Province of the
EASTERN CAPE
EDUCATION

NATIONAL
SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2022

PHYSICAL SCIENCES P1 (PHYSICS)

MARKS: 150

TIME: 3 hours

This question paper consists of 19 pages, including 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate space on the ANSWER BOOK.

2. This question paper consists of TEN 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 sub-questions, e.g. between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. Show ALL formulae and substitutions in ALL calculations.

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

9. Give brief motivations, discussions, etc. where required.

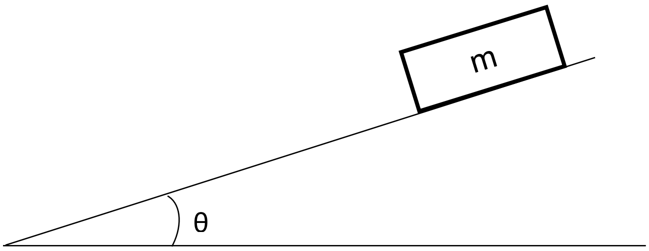
10. You are advised to use the attached DATA SHEETS.

11. 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 correct answer. Choose the correct answer and write only the letter of the correct answer (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 An object of mass **m** moves down an incline at a constant velocity as shown in the diagram below.



Which ONE of the following expressions represents the magnitude of frictional force acting on the object?

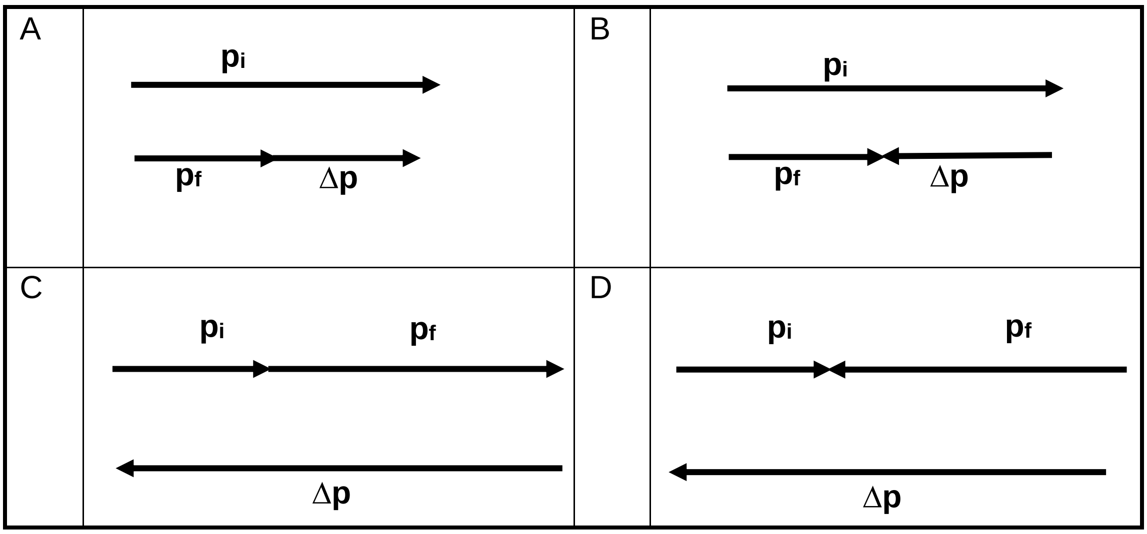
A $mg \cos \theta$

B $mg \sin \theta$

C $mg \tan \theta$

D $\tan \theta$ (2)

1.2 A car of mass **m** is travelling at a constant velocity and has a momentum **p**. The driver notices an object ahead of him and applies the brakes so that the momentum of the car changes to **½p.** Which ONE of the diagrams below correctly shows the relationship between $\mathbf{p_i}$, $\mathbf{p_f}$ and $\Delta\mathbf{p}$?



(2)

1.3 A hot air balloon is moving upwards at a constant velocity **v**. A stone is dropped from the hot air balloon. What is the velocity of the stone at the instant it is dropped from the balloon?

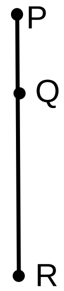
A Zero

B **v** downwards

C **v** upwards

D 2**v** downwards (2)

1.4 An object is thrown vertically upwards from **R**, passes point **Q** and reaches a maximum height at point **P**. Ignore the effects of air friction.



