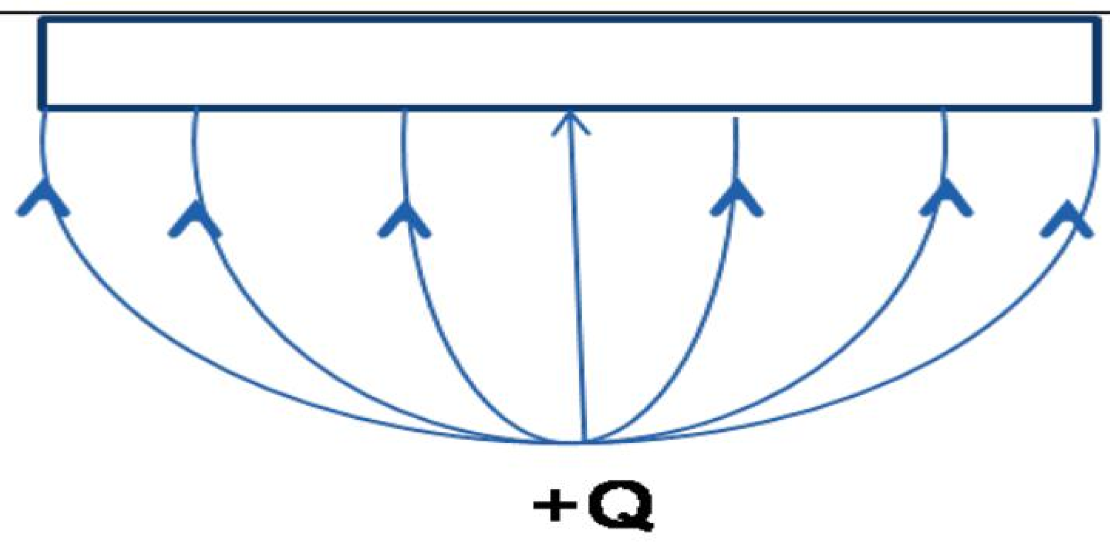
SET:55/1

MARKING SCHEME

Q. No.	Expected Answer/ Value Points SECTION A	Marks	Total Marks
Q1		1	1
Q2	Ratio of amplitude of modulating signal A_m to amplitude of carrier wave A_C Alternatively: $\mu = \frac{A_m}{A_C}$ It is kept less than one to avoid distortion	½ ½	1
Q3	Accept both the answers : A : +ve ; B: -ve or A : -ve ; B: +ve	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	Definition ½ SI Unit ½ Conductivity is reciprocal of resistivity $\sigma = \frac{1}{\rho}$ SI unit : S(siemen)	½ ½	1
	SECTION B		
Q6	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

*These answers are meant to be used by evaluators

Q7

Einstein's equation	½
Expression for $\boldsymbol{v}$	½
de Broglie relation	½
de Broglie wavelength	½

When work function is negligible, we have, from Einstein's equation

$$\frac{1}{2}mv^2 = \frac{hc}{\lambda}$$ ½

$$\therefore v = \sqrt{\frac{2hc}{m\lambda}}$$ ½

$$\lambda_{de} = \frac{h}{mv}$$ ½

$$\therefore \lambda_{dB} = \frac{h}{m}\sqrt{\frac{m\lambda}{2hc}}$$

$$= \sqrt{\frac{h\lambda}{2mc}}$$ ½

OR

de Broglie formula	½
de Broglie hypothesis	½
Bohr's quantization condition	1

We have $\lambda = \frac{h}{p} = \frac{h}{mv_n}$ ½

By de Broglie's hypothesis

$$2\pi r_n = n\lambda \qquad n = 1,2,3$$ ½

$$\therefore 2\pi r_n = \frac{nh}{mv_n}$$ ½

$$\therefore mv_n r_n = \frac{nh}{2\pi}$$ ½ **2**

Q8

Two characteristics	½ + ½
Plot of PE	1

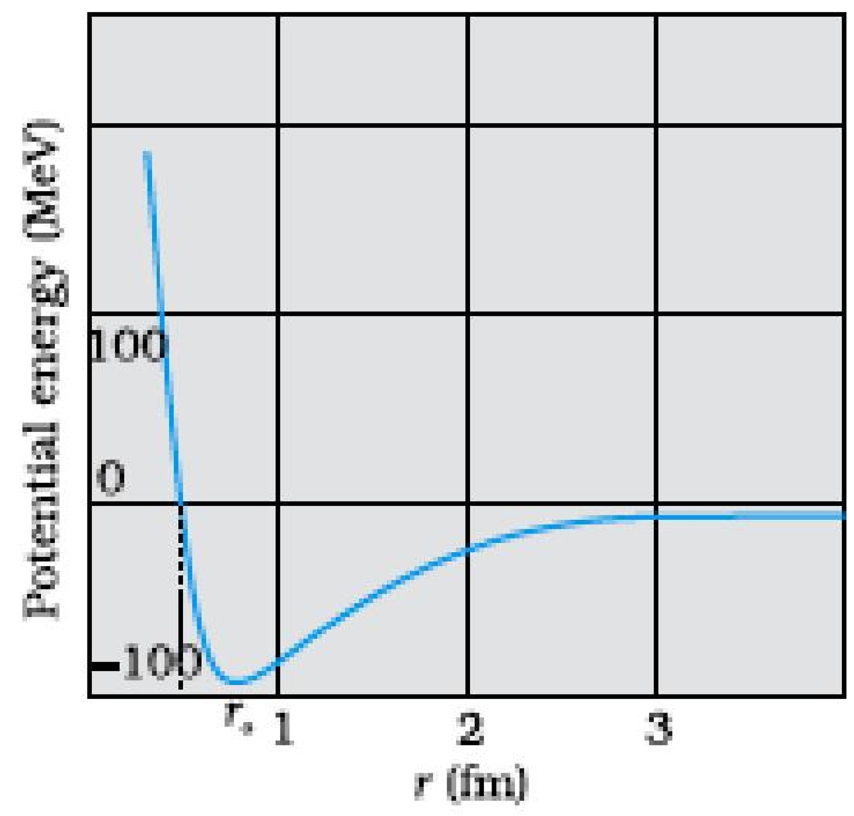
a)

