11. CURRENT ELECTRICITY

HOMEWORK SOLUTION

1. Given :

$V = 240\text{ V}$

$I = 0.25\text{ A}$

$t = 10\text{sec}$

To Find :

$R = ?$

$q = ?$

Formulae :

i) $V = IR$

ii) $I = \frac{q}{t}$

Solution :

$V = IR$

$240 = 0.25 \times R$

$\therefore \quad R = \frac{240}{0.25}$

$\therefore \quad R = 960\Omega$

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

$q = It$

$= 0.25 \times 10$

$q = 2.5\text{C}$

2. Given :

$l_1 = 2.4\text{ m}$

$R_1 = 10\Omega$

$l_2 = 1.2\text{ m}$

To Find :

$R_2 = ?$

Formulae :

$$R = \rho\frac{l}{A}$$

Solution :

$$R_1 = \rho\frac{l_1}{A} \quad \text{... (i)}$$

$$R_2 = \rho\frac{l_2}{A} \quad \text{... (ii)}$$

(Here, the wire is of the same material and same cross sectional area)

Dividing equation (i) , (ii), we get,

$$\frac{R_1}{R_2} = \frac{l_1}{l_2}$$

$$\frac{10}{R_2} = \frac{2.4}{1.2}$$

$$\therefore \quad R_2 = \frac{10 \times 1.2}{2.4}$$

$$R_2 = 5\ \Omega$$

3. Given :

Original resistance (R_1) = R

Original length (l_1) = X

Final length (l_2) = nX

To Find :

Final resistance (R_2) = ?

Formulae :

$$R = P\frac{l}{A}$$

Solution :

Let A_1 and A_2 be original area and final area. After wire is stretched length increases and area decreases.

But volume remains constant

$$V_1 = V_2$$

$$A_1 l_1 = A_2 l_2$$

$$A_1(x) = A_2(nx)$$

$$A_1 = nA_2$$

$$R_1 = P\frac{l_1}{A_1} \qquad R_2 = P\frac{l_2}{A_2}$$

$$\frac{R_2}{R_1} = \frac{l_2}{A_2} \times \frac{A_1}{l_1}$$

$$= \frac{nX}{A_2} \times \frac{nA_2}{X}$$

$= \quad n^2$

$R_2 = n^2R_1$

Final resistance is n^2 times the original resistance.

4. Given :

Original resistance (R_1) = R

Original length (l_1) = 0.01 m

Original area (A_1) = (0.01) [∵ cube]

Final length (l_2) = 2m

Final area (A_2) = $(2)^2$

$\rho = 0.55 \times 10^{-6}\ \Omega m$

To Find :

Final resistance (R_2) = ?

Formulae :

$$R = \rho \frac{1}{A}$$

Solution :

$$R_1 = \rho \frac{l_1}{A_1} \quad \frac{l_1}{l_1^2} = \frac{\rho}{l_1}$$

$$R_1 = \frac{0.55 \times 10^{-6} \times 0.01}{(0.01)^2}$$

$$= \frac{0.55 \times 10^{-6}}{0.01}$$

$$R_1 = 0.55 \times 10^{-4}$$

Now $R \propto l$

Let A_1 and A_2 be the original area and final Since the volume of wire remains the same.

$$l_1A_1 = l_2A_2$$

$$\therefore \frac{A_2}{A_1} = \frac{l_1}{l_2}$$

$$\therefore \frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)^2$$

$$\therefore \frac{0.55 \times 10^{-4}}{R_2} = \frac{(0.01)^2}{4}$$

$$R_2 = 2.2\ \Omega$$

5. Given :

Original resistance (R_1) = 8 **Ω**

Original length (l_1) = x

Final length (l_2) = $\frac{x}{2}$

To Find :

Final resistance (R_2) = ?

Formulae :

$$R = \rho \frac{l}{A}$$

Solution :

$$R_1 = \rho \frac{l_1}{A_1}$$

$$R_2 = \rho \frac{l_2}{A_2}$$

$$\therefore \frac{R_1}{R_2} = \frac{l_1}{l_2} \times \frac{A_2}{A_1} \qquad \text{... (i)}$$

Since the volume of wire remains the same in two cases.

$$l_1A_1 = l_2A_2$$

$$\therefore \frac{A_2}{A_1} = \frac{l_1}{l_2}$$

Substituting this in equation (i),

$$\therefore \frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)^2$$

$$\therefore \frac{8}{R_2} = 4$$

$$\therefore R_2 = \frac{8}{4} = 2\ \Omega$$

$$\therefore R_2 = 2\ \Omega$$

6. Given :

l = 50 cm = 0.5 m

b = 2 cm = 2×10^{-2} m

h = 1 cm = 10^{-2} m

p = $6 \times 10^{-6}\ \Omega m$

Solution :

$$A = b \times h$$

$$A = (2 \times 10^{-2}) \times (10^{-2})$$
$$= 2 \times 10^{-4} \text{ m}$$
$$R = \rho \frac{l}{A}$$
$$= \frac{0.5 \times 6 \times 10^{-6}}{2 \times 10^{-4}}$$
$$R = 0.015\ \Omega$$

7.

