



eduresourceza.com



CORNWALL HILL COLLEGE

Physical Science Department

Preliminary Examinations 2024

Paper 1: Physics

NAME:	MARKING GUIDELINE
--------------	-------------------

Grade: 12

Time: 3h

Marks: 200

Examiner: PP van der Merwe

Moderator: M Labuschagne

Instructions:

1. The question paper consists of **20** pages. Please check that your paper is complete.
2. Answer **ALL** questions on the question paper provided
3. An information pamphlet with relevant information is available.
4. Round all FINAL answers to **TWO DECIMAL NUMBERS**.
5. All formulae used and substitutions in formulae must be indicated.
6. Additional workspace is provided on page **20** of this paper should it be required. Clearly indicate at the relevant question that you used page **20**.
7. Work neatly and legibly.

QUESTION 1

Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross on the answer sheet provided below that corresponds with your choice.

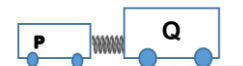
1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

1.1 What is the SI unit for the expression $\frac{1}{2}a\Delta t^2$?

- A. m.s^{-2}
- B. m.s^{-1}
- C. m
- D. m.s

(2)

1.2 Two trolleys, **P** and **Q** of mass **m** and **2m**, respectively, are at rest on a horizontal frictionless plane. The trolleys have a compressed spring between them. The spring is released and the trolleys move apart.



Which one of the following statements is TRUE?

- A. **P** and **Q** have equal energies.
- B. The speed of **P** is less than the speed of **Q**.
- C. The sum of the final kinetic energies of **P** and **Q** is zero.
- D. The sum of the final momentums of **P** and **Q** is zero.

(2)

1.3 An object, moving at constant velocity has kinetic energy **E** and momentum **p**. The velocity of the object is now doubled. Which one of the options below correctly indicates the magnitudes of the kinetic energy and momentum, of the object?

	Kinetic Energy	Momentum
A.	$2E$	p
B.	$4E$	$2p$
C.	$4E$	$4p$
D.	$2E$	$4p$

(2)

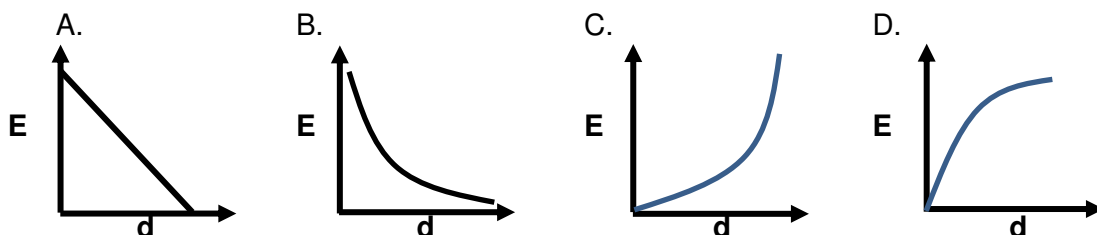
1.4 An object of mass **m** moves at a constant velocity **v** during a specific displacement Δx . The object experiences a constant frictional force of magnitude **f**

Which one of the following represents the power required to keep the object moving at constant velocity?

- A. **fv**
- B. $\frac{1}{2}mv^2$
- C. $\frac{1}{2}\Delta x$
- D. **mgh**

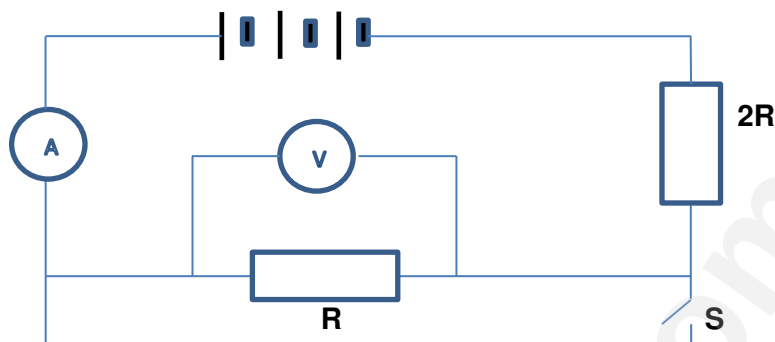
(2)

1.5 Which one of the following represents the relationship between the electric field strength **E** and the distance **d** from a given charge **Q**?



(2)

- 1.6 In the circuit diagram below, the internal resistance of the battery and conducting wires are negligible. The emf of the battery is E .

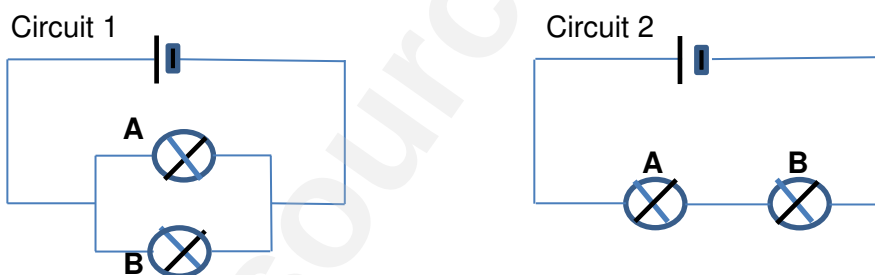


When the switch, S , is closed the reading on the voltmeter V , in volt, is:

- A. 0
- B. $\frac{1}{3}E$
- C. $\frac{2}{3}E$
- D. E

(2)

- 1.7 In circuit 1, represented below, the internal resistance of the cell is negligible. Bulb A grows **brighter** than bulb B. The bulbs are now connected in series as in circuit 2

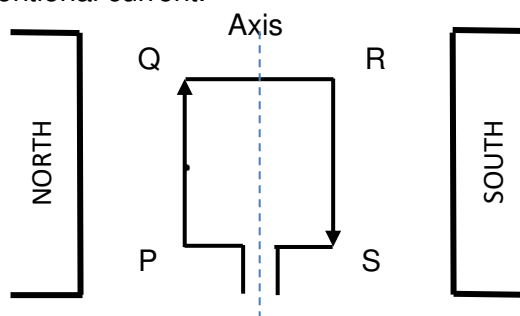


Which one of the following combinations correctly represents the comparison of the **resistance** of each bulb and the **power** dissipated in each bulb for **Circuit 2**?

