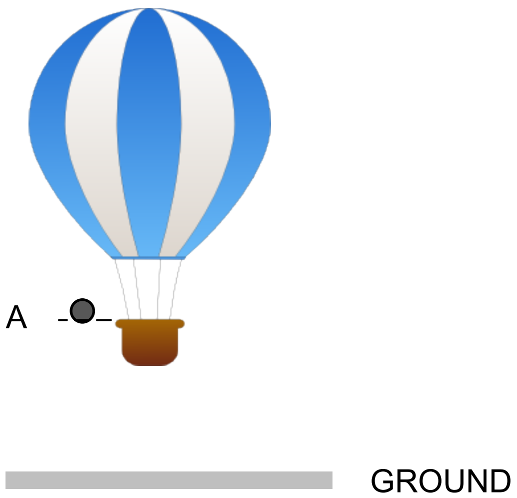
Calculate the magnitude of the:

2.4 Normal force acting on the 5 kg block (2)

2.5 Tension in the string connecting the two blocks (7)
[20]

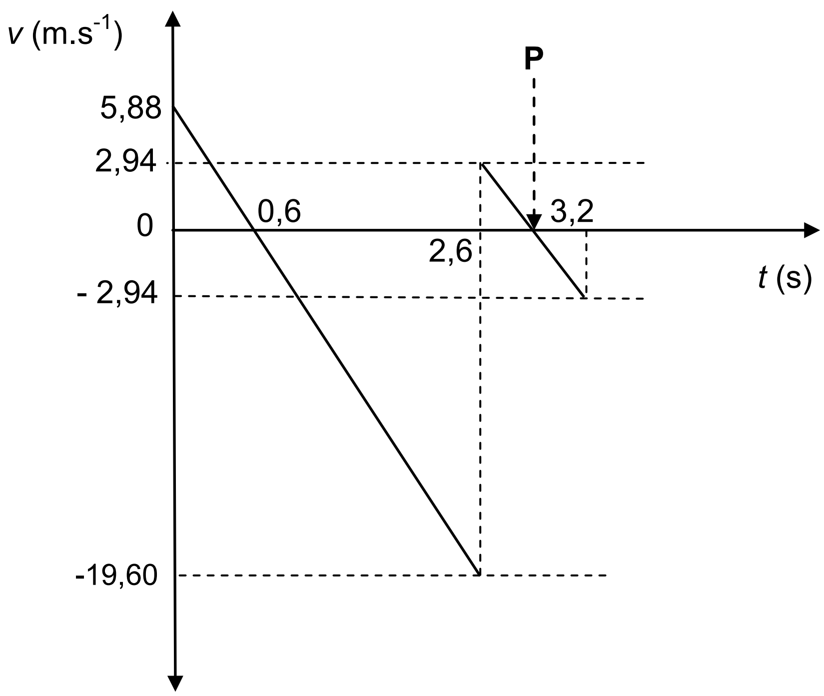
QUESTION 3 (Start on a new page.)

A hot air balloon is rising vertically at a constant velocity. When the hot air balloon reaches point **A** a few metres above the ground, a man in the hot air balloon drops a ball which hits the ground and bounces. Ignore the effects of friction.



The velocity-time graph below represents the motion of the ball from the instant it is dropped until after it bounces for the first time. The time interval between bounces is ignored. THE UPWARD DIRECTION IS TAKEN AS POSITIVE.

USE INFORMATION FROM THE GRAPH TO ANSWER THE QUESTIONS THAT FOLLOW.



3.1 Write down the magnitude of the velocity of the hot air balloon. (1)

3.2 Calculate the height above the ground from which the ball was dropped. (3)

Calculate the:

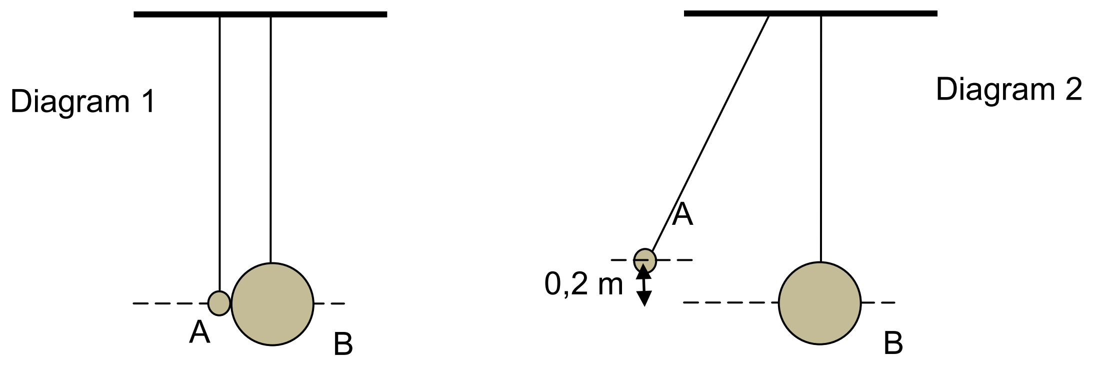
3.3 Time at the point **P** indicated on the graph (2)

3.4 Maximum height the ball reaches after the first bounce (3)

3.5 Distance between the ball and hot air balloon when the ball is at its maximum height after the first bounce (4)
[13]

QUESTION 4 (Start on a new page.)

Two stationary steel balls, **A** and **B**, are suspended next to each other by massless, inelastic strings as shown in Diagram 1 below.



Ball **A** of mass 0,2 kg is displaced through a vertical distance of 0,2 m, as shown in Diagram 2 above. When ball **A** is released, it collides elastically and head-on with ball **B**. Ignore the effects of air friction.

4.1 What is meant by an *elastic collision*? (2)

Immediately after the collision, ball **A** moves horizontally backwards (to the left). Ball **B** acquires kinetic energy of 0,12 J and moves horizontally forward (to the right).

Calculate the:

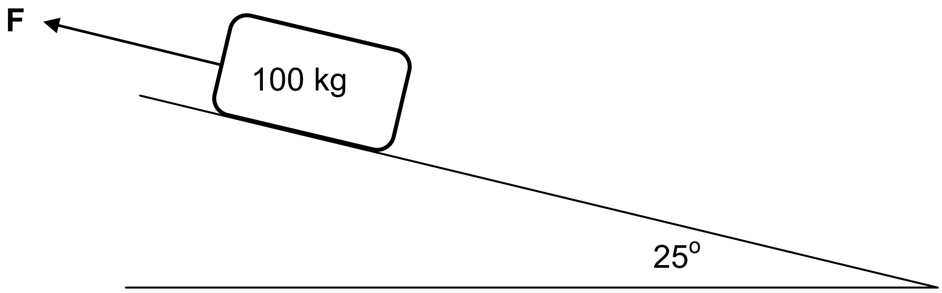
4.2 Kinetic energy of ball **A** just before it collides with ball **B** (Use energy principles only.) (3)

4.3 Speed of ball **A** immediately after the collision (4)

4.4 Magnitude of the impulse on ball **A** during the collision (5)
[14]

QUESTION 5 (Start on a new page.)

The diagram below shows a heavy block of mass 100 kg sliding **down** a rough 25° inclined plane. A constant force **F** is applied on the block parallel to the inclined plane as shown in the diagram below, so that the block slides down at a **constant velocity**.



The magnitude of the kinetic frictional force (f_k) between the block and the surface of the inclined plane is 266 N.

5.1 Friction is a non-conservative force. What is meant by the term *non-conservative force*? (2)

5.2 A learner states that the net work done on the block is greater than zero.

5.2.1 Is the learner correct? Answer only YES or NO. (1)

5.2.2 Explain the answer to QUESTION 5.2.1 using physics principles. (2)

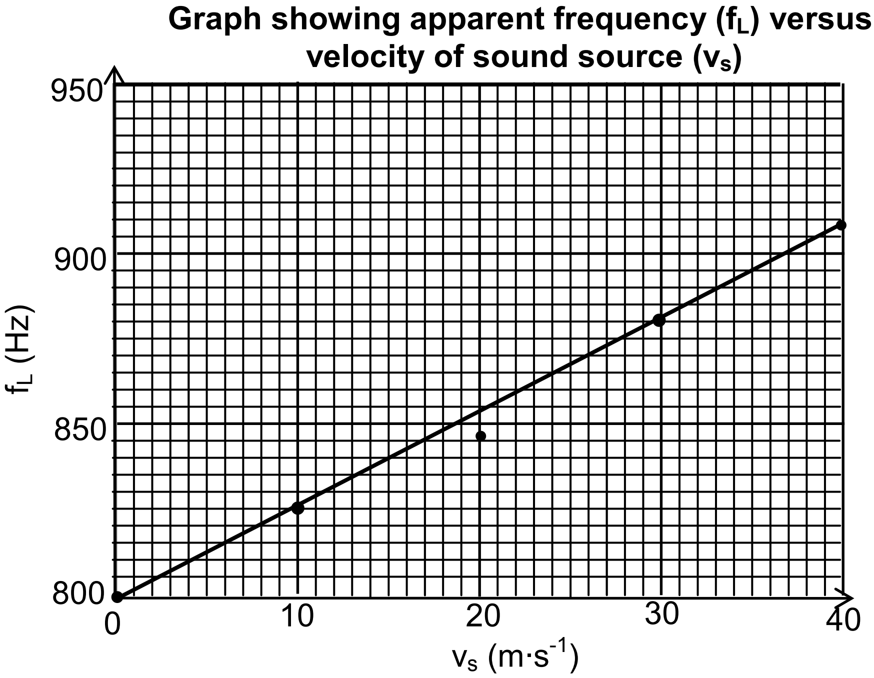
5.3 Calculate the magnitude of the force **F**. (4)

If the block is released from rest without the force **F** being applied, it moves 3 m down the inclined plane.

5.4 Calculate the speed of the block at the bottom of the inclined plane. (6)
[15]

QUESTION 6 (Start on a new page.)

The graph below shows the relationship between the apparent frequency (f_L) of the sound heard by a STATIONARY listener and the velocity (v_s) of the source travelling TOWARDS the listener.



6.1 State the Doppler effect in words. (2)

6.2 Use the information in the graph to calculate the speed of sound in air. (5)

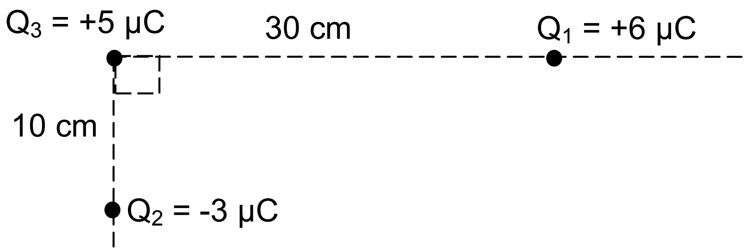
6.3 Sketch a graph of apparent frequency (f_L) versus velocity (v_s) of the sound source if the source was moving AWAY from the listener. It is not necessary to use numerical values for the graph. (2)

[9]

QUESTION 7 (Start on a new page.)

Three point charges, $\mathbf{Q_1}$, $\mathbf{Q_2}$ and $\mathbf{Q_3}$, carrying charges of +6 μC, -3 μC and +5 μC respectively, are arranged in space as shown in the diagram below.

The distance between $\mathbf{Q_3}$ and $\mathbf{Q_1}$ is 30 cm and that between $\mathbf{Q_3}$ and $\mathbf{Q_2}$ is 10 cm.

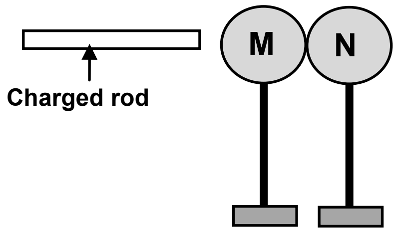


7.1 State Coulomb's law in words. (2)

7.2 Calculate the net force acting <u>on charge $\mathbf{Q_3}$</u> due to the presence of $\mathbf{Q_1}$ and $\mathbf{Q_2}$. (7)
[9]

QUESTION 8 (Start on a new page.)

Two identical neutral spheres, **M** and **N**, are placed on insulating stands. They are brought into contact and a charged rod is brought near sphere **M**.

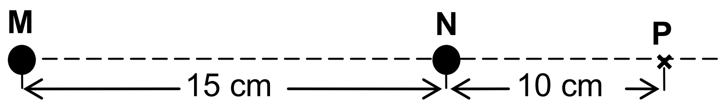


When the spheres are separated it is found that 5 x 10^6 electrons were transferred from sphere **M** to sphere **N**.

8.1 What is the net charge on sphere **N** after separation? (3)

8.2 Write down the net charge on sphere **M** after separation. (2)

The charged spheres, **M** and **N**, are now arranged along a straight line, in space, such that the distance between their centres is 15 cm. A point **P** lies 10 cm to the *right* of **N** as shown in the diagram below.

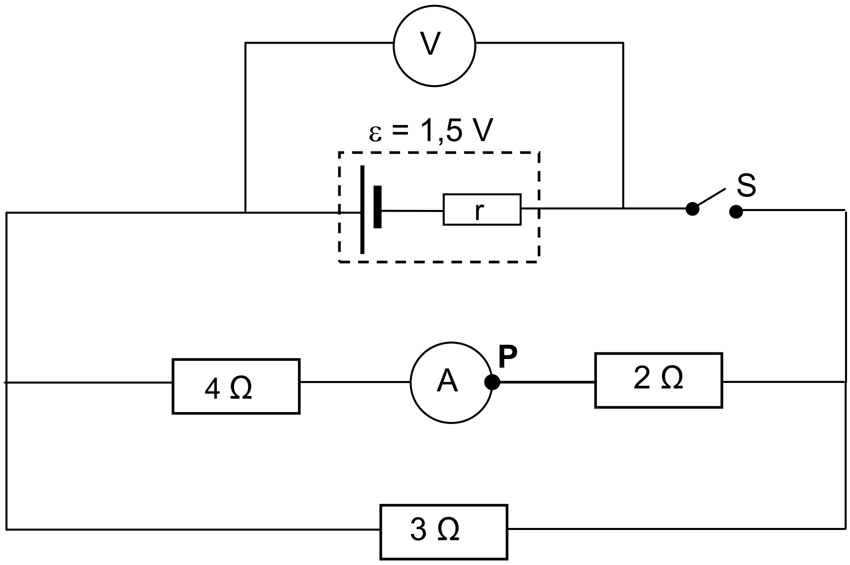


8.3 Define the *electric field* at a point. (2)

8.4 Calculate the net electric field at point **P** due to **M** and **N**. (6)
[13]

QUESTION 9 (Start on a new page.)

A cell of unknown internal resistance, *r*, has emf (ε) of 1,5 V. It is connected in a circuit to three resistors, a high-resistance voltmeter, a low-resistance ammeter and a switch S as shown below.



When switch S is closed, the voltmeter reads 1,36 V.

9.1 Which terminal of the ammeter is represented by point **P**?
Write down only POSITIVE or NEGATIVE. (1)

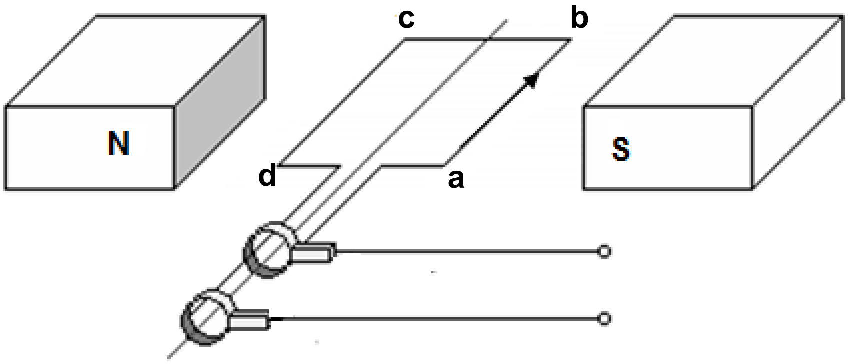
9.2 Calculate the ammeter reading. (3)

9.3 Determine the internal resistance of the cell. (7)

9.4 An additional resistor X is connected parallel to the 3 Ω resistor in the circuit. Will the reading on the ammeter INCREASE, DECREASE or REMAIN UNCHANGED? Give a reason for the answer. (4)
[15]

QUESTION 10 (Start on a new page.)

10.1 The output potential difference of an AC generator is 100 V at 20 Hz. A simplified diagram of the generator is shown below. The direction of the current in the coil is from **a** to **b**.



10.1.1 In which direction is the coil rotating? Write only CLOCKWISE or ANTICLOCKWISE. (1)

10.1.2 Starting from the position shown in the diagram, sketch a graph of the output potential difference versus time when the coil completes TWO full cycles. On the graph, clearly indicate the maximum potential difference (100 V) and the time taken to complete the two cycles. (3)

10.1.3 State ONE way in which this AC generator can be used to produce a lower output potential difference. (1)

10.2 An electrical device is rated 220 V, 1 500 W.

Calculate the maximum current output for the device when it is connected to a 220 V alternating current source. (5)

[10]

QUESTION 11 (Start on a new page.)

11.1 In the diagram below, green and blue light are successively shone on a metal surface. In each case, electrons are ejected from the surface.

11.1.1 What property of light is illustrated by the photoelectric effect? (1)

11.1.2 Without any calculation, give a reason why the maximum kinetic energy of an ejected electron, using blue light, is GREATER THAN that obtained using green light, for the same metal surface. (2)

11.2 The wavelength associated with the cut-off (threshold) frequency of a certain metal is 330 nm.

Calculate:

11.2.1 The work function of the metal (4)

11.2.2 The maximum speed of an electron ejected from the surface of the metal when light of frequency $1,2 \times 10^{15}$ Hz is shone on the metal (5)
[12]

TOTAL: 150

QUESTION 1/*VRAAG 1*

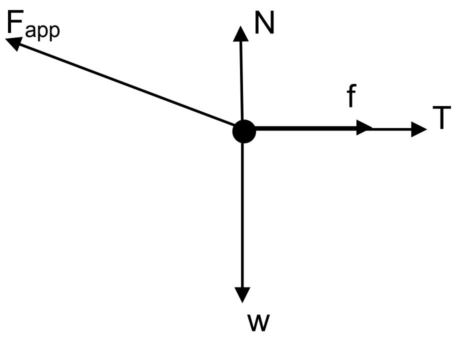
1.1	D ✓✓	(2)
1.2	B ✓✓	(2)
1.3	B ✓✓	(2)
1.4	C ✓✓	(2)
1.5	C ✓✓	(2)
1.6	A ✓✓	(2)
1.7	B ✓✓	(2)
1.8	C✓✓	(2)
1.9	D ✓✓	(2)
1.10	C ✓✓	(2)
		[20]

QUESTION 2/*VRAAG 2*

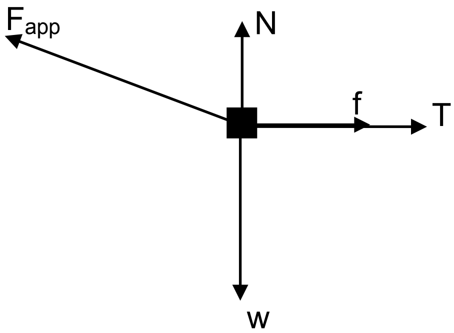
2.1

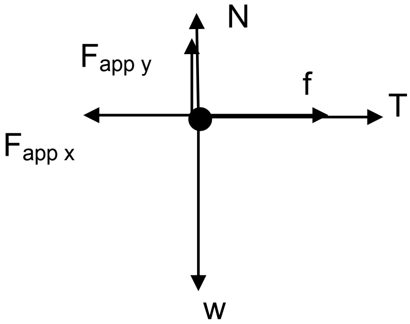
Accepted labels/*Aanvaarde benoemings*		
w	✓	F_g / F_w / weight / mg / gravitational force *F_g / F_w / gewig / mg / gravitasiekrag*
T	✓	F_T / tension F_T / *spanning*
F	✓	F_a / F_{60} / 60 N / $F_{applied}$ / F_t / $F_{toegepas}$
N	✓	F_N
f	✓	F_f

(5)



Accept / *Aanvaar*





Notes/*Aantekeninge*

- Mark awarded for label <u>and</u> arrow / *Punt toegeken vir benoeming <u>en</u> pyltjie*
- Do not penalise for length of arrows since drawing is not to scale. /*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie*
- Any other additional force(s) / *Enige ander addisionele krag(te)* Max/*Maks* $\frac{4}{5}$
- If force(s) do not make contact with body/*Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $\frac{4}{5}$

2.2.1

$F_{60y} = F_{60}\sin\theta$
$F_{60y} = 60\sin 10^o$ ✓ **OR/*OF*** $F_{60Y} = F_{60}\cos\theta$, $F_{60y} = 60\cos 80^o$ ✓
$= 10,42$ N✓

(2)

2.2.2

$F_{60x} = F_{60}\cos\theta$
$F_{60x} = 60\cos 10^o =$ ✓ **OR/*OF*** $F_{60x} = F_{60}\sin\theta$, $F_{60x} = 60\sin 80^o$ ✓
$= 59,09$ N✓

(2)

2.3 When a resultant/net force acts on an object, the object will accelerate in the direction of the force at an acceleration directly proportional to the force ✓ and inversely proportional to the mass of the object.✓
Wanneer 'n resultante/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig is aan die krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*
The net force acting on an object is equal to the rate of change of momentum.
Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum. (2)

2.4

POSITIVE MARKING FROM 2.2 ***POSITIEWE NASIEN VANAF 2.2*** $N = mg – F_{60y}$ $N = \{5(9,8) – 10,42\}$ } ✓ = 38,58 N✓	**OR/OF** $F_y + N = w$ $N = w – F_y = mg - F_y$ } ✓ [(5)(9,8) – 10,42] = 38,58 N✓

(2)

2.5 **POSITIVE MARKING FROM 2.2.2 and 2.4**
POSITIEWE NASIEN VANAF 2.2,2 en 2.4

$F_{net} = ma$
$T – m_2g = m_2a$ } ✓

T – 2(9,8) = 2a.
T – 19,6 ✓= 2a……………………….(1)

$F_{60x} – (f + T) = m_8a$
$60\cos10^o – (f + T) = 5a$.
$60\cos10^o – [(\mu_kN)$ ✓ +T)] = 5a.. ✓
59,09 – (0,5 x 38,58) –T ✓= 5a

OR/*OF* $60 \sin 80^o – [f +T) = 5a$

39,8 – T = 5a........................(2)
$a = 2,886\ ms^{-2}$

T – 19,6 = 2 (2,886) ✓
T = 25,37 N✓

NOTE: 1 mark for either μ_k N or substitution./
LET WEL: 1 punt vir μ_k N ót *vervanging.*

OR/*OF*
From equation/*Uit vergelyking* (2)
T = 25,37 N

OR/*OF*
T – 19,6 = 2a …………………..(1) x 5
59,09 – 19,29 – T = 5a ………(2) x 2

7T – 177,6 = 0✓
T = 25,37 N ✓ (7)

2.5

NOTES: ACCEPT FOR 5 MARKS
NOTAS: AANVAAR VIR 5 PUNTE

Fnet = ma✓ OR/*OF*
$F_{60x} – (f+m_2g) = (m_5 + m_2)a$

$60\cos10^o – (\mu_kN)$ ✓ $+ (2)(9,8) = 7a$
$59,09 – [(0,5 \times 38,58) + 19,6]$ ✓ $= 7a$
$a = 2,886\ ms^{-2}$

$T – m_2g = m_2a$
$T – 2(9,8) = 2(2,886)$ ✓
$T = 25,37\ N$✓

$F_{60x} – (f + T) = m_8a$
$60\cos10^o – (f + T) = 5a.$
$60\cos10^o – [(\mu_kN) +T)] = 5a..$
$59,09 – (0,5 \times 38,58) –T = 5(2,886)$ ✓
$T = 25,37\ N$✓

[20]

QUESTION 3/*VRAAG 3*

3.1 $5,88\ m·s^{-1}$✓ (1)

3.2

Notes/*Aantekeninge*
Accept/*Aanvaar*
g or/*of* a
$\Delta x = v_i\Delta t + ½ a\Delta t^2$✓
$s = ut + ½ at^2$
$v = u + at$

If/Indien:
$g = 10\ m·s^{-2}$ (deduct only 1 mark for the whole question)
Different convention i.e. upward negative: (deduct only 1 mark for the whole question

3.2

POSITIVE MARKING FROM 3.1
POSITIEWE NASIEN VANAF 3.1

OPTION 1/*OPSIE 1*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(-19,6)^2 = (5,88)^2 + 2(-9,8)\ \Delta y$ ✓
$\Delta y = - 17,84m$
Height above ground/*hoogte bo grond* = 17,84 m ✓ (3)

POSITIVE MARKING FROM 3.1
POSITIEWE NASIEN VANAF 3.1

OPTION 2/*OPSIE 2*
Area between graph and t-axis for 2,6 s
Oppervlakte tussen grafiek en t-as vir 2,6 s

$\Delta y = ½ bh + ½ bh$
$= ½ (0,6)(5,88)$✓$+ ½(2,6 – 0,6)(-19,6)$✓
$= - 17,84\ m$
∴Height above ground/*Hoogte bo grond* = 17,84 m ✓ (3)

POSITIVE MARKING FROM 3.1
POSITIEWE NASIEN VANAF 3.1

OPTION 3/*OPSIE 3*
By symmetry ball returns to A at 1,2s downward and v = -5,88 m·s^{-1}
Volgens simmetrie keer bal terug na A by 1,2s afwaarts en v = -5,88 m·s^{-1}

Δy = Area of trapezium / *Oppervlakte van trapesium*
= ½(sum of parallel sides / *som van parallelle sye*)(h) ✓ /
= ½{(-5,88) +(-19,6)} (2,6 - 1,2) ✓ = - 17,84m
∴Height above ground/*Hoogte bo grond* = 17,84 m ✓ (3)

POSITIVE MARKING FROM 3.1
POSITIEWE NASIEN VANAF 3.1

OPTION 4/*OPSIE 4*

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \checkmark$$

$$\Delta y = \left(\frac{5,88 + (-19,6)}{2}\right)(2,6) \checkmark = -17,836\ m$$

∴Height above ground/*Hoogte bo grond* =17,84 m ✓ (3)

POSITIVE MARKING FROM 3.1
POSITIEWE NASIEN VANAF 3.1

OPTION 5/*OPSIE 5*
$\Delta y = v_i\Delta t + ½ a\Delta t^2$ ✓
$\Delta y = (5,88)(2,6) + ½(-9,8)(2,6)^2$ ✓
= 15,288 – 33,124 = -17,836
∴Height above ground/*Hoogte bo grond* = 17,84 m ✓ (3)

POSITIVE MARKING FROM 3.1
POSITIEWE NASIEN VANAF 3.1

OPTION 6/*OPSIE 6*
From point of release to max height
Vanaf punt van vrylating tot maksimum hoogte

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ for either formula/*vir enige van die formules*
$(0)^2 = (5,88)^2 + 2(-9,8)\ \Delta y$ ✓ for substitions in both equations/ *vir vervanging in beide vergelykings*
Δy = 1,76 m up

From max height to ground/*Vir maksimum hoogte bo grond*

$v_f^2 = v_i^2 + 2a\Delta y$
$(-19,6)^2 = 0 + 2(-9,8)\ \Delta y$
∴Δy = - 19,6 (down/*afwaarts*)
∴Height above ground/*hoogte bo grond* = 19,6 -1,76 (3)

= 17,84 m ✓
NOTE: For substitions in both equations/***LET WEL:*** *Vir vervangings in beide vergelykings*: (5,88)(0,6) + ½(-9,8)(0,6)^2 ✓ = 1,77 m upward/*opwaarts*

<u>OPTION 7/*OPSIE 7*</u>

From point of release to max height/*Vanaf punt van vrylating tot maks hoogte*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ for either formula/*vir enige van die formules*

From max height to ground/*Vanaf maks hoogte bo grond*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓

$= 0 + \frac{1}{2}(-9,8)(2)^2$ ✓ = -19,6 m (down/*afwaarts*)

Height above ground/*hoogte bo grond*

= 19,6 -1,77=17,83 m ✓ (3)

<u>POSITIVE MARKING FROM 3.1</u>
<u>POSITIEWE NASIEN VANAF 3.1</u>

NOTE: For substitions in both equations/***LET WEL:*** *Vir vervangings in beide vergelykings*: (5,88)(0,6) + ½(-9,8)(0,6)^2 ✓ = 1,77 m up/*opwaarts*

<u>OPTION 8/*OPSIE 8*</u>

From point of release to max height/*Vanaf punt van vrylating tot maks hoogte*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓for either formula/*vir enige van die formules*

From max height to ground/*Vanaf maks hoogte bo grond*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

$\Delta y = \frac{0 + 19,6}{2}(2)$ ✓

$= -19,6$

Height above ground/*Hoogte bo grond* = 19,6 -1,76
= 17,84 m ✓ (3)

<u>POSITIVE MARKING FROM 3.1</u>
<u>POSITIEWE NASIEN VANAF 3.1</u>

NOTE/*LET WEL*:

1. For substitions in both equations/*Vir vervanging in beide vergelykings:*

$\Delta y = \left(\frac{5,88 + 0}{2}\right)(0,6)$ ✓= 1,76 m upwards/*opwaarts*

2. The steps can be swopped for options 6,7,8/*Vir opsie 6,7,8 kan stappe omgeruil word.*

3.3

OPTION 1/*OPSIE 1*

$t_p = \left(\frac{3,2 - 2,6}{2}\right) + 2,6$ ✓

Time at / *Tyd by* P (t_p) = 2,9 s ✓ (2)

OPTION 2/*OPSIE 2*

Gradient/*Gradiënt* = -9,8

$\frac{\Delta y}{\Delta t} = -9,8$

$\frac{0 - 2,94}{\Delta t} = -9,8$ ✓

$\Delta t = 0,3s$

Time at P (t_p) / *Tyd by P (t_p)* = (2,6 + 0,3) = 2,9 s ✓ (2)

OPTION 3/*OPSIE 3*

$v_f = v_i + a\Delta t$

$0 = 2,94 + (-9,8)\Delta t$ ✓

$\Delta t = 0,3s$

$\therefore t_p = 2,6 + 0,3 = 2,9s$ ✓ (2)

3.4

POSITIVE MARKING FROM 3.3
POSITEWE NASIEN VANAF 3.3

OPTION 1/*OPSIE 1*

Δy = area under graph / *oppervlakte onder die grafiek* ✓

= ½ (0,3)(2,94) ✓

= 0,44 m ✓ (3)

OPTION 2/*OPSIE 2*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$\Delta y = \frac{2,94 + 0}{2}(0,3)$ ✓

= 0,44 m ✓ (3)

OPTION 3/*OPSIE 3*

$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓

$= (2,94)(0,3) + ½(-9,8)(0,3)^2$ ✓

= 0,44 m ✓ (3)

OPTION 4/*OPSIE 4*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0 = 2,94^2 + 2(-9,8)\Delta y$ ✓

$\Delta y = 0,44m$ ✓ (3)

3.5 **<u>POSITIVE MARKING FROM 3.1, 3.2, 3.3 AND 3.4</u>**
<u>POSITIEWE NASIEN VANAF 3.1, 3.2, 3.3 EN 3.4</u>

for/*vir* t =2,9 s t_p = 2,9 s
distance travelled by balloon since ball was dropped
afstand deur ballon gereis vandat bal laat val is

$\Delta y = v\Delta t$
$= (5,88)(2,9)$ ✓
$= 17,05$ m

height of balloon when ball was dropped/*hoogte van ballon toe bal laat val is*
= 17,84 m

Height of balloon after 2,9 s/*Hoogte van ballon na 2,9 s* = (17.05 + 17,84) ✓
= 34,89 m

maximum height of ball above ground/*maksimum hoogte van bal bo grond*
= 0,44 m

∴distance between balloon and ball/*afstand tussen ballon en bal*
= (34,89 – ✓ 0,44) = 34,45 m ✓ (4)

[13]

QUESTION 4/*VRAAG 4*

4.1 A collision in which both total momentum and total kinetic energy are conserved. ✓✓(2 or/*of* 0)
'n Botsing waarin beide totale momentum en totale kinetiese energie behoue bly

Accept/*Aanvaar*
(Total)kinetic energy is conserved ✓✓
(Totale) kinetiese energie bly behoue

Accept/*Aanvaar*
$\sum K_i = \sum K_f$ ✓✓

(2)

4.2 **<u>OPTION 1/*OPSIE 1*</u>**
For ball A / *Vir bal A*
$(E_{mech/meg})_{top/bo} = (E_{mech/meg})_{bottom/onder}$
$(E_K + E_P)_{top/bo} = (E_K + E_P)_{bottom/onder}$ } Any one / *Enige een* ✓
$(\frac{1}{2}mv^2 + mgh)_{top/bo} = (\frac{1}{2}mv^2 + mgh)_{bottom/onder}$
$\frac{1}{2}(0,2)(0)^2 + (0,2)(9,8)(0,2)_{top/bo} = E_k + m(9,8)(0)_{bottom/onder}$ ✓
$E_k = 0,39$ J ✓

<u>OPTION 2/*OPSIE 2*</u>
$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$0 = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$
$0 = (0,2)(9,8)(0,2 - 0) + \frac{1}{2}mv_f^2 - \frac{1}{2}(0,2)(0)^2$ ✓
$\therefore E_k = 0,39$ J ✓ (3)

4.3 **POSITIVE MARKING FROM QUESTION 4.2**
POSITIEWE NASIEN VANAF VRAAG 4.2

$\Sigma E_{Kbefore} = \Sigma E_{Kafter}$
$E_{KiA} + E_{KiB} = E_{KfA} + E_{KfB}$
$E_{KiA} + E_{KiB} = \frac{1}{2} m_A v_{fA}^2 + E_{KfB}$
} ✓Any one /*Enige een*

$\underline{0,39 + 0}$✓ $= \frac{1}{2}\,\underline{(0.2)v_{fA}^2 + 0,12}$ ✓
$v_{fA} = 1,64\ m\cdot s^{-1}$✓ (Accept/*Aanvaar* $1,65\ m\cdot s^{-1}$) (4)

4.4 **POSITIVE MARKING FROM QUESTION 4.2**
POSITIEWE NASIEN VANAF VRAAG 4.2

$E_{Kbefore/voor} = \frac{1}{2} m_A v_{iA}^2$
$0,39 = \frac{1}{2}(0,2)\, v_{iA}^2$✓
$v_{iA} = 1,98\ m\cdot s^{-1}$
Impulse/*Impuls* $= m(v_f - v_i)$
Impulse/*Impuls* $= m(v_{iA} - v_{fA})$
} ✓Any one /*Enige een*
$= 0,2(-1,64)$ ✓$- (0,2)(1,98)$✓
$= 0,72\ N\cdot s$ ✓ (accept/*aanvaar*: $0,73\ N\cdot s$) (5)
(accept/*aanvaar* $kg\cdot m\cdot s^{-1}$ as unit /*eenheid*) **[14]**

QUESTION 5/*VRAAG 5*

5.1 If the work done in moving an object between two points depends on the path taken (then the force applied is non-conservative) ✓✓(2 or/*of* 0).
Indien die arbeid verrig om 'n voorwerp tussen twee punte te beweeg, afhanklik is van die pad wat gevolg word, (is die krag wat toegepas word, nie-konserwatief) (2)

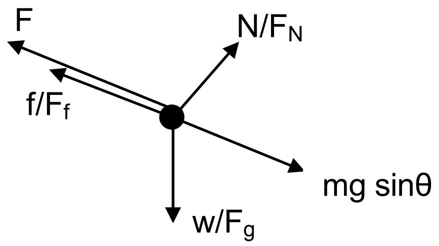
5.2.1 No/*Nee* ✓ (1)

5.2.2 Since there is no acceleration, the net force is zero ✓hence net work done (which is $F_{net}\Delta x \cos\theta$) must be zero. ✓
Omdat daar geen versnelling is nie, is die netto krag nul. Dus moet die netto arbeid verrig (wat $F_{net}\Delta x \cos\theta$ is) nul wees.

OR/*OF*
$W_{net} = \Delta K$.
Since it is moving with constant velocity ✓*Omdat dit teen konstante snelheid beweeg*
$\Delta K = 0\ \therefore W_{net} = 0$✓ (2)

5.3

$F_{//} - (f + F) = 0$✓
OR/*OF*
$F = mg\sin\theta - f_k$
OR/*OF*
$F = mg\sin\theta - 266$
$F = [100(9,8)\sin 25^o]$✓ $- 266$✓
$414,167 - 266$
$F = 148,17\ N$✓



(4)

NOTE/*LET WEL*
No mark for diagram / *Geen punt vir diagram nie*
1 mark for use of any of the three formulae / *1 punt vir gebruik van enige drie van die formules*

5.4

OPTION 1/*OPSIE 1*

1 mark for any of the three/ *1 punt vir enige van die drie*

$W = F\Delta x \cos\theta$
$W_{net} = W_f + W_g + W_N$
$W_{net} = f_k\, \Delta x \cos180^o$ ✓ $+ mg\sin\theta\, \Delta x \cos0^o + 0$
$= (266)(3)(-1)$ ✓ $+ [100(9,8) \sin 25^o (3)(1)]$ ✓ $+ 0$
$= 444,5$ J

$W_{net} = \Delta E_K / \Delta K = ½ m(v_f^{\,2} – v_i^{\,2})$ ✓
$444,5 = ½ (100) (v_f^{\,2} – 0)$ ✓
$v_f = 2,98$ m·s^{-1} ✓ (6)

OPTION 2/*OPSIE 2*
$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$f\Delta x\cos\theta$ ✓ $= (mgh_f – mgh_i) + (½ mv_f^2 – ½ mv_i^2)$
$266\Delta x \cos180^o$ ✓ $= (0 - mg\sin25^o\, \Delta x \cos0^o) + (½ mv_f^2 – 0)$
$266(3)(-1) = [-100(9,8) \sin 25^o (3)(1)]$ ✓ $-½ (100) (v_f^{\,2} – 0)$ ✓
$v_f = 2,98$ m·s^{-1} ✓ (6)

OPTION 3/*OPSIE 3*
POSITIVE MARKING FROM QUESTION 5.3
POSITIEWE NASIEN VANAF VRAAG 5.3
$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta$ ✓ $= ½ m(v_f^2 – v_i^2)$
$(148,17)$ ✓ $(3)\cos0^0$ ✓ $= ½ (100)(v_f^2 - 0^2)$
$444,51 = 50v_f^2$ ✓
$v_f = 2,98$ m·s^{-1} ✓ (6)

OPTION 4/*OPSIE 4*
POSITIVE MARKING FROM QUESTION 5.3
POSITIEWE NASIEN VANAF VRAAG 5.3
$F_{net} = ma$ ✓
$148,17$ ✓ $=100a$ ✓
$a = 1,48$ m·s^{-2}

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$= 2(1,48)(3)$ ✓
$v_f = 2,98$ m·s^{-1} ✓ (6)

<u>OPTION 5/*OPSIE 5*</u>
POSITIVE MARKING FROM QUESTION 5.3
POSITIEWE NASIEN VANAF VRAAG 5.3

$F_{net} = ma$ ✓
$148,17$✓ $= 100a$✓
$a = 1,48\ m \cdot s^{-2}$

✓
$\Delta x = v_i \Delta t + \frac{1}{2}a\Delta t^2$
$3 = 0 + \frac{1}{2}(1,48)\Delta t^2$
$\Delta t = 2,01\ s$

$v_f = v_i + a\Delta t$
$= 0 + (1,48)(2,01)$✓
$v_f = 2,97\ m \cdot s^{-1}$✓ (6)

<u>OPTION 6/*OPSIE 6*</u>
POSITIVE MARKING FROM QUESTION 5.3
POSITIEWE NASIEN VANAF VRAAG 5.3

$F_{net} = ma$ ✓
$148,17$✓ $= 100a$ ✓
$a = 1,48\ m \cdot s^{-2}$

✓
$\Delta x = v_i \Delta t + \frac{1}{2}a\Delta t^2$
$3 = 0 + \frac{1}{2}(1,48)\Delta t^2$
$\Delta t = 2,01\ s$

✓
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

$3 = \left(\frac{0 + v_f}{2}\right)(2,01)$

$v_f = 2,99\ m \cdot s^{-1}$✓ (6)

[15]

QUESTION 6/*VRAAG 6*

6.1 It is the (apparent) change in frequency (or pitch) of the sound detected ✓ by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation.✓
Dit is die (skynbare) verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, het
OR/*OF*
An (apparent) change in observed/detected frequency (pitch), (wavelength) ✓ as a result of the relative motion between a source and an observer ✓ (listener).
'n (Skynbare) verandering in waargenome frekwensie (toonhoogte), (golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar (2)

6.2

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

$825 = \frac{v}{v - v_s}(800)$ ✓ ✓

$(1{,}03125)(v - 10)$ ✓ $= v$

$\therefore\ v = 330\ m \cdot s^{-1}$ ✓

Notes/*Aantekeninge*:
The following values are obtained using other points
Die volgende waardes is verkry deur ander punte te gebruik

v_s ($m \cdot s^{-1}$)	Frequencies	v ($m \cdot s^{-1}$)
v_s = 20	850	310
v_s = 20	845	375,56
vs =30	880	330
40	910	331

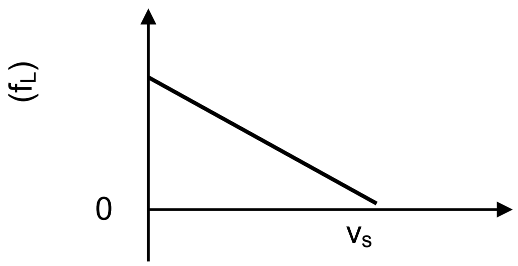
Any other Doppler formula, e.g.
Enige ander Doppler-formule, bv:

$f_L = \frac{v - v_L}{v - v_S}$ - Max./*Maks* $3/4$

Marking rule 1.5: No penalisation if zero substitutions are omitted.
Nasienreël 1.5: Geen penalisering indien nulvervangings uitgelaat is nie.

(5)

6.3 Straight line with negative gradient / frequency decreases (linearly)✓✓
Reguitlyn met negatiewe gradiënt/frekwensie neem af (lineêr)
(2 or/*of* 0)



(2)
[9]

QUESTION 7/*VRAAG 7*

7.1 The (magnitude) of the electrostatic force exerted by one charge on another is directly proportional to the product of the charges ✓ and inversely proportional to the square of the distance between their centres. ✓
Die (grootte) van die elektrostatiese krag wat een lading op 'n ander uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hul middelpunte. (2)

7.2 $F = k\frac{Q_1Q_2}{r^2}$ ✓

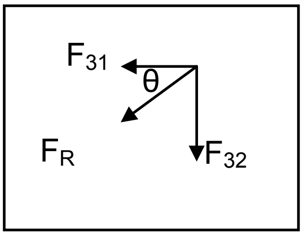
$F_{31} = \frac{(9\times10^9)(5\times10^{-6})(6\times10^{-6})}{(0,3)^2}$ ✓ ✓ = 3 N to the left/*na links*

$F_{32} = \frac{(9\times10^9)(5\times10^{-6})(3\times10^{-6})}{(0,1)^2}$ ✓ = 13,5 N downwards/*afwaarts*

$\mathbf{F_R} = \mathbf{F}_{31} + \mathbf{F}_{32}$

$F_R = \sqrt{(3)^2 + (13,5)^2}$ ✓
$= 13,83$ N

$\theta = \tan^{-1}\frac{13,5}{3}$ ✓
$= 77,47^o$



OR/*OF*

$\theta = \tan^{-1}\frac{3}{13,5}$ ✓
$= 12,53^o$

Can use any trigonometric ratio
Kan enige trigonometriese verhouding gebruik

∴ Net force/*Netto krag* = 13,83 N in direction/*rigting* $192,53^o$ / $77,47^o$ ✓ (7)
[9]

NOTE:
The final answer must be given in terms of magnitude and direction
Do not penalise if sketch is not shown
Do not accept directions which include the cardinal points (N, S, E or W)

***LET WEL**:*
Die finale antwoord moet in terme van grootte en rigting gegee word.
Moenie penaliseer as skets nie getoon word nie.
Moenie rigtings aanvaar wat kardinale punte (N, S, O of W) bevat nie

QUESTION 8/*VRAAG 8*

8.1 For object N / *Vir voorwerp N*:

$n = \frac{Q}{q_e}$ ✓

$Q = (5 \times 10^6)(-1,6 \times 10^{-19})$ ✓

$= -8 \times 10^{-13}$ C ✓

Accept /Aanvaar

Negative / *negatief* ✓ (3)

8.2 **POSITIVE MARKING FROM 8.1** (2)

POSITIEWE NASIEN VANAF 8.1

Charge on / *Lading op* M (Q_M) is $+8 \times 10^{-13}$ C ✓✓ (2 or/*of* 0)

8.3 The electric field at a point is the (electrostatic) force experienced per unit✓ positive charge placed at that point ✓

Die elektriese veld by 'n punt is die (elektrostatiese) krag wat per eenheid✓ positiewe lading wat by daardie punt ✓geplaas word, ervaar word. (2)

8.4 **POSITIVE MARKING FROM 8.1 AND 8.2**

POSITIEWE NASIEN VANAF 8.1 EN 8.2

$E = \frac{kQ}{r^2}$ ✓

$E_{PM} = \frac{(9 \times 10^9)(8 \times 10^{-13})}{(0,25)^2}$ ✓ ✓ ← Q from/*vanaf* 8.2

$= 0,12$ N·C^{-1} to the right/*na regs*

$E_{PN} = \frac{(9 \times 10^9)(8 \times 10^{-13})}{(0,1)^2}$ ✓ ← Q from/*vanaf* 8.1

$= 0,72$ N·C^{-1} to the left/*na links*

$E_{net} = E_{PM} - E_{PN}$ ✓ $= 0,12 - 0,72 = -0,60$ N·C^{-1}

$= 0,60$ N·C^{-1} to the left/*na links* ✓ (6)

[13]

QUESTION 9/*VRAAG 9*

9.1 NEGATIVE✓/*NEGATIEF* (1)

9.2

$I_{2\Omega} = \frac{V}{R}$ ✓

$= \frac{1,36}{(4+2)}$ ✓

= 0,23 A✓ (Note/*Let wel*: second decimal place/*tweede desimaal* ± 0,01) (3)

9.3

POSITIVE MARKING FROM QUESTION 9.2
POSITIEWE NASIEN VANAF VRAAG 9.2
<u>OPTION 1/*OPSIE 1*</u>

$I_{3\Omega} = \frac{V}{R}$

$= \frac{1,36}{3}$ ✓

= 0,45 A (Accept/*Aanvaar* 0,46 A)

$I_T = I_2 + I_3$

= 0,23 + 0,45 ✓

= 0,68 A (Accept/*Aanvaar* 0,69 A)

$V_{int/\text{"lost"}} = \varepsilon - V_{ext}$ ✓

= 1,5 - 1,36 ✓

= 0,14 V

$V_{int/\text{"lost"}} = Ir$ ✓

0,14 = (0,68)r✓

r = 0,21 Ω✓ (Accept/*Aanvaar* 0,20 Ω) (7)

<u>OPTION 2/*OPSIE 2*</u>

POSITIVE MARKING FROM QUESTION 9.2

POSITIEWE NASIEN VANAF VRAAG 9.2

$I_3 = \frac{V}{R}$

$= \frac{1,36}{3}$ ✓

$= 0,45$ A (Accept/*Aanvaar* 0,46 A)

$I_T = I_2 + I_3$

$= 0,23 + 0,45$ ✓

$= 0,68$ A (Accept/*Aanvaar* 0,69 A)

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{3}$ ✓

$R_P = 2\ \Omega$

$\varepsilon = I(R + r)$ ✓

$1,5 = 0,68(2 + r)$ ✓

$r = 0,21\ \Omega$ ✓ (Accept/*Aanvaar* 0,17 Ω) (7)

<u>OPTION 3/*OPSIE 3*</u>

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{3}$ ✓

$R_P = 2\ \Omega$

$V = IR$

$1,36$ ✓ $= I(2)$ ✓

$I = 0,68$ A (Accept/*Aanvaar* 0,69 A)

$\varepsilon = I(R+r)$ ✓

$1,5 = 0,68(2 + r)$ ✓

$r = 0,21\ \Omega$ ✓ (Accept/*Aanvaar* 0,17 Ω) (7)

OPTION 4/*OPSIE 4*

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \checkmark$$

$$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{3} \checkmark$$

$R_P = 2\ \Omega$

$V = IR \checkmark$

$1{,}36 = I(2) \checkmark$

$I = 0{,}68\ A$

$V_{int} = 1{,}5 - 1{,}36 \checkmark$

$= 0{,}14\ V$

$Ir = 0{,}14$

$(0{,}68)r = 0{,}14 \checkmark$

$R = 0{,}21\ \Omega \checkmark$ (7)

ACCEPT/*AANVAAR*

If the learner wrote I_3 as 0,46 (because resistance is halved) without calculation award marks ✓

Indien die leerder I_3 as 0,46 geskryf het (omdat weerstand gehalveer is) sonder om die berekening te doen, moet punte toegeken word.

