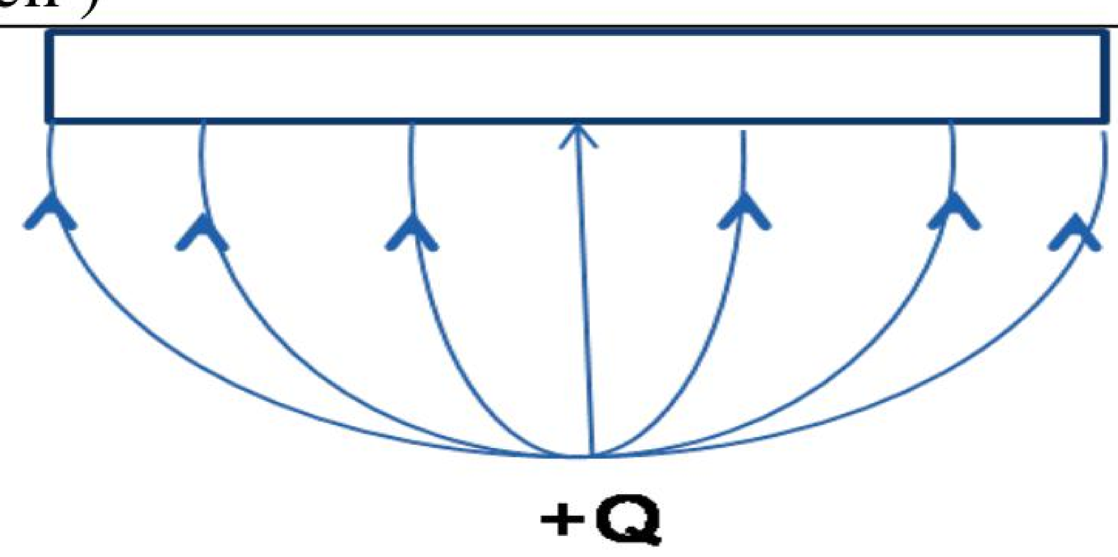
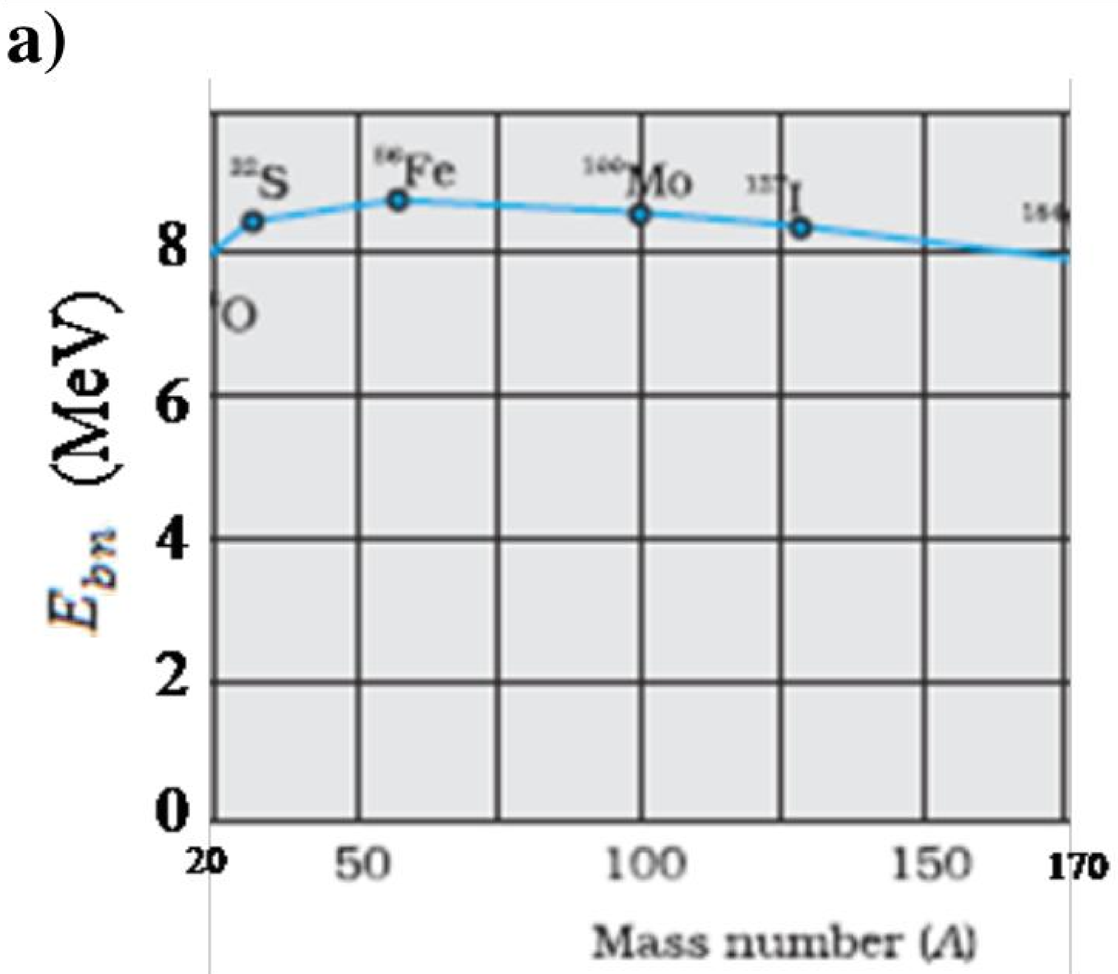
SET : 55/2

MARKING SCHEME

Q. No.	Expected Answer/ Value Points SECTION A	Marks	Total Marks
Q1	Because waves of frequency greater than 30 MHz penetrate through the ionosphere and do not get reflected by it.	1	1
Q2	Definition ½ SI Unit ½ Conductivity is reciprocal of resistivity $\sigma = \frac{1}{\rho}$ SI unit : S(siemen)	 ½ ½	 1
Q3		1	1
Q4	Resolving power is same (it does not depend on focal length of the objective.) Alternatively: Ratio of resolving power = 1:1	1	1
Q5	Accept both the answers : A : +ve ; B: -ve or A : -ve ; B: +ve	1	1
	SECTION B		
Q6	Emf of cell 1 Internal resistance 1 a) E = V for I =0 $\therefore E = 6$ V b) E = V + i r $\therefore 6 = 4 + r$ $r = 2\ \Omega$	 ½ ½ ½ ½	 2
Q7	Two points of Distinction 1 + 1 i. Sky wave propagation uses reflection from ionosphere whereas space waves propagation uses line of sight of propagation. ii. Sky wave propagation is for waves of frequency between 3 to 30 MHz whereas space waves propagation is preferred for waves of frequency more than 40 MHz [Also accept or any other correct distinction]	 1 1	 2

