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MEMO – Trials Paper 1 – 2020

Q1.

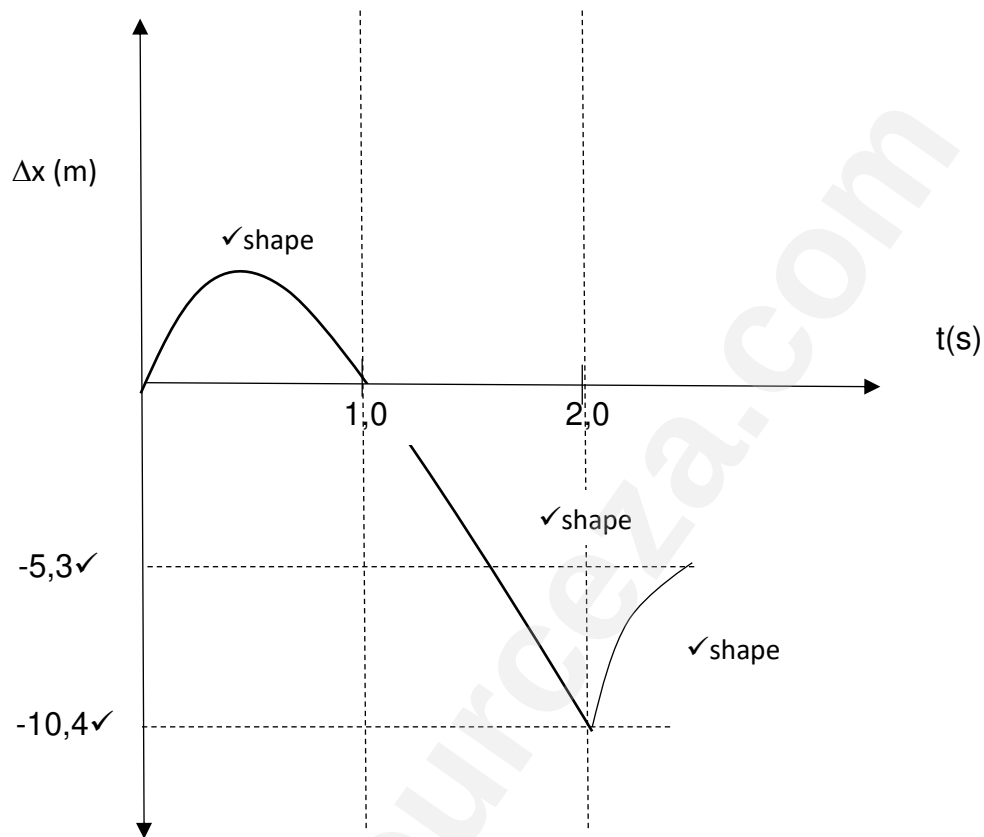
- 1.1 A✓✓
- 1.2 D
- 1.3 D
- 1.4 C
- 1.5 D
- 1.6 B
- 1.7 C
- 1.8 B
- 1.9 C
- 1.10 C

[10x2=20]

Question 2

- 2.1 Only force✓ acting on object is the force of gravity.✓ (2)
- 2.2 $9,8 \text{ m.s}^{-2}$ ✓down✓ (2)
- 2.3 gradient = $a = \frac{\Delta v}{\Delta t} = \frac{-15 - v_i}{2}$ ✓ = $-9,8$ ✓
 $v_i = 4,6 \text{ m.s}^{-1}$ ✓ upwards✓ (4)
- 2.4 $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
 $= (4,6)(2)$ ✓ + $\frac{1}{2}(-9,8)(2)^2$ ✓
 $= -10,4\text{m}$ ✓ (4)
- 2.5 $v_f = v_i + a \Delta t$ ✓
 0 ✓ = $4,6 + (-9,8) \Delta t$ ✓
 $\Delta t = 0,47\text{s}$ ✓ (4)
- 2.6 $v_f^2 = v_i^2 + 2a \Delta y$ ✓
 0 ✓ = $10^2 + 2(-9,8) \Delta y$ ✓
 $\Delta y = 5,1\text{m}$ ✓ (4)

2.7



(5)

[25]

Question 3

3.1 $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓

$-6 = v_i(1,6) + \frac{1}{2}(-9,8)(1,6)^2$ ✓

$v_i = 4,09 \text{ m.s}^{-1}$ ✓ upwards ✓

(6)

3.2 $v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0 = 4,09^2 + 2(-9,8)\Delta y$ ✓