$I_T = I_2 + I_3$

$= 0,23 + 0,46 = 0,69$ A ✓

$R_P = \frac{R_1R_2}{R_1 + R_2}$ ✓

$R_P = \frac{(6)(3)}{6+3}$ ✓ $= 2$

$\varepsilon = I(R + r)$ ✓

$1,5 = 0,69(2 + r)$ ✓

$r = 0,17\ \Omega$ ✓ (7)

9.4 Decrease ✓

The effective resistance across the parallel circuit decreases ✓

<u>The terminal potential difference</u> **decreases**

The resistance in the ammeter branch remains constant ✓ **hence the ammeter reading decreases**

Neem af

Die effektiewe weerstand oor die parallelle kring neemm af.

<u>Die terminaal- potensiaalverskil</u> ***neem af.***

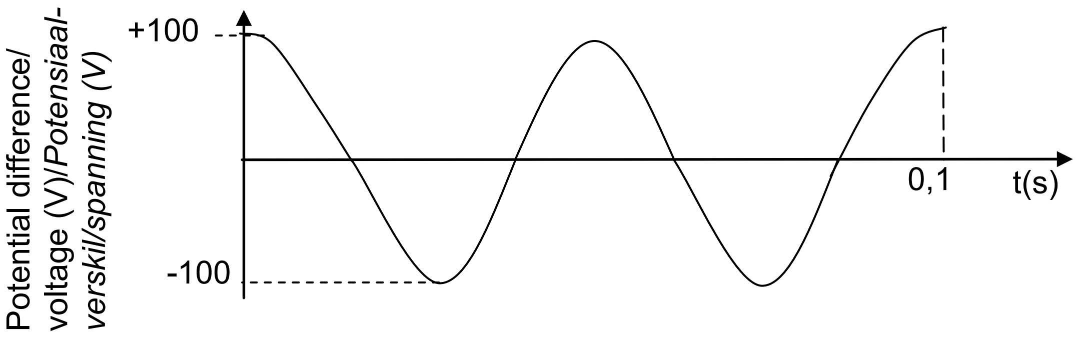
Die weerstand in die parallelle vertakking bly konstant, ***dus sal die ammeterlesing afneem.*** (4)

[15]

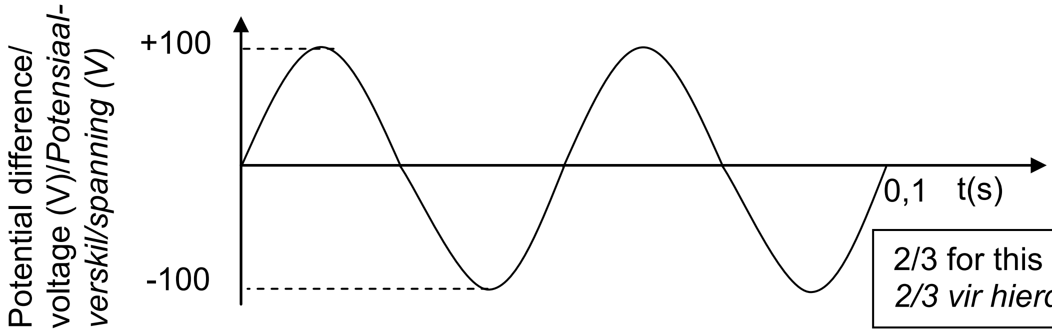
QUESTION 10/*VRAAG10*

10.1.1 Anticlockwise ✓/*Antikloksgewys* (1)

10.1.2



Crieteria for graph/*Kriteria vir grafiek*	**Marks/*Punte***
Two full cycles with correct shape /*Twee vol siklusse met korrekte vorm*	✓
Showing the maximum voltage/*Dui die maksimum spanning aan*	✓
Showing the time 0,1s for two cycles/*Dui die tyd 0,1s vir twee siklusse aan*	✓



2/3 for this drawing/
2/3 vir hierdie skets

Criteria for graph/*Kriteria vir grafiek*	**Marks/*Punte***
Showing the maximum voltage /showing the time of 0,1s for two cycles *Dui die maksimum spanning / tyd van 0,1 s vir twee siklusse aan*	✓
Showing two cycles / *Dui twee siklusse aan*	✓

(3)

10.1.3 Decrease the frequency/ speed of rotation ✓
Verlaag die frekwensie / spoed van rotasie (1)

10.2 $P_{average/gemiddeld} = V_{rms} I_{rms}$ ✓

$1\,500 = (220)(I_{rms})$ ✓

$I_{rms} = 6,82$ A

$I_{rms} = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$I_{max/maks} = (\sqrt{2})(6,82)$ ✓

$= 9,65$ A ✓

(5)

[10]

QUESTION 11/*VRAAG 11*

11.1.1 The particle nature of light ✓/*Die partikelaard /deeltjie-aard van lig.* (1)

11.1.2 Shorter wavelength means higher photon energy ✓

Photon energy is inversely proportional to wavelength ✓ ; $E = \frac{hc}{\lambda}$

For the same metal kinetic energy is proportional to photon energy

Korter golflengte beteken hoër foton energie

Foton energie is omgekeerd ewredig aan golflengte $E = \frac{hc}{\lambda}$

Vir dieselfde metaal is kinetiese energie eweredig aan foton energie

OR/*OF*

Shorter wavelength means higher frequency ✓
Higher frequency means higher photon energy ✓; E = hf
For the same metal kinetic energy is proportional to photon energy
Korter golflengte beteken hoër frekwensie
Hoër frekwensie beteken hoër foton energie; E = hf
Vir dieselfde metaal is kinetiese energie eweredig aan foton energie

Accept / *Aanvaar*
Shorter wavelength ✓✓
Korter golflengte

OR/*OF*
Higher frequency ✓✓
Hoër frekwensie

OR/OF
Higher photon energy ✓✓
Hoër foton nergie (2)

11.2.1 **<u>OPTION 1/ *OPSIE 1*</u>**

$W_0 = h\frac{c}{\lambda_0}$ ✓

$= \frac{(6,63\times10^{-34})(3\times10^{8})}{330\times10^{-9}}$ ✓ ✓

$W_o = 6,03 \times 10^{-19}$ J✓

<u>OPTION2/OPSIE 2</u>

c = fλ
$3 \times 10^8 = f_o(330 \times 10^{-9})$✓
$f_o = 9,09 \times 10^{14}$ Hz

✓ for both equations / *vir beide vergelykings*

$W_o = hf_o$
$= (6,63 \times 10^{-34})(9,09 \times 10^{7})$✓
$= 6,03 \times 10^{-19}$ J✓ (4)

11.2.2 **POSITIVE MARKING FROM QUESTION 11.2.1/*POSITIEWE NASIEN VANAF VRAAG 11.2.1***

OPTION 1/*OPSIE 1*

$E = W_o + E_k$
$hf = hf_o + E_k$
$hf = hf_o + ½ mv^2$
$E = W_o + ½ mv^2$
✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(1,2 \times 10^{15})$✓ $= (6,03 \times 10^{-19})$✓ $+ ½(9,11 \times 10^{-31})v^2$✓
$\therefore v = 6,5 \times 10^5 \text{ m·s}^{-1}$✓

OPTION 2/*OPSIE 2*

$E_K = E_{light/lig} – W_o$
$= hf_{light/lig} – hf_o$
✓ Any one/ *Enige een*
$= (6,63 \times 10^{-34})(1,2 \times 10^{15})$ ✓ $- 6,03 \times 10^{-19}$ ✓
$= 1,926 \times 10^{-19}$ J

$E_K = ½ mv^2$
$1,926 \times 10^{-19} = ½ (9,11 \times 10^{-31})v^2$✓
$\therefore v = 6,5 \times 10^5 \text{ m·s}^{-1}$✓

(5)
[12]

TOTAL/*TOTAAL*: 150

1.10 When light of a certain wavelength is incident on a metal surface, no electrons are ejected. Which ONE of the following changes may result in electrons being ejected from the metal surface?

A Increase the intensity of the light.

B Use light with a much shorter wavelength.

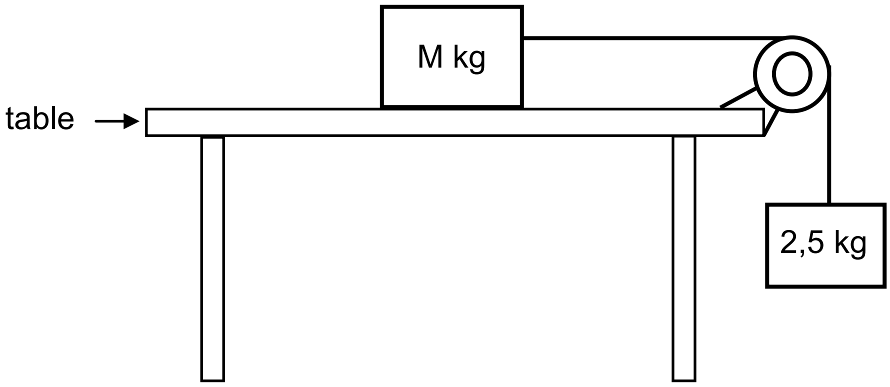
C Use metal with a larger work function.

D Increase the surface area of the metal. (2)
[20]

QUESTION 2 (Start on a new page.)

2.1 Two blocks of mass M kg and 2,5 kg respectively are connected by a light, inextensible string. The string runs over a light, frictionless pulley, as shown in the diagram below.

The blocks are **stationary**.



2.1.1 State Newton's THIRD law in words. (2)

2.1.2 Calculate the tension in the string. (3)

The coefficient of static friction (μ_s) between the unknown mass M and the surface of the table is 0,2.

2.1.3 Calculate the minimum value of M that will prevent the blocks from moving. (5)

The block of unknown mass M is now replaced with a block of mass 5 kg. The 2,5 kg block now accelerates downwards. The coefficient of kinetic friction (μ_k) between the 5 kg block and the surface of the table is 0,15.

2.1.4 Calculate the magnitude of the acceleration of the 5 kg block. (5)

2.2 A small hypothetical planet X has a mass of $6,5 \times 10^{20}$ kg and a radius of 550 km.

Calculate the gravitational force (weight) that planet X exerts on a 90 kg rock on this planet's surface. (4)

[19]

QUESTION 3 (Start on a new page.)

Ball **A** is projected vertically upwards at a velocity of 16 $m \cdot s^{-1}$ from the ground. Ignore the effects of air resistance. **Use the ground as zero reference.**

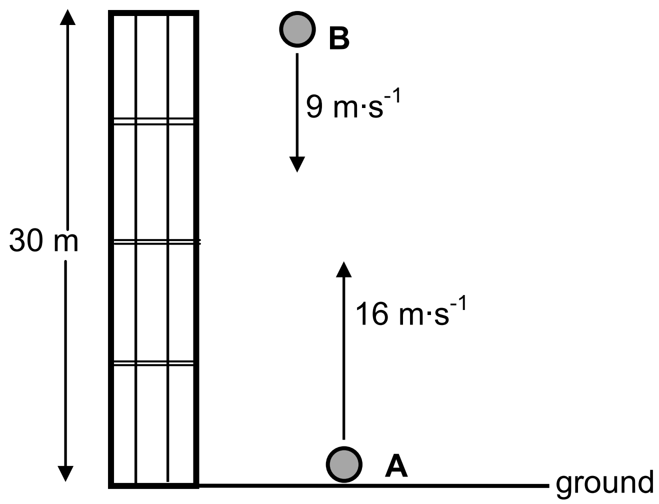
3.1 Calculate the time taken by ball **A** to return to the ground. (4)

3.2 Sketch a velocity-time graph for ball **A**.

Show the following on the graph:

(a) Initial velocity of ball **A**
(b) Time taken to reach the highest point of the motion
(c) Time taken to return to the ground (3)

ONE SECOND after ball **A** is projected upwards, a second ball, **B**, is thrown vertically downwards at a velocity of 9 $m \cdot s^{-1}$ from a balcony 30 m above the ground. Refer to the diagram below.



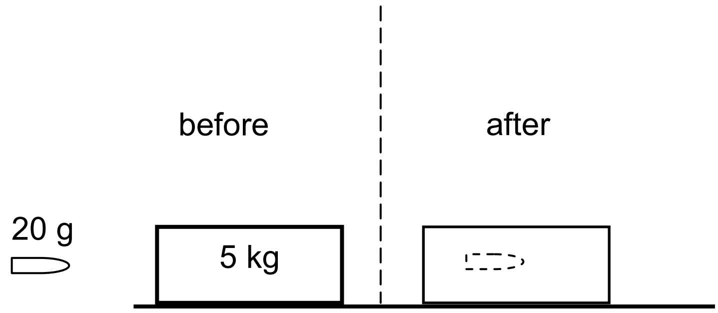
3.3 Calculate how high above the ground ball **A** will be at the instant the two balls pass each other. (6)
[13]

QUESTION 4 (Start on a new page.)

A bullet of mass 20 g is fired from a stationary rifle of mass 3 kg. Assume that the bullet moves horizontally. Immediately after firing, the rifle recoils (moves back) with a velocity of 1,4 $m \cdot s^{-1}$.

4.1 Calculate the speed at which the bullet leaves the rifle. (4)

The bullet strikes a stationary 5 kg wooden block **fixed** to a flat, horizontal table. The bullet is brought to rest after travelling a distance of 0,4 m **into the block**. Refer to the diagram below.



4.2 Calculate the magnitude of the average force exerted by the block on the bullet. (5)

4.3 How does the magnitude of the force calculated in QUESTION 4.2 compare to the magnitude of the force exerted by the bullet on the block? Write down only LARGER THAN, SMALLER THAN or THE SAME. (1)

[10]

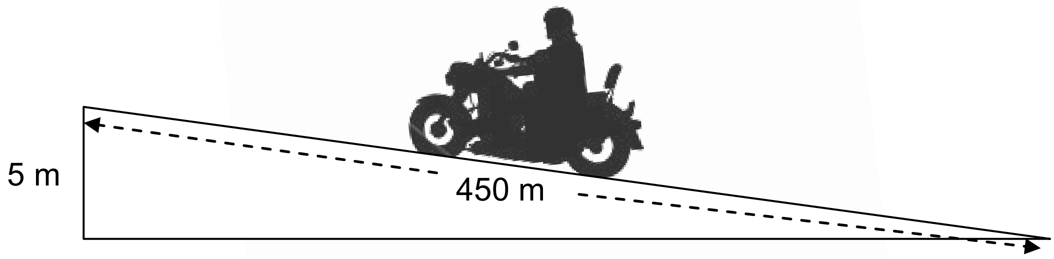
QUESTION 5 (Start on a new page.)

The track for a motorbike race consists of a straight, horizontal section that is 800 m long.

A participant, such as the one in the picture above, rides at a certain average speed and completes the 800 m course in 75 s. To maintain this speed, a constant driving force of 240 N acts on the motorbike.

5.1 Calculate the average power developed by the motorbike for this motion. (3)

Another person practises on the same motorbike on a track with an incline. Starting from rest, the person rides a distance of 450 m up the incline which has a vertical height of 5 m, as shown below.



The total frictional force acting on the motorbike is 294 N. The combined mass of rider and motorbike is 300 kg. The average driving force on the motorbike as it moves up the incline is 350 N. Consider the motorbike and rider as a single system.

5.2 Draw a labelled free-body diagram for the motorbike-rider system on the incline. (4)

5.3 State the WORK-ENERGY theorem in words. (2)

5.4 Use energy principles to calculate the speed of the motorbike at the end of the 450 m ride. (6)

[15]

QUESTION 6 (Start on a new page.)

6.1 The data below was obtained during an investigation into the relationship between the different velocities of a moving sound source and the frequencies detected by a stationary listener for **each** velocity. The effect of wind was ignored in this investigation.

Experiment number	1	2	3	4
Velocity of the sound source ($m \cdot s^{-1}$)	0	10	20	30
Frequency (Hz) of the sound detected by the stationary listener	900	874	850	827

6.1.1 Write down the dependent variable for this investigation. (1)

6.1.2 State the Doppler effect in words. (2)

6.1.3 Was the sound source moving TOWARDS or AWAY FROM the listener? Give a reason for the answer. (2)

6.1.4 Use the information in the table to calculate the speed of sound during the investigation. (5)

6.2 The spectral lines of a distant star are shifted towards the longer wavelengths of light. Is the star moving TOWARDS or AWAY FROM the Earth? (1)

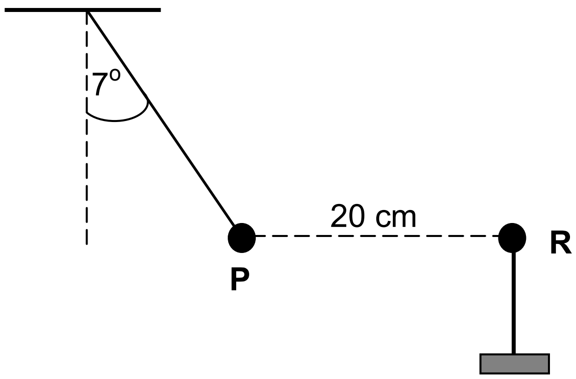
[11]

QUESTION 7 (Start on a new page.)

A very small graphite-coated sphere **P** is rubbed with a cloth. It is found that the sphere acquires a charge of + 0,5 μC.

7.1 Calculate the number of electrons removed from sphere **P** during the charging process. (3)

Now the charged sphere **P** is suspended from a light, inextensible string. Another sphere, **R**, with a charge of – 0,9 μC, on an insulated stand, is brought close to sphere **P**. As a result sphere **P** moves to a position where it is 20 cm from sphere **R**, as shown below. The system is in equilibrium and the angle between the string and the vertical is 7^{o}.



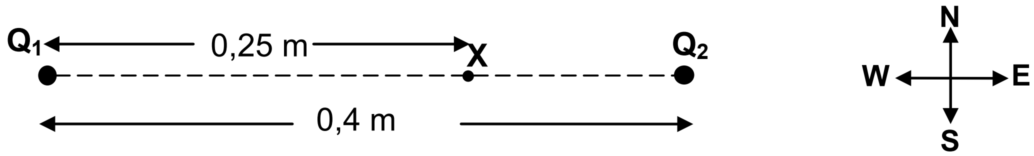
7.2 Draw a labelled free-body diagram showing ALL the forces acting on sphere **P**. (3)

7.3 State Coulomb's law in words. (2)

7.4 Calculate the magnitude of the tension in the string. (5)
[13]

QUESTION 8 (Start on a new page.)

Two charged particles, $\mathbf{Q_1}$ and $\mathbf{Q_2}$, are placed 0,4 m apart along a straight line. The charge on $\mathbf{Q_1}$ is + 2 x 10^{-5} C, and the charge on $\mathbf{Q_2}$ is – 8 x 10^{-6} C. Point **X** is 0,25 m **east** of $\mathbf{Q_1}$, as shown in the diagram below.



Calculate the:

8.1 Net electric field at point **X** due to the two charges (6)

8.2 Electrostatic force that a – 2 x 10^{-9} C charge will experience at point **X** (4)

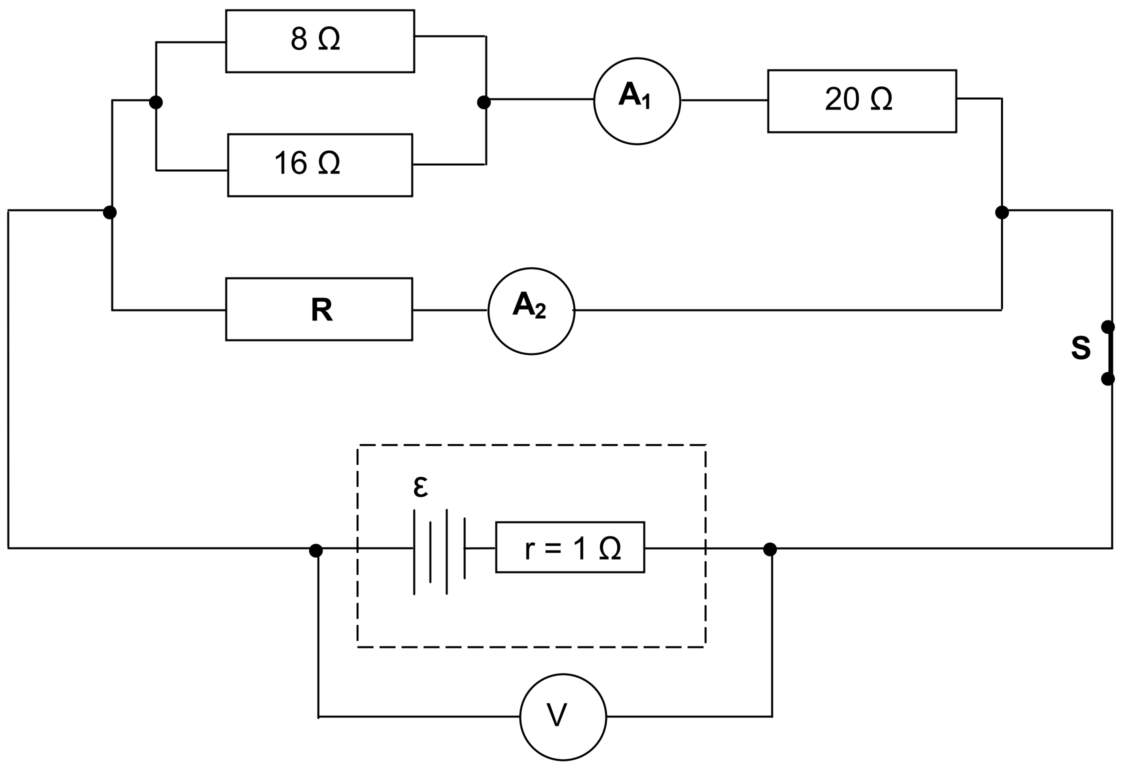
The – 2 x 10^{-9} C charge is replaced with a charge of – 4 x 10^{-9} C at point **X**.

8.3 **Without any further calculation**, determine the magnitude of the force that the – 4 x 10^{-9} C charge will experience at point **X**. (1)

[11]

QUESTION 9 (Start on a new page.)

A battery with an internal resistance of 1 Ω and an unknown emf (ε) is connected in a circuit, as shown below. A high-resistance voltmeter (V) is connected across the battery. $\mathbf{A_1}$ and $\mathbf{A_2}$ represent ammeters of negligible resistance.



With switch **S** closed, the current passing through the 8 Ω resistor is 0,5 A.

9.1 State Ohm's law in words. (2)

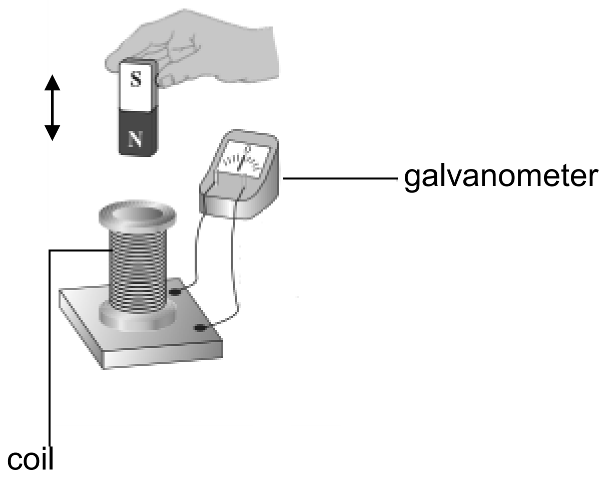
9.2 Calculate the reading on ammeter $\mathbf{A_1}$. (4)

9.3 If device **R** delivers power of 12 W, calculate the reading on ammeter $\mathbf{A_2}$. (5)

9.4 Calculate the reading on the voltmeter when switch **S** is open. (3)
[14]

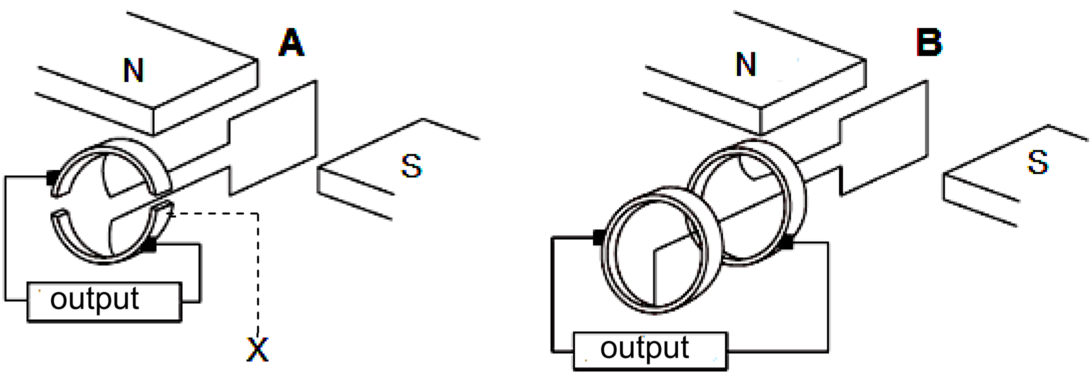
QUESTION 10 (Start on a new page.)

10.1 A teacher demonstrates how current can be obtained using a bar magnet, a coil and a galvanometer. The teacher moves the bar magnet up and down, as shown by the arrow in the diagram below.



10.1.1 Briefly describe how the magnet must be moved in order to obtain a LARGE deflection on the galvanometer. (2)

The two devices, **A** and **B**, below operate on the principle described in QUESTION 10.1.1 above.



10.1.2 Write down the name of the principle. (1)

10.1.3 Write down the name of part **X** in device **A**. (1)

10.2 A 220 V, AC voltage is supplied from a wall socket to an electric kettle of resistance 40,33 Ω. Wall sockets provide rms voltages and currents.

Calculate the:

10.2.1 Electrical energy consumed by the kettle per second (4)

10.2.2 Maximum (peak) current through the kettle (3)
[11]

QUESTION 11 (Start on a new page.)

In an experiment to demonstrate the photoelectric effect, light of different wavelengths was shone onto a metal surface of a photoelectric cell. The maximum kinetic energy of the emitted electrons was determined for the various wavelengths and recorded in the table below.

INVERSE OF WAVELENGTH $\frac{1}{\lambda}$ **(× 10^6 m^{-1})**	**MAXIMUM KINETIC ENERGY** $E_{k(max)}$ **(× 10^{-19} J)**
5,00	6,60
3,30	3,30
2,50	1,70
2,00	0,70

11.1 What is meant by the term *photoelectric effect?* (2)

11.2 Draw a graph of $E_{k(max)}$ (y-axis) versus $\frac{1}{\lambda}$ (x-axis) ON THE ATTACHED ANSWER SHEET. (3)

11.3 USE THE GRAPH to determine:

11.3.1 The threshold frequency of the metal in the photoelectric cell (4)

11.3.2 Planck's constant (4)
[13]

TOTAL: 150

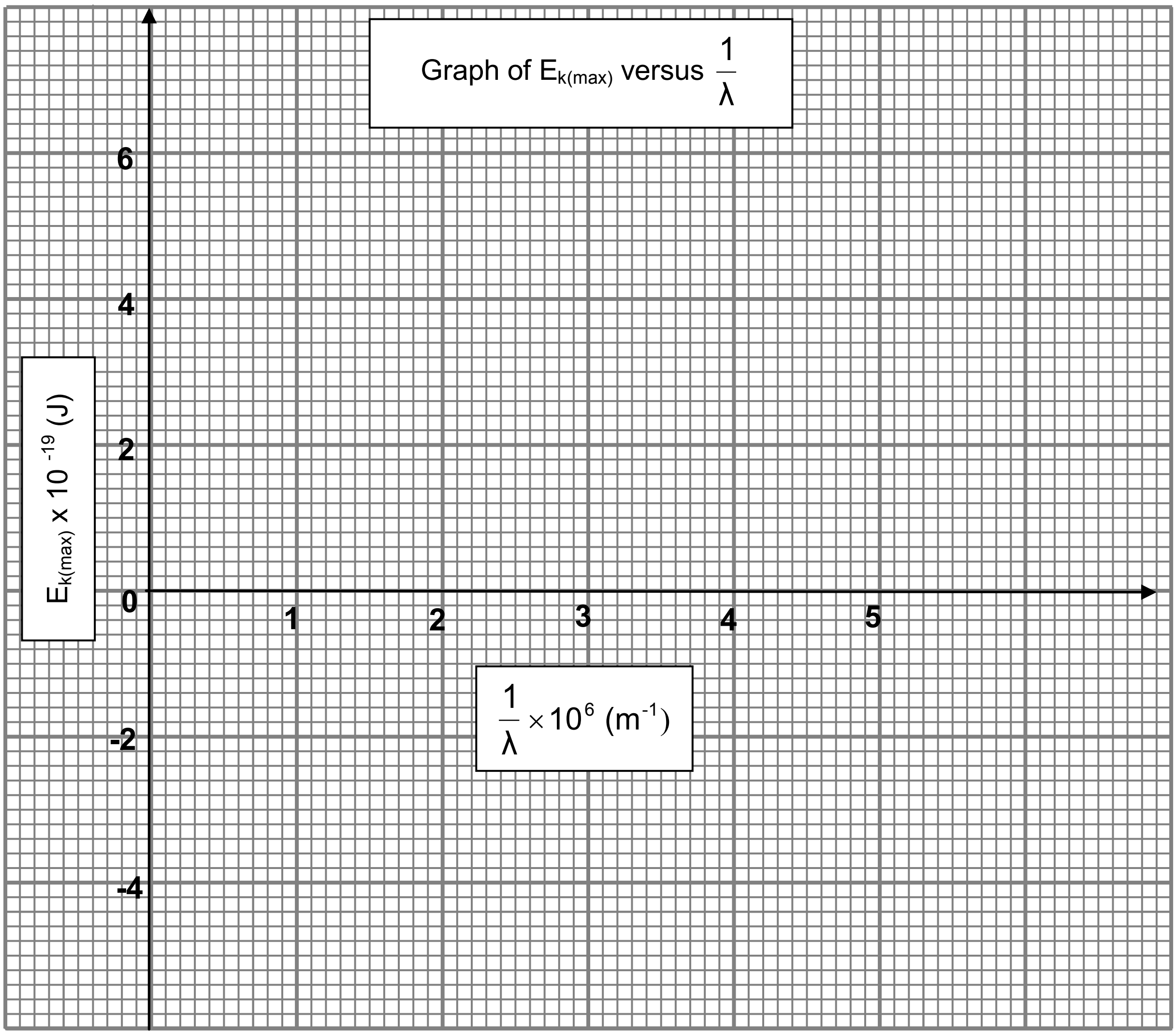
CENTRE NUMBER:

EXAMINATION NUMBER:

ANSWER SHEET

QUESTION 11.2

Hand in this ANSWER SHEET with your ANSWER BOOK.



QUESTION 1/*VRAAG 1*

1.1	B✓✓	(2)
1.2	D✓✓	(2)
1.3	C✓✓	(2)
1.4	D✓✓	(2)
1.5	A✓✓	(2)
1.6	A✓✓	(2)
1.7	A✓✓	(2)
1.8	D✓✓	(2)
1.9	C✓✓	(2)
1.10	B✓✓	(2)
		[20]

QUESTION 2/*VRAAG 2*

2.1.1 When body A exerts a force on body B, body B exerts a force of equal magnitude in the opposite direction on body A. ✓✓
Wanneer liggaam A 'n krag uitoefen op liggaam B, oefen liggaam B 'n krag van gelyke grootte in die teenoorgestelde rigting op liggaam A uit.
OR/*OF*
If body A exerts a force on body B, then body B exerts an equal ✓ and opposite✓ force on body A
Indien liggaam A 'n krag uitoefen op liggaam B, dan sal liggaam B 'n gelyke maar teenoorgestelde krag op liggaam A uitoefen (2)

2.1.2

For 2,5 kg block/*Vir 2,5 kg blok* T = mg✓ ∴T = (2,5)(9,8)✓ = 24,5 N✓	**OR/*OF*** F_{net} = ma T – mg = (2,5)(0) } ✓ T – (2,5)(9,8)✓ = 0 T = 24,5 N ✓	**OR/*OF*** F_{net} = ma mg - T = (2,5)(0) } ✓ (2,5)(9,8) - T✓ = 0 T = 24,5 N ✓

(3)

2.1.3

POSITIVE MARKING FROM 2.1.2 ***POSITIEWE NASIEN VANAF 2.1.2*** For mass M/*Vir mass M* $f_s = \mu_s N$✓ $\therefore N = \frac{24,5}{0,2}$ ✓✓ = 122,5 N N = Mg = 122,5 N <u>M(9,8) = 122,5 N</u>✓ M = 12,5 kg✓	**OR/*OF*** $\mu_s N$✓ = $\mu_s Mg$ 24,5✓= (0,2)✓<u>M(9,8)</u> ✓ M = 12,5 kg✓

(5)

2.1.4

For the 5 kg block/*Vir die 5 kg blok*:
$f_k = \mu_k N$
f_k = (0,15)(5)(9,8) ✓
= 7,35 N
F_{net} = ma
T – f_k = ma } ✓
<u>T – 7,35 = 5a</u>✓

For the 2,5 kg block/*Vir die 2,5 kg blok*
w – T = ma
<u>(2,5)(9,8) – T = 2,5 a</u> ✓

17,15 = 7,5 a
a = 2,29 $m{\cdot}s^{-2}$✓ (5)

2.2

$F = G\frac{m_1 m_2}{r^2}$ ✓

$F = \frac{(6,67 \times 10^{-11})(6,5 \times 10^{20})(90)}{(550 \times 10^3)^2}$ ✓ ✓

= 12,90 N✓ (12,899 N)

(4)

OR/*OF*

$g = \frac{Gm}{r^2}$ ✓

$g = \frac{(6,67 \times 10^{-11})(6,5 \times 10^{20})}{(550 \times 10^3)^2}$ ✓

$= 0,143...\text{m·s}^{-2}$

w = mg

= (90)(0,143..)✓

= 12,89 N✓(*downwards/afwaarts*)

(4)

[19]

QUESTION 3/*VRAAG 3*

3.1.

OPTION 1/*OPSIE 1*	
Upwards positive/*Opwaarts positief:* $v_f = v_i + a\Delta t$✓ -16✓ = 16 – 9,8(Δt) ✓ Δt = 3,27s✓	**Downwards positive/*Afwaarts positief:*** $v_f = v_i + a\Delta t$✓ 16✓ = -16 +9,8(Δt) ✓ Δt = 3,27s✓

(4)

OPTION 2/*OPSIE 2*	
Upwards positive/*Opwaarts positief:* $v_f = v_i + a\Delta t$✓ To the top/*By bopunt*: 0✓ = 16 – 9,8(Δt) ✓ Δt = 1,63s Total time/*Totale tyd* = 1,63 x 2 = 3,26(7) s✓	**Downwards positive/*Afwaarts positief:*** $v_f = v_i + a\Delta t$✓ To the top/*By bopunt*: 0✓ = -16 +9,8(Δt) ✓ Δt = 1,63s Total time/*Totale tyd* = 1,63 x 2 = 3,26(7) s✓

(4)

3.1

OPTION 3/*OPSIE 3*	
Upwards positive/*Opwaarts positief:* $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓ 0✓ = $16\Delta t + \frac{1}{2}(-9,8)\Delta t^2$✓ Δt(16 - 4,9Δt) = 0 Δt = 0 or/*of* 3,27 s Time taken/*Tyd geneem* = 3,27 s (accept/*aanvaar* 3,26 s) ✓	**Downwards positive/*Afwaarts positief:*** $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓ 0✓ = $-16\Delta t + \frac{1}{2}(9,8)\Delta t^2$✓ Δt(-16 +4,9Δt) = 0 Δt = 0 or/*of* 3,27 s Time taken/*Tyd geneem* = 3,27 s (accept/*aanvaar* 3,26 s) ✓

(4)

OPTION 4/*OPSIE 4*	
Upwards positive/*Opwaarts positief:* $v_f^2 = v_i^2 + 2a\Delta y$ At highest point/*By hoogste punt* $0 = 16^2 + 2(-9,8)\Delta y$✓ Δy = 13,06 m $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $13,06 = 16\Delta t - 4,9\Delta t^2$✓ Δt =1,62 or 1,65 Total time/*Totale tyd* = (1,62/1,65)x2 = 3,24 s✓or/*of* 3,3 s	**Downwards positive/*Afwaarts positief:*** $v_f^2 = v_i^2 + 2a\Delta y$ At highest point/*By hoogste punt* $0 = (-16)^2 + 2(9,8)\Delta y$✓ Δy = 13,06 m $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $13,06 = -16\Delta t + 4,9\Delta t^2$✓ Δt =1,62 or 1,65 Total time/*Totale tyd* = (1,62/1,65) x 2 = 3,24 s✓or/*of* 3,3 s

(4)

OPTION 5/*OPSIE 5* **Upwards positive/*Opwaarts positief:***	**Downwards positive/*Afwaarts positief:***
$v_f^2 = v_i^2 + 2a\Delta y$	$v_f^2 = v_i^2 + 2a\Delta y$
At highest point/*By hoogste punt*	At highest point/*By hoogste punt*
$0 = 16^2 + 2(-9,8)\Delta y$ ✓	$0 = (-16)^2 + 2(9,8)\Delta y$ ✓
$\Delta y = 13,06$ m	$\Delta y = -13,06$ m
$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓	$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓
$13,06 = \left(\frac{0+16}{2}\right)\Delta t$ ✓	$-13,06 = \left(\frac{0-16}{2}\right)\Delta t$ ✓
$\Delta t = 1,63$ s	$\Delta t = 1,63$ s
Total time/*totale tyd* = 3,26 s✓	Total time/*totale tyd* = 3,26 s✓

(4)

3.1

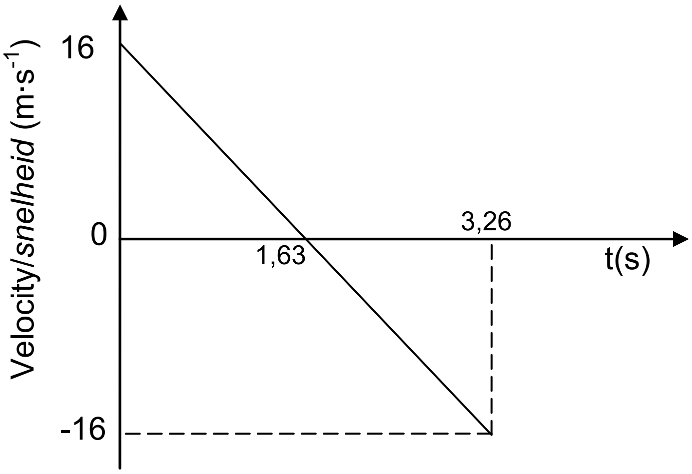
OPTION 6 /*OPSIE 6* **Upwards positive/*Opwaarts positief:***	**Downwards positive/*Afwaarts positief:***
$F_{net}\Delta t = \Delta p$ ✓	$F_{net}\Delta t = \Delta p$ ✓
$mg\Delta t = m(v_f - v_i)$	$mg\Delta t = m(v_f - v_i)$
$-9,8\Delta t$ ✓ $= (0 - 16)$ ✓	$9,8\Delta t$ ✓ $= \{0 - (-16)\}$ ✓
$\Delta t = 1,63$ s	$\Delta t = 1,63$ s
Total time/*Totale tyd* = (1,63)(2) = 3,26 s✓	Total time/*Totale tyd* = (1,63)(2) = 3,26 s✓

(4)

OPTION 7 /*OPSIE 7* **Upwards positive/*Opwaarts positief:***	**Downwards positive/*Afwaarts positief:***
$F_{net}\Delta t = \Delta p$ ✓	$F_{net}\Delta t = \Delta p$ ✓
$mg\Delta t = m(v_f - v_i)$	$mg\Delta t = m(v_f - v_i)$
$-9,8\Delta t$ ✓ $= [-16 - (+16)]$ ✓	$9,8\Delta t$ ✓ $= [16 - (-16)]$ ✓
$\Delta t = 3,26$ s	$\Delta t = 3,26$ s
Total time/*Totale tyd* = 3,26 s✓	Total time/*Totale tyd* = 3,26 s ✓

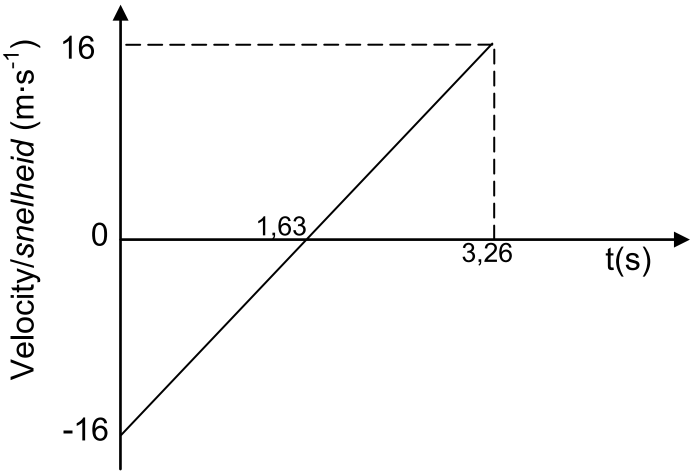
(4)

3.2 **POSITIVE MARKING FROM 3.1./*POSITIEWE NASIEN VANAF 3.1***
Upwards positive/*Opwaarts positief:*



(3)

POSITIVE MARKING FROM 3.2./*POSITIEWE NASIEN VANAF 3.2*
Downwards positive/*Afwaarts positief:*



Criteria for graph/*Kriteria vir grafiek*	**Marks/*Punte***
Correct shape for line extending beyond t = 1,63 s. *Korrekte vorm vir lyn verleng verby t = 1,63 s*	✓
Initial velocity correctly indicated as shown. *Beginsnelheid korrek aangedui soos getoon.*	✓
Time to reach maximum height and time to return to the ground correctly shown. *Tyd om maksimum hoogte te bereik en om na die grond terug te keer.*	✓

(3)

3.3

<u>OPTION 1 / *OPSIE 1*</u>
Upwards positive/*Opwaarts positief:*
Take y_A as height of ball A from the ground. (no penalising)/Neem y_A as hoogte van bal A vanaf die grond. (geen penalisering)
$\Delta y_A = v_i\Delta t + ½ a\Delta t^2$ ✓
$y_A - 0 = 16\Delta t + ½(-9,8)\Delta t^2$
$= 16\Delta t – 4,9\Delta t^2$ ✓
Take y_B as height of ball B from the ground./Neem y_B as hoogte van bal B vanaf die grond.
$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$
$y_B – 30 = (v_i\Delta t + ½ a\Delta t^2)$
$y_B = 30 - [-9(\Delta t -1) + ½(-9,8)(\Delta t – 1)^2$ ✓
$= 34,1 + 0,8\Delta t - 4,9 \Delta t^2$ ✓
$y_A = y_B$
$\therefore 16\Delta t – 4,9\Delta t^2 = 34,1 + 0,8\Delta t - 4,9\Delta t^2$
$15,2\Delta t = 34,1$
$\Delta t = 2,24$ s ✓
$y_A = 16 (2,24) - 4,9(2,24)^2$
$= 11,25$ m ✓ (6)

Downwards positive/*Afwaarts positief:*
Take y_A as height of ball A from the ground.(no penalising)/Neem y_A as hoogte van bal A vanaf die grond. (geen penalisering)
$\Delta y_A = v_i\Delta t + ½ a\Delta t^2$ ✓
$y_A - 0 = -16\Delta t + ½(9,8)\Delta t^2$
$= -16\Delta t + 4,9\Delta t^2$ ✓

