H.W

Ch-3 - Current Electricity

3.1) emf = 12 V $r = 0.4\,\Omega$ $I_{max} = \frac{\varepsilon}{r} = \frac{12}{0.4} = 30A$

3.2) emf = 10 V, $r = 3\,\Omega$, $I = 0.5A$

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

Terminal voltage = $V = IR = \frac{5}{10} \times 17 = 8.5V$

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

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

ii) emf (ε) = 12 V, $V_1 = IR_1 = 2 \times 1 = 2V$

Current $= \frac{V}{R_{eq}} = \frac{12}{6} = 2I$ $V_2 = 2 \times 2 = 4V$

$V_3 = 2 \times 3 = 6V$

3.4) i) $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{2} + \frac{1}{4} + \frac{1}{5} = \frac{10+5+4}{20} = \frac{19}{20}$

$R_p = \frac{20}{19}\,\Omega$

ii) Emf = 20 V, $I_1 = \frac{\varepsilon}{R_1} = \frac{20}{2} = 10A$

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

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

Total current $= I_1 + I_2 + I_3 = 10 + 5 + 4 = 19A$

3.5) $R_1 = 100\,\Omega$, $R_2 = 117\,\Omega$ $t_1 = 27°c$ $\alpha = 1.7 \times 10^{-4}$ c

$\alpha = \frac{R_2 - R_1}{R_1(t_2 - t_1)}$ $t_2 - t_2 = \frac{R_2 - R_1}{R_1 \alpha} = \frac{17 \times 10}{10^4 \times 17 \times 10^{-4}}$

$= 10^3 = 1000$

$t_2 = 1000 + 27$

$= 1027°c$

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3.6) $l = 15\,m$, $A = 6 \times 10^{-7} m^2$, $R = 5\,\Omega$

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

3.7) $R_1 = 21\,\Omega$, $t_1 = 27.5°C$
$R_2 = 27\,\Omega$, $t_2 = 100°C$

$$\alpha = \frac{R_2 - R_1}{R_1(t_2 - t_1)} = \frac{0.6}{21(72.52)}$$

$$= \frac{6}{2(72.52)} = 0.00394\,°C^{-1}$$

3.8) $V = 230\,V$, $I_1 = 3.2\,A$, $I_2 = 2.8\,A$
$\alpha = 1.70 \times 10^{-4}\,C^{-}$

$V = I_1 R_1$

$$R_1 = \frac{2300}{32} = 71.575\,\Omega$$

$$R_2 = \frac{V}{I_2} = \frac{2300}{28} = 82.143\,\Omega$$

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

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

$\therefore t_2 = 840.35 + 27$
$= 867.35\,°C$

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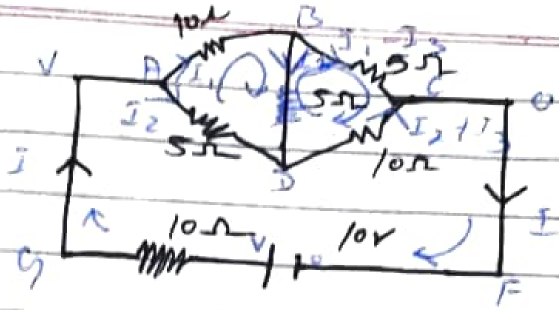
3.9)



In loop ABDA :-

$10I_1 + 5I_3 - 5I_2 = 0$

In loop BCDB :-

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

In ADCEGA :-

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

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

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

$10I_1 - 5I_2 + 5I_3 = 0$ — (i)

$5I_1 - 10I_2 - 20I_3 = 0$ — (ii)

$10I_1 + 25I_2 + 10I_3 = 10$ — (iii)