$\Delta y = 0,85 \text{ m}$ ✓

(5)

$$3.3 \quad v_f = v_i + a\Delta t \checkmark$$

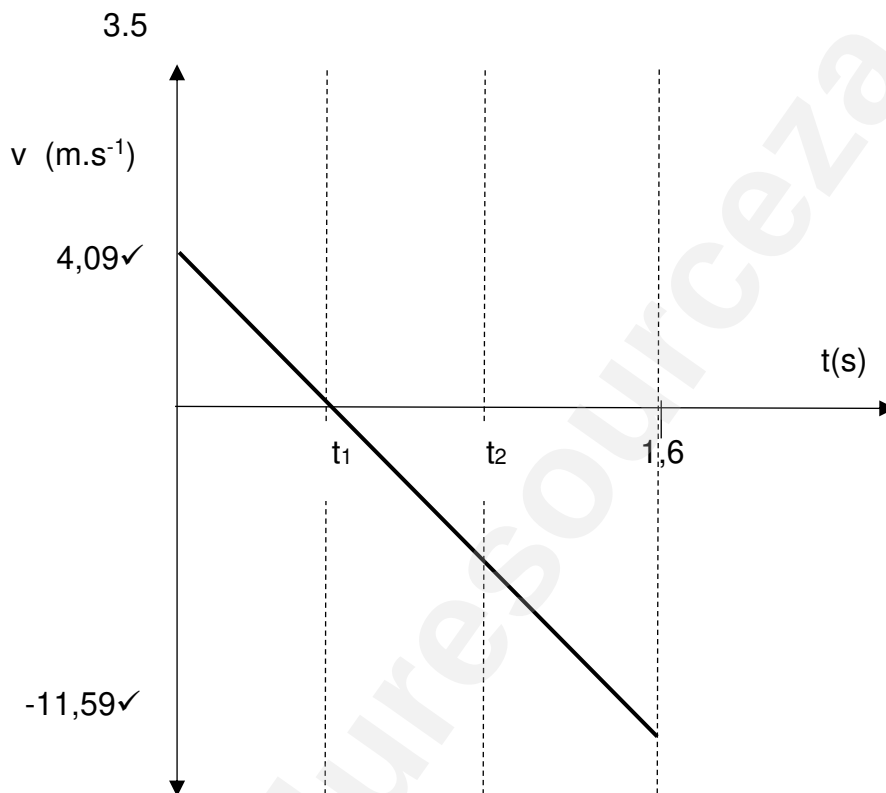
$$0 \checkmark = 4,09 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 0,42s \checkmark \quad (4)$$

$$3.4 \quad v_f^2 = v_i^2 + 2a\Delta y$$

$$= 4,09^2 \checkmark + 2(-9,8)(-6) \checkmark$$

$$= 11,59m.s^{-1} \checkmark \quad (3)$$



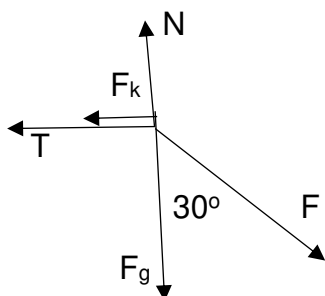
(4)

[22]

Question 4

- 4.1 When a net force acts on an object of mass m , the object will accelerate in the direction of the net force. The acceleration is directly proportional to the net force but inversely proportional to the mass of the object. ✓✓ (2) **L 1**

4.2



N = force of surface on box

F_k = kinetic frictional force

T = tension force in string

F = pushing force of 25 N

F_g = weight

Diagram correct + angle ✓✓ labels ✓✓✓

(5) **L 3**

4.3 $F_k = \mu_k \cdot N$ ✓ = $0,15 \cdot 3 \cdot 9,8$ ✓ = **4,41 N** ✓

(3) **L 2**

4.4.1 $F_k = \mu_k \cdot (mg + N)$ ✓

= $0,15 \cdot ((1,5 \cdot 9,8) + (25 \cdot \sin 30^\circ))$ ✓

$F_k = 4,08 \text{ N}$ ✓

(3) **L 3**

4.4.2 $F_{\text{net}} = m \cdot a$ (for the 1,5 kg block)

$F_h + F_k - T = m \cdot a$ ✓

$(25 \cdot \cos 30^\circ) - 4,08 - T = 1,5 \cdot a$ ✓

$17,571 - T = 1,5 \cdot a$ (1) $a = 17,571 - T / 1,5$

$F_{\text{net}} = m \cdot a$ (for the 3 kg block)

$T + F_k = m \cdot a$

$T - 4,41 = 3 \cdot a$ ✓(2) $a = T - 4,41 / 3$

$a = \frac{17,571 - T}{1,5} = \frac{T - 4,41}{3}$ ✓

$T = 13,18 \text{ N}$ ✓

(6) **L 3**

- 4.5 The horizontal force component was insufficient to overcome both the friction force ✓ and the inertia ✓ of the block system. **L 3** (2)

- 4.6 The pushing force was exerted directly to the block as it would not bend ✓ and the angle of application could be measured easily. ✓

