SELF ASSESSMENT PAPER - 2

SOLUTIONS

I. Multiple Choice Questions **[1 × 4 = 4]**

1. Option (A) is correct.

2. Option (C) is correct.

Explanation: Wheatstone bridge is suitable for measurement of medium value resistances because to ensure sensitivity, other resistors must be of comparable values.

3. Option (B) is correct.

Explanation: Kirchhoff's voltage law is based on the law of conservation of energy.

4. Option (A) is correct.

Explanation: Kirchhoff's First Law states that the total current entering a junction is equal to the total current leaving the junction. Thus, the algebraic sum of currents at a junction is zero.

II. Assertion & Reason **[1 × 2 = 2]**

1. Option (D) is correct.

Explanation: Fuse wire should melt and disconnect the circuit from mains supply if the current increases beyond a rated value. For this reason, its resistance should be high for more heat generation and melting point should be low for fast melting. So assertion is false. Fuse wire may be various current rating depending on the type of appliance being used and the capacity of the wiring. So, the reason is true.

2. Option (C) is correct.

Explanation: Kirchhoff's junction rule is applicable at any point. So the assertion is true. While steady current is flowing there is no accumulation of charge at the junction. Total incoming charge = total outgoing charge. So the reason is also false.

III. Competency Based Questions **[1 × 4 = 4]**

1. Option (B) is correct.

Explanation: The heating element is made of nichrome 80/20 (80% nickel, 20% chromium).

2. Option (B) is correct.

Explanation: Nichrome 80/20 means an alloy of 80% nickel, 20% chromium.

3. Option (D) is correct.

Explanation: Electricity consumption is measured by kWH. So, 1200 W toaster will consume more electricity.

4. Option (A) is correct.

Explanation: The designed electric toaster is operated at 220 volts A.C., single phase.

5. Option (D) is correct.

Explanation: The element is wound separately on Mica sheets and fitted with body of toaster with the help of ceramic terminals.

IV. Very Short Answer Type Questions **[1 × 3 = 3]**

1. From the circuit we see that, the two batteries are joined together with positive terminal, so equivalent emf of both the batteries will result as:

$$I = \frac{E}{R} = \frac{190}{38} = 5\text{ A.} \qquad \mathbf{1}$$

[CBSE Marking Scheme, 2018]

2. Zero

3. Conservation of charge because the total incoming current is equal to the total outgoing current.

V. Short Answer Type Questions-I **[2 × 3 = 6]**

1. Since, in series combination of resistance, the current flowing is same but voltage is different, therefore power dissipation is given by

$$P = I^2 R \Rightarrow P \propto R \Rightarrow \frac{P_1}{P_2} = \frac{R_1}{R_2}$$

$$\frac{P_1}{P_2} = \frac{2}{4} = \frac{1}{2} \qquad \mathbf{1}$$

2. By Kirchhoff's law, we have, for the loop ABCDA

$$150 - 30i - 10 = 0$$

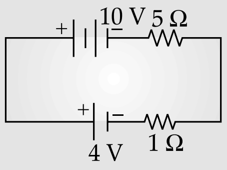
$$30i = 140$$

$$i = \frac{140}{30} = 4.66\text{ A} \qquad \mathbf{1}$$

3. Calculation of Current **1**

Calculation of Terminal Voltage **1**

$$10 - 4 = I(1 + 5) \qquad ½$$



$\therefore \qquad I = 1\text{ A} \qquad ½$

$\therefore$ Terminal voltage across cell

$$= (4 + 1 \times 1)\,V \qquad ½$$

$$= 5\,V \qquad ½$$

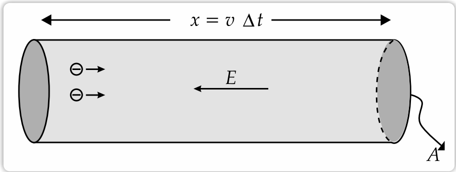
[CBSE Marking Scheme, 2017]

VI. Short Answer Type Questions-II **[3 × 2 = 6]**

1. (i) According to the figure,

$$\Delta x = v_d\,\Delta t \qquad ½$$

Hence, amount of charge crossing area A in time Δt



$$\therefore \quad \Delta Q = I\Delta t = neA|v_d|\Delta t \qquad ½+½$$

$$\therefore \quad I = neAv_d \qquad ½$$

(ii) Charge flowing $= \Sigma I\Delta t$

= area under the curve

$$= \left[\frac{1}{2}\times 5\times 5 + 5(10-5)\right]\text{C} \qquad ½$$

$$= 37.5\ \text{C} \qquad ½$$

2. (a) Definition and SI unit of conductivity ½ + ½

(b) Derivation of the expression for conductivity 1½

Relation between current density and electric field ½

(a) The conductivity of a material equals to the reciprocal of the resistance of its wire of unit length and unit area of cross-section. ½

