Final Assessment

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Section: A.

Course Name: Physics.

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Question - 01

① ⓐ We know that,

$$F = \frac{k q_1 q_2}{r^2}$$

$$\Rightarrow F \propto \frac{1}{r^2}$$

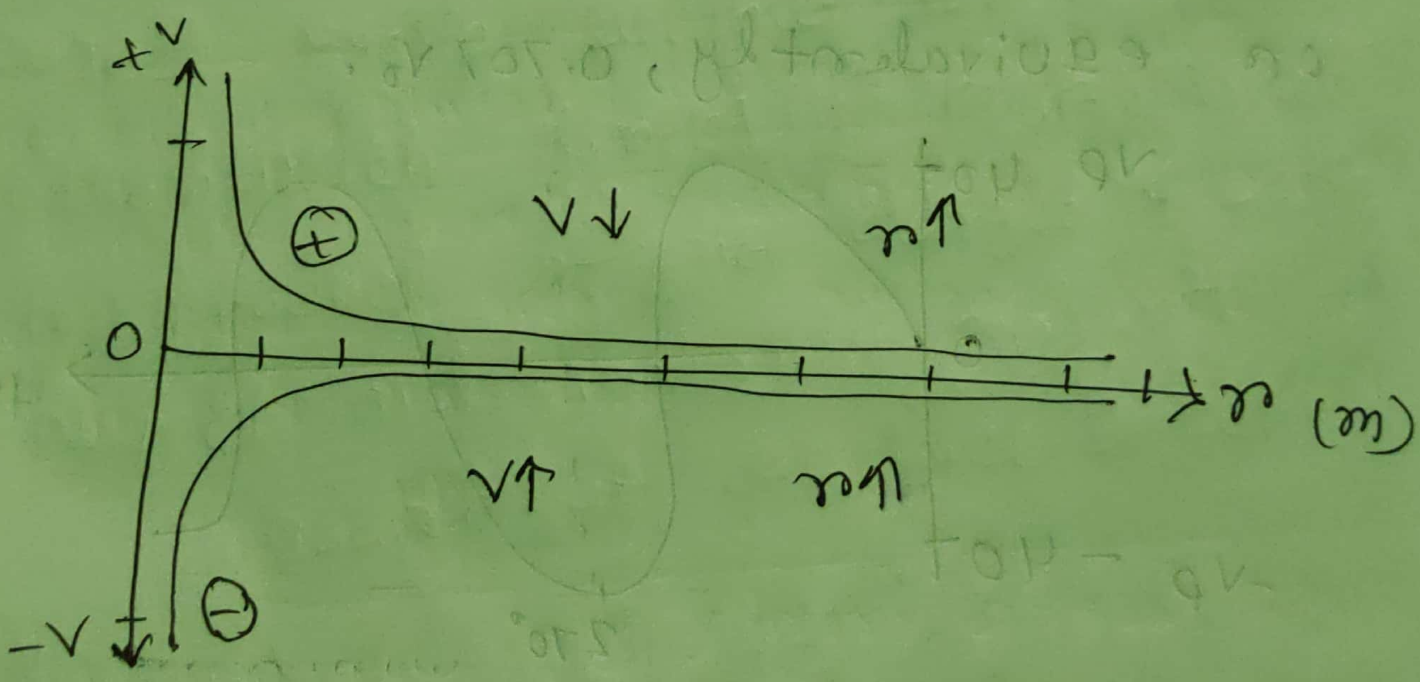
coulomb's law states that two charged object exerts electric for on each otherwhich directly proportional to product of net charges of both object and inversly proportional to square of distance between them.

1 b

Energy required to move a charge from one place to another place inside the electric field is called electric potential energy.