Take y_B as height of ball B from the ground/Neem as hoogte van bal B vanaf die grond..
$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$
$y_B – 30 = – (v_i\Delta t + ½ a\Delta t^2)$
$y_B = 30 – [9(\Delta t -1) + ½(9,8)(\Delta t – 1)^2$ ✓
$= 34,1 + 0,8\Delta t - 4,9 \Delta t^2$ ✓
$y_A = y_B$
$16\Delta t – 4,9\Delta t^2 = 34,1 + 0,8\Delta t – 4,9\Delta t^2$
$15,2\Delta t = 34,1$
$\Delta t = 2,24$ s ✓
$\Delta y_A = (- 16 (2,24) + 4,9(2,24)^2)$
$= 11,25$ m ✓ (6)

3.3

<u>OPTION 2/*OPSIE 2*</u>

Upwards positive/*Opwaarts positief:*

$\Delta y_A = v_i\Delta t + ½ a\Delta t^2$ ✓

$= 16\Delta t + ½(-9,8)\Delta t^2$

$=16\Delta t – 4,9\Delta t^2$ ✓

Distance travelled by ball A = $y_A = 16\Delta t – 4,9\Delta t^2$

$\Delta y_B = v_i\Delta t + ½ a\Delta t^2$

$= -9(\Delta t -1) + ½(-9,8)(\Delta t – 1)^2$✓

$= 0,8\Delta t – 4,9\Delta t^2 + 4,1$✓

Distance travelled by ball B = $y_B = 0,8\Delta t – 4,9\Delta t^2 + 4,1$

$y_A +(-y_B) = 30$

$16\Delta t – 4,9\Delta t^2 – (0,8\Delta t – 4,9\Delta t^2 + 4,1) = 30$

$15,2\Delta t = 34,1$

$\Delta t = 2,24$ s ✓

$\therefore \Delta y_A = v_i\Delta t + ½ a\Delta t^2$

$y_A = 16 (2,24) - 4,9(2,24)^2$

$= 11,25$ m✓ (6)

3.3

Downwards positive/*Afwaarts positief:*

$y_A = v_i\Delta t + ½ a\Delta t^2$ ✓

$= -16\Delta t + ½(9,8)\Delta t^2$

$= -16\Delta t + 4,9\Delta t^2$✓

$y_B = v_i\Delta t + ½ a\Delta t^2$

$= 9(\Delta t -1) + ½(9,8)(\Delta t – 1)^2$ ✓

$= - 0,8\Delta t + 4,9\Delta t^2 - 4,1$ ✓

$(-y_A) + y_B = 30$

$-(-16\Delta t + 4,9\Delta t^2) - 0,8\Delta t + 4,9\Delta t^2 - 4,1 = 30$

$15,2\Delta t = 34,1$

$\Delta t = 2,24$ s ✓

$\therefore \Delta y_A = v_i\Delta t + ½ a\Delta t^2$

$\Delta y_A = -16 (2,24)+ 4,9(2,24)^2$

$= - 11,25$ m

$\therefore$Height of ball A/*Hoogte van bal A* = 11,25 m✓ (6)

<u>OPTION 3/*OPSIE 3*</u>

Upwards positive/*Opwaarts positief:*

$v_f = v_i + a\Delta t$

After 1 s, speed of ball A/*Spoed van bal A na 1 s*

$v_f = 16 + (-9,8)(1)$

$= 6,2\ m\cdot s^{-1}$

Distance travelled by ball A in 1 s/*Afstand deur bal A afgelê in 1 s*

$\Delta y_A = v_i\Delta t + ½\ a\Delta t^2$ ✓

$= (16)(1) + ½(-9,8)1^2$

$= 11,1\ m$

For ball A, after 1 s/*Vir bal A na 1 s*

$\Delta y_A = 6,2\Delta t – 4,9\Delta t^2$ ✓

For ball/*Vir bal* **B,**

$\Delta y_B = v_i\Delta t + ½\ a\Delta t^2$

$= -9\Delta t + ½(-9,8)\Delta t^2$✓

$y_A + (-y_B) = (30 - 11,1) = 18,9$

$6,2\Delta t – 4,9\Delta t^2 – [-9\Delta t + ½(-9,8)\Delta t^2] = 18,9$

$15,2\Delta t = 18,9$

$\Delta t = 1,24\ s$ ✓

The balls meet after/*Die balle ontmoet na* (1,24 +1) = 2,24 s✓

$\Delta y_A = [6,2\ (1,24) – 4,9\ (1,24)^2]$

$= 0,154\ m$

Meeting point/*Ontmoetingspunt* = (11,1 + 0,154) = 11,25 m✓

OR/OF

$\Delta y = (-9)(1,24) + ½\ (-9,8)(1,24)^2$ ✓

$= -18,69\ m$

Meeting point/*Ontmoetingspunt* = (30 -18,69) = 11,31 m✓ (6)

Downwards positive/*Afwaarts positief:*

$v_f = v_i + a\Delta t$

After 1 s, speed of ball A/*Spoed van bal A na 1 s*

$v_f = -16 + (9,8)(1)$

$= -6,2\ ms^{-1}$

Distance travelled by ball A in 1 s/*Afstand deur bal A afgelê in 1 s*

$\Delta y_A = v_i\Delta t + ½\ a\Delta t^2$ ✓

$= (-16)(1) + ½(9,8)(1)^2$

$= -\ 11,1\ m$

For ball A, after 1 s/*Vir bal A na 1 s*

$\Delta y_A = -\ 6,2\Delta t + 4,9\Delta t^2$✓

For ball/*Vir bal* **B**

$\Delta y_B = v_i\Delta t + ½\ a\Delta t^2$

$= 9\Delta t + ½(9,8)\Delta t^2$✓

$-\ \Delta y_A + \Delta y_B = 18,9$

$6,2\Delta t - 4,9\Delta t^2 + [\ 9\Delta t + ½(9,8)\Delta t^2] = 18,9$

$15,2\Delta t = 18,9$

$\Delta t = 1,24\ s$✓

The balls meet after/*Die balle ontmoet na* (1,24 +1) = 2,24 s✓

$\Delta y_A = -6,2\ (1,24) + 4,9\ (1,24)^2$

$= -\ 0,154\ m$

Meeting point/*Ontmoetingspunt* = (-11,1 - 0,154) = 11,25 m✓

OR/*OF*

$\Delta y = (9)(1,24) + ½\ (9,8)(1,24)^2$ ✓

$= 18,69\ m$

Meeting point/*Ontmoetingspunt* = (30 -18,69) = 11,31 m✓ (6)

[13]

QUESTION 4/*VRAAG 4*

4.1

OPTION 1/*OPSIE 1*

Take motion to the right as positive/*Neem beweging na regs as positief.*

$\Sigma p_i = \Sigma p_f$
$(m_1 + m_2)v_i = m_1v_{f1} + m_2v_{f2}$
$(m_1+m_2)v_i = m_1v_{f1} + m_2v_{f2}$ } ✓ Any one/*Enige een*

$(3 + 0,02)\underline{(0)}$ ✓ = $\underline{(3)(-1,4) + (0,02)\ v_{f2}}$ ✓
v_{f2} = 210 m·s^{-1} ✓

OR/OF

Take motion to the left as positive/*Neem beweging na links as positief.*

$\Sigma p_i = \Sigma\ p_f$
$(m_1 + m_2)v_i = m_1v_{f1} + m_2v_{f2}$
$(m_1+m_2)v_i = m_1v_{f1} + m_2v_{f2}$ } ✓ Any one/*Enige een*

$(3 + 0,02)\underline{(0)}$ ✓ = $\underline{(3)(1,4) + (0,02)\ v_{f2}}$ ✓
v_{f2} = -210 m·s^{-1}
Speed/*Spoed* = 210 m·s^{-1} ✓ (4)

OPTION 2/*OPSIE 2*

Take motion to the right as positive/*Neem beweging na regs as positief.*

$\Delta p_{bullet} = -\Delta p_{block}$ ✓
$m(v_f – v_i) = - m(v_f – v_i)$
$\underline{(0,02)(v_f – 0)}$ ✓ = $\underline{-(3)(-1,4 – 0)}$ ✓
∴v_i = 210 m·s^{-1} ✓

OR/OF

Take motion to the left as positive/*Neem beweging na links as positief*

$\Delta p_{bullet} = -\Delta p_{block}$ ✓
$m(v_f – v_i) = - m(v_f – v_i)$
$\underline{(0,02)(v_f – 0)}$ ✓ = $\underline{-(3)(1,4 – 0)}$ ✓
∴v_i = -210 m·s^{-1}
Speed/*Spoed* = 210 m·s^{-1} ✓ (4)

4.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$v_f^2 = v_i^2 + 2a\Delta x$✓ $0 = 210^2 + 2a(0,4)$✓ $a = -55\ 125\ m \cdot s^{-2}$ $F_{net} = ma$✓ $= (0,02)(-55\ 125)$✓ $= -1\ 102,5\ N$ Magnitude of force = 1 102,5 N✓ *Grootte van krag = 1 102,5 N*	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $0,4 = \left(\frac{210 + 0}{2}\right)\Delta t$ ✓ $\Delta t = 0,004\ s\ (0,00381 s)$ $F_{net}\Delta t = \Delta p = m\Delta v$✓ $F_{net} = \frac{(0,02)(0 - 210)}{(0,004)}$ ✓ $= -1\ 050\ N$ Magnitude of force = 1 050 N✓ *Grootte van krag = 1 050 N* (Accept/*Aanvaar*: 1102,5 N)

(5)

OPTION 3/*OPSIE 3*

$v_f^2 = v_i^2 + 2a\Delta x$✓
$0 = 210^2 + 2a(0,4)$✓
$a = -55\ 125\ m \cdot s^{-2}$

$v_f = v_i + a\Delta t$
$0 = 210 - (55\ 125)\Delta t$
$\Delta t = 0,004\ s\ (0,00381\ s)$

$F_{net}\Delta t = \Delta p = m\Delta v$✓
$F_{net} = \frac{(0,02)(0 - 210)}{(0,004)}$ ✓
$= -1\ 050\ N$
Magnitude of force = 1 050 N✓ (Accept/*Aanvaar*: 1 102,5 N)
Grootte van krag = 1 050 N

(5)

OPTION 4/*OPSIE 4*

$W_{net} = \Delta K$
$F_{net}\Delta x\cos\theta = \Delta K = ½\ m(v_i^2 - v_f^2)$
} ✓ Any one/*Enige een*

$F_{net}(0,4)$ ✓$\cos 180°$✓$= ½\ (0,02)(0^2 - 210^2)$ ✓
$F_{net} = 1\ 102,5\ N$✓

OR/OF

$W_{nc} = \Delta E_p + \Delta E_k$
$F_{net}\Delta x\cos\theta = 0 + ½\ m(v_i^2 - v_f^2)$
} ✓ Any one/*Enige een*
$F_{net}(0,4)$ ✓$\cos 180°$✓$= ½\ (0,02)(0^2 - 210^2)$ ✓
$F_{net} = 1\ 102,5\ N$✓

(5)

4.3 The same as/equal✓
Dieselfde as/gelyk (1)

[10]

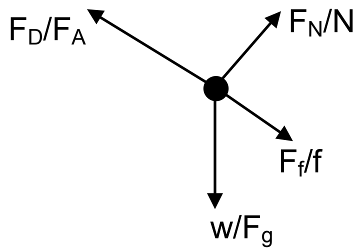
QUESTION 5/*VRAAG 5*

5.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$v_{ave} = \frac{800}{75}$ ✓ $= 10{,}67 m·s^{-1}$ $P_{ave} = Fv_{ave}$ ✓ $P_{ave} = (240)(10{,}67)$ $= 2\,560{,}8$ W (2,56 kW) ✓	$v_{ave} = \frac{800}{75}$ ✓ $= 10{,}67 m·s^{-1}$ ∴ Distance covered in 1s = 10,67m· ∴ W(Work done in 1 s) = $F\Delta x\cos\theta$ ✓ $= (240)(10{,}67)(1)$ $= 2\,560{,}8 J s^{-1}$ ∴ $P_{ave} = 2\,560{,}8$ W (2,56 kW) ✓
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$P = \frac{W}{\Delta t}$ ✓ $= \frac{F\Delta x\cos\theta}{\Delta t}$ $= \frac{(240)(800)\cos 0°}{75}$ ✓ $= 2\,560$ W ✓	$P = \frac{W}{\Delta t}$ ✓ $= \frac{F\Delta x\cos\theta}{\Delta t}$ $= \frac{(240)(10{,}67)\cos 0°}{1}$ ✓ $= 2\,560$ W ✓

(3)

5.2



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg / gravitational force/2 940 N *F_g / F_w / gewig / mg / gravitasiekrag*
f	$F_{friction}$ / F_f / friction /294 N /f_k *$F_{wrywing}$ / F_w / wrywing/294 N /f_k*
N	F_N / F_{normal} / normal force F_N / $F_{normaal}$ / *normaalkrag*
F_D	$F_{Applied/toegepas}$/350 N/Average driving force $F_{driving/dryfkrag}$/350/*Gemiddelde aandrywingskrag*

(4)

5.3 The net/total work done on an object is equal✓ to the change in the object's kinetic energy ✓
Die netto/totale arbeid verrig op 'n voorwerp is geyk aan die verandering in die voorwerp se kinetiese energie.
OR/*OF*
The work done on an object by a resultant/net force is equal✓ to the change in the object's kinetic energy. ✓
Die arbeid verrig op 'n voorwerp deur 'n resulterende krag is gelyk aan die verandering in die voorwerp se kinetiese energie. (2)

5.4

OPTION 1/*OPSIE 1*

$W_{nc} = \Delta U + \Delta K$✓
$W_f + W_D = \Delta U + \Delta K$
$f\Delta x\cos\theta + W_D = mg(h_f - h_i) + ½ (m)(v_f^2 – v_i^2)$
$(f\Delta x\cos\theta + F_D\Delta x \cos\theta = mg(h_f - h_i) + ½ m(v_f^2 – v_i^2)$
$(294)(450)(\cos180^o)$✓ + $(350)(450)\cos0^o$✓= $(300)(9,8)(5 - 0)$✓ + $½(300)(v_f^2 – 0)$✓
$v_f = 8,37\ m\cdot s^{-1}$✓ (6)

OPTION 2/*OPSIE 2*

$W_{net} = \Delta K$✓
$W_{net} = W_D + W_g + W_f + W_N$
$= (F_D\Delta x\cos\theta) + (mg \sin\alpha)\Delta x\cos\theta) + (f\Delta x\cos\theta) + 0$
$W_{net} = [350(450)](\cos0)$✓+ $(300)(9,8)\ \frac{5}{450}(450)(\cos180)$✓+
$294(450)(\cos180^o)$✓
$= 157\ 500 – 14\ 700 – 132\ 300$
$= 10\ 500\ J$

OR/*OF*
$\alpha = \sin^{-1}\frac{5}{450}$
$= 0,64^o$

$W_{net} = \Delta K$
$10\ 500 = ½ (300)(v_f^2 – 0)$ ✓
$v_f = 8,37\ m\cdot s^{-1}$ ✓ (6)

OPTION 3/*OPSIE 3*

$W_{net} = W_D + W_g + W_f + W_N$
$= (F_D\Delta x\cos\theta) + mg\Delta x\cos\theta) + f\Delta x\cos\theta + 0$
$W_{net} = (350)(450)(\cos0^o)$✓+$(300)(9,8)(450)\cos(90 + 0,64)$ ✓+$294(450)(\cos180^o)$✓
$= 157\ 500 – 14\ 777,74 – 13\ 2300$
$= 10\ 430,51\ J$

OR/*OF*
$\alpha = \sin^{-1}\frac{5}{450}$
$= 0,64^o$

$W_{net} = \Delta K$ ✓
$10\ 430,51 = ½ (300)(v_f^2 – 0)$✓
$v_f = 8,34\ m\cdot s^{-1}$ ✓ (6)

OPTION 4/*OPSIE 4*

$F_{net} = F_D + (-mg\sin\alpha) +(-f)$
$= 350$ ✓+$[-(300)(9,8)\sin0,64^o]$✓ + $(- 294)$✓
$= 23,16\ N$

OR/*OF*
$F_{net} = 350$ ✓ - $(300)(9,8)\sin0,64^o$✓ - 294✓
$= 350 - 32,84 - 294$
$= 23,16\ N$

$W_{net} = F_{net}\ \Delta x \cos\theta$
$= (23,16)(450) \cos0^o$
$= 10\ 422\ J$

$W_{net} = \Delta K$ ✓
$10\ 422 = ½ (300)(v_f^2 – 0)$✓
$v_f = 8,34\ m\cdot s^{-1}$ ✓ (6)

[15]

QUESTION 6/*VRAAG 6*

6.1.1 Frequency (of sound detected by the listener (observer))✓
Frekwensie van klank deur luisteraar (waarnemer) waargeneem (1)

6.1.2 The apparent change in frequency or pitch of sound (detected (by a listener) because the sound source and the listener have different velocities relative to the medium of sound propagation.✓ ✓
Die verandering in frekwensie (of toonhoogte) van die klank deur 'n luisteraar waargeneem omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klankvoortplanting het. (2)

6.1.3 Away/*Weg van*✓
Detected frequency of source decreases✓
Waargenome frekwensie van bron neem af (2)

6.1.4

OPTION 1/OPSIE 1

EXPERIMENT/*EKSPERIMENT* 2

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$ ✓

$874 \overset{✓}{=} \frac{v}{v+10}\overset{✓}{} (900)$ ✓

v = 336,15 m·s^{-1}✓ (Accept/*Aanvaar* : 336,15 m·s^{-1} – 323,33 m·s^{-1}) (5)

EXPERIMENT/*EKSPERIMENT* 3

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$ ✓

$850 \overset{✓}{=} \frac{v}{v+20}\overset{✓}{} (900)$ ✓

v = 340 m·s^{-1}✓ (Accept/*Aanvaar* : 313,33 m·s^{-1} – 340 m·s^{-1}) (5)

EXPERIMENT 4/*EKSPERIMENT* 4

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$ ✓

$827 \overset{✓}{=} \frac{v}{v+30}\overset{✓}{} (900)$ ✓

v = 339,86 m·s^{-1}✓ (Accept/*Aanvaar* : 339,86 m·s^{-1} – 345 m·s^{-1}) (5)

OPTION 2/OPSIE 2

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v + v_s} f_s$ ✓

Experiment/Eksperiment 2 and/en 3

$\frac{874(v+10)}{v}$ ✓ $= \frac{850(v+20)}{v}$ ✓

874v + 8740 = 850v + 1700 ✓ both frequencies / beide frekwensies

$\therefore$v = 344,17 m·s^{-1} ✓

Experiment/Eksperiment 2 and/en 4

$\frac{874(v+10)}{v}$ ✓ $= \frac{827(v+30)}{v}$ ✓

874v + 8740 = 827v + 24810 ✓ both frequencies / beide frekwensies

$\therefore$v = 341,91 m·s^{-1} ✓

Experiment/Eksperiment 3 and/en 4

$\frac{850(v+20)}{v}$ ✓ $= \frac{827(v+30)}{v}$ ✓

850v + 1700 = 827v + 24810 ✓ both frequencies / beide frekwensies

$\therefore$v = 339,57 m·s^{-1} ✓ (5)

6.2 Away from the Earth/*Weg vanaf die aarde*✓ (1)

[11]

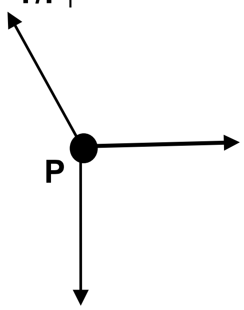
QUESTION 7/*VRAAG 7*

7.1 $n = \frac{Q}{e}$ ✓

$n = \frac{0,5 \times 10^{-6}}{1,6 \times 10^{-19}}$ ✓

$n = 3,13 \times 10^{12}$ ✓electrons/*elektrone* (3)

7.2



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg / gravitational force *F_g / F_w / gewig / mg / gravitasiekrag*
T	F_T / tension F_T / *spanning*
F_E	Electrostatic force/F_C/ Coulombic force/F_Q /$F_{RP/PR}$ *Elektrostiesekrag / Coulombkrag / F_Q /$F_{RP/PR}$*

(3)

7.3 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the (magnitudes of the) charges and inversely proportional to the square of the distance (r) between them. ✓✓

Die grootte van die elektrostatiese krag wat deur een puntlading (Q_1) op 'n ander puntlading (Q_2)uitgeoefen word, is direk eweredig aan die produk van die (groottes van die) ladings en omgekeerd eweredig aam die kwadraat van die afstand (r) tussen hulle. (2)

7.4

OPTION 1/*OPSIE 1*

$F_E = k\frac{Q_1Q_2}{r^2}$ ✓

Tsinθ/(Tcosθ) = F_E

$\therefore$ T sin7°/(Tcos83°)✓ = $\frac{(9\times10^9)(0,5\times10^{-6})(0,9\times10^{-6})}{(0,2)^2}$ ✓ ✓

$\therefore$T = 0,83 N✓ (Accept/*Aanvaar* 0,82 N) (5)

OPTION 2/*OPSIE 2*

$F_E = \frac{kQ_1Q_2}{r^2}$ ✓

$F_E = \frac{(9\times10^9)(0,5\times10^{-6})(0,9\times10^{-6})}{(0,2)^2}$ ✓ ✓

= 0,101 N

$\tan 7° = \frac{T_x}{T_Y} = \frac{0,101}{T_Y}$ ✓

T_Y = 0,823 N

$T = \sqrt{T_X^2 + T_Y^2} = \sqrt{(0,101)^2 + (0,823)^2} = 0,83\text{ N}$ ✓ (5)

OPTION 3/*OPSIE 3*

F = $\frac{kQ_1Q_2}{r^2}$ ✓= $\frac{(9\times10^9)(0,5\times10^{-6})(0,9\times10^{-6})}{(0,2)^2}$ ✓ ✓ = 0,101 N

$\frac{F_E}{\sin 7°} = \frac{T}{\sin 90°}$

$\frac{0,101}{\sin 7°} = \frac{T}{\sin 90°}$ ✓

T = 0,83 N ✓ (5)

[13]

QUESTION 8/*VRAAG 8*

8.1 $E_X = E_2 + E_{(-8)}$ ✓

$= \frac{kQ_2}{r^2} + \frac{kQ_{-8}}{r^2}$ ✓correct equation /*korrekte vergelyking*

$= \frac{(9\times10^9)(2\times10^{-5})}{(0,25)^2}$ ✓ + $\frac{(9\times10^9)(8\times10^{-6})}{(0,15)^2}$ ✓

$= 2,88 \times 10^6 + 3,2 \times 10^6$

$= 6,08 \times 10^6$ N·C^{-1} ✓ to the east/*na oos* ✓

OR/*OF*

$E = k\frac{Q}{r^2}$ ✓

$E_2 = \frac{(9\times10^9)(2\times10^{-5})}{(0,25)^2}$ ✓

$= 2,88 \times 10^6$ NC^{-1} to the east/*na oos*

$E_{-8} = \frac{(9\times10^9)(8\times10^{-6})}{(0,15)^2}$ ✓

$= 3,2 \times 10^6$ N·C^{-1} to the east/*na oos*

$E_X = E_2 + E_{(-8)}$

$= (2,88 \times 10^6 + 3,2 \times 10^6)$ ✓

$= \underline{6,08 \times 10^6}$ $\underline{\text{N·C}^{-1}}$ ✓ to the east/*na oos*✓ (6)

8.2 **OPTION 1/*OPSIE 1***

$F_E = QE$✓

$= (-2 \times 10^{-9})(6,08 \times 10^6)$✓

$= -12,16 \times 10^{-3}$ N

$= 1,22 \times 10^{-2}$ N✓ to the west/*na wes*✓ (4)

OPTION 2/*OPSIE 2*

$F_{(-2)Q1} = qE_{(2)}$ ✓

$= (2 \times 10^{-9})(2,88 \times 10^6)$

$= 5,76 \times 10^{-3}$ N to the west/*na wes*

$F_{(-2)Q2} = qE_{(8)}$

$= (2 \times 10^{-9})(3,2 \times 10^6)$

$= 6,4 \times 10^{-3}$ N to the west/*na wes*

$F_{net} = \underline{5,76 \times 10^{-3} + 6,4 \times 10^{-3}}$ ✓

$= 1,22 \times 10^{-2}$ N ✓to the west/*na wes*✓ (4)

OPTION 3/*OPSIE 3*
$F = k\frac{Q_1Q_2}{r^2}$ ✓ $F_{(-2)2} = \frac{(9\times10^9)(2\times10^{-9})(2\times10^{-5})}{(0,25)^2}$ $= 5,76 \times 10^{-3}$ N to the west/*na wes* $F_{(-2)(-8)} = \frac{(9\times10^9)(2\times10^{-9})(8\times10^{-6})}{(0,15)^2}$ $= 6,4 \times 10^{-3}$ N to the west/*na wes* $F_{net} = (5,76 \times 10^{-3} + 6,4 \times 10^{-3})$ ✓ $= 1,22 \times 10^{-2}$ N ✓to the west/*na wes* ✓

(4)

8.3 $2,44 \times 10^{-2}$ N✓ (1)

[11]

QUESTION 9/*VRAAG 9*

9.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. (provided temperature and all other physical conditions are constant) ✓✓
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur (mits temperatuur en alle fisiese toestande konstant bly)
OR/*OF*
.
The current in a conductor is directly proportional to the potential difference across the conductor, provided temperature and all other physical conditions are constant ✓✓
Die stroom in 'n geleier is direk eweredig aan die potensiaalverskil oor 'n geleier by konstante temperatuur mits temperatuur en alle fisiese toestande konstant bly (2)

9.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
V = IR✓ $V_8 = (0,5)(8)$✓ = 4 V $V_8 = V_{16}$ $\therefore V_{16} = 4$ V $I_{16} = \frac{V}{R} = \frac{4}{16} = 0,25$ A $I_{tot//} = A_1 = (0,5 + 0,25)$ ✓ = 0,75 A✓	V = IR✓ $V_8 = (0,5)(8)$ ✓ = 4 V $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ $= \frac{1}{8} + \frac{1}{16}$ ✓ R = 5,33 Ω $I_{tot//} = \frac{4}{5,33}$ $A_1 = 0,75$ A✓

(4)

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$I_1R_1 = I_2R_2$ ✓ $(0,5)(8) = I_{16}(16)$ ✓ $I_{16} = \frac{(8)(0,5)}{16} = 0,25\text{ A}$ $I_{tot//} = A_1 = (0,5 + 0,25)$ ✓ $= 0,75\text{ A}$ ✓	$2R_{8\Omega} = R_{16\Omega}$ ✓ $\therefore I_{R16} = \frac{1}{2} I_{R8}$ ✓ $\therefore I_{R16} = \frac{1}{2}(0,5) = 0,25\text{ A}$ $A_1 = (0,5 + 0,25)$ ✓ $= 0,75\text{ A}$ ✓

(4)

9.3

OPTION 1/*OPSIE 1*

$V = IR$

$V_{20\Omega} = (0,75)(20)$ ✓ $= 15\text{ V}$

$V_{//tot} = (15 + 4)$ ✓ $= 19\text{ V}$

$V_R = 19\text{ V}$

$P = VI$ ✓

$12 = (19)I$ ✓

$I_R = A_2 = 0,63\text{ A}$ ✓

(5)

OPTION 2/*OPSIE 2*

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{8} + \frac{1}{16}$ ✓

$R_{//} = 5,33\ \Omega$

OR/*OF*

$R = \frac{R_1R_2}{R_1 + R_2} = \frac{8 \times 16}{8 + 16}$ ✓ $= 5,33\ \Omega$

$R_{//} + R_{20} = (5,33 + 20)$ ✓ $= 25,33\Omega$

$V_{//tot} = I(R_{//} + R_{20})$

$= (0,75)(25,33)$

$= 19\text{ V}$

$P = VI$

12 ✓ $= I(19)$ ✓

$I_R = A_2 = 0,63\text{ A}$ ✓

(5)

OPTION 3/*OPSIE 3*

$V = IR$

$V_{20\Omega} = (0,75)(20)$ ✓ $= 15\text{ V}$

$V_{//tot} = (15 + 4)$ ✓ $= 19\text{ V}$

$V_R = 19\text{ V}$

$P = \frac{V^2}{R}$

$12 = \frac{(19)^2}{R}$

$R = 30,08\ \Omega$

$P = I^2R$ ✓

$12 = I^2(30,08)$ ✓

$I = 0,63\text{ A}$ ✓

(5)

9.4

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$(\varepsilon) = I(R + r)$ ✓ $= V_{terminal} + V_{int}$ $= 19 + (0,75 + 0,63)(1)$ ✓ $= 20,38$ V✓	$V_{int} = Ir$ $= (0,75 + 0,63)(1)$✓ $= 1,38$ V $\varepsilon = V_{terminal} + V_{int}$ ✓ $= 19 + 1,38$ $= 20,38$ V ✓

(3)

OPTION 3/OPSIE 3

$R = \frac{V}{I} = \frac{19}{0,63} = 30,16\ \Omega$

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{30,16} + \frac{1}{25,33}\ \therefore R_p = 13,77\ \Omega$

$I_{tot} = 0,63 + 0,75 = 1,38$ A

$\varepsilon = I(R + r)$ ✓
$= (1,38)(13,77 + 1)$✓
$= 20,38$ V✓

[14]

QUESTION 10/*VRAAG10*

10.1.1 Move the bar magnet very quickly✓
up and down inside the coil ✓
Beweeg die staafmagneet baie vinnig
op en af binne in die spoel. (2)

10.1.2 Electromagnetic induction/*Elektromagnetiese induksie* ✓ (1)

10.1.3 Commutator/*kommutator /* split rings/*spleetringe* ✓ (1)

10.2.1

OPTION 1/*OPSIE 1* $P_{average} = \frac{V_{rms}^2}{R}$ ✓ $= \frac{220^2}{40,33}$ ✓ ✓ = 1 200,10 W ($J\cdot s^{-1}$)✓	$W = \frac{V_{rms}^2}{R}\Delta t$ ✓ $= \frac{220^2}{40,33}(1)$ ✓ ✓ = 1200,10 J ✓
OPTION 2/*OPSIE 2* $I_{rms} = \frac{V_{rms}}{R}$ ✓ $= \frac{220}{40,33}$ ✓ = 5,45 A $P_{average} = I_{rms}^2 R$ = $(5,45^2)(40,33)$ ✓ = 1 197,9 W **OR/*OF*** 1 200,10 W✓	$I_{rms} = \frac{V_{rms}}{R}$ ✓ $= \frac{220}{40,33}$ ✓ = 5,45 A $W = I_{rms}^2 R\Delta t$ = $(5,45^2)(40,33)(1)$✓ = 1 197,9 J **OR/*OF*** 1 200,10 J✓

(4)

(4)

OPTION 3/*OPSIE 3* $I_{rms} = \frac{V_{rms}}{R}$ ✓ $= \frac{220}{40,33}$ ✓ = 5,45 A $P_{average} = V_{rms} I_{rms}$ = (220)(5,45) ✓ = 1 199 W **or/*of*** 1 200,10 W✓	$I_{rms} = \frac{V_{rms}}{R}$ ✓ $= \frac{220}{40,33}$ ✓ = 5,45 A $W = V_{rms} I_{rms}\Delta t$ = (220)(5,45)(1) ✓ = 1 199 J **or/*of*** 1 200,10 J✓

(4)

10.2.2

OPTION 1/*OPSIE 1*

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$

$220 = \frac{V_{max}}{\sqrt{2}}$

V_{max} = 311,13 V

$I_{max} = \frac{V_{max}}{R} = \frac{331{,}13}{40{,}33}$ ✓

= 7,71 A ✓

OR/OF

$P_{ave} = \frac{V_{max} I_{max}}{2}$

$1200{,}1 = \frac{(311{,}13) I_{max}}{2}$

I_{max} = 7,71 A

(3)

OPTION 2/*OPSIE 2*

$P_{average} = V_{rms} I_{rms}$ ✓

<u>1200,1 = (220)I_{rms}</u> ✓

I_{rms} = 5,455 A

$I_{max} = \sqrt{2}(5{,}455)$

= 7,71 A ✓ (7,715 A)

(3)

OPTION 3/*OPSIE 3*

$P_{average} = I_{rms}^2 R$ ✓

<u>1200,1 = I^2_{rms}(40,33)</u> ✓

I_{rms} = 5,455 A

$I_{max} = \sqrt{2} I_{rms}$

$= \sqrt{2}(5{,}455)$

= 7,71 A ✓

(3)

OPTION 4/*OPSIE 4*

$V_{rms} = I_{rms} R$ ✓

<u>220 = I_{rms}(40,33)</u> ✓

I_{rms} = 5,455 A

$I_{max} = \sqrt{2} I_{rms}$

$= \sqrt{2}(5{,}455)$

= 7,71 A ✓

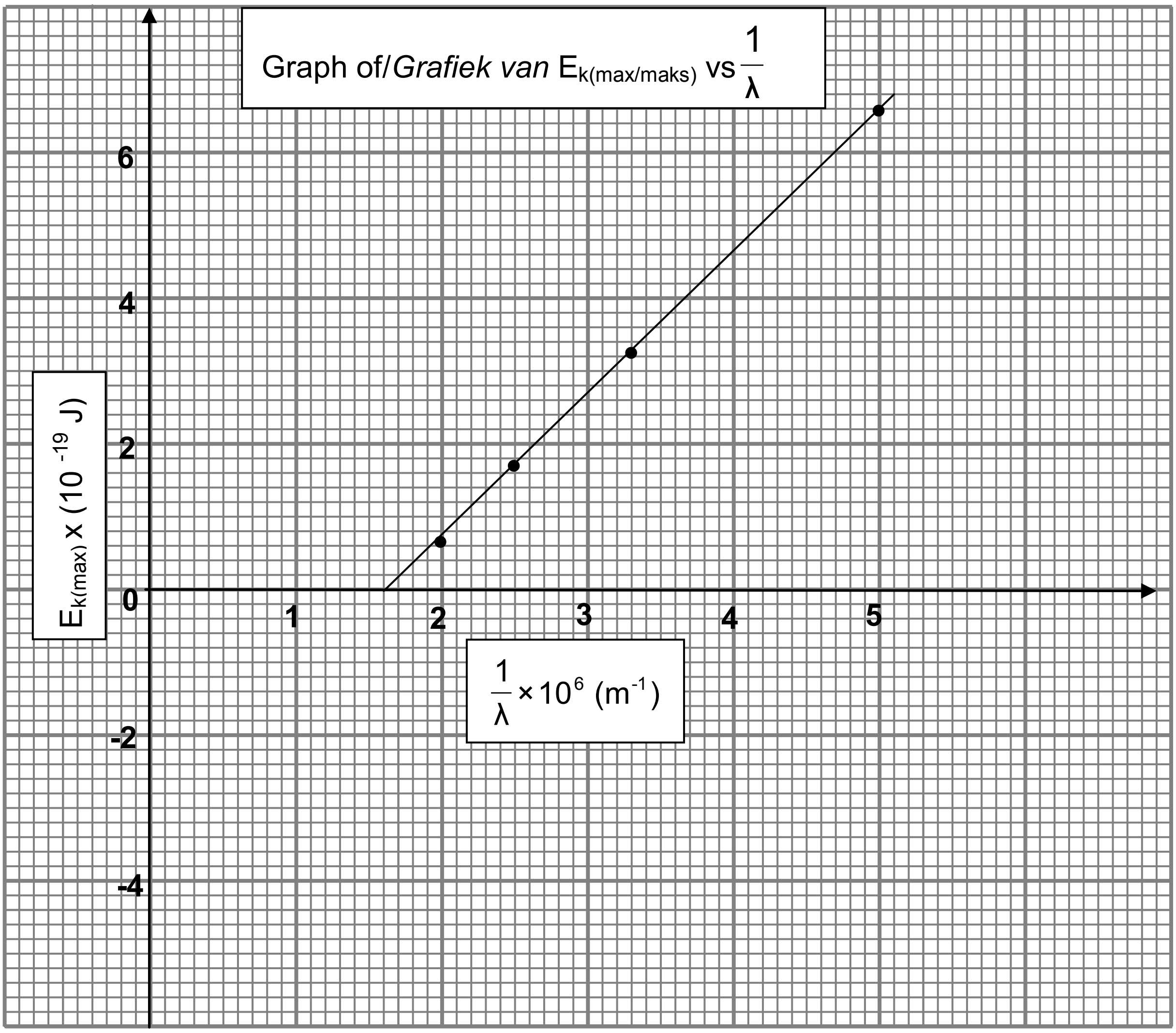
(3)

[11]

QUESTION 11/*VRAAG 11*

11.1 It is the process whereby electrons are ejected from a metal surface when light (of suitable frequency) is incident on it. ✓✓
Dit is die proses waartydens elektrone vanaf 'n metaaloppervlak vrygestel word wanneer van geskikte frekwensie daarop inval✓✓ (2)

11.2



11.3.1

OPTION 1/OPSIE 1 $\frac{1}{\lambda} = 1{,}6 \times 10^6 \text{ m}^{-1}$ ✓ $f_o = c\frac{1}{\lambda}$ ✓ $= (3 \times 10^8)(1{,}6 \times 10^6)$ ✓ $= 4{,}8 \times 10^{14}$ Hz✓ (**Accept/*Aanvaar*** $4{,}8 \times 10^{14}$ Hz to/*tot* $5{,}1 \times 10^{14}$ Hz) (4)
OPTION 2/OPSIE 2 By extrapolation: y-intercept = $-W_o$/*Deur ekstrapolasie : y-afsnit =* $-W_o$ $W_o = hf_o$ ✓ $3{,}2 \times 10^{-19}$✓ $= (6{,}63 \times 10^{-34})f_o$ ✓ $f_o = 4{,}8 \times 10^{14}$ Hz✓ (**Accept/*Aanvaar*** $4{,}8 \times 10^{14}$ Hz to/*tot* $4{,}83 \times 10^{14}$ Hz) (4)
OPTION 3/OPSIE 3 (Points from the graph/ *Punte vanaf grafiek*) $E = W_o + E_{k(max)}$ $\frac{hc}{\lambda_0} = hf_0 + E_{k(max)}$ ✓ $(6{,}63 \times 10^{-34})(3 \times 10^8)(1{,}6 \times 10^6)$✓$= (6{,}63 \times 10^{-34})f_0 + 0$ ✓ $f_o = 4{,}8 \times 10^{14}$ Hz ✓ **OR/*OF*** $(6{,}63 \times 10^{-34})(3 \times 10^8)(5 \times 10^6) = (6{,}63 \times 10^{-34})f_0 + 6{,}6 \times 10^{-19}$ $f_o = 4{,}92 \times 10^{14}$ Hz **OR/*OF*** $(6{,}63 \times 10^{-34})(3 \times 10^8)(3{,}3 \times 10^6) = (6{,}63 \times 10^{-34})f_0 + 3{,}3 \times 10^{-19}$ $f_o = 4{,}8 \times 10^{14}$ Hz **OR/OF** $(6{,}63 \times 10^{-34})(3 \times 10^8)(2{,}5 \times 10^6) = (6{,}63 \times 10^{-34})f_0 + 1{,}7 \times 10^{-19}$ $f_o = 4{,}94 \times 10^{14}$ Hz **OR/OF** $(6{,}63 \times 10^{-34})(3 \times 10^8)(2{,}2 \times 10^6) = (6{,}63 \times 10^{-34})f_0 + 0{,}7 \times 10^{-19}$ $f_o = 5{,}54 \times 10^{14}$ Hz (4)

11.3.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
hc = Gradient/ *Helling* ✓ $= \frac{\Delta y}{\Delta x}$ $= \frac{6{,}6 \times 10^{-19}}{(5-1{,}6)\times 10^{6}}$ ✓ $= 1{,}941 \times 10^{-25}$ (J·m) $h = \frac{\text{gradient / helling}}{c}$ $h = \frac{1{,}941 \times 10^{-25}}{3 \times 10^{8}}$ ✓ $= 6{,}47 \times 10^{-34}$ J·s ✓	W_0 = y intercept/*afsnit* $= 3{,}2 \times 10^{-19}$ J ✓ **Accept /*Aanvaar*** $3{,}2 \times 10^{-19}$ J to/*tot* $3{,}4 \times 10^{-19}$J) $W_o = hf_o$ $3{,}2 \times 10^{-19}$✓ $= h(4{,}8 \times 10^{14})$ ✓ $h = 6{,}66 \times 10^{-34}$ J·s✓ **Accept /*Aanvaar*** $6{,}66 \times 10^{-34}$ J·s to/*tot* $7{,}08 \times 10^{-34}$J·s)

(4)

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
(Points from the graph *(Punte vanaf grafiek***)** $\frac{hc}{\lambda} = W_0 + K_{max} = 3{,}2 \times 10^{-19}$✓$+ 6{,}6 \times 10^{-19}$ ✓ $h = \frac{9{,}8 \times 10^{-19}}{(3\times 10^{8})(5 \times 10^{6})}$✓$= 6{,}53 \times 10^{-34}$✓ J·s **OR/*OF*** $\frac{hc}{\lambda} = W_0 + K_{max} = 3{,}2 \times 10^{-19}$✓$+ 3{,}3 \times 10^{-19}$ ✓ $h = \frac{6{,}5 \times 10^{-19}}{(3\times 10^{8})(3{,}3 \times 10^{6})}$✓$= 6{,}57 \times 10^{-34}$✓ J·s **OR/*OF*** $\frac{hc}{\lambda} = W_0 + K_{max} = 3{,}2 \times 10^{-19}$✓$+ 1{,}7 \times 10^{-19}$ $h = \frac{4{,}7 \times 10^{-19}}{(3\times 10^{8})(2{,}5 \times 10^{6})}$✓$= 6{,}27 \times 10^{-34}$ J·s **OR/*OF*** $\frac{hc}{\lambda} = W_0 + K_{max} = 3{,}2 \times 10^{-19}$✓$+ 0{,}7 \times 10^{-19}$ ✓ $h = \frac{3{,}9 \times 10^{-19}}{(3\times 10^{8})(2 \times 10^{6})}$✓$= 6{,}5 \times 10^{-34}$ J·s	$W_o = \frac{hc}{\lambda_o}$ or / of $W_o = hc\frac{1}{\lambda_o}$ $3{,}2 \times 10^{-19}$ ✓$= h(3 \times 10^{8})(1{,}6 \times 10^{6})$✓ $h = 6{,}66 \times 10^{-34}$ J·s ✓

(4)
[13]

TOTAL/*TOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2016

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 A net force **F** which acts on a body of mass *m* causes an acceleration *a*. If the same net force **F** is applied to a body of mass 2*m*, the acceleration of the body will be …

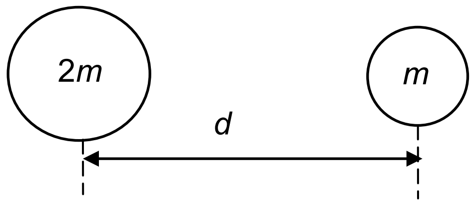
A ¼a

B ½a

C 2a

D 4a (2)

1.2 Two objects of masses 2*m* and *m* are arranged as shown in the diagram below.



Which ONE of the changes below will produce the GREATEST increase in the gravitational force exerted by the one mass on the other?

A Double the larger mass.

B Halve the smaller mass.

C Double the distance between the masses.

D Halve the distance between the masses. (2)

1.3 The statements below describe the motion of objects.

(i) A feather falls from a certain height inside a vacuum tube.

(ii) A box slides along a smooth horizontal surface at constant speed.

(iii) A steel ball falls through the air in the absence of air friction.

Which of the following describes UNIFORMLY ACCELERATED motion CORRECTLY?

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

D (i), (ii) and (iii) (2)

1.4 Airbags in modern cars provide more safety during an accident.

The statements below are made by a learner to explain how airbags can ensure better safety in a collision.

(i) The time of impact increases.

(ii) The impact force decreases.

(iii) The impulse increases.

Which of the statements above are CORRECT?

A (i) only

B (ii) only

C (ii) and (iii) only

D (i) and (ii) only (2)

1.5 The work done by a constant force F applied to an object to increase the object's speed from v to $2v$ is W.

The work done by the same force to increase the speed of the object from 0 to v will be ...

A ⅓W

B ½W

C 2W

D 3W (2)

1.6 Light reaching the Earth from a galaxy moving away is shifted towards …

A greater velocities.

B higher frequencies.

C longer wavelengths.

D shorter wavelengths. (2)

1.7 P, Q and R are three charged spheres. When P and Q are brought near each other, they experience an attractive force. When Q and R are brought near each other, they experience a repulsive force.

Which ONE of the following is TRUE?

A P and R have charges with the same sign.

B P and R have charges with opposite signs.

C P, Q and R have charges with the same sign.

D P, Q and R have equal charges. (2)

1.8 The minimum value of the resistance that can be obtained by connecting two 4 Ω resistors is ...

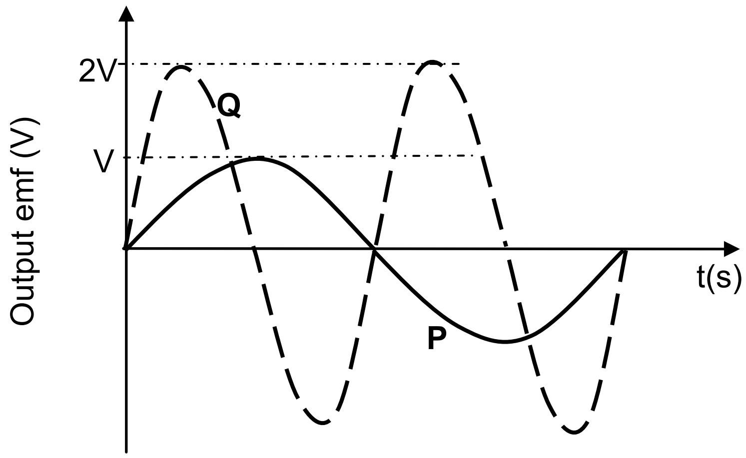
A 1 Ω.

B 2 Ω.

C 3 Ω.

D 8 Ω. (2)

1.9 Graph **P** represents the output emf of an AC generator. Graph **Q** is the output emf after a change has been made using the SAME generator.



Which ONE of the following changes has been made to the generator to produce graph **Q**?

