Solutions - 6

FORMULAE

Chap 17

$$R = \frac{V}{I}$$

$$R = \frac{\rho l}{A} \qquad \rho = \rho_0(1 + \alpha T)$$

$$R = R_0[1 + \alpha T]$$

$$P = I^2 R = \frac{V^2}{R}$$

Chap 18

Kirchhoff Rules

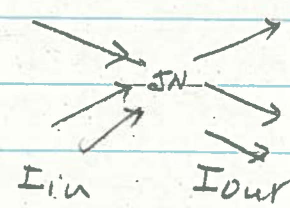
Loop Rule: Potl. at any pt. is unique so

$$\sum_{Loop} \Delta V = 0$$

Total change of potential in a loop is zero.

Junction Rule: Current is flux of charge, charge is conserved hence

$$\sum I_{out} = \sum I_{in}$$



Resistors in series, I common, V's ADD

$$R_s = \sum R_i$$

Resistor is Parallel, V common, I's ADD

$$\frac{1}{R_p} = \sum \frac{1}{R_i}$$

CHAPTER 17

Problem 21.

$T_1 = 58^\circ C$ $\quad T_2 = -88^\circ C$ $\quad \alpha = 3.9 \times 10^{-3}\ {}^\circ C^{-1}$

$I_1 = 1\ A.$ $\quad I_2 = ?$

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

$\frac{V}{I_1} = R_1 \qquad \frac{V}{I_2} = R_2.$

$\therefore \frac{R_1}{R_2} = \frac{I_2}{I_1}.$

$$\therefore I_2 = I_1 \frac{R_0(1+\alpha(T_1 - T_0))}{R_0(1+\alpha(T_2 - T_0))} = \frac{1 + 3.9\times10^{-3}(58-(-88))}{1 + 3.9\times10^{-3}(-88-(-88))}$$

$\therefore I_2 = 1.5894\ A.$

Problem 29.

a) $$R = \frac{\rho l}{A} = \frac{9.4\times10^{-7}\times 1}{\pi \times \left(\frac{1\times10^{-3}}{2}\right)^2} = \frac{9.4\times10^{-7}}{\pi \times 0.25\times10^{-6}} \approx 1.2\ \Omega.$$

b) $$\Delta R = \frac{\rho \Delta l}{A} = \frac{9.4\times10^{-7}\times 4\times10^{-4}}{\pi \times \left(\frac{1\times10^{-3}}{2}\right)^2} = 4.79\times10^{-4}\ \Omega.$$

Problem 33.

For a single Resistor $R = \frac{V^2}{P} = \frac{120^2}{100} = 144\ \Omega.$

If n are connected in parallel, effective resistance

$= \frac{R}{n}.$

And if current I passes through each,

$$\therefore I = \frac{V}{R} = \frac{120}{144} = 0.83$$

$\therefore$ Total current $= nI = n(0.83) < 15$.

$\therefore n < 17.85$

$\therefore$ Atmost 17 bulbs.

Problem 39.

$\frac{P}{l} = 2.00 \, W/m$.

But $P = I^2 R = I^2\left(\frac{\rho l}{A}\right) = \frac{I^2 \rho l}{\pi r^2}$.

$\therefore r = \sqrt{\frac{I^2 \rho}{\pi (P/l)}} = \sqrt{\frac{9\times10^4 \times 1.7\times10^{-8}}{3.14 \times 2}} = 1.58 \times 10^{-4} \, m$.

Problem 45

$E_{eff} = 100\times11 = 1100 \, kWh$.

$E_{con} = 100\times40 = 4000 \, kWh$.

$\therefore E_{con} - E_{eff} = 2900 \, kWh$.

$\therefore$ Money Saved $= \$232$.

Problem 52.

$r = 1.1 \, cm = 0.011 \, m$. $\quad l = 0.04 \, m$

$I = 50 \, A$.

$V = IR = \frac{I \rho l}{A} = \frac{50 \times 1.7\times10^{-8} \times 0.04}{\pi \times 0.011^2} = 8.948 \times 10^{-5} \, V$.

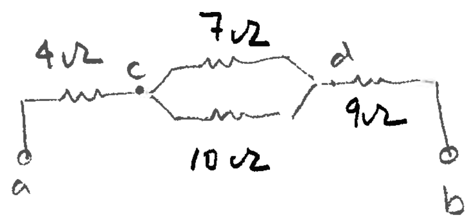
Problem 1.

