education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)



This question paper consists of 17 pages and 3 information 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 10 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 pocket 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, et cetera 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 correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in your ANSWER BOOK, e.g. 1.11 E.

1.1 Newton's second law of motion can be expressed as F_{net} = ma. This equation consists of …

A one vector quantity and two scalar quantities.

B two vector quantities and one scalar quantity.

C three vector quantities.

D three scalar quantities. (2)

1.2 The acceleration due to gravity on Earth is *g*. What is the acceleration due to gravity on a planet which has double the mass of the Earth and half the radius of the Earth?

A ½ g

B 2 g

C 4 g

D 8 g (2)

1.3 Two cars **P** and **R** are travelling in opposite directions as shown in the diagram below. Car **R** has a greater mass than car **P** and it is moving at a higher speed. The two cars collide head-on.



Which statement best describes the magnitude of the forces experienced by the cars during the collision?

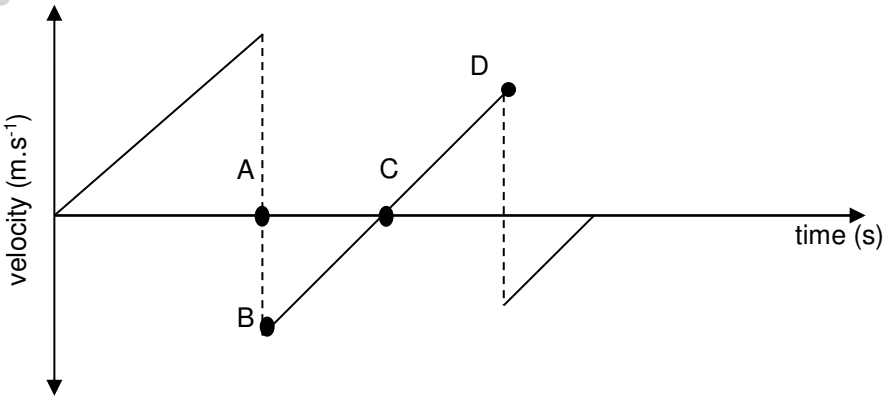
A Both cars experience equal force.

B Car **R** experiences greater force.

C Car **P** experiences greater forces.

D A force depends on the ratio of the cars' masses. (2)

1.4 A ball is dropped vertically downwards and bounces off the ground. The velocity versus time graph, not drawn to scale, represents the motion of the ball. Ignore the effect of air friction.



At which point labelled on the graph, does the ball reach its maximum height after the first bounce?

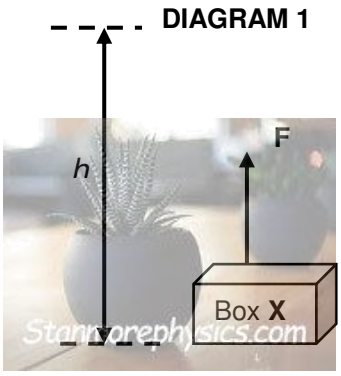
A A

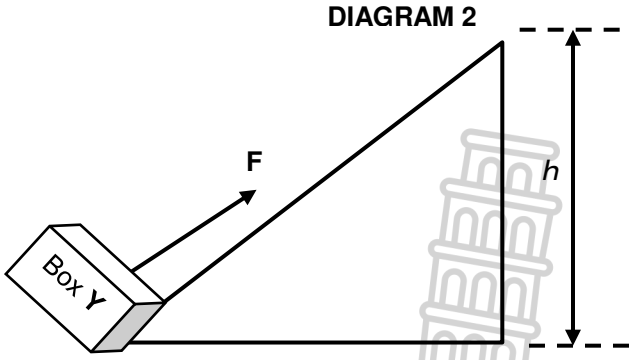
B B

C C

D D (2)

1.5 Two boxes, **X** and **Y**, of the same masses are lifted up with a constant velocity through a vertical height *h* and pulled up a frictionless surface by the same force **F** as shown in Diagram **1** and Diagram **2** below respectively.





Which ONE of the statements is CORRECT?

