education

DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 18 pages and 3 information sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name on 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, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-proggrammable calculator.
7. You may use appropiate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE answer. Choose the answer and write only the letter (A-D) next to the question numbers (1.1 -1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 The base SI unit for the quantity 'work done' is ...

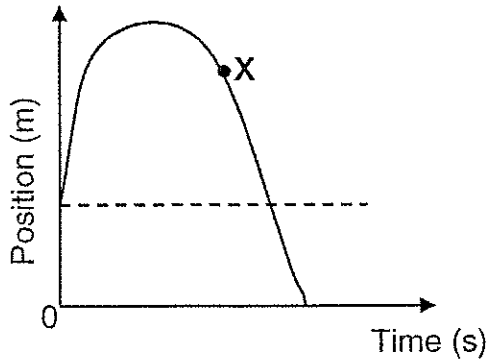
A $m \cdot s^{-1}$

B $kg \cdot m \cdot s^{-1}$

C $kg \cdot m \cdot s^{-2}$

D $kg \cdot m^2 \cdot s^{-2}$ (2)

1.2 A ball is projected vertically upwards from the balcony of a building. On the way downwards the ball passes the balcony and comes to rest on the ground. The position-time graph below represents the movement of the ball.



Which ONE of the following combinations indicates the CORRECT directions for the DISPLACEMENT (with reference to the balcony) and the VELOCITY of the ball at point **X**?

	DISPLACEMENT	VELOCITY
A	Upwards	Upwards
B	Upwards	Downwards
C	Downwards	Upwards
D	Downwards	Downwards

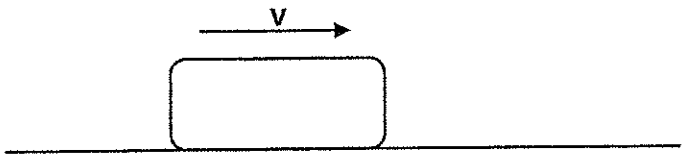
(2)

1.3 The options below represent four planets, each with a mass and radius as indicated.

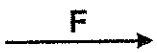
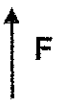
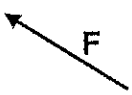
Which ONE of the planets has the greatest gravitational acceleration **g** on the surface of the planet?

Radius R	Radius R	Radius 2R	Radius 3R
Mass M	Mass 2M	Mass 2M	Mass 3M
A	B	C	D

1.4 A block moves at a constant velocity to the right over a frictionless surface. A force **F** is exerted on the block in different directions. See the diagram below.



Which ONE of the following indicates the CORRECT direction of the force that will do NEGATIVE work on the block, while it is still moving to the right?

A	
B	
C	
D	

1.5 The type of collision where both the total momentum as well as the total kinetic energy are conserved, is called ...

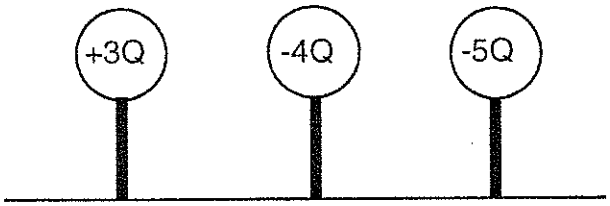
A an elastic collision.

B an inelastic collision.

C a liniar collision.

D head on collision. (2)

1.6 Three spheres with charges of +3Q, -4Q and -5Q respectively are placed on isolated stands as shown in the diagram below.



The spheres are simultaneously brought into contact with each other and returned to their original positions.

The charge on each sphere after contact is ...

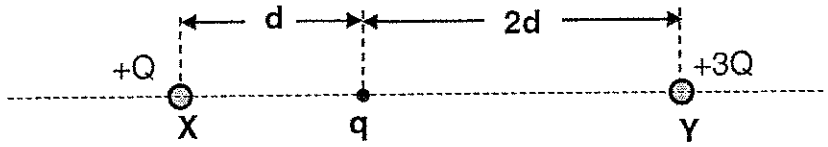
A Q

B -2Q

C -3Q

D 6Q (2)

1.7 Two positive charges, +Q and +3Q, are placed at points **X** and **Y** respectively. A NEGATIVE charge **q** is placed between points **X** and **Y** as shown in the diagram below.



When **q** is released, it will ...