Which ONE of the following is correct as the object moves from point **R** to point **Q**?

A Total mechanical energy has increased.

B The total kinetic energy at point **P** is zero.

C The decrease in kinetic energy is equal to the increase in potential energy.

D The average work done on the object is equal to zero. (2)

1.5 The net work done by a constant force **F** that acts on an object to increase its velocity from **0** to **v** is **W**.

The net work done by the same force on the object to increase its velocity from **v** to **2v** is …

A ⅓ W.

B ½ W.

C 2 W.

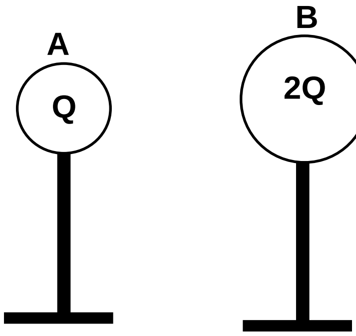
D 3 W. (2)

1.6 Astronomers observed that a light from distant star undergoes a red shift. Which ONE of the following combinations regarding the observed wavelength and frequency correctly explains this shift?

	OBSERVED WAVELENGTH	OBSERVED FREQUENCY
A	Increases	Decreases
B	Decreases	Decreases
C	Decreases	Increases
D	Increases	Increases

(2)

1.7 Two charged spheres, **A** and **B**, carrying charges **Q** and **2Q** respectively, are placed on insulating stands as shown in the diagram below. Sphere **A** exerts a force of **F** on sphere **B**. What is the magnitude of the force exerted by sphere **B** on sphere **A**?



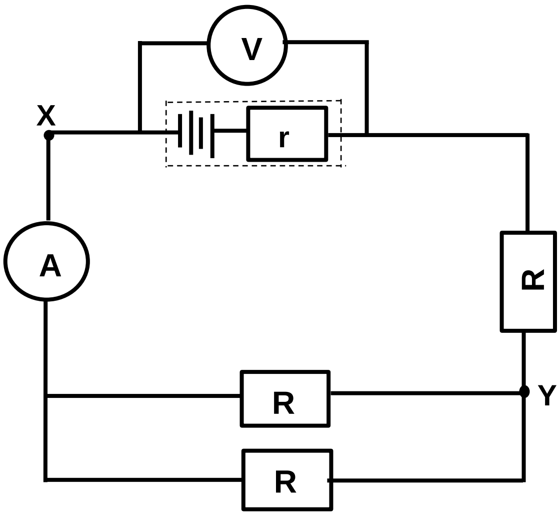
A 4**F**

B 2**F**

C **F**

D **½F** (2)

1.8 A battery with internal resistance **r** is connected into a circuit as shown in the diagram below.

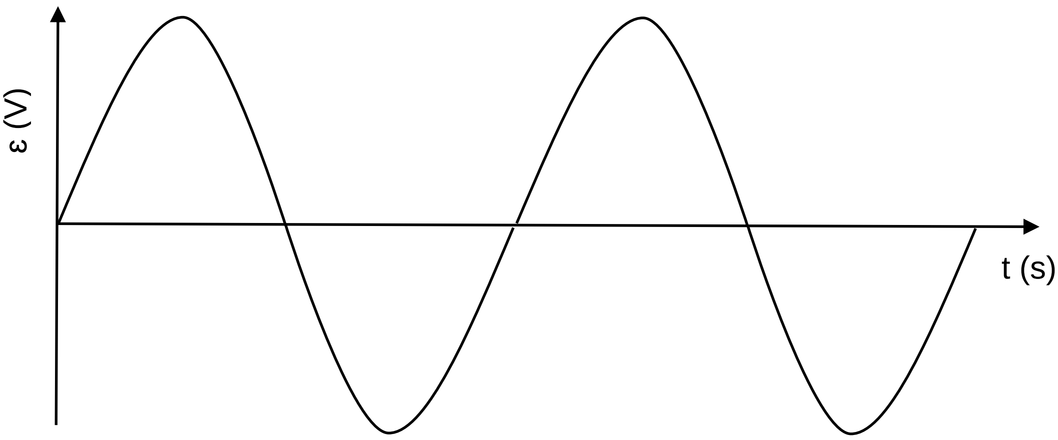


A conducting wire of negligible resistance is now connected into the circuit across points **X** and **Y**. Which combinations below correctly shows the changes to the readings on the voltmeter and ammeter?