Q8	Definition 1 Calculation of Speed 1 i. Refractive index of a medium is the ratio of speed of light (c) in free space to the speed of light (v) in that medium. $\mu = \frac{c}{v}$ ii. $\mu = \frac{c}{v} = \frac{1}{sin\, i_c}$ $= \frac{3 \times 10^8}{v} = \frac{1}{30/50}$ $v = \frac{30}{50} \times 3 \times 10^8 = 1.8 \times 10^8\, m/s$	**1** ½ ½	 **2**
Q9	Two Characteristics ½ + ½ Relation 1 a) i. Nuclear force is much stronger than the Coulomb or gravitational force. ii. It is a very short range force, leads to saturation of forces. iii. Nuclear force is charge independent **[Any two]** $T_{1/2} = \frac{ln2}{\lambda} = \frac{0.693}{\lambda}$ **OR** Formula 1 Calculation 1 $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mk}}$ $\therefore$ 1 x $10^{-10} = \frac{6..63\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}K}}$ $\therefore$ K = $\frac{(6..63\times10^{-34})^2}{10^{-20}\times2\times9.1\times10^{-31}}$J =2.4 $\times\ 10^{-17}$J =1.5 $\times\ 10^{2}$eV = 150eV	½ ½ **1** **1** **1**	 **2**
Q10	Formula 1 Comparison of the rates of disintegration 1 $\frac{dN}{dt} = -\lambda N; N = N_o e^{-\lambda t}$ Given time = 12hrs = $4(T_x)_{\frac{1}{2}}$ $= 3(T_y)_{\frac{1}{2}}$	½	

	$\therefore \frac{N_x}{N_o} = \left(\frac{1}{2}\right)^4 = \frac{1}{16} => N_x = \frac{N_o}{16}$	½	
	and $\frac{N_y}{N_o} = \left(\frac{1}{2}\right)^3 = \frac{1}{8} => N_y = \frac{N_o}{8}$ $R_x = \left(\frac{dN}{dt}\right)_x = \frac{.693}{\left(T_{1/2}\right)_x} \cdot \frac{N_o}{16}$ $R_y = \left(\frac{dN}{dt}\right)_y = \frac{.693}{\left(T_{1/2}\right)_y} \cdot \frac{N_o}{8}$	½	
	$\therefore \frac{R_x}{R_y} = \frac{1}{2}\frac{\left(T_{1/2}\right)_x}{\left(T_{1/2}\right)_y} = \frac{1}{2} \times \frac{4}{3} = \frac{2}{3}$	½	**2**
	SECTION C		
Set1 Q11	Reason 1 Ratio of Intensity 2		
	If sources are not coherent, the superposition pattern (the intensity pattern) is not stable. It keeps on changing with time	½	
	$\therefore$ It is necessary to have coherent sources to observe interference.	½	
	$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$	½	
	$I_{max} = I_1 + I_2 + 2\sqrt{I_1 I_2};\ \phi = 0$	½	
	$I_{min} = I_1 + I_2 - 2\sqrt{I_1 I_2};\ \phi = \pi$	½	
	$\therefore \frac{I_{max}}{I_{min}} = \frac{4x + 9x + 12x}{4x + 9x - 12x} = \frac{25x}{x}$ $= \frac{25}{1}$	½	
	Alternatively : $\frac{A_1}{A_2} = \sqrt{\frac{I_1}{I_2}} = \frac{2}{3}$	½	
	$\therefore \frac{I_{max}}{I_{min}} = \left(\frac{A_2 + A_1}{A_2 - A_1}\right)^2 = \left(\frac{3+2}{3-2}\right)^2 = \frac{25}{1}$	½ + ½ + ½	**3**
Q12	Effect on capacitance 1 Effect on charge 1 Effect on energy 1		
	i. $C = \frac{\epsilon_o A}{d}$	½	

	$C' = \frac{K\epsilon_o A}{d'} = \frac{10}{3}\frac{\epsilon_o A}{d} = \frac{10}{3}C$ ii. V remains same since battery is not disconnected $\therefore Q' = C'V$ $= \frac{10}{3}CV = \frac{10}{3}Q$ iii. Energy density, $u_d = \frac{1}{2}\epsilon_o E^2$ $E = \frac{V}{d}$ $u'_d = \frac{1}{2}K\epsilon_o E'^2$ $= \frac{10}{2}\epsilon_o \left(\frac{V}{d'}\right)^2$ $= \frac{10}{9}\left(\frac{1}{2}\epsilon_o E^2\right)$ $= \frac{10}{9}u_d$	½ ½ ½ ½ ½	3
Q13	Energy of Photon — 1 Einstein's Equation — 1 Calculation of work function — 1 Energy of photon = [(13.6)-(3.4)]eV = 10.2eV $E = eV_o + \phi_o$ $\therefore 10.2 = 5 + \phi_o$ $\therefore \phi_o = 5.2\ eV$	1 1 ½ ½	3
Q14	Graph of BE — 1 Calculation of energy released — 2 **a)**  b) Energy released = [(110+130) x 8.5 – 240 x 7.6] MeV = 240(8.5 – 7.6) MeV = 216 MeV	1 1 1	3

Q15

Reason for use in reverse bias	1
Working Principle	1
Whether it can detect	1

The fractional change, due to photo effects, on the minority charge carrier dominated reverse bias current, is much more than the fractional change in the forward bias current. Hence, photodiode is used in reverse bias. **1**

Working principle of photodiode:

i. Generation of e –h pairs due to light close to junction. **½**

ii. Separation of electrons and holes due to electric field of the depletion region. **½**

Detection is possible if $E_p > E_g$ **½**

$$E_p = \frac{hc}{\lambda} \text{ J}$$

$$= \frac{hc}{e\lambda}\ eV$$

$$= \frac{6.63\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}\times400\times10^{-9}} = 3.1 \text{ eV}(>\text{Eg})$$

