Western Cape Government

Education

METRO CENTRAL EDUCATION DISTRICT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2019

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 3 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your name on the first page of your RULED A4 PAPER or ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions on your RULED A4 PAPER or ANSWER BOOK.
3. Start EACH question on a NEW SIDE of your RULED A4 PAPER or ANSWER BOOK. Use BOTH sides of the page in order to avoid wasting paper
4. Number the answers correctly according to the numbering system used in this question paper.
5. From QUESTION 2 onwards, 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.

1.1 A car is moving at a **constant velocity**.

Which ONE of the following statements about the forces acting on the car is always CORRECT?

A There is a non-zero net force acting on the car.

B The normal force acting on the car is equal to the weight of the car.

C There are no forces acting on the car

D The net force acting on the car is zero. (2)

1.2 A satellite orbits Earth at a height where the gravitational force is a quarter (¼) of the force it experiences on the surface of the Earth. If the radius of Earth is **R,** the height of the satellite ABOVE THE SURFACE of Earth is …

A 4**R**

B 2**R**

C **R**

D ½ **R** (2)

1.3 The same force of magnitude **F**, is applied to trolley A and B respectively, as shown in the sketch below.

The mass of trolley A is twice that of trolley B and the trolleys are on a frictionless surface. If the rate of change in momentum of trolley A is **x**, then the rate of change of momentum of trolley B will be:

A. $\frac{1}{2}$**x**

B. **x**

C. 2**x**

D. 4**x** (2)

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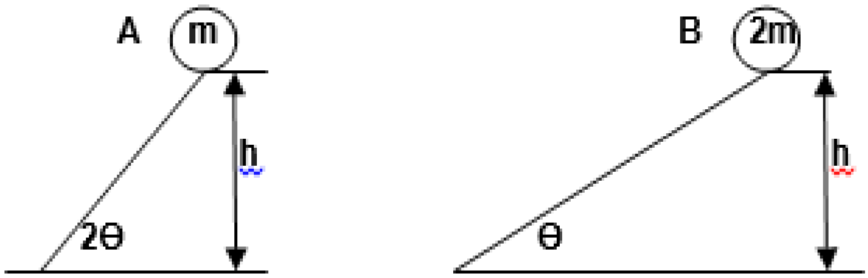
1.4 Two metal balls **A** and **B**, mass **m** and **2m** respectively, are allowed to roll down two different frictionless slopes of the same height, **h**, as indicated in the diagram below. Ball A falls vertically downwards while ball B rolls down the slope.

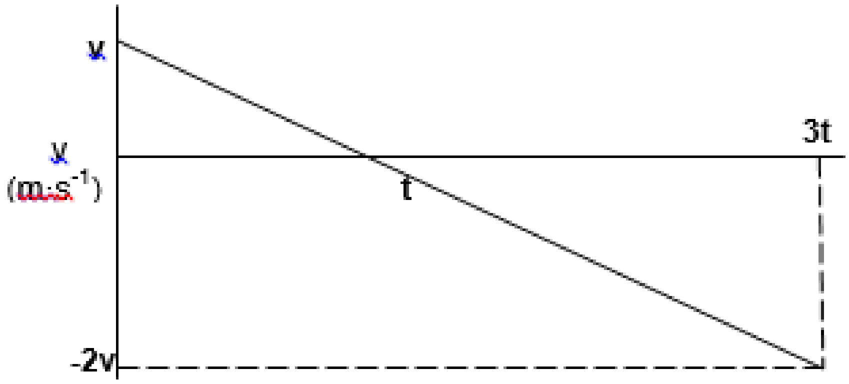


Which ONE of the following is true for the work done, W, by the gravitational force on balls **A** and **B**?

	WORK DONE
A	$W_A < W_B$
B	$W_A > W_B$
C	$W_A = W_B$
D	$W_A = W_B = 0$ J

(2)

1.5 The velocity versus time graph below represents the movement of an object that is initially projected vertically upward. Ignore the effects of friction.