	ΔE_P of the boxes	Amount of work done by F
A	Is the same for both boxes	Is the same for both boxes
B	Is the same for both boxes	Box **y** is more than box **x**
C	Box **y** is less than box **x**	Box **y** is less than box **x**
D	Box **y** is more than box **x**	Box **y** is more than box **x**

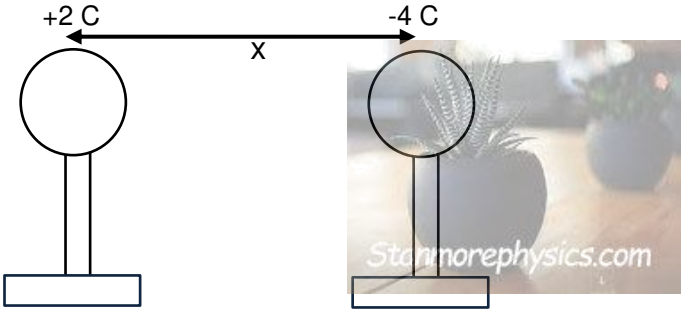
(2)

1.6 A police car with its siren on, moves at a constant speed towards a stationary observer. Which ONE of the following describes how the observed frequency and pitch differ from that of the sound source?

	Frequency	**Pitch**
A	Higher	Lower
B	Lower	Higher
C	Higher	Higher
D	Lower	Lower

(2)

1.7 Two small identical metal spheres on insulated stands, carry charges of +2 C and -4 C respectively. Each sphere experiences a force **F.** When they are distance *x* apart, they are brought together to touch and then separated to half the original distance. The magnitude of the electrostatic force which the spheres exert on each other in terms of **F** is …



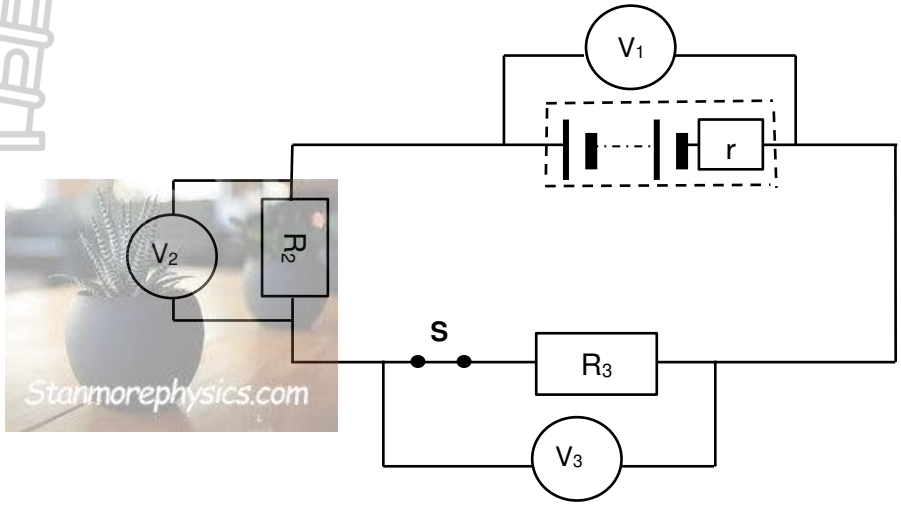
A ¼ **F**.

B ½ **F**.

C 2 **F**.

D 4 **F**. (2)

1.8 In the circuit diagram shown below, voltmeters **V_1**, **V_2** and **V_3** have very high resistance. The battery has an internal resistance, and the switch **S** and connecting wires have negligible resistance.

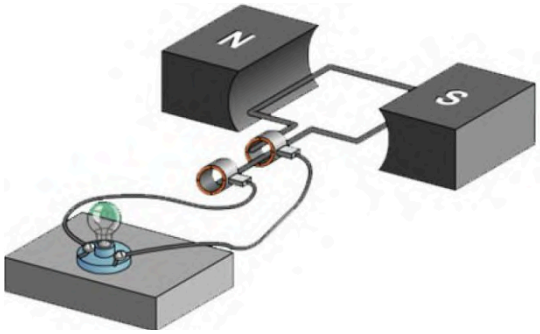


Switch **S** is now open. How will the readings of voltmeters **V_1** and **V_2** be affected?