	Resistance	Power
A.	$R_A < R_B$	$P_A > P_B$
B.	$R_A > R_B$	$P_A < P_B$
C.	$R_A < R_B$	$P_A < P_B$
D.	$R_A > R_B$	$P_A > P_B$

(2)

- 1.8 A rectangular current-carrying coil, PQRS, is placed in a uniform magnetic field with its plane parallel to the field as shown below. The arrows indicate the direction of the conventional current.

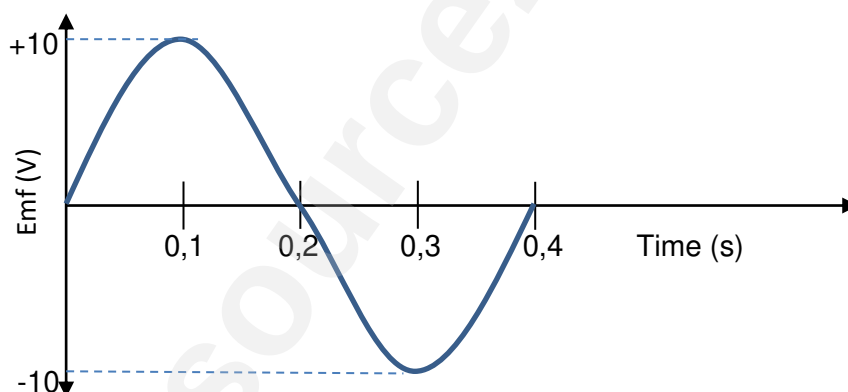


The coil will

- A. rotate clockwise.
- B. remain stationary.
- C. rotate anticlockwise
- D. rotate clockwise and then anticlockwise

(2)

- 1.9 The graph below shows the change in the **emf** versus the **time** generated by a generator:



The rotation speed of the generator is doubled, how will this change affect the emf and period represented by the graph?

	Emf (V)	Period (s)
A.	Larger than 10	0,2
B.	Larger than 10	0,1
C.	10	0,4
D.	Smaller than 10	0,4

(2)

- 1.10 The wavelength of a monochromatic light source **P** is twice that of a monochromatic light source **Q**. The energy of the photon from source **P** will be of a photon from source **Q**.

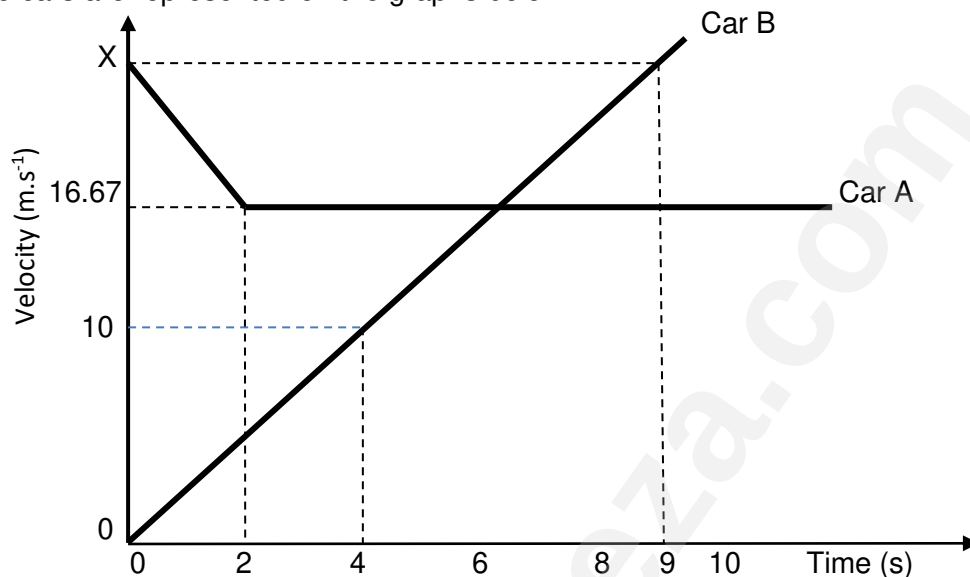
- A. a quarter of the energy
- B. half of the energy
- C. equal to the energy
- D. twice the energy

(2)

[20]

QUESTION 2

A car **B** is stationary at a traffic light and starts to accelerate constantly when the light turns green. At the same time a car **A** passes, going in the same direction as **B**. Car **A**, travelling at 70 km.h^{-1} , realises that he is exceeding the speed limit slows down to within the speed limit and continues after 2s to travel with constant velocity. The motion of the two cars are represented on the graphs below:



- 2.1 Define the concept *acceleration*. (2)
Rate of change of velocity

- 2.2 Convert 70 km.h^{-1} to m.s^{-1} and substitute the value for X on the graph. (2)
 $70/3,6 = 19,44 \text{ m.s}^{-1} \checkmark$ (indicate on graph - $\checkmark$)

- 2.3 Make use of the graph and determine the acceleration of Car A needed to bring it into the speed limit. (3)
Acceleration = gradient $\checkmark$

$$a = \frac{\Delta y}{\Delta x} = \frac{16,67 - 19,44}{2 - 0} = -1,39 \text{ m.s}^{-2} \checkmark$$