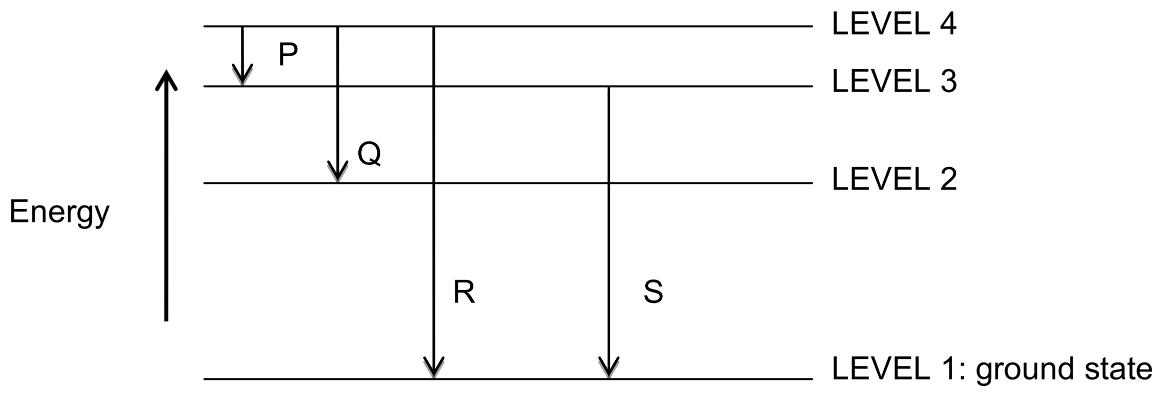
A The number of turns of the coil has been doubled.

B The surface area of the coil has been doubled.

C The speed of rotation has been doubled.

D The strength of the magnetic field has been doubled. (2)

1.10 The possible atomic transitions in an excited atom of an element are shown below.



Which transition will produce the spectral line with the longest wavelength?

A P

B Q

C R

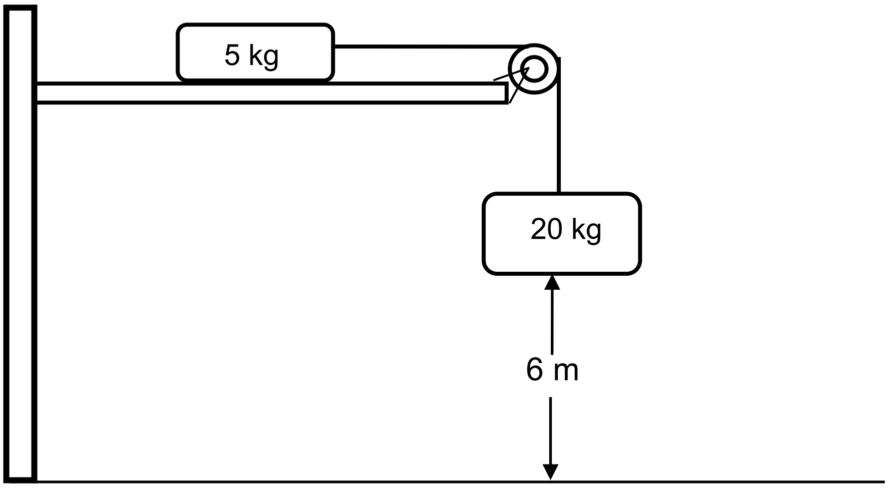
D S (2)

[20]

QUESTION 2 (Start on a new page.)

2.1 A 5 kg mass and a 20 kg mass are connected by a light inextensible string which passes over a light frictionless pulley. Initially, the 5 kg mass is held stationary on a horizontal surface, while the 20 kg mass hangs vertically downwards, 6 m above the ground, as shown in the diagram below.

The diagram is not drawn to scale.



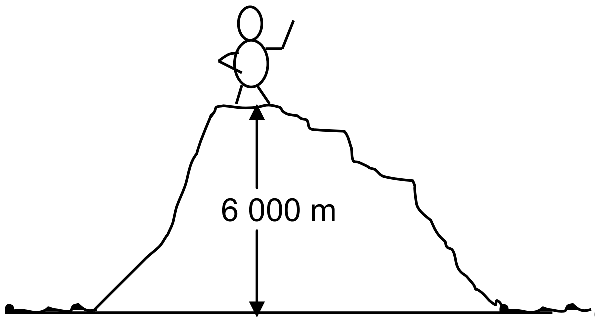
When the *stationary* 5 kg mass is released, the two masses begin to move. The coefficient of kinetic friction, μ_k, between the 5 kg mass and the horizontal surface is 0,4. Ignore the effects of air friction.

2.1.1 Calculate the acceleration of the 20 kg mass. (5)

2.1.2 Calculate the speed of the 20 kg mass as it strikes the ground. (4)

2.1.3 At what minimum distance from the pulley should the 5 kg mass be placed initially, so that the 20 kg mass just strikes the ground? (1)

2.2 A person of mass 60 kg climbs to the top of a mountain which is 6 000 m above ground level.



2.2.1 State Newton's Law of Universal Gravitation in words. (2)

2.2.2 Calculate the *difference* in the weight of the climber at the top of the mountain and at ground level. (6)
[18]

QUESTION 3 (Start on a new page.)

A man throws ball **A** downwards with a speed of 2 m·s^{-1} from the edge of a window, 45 m above a dam of water. One second later he throws a second ball, ball **B**, downwards and observes that both balls strike the surface of the water in the dam at the same time. Ignore air friction.

3.1 Calculate the:

3.1.1 Speed with which ball **A** hits the surface of the water (3)

3.1.2 Time it takes for ball **B** to hit the surface of the water (3)

3.1.3 Initial velocity of ball **B** (5)

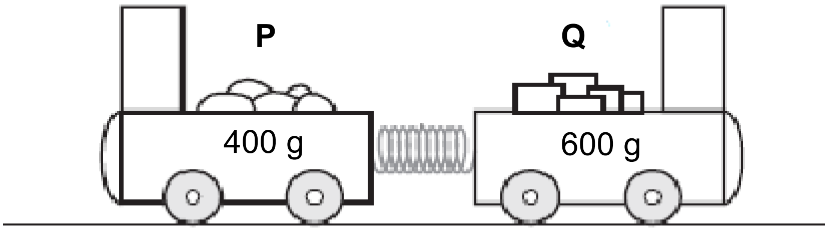
3.2 On the same set of axes, sketch a velocity versus time graph for the motion of balls **A** and **B**. Clearly indicate the following on your graph:

- Initial velocities of both balls **A** and **B**
- The time of release of ball **B**
- The time taken by both balls to hit the surface of the water (5)

[16]

QUESTION 4 (Start on a new page.)

The diagram below shows two trolleys, **P** and **Q**, held together by means of a compressed spring on a flat, frictionless horizontal track. The masses of **P** and **Q** are 400 g and 600 g respectively.



When the trolleys are released, it takes 0,3 s for the spring to unwind to its natural length. Trolley **Q then** moves to the right at 4 $m \cdot s^{-1}$.

4.1 State the *principle of conservation of linear momentum* in words. (2)

4.2 Calculate the:

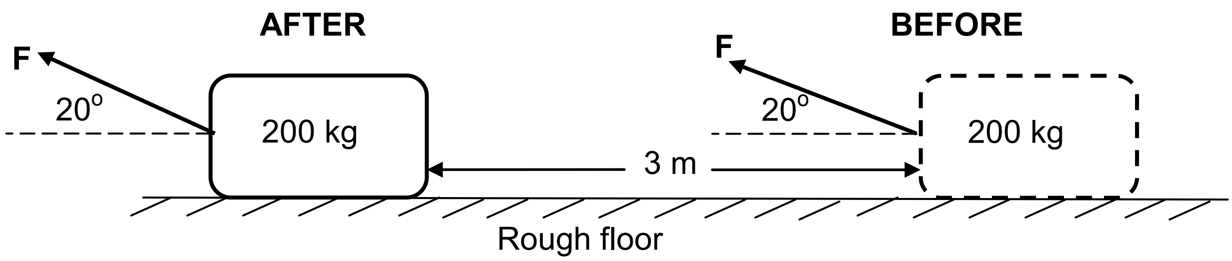
4.2.1 Velocity of trolley **P** after the trolleys are released (4)

4.2.2 Magnitude of the average force exerted by the spring on trolley **Q** (4)

4.3 Is this an elastic collision? Only answer YES or NO. (1)
[11]

QUESTION 5 (Start on a new page.)

A constant force **F**, applied at an angle of 20° above the horizontal, pulls a 200 kg block, over a distance of 3 m, on a rough, horizontal floor as shown in the diagram below.



The coefficient of kinetic friction, μ_k, between the floor surface and the block is 0,2.

5.1 Give a reason why the coefficient of kinetic friction has no units. (1)

5.2 State the work-energy theorem in words. (2)

5.3 Draw a free-body diagram indicating ALL the forces acting on the block while it is being pulled. (4)

5.4 Show that the work done by the kinetic frictional force (W_{fk}) on the block can be written as W_{fk} = (-1 176 + 0,205 **F**) J. (4)

5.5 Calculate the magnitude of the force **F** that has to be applied so that the net work done by all forces on the block is zero. (4)
[15]

QUESTION 6 (Start on a new page.)

Reflection of sound waves enables bats to hunt for moths. The sound wave produced by a bat has a frequency of 222 kHz and a wavelength of $1,5 \times 10^{-3}$ m.

6.1 Calculate the speed of this sound wave through the air. (3)

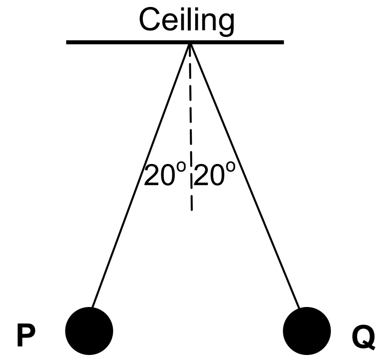
6.2 A stationary bat sends out a sound signal and receives the same signal reflected from a moving moth at a frequency of 230,3 kHz.

6.2.1 Is the moth moving TOWARDS or AWAY FROM the bat? (1)

6.2.2 Calculate the magnitude of the velocity of the moth, assuming that the velocity is constant. (6)
[10]

QUESTION 7 (Start on a new page.)

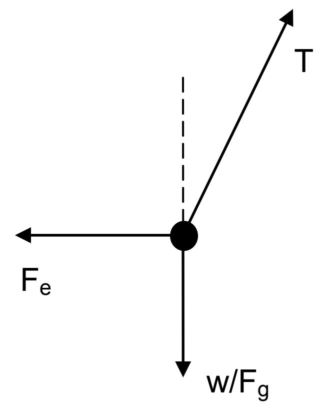
Two identical spherical balls, **P** and **Q**, each of mass 100 g, are suspended at the same point from a ceiling by means of identical light, inextensible insulating strings. Each ball carries a charge of +250 nC. The balls come to rest in the positions shown in the diagram below.



7.1 In the diagram, the angles between each string and the vertical are the same. Give a reason why the angles are the same. (1)

7.2 State Coulomb's law in words. (2)

7.3 The free-body diagram, not drawn to scale, of the forces acting on ball **P** is shown below.



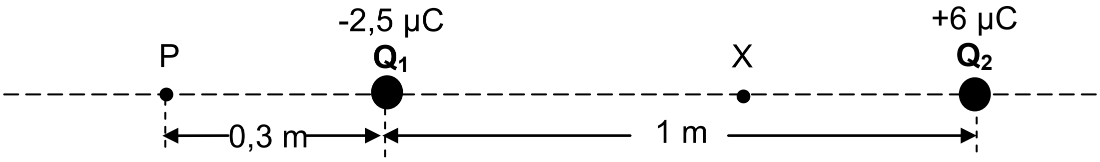
Calculate the:

7.3.1 Magnitude of the tension (T) in the string (3)

7.3.2 Distance between balls **P** and **Q** (5)
[11]

QUESTION 8 (Start on a new page.)

A sphere $\mathbf{Q_1}$, with a charge of -2,5 μC, is placed 1 m away from a second sphere $\mathbf{Q_2}$, with a charge +6 μC. The spheres lie along a straight line, as shown in the diagram below. Point **P** is located a distance of 0,3 m to the left of sphere $\mathbf{Q_1}$, while point **X** is located between $\mathbf{Q_1}$ and $\mathbf{Q_2}$. The diagram is not drawn to scale.

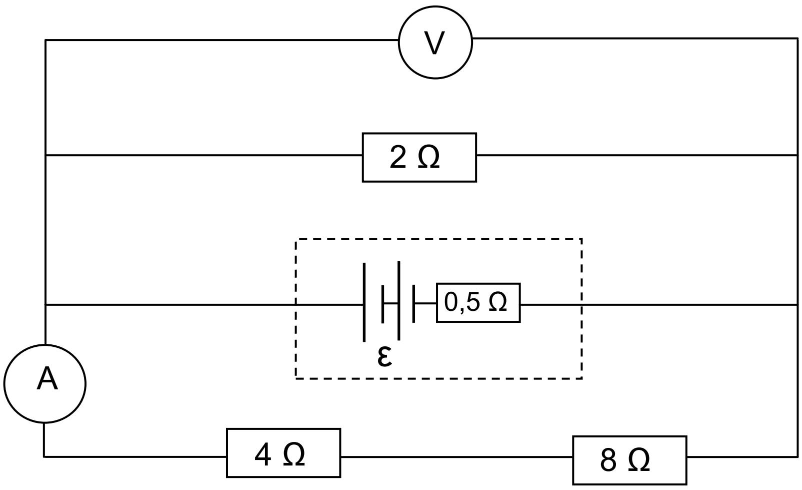


8.1 Show, with the aid of a VECTOR DIAGRAM, why the net electric field at point **X** *cannot be zero.* (4)

8.2 Calculate the net electric field at point **P**, due to the two charged spheres $\mathbf{Q_1}$ and $\mathbf{Q_2}$. (6)
[10]

QUESTION 9 (Start on a new page.)

A battery of an unknown emf and an internal resistance of 0,5 Ω is connected to three resistors, a high-resistance voltmeter and an ammeter of negligible resistance, as shown below.



The reading on the ammeter is 0,2 A.

9.1 Calculate the:

9.1.1 Reading on the voltmeter (3)

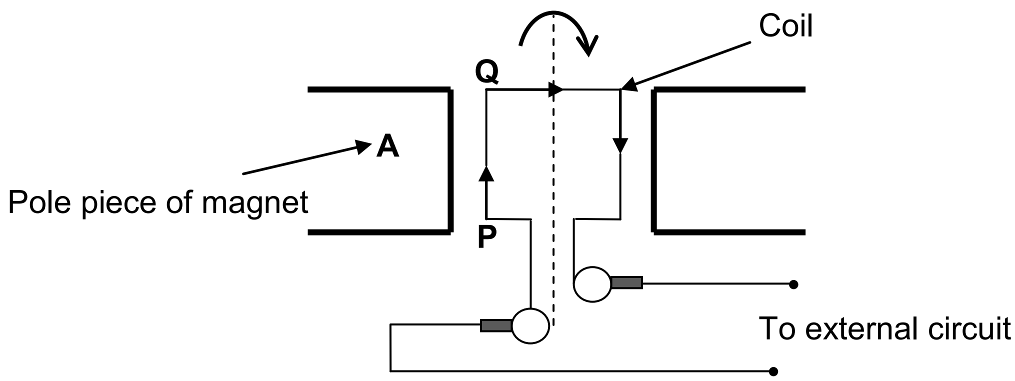
9.1.2 Total current supplied by the battery (4)

9.1.3 Emf of the battery (5)

9.2 How would the voltmeter reading change if the 2 Ω resistor is removed from the circuit? Write down INCREASE, DECREASE or REMAIN THE SAME. Explain the answer. (3)
[15]

QUESTION 10 (Start on a new page.)

10.1 A simplified sketch of an AC generator is shown below.



The coil of the generator rotates clockwise between the pole pieces of two magnets. At a particular instant, the current in the segment **PQ** has the direction shown above.

10.1.1 Identify the magnetic pole **A**.
Only write NORTH POLE or SOUTH POLE. (1)

10.1.2 The coil is rotated through 180^{o}.

Will the direction of the current in segment **PQ** be from **P** to **Q** or **Q** to **P**? (1)

10.2 An electrical device is connected to a generator which produces an rms potential difference of 220 V. The maximum current passing through the device is 8 A.

Calculate the:

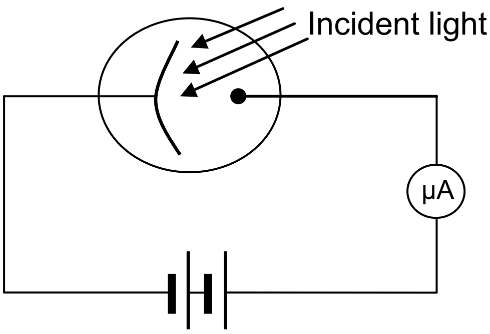
10.2.1 Resistance of the device (5)

10.2.2 Energy the device consumes in two hours (5)
[12]

QUESTION 11 (Start on a new page.)

An investigation was conducted to determine the effects of changes in frequency AND intensity on the current generated in a photoelectric cell when light is incident on it.

The apparatus used in the investigation is shown in the simplified diagram below.



The results of the experiment are shown in the table below.

EXPERIMENT	FREQUENCY (Hz)	INTENSITY (Cd)	CURRENT (μA)
A	$4,00 \times 10^{14}$	10	0
B	$4,50 \times 10^{14}$	10	0
C	$5,00 \times 10^{14}$	10	0
D	$5,01 \times 10^{14}$	10	20
E	$5,01 \times 10^{14}$	20	40
F	$6,50 \times 10^{14}$	10	30

11.1 Define the term *work function*. (2)

11.2 Identify an independent variable. (1)

The threshold frequency for the metal used in the photocell is $5,001 \times 10^{14}$ Hz.

11.3 Define the term *threshold frequency.* (2)

11.4 Calculate the maximum speed of an emitted electron in experiment **F**. (5)

In experiments **D** and **E**, the current doubled when the intensity was doubled at the same frequency.

11.5 What conclusion can be made from this observation? (2)
[12]

TOTAL: 150

QUESTION 1/*VRAAG 1*

1.1	B ✓✓	(2)
1.2	D ✓✓	(2)
1.3	B ✓✓	(2)
1.4	D ✓✓	(2)
1.5	A ✓✓	(2)
1.6	C✓✓	(2)
1.7	B✓✓	(2)
1.8	B ✓✓	(2)
1.9	C ✓✓	(2)
1.10	A ✓✓	(2)
		[20]

QUESTION 2/*VRAAG 2*

2.1 **For the 5 kg mass/*Vir die 5 kg massa*:**

2.1.1 T – f = ma

T - μ_k(mg) = ma✓

T – (0,4)(5)(9,8)✓ = 5a✓……..(1)

> **NOTE/*LET WEL*:**
> 1 mark for any of the 2 formulae
> *1 punt vir enige van die 2 formules*

For the 20 kg mass/*Vir die 20 kg massa*

mg – T = ma

20(9,8) – T = 20a✓……….(2)

176,4 = 25a (1) + (2)

∴a = 7,06 (7,056) m·s^{-2}✓

(5)

ACCEPT/*AANVAAR* (4 marks/*4 punte*)

F_{net} = ma

Mg – f = (M + m) a✓

[20(9,8) – (0,4)(5)(9,8)]✓ = 25a✓

∴a = 7,06 m·s^{-2}✓ (4)

2.1.2

POSITIVE MARKING FROM QUESTION 2.1.1
POSITIEWE NASIEN VANAF VRAAG 2.1.1
OPTION 1/*OPSIE 1*

$v_f^2 = v_i^2 + 2a\Delta y$✓

= 0✓ + (2)(7,056)(6)✓

v_f = 9,20 m·s^{-1}✓

POSITIVE MARKING FROM QUESTION 2.1.1
POSITIEWE NASIEN VANAF VRAAG 2.1.1
OPTION 2/*OPSIE 2*

The 5 kg mass travels as fast as the 20 kg mass
Die 5 kg massa beweeg net so vinnig soos die 20 kg massa

$W_{net} = \Delta K$✓

(5)(7,056)(6cos0°)✓ = ½(5)(v_f^2 - 0)✓

v_f = 9,20 m·s^{-1}✓

OPTION 3/*OPSIE 3*
For the 20 kg mass/*Vir die 20 kg massa*

$W_{net} = \Delta K$✓

Mg – T = Ma

(20)(9,8) – T = (20)(7,056)✓

T = 54,88 N

$W_{net} = \Delta K$

$W_T + W_g = ½m(v_f^2 – v_i^2)$

(54,88)(6)(cos 180) + 20(9,8)(6)(cos0) = ½(20) (v_f^2- 0)✓

v_f = 9,202 m·s^{-1}✓

OPTION 4/*OPSIE 4*
$W_{nc} = \Delta K + \Delta U$ ✓
$W_{nc} = f_k\Delta x\cos\theta = \mu_k N\Delta x\cos\theta = \Delta U + \Delta K$
$(0,4)(5)(9,8)(6)\cos180^\circ$ ✓ $= (20)(9,8)(0 - 6) + ½ (25)(v_f^2 - 0)$ ✓
$-117,6 = (20)(9,8)(-6) + ½(25)(v_f^2 - 0)$
$v_f = 9,202\ m\cdot s^{-1}$ ✓ (4)

2.1.3 6 m✓ (1)

2.2

2.2.1 Each body in the universe attracts every other body with a force that is directly proportional to the product of their masses ✓and inversely proportional to the square of the distance between their centres. ✓
Elke liggaam in die heelal trek elke ander liggaam aan met 'n krag wat direk eweredig is aan die produk van hul massas ✓ en omgekeerd eweredig is aan die kwadraat van die afstand tussen hul middelpunte. ✓ (2)

2.2.2 $F = \frac{Gm_1m_2}{r^2}$ ✓

On the mountain/*Op die berg*

$F_g = \frac{(6,67\times10^{-11})(5,98\times10^{24})(65)}{(6,38\times10^6 + 6\times10^3)^2}$ ✓ ✓
= 627,2 N

On the ground/*Op die grond*

$F_g = W = mg$
= (65 x 9,8)✓
= 637 N

OR:

$F_g = \frac{(6,67\times10^{-11})(5,98\times10^{24})(65)}{(6,38\times10^6)^2}$
= 636,94 N

Difference/*Verskil* = (637 – 627,2)✓
= 9,8 N✓ (6)

[18]

QUESTION 3/*VRAAG 3*

3.1

3.1.1

OPTION 1/*OPSIE 1*

Upwards positive/*Opwaarts positief*:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$v_f^2 = (-2)^2 + 2(-9,8)(-45)$ ✓

$v_f = 29,76\ m \cdot s^{-1}$ ✓

Downwards positive/*Afwaarts positief:*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$v_f^2 = (2)^2 + 2(9,8)(45)$ ✓

$v_f = 29,76\ m \cdot s^{-1}$ ✓ ($29,77\ m \cdot s^{-1}$)

OPTION 2/*OPSIE 2* **Upwards positive/*Opwaarts positief*:**	**Downwards positive/*Afwaarts positief:***
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ for either equation/*vir beide vergelykings* $- 45 =- 2\Delta t + ½(-9,8)\Delta t^2$ $- 4,9\ \Delta t^2 - 2\Delta t + 45 = 0$ $4,9\ \Delta t^2 + 2\Delta t - 45 = 0$ ✓ $\Delta t = 2,83$ $v_f = v_i + a\ \Delta t$ $v_f = 0 + (-9,8)(2,83)$ $v_f = -29,73\ m\ s^{-1}$ ✓	$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ for either equation/*vir beide vergelykings* $45 = 2\Delta t + ½(9,8)\Delta t^2$ $4,9\ \Delta t^2 + 2\Delta t - 45 = 0$ ✓ $\Delta t = 2,83$ $v_f = v_i + a\ \Delta t$ $v_f = 0+(9,8)(2,83)$ $v_f = 29,73\ m\ s^{-1}$ ✓

OPTION 3/*OPSIE 3* **Downwards positive/*Afwaarts positief:***	**Upwards positive/*Opwaarts positief*:**
$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ for either equation/*vir beide vergelykings* $45 = 2\Delta t + ½(9,8)\Delta t^2$ $4,9\ \Delta t^2 + 2\Delta t - 45 = 0$ ✓ $\Delta t = 2,83$ $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $45 = \frac{2 + v_f}{2}\ 2,83$ $v_f = 29,80 m\ s^{-1}$ ✓	$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ for either equation/*vir beide vergelykings* $- 45 = - 2\Delta t + ½(-9,8)\Delta t^2$ $- 4,9\ \Delta t^2 - 2\Delta t + 45 = 0$ $4,9\ \Delta t^2 + 2\Delta t - 45 = 0$ ✓ $\Delta t = 2,83$ $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $- 45 = \frac{- 2 + v_f}{2}\ 2,83$ ✓ $v_f = -29,80 m\ s^{-1}$ ✓

OPTION 4/*OPSIE 4*

$E_{mech\ at\ top} = E_{\ mech\ at\ surface\ of\ water}$

$\frac{1}{2} mv_i^2 + mgh_i = \frac{1}{2} mv_f^2 + mgh_f$ ✓

$\frac{1}{2}(2)^2 + 9,8(45) = \frac{1}{2} v_f^2 + 0$ ✓

$v_f = 29,76\ m \cdot s^{-1}$ ✓

OPTION 5/OPSIE 5

$W_{net} =$ ***:*** ΔK ✓

$F_g\ \Delta h \cos\theta = \frac{1}{2} m (v_f^2 - v_i^2)$

$mg\ \Delta h \cos\theta = \frac{1}{2} m (v_f^2 - v_i^2)$

$9,8(45)\cos 0 = \frac{1}{2}(v_f^2 - 2^2)$ ✓

$v_f = 29,76\ m \cdot s^{-1}$ ✓ (3)

3.1.2

POSITIVE MARKING FROM 3.1	POSITIVE MARKING FROM 3.1
POSITIEWE NASIEN VANAF 3.1 **OPTION 1/*OPSIE 1*** **Upwards positive/*Opwaarts positief*:** The balls hit the water at the same instant./*Die balle tref die water gelyktydig* $v_f = v_i + a\Delta t$ ✓ Ball/*Bal* **A** $-29,76 = -2+(-9,8)\ \Delta t$\` $\Delta t = 2,83$ s ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2,83 - 1 = 1,83$ s ∴ for ball/*vir bal* **B** $\Delta t_B = 2,83 - 1 = 1,83$ s ✓	**POSITIEWE NASIEN VANAF 3.1** **OPTION1/*OPSIE 1*** **Downwards positive/*Afwaarts positief*** The balls hit the water at the same instant./*Die balle tref die water gelyktydig* $v_f = v_i + a\Delta t$ ✓ Ball/*Bal* **A** $29,76 = 2 + (9,8)\ \Delta t$\` $\Delta t = 2,83$ s ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2,83 - 1 = 1,83$ s ∴ for ball/*vir bal* **B** $\Delta t_B = 2,83 - 1 = 1,83$ s ✓

OPTION 2	Downwards positive/*Afwaarts positief:*
Upwards positive/*Opwaarts positief*: Ball/*Bal* A $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $-45 =- 2\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ $-4,9\ \Delta t^2 - 2\Delta t + 45 = 0$ $4,9\ \Delta t^2 + 2\Delta t - 45 = 0$ $\Delta t = 2,83$ ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2,83 - 1 = 1,83$ s ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $45 = 2\Delta t + \frac{1}{2}(9,8)\Delta t^2$ $4,9\ \Delta t^2 + 2\Delta t - 45 = 0$ $\Delta t = 2,83$ ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2,83 - 1 = 1,83$ s ✓

OPTION 3	**Upwards positive/*Opwaarts positief*:**
Downwards positive/*Afwaarts positief:* Ball/*Bal* A $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $45 = \frac{2 + 29{,}76}{2}\Delta t$ $\Delta t = 2{,}83$ ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2{,}83 - 1 = 1{,}83$ s ✓	Ball/*Bal* A $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $-45 = \frac{-2 - 29{,}76}{2}\Delta t$ $\Delta t = 2{,}83$ ✓ ∴ for ball/*vir bal* **B** $\Delta t_B = 2{,}83 - 1 = 1{,}83$ s ✓

(3)

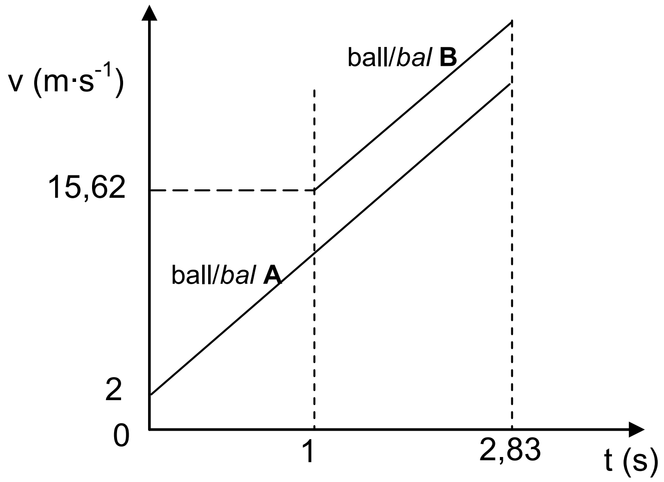
3.1.3

POSITIVE MARKING FROM 3.2/*POSITIEWE NASIEN VANAF 3.2*	**Downwards positive/*Afwaarts positief:***
Upwards positive/*Opwaarts positief*: $\Delta t_B = 1.83$s ✓ $\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ -45 ✓ $= v_i(1{,}83) + ½(-9.8)(1{,}83)^2$ ✓ $v_i = -15{,}62$ m·s^{-1} ✓	$\Delta t_B = 1.83$s ✓ $\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓ 45 ✓ $= v_i(1{,}83) + ½(9.8)(1{,}83)^2$ ✓ $v_i = 15{,}62$ m·s^{-1} ✓

(5)

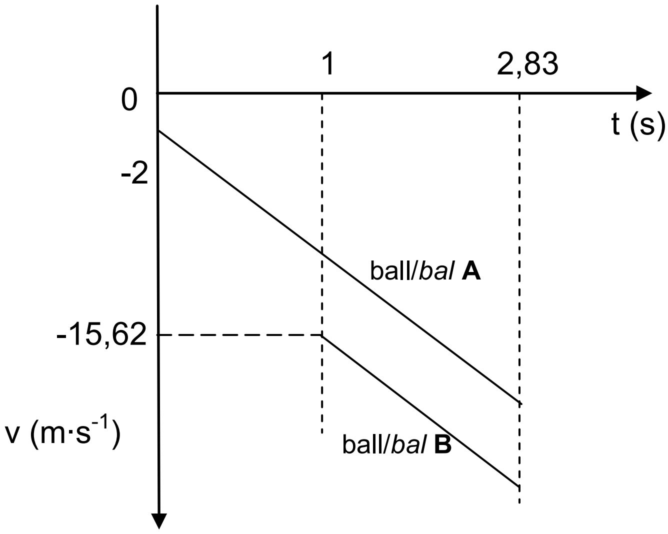
3.2

POSITIVE MARKING FROM 3.1.2; 3.1.3/*POSITIEWE NASIEN VANAF 3.1.2; 3.1.3*
CONSIDER MOTION DOWNWARD AS POSITIVE/*BESKOU BEWEGING AFWAARTS AS POSITIEF*



CRITERIA FOR MARKING/*KRITERIA VIR NASIEN*	
1 mark for each initial velocity shown/*1 punt vir elke beginsnelheid aangedui* (For/*Vir* A 2 m·s^{-1} for/*vir* B 15,62 m·s^{-1})	✓✓
Time of release of ball/*Tyd van vrystelling van bal* **B** t= 1s	✓
Time of flight for both balls must be indicated as same on time axis/*Vlugtyd van beide balle moet op dieselfde tydas aangetoon word* (2,83 s)	✓
Shape: Lines must be parallel or nearly so/*Vorm: Lyne moet parallel of amper parallel wees*	✓

CONSIDER MOTION UPWARD AS POSITIVE/*BESKOU OPWAARTSE BEWEGING AS POSITIEF*



CRITERIA FOR MARKING/*KRITERIA VIR NASIEN*	
1 mark for each initial velocity shown/*1 punt vir elke beginsnelheid aangedui* (For/*Vir* A -2 $m \cdot s^{-1}$ for/*vir* B -15,62 $m \cdot s^{-1}$)	✓✓
Time of release of ball/*Tyd van vrystelling van bal* **B** t= 1s	✓
Time of flight for both balls must be indicated as same on time axis/*Vlugtyd van beide balle moet op dieselfde tydas aangetoon word* (2,83 s)	✓
Shape: Lines must be parallel or nearly so/*Vorm: Lyne moet parallel of amper parallel wees*	✓

(5)
[16]

QUESTION 4/*VRAAG 4*

4.1 The total linear momentum in a closed system✓ remains constant./is conserved ✓/*Die totale lineêre momentum in 'n geslote stelsel*✓ *bly konstant/bly behoue.* ✓

OR/*OF*
In a closed/isolated system, the total momentum before a collision is equal to the total momentum after the collision./*In 'n geslote/geïsoleerde stelsel is die totale momentum voor 'n botsing gelyk aan die totale momentum na die botsing.* (2)

4.2

4.2.1 $\sum p_i = \sum p_f$✓
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$

0✓ = $(0,4)v_{1f} + 0,6\,(4)$✓
$v_{1f} = -6\ m\cdot s^{-1}$
$= 6\ m\cdot s^{-1}$ to the left/*na links*✓

NOTE: Mark for final answer to be forfeited if direction is not given/ ***LET WEL:*** *Punt vir finale antwoord word verbeur indien rigting nie gegee word nie.*

(4)

4.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE* 2**
$\Delta p = F_{net}\Delta t$✓ $[(0,6)(4) - 0]$✓ $= F_{net}\,(0,3)$✓ $F_{net} = 8$ N✓ **OR/*OF*** $m(v_f - v_i) = F_{net}\Delta t$✓ $0,6(4 - 0)$✓$= F_{net}(0,3)$✓ $F_{net} = 8$ N✓	$v_f = v_i + a\Delta t$ $4 = 0 + a(0,3)$ $a = 13,33\ m\cdot s^{-2}$ $F_{net} = ma$ $= 0,6(13,33)$ $F_{net} = 8$ N✓
OPTION 3/*OPSIE* 3 $\Delta p = F_{net}\Delta t$✓ $[(0,4)(6) - 0]$✓ $= F_{net}\,(0,3)$✓ $F_{net} = 8$ N✓ **OR/*OF*** $m(v_f - v_i) = F_{net}\Delta t$✓ $0,4(6 - 0)$✓$= F_{net}(0,3)$✓ $F_{net} = 8$ N✓	**OPTION 4/*OPSIE* 4** $v_f = v_i + a\Delta t$ $6 = 0 + a(0,3)$ $a = 20\ m\cdot s^{-2}$ $F_{net} = ma$ $= 0,4(20)$ $F_{net} = 8$ N✓

(4)

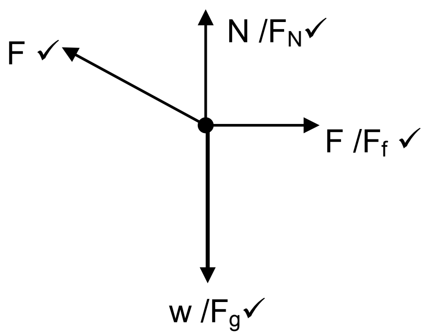
4.3 No/*Nee*✓ (1)
[11]

QUESTION 5/*VRAAG 5*

5.1 It is a ratio of two forces ✓ (hence units cancel out)./*Dit is 'n verhouding van twee kragte ✓ (dus word eenhede uitgekanseleer)* (1)

5.2 The net work done on an object is equal ✓to the change in kinetic energy of the object✓/*Die netto arbeid wat op 'n voorwerp verrig word, is gelyk ✓ aan die verandering in kinetiese energie van die voorwerp*✓ (2)

5.3



(4)

5.4 $F\sin 20^{o} + N = mg$✓
$N = mg - F\sin 20^{o}$

$W_{fk} = f_k\Delta x \cos\theta = \mu_k N\Delta x \cos\theta$✓
$= \mu_k(mg - F\sin 20)(3)\cos\theta$
$= \underline{(0,2)[200(9,8) - F \sin 20](3)\cos 180^{o}}$✓
$= (-1176 + 0,205\ F)$ J✓ (4)

5.5 $W_{tot} = [W_g] + W_f + W_F$ ✓
0 ✓ = $\underline{[0]} + \underline{[(-1176 + 0,205\ F)]} + \underline{[F (\cos 20) (3) (\cos 0)]}$✓
F = 388,88 N✓
NOTE: Do not penalise if value of W_g is not indicated/
LET WEL: *Moenie penaliseer indien die waarde van* W_g *nie aangedui word nie.* (4)
[15]

QUESTION 6/*VRAAG 6*

6.1 $v = f\lambda$ ✓
$= (222 \times 10^{3})(1,5 \times 10^{-3})$✓
$= 333 \text{ m.s}^{-1}$ ✓ (3)

6.2

6.2.1 Towards the bat/*Na die vlermuis toe* ✓ (1)

6.2.2 **POSITIVE MARKING FROM QUESTION 6.1/*POSITIEWE NASIEN VANAF VRAAG 6.1***

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

$230,3 = \frac{333}{333 - v_s}(222)$ ✓✓✓✓

$76689,9 – 230,3\ v_s = 73\ 926$

$v = 12 \text{ m.s}^{-1}$ ✓ (towards bat/*na die vlermuis toe*)

Notes/*Notas*:

- Any other Doppler formula, e.g./*Enige ander Doppler-formule, bv.:*
  $f_L = \frac{v - v_L}{v - v_s}$ - Max./*Maks.* $\frac{3}{4}$
- Marking rule 1.5: No penalisation if zero substitutions are omitted./*Nasienreël 1.5: Geen penalisering indien nulvervangings uitgelaat is nie.*

(6)

[10]

QUESTION 7/*VRAAG 7*

7.1 The magnitude of the charges are equal✓/ The balls repel each other with the same/identical force or force of equal magnitude✓/*Die grootte van die ladings is gelyk✓/Die balle stoot mekaar af met dieselfde/identiese kragte of krag van dieselfde grootte.* ✓ (1)

7.2 The electrostatic force of attraction between two point charges is directly proportional to the product of the charges ✓and inversely proportional to the square of the distance between them. ✓/*Die elektrostatiese aantrekkingskrag tussen twee puntladings is direk eweredig aan die produk van die ladings✓ en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.*✓ (2)

7.3

7.3.1 $T\cos 20^{o} = w$✓
$= mg$
$= (0,1)(9,8)$✓ $= 0,98$ N

$\therefore T = 1,04$ N✓ (3)

7.3.2 **POSITIVE MARKING FROM 7.3/*POSITIEWE NASIEN VANAF 7.3***

$F_{electrostatic/elektrostaties} = T\sin 20^o$ ✓

$\frac{kQ_1Q_2}{r^2}$ ✓ $= (1{,}04)\sin 20^o$

$\frac{kQ_1Q_2}{r^2} = 0{,}356$

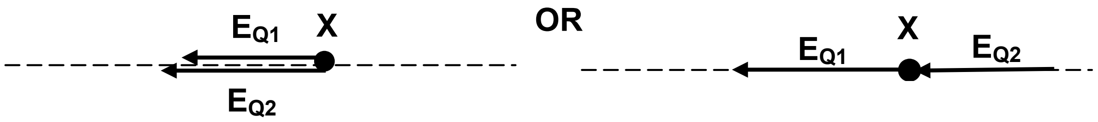
$\frac{(9\times10^9)(250\times10^{-9})(250\times10^{-9})}{r^2}$ ✓ $= 0{,}356$ ✓

$\therefore r = 0{,}0397$ m ✓ (5)

[11]

QUESTION 8/*VRAAG 8*

8.1



Vectors E_{Q1} and E_{Q2} in the same direction✓✓/*Vektore E_{Q1} en E_{Q2} in dieselfde rigting*✓✓
Correct drawing of vectors E_{Q1} and E_{Q2}✓✓/*Korrekte tekening van vektore E_{Q1} en E_{Q2}*✓✓/

The fields due to the two charges add up because <u>they come from the same direction.</u> Hence the field cannot be zero./*Die velde as gevolg van die twee ladings word bymekaar getel omdat <u>hulle uit dieselfde rigting inwerk</u>. Die veld kan dus nie nul wees nie.* (4)

8.2 $E = k\frac{Q}{r^2}$ ✓

$E_{-2,5\mu C} = k\frac{Q}{r^2} = \frac{(9\times10^9)(2{,}5\times10^{-6})}{(0{,}3)^2}$ ✓ $= 250\ 000\ N.C^{-1}$ to the left/*na links*

$E_{6\ \mu C} = k\frac{Q}{r^2} = \frac{(9\times10^9)(6\times10^{-6})}{(1{,}3)^2}$ ✓ $= 31\ 952{,}66\ N.C^{-1}$ to the left/*na links*

$E_P = E_{6\mu C} + E_{-2,5\mu C}$ ✓
$= 31\ 952{,}66 + 250\ 000$
$= 281\ 952{,}66\ N.C^{-1}$ ✓ to the left/*na links* ✓ (6)

[10]

QUESTION 9/*VRAAG 9*

9.1

9.1.1 V = IR✓
= (0,2)(4+8)✓
= 2,4 V✓ (3)

9.1.2 **POSITIVE MARKING FROM QUESTION 9.1.1/*POSITIEWE NASIEN VANAF VRAAG 9.1.1***

V = IR	OR
2,4 = I_2(2) ✓	I_2= 6 x 0,2 ✓
$I_{2\Omega}$ = 1,2 A✓	I_2 = 1,2 A✓
I_T = I_2 + 0,2 A✓	I_T = I_2 + 0,2 ✓
= 1,4 A✓	= 1,4 A✓

(4)

9.1.3 **POSITIVE MARKING FROM QUESTION 9.1.2/*POSITIEWE NASIEN VANAF VRAAG 9.1.2***

OPTION 2/*OPSIE* 2	**OR/*OF***
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓	$R_P = \frac{R_1R_2}{R_1 + R_2}$ ✓
$\frac{1}{R_p} = \frac{1}{12} + \frac{1}{2}$	$R_P = \frac{(12)(2)}{12+2}$
R_P = 1,72 Ω✓	= 1,71 Ω✓
ε = I(R+r) ✓ = 1,4(1,72+ 0,5) ✓ = 3,11 V✓	ε = I(R+r) ✓ = 1,4(1,71+0,5) ✓ = 3,09 V✓

OPTION 2/*OPSIE* 2
V_{int} = Ir✓
=(1,4)(0,5)
= 0,7 V✓
ε = $V_{ext/eks}$ + V_{int}✓
= 2,4 +0,7✓
= 3,1 V✓ (5)

9.2 Removing the 2 Ω resistor increases the total resistance of the circuit. ✓ Thus the total current decreases, decreasing the V_{int} (V_{lost}). ✓ Therefore the voltmeter reading increases. V✓/*Wanneer die 2 Ω-resistor verwyder word, verhoog dit die totale weerstand van die kring.* ✓ *Dus verklein die totale stroom, wat die V_{int} ($V_{verloor}$) verlaag.* ✓ *Dus verhoog die voltmeterlesing V.* ✓ (3)

[15]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 North pole/*Noordpool*✓ (1)

10.1.2 Q to P✓ (1)

10.2

10.2.1

OPTION 1/*OPSIE 1*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{rms} = \frac{8}{\sqrt{2}}$ ✓

= 5,66 A

$V_{rms} = I_{rms} R$ ✓

220 = (5,66)R✓

R = 38,87 Ω✓

(5)

OPTION 2/*OPSIE 2*

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$220 = \frac{V_{max}}{\sqrt{2}}$ ✓

V_{max} = 311,12 V

$V_{max} = I_{max} R$ ✓

311,12 = (8)R✓

R = 38,89 Ω✓

10.2.2

POSITIVE MARKING FROM QUESTION 10.4.1/*POSITIEWE NASIEN VANAF VRAAG 10.4.1*

OPTION 1/*OPSIE 1*

$P_{average} = V_{rms} I_{rms}$ ✓

= (220)(5,66)✓

= 1 245,2 W

$P = \frac{W}{\Delta t}$ ✓

$1245,2 = \frac{W}{7200}$ ✓

W = 8 965 440 J ✓

$P_{average} = I_{rms}^2 R$

= $(5,66)^2(38,89)$

= 1245,86

E = Pt

= (1245,86)(7200)

= 8970192J

(5)

OPTION 2/*OPSIE* 2

$P_{average} = I_{rms}^2 R$ ✓

$= (5{,}66)^2(38{,}87)$ ✓

$= 1\ 245{,}22$ W ✓

$1245{,}22 = \frac{W}{7200}$ ✓

W = 8 965 584 J ✓

OPTION 3/*OPSIE* 3

$P_{average} = \frac{V_{rms}^2}{R}$ ✓

$P_{average} = \frac{220^2}{38{,}87}$ ✓

= 1245,18 W

$P = \frac{W}{\Delta t}$ ✓ ✓

$1245{,}18 = \frac{W}{7200}$ ✓

W = 8 965 296 J ✓

$P_{average} = \frac{V_{rms}^2}{R}$

$P_{average} = \frac{220^2}{38{,}89}$

= 1244,54 W

E = Pt

= (1244,54)(7200)

= 8960688 J

OPTION 3/*OPSIE* 3

$W = I_{rms}^2 R\Delta t$

$= \left(\frac{I_{max}}{\sqrt{2}}\right)^2 R\Delta t$

$= \left(\frac{8}{\sqrt{2}}\right)^2 (38{,}87)(7200)$

W = 8 965 296 J ✓ (5)

[12]

QUESTION 11/*VRAAG 11*

11.1 It is the minimum energy that an electron in the metal needs to be emitted from the metal surface. ✓/*Dit is die minimum energie wat 'n elektron in die metaal benodig om elektrone uit die metaaloppervlak vry te stel.* ✓ (2)

11.2 Frequency/Intensity ✓/*Frekwensie/Intensiteit* (1)

11.3 The minimum frequency required to remove an electron from the surface of the metal✓/*Die minimum frekwensie benodig om 'n elektron vanaf die oppervlak van die metaal te verwyder*✓ (2)

11.4 **POSITIVE MARKING FROM QUESTION 11.4/**
POSITIEWE NASIEN VANAF VRAAG 11.4

$E = W_0 + E_k$
$hf = hf_0 + E_k$ } ✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(6,50 \times 10^{14})$✓$=(6,63 \times 10^{-34})(5,001 \times 10^{14})$ ✓$+ \frac{1}{2}(9,11 \times 10^{-31})v^2$✓

$\therefore v = 4,67 \times 10^5 \text{ m·s}^{-1}$✓

<u>OR/*OF*</u>

$E_K = E_{light} - W_o$
$= hf_{light} - hf_o$ } ✓ Any one/*Enige een*

$= (6,63 \times 10^{-34})(6,50 \times 10^{14} - 5,001 \times 10^{14})$ ✓

$= 9,94 \times 10^{-20}$ J

$E_K = \frac{1}{2} mv^2$ ✓

$$v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{(2)(9,94 \times 10^{-20})}{9,11 \times 10^{-31}}}$$ ✓

$v = 4,67 \times 10^5 \text{ m·s}^{-1}$ ✓ (5)

11.5 The <u>photocurrent is directly proportional to the intensity of the incident light.</u>✓✓/*Die <u>fotostroom is direk eweredig aan die intensiteit van die invallende lig.</u>* ✓✓ (2)

[12]

TOTAL/*TOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2016

MARKS: 150

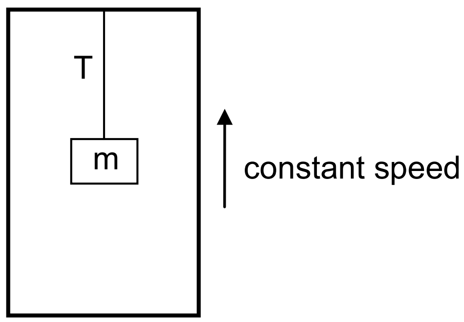
TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 An object, of mass m, hangs at the end of a string from the ceiling of a lift cage. The lift is moving upward at CONSTANT SPEED. The acceleration due to gravity is g.