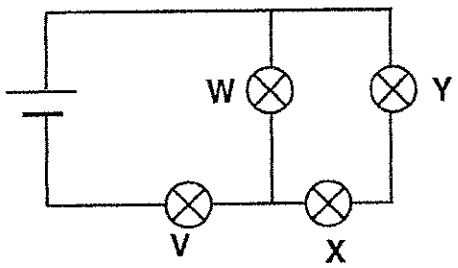
A stay at rest.

B move towards **Y**.

C move towards **X**.

D move vertically downwards.

1.8 Four identical bulbs, **V**, **W**, **X** and **Y** are connected to a cell as shown in the circuit below.



Which ONE of the following combinations indicates the TWO bulbs which glow with the same brightness?

A **V** and **W**

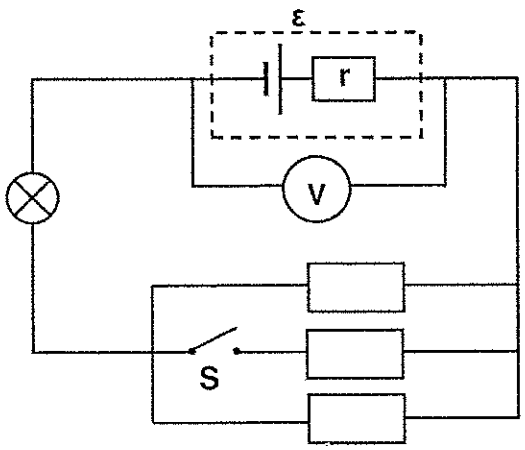
B **W** and **X**

C **X** and **Y**

D **W** and **Y**

1.9 A cell has an emf **ε** and an internal resistance **r**. A bulb and three identical resistors are connected to the cell as shown in the circuit diagram below.

Switch **S** is OPEN.



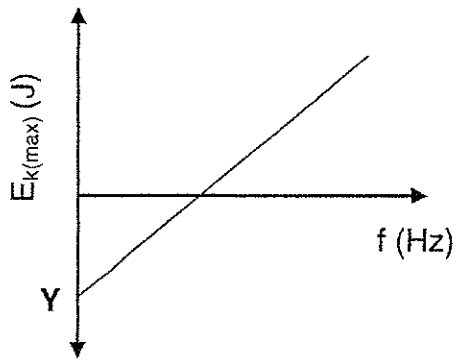
Switch **S** is now CLOSED.

Which ONE of the following combinations shows the CORRECT change in the voltmeter reading and the power dissipated in the bulb?

	VOLTMETER READING	**POWER DISSIPATED IN THE BULB**
A	Decreases	Increases
B	Stays the same	Stays the same
C	Increases	Decreases
D	Decreases	Decreases

(2)

1.10 The relationship between the maximum kinetic energy ($E_{k(max)}$) and the frequency (f) of the photoelectrons emitted from the surface of a metal is shown in the graph below.



The intercept (**Y**) represents the ...

A work function of the metal.

B Planck's constant.

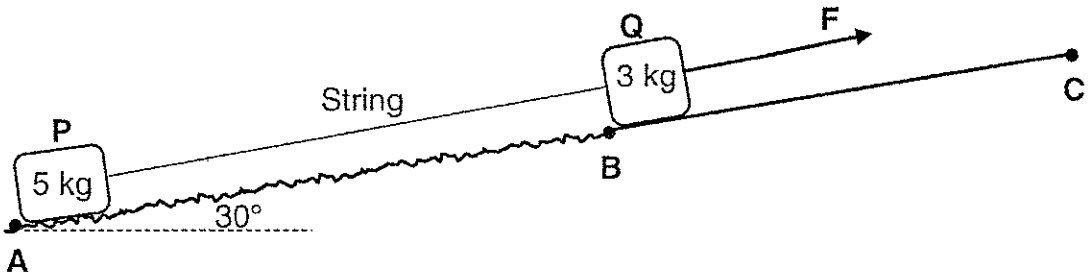
C threshold frequency of the metal.

D frequency of the photon. (2)
[20]

QUESTION 2 (Start on a new page.)

A block **P** of mass 5 kg is connected to a block **Q** of mass 3 kg by a light inextensible string. Both blocks are at rest on a plane inclined at an angle of 30° to the horizontal. Block **P** is on a rough section of the incline **AB**, while block **Q** is on a frictionless section **BC** as shown in the diagram below.