- 2.4 Make use of the graphs and determine which car, A or B, is in front after 9 s of travelling. (7)

For car A

$$\begin{aligned} \text{Area} &= \frac{1}{2}bxh + lxb \quad \checkmark \\ &= \frac{1}{2}(2)(2,77) \checkmark + (9 \times 16,67) \checkmark \\ &= 152,8 \text{ m} \end{aligned}$$

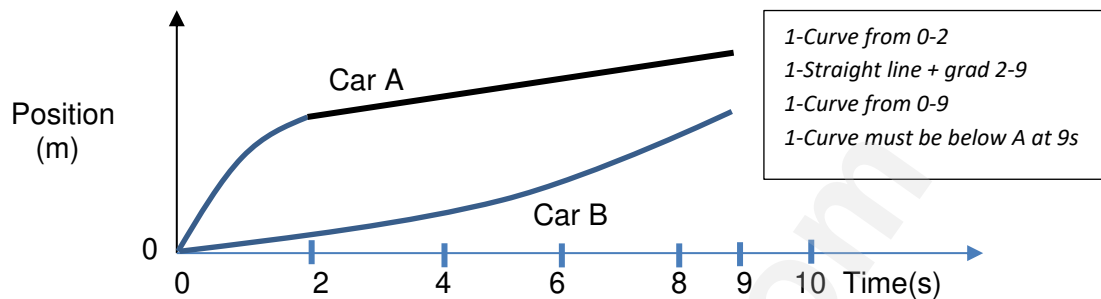
For car B

$$\begin{aligned} \text{Area} &= \frac{1}{2}bxh \quad \checkmark \\ &= \frac{1}{2}(9 \times 19,44) \checkmark \\ &= 87,48 \text{ m} \checkmark \end{aligned}$$

$\therefore$ A in front of B $\checkmark$

- 2.5 Use the axis below and draw a position vs time sketch graph that will represent the motion of the cars for the 9 s travelled. Use the traffic light as the point of reference.

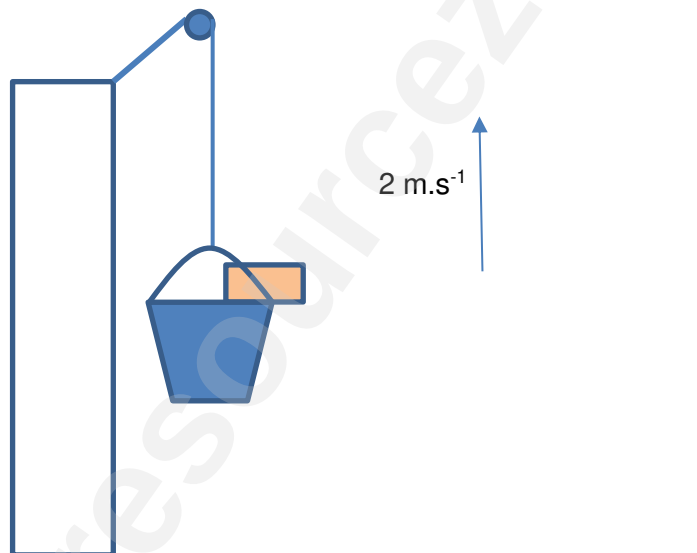
(4)



[18]

QUESTION 3

A brick layer loads bricks, with a mass of 2 kg each, in a bucket, to move them to the top of a building. The bucket is travelling with a constant velocity of 2 m.s^{-1} upwards, when one of the bricks dislodges and falls to the ground.



It takes 4 s for the brick to hit the ground. The brick is in contact with the earth for 0,01 s before it bounces from the ground and hits the ground again after 1s after which it comes to a standstill.

- 3.1 Define the term *free fall*. (2)
Movement of an object only under influence of earth's gravitational field

- 3.2 Determine the velocity with which the brick hits the ground for the first time. (3)

$$v_f = v_i + g\Delta t = (-2) + (9,8 \times 4) = 37,2 \text{ m.s}^{-1}$$

- 3.3 At what height above the ground did the brick become dislodged from the bucket? (3)

$$\Delta y = v_i \Delta t + \frac{1}{2} g \Delta t^2 = (-2) \times 4 + \left(\frac{1}{2} \times 9,8 \times (4)^2 \right) = 70,4 \text{ m}$$

- 3.3 State *Newton's second law* of motion in terms of *momentum*. (2)
Net force is equal to rate of change of momentum

- 3.4 Determine the force exerted by the ground on the brick, if the brick bounces away from the ground with a velocity of 10 m.s^{-1} . (4)

Away from ground +

$$F \Delta t = m(\Delta v) = 2(10 - (-37,2)) = 94,4$$

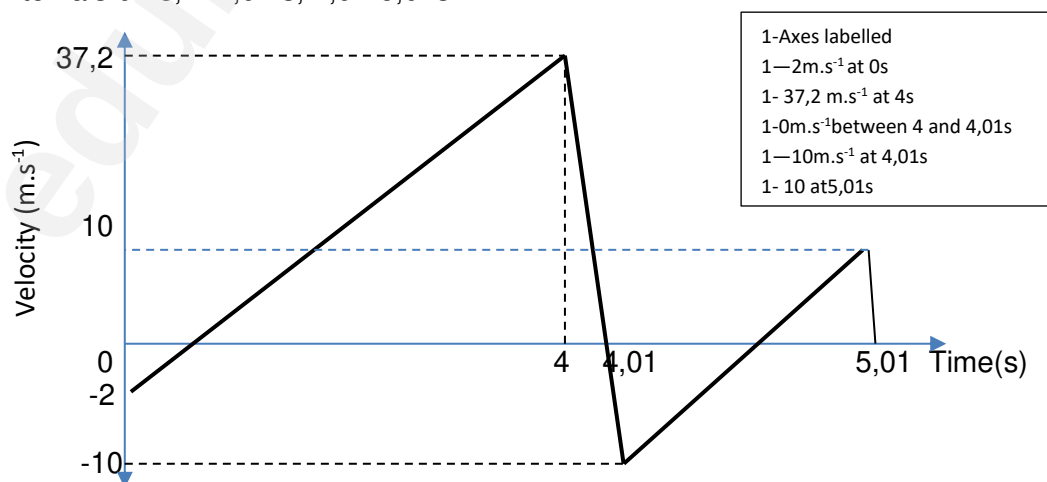
$$F = \frac{m(\Delta v)}{\Delta t} = \frac{94,4}{0,01} = 9440 \text{ N away from ground}$$