	VOLTMETER READING	AMMETER READING
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Decreases
D	Decreases	Increases

(2)

1.9 The graph below represents the emf generated versus time for an alternating current (ac) generator.



The speed of rotation of the generator's coil is now DOUBLED. What happens to the emf and the period of one cycle?

	EMF	PERIOD
A	Doubles	Doubles
B	Doubles	Halves
C	Halves	Doubles
D	Halves	Halves

(2)

1.10 The photoelectric effect provides evidence of the fact that:

A Positive charges can be emitted from metal surfaces.

B Light is an electromagnetic wave.

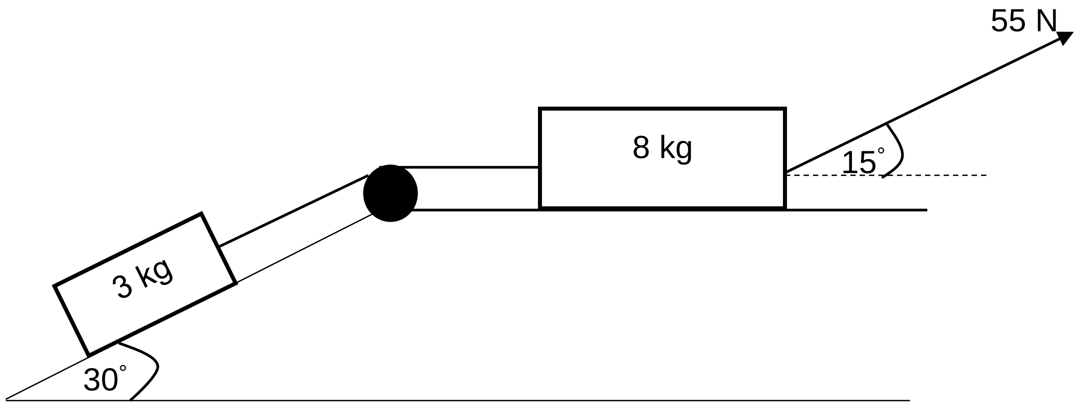
C Light has a wave nature.

D Light has a particle nature. (2)

[20]

QUESTION 2 (Start on a new page.)

Two blocks of masses 3 kg and 8 kg respectively are connected by means of a light, inextensible string as shown in the diagram below. The string moves over a frictionless pulley and the 3 kg block is placed on a plane that is inclined at an angle of 30˚ to the horizontal.
A force of 55 N, which makes an angle of 15˚ with the horizontal, is applied to the 8 kg block to move the system of blocks to the right.
The 3 kg block experiences a constant frictional force of 5 N. The coefficient of kinetic friction between the 8 kg block and the surface is 0,16.



2.1 State Newton's Second Law of motion in words. (2)

2.2 Draw a labelled free-body diagram of all forces acting on the 8 kg block. (5)

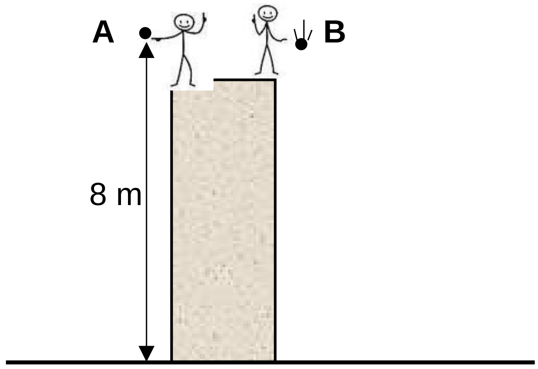
2.3 Calculate the:

2.3.1 Kinetic frictional force that the 8 kg block experiences (4)

2.3.2 Tension in the string connecting the two blocks (6)
[17]

QUESTION 3 (Start on a new page.)

A learner drops a ball **A** from a height of 8 m. After 0,6 s, another learner throws a second ball **B** downwards from the same height. Both balls **A** and **B**, hit the ground at the same time. Ignore the effects of friction.



