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KINGSWOOD COLLEGE
PHYSICAL SCIENCES: PAPER 1

GRADE 12

PRELIMINARY EXAMS

SEPTEMBER 2023

Examiner: Mrs Price

Moderator: Mr Makoni

Time: 3 hours

Total: 200 marks

NAME:

TOTAL: [/200]

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of:
A "write-on" question paper with **27** printed pages (excluding front page) made of **13** questions.
A double-sided coloured formula and data sheet is provided separately
2. Express numerical answers to **TWO** decimal places unless instructed otherwise.
3. Show all your working and formulas used in calculations.
4. Appropriate units must be shown in the final numerical answers.
5. Write in black or dark blue pen. (Diagrams and graphs should be drawn in pencil).

MARKS OBTAINED:

Question	Examiner	Moderator	Question	Examiner	Moderator	Question	Examiner	Moderator
1			6			10		
2			7			11		
3			8			12		
4			9			13		
5			TOTAL MARK:					

DO NOT TURN OVER THIS PAGE UNTIL THE INVIGILATOR INSTRUCTS YOU TO DO SO.

QUESTION 1: (Multiple Choice)

Only ONE answer is correct for each question. Make a cross (X) in the box corresponding to the letter that you consider to be correct.

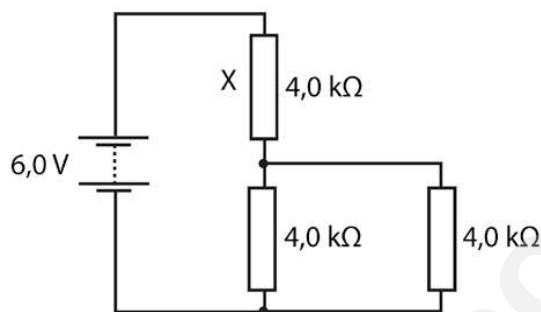
QUESTION	LETTER			
1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

QUESTION 1:

- 1.1 Two forces of magnitude 10 N and 13 N respectively, act simultaneously on an object. Which of the following is **not** a possible resultant of these forces? (2)
- A. 17 N
 - B. 15 N
 - C. 25 N
 - D. 4 N
- 1.2 Shiloh (weight 600 N) climbs into a stationary lift on the fifth floor and takes it **down** to the ground floor. Which statement concerning the normal force of the lift on Shiloh is correct? (2)
- The normal force on Shiloh is...
- A. more than 600 N throughout the motion
 - B. less than 600 N throughout the motion
 - C. more than 600 N when the lift starts moving and less than 600 N as it slows down to stop
 - D. less than 600 N when the lift starts moving and more than 600 N as it slows down to stop

- 1.3 Saffi exerts a force of 400 N on a crate to pull it along the floor at a constant velocity. Read these three statements and decide which of them is/are correct.
- I The crate exerts a reaction force of 400 N on Saffi.
 - II The frictional force must be zero since the crate exerts 400 N on Saffi to balance the forces.
 - III The frictional force must be equal to 400 N.
- The following statement(s) is/are correct: (2)
- A. I and II
 - B. II and III
 - C. I and III
 - D. I only
- 1.4 Which of the following statements is INCORRECT? (2)
- A. Momentum is the product of mass and velocity
 - B. Change in momentum can be measured in N.s
 - C. Rate of change in momentum is impulse
 - D. A change in momentum is caused by a resultant force
- 1.5 Two marbles, one of mass m and the other of mass $2m$, are dropped to the ground from the same height. Air resistance is negligible. Just before hitting the ground the kinetic energy of the lighter marble is E . This means that the kinetic energy of the heavier marble is: (2)
- A. E
 - B. $2E$
 - C. $4E$
 - D. $0.5E$
- 1.6 A test charge of magnitude $2 \times 10^{-10} \text{ C}$ is placed in an electric field of intensity 5000 N.C^{-1} . What is the force experienced by the charge? (2)
- A. $2,5 \times 10^{-13} \text{ N}$
 - B. $1 \times 10^{-6} \text{ N}$
 - C. $2,5 \times 10^{-7} \text{ N}$
 - D. $4 \times 10^{-14} \text{ N}$

- 1.7 A battery with an emf of 6,0 V and negligible internal resistance is connected to three resistors as shown in the diagram below:



Each resistor has a resistance of 4 kΩ. What is the current in resistor X? (2)

- A. 0,50 mA
 B. 0,67 mA
 C. 0,75 mA
 D. 1,00 mA
- 1.8 The diagram shows a current carrying conductor AB which crosses a magnetic field which runs into the plane of the page:



Which of the following is true for the direction of the current and the direction of the force that is experienced by the conductor? (2)

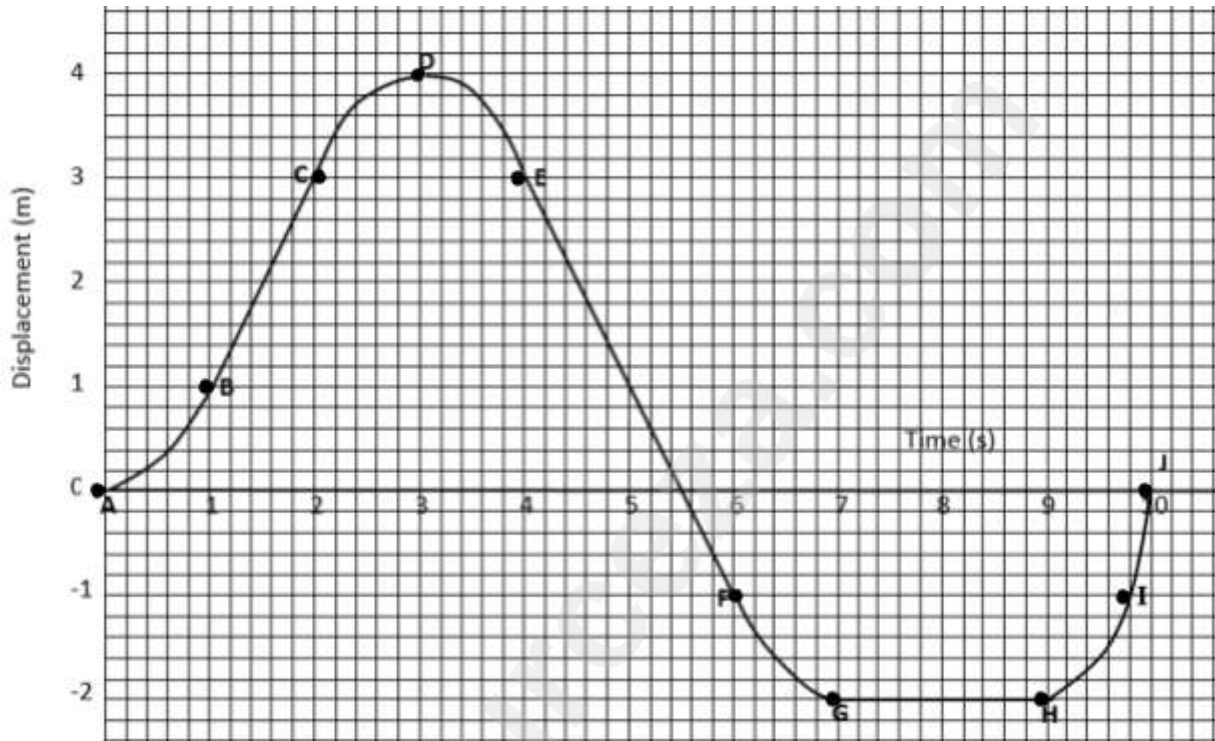
	Direction of conventional current	Direction of force
A	From A to B	out of page
B	From A to B	to the bottom of the page
C	From B to A	to the top of the page
D	From B to A	to the bottom of the page

- 1.9 A transformer is used to supply voltage to a 15 V model train which draws a current of 0.7 A. If the voltage of the AC source is 210 V, the current in the primary should be:(2)
- A. 0.04 A
 - B. 0.05 A
 - C. 0.03 A
 - D. 0.02 A
- 1.10 When a metal is illuminated with yellow light no electrons are emitted. Which one of the following procedures is most likely to cause emission of electrons? (2)
- Illuminating the cathode with:
- A. yellow light for a longer period of time
 - B. yellow light of higher intensity
 - C. Blue light of the same intensity as the yellow light
 - D. Red light of the same intensity as the yellow light