- 3.5 To what height above the ground will the brick bounce, after leaving the ground? (3)

$$v_f^2 = v_i^2 + 2g\Delta y \quad \therefore 0 = (-10)^2 + (2 \times 9,8)\Delta y$$

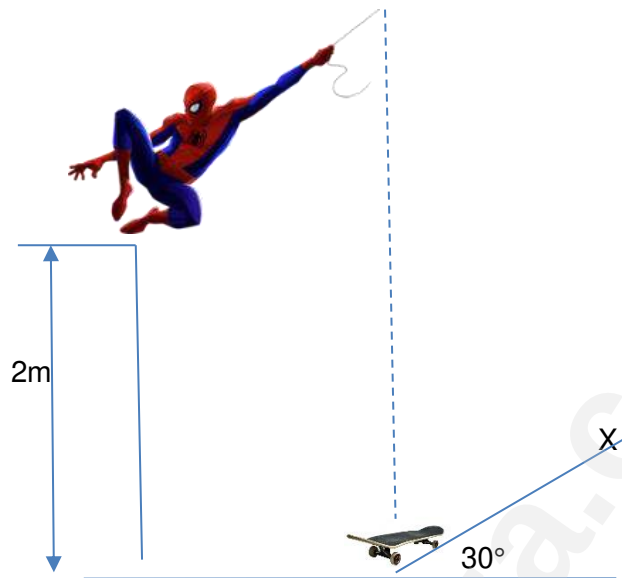
$$\Delta y = -5,1 \text{ m}$$

- 3.6 Draw a sketch graph of velocity versus time from the moment that the brick first dislodges until it finally comes to rest. Show the changes in velocity for the time intervals 0-4s, 4-4,01 s, 4,01-5,01s. (6)



QUESTION 4

Spiderman has a mass of 80 kg and falls from a ledge swinging on a web.



At the bottom of his swing he jumps on a stationary skateboard of mass 5 kg. The skateboard is 10 cm above the ground. Spiderman and the skateboard then start to move up an incline making an angle of 30° with the horizontal as indicated in the diagram. Friction on the slope cannot be ignored.

- 4.1 Define the concept *work done on an object*. (2)

Work done by a force on an object is the product of the displacement and the component of the force parallel to the displacement.

- 4.2 Make use of energy principles (i.e. no equations of motion may be used) and determine the velocity of Spiderman when he reaches the skateboard. Air friction must be ignored. (5)

$$E_{\text{mech at top}} = E_{\text{mech at bottom}}$$

$$\underbrace{mgh}_{\checkmark} + \underbrace{\frac{1}{2}mv^2}_{\checkmark} = \underbrace{\frac{1}{2}mv^2}_{\checkmark} + \underbrace{mgh}_{\checkmark}$$

$$80 \times 9,8 \times 2 + 0 = \frac{1}{2} \times 80 v^2 + 80 \times 9,8 \times 0,1$$

$$\therefore v = 6,1 \text{ m.s}^{-1} \quad \checkmark$$

- 4.3 State the principle of conservation of linear momentum. (2)

The total linear momentum of an isolated system remains constant

- 4.4 Determine the velocity with which Spiderman and the skateboard, at the base of the slope, move up the slope. (5)

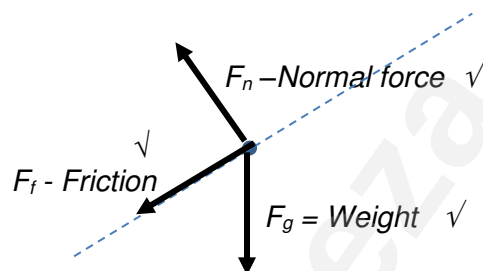
$$\Sigma p_{\text{before}} = \Sigma p_{\text{after}}$$

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v \quad \checkmark$$

$$(80 \times 6,1) + 0 = (80 + 5) v$$

$$\therefore v = 5,74 \text{ m.s}^{-1} \quad \checkmark$$

- 4.5 In his movement up the slope, Spiderman reached point X on his journey. Draw a fully labelled free body diagram of all the forces acting on Spiderman at point X. (3)



- 4.6 Determine the force of friction acting on Spiderman and the skateboard if his velocity decreases by 2 m.s^{-1} in 2 s. (5)

$$a = \frac{\Delta v}{\Delta t} = -1 \text{ m.s}^{-1} \quad \checkmark$$

$$F_{\text{net}} = F_{g \parallel} + F_f = ma \quad \checkmark$$

$$m x g x \sin 30^\circ + F_f = 85 x (-1) \quad \checkmark$$

$$\therefore F_f = 501,5 \text{ N} \quad \checkmark$$

- 4.7 Use the answer in QUESTION 4.6 and determine the coefficient of friction between the skateboard and the surface. (3)

$$F_f = \mu F_N$$

$$\mu = \frac{F_f}{F_N} = \frac{501,5}{m g \cos 30^\circ} = \frac{501,5}{85 x 9,8 x \cos 30^\circ} = 0,7 \quad \checkmark$$