3.1 Define the term *free fall*. (2)

3.2 Calculate the speed at which:

3.2.1 Ball **A** hits the ground (3)

3.2.2 Ball **B** was thrown downwards (5)

Ball **A** bounces off the ground to a maximum height of 6,5 m above the ground.

3.3 Calculate the velocity of ball **A** as it bounces off the ground. (4)

3.4 Sketch a velocity versus time graph for the motion of ball **A** from the moment it was dropped until it reaches its maximum height after the bounce.

Indicate the following on the graph:

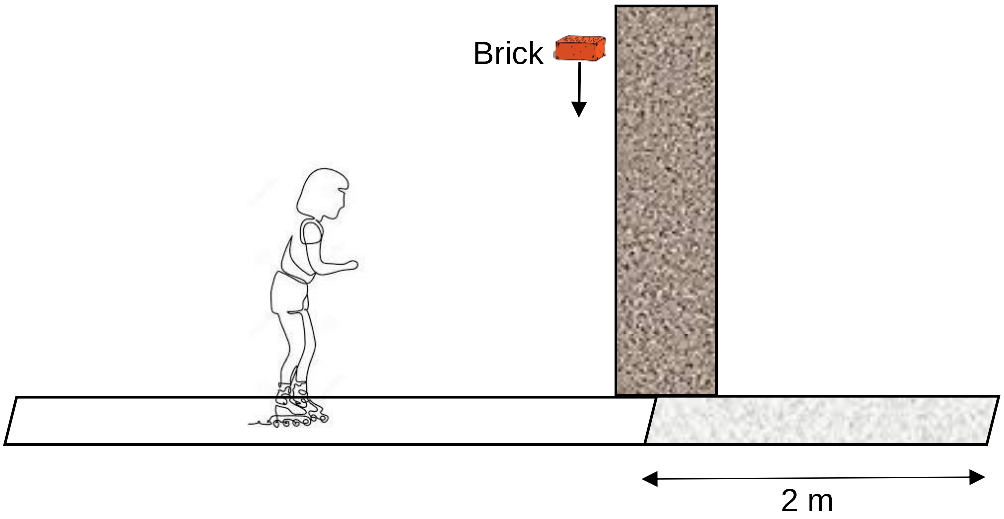
- The velocity with which ball **A** hits the ground
- The velocity with which the ball bounces off the ground (3)

[17]

QUESTION 4 (Start on a new page.)

A girl on roller skates, of combined mass 52 kg, moves horizontally at a certain constant velocity. She catches a brick of mass 5 kg which is thrown vertically downwards from the top of a high wall. The girl continues to move in a straight line at a speed of 2,4 m·s^{-1} after catching the brick.

Ignore the effects of friction.



4.1 Write down the horizontal speed of the brick just before the girl catches it. (1)

4.2 Calculate the girl's speed just before she catches the brick. (4)

The girl-brick combination, moving at 2,4 m·s^{-1} moves onto a rough surface. She comes to rest after moving 2 m along the rough surface.

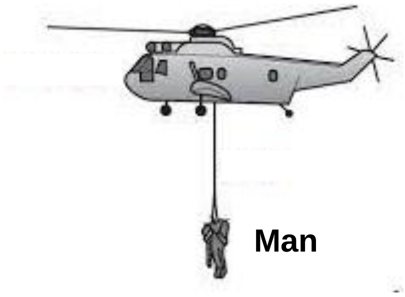
4.3 Write down a pair of action-reaction forces acting while the girl catches the brick. (2)

4.4 Calculate the magnitude of the net force exerted by the rough surface to bring the girl-brick combination to a stop after 2 m. (5)

[12]

QUESTION 5 (Start on a new page.)

A rescue helicopter lifts a man of mass 75 kg, initially at rest, vertically upwards by means of a light inextensible massless cable as shown in the diagram below. While the man is lifted to a height of 12 m, the average tension in the cable is 3 600 N. A constant downward air resistance of 1 540 N is exerted on the man while he is being lifted.



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

5.2 Draw a free body diagram of all forces acting on the man as he is lifted upwards. (3)

5.3 Name a non-conservative force acting on the man while he is being lifted. (1)

5.4 Calculate the work done on the man by the gravitational force while he is being lifted. (3)

5.5 Use ONLY energy principles to calculate the speed of the man at 12 m above the ground. (5)

[14]

QUESTION 6 (Start on a new page.)

