10/7/21

Chapter - 3

NCERT EXERCISES

1) $\mathcal{E} = 12\ V$

$r = 0.4\ \Omega$

The current drawn from the battery will be maximum when the external resistance in the circuit is zero.

$R = 0$

$\therefore I_{max} = \frac{\mathcal{E}}{R} = \frac{12}{0.4} = 30\ A$

2) $T = 0.$

$R + r.$

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

$R = \frac{\mathcal{E}}{I} - r = \frac{10}{0.5} - 3 = 17\ \Omega.$

$\therefore$ terminal voltage

$V = IR = 0.5 \times 17 = 8.5\ V.$

3i) $R_s = R_1 + R_2 + R_3 = 6\ \Omega$

ii) Current in the circuit $\Rightarrow I = \frac{\mathcal{E}}{R} = \frac{12}{6} = 2\ A.$

$\therefore$ Potential drops across different resistors are

$V_1 = IR_1 = 2 \times 1 = 2V$

$V_2 = IR_2 = 2 \times 2 = 4V$

$V_3 = IR_3 = 2 \times 3 = 6\ V$

4. i) $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$= \frac{1}{2} + \frac{1}{4} + \frac{1}{5} = \frac{19}{20}$

$\therefore R_p = \frac{20}{19}\ \Omega.$

ii) Currents drawn through diff. resistors are

$I_1 = \frac{\mathcal{E}}{R_1} = \frac{20}{2} = 10\ A$

$I_2 = \frac{\mathcal{E}}{R_2} = \frac{20}{4} = 5\ A$

$I_3 = \frac{\mathcal{E}}{R_3} = \frac{20}{5} = 4\ A$

Total amount drawn from the battery:

$I = I_1 + I_2 + I_3 = 10 + 5 + 4 = 19\ A.$

5) Here, $R_1 = 100\ \Omega$

$R_2 = 117\ \Omega.$

$t_1 = 27^\circ C$

$\alpha = 1.70 \times 10^{-4}\ ^\circ C^{-1}$

As $\alpha = \frac{R_2 - R_1}{R_1(t_2 - t_1)}$

$\therefore t_2 - t_1 = \frac{R_2 - R_1}{R_1 \alpha} = \frac{117 - 100}{100 \times 1.70 \times 10^{-4}} = 1000$

$\therefore t_2 = 1000 + t_1 = 1000 + 27 = 1027^\circ C$.

6) $l = 15 m$.

$A = 6.0 \times 10^{-7} m^2$

$R = 5.0 \Omega$

Resistivity $\rho = \frac{RA}{l} = \frac{5.0 \times 6.0 \times 10^{-7}}{15}$

$= 2.0 \times 10^{-7} \Omega m$

7) Here, $R_1 = 2.1 \Omega$

$t_1 = 27.5^\circ C$

$R_2 = 2.7 \Omega$

$t_2 = 100^\circ C$

temp. coefficient of resistivity of silver

$$\alpha = \frac{R_2 - R_1}{R_1(t_2 - t_1)} = \frac{2.7 - 2.1}{2.1(100 - 27.5)}$$

$$= \frac{0.6}{2.1 \times 72.5}$$

$= 0.00394^\circ C^{-1}$

8) Here, $V = 230\ V$

$I_1 = 3.2\ A$

$I_2 = 2.8\ A$,

$\alpha = 1.70 \times 10^{-4}\ °C^{-1}$

Resistance at room temp

$$R_1 = \frac{V}{I_1} = \frac{230}{3.2} = 71.875\ \Omega$$

Resistance at steady temp.

$$R_2 = \frac{V}{I_2} = \frac{230}{2.8} = 82.143\ \Omega$$

Now, $\alpha = \frac{R_2 - R_1}{R_1(t_2 - t_1)}$

$$\therefore t_2 - t_1 = \frac{R_2 - R_1}{R_1 \alpha}$$

$$= \frac{82.143 - 71.875}{71.875 \times 1.70 \times 10^{-4}} = \frac{10.268 \times 10^4}{71.875 \times 17}$$

$$= 840.35°C$$

∴ Steady temp. of element.

$t_2 = 840.35 + 27$

$= 867.35°C$.

9) let I, I_1, I_2, I_3 be the currents as shown in the below figure we apply kirchoff's second rule to different rules.

for loop ABDA,

$$10I_2 + 5I_3 - 5I_2 = 0$$

for loop BCDB,

$$5(I_2 - I_3) - 10(I_2 + I_3) - 5I_3 = 0$$

for loop ADCPGA,

$$5I_2 + 10(I_2 + I_3) + 10(I_1 + I_2) = 10$$

$$10I_1 - 5I_2 + 5I_3 = 0 \quad -(1)$$

$$5I_1 - 10I_2 - 20I_3 = 0 \quad -(2)$$

$$10I_1 + 25I_2 + 10I_3 = 10 \quad -(3)$$

Solving equations (1), (2) & (3), we get

$$I_1 = \frac{4}{17} A, \quad I_2 = \frac{6}{17} A, \quad I_3 = \frac{-2}{17} A.$$

Currents in different branches are

$$I_{AB} = I_1 = \frac{4}{17} A. \quad I_{BC} = I_1 - I_3 = \frac{6}{17} A$$

$$I_{BC} = I_2 + I_3 = \frac{4}{17} A, \quad I_{AD} = I_2 = \frac{6}{17} A.$$

$$I_{BD} = I_3 = \frac{-2}{17} A$$

Total current,

$$I = I_1 + I_2 = \frac{10}{17} A$$

11) When the storage battery of 8.0 V is charged with a dc supply of 120 V, the net emf in the circuit will be

$\mathcal{E}' = 120 - 8.0 = 112$ V.

Current in the circuit during charging

$$I = \frac{\mathcal{E}'}{R + r} = \frac{112}{15.5 + 0.5} = 7\text{ A}$$

The terminal voltage of battery during Charging
$V = \mathcal{E} + Ir = 8 + 7 \times 0.5 = 11.5$ V.

12) Here, $\mathcal{E}_1 = 1.25$ V
$l_1 = 35.6$ cm
$l_2 = 63.0$ cm
$\mathcal{E}_2 = ?$

$$\frac{\mathcal{E}_2}{\mathcal{E}_1} = \frac{a_2}{a_1} = \frac{l_2}{l_1}$$

$$\therefore \mathcal{E}_2 = \frac{l_2}{l_1} \times \mathcal{E}_1 = \frac{63 \times 1.25}{35} = 2.25\text{ V}.$$

13) Drift speed,

$$v_A = \frac{I}{enA}$$

$$= \frac{3}{1.6 \times 10^{-19} \times 8.5 \times 10^{28} \times 2 \times 10^{-6}}\ \text{m/s}$$

$$= \frac{3}{16 \times 3.5 \times 2 \times 10}\ \text{m/s} = 1.1 \times 10^{-4}\ \text{m/s}$$

Required time

$$t = \frac{\pi}{4A}$$

$$= \frac{3}{1.1 \times 10^{-4}} \text{ s} = 2.73 \times 10^{4} \text{ s} \simeq 7.57 \text{ h}$$