education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION



GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)



SEPTEMBER 2025

MARKS: 150

TIME: 3 HOURS

This question paper consists of 15 pages and 3 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL 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. You may use appropriate 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 where applicable.
10. Give brief motivations, discussions, etc., where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

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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 answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 When a book lies on the table, it does not move because …

A the force exerted by the table on the book is equal to the force exerted by the Earth on the book.

B the force exerted by the table on the book is greater than the force exerted by the Earth on the book.

C the forces acting on the book are in equilibrium.

D no forces are acting on it. (2)

1.2 A maximum force of 8 N is exerted on the 6 kg block, which is at rest and just about to move on a rough surface as shown in the diagram below.



Which ONE of the following will increase the frictional force experienced by the block?

A Increase the applied force to 10 N.

B Decrease the applied force to 4 N.

C Place a 2 kg block on top of the block.

D Rotate the block so that the smaller area is in contact with the surface. (2)

1.3 The acceleration due to gravity on the Moon is *g*. Which ONE of the following represents the acceleration due to gravity on a planet that is three times the mass and ⅓ the radius of the Moon?

A 81 g

B 27 g

C 9 g

D 3 g (2)

1.4 A body falls freely in the absence of air resistance. Which physical quantity of the body is equal to the rate of change of momentum?

A Mass

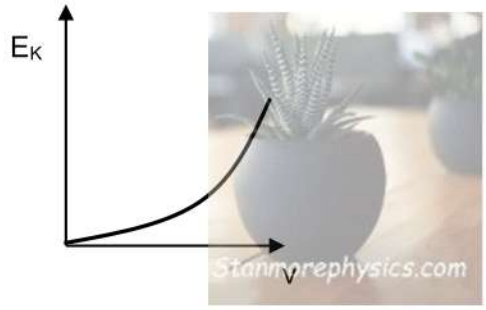
B Weight

C Power

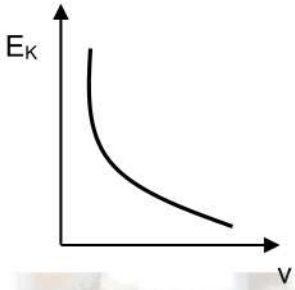
D Kinetic energy (2)

1.5 A ball is dropped from a learner's hand to the ground. Which graph represents the kinetic energy E_k versus the velocity of ball v?

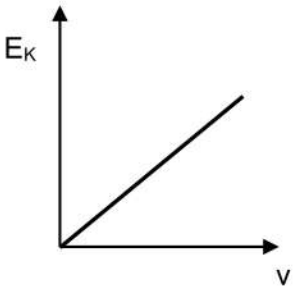
A



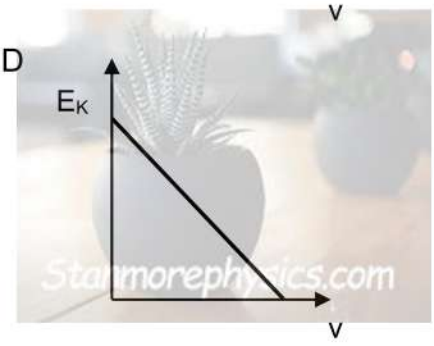
B



C



D



(2)

1.6 An astronomer on Earth observes light with a wavelength λ originating from a distant galaxy moving away from the Earth. The wavelength observed by the astronomer will likely be ...

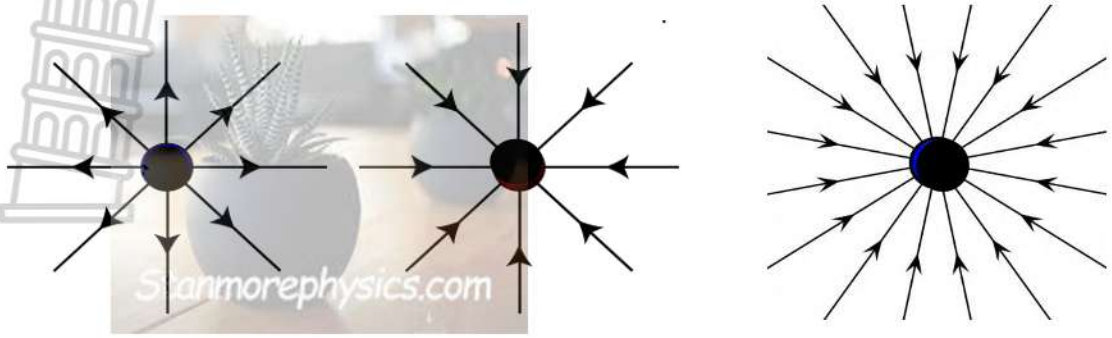
A greater than λ.