Brown	Black	Orange	Gold	
↓	↓	↓	↓	
1	0	10^3	5%	ohm

$\therefore$ 10000 Ω ± 5 %

10 K Ω ± 5 %

8. Given :

$r = 6\ \Omega$

$R_1 = 14\ \Omega$

$I_1 = 0.5$ A

$R_2 = 24\ \Omega$

To Find :

$I_2 = ?$

Formulae :

$$I = \frac{E}{R + r}$$

Solution :

$$I_1 = \frac{E}{R_1 + r}$$
$$0.5 = \frac{E}{14 + 6}$$
$$0.5 = \frac{E}{20}$$
$$\therefore E = 0.5 \times 20$$
$$\therefore E = 10 \text{ V}$$
$$I_2 = \frac{E}{R_2 + r}$$
$$= \frac{10}{24 + 6} = \frac{10}{30}$$
$$I_2 = \frac{1}{3} \text{ A}$$

9. Given :

Let the 3 equal resistors be of R **Ω**

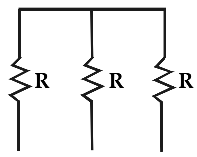
When connected in series

$$R_S = R + R + R = 3R$$

$$P_S = 10 \text{ W}$$

When connected in parallel

$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R}$$



$$\therefore R_P = \frac{R}{3}$$

To Find :

$P_P = ?$

Solution :

$$P = \frac{V^2}{R}$$
$$P_S = \frac{V^2}{R_S} \quad \text{and} \quad P_P = \frac{V^2}{R_P}$$
$$\frac{P_S}{P_P} = \frac{R_P}{R_S}$$
$$\therefore \frac{10}{P_P} = \frac{R}{3.3R}$$
$$\frac{10}{P_P} = \frac{1}{9}$$
$$P_P = 90 \text{ W}$$

10. Given :

$Q = 3C$

$V_1 = 120V \quad V_2 = 200V$

To Find :

$W = ?$

Formulae :

$W = QV$

Solution :

$W = Q(V_2 - V_1)$

$W = 3 \times (200 - 120)$

$W = 3 \times 80$

$W = 240J$

11. Given :

Resistance of wire $= 2.1 \ \Omega(R_0)$

$T = 100^0C - 27.5^0C$

$T = 72.5^0C$

$\alpha = 3.94 \times 10^{-3}/^0C.$

To Find :

$R_T = ?$

Formulae :

$$\alpha = \frac{R_T - R_0}{R_0 T}$$

Solution :

$$3.94 \times 10^{-3} = \frac{R_T - 2.1}{152.25}$$

$3.94 \times 10^{-3} \times 152.25 = R_T - 2.1$

$3.94 \times 10^{-5} \times 152.25 = R_T - 2.1$

$$Al\begin{bmatrix} \log 394 \\ +\log 152.25 \end{bmatrix} \times 10^{-5} = R_T - 2.1$$

$Al\ [2.5955 + 2.1824] \times 10^{-5} = RT - 2.1$

$Al\ [4.7779] \times 10^{-5} = R_T - 2.1$

$5.996 \times 10^4 \times 10^{-5} = R_T - 2.1$

$5.996 \times 10^{-1} = R_T - 2.1$

$0.5996 = RT - 2.1$

$R_T = 2.699\Omega$

12. Given :

$R_1 + R_2 = 18 \ \Omega$

$R_1 \mid\mid R_2 = 4 \ \Omega$

To Find :

$R_1, R_2 = ?$

Solution :