Which ONE of the following statements regarding the tension (T) in the string is CORRECT?

The tension T …

A will be equal to mg.

B will be less than mg.

C will be greater than mg.

D cannot be determined without knowing the speed of the lift cage. (2)

1.2 Two hypothetical planets, X and Y, have the same mass. The diameter of planet Y is twice that of planet X.

If the acceleration due to gravity on the surface of planet X is g, then the acceleration due to gravity on the surface of planet Y will be …

A $\frac{g}{16}$

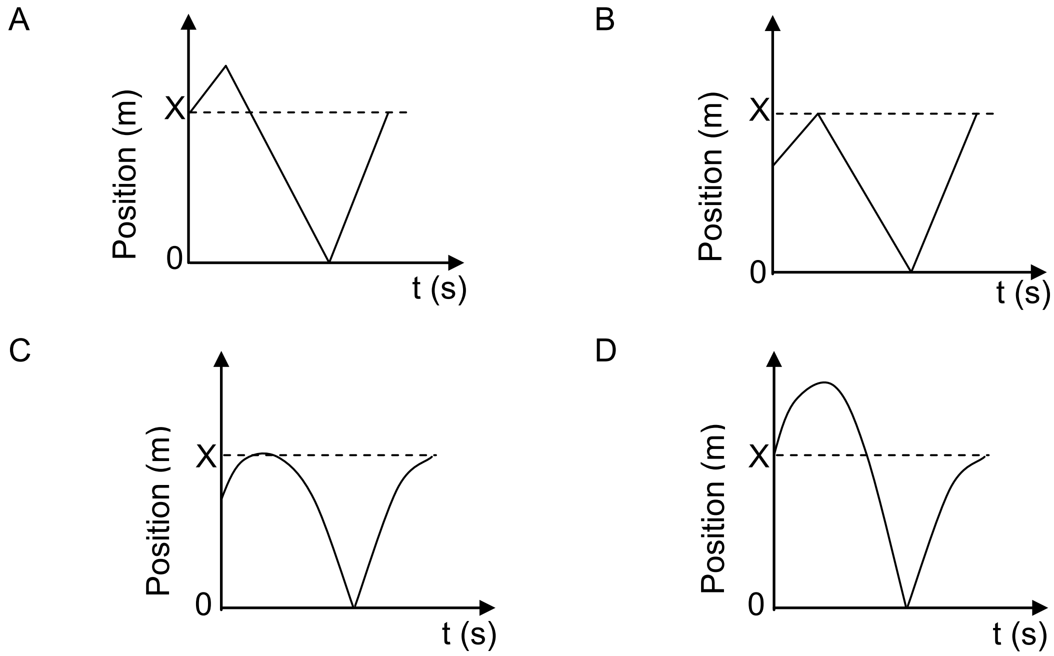
B $\frac{g}{4}$

C $\frac{g}{2}$

D $2g$ (2)

1.3 A ball is projected vertically upwards from a *height X above the ground*. After some time, the ball falls to the ground and bounces back to the same height from which it was projected. Ignore friction and assume that there is a negligible time lapse during the collision of the ball with the ground.

Which ONE of the following is the CORRECT position-time graph for the motion of the ball as described above?



(2)

1.4 Which ONE of the following statements is always TRUE for *inelastic collisions* in an isolated system?

A Both momentum and kinetic energy are conserved.

B Both momentum and kinetic energy are not conserved.

C Momentum is conserved, but kinetic energy not.

D Kinetic energy is conserved, but momentum not. (2)

1.5 When the net work done on an object is positive (greater than zero), the …

A kinetic energy of the object is zero.

B kinetic energy of the object is increasing.

C kinetic energy of the object is decreasing.

D kinetic energy of the object remains unchanged. (2)

1.6 A police car with its siren wailing is moving away from a stationary observer at constant speed. The siren emits a sound of constant frequency.

Which of the following characteristics associated with the sound of the siren, as perceived by the observer, is/are CORRECT?

(i) The speed remains the same.
(ii) The frequency increases.
(iii) The wavelength increases.
(iv) The pitch decreases.

A (iii) only

B (i), (iii) and (iv)

C (i) and (iii) only

D (i) and (ii) only (2)

1.7 The magnitude of the electric field at a point P from a positive point charge *q* is x N·C^{-1}.

Which ONE of the statements below regarding this electric field is CORRECT?

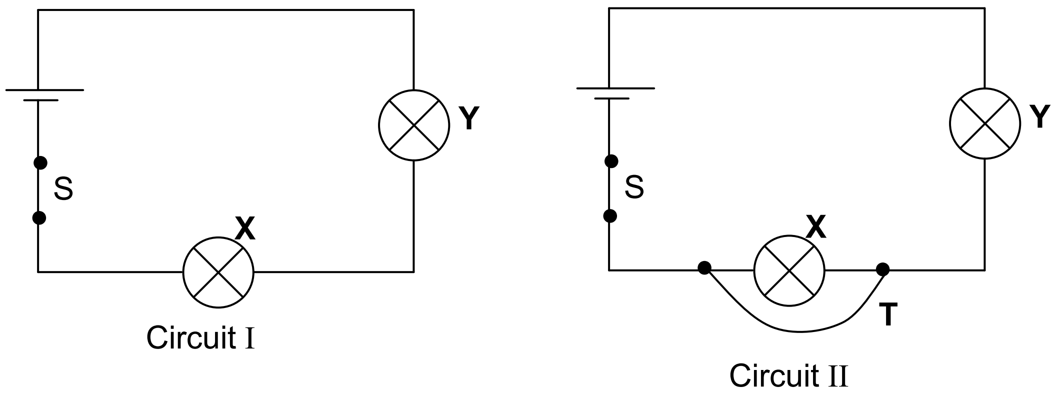
A A + 1 C charge placed at P will experience a force of magnitude x N directed away from *q.*

B The force on a + 2 C charge placed at P will have a magnitude ¼ x N directed away from *q*.

C A + 1 C charge placed at P will experience a force of magnitude x N directed towards *q.*

D The force on a + 2 C charge placed at P will have a magnitude ¼ x N directed towards *q*. (2)

1.8 Circuit I shows two identical lamps **X** and **Y** connected to a cell of negligible internal resistance. Switch S is closed.



A wire **T**, of negligible resistance, is now connected across **X** as shown in Circuit II.

Which ONE of the statements below best describes how the brightness of the lamps have changed after **T** had been connected?

	X	Y
A	Does not light up	Dimmer
B	Brighter	Dimmer
C	Brighter	Brighter
D	Does not light up	Brighter

(2)

1.9 Some learners decided to build a small electrical generator in the laboratory. They then used this generator to investigate how the magnitude of the induced emf would change as the magnetic field strength changed.

Which ONE of the following is CORRECT regarding the variables for the investigation?

	DEPENDENT VARIABLE	INDEPENDENT VARIABLE	CONTROL VARIABLE
A	Magnitude of induced emf	Number of turns of coil of generator	Magnetic field strength
B	Number of turns of coil of generator	Magnitude of induced emf	Magnetic field strength
C	Magnitude of induced emf	Magnetic field strength	Number of turns of coil of generator
D	Magnetic field strength	Number of turns of coil of generator	Magnitude of induced emf

(2)

1.10 In an experiment on the photoelectric effect, a scientist shines red light on a metal surface and observes that electrons are ejected from the metal surface. Later the scientist shines blue light, with the same intensity as the red light, on the same metal surface.

Which ONE of the statements below will be the CORRECT observation as a result of this change?

A The number of ejected electrons per second will increase.

B The number of ejected electrons per second will decrease.

C The speed of the ejected electrons will decrease.

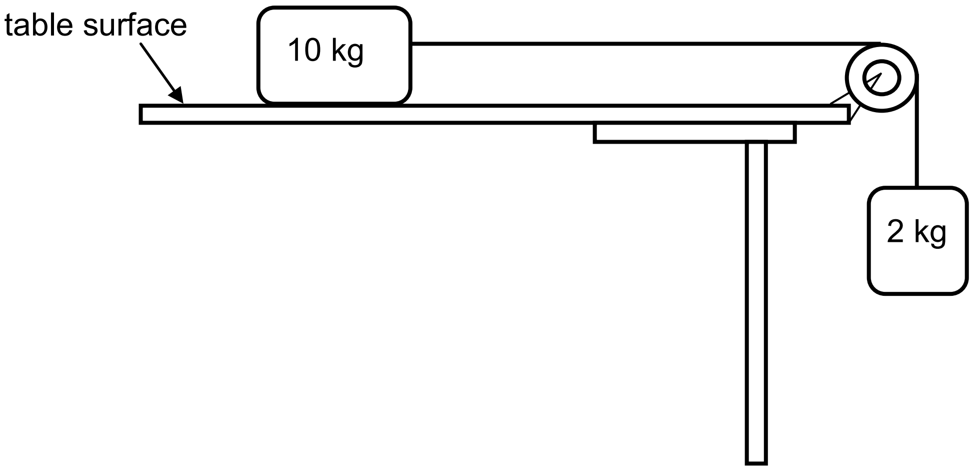
D The maximum kinetic energy of the ejected electrons will increase. (2)

[20]

QUESTION 2 (Start on a new page.)

The diagram below shows a 10 kg block lying on a flat, rough, horizontal surface of a table. The block is connected by a light, inextensible string to a 2 kg block hanging over the side of the table. The string runs over a light, frictionless pulley.

The blocks are **stationary**.



2.1 State Newton's FIRST law in words. (2)

2.2 Write down the magnitude of the NET force acting on the 10 kg block. (1)

When a 15 N force is applied vertically downwards on the 2 kg block, the 10 kg block accelerates to the right at 1,2 $m \cdot s^{-2}$.

2.3 Draw a free-body diagram for the 2 kg block when the 15 N force is applied to it. (3)

2.4 Calculate the coefficient of kinetic friction between the 10 kg block and the surface of the table. (7)

2.5 How does the value, calculated in QUESTION 2.4, compare with the value of the coefficient of STATIC friction for the 10 kg block and the table? Write down only LARGER THAN, SMALLER THAN or EQUAL TO. (1)

2.6 If the 10 kg block had a larger surface area in contact with the surface of the table, how would this affect the coefficient of kinetic friction calculated in QUESTION 2.4? Assume that the rest of the system remains unchanged. Write down only INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

[16]

QUESTION 3 (Start on a new page.)

Ball **A** is projected vertically upwards from the ground, near a tall building, with a speed of 30 $m \cdot s^{-1}$. Ignore the effects of air friction.

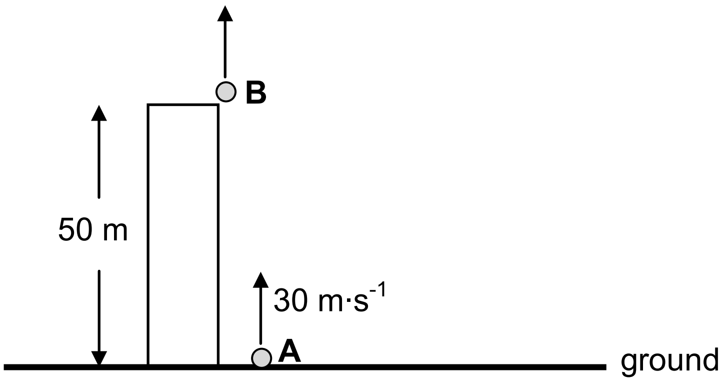
3.1 Explain what is meant by a *projectile*. (2)

3.2 Calculate:

3.2.1 The total time that ball **A** will be in the air (4)

3.2.2 The distance travelled by ball **A** during the last second of its fall (4)

3.3 TWO SECONDS after ball **A** is projected upwards, ball **B** is projected vertically upwards from the roof of the same building. The roof the building is 50 m above the ground. Both balls **A** and **B** reach the ground *at the same time*. Refer to the diagram below. Ignore the effects of air friction.



Calculate the speed with which ball **B** was projected upwards from the roof. (4)

3.4 Sketch velocity-time graphs for the motion of both balls **A** and **B** on the *same set of axes.* Clearly label the graphs for balls **A** and **B** respectively.

Indicate the following on the graphs:

(a) Time taken by both balls **A** and **B** to reach the ground
(b) Time taken by ball **A** to reach its maximum height (4)

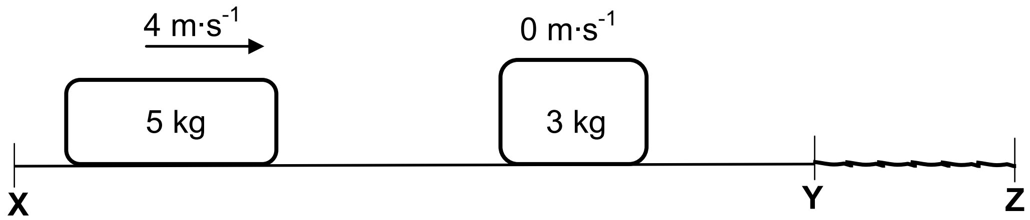
[18]

QUESTION 4 (Start on a new page.)

The diagram below shows two sections, **XY** and **YZ**, of a horizontal, flat surface. Section **XY** is smooth, while section **YZ** is rough.

A 5 kg block, moving with a velocity of 4 $m \cdot s^{-1}$ to the right, collides head-on with a stationary 3 kg block. After the collision, the two blocks stick together and move to the right, past point **Y**.

The combined blocks travel for 0,3 s from point **Y** before coming to a stop at point **Z**.



4.1 State the *principle of conservation of linear momentum* in words. (2)

4.2 Calculate the magnitude of the:

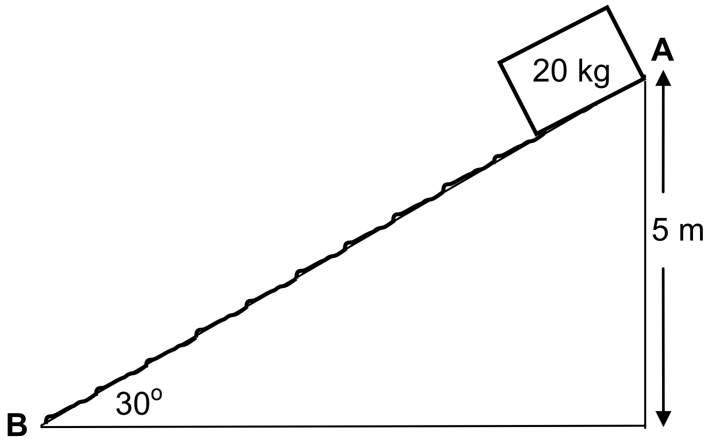
4.2.1 Velocity of the combined blocks at point **Y** (4)

4.2.2 Net force acting on the combined blocks when they move through section **YZ** (4)
[10]

QUESTION 5 (Start on a new page.)

A 20 kg block is released from rest from the top of a ramp at point **A** at a construction site as shown in the diagram below.

The ramp is inclined at an angle of 30° to the horizontal and its top is at a height of 5 m above the ground.



5.1 State the *principle of conservation of mechanical energy* in words. (2)

5.2 The kinetic frictional force between the 20 kg block and the surface of the ramp is 30 N.

Use *energy principles* to calculate the:

5.2.1 Work done by the kinetic frictional force on the block (3)

5.2.2 Speed of the block at point **B** at the bottom of the ramp (5)

5.3 A 100 kg object is pulled up the SAME RAMP at a constant speed of 2 $m \cdot s^{-1}$ by a small motor. The kinetic frictional force between the 100 kg object and the surface of the ramp is 25 N.

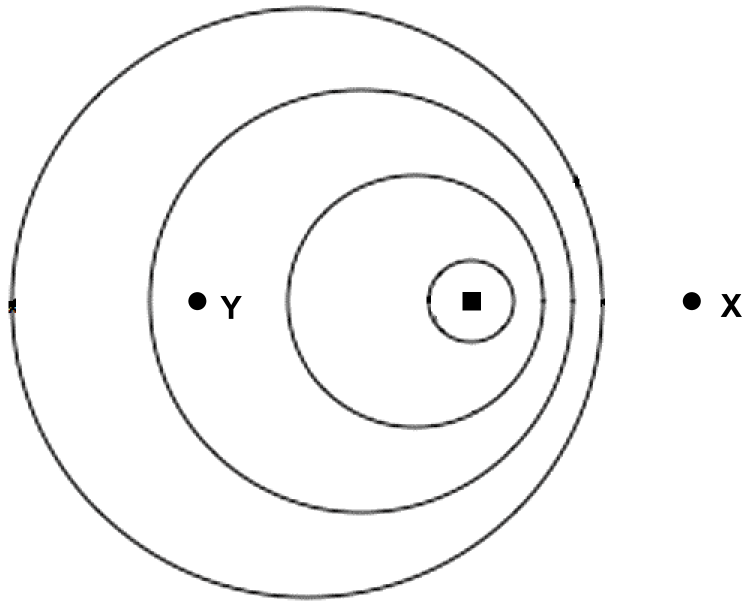
Calculate the average power delivered by the small motor in the pulling of the object up the incline. (4)

[14]

QUESTION 6 (Start on a new page.)

An ambulance is travelling towards a hospital at a constant velocity of 30 $m \cdot s^{-1}$. The siren of the ambulance produces sound of frequency 400 Hz. Take the speed of sound in air as 340 $m \cdot s^{-1}$.

The diagram below shows the wave fronts of the sound produced from the siren as a result of this motion.



6.1 At which side of the diagram, **X** or **Y**, is the hospital situated? (1)

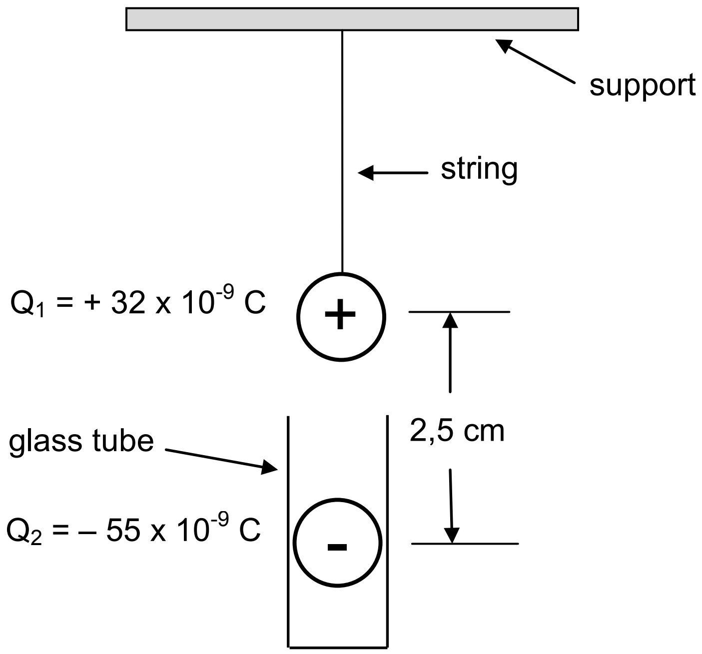
6.2 Explain the answer to QUESTION 6.1. (3)

6.3 Calculate the frequency of the sound of the siren heard by a person standing at the hospital. (5)

6.4 A nurse is sitting next to the driver in the passenger seat of the ambulance as it approaches the hospital. Calculate the wavelength of the sound heard by the nurse. (3)
[12]

QUESTION 7 (Start on a new page.)

A small sphere, Q_1, with a charge of + 32 x 10^{-9} C, is suspended from a light string secured to a support. A second, identical sphere, Q_2, with a charge of – 55 x 10^{-9} C, is placed in a narrow, cylindrical glass tube vertically below Q_1. Each sphere has a mass of 7 g. Both spheres come to equilibrium when Q_2 is 2,5 cm from Q_1, as shown in the diagram. Ignore the effects of air friction.



7.1 Calculate the number of electrons that were removed from Q_1 to give it a charge of + 32 x 10^{-9} C. Assume that the sphere was neutral before being charged. (3)

7.2 Draw a labelled free-body diagram showing all the forces acting on sphere Q_1. (3)

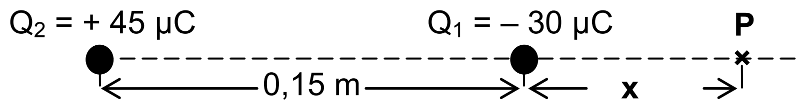
7.3 Calculate the magnitude of the tension in the string. (5)
[11]

QUESTION 8 (Start on a new page.)

8.1 Define *electric field at a point* in words. (2)

8.2 Draw the electric field pattern for two identical positively charged spheres placed close to each other. (3)

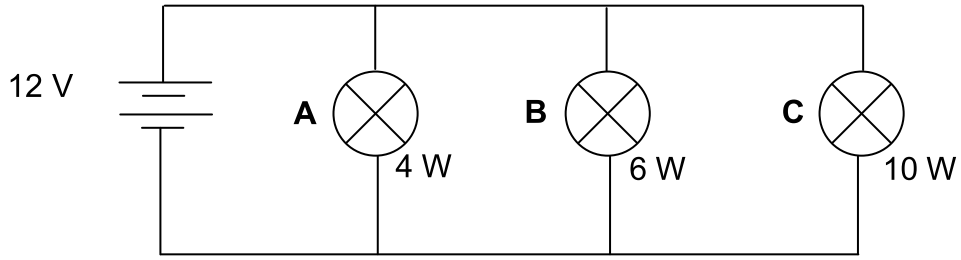
8.3 A – 30 µC point charge, Q_1, is placed at a distance of 0,15 m from a + 45 µC point charge, Q_2, in space, as shown in the diagram below. The net electric field at point **P**, which is on the same line as the two charges, is zero.



Calculate **x**, the distance of point **P** from charge Q_1. (5)
[10]

QUESTION 9 (Start on a new page.)

9.1 In the diagram below, three light bulbs, **A**, **B** and **C**, are connected in parallel to a 12 V source of negligible internal resistance. The bulbs are rated at 4 W, 6 W and 10 W respectively and are all at their maximum brightness.



9.1.1 Calculate the resistance of the 4 W bulb. (3)

9.1.2 How will the equivalent resistance of the circuit change if the 6 W bulb burns out? Write down only INCREASES, DECREASES or NO CHANGE. (1)

9.1.3 How will the power dissipated by the 10 W bulb change if the 6 W bulb burns out? Write down only INCREASES, DECREASES or NO CHANGE. Give a reason for the answer. (2)

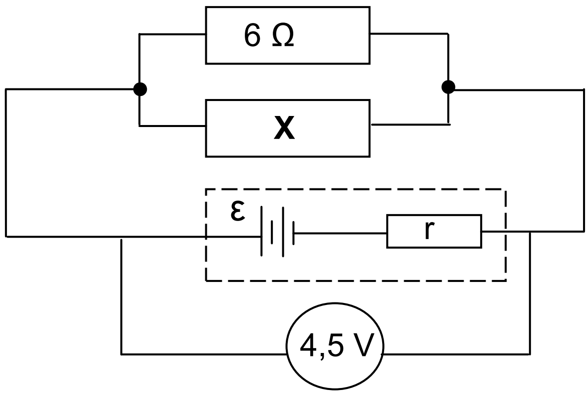
9.2 A learner connects a high-resistance voltmeter across a battery. The voltmeter reads 6 V.

She then connects a 6 Ω resistor across the battery. The voltmeter now reads 5 V.

9.2.1 Calculate the internal resistance of the battery. (4)

The learner now builds the circuit below, using the same 6 V battery and the 6 Ω resistor. She connects an unknown resistor **X** in parallel with the 6 Ω resistor. The voltmeter now reads 4,5 V.

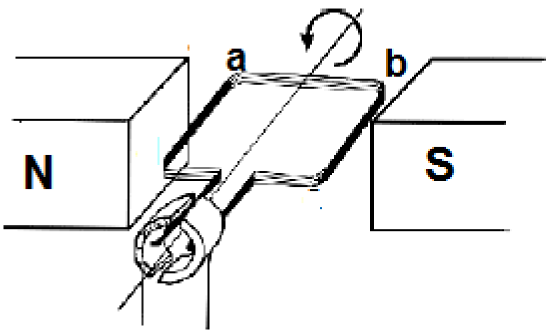
9.2.2 Define the term *emf* of a cell. (2)



9.2.3 Calculate the resistance of **X** when the voltmeter reads 4,5 V. (5)
[17]

QUESTION 10 (Start on a new page.)

10.1 A part of a simplified DC motor is shown in the sketch below.



10.1.1 In which direction (**a** to **b**, OR **b** to **a**) is the current flowing through the coil if the coil rotates anticlockwise as indicated in the diagram? (1)

10.1.2 Name the rule you used to answer QUESTION 10.1.1. (1)

10.1.3 Which component in the diagram must be replaced in order for the device to operate as an AC generator? (1)

10.2 An electrical device of resistance 400 Ω is connected across an AC generator that produces a maximum emf of 430 V. The resistance of the coils of the generator can be ignored.

10.2.1 State the energy conversion that takes place when the AC generator is in operation. (2)

10.2.2 Calculate the root mean square value of the current passing through the resistor. (5)

[10]

QUESTION 11 (Start on a new page.)

11.1 In an experiment on the photoelectric effect, light is incident on the surface of a metal and electrons are ejected.

11.1.1 What does the photoelectric effect indicate about the nature of light? (1)

11.1.2 The intensity of the light is increased. Will the maximum speed of the ejected electrons INCREASE, DECREASE or REMAIN THE SAME? Give a reason for the answer. (2)

The wavelength corresponding with the threshold frequency is referred to as *threshold wavelength.*

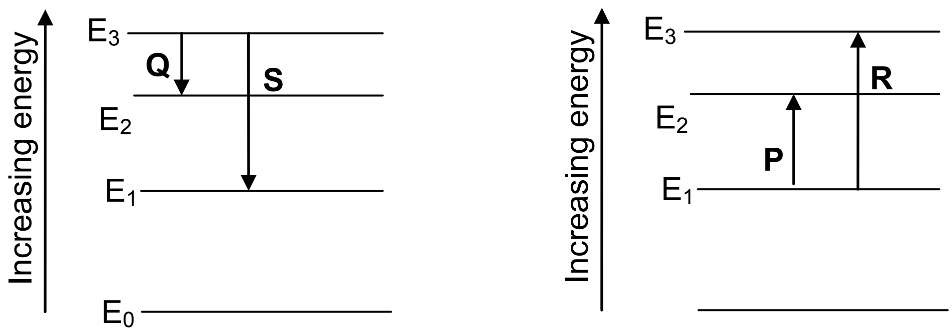
The table below gives the values of threshold wavelengths for three different metals.

METAL	THRESHOLD WAVELENGTH (λ_0) IN METRES
Silver	$2,88 \times 10^{-7}$
Calcium	$4,32 \times 10^{-7}$
Sodium	$5,37 \times 10^{-7}$

In the experiment using one of the metals above, the maximum speed of the ejected electrons was recorded as $4,76 \times 10^5$ m·s^{-1} for light of wavelength 420 nm.

11.1.3 Identify the metal used in the experiment by means of suitable calculations. (5)

11.2 The simplified energy diagrams showing the possible electron transitions in an atom are shown below.



Using the letters **P**, **Q**, **R** and **S**, identify the lines that CORRECTLY show transitions that will result in the atom giving off an EMISSION SPECTRUM. Give a reason for the answer. (4)

[12]

TOTAL: 150

QUESTION/*VRAAG 1*

1.1	A✓✓	(2)
1.2	B✓✓	(2)
1.3	D✓✓	(2)
1.4	C✓✓	(2)
1.5	B✓✓	(2)
1.6	B✓✓	(2)
1.7	A✓✓	(2)
1.8	D✓✓	(2)
1.9	C✓✓	(2)
1.10	D✓✓	(2)
		[20]

QUESTION/*VRAAG 2*

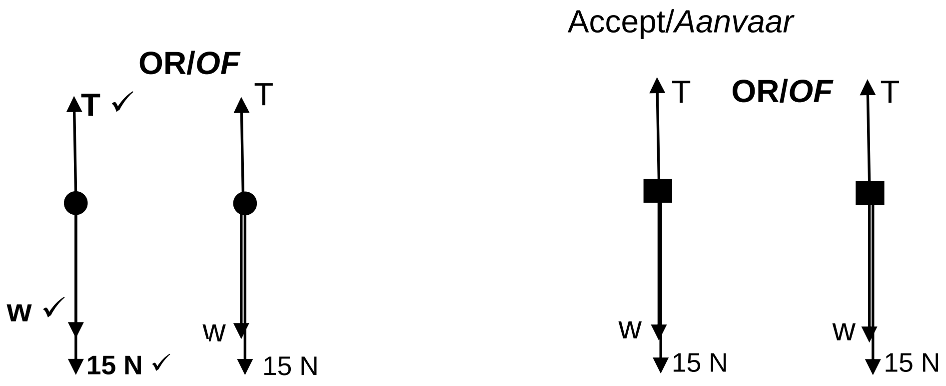
2.1 A body will <u>remain in its state of rest or motion at constant velocity</u> ✓<u>unless a resultant/net force</u>✓ acts on it.
'n Liggaam sal in sy <u>toestand van rus of beweging teen konstante snelheid bly tensy 'n resulterende/netto krag</u> daarop inwerk

OR/*OF*
Every body <u>continues in its state of rest or of uniform motion in a straight line</u> ✓<u>unless a resultant/net force</u> ✓acts on it.
Elke liggaam <u>bly in sy toestand van rus of uniforme beweging in 'n reguitlyn tensy 'n resulterende/netto krag</u> daarop inwerk (2)

2.2 0 (N)✓/zero/*nul* (newton)
NOTE: No penalisation if the unit is omitted
***LET WEL:** Geen penalisering as eenheid weggelaat is nie* (1)

2.3

Accepted labels/*Aanvaarde byskrifte*	
w	F_g / F_w / weight / mg / gravitational force *F_g / F_w / gewig / mg / gravitasiekrag*
T	F_T / tension F_S / *spanning*
15 N	F_a / F_{15N} / $F_{applied}$ / F_t / $F_{toegepas}$ / F



(3)

<u>Notes/*Aantekeninge*</u>

- Mark awarded for label <u>and</u> arrow/*Punt toegeken vir byskrif <u>en</u> pyltjie*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie*
- Any other additional force(s)/*Enige ander addisionele krag(te)* Minus 1 (-1) mark/*punt*
- If force(s) do not make contact with body/*Indien krag(te) nie met die voorwerp kontak maak nie:* Minus 1 (-1) mark/*punt*
- Minus 1 mark if all arrows are omitted but correctly labelled / *Minus 1 punt indien alle pyltjies weggelaat is maar korrek benoem*

2.4

<u>2 kg block/*blok*</u>

$F_{net} = ma$
$F_a + F_g + (-T) = ma$
$F_a + mg + (-T) = ma$ } ✓

<u>[15 + (2)(9,8) – T]</u>✓ = <u>(2)(1,2)</u>✓

T = 32,2 N

<u>10 kg block/*blok*</u>

$T + (-f_k) = ma$
$T - \mu_k N = ma$
$T - \mu_k mg = ma$ } ✓

32,2 - <u>(μ_k)(10)(9,8)</u>✓ = (10)(1,2)✓

$\mu_k = 0,21$✓

NOTE:*LET WEL*

If f_k is calculated separately – award one mark. *Indien f_k apart bereken is - ken een punt toe*

Massless string approximation/Systems approach /*Massalose toutjie benadering /Sisteem Benadering* ($\frac{4}{7}$)

$F_{net} = ma$✓

$F_A – f_k + w = (M + m)a$

$15 – \mu_k Mg + mg = (M + m)a$

<u>15 - μ_k(10(9,8) + (2)(9,8)</u>✓ = <u>(10 + 2)(1,2)</u>✓

$\mu_k = 0,21$✓ (7)

2.5 Smaller than / *Kleiner as* ✓ (1)

2.6 Remains the same / *Bly dieselfde* ✓

The coefficient of kinetic friction is independent of the (apparent microscopic) surface areas in contact. ✓
Die kinetiese wrywingskoëffisiënt is onafhanklik van die (waarskynlike mikroskopiese) oppervlakareas waarmee in kontak is

OR/*OF*

The coefficient of kinetic friction depends only on the type of materials used✓
Die kinetiese wrywingskoëffisiënt hang slegs af van die tipe materiaal gebruik (2)

[16]

QUESTION/*VRAAG 3*

3.1 An object upon which the <u>only force</u>✓ acting is the <u>force of gravity</u>.✓
'n Voorwerp waarop die <u>enigste krag</u> wat inwerk, <u>swaartekrag</u> is

ACCEPT/AANVAAR
An object that <u>falls freely</u> ✓with an <u>acceleration of (g) 9,8 m·s^{-2}</u> ✓
'n Voorwerp wat <u>vryval</u> met 'n <u>versnelling van (g) 9,8 m·s^{-2}</u>

An object that is <u>launched</u> ✓(or synonyms) with an initial velocity under the influence of the <u>force of gravity</u>.✓
'n Voorwerp wat met 'n beginsnelheid <u>geprojekteer</u> ✓(of sinonieme) word onder die invloed van die <u>gravitasiekrag</u>✓ (2)

3.2.1

OPTION 1/*OPSIE 1*	
Upward positive ***Opwaarts positief*** $v_f = v_i + a\Delta t$ ✓ <u>-30 = 30</u>✓ + (-9,8)Δt✓ Δt = 6,12 s✓	**Downward positive** ***Afwaarts positief*** $v_f = v_i + a\Delta t$ ✓ <u>30 = -30</u>✓ + (9,8)Δt✓ Δt = 6,12 s✓

OPTION 2/*OPSIE 2*	
Upward positive ***Opwaarts positief*** $v_f = v_i + a\Delta t$ ✓ <u>0 = 30</u>✓ + (-9,8)Δt✓ Δt = 3,06 s Total time/*Totale tyd* = (2)(3,06) = 6,12 s ✓	**Downward positive** ***Afwaarts positief*** $v_f = v_i + a\Delta t$ ✓ <u>0 = -30</u>✓ + (9,8)Δt✓ Δt = 3,06 s Total time/*Totale tyd* = (2)(3,06) = 6,12 s ✓

OPTION 3/*OPSIE 3*	
Upward positive ***Opwaarts positief*** $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓ <u>0 = (30) Δt</u>✓ +½ (-9,8)Δt²✓ Δt = 6,12 s✓	**Downward positive** ***Afwaarts positief*** $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$✓ <u>0 = (-30) Δt</u>✓ +½ (9,8)Δt²✓ Δt = 6,12 s✓

OPTION 4/*OPSIE 4*	
Upward positive ***Opwaarts positief*** $F_{net}\Delta t = \Delta p = (mv_f - mv_i)$✓ $mg\Delta t = m(v_f - v_i)$ 9,8Δt✓ = (30-(-30))✓ Δt = 6,12 s✓	**Downward positive** ***Afwaarts positief*** $F_{net}\Delta t = \Delta p = (mv_f - mv_i)$✓ $mg\Delta t = m(v_f - v_i)$ -9,8Δt ✓= (-30-30)✓ Δt = 6,12 s✓

OPTION 5/*OPSIE 5*	
Upward positive ***Opwaarts positief*** From top to bottom/*Van bo na onder* $v_f = v_i + a\Delta t$ ✓ -<u>30 = 0</u> ✓+ (-9,8)Δt✓ Δt = 3,06 s Total time/totale tyd = 2(3,06) = 6,12 s✓	**Downward positive** ***Afwaarts positief*** From top to bottom/*Van bo na onder* $v_f = v_i + a\Delta t$ ✓ <u>30 = 0</u>✓ + (9,8)Δt✓ Δt = 3,06 s Total time/totale tyd = 2(3,06) = 6,12 s✓

(4)

3.2.2

POSITIVE MARKING FROM QUESTION 3.2.1 /*POSITIEWE NASIEN VANAF VRAAG 3.2.1*

OPTION 1/*OPSIE 1*
Upward positive/*Opwaarts positief*

$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$\Delta y_{last} = \Delta y_{(6,12)} - \Delta y_{(5,12)}$ ✓

= {30(6,12) +½ (-9,8)(6,12)^2 }✓- {30 <u>(5,12) +½ (-9,8)(5,12)^2</u>}✓
= -25,076
Distance/*Afstand* = |Δy| = 25,08 m✓

OR/*OF*

POSITIVE MARKING FROM QUESTIONS 3.2.1
POSITIEWE NASIEN VANAF VRAAG 3.2.1
Downward positive/*Afwaarts positief*

$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$\Delta y_{last} = \Delta y_{(6,12)} - \Delta y_{(5,12)}$ ✓

= {-30(6,12) +½ (9,8)(6,12)^2 }✓- {-30(5,12) +½ (9,8)(5,12)^2}✓
= 25,076
Distance/*Afstand* = |Δy| = 25,08 m✓

<table>
<tr><td>
OPTION 2/OPSIE 2
Upward positive
Opwaarts positief
$v_f = v_i + a\Delta t$
$= 0 + (-9,8)(2,06)$ ✓
$= -20,188\ m\cdot s^{-1}$

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$= \underline{(-20,188)(1) + \frac{1}{2}(-9,8)(1)^2}$ ✓
$= -25,09\ m$

Distance /Afstand = $|\Delta y|$ = 25,09 m ✓

OR/OF
$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓
$= \left(\frac{-20,188 + (-30)}{2}\right)(1)$ ✓
$= -25,09\ m$

Distance /Afstand = $|\Delta y|$ = 25,09 m ✓

OR/OF
$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$\underline{(-30)^2 = (-20,188)^2 + 2(-9,8)\Delta x}$ ✓
$\Delta x = -25,12\ m$

Distance /Afstand = $|\Delta y|$ = 25,12 m ✓
</td><td>
Downward positive
Afwaarts positief
$v_f = v_i + a\Delta t$
$= 0 + (9,8)(2,06)$ ✓
$= 20,188\ m\cdot s^{-1}$

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$= \underline{(20,188)(1) + \frac{1}{2}(9,8)(1)^2}$ ✓
$= 25,09\ m$

Distance /Afstand = $|\Delta y|$ = 25,09 m ✓

OR/OF
$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓
$= \left(\frac{20,188 + 30}{2}\right)(1)$ ✓
$= 25,09\ m$

Distance /Afstand = $|\Delta y|$ = 25,09 m ✓

OR/OF
$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$\underline{(30)^2 = (20,188)^2 + 2(9,8)\Delta x}$ ✓
$\Delta x = 25,12\ m$

Distance /Afstand = $|\Delta y|$ = 25,12 m ✓
</td></tr>
<tr><td>
OPTION 3/OPSIE 3
$v_f = v_i + a\Delta t$
$= 0 + (-9,8)(2,06)$ ✓
$= -20,188\ m\cdot s^{-1}$

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓
$= \left(\frac{-20,188 + 30}{2}\right)(5,12)$ ✓
$= 25,12\ m$

Distance /Afstand = $|\Delta y|$ = 25,12 m ✓
</td><td>
$v_f = v_i + a\Delta t$
$= 0 + (9,8)(2,06)$ ✓
$= 20,188\ m\cdot s^{-1}$

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓
$= \left(\frac{20,188 - 30}{2}\right)(5,12)$ ✓
$= -25,12\ m$

Distance /Afstand = $|\Delta y|$ = 25,12 m ✓
</td></tr>
</table>

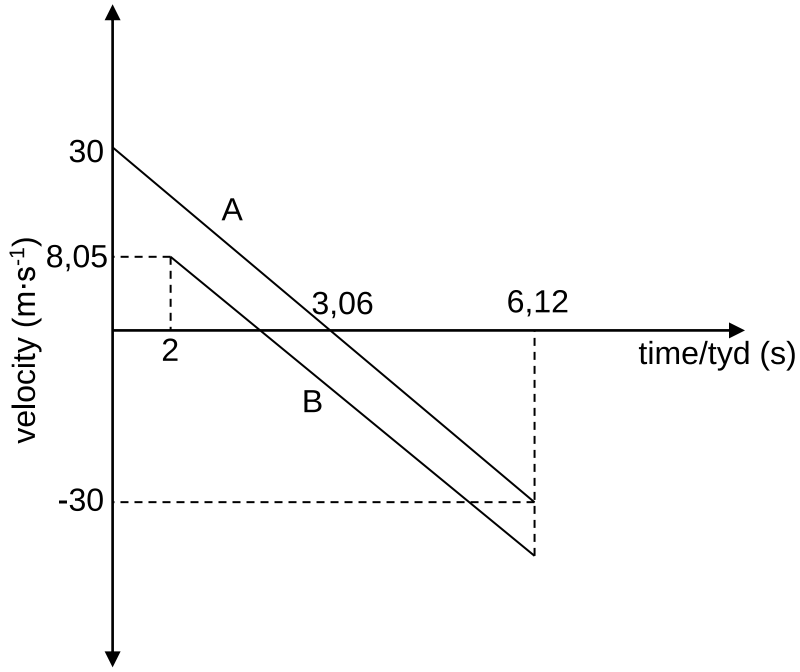
OPTION 4/*OPSIE* 4 **Upward positive** **Opwaarts positief**	 **Downward positive** **Afwaarts positief**	
Distance travelled in the first second = distance travelled in the last second *Afstand afgelê in die eerste sekonde = afstand afgelê in laaste sekonde* $\Delta y = v_i\Delta t + ½ \Delta t^2$ ✓ $= (30)(1) + ½ (-9,8)(1)^2$ ✓ $= 25,1$ m ✓ Distance /*Afstand* = $\lvert\Delta y\rvert$ = 25,1 m ✓	Distance travelled in the first second = distance travelled in the last second *Afstand afgelê in die eerste sekonde = afstand afgelê in laaste sekonde* $\Delta y = v_i\Delta t + ½ \Delta t^2$✓ $= (-30)(1) + ½ (9,8)(1)^2$ ✓ $= -25,1$ m ✓ Distance /*Afstand* = $\lvert\Delta y\rvert$ = 25,1 m ✓	(4)

3.3

POSITIVE MARKING FROM QUESTION 3.2.1 ***POSITIEWE NASIEN VANAF VRAAG 3.2.1***		
Upward positive ***Opwaarts positief*** $\Delta y = v_i\Delta t + ½ a\Delta t^2$✓ -50✓= $\underline{[v_i (4,12)] + [½ (-9,8)(4,12)^2]}$✓ $v_i = 8,05 \text{ m·s}^{-1}$ speed/*spoed* = $8,05 \text{ m·s}^{-1}$✓	**Downward positive** ***Afwaarts positief*** $\Delta y = v_i\Delta t + ½ a\Delta t^2$✓ 50✓= $\underline{v_i (4,12) + [½ (9,8)(4,12)^2]}$✓ $v_i = - 8,05 \text{ m·s}^{-1}$ speed/*spoed* = $8,05 \text{ m·s}^{-1}$✓	(4)

3.4

POSITIVE MARKING FROM QUESTIONS 3.2.1 AND 3.2.2
POSITIEWE NASIEN VANAF VRAAG 3.2.1 EN 3.2.2
Upward positive/ *Opwaarts positief*

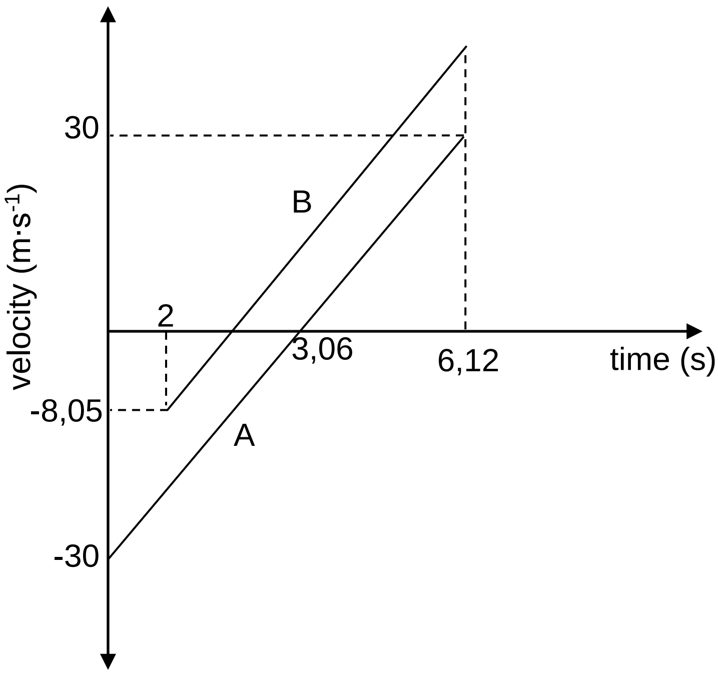


Criteria/*Kriteria*	**Marks/*Punte***
Correct shape of A *Korrekte vorm van A*	✓
Correct shape of Graph B parallel to A below A *Korrekte vorm van Grafiek parallel met A onder A*	✓
Time at which both A and B reach the ground (6,12 s) *Tyd wat beide A en B die grond bereik (6,12 s)*	✓
Time for A to reach the maximum height (3,06 s) shown *Tyd vir A om maksimum hoogte te bereik (3,06 s) aangedui*	✓