$I\ (R+r) = \mathcal{E}$

$\therefore\ 117\times10^{-3}\ (72+r) = 9.$

$\therefore\ r = \frac{9}{117\times10^{-3}} - 72 = 4.92\ \Omega.$

Problem 5



a)

$R_{tot} = 4 + \frac{7\times10}{7+10} + 9$

$= 17.12\ \Omega$

b) $I = \frac{V}{R_{eq}} = \frac{34}{17.12} = 1.99\ A.$ Current through 4Ω & 9.

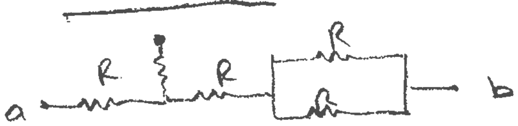
$\therefore$ Potential at C $= 34 - 4\times1.99 \approx 26\ V.$

D $= 9\times1.99 \approx 18\ V.$

$\therefore$ Current through $7\ \Omega = \frac{18}{7} = 2.57\ A.$

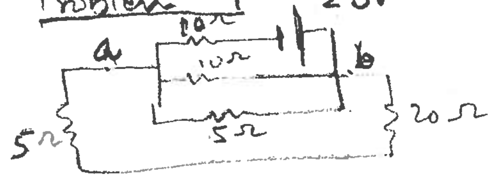
$10\ \Omega = \frac{18}{10} = 1.8\ A.$

Problem 7.



$R_{eq} = 2R + \frac{R^2}{2R} = 2R + R = 3R.$

1) **Problem 9**



a) $R_{eq} = 20 + 5 + \frac{1}{\frac{1}{10} + \frac{1}{10} + \frac{1}{5}}$

$= 27.5\ \Omega$.

$\therefore I = \frac{25}{27.5} = 0.91\ A$.

b) $V_b = 25\ V$.

$V_a = 25 - 0.91 \times 25 = 22.5\ V$.

Problem 13.

The upper branch has $R_{eq1} = 3 + \frac{1}{\frac{1}{6} + \frac{1}{6}}$

$= 6\ \Omega$

lower branch $R_{eq2} = \frac{1}{\frac{1}{4} + \frac{1}{12}} + 2$

$= 5\ \Omega$.

$\therefore R_{eq} = 3 + \frac{1}{\frac{1}{6} + \frac{1}{5}}$

$= 5.72\ \Omega$.

$\therefore I = 3.14 A$.

$\therefore$ Voltage across network $= 18 - 3.14 \times 3$

$= 8.58$.

$\therefore$ Current through lower branch $= \frac{8.58}{5} = 1.716\ A$

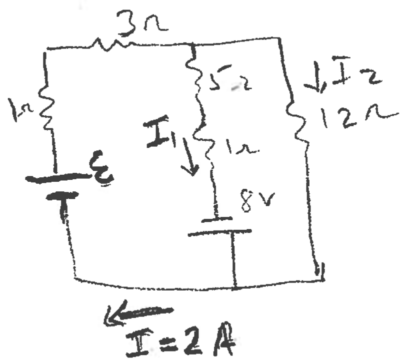
∴ Voltage across 4Ω, 12Ω branch $= 8.58 - 1.716 \times 2$

$= 5.14$ V.

$$\therefore I = \frac{5.14}{12}$$

$$\boxed{I = 0.43 \text{ A}}$$

Problem 21.



$8 + \varepsilon = (I \cdot 1 + I \cdot 3 + I_1 5 + I_1 \cdot 1)$ — ①

$\varepsilon = I \cdot 1 + 3 \cdot I + I_2 12$. — ②

$I_1 + I_2 = I$. — ③

① − ②, ③ ⇒ $8 = 6I_1 - 12(I - I_1)$

$= 6I_1 - 24 + 12I_1 = -24 + 18I_1$.

$\therefore I_1 = \frac{32}{18} = 1.78$ A.

$\therefore I_2 = 0.22$ A.

$\therefore \varepsilon = 4 \times 2 + 12 \times 0.22$

$= 10.64$ V.

(i) Problem 33.

$R = 1\ M\Omega \quad C = 5\ \mu F \quad \mathcal{E} = 30V.$

$q = Q(1 - e^{-t/RC})$; $Q = C\mathcal{E}$.

$\therefore Q = 5 \times 30 \times 10^{-6} = 150\ \mu C$.

$\therefore q = 150 \times 10^{-6}(1 - e^{-10/5})$

$q = 1.29 \times 10^{-4}\ C$

(ii) Problem 40.

$P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P}$. $\quad R_{eq} = \frac{R}{2}$.

$\therefore R = \frac{120^2}{1200} = 12\ \Omega$.

$\therefore I = \frac{120}{12} = 10\ A$.

Yes you can operate them together.