∴ It can detect this light **½** **3**

Q16

Name of em wave	1
Method of generation	1
Two uses	½ + ½

Microwaves **1**

Produced by special vacuum tubes

- Klystron, magnetron, gunn diodes **1**

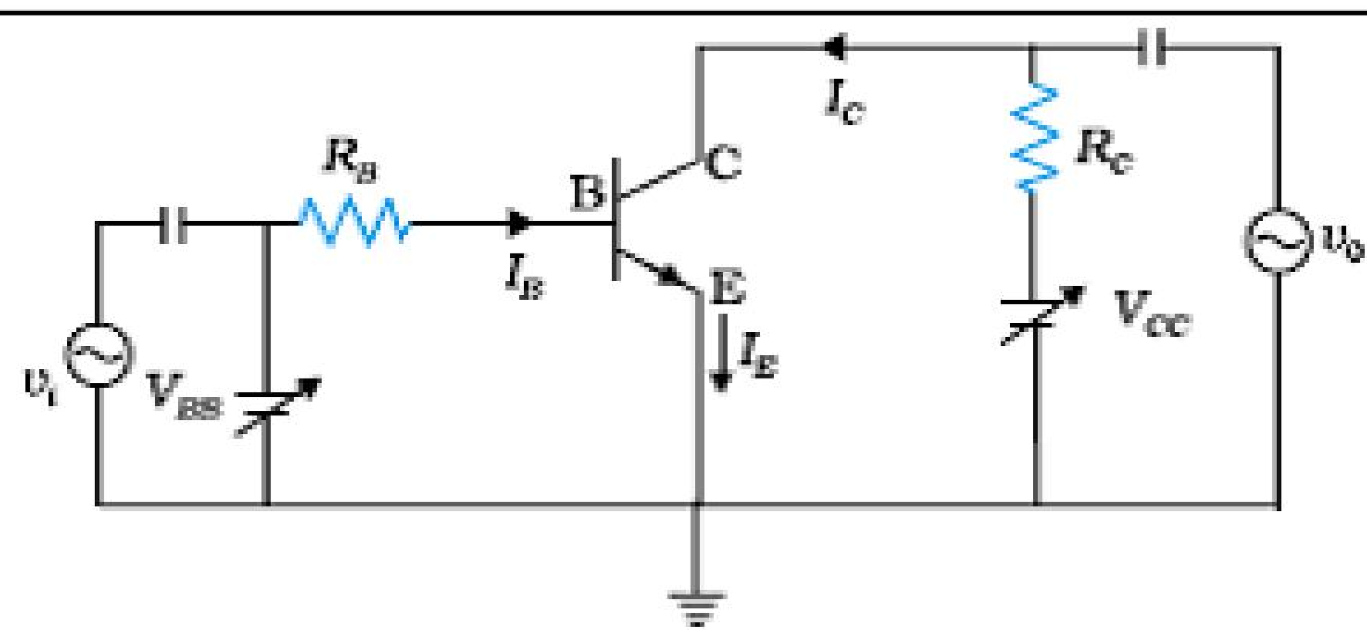
Uses

i. In Radar system for aircraft navigation **½ + ½**

ii. In ovens for heating/ cooking **3**

Q17

Circuit diagram	1
Expression for voltage gain	1
Explanation for 180^o phase difference	1



1

$$A_V = \frac{V_o}{V_i} = \frac{\Delta V_{CE}}{r\Delta I_B} = -\beta_{ac}\frac{R_L}{r}$$ **1**

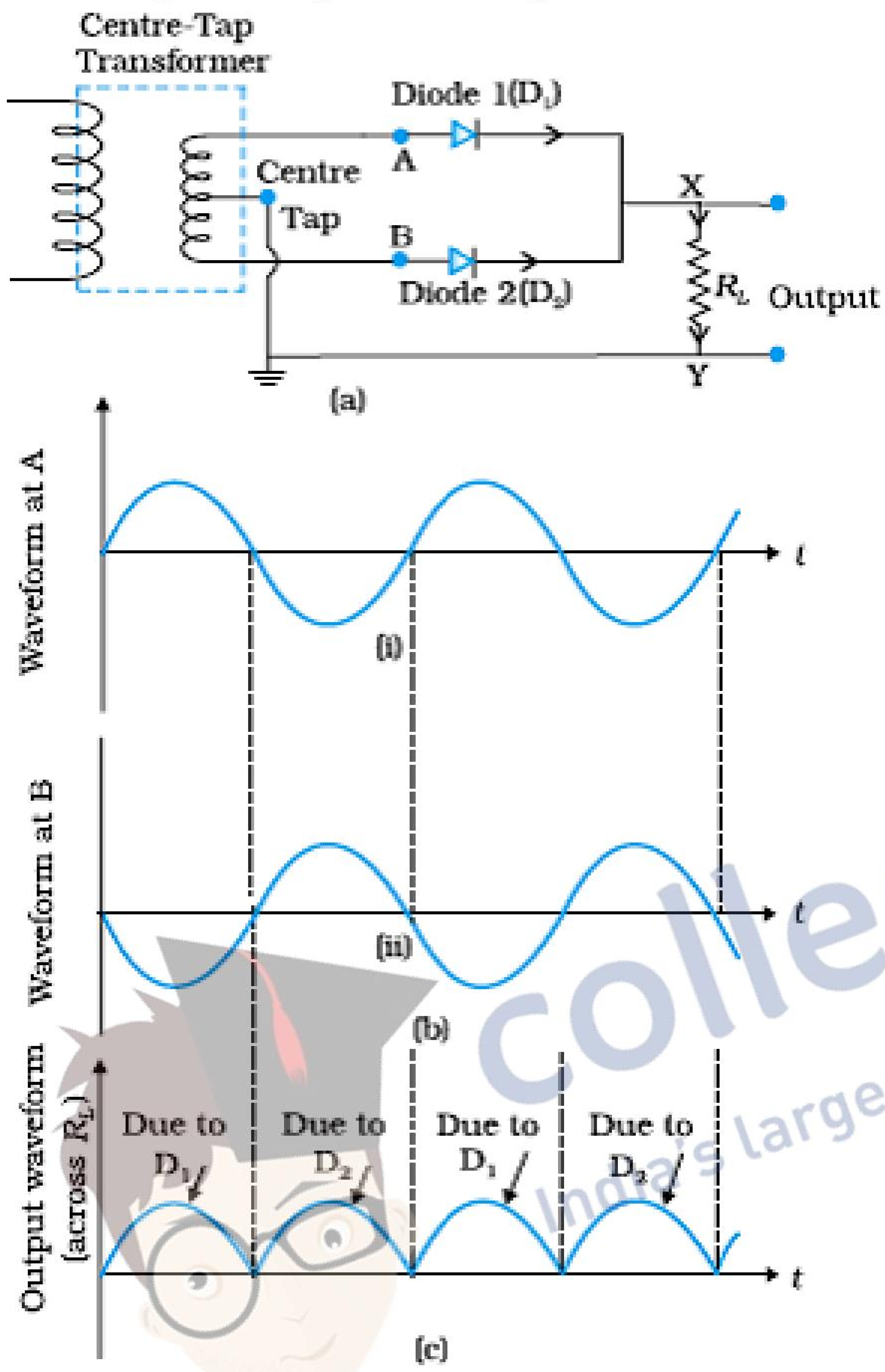
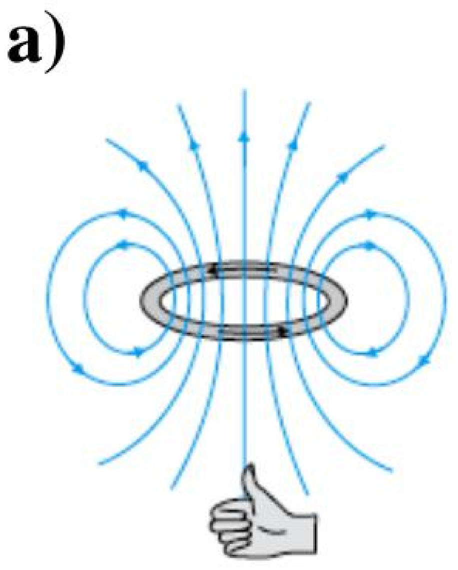
$V_{CC} = V_{CE} + I_C R_L$ **½**

