II Terminal Examination - December 2022

HSE II

PHYSICS

① Coulomb (C)

② (d) 0 J

③ (b) Increases

④ (c) Zero

⑤ - Gauss' law in magnetism

⑥ Energy

⑦ (c) leads the applied voltage by 90°

⑧ (i) Additivity of charge
(ii) quantisation of charge ($q = \pm ne$)
(iii) conservation of charge
(iv) charge is scalar (Any 2)

⑨ $\vec{P} = q \times 2\vec{l}$

Direction from $-q$ to $+q$

⑩ The algebraic sum of current meeting at a junction is zero

OR

Current entering the junction is equal to current leaving the junction.

OR

$$\Sigma I = 0$$

(11) By connecting a shunt ~~resist~~ resistance parallel to a galvanometer

Pd across Galvanometer = Pd across shunt

$$I_g R_G = (I - I_g) S$$

shunt to be connected,

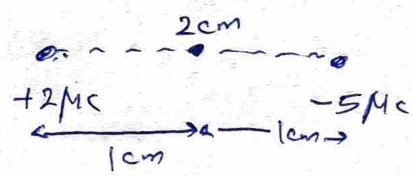
$$S = \frac{I_g R_G}{(I - I_g)}$$

(12) (i) Copper loss / Heat loss
(ii) Eddy current loss
(iii) Flux leakage loss
(iv) Hysteresis loss

(13) It is the current due to the change in electric field with respect to time.

$$i_d = \varepsilon_0 \frac{d\phi_E}{dt}$$

(14)



$V = V_1 + V_2$

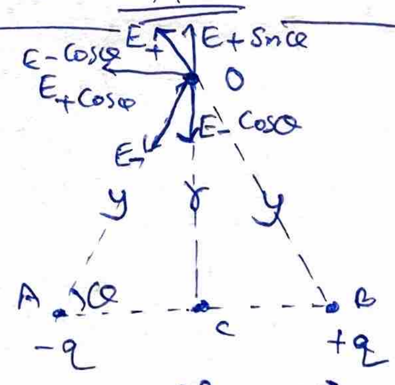
$$= \frac{1}{4\pi\varepsilon_0}\frac{q_1}{r_1} + \frac{1}{4\pi\varepsilon_0}\frac{q_2}{r_2}$$

$$= 9 \times 10^9 \left[\frac{2 \times 10^{-6}}{10^{-2}} + \frac{-5 \times 10^{-6}}{10^{-2}}\right]$$

$$= 9 \times 10^9 \times 10^{-4} [2 - 5]$$

$$= -27 \times 10^5 \, V$$

(15)



$E_+ = \frac{1}{4\pi\varepsilon_0}\frac{q}{y^2}$ —① along BO

$E_- = \frac{1}{4\pi\varepsilon_0}\frac{q}{y^2}$ —② along OA

Vertical components cancel out.

$\therefore E = E_- \cos\theta + E_+ \cos\theta$

$= 2 \times \frac{1}{4\pi\varepsilon} \frac{q}{y^2} \times \cos\theta$ — (3)

$y^2 = r^2 + l^2$, $\cos\theta = \frac{l}{(r^2+l^2)^{1/2}}$

$\therefore E = \frac{1}{4\pi\varepsilon} \frac{q}{r^2+l^2} \times \frac{2l}{(r^2+l^2)^{1/2}}$

$= \frac{1}{4\pi\varepsilon} \frac{p}{(r^2+l^2)^{3/2}}$

$\because l^2 <<< r^2$, $(r^2+l^2)^{3/2} \approx r^3$

$$\boxed{\therefore E = \frac{1}{4\pi\varepsilon} \frac{p}{r^3}}$$

(16) $C = 10\times10^{-6} F = 10^{-5} F$

$V = 10V$

$U = \frac{1}{2}CV^2 = \frac{1}{2}\times10^{-5}\times10^2$

$= 0.5\times10^{-3}$

$= 5\times10^{-4} J$

Energy stored in the electric field

(17) Average velocity of drifted electrons, when electrons moving through a conductor

Derivation of $I = neAV_d$

(18) Any 3 properties of each.

(19) It is the p.d between the ends of a conductor when it is moving in a magnetic field.