The maximum height that the object reaches above the projection point is given by…

A $\frac{1}{2}$**vt**

B Zero

C -2**vt**

D $\frac{2}{3}$**vt** (2)

1.6 The Doppler effect is used in medicine to …

A detect cancer.

B determine the length of an artery.

C monitor the heartbeat of a foetus.

D monitor the growth rate of a foetus. (2)

1.7 The magnitude of the electrostatic force on a charge $\mathbf{Q_1}$ due to another charge $\mathbf{Q_2}$ is **F**. Both charges are now doubled without changing the distance between them.

The magnitude of the new electrostatic force that $\mathbf{Q_2}$ exerts on $\mathbf{Q_1}$ will be:

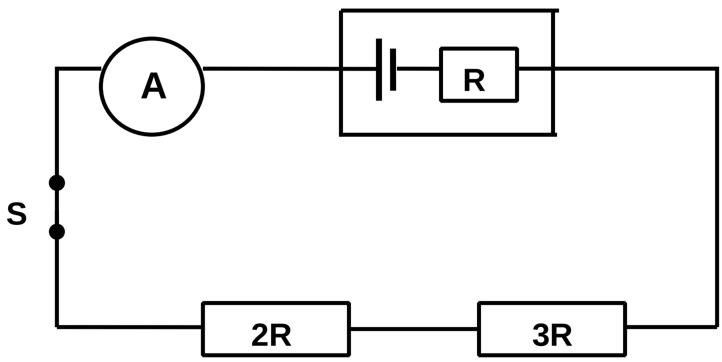
A ½ **F**

B 4**F**

C 2**F**

D 6**F** (2)

1.8 In the circuit below, two resistors of resistance **2R** and **3R** are connected in series with a battery, which has an emf of **Ɛ** and an internal resistance **R**.



What is the potential difference across the resistor of resistance 2R?

A $\frac{\varepsilon}{3}$

B $\frac{2\varepsilon}{5}$

C $\frac{\varepsilon}{2}$

D $\frac{\varepsilon}{6}$ (2)

1.9 An electrical device that uses electrical energy to produce mechanical energy is called a(n) …

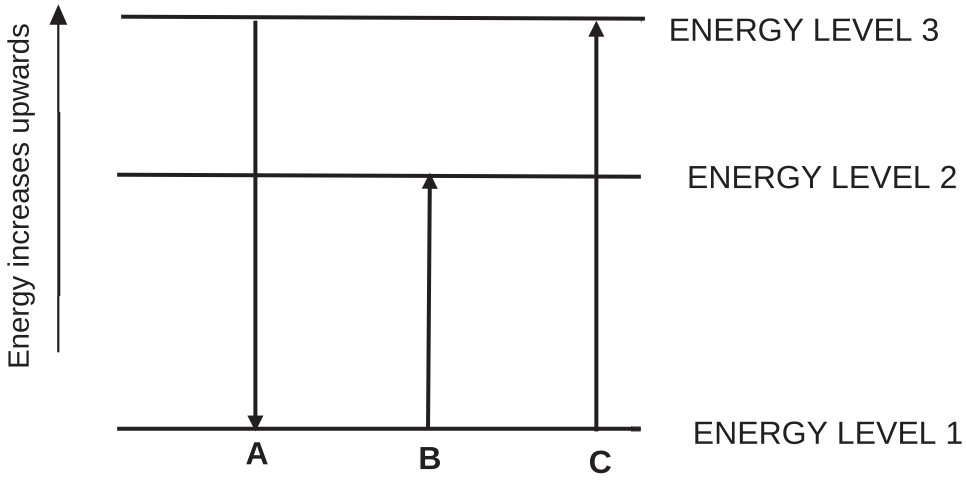
A electric motor .

B alternator.

C dynamo

D generator. (2)

1.10 In the diagram below **A, B** and **C** represent transitions made by an electron in an atom.



Which of the transition(s),below, represent energy absorption?