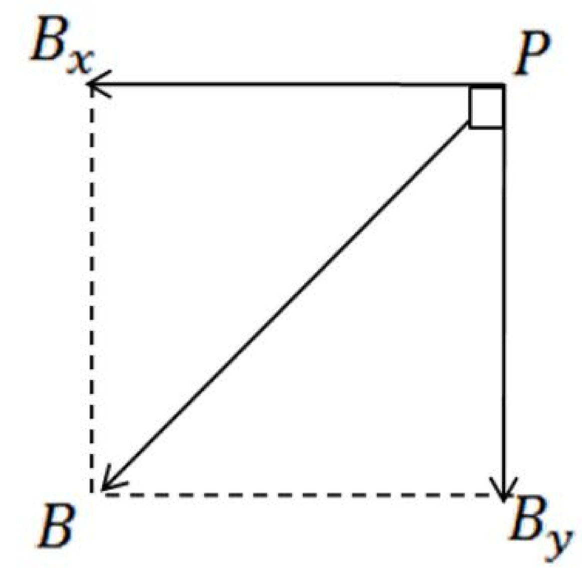
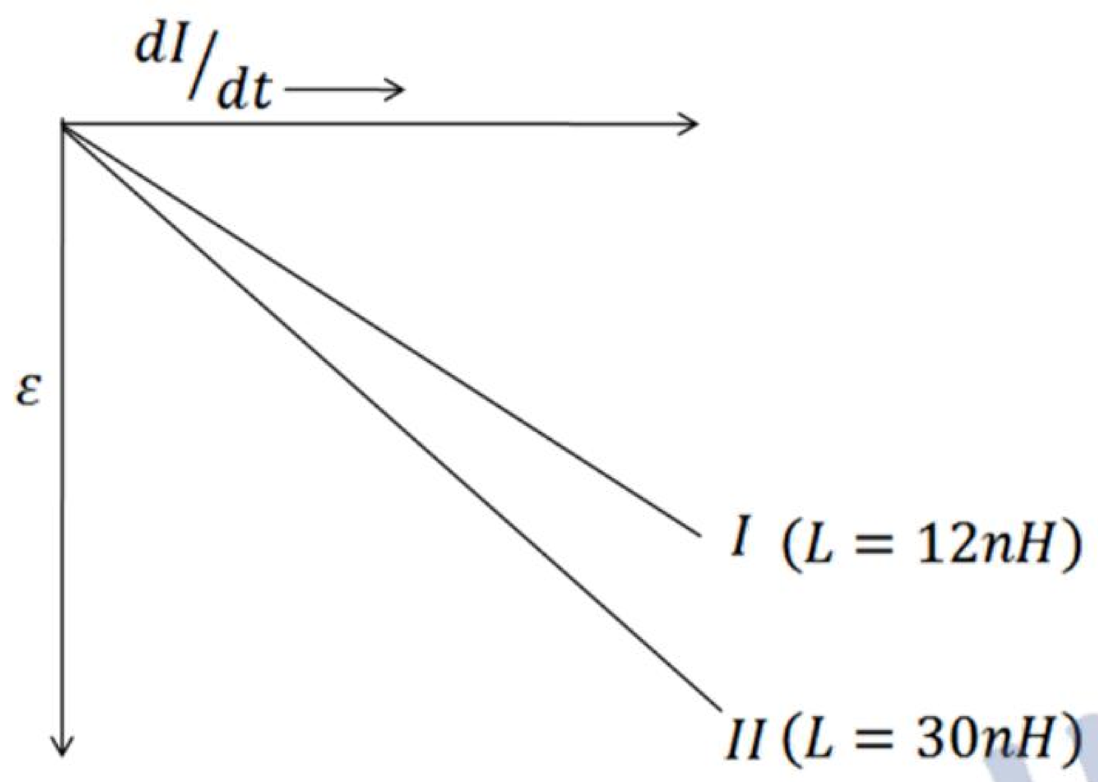
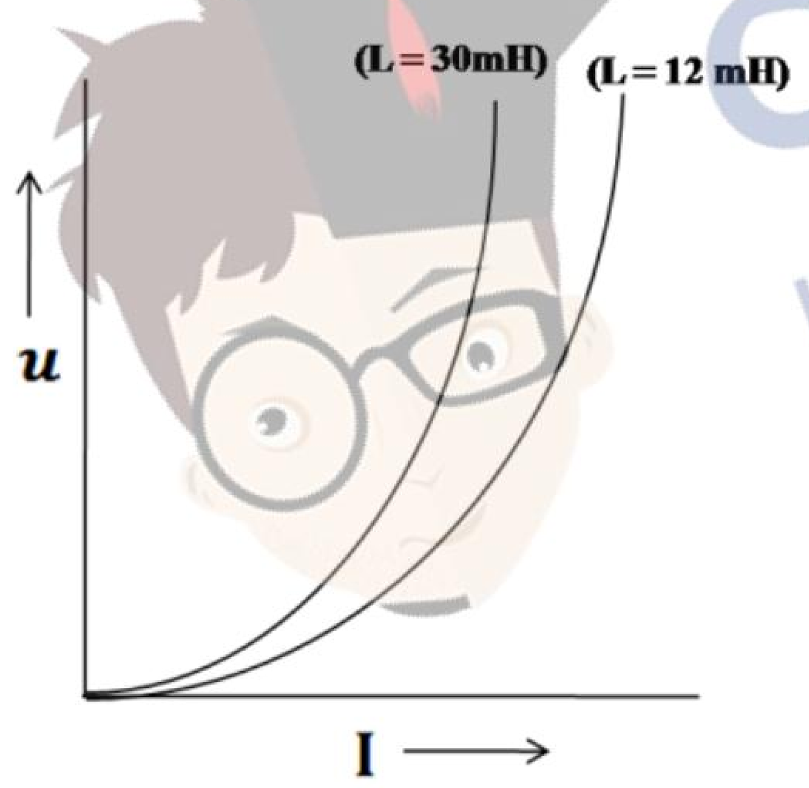
∴ $\Delta V_{CC} = \Delta V_{CE} + R_L \Delta I_C = 0$

∴ $\Delta V_{CE} = -R_L \Delta I_C$ **½**

Hence, change in output is negative when the input signal is +ve.

