

Chapter 12

CURRENT ELECTRICITY

Solved Problems

Q1. A wire of length 3m and area of cross section $1.7 \times 10^{-6} m^2$ has resistance $3 \times 10^{-2} ohm$. Calculate resistivity of the wire?

Sol: Given, $l = 3m$, $A = 1.7 \times 10^{-6}$

$$R = 3 \times 10^{-2} \Omega$$

$$\rho = \frac{RA}{L} = \frac{3 \times 10^{-2} \times 1.7 \times 10^{-6}}{3} = 1.7 \times 10^{-8} \Omega m$$

Q2. A current of 1A is drawn by a filament of an electric bulb number of electrons passing through a cross section of the filament in 16 sec would be.

Sol: Given, $I = 1A$, $t = 16$ sec

$$I = \frac{Q}{t}$$

$$Q = It = 1 \times 16 \text{ coulomb's}$$

We know that charge on 1 electron $= 1.6 \times 10^{-19} C$

$$1.6 \times 10^{-19} C = 1 \text{ electrons}$$

$$1C = \frac{1}{1.6 \times 10^{-19}} \text{ electrons}$$

$$1C = \frac{1}{16 \times 10^{-20}} \text{ electrons}$$

$$1C = \frac{10^{20}}{16} \text{ electrons}$$

Number of electrons is $16\text{c charge} = 16 \times \frac{10^{20}}{16} \text{ electrons}$
 $= 10^{20} \text{ electrons}$

Q3. What is the maximum resistance which can be made using five resistors each of $\frac{1}{5} \Omega$?

Sol: Given number of resistors $n = 5$

$$\text{Resistance } R = \frac{1}{5} \Omega$$

In series combination $R_s = nR$

$$R_s = (5) \left(\frac{1}{5} \right) = 1 \Omega$$

$$R_s = 1 \Omega$$

Q4. What is minimum resistance which can be made using five resistors each of $\frac{1}{5} \Omega$?

Sol: Given number of resistors $n = 5$

$$\text{Each resistance } R = \frac{1}{5} \Omega$$

Minimum Resistance parallel combination $R_p = \frac{R}{n}$

$$R_p = \frac{\left(\frac{1}{5} \right)}{5} = \frac{1}{25}$$

$$R_p = \frac{1}{25} \Omega$$

Q5. A cylindrical conductor of length ' l ' and uniform area of cross section ' A ' has resistance R . Another conductor of length ' $2l$ ' and resistance R of the same material has area of cross section.

Sol: Given,

$$l_1 = l$$

$$l_2 = 2l$$

$$A_1 = A$$

$$R_2 = R$$

$$R_1 = R$$

$$A_2 = ?$$

We know that $R = \frac{\rho l}{A}$ or $A = \frac{\rho l}{R}$

$$A \propto \frac{l}{R}$$

$$\frac{A_1}{A_2} = \frac{l_1}{l_2} \left(\frac{R_2}{R_1} \right)$$

$$A_2 = A_1 \left(\frac{l_2 R_1}{l_1 R_2} \right)$$

$$A_2 = A \frac{(2l)R}{l(R)} = 2A$$

Q6. In an electrical circuit two resistors of 2Ω and 4Ω respectively are connected in series to 6 volt battery. The heat dissipated by the 4Ω resistors in 5 sec will be.

Sol: Given, $V = 6$ Volt

$$t = 5 \text{ sec}$$

$$R_1 = 2\Omega, R_2 = 4\Omega$$

$$R_s = R_1 + R_2 = 2 + 4 = 6\Omega$$

$$R_s = 6\Omega$$

$$V = IR \text{ or } I = \frac{V}{R} = \frac{6}{6} = 1A$$

$$I = 1A$$

Heat dissipated by 4Ω

$$H = I^2 R_2 t$$

$$= (1)^2 (4) 5$$

$$H = 20 \text{ Joule}$$

Q7. Three resistors 2Ω , 4Ω and 6Ω are combined in parallel. If the combination is connected to a battery of emf 20 volt and negligible internal resistance, determine the current through each resistor and the total current drawn from the battery and effective resistance?

