SECOND YEAR HIGHER SECONDARY EXAM - MARCH - 2023

HSE II

PHYSICS

Section A

1) True
2) Ohm (Ω)
3) Magnetic dipole
4) c) electromagnetic
5) a) spherical
6) a) Roentgen
7) c) Isotopes

Section B

8) It is the net magnetic moment per unit volume

$$M = \frac{m}{V}$$

dimension $\rightarrow [L^{-1}A]$

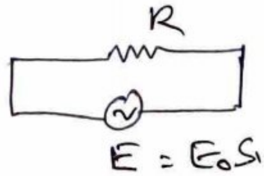
9) a)(i) whenever the magnetic flux linked with a conductor changes, an emf is induced in the conductor. The induced emf lasts as long as the change in magnetic flux last

(ii) The magnitude of induced emf is equal to rate of change in magnetic flux linked with coil (OR) $\varepsilon = \frac{d\phi_B}{dt}$

(iii) Lenz's law statement

or $\varepsilon = -\frac{d\phi_B}{dt}$

10)



$E = E_0 \sin\omega t$

$$I = \frac{E}{R} = \frac{E_0 \sin\omega t}{R}$$

$$\boxed{I = I_0 \sin\omega t}$$

11) Ampere circuital theorem is

$$\oint \vec{B}\cdot\vec{dl} = \mu_0 I_c$$

I_c is the conduction current

Maxwell added a missing term related to displacement current given by $I_d = \varepsilon_0 \frac{d\phi_E}{dt}$

$$\therefore \oint \vec{B}\cdot\vec{dl} = \mu_0 (I_c + I_d)$$

$$= \mu_0 I_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$$

This is Ampere - Maxwell law

12) When light passes from a denser to rarer medium, and when the angle of incidence is greater than critical angle, the ray reflects back to the same medium. → TIR (figure)

13) It is the minimum amount of energy required to eject an electron from the surface of a photosensitive material.

14) Nuclear fission → Splitting of large nucleus into 2 smaller nuclei along with some neutrons.

Nuclear fusion → fusion of two light nuclei to form a larger nucleus, with emission of energy.

Section C

(15) a)(i) quantisation of charge

$q = \pm Ne$

(ii) Additivity of charge

$q = q_1 + q_2 + \dots$

(iii) Scalar quantity

(iv) Conservation of charge

(16) (a) $Q = \sigma A$ — ①

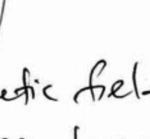
$V = Ed$

$= \frac{\sigma}{\varepsilon_0} d$ — ②

$C = \frac{Q}{V} = \frac{\sigma A}{\frac{\sigma d}{\varepsilon_0}} = \frac{\varepsilon_0 A}{d}$

(b) Increases $\left[C_m = \frac{\varepsilon_0 K A}{d}\right]$

17) a)



The magnetic field due to a small current carrying element is,

$dB \propto I$, current through conductor

$dB \propto dl$, length of the current element

$dB \propto \sin\theta$

$dB \propto \frac{1}{r^2}$

or $dB \propto \frac{I dl \sin\theta}{r^2}$

b) derivation of

$B = \frac{\mu_0}{2} \frac{IR^2}{(x^2 + R^2)^{3/2}}$

(figure also)

(18) Any 2 properties each.

(19) a) Electromagnetic induction

b) $E = -\frac{d\phi_B}{dt}$

$\phi_B = N(\vec{B} \cdot \vec{A})$

$= NBA\cos\theta$

$= NBA\cos\omega t$

$\therefore E = -\frac{d}{dt}(NBA\cos\omega t)$

$= -NBA \times -\sin\omega t \times \omega$

$= NBA\omega\sin\omega t$

$E = \underline{E_0 \sin\omega t}$

(20) Derivation of $n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin(A/2)}$

[figure

$A = r_1 + r_2$

$d = i + e - A$

$i = \frac{A+D}{2}$

$r = A/2$

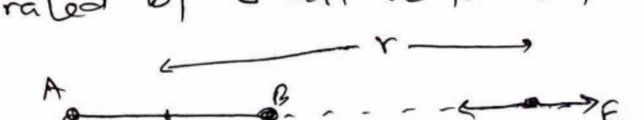
$n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin A/2}$]

(21) Explanation of Rutherford expt.

Section D

(22) a) Two equal and opposite charges separated by small vector distance

b)



$E_+ = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r-l)^2}$ — ①

$E_- = \frac{1}{4\pi\varepsilon_0} \frac{q}{(r+l)^2}$ — ②

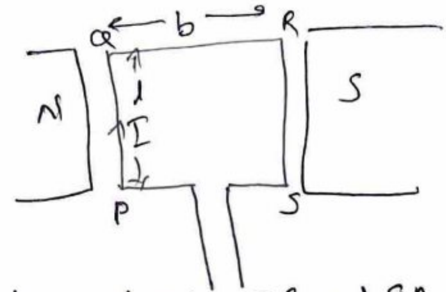
$E = E_+ - E_-$

$= \frac{q}{4\pi\varepsilon_0} \left[\frac{1}{(r-l)^2} - \frac{1}{(r+l)^2}\right]$

$= \frac{q \times 4rl}{4\pi\varepsilon_0 (r^2 - l^2)^2}$

$\boxed{E = \frac{1}{4\pi\varepsilon_0} \frac{2p}{r^3}}$

(23)



The two Arms, QR and SP experiences no force as I and B are parallel.