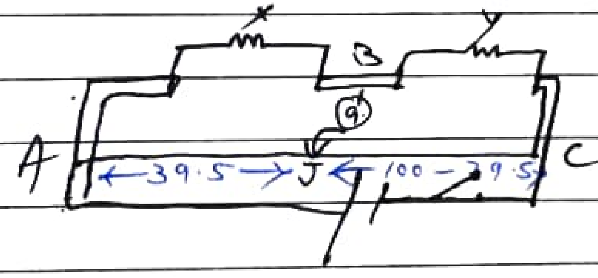
$I_{AB} = I_1 = \frac{4}{17}$ A

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

$I_{3C} = \frac{4}{17}$ A $I_{AD} = \frac{5}{17}$ A $I_{BD} = \frac{-2}{17}$ A

Total amount $= \frac{10}{17}$ A

3.10)



i) $l = 39.5$ cm , $R_y = 12.5\,\Omega$

$\frac{R_x}{39.5} = \frac{12.5}{(100 - 39.5)}$ $R_x = \frac{12.5 \times 39.5}{60.5} = 8.16\,\Omega$

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ii) $R = Y = 12.5\,\Omega$ $S = X = 8.16$

$$\frac{12.5}{l} = \frac{8.16}{100 - l} \Rightarrow 1250 - 12.5l = 8.16l$$
$$\Rightarrow 12.5l + 8.16l = 1250$$
$$\Rightarrow l = \frac{1250}{20.66} = 60.5\,\Omega$$

iii) Then the conditions of the balanced bridge still remains satisfied and again the galvanometer will not show any current.

11.) $Emf(\mathcal{E}) = 8V$, $r = 0.5\,\Omega$, $V = \mathcal{E} + Ir$, $R = 15.5\,\Omega$

$\mathcal{E}'_{net} = 120 - 8.0 = 112\,V$

$$I = \frac{\mathcal{E}'}{R + r} = \frac{112}{15.5 + 0.5} = \frac{112}{16} = 7A$$

$$V = \mathcal{E} + Ir = 8 + 7 \times \frac{5}{10} = 8 + 3.5 = 11.5V$$

12.) $emf_1 = 1.25\,V$ $l_1 = 35$ $l_2 = 63\,cm$

$Emf_2 =$

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

$$\mathcal{E}_2 = \frac{l_2}{l_1} \times \mathcal{E}_1 = \frac{63}{35} \times \frac{125}{100} = 2.25V$$

13.) $n = 8.5 \times 10^{28} m^{-3}$, $l = 3m$, $a = 2 \times 10^{-6} m^2$

$I = 3A$

$I = V_d enA$ $$V_d = \frac{I}{enA} = \frac{3 \times 10^{-28} \times 10^{19}}{1.6 \times 8.5 \times 2 \times 10^{-6}} = 1.1 \times 10^{-4} ms^{-1}$$

$$t = \frac{l}{V_d} = \frac{3 \times 10^4}{1.1} = 2.73 \times 10^4 s$$
$$= 7.57\,hr$$

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14.) $\sigma = 10^{-9}\,cm^{-2}$, $V = 400\,kV$, $I = 1800\,A$

$R = 6.37 \times 10^{6}\,m$

Charge (q) = Surface area $\times \sigma = 4\pi R^2 \sigma$

$= 4 \times 3.14 \times (6.37 \times 10^6) \times 10^{-9}$

$= 509.65 \times 10^{3}\,C$

$t = \frac{q}{I} = \frac{509 \times 10^3}{1800} = 509.65 \times 10^3\,C$

$= 283\,sec$

15.) a) emf $= 2V$, $n = 6$, $r = 0.015\,\Omega$, $R = 8.5\,\Omega$

$I = \frac{n\varepsilon}{R + rn} = \frac{6 \times 2}{8.5 + 6 \times 0.015} = \frac{12}{8.59} = 1.4A$