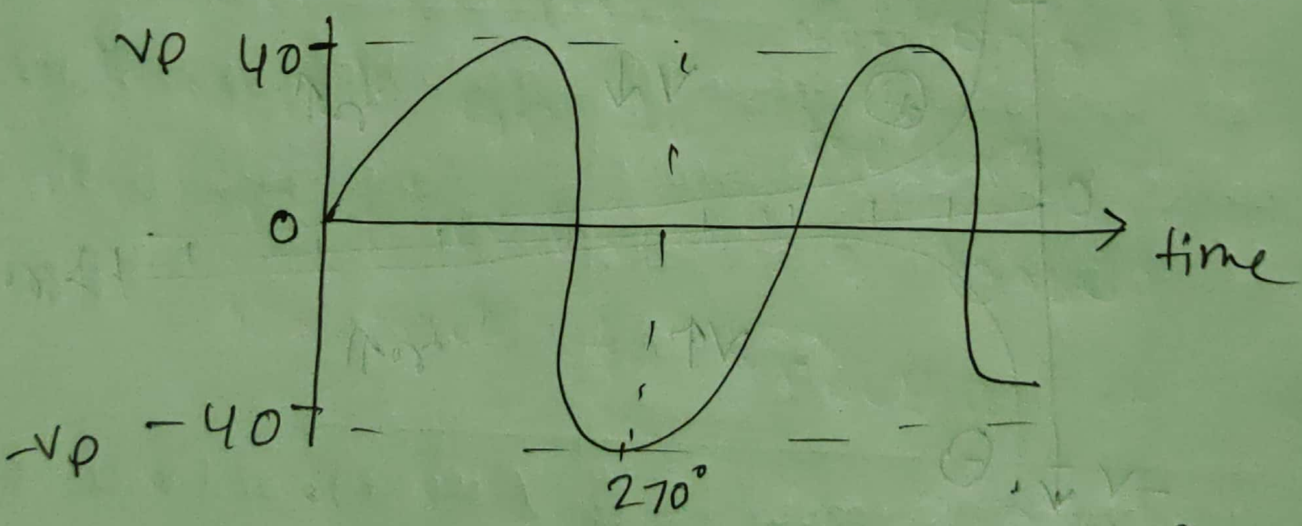
Electric Potential	Electric Potential energy
① Work done per unit charge is called electric potential.	① Energy required to move a charge is called electric potential energy.
② It works from ∝ to inside electric field. (outside → inside)	② It works from one place to another inside E. (outside → Inside)
③ mathematically, $V = \frac{W}{q}$ (energy related)	③ mathematically, $U = qV$ (energy)

(4) $V = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{r}$	(4) $U = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 q_2}{r}$
(5) unit: V	(5) unit: J.
(6) $\Delta V = \frac{\Delta U}{q}$	(6) $\Delta U = -W$



(graphically showed)

1 (c) The root-mean-square (rms) voltage of a sinusoidal source of electromotive force (V_{rms}) is used to characterize the source. It is the square root of the time average of the voltage squared. The value of V_{rms} is V_0/square root of $\sqrt{2}$, or, equivalently, 0.707 V_0.



Both AC and DC describe types of current flow in a circuit. In direct current (DC), the electric charge (current) only flows in one direction. Electric charge in altenating current

(AC) on the other hand, change direction periodically. Direct current is produced by source such as batteries, thermocouples, solar cells. on the other hand outlets supply AC power and also electric motors.

Question - 02

② ⓐ ⓘ Here,

$F = 5.70\ N$

$k = 9 \times 10^{9}\ N m^2 C^{-2}$

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

We know that;

$$F = \frac{k q_1 q_2}{r^2}$$

$$\Rightarrow 5.70 = \frac{9 \times 10^{9} \times 1.6 \times 10^{-19} \times 1.6 \times 10^{-19}}{r^2}$$

$$\Rightarrow r^2 = \frac{9 \times 10^{9} \times 1.6 \times 10^{-19} \times 1.6 \times 10^{-19}}{5.70}$$

$$\Rightarrow r = 6.36 \times 10^{-15}\ m \text{ (Result)}$$

(2) (ii)

We find,

$r = 6.36 \times 10^{-15}$ m

$G = 6.673 \times 10^{-11}$ N m^2 kg^{-2}

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

$m_p = 1.67 \times 10^{-27}$ kg

$m_e = 9.1 \times 10^{-31}$ kg.

