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01

Assignment 02

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Section A

Here,

atmospheric electricity, $E = 100\ NC^{-1}$

acting downward, $d = 100\ km$
$= 10^5\ m$

Ionosphere voltage(v) = ?

We know that,

$$E = \frac{v}{d}$$

$$\Rightarrow v = Ed$$

$$= 100 \times 10^5$$

$$= 10^7\ V.$$

(Result)

We know that;

$$\Delta K = -\Delta U$$

$$\Rightarrow k_i + U_i = k_f + U_f$$

$$\Rightarrow k_i + 0 = 0 + U_f$$

$$\therefore k_i = U_f$$

$$= \frac{q_1 q_2}{4\pi\epsilon_0 r}$$

Here,

$r = 9.23\ fm$

$= 9.23 \times 10^{-15}\ m$

$\epsilon_0 = 8.854 \times 10^{-12}\ Fm^{-1}$

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

$q_1 = 2e\ [n = 2]$

$q_2 = 79e\ [n = 79]$

$$= \frac{2e \times 79e}{4\pi \times 8.854 \times 10^{-12} \times 9.23 \times 10^{-15}}$$

$$= \frac{2 \times 1.6 \times 10^{-19} \times 79 \times 1.6 \times 10^{-19}}{4\pi \times 8.854 \times 10^{-12} \times 9.23 \times 10^{-15}}$$

$$= 3.94 \times 10^{-12}\ J$$

$\therefore$ kinetic energy $k_i = 3.94 \times 10^{-12}\ J$.

(Result)

Here given;

$$R = 13pm = 13\times10^{-12} m.$$

ⓐ We know,

$$V = \sum_{i=1}^{n} V_i$$

$$= \frac{1}{4\pi\epsilon_0}\left\{\frac{12(-e)}{R}\right\}$$

$$= \frac{1}{4\pi\epsilon_0} \times \frac{12\times(-1.6\times10^{-19})}{13\times10^{-12}}$$

$$= -1327.42 \, V.$$

Electric field in the centre is zero, $E=0$. Because, electrons are arranged symmetrically. Electric field produced by each electron is cancelled out by the electric field produced by the electron diametrically opposite of it.

(b) When the orientation of the Figure is changed, the electric Potential v will remain unchanged because of it is a Scalar equation.

So, the value of $V = -1327.42\,V$.

And at this Point orientation has been changed and also the electrons are not symmetrical here. So, In this case here the electric field is not zero.

(04)

Here given,

$q = 200C$.

$h = 60km = 60 \times 1000$

$h = \frac{d}{2}$ $= 60000m$

$\Rightarrow d = 2h = 2 \times 60000$ m

(a) We know,

$E = \frac{1}{2\pi\epsilon_0} \times \frac{qd}{z_1^3}$ [When; $z_1 = 30km$ $= 30 \times 1000 m$ $= 30000$ m]

$= \frac{1}{2\pi\epsilon_0} \times \frac{200 \times 2 \times 60000}{(30000)^3}$

$= 15978.21$ N/C

(b) $E = \frac{1}{2\pi\epsilon_0} \times \frac{qd}{z_2^3}$ [When; $z_2 = 60km = 60 \times 1000m$ $= 60000$ m]

$= \frac{1}{2\pi\epsilon_0} \times \frac{200 \times 2 \times 60000}{(60000)^3}$

$= 1997.28$ N/C. (Result)

(05)

Here given;

molecule, $d = 1.12\ pm$

$= 1.12 \times 10^{-12}\ m$

charge $\Rightarrow q = \pm 18e$

Dipole moment, $P = ?$

We know the value of; $e = 1.6 \times 10^{-19} C$.

Now, $P = |q| \cdot d$

$= |\pm 18e| \cdot (1.12 \times 10^{-12})$

$= 18e \cdot (1.12 \times 10^{-12})$

$= 18 \times (1.6 \times 10^{-19}) \times (1.12 \times 10^{-12})$

$= 3.22 \times 10^{-30}\ C.m.$

(Result)

Here, $m_1 = 23g.$

$m_2 = 4g.$

initial speed $v = 10^6 m/s.$

$k = 8.99 \times 10^9 \, Nm^2C^{-2}$

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

We know; $U_e = K$

$$\Rightarrow k \frac{q_1 q_2}{r} = \frac{1}{2} m_1 v^2 + \frac{1}{2} m_2 v^2$$

$$\Rightarrow k \frac{11e \times 2e}{r} = \frac{1}{2} v^2 (m_1 + m_2)$$

$$\Rightarrow \frac{22e^2 k}{r} = \frac{1}{2} v^2 (m_1 + m_2)$$

$$\Rightarrow \frac{22 \times 2 \times (1.6 \times 10^{-19})^2 \times 8.99 \times 10^9}{(10^6)^2 \times (23+4)} = r$$

$$\Rightarrow r = 3.75 \times 10^{-40} m.$$

(Result)

Here given,

Resistor $R = 65.0\,\Omega$

emf, $\epsilon = 12.0\,V$

Internal resistance, $r = 0.5\,\Omega$.