Any 1 of these answers are acceptable **L 4**

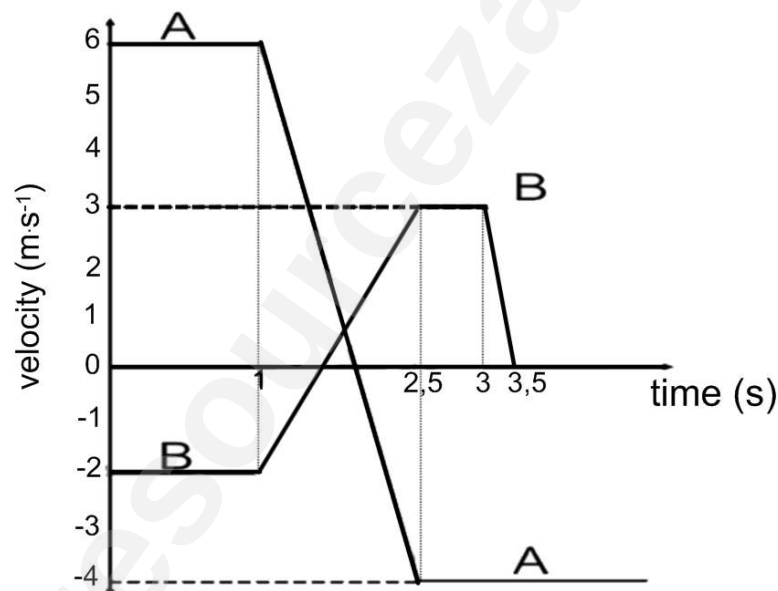
(1)

- 4.7 By repeating the experiment they should have got results that were close together indicating that controlled variables were precise and that their measurements were of a high degree of precision. ✓✓
If reliable then they could make accurate predictions of the outcome and then could draw accurate conclusions and patterns from their results. ✓✓ **L4** (4)

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Question 5

In the parking area of a shopping mall, on an icy morning, the tarred surface is covered with an ice layer. Trolley A, sliding towards the right, collides head-on with trolley B of mass 8 kg along a straight level path. The graph shows how the velocity of each trolley varies with time.



Ignore air resistance and the frictional forces between the trolleys and the iced road during the collision.

- 5.1.1 Calculate the magnitude of the change in momentum of trolley **B** during the collision. (3)

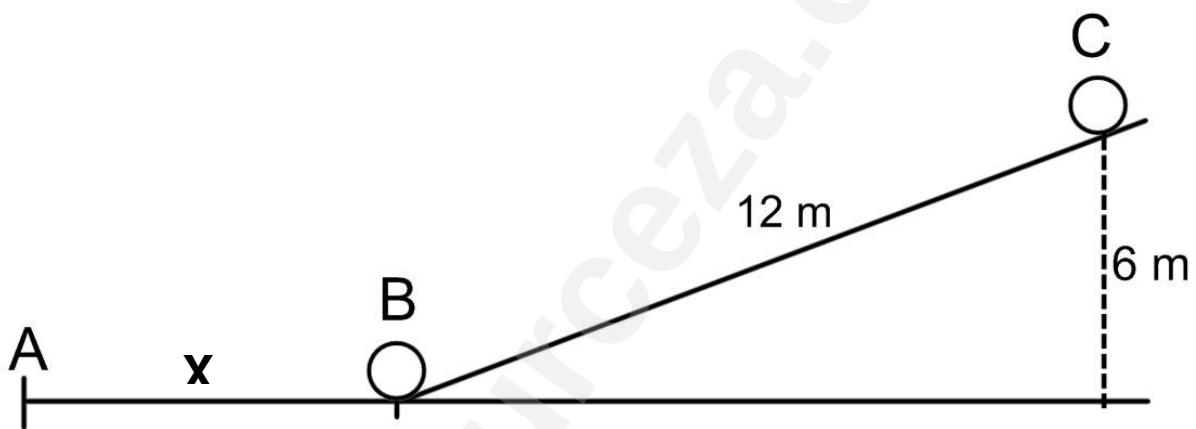
$$\begin{aligned}
 \Delta p &= mv_f - mv_i \quad \checkmark \\
 &= 8(3 - (-2)) \quad \checkmark \\
 &= 40 \text{ kg.m.s}^{-1} \quad \checkmark
 \end{aligned}$$

5.1.2 Calculate the net force experienced by trolley **B** during the collision. (4)

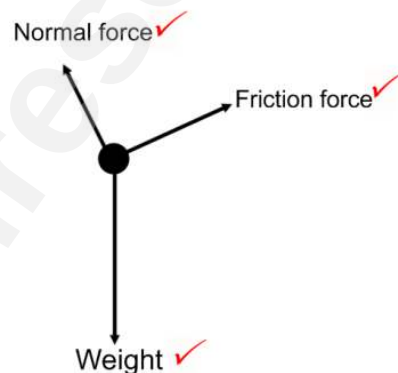
$$\begin{aligned}
 F_{\text{net}} &= \frac{\Delta p}{\Delta t} \checkmark \\
 &= \frac{40}{1,5} \checkmark \\
 &= 26,67 \text{ N} \checkmark \text{ right} \checkmark
 \end{aligned}$$

5.2

A marble of mass 600 g is released from rest at point C, 6 m above the ground. It rolls down a rough 12 m slope, inclined at an angle θ to the horizontal. When the marble is at point B, its speed is $4 \text{ m} \cdot \text{s}^{-1}$.