A A only

B B only

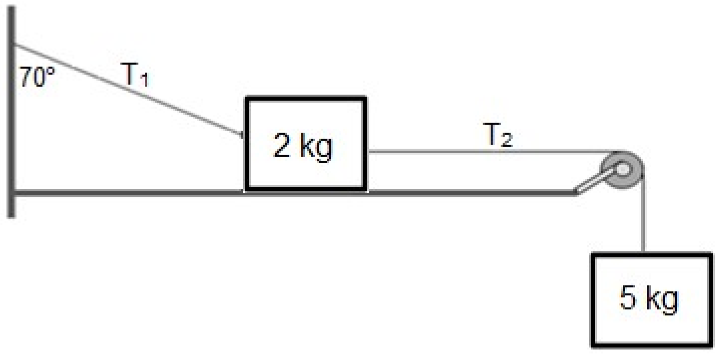
C A and C only

D B and C only (2)

[20]

QUESTION 2 [Start on a NEW Page]

2.1 Two blocks of different masses are attached to each other via a light inextensible String, T_2, which is placed over a frictionless pulley. A block of mass 2 kg is placed on a ROUGH surface and attached to the wall by a second string which makes an angle of 70° to the vertical as shown in the diagram below. A second block of mass 5 kg hangs freely. The entire system is in equilibrium.



2.1.1 State in words, *Newton's Second Law of Motion*. (2)

2.1.2 Draw a labelled free body diagram for the 2 kg mass. (5)

2.1.3 Determine the magnitude of the tension force T_2. (2)

The static frictional force between the 2 kg block and the rough surface is 10,47 N.

2.1.4 Show that the magnitude of the normal force exerted on the 2 kg mass, is 5,58 N. (4)

2.1.5 Determine the coefficient of static friction between the 2 kg block and the rough surface. (3)

2.2 The acceleration due to gravity on planet X is 2,7 $m \cdot s^{-2}$. The radius of this planet is a third (⅓) of the radius of Earth.

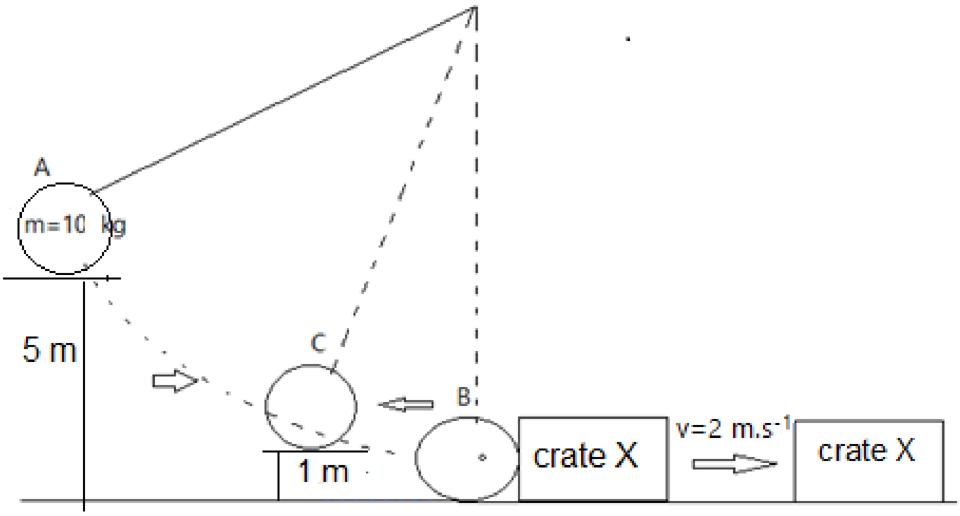
2.2.1 Calculate the mass of planet X. (4)

2.2.2 Determine the factor by which the weight of an object on planet X will differ from the weight of the same object on Earth. (1)

[21]

QUESTION 3 **[Start on a NEW Page]**

A metal sphere of mass 10 kg is suspended from a chain at a height of 5 m above the ground, at position A. The sphere is held in position A by means of an electromagnet as shown in the sketch below. When the electromagnet is switched off, the sphere swings down to position B, striking a stationary crate, X, of unknown mass.
The crate, X, moves to the right with a velocity of 2 m·s^{-1}. The pendulum swings to the left and reaches a height of 1 m at position C.
Ignore ALL friction forces.



