14.7.21

NCERT EXERCISES

Current Electricity

3.1) $E = 12V$

$r = 0.4\,\Omega$

$I_{max} = \frac{E}{r} = \cancel{\frac{12}{0.3}}\ \frac{12}{0.4} = 30\,A$

3.2) $E = 10V$

$r = 3\,\Omega$

$I = 0.5\,A$

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

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

$\Rightarrow R = \frac{10V}{0.5A} - 3\,\Omega$

$\Rightarrow R = 20 - 3 = 17\,\Omega$

Terminal Voltage, $V = E - Ir$

$= 10 - 0.5(3)$

$= 10 - 1.5 = 8.5\,V$

3.3) a) $R_1 = 1\,\Omega$ $\quad R_2 = 2\,\Omega$ $\quad R_3 = 3\,\Omega$

$R_{eq} = R_1 + R_2 + R_3 = 1 + 2 + 3 = 6\,\Omega$

b) Emf, $E = 12V$

$I = \frac{E}{R_{eq}} = \frac{12}{6} = 2A$

Potential drop across each resistor is :-

$V_1 = IR_1 = 2 \times 1 = 2V$
$V_2 = IR_2 = 2 \times 2 = 4V$
$V_3 = IR_3 = 2 \times 3 = 6V$

3.4) a) $R_1 = 2\Omega$ $R_2 = 4\Omega$ $R_3 = 5\Omega$

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$= \frac{1}{2} + \frac{1}{4} + \frac{1}{5} = \frac{10+5+4}{20} = \frac{19}{20}$

$R_{eq} = \frac{20}{19}\Omega$

b) Emf, $E = 20V$

$I_{total} = \frac{E}{R_{eq}} = \frac{20}{\frac{20}{19}} = 19A$

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

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

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

3.5) $T_0 = 27°C$ $T = ?$
$R_{T_0} = 100\Omega$ $R_T = 117\Omega$
$\alpha = 1.70 \times 10^{-4} °C^{-1}$

Date
Page

$R = R_0 [1 + \alpha (T - T_0)]$

$\Rightarrow 1.17\,\Omega = 100\,\Omega (1 + 1.70 \times 10^{-4}\ {}^\circ C^{-1} (T - 27^\circ C))$

$\Rightarrow 1.17\,\Omega = 1 + 1.70 \times 10^{-4}\ {}^\circ C^{-1} (T - 27^\circ C)$

$\Rightarrow 0.17 = 1.70 \times 10^{-4}\ {}^\circ C^{-1} (T - 27^\circ C)$

$\Rightarrow \dfrac{0.17}{1.70 \times 10^{-4}\ {}^\circ C^{-1}} = T - 27^\circ C$

$\Rightarrow \dfrac{1}{10^{-3}\ {}^\circ C^{-1}} = T - 27^\circ C$

$\Rightarrow 10^3\ {}^\circ C = T - 27^\circ C \Rightarrow 1000 + 27 = T \Rightarrow T = 1027^\circ C$

3.6) $l = 15 m$ $\quad I \approx 0$
$A = 6.0 \times 10^{-7} m^2$
$R = 5\,\Omega$

We know that, $R = \dfrac{\rho l}{A}$

$\Rightarrow \rho = \dfrac{RA}{l} = \dfrac{5 \times 6 \times 10^{-7}}{15} = 2 \times 10^{-7}\,\Omega m$

3.7) $R_0 = 2.1\,\Omega$ $\quad T_0 = 27.5^\circ C$
$R_T = 2.7\,\Omega$ $\quad T = 100^\circ C$
$\alpha = ?$

We know that, $R_T = R_0 (1 + \alpha (T - T_0))$

Date ______
Page ______

$\Rightarrow 2.7\,\Omega = 2.1\,\Omega\,(1 + \alpha\,(100 - 27.5)\,^\circ C)$

$\Rightarrow \frac{2.7}{2.1} = 1 + \alpha \times 72.5$

$\Rightarrow \frac{2.7}{2.1} - 1 = \alpha \times 72.5$

$\Rightarrow \frac{2.7 - 2.1}{2.1 \times 72.5\,^\circ C} = \alpha$ $\Rightarrow \alpha = \frac{\overset{0.2}{\cancel{0.6}}}{\underset{0.7}{\cancel{2.1}} \times 72.5\,^\circ C} = \frac{2 \times 10^{-1}}{7 \times 10^{-1} \times 725 \times 10^{-1}\,^\circ C}$

$= \frac{2 \times \cancel{10}}{\cancel{7 \times 725}} = \frac{\cancel{4}}{\cancel{1015}}$
$\qquad 145 \qquad 253.75\,^\circ C$