5.2.1 Draw a labelled free body diagram for the marble while it is at rest at point C. (3)



5.2.2 Use **energy principles** to determine the angle of the slope with the ground. (3)

$$\begin{aligned}
 mgh &= F_g // \Delta x \checkmark \\
 mgh &= mg \sin \theta \times 12 \\
 6 &= \sin \theta \times 12 \checkmark \\
 \theta &= 30^\circ \checkmark
 \end{aligned}$$

5.2.3 State the work energy theorem. (2)

The work done by a **net force** on an object is equal to the change in the kinetic energy of the object.

5.2.4 Use the work-energy theorem to calculate the work done by friction. (4)

$$\begin{aligned} W_{\text{net}} &= \Delta E_k = W_g + W_f \\ \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 &= mgsin\theta\Delta x + W_f \\ \frac{1}{2}(0,6)4^2 - \frac{1}{2}(0,6)0^2 &= 0,6(9,8)\sin 30^\circ(12) + W_f \\ 4,8 - 35,28 &= W_f \\ W_f &= -30,48 \text{ J} \end{aligned}$$

5.2.5 Calculate the coefficient of kinetic friction between the marble and the slope. (6)

$$\begin{aligned} W_f &= -30,48 = F_f \Delta x \cos 180^\circ \\ -30,48 &= F_f \times 12 \cos 180^\circ \\ F_f &= 2,54 \text{ N} \end{aligned}$$

$$\begin{aligned} F_N &= mg \cos \theta \\ &= 0,6(9,8) \cos 30^\circ \\ &= 5,09 \text{ N} \end{aligned}$$

$$\begin{aligned} \mu_k &= \frac{F_f}{F_N} \\ &= \frac{2,54}{5,09} \\ &= 0,499 \end{aligned}$$

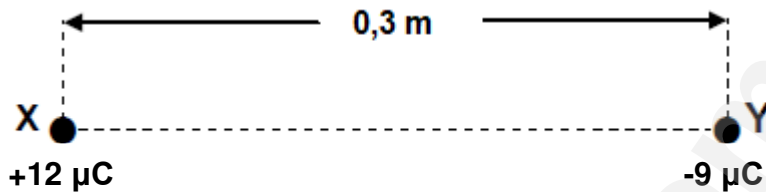
As the marble rolls from point B to point A, (distance X), a frictional force of 1,92 N acts on the marble causing it to slow down to rest at point A.

5.2.6 Use energy principles to determine the length of the track (x) between points B and A. (4)

$$\begin{aligned} W_{\text{net}} &= \Delta E_k = W_f \\ \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 &= F_f \Delta x \cos 180^\circ \\ \frac{1}{2}(0,6)0^2 - \frac{1}{2}(0,6)4^2 &= -1,92 (\Delta x) \\ 0 - 4,8 &= -1,92 (\Delta x) \\ \Delta x &= 2,5 \text{ m} \end{aligned}$$

Question 6

Two small spheres, **X** and **Y**, carrying charges of **+12 μC** and **-9 μC** respectively, are placed **0,30 m** apart in air.



- 6.1 State *Coulomb's law* in words. (2)

Two point charges in free space or air exert forces on each other. The force is directly proportional to the product of the charges and inversely proportional to the square of the distance between the charges. ✓✓

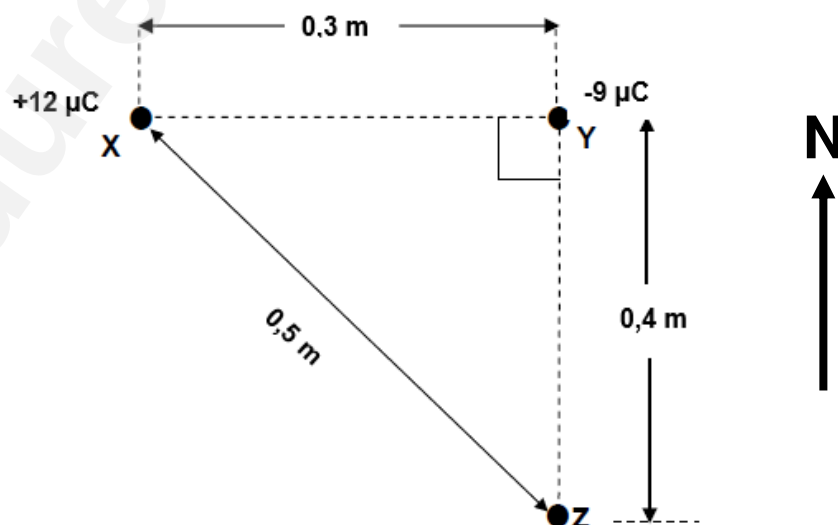
- 6.2 Calculate the magnitude of the electrostatic force experienced by charged sphere X. (4)

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

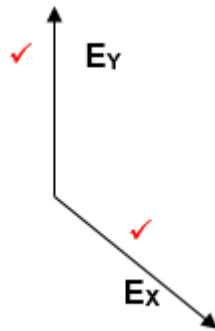
$$F = \frac{(9 \times 10^9)(12 \times 10^{-6})(9 \times 10^{-6})}{(0,3)^2} \checkmark$$

$$= 10,8 \text{ N} \checkmark \quad (4)$$

- 6.3 A point, **Z**, is now chosen at a distance of **0,40 m** below sphere **Y**, in such a way that the line joining the charged spheres **X** and **Y** is perpendicular to the line joining the charged sphere **Y** and point **Z**, as shown in the diagram below. The distance between point **X** and point **Z** is found to be **0,5 m**.