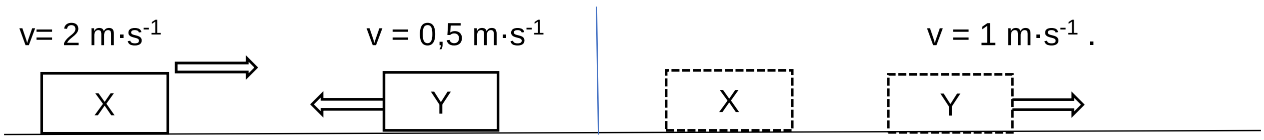
3.1 State in words, the *principle of conservation of mechanical energy*. (2)

3.2 Calculate the kinetic energy of the sphere at position B, just before it collides with the crate. (3)

3.3 Show that the kinetic energy of crate X, when the sphere reaches point C, is 392 J. (3)

3.4 Hence, calculate the mass of the crate. (3)

3.5 After moving a short distance, crate X collides with a second crate, Y, of mass 150 kg which was moving towards it (to the left) at a velocity of 0,5 m·s^{-1}. After the collision crate Y moves off to the right with a velocity of 1 m·s.$^{-1}$. Assume the surface to be frictionless.



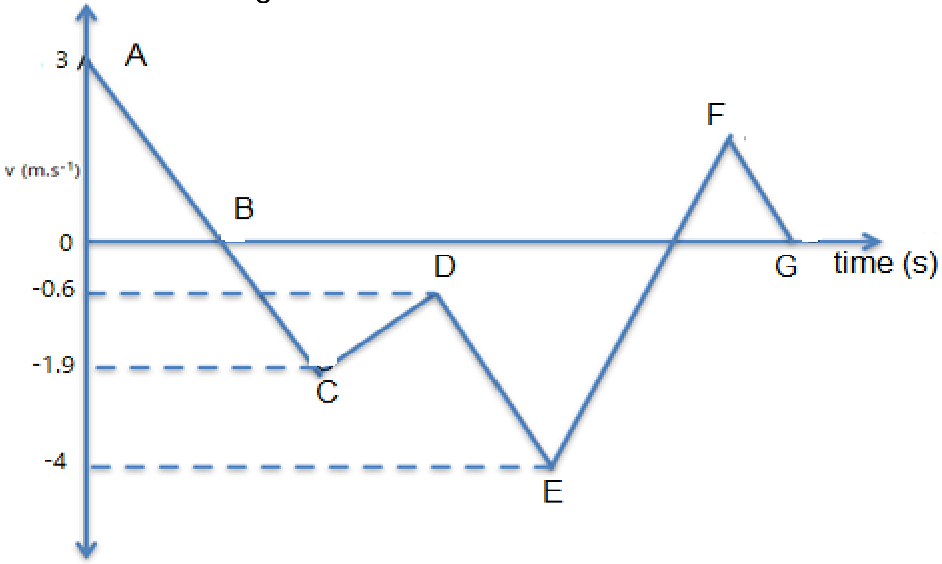
3.5.1 State in words, the *principle of conservation of linear momentum*. (2)

3.5.2. Calculate the velocity of crate, X, immediately after the collision. (4)

[17]

QUESTION 4 **[Start on a NEW Page]**

A steel ball of mass 160 g, is thrown vertically upwards with a velocity of 3 $m \cdot s^{-1}$ from a certain height above the ground. On the way down, a very thin horizontal glass pane is pushed in its path. The ball crashes through it and then continues downward, eventually bouncing on the ground. The velocity- time graph below, (not drawn to scale) shows the motion of the steel ball, from the point of projection. Assume that none of the broken pieces of glass sticks to the ball. Ignore the effects of air friction and the thickness of the glass.