	V_1	**V_2**
A	No change	Increase
B	No change	Decrease
C	Increase	Decrease
D	Increase	Increase

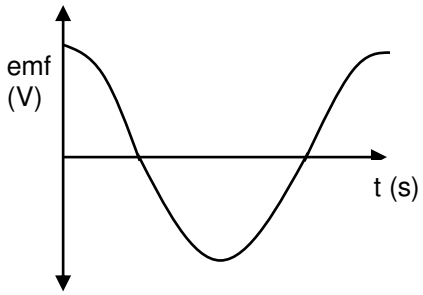
(2)

1.9 The diagram below represents a simple generator which is rotated clockwise.

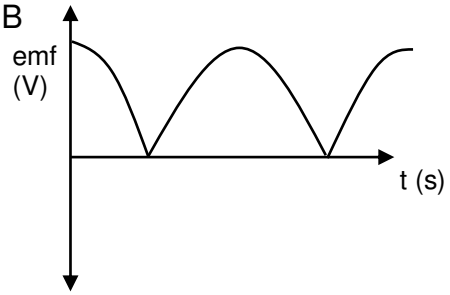


Which ONE of the following graphs represents the induced emf versus time for one full rotation of the coil, starting from the horizontal position as shown above?

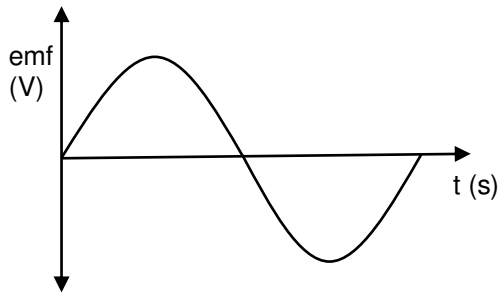
A



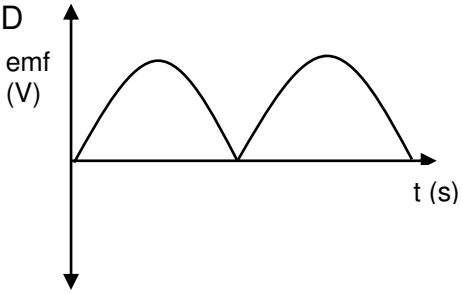
B



C



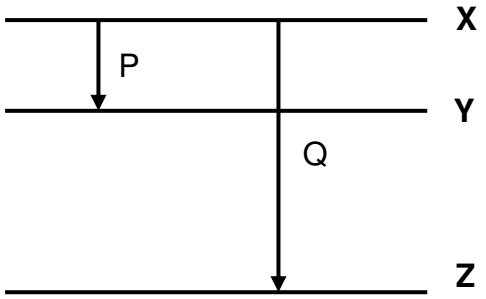
D



(2)

1.10 The diagram below represents 3 energy levels **X**, **Y** and **Z** in a certain atom. The energy difference between levels **Y** and **Z** is twice the energy difference between levels **X** and **Y**. The wavelength of a photon emitted as a result of transition **P** from level **X** to **Y** is *λ*.

What is the wavelength of the photon emitted during transition **Q**, from level **X** to **Z**?



A 2 λ

B 3 λ

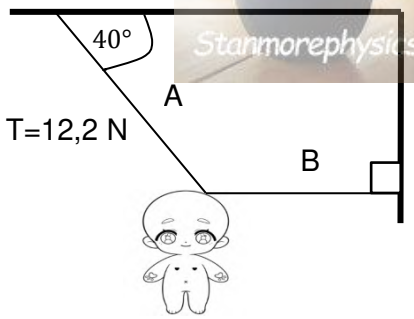
C ½ λ

D ⅓ λ (2)

[20]

QUESTION 2

2.1 A doll is suspended by two light inextensible strings from the ceiling in the corner of a room. String **A** makes an angle of 40° with the ceiling and string **B** makes an angle of 90° with the wall. The tension in string **A** is 12,2 N.