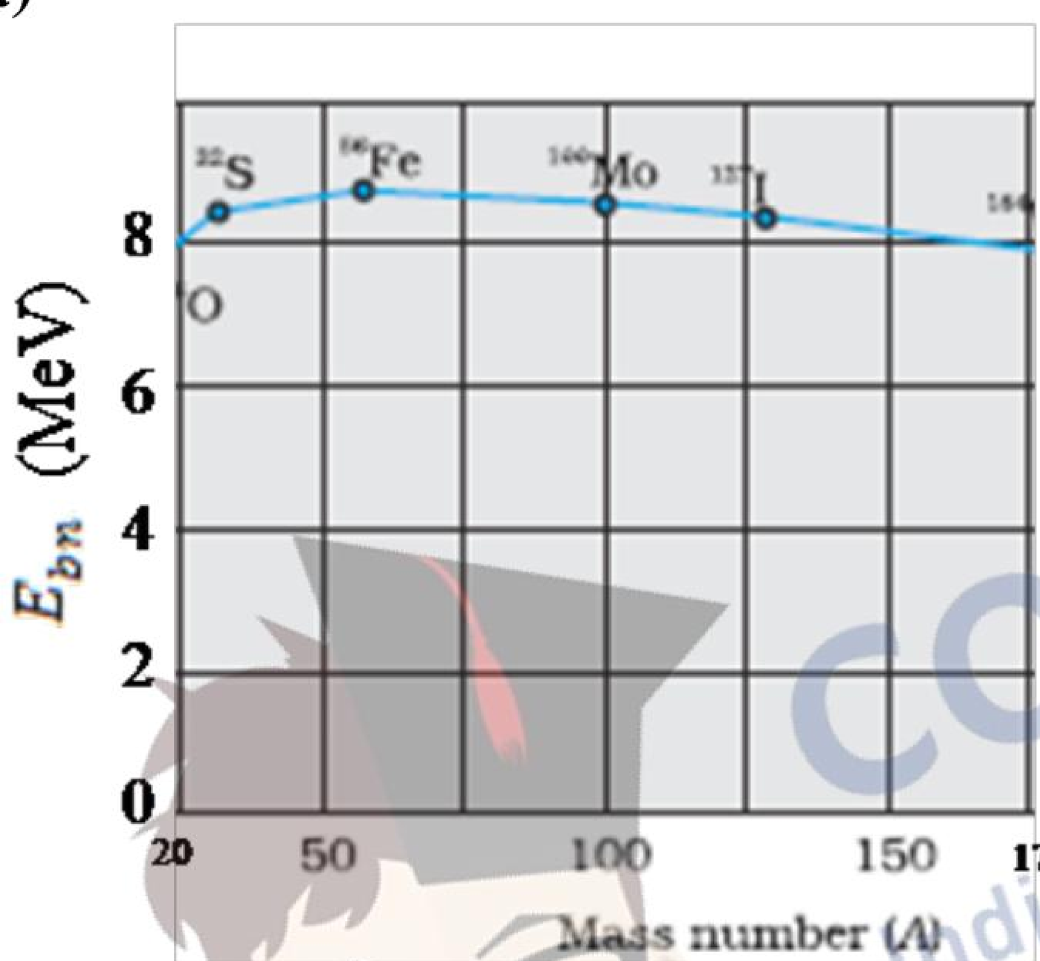
i. Nuclear force is much stronger than coulomb or gravitational force. ½

ii. It is a very short range force therefore leads to saturation of forces. ½

iii. Nuclear force is independent of charge

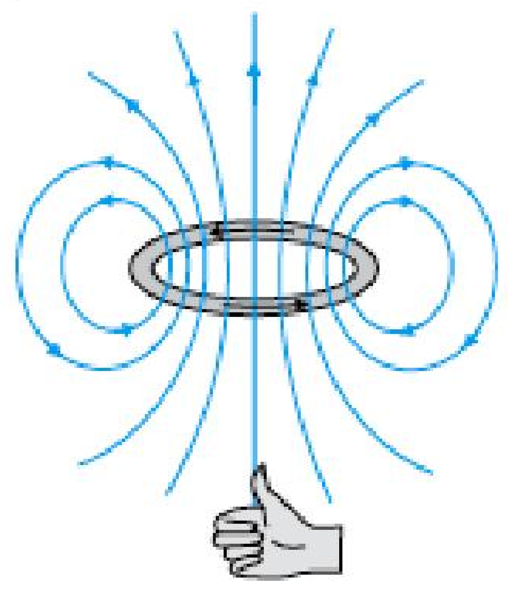
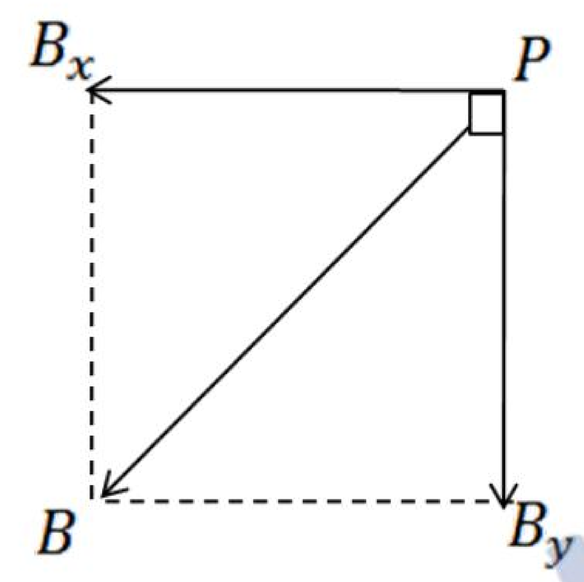
[Any two]