$V = 1.4 \times 8.5$

$= 11.9$

b) emf $= 1.9V$, $r = 380\,\Omega$

$I = \frac{1.9}{380} = \frac{19}{3800} = 0.005\,A$

16.) R •——l——• Al

R •————• Cu

$\rho_{Al} = 2.63 \times 10^{-6}\,\Omega m$ $\qquad$ $\rho_{Cu} = 1.72 \times 10^{-8}\,\Omega m$

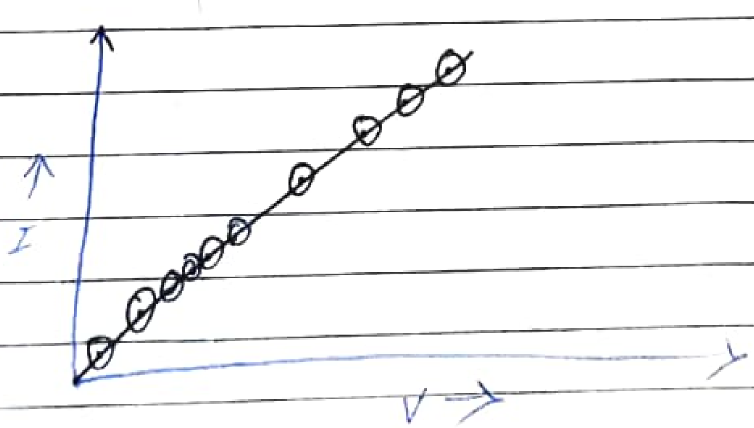
$RD_{Al} = 2.7$ $\qquad$ $R.D = 8.9$

mass = vol × density $\qquad$ $\frac{m_{Cu}}{m_{Al}} = \frac{\rho_{Cu} d_{Cu}}{\rho_{Al} d_{Al}} = \frac{1.72 \times 10^{-8} \times 8.9}{2.63 \times 10^{-8} \times 2.7} = 2.2$

$= Al \times d$

$R = \frac{\rho l}{A}$ $\qquad$ $\frac{\rho l}{A}\, ld = \frac{\rho l d}{R}$

17.)



18.) a) only current is constant, other quantity vary inversely with the area of cross section.

b) No, non-ohmic conductor like, semiconductor diode, vaccume diode.

c) $I_{max} = \frac{\varepsilon}{r}$, $I \propto \frac{1}{r}$ So, I_{max} is large if r is small.

d) If the internal resistance is not very high, then the current will exceed the safety limit in case the circuit is short - circuited accidentally.

19.) a) greater

b) lower

c) nearly independent of

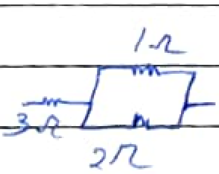
d) 10^{22}

20.) a) For max effective - resistance all the n resistors must be connected in series $R_s = nR$
For minimum effective resistors all n Resistors must be connected in parallel

$$\frac{1}{R_P} = \frac{1}{R} + \frac{1}{R} + \cdots + n = \frac{n}{R}$$

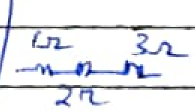
$$R_P = R/n$$

$$\text{Ratio} = \frac{nR}{R} \times n = n^2 : 1$$

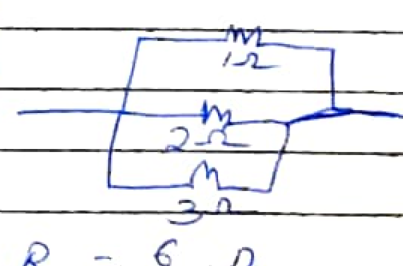
b)