B less than λ.

C equal to λ.

D zero. (2)

1.7 Consider the electric field patterns around the charged particles **Q**, **R** and **S** as shown in the diagrams below.



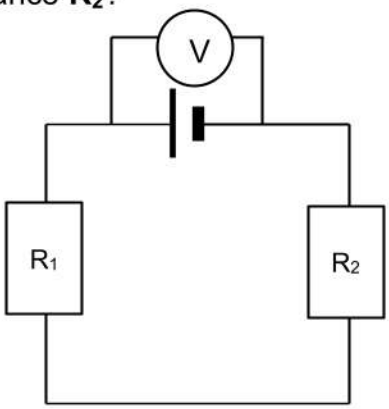
Q **R** **S**

What are the respective charges and polarity on **Q, R** and **S**?

	CHARGE Q	CHARGE R	CHARGE S
A	-q	+q	+q
B	+q	-q	-q
C	+q	-q	-2q
D	-q	+q	+2q

(2)

1.8 The circuit diagram below has two identical resistors $\mathbf{R_1}$ and $\mathbf{R_2}$, and a battery with a potential difference of **V**. What is the potential difference across the resistor with resistance $\mathbf{R_2}$?



A $\frac{R_1}{R_2} \times V$

B $\frac{R_2}{R_1} \times V$

C $\frac{R_1}{R_1 - R_2} \times V$

D $\frac{R_2}{R_1 + R_2} \times V$

(2)

1.9 The difference between a DC and an AC generator is that a DC generator …

A uses brushes for commutation, while an AC generator uses slip rings.

B. produces a unidirectional current, whereas an AC generator generates alternating current.

C operates at a constant frequency, whereas an AC generator varies its frequency.

D produces a lower current than an AC generator. (2)

1.10 The number of photo electrons emitted by an incident light of frequency f, which is higher than the threshold frequency f_0, is proportional to …

A threshold frequency.

B frequency of light.

C intensity of light.

D $f - f_0$. (2)

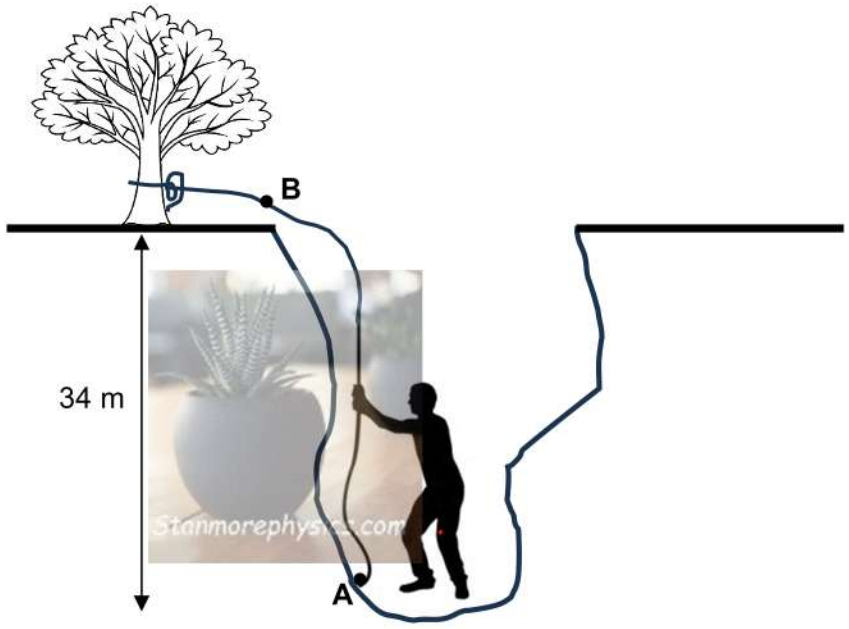
[20]

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QUESTION 2 (Start on a new page.)