	b)  	**1**	**2**
Q9	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**
Q10	Emf of cell 1 Internal resistance 1 a) E = V for I =0 $\therefore E = 6$ V b) $E = V + ir$ $\therefore 6 = 4 + r$ $r = 2\ \Omega$	½ ½ ½ ½	**2**
	SECTION C		
Q11	Effect on capacitance 1 Effect on charge 1 Effect on energy 1 i. $C = \frac{\epsilon_o A}{d}$ $C' = \frac{K\epsilon_o A}{d'} = \frac{10}{3}\frac{\epsilon_o A}{d} = \frac{10}{3}C$ ii. V remains same since battery is not disconnected $\therefore Q' = C'V$ $= \frac{10}{3}CV = \frac{10}{3}Q$	½ ½ ½ ½	

	iii. Energy density, $u_d = \frac{1}{2} \in_o E^2$ $E = \frac{V}{d}$ $u'_d = \frac{1}{2} K \in_o E'^2$ $= \frac{10}{2} \in_o \left(\frac{V}{d'}\right)^2$ $= \frac{10}{9}\left(\frac{1}{2} \in_o E^2\right)$ $= \frac{10}{9} u_d$	½ ½	3
Q12	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
Q13	Explanation / reason 1 Finding intensities 1+1 a) Interference pattern will not be observed as two independent lamps are not coherent sources. b) $I_1 = 4I_0^2 cos^2\left(\frac{\phi_1}{2}\right) = 4I_0^2 \quad \phi_1 = 0$ $I_2 = 4I_0^2 cos^2\left(\frac{\pi}{2}\right) = 0 \quad \phi_1 = \pi$ [Note: Give full two marks if the student just writes : Ratio →∞ $(as\ I_2 = 0)$]	1 1 1	3

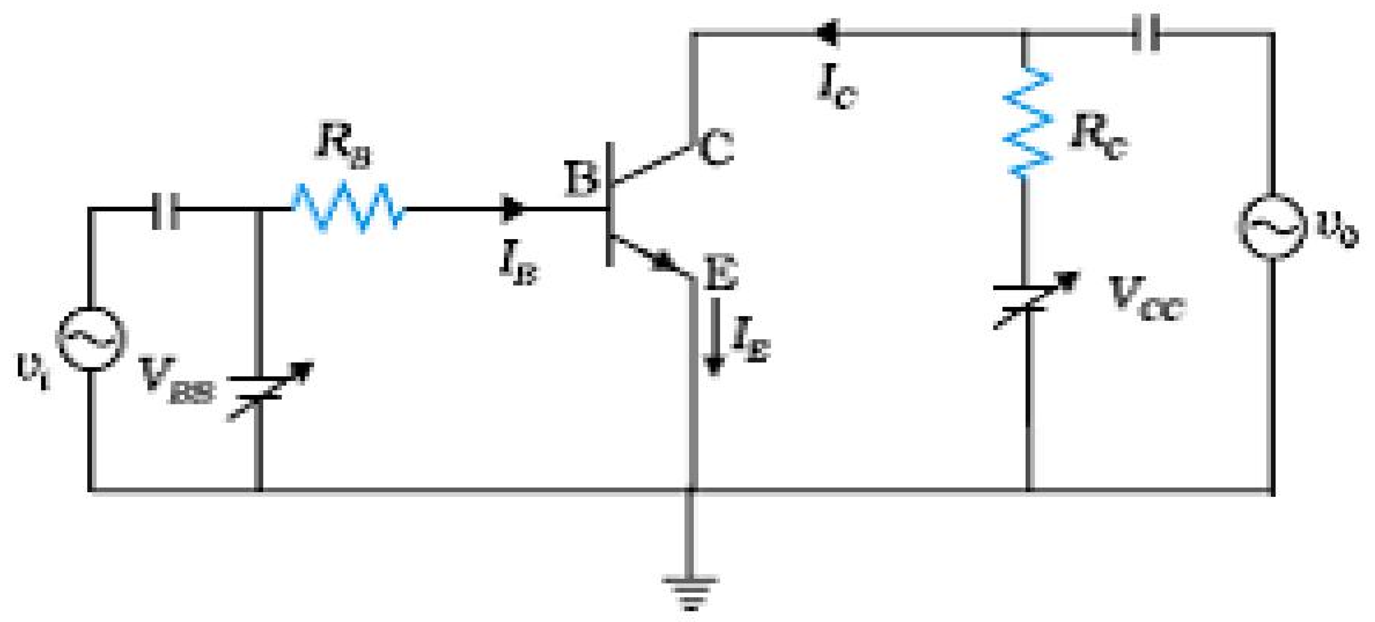
*These answers are meant to be used by evaluators