(a) The current in the circuit;

We know;

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

$$= \frac{12}{65+0.5} = \frac{12}{65.5} = 0.183\,A$$

(b) The terminal voltage of the battery,

$$V_{ab} = \epsilon - Ir = 12 - (0.183 \times 0.5)$$

$$= 11.91\,V.$$

P.T.O

(c) The Power dissipated in the resistor R;

we know;

$$P_R = I^2R = (0.183)^2 \times 65$$

$$= 2.18 \text{ W.}$$

And, The Power dissipated in the battery's internal resistance r;

we know;

$$P_r = I^2r = (0.183)^2 \times 0.5$$

$$= 0.017 \text{ W.}$$

(Result)

(08)

Here given, $d = 3.2\ mm$ $\therefore$ radius $R = \frac{d}{2}$

$I = 5\ A.$ $= \frac{3.2}{2}$

$= 1.6\ mm$

$\therefore R = 1.6 \times 10^{-5}\ m$

$n = 8.49 \times 10^{28}$ electrons/m^3

ⓐ The current density in the wire;

$$J = \frac{I}{A} = \frac{I}{\pi r^2} = \frac{5}{3.1416 \times (1.6 \times 10^{-5})^2}$$

$$= 6216989965\ Am^{-2}.$$

(b) The drift velocity of the free electrons.

$$v_d = \frac{J}{ne} = \frac{6216989965}{8.49\times10^{28}\times1.6\times10^{-19}}$$

$$= 0.458\ ms^{-1}$$

(c) Rms speed of, electrons;