TOTAL FOR QUESTION 1: [20]

QUESTION 2:

The displacement-time graph below shows an object moving to the **right** of its initial position:



2.1 Define *displacement*. (2)

2.2 Make use of the letters on the graph to indicate between which times the object is...

2.2.1 stationary for a length of time (more than a second) (2)

2.2.2 moving with greatest speed (2)

2.2.3 slowing down to the left (2)

2.3 Use the graph to determine the following:

2.3.1 The total distance traveled by the object from A to J ($t = 0 \text{ s}$ to $t = 10 \text{ s}$) (2)

2.3.2 The displacement of the object from D to J ($t = 3 \text{ s}$ to $t = 10 \text{ s}$) (2)

2.3.3 The instantaneous velocity of the object at position D. (2)

2.3.4 Whether the acceleration of the object at position D is zero or non-zero. Give a reason for your answer. (3)

2.3.5 The velocity of the object between E and F ($t = 4 \text{ s}$ to $t = 6 \text{ s}$). (4)

TOTAL FOR QUESTION 2: [21]

QUESTION 3:

Alex drops a stone from a bridge and it reaches the water in 3 seconds.



3.1 Deduce by calculation the height of the bridge above the water? (3)

3.2 Define *velocity*. (2)

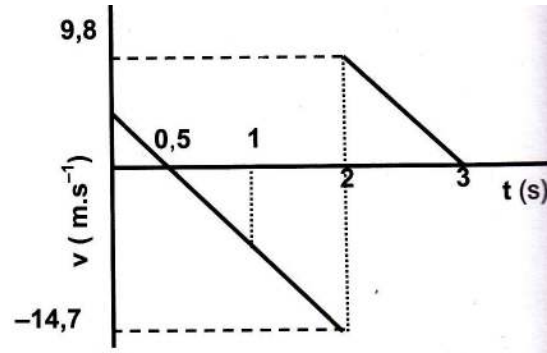
3.3 Calculate the velocity of the stone as it hits the water? (3)

3.4 If the stone was thrown vertically down with an initial velocity of 4.7 m.s^{-1} , how will the time taken to reach the water change when compared to when it was dropped?
Write only LONGER, SHORTEN, or NO CHANGE. (1)

TOTAL FOR QUESTION 3: [9]

QUESTION 4:

The velocity-time graph below shows the motion of a ball which is thrown upwards, falls to the ground and bounces back up:



Graph is not drawn to scale

4.1 What is represented by the gradient of the graph? (1)

4.2 Determine the initial velocity of the ball? (3)

4.3 Where during the motion of the ball is it at:
(i) $t = 0,5$ seconds (1)

(ii) $t = 2$ seconds (1)

(iii) $t = 3$ seconds (1)

4.4 Determine how high the ball was above the ground when it was first thrown? (3)

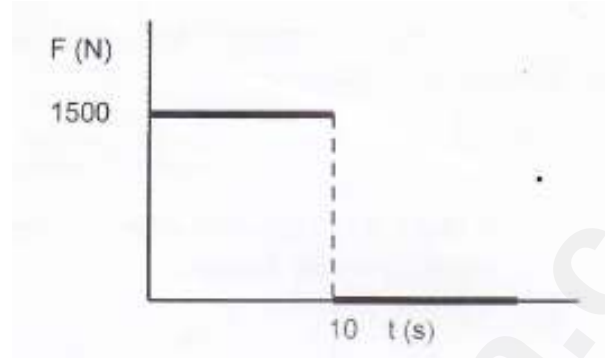
4.5 How high did the ball bounce? (3)

4.6 Use your answers from above to sketch a displacement-time graph for the motion of the ball. Let the ground be the reference point.
(axes must be labeled but no values are required) (5)

TOTAL FOR QUESTION 4: [18]

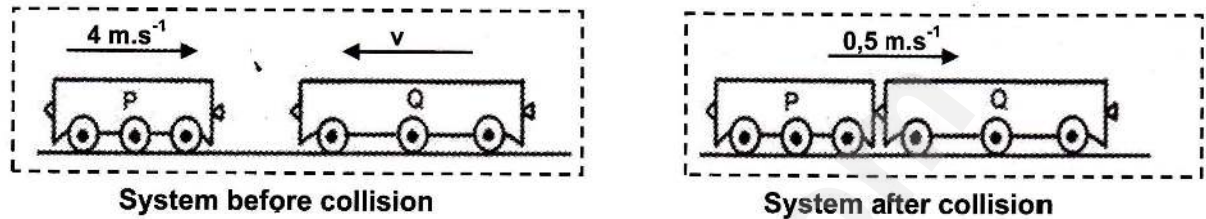
QUESTION 5:

- 5.1 The diagram below shows the force versus time graph for a car of mass 1200 kg which moves from rest:



- 5.1.1 State the quantity represented by the area between the graph and the time axis? (1)
- 5.1.2 Calculate the change in momentum of the car during the first 5 seconds. (2)
- 5.1.3 How fast will the car be moving at $t = 10$ seconds? (3)

- 5.2 A truck P moving at 4 m.s^{-1} due **east** collides and joins with a truck Q which is rolling backwards towards truck P. After the collision P and Q move together due east at 0.5 m.s^{-1} .

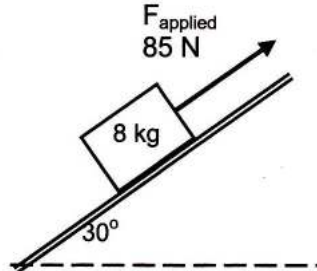


- 5.2.1 Define *momentum*. (2)
- 5.2.2 If the mass of P is 5000 kg and the mass of Q is 7000 kg calculate the velocity of Q **before** the collision by applying the Law of Conservation of Linear Momentum. (5)
- 5.2.3 If the time taken for the trucks to couple (join) is 1.4 seconds, calculate the magnitude of the force exerted by P on Q. (4)
- 5.2.4 Show that the collision is inelastic. (3)

TOTAL FOR QUESTION 5: [20]

QUESTION 6:

A crate of mass 8 kg is pulled, by a 85 N force, up an inclined plane which makes an angle of 30° with the level ground. A constant friction force of 23.4 N acts on the crate. The crate moves from rest and reaches a velocity of 3 m.s^{-1} in a distance of X meters.



- 6.1 Explain the difference between static friction and kinetic friction. (2)
- 6.2 Calculate the component of gravitational force acting on the 8 kg mass that is parallel to the inclined plane (2)
- 6.3 Calculate the net force acting on the crate. (4)
- 6.4 State the *work energy theorem* (2)

6.5 Use the work-energy theorem to calculate the net work done by the crate (3)

6.6 Determine the distance X. (3)

TOTAL FOR QUESTION 6: [16]

QUESTION 7:

Part of the Grade 12 practical investigation was to “play” with the equipment at Kingswood Pre-Primary. Starting from rest, Matthew of mass 80 kg slides down a vertical rope 16 m long at a constant downward acceleration of 2 m.s^{-2} .



- 7.1 Calculate the velocity of Matthew at the bottom of the rope (after he slid 16 m) (3)
- 7.2 Define *kinetic energy*. (2)
- 7.3 Calculate the kinetic energy of Matthew at the bottom of the rope (3)
- 7.4 Define *weight* (2)
- 7.2 Calculate the amount of heat transferred (energy “lost”) to the rope as the result of friction between Matthew and the rope. (5)

TOTAL FOR QUESTION 7: [15]

QUESTION 8:

A mechanical shovel (shown below) raises 500 kg of soil to a height of 4 m in 7 seconds



8.1 How much gravitational potential energy is gained by the load of soil? (3)

8.2 Define *power*. (2)

8.3 What is the output power of the engine? (3)

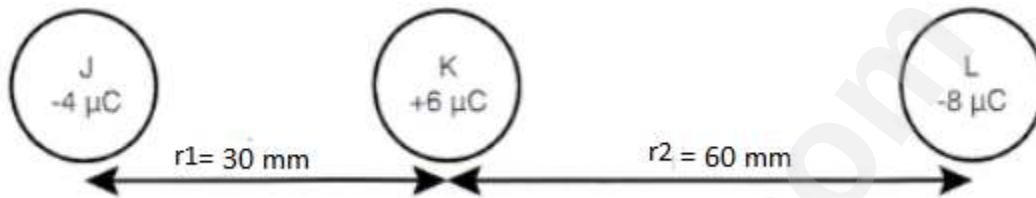
8.4 If the engine is rated at 7 kW calculate the percentage efficiency. (3)

TOTAL FOR QUESTION 10: [11]

QUESTION 9:

9.1 Three charged spheres, J, K and L, with charges $-4 \mu\text{C}$, $+6 \mu\text{C}$ and $-8 \mu\text{C}$, respectively, are placed in a row as shown in the diagram below. Determine the **net** electrostatic force on K.

