SY-224

SECOND TERMINAL EXAMINATION - DECEMBER 2024

HSE II

PHYSICS

I) Any 5 (1-7) - 5×1=5

1) UV ray.

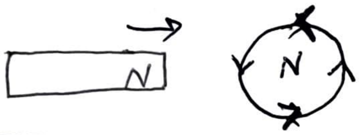
2) Polarisation

3) Reflecting telescope

4) $P = I^2R$ (OR) $P = VI$ (OR) $P = \frac{V^2}{R}$
[Hint : At resonance $Z = R$, $\phi = 0$ ($P = I^2Z\cos\phi$)]

5) Decreases.

6) $\mu_r = 1 + \chi = 1 + 5499 = 5500$

7) 

II) Any 5 (8-14) 5×2=10

8) $q = Ne$
$N = \frac{q}{e} = \frac{3\times10^{-7}}{1.6\times10^{-19}} = 1.875\times10^{12}$ electron

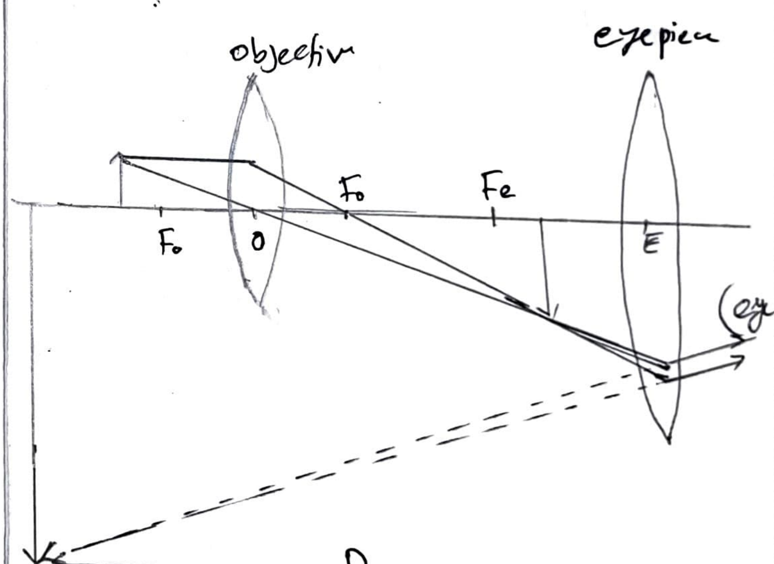
9) Electric field
1) It is produced by stationary charge
2) Electric field is angle independant

Magnetic field
1) produced by moving charge.
2) Magnetic field is angle dependant
(OR) (Any 2 differences)

10) The net magnetic flux through any closed surface is zero
$\oint \vec{B}\cdot\vec{ds} = 0$ (OR) $\sum_{all} \vec{B}\cdot\vec{\Delta S} = 0$

11) Displacement current is current due to change in electric flux.
$I_d = \varepsilon_0 \frac{d\phi_E}{dt}$

12) $|\varepsilon| = L\frac{dI}{dt}$ $\frac{dI}{dt} = \frac{5-0}{0.1} = 50$ A/s.
$L = \frac{|\varepsilon|}{(dI/dt)} = \frac{200}{50} = 4$ H $E = 200$ V.

(13) 

14) a) spherical wave front
b) plane "

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III) Any 6 (15-21) $6 \times 3 = 18$

15) a) $U_p = -\vec{p} \cdot \vec{E}$

$= -pE\cos\theta$

b) $q_1 = -1.6 \times 10^{-19} C$

$q_2 = +1.6 \times 10^{-19} C$

$r = 1$ Fermi $= 10^{-15} m$

$U_p = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r}$

$= 9 \times 10^9 \times \frac{-1.6 \times 10^{-19} \times 1.6 \times 10^{-19}}{10^{-15}}$

$= -9 \times 1.6 \times 1.6 \times 10^{-14}$

$= -23.04 \times 10^{-14} J$

16) a) Dia magnetic

1) weak force of repulsion towards magnets

2) moving from stronger to weaker regions when placed in non-uniform magnetic field

b) Para magnetic

1) weak force of attraction towards magnets

2) moving from weaker to stronger regions when placed in non-uniform magnetic field.

c) Ferromagnetic

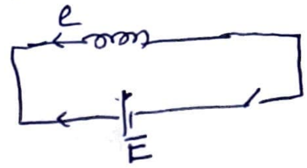
1) strong force of attraction towards magnets

2) moving from weaker to stronger region when placed in non-uniform magnetic field.