We know, $F = \frac{G q^2}{r^2}$

$$= \frac{6.673 \times 10^{-11} \times (1.6 \times 10^{-19})^2}{(6.36 \times 10^{-15})^2}$$

$= 4.22 \times 10^{-20}$ N.

(Result)

2 b

$E = 5\hat{i} - 4\hat{j}$

$A = 4^2 = 16$

$q_{enc} = ?$

Now,

we know,

$\Phi_L = \int E \, dA$

$= \int (5\hat{i} - 4\hat{j}) \cdot dA(-\hat{i})$

$= -5 \int dA$

$= -5A = (-5 \times 16) = -80$

$\Phi_r = \int (5\hat{i} - 4\hat{j}) \cdot dA(\hat{i})$

$= 5 \int dA = 5A = (5 \times 16) = 80$

$\Phi_T = \int (5\hat{i} - 4\hat{j}) \, dA(\hat{j})$

$= -4 \int dA = -4A = (-4 \times 16)$

$= -64$. P.T.O

$$Q_b = \int (5\hat{i} - 4\hat{j})\, dA(-\hat{j})$$

$$= 4\int dA = 4A = (4 \times 16) = 64.$$

$$\therefore Q = P_L + P_R + Q_T + Q_b$$

$$= -80 + 80 - 64 + 64$$

$$= 0$$

$$\therefore q_{enc} = Q \times \epsilon_0$$

$$= 0 \times \epsilon_0$$

$$= 0 \text{ C.}$$ (Result)

Question - 03

3 (a) Here given,

$q = |\pm 18e| = 18e$

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

$d = 3.5\ fm = 3.5 \times 10^{-15} m$

(i) dipole moment;

$P = |q| d$

$= 18 \times 1.6 \times 10^{-19} \times 3.5 \times 10^{-15}$

$= 1.008 \times 10^{-32} m.$

(ii) From (i), $P = 1.008 \times 10^{-32} m.$

$\theta = 105°$

given, $E = 2.3 \times 10^{3}\ N/C$

$\therefore$ torque, $\tau = PE \sin\theta$

$= 1.008 \times 10^{-32} \times 2.3 \times 10^{3} \times \sin 105°$

$= 2.239 \times 10^{-29}\ Nm.$

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(12) (iii) Potential energy,

$$U = -\vec{P}\cdot\vec{E}$$

$$= -PE\cos\theta$$

$$= -1.008\times10^{-32}\times2.3\times10^{3}\times\cos$$

$$U = qV$$

$$= qEd$$

$$= 18\times1.6\times10^{-19}\times2.3\times10^{3}\times3.5\times10^{-15}$$

$$= 2.3184\times10^{-29}\ \text{J}.$$

$\therefore$ Potential energy 2.3184×10^{-29} J.

(Result)

(3) (b) Here given,

$E = 1020\ NC^{-1}$

$d = 40\ mm = 40 \times 10^{-3}\ m$

$y = 3.6\ cm = 3.6 \times 10^{-2}\ m$

$v = ?$

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

We know that;

$$y = \frac{1}{2} at^2$$

$$\Rightarrow 3.6 \times 10^{-2} = \frac{1}{2} \times \frac{q_0 E}{m} t^2$$

$$\Rightarrow 3.6 \times 10^{-2} = \frac{1}{2} \times \frac{1.6 \times 10^{-19} \times 1020}{9.1 \times 10^{-31}} t^2$$

$$\Rightarrow 3.6 \times 10^{-2} = 8.97 \times 10^{13} t^2$$

$$\Rightarrow t^2 = \frac{3.6 \times 10^{-2}}{8.97 \times 10^{13}}$$

$$\Rightarrow t = 2.003 \times 10^{-8}$$

P.T.O

And now;

We know,

$$\Rightarrow d = vt$$

$$\Rightarrow v = \frac{d}{t}$$

$$= \frac{40 \times 10^{-3}}{2.003 \times 10^{-8}}$$

$$= 1997004.49\ ms^{-1}$$

$\therefore$ Speed is $1997004.49\ ms^{-1}$

(Result)