(9)



- 9.2 Determine the electric field strength at a distance of 3 cm from a sphere with a charge of $+3.2 \times 10^{-8}$ C. (4)

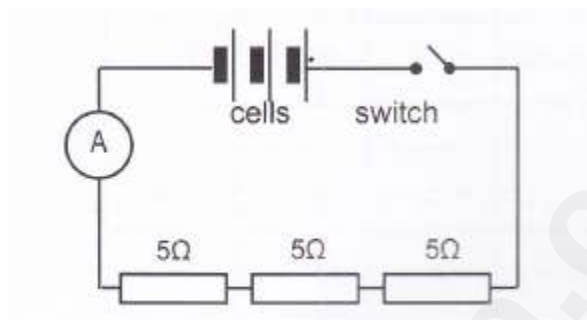
- 9.3 State Newton's Law of Universal Gravitation. (2)

- 9.4 An object that is falling freely on the planet Mars, experiences a gravitational acceleration of 3.8 m.s^{-2} . The mass of Mars is 6.4×10^{23} kg. Calculate the radius of Mars, in meters. (3)

TOTAL FOR QUESTION 9: [18]

QUESTION 10:

Jamie is doing an experiment to investigate the current flowing in a circuit. She connects three cells in series and then connects them to three 5 ohm resistors in series. She includes a switch and an ammeter in the circuit as shown below.



By changing the way the resistors are connected as well as the number of resistors in the circuit Jamie alters the resistance in the circuit and takes several readings of current. She records some of her results in a table shown below:

CONNECTION	RESISTANCE (Ω)	CURRENT (A)	IR	1/R
3 resistors in series	15	0.3	4.5	0.067
2 resistors in series	10	0.45	4.5	0.1
	7.5	0.6	4.5	0.133
1 resistor	5	0.9	4.5	0.2
2 resistors in parallel	2.5	1.8	4.5	0.4
3 resistors in parallel	1.67	2.7	4.5	0.6