4.1 Identify two sections, from the graph, where the acceleration is not equal to 9,8 $m \cdot s^{-2}$. Give a reason for your answer (3)

4.2 According to the information provided on the graph, how many times did the ball bounce on the ground? (1)

4.3 Use ONLY the information provided on the graph and

4.3.1 calculate the maximum height reached by the steel ball, above the point of projection. (3)

4.3.2 calculate the distance between the pane of the glass and the initial position from which the ball was thrown. Ignore the thickness of the glass pane. (4)

4.4 Calculate the impulse of the ball while it is in contact with the glass. (3)

After crashing through the glass, the time for the ball to reach the ground is **t**. Analysis shows that the ball made contact with the glass for $\frac{1}{1,2}$**t**.

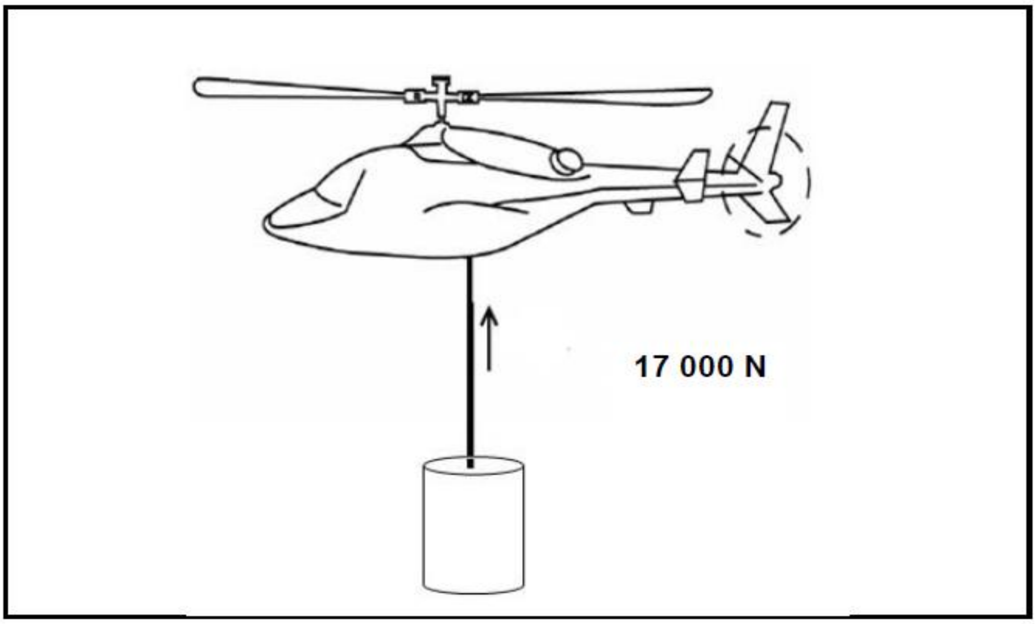
4.5 Show that the contact time of the steel ball with the glass pane is 0,289 s. (2)

4.6 The acceleration during its contact with the glass compared to its acceleration on the ground is in the ratio of 1 : 4,3. Calculate the ratio between the impulse on the glass and the impulse on the ground if the contact time on the ground is 0,669 **t**. (5)

[21]

QUESTION 5 [Start on a NEW Page]

A large bucket of mass 80 kg is filled with 1 600 kg of water. It is lifted vertically upwards by a helicopter, through a height of 20 m, at CONSTANT SPEED of 2 m·s^{-1}. The tension in the cable is 17 000 N.
Assume there is no sideways movement.



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

5.2 Draw a labelled free-body diagram showing ALL the forces acting on the bucket, while being lifted upwards. (3)

5.3 Use energy principles only to calculate the work done by air friction on the bucket of water after moving through a height of 20 m. (5)
[10]

QUESTION 6

A racing car approaches the finishing line in a race at a CONSTANT VELOCITY of 284,4 km·h^{-1}. The engine of the car produces a sound of frequency 1 200 Hz.

The speed of sound in air is 340 m·s^{-1}.