- 4.8 Make use of the work-energy theorem and determine how far Spiderman and the skateboard will move up the slope. (4)

$$W_{\text{net}} = \Delta E_k = (0 - \frac{1}{2} 85 x (5,74)^2) = -1400,27 \text{ J} \quad \checkmark$$

$$W_{\text{net}} = W_w + W_f = m g \Delta x \sin 30^\circ \cos 180^\circ + F_f \Delta x \cos 180^\circ = ((85 x 9,8 x \sin 30^\circ) - 501,5) \Delta x \quad \checkmark$$

$$= -85 \Delta x$$

$$\therefore \Delta x = 16,47 \text{ m} \quad \checkmark$$

- 4.9 If the angle of the incline decreases how will the distance Spiderman moves up the slope be affected before he comes to a standstill. Choose from SAME, FURTHER UP SLOPE or LOWER DOWN THE SLOPE. Explain using appropriate physics equations. (4)

FURTHER ✓✓

$mgsin\theta \Delta x \cos 180$ decreases as θ decrease ✓

W_{net} remains same as Δv is constant ✓

[33]

QUESTION 5

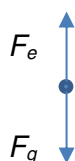
A metal coated pith ball A, carrying a charge of $+5 \mu\text{C}$ is placed in the bottom of a glass tube. A second pith ball B, carrying a charge of $+9 \mu\text{C}$ is now dropped in the glass tube. Each pith ball has a mass of $0,05 \text{ g}$. It is found that pith ball B hovers above the pith ball A as indicated in the diagram below:



- 5.1 State *Coulomb's law of Electrostatic force*. (2)
The electrostatic force between two charges is directly proportional to the product of the charges and inversely proportional to the square distance between the centres of the two charges

- 5.2 Why does the pith ball B hover above pith ball A? (1)
Like charges repel

- 5.3 Draw a free body diagram showing the forces acting on pith ball B. (2)



- 5.4 Calculate the distance between the two pith balls. (6)

$$F_g = F_e \quad \checkmark$$

$$F_g = mg = 0,05 \times 10^{-3} \times 9,8 = 4,9 \times 10^{-4} \text{ N} \quad \checkmark$$

$$F_e = \frac{kQ_1Q_2}{r^2} = \frac{9 \times 10^9 \times 9 \times 10^{-6} \times 5 \times 10^{-6}}{r^2} \quad \checkmark \text{ (for converting)}$$

$$\checkmark \text{ (for subs in formula)}$$

$$\therefore r = 28,75 \text{ m} \quad \checkmark$$

- 5.5 Determine the strength of the electric field 2 cm above the +9 μC charge. (3)

$$E = \frac{kQ}{r^2} = \frac{9 \times 10^9 \times 9 \times 10^{-6}}{(0,02)^2} = 2,03 \times 10^8 \text{ N} \cdot \text{C}^{-1} \quad \checkmark$$

- 5.6 Pith ball B is now pushed down the glass tube until it makes contact with pith ball A after which it is repelled. How will this affect the height that pith ball B will come to rest above pith ball A? State INCREASE, DECREASE or SAME HEIGHT and explain your choice. (4)

INCREASE $\checkmark$

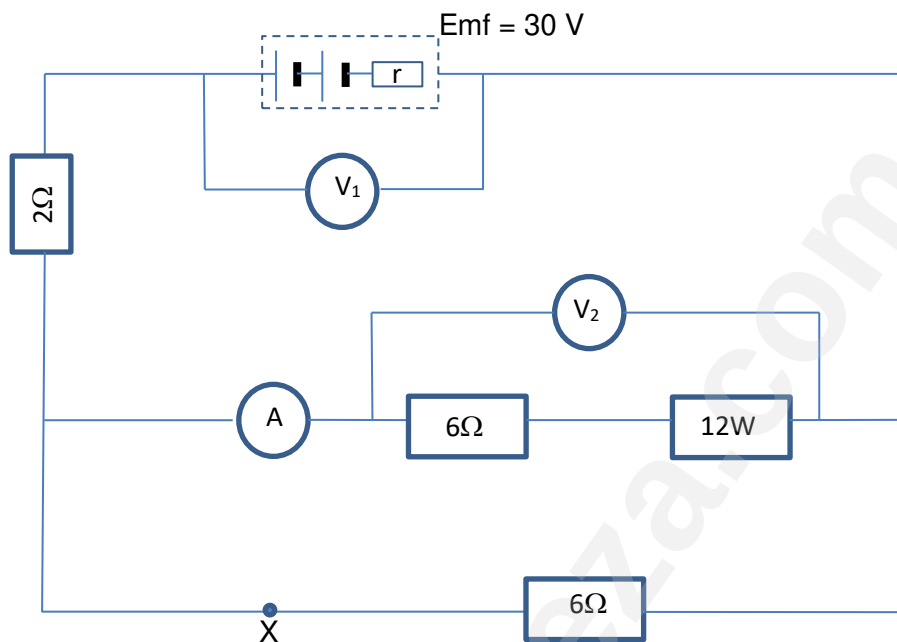
After touching each charge obtains charge of $7 \mu\text{C}$ $\checkmark$

$$F_e > F_g \quad \checkmark$$

[18]

QUESTION 6

Three resistors and an electrical device are connected to a 30 V battery with an internal resistance r , as shown in the circuit diagram below. The ammeter has a reading of 2 A.