[Alternatively:

The conductivity (σ) of a material is the reciprocal of its resistivity (ρ)]

(Also accept $\sigma = \dfrac{1}{\rho}$)

Its SI unit is

$\left(\dfrac{1}{\text{ohm-metre}}\right)$/ ohm^{-1}m^{-1} / (mho m^{-1}) / Siemen m^{-1} ½

(b) The acceleration, $\vec{a} = -\dfrac{e}{m}\vec{E}$

The average drift velocity, v_d, is given by

$$v_d = -\frac{eE}{m}\tau$$

(τ = average time between collisions/relaxation time)

If n is the number of free electrons per unit volume, the current I is given by ½

$$I = neA|v_d| = \frac{e^2A}{m}\tau n|E| \qquad ½$$

But $I = |j|A \quad (j = \text{current density})$

We, therefore, get

$$|j| = \frac{ne^2}{m}\tau|E|,$$

The term $\dfrac{ne^2}{m}\tau$ is conductivity

$$\therefore \qquad \sigma = \frac{ne^2\tau}{m} \qquad ½$$

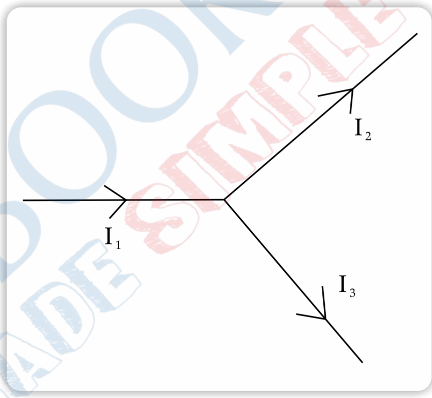
$$\Rightarrow \qquad J = \sigma E \qquad ½$$

[CBSE Marking Scheme, 2018]

VII. Long Answer Type Questions [5 × 1 = 5]

1. (i) First rule

Kirchhoff's first rule is also known as junctions law which states that for a given junction or node in a circuit, sum of the currents entering in a junction will be equal to sum of currents leaving that junction, $I_1 = I_2 + I_3$



The algebraic sum of all currents meeting at a junction in a closed circuit is zero, i.e., $\Sigma I = 0$.

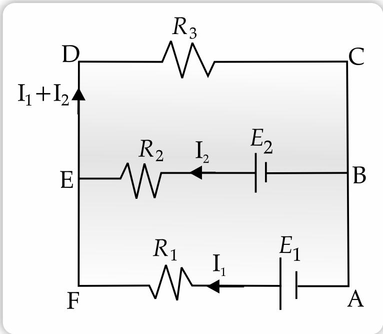
This is follows the law of conservation of charge.

Second rule

Kirchhoff's second rule is also known as loop rule which states that around any closed loop in a circuit, sum of the potential differences across all elements will be zero.

$$\Sigma V = 0 \text{ or } \Sigma V = \Sigma IR$$

This follows the law of conservation of energy.

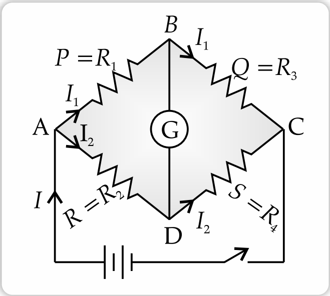


For example: Apply junction law in loop AFEBA

$$E_1 - E_2 = I_1R_1 - I_2R_2$$

(ii) Applying Kirchhoff's loop rule to closed loop ADBA,

$$-I_1 R_1 + I_g R_G + I_2 R_2 = 0\ (I_g = 0) \qquad \text{...(i)}$$



For loop CBDC,

$-I_2 R_4 + I_g R_G + I_1 R_3 = 0 \ (I_g = 0)$ ...(i)

from equation (i)

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$ ½

From equation (ii)

$$\frac{I_1}{I_2} = \frac{R_4}{R_3}$$

or, $$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

$$\frac{P}{Q} = \frac{R}{S}$$