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2.1.1 State Newton's First Law of Motion in words. (2)

2.1.2 Calculate the magnitude of the vertical component of the tension in string **A**. (2)

2.1.3 Calculate the mass of the doll. (3)

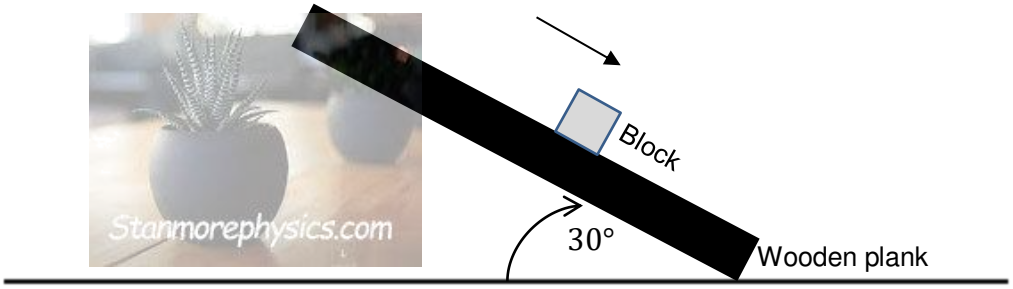
2.2 A learner wants to determine the coefficients of both static and kinetic frictional force between a flat wooden plank and a block. He places a block of mass m on the wooden plank that lies on the flat horizontal surface as shown on the diagram below.

He then gradually raises one end of the plank. When the wooden plank reaches an angle of 30° with the horizontal, the block starts to slip and then slides 2,5 m down the plank for 4 seconds at constant acceleration.

Before



After



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2.2.1 Define *static frictional force* in words. (2)

2.2.2 Draw a free-body diagram and identify all the forces acting on the block just before it slides down the wooden plank. (3)

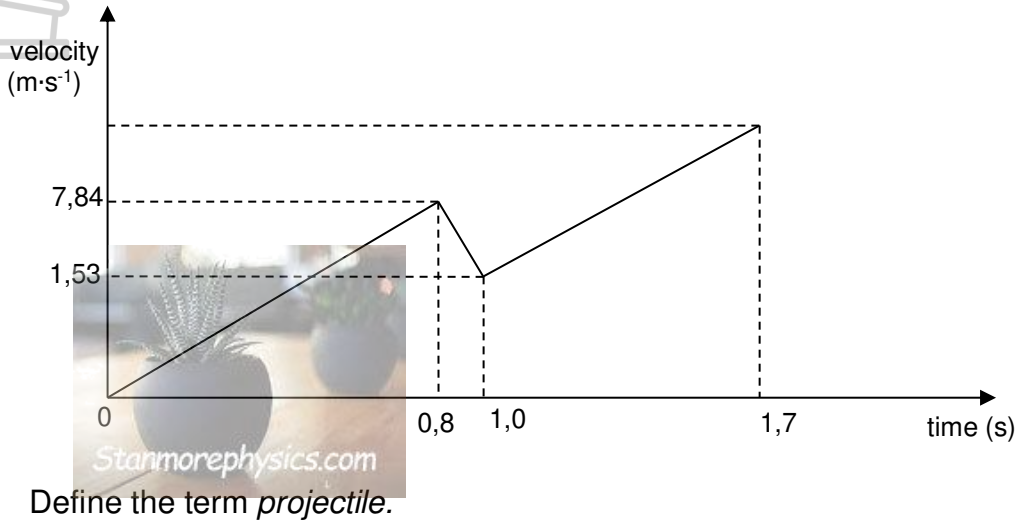
2.2.3 Calculate the coefficient of static friction between the plank and the block before the plank is tilted. (4)

2.2.4 Calculate the coefficient of kinetic friction between the block and the plank. (5)

2.2.5 Draw a labelled graph showing the relationship between the force applied and frictional force. (3)
[24]

QUESTION 3

A ball of mass 175 g falls from a tree and breaks the glass roof of a wooden cabin directly below it. The ball continues to fall freely until it hits the ground. The velocity-time graph below represents the motion of the ball from when it left the tree until it hit the ground.