This shows 180^0 phase difference between input and output signal.

	OR Circuit of full wave rectifier 1 Working Principle 1 Input and output waveforms 1 Circuit diagram; input and output waveforms;  	1 ½ ½	
	<u>Working Principle:</u> When A is +ve, B is negative Only D_1 conducts because it is forward biased Current in R_L flows from X to Y When B is positive and A is negative, only D_2 conducts and Current in R_L is once again from X to Y.	½ ½	3
Q18	a) Diagram of magnetic field line pattern 1 b) Calculation of Magnetic field 1 ½ Direction ½ **a)** 	1	

	b) $B_x = B_y = \frac{\mu_o i R^2}{2(R^2+x^2)^{\frac{3}{2}}}$ 	1	
	$B = \sqrt{2}\,B_x$ $= \frac{\sqrt{2}\,\mu_o i R^2}{2(R^2+x^2)^{\frac{r}{2}}}$;	½	
	making 45^0 with either B_x or B_y	½	3
Q19	Graph of emf ½ Graph of energy stored ½ Ratio of energy stored 2		
	a) 	½	
	b) 	½	
	$\frac{u_1}{u_2} = \frac{\frac{1}{2}L_1 i_1^2}{\frac{1}{2}L_2 i_2^2}$	½	
	But $\varepsilon_1 i_1 = \varepsilon_2 i_2$ ($\because$power dissipated is same)	½	
	$\therefore \frac{i_1}{i_2} = \frac{\varepsilon_2}{\varepsilon_1} = \frac{L_2}{L_1}$ $\left(\because \frac{dI}{dt} \text{ is same and } \varepsilon = -L\frac{dI}{dt}\right)$	½	
	$\therefore \frac{u_1}{u_2} = \frac{L_1}{L_2}\left(\frac{L_2}{L_1}\right)^2$ $= \frac{L_2}{L_1} = \frac{30}{12} = 2.5$	½	3

Q20	Two points of distinction ½ + ½ Calculation of separation between maxima 2 i. All fringes in interference pattern have same width; in diffraction central maxima is twice the width of secondary maxima. ii. Intensity of all maxima is same in interference pattern; in diffraction higher order maxima have lower intensities [alternatively maxima do not have same intensity] Separation $\Delta x = x_2 - x_1$ $= \frac{5}{2}\frac{\lambda_2 D}{a} - \frac{5}{2}\frac{\lambda_1 D}{a} = \frac{5}{2}\frac{D}{a}(\lambda_2 - \lambda_1)$ $= \frac{5}{2}\left(\frac{2}{2\times 10^{-3}}\right) \times 10 \times 10^{-9}\text{m}$ $= 2.5 \times 10^{-5}\text{m}$	½ ½ 1 1	3
Q21	Three factors justifying the Need for modulation 1+1+1 i. Size of antenna – The antenna should have a size comparable to the wavelength of signal (at least $\lambda/4$). For low frequency (unmodulated) signal λ may be a few km. It is not possible to have such a long antenna. Hence low frequency transmission is not possible directly. ii. Power radiated by antenna – Power radiated by an antenna of length ℓ is proportional to $\left(\ell/\lambda\right)^2$. Therefore, for same ℓ, power radiated increases with decreasing λ i.e. increasing frequency. Hence, for low frequency signal, power radiated by antenna is very small and good transmission of signal is not possible. **iii.** Mixing up of signals: All the low frequency (baseband) signals from various transmitters, can get mixed up because they have the same frequency range. They can be separated only if communication is done at high frequency and different band of frequencies are allotted to different transmitters.	1 1 1	3
Q22	Definition of current sensitivity 1 Ratio $\frac{R_1}{R_2}$ Current sensitivity of a galvanometer is deflection per unit current (Alternatively $I_s = \frac{\phi}{I} = \frac{NAB}{K}$) In circuit i. $\frac{6}{9} = \frac{R_1}{12} => R_1 = 8\Omega$ ii. $\frac{9}{R_2} = \frac{15}{10} => R_2 = 6\Omega$ $\therefore \frac{R_1}{R_2} = \frac{4}{3}$	1 ½ ½ 1	3

*These answers are meant to be used by evaluators

SECTION D

Q23

Two values of Mr. Hiorki	1
Two values of Mr. Kamath	1
Meissner effect	1
Value of μ_r	1

a) Eager to share ideas and knowledge; Professionalism; Environment friendly nature. (any two) — ½ + ½

b) Eager to learn (open minded); observant; appreciating good ideas.(any two) — ½ + ½

c) Phenomenon of perfect diamagnetism in super conductors — **1**

$\mu_r = 0$ — **1** — **4**

SECTION E

Q24

a) Average Power dissipation is zero	2
b) Numerical	3

a) Instantaneous Power = $vi = V_o sinwt\ I_o coswt$

Average power, P = $\frac{1}{T}\int_o^T vidt$ — ½

$= \frac{V_o I_o}{2T}\int_o^T 2\ sinwt\ coswt\ dt$ — ½

$= \frac{V_o I_o}{2T}\int_o^T\ sin2wt\ dt$ — ½

$= 0$ — ½

b)

i. $\omega_o = \frac{1}{\sqrt{LC}}$ — ½

$= \frac{1}{(200\times10^{-3}\times400\times10^{-6})^{\frac{1}{2}}}$

$= \frac{1}{\sqrt{8\times10^{-5}}}\ s^{-1} = \frac{10^3}{\sqrt{80}}\ s^{-1} \simeq 111s^{-1}$ — ½

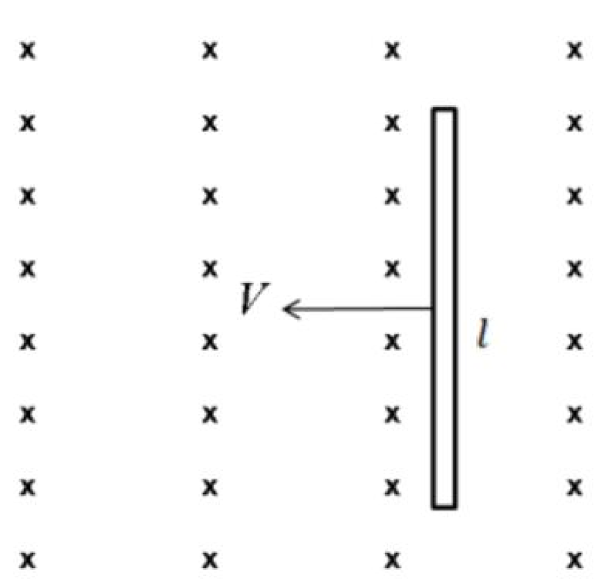
$I = \frac{V}{R} = \frac{50}{10} = 5\ A$ — **1**

ii. $Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{10}\sqrt{\frac{200\times10^{-3}}{400\times10^{-6}}} = \sqrt{5}$ — **1** — **5**