6.1 State in words, the *Doppler Effect*. (2)

6.2 Calculate the frequency of the sound heard by a man standing at the finishing line. (5)

6.3 Draw a graph of frequency vs time for the sound as the car approaches the man and then passes him. (2)
[9]

QUESTION 7 [Start on a NEW Page]

7.1 Two point charges, A (+12 mC) and B (+28 mC), are placed 1 cm apart inside a vacuum.

7.1.1 Draw the electric field pattern due to the charges A and B. (3)

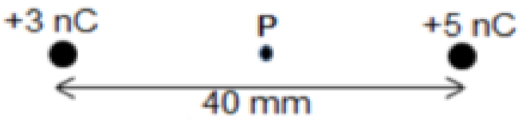
The spheres are brought together, allowed to touch, and then moved back to their original positions.

7.1.2 When the spheres touch, are electrons transferred from A to B or from B to A? (1)

7.1.3 Calculate the number of electrons transferred from one sphere to the other. (4)

7.1.4 Calculate the loss or gain in mass of each of the point charges. (2)

7.2 Two small identical, charged spheres which carry charges of +3 nC and +5 nC are placed a distance of 40 mm apart as shown in the diagram. Along the line joining the two small spheres, there is a point P, which is 10 mm to right from the +3 nC charge.

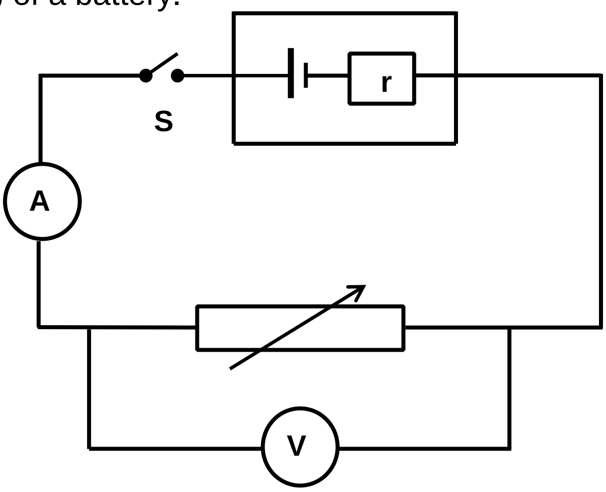


7.2.1 Define *electric field at a point*. (2)

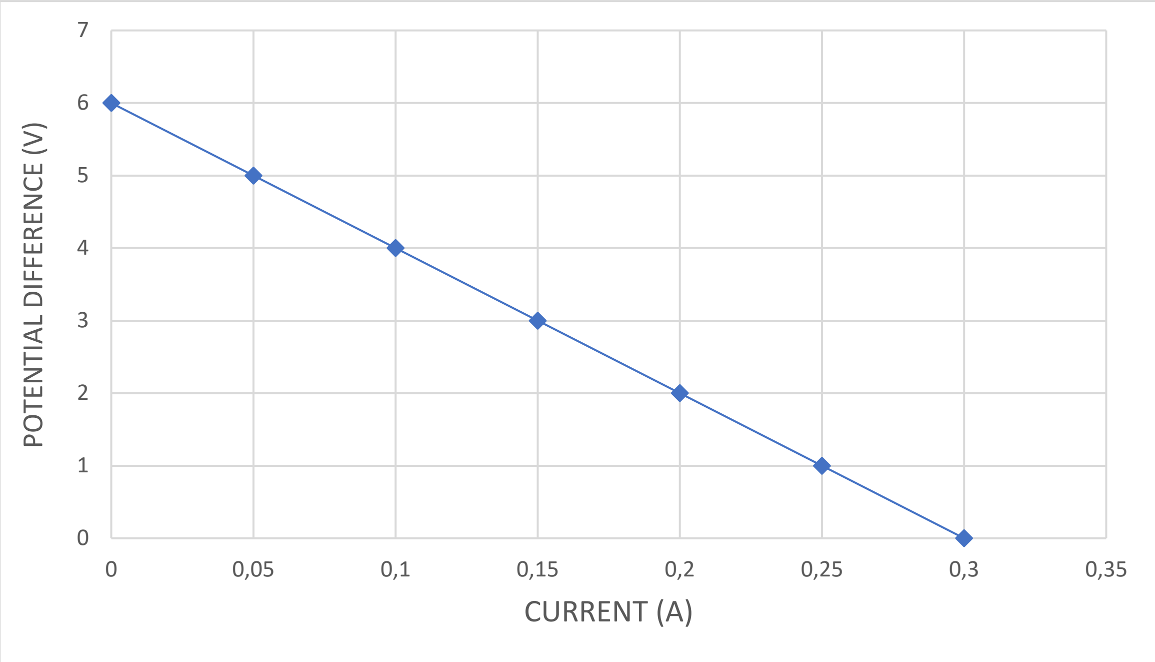
7.2.2 Calculate the magnitude and direction of the resultant electric field strength at P. (6)
[18]

