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.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate space in the ANSWER BOOK.

2. This question paper consists of ELEVEN questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your FINAL numerical answers to a minimum of TWO decimal places.

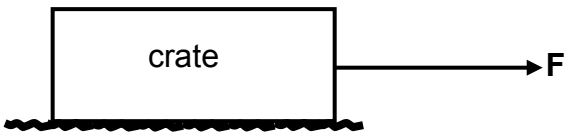
11. Give brief motivations, discussions, et cetera where required.

12. Write neatly and legibly.

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?

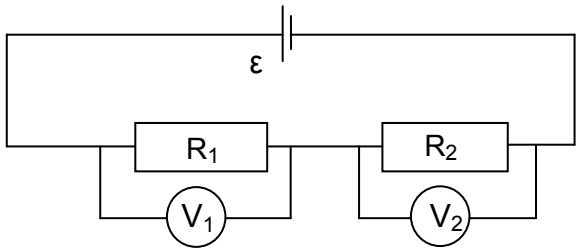
A They move away from each other with increasing acceleration.

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.

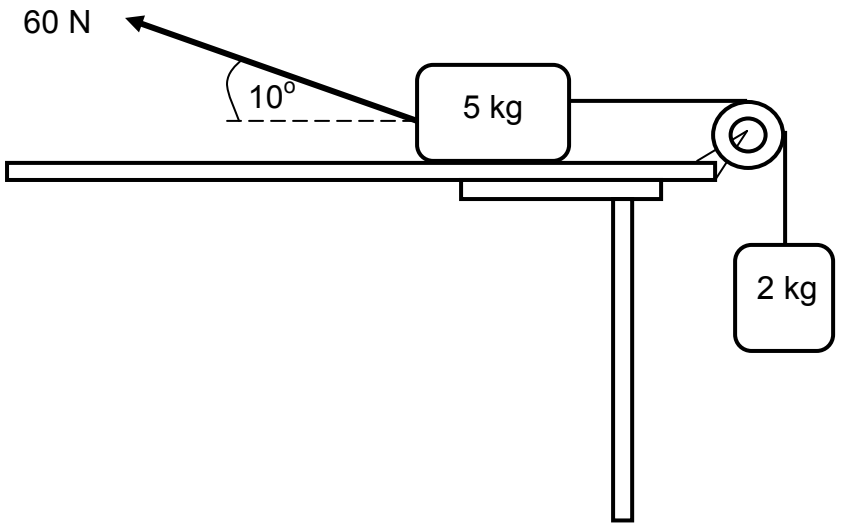
D number of photoelectrons emitted per second decreases. (2)

[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)

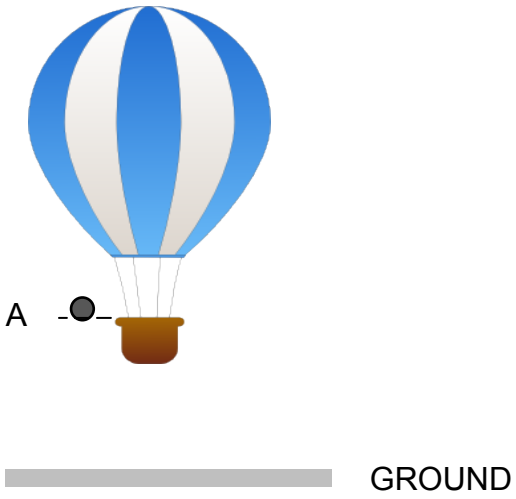
Calculate the magnitude of the:

2.4 Normal force acting on the 5 kg block (2)

2.5 Tension in the string connecting the two blocks (7)
[20]

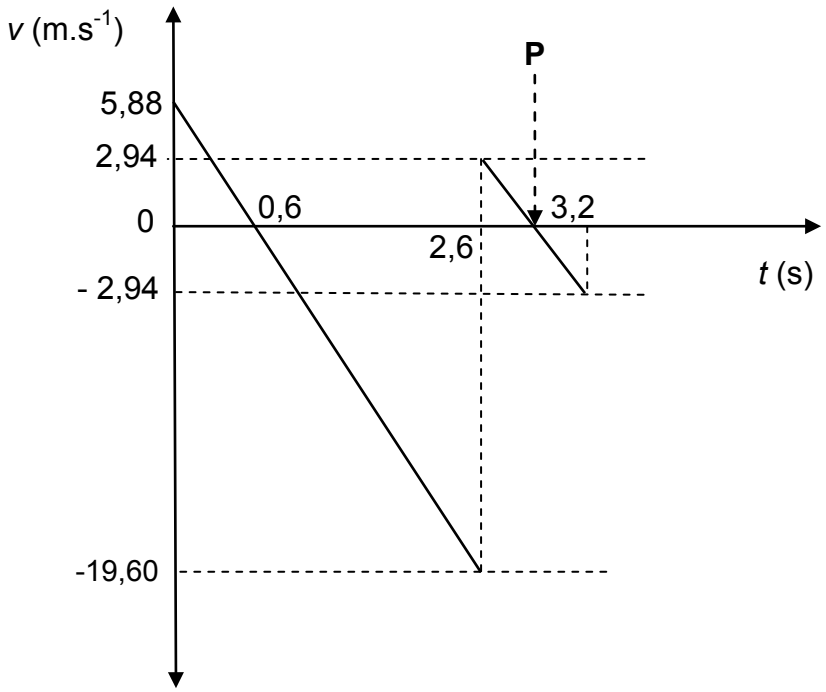
QUESTION 3 (Start on a new page.)