An ambulance, with its siren emitting sound of a certain constant frequency, approaches an accident scene at a constant velocity. A stationary sound detector at the accident scene records a frequency that is 2% higher than the actual frequency of the siren.

6.1 State the Doppler effect in words. (2)

6.2 Explain why the detector records a higher frequency. (2)

6.3 Calculate the speed of the ambulance.

Take velocity of sound as 343 $m.s^{-1}$. (5)

6.4 The frequency of the sound emitted by the siren is 720 Hz. Calculate the wavelength of the siren's sound. (3)

6.5 State ONE use of a Doppler flowmeter. (1)

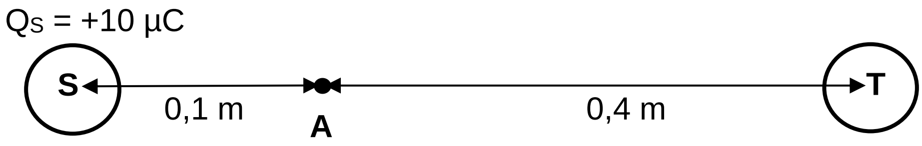
[13]

QUESTION 7 (Start on a new page.)

7.1 Define the *electric field at a point* in words. (2)

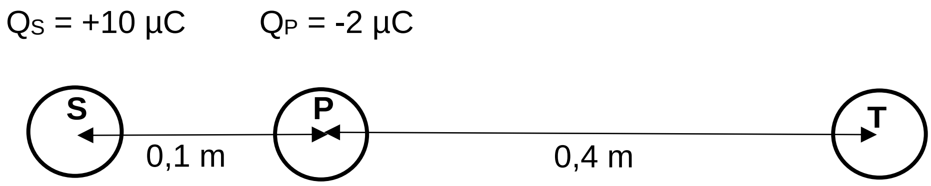
7.2 Draw the resultant electric field pattern due to two-point charges with identical positive charges. (3)

Two identical spheres, **S** and **T,** are placed with their centres 0,5 m apart. Point **A** is 0,1 m to the right of sphere **S**, as shown in the diagram below. The charge on sphere **S** is +10 µC while sphere **T** carries an unknown positive charge of similar magnitude.



7.3 The net electric field strength at point **A** is 4,70 x 10^6 $N.C^{-1}$ to the left. Calculate the unknown charge on sphere **T**. (6)

A third sphere **P** carrying a charge of -2 µC is now placed at point **A** as shown in the diagram below.