$= \frac{1}{253.75\,^\circ C}$

$= \frac{100}{25375\,^\circ C} = 0.0039\,^\circ C^{-1}$

So, $\alpha = 0.0039\,^\circ C^{-1}$

3.8) $V = 230\,V$ $\qquad T_0 = 27^\circ C$ $\qquad \alpha = 1.7 \times 10^{-4}\,^\circ C^{-1}$

$I_0 = 3.2\,A$

$R_0 = \frac{V}{I_0} = \frac{230}{3.2} = \frac{2300}{32} = 71.87\,\Omega$

$I_T = 2.8\,A$

$R_T = \frac{230}{2.8} = \frac{2300}{28} = 82.14$

$R_T = R_0\,(1 + \alpha\,(T - T_0))$

$\Rightarrow 82.14 = 71.87\,(1 + 1.7 \times 10^{-4}\,(T - 27))$

$$\frac{82.14}{71.87} - 1 = 1.7 \times 10^{-4}\ °C^{-1}\ (T - 27°C)$$

$$\frac{1.1428 - 1}{1.7 \times 10^{-4}} = T - 27$$

$$\Rightarrow \frac{0.1428}{1.7 \times 10^{-4}} = T - 27$$

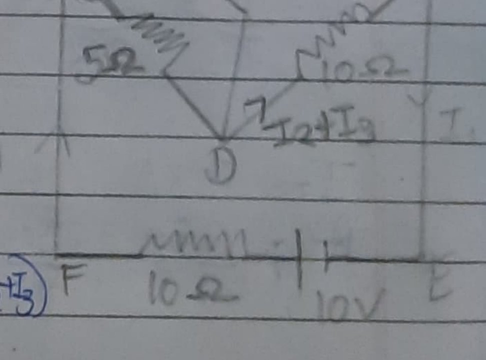
$$\Rightarrow \frac{0.1428 \times 10^{5}}{17} = T - 27$$

$$\Rightarrow \frac{1428 \times 10}{17} = T - 27$$

$$\Rightarrow 84 \times 10 + 27 = T \Rightarrow T = 840 + 27 = 867°C$$

~~⇒ T = 840 + 27 = 850°C~~

3.9) By applying Kirchhoff's loop law :-



i) in ABDA ⇒ $0 = 10(I_1 - I_2) + 5(I_3) - 5(I_2)$

$\Rightarrow 2I_1 - 2I_2 + I_3 - I_2 = 0$

$\Rightarrow 2I_1 - 3I_2 + I_3 = 0$ — (i)

ii) in BCDB ⇒ $0 = 5(I_1 - I_2 - I_3) - 5I_3 - 10(I_2 + I_3)$

$\Rightarrow I_1 - I_2 - I_3 - I_3 - 2I_2 - 2I_3 = 0$

$\Rightarrow I_1 - 3I_2 - 4I_3 = 0$ — (ii)

iii) in ABCEFA $\Rightarrow 10 = 10I_1 + 10(I_1 - I_2) + 5(I_1 - I_2 - I_3)$

$\Rightarrow 2 = 2I_1 + 2I_1 - 2I_2 + I_1 - I_2 - I_3$

$\Rightarrow 5I_1 - 3I_2 - I_3 = 2 \quad \text{— (iii)}$

Subtracting (ii) from (i)

$2I_1 - 3I_2 + I_3 - I_1 + 3I_2 + 4I_3 = 0 - 0$

$= I_1 + 5I_3 = 0 \quad \text{— (iv)}$

Now, (ii) from (iii), $\Rightarrow$

$$\begin{aligned} 5I_1 - 3I_2 - I_3 &= 2 \\ -I_1 + 3I_2 + 4I_3 &= 0 \\ \hline 4I_1 + 3I_3 &= 2 \end{aligned}$$

$$\cancel{\begin{aligned} 4I_1 - 6I_2 - I_3 &= 2 \\ -2I_1 + 6I_2 + 8I_3 &= 0 \\ \hline 9I_1 + 7I_3 &= 2 \end{aligned}}$$

$\Rightarrow 4I_1 + 3I_3 = 2$

$\Rightarrow \cancel{8I_1 + I_3 = 0} \quad \text{— (v)}$

$\Rightarrow \cancel{9I_1 + 3I_3 = 2} \quad \text{— (v)}$

Now subtracting (v) from 4(iv),

$$\cancel{\begin{aligned} 9I_1 + 45I_3 &= 0 \\ -9I_1 - 7I_3 &= -2 \\ \hline 42I_3 &= -2 \end{aligned}}$$

$\Rightarrow \cancel{I_3 = \frac{-2}{42} = \frac{-1}{21}}$

$$\begin{aligned} 4I_1 + 20I_3 &= 0 \\ -4I_1 - 3I_3 &= 2 \\ \hline 17I_3 &= -2 \end{aligned}$$