- 6.3.1 Draw a vector diagram showing the directions of the electrostatic fields experienced by point Z along the lines XZ and YZ due to the presence of charged spheres X and Y respectively. (2)



- 6.3.2 Calculate the magnitude and direction of the electric field at point Z due to the presence of sphere X. (5)

$$E_X = \frac{kQ_1}{r^2} \checkmark = \frac{(9 \times 10^9)(12 \times 10^{-6})}{0,5^2} \checkmark = 432000 \text{ N.C}^{-1} \checkmark \text{ on a bearing of}$$

$$143,13^\circ \checkmark$$

$$\Theta = \sin^{-1}\left(\frac{0,4}{0,5}\right) \quad \Theta = 53,13^\circ \checkmark \quad (5)$$

- 6.3.3 Calculate the magnitude of the net electric field strength at point Z. (5)

$$E_y = \frac{kQ_1}{r^2} = \frac{(9 \times 10^9)(9 \times 10^{-6})}{0,4^2} = 506250 \text{ N.C}^{-1} \text{ up } \checkmark$$

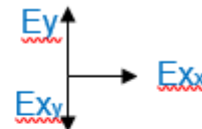
$$E_{xy} = E_x \sin \Theta = 432000 \sin 53,13^\circ = 345599,537 \text{ N down } \checkmark$$

$$E_{xx} = E_x \cos \Theta = 432000 \cos 53,13^\circ = 259200,6174 \text{ N right } \checkmark$$

$$E_{nety} = E_y - E_{xy} = 506250 - 345599,537 = 160650,463 \text{ N up } \checkmark$$

$$E_{net}^2 = E_{xx}^2 + E_{nety}^2 = 259200,6174^2 + 160650,463^2$$

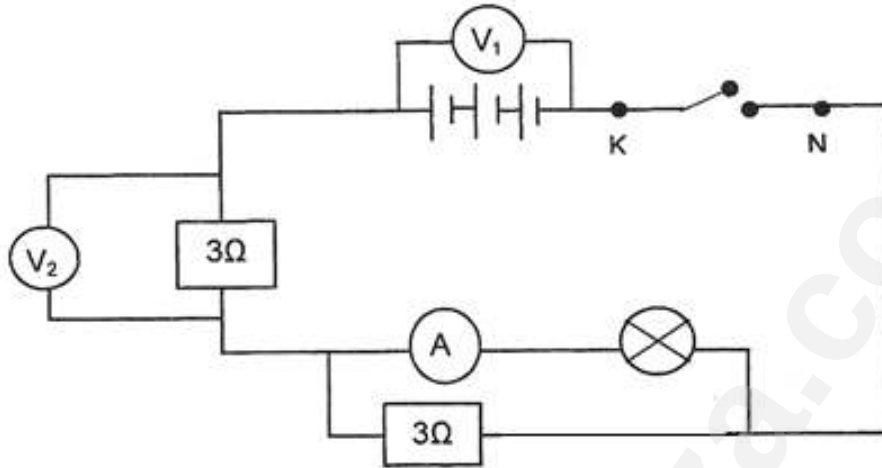
$$E_{net} = 304948,41 \text{ N.C}^{-1} \checkmark \quad (5)$$



[18]

Question 7

The internal resistance of the circuit below is 1Ω .



The reading on the voltmeter, V_1 , decreases from 12 V to 10 V when the switch is closed.