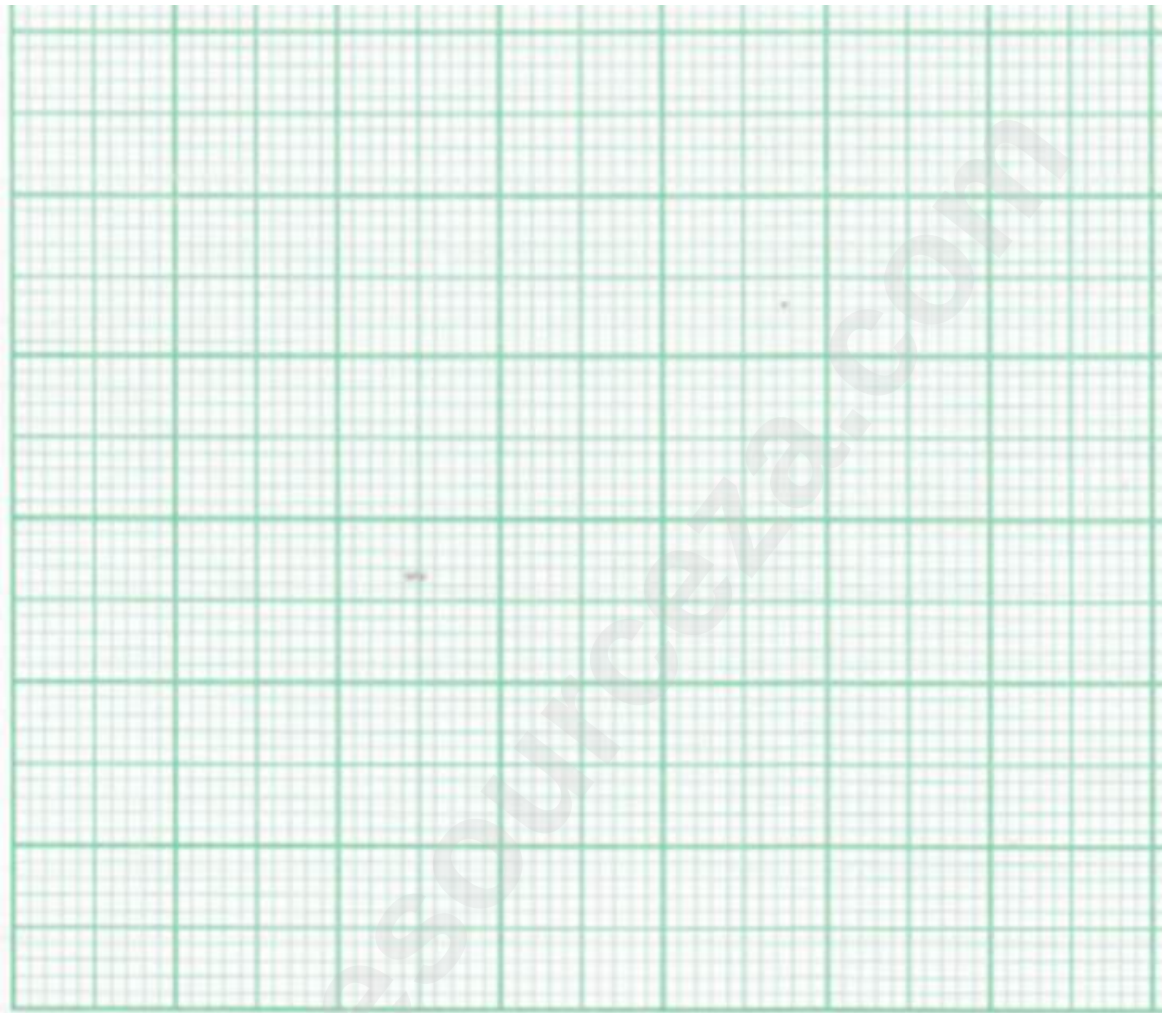
10.1 State one FIXED variable in this experiment.

(1)

10.2 Jamie wrote the following hypothesis for the experiment: “ if the resistance of a circuit changes then the current changes”. Criticize her statement. (2)

10.3 How did Jamie connect the resistors to give a total resistance of 7.5Ω ? (1)

- 10.4 Plot a best fit line graph of current (y-axis) versus $1/\text{resistance}$ (x-axis) for these results. (4)



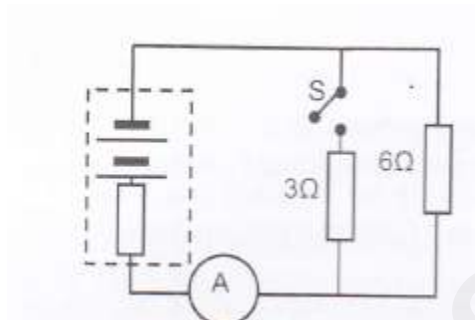
- 10.5 Calculate the gradient of this graph. (Show points used in the calculation on graph)(2)

- 10.6 What does the gradient represent? (1)

TOTAL FOR QUESTION 10: [11]

QUESTION 11:

- 11.1 In the circuit shown below the ammeter reads 1.5 A when the switch (S) is opened and 3 A when the switch is closed.

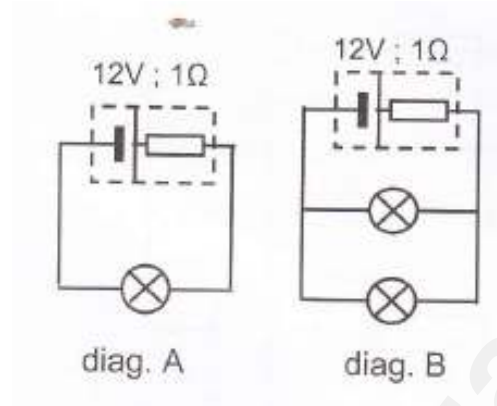


- 11.1.1 Define *resistance* (2)

- 11.1.2 Calculate the internal resistance of the battery. (4)

- 11.1.3 Calculate the emf of the battery (2)

- 11.2 An electric bulb of resistance 3 ohms is connected to a 12 V source with internal resistance of 1 ohm as shown in diagram A. Mila wants to connect two 3 ohm bulbs to another circuit so that each bulb will have the same brightness as the bulb in diagram A. He connects the bulbs in parallel to an identical source with the same internal resistance as shown in diagram B.