Derivation of $\boxed{V_m = Blv}$

(20) $N = 100$

$r = 8\times10^{-2} m$

$I = 0.4 A$

$B_c = \frac{\mu_0 N I}{2r}$

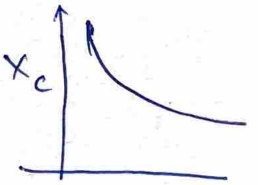
$= \frac{4\pi\times10^{-7}\times100\times0.4}{2\times8\times10^{-2}}$

$= 0.314\times10^{-3}$

$= 3.14\times10^{-4} T$

(21) It is the resistance offered by the capacitor in an ac circuit

(b) $X_c = \frac{1}{C\omega} = \frac{1}{C\times2\pi f}$



(Not in syllabus) b part

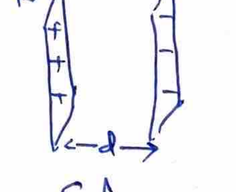
22) a) Charge per unit potential difference between the two plates

$C = \frac{Q}{V}$

b) charge, $Q = \sigma A$

P.d, $V = Ed$

$= \frac{\sigma}{\varepsilon} d$



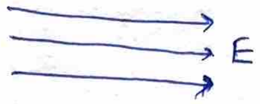
$\therefore C = \frac{Q}{V} = \frac{\sigma A}{\left(\frac{\sigma d}{\varepsilon}\right)} = \frac{\varepsilon A}{d}$

(c) $d' = 2d$

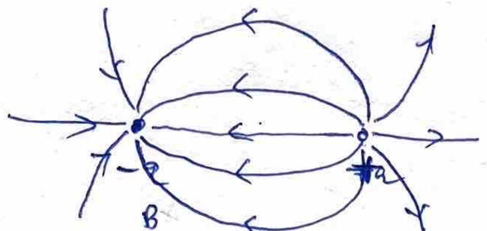
$c' = c/2$ (Halved)

(23) (a) Any 2 properties like
(i) No two lines intersect
(ii) Starts from + charge and end at -ve charge

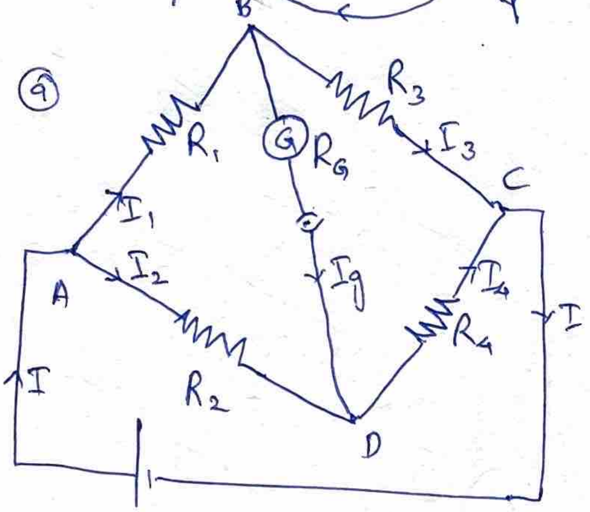
(b) (i)



(ii)



(24) (a)



(b) For ABD,

$I_1 R_1 + I_g R_G + {-I_2 R_2} = 0$ —(1)

For BCD,

$I_3 R_3 + {-I_4 R_4} + {-I_g R_G} = 0$ —(2)

(c) when bridge is balanced,

$I_g = 0, \quad I_1 = I_3$

$I_2 = I_4$

(1) ⇒ $I_1 R_1 = I_2 R_2$ —(3)

(2) ⇒ $I_1 R_3 = I_2 R_4$ —(4)

$\frac{(3)}{(4)}$ ⇒ $\frac{R_1}{R_3} = \frac{R_2}{R_4}$ OR $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

(25) Diagram. (2)
Explanation (2)

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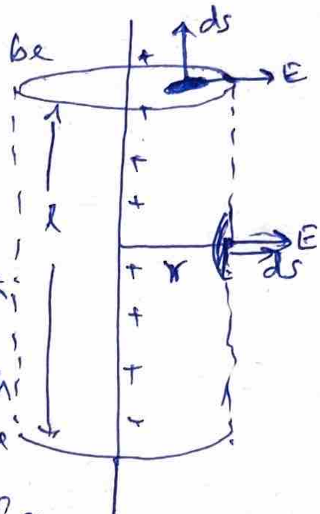
(26) (a) statement,

$\phi_E = \int_S \vec{E} \cdot \vec{ds} = \frac{1}{\epsilon_0} \times q$

(b) Let $\lambda = \frac{q}{l}$ be the linear charge density of wire.