Q14	Derivation of total energy expression — 2 Wavelength of H_α line — 1		
	$\frac{mv_n^2}{r_n} = \frac{1}{4\pi\epsilon_o}\frac{e^2}{r_n^2}$	½	
	$\therefore mv_n^2 r_n = \frac{1}{4\pi\epsilon_o}e^2$		
	Also $mv_n\ r_n = \frac{nh}{2\pi}$ (Bohr Postulate)	½	
	$\therefore v_n = \frac{e^2}{2\epsilon_o nh}$	½	
	Now total energy $E = -KE$ $\therefore E = -\frac{1}{2}mv_n^2$		
	$= \frac{-me^4}{8\epsilon_o n^2 h^2}$	½	
	For H_α line $n_i = 3, n_f = 2$ $\therefore \frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$	½	
	$= 1.1 \times 10^7 \left[\frac{5}{36}\right]$		
	$\lambda = \frac{36}{5.5} \times 10^{-7}/m$ =655nm	½	3
Q15	Name of em waves — 1 Method of generation — 1 Two uses — ½ + ½		
	X- rays	1	
	Produced by bombarding a metal target with high energy electrons.	1	
	Uses:		
	i. Used in diagnosis of bone fractures/	½	
	ii. Treatment of some forms of cancer	½	3
	[or any other use]		

Q16	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**
Q17	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	
	$E_p = \frac{hc}{\lambda}$ J $= \frac{hc}{e\lambda}\ eV$ $= \frac{6.63\times10^{-34}\times3\times10^8}{1.6\times10^{-19}\times400\times10^{-9}}$ = 3.1 eV(>Eg)	½	
	∴ It can detect this light		**3**

Q18

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

$\therefore \Delta V_{CC} = \Delta V_{CE} + R_L \Delta I_C = 0$ ½

$\therefore \Delta V_{CE} = -R_L \Delta I_C$

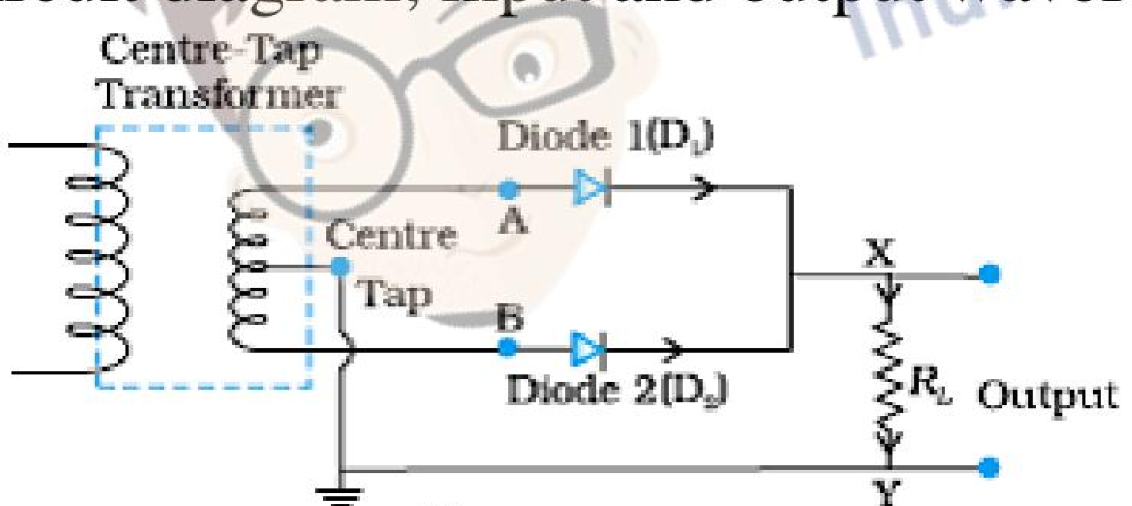
Hence, change in output is negative when the input signal is +ve.