Let the two resistances be $R_1$and R_2. When connected in series

$R_1 + R_2 = 18 \quad \dots \text{(i)}$

When connected in parallel

$$\frac{R_1R_2}{R + R_2} = 4 \quad \dots \text{(ii)}$$

$$\therefore \frac{R_1R_2}{18} = 4 \quad \text{(From (i))}$$

$\therefore R_1R_2 = 72$

$R_1 (18 - R_1) = 72$

$18R_1 - R^2_1 = 72$

$R^2_1 - 18 R_1 + 72 = 0$

$R^2_1 - 6R_1 - 12R_1 + 72 = 0$

$R_1 (R_1 - 6) - 12 (R_1 - 6) = 0$

$(R_1 - 12) (R_1 - 6) = 0$

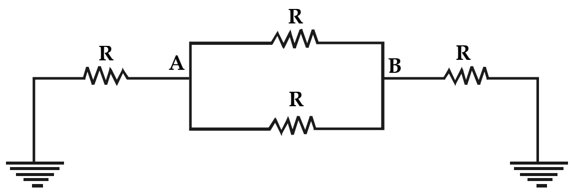
$R_1 = 6\Omega$ to $R_1 = 12\Omega$

When $R_1 = 6\Omega$, $6 + R_2 = 18$ $R_2 = 12\Omega$

When $R_1 = 12\Omega$, $12 + R_2 = 18$ R $= 6\Omega$

The two resistances are 6Ω and 12Ω

13. Given :

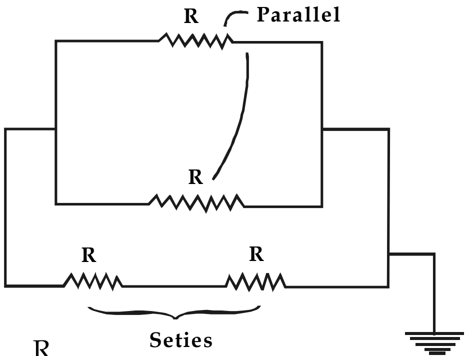


To Find :

$R_{AB} = ?$

Solution :

The circuit can be redrawn as follows :



$$\frac{R}{2} || 2R$$

$$= \frac{\frac{R}{2} \times 2R}{\frac{R}{2} + 2R}$$

$$= \frac{R^2}{\frac{5}{2} R}$$

$$R_{AB} = \frac{2}{5} R$$

14.Given :

$l_1 : l_2 : l_3 = 2 : 3 : 5$

$I_1 + I_2 + I_3 = 31$ A

To Find :

$I_1, I_2, I_3 = ?$

Solution :

$$R = \rho \frac{l}{A}$$

$R \propto l$

$\therefore\ l_1 : l_2 : l_3 = R_1 : R_2 : R_3$

$= 2 : 3 : 5$

Now, $I_1 + I_2 + I_3 = 31$

(I)

$I_1 R_1 = I_2 R_2$

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

$$I_1 \times \frac{2}{3} = I_2$$

(II)

$I_1 R_1 = I_3 R_3$

$$I_1 \times \frac{R_1}{R_3} = I_3$$

$$I_1 \times \frac{2}{5} = I_3$$

Substituting in equation (i), we get

$$I_1 + \frac{2}{3} I_1 + \frac{2}{5} I = 31$$

$$\frac{15I_1}{15} + \frac{10I_1}{15} + \frac{6I_1}{15} = 31$$

$$\therefore \frac{31I_1}{15} = 31$$

$\therefore\ I_1 = 15$A

$$I_2 = I_1 \times \frac{2}{3} = 15 \times \frac{2}{3} = 10A$$

$$I_3 = I_1 \times \frac{2}{5} = 15 \times \frac{2}{5} = 6A$$

15.Given :

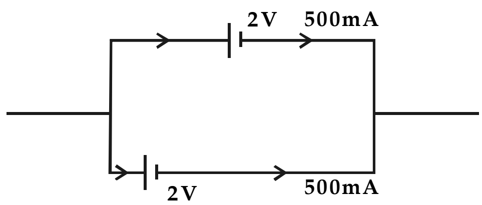
Two cells of 2V/500mA conected in parallel

To Find :

Total output voltage = ?

Current capacity = ?

Solution :



Total output voltage = 2V

($\because$ the cells are connected in parallel)

Total output current = 500mA + 500mA

= 1000mA

= 1A

16. Given :

Power = 250 watt

Daily usage = 8 hrs/day

Total Reriod = 30 days

Rate = $R_s 3$/kWh

To Find :

cost of electrical energy = ?

Solution :

Electric energy consumed per day

E = 250 × 8 = 2000 watt day

Electric energy consumed in 30 days

E_1 = 2000 watt/ day × 30 day

= 6000 0 watt

= 60 kWH

Hence, total cost is given as

cost = Rs3/kWH × 60 kWH

cost = Rs180