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

Total energy supplied per coulomb of charge by the cell

- 6.2 Calculate the voltmeter reading V_1 . (8)

$$P = I^2 R \quad \therefore 12 = (2)^2 R \quad R_{\text{device}} = 3\Omega \quad \checkmark$$

$$\frac{1}{R_{\text{par}}} = \frac{1}{6} + \frac{1}{(6+3)} \quad \therefore R_{\text{par}} = 3,6\Omega \quad \checkmark$$

(1 mark once for Ohm's law)

$$R_{\text{par}} = \frac{V_{\text{par}}}{I_{\text{par}}} \quad \therefore V_{\text{par}} = I_{\text{top}} \times R_{\text{top}} = 2 \times 9 = 18V \quad \checkmark$$

$$I_{\text{par}} = \frac{V_{\text{par}}}{R_{\text{par}}} = \frac{18}{3,6} = 5A \quad \checkmark$$

$$R_{2\Omega} = \frac{V_{2\Omega}}{I_{2\Omega}} \quad \therefore V_{2\Omega} = I_{2\Omega} \times R_{2\Omega} = 5 \times 2 = 10V \quad \checkmark$$

$$V_{\text{ex}} = V_{\text{par}} + V_{2\Omega} = 18 + 10 = 28V \quad \checkmark$$

- 6.3 Calculate the internal resistance of the battery. (3)

$$Emf = V_{ex} + Ir \quad \checkmark \quad \checkmark \quad \therefore 30 = 28 + 5r$$

$$r = 0,4\Omega \quad \checkmark$$

- 6.4 An additional resistor is connected at position **X** as indicated in the diagram. How will the voltmeter reading **V₁** be affected? Write down only INCREASE, DECREASE or STAY THE SAME. Give an explanation for your answer. (4)

DECREASE $\checkmark$

R_{tot} decrease $\checkmark$

I_{tot} increase $\checkmark$

Emf and r constant $\checkmark$

- 6.5 The circuit is now opened at point X. Determine the reading on voltmeter **V₂**. (5)

$$R_{ex} = 6 + 3 + 2 = 11\Omega \quad \checkmark$$

$$Emf = I(R + r) \quad \therefore 30 = I(11 + 0,4) \quad \checkmark$$

$$\therefore I_{new} = 2,63 \text{ A} \quad \checkmark$$

$$V_2 = I_{new} \times R = 2,63 \times 9 = 23,68 \text{ V} \quad \checkmark$$

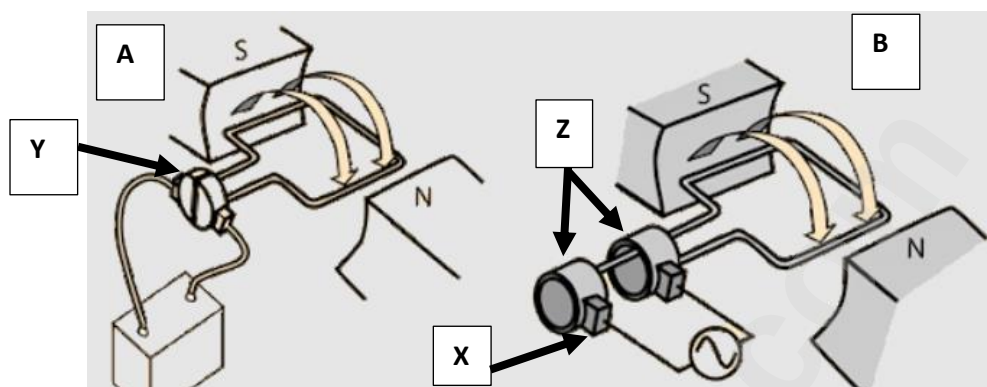
- 6.6 The cost of electricity is R 261 for 180 kWh. What will the cost of electricity be if the electrical device (12W) is run for 4 hours a day for 30 days. (4)

$$1 \text{ kWh} = 261/180 = R1,45 \quad \checkmark$$

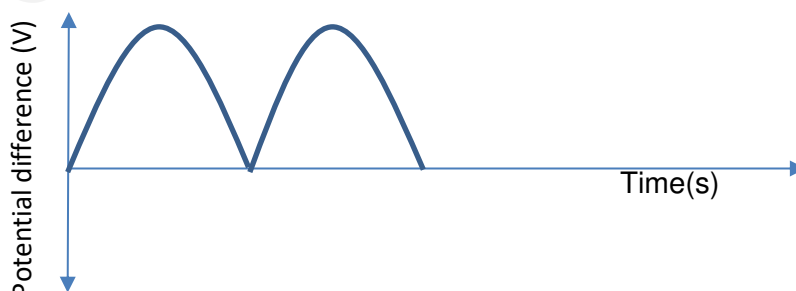
$$Cost = 12 \times 10^{-3} \times 4 \times 30 \times 1,45 = R2,09 \quad \checkmark$$

QUESTION 7

Electric motors operate on the principle that a coil rotates in a magnetic field and thereby converting energy from one form to another. Study the diagram below that shows two different motors and answer the questions that follow:



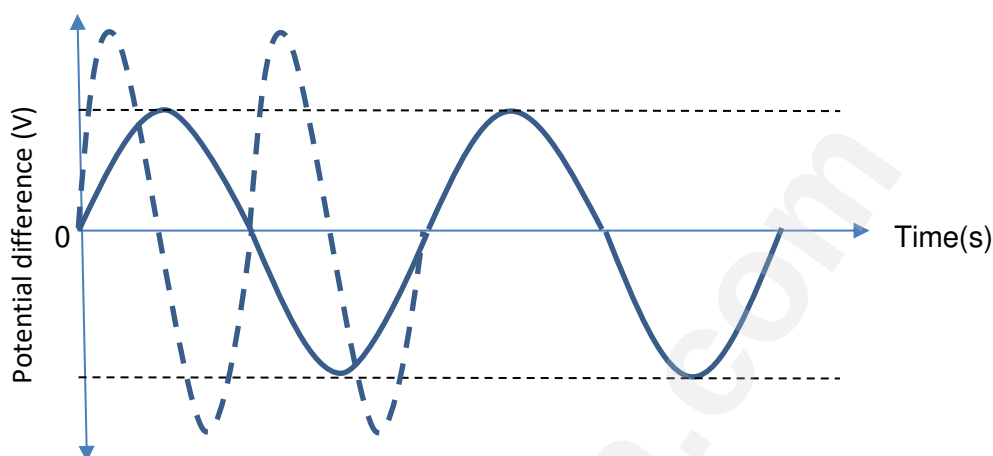
- 7.1 State *Faraday's Law of electromagnetic induction*. (2)
The emf induced is directly proportional to the rate of change of magnetic flux
- 7.2 State the energy conversion taking place in both motors. (2)
Electrical energy ✓ to Kinetic energy ✓
- 7.3 Identify component **X** of motor **B** and explain their purpose. (2)
Carbon brushes. ✓
Connection between power source and armature ✓
- 7.4 Identify component **Y** of motor **A** and explain its purpose. (2)
Split ring commutator ✓
Changes direction of current in coil ✓
- 7.5 Why does motor **B** have a device **Z** and not device **Y** as in motor **A**? (1)
Uses alternating current ✓
- 7.6 State the difference between a DC **motor** and a DC **generator**. (2)
Motor uses electricity to create movement ✓
Generator uses movement to create electricity ✓
- 7.7 The graph below shows the output potential difference of a DC generator for one cycle, during its operation;



- Write down ONE way in which the output of this generator can be increased. (1)

Stronger magnets/ more coils/ faster rotation (Any one)

- 7.8 A specific change is made to the structure of the DC generator of QUESTION 7.7. The graph below shows the output potential as result of this change:



Write down the change that was made to the DC generator that will result in the graph above.

Split ring commutator is replaced by slip rings ✓

(1)

- 7.9 On the same set of axes of QUESTION 7.8, sketch the graph of output potential that will be obtained, if the generator is rotated at TWICE its original speed. You must show TWO complete cycles on your graph.
(1 – Higher Max voltage, 2 – cycles)

(3)

- 7.10 The armature of the generator contains 500 coils and it takes 0,05s to rotate in a field of 25 T, from maximum field strength to minimum field strength. Determine the maximum output voltage that the generator will generate during the 0,05 s of rotation.

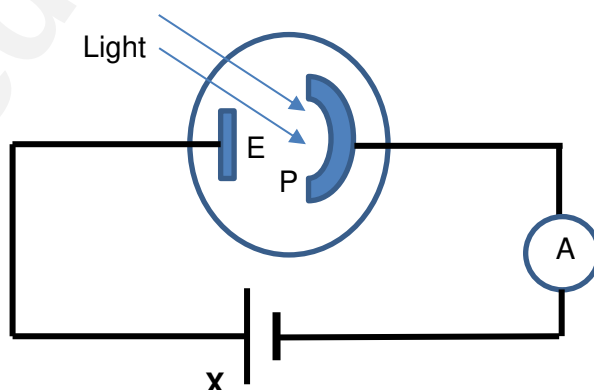
(5)

$$Emf = -N \frac{\Delta\phi}{\Delta t} = -500 \times \frac{(0-25)}{0,05} = 2,5 \times 10^5 V \quad \checkmark$$

[21]

QUESTION 8

A photocell consists of a metal plate **P** and a smaller electrode **E** placed inside an evacuated glass tube.



When the photocell is in the dark, the ammeter reads zero. However, when monochromatic red light, with a frequency of $4,65 \times 10^{14} \text{ Hz}$ is shone onto the photocell, a small current is registered on the ammeter while the red bulb operates.

The table below shows the *work function* of two metals, caesium and gold.

Metal:	Caesium	Gold
Work function (J)	$3,00 \times 10^{-19}$	$7,81 \times 10^{-19}$

- 8.1 Define the concept *work function of a metal*. (2)
Minimum amount of energy needed to emit an electron from the surface of a metal.

- 8.2 Determine, by calculation, which metal, Caesium or Gold, should be chosen to make **P**, to ensure that the photocell works with red light? Explain your choice clearly. (5)

Caesium ✓

$$E = hf = 6,63 \times 10^{-34} \times 4,65 \times 10^{14} = 3,08 \times 10^{-19} \text{ J}$$

Energy of photons of red light must be higher than work function to emit electrons ✓

- 8.3 The red bulb is now replaced with another red bulb that shines with a higher intensity. What effect will this have on the ammeter reading? Explain your answer. (2)
Increase ✓
Higher intensity implies more e^- released per unit of time ✓

- 8.4 Light with a wavelength of 248 nm now falls on **P**, and **P** is made of Caesium. Calculate the speed of an electron that will be emitted from the surface of **P**. (7)

$$f = \frac{c}{\lambda} = \frac{3 \times 10^8}{248 \times 10^{-9}} = 1,21 \times 10^{15} \text{ Hz} \quad \checkmark$$

$$hf = W_0 + \frac{1}{2}mv^2$$

$$6,63 \times 10^{-34} \times 1,21 \times 10^{15} = 3 \times 10^{-19} + \frac{1}{2}(9 \times 10^{-31})v^2$$

$$\therefore v = 1,33 \times 10^7 \text{ m.s}^{-1} \quad \checkmark$$

- 8.5 Does the work function of Caesium INCREASE, DECREASE or REMAIN THE SAME when different frequencies of light are used? Explain your choice. (2)
REMAINS THE SAME ✓
Work function of a substance is constant ✓

- 8.6 When the light in QUESTION 8.4 falls on the photocell a current is registered on the ammeter. What will happen to reading on the ammeter, if the polarity of the cell marked **X**, is reversed? Choose from INCREASE, DECREASE or REMAIN THE SAME. Explain your choice. (3)

DECREASE ✓✓

If cell polarity is reversed electrode E will become negative and will repel e^- ✓

[21]

QUESTION 9

The Grade 12 learners are tasked to determine the internal resistance of a cell. They are provided with a cell, an ammeter, a voltmeter, a rheostat, connecting wires and a switch.