$R = \frac{11}{3}\ \Omega$

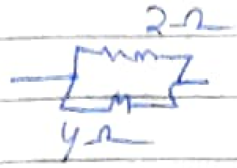
$R = \frac{11}{5}\ \Omega$



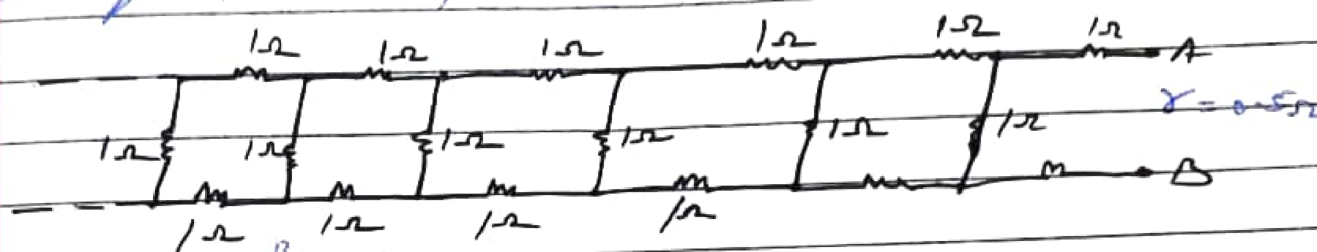
$R = 6\ \Omega$

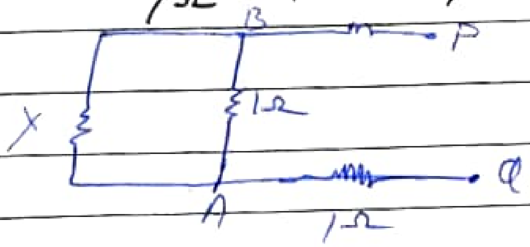


$R = \frac{6}{11}\ \Omega$

c)  $R = \frac{4}{3}\ \Omega \rightarrow R = 4 \times \frac{4}{3} = \frac{16}{3}\ \Omega$

d) equivalence Resistance R : $E_{eq} = 5R$

21.) 



Resistance between P and Q

$x = 1 + \frac{1 \times x}{1+x} + 1 = \frac{2+x}{x+1}$

$x^2 + x = 2x + 2 + x$

$x^2 - 2x - 2 = 0$

$x = 1 + \sqrt{3}$

$x = 2.732\ \Omega$

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

$= \frac{12}{2.732 + 0.5} = 3.713\text{A}$

22.) a) $\varepsilon_1 = 1.02\text{V}$, $V = 2\text{V}$, $r = 0.4\ \Omega$, $l_1 = 67.3\text{cm}$

$l_2 = 82.3\text{cm}$

$\varepsilon_2 - \varepsilon$ $\quad \frac{\varepsilon}{1.02} = \frac{82.3}{67.3}$ $\quad \varepsilon = \frac{823}{673} \times \frac{102}{100} = 1.25\text{V}$

b) Protects the glanometer for position far away from the balance point by decreasing current through it.

c) No balance point is not affected, as no current flows through the standard cell at the balance point.

d) Yes, it changes the potential gradient and affects the balance point.

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e) No, if $\mathcal{E}_0 >$ emf there will be no balanced point on the wire AB.

f) unsuitable, because the balance point will be very close to the end A and the % error measured is very large. Modified by putting R in series so that V_{drop} is slightly greater than the emf measured.

23) $R = 10\,\Omega$, $l_1 = 58.3$ cm , x $l_2 = 68.5$ cm

$$\frac{\mathcal{E}_2}{\mathcal{E}_1} = \frac{l_2}{l_1} \cdot \frac{x}{R} = \frac{l_2}{l_1} \quad x = \frac{l_2}{l_1} \times R = \frac{68.5 \times 10}{58.3} = 11.75\,\Omega$$

We should reduce current in the outside circuit suitably by putting a series resistor.

24) $r = ?$, $V = 1.5$ V , $l_1 = 76.3$ cm , $l_2 = 64.8$
$R = 9.5\,\Omega$

$$r = R\left(\frac{l_1 - l_2}{l_2}\right) = \left(\frac{76.3 - 64.8}{64.8}\right) \times \frac{95}{10} = \frac{9.5 \times 11.5}{64.8}$$

$$= 1.7\,\Omega$$