QUESTION 8 [Start on a NEW Page]

8.1 A learner sets up the circuit shown below to determine the emf (ε) and internal resistance (r) of a battery.



The learner obtained the following graph from the data of the investigation.

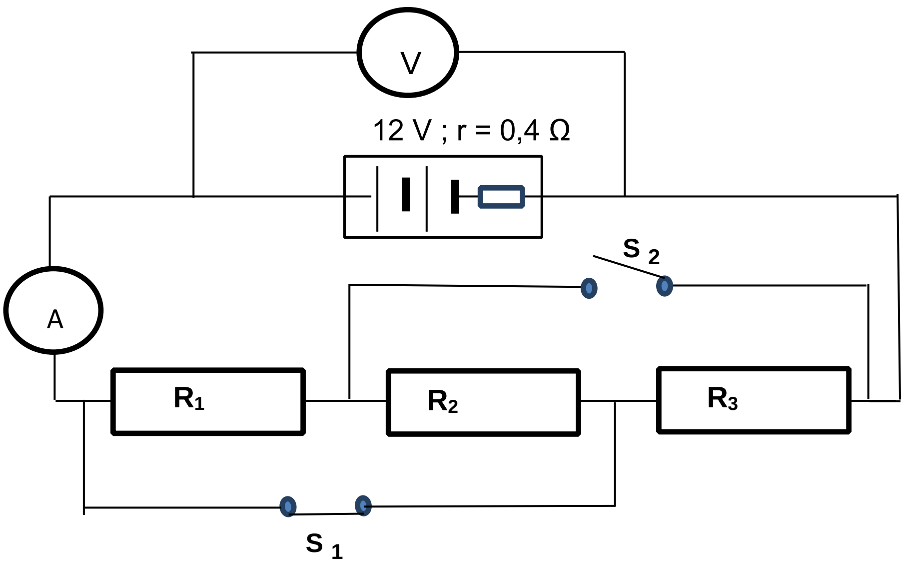


8.1.1 State ONE factor that must be kept constant during the experiment. Provide a reason for your answer. (2)

8.1.2 What does the y – intercept of the graph represent? (1)

8.1.3 Using the graph ONLY determine the value of the internal resistance of the battery. (3)

8.2 In the circuit diagram below the emf of the battery is 12 V and the internal resistance is 0,4 Ω. The resistance R_1, R_2 and R_3 are identical. Ignore the resistance of the wires and ammeter.



8.2.1 State in words, *Ohm's law*. (2)

With switch **S_1** closed and **S_2** open, the ammeter reads 3 A.

8.2.2 Calculate the resistance of resistor **R_3**. (3)

8.2.3 Determine the reading of the voltmeter. (3)

Both the switches **S_1** and **S_2** are now closed.

