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.

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 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 ...

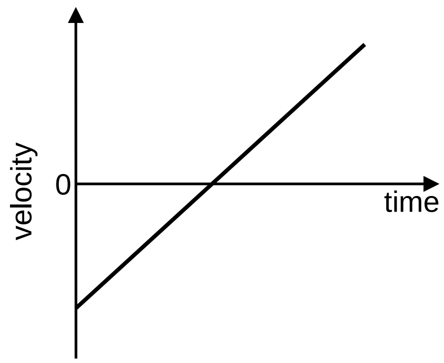
A mass of the object.

B acceleration of the object.

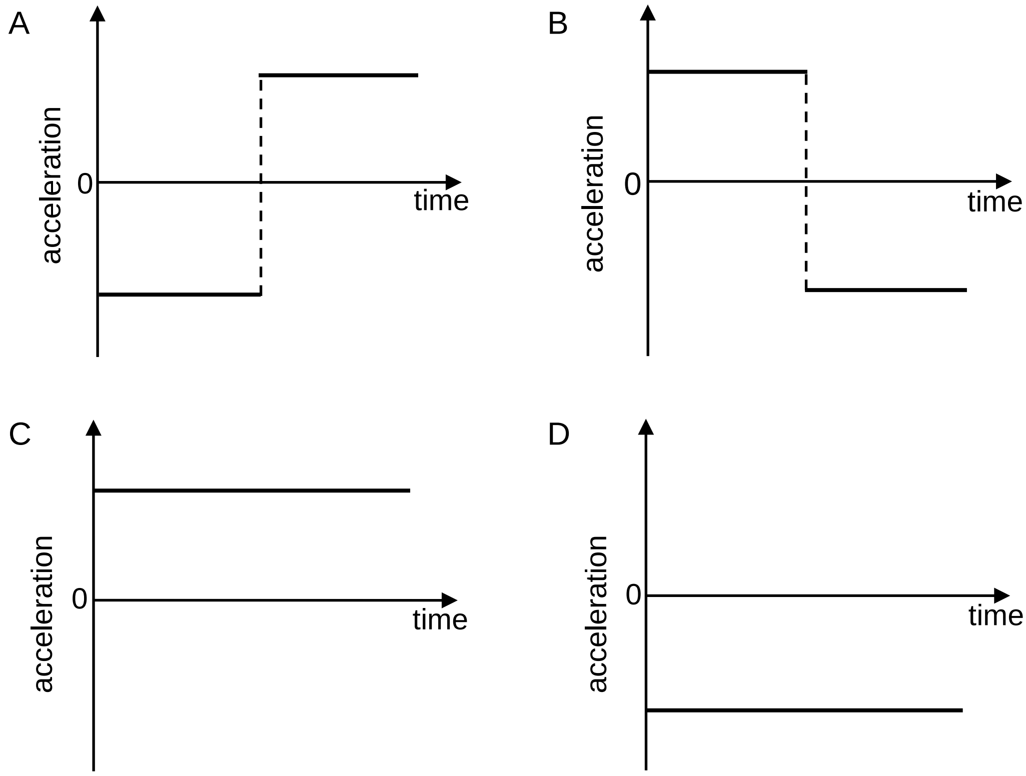
C change in momentum of the object.

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?



(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 $\frac{1}{2}a$

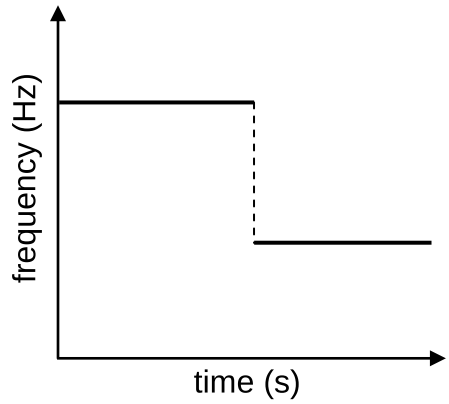
C a

D $2a$ (2)