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)

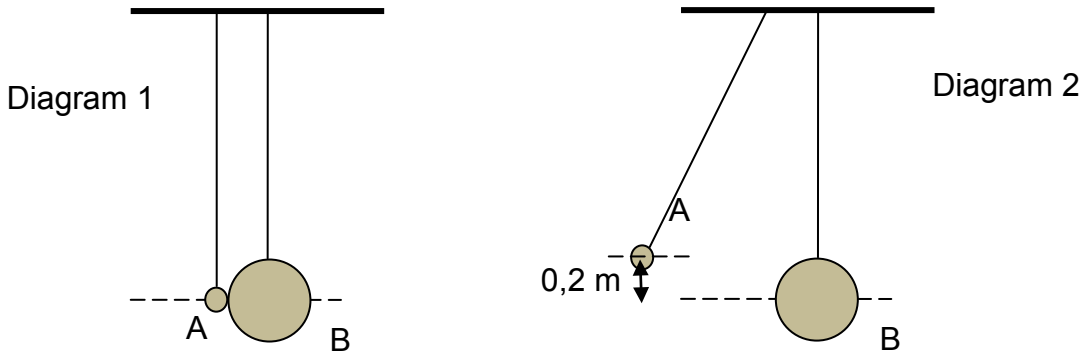
3.4 Maximum height the ball reaches after the first bounce (3)

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)

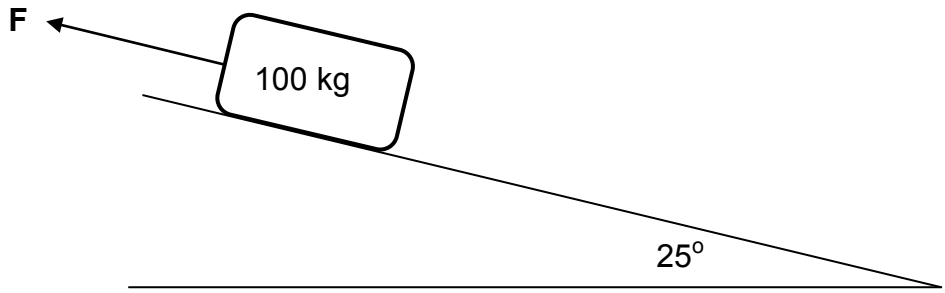
4.3 Speed of ball **A** immediately after the collision (4)

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)

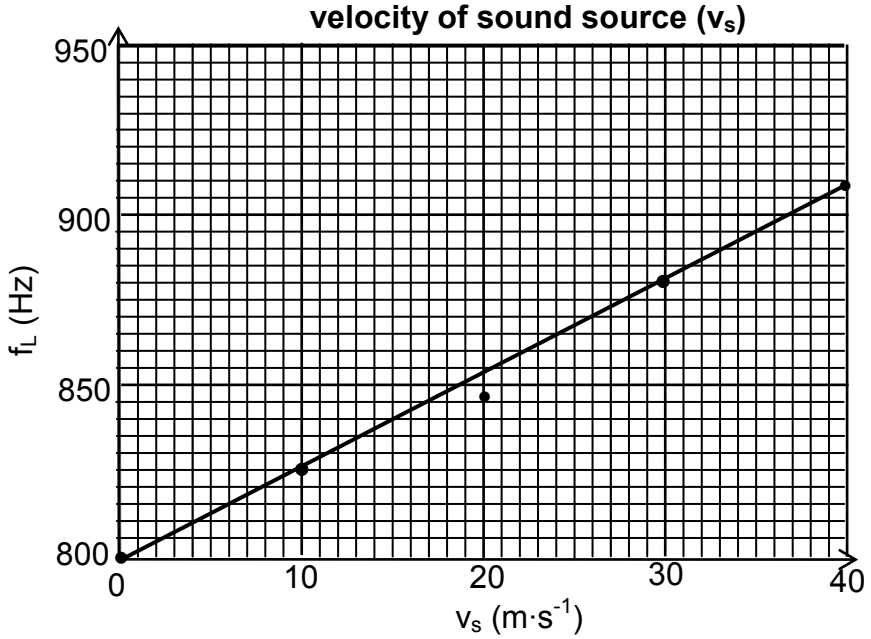
If the block is released from rest without the force **F** being applied, it moves 3 m down the inclined plane.