Sol: Given, $R_1 = 6\Omega$, $R_2 = 4\Omega$, $R_3 = 6\Omega$ and $V = 20$ volt

$$\text{In parallel } R_p = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1}$$

$$R_p = \frac{(2)(4)(6)}{(2)(4) + (4)(6) + (2)(6)}$$

$$R_p = \frac{48}{8 + 24 + 12}$$

$$R_p = \frac{48}{44}$$

$$R_p = \frac{12}{11}$$

$$\text{Current through } R_1 \text{ Resistor } I_1 = \frac{V}{R_1} = \frac{20}{2} = 10A$$

$$\text{Current through } R_2 \text{ Resistor } I_2 = \frac{V}{R_2} = \frac{20}{4} = 5A$$

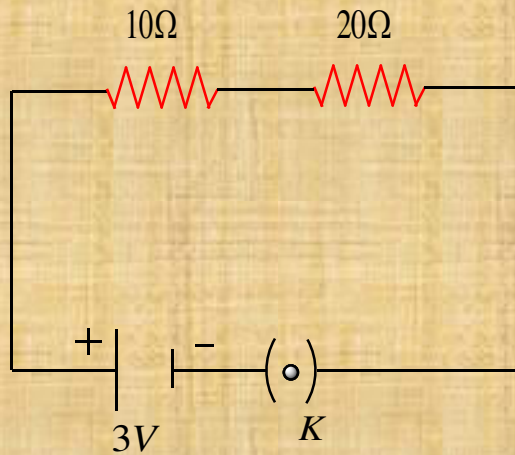
$$\text{Current through } R_3 \text{ Resistor } I_3 = \frac{V}{R_3} = \frac{20}{6} = 3.33A$$

$$\text{Total current } I = I_1 + I_2 + I_3$$

$$I = 10 + 5 + 3.33 = 18.33 A$$

Q8. Study the following electric circuit and find,

- The current flowing in the circuit and
- The potential difference across 10Ω Resistor.



Sol: Given, $R_1 = 10\Omega$, $R_2 = 20\Omega$, $V = 3$ Volt

R_1 and R_2 in series

$$R_s = R_1 + R_2$$

$$R_s = 10 + 20$$

$$R_s = 30\Omega$$

(i) Current flowing in the circuit $I = \frac{V}{R_s}$

$$I = \frac{3}{30} = \frac{1}{10} = 0.1\Omega$$

(ii) Potential difference across 10Ω Resistor

$$V = IR$$

$$V = \frac{1}{10} \times 10 = 1 \text{ Volt}$$

Q9. The resistance of a wire 0.01 cm radius is 10Ω . If the resistivity of the material of the wire is $50 \times 10^{-8} \Omega m$, Find the length of the wire?

Sol: Given, $r = 0.01 \text{ cm} = 10^{-4} \text{ m}$

$$\rho = 50 \times 10^{-8}, R = 10\Omega, l = ?$$

$$R = \frac{\rho l}{A} \Rightarrow l = \frac{RA}{\rho} = \frac{10 \times \pi \times (10^{-4})^2}{50 \times 10^{-8}}$$

$$l = 62.8 \text{ cm}$$

Q10. Two lamps, one rated 100 W, 220 V and other 60 W, 220 V are connected in parallel to electric mains supply. Find the current drawn by the two lamps from the line, if the supply voltage is 220 volt.

Sol: Given,

$$P_1 = 100 \text{ W}, V_1 = 220 \text{ V}$$

$$I_1 = \frac{P_1}{V_1} = \frac{100}{220} = \frac{10}{22} \text{ A}$$

$$P_2 = 60 \text{ W}, V_2 = 220 \text{ V}$$

$$I_2 = \frac{P_2}{V_2} = \frac{60}{220} = \frac{6}{22} \text{ A}$$

Net current, $I = I_1 + I_2$

$$I = \frac{10}{22} + \frac{6}{22} = \frac{16}{22} \text{ A}$$

$$I = 0.73 \text{ A}$$