Here,

$T = 273+20$
$= 298K$

$k = 1.3\times10^{-23}\ JK^{-1}mol$

$m = 9.11\times10^{-31}\ kg.$

$$v_{rms} = \sqrt{\frac{3kt}{m}}$$

$$= \sqrt{\frac{3\times1.3\times10^{-23}\times298}{9.11\times10^{-31}}}$$

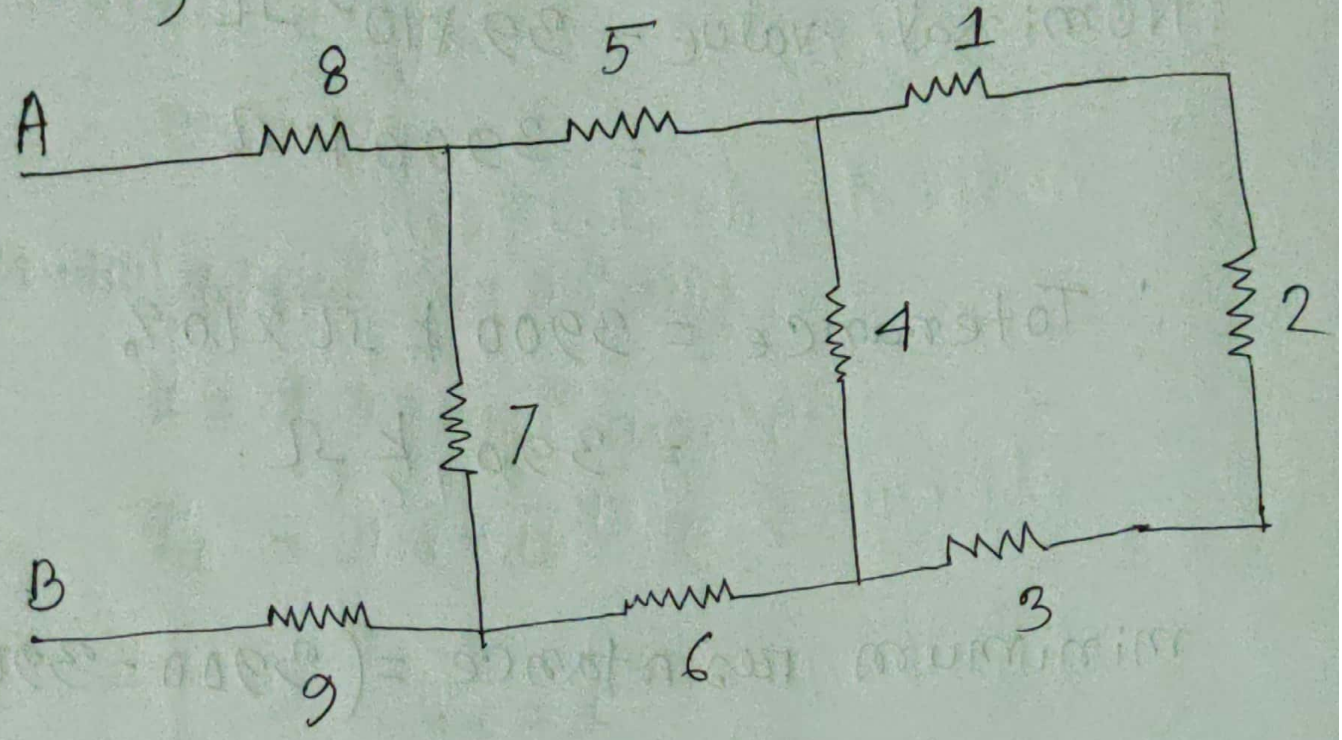
$$= 112948.7\ ms^{-1}$$

(Result).

Scanned with CamScanner

09

Suppose;



R_1, R_2, R_3 is Series $= R+R+R = 3R\,\Omega$

$3R$ and R_4 is Parallel

$$R_{4(P)} = \left(\frac{1}{R} + \frac{1}{3R}\right)^{-1} = \left(\frac{3+1}{3R}\right)$$

$$R_4 = \frac{3R}{4}\,\Omega$$

R_4, R_5, R_6 in Series;

$$R_{6(S)} = R + R + \frac{3R}{4} = \frac{4R+4R+3R}{4}$$

$$= \frac{11R}{4}\,\Omega$$

P.T.O

$R_{6(S)}$ and R_7 in parallel;

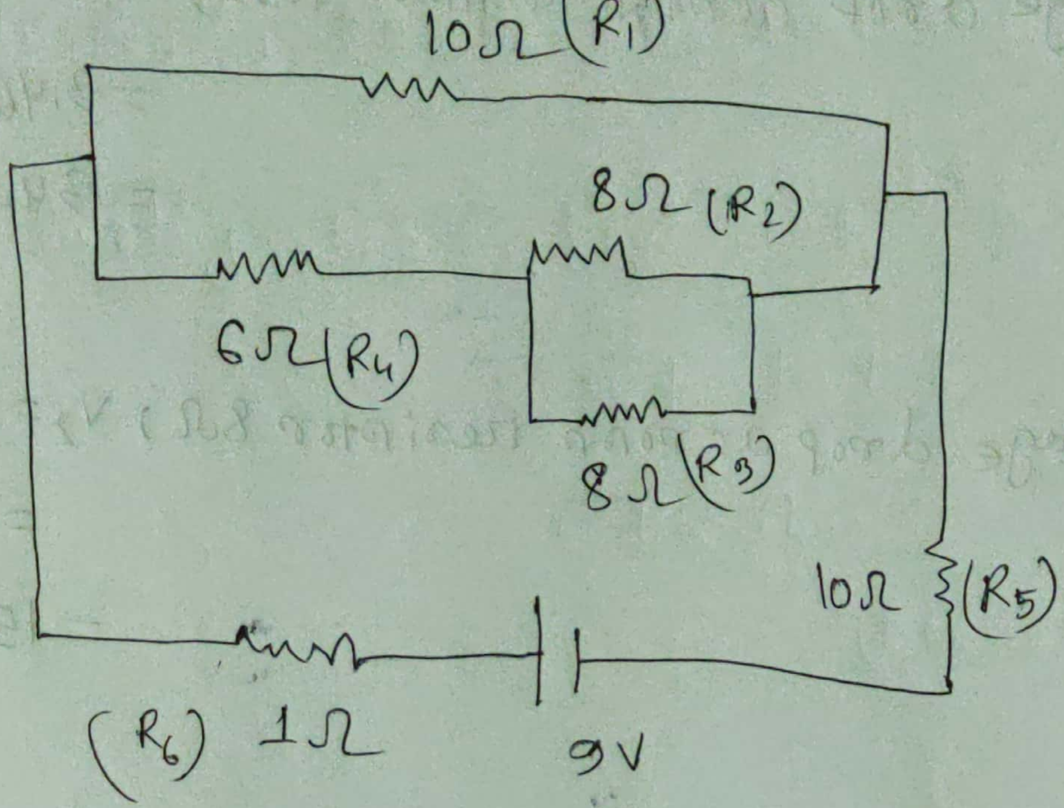
$$R_{7(p)} = \left(\frac{11R^{-1}}{4} + R^{-1}\right)^{-1} = \frac{11R}{15}\,\Omega$$