NOTE/*LET WEL*
Do not penalise if velocities are not indicated
Moenie penaliseer indien snelhede nie aangedui is nie

3.4

POSITIVE MARKING FROM QUESTIONS 3.2.1 AND 3.2.2
POSITIEWE NASIEN VANAF VRAAG 3.2.1 EN 3.2.2
Downward positive/*Afwaarts positief*



Criteria/*Kriteria*	**Marks/*Punte***
Correct shape of A *Korrekte vorm van A*	✓
Correct shape of Graph B parallel to A above A *Korrekte vorm van Grafiek parallel met A bo A*	✓
Time at which both A and B reach the ground (6,12 s) *Tyd wat beide A en B die grond bereik (6,12 s)*	✓
Time for A to reach the maximum height (3,06 s) shown *Tyd vir A om maksimum hoogte te bereik (3,06 s) aangedui*	✓

(4)
[18]

QUESTION/*VRAAG 4*

4.1 The total (linear) momentum of an isolated (closed) system ✓is constant (is conserved) ✓
Die totale (lineêre) momentum van 'n geïsoleerde (geslote) sisteem is konstant (bly behoue)

OR/*OF*
In an isolated (closed) system, the total (linear) momentum ✓before collision is equal to the total linear momentum after collision. ✓
In 'n geïsoleerde (geslote) sisteem is die totale (lineêre) momentum✓ voor botsing gelyk aan die totale (lineêre) momentum van botsing ✓ (2)

4.2.1

$\sum p_i = \sum p_f$
$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$
$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$
} 1 mark for any / *1 punt vir enige*
$(5)(4) + (3)(0)$ ✓ $= (5 + 3)v_f$ ✓
$\therefore v = 2,5\ m\cdot s^{-1}$ ✓

OR/*OF*
$\Delta p_{5kg} = -\Delta p_{3kg}$ ✓
$mv_f - mv_i = mv_f - mv_i$
$5v_f - (5)(4)$ ✓ $= 3v_f - (3)(0)$ ✓
$v_f = 2,5\ m\cdot s^{-1}$ ✓ (4)

4.2.2

OPTION 1/*OPSIE 1*
POSITIVE MARKING FROM QUESTION 4.2.1
POSITIEWE NASIEN VANAF VRAAG 4.2.1

$F_{net}\Delta t = \Delta p = (p_f - p_i) = (mv_f - mv_i)$ ✓
$F_{net}(0,3)$ ✓ $= 8 [(0 - (2,5)]$ ✓
$F_{net} = - 66,67\ N$
$\therefore F_{net} = 66,67\ N$ ✓

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 4.2.1
POSITIEWE NASIEN VANAF 4.2.1
$F_{net} = ma$ ✓
$= \frac{m(v_f - v_i)}{\Delta t}$
$= \frac{8(0 - 2,5)}{0,3}$ ✓ ✓ $= - 66,67\ N$
$\therefore F_{net} = 66,67\ N$ ✓

OPTION 3/*OPSIE 3*
POSITIVE MARKING FROM 4.2.1
POSITIEWE NASIEN VANAF 4.2.1
$v_f = v_i + a\Delta t$
$0 = 2,5 + a(0,3)$ ✓
$a = - 8,333\ m\cdot s^{-2}$
$F_{net} = ma$ ✓
$= 8 (-8,333)$ ✓
$= - 66,67\ N$
$\therefore F_{net} = 66,67\ N$ ✓

(4)

OPTION 4/*OPSIE 4*

$W_{net} = \Delta E_k$
$F_{net}\Delta x\cos\theta = ½\, m(v_f^2 - v_i^2)$
$F_{net}\left(\frac{v_f + v_i}{2}\right)\Delta t \cos 180^o = ½\, m(v_f^2 - v_i^2)$
} ✓ Any one/*Enige een*

$F_{net}\left(\frac{2,5+0}{2}\right)(0,3)\,(-1)$✓ $= ½(8)(0^2 - 2,5^5)$✓

$F_{net} = 66,67$ N✓

[10]

QUESTION/*VRAAG 5*

5.1 The <u>total mechanical energy in an isolated (closed) system</u> ✓<u>remains constant (is conserved).</u> ✓
Die <u>totale meganiese energie in 'n geslote (geïsoleerde) sisteem</u>✓ <u>bly konstant (bly behoue)</u>✓

NOTE/*LET WEL*
If total or isolated/closed is omitted (max: 1/2)
Indien totale of geslote (geïsoleerde) weggelaat is (maks: 1 2) (2)

5.2.1
$W = F\Delta x \cos\theta$✓
$= (30)(\frac{5}{\sin 30^o})\cos\theta$
$= (30)(10)\cos 180^o$
$= (30)(10)(-1)$
} ✓
$= -300$ J✓ (3)

5.2.2

OPTION1/*OPSIE 1*
POSITIVE MARKING FROM 5.2.1/*POSITIEWE NASIEN VANAF 5.2.1*

$W_{nc} = \Delta E_P + \Delta E_K$
$W_{nc} = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$
} ✓

-300 ✓$=$ <u>$(20)(9,8)(0-5)$</u> ✓$+$ <u>$½\,(20)(v_f^2 - 0)$</u> ✓
$v = 8,25$ m·s^{-1}✓

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 5.2.1/*POSITIEWE NASIEN VANAF 5.2.1*

$W_{net} = \Delta E_K$
$W_g + W_f = \frac{1}{2}m(v_f^2 - v_i^2)$
} ✓

$W_g + (-300) =$ <u>$½\,(20)(v_f^2 - 0)$</u>✓
$[(20)(9,8)\sin 30^o \frac{5}{0,5} \cos 0\,]$ ✓ $+ (-300)$ ✓ $= 10v_f^2$
$v_f = 8,25$ m·s^{-1}✓ (5)

5.3

$F = w_{//} + f$
$= (100)(9,8)\sin 30^o + 25$ ✓
$= 515$ N

$P_{ave} = Fv_{ave}$ ✓
$= (515)(2)$ ✓
$= 1\ 030$ W ✓

(4)
[14]

QUESTION/*VRAAG* 6

6.1 **X** ✓ (1)

6.2 As ambulance approaches the hospital the waves are compressed✓or wavelengths are shorter. Since the speed of sound is constant✓ the observed frequency must increase✓. Therefore the hospital must be located on the side of X (from $v = f\lambda$)
Soos die ambulans die hospitaal nader word die golwe saamgepers of golflengtes word korter. Aangesien die spoed van klank konstant is, moet die waargenome frekwensie verhoog. Die hospitaal moet dus aan die kant van X wees (vanaf $v = f\lambda$)

OR/*OF*
The number of wave fronts per second reaching the observer are more at X✓✓. For the same constant speed, this means that the observed frequency increases ✓therefore the hospital must be located on the side of X. (from $v = f\lambda$)
Die aantal golffronte per sekonde wat die waarnemer bereik, is meer by X. Vir dieselfde konstante spoed moet die waargenome frekwensie verhoog, dus is die hospitaal aan die kant van X geleë (vanaf $v = f\lambda$) (3)

6.3

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ ✓

$f_L = \frac{340 ✓}{(340 - 30) ✓}(400) ✓$

$f_L = 438,71$ Hz ✓

NOTE/*LET WEL*
If any other value for the speed of sound is used subtract 2 marks. One for substitution and one for answer / *Indien enige ander waarde vir die spoed van klank gebruik word, trek 2 punte af. Een vir vervanging en een vir die antwoord.*

(5)

6.4

$v = f\lambda$ ✓
$340 = 400\lambda$ ✓
$\lambda = 0,85$ m ✓

(3)
[12]

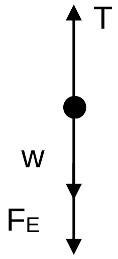
QUESTION/*VRAAG* 7

7.1

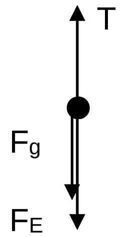
$n = \frac{Q}{e}$ ✓ $= \frac{-32 \times 10^{-9}}{-1,6 \times 10^{-19}}$ ✓ $= 2 \times 10^{11}$ ✓ electrons/*elektrone* **NOTE:/*LET WEL*** Answer must be positive (-1 mark) *Antwoord moet positief wees (-1 punt)*	$n = \frac{Q}{e}$ ✓ $= \frac{32 \times 10^{-9}}{1,6 \times 10^{-19}}$ ✓ $= 2 \times 10^{11}$ ✓ electrons/*elektrone*

(3)

7.2



OR/*OF*



Accepted labels/*Aanvaarde byskrifte*	
w	F_g/F_w/weight/mg/gravitational force *F_g/F_w/gewig/mg/gravitasiekrag*
T	F_T/tension F_S/*spanning*
F_E	$F_{electrostatic}$/F_{Q1Q2} /Coulomb force/F $F_{elektrostatiese}$$F_{Q1Q2}$ /*Coulomb krag/F*

(3)

7.3

$F_{net} = 0$

$mg + F_E = T$

$mg + k\frac{Q_1Q_2}{r^2}$ ✓ $- T = 0$

$(0,007)(9,8)$ ✓ $+ (9 \times 10^9)\frac{(32 \times 10^{-9})(55 \times 10^{-9})}{(0,025)^2}$ ✓ ✓ $= T$

$\therefore T = 9,39(4) \times 10^{-2}$ N ✓ (Accept/*Aanvaar*: 0,1 N)

ACCEPT/*AANVAAR*

$F_E = w_{Q2}$ ✓

$(0,007)(9,8)$ ✓ $+ (0,007)(9,8)$ ✓✓ $= T$

$T = 0,137$ N ✓

(5)

[11]

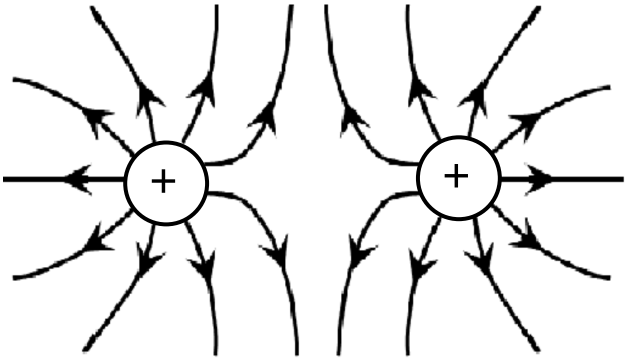
QUESTION/*VRAAG 8*

8.1 The (electrostatic) force experienced by a unit positive charge (placed at that point).✓✓

Die (elektrostatiese) krag ondervind per eenheid positiewe lading by daardie punt.

NOTE/*LET WEL*
If the words "unit positive" is omitted (max 1/2)
Indien die woorde "eenheid positiewe" weggelaat is (maks 1/2) (2)

8.2



Guideline for allocating marks/*Riglyne vir toekenning van punte*		
	Lines must not cross / Lines must touch the spheres but not enter spheres *Lyne moet nie kruis nie/Lyne moet die sfere raak maar nie binnegaan nie*	✓
	Arrows point outwards *Pyle uitwaarts gerig*	✓
	Correct shape *Korrekte vorm*	✓

(3)

8.3

$E = \frac{kQ}{r^2}$ ✓

$E_{Q1X} = \frac{(9\times10^9)(30\times10^{-6})}{(x)^2}$ ✓

$E_{Q2X} = \frac{(9\times10^9)(45\times10^{-6})}{(0,15+x)^2}$ ✓

$E_{net} = 0$

$E_{Q1X} = E_{Q2X}$

$\frac{(9\times10^9)(30\times10^{-6})}{(x)^2} = \frac{(9\times10^9)(45\times10^{-6})}{(0,15+x)^2}$ ✓

For equating equations
Vir gelykstelling van vergelykings

$\frac{5,477}{x} = \frac{6,708}{0,15+x}$

x = 0, 67 m (0,667 m) ✓ (5)

[10]

QUESTION/*VRAAG 9*

9.1.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$P = \frac{V^2}{R}$ ✓ $4 = \frac{V^2}{R} = \frac{(12)^2}{R}$ ✓ R = 36 Ω✓	P = VI 4 = I(12) I = 0,33...A V = IR✓ 12 = 0,33R✓ R = 36,36 Ω✓	P = V I 4 = I(12) I = 0,33 ..A $P = I^2 R$ ✓ $4 = (0,33^2)$ R✓ R = 36,73 Ω✓

(3)

9.1.2 Increase/*Toeneem*✓ (1)

9.1.3 No change/*Geen verandering nie*✓

Same potential difference✓ (and resistance)
Dieselfde potensiaalverskil (en weerstand) (2)

9.2.1

V = IR ✓
5 = I(6) ✓
∴ I = 0,83 A

$V_{\text{"lost"}}$ = Ir
1 = (0,83)r ✓
r = 1,20 Ω✓

OR/*OF*

ε = I(R + r)
6 = (0,83)(6 + r) ✓
r = 1,23 Ω✓

(4)

9.2.2 Work done ✓in moving a unit charge ✓ through a cell.
Arbeid verrig ✓om 'n eenheidslading ✓deur 'n sel te beweeg.

ACCEPT/AANVAAR
Energy transferred per unit charge/*Energie oorgedra per eenheidslading*
Work done in moving in 1 C of charge. / *Arbeid verrig deur 1 C lading te beweeg* (2)

9.2.3

OPTION 1/*OPSIE 1*
POSITIVE MARKING FROM 9.2.1/*POSITIEWE NASIEN VANAF 9.2.1*

$V_{\text{"lost"}}$ = Ir
1,5✓ = I(1,2)
I = 1,25 A

$V_{||} = I_6R_6$
$4,5 = I_6(6)$✓
I_6 = 0,75 A

$V_x = IR_x$✓ **or/*of*** V = IR
$4,5 = (1,25 – 0,75)R_x$✓
Rx = 9 Ω✓

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 9.2.1/*POSITIEWE NASIEN VANAF 9.2.1*

$V_{\text{"lost"}} = Ir$
$1,5✓ = I(1,2)$
$I = 1,25$ A

$V_{||} = I_pR_p$
$4,5 = (1,25)R_p$ ✓
$R_p = 3,6\ \Omega$

$$\frac{1}{R_{//}} = \frac{1}{R_X} + \frac{1}{R_6}\ ✓$$
$$\frac{1}{R_{//}} = \frac{1}{R_X} + \frac{1}{6}\ ✓$$
$$\therefore R_{//} = \frac{6R_X}{R_X + 6} = 3,6$$
$R_X = 9\ \Omega$ ✓

OR:

$$R_{//} = \frac{R_X R_6}{R_X + R_6}\ ✓$$
$$3,6 = \frac{(R_X)(6)}{(R_X + 6)}\ ✓$$
$R_X = 9\ \Omega$ ✓

(5)
[17]

QUESTION/*VRAAG 10*

10.1.1 a to b/*a na b* ✓ (1)

10.1.2 Fleming's left hand rule /Left hand motor rule✓
Fleming se linkerhandreël / Linkerhand motorreël

ACCEPT/*AANVAAR*
Right hand rule
Regterhandreël (1)

10.1.3 Split rings /commutator ✓ (1)
Splitringe / kommutator

10.2.1 Mechanical/Kinetic energy to electrical energy. ✓✓ (2 or/*of* 0)
Meganiese /kinetiese energie na elektriese energie (2)

10.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $= \frac{430}{\sqrt{2}}$ ✓ $= 304,06$ V $I = \frac{V}{R}$ ✓ $= \frac{304,06}{400}$ ✓ $= 0,76$ A ✓	$V_{max} = I_{max}R$ ✓ $430 = I_{max}(400)$ ✓ $I_{max} = 1,075$ $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ $= \frac{1,075}{\sqrt{2}}$ ✓ $= 0,76$ A ✓

(5)

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓	$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓
$= \frac{430}{\sqrt{2}}$ ✓ $= 304,06\ V$	$= \frac{430}{\sqrt{2}}$ ✓ $= 304,06\ V$
$P_{average} = \frac{V^2_{rms}}{R} = \frac{(304,06)^2}{400}$	$P_{average} = \frac{V^2_{rms}}{R} = \frac{(304,06)^2}{400}$
$= 231,13\ W$	$= 231,13\ W$
$P_{ave} = I_{rms}V_{rms}$ ✓	$P_{ave} = I^2_{rms}R$ ✓
$231,13 = I_{rms}\ (304,06)$ ✓	$231,13 = I^2_{rms}\ (400)$ ✓
$I_{rms} = 0,76\ A$ ✓	$I_{rms} = 0,76\ A$ ✓

[10]

QUESTION/*VRAAG 11*

11.1.1 It tells us that light has a particle nature.✓
Dit sê vir ons dat lig 'n deeltjie-aard het (1)

11.1.2 Remain the same. ✓
Bly dieselfde

For the same colour/ frequency/wavelength the energy of the photons will be the same✓. (The brightness causes more electrons to be released, but they will have the same maximum kinetic energy.)
Vir dieselfde kleur / frekwensie/ golflengte is die energie van die fotone dieselfde. (Die helderheid veroorsaak dat meer elektrone vrygestel word, maar hulle sal dieselfde maksimum kinetiese energie hê.)

OR/*OF*
Intensity only affects the number of ejected photo-electrons and not the maximum kinetic energy or maximum speed of the ejected photo-electrons
Intensiteit beinvloed slegs die aantal vrygestelde foto-elektrone en nie die maksimum kinetiese energie of maksimum spoed van die foto-elektrone.
OR/OF
Maximum kinetic energy of ejected photo-electrons is independent of intensity of radiation
Maksimum kinetiese energie van vrygestelde foto-elektrone is onafhanklik van die intensiteit van straling. (2)

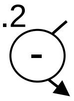
11.1.3

$E = W_0 + E_k$
$hf = hf_0 + E_k$
$hf = hf_0 + ½\ mv^2$
$E = W_0 + ½\ mv^2$
✓ Any one/*Enige een*

$$\frac{(6,63\times10^{-34})(3\times10^{8})}{420\times10^{-9}}✓ = \frac{(6,63\times10^{-34})(3\times10^{8})}{\lambda_0}✓ + \frac{1}{2}(9,11\times10^{-31})(4,76\times10^{5})^2 ✓$$

$\lambda_0 = 5,37 \times 10^{-7}\ m$
∴ the metal is sodium / *die metaal is natrium* ✓ (5)

11.2 **Q**✓ and/*en* **S** ✓



Emission spectra occur when excited atoms /electrons drop from higher energy levels to lower energy levels. ✓✓
Emissiespektra ontstaan wanneer opgewekte atome/elektrone vanaf hoër energievlakke na laer energievlakke beweeg.
(Characteristic frequencies are emitted/*Kenmerkende frekwensies word vrygestel.*) (4)

[12]

TOTAL/*TOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2016

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Write down the question number (1.1–1.10), choose the answer and make a cross (X) over the letter (A–D) of your choice in the ANSWER BOOK.

EXAMPLE:

1.11 | A | B | C | ~~D~~ (crossed)

1.1 The tendency of an object to remain at rest or to continue in its uniform motion in a straight line is known as …

A inertia.

B acceleration.

C Newton's Third Law.

D Newton's Second Law. (2)

1.2 The mass of an astronaut on Earth is M. At a height equal to twice the radius of the Earth, the **mass** of the astronaut will be …

A $\frac{1}{4}$M

B $\frac{1}{9}$M

C M

D 2M (2)

1.3 An object is thrown vertically upwards from the ground.

Which ONE of the following is CORRECT regarding the direction of the acceleration of the object as it moves upwards and then downwards? Ignore the effects of air resistance.

	OBJECT MOVING UPWARDS	**OBJECT MOVING DOWNWARDS**
A	Downwards	Upwards
B	Upwards	Downwards
C	Downwards	Downwards
D	Upwards	Upwards

(2)

1.4 A person drops a glass bottle onto a concrete floor from a certain height and the bottle breaks. The person then drops a second, identical glass bottle from the same height onto a thick, woollen carpet, but the bottle does not break.

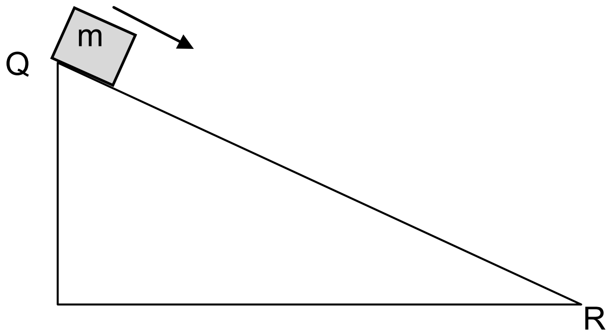
Which ONE of the following is CORRECT for the second bottle compared to the first bottle for the same momentum change?

	AVERAGE FORCE ON SECOND BOTTLE	TIME OF CONTACT WITH CARPET
A	Larger	Smaller
B	Smaller	Smaller
C	Larger	Larger
D	Smaller	Larger

(2)

1.5 A block of mass m is released from rest from the top of a frictionless inclined plane **QR**, as shown below.

The total mechanical energy of the block is E_Q at point **Q** and E_R at point **R**. The kinetic energy of the block at points **Q** and **R** is K_Q and K_R respectively.

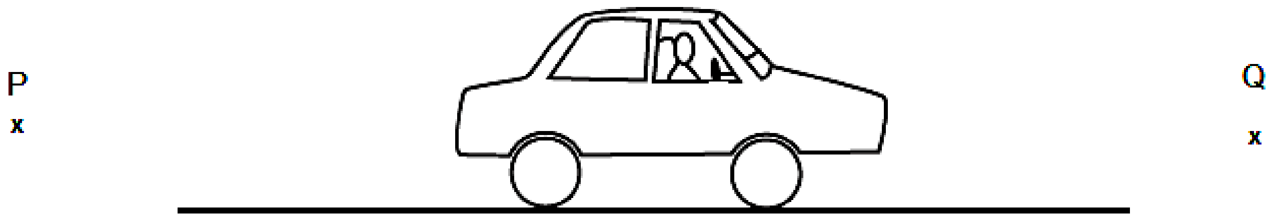


Which ONE of the statements regarding the total mechanical energy and the kinetic energy of the block at points **Q** and **R** respectively is CORRECT?

	TOTAL MECHANICAL ENERGY E	KINETIC ENERGY K
A	$E_Q > E_R$	$K_Q = K_R$
B	$E_Q = E_R$	$K_Q < K_R$
C	$E_Q = E_R$	$K_Q = K_R$
D	$E_Q < E_R$	$K_Q > K_R$

(2)

1.6 The diagram below shows the positions of two stationary listeners, **P** and **Q**, relative to a car moving at a constant velocity towards listener **Q**. The hooter on the car emits sound. Listeners **P** and **Q** and the driver all hear the sound of the hooter.

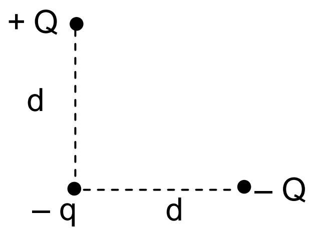


Which ONE of the following CORRECTLY describes the frequency of the sound heard by **P** and **Q**, *compared to that heard by the driver*?

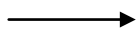
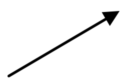
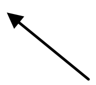
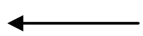
	FREQUENCY OF THE SOUND HEARD BY P	**FREQUENCY OF THE SOUND HEARD BY Q**
A	Lower	Higher
B	Higher	Higher
C	Lower	Lower
D	Higher	Lower

(2)

1.7 Two charges, + Q and – Q, are placed a distance d from a negative charge – q. The charges, + Q and – Q, are located along lines that are perpendicular to each other as shown in the diagram below.



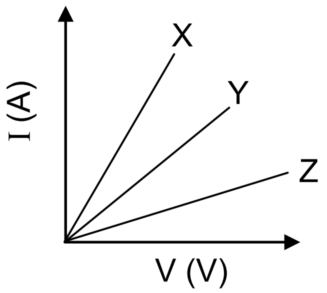
Which ONE of the following arrows CORRECTLY shows the direction of the net force acting on charge – q due to the presence of charges + Q and – Q?

A	
B	
C	
D	

(2)

1.8 Learners investigate the relationship between current (I) and potential difference (V) at a constant temperature for three different resistors, **X**, **Y** and **Z**.

They obtain the graphs shown below.



The resistances of **X**, **Y** and **Z** are R_X, R_Y and R_Z respectively.

Which ONE of the following conclusions regarding the resistances of the resistors is CORRECT?

A $R_z > R_Y > R_x$

B $R_X = R_Y = R_Z$

C $R_X > R_Y > R_Z$

D $R_X > R_Y$ and $R_Y < R_Z$ (2)

1.9 Which ONE of the following changes may lead to an increase in the emf of an AC generator without changing its frequency?

A Decrease the resistance of the coil.

B Increase the area of the coil.

C Increase the resistance of the coil.

D Decrease the speed of rotation. (2)

1.10 The wavelength of a monochromatic light source **P** is twice that of a monochromatic light source **Q**. The energy of a photon from source **P** will be … of a photon from source **Q**.

A a quarter of the energy

B half the energy

C equal to the energy

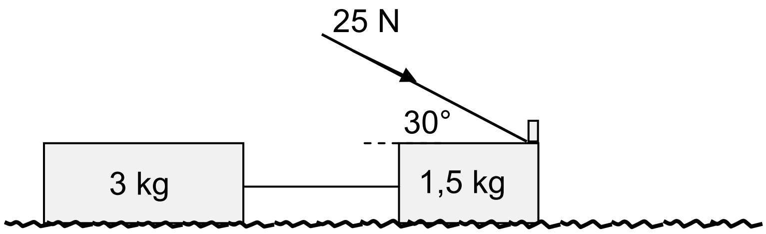
D twice the energy (2)

[20]

QUESTION 2 (Start on a new page.)

A learner constructs a push toy using two blocks with masses 1,5 kg and 3 kg respectively. The blocks are connected by a massless, inextensible cord.

The learner then applies a force of 25 N at an angle of 30° to the 1,5 kg block by means of a light rigid rod, causing the toy to move across a flat, rough, horizontal surface, as shown in the diagram below.



The coefficient of kinetic friction (μ_k) between the surface and each block is 0,15.

2.1 State Newton's Second Law of Motion in words. (2)

2.2 Calculate the magnitude of the kinetic frictional force acting on the 3 kg block. (3)

2.3 Draw a labelled free-body diagram showing ALL the forces acting on the 1,5 kg block. (5)

2.4 Calculate the magnitude of the:

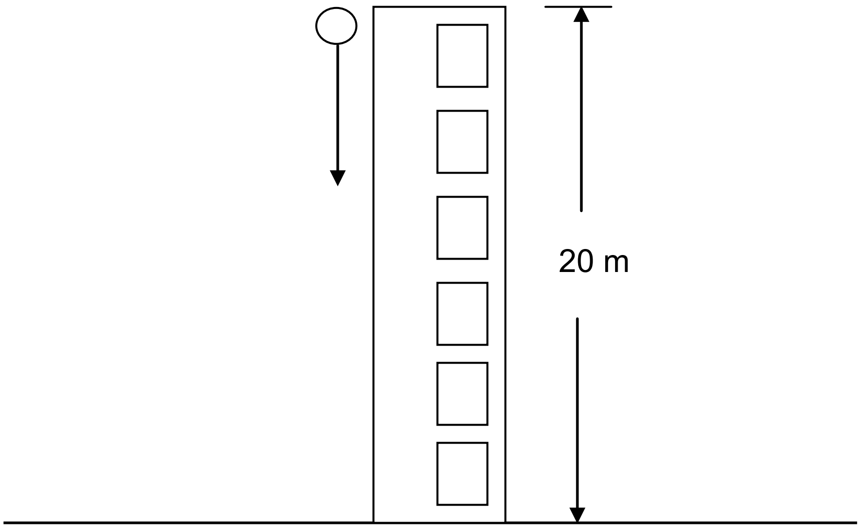
2.4.1 Kinetic frictional force acting on the 1,5 kg block (3)

2.4.2 Tension in the cord connecting the two blocks (5)

[18]

QUESTION 3 (Start on a new page.)

A ball is dropped from the top of a building 20 m high. Ignore the effects of air resistance.



3.1 Define the term *free fall*. (2)

3.2 Calculate the:

3.2.1 Speed at which the ball hits the ground (4)

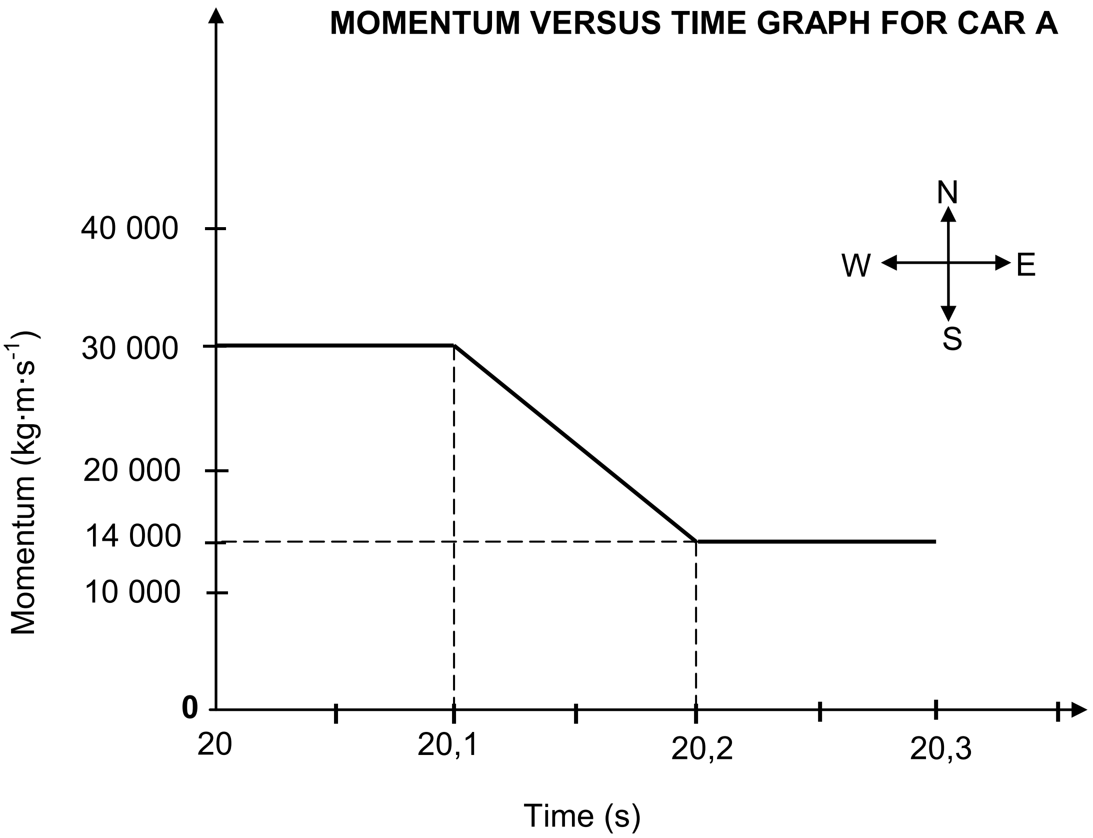
3.2.2 Time it takes the ball to reach the ground (3)

3.3 Sketch a velocity-time graph for the motion of the ball (no values required). (2)
[11]

QUESTION 4 (Start on a new page.)

The graph below shows how the momentum of car **A** changes with time *just before* and *just after* a head-on collision with car **B**.

Car **A** has a mass of 1 500 kg, while the mass of car **B** is 900 kg.
Car **B** was travelling at a constant velocity of 15 $m \cdot s^{-1}$ west before the collision.
Take east as positive and consider the system as isolated.



4.1 What do you understand by the term *isolated system* as used in physics? (1)

Use the information in the graph to answer the following questions.

4.2 Calculate the:

4.2.1 Magnitude of the velocity of car **A** just before the collision (3)

4.2.2 Velocity of car **B** just after the collision (5)

4.2.3 Magnitude of the net average force acting on car **A** during the collision (4)

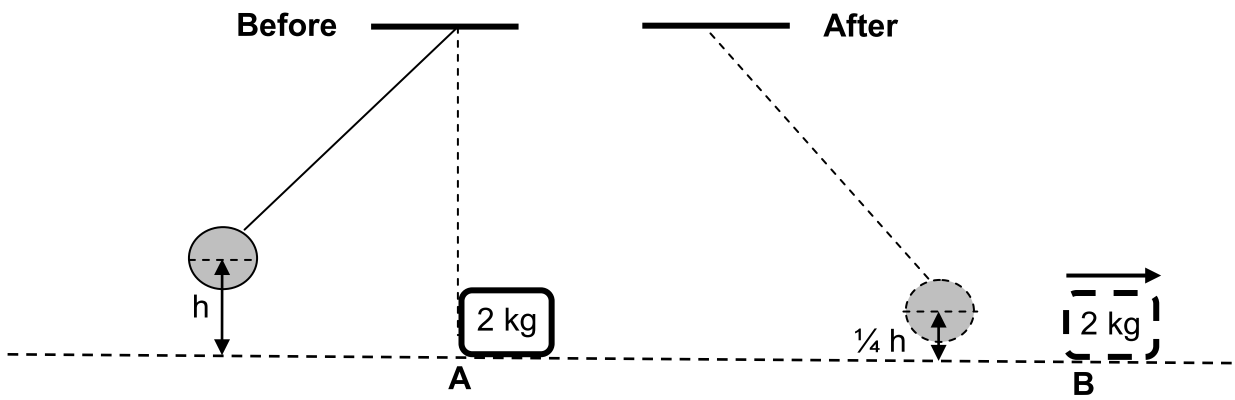
[13]

QUESTION 5 (Start on a new page.)

A pendulum with a bob of mass 5 kg is held stationary at a height h metres above the ground. When released, it collides with a block of mass 2 kg which is stationary at point **A**.

The bob swings past **A** and comes to rest momentarily at a position ¼ h above the ground.

The diagrams below are NOT drawn to scale.



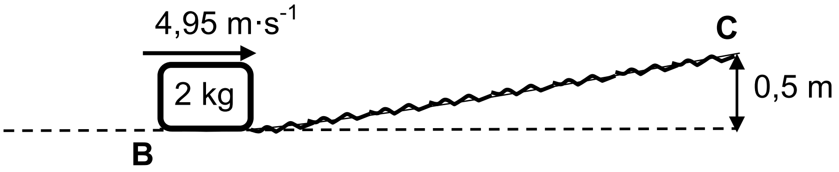
Immediately after the collision the 2 kg block begins to move from **A** to **B** at a constant speed of 4,95 $m{\cdot}s^{-1}$.
Ignore frictional effects and assume that no loss of mechanical energy occurs during the collision.

5.1 Calculate the:

5.1.1 Kinetic energy of the block immediately after the collision (3)

5.1.2 Height h (4)

The block moves from point **B** at a velocity of 4,95 $m{\cdot}s^{-1}$ up a rough inclined plane to point **C**. The speed of the block at point **C** is 2 $m{\cdot}s^{-1}$. Point **C** is 0,5 m above the horizontal, as shown in the diagram below.
During its motion from **B** to **C** a uniform frictional force acts on the block.



5.2 State the work-energy theorem in words. (2)

5.3 Use energy principles to calculate the work done by the frictional force when the 2 kg block moves from point **B** to point **C**. (4)
[13]

QUESTION 6 (Start on a new page.)

6.1 An ambulance is moving towards a stationary listener at a constant speed of 30 $m \cdot s^{-1}$. The siren of the ambulance emits sound waves having a wavelength of 0,28 m. Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1.1 State the Doppler effect in words. (2)

6.1.2 Calculate the frequency of the sound waves emitted by the siren as heard by the ambulance driver. (3)

6.1.3 Calculate the frequency of the sound waves emitted by the siren as heard by the listener. (5)

6.1.4 How would the answer to QUESTION 6.1.3 change if the speed of the ambulance were LESS THAN 30 $m \cdot s^{-1}$? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

6.2 An observation of the spectrum of a distant star shows that it is moving away from the Earth.

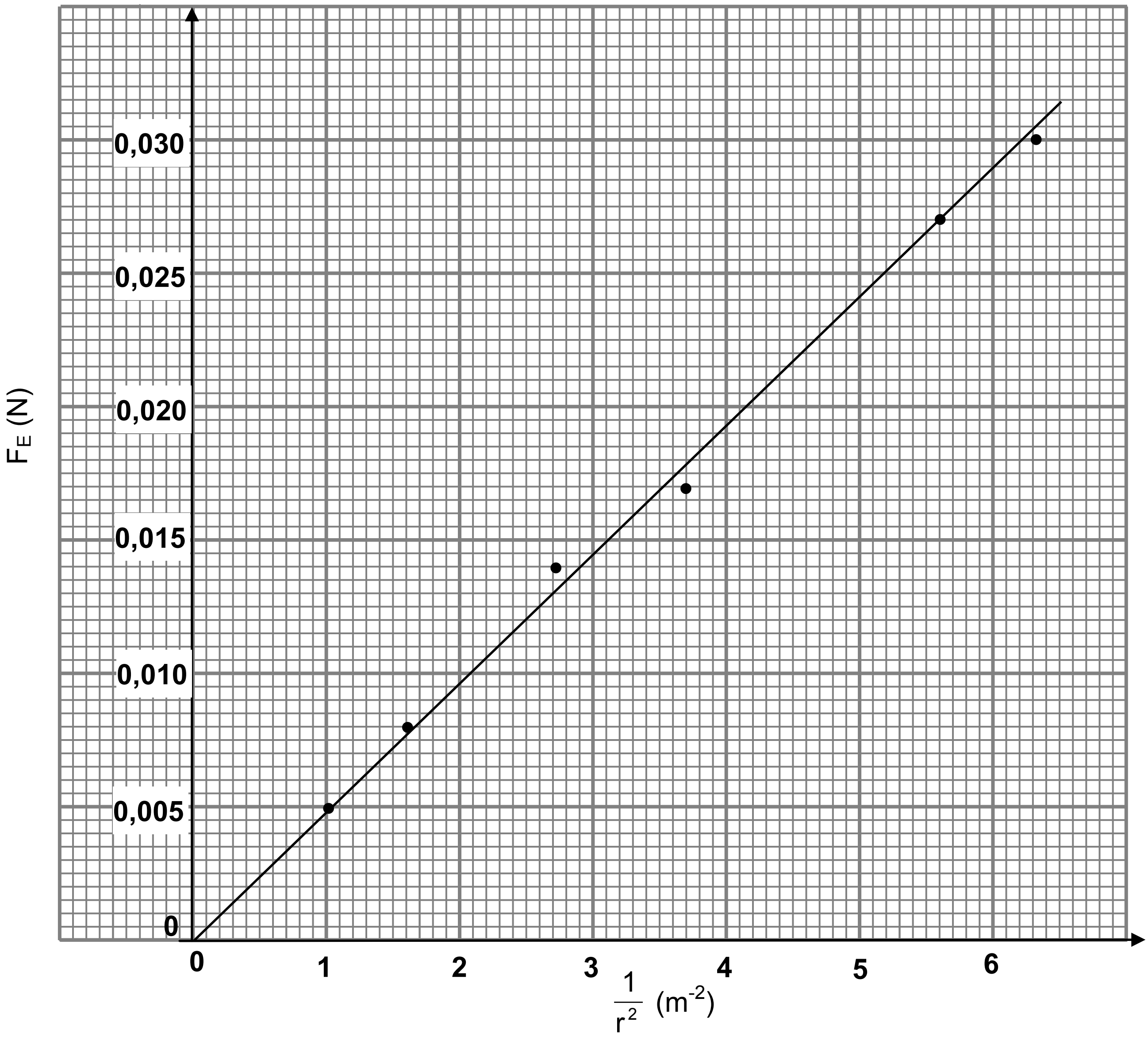
Explain, in terms of the frequencies of the spectral lines, how it is possible to conclude that the star is moving away from the Earth. (2)

[13]

QUESTION 7 (Start on a new page.)

7.1 In an experiment to verify the relationship between the electrostatic force, F_E, and distance, r, between two **identical**, positively charged spheres, the graph below was obtained.

GRAPH OF F_E VERSUS $\frac{1}{r^2}$



7.1.1 State Coulomb's law in words. (2)

7.1.2 Write down the dependent variable of the experiment. (1)

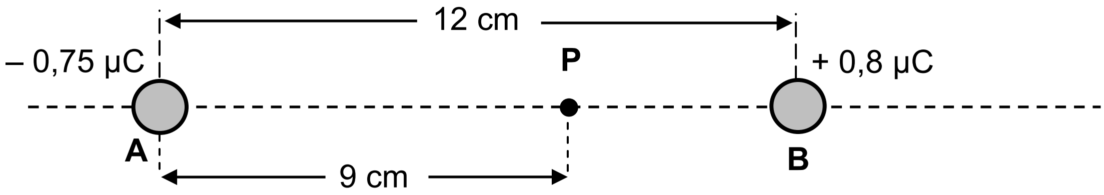
7.1.3 What relationship between the electrostatic force F_E and the square of the distance, r^2, between the charged spheres can be deduced from the graph? (1)

7.1.4 Use the information in the graph to calculate the charge on each sphere. (6)

7.2 A charged sphere, **A**, carries a charge of – 0,75 μC.

7.2.1 Draw a diagram showing the electric field lines surrounding sphere **A**. (2)

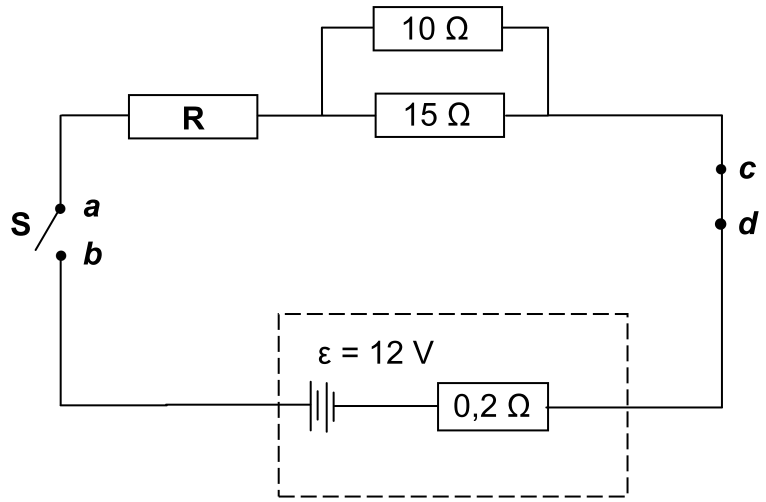
Sphere **A** is placed 12 cm away from another charged sphere, **B**, along a straight line in a vacuum, as shown below. Sphere **B** carries a charge of +0,8 μC. Point **P** is located 9 cm to the right of sphere **A**.



7.2.2 Calculate the magnitude of the net electric field at point **P**. (5)
[17]

QUESTION 8 (Start on a new page.)

8.1 In the circuit below the battery has an emf (ε) of 12 V and an internal resistance of 0,2 Ω. The resistances of the connecting wires are negligible.



8.1.1 Define the term *emf of a battery.* (2)

8.1.2 Switch **S** is open. A high-resistance voltmeter is connected across points ***a*** and ***b***.
What will the reading on the voltmeter be? (1)

8.1.3 Switch **S** is now closed. The same voltmeter is now connected across points ***c*** and ***d***.
What will the reading on the voltmeter be? (1)

When switch **S** is closed, the potential difference across the terminals of the battery is 11,7 V.

Calculate the:

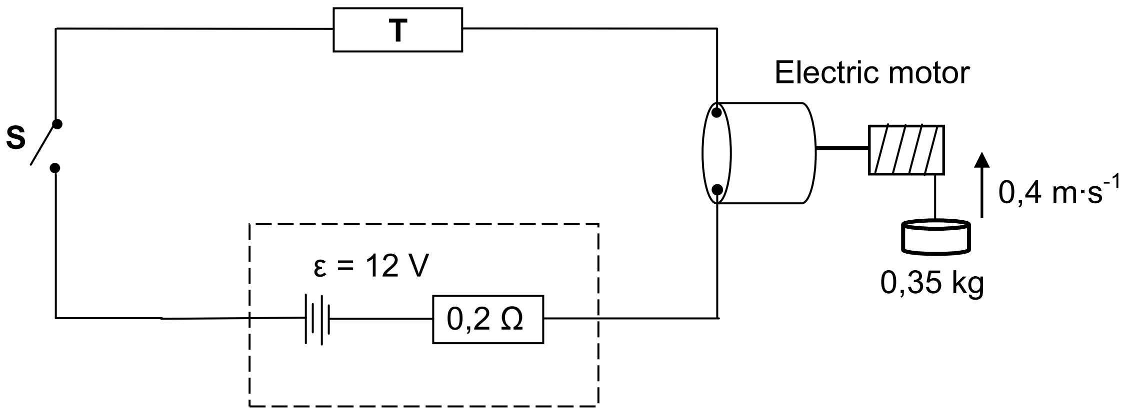
8.1.4 Current in the battery (3)

8.1.5 Effective resistance of the **parallel** branch (2)

8.1.6 Resistance of resistor **R** (4)

8.2 A battery with an emf of 12 V and an internal resistance of 0,2 Ω are connected in series to a very small electric motor and a resistor, **T**, of unknown resistance, as shown in the circuit below.

The motor is rated **X** watts, 3 volts, and operates at optimal conditions.



When switch **S** is closed, the motor lifts a 0,35 kg mass vertically upwards at a constant speed of 0,4 $m \cdot s^{-1}$. Assume that there is no energy conversion into heat and sound.

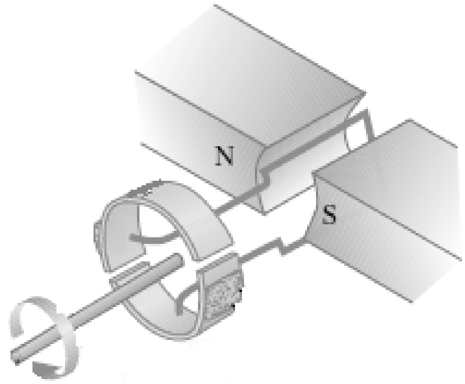
Calculate the value of:

8.2.1 **X** (3)

8.2.2 The resistance of resistor **T** (5)
[21]

QUESTION 9 (Start on a new page.)