A 73 kg man is at the bottom of a 34 m deep hole at position **A**. He is pulled vertically upwards from rest at position **A** by an inextensible rope attached to a tree, until he reaches position **B** at the top. The tension in the rope is 780 N.

Ignore the effects of air friction.



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

2.2 Draw a free-body diagram showing all the forces acting on the man. (2)

2.3 Calculate the magnitude of the man's weight. (3)

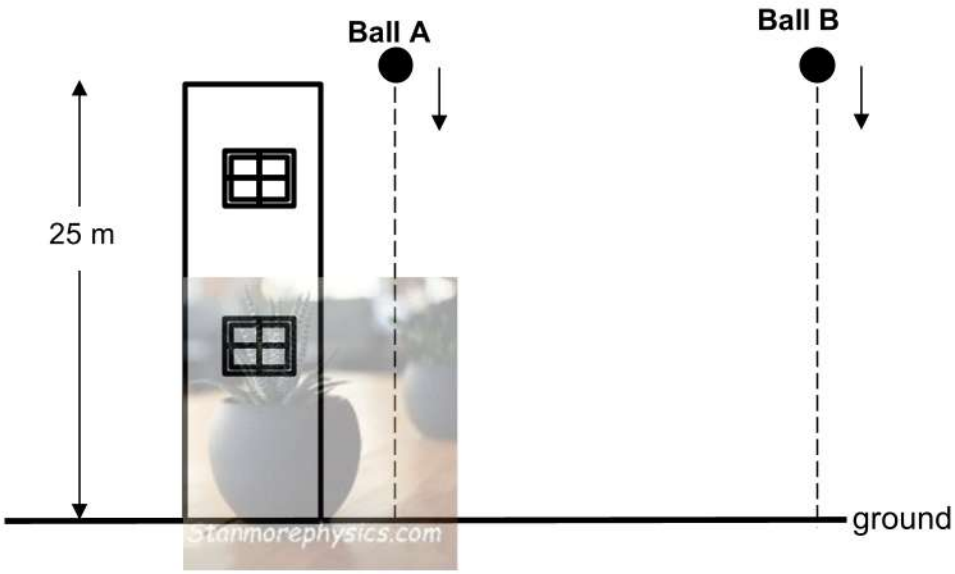
2.4 Calculate the time taken to pull the man out of the hole, from position **A** to position **B**. (5)

2.5 Will the tension in the rope be greater when the man is at rest, or when the man is pulled upward? Explain your answer. (3)
[15]

QUESTION 3 (Start on a new page.)

Ball **A** is dropped vertically downwards from the top of a 25 m high building. ONE second later, another ball **B** is thrown vertically downwards from the same height with a speed of 30 $m \cdot s^{-1}$.

Ignore the effects of friction.



3.1 Define the term *projectile*. (2)

3.2 Use EQUATIONS OF MOTIONS ONLY to calculate the:

3.2.1 Time it takes ball **A** to travel 12,5 m above the ground (3)

3.2.2 Time it takes ball **B** to pass ball **A** (6)

3.2.3 Speed of ball **B** when it reaches the ground (3)

3.3 On the same set of axes, sketch the position-time graphs of ball **A** and ball **B** while they are in free fall. Label graphs **A** and **B** respectively.

Clearly indicate the following on the graphs:

- The initial height of the building
- The times at which each ball is thrown
- The time at which ball **A** passes ball **B** (5)

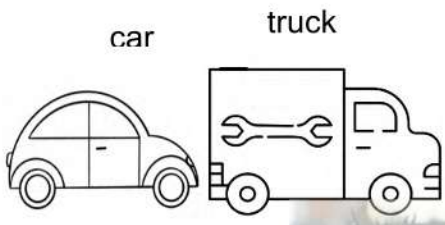
[19]

QUESTION 4 (Start on a new page.)