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

OR

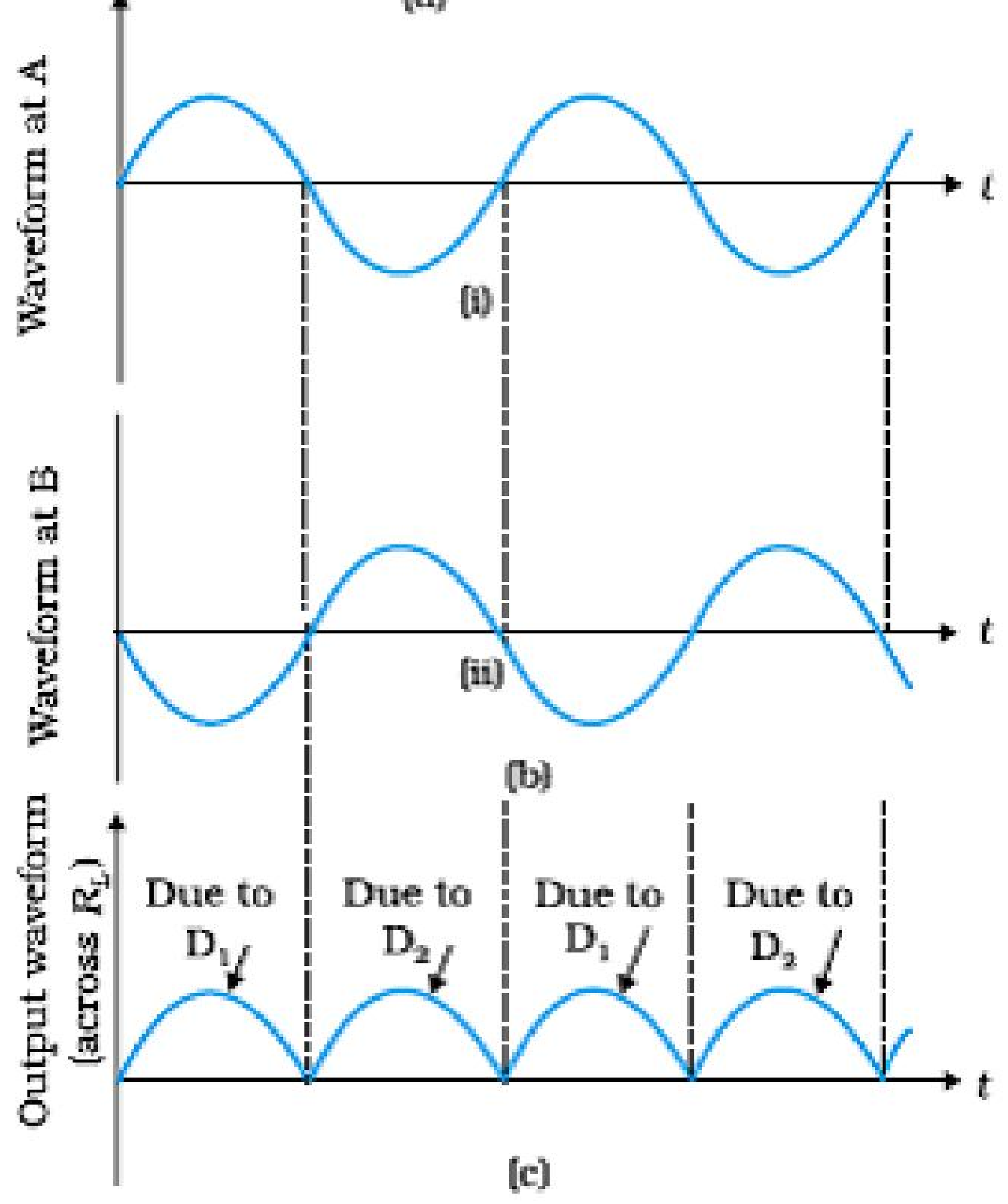
Circuit of full wave rectifier	1
Working Principle	1
Input and output waveforms	1

Circuit diagram; input and output waveforms;



(a)

1



½

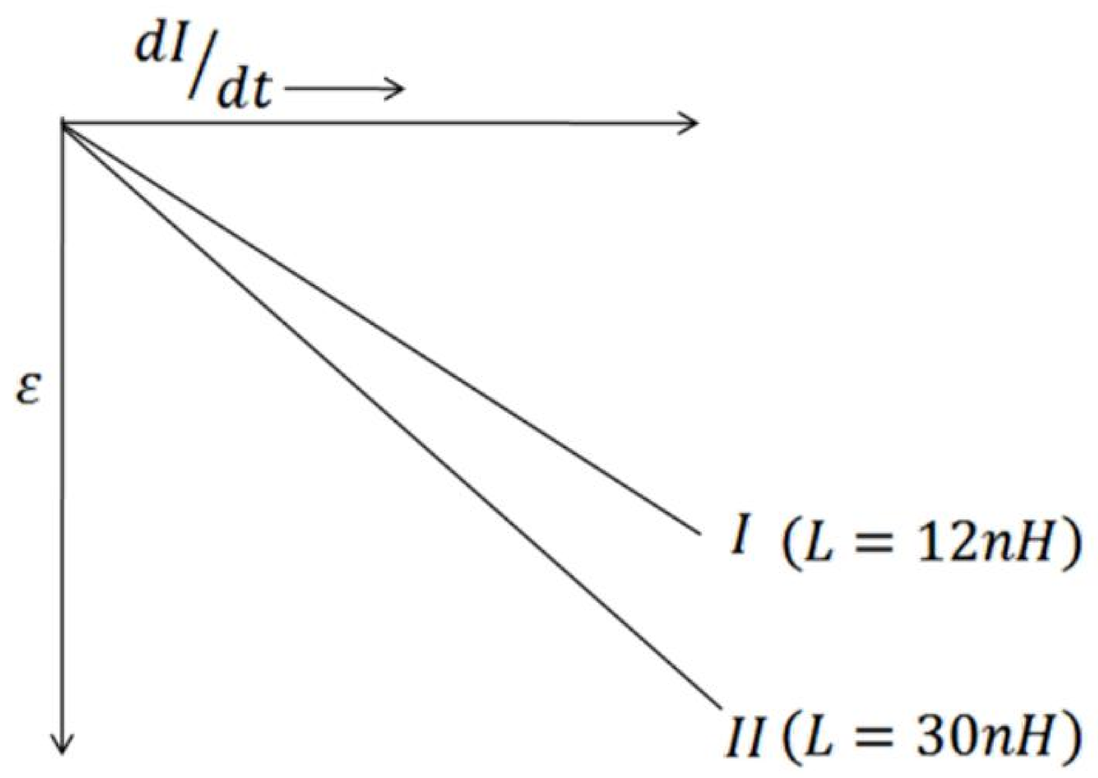
½

	Working Principle: 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
Q19	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
Q20	Definition of current sensitivity 1 Ratio $R_1/_{R_2}$ 2 Current sensitivity of a galvanometer is deflection per unit current $\left[\text{Alternatively: } I_s = \frac{\phi}{I} = \frac{NAB}{K}\right]$ In circuit (i) $\frac{4}{6} = \frac{R_1}{4} => R_1 = \frac{8}{3}\ \Omega$ In circuit (ii) $\frac{6}{R_2} = \frac{12}{8} => R_2 = 4\ \Omega$ $\therefore \frac{R_1}{R_2} = \frac{2}{3}$	1 ½ ½ 1	3