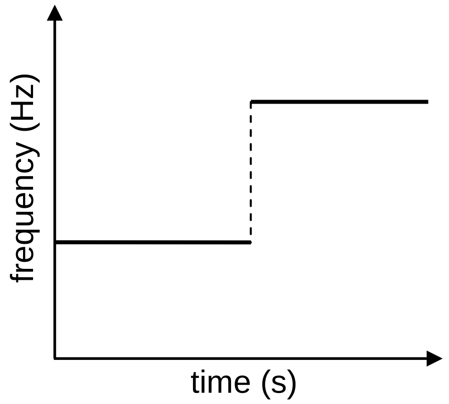
2.5 A source of sound approaches a stationary listener in a straight line at constant velocity. It passes the listener and moves away from him in the same straight line at the same constant velocity.

Which ONE of the following graphs best represents the change in observed frequency against time?

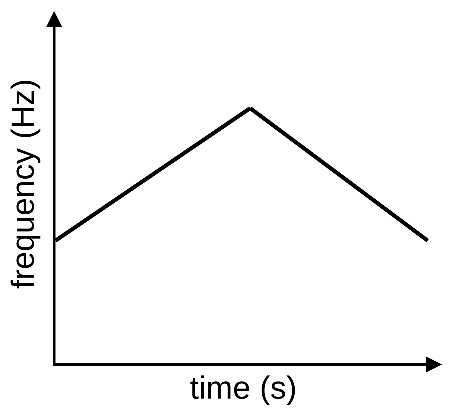
A



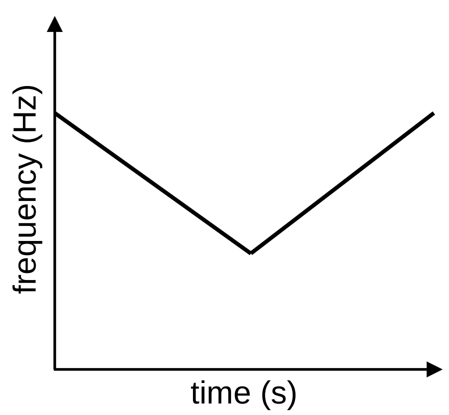
B



C

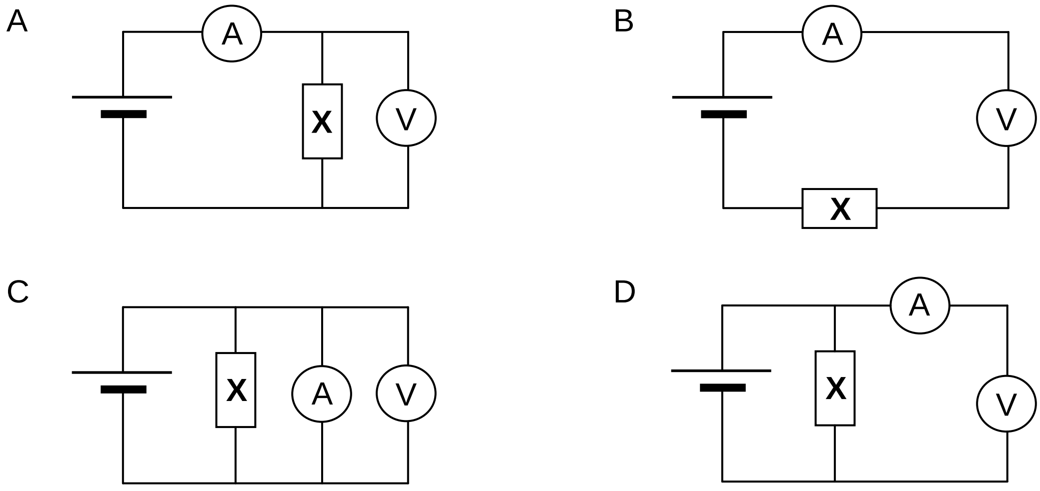


D



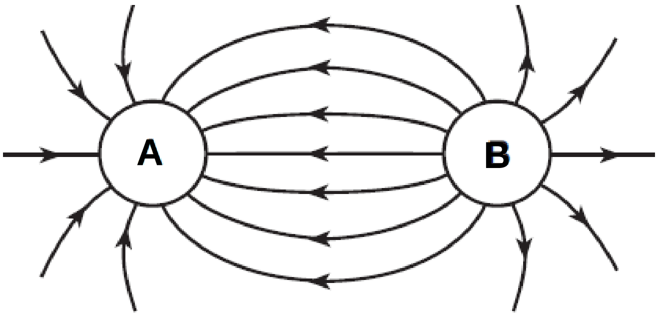