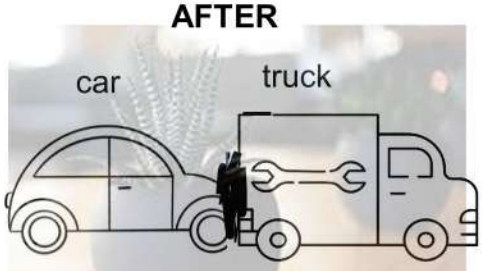
A car of mass 1 200 kg moving at a speed of 25 $m \cdot s^{-1}$ in the eastern direction, crashes into the back of a truck of mass 6 000 kg moving in the same direction at 15 $m \cdot s^{-1}$. The velocity of the car after the collision is 16 $m \cdot s^{-1}$ to the east.

Ignore all frictional and rotational effects.

BEFORE



AFTER



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4.1 Write the *principle of conservation of linear momentum* in words. (2)

4.2 Calculate the velocity of the truck after the collision. (4)

4.3 Calculate the mechanical energy lost during the car-truck collision. (5)

4.4 Explain why mechanical energy is lost. (2)
[13]

QUESTION 5 (Start on a new page.)

An 8 kg steel ball initially at rest is pulled upward by an electric motor with a constant applied force of 45 N. The ball moves at constant speed in each of the sections **XY** and **YZ** along a rough inclined slope as shown below. Each section is 4 meters long and exerts a different frictional force on the steel ball as it moves up the incline. The incline makes an angle of 25° with the horizontal. (See **DIAGRAM 1**)

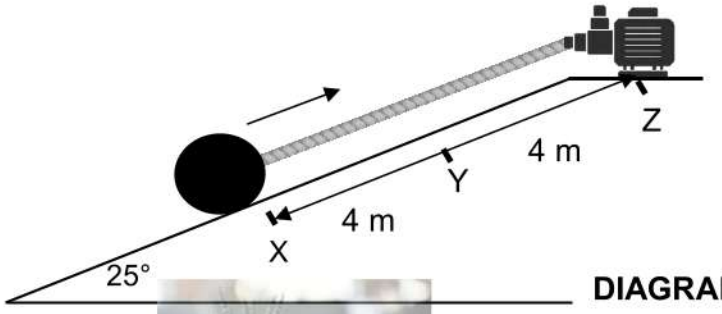


DIAGRAM 1

The graph below shows the kinetic energy of the object versus the distance for the entire motion until point **Z**. (See **DIAGRAM 2**)