(OR) Any 2 properties.

17) a) henry (H)

b)



~~Kirchhoff loop rule~~

$E - e = 0$

Rate of workdone,

$\frac{dw}{dt} = |E| I$

$= L\frac{dI}{dt} \times I$

$dw = LI\,dI$

$W = \int dw = \int_0^I LI\,dI$

$= \frac{1}{2}LI^2$, is stored as potential energy

$$\boxed{U_p = \frac{1}{2}LI^2}$$

18) a)

$V = V_m \sin\omega t$

$q = CV$

$= CV_m \sin\omega t$

$I = \frac{dq}{dt} = \frac{d}{dt}(CV_m \sin\omega t)$

$= CV_m \times \cos\omega t \times \omega$

$= \frac{V_m}{(1/C\omega)} \times \cos\omega t$

$I = \frac{V_m}{X_C} \times \sin(\omega t + \pi/2)$

$$\boxed{I = I_m \sin(\omega t + \pi/2)}$$

b) Zero

19) $\frac{1}{f} = (n_{21} - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

19) b) $n_2 = 1.55$

$n_1 = 1$

$f = 20\text{ cm}$

$R_1 = +R$ & $R_2 = -R$

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

$$\frac{1}{20} = \left(\frac{1.55}{1} - 1\right)\left(\frac{1}{R} - \frac{1}{-R}\right)$$

$$= 0.55 \times \frac{2}{R}$$

$$R = 0.55 \times 2 \times 20$$

$$= \underline{22\text{ cm}}$$

20) a) For dark bands, the path difference between two waves reaching at a point should be $\delta = (2n-1)\frac{\lambda}{2}$, $n = 1, 2, 3 \ldots$

For bright bands,

$\delta = n\lambda$ $\quad n = 0, 1, 2 \ldots$

b) The sources should be coherent for sustained pattern.

(Any 2 condition.)

b) $\beta = \frac{\lambda D}{d}$

$D = 1.4\text{ m}$

$d = 0.28 \times 10^{-3}\text{ m}$

$$\lambda = \frac{\beta d}{D}$$

$$= \frac{0.3 \times 10^{-2} \times 0.28 \times 10^{-3}}{1.4}$$

$$= 0.06 \times 10^{-5}\text{ m}$$

$$= \underline{6 \times 10^{-7}\text{ m}}$$

$x = n\beta$

$\beta = \frac{x}{n}$

$= \frac{1.2\text{ cm}}{4}$

$= 0.3\text{ cm}$

$= 0.3 \times 10^{-2}\text{ m}$

21) a) Radar system, microwave oven

b) $f = 25 \times 10^6\text{ Hz}$

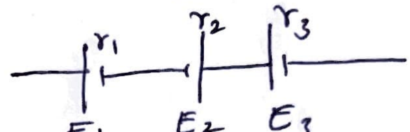
$\vec{E} = 6.3\,\hat{j}\text{ V/m}$

$B = \frac{E}{c} = \frac{6.3}{3 \times 10^8} = 2.1 \times 10^{-8}$

$\vec{B} = 2.1 \times 10^{-8}\,\hat{k}\text{ T}$

IV) Any 3 (22-25) $\quad 3 \times 4 = 12$

22) ⓐ

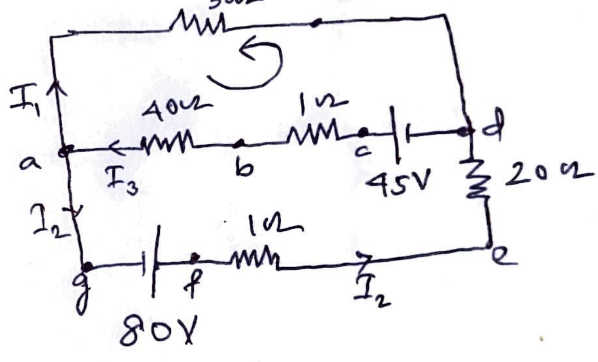


In series, $E_{eff} = E_1 + {-E_2} + E_3$

$= E_1 + E_3 - E_2$

$r_{eff} = r_1 + r_2 + r_3$

b)