(2)

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?

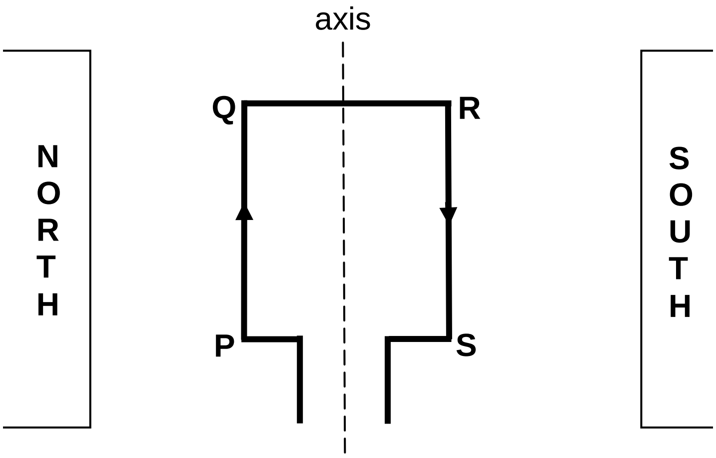
A X-rays; ultraviolet rays; infrared rays; visible light

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 ...

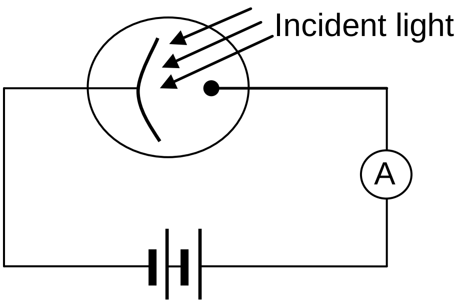
A rotate clockwise.

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.

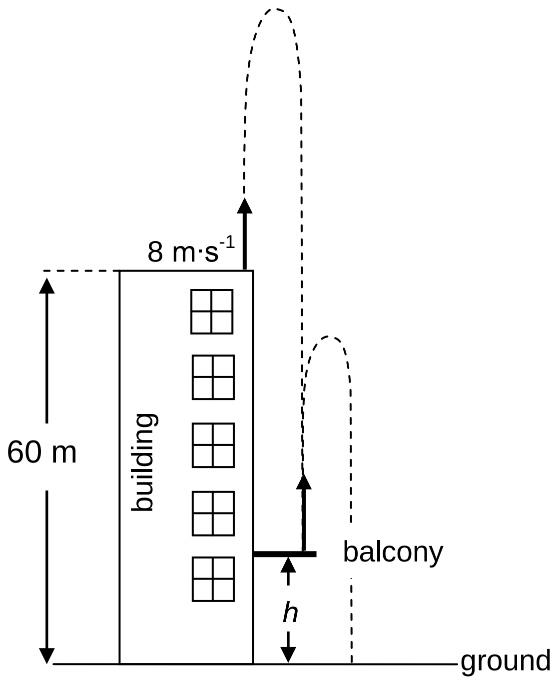
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

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)