The blocks remain at rest when a force **F** is applied parallel to the plane on block **Q**. The static frictional force on block **P** is 16,97 N.



2.1 State *Newton's First Law* in words. (2)

2.2 Draw a labelled free-body diagram for block **Q**. (4)

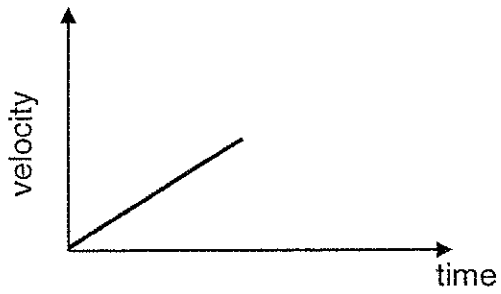
2.3 Calculate the magnitude of force **F**. (3)

The applied force **F** is now increased to 85 N. The kinetic frictional force on block **P** is 4,5 N.

2.4 Apply Newton's Second Law on each of the blocks to calculate the magnitude of the acceleration of the blocks. (5)

While the blocks are still accelerating up the slope the string suddenly breaks.

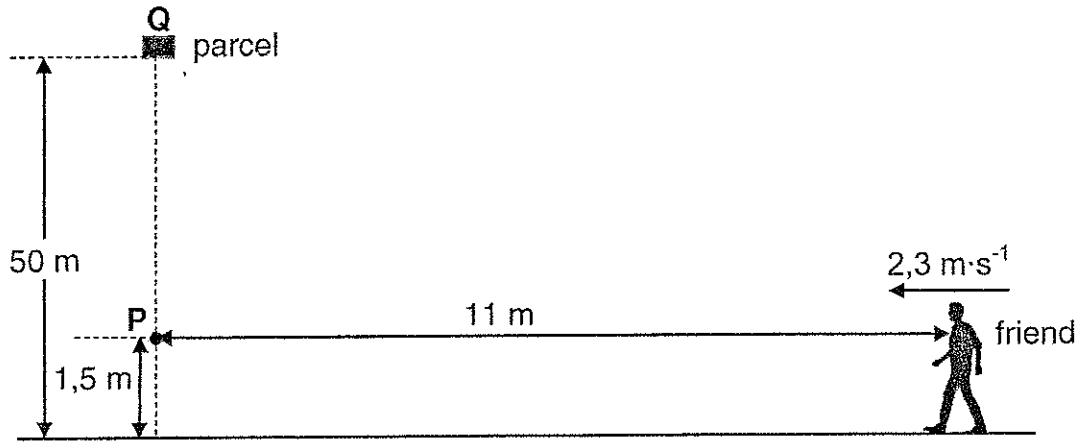
Learners plot a velocity-time graph for the motion of **P** and **Q** before the string breaks, as shown below.



2.5 Redraw the graph above in your ANSWER BOOK.
On the same set of axis, complete this graph by drawing the graphs for each block, after the string broke. Label each graph clearly as **P** and **Q**. (3)
[17]

QUESTION 3 (Start on a new page.)

A learner at point **Q**, on a 50 m high building, drops a parcel from rest. Ignore the effects of air friction.



3.1 Write down the magnitude and direction of the acceleration of the parcel after leaving the learner's hand. (2)

3.2 Calculate the:

3.2.1 Magnitude of the velocity of the parcel at point **P** (4)

3.2.2 Time the parcel takes to reach point **P** (3)

A friend, 11 m away from the building, moves at a constant velocity of 2,3 $m \cdot s^{-1}$ towards the building the moment a second identical parcel is thrown vertically upwards from point **Q** as shown in the diagram above.

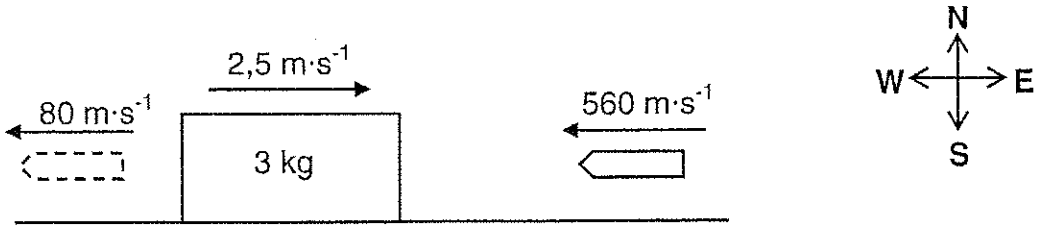
3.3 Calculate the INITIAL speed at which the second parcel is thrown vertically upwards for the friend to catch it at point **P**. (5)
[14]

QUESTION 4 (Start on a new page.)