(i) $I_1 + I_2 = I_3$

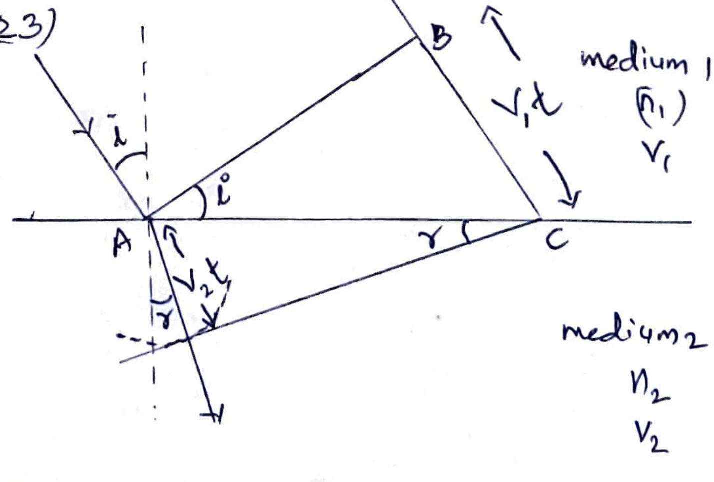
(ii) abdha

$-40I_3 + -I_3 + -30I_1 + 45 = 0$

(OR)

$30I_1 + I_3 + 40I_3 = 45$

(23)



AB is incident wavefront and CE is the refracted wavefront.

$\Delta ABC \rightarrow \sin i = \frac{BC}{AC} = v_1 t$

$\Delta AEC \rightarrow \sin r = \frac{AE}{AC} = v_2 t$

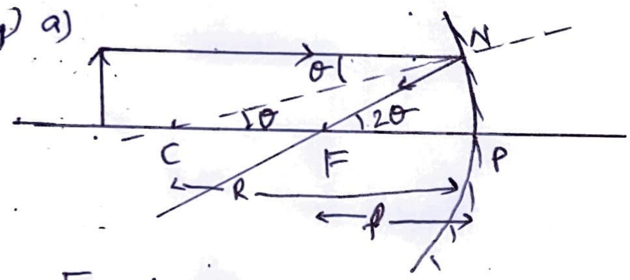
$$\frac{\sin i}{\sin r} = \frac{BC}{AE} = \frac{v_1 t}{v_2 t} = \frac{v_1}{v_2} \quad \text{—} (1)$$

We have, $n_1 = \frac{c}{v_1}$; $n_2 = \frac{c}{v_2}$

$$\frac{v_1}{v_2} = \frac{n_2}{n_1}$$

$$\therefore \frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{n_2}{n_1} \Rightarrow \text{Snell's law}$$

(24) a)



For $\angle NCP$, $\theta = \frac{PN}{R}$ — (1)

for $\angle NFP$ $2\theta = \frac{PN}{f}$

$\theta = \frac{PN}{2f}$ — (2)

From (1) and (2), $\Rightarrow$ $\boxed{R = 2f}$

b) $f_1 = 30\,cm$

$f_2 = -20\,cm$

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$f = \frac{f_1 f_1}{f_2 + f_1} = \frac{30 \times -20}{-20 + 30}$$

$$= -\frac{30 \times 20}{10}$$

$$= -60\,cm$$

diverging

(25) a) 1) Heat loss / copper loss
2) Flux leakage loss
3) Hysteresis loss
4) Eddy current loss (Any 2)

b) $L = 44 \times 10^{-3}\,H$

$f = 50\,Hz$

$V_{rms} = 220\,V$

$X_L = L\omega = L \times 2\pi f$

$= 44 \times 10^{-3} \times 2 \times 3.14 \times 50$

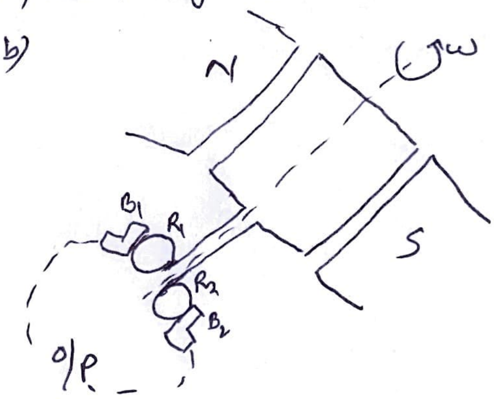
$= 13.816\,\Omega$

$$I_{rms} = \frac{V_{rms}}{X_L} = \frac{220}{13.816} = 15.92\,A$$

Any 3 (26 − 29) (3×5 = 15)