Q21

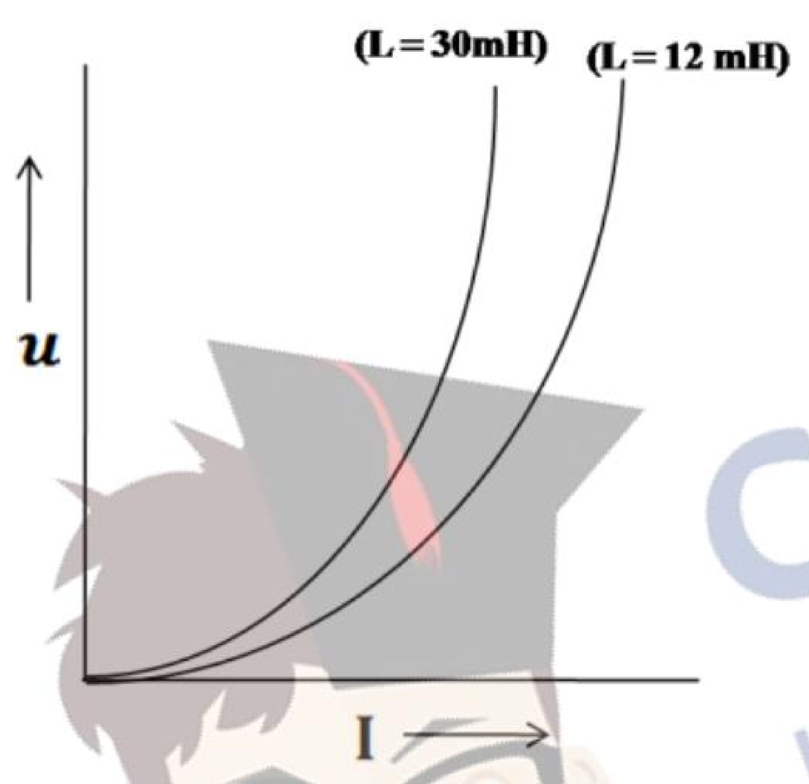
Graph of emf	½
Graph of energy stored	½
Ratio of energy stored	2

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 $\varepsilon_1 i_1 = \varepsilon_2 i_2$ (∵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

$$\therefore \frac{u_1}{u_2} = \frac{L_1}{L_2}\left(\frac{L_2}{L_1}\right)^2$$ ½

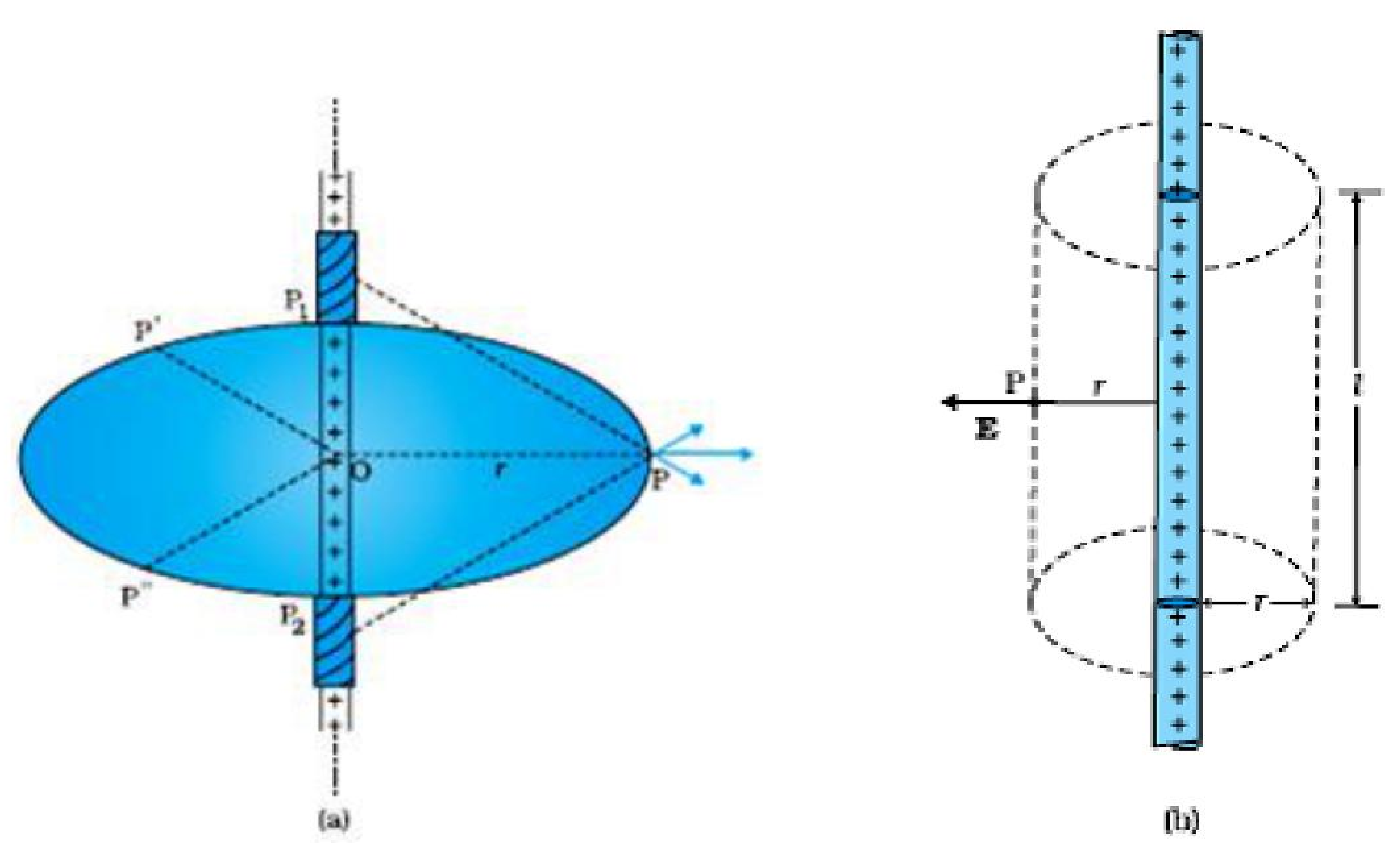
$$= \frac{L_2}{L_1} = \frac{30}{12} = 2.5$$

