NCERT EXERCISES

3.1) Here $\varepsilon = 12V$

$r = 0.4\Omega$

The current drawn from the battery will be maximum when the external resistance in the circuit is zero i.e, $R = 0$.

$$\therefore I_{max} = \frac{\varepsilon}{r} = \frac{12}{0.4}$$

$$= 30\ A.$$

3.2) As $I = \frac{\varepsilon}{R+r}$

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

$\therefore R = \frac{\varepsilon}{I} - r = \frac{10}{0.5} - 3 = 17\ \Omega$

Terminal voltage,

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

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

ii) Current in the circuit, $I = \frac{\varepsilon}{R} = \frac{12}{6} = 2A.$

$\therefore$ Potential drops across different resistors are

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

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

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

3.4) 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 different resistors are

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

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

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

Total current drawn from the battery.

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

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

$R_2 = 117\,\Omega$

$t_1 = 27°C$

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

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

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

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

3.6) Here, $l = 15$ m

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

$R = 5.0\,\Omega$

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

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

3.7) Here, $R_1 = 2.1\,\Omega$

$t_1 = 27.5°C$

$R_2 = 2.7\,\Omega$

$t_2 = 100°C$.

Temperature coefficient of resistivity of silver

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

$$= \frac{2.7 - 2.1}{2.1(100 - 27.5)}$$

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

$$= 0.003944 \, ^\circ C^{-1}.$$

3.8) Here, $V = 230$ V

$I_1 = 3.2$ A

$I_2 = 2.8$ A

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

Resistance at room temperature,

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

Resistance at steady temperature

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

Now,

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

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

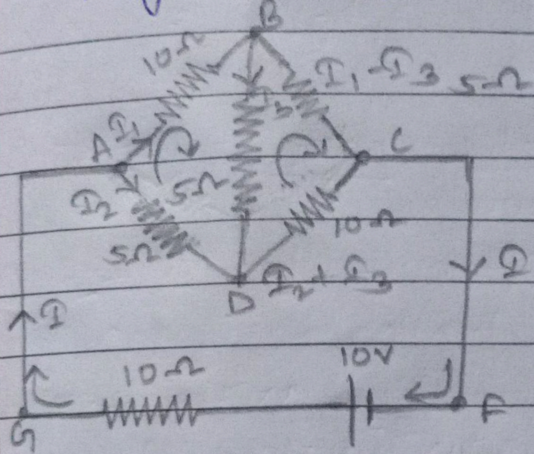
$= \frac{82.143 - 71.875}{71.875 \times 1.70 \times 10^{-4}}$.

$= \frac{10.268 \times 10^4}{71.875 \times 1.7} = 840.35^\circ C$.

$\therefore$ steady temperature of element

$t_2 = 840.35 + 27$
$= 867.35^\circ C$.

29) Let I, I_1, I_2, I_3 be the currents as shown in the below figure we apply Kirchhoff'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 ADCFGA,

$5I_2 + 10(I_2 + I_3) + 10(I_1 + I_2) = 10$ $(\because I_1 + I_2 = I)$

$10I_1 - 5I_2 + 5I_3 = 0$ —— (1)

$5I_1 - 10I_2 - 20I_3 = 0$ —— (2)

$10I_1 + 25I_2 + 10I_3 = 0$ —— (3)

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

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

Currents in different branches are

$I_{AB} = I_1 = \frac{4}{17}$ A

$I_{BC} = I_1 - I_3 = \frac{6}{17}$ A

$I_{DC} = I_2 + I_3 = \frac{4}{17}$ A

$I_{AD} = I_2 = \frac{6}{17}$ A.

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

Total current,

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

3.10) i) Here, $l = 35.9$ cm

$R = X = ?$.

$S = Y = 12.5\,\Omega$

As $S = \frac{100 - l}{l} \times R$

$\therefore 12.5 = \frac{100 - 39.5}{39.5} \times R$.

$R = \frac{12.5 \times 39.5}{60.5} = 8.16\,\Omega$

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

(i) When X and Y are interchanged,

$R = Y = 12.5\,\Omega$

$S = X = 8.16\,\Omega$

$l = ?$

As $S = \frac{100-l}{l} \times R$

$\therefore 8.16 = \frac{100-l}{l} \times 12.5$

$8.16\,l = 1250 - 12.5\,l$

$l = \frac{1250}{20.66} = 60.5\,\Omega$ from the end A.

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

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

$e' = 120 - 8.0 = 112\,V$.

Current in the circuit during charging

$I = \frac{e'}{R+r} = \frac{112}{15.5+0.5} = 7\,A$.

The terminal voltage of the battery during charging.

$V = e + Ir = 8.0 + 7 \times 0.5 = 11.5\,V$.

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

3.12) Here, $\varepsilon_1 = 1.25\,V$

$l_1 = 35.0\,cm$

$l_2 = 63.0\,cm$

$\varepsilon_2 = ?$

As $\frac{\varepsilon_2}{\varepsilon_1} = \frac{l_2}{l_1}$

$\therefore \varepsilon_2 = \frac{l_2}{l_1} \times \varepsilon_1 = \frac{63 \times 1.25}{35} = 2.25\,V$

3.13) Here,

$n = 8.5 \times 10^{28}\,m^{-3}$

$l = 3\,m$

$A = 2.0 \times 10^{-6}\,m^2$

$e = 1.6 \times 10^{-19}\,C$

$I = 3.0\,A$

Drift speed,

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

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

$= \frac{3}{16 \times 85 \times 2 \times 10}\,m/s = 1.1 \times 10^{-4}\,m/s.$

Required time,

$$t = \frac{l}{v_d}$$

$$= \frac{3}{1.1 \times 10^{-4}} \ s$$

$$= 2.73 \times 10^{4} \ s \simeq 7.57 \ h.$$