Force on side PQ and RS are equal in magnitude, but opposite given by,

$$F = IlB\sin\theta \quad \text{--- (1)}$$

Now, Torque,

τ = Force × ⊥r distance

$= IlB\sin\theta \times b$

$= IAB\sin\theta$

$$\boxed{\tau = MB\sin\theta}$$

(OR) $\vec{\tau} = \vec{m} \times \vec{B}$

(B) $N = 100$

$R = 10cm = 0.1m.$

$I = 3.2A$

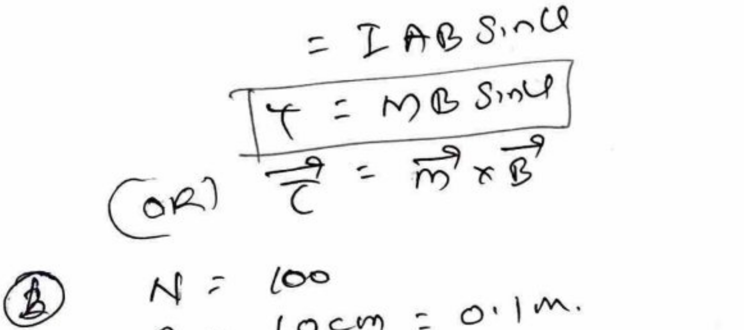
$m = NIA$

$= 100 \times 3.2 \times \pi(0.1)^2$

$= 100 \times 3.2 \times 3.14 \times 10^{-2}$

$= 10.048\ Am^2$

(24)



For The surface ABC,

$$\frac{n_2}{v_1} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1} \quad \text{--- (1)}$$

For the surface ADC, image of first surface act as virtual object

$$\therefore \frac{n_1}{v} - \frac{n_2}{v_1} = \frac{n_1 - n_2}{R_2}$$

$$= -\left[\frac{n_2 - n_1}{R_2}\right] \quad \text{--- (2)}$$

(1) + (2) ⟹

$$\frac{n_1}{v} - \frac{n_1}{u} = n_2 - n_1\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\boxed{\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$$

(B) $R_1 = +10cm$

$R_2 = -15cm.$

$f = +12\ cm.$

$$\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$\frac{1}{12} = (n-1)\left[\frac{1}{10} - \frac{1}{-15}\right]$$

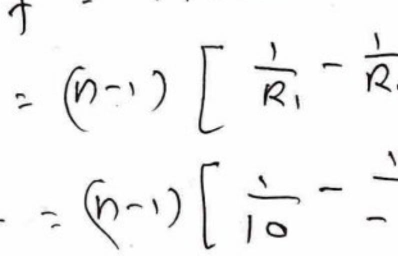
$$= (n-1)\left[\frac{15+10}{150}\right]$$

$$= (n-1)\left[\frac{1}{6}\right]$$

$$n - 1 = \frac{6}{12} = \frac{1}{2}$$

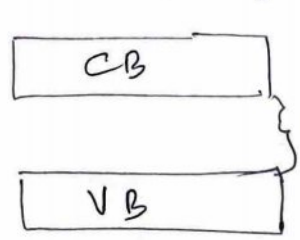
$$n = \frac{1}{2} + 1 = \underline{1.5}$$

(25)

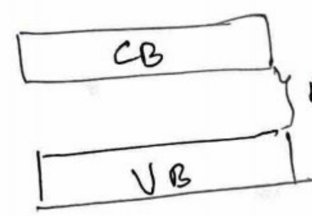


(i) Conductors — For conductors Valance band and Conduction over lap.

(ii) For insulators, Forbidden energy gap $E_g > 3eV$.



(iii) For semiconductor, $E_g < 3eV$



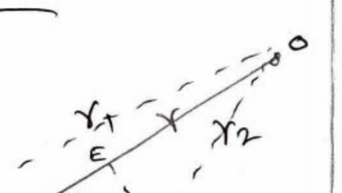
(b) Intrinsic → pure semiconductors

Extrinsic → dopped semiconductor

Section E

26 (a) $E = -\frac{dV}{dx}$

(b)



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

$V_- = \frac{1}{4\pi\varepsilon_0} \frac{-q}{r_1}$ —— (2)

$V = V_+ + V_-$

$r_1 = r + l\cos\theta$

$r_2 = r - l\cos\theta$

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

$V = \frac{1}{4\pi\varepsilon_0} \times \frac{q \times 2l\cos\theta}{r^2 - l^2\cos^2\theta}$