Question-04

ⓐ $l = 9m$

$d = 6mm = 6 \times 10^{-3} m$

$I = 16 mA = 16 \times 10^{-3} A$

$t = 17 \text{ min} = 0.27 \text{ hr.}$

$E = 3.75 \times 10^{-2} \text{ V/m.}$

Here, $A = \pi r^2 = \pi \left(\frac{d}{2}\right)^2$

$= \pi \left(\frac{6 \times 10^{-3}}{2}\right)^2$

$= 2.83 \times 10^{-5} m^2$

Current density,

$J = \frac{I}{A} = \frac{16 \times 10^{-3}}{2.83 \times 10^{-5}}$

$= 565.37 A/m^2$

① $E = \rho J$

$\Rightarrow \rho = \frac{E}{J} = \frac{3.75 \times 10^{-2}}{565.37} = 6.63 \times 10^{-5} \Omega.$

(Result)

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(ii) Here,

$V = (P \cdot \frac{Y}{A}) \cdot t$

$= 6.63 \times 10^{-5} \times \frac{9}{2.83 \times 10^{-5}} \times 16 \times 10^{-3}$

$= 0.34\ V.$

NOW;

$\therefore P = VI = (0.34 \times 16 \times 10^{-3})\ W$

$= 5.416 \times 10^{-3} W.$

In BOT unit;

$N = \frac{Pt}{1000} = \frac{5.416 \times 10^{-3} \times 0.27}{1000}$

$= 1.46 \times 10^{-6}$ units.

(Result)

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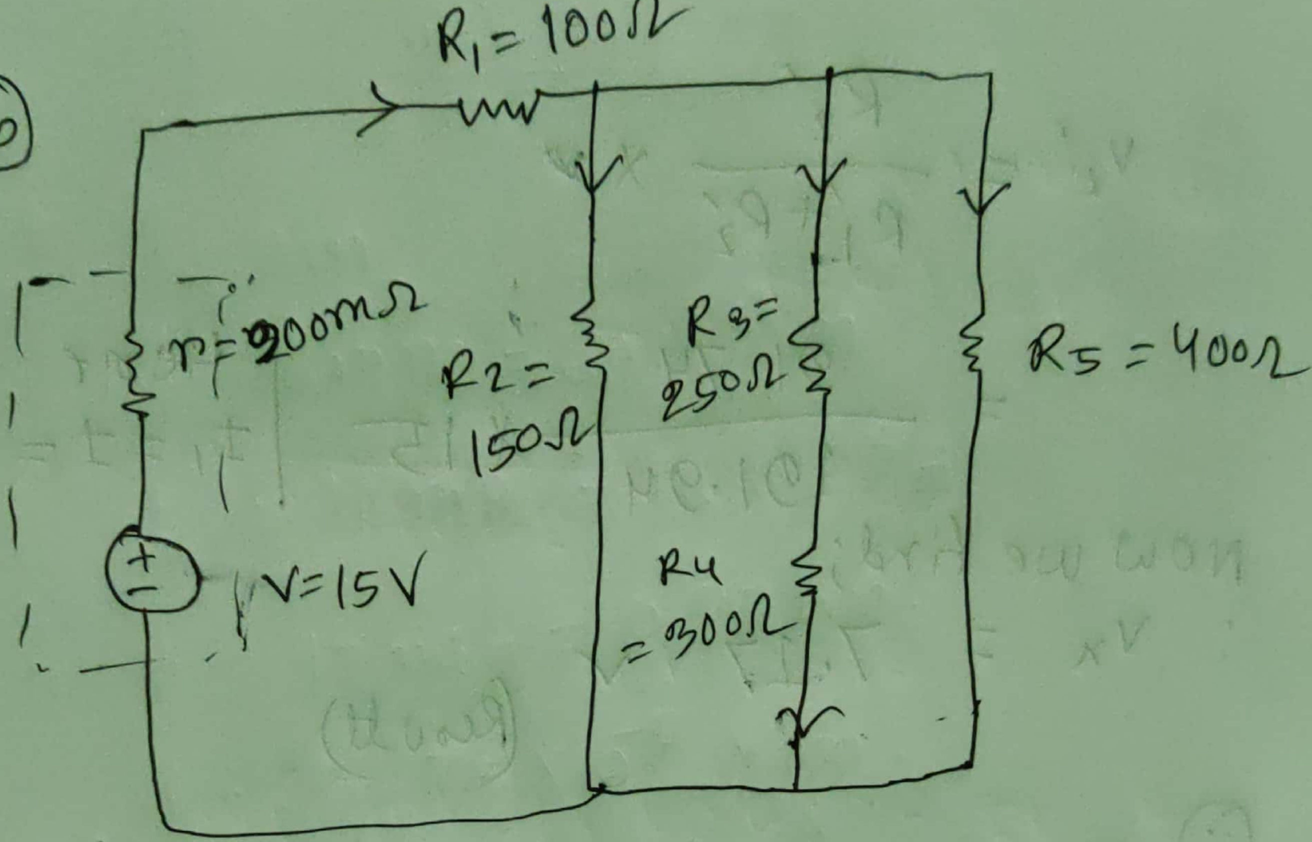
(b)