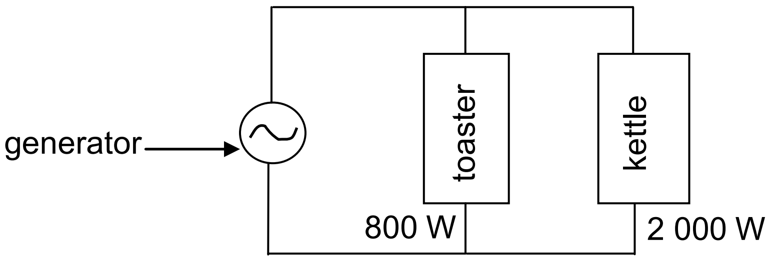
9.1 A generator is shown below. Assume that the coil is in a vertical position.



9.1.1 Is the generator above AC or DC? Give a reason for the answer. (2)

9.1.2 Sketch an induced emf versus time graph for ONE complete rotation of the coil. (The coil starts turning from the vertical position.) (2)

9.2 An AC generator is operating at a maximum emf of 340 V. It is connected across a toaster and a kettle, as shown in the diagram below.



The toaster is rated at 800 W, while the kettle is rated at 2 000 W. Both are working under optimal conditions.

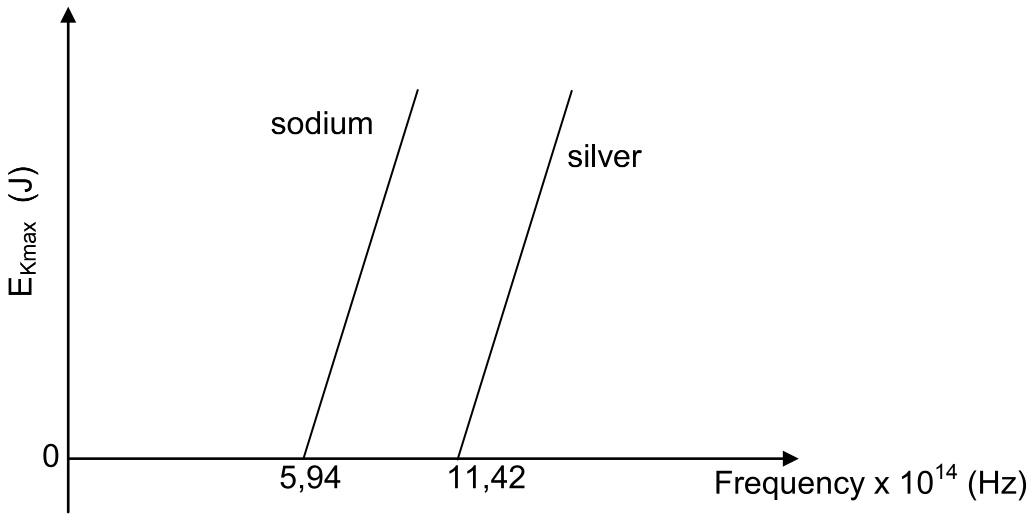
Calculate the:

9.2.1 rms current passing through the toaster (3)

9.2.2 Total rms current delivered by the generator (4)
[11]

QUESTION 10 (Start on a new page.)

10.1 A learner is investigating the photoelectric effect for two different metals, silver and sodium, using light of different frequencies. The maximum kinetic energy of the emitted photoelectrons is plotted against the frequency of the light for each of the metals, as shown in the graphs below.



10.1.1 Define the term *threshold frequency*. (2)

10.1.2 Which metal, sodium or silver, has the larger work function? Explain the answer. (3)

10.1.3 Name the physical constant represented by the slopes of the graphs. (1)

10.1.4 If light of the same frequency is shone on each of the metals, in which metal will the ejected photoelectrons have a larger maximum kinetic energy? (1)

10.2 In a different photoelectric experiment blue light obtained from a light bulb is shone onto a metal plate and electrons are released.

The wavelength of the blue light is 470×10^{-9} m and the bulb is rated at 60 mW. The bulb is only 5% efficient.

10.2.1 Calculate the number of photons that will be incident on the metal plate per second, assuming all the light from the bulb is incident on the metal plate. (5)

10.2.2 **Without any further calculation**, write down the number of electrons emitted per second from the metal. (1)
[13]

TOTAL: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2016

MEMORANDUM

MARKS/*PUNTE*: 150

This memorandum consists of 19 pages.
Hierdie memorandum bestaan uit 19 bladsye.

QUESTION 1/*VRAAG 1*

1.1	A ✓✓	(2)
1.2	C ✓✓	(2)
1.3	C ✓✓	(2)
1.4	D ✓✓	(2)
1.5	B ✓✓	(2)
1.6	A ✓✓	(2)
1.7	C ✓✓	(2)
1.8	A ✓✓	(2)
1.9	B ✓✓	(2)
1.10	B ✓✓	(2)
		[20]

QUESTION 2/*VRAAG 2*

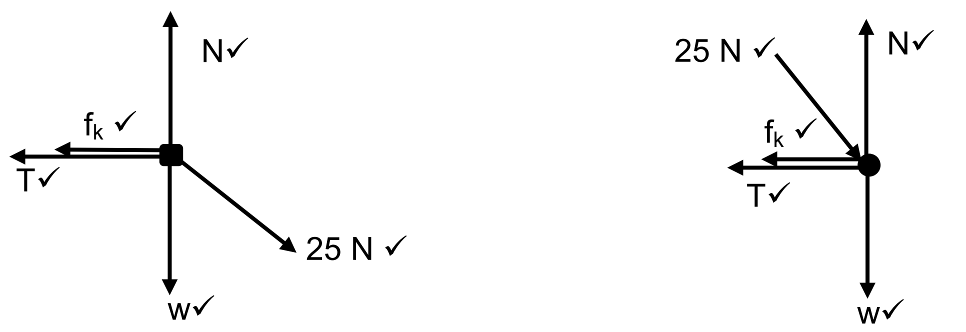
2.1 When a resultant/net force acts on an object, the object will accelerate in the (direction of the net/resultant force). The acceleration is directly proportional to the net force ✓and inversely proportional to the mass ✓of the object.
Wanneer 'n netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die netto krag teen 'n versnelling direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*
The resultant/net force acting on the object is equal (is directly proportional to) to the rate of change of momentum of an object (in the direction of the force). ✓✓
Die resulterende/netto krag wat op 'n voorwerp inwerk, is gelyk aan (is direk eweredig aan) die tempo van verandering van momentum van die voorwerp (in die rigting van die netto krag). (2)

2.2

$f_k = \mu_k N$ ✓ $= \mu_k mg$
$= (0,15)(3)(9,8)$ ✓
$= 4,41$ N ✓ (3)

2.3



Accepted Labels/*Aanvaarde benoemings*	
w	F_{g}/F_{w}/force of Earth on block/weight/14,7 N/mg/gravitational force *F_{g}/F_{w}/krag van Aarde op blok/gewig/14,7 N/mg/gravitasiekrag*
N	F_N/F_{normal}/normal force F_N/$F_{normaal}$/normalekrag
T	Tension/F_T *Spanning*/F_T
f_k	$f_{kinetic\ friction/kinetiesewrywing}$/$f_{f/w}$/f//$F_{f/w}$kinetic friction/*kinetiesewrywing*
25 N	$F_{applied}$/F_A/F $F_{toegepas}$/F_A/F

2.4.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$f_k = \mu_k N = \mu_k(25\sin 30^o + mg)$ $= 0,15[(25\sin30^o)$✓ $+ (1,5)(9,8)$✓$]$ $= 4,08$ N✓	$f_k = \mu_k N = \mu_k(25\cos 60^o + mg)$ $= 0,15[(25\cos60^o)$✓ $+ (1,5)(9,8)$✓$]$ $= 4,08$ N✓

(3)

2.4.2

POSITIVE MARKING FROM QUESTION 2.2 AND QUESTION 2.4.1
POSITIEWE NASIEN VANAF VRAAG 2.2 EN VRAAG 2.4.1

OPTION 1/*OPSIE 1*

For the 1,5 kg block/*Vir die 1,5 kg blok*

$F_{net} = ma$
$F_x + (-T) + (-f_k) = ma$ } ✓

$25\cos 30^o - T - f_k = 1,5a$

$(25\cos 30^o - T) - 4,08$ ✓ $= 1,5a$

$17,571 - T = 1,5a$ ……….(1)

✓either one
enigeen

For the 3 kg block
Vir die 3 kg blok

$T - f_k = 3a$

$T - 4,41$✓ $= 3a$ ………….(2)

$13,161 = 4,5\ a$

$a = 2,925\ m\cdot s^{-2}$

$T = 13,19$ N ✓ (13,17 N – 13,19 N)

<table>
<tr>
<td>

OPTION 2/*OPSIE 2*
For the 1,5 kg block/*Vir die 1,5 kg blok*
$F_{net} = ma$
$F_x + (-T) + (-f_k) = ma$ } ✓
$25 \cos 30^o - T - f_k = 1,5a$
$\underline{(25 \cos 30^o - T) - 4,08}$ ✓ $= 1,5a$
$17,571 - T = 1,5a$ ……….(1)
✓either one / *enigeen*
For the 3 kg block
Vir die 3 kg blok
$T - f_k = 3a$
$\underline{T - 4,41}$✓ $= 3a$ ………….(2)

$35,142 - 2T = T - 4,41$
$T = 13,18$ N ✓

</td>
<td>

OPTION 3/*OPSIE 3*
For the 1,5 kg block/*Vir die 1,5 kg blok*
$F_{net} = ma$
$F_x + (-T) + (-f_k) = ma$ } ✓
$25 \cos 30^o - T - f_k = 1,5a$
$\underline{(25 \cos 30^o - T) - 4,08}$ ✓ $= 1,5a$
$17,571 - T = 1,5a$ ……….(1)
$a = \frac{17,571 - T}{1,5}$
✓either one / *enigeen*
For the 3 kg block
Vir die 3 kg blok
$T - f_k = 3a$
$\underline{T - 4,41}$✓ $= 3a$ ………….(2)
$a = \frac{T - 4,41}{3}$
$\frac{17,571 - T}{1,5} = \frac{T - 4,41}{3}$
$T = 13,18$ N✓

</td>
</tr>
</table>

(5)

[18]

QUESTION 3/*VRAAG 3*

3.1 The motion of an object under the influence of gravity/weight/gravitational force only / Motion in which the only force acting is the gravitational force.✓✓
Die beweging van 'n voorwerp slegs onder die invloed van swaartekrag/gewig gravitasiekrag.
Beweging waarin die enigste krag wat op die liggaam inwerk, die gravitasiekrag is. (2)

3.2.1

<table>
<tr>
<td>

OPTION 1/*OPSIE 1*
Upwards positive/*Opwaarts positief:*
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$= 0^2 + (2)(-9,8)$✓(-20)✓
$v_f = 19,80$ m·s^{-1} ✓

Downwards positive
Afwaarts positief
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$= 0^2 + (2)(9,8)$✓(20)✓
$v_f = 19,80$ m·s^{-1}✓

</td>
<td>

OPTION 2/*OPSIE 2*
Upwards positive/*Opwaarts positief:*
$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$-20 = 0 + ½ (-9,8) \Delta t^2$✓ ✓either one / *enigeen*
$\Delta t = 2,02$ s
$v_f = v_i + a\Delta t$
$= 0 + (-9,8)(2,02)$ ✓
$= -19,80$ m·s^{-1}
$= 19,80$ m·s^{-1} ✓
Downwards positive
Afwaarts positief
$\Delta y = v_i\Delta t + ½ a\Delta t^2$
$20 = 0 + ½ (9,8) \Delta t^2$✓ ✓either one / *enigeen*
$\Delta t = 2,02$ s
$v_f = v_i + a\Delta t$
$= 0 + (9,8)(2,02)$✓
$= 19,80$ m·s^{-1}✓

</td>
</tr>
</table>

OPTION 3/*OPSIE 3* $(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$ $(E_P + E_K)_{Top} = (E_P + E_K)_{Bottom/Onder}$ $(mgh + ½ mv^2)_{Top/Bo} = (mgh + ½ mv^2)_{Bottom/Onder}$ $\underline{(9,8)(20) + 0}$✓ = $\underline{(0 + ½v_f^2)}$✓ $v_f = 19,80\ m·s^{-1}$✓	✓1 mark for any *1 punt vir enige*
OPTION 4/*OPSIE 4* $W_{nc} = ΔE_p + ΔE_k$ ✓ $0 = mgΔh + ½ mΔv^2$ 0✓ = $\underline{m(9,8)(0 – 20) + ½ m(v_f^2 – 0)}$ ✓ $v_f = 19,80\ m·s^{-1}$✓	
OPTION 5/*OPSIE 5* $W_{net} = ΔE_k$ ✓ $mgΔx\cos0^o = ½ m(v_f^2 – 0)$ $\underline{m(9,8)(20)(1)}$✓ = $½ mv_f^2$ ✓ $v_f = 19,80\ m·s^{-1}$✓	

(4)

3.2.2

POSITIVE MARKING FROM QUESTION 3.2.1/*POSITIEWE NASIEN VANAF VRAAG 3.2.1*

OPTION 1/*OPSIE 1*

Downwards positive/*Afwaarts positief*

$v_f = v_i + aΔt$ ✓

$\underline{19,80 = 0 + (9,8)Δt}$ ✓

Δt = 2,02 s ✓

Upwards positive/*Opwaarts positief*

$v_f = v_i + aΔt$ ✓

$\underline{-19,80 = 0 + (-9,8)Δt}$ ✓

Δt = 2,02 s ✓

OPTION 2/*OPSIE 2*	
Upwards positive/*Opwaarts positief:* $Δy = v_iΔt + ½ aΔt^2$✓ $\underline{-20 = 0 + ½ (-9,8) Δt^2}$✓ Δt = 2,02 s✓	**Downwards Positive/*Afwaarts positief*** $Δy = v_iΔt + ½ aΔt^2$✓ $\underline{20 = 0 + ½ (9,8) Δt^2}$✓ Δt = 2,02 s✓

OPTION 3/*OPSIE 3*

Downwards positive/*Afwaarts positief:*

$$Δy = \left(\frac{v_i + v_f}{2}\right)Δt$$ ✓

$$20 = \left(\frac{0 + 19,80}{2}\right)(Δt)$$ ✓

Δt = 2,02 s✓

Upwards positive/*Opwaarts positief:*

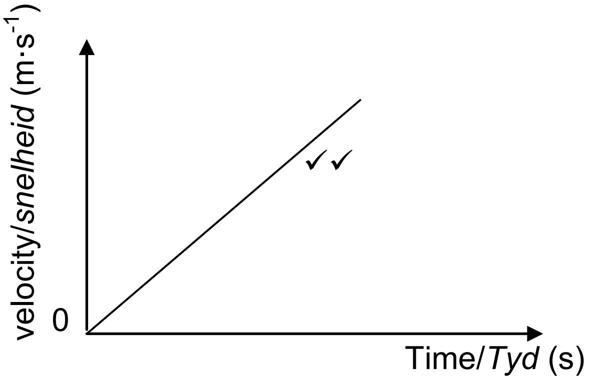
$$Δy = \left(\frac{v_i + v_f}{2}\right)Δt$$ ✓

$$-20 = \left(\frac{0 - 19,80}{2}\right)(Δt)$$ ✓

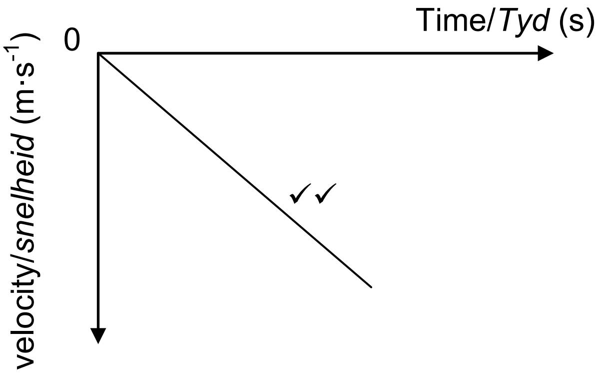
Δt = 2,02 s✓

(3)

3.3 **Downward positive/*Afwaarts positief***



Upward positive/*Opwaarts positief*



Notes/*Aantekeninge*

✓✓	Straight line through the origin. *Reguitlyn deur die oorsprong*

(2)

[11]

QUESTION 4/*VRAAG 4*

4.1 A system on which the resultant/net external force is zero/*'n Sisteem waarop die resulterende krag/netto eksternekrag nul is* ✓
A system which excludes external forces /*'n Sisteem wat eksterne kragte uitlaat.* (1)

4.2.1

OPTION 1/*OPSIE 1* $p = mv$✓ $30\ 000 = (1\ 500)v$ ✓ $v = 20\ m{\cdot}s^{-1}$✓
OPTION 2/*OPSIE 2* $\Delta p = mv_f - mv_i$ ✓ $0 = (1\ 500)v_f - 30\ 000$ ✓ $v = 20\ m{\cdot}s^{-1}$✓

(3)

4.2.2 **POSITIVE MARKING FROM QUESTION 4.2.1/*POSITIEWE NASIEN VANAF VRAAG 4.2.1***

OPTION 1/*OPSIE 1* $\sum p_i = \sum p_f$ $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$ } ✓ 1 mark for any/*1 punt vir enige* $30\ 000 + (900)(-15)$✓ $= 14\ 000 + 900v_B$✓ $\therefore v_B = 2{,}78\ m{\cdot}s^{-1}$ ✓east/*oos* ✓ (Accept/*Aanvaar:* to the right/*na regs*)
OPTION 2/*OPSIE 2* $\Delta p_A = -\Delta p_B$ $p_f - p_i = -(mv_f - mv_i)$ } 1 mark for any/*1 punt vir enige* $14\ 000 - 30\ 000$ ✓$= 900v_f - 900(-15)$ ✓ $v_f = 2{,}78\ m{\cdot}s^{-1}$✓ east/*oos* ✓ (Accept/*Aanvaar:* to the right/*na regs*)

(5)

4.2.3

OPTION 1/*OPSIE 1* Slope/*Helling* $= \frac{\Delta p}{\Delta t} = F_{net}$✓ $= \frac{(14\ 000 - 30\ 000)}{(20{,}2 - 20{,}1)}$ ✓ ✓ $= -160\ 000$ $F_{net} = 160\ 000\ N$ ✓
OPTION 2/*OPSIE 2* $F_{net}\Delta t = \Delta p$ ✓ $F_{net}(0{,}1)$✓ $= 14\ 000 - 30\ 000$✓ $F_{net} = -160\ 000\ N$ $F_{net} = 160\ 000\ N$ ✓
POSITIVE MARKING FROM QUESTION 4.2.2/POSITIEWE NASIEN VANAF VRAAG 4.2.2 **OPTION 3/*OPSIE 3*** $F_{net}\Delta t = \Delta p$ ✓ $F_{net}(0{,}1)$✓ $= 900[(2{,}78) - (-15)]$✓ $F_{net} = 160\ 020\ N$ $F_A = -F_B$ $F_{net} = 160\ 020\ N$ ✓

OPTION 4/*OPSIE 4*

p = mv

$14\ 000 = 1\ 500v_f$ ✓

$v_f = 9,33\ m·s^{-1}$

$F_{net} = \frac{m(v_f - v_i)}{\Delta t}$ ✓ $= \frac{1500(9,33-20)}{0,1}$ ✓ = -160 050 = 160 050 N ✓	$v_f = v_i + a\Delta t$ 9,33 = 20 + a(0,1) $a = -106.7\ m·s^{-2}$ $F_{net} = ma$ ✓ = 1 500(-106,7) ✓ F_{net} = - 160 050 N F_{net} = 160 050 N ✓

(4)

[13]

QUESTION 5/*VRAAG 5*

5.1.1 $E_k/K = ½ mv^2$ ✓

$= ½ (2)(4,95)^2$ ✓

= 24,50 J ✓ (3)

5.1.2

POSITIVE MARKING FROM QUESTION 5.1.1/*POSITIEWE NASIEN VANAF 5.1.1*

OPTION 1/*OPSIE 1*

$E_{mech\ before} = E_{mech\ after}$

$[(E_{mech})_{bob} + (E_{mech})_{block}]_{before/voor} = [(E_{mech})_{Block} + (E_{mech})_{bob}]_{after/na}$

$(mgh + ½ mv^2)_{before/voor} = (mgh + ½ mv^2)_{after/na}$

Any one/ *Enige een* ✓

(5)(9,8)h + 0 + 0 ✓= 5(9,8)¼h + 0 + 24,50 ✓

h = 0,67 m ✓

OPTION 2/*OPSIE 2*	**OPTION 3/*OPSIE 3***
$W_{nc} = \Delta E_p + \Delta E_k$ $0 = \Delta E_p + \Delta E_k$ $-\Delta E_p = \Delta E_k$ Any one/ *Enige een* ✓ -[(5)(9,8)(¼h) – (5)(9,8)h] ✓ = 24,50 ✓ h = 0,67 m ✓	Loss Ep bob = Gain in Ek of block ✓ mg(¾h) = 24,5 (5)(9,8)(¾h) ✓ = 24,5 ✓ h = 0,67 m ✓

(4)

OPTION 4 /*OPSIE 4*

Before/*Voor*

$(mgh + ½ mv^2)_{top/bo} = (mgh + ½ mv^2)_{bottom/onder}$

$(5)(9,8)h + 0 = (5)(9,8)h_o + ½ (5)v^2$

$v_i^2 = 19,6h - 19,6h_o$

After/*Na*

$(mgh + ½ mv^2)_{bottom/onder} = (mgh + ½ mv^2)_{top/bo}$

$(5)(9,8)h_o + ½(5)v_f^2 = (5)(9,8)(¼h) + 0$

$v_f^2 = 4,9h – 19,6h_o$

$E_{mech/meg}$ before collision/*voor botsing* = $E_{mech/meg}$ after collision/*na botsing* ✓

$½ mv_i^2$(bob/skietlood) + 0 = $½ mv_f^2$(bob/skietlood)+ $½ mv^2$(block/blok)

$½ (5)(19,6h – 19,6h_o)$ ✓ = $½ (5)(4,9h -19,6h_o) + 24,5$ ✓

h = 0,67 m ✓

5.2 The net/total work done on an object is equal ✓to the change in the object's kinetic energy ✓
Die netto/totale arbeid op 'n voorwerp verrig is gelyk aan die verandering in die kinetiese energie van die voorwerp.

OR/*OF*
The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy.
Die arbeid verrig op 'n voorwerp deur 'n resulterende/netto krag is gelyk aan die voorwerp se verandering in kinetiese energie. (2)

5.3

OPTION 1/*OPSIE 1*
$W_{net} = \Delta E_K$ ✓
$W_f + mg\Delta y\cos\theta = ½m(v_f^2 - v_i^2)$
$W_f + (2)(9,8)(0,5)\cos180^{\circ}$ ✓ = $½(2)(2^2 - 4,95^2)$ ✓
$W_f = -10,7$ J ✓
OPTION 2/*OPSIE 2*
$W_{nc} = \Delta E_K + \Delta U$ / $W_{nc} = \Delta E_K + \Delta E_P$ ✓
$W_f = ½(2)(2^2 - 4,95^2)$ ✓ + $(2)(9,8)(0,5-0)$ ✓
$= -10,7$ J ✓

(4)
[13]

QUESTION 6/*VRAAG 6*

6.1.1 It is the (apparent) change in frequency (or pitch) of the sound (detected by a listener) ✓ because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓
Dit is die verandering in frekwensie (of toonhoogte) van die klank (waargeneem deur 'n luisteraar) omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klankvoortplanting het.

OR/OF
An (apparent) change in (observed/detected) frequency (pitch), (wavelength) ✓as a result of the relative motion between a source and an observer ✓(listener).
'n Skynbare verandering in (waargenome) frekwensie (toonhoogte),(golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar. (2)

6.1.2 $v = f\lambda$ ✓
$340 = f(0,28)$ ✓
$f_s = 1\ 214,29$ Hz ✓ (3)

6.1.3 **POSITIVE MARKING FROM QUESTION 6.1.2/*POSITIEWE NASIEN VANAF VRAAG 6.1.2***

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v \pm v_L}{v \pm v_s} \times \frac{v}{\lambda_s}$ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$ **OR/*OF*** $f_L = \frac{f_s}{1 - \frac{v_s}{v}}$ ✓

$f_L = (\frac{340}{340 - 30}✓)1214,29$✓ **OR/*OF*** $f_L = (\frac{340}{340 - 30}) \times \frac{340}{0,28}$ **OR/*OF*** $f_L = \frac{1214,29}{1 - \frac{30}{340}}$

= 1 331,80 Hz✓ (1 331,80 Hz – 1 335,72 Hz) (5)

6.1.4 Decreases/*Verlaag*✓ (1)

6.2 The spectral lines of the star are/should be shifted towards the lower frequency ✓ end, which is the red end (red shift) of the spectrum. ✓
Die spektraallyne van die van die ster is verskuif na die laer frekwensie ent, wat die rooi ent van die spektrum is. (2)
[13]

QUESTION 7/*VRAAG 7*

7.1.1 The (magnitude of the) electrostatic force exerted by one (point) charge on another is directly proportional to the product of the charges ✓ and inversely proportional to the square of the distance between their (centres) them. ✓
Die (grootte) van die elektrostatiese krag wat een (punt) lading op 'n ander uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hul middelpunte. (2)

7.1.2 F_E/Electrostatic force/*Elektrostatiese krag*✓ (1)

7.1.3 The electrostatic force is inversely proportional to the square of the distance between the charges ✓
Die elektrostatiese krag is omgekeerd eweredig aan die kwadraat van die afstand tussen die ladings

OR/OF
The electrostatic force is directly proportional to the inverse of the square of the distance between the charged spheres (charges). ✓
Die elektrostatiese krag is direk eweredig aan omgekeerde van die kwadraat van die afstand tussen die gelaaide sfere (ladings).

OR/OF
$F \alpha \frac{1}{r^2}$ ✓

OR/*OF*
They are inversely proportional to each other /*Hulle is omgekeerd eweredig aan mekaar* (1)

7.1.4

OPTION 1/OPSIE 1	1 mark for using slope/ *1 punt vir die gebruik van helling*

Slope/*Helling* = $\frac{\Delta F_E}{\Delta \frac{1}{r^2}}$ ✓ = $\frac{(0,027 - 0)}{(5,6 - 0)}$ ✓

= $4,82 \times 10^{-3}$ N·m^2 ($4,76 \times 10^{-3} – 5 \times 10^{-3}$)

Slope/*Helling* = $F_E r^2 = kQ_1Q_2 = kQ^2$ ✓

$4,82 \times 10^{-3}$ ✓ = $\underline{9 \times 10^9}$ $\underline{Q^2}$ ✓

∴ Q = $7,32 \times 10^{-7}$C ✓

OPTION 2/*OPSIE 2*

Accept any pair of points on the line/*Aanvaar enige paar punte op die lyn*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

( ) ✓ = $\frac{(9 \times 10^9)Q^2}{(\ \ )}$ ✓ ✓✓

Q = $7,32 \times 10^{-7}$C ✓ ($7,32 \times 10^{-7} – 7,45 \times 10^{-7}$ C)

Examples/*Voorbeelde*

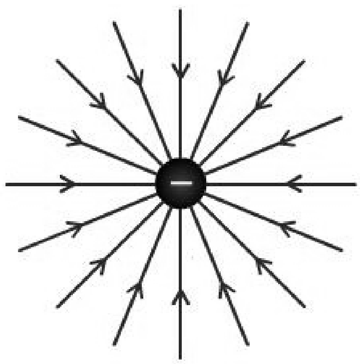
(0,005) ✓ = $\frac{(9 \times 10^9)Q^2}{(\ 1\ )}$ ✓ ✓✓

Q = $7,45 \times 10^{-7}$ C ✓

(0,027) ✓ = $\frac{(9 \times 10^9)Q^2}{\left(\frac{1}{5,6}\right)}$ ✓ ✓✓

Q = $7,32 \times 10^{-7}$ C ✓ (6)

7.2.1



Criteria for drawing electric field: ***Kriteria vir teken van elektriese veld:***	**Marks/*Punte***
Direction /*Rigting*	✓
Field lines radially inward/*Veldlyne radiaal inwaarts*	✓

7.2.2 $E = \dfrac{kQ}{r^2}$ ✓

Take right as positive/*Neem regs as positief*

$E_{PA} = \dfrac{(9\times10^9)(0{,}75\times10^{-6})}{(0{,}09)^2}$ ✓

$= 8{,}33 \times 10^5\ N{\cdot}C^{-1}$ to the left/*na links*

$E_{PB} = \dfrac{(9\times10^9)(0{,}8\times10^{-6})}{(0{,}03)^2}$ ✓

$= 8 \times 10^6\ N{\cdot}C^{-1}$ to the left/*na links*

$E_{net} = E_{PA} + E_{PC}$

$= [-8{,}33 \times 10^5 + (-8 \times 10^6)]$ ✓

$= -8{,}83 \times 10^6$

$= 8{,}83 \times 10^6\ N{\cdot}C^{-1}$ ✓

1 mark for the addition of same signs/
1 punt vir optelling van dieselfde tekens

Take left as positive/*Neem links as positief*

$E_{PA} = \dfrac{(9\times10^9)(0{,}75\times10^{-6})}{(0{,}09)^2}$ ✓

$= 8{,}33 \times 10^5\ N{\cdot}C^{-1}$ to the left/*na links*

$E_{PB} = \dfrac{(9\times10^9)(0{,}8\times10^{-6})}{(0{,}03)^2}$ ✓

$= 8 \times 10^6\ N{\cdot}C^{-1}$ to the left/*na links*

$E_{net} = E_{PA} + E_{PC}$

$= \underline{(8{,}33 \times 10^5 + 8 \times 10^6)}$ ✓

$= 8{,}83 \times 10^6\ N{\cdot}C^{-1}$ ✓

1 mark for the addition of same signs/
1 punt vir optelling van dieselfde tekens

(5)
[17]

QUESTION 8/*VRAAG 8*

8.1.1 (Maximum) energy provided (work done) by a battery per coulomb/unit charge passing through it ✓✓ / *Energie verskaf (arbeid verrig) deur 'n battery per coulomb/eenheid lading wat daardeur vloei.* (2)

8.1.2 12 (V)✓ (1)

8.1.3 0 (V) / Zero/*nul* ✓ (1)

8.1.4 $\varepsilon = I(R + r)$ / $\varepsilon = V_{ext} + V_{int}$ ✓
$12 = 11,7 + Ir$
$\underline{0,3 = I_{tot}(0,2)}$ ✓
$I_{tot} = 1,5$ A ✓

OR/*OF*
V = IR ✓ (Accept/Aanvaar: $V_{\text{"lost"}} = Ir$)
$\underline{0,3 = I_{tot}(0,2)}$ ✓
$I_{tot} = 1,5$ A✓ (3)

8.1.5

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$ / $\frac{1}{R} = \frac{1}{10} + \frac{1}{15}$ ✓Any one *Enigeen*	$R_{\|\|} = \frac{R_1R_2}{R_1 + R_2}$ / $= \frac{(10)(15)}{10+15}$ ✓Any one *Enigeen*
R = 6 Ω ✓	= 6 Ω ✓

(2)

8.1.6

POSITIVE MARKING FROM QUESTIONS 8.1.4 AND 8.1.5/*POSITIEWE NASIEN VANAF VRAE 8.1.4 EN 8.1.5*
OPTION 1/*OPSIE 1*

	OR/OF
V = IR ✓ $11,7$✓ $= \underline{1,5(6 + R)}$ ✓ R = 1,8 Ω ✓	V = IR ✓ $\underline{11,7 = 1,5R}$ ✓ R = 7,8 Ω ↓ $R_R = 7,8 – 6$ ✓ = 1,8 Ω ✓

<u>OPTION 2/*OPSIE 2*</u> $\varepsilon = I(R + r)$ ✓ $\underline{12 = 1{,}5(R + 0{,}2)}$ ✓ $R = 7{,}8\ \Omega$ ↓ $R_R = 7{,}8 - 6$ ✓ $= 1{,}8\ \Omega$ ✓
<u>OPTION 3/*OPSIE 3*</u> $V_{\|\|} = IR_{\|\|}$ $= (6)(1{,}5)$ ✓ $= 9\ V$ $V_R = IR$ ✓ $\underline{(11{,}7 - 9) = (1{,}5)R}$ ✓ $R = 1{,}8\ \Omega$ ✓

(4)

8.2.1

$P_{ave/gemid} = Fv_{ave/gemid}$ ✓ $= mg(v_{ave/gemid})$
$= (0{,}35)(9{,}8)(0{,}4)$ ✓
$= 1{,}37\ W$ ✓

OR/*OF*

$P = \frac{W_{nc}}{\Delta t}$ ✓ $= \frac{\Delta E_k + \Delta E_p}{\Delta t} = \frac{0 + (0{,}35)(9{,}8)(0{,}4 - 0)}{1}$ ✓ $= 1{,}37\ W$ ✓

OR/*OF*

$P = \frac{W}{\Delta t}$ ✓ $= \frac{E_p}{\Delta t} = \frac{(0{,}35)(9{,}8)(0{,}4)}{1}$ ✓ $= 1{,}37\ W$ ✓

(3)

8.2.2

POSITIVE MARKING FROM QUESTION 8.2.1/*POSITIEWE NASIEN VANAF VRAAG 8.2.1*	
<u>OPTION 1/*OPSIE 1*</u> $P = VI$ $\underline{1{,}37 = (3)I}$ ✓ $I = 0{,}46\ A$ $\varepsilon = V_{ext} + V_{int}$ $= V_T + V_X + V_{int}$ $\underline{12 = V_T + 3 + (0{,}2)(0{,}46)}$ ✓ $V_T = 8{,}91\ V$ $V_T = IR_T$ $\underline{8{,}91 = (0{,}46)R_T}$ ✓ $R_T = 19{,}37\ \Omega$ ✓ ✓Any one / *Enigeen*	**<u>OPTION 2/*OPSIE 2*</u>** $P = \frac{V^2}{R}$ $\underline{1{,}37 = \frac{3^2}{R}}$ ✓ $R = 6{,}57\ \Omega$ $P = VI$ $\underline{1{,}37 = (3)I}$ ✓ $I = 0{,}46\ A$ $\varepsilon = I(R + r)$ $\underline{12 = 0{,}46(6{,}57 + R_T + 0{,}2)}$ ✓ $R_T = 19{,}38\ \Omega$ ✓ ✓Any one / *Enigeen*

OPTION 3/*OPSIE 3*

$P = VI$ ✓
$\underline{1,37 = (3)I}$ ✓
$I = 0,46\ A$

$P_{tot} = P_r + P_{motor} + P_T$
$(12)(0,46)$✓ $= \underline{(0,46)^2(0,2) + 1,37 + (0,46)^2R_T}$ ✓
$R_T = 19,41\ \Omega$ ✓

OR/*OF*

$P = VI$ ✓
$\underline{1,37 = (3)I}$ ✓
$I = 0,46\ A$

$P_{tot} = P_r + P_{motor} + P_T$
$\underline{(12)(0,46) = (0,46)^2(0,2) + 1,37 + P_T}$ ✓
$P_T = 4,07\ W$

$P = I^2R$
$\underline{4,07 = (0,46)^2R_T}$ ✓
$R_T = 19,49\ \Omega$ ✓

OPTION 4/*OPSIE 4*

$P = VI$
$1,37 = (3)I$ ✓
$I = 0,46\ A$

✓Any one
Enigeen

$\varepsilon = I(R + r)$
$\underline{12 = (0,46)(R + 0,2)}$ ✓
$R = 25,87\ \Omega$

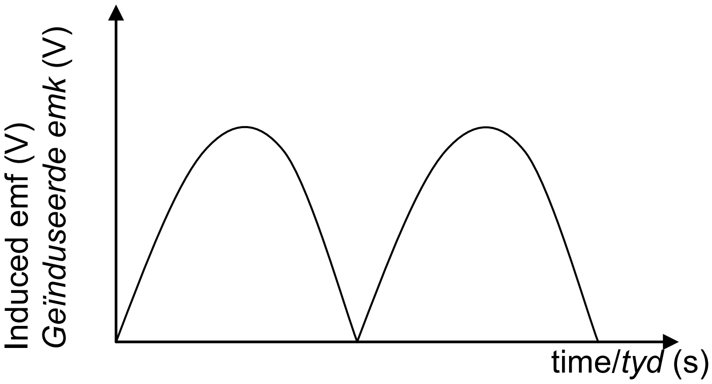
$V = IR$ $\underline{3 = (0,46)R}$✓ $R = 6,52\ \Omega$ $R_T = 25,87 - 6,52$ $= 19,35\ \Omega$ ✓	$P = I^2R$ $\underline{1,37 = (0,46)^2R}$✓ $R = 6,47\ \Omega$ $R_T = 25,87 - 6,47$ $= 19,4\ \Omega$ ✓	$P_{motor} = \frac{V^2}{R}$ $\underline{1,37 = \frac{3^2}{R}}$ ✓ $R = 6,56\ \Omega$ $R_T = 25,87 - 6,56$ $= 19,31\ \Omega$ ✓

(5)
[21]

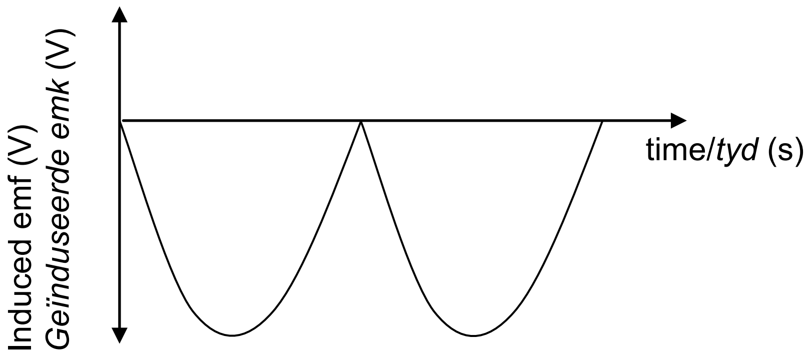
QUESTION 9/*VRAAG 9*

9.1.1 DC/*GS*-generator✓
Uses split ring/commutator/*Gebruik spleetring/kommutator*✓ (2)

9.1.2



OR/*OF*



(2)

9.2.1

OPTION 1/*OPSIE 1*	**OR/*OF***
$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$ $P_{ave/gem} = V_{rms/wgk} I_{rms/wgk}$ ✓ $800 = \frac{340}{\sqrt{2}} (I_{rms/wgk})$ ✓ $I_{rms/wgk} = 3,33$ A ✓	$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}} = \frac{340}{\sqrt{2}} = 240,416$ $P_{ave/gem} = V_{rms/wgk} I_{rms/wgk}$ ✓ $800 = I_{rms/wgk}(240,416)$ ✓ $I_{rms/wgk} = 3,33$ A ✓

OPTION 2/*OPSIE 2*

✓ $P_{ave/gem} = \left(\frac{V^2_{rms/wgk}}{R}\right) = \frac{(V^2_{max/maks})}{(2)(R)}$

$800 = \frac{(340)^2}{(\sqrt{2})^2(R)}$

$R = 72{,}25\ \Omega$

$V_{rms/wgk} = I_{rms/wgk}R$

$I_{rms/wgk} = \frac{240{,}416}{72{,}25}$ ✓

$= 3{,}33\ A$ ✓

OR (from R = 72,25 Ω):

$P_{ave/gem} = I_{rms/wgk}^2 R$

$800 = I_{rms/wgk}^2 (72{,}25)$ ✓

$I_{rms/wgk} = 3{,}33\ A$ ✓

(3)

9.2.2 **POSITIVE MARKING FROM QUESTION 9.2.1**
POSITIEWE NASIEN VANAF VRAAG 9.2.1

OPTION 1/*OPSIE 1*

$P_{ave/gemid} = V_{rms/wgk} I_{rms/wgk}$ ✓

for the kettle/*vir die ketel*:

$2000 = \frac{340}{\sqrt{2}}(I_{rms/wgk})$ ✓

$I_{rms/wgk} = 8{,}32\ A$

$I_{tot} = (8{,}32 + 3{,}33)$ ✓

$= 11{,}65\ A$ ✓

OPTION 2/*OPSIE 2*

$P_{ave/gemid} = \left(\frac{V^2_{rms/wgk}}{R}\right)$ ✓ $= \frac{(V^2_{max/maks})}{(2)(R)}$

$800 = \frac{(340)^2}{(\sqrt{2})^2(R)}$ ✓

$R = 72{,}25\ \Omega$

$2\ 000 = \frac{(340)^2}{(\sqrt{2})^2(R_{2000})}$

$R = 28{,}9\ \Omega$

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ → $R = \frac{(28{,}9)(72{,}25)}{(28{,}9 + 72{,}25)} = 20{,}64\ \Omega$

$V_{rms/wgk} = I_{rms/wgk}\ R$

$240{,}42 = I_{rms/wgk}\ (20{,}64)$ ✓

$I_{rms/wgk} = 11{,}65\ A$ ✓

OPTION 3/*OPSIE 3* $P_{ave/gemid} = V_{rms/wgk}\ I_{rms/wgk}$ ✓ = $\frac{V_{max/maks} I_{max/maks}}{2}$ 2 800✓ = $\frac{(340)\ I_{max/maks}}{2}$ ✓ $I_{max/maks}$ = 16,47 A $I_{rms} = \frac{I_{max/maks}}{\sqrt{2}} = \frac{16,47}{\sqrt{2}}$ $I_{rms/wgk}$ = 11,65 A✓
OPTION 4/*OPSIE 4* $P_{ave/gemid} = V_{rms/wgk}\ I_{rms/wgk}$✓ 2 800 ✓= $\frac{340}{\sqrt{2}}\ I_{rms/wgk}$✓ $I_{rms/wgk}$ = 11,65 A ✓
OPTION 5/*OPSIE 5* P_T : P_K 800 : 2 000 ✓ 1 : 2,5 I_T : I_K 3,33 : 8,325 ✓ I_{rms} = 3,33 + 8,325 ✓ = 11,66 A ✓

(4)
[11]

QUESTION 10/*VRAAG 10*

10.1.1 The minimum frequency (of a photon/light) needed✓ to emit electrons from (the surface of) a metal. (substance) ✓
Die minimum frekwensie (van 'n foton/lig) benodig om elektrone vanaf die (oppervlakte van)'n metaal (stof) vry te stel

OR/OF
The frequency (of a photon/light) needed✓ to emit electrons from (the surface of) a metal. (substance) with zero kinetic energy✓
Die frekwensie (van 'n foton/lig) benodig om elektrone vanaf die (oppervlakte van)'n metaal (stof) met nul/geen kinetiese energie vry te stel (2)

10.1.2 Silver/*Silwer*✓

Threshold/cutoff frequency (of Ag) is higher/*Drumpel/afsnyfrekwensie (van Ag) is hoër*✓
$W_o \propto f_o$ / $W_o = hf_o$ ✓
OR/*OF*
To eject electrons with the same kinetic energy from each metal, light of a higher frequency/energy is required for silver. ✓ Since $E = W_o + E_{k(max)}$ (and E_k is constant), the higher the frequency/energy of the photon/light required, the greater is the work function/W_o.✓
Om elektrone met dieselfde kinetiese energie van elke metal vry te stel,is lig van hoër frekwensie benodig vir silwer. Aangesien $E = W_o + E_{k(maks)}$ (en $E_{k(maks)}$ is konstant) word fotone/lig van hoër frekwensie/energie benodig, dus is arbeidsfunksie hoër (3)

10.1.3 Planck's constant /*Planck se konstante* ✓ (1)

10.1.4 Sodium/*Natrium*✓ (1)

10.2.1 Energy radiated per second by the blue light /*Energie per sekonde uitgestraal deur die bloulig* = $\left(\frac{5}{100}\right)(60 \times 10^{-3})$ ✓ = 3×10^{-3} J·s^{-1}

$E_{photon/foton} = \frac{hc}{\lambda}$ ✓

$= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{470 \times 10^{-9}}$ ✓

$= 4,232 \times 10^{-19}$ J

Total number of photons incident per second/*Totale aantal fotone wat per sekonde inval* = $\frac{3 \times 10^{-3}}{4,232 \times 10^{-19}}$ ✓

$= 7,09 \times 10^{15}$ ✓ (5)

10.2.2 **POSITIVE MARKING FROM QUESTION 10.2.1**
POSITIEWE NASIEN VANAF VRAAG 10.2.1

$7,09 \times 10^{15}$ (electrons per second/*elektron per sekonde*) ✓

OR/*OF*
Same number as that calculated in Question 10.2.1 above/*Dieselfde as die in Vraag 10.2.1 hierbo bereken* (1)
[13]

TOTAL/*TOTAAL*: 150

NATIONAL SENIOR CERTIFICATE EXAMINATION
SUPPLEMENTARY EXAMINATION MARCH 2017

PHYSICAL SCIENCES: PAPER I

Time: 3 hours | 200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 14 pages, an Answer Sheet of 1 page and an Examination Data Sheet of 2 pages (i–ii). Please make sure that your question paper is complete.
2. Answer ALL the questions.
3. Read the questions carefully.
4. Use the data and formulae whenever necessary.
5. Start each question on a new page.
6. Show your working in all calculations.
7. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
8. Where appropriate, express answers to TWO decimal places.
9. It is in your own interest to write legibly and present your work neatly.

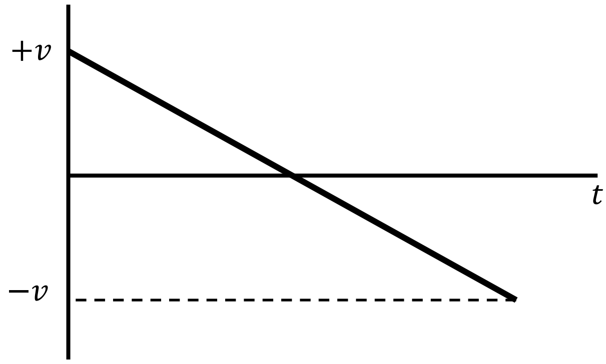
QUESTION 1 MULTIPLE CHOICE

Answer these questions on the multiple-choice Answer Sheet on the inside front cover of your Answer Book. Make a cross (X) in the box corresponding to the letter that you consider to be correct.

1.1 Which group of quantities contains only vectors?

A acceleration, momentum, speed
B velocity, weight, electric field
C energy, momentum, velocity
D work, electric field, acceleration

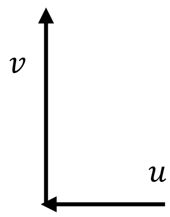
1.2 The velocity vs time graph for a moving object is sketched below. Upwards is taken as positive.