7.1 Define the term *emf*. **L1** (2)

The total energy supplied per coulomb of charge by the cell. ✓✓

7.2 Explain why the reading on the voltmeter, V_1 , decreases when the switch is closed. **L2** (2)

Some work is done to overcome the internal resistance of the battery. ✓✓

7.3 Calculate the current that flows through the light bulb. **L3** (6)

$$I = \frac{V}{R}$$

$$I = \frac{12-10}{(1)}$$

$$I = 2\text{ A} \checkmark$$

$$V_2 = IR$$

$$= 2(3)$$

$$= 6\text{ V} \checkmark$$

$$V_{\text{bulb}} = 10 - 6 = 4\text{ V} \checkmark$$

$$I_{3\Omega} = \frac{V}{R}$$

$$= \frac{4}{3} \checkmark$$

$$= 1,33A \checkmark$$

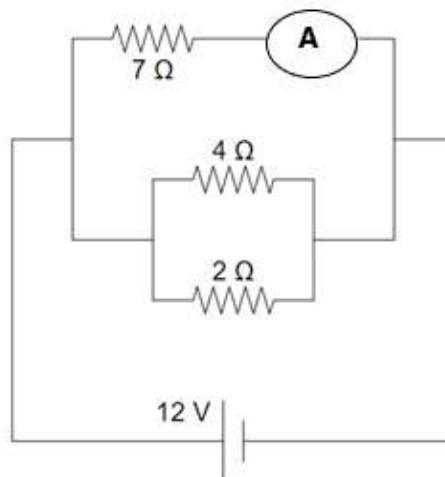
$$I_{bulb} = 2 - 1,33$$

$$= 0,67A \checkmark$$

7.4 The voltmeter, V_2 , is now removed from its present position and is connected across the points KN. The switch is opened. Explain how the brightness of the light bulb will be affected. L4 (4)

- *Bulb will stop burning.* $\checkmark$
- *Voltmeter V_2 will now be connected in series.* $\checkmark$
- *Since voltmeters have a high resistance the current will be almost zero.* $\checkmark$
- *Therefore, the potential difference is also almost zero.* $\checkmark$

7.5 Consider the circuit below and answer the questions that follow. The battery and connecting wires have negligible resistance.



7.5.1 Define resistance: **the opposition to the flow of current** **L1** (2)

7.5.2 Calculate the total resistance of this circuit. **L2** (3)

$$R_p = \frac{\text{Product}}{\text{sum}}$$

$$R_p = \frac{8}{6}$$

$$= 1,33\Omega \checkmark$$

$$R_p = \frac{\text{Product}}{\text{sum}}$$

$$= \frac{9,33}{8,33} \checkmark$$

$$= 1,12 \Omega \checkmark$$

- **Students could use alternative method to calculate.**

7.5.3 Find the total current in this circuit. **L2** (2)

$$I = \frac{V}{R}$$

$$I = \frac{12}{(1,12)} \checkmark \quad (\text{can allocate this mark to the formula as well})$$

$$I = 10,71A \checkmark$$

7.5.4 Calculate the current through the 2Ω resistor. **L2** (3)

Current through the 2Ω resistor:

$$I = \frac{V}{R} \checkmark$$

$$I = \frac{12}{(2)} \checkmark$$

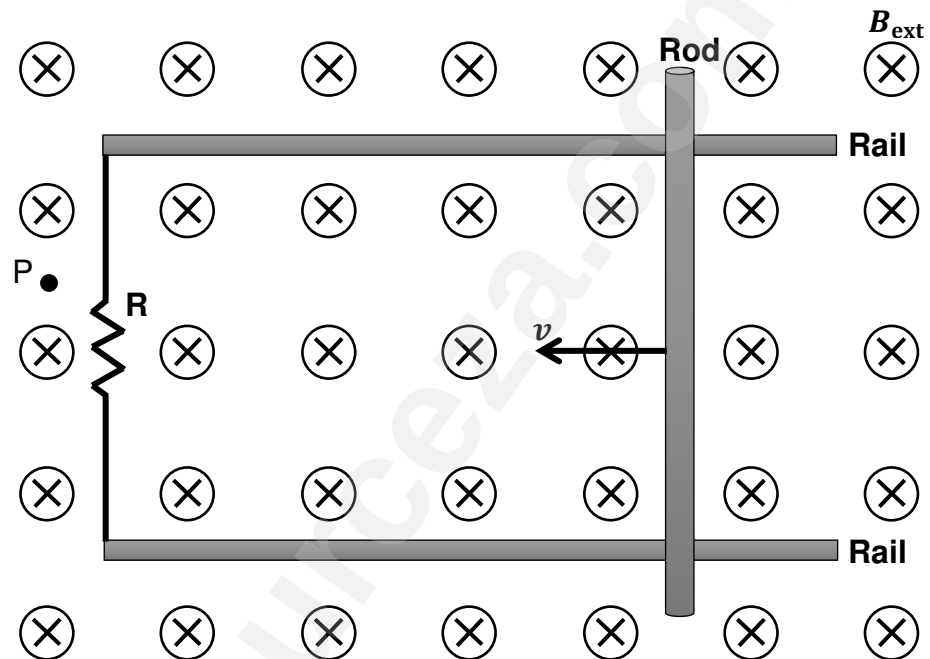
$$I = 6A \checkmark$$

[24]

Question 8

A resistor **R** is connected to two stationary rails. A rod is placed onto the rails, creating a closed loop, as shown in the diagram below. A uniform external magnetic flux density is present as shown.

The rod is then pulled to the left with a constant velocity v .



- 8.1. State what is meant by *magnetic flux density*. (2)

A representation of the magnitude and direction of the magnetic field. ✓✓

- 8.2. With reference to an electromagnetic law, fully explain why pulling the rod to the left causes a **current** to be induced in resistor **R**. (5)

- *As the rod is pulled to the left, the area of the loop exposed to the magnetic field decreases (changes) ✓*
- *This causes the magnetic flux through the loop to decrease (change) ✓*
- *According to Faraday's law ✓*
- *This change in magnetic flux causes an emf to be induced ✓*
- *Because, the loop is closed (closed circuit), this emf causes a current to be induced ✓*

8.3.