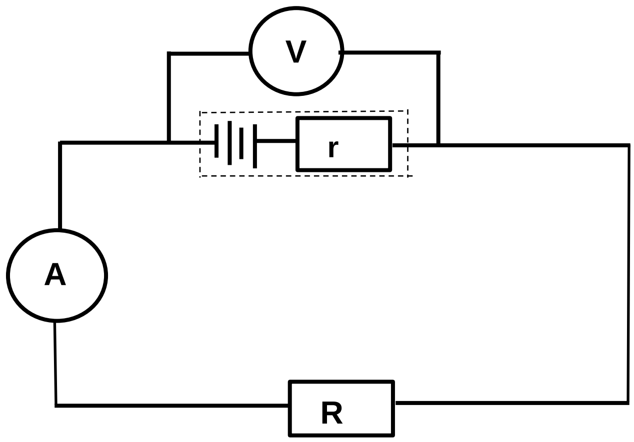


7.4 Calculate the NET electrostatic force exerted on sphere **P** due to charged spheres **S** and **T**. (4)

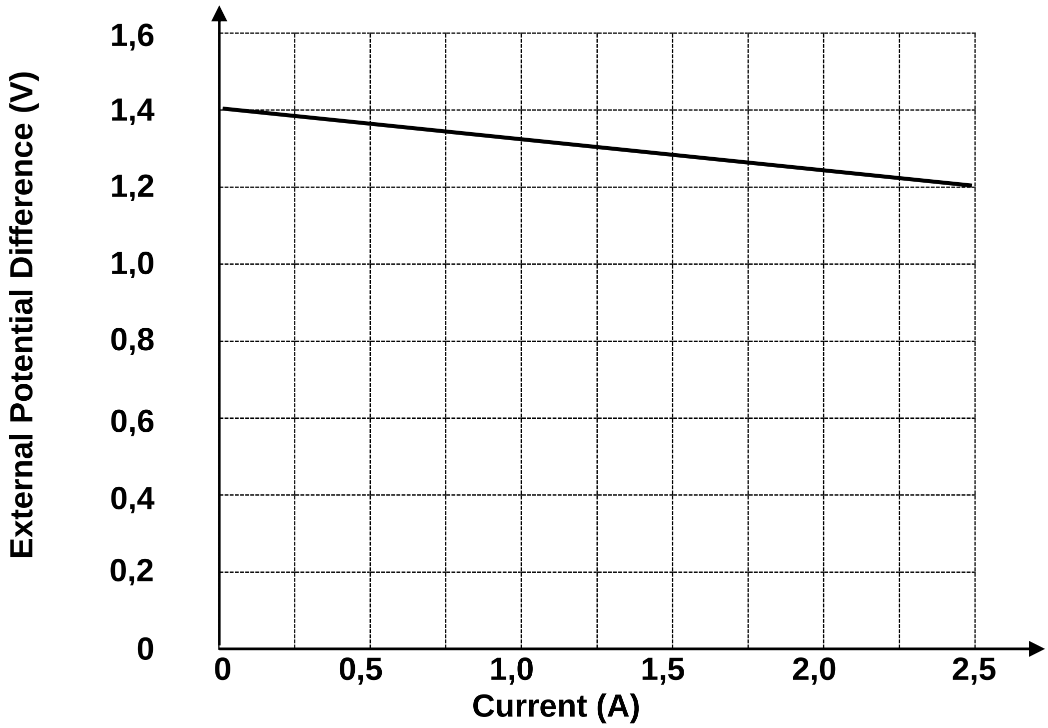
[15]

QUESTION 8 (Start on a new page.)

8.1 A learner sets up a circuit to determine the emf and internal resistance of a battery.



She uses the results obtained to plot the graph shown below.



8.1 Define the term *emf* of a battery. (2)

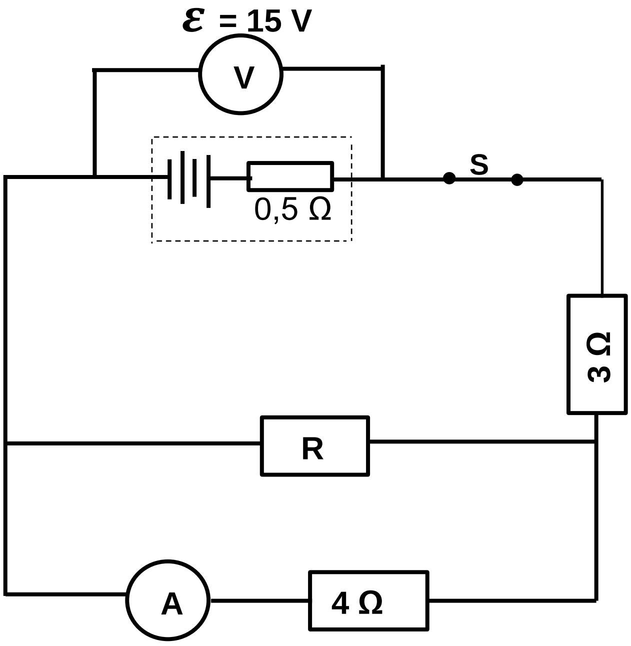
8.2 Use the graph to:

8.2.1 Determine the emf of the battery (1)

8.2.2 Calculate the internal resistance of the battery (3)

8.3 A circuit is connected as shown below. The resistance of **R**, which is connected in parallel with the 4 Ω resistor, is unknown. The battery has an emf of 15 V and an internal resistance of 0,5 Ω.

When switch **S** is closed the voltmeter reads 13,5 V.