$\therefore$ R_{7_S}, R_8, R_9 in series.

$$\therefore R_{(fin)} = \frac{11R}{15} + R + R = \frac{41R}{15}\,\Omega$$

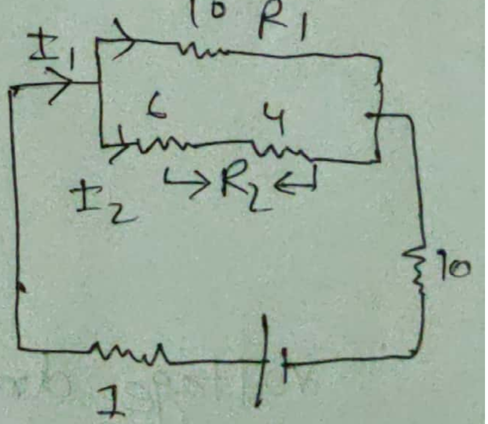
$\therefore$ final resistance $R_{(fin)} = \frac{41R}{15}\,\Omega$ (Result)

(10)



$\therefore I = \frac{V}{R_{eq}} = \frac{9}{16} = 0.5625\ A.$

$\therefore$ Across 6Ω resistor, I



Now;

$I_2 = \frac{R_1}{R_1+R_2} \times I$
(across 6Ω)

$= \frac{10}{10+(6+4)} \times 0.5625$

$= \frac{10}{20} \times 0.5625$

$= 0.28125\ A.$

$R_1 = 10\Omega$
$R_2 = 6+4 = 10\Omega$

R_2 and R_3 Parallel.

$$\frac{1}{R_{eq}} = \frac{1}{8} + \frac{1}{8}$$

$$= \frac{1+1}{8}$$

$$= \frac{2}{8}$$

$\therefore R_{eq} = 4\,\Omega.$

Now, R_{eq} and R_4 is in series,

$$\therefore R_{eq}' = R_{eq} + R_4$$

$$= 4\,\Omega + 6\,\Omega$$

$$= 10\,\Omega.$$

Now, R_{eq}' and R_1 in parallel,

$$\therefore \frac{1}{R_{eq}''} = \frac{1}{R_{eq}'} + \frac{1}{R_1}$$

$$= \frac{1}{10} + \frac{1}{10}$$

$$= \frac{2}{10}$$

$\therefore R_{eq}'' = 5\,\Omega.$

NOW, R_{eq}'', R_5, R_6 are in series.