OR

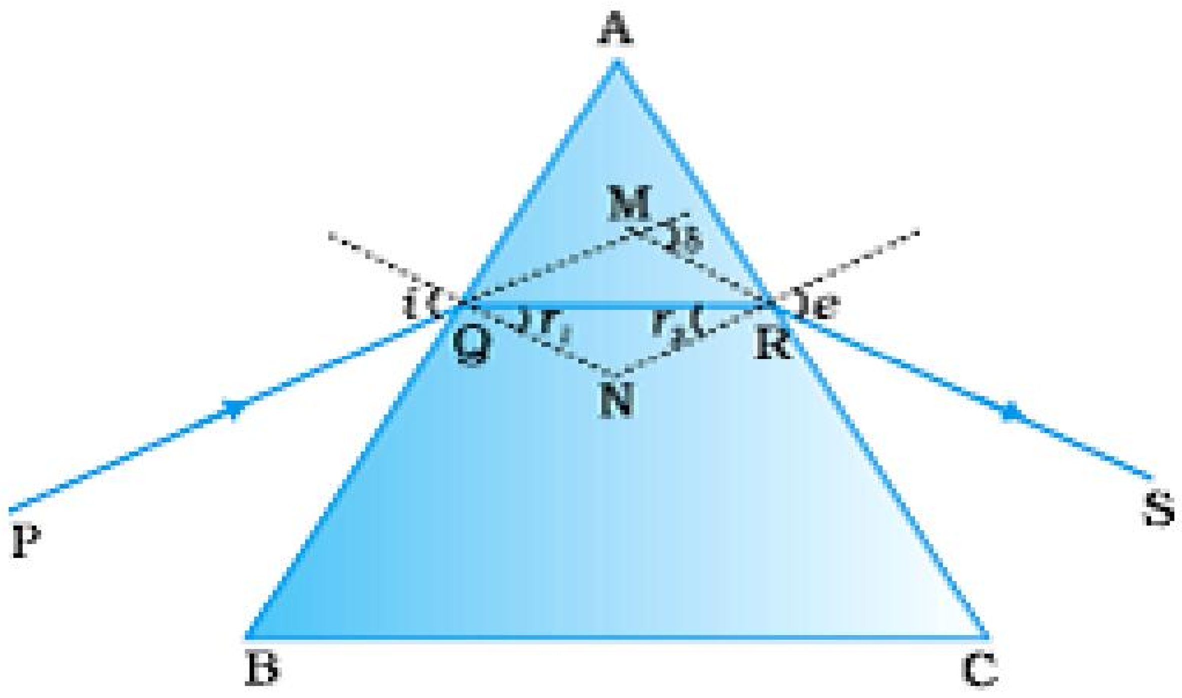
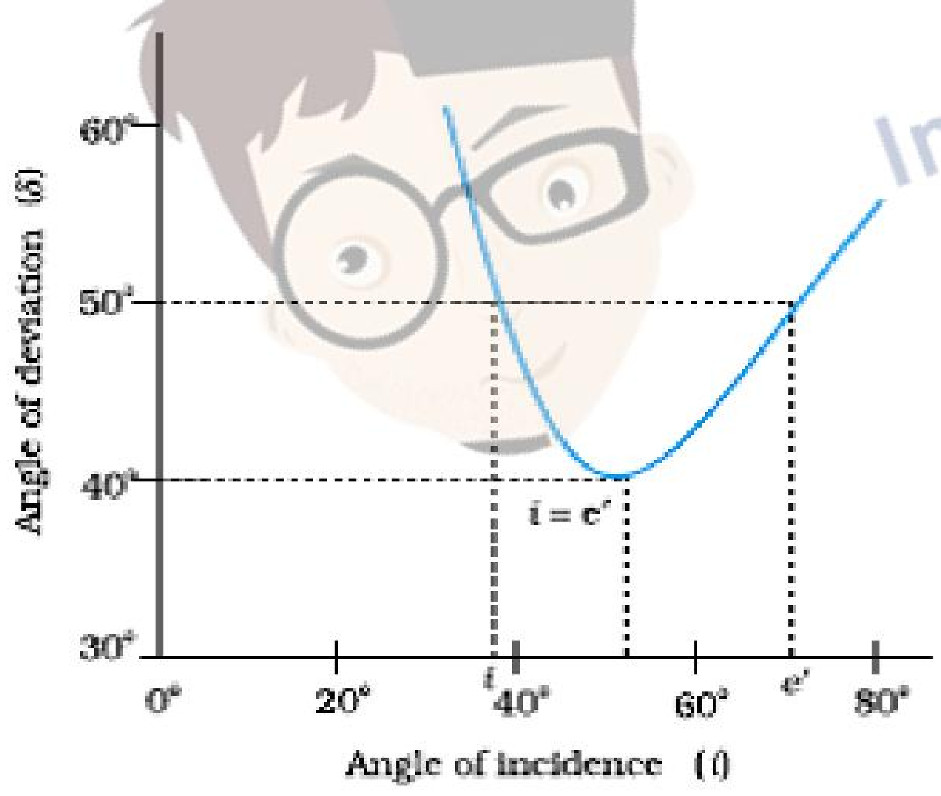
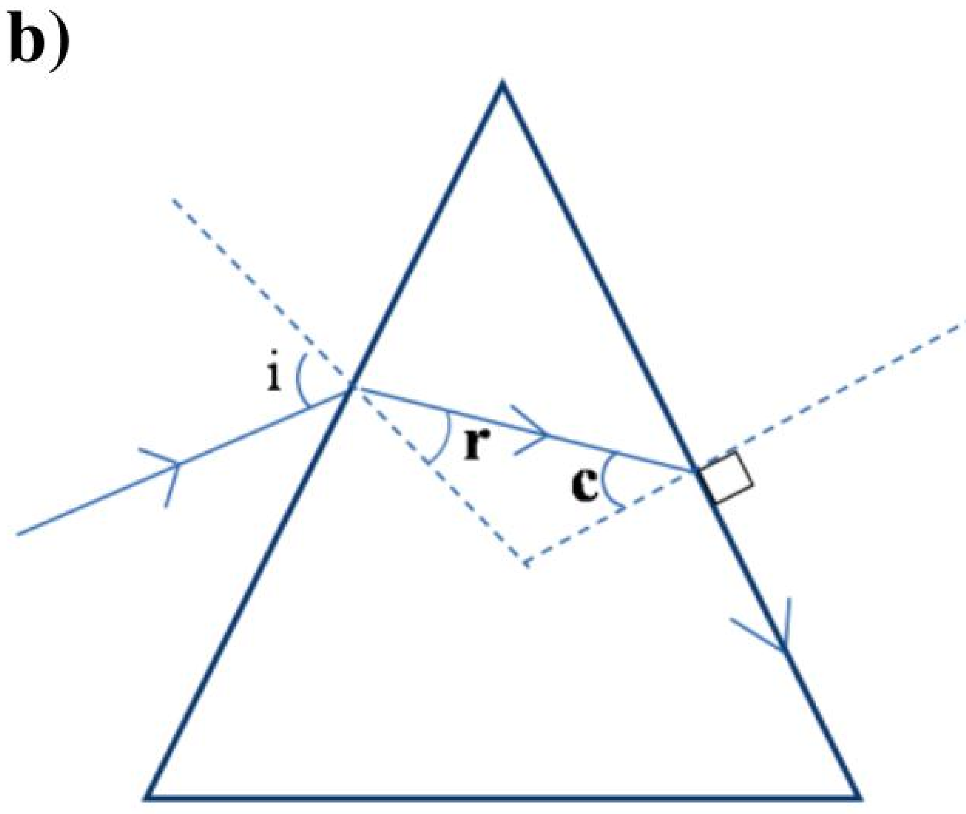
a) Derivation of induced emf	2 ½
b) Numerical	2 ½