3

Q22

Variation of intensity	1
Separation between maxima	2

a) Intensity of diffraction pattern drops rapidly with order n because every higher order maxima gets intensity only from $\frac{1}{2n+1}$ part of the slit. The central maxima gets intensity from the whole slit (n=0) **1**

	1[st] secondary maxima gets its intensity only from 1/3 of slit 2[nd] secondary maxima gets its intensity only from 1/5 of slit and so on. b) Position of 1[st] maxima on the screen: $x_1 = \frac{3}{2}\frac{\lambda_1}{a}D$; $\lambda_1 = 590nm$ $x_2 = \frac{3}{2}\frac{\lambda_2}{a}D$; $\lambda_2 = 596nm$ Separation $\Delta x = x_2 - x_1$ $= \frac{3}{2}\frac{D}{a}(\lambda_2 - \lambda_1)$ $= \frac{3}{2}\left(\frac{2}{4\times10^{-3}}\right) \times 6 \times 10^{-9}$m $= 4.5 \text{ x } 10^{-6}$m	 ½ ½ ½ ½	 3
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) b) Eager to learn (open minded); observant; appreciating good ideas.(any two) c) Phenomenon of perfect diamagnetism in super conductors $\mu_r = 0$	 ½ + ½ ½ + ½ **1** **1**	 **4**
SECTION E			
Q24	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. $\phi = \frac{Q_{enclosed}}{\epsilon_o}$  $\phi = \oint \vec{E}.\vec{ds} = \frac{Q_{enclosed}}{\epsilon_o}$	 **1** ½	

$\therefore E.2\pi rl = \frac{\lambda l}{\epsilon_o}$ ½

$\therefore E = \frac{\lambda}{2\pi\epsilon_o r}$ **1**

b) $dq = \lambda dx = kxdx$ ½

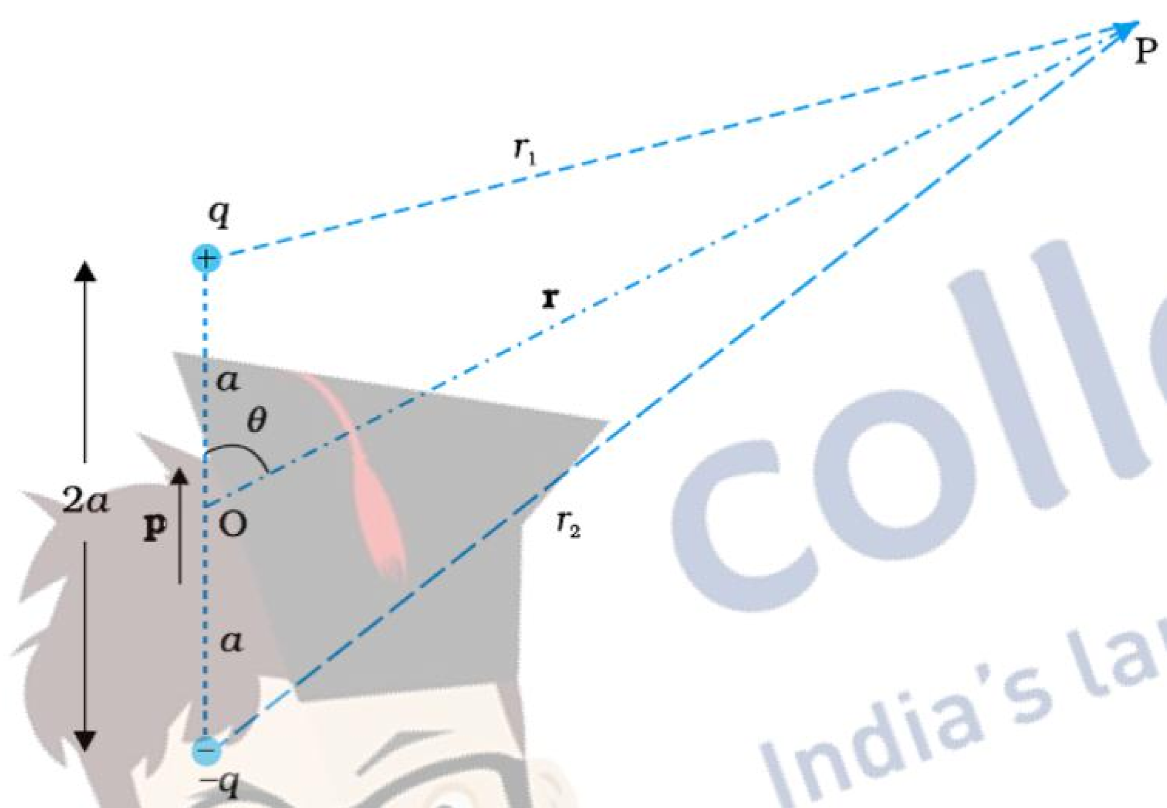
$$Q = \int_o^l dq = \int_o^l kxdx = \frac{1}{2}kl^2$$ ½

$$\therefore \phi = \frac{Q}{\epsilon_o} = \frac{kl^2}{2\,\epsilon_o}$$ **1**

OR

a)	Derivation of expression for electric potential	3
b)	Numerical Problem	2

a)