The gaussian surface is a cylinder of length l and radius r.

Electric flux through the two flat surface is zero.



For the curved surface,

$\phi_E = \int \vec{E} \cdot \vec{ds} = \int E\,ds \cos 0$

$= E \int ds$

$= E \times 2\pi r l$ —(1)

According to Gauss' law,

$\phi_E = \frac{1}{\epsilon_0} \times q = \frac{1}{\epsilon_0} \times \lambda l$ —(2)

$E \times 2\pi r l = \frac{1}{\epsilon_0} \times \lambda l$

$$\boxed{E = \frac{1}{2\pi\epsilon_0} \times \frac{\lambda}{r}}$$

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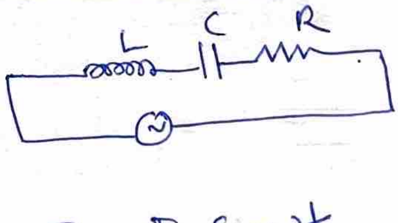
(27) (a)



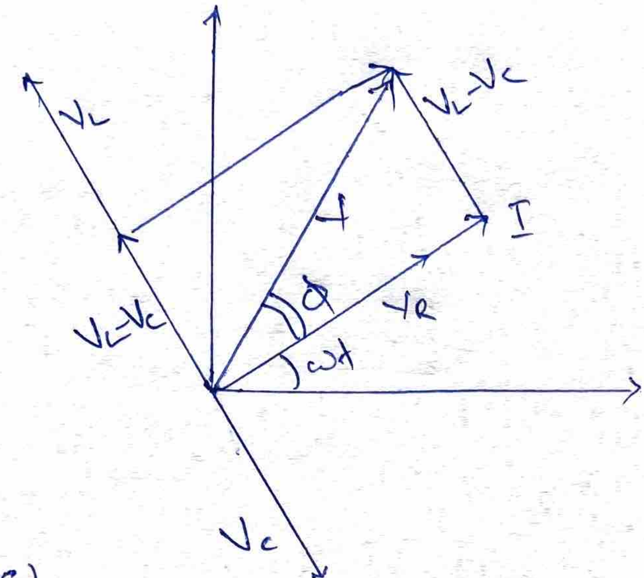
(b) $I = I_0 \sin \omega t$

$V_L = V_0 \sin(\omega t + \pi/2)$

$V_C = V_0 \sin(\omega t - \pi/2)$

$V_R = V_0 \sin \omega t$

$V = \sqrt{V_R^2 + (V_L - V_C)^2}$



(c)

$$V = \sqrt{(IR)^2 + (IX_L - IX_C)^2}$$

$$= I\sqrt{R^2 + (X_L - X_C)^2}$$

Impedence,

$$Z = \frac{V}{I} = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\boxed{Z = \sqrt{R^2 + \left(L\omega - \frac{1}{C\omega}\right)^2}}$$

(d) Power factor = $\cos\phi$

From the figure.

$$\tan\phi = \frac{V_L - V_C}{V_R}$$

$$= \frac{IX_L - IX_C}{IR}$$

$$= \frac{X_L - X_C}{R}$$

$$\phi = \tan^{-1}\left[\frac{X_L - X_C}{R}\right]$$

$$\text{Power factor} = \cos\left[\tan^{-1}\left(\frac{X_L - X_C}{R}\right)\right]$$