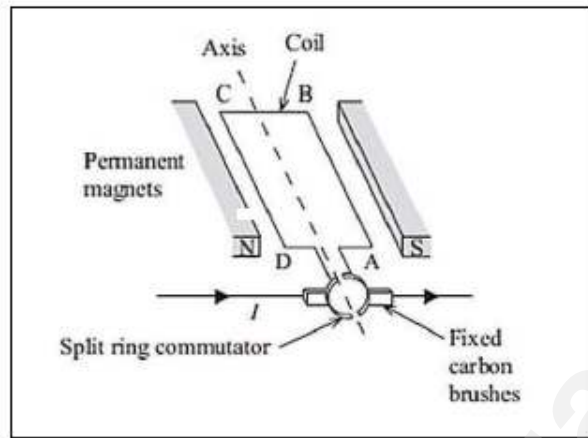


By using appropriate calculations explain clearly if the bulbs in circuit B glow with the same brightness as the bulb in A? (6)

TOTAL FOR QUESTION 11: [14]

QUESTION 12:

12.1 The simplified diagram below illustrates a DC electric motor.



The arrows show the direction of current as it enters and exits the coil through the carbon brushes and the split ring commutator.

12.1.1 State whether the coil turns clockwise or anti-clockwise when viewed from the split-ring commutator. (1)

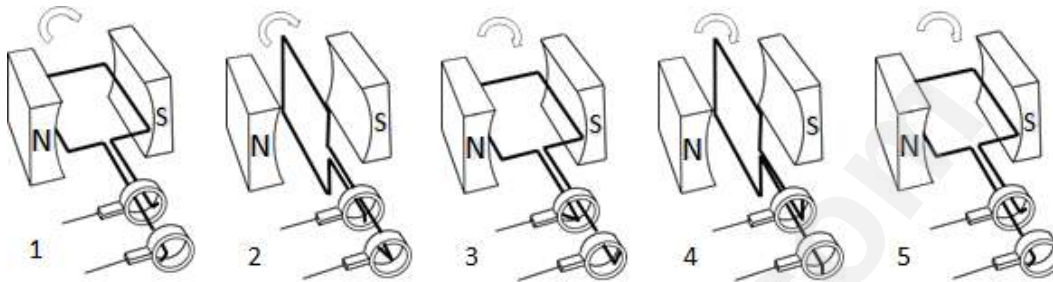
12.1.2 State the function of the split-ring commutator. (2)

12.1.3 Refer to an appropriate formulae to explain three ways in which the turning force that the coil experiences can be increased. (3)

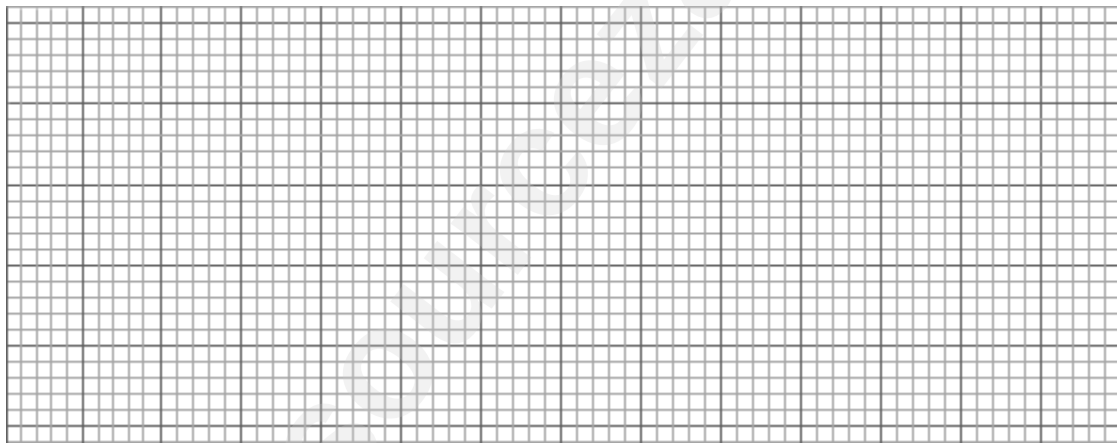
12.2 Define *magnetic flux linkage*. (2)