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.

Graph showing apparent frequency (f_L) versus velocity of sound source (v_s)



6.1 State the Doppler effect in words. (2)

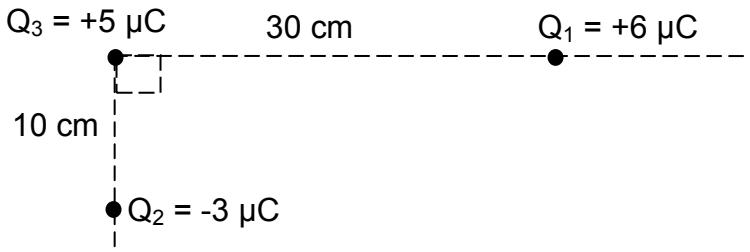
6.2 Use the information in the graph to calculate the speed of sound in air. (5)

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.

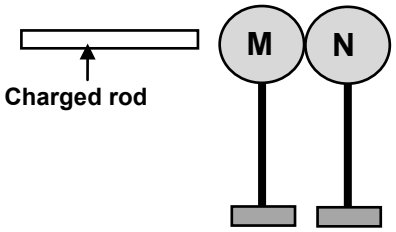


7.1 State Coulomb's law in words. (2)

7.2 Calculate the net force acting on charge $\mathbf{Q_3}$ 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**.

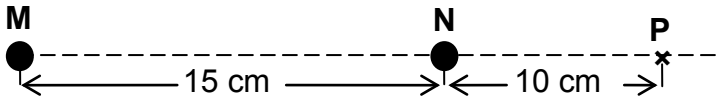


When the spheres are separated it is found that 5×10^6 electrons were transferred from sphere **M** to sphere **N**.

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.

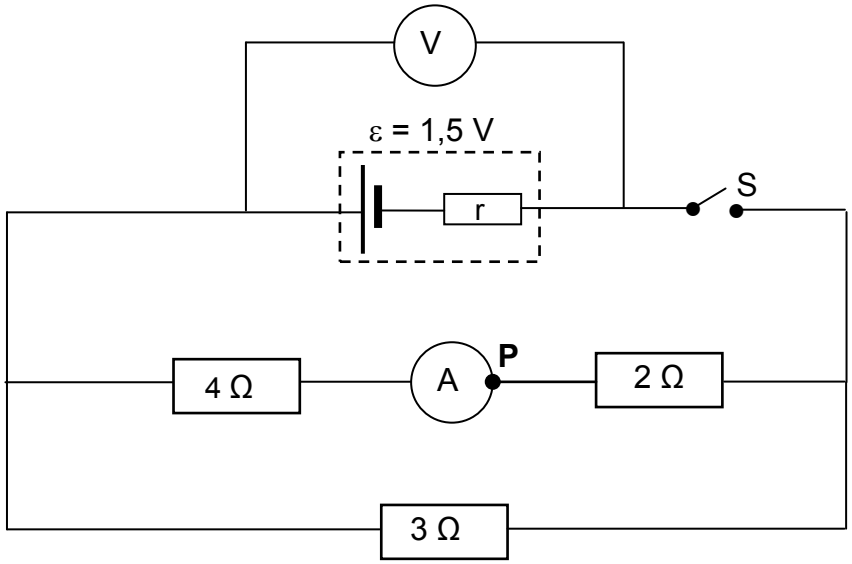


8.3 Define the *electric field* at a point. (2)

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)

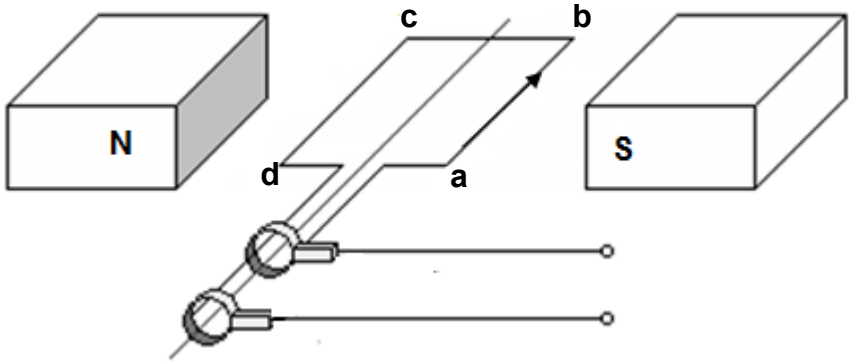
9.2 Calculate the ammeter reading. (3)

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

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 $m \cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} J·s
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg
Mass of the Earth *Massa van die Aarde*	M	5,98 x 10^{24} kg
Radius of the Earth *Radius van die Aarde*	R_E	6,38 x 10^6 m

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*

$F_{net} = ma$	$p = mv$
$f_s^{\,max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = m_f - m_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$	

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*

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