Here,

$$R_1' = 100 + \frac{200}{1000} = 100.2\,\Omega$$

$$\therefore \frac{1}{R_2'} = \frac{1}{150} + \frac{1}{550} + \frac{1}{400} = 0.0109$$

$$\therefore R_2' = 91.74\,\Omega.$$

$$\therefore R_5 = R_1' + R_2' = 100.2 + 91.74 = 191.94\,\Omega.$$

$$\therefore I = \frac{V}{R_5} = \frac{15}{191.94}\,A = 0.078\,A.$$

P.T.O

$$V_2' = \frac{R_2'}{R_1' + R_2'} \times V$$

$$= \frac{91.74}{191.94} \times 15$$

Here
$I_1 = I = 0.078A$

Now we find;

$\therefore V_x = 7.17$ V

(Result)

(ii) Terminal voltage; $(15 - (0.078 \times 0.2))$

$= 14.98$ V.

(Result)

Question - 06

ⓐ The electric Potential of a Point chare is $V = \frac{KQ}{r}$.

Where K is constant $K = 9 \times 10^9 \, Nm^2 C^{-2}$.

(Result)

ⓑ We know that,

$$F = qE.$$

Where, q is the charge

E is the electric field.

Therefore, $V = a\tau$

Where v is the drift velocity.

a is the acceleration time.

τ is the average relaxation time between two successive collision.

And $N = nV$, where N is the total number of electrons, n is the number of density of electron and V is the volume.

Now;

From (1);

$$a = \frac{qE}{m_e} \quad ---(2)$$

From (2);

$$v = \frac{qE}{m_e}\tau \quad ---(3)$$

Here $v = a\tau$

From (3);

$$d = \frac{qE}{m_e}\tau\, \Delta t \quad -(4)$$

Here, $d = v\Delta t$

From (4);

$$V = \frac{qE}{m_e}\tau A\, \Delta t \quad -(5)$$

Here $V = Ad$.

P.T.O

From (5);

$$N = \frac{n q E}{m_e} \tau A \Delta t \quad -(6)$$

Here, $N = nV$.

From (6);

$$q = \frac{n q^2 E}{m_e} \tau A \Delta t \quad -(7)$$

Here, $q = Ne$

From (7);

$$I \Delta t = \frac{n q^2 E}{m_e} \tau A \Delta t \quad -(8)$$

Here $V = \frac{qE}{m_e} \tau$

From (8);

$$I = n q v A \quad -(9)$$

Here, $V = \frac{qE}{m_e} \tau$

From (9); $J = nqv$

$\therefore J = nqv$

therefore, $J = \frac{I}{A}$.

Therefore, we can see that the drift speed is proportional to the number density of the electrons.

(Result)