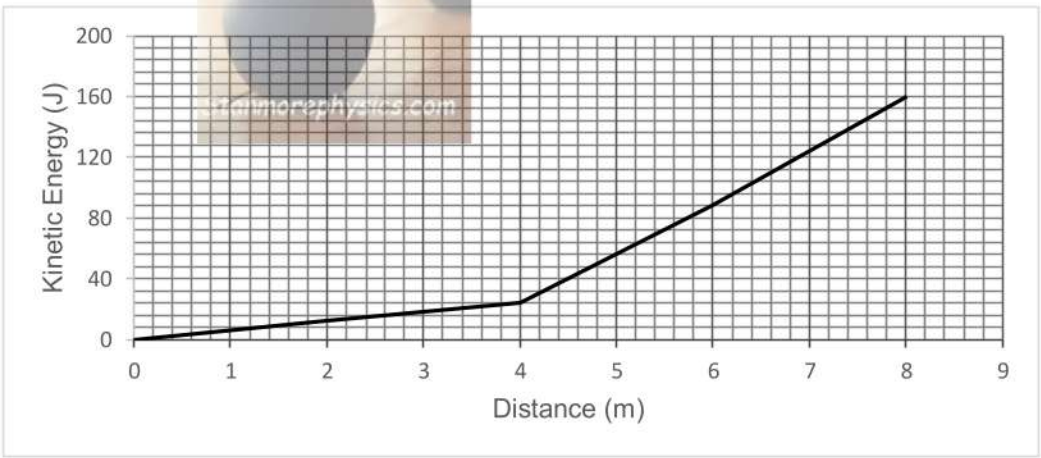


DIAGRAM 2

5.1 Define the term *non-conservative force.* (2)

5.2 Use a suitable formula to show the physical quantity represented by the slope of the graph. (2)

5.3 Calculate:

5.3.1 The net force experienced by the steel ball as it moves from **Y** to **Z** (3)

5.3.2 The magnitude of the frictional force experienced by the block as it moves from **Y** to **Z** (4)

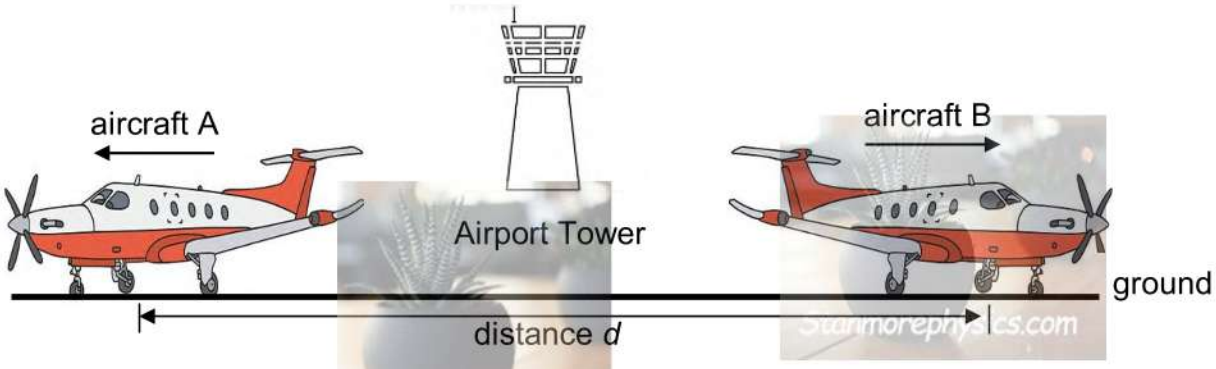
5.3.3 The power dissipated by the block from **X** to **Z** (4)

5.4 Which region, **XY** or **YZ,** has the largest frictional force? Explain your answer. (2)
[17]

QUESTION 6 (Start on a new page.)

Two identical aircraft, **A** and **B,** each producing a sound wave with a frequency of 600 Hz, start moving at the same time in opposite directions away from the airport tower, as shown in the diagram below. A listener sitting in the tower measures a 30 Hz decrease from the actual frequency of aircraft **A**, while the frequency measured for aircraft **B** is 450 Hz.

Assume the speed of sound is 340 $m \cdot s^{-1}$.



6.1 Name the phenomenon that describes the apparent change in frequency detected by the observer. (1)

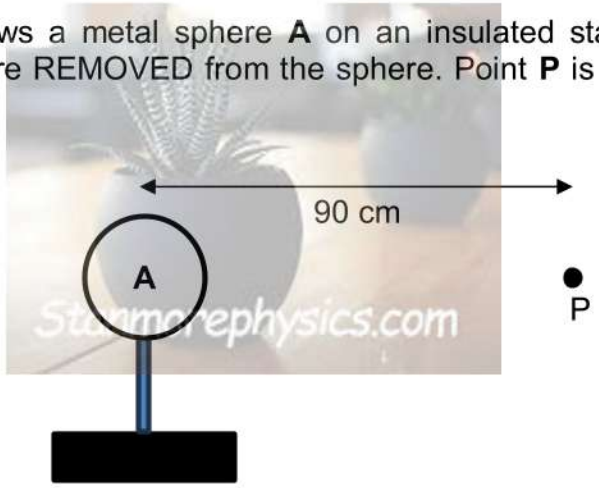
6.2 How does the frequency heard by the pilot in aircraft **A,** compare to the actual frequency of the sound waves produced by aircraft **A**?
Write down HIGHER THAN, LOWER THAN or REMAINS THE SAME. (1)

6.3 Give a reason for the answer to QUESTION 6.2. (2)

6.4 Calculate the distance *d* between the two aircraft after they moved in opposite directions at a constant velocity for 60 seconds. (7)
[11]

QUESTION 7 (Start on a new page.)