A bullet moves west at a velocity of 560 $m \cdot s^{-1}$. It hits a wooden block with a mass of 3 kg which is moving at 2,5 $m \cdot s^{-1}$ east on a frictionless floor. The bullet takes 0,02 s to move through the wooden block and leaves the block with a velocity of 80 $m \cdot s^{-1}$ west.

The magnitude of the momentum of the bullet before it hits the block is 8,4 $kg \cdot m \cdot s^{-1}$. See the diagram below.

Ignore the effects of air friction as well as any loss of mass of both the block and bullet. Assume that the block-bullet system is an isolated system.



4.1 Explain the meaning of the term *isolated system.* (2)

4.2 Calculate the:

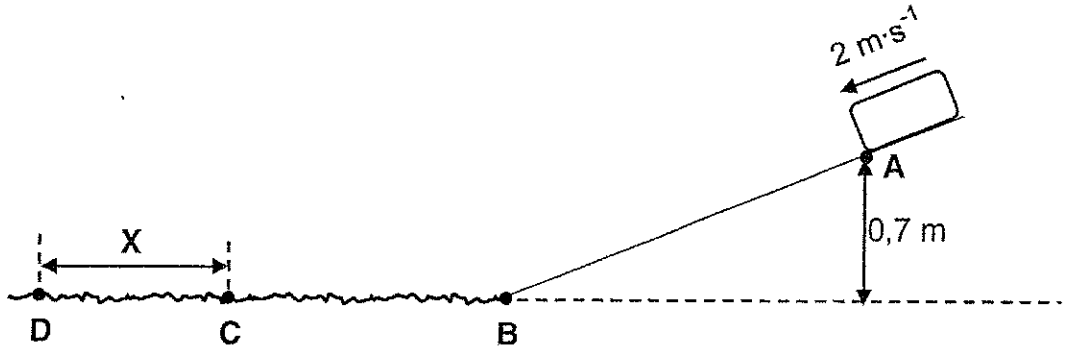
4.2.1 Mass of the bullet (3)

4.2.2 Speed of the block after the bullet left the block (4)

4.2.3 Average net force the block excerted on the bullet during the collision (4)
[13]

QUESTION 5 (Start on a new page.)

A block of mass **m** slides down a frictionless slope to point **B**. At point **A**, which is 0,7 m above the ground, the speed of the block is 2 $m \cdot s^{-1}$ as shown in the diagram below.



5.1 Use the LAW OF CONSERVATION OF MECHANICAL ENERGY to calculate the speed of the block at point **B**. (3)

The block moves from point **B** to point **D** on a rough, horizontal surface. The kinetic frictional force between the block and the rough surface is 3 N. The block reaches point **C** with a momentum of 5,79 $kg \cdot m \cdot s^{-1}$ to the left and kinetic energy of 11,17 J.

5.2 Calculate the speed of the block at point **C**. (3)

The block comes to rest at point **D**, a distance **X** from point **C**.

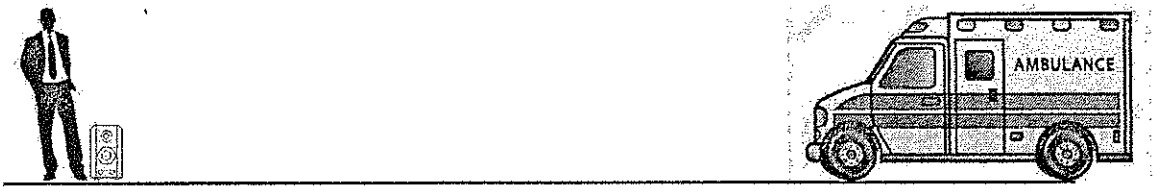
5.3 State the *work-energy theorem* in words. (2)

5.4 Use energy principles ONLY to calculate the distance **X**. (5)

[13]