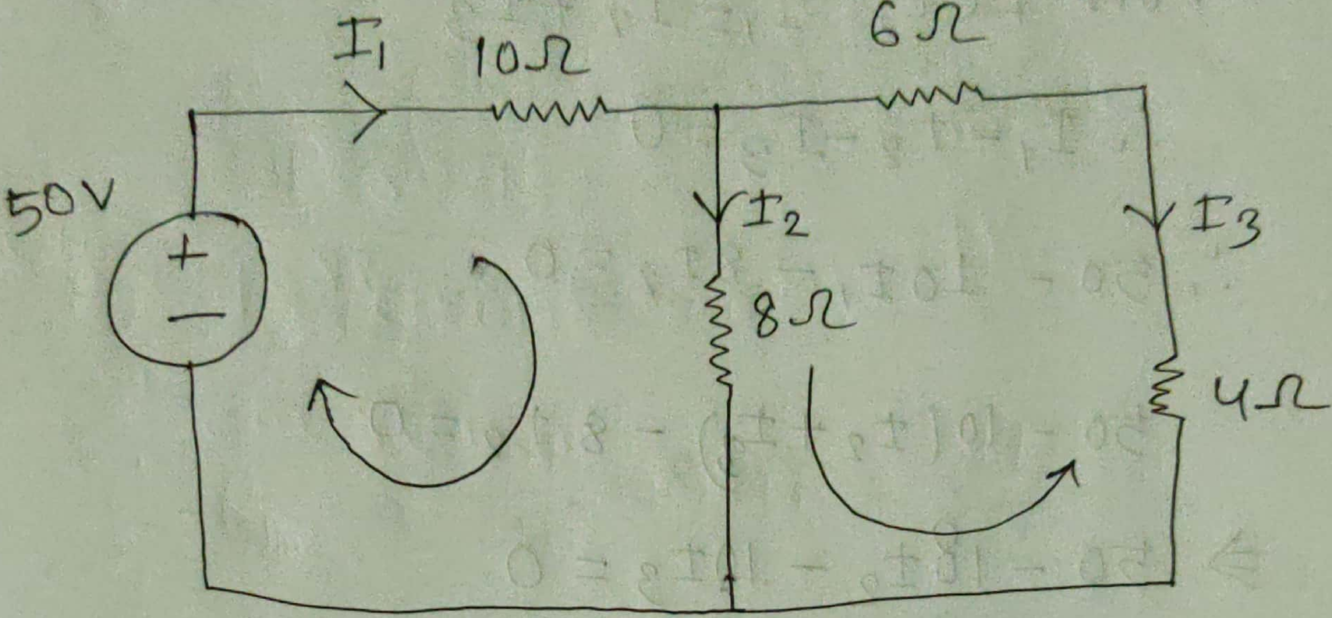
So, lastly $R_{eq} = R_{eq}'' + R_5 + R_6$

$= 5 + 10 + 1$

$= 16\,\Omega$.

(Result)

(11)



At the left loop, KVL (moving downward mesh)

$$50 - 10I_1 - 8I_2 = 0$$

At the right loop, KVL (moving upward mesh)

$$8I_2 - 4I_3 - 6I_3 = 0$$

$$\Rightarrow 8I_2 - 10I_3 = 0$$

$$\Rightarrow 8I_2 = 10I_3$$

$$\therefore I_2 = \frac{10}{8} I_3 = 1.25 I_3$$

P.T.O

From KCL, $I_1 = I_2 + I_3$

$\therefore I_1 - I_2 - I_3 = 0$

$\therefore 50 - 10I_1 - 8I_2 = 0$

$50 - 10(I_2 + I_3) - 8I_2 = 0$

$\Rightarrow 50 - 18I_2 - 10I_3 = 0$

But, $I_2 = 1.25 I_3$

$\therefore 50 - (18 \times 1.25 I_3) - 10 I_3 = 0$

$\Rightarrow 50 - 22.5 I_3 - 10 I_3 = 0$

$\Rightarrow 50 - 32.5 I_3 = 0$

$\Rightarrow 50 = 32.5 I_3$

$\therefore I_3 = \frac{50}{32.5} = 1.538\,A$.

$\therefore I_2 = 1.25 I_3 = 1.25 \times 1.538 = 1.923\,A$

$\therefore I_1 = I_2 + I_3 = 1.538 + 1.923 = 3.461\,A$.

P.T.O

$\therefore$ voltage drop across resistor 10Ω, $V_1 = I_1 R_1$

$= 3.461 \times 10$

$= 34.61$ V.

$\therefore$ voltage drop across resistor 8Ω, $V_2 = I_2 R_2$

$= 1.923 \times 8$

$= 15.384$ V.

$\therefore$ voltage drop across resistor 6Ω, $V_3 = I_3 R_3$

$= 1.538 \times 6$

$= 9.228$ V.

$\therefore$ voltage drop across resistor 4Ω, $V_4 = I_3 R_4$

$= 1.538 \times 4$

$= 6.152$ V.

(Result)

(12)

(a)

Nominal value $= 39 \times 10^5 \,\Omega$

$= 3900 \,k\Omega$.

$\therefore$ Tolerance $= 3900 \,k\Omega \times 10\%$

$= 390 \,k\Omega$.

minimum resistance $= (3900 - 390) \,k\Omega$

$= 3510 \,k\Omega$.

maximum resistance $= (3900 + 390) \,k\Omega$

$= 4290 \,k\Omega$

(b) Nominal value $= 1.5 \,k\Omega$

$= 15 \times 10^2$

1 → Brown, 5 → green, 10^2 → red

tolerance

↓

$= 1.5 \,k\Omega \times 5\%$

$= 0.075 \,k\Omega$

Tolerance of $\pm 5\%$ is indicating Gold colour. (Result).