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3.1 Define the term *projectile.* (2)

3.2 Calculate the distance the ball fell from the instant that it left the tree until it hit the glass roof at 0,8 s. (4)

3.3 For how long was the ball in contact with the glass roof? (1)

3.4 Calculate the average net force acting on the ball while it was in contact with the glass roof. (4)

3.5 Calculate the speed the ball reached when it hit the ground. (3)

3.6 How does the magnitude of the force exerted by the ball on the glass roof compare to that of the force exerted by the glass roof on the ball? (1)

3.7 Name the Physics law used in QUESTION 3.6 to support the answer. (1)

[16]

QUESTION 4

A 4,5 kg skateboard is pushed to the left at a constant speed of 3 m·s^{-1} on a horizontal flat surface. A boy of mass 45 kg runs to the right at a speed of 1,5 m·s^{-1} and jumps onto the skateboard.



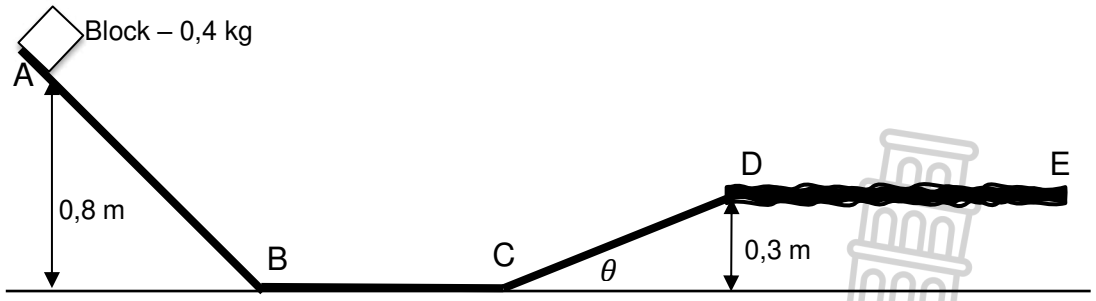
4.1 State the law of conservation of linear momentum. (2)

4.2 Calculate the velocity of the boy and the skateboard immediately after he lands on the skateboard. (4)
[6]

QUESTION 5

A small block of mass 0,4 kg is released from rest at point **A**, which is 0,8 m vertically above the ground. It takes the block 3 s to slide down from point **A** to **E** where it comes to rest. The length of the track from **A** to **E** is 8,1 m. Point **D** is 0,3 m vertically above the ground.

The surface of points **A** to **D** is frictionless. Points **D** to **E** have a rough surface. Ignore the effect of air resistance.



5.1 State the principle of conservation of mechanical energy. (2)

5.2 Is the kinetic energy at point **B** the same as that at point **C**? Write only YES or NO. (1)

5.3 Give a reason for the answer to QUESTION 5.2. (1)

5.4 Use the energy principles to calculate the speed of the block as it reaches point **D**. (4)

5.5 The distance between **D** and **E** is 3 m. Use energy principles to calculate the magnitude of the frictional force acting on the block between point **D** and **E**. (4)
[12]

QUESTION 6

A bird flies directly towards the stationary birdwatcher at constant velocity. The birdwatcher, with a detector, registers sound waves at a frequency of 890 Hz as the bird approaches him. After passing him, and moving away at the same speed, sound waves of frequency 760 Hz are registered. Assume that the speed of sound in air is 343 $m \cdot s^{-1}$.