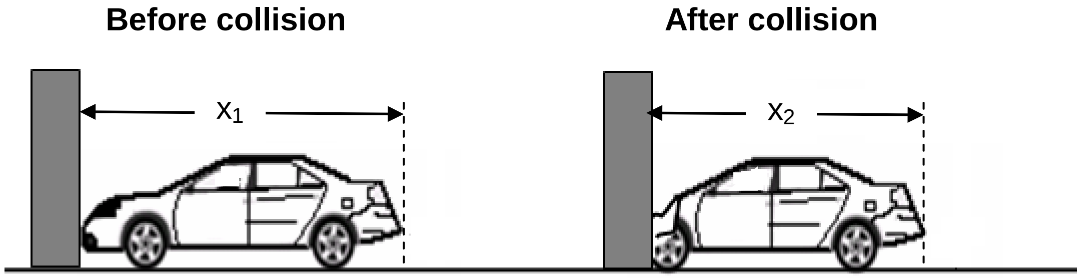
4.4.2 Determine, in terms of *a*, the acceleration that the truck experiences on impact. Give a reason for the answer. (2)

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·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]

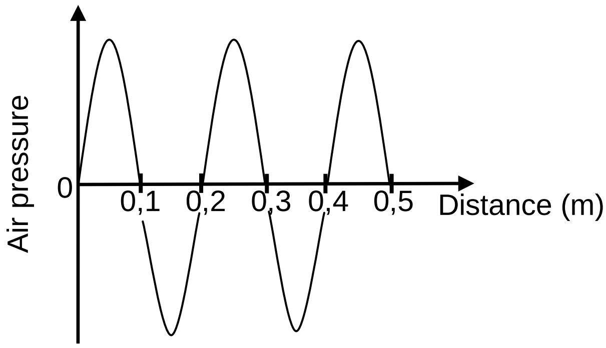
QUESTION 6 (Start on a new page.)

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]

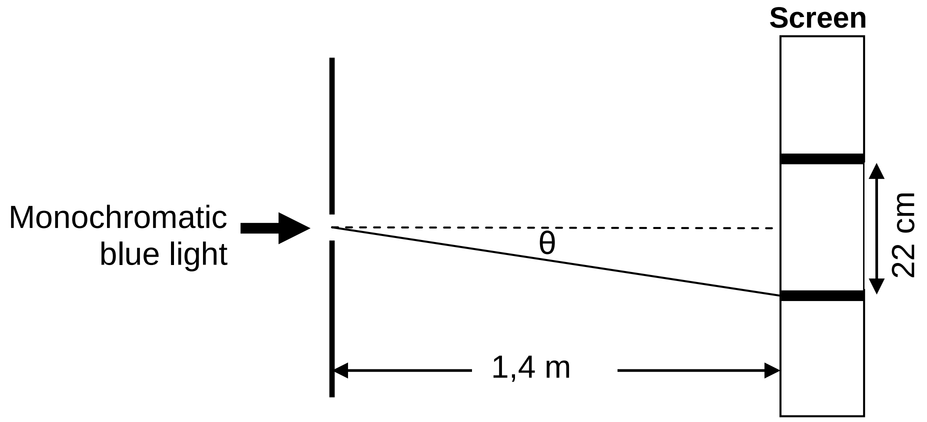
QUESTION 7 (Start on a new page.)

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:

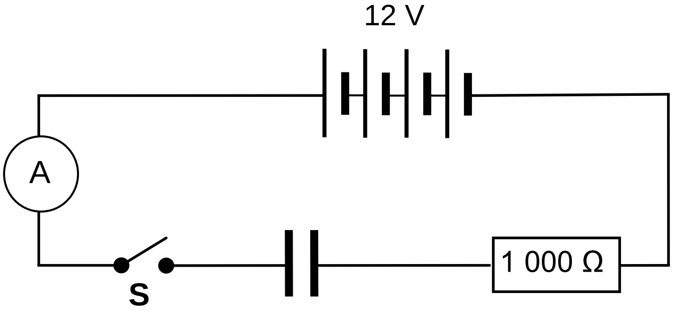
7.3.1 Angle θ at which the first minimum will be observed on the screen (3)

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.