- 9.1 Draw a circuit diagram to show the experimental set up that they must use to obtain data for determining the internal resistance. (5)

- 9.2 The following data is obtained in the experiment:

Current (A)	Potential difference (V)
1,00	1,00
0,80	1,10
0,75	1,13
0,60	1,20
0,55	1,28
0,40	1,30
0,30	1,35
0,10	1,45

For this experiment identify the:

- 9.2.1 Independent variable and explain how this experiment will lead to this (2)

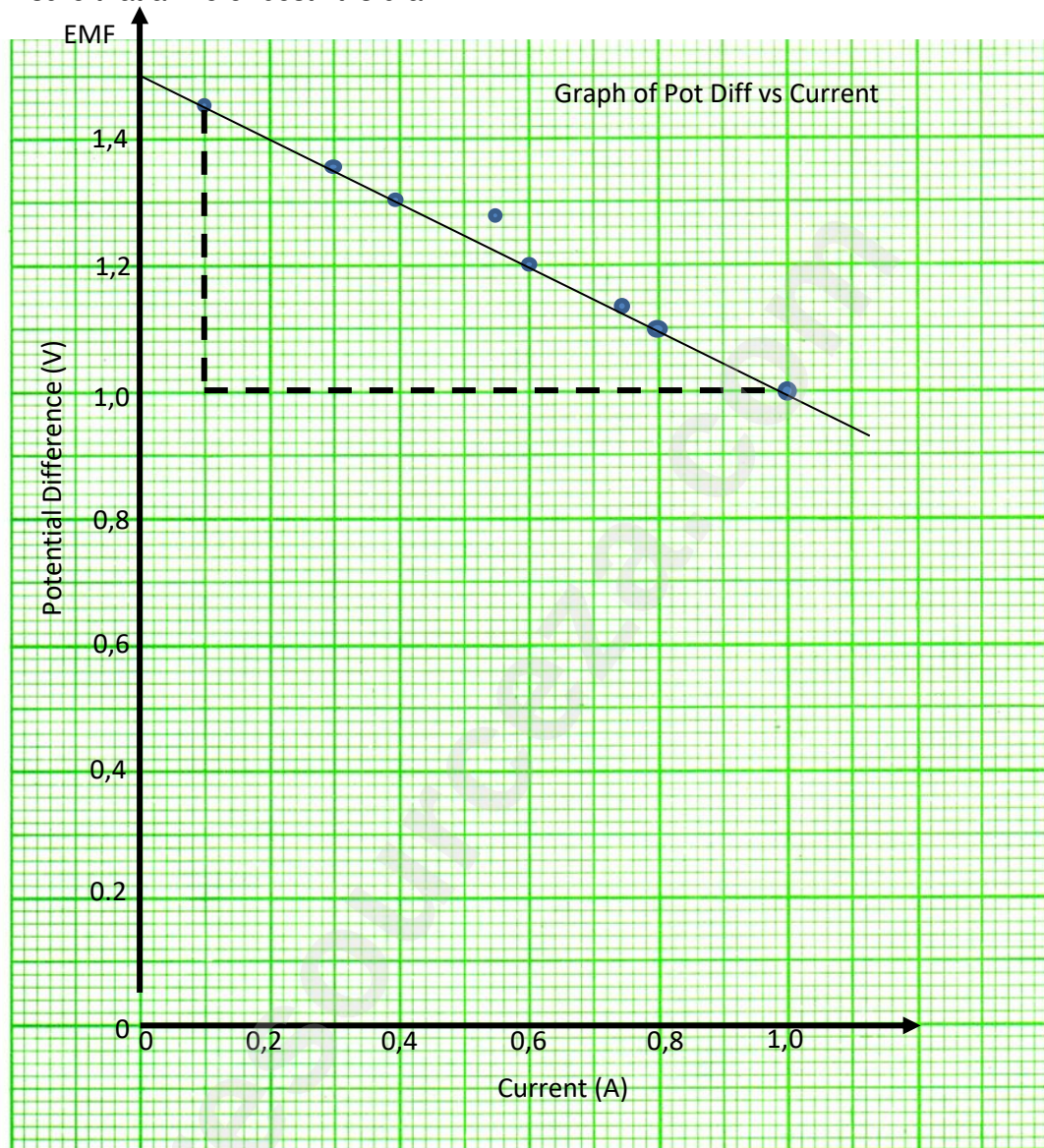
Current ✓

Changing rheostat changes current ✓

- 9.2.2 Dependent variable (1)

Potential difference ✓

- 9.3 Use the graph paper provided below and represent this data on a set of axes. Ensure that a line of best fit is drawn. (7)



- 9.4 Make use of the graph and determine the internal resistance of the cell. Clearly show on the graph which values were used in your calculation. (4)

$$r = \text{gradient} = \frac{\Delta y}{\Delta x} = \frac{(1,0 - 1,45)}{(1,0 - 0,1)} = -0,5 \Omega$$

- 9.5 Show on the graph what the EMF is of the cell that you used in the experiment. 1,5 V (1)

[20]

TOTAL:200

ADDITIONAL SPACE (ALL QUESTIONS)

**REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE
ASSITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.**

eduresourceza.com