8.2.4 How will the reading on the voltmeter be affected? Write down only INCREASES, DECREASES or REMAINS THE SAME.
Explain the answer. (3)
[17]

QUESTION 9 **[Start on a NEW Page]**

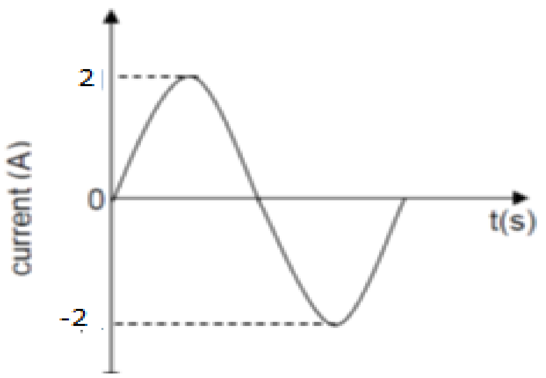
MyCiti buses make use of electric motors on windscreen wipers as well as AC generators for recharging batteries.

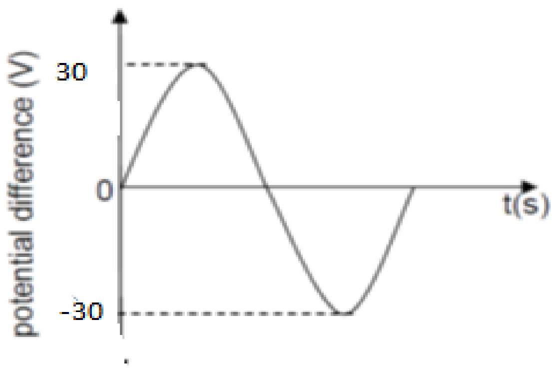
9.1 The table below compares a motor and a generator in terms of the type of energy conversion, type of rings connected to brushes and the underlying principle on which each operates. Complete the table by writing down only the question number (9.1.1–9.1.3) in your ANSWER BOOK and next to each number your answer.

	TYPE OF ENERGY CONVERSION	**TYPE OF RINGS CONNECTED TO BRUSHES**	**PRINCIPLE OF OPERATION**
Electric motor	9.1.1		
AC generator		9.1,2	9.1.3

(3)

9.2 Graphs of the current and potential difference outputs of an AC generator is shown below.

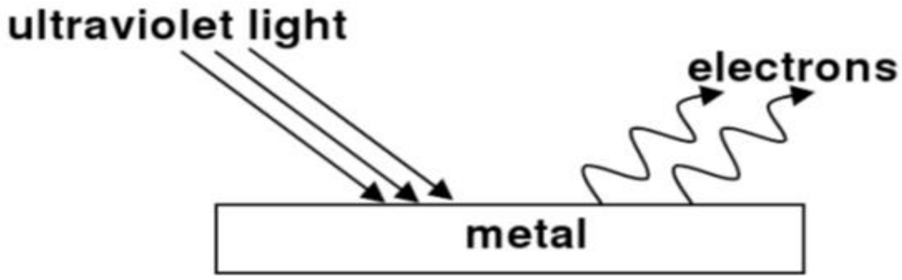




To recharge the battery, the Myciti bus requires a power output of 48 W. Determine by suitable calculation(s), whether the above generator can be used to recharge the battery of the Myciti bus. (5)
[8]

QUESTION 10 **[Start on a NEW Page]**

A metal surface is illuminated with ultraviolet (UV) light of wavelength 330 nm.
Electrons are emitted from the metal surface.
<u>The minimum frequency required to emit an electron from the surface of this metal</u> is $9{,}9 \times 10^{14}$ Hz



10.1 Name the phenomenon illustrated above. (1)

10.2 Give ONE word or term for the underlined sentence in the above paragraph, (1)

10.3 Calculate the kinetic energy of the electrons ejected when the metal is illuminated by UV light. (4)

10.4 The intensity of the UV light on metal surface was increased, state and explain what happen to the number of electrons ejected per second. (3)

[9]

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} $J \cdot s$
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

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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*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ 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* $E_{k(max)} = \frac{1}{2}mv^2_{max}$ or/*of* $K_{max} = \frac{1}{2}mv^2_{max}$	

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

ALTERNATING CURRENT/*WISSELSTROOM*

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