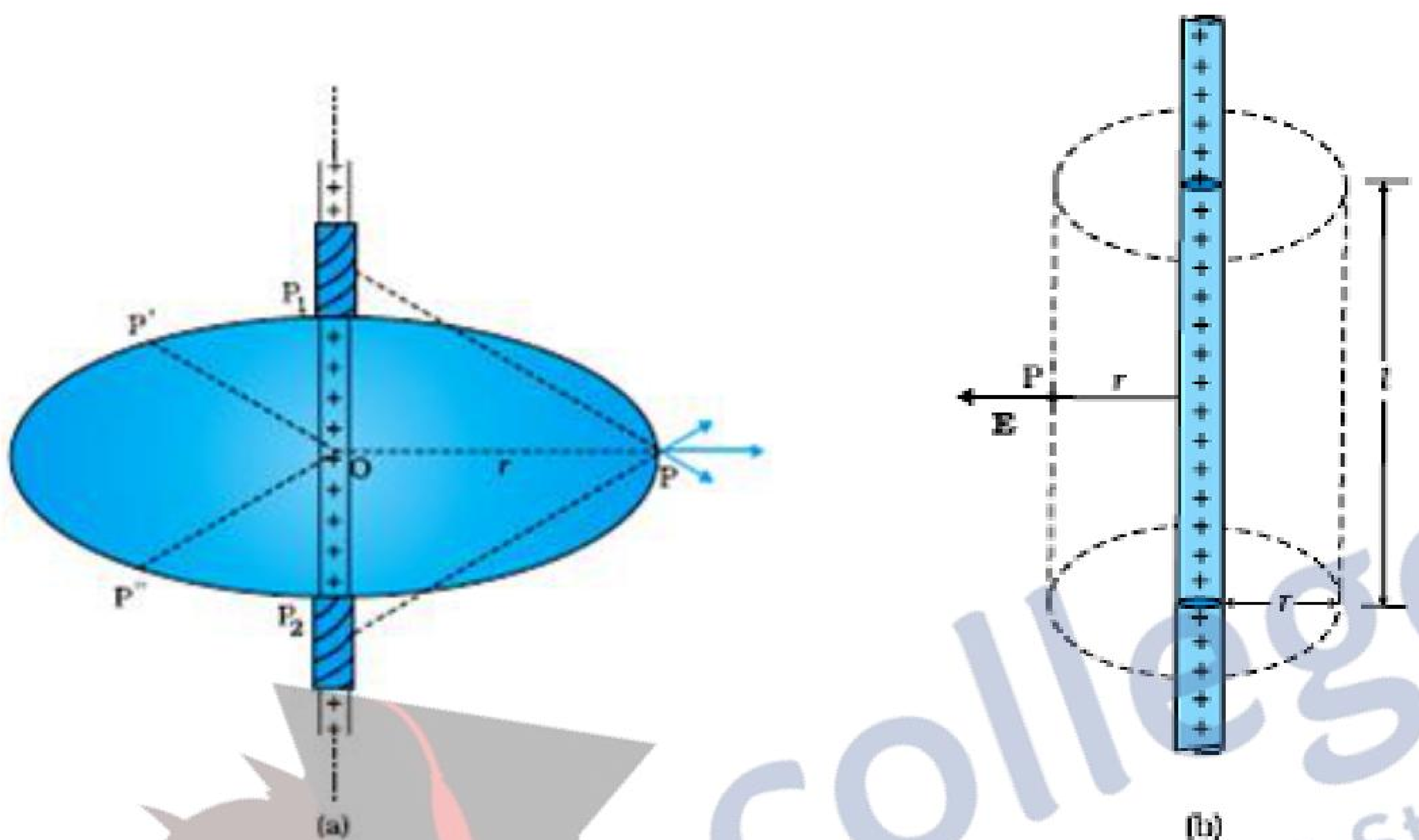
a)