- 8.3.1 State the direction of the induced magnetic field at point P. State either INTO THE PAGE or OUT OF THE PAGE. (2)

Out of the page ✓✓

- 8.3.2 State the direction of the induced current through resistor **R**. State either UP or DOWN. (2)

Up ✓✓

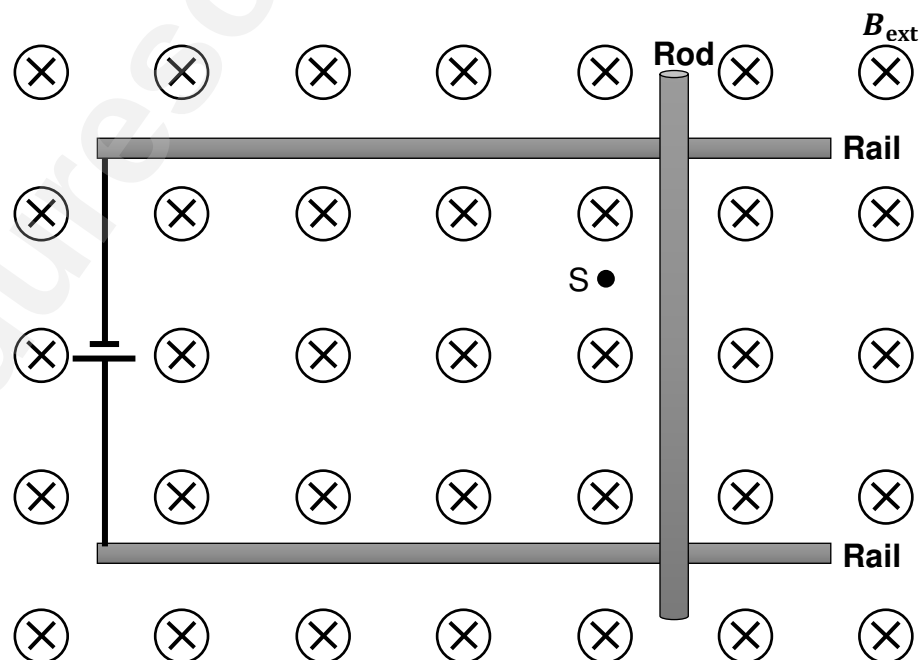
- 8.4. 8.4.1 The position of the rod is reset and it is now pulled with a constant velocity $3v$. State the new current in terms of the original current, I . (2)

$3I$ ✓✓

- 8.4.2 The position of the rod is reset. The rails are brought closer together, to half the original separation distance and resistor **R** is replaced with a new resistor of $2R$. The rod is pulled away with a constant velocity v . State the new current in terms of the original current, I . (2)

$\frac{1}{4}I$ ✓✓

- 8.5. The resistor is now replaced with a DC supply, causing the rod to move. The setup is shown in the diagram below.



8.5.1 State the electromagnetic principle illustrated here. (1)

The motor effect ✓

8.5.2 What direction does the rod move? State only LEFT or RIGHT. (2)

Left ✓✓

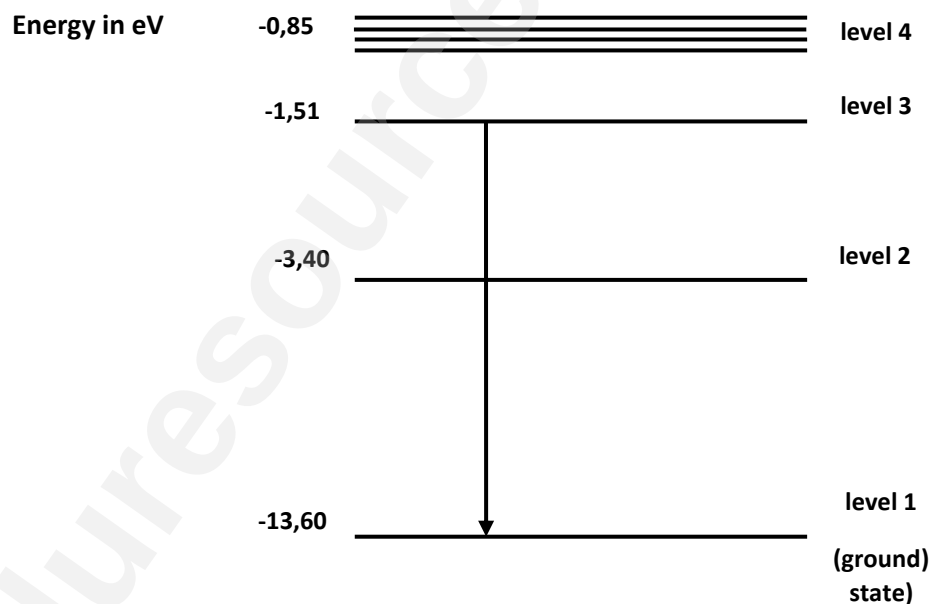
8.5.3 State the direction of the magnetic field induced by the rod at point S. (2)