The diagram below shows a metal sphere **A** on an insulated stand in a vacuum. 4,625 x 10^{10} electrons are REMOVED from the sphere. Point **P** is 90 cm away from sphere **A.**



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

7.2 Explain why sphere **A** is placed on an insulated stand. (2)

7.3 Calculate the net charge on sphere **A.** (3)

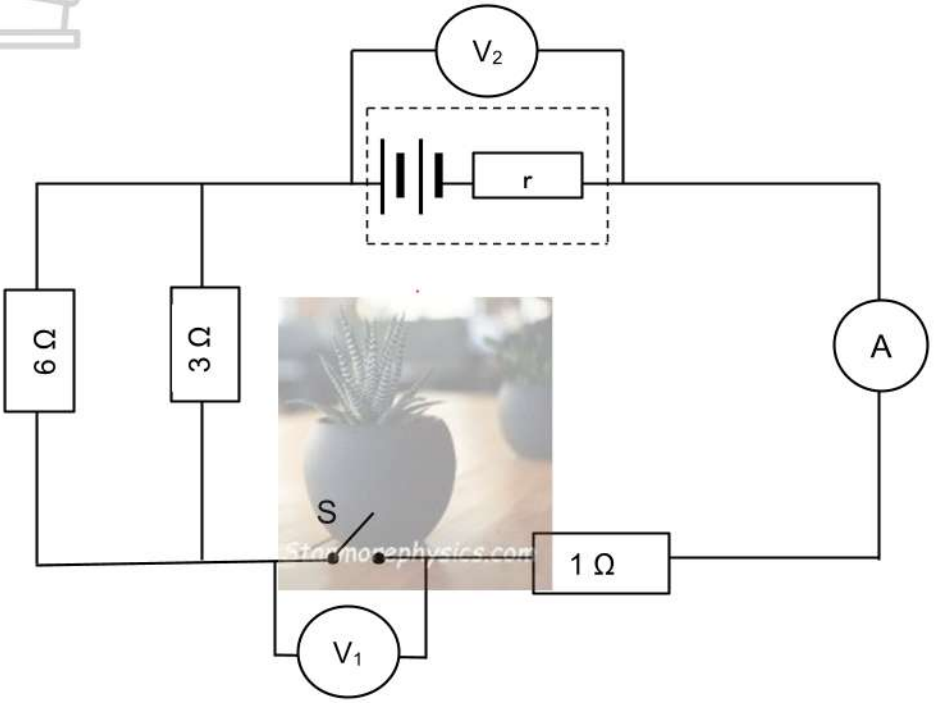
7.4 Calculate the magnitude of the electric field at point **P** due to sphere **A**. (3)

Another sphere **B**, carrying a charge of −5 nC, is placed at point **P**.

7.5 Calculate how far from point **P** sphere **B** should be placed, to decrease the net electrostatic force between the two spheres by 15%. (6)
[16]

QUESTION 8 (Start on a new page.)

In the circuit diagram below, the battery has an emf of 10 V and an unknown internal resistance r. Voltmeter V_1 is connected across the open switch, and V_2 is connected across the battery. The resistance of the connecting wires and the ammeter can be ignored. Switch S is open.



8.1 State Ohm's law in words. (2)

8.2 Determine the:

8.2.1 Reading on voltmeter V_1 (1)

8.2.2 Reading on voltmeter V_2 (1)

Switch S is now closed. The reading on V_2 drops by 2,5 V.

8.3 Calculate the:

8.3.1 Reading on V_2 (1)

8.3.2 Reading on the ammeter (6)

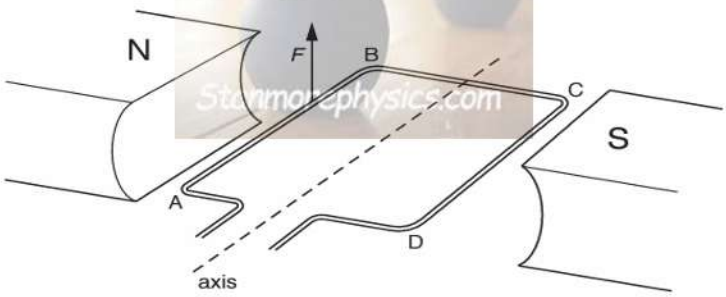
8.3.3 Internal resistance of the battery (3)

8.4 How will the magnitude of the current passing through the 6 Ω resistor compare to that of 3 Ω? (2)

[16]

QUESTION 9 (Start on a new page.)

