CHAPTER 3

Current Electricity

NCERT FOCUS

ANSWERS

Topic 1

1. We can first calculate drift velocity of the electrons from the given data

$I = Anev_d$

$3 = 2 \times 10^{-6} \times 8.5 \times 10^{28} \times 1.6 \times 10^{-19}\, v_d$

$v_d = 0.11 \times 10^{-3}$ m s^{-1}

Now time taken by an electron to drift a length of 3 m with drift speed is

$t = \dfrac{l}{v_d} = 27.27 \times 10^3$ s.

Topic 2

1. As $R_2 = R_1[1 + \alpha(t_2 - t_1)]$

$\therefore$ $117 = 100[1 + 1.7 \times 10^{-4}(t - 27)]$

or $17 = 1.7 \times 10^{-2}(t - 27)$

or $1000 = t - 27$ or $t = 1027°$C.

2. We know the relation, $R = \rho\dfrac{l}{A}$

$$5 = \rho\frac{15}{6\times10^{-7}}$$

$\therefore$ Resistivity, $\rho = \dfrac{30\times10^{-7}}{15} = 2\times10^{-7}\ \Omega$ m

3. $T_1 = 27.5°$C, $R_1 = 2.1\ \Omega$, $T_2 = 100°$C and $R_2 = 2.7\ \Omega$

Using the relation,

$R_2 = R_1[1 + \alpha(T_2 - T_1)]$, we have

Temperature coefficient of resistivity of silver,

$$\alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)} = \frac{2.7 - 2.1}{2.1\times(100 - 27.5)} = \frac{0.6}{152.25}$$

$= 3.94 \times 10^{-3}$ or $0.0039\ °C^{-1}$

4. At room temperature 27 °C, the resistance of the heating element.

$R_{27°} = \dfrac{230}{3.2} = 71.875\ \Omega$

At the steady temperature t °C, the resistance.

$R_t = \dfrac{230}{2.8} = 82.143\ \Omega$

Now, $R_2 = R_1[1 + \alpha(t_2 - t_1)]$

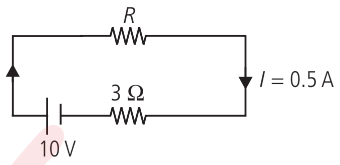
or $82.143 = 71.875[1 + 1.7 \times 10^{-4}(t - 27)]$

or $0.0840 \times 10^4 = t - 27$

or $840 = t - 27$ or $t = 867$ °C.

Topic 3

1. $I = \dfrac{E}{R + r}$



$0.5 = \dfrac{10}{R + 3}$

$R + 3 = 20$

$R = 17\ \Omega$

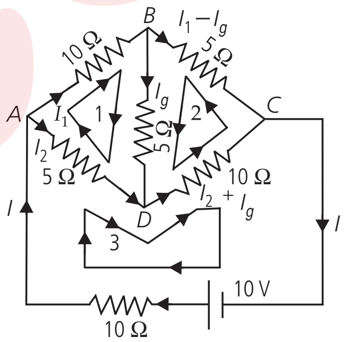
Terminal voltage of the battery

$V = E - Ir$

$V = 10 - 0.5 \times 3 = 8.5$ V

2. Let us first distribute the current in different branches.

Now, equations for different loops using Kirchhoff's IInd law,



Loop 1

$\Sigma E = \Sigma IR$

$10I_1 + 5I_g - 5I_2 = 0$ or $2I_1 + I_g - I_2 = 0$ ...(i)

Loop 2

$\Sigma E = \Sigma IR$

$5I_g + 10[I_2 + I_g] - 5[I_1 - I_g] = 0$

$10I_2 + 20I_g - 5I_1 = 0$ or $2I_2 + 4I_g - I_1 = 0$ ...(ii)

Loop 3

$5I_2 + 10(I_2 + I_g) + 10I = 10$

$15I_2 + 10I_g + 10I = 10$

or $3I_2 + 2I_g + 2I = 2$ ...(iii)

Solving equations (i) and (ii)

$2I_1 + I_g - I_2 = 0$

$[-I_1 + 4I_g + 2I_2 = 0]2$

or $9I_g + 3I_2 = 0$ or $I_2 = -3I_g$ ...(iv)

In the loop *ABCDA*

$10I_1 + 5[I_1 - I_g] - 10[I_2 + I_g] - 5I_2 = 0$

$15I_1 - 15I_2 - 15I_g = 0$ or $I_1 - I_2 - I_g = 0$ ...(v)

Solving equations (ii) and (v)

$$2I_2 + 4I_g - I_1 = 0 \quad \text{or} \quad 2(I_1 - I_2 - I_g = 0)$$

or $2I_g + I_1 = 0$ or $I_1 = -2I_g$ ...(vi)

Now using the result of (iv) and (vi) in equation (iii)

$$3I_2 + 2I_g + 2I = 2$$

$$-3[3I_g] + 2I_g + 2I = 2 \quad \text{or} \quad 2I - 7I_g = 2 \quad \text{...(vii)}$$

Using Kirchhoff's law, $I = I_1 + I_2$

$$I = -5I_g$$

So, equation (vii)

$$2[-5I_g] - 7I_g = 2 \quad \text{or} \quad -17I_g = 2$$

So, finally $I_g = -2/17$ A and $I = \frac{+10}{17}$ A

Also $I_1 = \frac{4}{17}$ A, $I_2 = \frac{6}{17}$ A

Current in branch $AB = \frac{4}{17}$ A

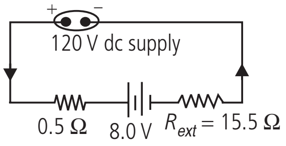
Current in branch $AD = \frac{6}{17}$ A

Current in branch $BD = \frac{-2}{17}$ A

Current in branch $BC = \frac{6}{17}$ A

Current in branch $DC = \frac{4}{17}$ A

3.



During charging, the electric current is sent into the 8.0 V battery. The current in the circuit

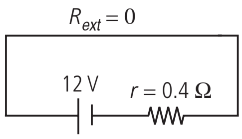
$$I = \frac{E_1 - E_2}{R_{ext} + r} = \frac{120 - 8}{15.5 + 0.5} \quad \text{or} \quad I = \frac{112}{16} = 7\text{ A}$$

Now, terminal voltage of the battery during charging

$$V = E + Ir = 8 + 7(0.5) = 11.5\text{ V}$$

A series resistance is joined in the charging circuit to limit the excessive current so that charging is slow and permanent.

4. The maximum current will be obtained when no external resistance is offered by wire joining the two terminals.



$$I = \frac{E}{R_{ext} + r} \Rightarrow I = \frac{12}{0.4} = 30\text{ A}$$

$(\because R_{ext} = 0)$