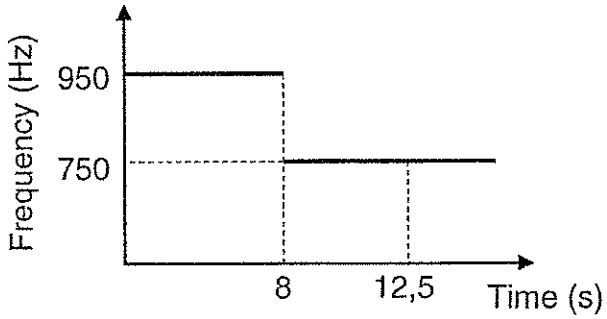
QUESTION 6 (Start on a new page.)

The siren of a stationary ambulance emits sound waves at a constant frequency. The diagram below shows a learner next to a stationary detector that registers the frequency of the sound emitted by the siren.



The detector registers the frequency as the ambulance moves at a constant speed towards the learner, passes him and moves away.

The graph below shows the changes in the detected frequencies versus time as the ambulance approaches and moves away from the learner:



6.1 State the Doppler-effect in words. (2)

6.2 Explain in terms of wavelength and the number of waves that reaches the detector, why the observed frequency is higher when the ambulance moves towards the learner. (2)

The speed of sound in air is 330 $m \cdot s^{-1}$.

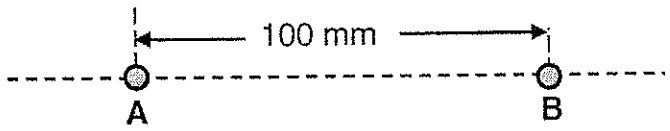
6.3 Calculate the:

6.3.1 Speed of the ambulance (6)

6.3.2 Distance between the ambulance and the detector, 12,5 s after the detector started registering the frequency (4)
[14

QUESTION 7 (Start on a new page.)

7.1 Two identical point charges, **A** and **B**, are placed 100 mm apart as shown in the diagram below. Point charge **B** is negatively charged and experiences an electrostatic force of 57,6 N to the RIGHT due to point charge **A**.

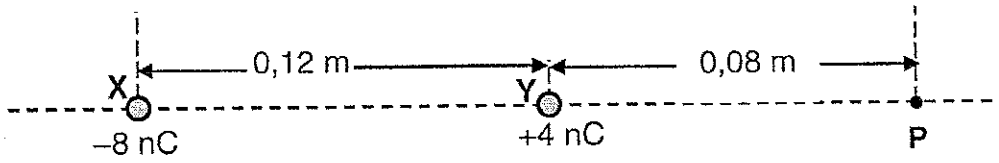


7.1.1 State *Coulomb's Law* in words. (2)

7.1.2 What is the nature of the charge on **A**? Choose from POSITIVE or NEGATIVE. (1)

7.1.3 Calculate the magnitude of the charge on **B**. (3)

7.2 Two point charges, **X** and **Y**, of –8 nC and +4 nC respectively are placed 0,12 m from each other as shown in the diagram below. **P** is a point on the line through **X** and **Y**, 0,08 m from point charge **Y**.



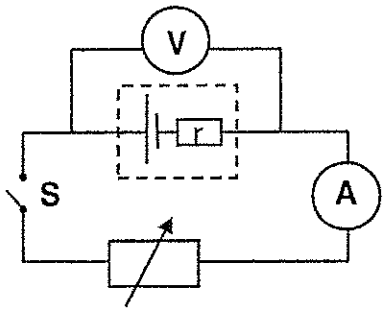
7.2.1 Define the term *electric field at a point.* (2)