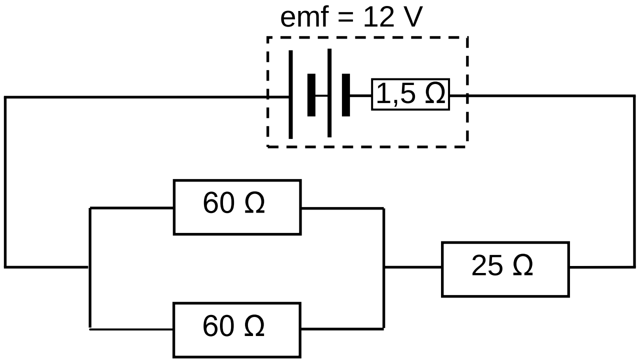
8.5.1 Sketch the electric field pattern between the parallel plates. (3)

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:

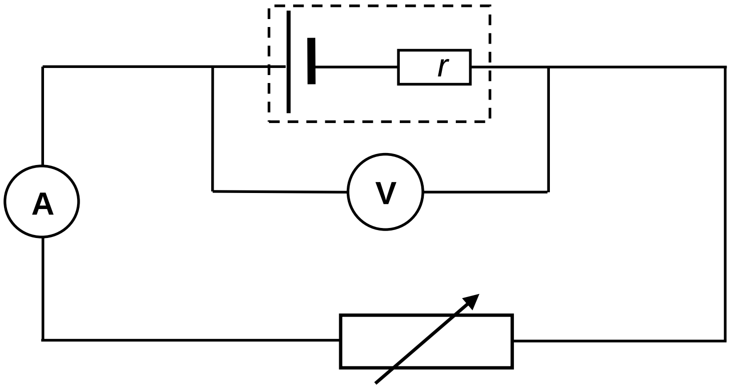
9.1.1 Equivalent resistance of the parallel combination (3)

9.1.2 Total current in the circuit (5)

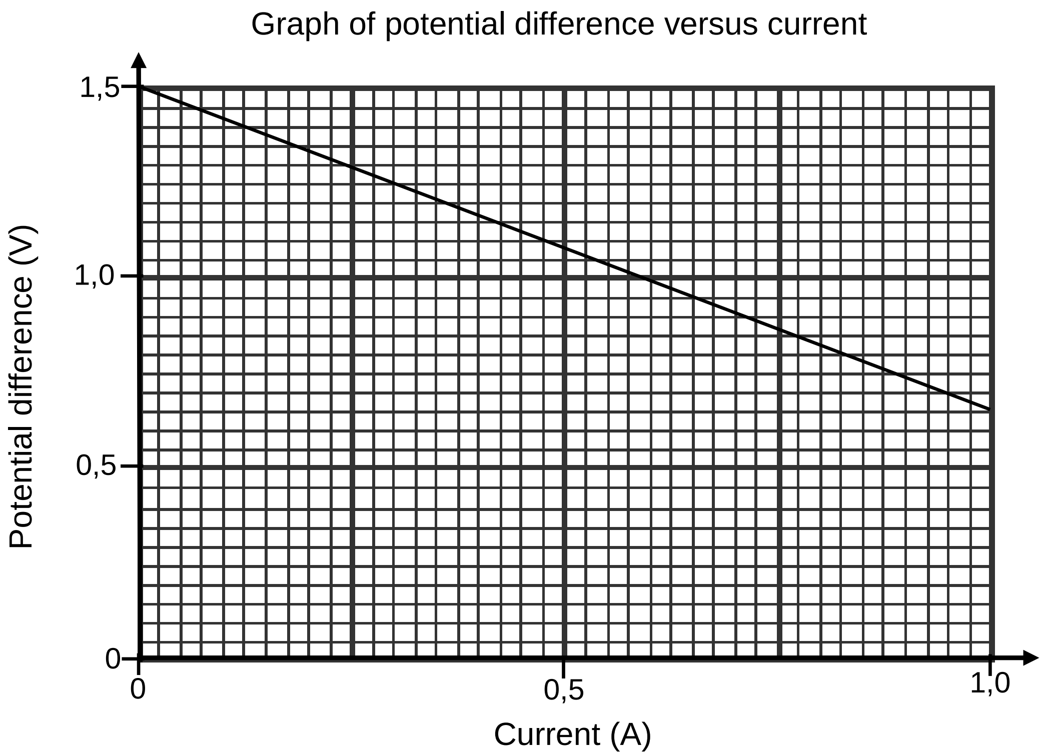
9.1.3 Potential difference across the parallel resistors (3)

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.