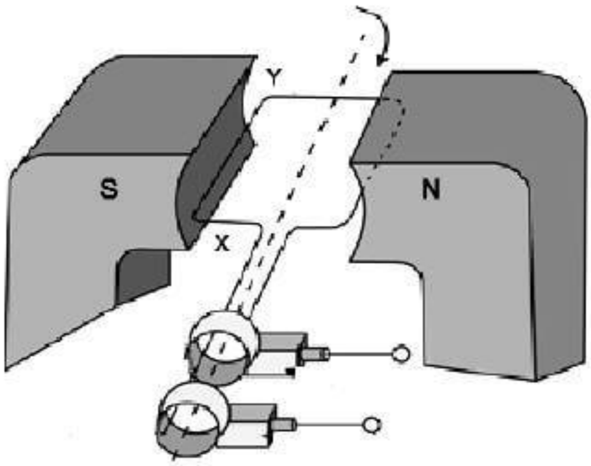
Calculate the:

8.3.1 Reading on ammeter **A** (6)

8.3.2 Resistance of resistor **R** (3)
[15]

QUESTION 9 (Start on a new page.)

9.1 The diagram of a simplified generator is shown below. The coil is rotated clockwise in a uniform magnetic field.



9.1.1 What type of generator is illustrated in the diagram? Give a reason for your answer. (2)

9.1.2 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)

9.2 Eskom supplies electricity to homes at rms voltage of 220 V. A certain electrical appliance dissipates 1 200 W of power when it is plugged in at a home.

9.2.1 Define the term *rms potential difference.* (2)

Calculate the:

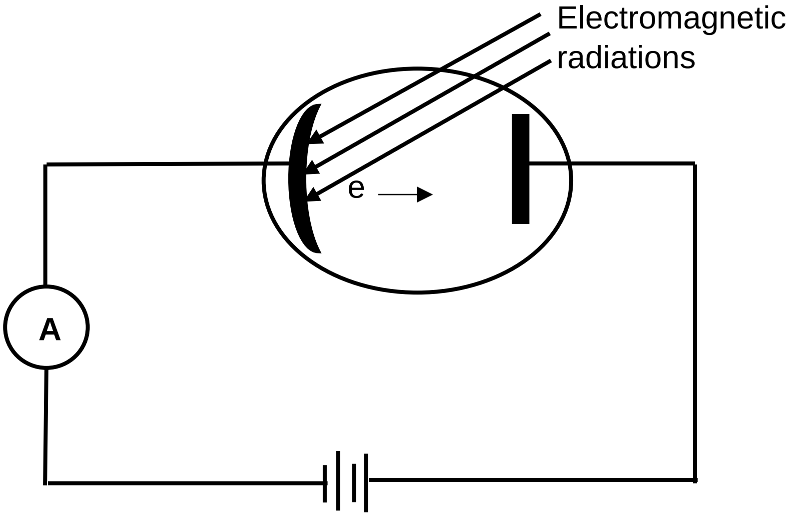
9.2.2 Resistance of the appliance (3)

9.2.3 Peak (maximum) current that passes through the appliance (5)

[14]

QUESTION 10 (Start on a new page.)

The diagram below shows a photocell that emits electrons when a certain frequency of electromagnetic radiation is incident on the metal plate.



10.1 Describe the *photoelectric effect*. (2)

10.2 Define the term *work function of a metal.* (2)

When radiation of wavelength 555 nm is incident on the metal plate, electrons are released with zero kinetic energy.

10.3 Calculate the work function of this metal. (3)

10.4 The intensity of the incident light is now increased. State how this increase in intensity will affect the reading on the ammeter.

Write down only INCREASES, DECREASES or REMAINS THE SAME. Give a reason for your answer. (2)

10.5 Another light source shines light onto the same metal and the emitted electron moves away from the metal surface with a velocity of 5×10^6 m.s^{-1}.

Calculate the frequency of this light source. (4)
[13]

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

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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{d^2}$	$g = G\frac{M}{d^2}$

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* $W_{nc} = \Delta E_K + \Delta E_P$	$P = \frac{W}{\Delta t}$
$P_{av} = Fv$	

ELECTROSTATICS/*ELEKTROSTATIKA*

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

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

$V = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} \cdot f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} \cdot f_b$	$E = hf$ or/of $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(max)}$ or $E = W_0 + K_{max}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(max)} = \frac{1}{2}mv^2_{max}$ / $K_{(max)} = \frac{1}{2}mv^2_{max}$	
$E = W_0 + E_{k(maks)}$ of $E = W_0 + K_{maks}$ waar $E = hf$ en $W_0 = hf_0$ en $E_{k(maks)} = \frac{1}{2}mv^2_{maks}$ / $K_{(maks)} = \frac{1}{2}mv^2_{maks}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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