$\Rightarrow \boxed{I_3 = \frac{-2}{17}\ A}$

Date
Page

Putting the value of I_3 in (iv) :-

$I_1 + 5I_3 = 0$

$\Rightarrow I_1 = -5I_3 = -5\left(\frac{-2}{17}\right) = \frac{10}{17}$

$\Rightarrow \boxed{I_1 = \frac{10}{17} A}$

Putting the values of I_1 & I_{III} in (i)

$2I_1 - 3I_2 + I_3 = 0$

$\Rightarrow 3I_2 = 2I_1 + I_3 = 2\left(\frac{10}{17}\right) + \left(\frac{-2}{17}\right) = \frac{20}{17} - \frac{2}{17} = \frac{18}{17}$

$\Rightarrow I_2 = \frac{\cancel{18}}{17 \times \cancel{3}} = \frac{6}{17} A$

$\Rightarrow \boxed{I_2 = \frac{6}{17} A}$

Current flowing through :-

i) $AB = I_1 - I_2 = \frac{10}{17} - \frac{6}{17} = \frac{4}{17} A$

ii) $AD = I_2 = \frac{6}{17} A$

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

Total Current $= \cancel{AB + AD} \; I_1 = \frac{10}{17} A$

iv) $BC = I_1 - I_2 - I_3 = \frac{10}{17} - \frac{6}{17} - \left(\frac{-2}{17}\right) = \frac{6}{17} A$

v) $DC = I_2 + I_3 = \frac{6}{17} + \left(\frac{-2}{17}\right) = \frac{4}{17} A$

Date ______
Page ______

a) 3.10 $l = 39.5\,cm$
$Y = 12.5\,\Omega$

$$\frac{X}{Y} = \frac{l}{100-l}$$

$$\Rightarrow \frac{X}{12.5} = \frac{39.5}{100-39.5} \Rightarrow x = \frac{39.5 \times 12.5}{60.5} = 8.16\,\Omega$$

Connections are made ~~of~~ by thick copper strips to minimise the resistances of connections which are not counted in the above formula.

b) If $X \Leftrightarrow Y$, then $X = 12.5\,\Omega$, $Y = 8.16\,\Omega$

$$\frac{X}{Y} = \frac{l}{100-l}$$

$$\Rightarrow \frac{12.5}{8.16} = \frac{l}{100-l} \Rightarrow 1.53 = \frac{l}{100-l}$$

$$\Rightarrow 1.53(100-l) = l \Rightarrow 153 - 1.53l = l$$

$$\Rightarrow l + 1.53l = 153$$

$$\Rightarrow l(1+1.53) = 153$$

$$\Rightarrow l = \frac{153}{2.53} = 60.47 \approx 60.5\,cm$$

Balance point $= 60.5\,cm$ from A

c) When the galvanometer & cell are interchanged at the balance point, the conditions of the balanced bridge are still satisfied, so again galvanometer will not show any current.

3.11) Emf $= 8V$

$r = 0.5\Omega$

$V = 120V$

$R = 15.5\Omega$

$$i = \frac{E_{net}}{R_{eq}} = \frac{120-8}{15.5+0.5} = \frac{112}{16} = 7A$$

$$V = E + ir = 8 + 7(0.5) = 8 + 3.5 = 11.5V$$

The series resistor limits the current drawn from the ext. source. In its absence, the current will be extremely high.

3.12) $E_1 = 1.25V$ $\quad$ $E_2 = ?$

$l_1 = 35cm$ $\quad$ $l_2 = 63cm$

We know that, $\frac{E_1}{E_2} = \frac{l_1}{l_2}$

$$\Rightarrow \frac{1.25}{E_2} = \frac{35}{63}$$

$$\Rightarrow E_2 = \frac{\cancel{1.25}^{0.25} \times \cancel{63}^{9}}{\cancel{35}_{7}} = 2.25V$$

3.13) $n = 8.5 \times 10^{28} m^{-3}$ $\quad$ $I = 3A$

$l = 3m$ $\quad$ $e = 1.6 \times 10^{-19}C$

$A = 2 \times 10^{-6} m^2$

We know that, $I = enAV_d \Rightarrow V_d = \frac{I}{enA}$

$$\Rightarrow V_d = \frac{3}{1.6\times10^{-19} \times 8.5\times10^{28} \times 2\times10^{-6}} = \frac{3}{1.6\times8.5\times2\times10^{3}}$$

$$= \frac{3}{27.2\times10^{3}}$$

$$= \frac{3}{272\times10^{2}}\ m/s \cancel{= 0.011\times10^{-2}}$$

$$\cancel{= 1.1\times10^{-4}}$$

$$T = \frac{l}{V_d} = \frac{3}{\frac{3}{272\times10^{2}}} = 272\times10^{2}$$

$$= 2.72\times10^{4}\ \text{sec} \simeq 7.5\ \text{hour.}$$