12.3 State *Faraday's Law of electromagnetic induction*. (2)

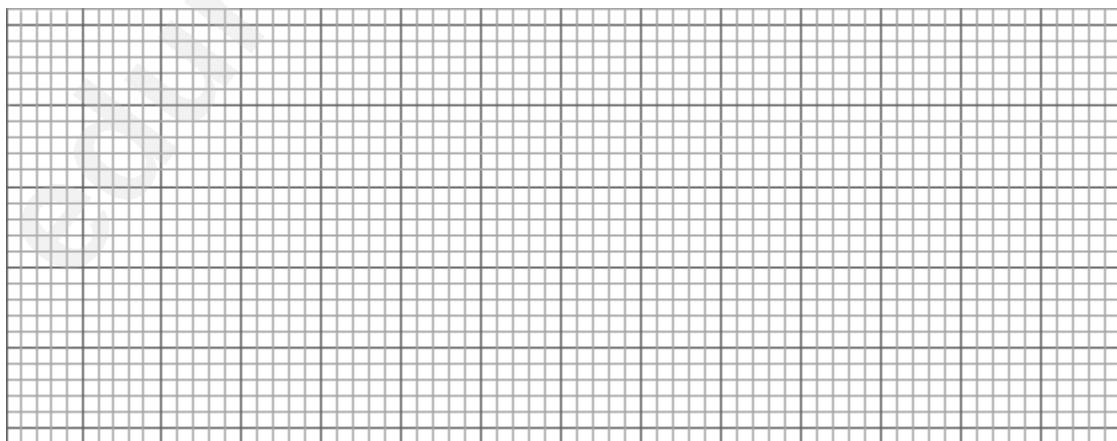
- 12.4 The diagrams below show 5 positions in the clockwise rotation of the coil of a simple generator.



- 12.4.1 Draw a sketch graph of the flux (Φ) in the coil versus time for one complete rotation of the coil. Mark positions 1 to 5 on the time axis. (3)



- 12.4.2 Draw a sketch graph of the corresponding emf generated versus time. (2)



TOTAL FOR QUESTION 12: [15]

QUESTION 13:

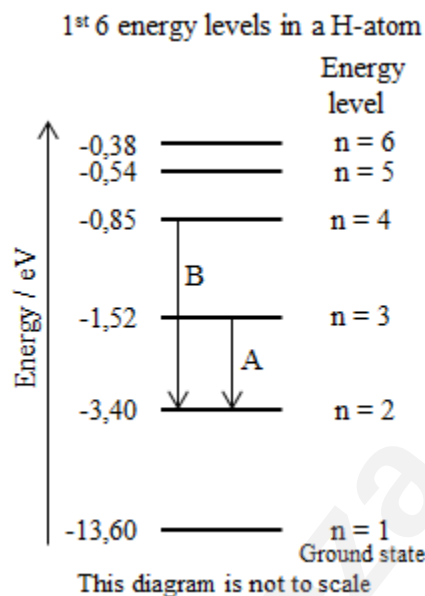
13.1 The work function of three metals is shown in the table below:

METAL	ALUMINIUM	ZINC	SILVER
WORK FUNCTION (W_0) in J	6.54×10^{-19}	6.89×10^{-19}	7.58×10^{-19}

13.1.1 Define *work function*. (2)

13.1.2 Light of wavelength 2.3×10^{-7} m is shone onto a metal X. The maximum velocity of the emitted electrons is 4.78×10^5 m.s⁻¹. Identify metal X by performing the relevant calculations. (5)

13.2 The diagram shows some of the energy levels of an isolated hydrogen atom.



The arrows, labelled A and B, represent transitions of electrons between energy levels. **One** of the lines of the emission spectrum of the hydrogen atom is red with a wavelength of 658 nm. Carry out a calculation to determine which energy level transition (A or B) corresponds to this line in the hydrogen spectrum. (5)

TOTAL FOR QUESTION 13: [12]

ADDITIONAL SPACE:

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