Out of the page ✓✓

[20]

Question 9

9.1 The diagram below shows the energy levels for a hydrogen atom.

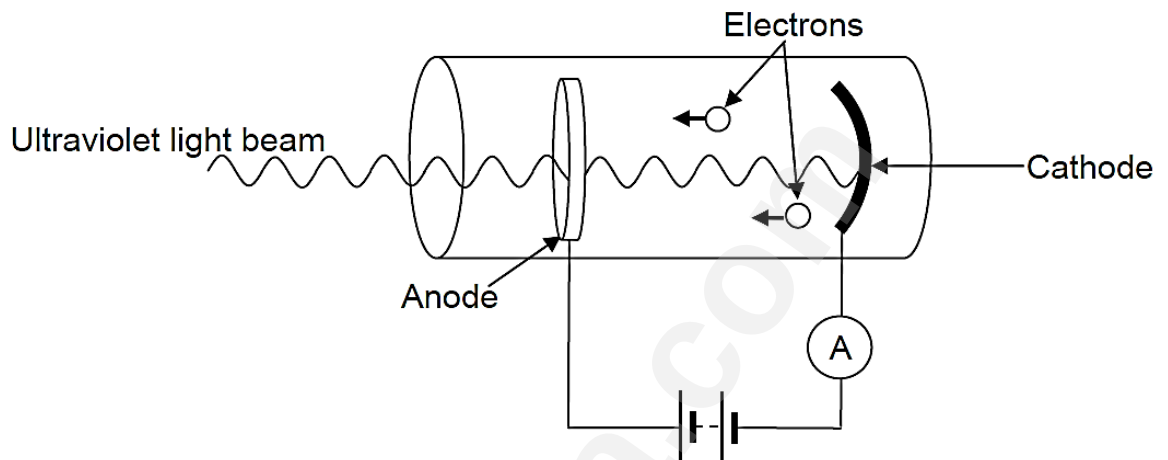


Energy level diagram of a hydrogen atom

9.1.1 Calculate the energy (in joules) of the photon emitted when an electron drops from level 3 back to its ground state (level 1). (3)

9.1.2 Determine the frequency of the photon given off as a result of the electron transition from level 3 back to its ground state (level 1). (3)

- 9.2 The photo-electric effect has many practical applications. A photocell, such as the one below used in burglar alarm systems, is one such application.



Ultraviolet light of wavelength **250 nm** is used to illuminate the photocell. When a person interrupts the ultraviolet beam, the sudden drop in current activates a switch, which sets off the alarm.

The work function of the metal used as a cathode in the photocell is **$6,9 \times 10^{-19} \text{ J}$** .

- 9.2.1 Define *work function*. (2)
- 9.2.2 Calculate the energy of a photon of the ultra-violet light. (4)
- 9.2.3 Calculate the maximum velocity of an electron that is emitted from the surface of the metal. (4)

[16]

$$\begin{aligned} 9.1.1 \quad & -1,51 - (-13,6) = 12,09 \text{ eV} \checkmark \\ & = 12,09 \text{ eV} \times 1,6 \times 10^{-19} \text{ J.eV}^{-1} \checkmark \\ & = \underline{\underline{1,93 \times 10^{-18} \text{ J}}} \checkmark \end{aligned} \quad (3)$$

$$\begin{aligned} 9.1.2 \quad & E = h \cdot f \checkmark \\ & f = \frac{1,93 \times 10^{-18} \text{ J}}{6,6 \times 10^{-34} \text{ J.s}} \checkmark \\ & = \underline{\underline{2,92 \times 10^{15} \text{ Hz}}} \checkmark \end{aligned} \quad (3)$$

- 9.2.1 The minimum amount of energy needed to emit an electron from the surface of a metal is called the **work function** of the metal. $\checkmark\checkmark$ (2)

$$\begin{aligned} 9.2.2 \quad & E = \frac{hc}{\lambda} \checkmark \\ & = \frac{(6,6 \times 10^{-34} \text{ J.s})(3 \times 10^8 \text{ m.s}^{-1})}{(250 \times 10^{-9} \text{ m})} \checkmark \\ & = \underline{\underline{7,92 \times 10^{-19} \text{ J}}} \checkmark \end{aligned} \quad (4)$$

$$9.2.3 \quad E = W_f + \frac{1}{2} mv^2 \quad \checkmark$$

$$\therefore v^2 = \frac{E - W_f}{(0,5)m_e}$$

$$= \frac{(7,92 \times 10^{-19}) \checkmark - (6,9 \times 10^{-19}) \checkmark}{(0,5)(9,1 \times 10^{-31})}$$

$$\therefore v = \underline{473\,472,09 \text{ m.s}^{-1}} \checkmark (4,73 \times 10^5 \text{ m.s}^{-1}) \quad (4)$$

[16]

TOTAL = 200