7.2.2 Calculate the magnitude and direction of the electric field at point **P** due to **X** ONLY. (4)

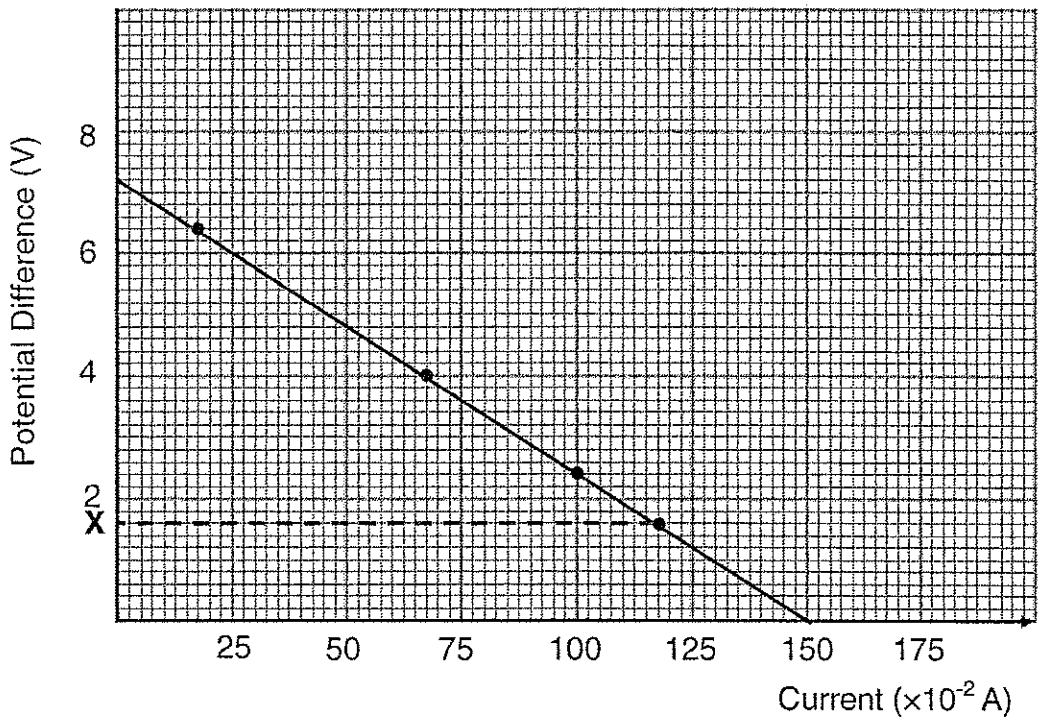
7.2.3 Calculate the number of electrons that must be transferred to **X** to obtain a net electric field of 120 $N \cdot C^{-1}$ to the LEFT at point **P**. (5)
[17]

QUESTION 8 (Start on a new page.)

A group of learners conduct an experiment to detemine the emf (ε) and internal resistance (r) of a battery by using the circuit diagram below.



The learners draw the following potential difference versus current graph from the results obtained:



8.1 Write down the value of the emf of the battery. (1)

8.2 Calculate the:

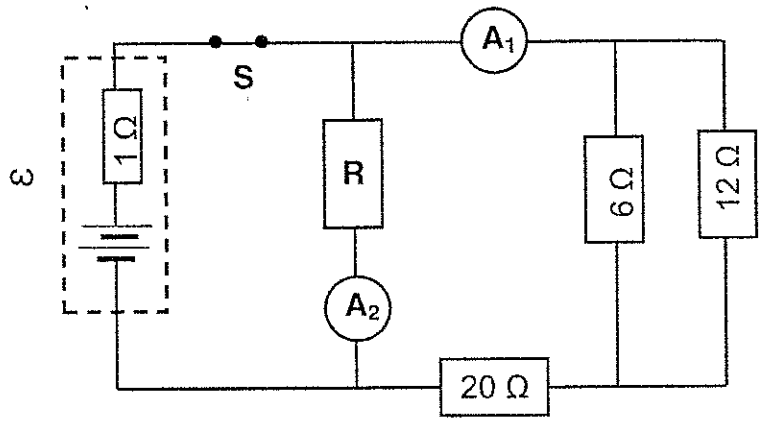
8.2.1 Internal resistance of the battery (2)

8.2.2 External resistance of the circuit when the voltmeter reading is **X** (3)
[6]

QUESTION 9 (Start on a new page.)

A battery with emf ε and internal resistance of 1 Ω, is connected to four resistors as shown in the circuit diagram below.

Switch **S** is CLOSED. A current of 0,5 A passes through the 6 Ω resistor.