For $r >> l$

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

27 (a)(i) Algebraic sum of current meeting at a junction in a closed circuit is zero

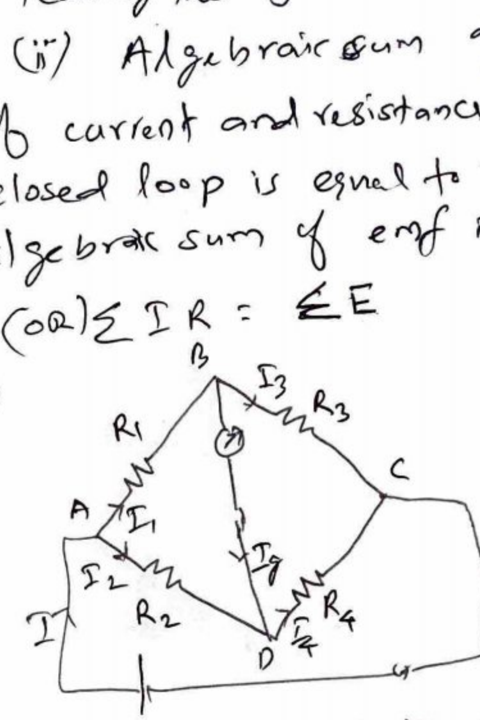
(OR)

current entering a junction = current leaving the junction (OR) $\Sigma I = 0$

(ii) Algebraic sum of product of current and resistances in a closed loop is equal to the algebraic sum of emf in that loop.

(OR) $\Sigma IR = \Sigma E$

(b)



For the loop, ABDA, Kirchoff II law,

$I_1R_1 + I_gR_G + {-I_2R_2} = 0$ —— (1)

For the loop, BCDB,

$I_3R_3 + {-I_4R_4} + {-I_gR_G} = 0$ —— (2)

when the bridge is balanced, $I_g = 0$

$I_1 = I_3$ and $I_2 = I_4$

(1) ⇒ $I_1R_1 = I_2R_2$ —— (3)

(2) ⇒ $I_1R_3 = I_2R_4$ —— (4)

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

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

(OR)

(Any correct method with $\frac{P}{Q} = \frac{R}{S}$)

(28) a) Mutual induction (OR) electromagnetic induction

(b) when an alternating current is given to the primary coil, the magnetic flux linked with the secondary coil changes, and an induced emf is produced in the secondary coil. The flux change in each coil in primary and secondary coil are the same.

$$\therefore V_p = N_p \frac{d\phi_B}{dt}$$

$$V_s = N_s \frac{d\phi_B}{dt}$$

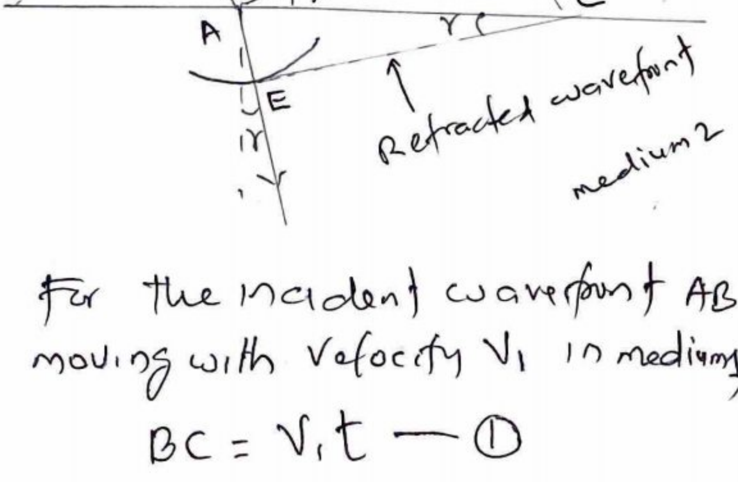
$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$ [Equation not necessary]

(c)

Step up	Step down
1) Thickness in primary	1) Thickness in secondary
2) $N_p < N_s$	2) $N_s < N_p$

(29) a) statements

(b)



For the incident wavefront AB moving with velocity V_1 in medium,

$$BC = V_1 t \quad \text{—} (1)$$

For getting the shape of refracted wave, draw a sphere of radius $V_2 t$ from point A in medium 2. Let CE be the tangent from C on to the sphere. Then,

$$AE = V_2 t \quad \text{—} (2)$$

Now, ∆les ABC and AEC gave,

$$\sin i = \frac{BC}{AC} = \frac{V_1 t}{AC}$$

$$\sin r = \frac{AE}{AC} = \frac{V_2 t}{AC}$$

$$\frac{\sin i}{\sin r} = \frac{V_1 t}{V_2 t} = \frac{V_1}{V_2} \quad \text{—} (3)$$

But $n_1 = \frac{c}{V_1}$ and $n_2 = \frac{c}{V_2}$

$$\therefore \frac{\sin i}{\sin r} = \frac{V_1}{V_2} = \frac{n_2}{n_1}$$

is the snell's law.

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