26) a) electromagnetic induction

b)



× explanation

× $E = -N\frac{d\phi}{dt}$ — (1)

$\phi = \vec{B} \cdot \vec{A}$

$= BA\cos\omega t$

$E = -N\frac{d}{dt}(BA\cos\omega t)$

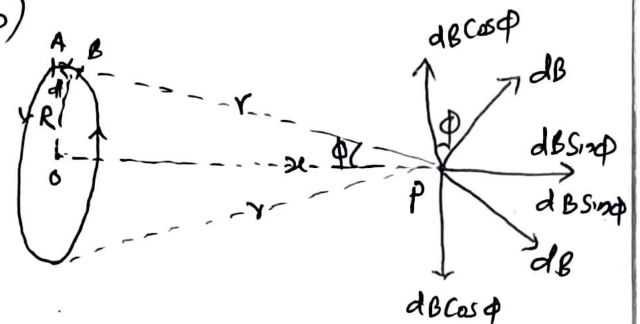
$= -NBA \times -\sin\omega t \times \omega$

$= NBA\omega \sin\omega t$

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

27) a) $\oint \vec{B}\cdot\vec{dl} = \mu_0 \Sigma I$

b)



Biot-savart law,

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

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

Total magnetic field at P,

$$B = \oint dB \sin\phi$$

$$= \Sigma \frac{\mu_0}{4\pi} \frac{I\,dl}{r^2} \sin\phi \quad —②$$

$$r^2 = x^2 + R^2$$

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

$$B = \Sigma \frac{\mu_0}{4\pi} \frac{I\,dl}{(x^2+R^2)} \times \frac{R}{(x^2+R^2)^{1/2}}$$

$$= \frac{\mu_0}{4\pi} \frac{IR}{(x^2+R^2)^{3/2}} \Sigma dl$$

$$= \frac{\mu_0}{4\pi} \frac{IR}{(x^2+R^2)^{3/2}} \times 2\pi R$$

$$= \frac{\mu_0}{4\pi} \frac{2I \times \pi R^2}{(x^2+R^2)^{3/2}}$$

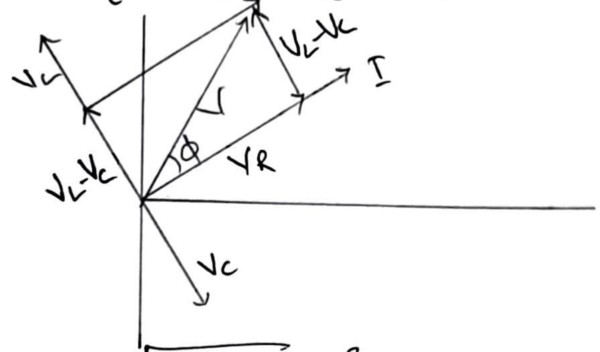
$$\boxed{B = \frac{\mu_0}{4\pi} \frac{2IA}{(x^2+R^2)^{3/2}}}$$

28) $I = I_0 \sin\omega t$

$V_R = V_0 \sin\omega t$

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

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



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

$$= \sqrt{I^2R^2 + (IX_L - IX_C)^2}$$

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

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

b) At resonance

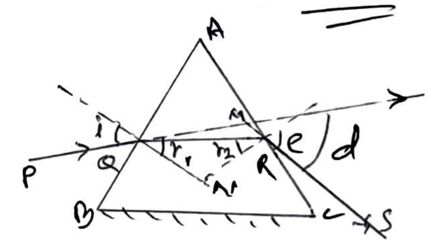
$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$= \frac{1}{2\pi\sqrt{5 \times 80 \times 10^{-6}}}$$

$$= \frac{1}{2\pi \times 20 \times 10^{-3}}$$

$$= 7.96\ Hz$$

29)



□ AQNR, $A + 90 + N + 90 = 360°$

$A + N = 180$ —①

△ QNR, ⇒ $r_1 + r_2 + N = 180$

$\boxed{A = r_1 + r_2}$ —②

$d = (i - r_1) + (e - r_2)$

$d = i + e - (r_1 + r_2) = i + e - A$ —③

b) $i = e$

$r_1 = r_2 = r$