9.1 State *Ohm's Law* in words. (2)

9.2 Calculate the:

9.2.1 Reading on A_1 (3)

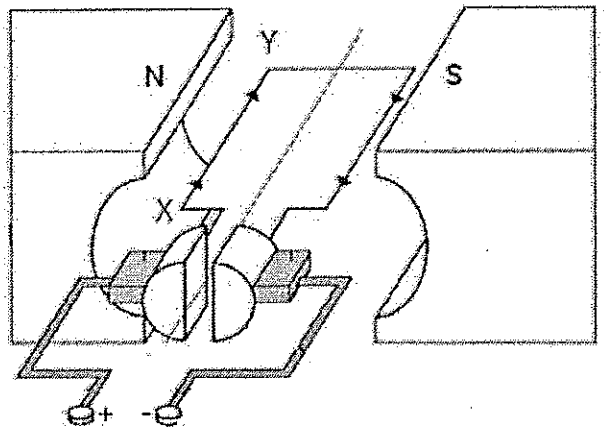
9.2.2 Reading on A_2 when the power dissipated in resistor **R** is 16 W (3)

9.2.3 Emf of the battery (4)

[12]

QUESTION 10 (Start on a new page.)

10.1 The simplified diagram of a DC motor is shown below. The current in the coil is in the direction **XY**.



10.1.1 Name the component that ensures the continuous rotation of the coil in ONE DIRECTION. (1)

10.1.2 In which direction will the above coil rotate? Choose from CLOCKWISE or ANTI-CLOCKWISE. (2)

10.1.3 Write down the energy conversion that takes place in a motor. (1)

10.2 An AC generator delivers a maximum current (peak current) of 8 A and is connected to a heater with a resistance of 40 Ω.

10.2.1 Define the term *rms current* in words. (2)

10.2.2 Calculate the average power dissipated in the heater. (5)
[11]

QUESTION 11 (Start on a new page.)

The threshold wavelength (λ_0) of two metals, potassium and zinc, are given in the table below.

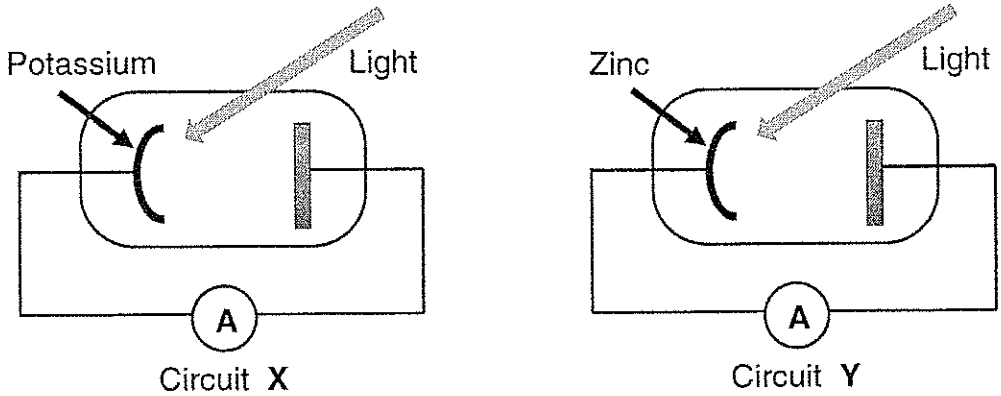
METAL	THRESHOLD WAVELENGTH (λ_0) ($\times 10^{-7}$ m)
Potassium	10
Zinc	4,62

11.1 Define the term *work function* in words. (2)

11.2 Which ONE of the two metals in the table above has a higher work function? Give a reason for the answer. (3)

The simplified photocell diagrams **X** and **Y** below contain cathodes of potassium metal and zinc metal respectively.

Light of the same intensity and a frequency of 5×10^{14} Hz is incident on both metals. The ammeter in **X** registers a reading, but the reading on the ammeter in **Y** is ZERO.



11.3 Write down a reason why the ammeter reading in circuit **Y** is zero. (2)

11.4 Calculate the maximum kinetic energy of a photoelectron emitted in circuit **X**. (4)

11.5 The intensity of the light is now increased,

How will EACH of the following in circuit **X** be affected?
Choose from INCREASES, DECREASES or REMAINS THE SAME.

11.5.1 Maximum kinetic energy of the photoelectrons (1)

11.5.2 The number of photoelectrons emitted per unit time (1)
[13]

TOTAAL: 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	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
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	$9,11 \times 10^{-31}\ kg$
Mass of the Earth *Massa van die Aarde*	M	$5,98 \times 10^{24}\ kg$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^{6}\ m$

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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ 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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

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

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