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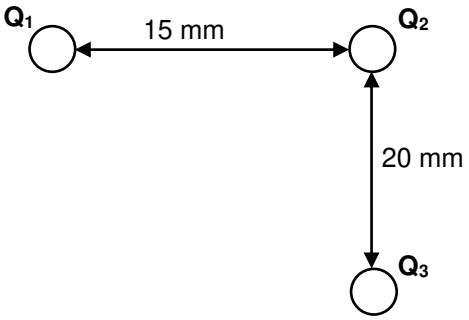
6.1 Write down the property of sound that is related to the pitch. (1)

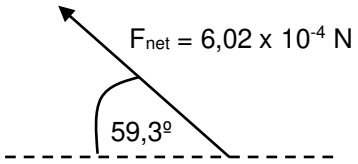
6.2 Calculate the speed at which the bird is flying. (6)

6.3 Calculate the frequency of sound emitted by the bird. (2)
[9]

QUESTION 7

7.1 Three point charges Q_1, Q_2 and Q_3 are arranged in space as shown in the diagram below. The magnitudes of Q_1 and Q_3 are unknown and the charge on Q_2 is +4 nC. The magnitude of Q_3 is three times bigger than that of Q_1. The distance between Q_1 and Q_2 is 15 mm and that between Q_2 and Q_3 is 20 mm. The charge Q_2 experiences the net electrostatic force of 6,02 x 10^{-4} N at 59,3º with the horizontal. The net force diagram below shows the electrostatic forces that Q_1 and Q_3 exert on Q_2.





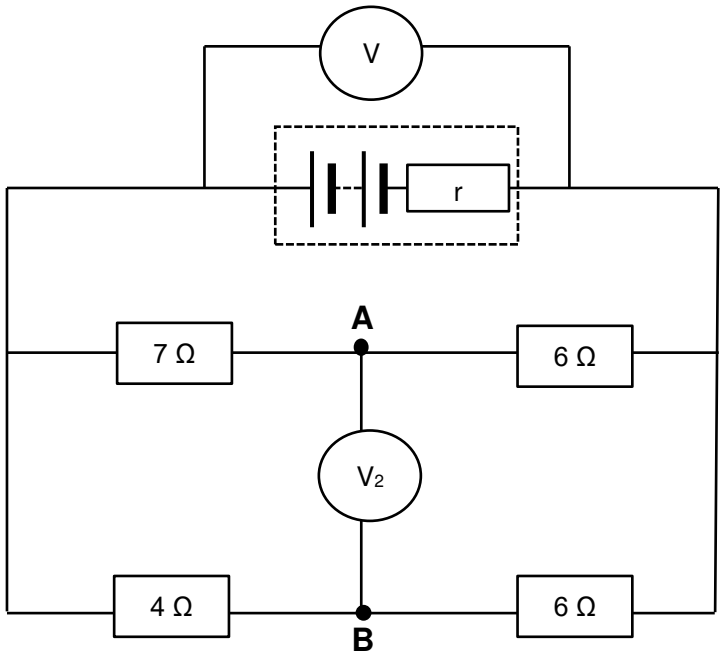
7.1.1 State Coulomb's law in words. (2)

7.1.2 In which direction does Q_2 exert a force on Q_1 and Q_3?
Write only LEFT or RIGHT and UPWARDS or DOWNWARDS. (2)

7.1.3 Calculate the magnitude of charges Q_1 and Q_3. (6)
[10]

QUESTION 8

8.1 In the circuit diagram shown below, the battery has an emf of 15 V. The internal resistance of the battery is 0,45 Ω. Voltmeter V_2 with a very high resistance is placed between point **A** and **B**.



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

Calculate the:

8.1.2 Equivalent resistance of the external circuit (4)

8.1.3 Total current flowing through the circuit (3)

8.1.4 Reading on V_2 (7)

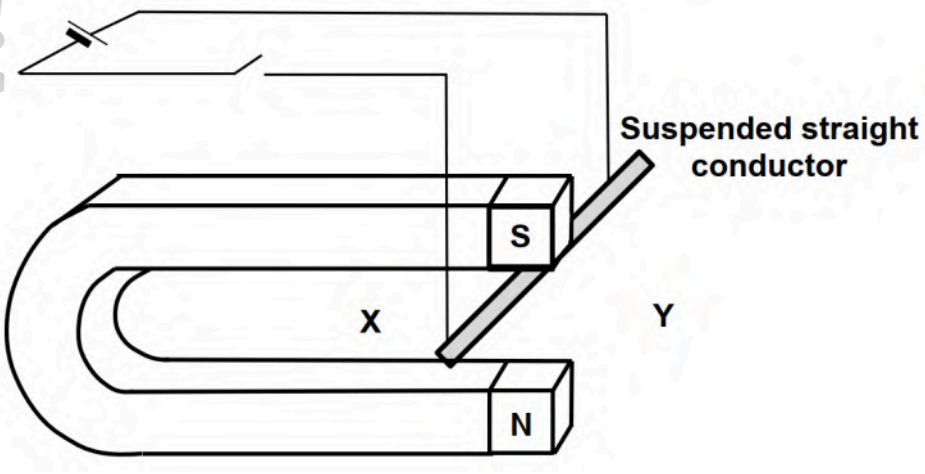
8.2 4 Ω and 6 Ω resistors alongside point **B** are removed. How will this change affect the **V** reading?
Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

8.3 Explain the answer to QUESTION 8.2. (2)

8.4 The cost of energy is R2,55 per 1 kWh. How many 60 W light bulbs can you have on for 8 hours per day if your budget for lighting is R250 per month? Assume that an average month has 30 days. (5)
[24]

QUESTION 9

9.1 The diagram below shows a straight conductor connected to a battery and suspended between the poles of a permanent magnet so that it is perpendicular to the magnet. The conductor is free to move.



9.1.1 The switch is closed. Will the conductor move towards **X** or **Y**? (1)

9.1.2 Write down ONE change that could be made to the set-up, so that the conductor will move in the opposite direction. (1)

9.1.3 Identify TWO changes that could be made to increase the emf through the conductor. (2)

9.2 An AC generator, producing a maximum voltage of 460 V, is connected to a heater of resistance 40 Ω.

9.2.1 Define the *root mean square potential difference*. (2)

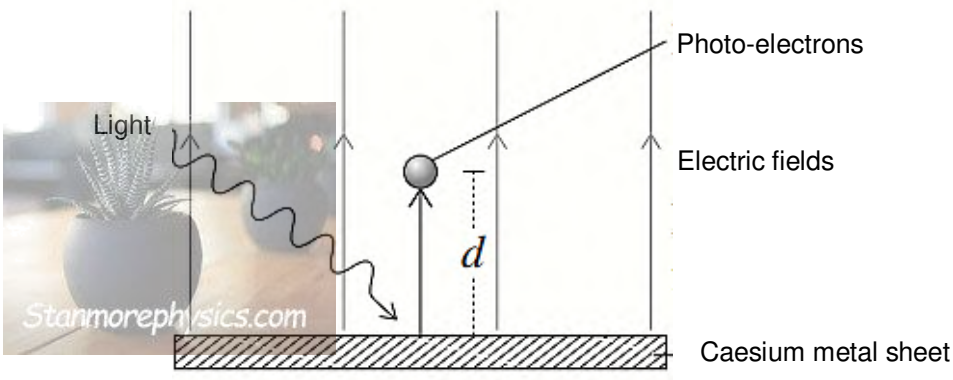
9.2.2 Write down the TWO structural differences between the AC generator and the DC generator. (2)

9.2.3 Calculate the root mean square value of the voltage. (3)

9.2.4 Calculate the root mean square value of the current in the heater. (4)
[15]

QUESTION 10

A caesium metal sheet has a wavelength of 400 nm and a work function of $3,36 \times 10^{-19}$ J. The uniform electric field of 4,6 $N.C^{-1}$ is perpendicular to the sheet. The photo-electrons travel a distance *d* to the anode as shown below.



10.1 Define the term *work function*. (2)

10.2 Show that the maximum kinetic energy of an emitted photo-electron is $1,61 \times 10^{-19}$ J. (3)

10.3 How will the maximum kinetic energy of the ejected photo-electron calculated in QUESTION 10.2 change when the intensity of the incident light increases? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)

10.4 Calculate the change in momentum carried by the photo-electron to travel from the surface of the metal to distance *d*. (4)

10.5 Calculate the maximum distance *d*. (4)
[14]

TOTAL: 150

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DATA FOR PHYSICALSCIENCES 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*

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

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