9.1 The diagram below shows a horizontal rectangular coil **ABCD** placed between magnets. The coil has a current when an upward force **F** is applied to side **AB** of the coil.



9.1.1 Explain why there is a current induced in segment **AB.** (1)

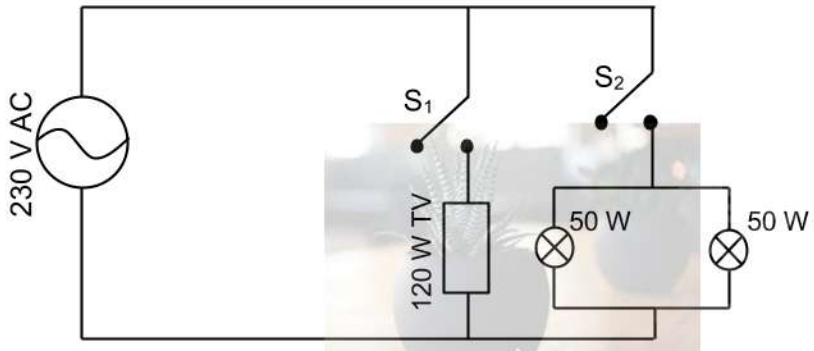
9.1.2 Determine the direction of the current in **AB**. Write only **A** to **B** or **B** to **A**. Explain your answer. (2)

A change is made to the device to operate as a DC motor.

9.1.3 Name the part of the component that makes it possible for the machine to operate as a DC motor. (1)

9.1.4 Name ONE change that can be made to the diagram above to produce a greater turning effect in coil **ABCD**. (1)

9.2 A 120 W television and two 50 W tungsten lights are connected to a 230 V AC supply that operates for only 12 hours a day when S_1 and S_2 are closed.

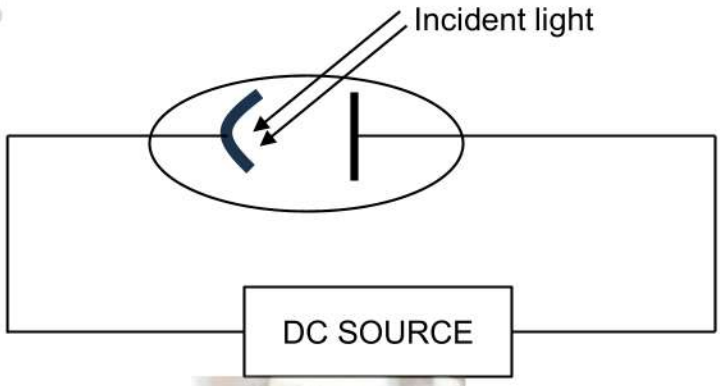


How long should switch S_1 be open in a day while S_2 is closed, in order to save R36 weekly (7 days)? The cost of electricity is R9 per kWh. (7)

[12]

QUESTION 10 (Start on a new page.)

In the diagram below, an incident light is shown on the metal surface photocell. A learner uses the photocell to determine the photoelectrons emitted.



The total output power of the electromagnetic radiation waves from the surface is $3,2 \times 10^{27}$ J·s^{-1}. The wavelength of the incident light is $5,2 \times 10^{-7}$ m.

10.1 Define the term *photoelectric effect*. (2)

10.2 Calculate the number of photons emitted per second from the metal surface. (6)

10.3 How will the maximum kinetic energy of the photoelectrons be affected when:

Write down only INCREASES, DECREASES or REMAINS THE SAME.

10.3.1 Incident light of a shorter wavelength is used (1)

10.3.2 A metal with a higher work function is used (1)

10.3.3 Incident light of greater intensity is used (1)

[11]

TOTAL: 150

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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} $N \cdot m^2 \cdot kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	6,38 x 10^6 m
Mass of the Earth *Massa van die Aarde*	M_E	5,98 x 10^{24} kg
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

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

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

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