(28) (a) statement

b) $dB = \frac{\mu_0}{4\pi}\frac{I\,dl\sin\theta}{r^2}$

$\mu_0 \rightarrow$ Permeability of freespace

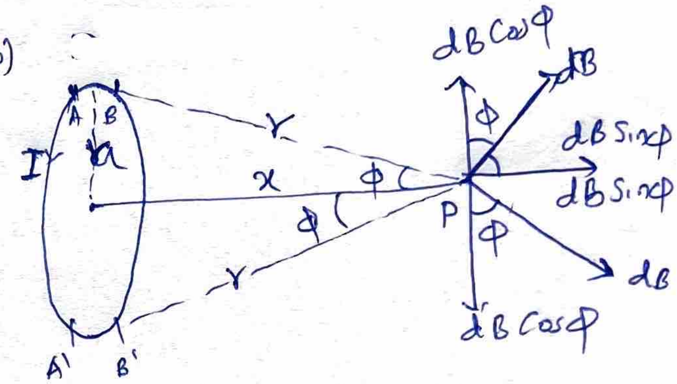
$I \rightarrow$ current

$dl \rightarrow$ length of current element

$r \rightarrow$ Distance of the point from the current element

$\theta \rightarrow$ Angle between current element and the position vector $\vec{r}$.

(b)



Magnetic field due to AB of length dl carries a current I at P,

$$dB = \frac{\mu_0}{4\pi}\frac{I\,dl\sin\theta}{r^2} \qquad \text{Here } \theta = 90$$

$$= \frac{\mu_0}{4\pi}\frac{I\,dl}{r^2} \quad \text{—①}$$

Magnetic field due to A'B' is having the same magnitude.

The vertical components ~~cancel out~~ cancel out and horizontal component adds up.

$\therefore$ Total magnetic field

$$B = \sum dB\sin\phi$$

$$= \sum \frac{\mu_0}{4\pi}\frac{I\,dl}{r^2}\sin\phi.$$

$$\sin\phi = \frac{a}{r} = \frac{a}{(x^2+a^2)^{\frac{1}{2}}}$$

$$r^2 = (x^2+a^2)$$

$$\therefore B = \sum \frac{\mu_0}{4\pi}\frac{I\,dl}{(x^2+a^2)} \times \frac{a}{(x^2+a^2)^{\frac{1}{2}}}$$

$$= \frac{\mu_0}{4\pi}\frac{Ia}{(x^2+a^2)^{3/2}}\sum dl$$

$$\sum dl = 2\pi a$$

$$B = \frac{\mu_0}{4\pi}\frac{Ia}{(x^2+a^2)^{3/2}} \times 2\pi a$$

$$\boxed{B = \frac{\mu_0}{2}\frac{Ia^2}{(x^2+a^2)^{3/2}}}$$

(29) (a) Definition

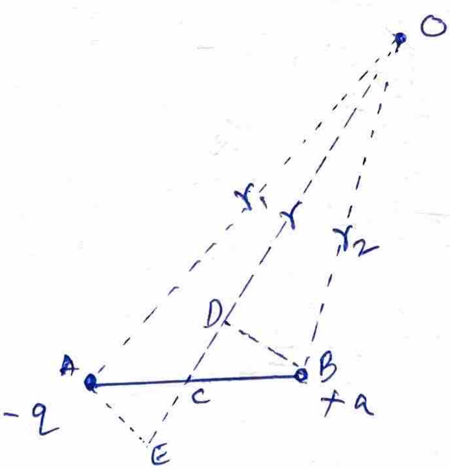
OR

$$V = \int \vec{E}\cdot\vec{dl}$$

OR

$$V = W/q$$

(b)



$$V_- = \frac{1}{4\pi\varepsilon_0}\cdot\frac{-q}{r_1} \quad \text{—(1)}$$

$$V_+ = \frac{1}{4\pi\varepsilon_0}\times\frac{q}{r_2} \quad \text{—(2)}$$

$$V = V_+ + V_-$$

$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r_2} - \frac{1}{r_1}\right] \quad \text{—(3)}$$

$$r_1 = r + CE$$

$$r_2 = r - CD$$

from the figure $CE = CD = l\cos\theta$

$$\therefore V = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r - l\cos\theta} - \frac{1}{r + l\cos\theta}\right]$$

$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{2l\cos\theta}{r^2 - l^2\cos^2\theta}\right]$$

$$\because r^2 >\!\!> l^2\cos^2\theta,\ r^2 - l^2\cos^2\theta \approx r^2$$

$$\therefore V = \frac{q}{4\pi\varepsilon_0}\left[\frac{2l\cos\theta}{r^2}\right]$$

$$\boxed{V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2}}$$

(c) $$E = -\frac{\Delta V}{\Delta x}$$

Electric intensity is the negative gradient of potential

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