9.2.1 Use the graph to determine the emf of the battery. (1)

9.2.2 Calculate the gradient of the graph. (3)

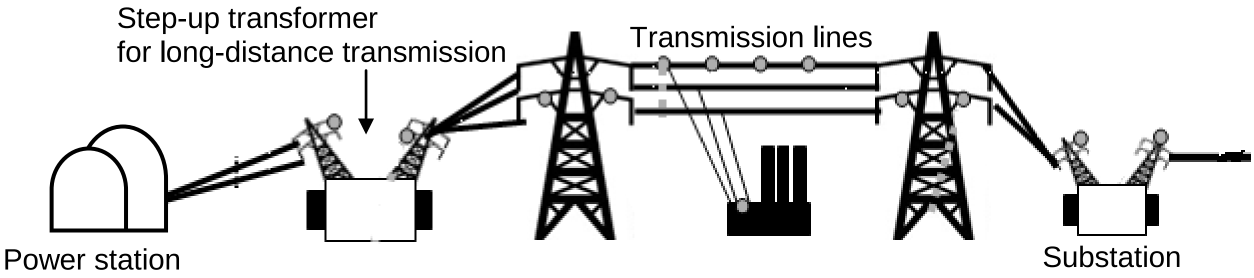
9.2.3 Which physical quantity is represented by the magnitude of the gradient of the graph? (2)

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.

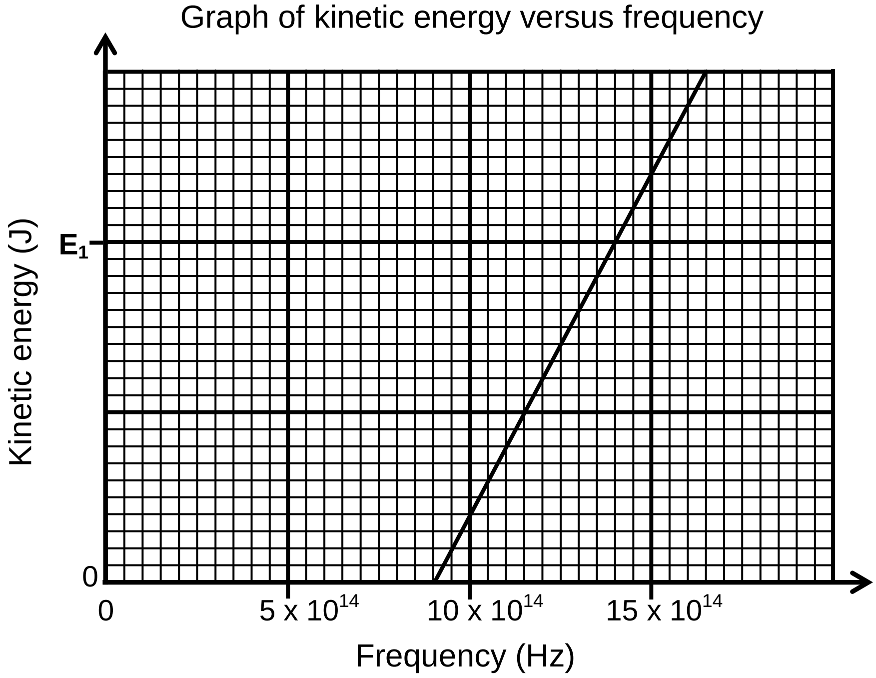
Calculate the rms current in the transmission lines if the power is transmitted at a maximum voltage of 30 000 V. (5)

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.



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

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*

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