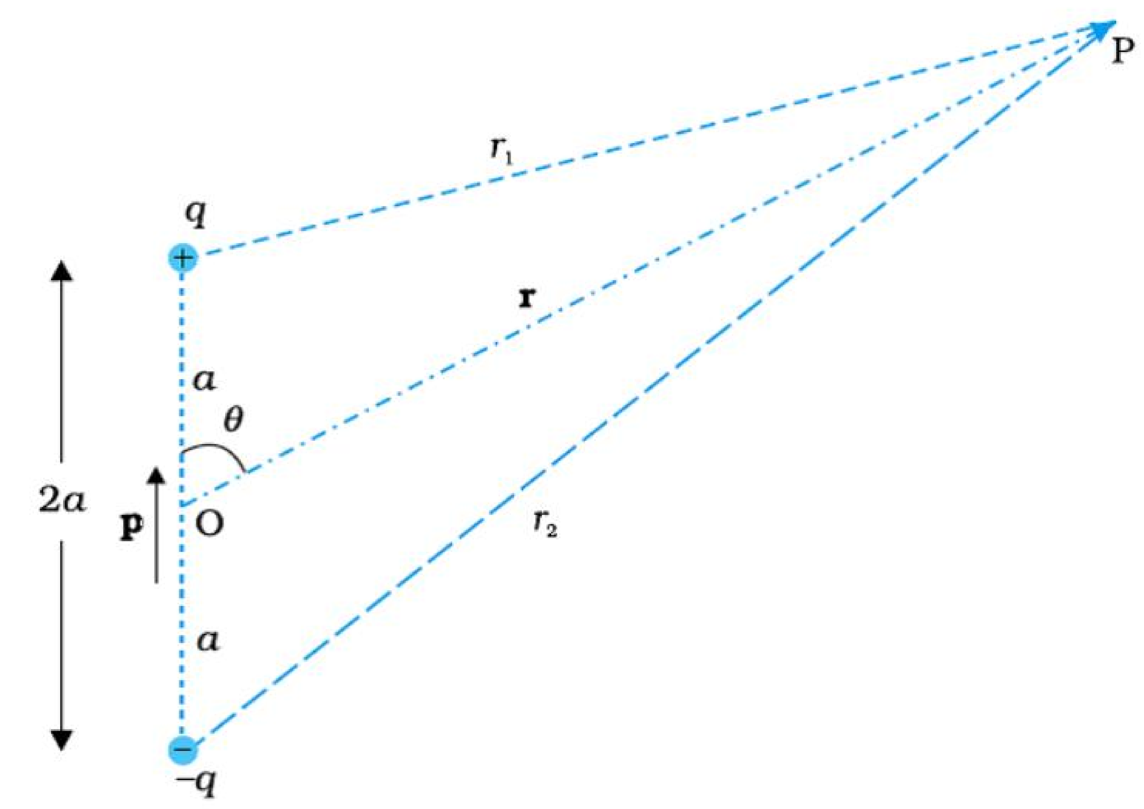


½

	$\phi_B = Blx$ $\varepsilon = \frac{-d\phi_B}{dt}$ $= -Bl\,\frac{dx}{dt}$ $= Blv$ b) $\omega = 360 \times \frac{2\pi}{60} = 12\,\pi$ $\varepsilon = \frac{1}{2} B_H l^2 \omega$ $\therefore 400 \text{ x } 10^{-3} = \frac{1}{2}.B_H \times (60 \times 10^{-2})^2 \times 12\pi$ $\therefore B_H = \frac{5}{27\pi} = 0.06\text{T}$ No change in emf if no. of spokes is increased.	½ ½ ½ ½ ½ ½ ½ ½ ½	 5
Q25	a) Explanation with reason 2 ½ b) Calculation of separations 2 ½ a) $\text{P} = \frac{1}{f} = \left(\frac{n_2 - n_1}{n_2}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $= \left(\frac{n_2 - n_1}{n_2}\right)\left(-\frac{2}{R}\right)$ for diverging lens = negative i. If $n_1 > n_2$ $\frac{n_2 - n_1}{n_1}$ becomes negative $\therefore P = \frac{1}{f}$ becomes positive *or lens become converging* ii. $(n_2)_{violet} > (n_2)_{red}$ ∴Power increases on changing to violet light b) Rays on L_3 be incident parallel to the principal axis image from L_1 is formed at focus of L_2 and focus of L_2 is $2f_1$ from 'O' of L_1 $\therefore L_1 L_2 = 2f_1 + f_2$ = (3 x 30)cm = 90cm $L_2 L_3$ can be any distance **OR** a) Derivation of expression for refractive index 2 Graph 1 b) Numerical 2 **a)**	 ½ ½ ½ ½ ½ ½ ½ ½ ½ ½	 5

		½ ½	
	$\angle A + \angle QNR = 180^o$ $r_1 + r_2 + \angle QNR = 180^o$ $\therefore r_1 + r_2 = \angle A$ $\delta = (i - r_1) + (e - r_2)$ $\delta = i + e - A$	½	
	For minimum derivation, $\delta = D_m,\ i = e$ and $r_1 = r_2$ $\therefore 2r = A \Rightarrow r = \frac{A}{2}$ $D_m = 2i - A \Rightarrow i = \frac{A+D_m}{2}$	½	
	$\therefore n = \frac{n_2}{n_1} = \frac{\sin i}{\sin r}$ $= \frac{sin\left(\frac{A+D_m}{2}\right)}{\sin\frac{A}{2}}$		
		**1**	
	b) 	½ ½	
	Sin c = $\frac{1}{n} = \frac{1}{\sqrt{2}}$ $\Rightarrow c = 45^0$	½	

	$r + c = 60^0 \quad => r = 15^0$ $n = \frac{\sin i}{\sin r}$ $\Rightarrow \sqrt{2} = \frac{\sin i}{\sin 15^0}$ $\Rightarrow i = sin^{-1}[\sqrt{2} \sin 15^0]$	½	5
Q26	a) Statement of Guass's law 1 Derivation 2 b) Electric flux Expression 2		
	a) Electric flux through a closed surface is $\frac{1}{\epsilon_o}$ times charge enclosed by the closed surface. $\phi = \frac{Q_{enclosed}}{\epsilon_o}$	1	
		½	
	$\phi = \oint \vec{E}.\vec{ds} = \frac{Q_{enclosed}}{\epsilon_o}$		
	$\therefore E.2\pi rl = \frac{\lambda l}{\epsilon_o}$	½	
	$\therefore E = \frac{\lambda}{2\pi\epsilon_o r}$	1	
	b) $dq = \lambda dx = kxdx$	½	
	$Q = \int_o^l dq = \int_o^l kxdx = \frac{1}{2}kl^2$	½	
	$\therefore \phi = \frac{Q}{\epsilon_o} = \frac{kl^2}{2\ \epsilon_o}$	1	
	OR		
	a) Derivation of expression for electric potential 3 b) Numerical Problem 2		
	a)		

		½	
	$V = \frac{1}{4\pi \in_o}\left[\frac{q}{r_1} - \frac{q}{r_2}\right]$	½	
	$r_1^2 = r^2 + a^2 - 2ar\cos\theta \approx r^2\left(1 - \frac{2a\cos\theta}{r}\right)$	½	
	$r_2^2 = r^2 + a^2 + 2ar\cos\theta \approx r^2\left(1 + \frac{2a\cos\theta}{r}\right)$	½	
	If r > > a		
	$\frac{1}{r_1} = \frac{1}{r}\left[1 - \frac{2a\cos\theta}{r}\right]^{-\frac{1}{2}} \simeq \frac{1}{r}\left[1 + \frac{a}{r}\cos\theta\right]$	½	
	and $\frac{1}{r_2} \simeq \frac{1}{r}\left[1 - \frac{a}{r}\cos\theta\right]$	½	
	$\therefore V = \frac{q}{4\pi \in_o} . \frac{2a\cos\theta}{r^2}$ $= \frac{1}{4\pi\in_o}\frac{p\cos\theta}{r^2}$	½	
	b) $\frac{1}{4\pi\in_o}\frac{4\mu C}{x^2} = \frac{1}{4\pi\in_o}\frac{1\mu C}{(2-x)^2}$	1	
	$\therefore \frac{x}{2} = 2 - x$		
	$\therefore 3x = 4 => x = \frac{4}{3}m$	½	5

These answers are meant to be used by evaluators