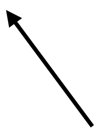
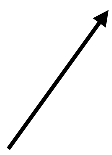
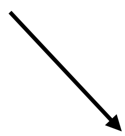
The motion of the object can be described as:

A the object is travelling downwards throughout its motion
B the object is travelling with a constant velocity throughout its motion
C the object's speed is decreasing throughout its motion
D the object is travelling with a constant acceleration throughout its motion

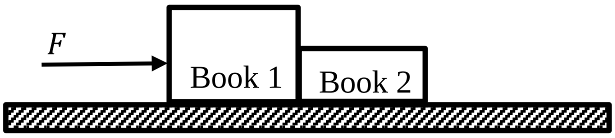
1.3 An orange ball is travelling along a smooth surface with an initial velocity u, when it is struck by another ball. After the collision, the orange ball is travelling with a speed v, which is greater in magnitude than u, in the direction shown below.



Which vector best indicates the direction of the acceleration of the orange ball during this collision?

A 
B 
C 
D 

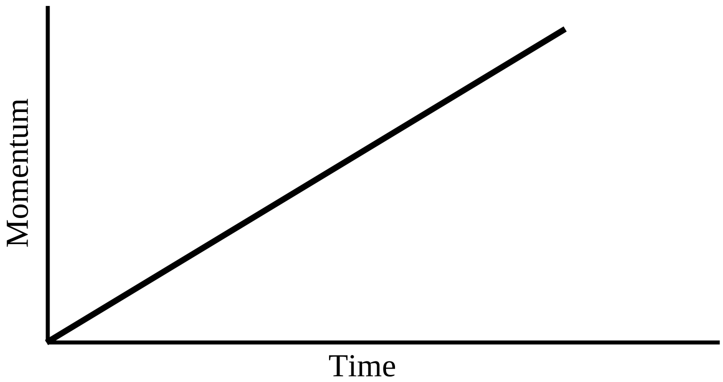
1.4 Peter pushes two books on a frictionless surface with a force F as shown in the diagram.



The force that Book 1 exerts on Book 2 is X. The force that Book 2 exerts on Book 1 is Y. The magnitude of force X compared to force Y is:

A $X = Y$
B $X > Y$
C $X < Y$
D Depends on the acceleration of the system

1.5 The momentum of a car vs time is illustrated in the graph below.



The gradient of the graph represents:

A the velocity of the car
B the resultant force on the car
C the kinetic energy of the car
D the rate of change of velocity of the car

1.6 A ball thrown vertically upwards with an initial velocity v_i reaches a maximum height y. The velocity of the ball when it is halfway up is:

A $\frac{v_i}{2}$

B $\sqrt{v_i - 2gy}$

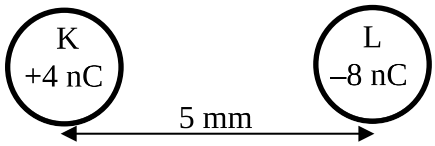
C $\frac{1}{\sqrt{2}} v_i$

D gy

1.7 An object has a weight of 88,20 N on the Earth. The gravitational field strength on the Moon is 1,64 m·s^{-2}. What are the weight and the mass of the object when on the Moon?

	Weight (N)	**Mass (kg)**
A	14,76	1,5
B	14,76	9,0
C	88,20	1,5
D	88,20	9,0

1.8 A metal sphere K has a charge of +4 nC and an identical sphere L has a charge of –8 nC. When the spheres are 5 mm apart, sphere K exerts a force ***F*** on sphere L.



The spheres are then touched together and then replaced in their original position 5 mm apart. What is the magnitude of the force that sphere K now exerts on sphere L?

A $\frac{1}{8}\boldsymbol{F}$

B $\frac{1}{4}\boldsymbol{F}$

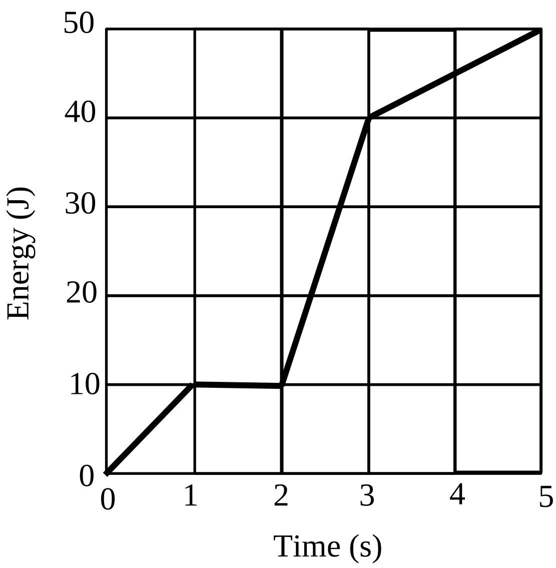
C $\frac{1}{2}\boldsymbol{F}$

D ***F***

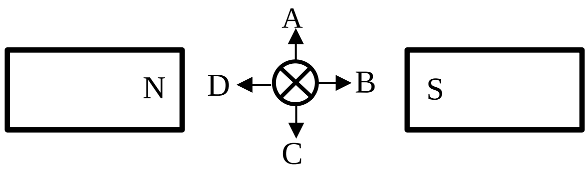
1.9 An electrical generator is started at time zero. The total electrical energy generated during the first 5 s is shown in the graph on the right.

During which time interval during these 5 s is the maximum electrical power generated?

A 0–1 s
B 1–2 s
C 2–3 s
D 3–5 s



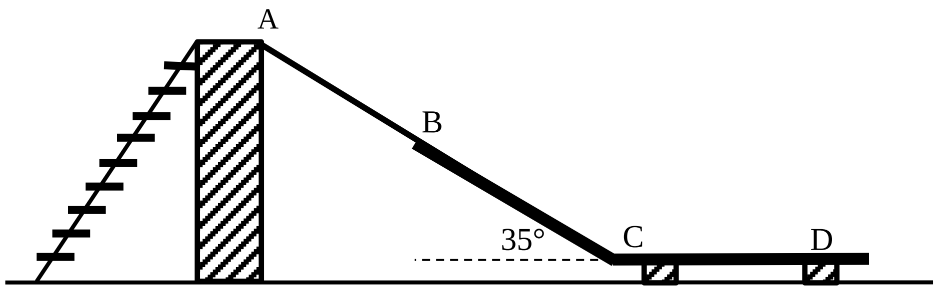
1.10 A conductor carries a current perpendicularly into the page between the poles of two magnets as shown in the diagram. In what direction will the conductor experience a force?



[20]

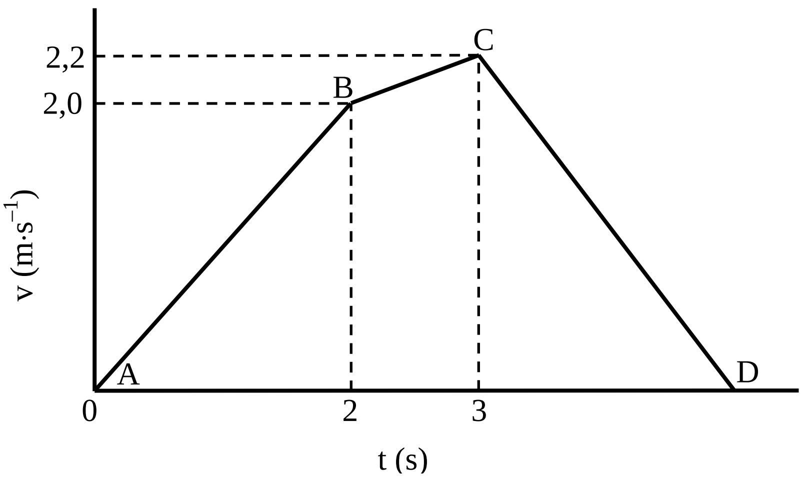
QUESTION 2 KINEMATICS

A slide in a playground has a structure as shown in the diagram below.



Children climb up the stairs and slide down starting at point A. The surface AB is smooth, while the surface BD has been covered so that there is friction present along BD.

A boy of mass 30 kg slides down the slide. The magnitude of the boy's velocity is represented on the velocity-time graph shown.



2.1 Define *velocity*. (2)

2.2 Define *acceleration*. (2)

2.3 Calculate the magnitude of the boy's acceleration while sliding on slope BC. (3)

2.4 Draw a labelled, free-body diagram of the boy while sliding on BC. (3)

2.5 Calculate the magnitude of the frictional force acting on the boy while sliding on slope BC. (5)

2.6 Calculate the length of the slide ABC. (4)

The boy slows down on the flat surface CD at 1,1 $m \cdot s^{-2}$.

2.7 Calculate the time taken from C for the boy to stop. (3)

2.8 What is the minimum length of CD required to ensure the boy comes to rest and does not slide over the edge at D? (3)

[25]

QUESTION 3 KINEMATICS

A group of students decided to measure the acceleration due to gravity. They carried out an experiment by dropping a small steel ball (mass 10 g) from different heights and measured the time taken (t) for the ball to fall through the particular height (h).

The results are recorded in the table below:

h (m)	t (s)	t^2 (s^2)
0,4	0,27	0,07
0,7	0,40	0,16
1,2	0,47	0,22
1,7	0,60	0,36
2,1	0,64	0,41
2,5	0,72	0,52

The students decided to plot h vs t^2.

3.1 Why is it necessary to plot h vs t^2 rather than h vs t? (3)

3.2 Use the data in the table to plot a graph of h (y-axis) vs t^2 (x-axis) on the graph paper provided on the **Answer Sheet**. (6)

3.3 Calculate the gradient of the graph. Indicate the values you used for this calculation on your graph. (4)

3.4 Write an equation of motion that describes the relationship between h and t^2. (2)

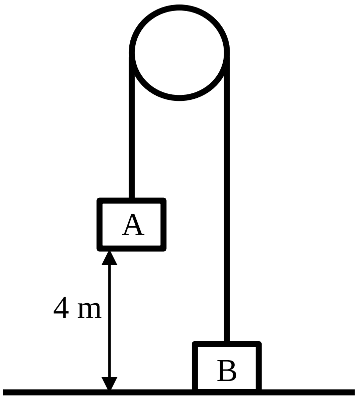
3.5 Use your answer from Question 3.4 and your knowledge that the equation $y = mx + c$ describes a straight line to determine the acceleration due to gravity. (2)

3.6 The students repeated the experiment with a ball of twice the mass. Describe the graph of h vs t^2 for the heavier mass in comparison with the graph plotted for the 10 g ball. Briefly explain your answer. (2)

[19]

QUESTION 4 NEWTON'S LAWS

Two identical blocks A and B are connected by a light, inextensible string that passes over a frictionless pulley as shown in the diagram. Each block has a mass of 2 kg. Initially block B is resting on the ground while block A is 4 m above the ground.



A block of mass 1 kg is placed on block A. The system accelerates as a result.

4.1 Draw a labelled free-body diagram of the forces acting on block B after it has left the ground and while it is accelerating upwards. The relative sizes of the forces must be clear. (3)

4.2 State *Newton's second law of motion*. (2)

4.3 Calculate the magnitude of the acceleration of the system. (5)

4.4 Calculate the tension in the string joining block A and block B while the blocks are accelerating. (2)

Block A hits the floor with a speed of 3,96 $m \cdot s^{-1}$ and comes to rest almost immediately.

4.5 Determine the resultant force acting on block B just after block A has reached the floor. (2)

4.6 Define *mechanical energy*. (2)

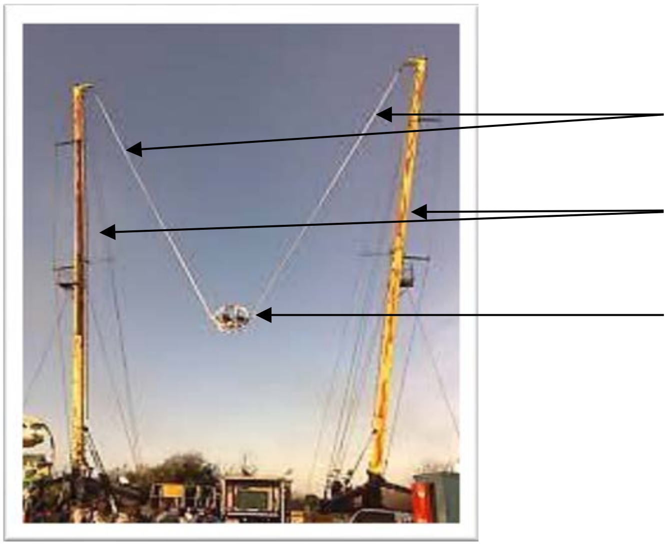
4.7 Explain why the conservation of mechanical energy may be used to calculate the maximum height reached by block B. (2)

4.8 Use the principle of conservation of mechanical energy to calculate the maximum height from the ground reached by block B. (4)

[22]

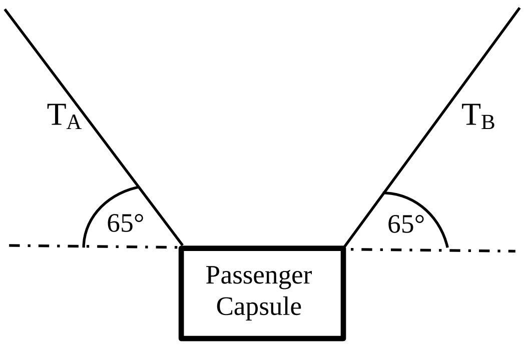
QUESTION 5 FORCE, WORK, ENERGY AND POWER

A reverse bungee is a thrill ride where passengers are strapped into a capsule and are shot into the air by using a pair of strong bungee cords (thick, elastic cables with negligible mass).



[Source: <www.teoc.ws>]

Consider the cables at the bottom of the bungee, i.e. at the lowest point. The cables exert a maximum tension at this point of 7 000 N per cable and the cables are angled at 65° to the horizontal at this point. (See the diagram below.)



T_A: The tension exerted by cable A

T_B: The tension exerted by cable B

5.1 Calculate the total upward force that the bungee cables exert on the passenger capsule at this point. (3)

5.2 Define *resultant vector*. (2)

5.3 Calculate the mass of a capsule if it experiences a net force of 4 000 N upwards at this point as it is released. (5)

At a height of 25 m above the release point, a different capsule of mass 320 kg has a speed of 19 $m \cdot s^{-1}$.

5.4 State the *work-energy theorem*. (2)

5.5 Calculate the work done by the net force on the capsule to get the capsule to this point. (3)

5.6 Calculate the increase in mechanical energy of the capsule at this point. (5)

5.7 Calculate the **average applied force** that the cables exerted on the capsule to accelerate it to the speed of 19 $m \cdot s^{-1}$. (4)

5.8 Calculate the maximum height from the release position that the capsule will reach if the cable exerts no further force on the capsule, i.e. the capsule is free to move upwards from the 25 m position. (4)

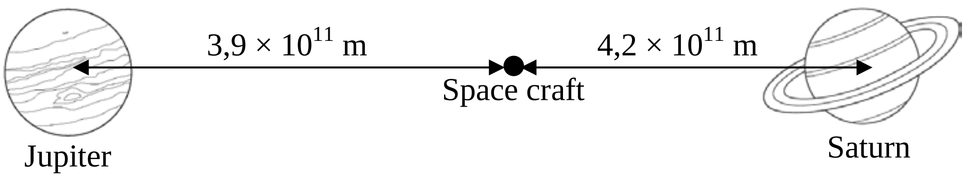
5.9 Sketch a position vs time graph for the upward motion of the capsule from its release position to its maximum height. Show on the graph the height 25 m and the maximum height reached. (4)

[32]

QUESTION 6 FIELDS

6.1 A spacecraft on a mission to explore the outer solar system was between Jupiter and Saturn at the distances shown on the diagram.

The mass of Jupiter is $1{,}9 \times 10^{27}$ kg and the mass of Saturn is $5{,}7 \times 10^{26}$ kg.



[Source: images of Jupiter and Saturn available at <http://www.windows2universe.org/coloring_book/>]

6.1.1 State *Newton's Law of Universal Gravitation*. (2)

The mass of the spacecraft is $2{,}2 \times 10^{3}$ kg.

6.1.2 Calculate the magnitude of the force that Jupiter exerts on the spacecraft at the position shown. (3)

6.1.3 Calculate the magnitude of the acceleration experienced by the spacecraft at the position shown. (6)

6.2 A small metal sphere has a charge of +5 nC. The electric field is measured to have a magnitude of 312 500 $N \cdot C^{-1}$ at an unknown distance from the charge.

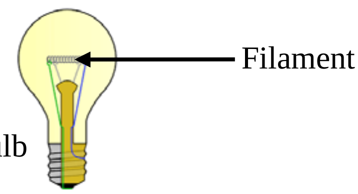
6.2.1 Define *electric field*. (2)

6.2.2 Calculate the distance from the charge where the electric field strength was measured. (3)

[16]

QUESTION 7 ELECTRIC CIRCUITS

7.1 Older torches have bulbs that are filament light bulbs.



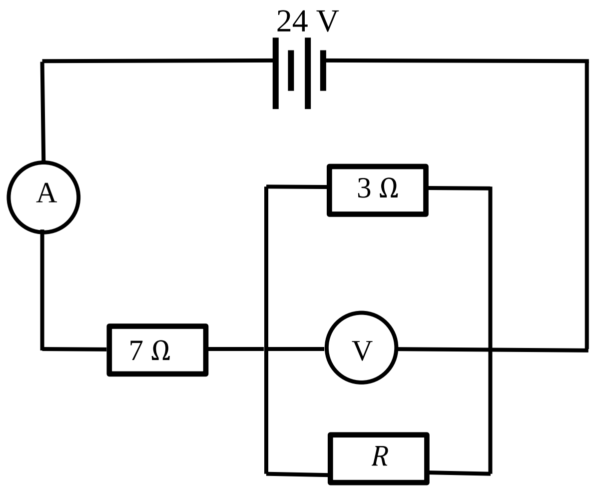
[Source: Image from <http://caitboo.com/?p=230>]

7.1.1 Is the filament light bulb an ohmic conductor? Explain your answer. (3)

7.1.2 Draw a sketch graph of V (y-axis) vs I (x-axis) for a filament light bulb. (2)

7.1.3 When used in a torch, the filament light bulb gets hot while the wires connecting the bulb to the battery do not, even though the current in both is the same. Explain the difference in temperature by making use of a relevant equation. (3)

7.2 Three resistors are connected to a 24 V battery of negligible internal resistance as shown in the diagram. The battery supplies 60 W of power to the circuit. The value of the resistance of resistor R is unknown.



7.2.1 Define *power*. (2)

7.2.2 Calculate the reading on the ammeter. (3)

7.2.3 State *Ohm's law*. (2)

7.2.4 Calculate the potential difference across the 7 Ω resistor. (3)

7.2.5 Calculate the reading on the voltmeter. (2)

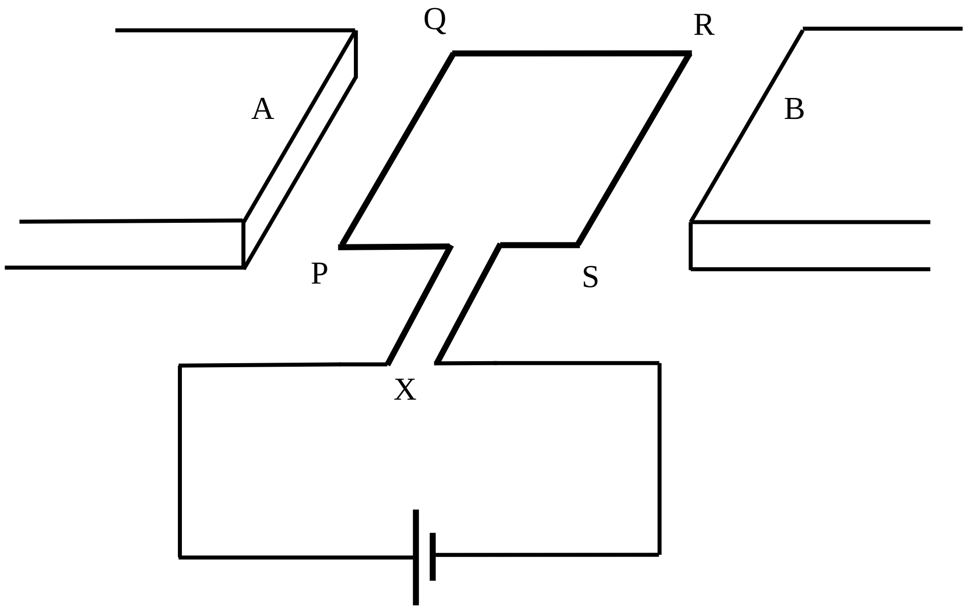
7.2.6 Determine the current flowing through resistor R. (5)

7.2.7 Hence calculate the value of the resistance of resistor R. (3)

[28]

QUESTION 8 ELECTRODYNAMICS

8.1 A student constructs an electromagnetic device as shown in the diagram. The poles of the magnets are labelled A and B.



8.1.1 Is the electromagnetic device being used as a motor or a generator? Use energy considerations to motivate your answer. (2)

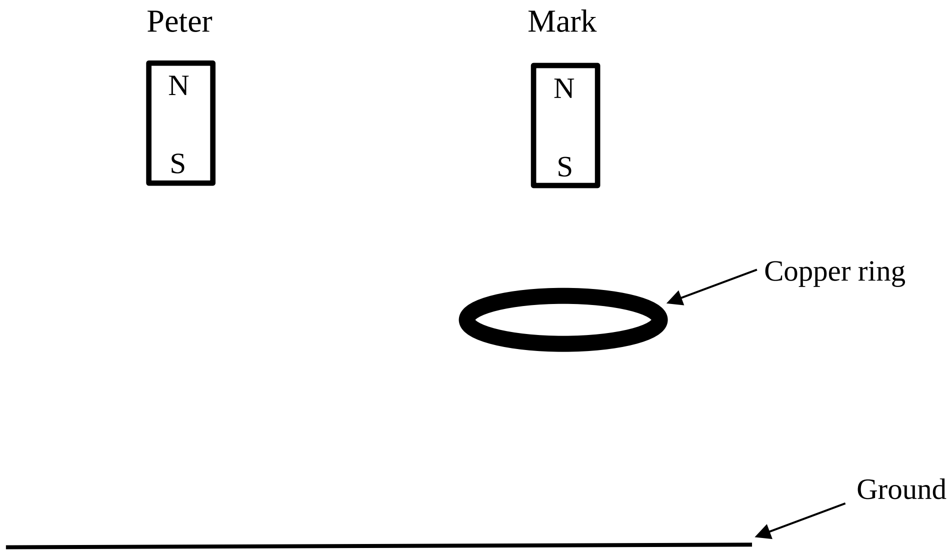
8.1.2 Is the direction of the conventional current in the coil PQRS or SRQP? (2)

8.1.3 When viewing the coil from position X, the coil rotates anticlockwise. Is the pole labelled A, north or south? (2)

8.1.4 When the coil reaches its vertical direction, state the direction of the force acting on side PQ. (2)

8.1.5 Does the coil rotate continuously in one direction? Briefly explain your answer. (3)

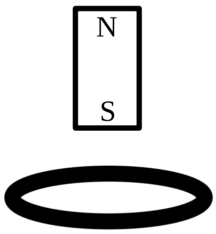
8.2 Two students, Peter and Mark, each drop a magnet from the same height. Peter simply drops the magnet, while Mark drops the magnet through a copper ring. Both students drop the magnet with the south pole facing downwards.



8.2.1 Describe the change in energy when Mark drops the magnet. (3)

8.2.2 State *Lenz's law*. (2)

The diagram below shows the copper ring with the magnet approaching.



8.2.3 State the direction of the current in the copper ring (clockwise or anticlockwise). (2)

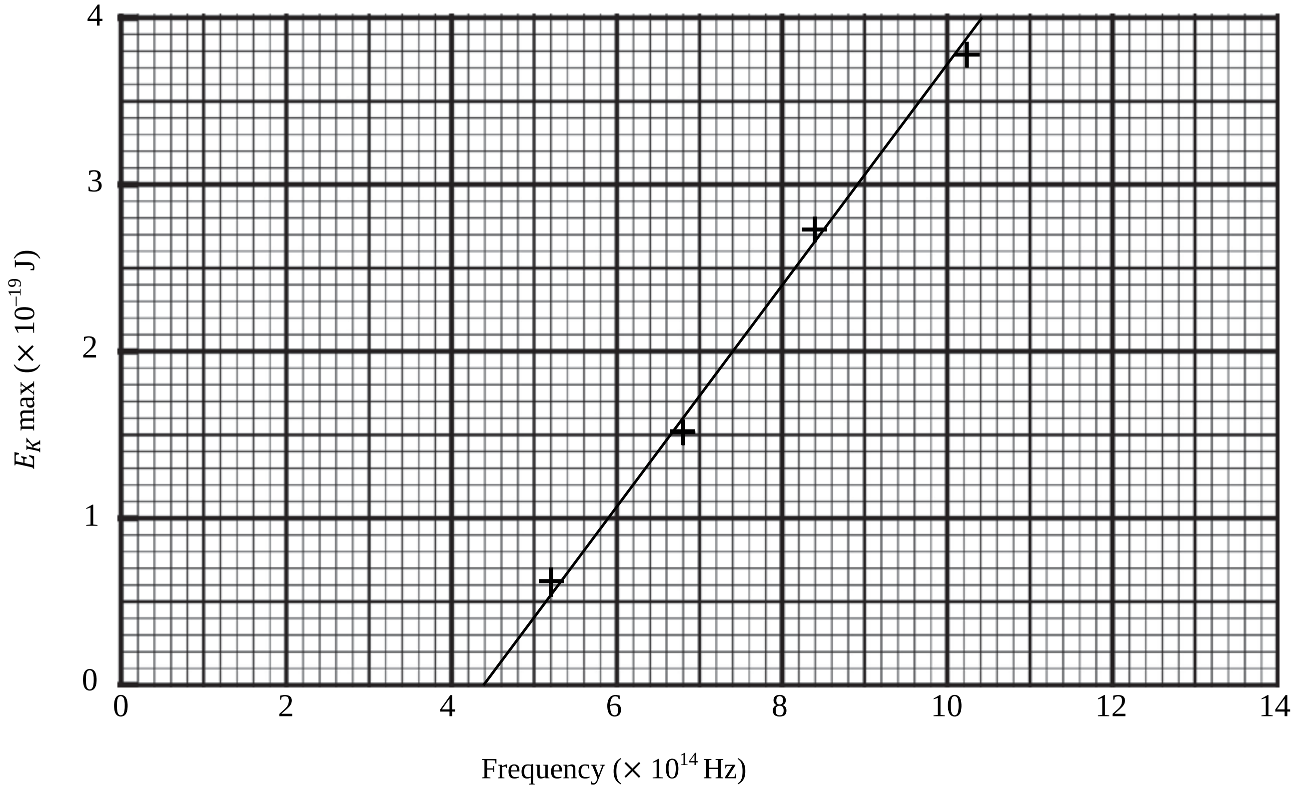
8.2.4 Will the magnets reach the ground at the same time if dropped simultaneously? If not, whose magnet will reach the ground first? Explain your answer. (4)

[22]

QUESTION 9 PHOTONS AND ELECTRONS

In experiments to demonstrate the photoelectric effect, a beam of light with a single frequency is shone onto a clean, metal surface. The maximum kinetic energy of the ejected electrons was measured.

The experiment was repeated at different frequencies of light and the graph of maximum kinetic energy vs frequency was obtained for potassium metal.



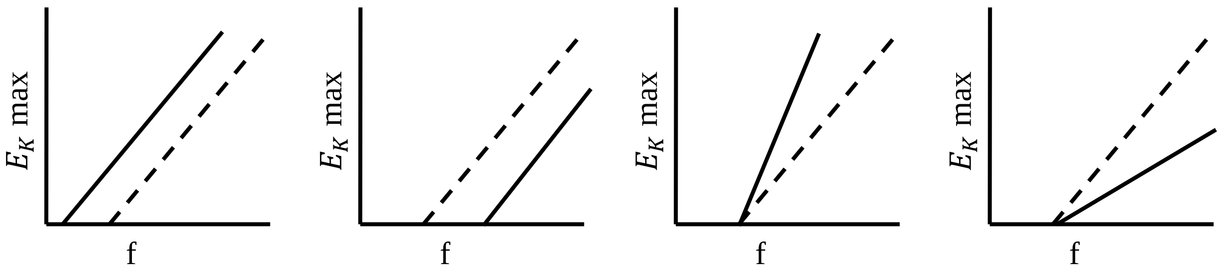
9.1 Define *threshold frequency*. (2)

9.2 Use the graph to help you determine the minimum energy needed to eject an electron from the surface of potassium. (3)

9.3 Use the graph to describe the relationship between maximum kinetic energy and the frequency of the incident light. (3)

The work function of copper is double the work function of potassium.

9.4 The experiment is repeated with copper instead of potassium. Which one of the graphs below would best represent the results for copper (———)? The graph for potassium (– – – –) has been included for comparison. Explain your choice of answer by referring to relevant features of the graph. (4)



A B C D

9.5 Light of frequency 15×10^{14} Hz is incident on the copper metal. Calculate the kinetic energy of the electrons ejected from **copper**. (4)

[16]

Total: 200 Marks

NATIONAL SENIOR CERTIFICATE EXAMINATION
SUPPLEMENTARY EXAMINATION MARCH 2017

PHYSICAL SCIENCES: PAPER I

MARKING GUIDELINES

Time: 3 hours | 200 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

QUESTION 1 MULTIPLE CHOICE

1.1 B
1.2 D
1.3 C
1.4 A
1.5 B
1.6 C
1.7 B
1.8 A
1.9 C
1.10 C (2 × 10 = 20)

[20]

QUESTION 2 KINEMATICS

2.1 *Velocity is rate of displacement OR rate of change of position OR rate of change of displacement.* ✓✓ (2)

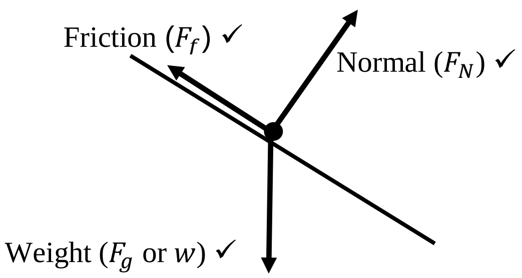
2.2 *Acceleration is the rate of change of velocity.* ✓✓ (2)

2.3 a = slope of v–t graph OR $\frac{\Delta v}{\Delta t}$ ✓ OR v = u + at ✓

a = $\frac{2,2-2,0}{1}$ ✓ 2,2 = 2,0 + a(1) ✓

a = 0,2 m·s^{-2} ✓ **a = 0,2 m·s^{-2}**✓ (3)

2.4



(3)

2.5 F_{net} = ma ✓

mg sin 35° ✓ – F_f ✓ = (30)(0,2)✓

$\boldsymbol{F_f}$ = **162,63 N** ✓ (5)

2.6 distance = area under v–t graph✓

distance = $\frac{1}{2}$(2)(2) + $\frac{1}{2}$(1)(0,2) + (1)(2) ✓✓

distance = 4,1 m ✓ (4)

2.7 $v = u + at$ ✓

0 = 2,2 – 1,1t✓

t = **2 s** ✓ (3)

2.8 $v^2 = u^2 + 2at$ ✓ OR s = area under v–t graph ✓

0 = $(2,2)^2$ + 2(–1,1)s✓ s = $\frac{1}{2}$(2)(2,2) ✓

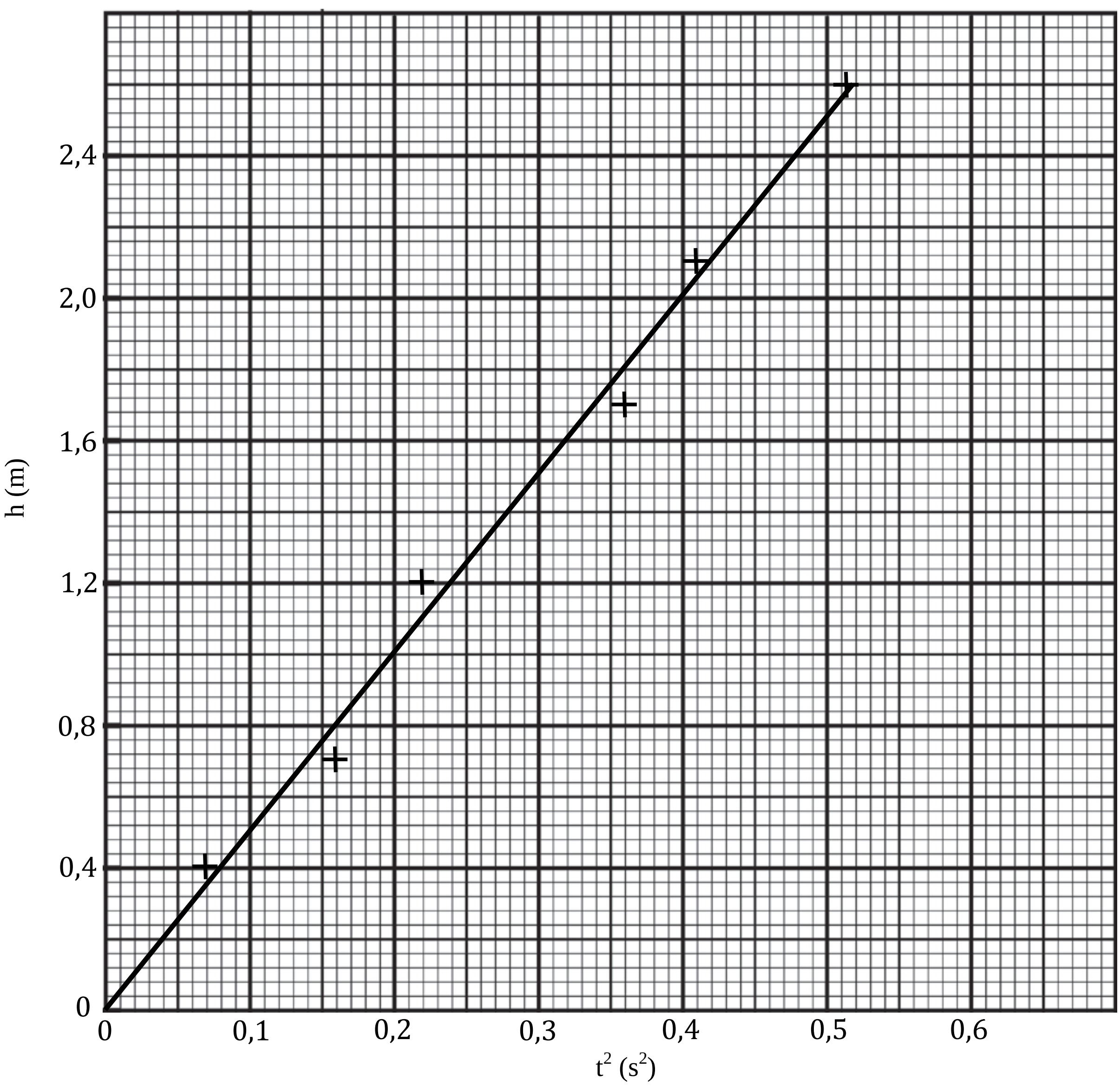
***s* = 2,2 m** ✓ ***s* = 2,2 m** ✓ (3)

[25]

QUESTION 3 KINEMATICS

3.1 To carry out analysis, a straight line is most useful. ✓ The graph of h vs t yields a curved line ✓ while h vs t^2 is linear. ✓ (3)

3.2 Graph of h vs t^2



Heading ✓
y-axis title and unit ✓
x-axis title and unit ✓
scale (plotted points > $\frac{1}{2}$ graph paper, scale must be in sensible multiples) ✓
plotted points (all 6 points plotted within half small block) ✓
line of best fit (with a ruler) ✓ (6)

3.3 Gradient = $\frac{\Delta y}{\Delta x}$ ✓

Gradient = $\frac{values\ \ from\ \ y-axis}{values\ \ from\ \ x-axis}$ ✓✓ (–1 if not shown on graph)

Gradient = 4,84 ✓ (allow 4,58–5,10) (4)

3.4 $h = \frac{1}{2}at^2$ ✓✓ (2)

3.5 $\text{slope} = \frac{1}{2}a$

$4{,}84 = \frac{1}{2}a$ ✓

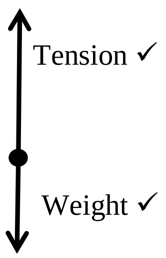
$\boldsymbol{a} = \mathbf{9{,}68\ m\cdot s^{-2}}$ ✓ **(allow 9,16–10,20)** (2)

3.6 Same graph ✓ as acceleration due to gravity (g) is independent of the mass of the falling object. ✓ (2)

[19]

QUESTION 4 NEWTON'S LAWS

4.1



Tension > weight✓

(3)

4.2 *When a <u>net force</u> is applied on an object of mass m, the object accelerates in the direction of the net force. The acceleration is directly proportional to the net force and inversely proportional to the mass.* ✓✓ (2)

4.3 For block A:

$F_{net} = ma$ ✓

$mg - T = ma$

$3(9{,}8) - T$ ✓ $= 3a$ ✓

$\mathbf{a = 1{,}96\ m\cdot s^{-2}}$ ✓

For block B:

$T - mg = ma$

$T - 2(9{,}8) = 2a$

(5)

4.4 $T = 2(1{,}96) = 2(9{,}8)$ ✓

$\boldsymbol{T} = \mathbf{23{,}56\ N}$ ✓ (2)

4.5 $W = mg$ ✓

$\boldsymbol{W} = \mathbf{19{,}6\ N}$ ✓ (2)

4.6 *Mechanical energy is the sum of gravitational potential energy and kinetic energy* ✓ *at a point.* ✓ (2)

4.7 No external forces or friction are acting on block B once A has hit the floor. ✓✓ (2)

4.8 E_K of B when A hits ground $= E_P$ of B at top ✓

$\frac{1}{2}(2)(3{,}96)^2 = (2)(9{,}8)h$ ✓

$h = 0{,}80\text{ m}$ ✓

height above ground = 4 + 0,8

height above ground = 4,8 m ✓ (4)

[22]

QUESTION 5 FORCE, WORK, ENERGY AND POWER

5.1 $F_{up} = 2T \sin 65°$ ✓
$F_{up} = 2(7\ 000) \sin 65°$ ✓
$\boldsymbol{F_{up}}$ **= 12 688,31 N** ✓ (3)

5.2 *Resultant vector is the single vector that has the same effect as the original vectors acting together.* ✓✓ (2)

5.3 $F_{net} = F_{up} - w$ ✓
$4\ 000 = 12\ 688,31 - w$ ✓
$w = 8\ 688,31$ N ✓

$w = mg$
$8\ 688,3 = m\,(9,8)$ ✓
$\boldsymbol{m}$ **= 886,56 kg** ✓ (5)

5.4 *Work-energy theorem states that the* *<u>work done by a net force</u>* ✓ *on an object is equal to the* *<u>change in kinetic energy of the object</u>*. ✓ (2)

5.5 $W_{net} = \Delta E_K$ ✓
$W_{net} = \frac{1}{2}(320)(19^2 - 0)$ ✓
$\boldsymbol{W_{net}}$ **= 57 760 J** ✓ (3)

5.6 $W_{mech} = \Delta E_K + \Delta E_P$ ✓
$W_{mech} = 57\ 760$ ✓ + (320)(9,8)(25) ✓
$W_{mech} = 57\ 760 + 78\ 400$ ✓
$\boldsymbol{W_{mech}}$ **= 136 160 J** ✓ (5)

5.7 $F_{applied} \cdot s = 136\ 160$ ✓
$F_{applied}(25)$ ✓ $= 136\ 160$ ✓
$\boldsymbol{F_{applied}}$ **= 5 446,4 N** ✓ (4)

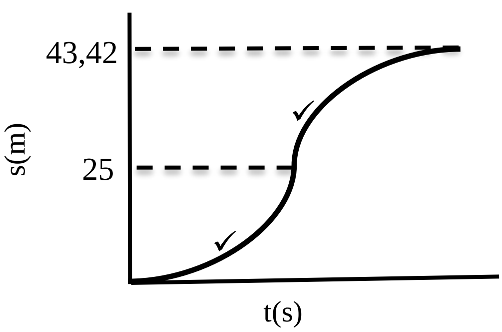
5.8 $v^2 = u^2 + 2at$ ✓
$0 = 19^2 + 2(-9,8)s$ ✓
$s = 18,42$ m ✓

height = 18,42 + 25
height = **43,42 m** ✓

OR

$136\ 160 = mgh$ ✓
$136\ 160 = (320)(9,8)h$ ✓✓
$\boldsymbol{h}$ **= 43,42 m** ✓ (4)

5.9



✓ axes labelled
✓ values indicated

(4)

[32]

QUESTION 6 FIELDS

6.1 6.1.1 *Newton's Law of Universal Gravitation: Every particle in the universe attracts every other particle with a force that is directly proportional to the product of their masses ✓ and inversely proportional to the square of the distance (between their centres).*✓ (2)

6.1.2 $F_J = \frac{GM_J m_s}{r^2}$ ✓

$F_J = \frac{(6{,}7\times10^{-11})(1{,}9\times10^{27})(2{,}2\times10^{3})}{(3{,}9\times10^{11})^2}$ ✓

$\boldsymbol{F_J = 1{,}84\times10^{-3}}$ **N**✓ (3)

6.1.3 $F_S = \frac{GM_s m_s}{r^2}$ ✓

$F_S = \frac{(6{,}7\times10^{-11})(5{,}7\times10^{26})(2{,}2\times10^{3})}{(4{,}2\times10^{11})^2}$

$\boldsymbol{F_S = 4{,}76\times10^{-4}}$ N ✓

$F_{net} = F_J - F_S$

$F_{net} = 1{,}84\times10^{-3} - 4{,}76\times10^{-4}$ ✓

$F_{net} = 1{,}36\times10^{-3}$ N ✓

$F_{net} = ma$

$1{,}36\times10^{-3} = 2{,}2\times10^{3} a$

$a = 6{,}2\times10^{-7}\, m\cdot s^{-2}$ ✓

(6)

6.2 6.2.1 *Electric field is the force per unit positive charge.* ✓✓ (2)

6.2.2 $E = \frac{kQ}{r^2}$ ✓

$312\ 500 = \frac{(9\times10^{9})(5\times10^{-9})}{r^2}$

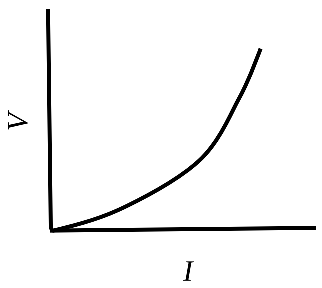
r = 0,012 m ✓ (3)

[16]

QUESTION 7 ELECTRIC CIRCUITS

7.1 7.1.1 No, ✓ a filament light bulb is non-ohmic. The current through the filament is not directly proportional to the potential difference across the filament ✓ (or does not obey Ohm's law) as resistance changes with temperature. ✓ (3)

7.1.2



Labelled axes ✓
Correct curve ✓

(2)

7.1.3 $P = I^2R$✓
The resistance of the bulb > resistance of the wires ✓
So even for same current $P_{bulb} > P_{wires}$✓ ✓ (3)

7.2 7.2.1 *Power is the rate of doing work.* ✓✓ (2)

7.2.2 $P = VI$✓
$60 = 24I$ ✓
$\boldsymbol{I = 2{,}5\ \text{A}}$ ✓ (3)

7.2.3 *Ohm's law states that the current through a conductor is directly proportional to the potential difference across the conductor at constant temperature.* ✓✓ (2)

7.2.4 $V = RI$ ✓
$V = (7)(2{,}5)$ ✓
$\boldsymbol{V = 17{,}5\ \text{V}}$ ✓ (3)

7.2.5 $V_{volt} = 24 - 17{,}5$ ✓
$\boldsymbol{V_{volt} = 6{,}5\ \text{V}}$ ✓ (2)

7.2.6 $V = IR$
$6{,}5 = 3I$ ✓
$I = 2{,}17\ \text{A}$ ✓

$I_R = I_{total} - I_{7\Omega}$ ✓
$I_R = 2{,}5 - 2{,}17$ ✓
$\boldsymbol{I_R = 0{,}33\text{A}}$ ✓ (5)

7.2.7 $V = IR$
$6{,}5 = R\ (0{,}33)$ ✓✓
$\boldsymbol{R = 19{,}70\ \Omega}$ ✓ (3)

[28]

QUESTION 8 ELECTRODYNAMICS

8.1 8.1.1 Motor ✓ as electrical energy → mechanical energy ✓ (2)

8.1.2 PQRS ✓✓ (2)

8.1.3 North ✓✓ (2)

8.1.4 Down ✓✓ (2)

8.1.5 No ✓, there is no split ring commutator ✓
so when PQ is next to pole B, force on wire is up. ✓ (3)

8.2 8.2.1 gravitational potential energy ✓ to kinetic energy ✓ AND electrical energy ✓ (3)

8.2.2 *Lenz's law: the induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux.* ✓✓ (2)

8.2.3 clockwise ✓✓ (2)

8.2.4 No ✓, Peter's magnet will reach the ground first; ✓ induced current in the ring will set up a magnetic field to oppose the magnet falling. ✓ The acceleration of the magnet falling through the ring will be less than *g*. ✓ (4)

[22]

QUESTION 9 PHOTONS AND ELECTRONS

9.1 *Threshold frequency is the* <u>*minimum frequency*</u> *of incident radiation at which electrons will be emitted from a particular metal.* ✓✓ (2)

9.2 $E = hf$ ✓
$E = (6,6 \times 10^{-34})(4,4 \times 10^{14})$ ✓
$\boldsymbol{E = 2,90 \times 10^{-19}}$ **J** ✓ (3)

9.3 If $f > f_0$ ✓ then E_K max increases as frequency increases. ✓
If $f < f_0$ then E_K max is zero and no electrons are ejected. ✓ (3)

9.4 B✓✓
f_0 is double as W_0 is double, therefore greater x intercept. ✓
Slope = h therefore constant slope✓ (4)

9.5 $hf = W_0 + E_{K\,max}$ ✓
$(6,6 \times 10^{-34})(15 \times 10^{14})$ ✓ $= 2\,(2,90 \times 10^{-19}) + E_{K\,max}$
$\mathbf{E_{K\,max} = 4,1 \times 10^{-19}}$ **J** ✓ (4)

[16]

Total: 200 marks