½

$$V = \frac{1}{4\pi\,\epsilon_o}\left[\frac{q}{r_1} - \frac{q}{r_2}\right]$$ 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

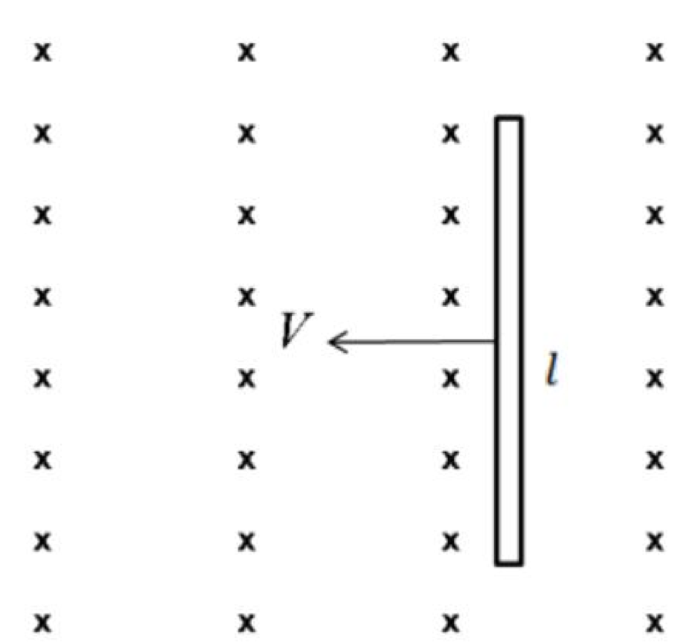
$$\frac{1}{r_1} = \frac{1}{r}\left[1 - \frac{2a\cos\theta}{r}\right]^{-\frac{1}{2}} \simeq \frac{1}{r}\left[1 + \frac{a}{r}\cos\theta\right]$$ ½

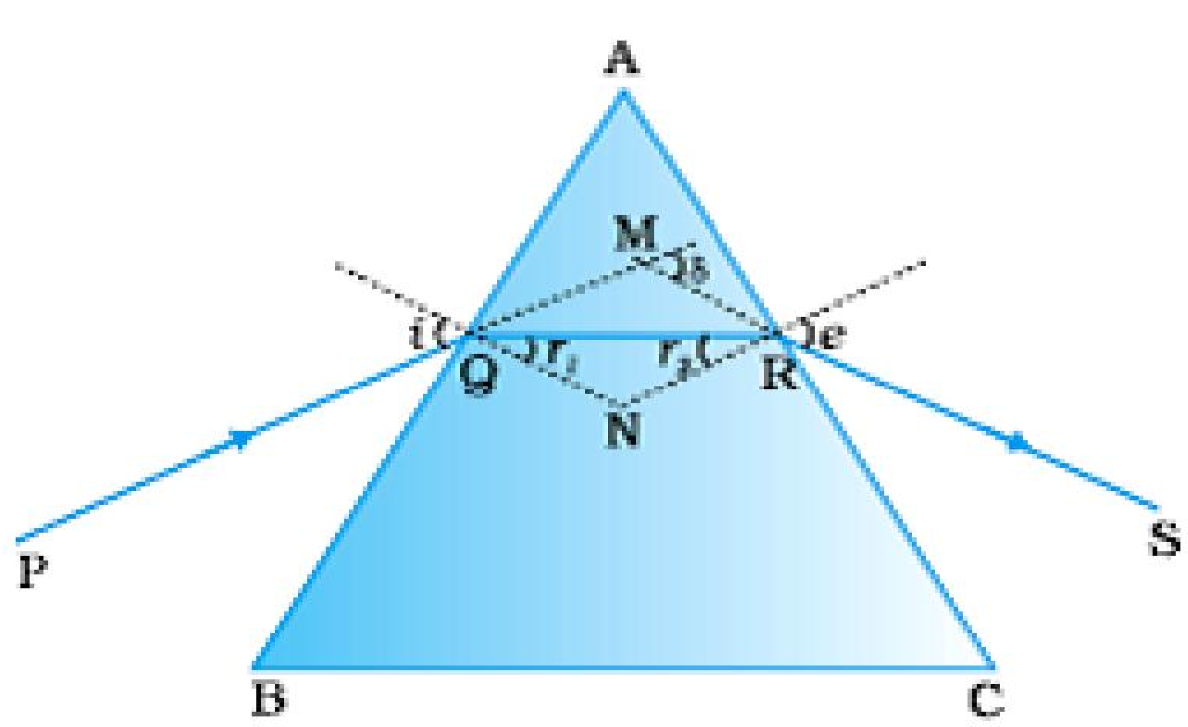
and $\frac{1}{r_2} \simeq \frac{1}{r}\left[1 - \frac{a}{r}\cos\theta\right]$

$$\therefore V = \frac{q}{4\pi\,\epsilon_o}.\frac{2a\cos\theta}{r^2}$$ ½

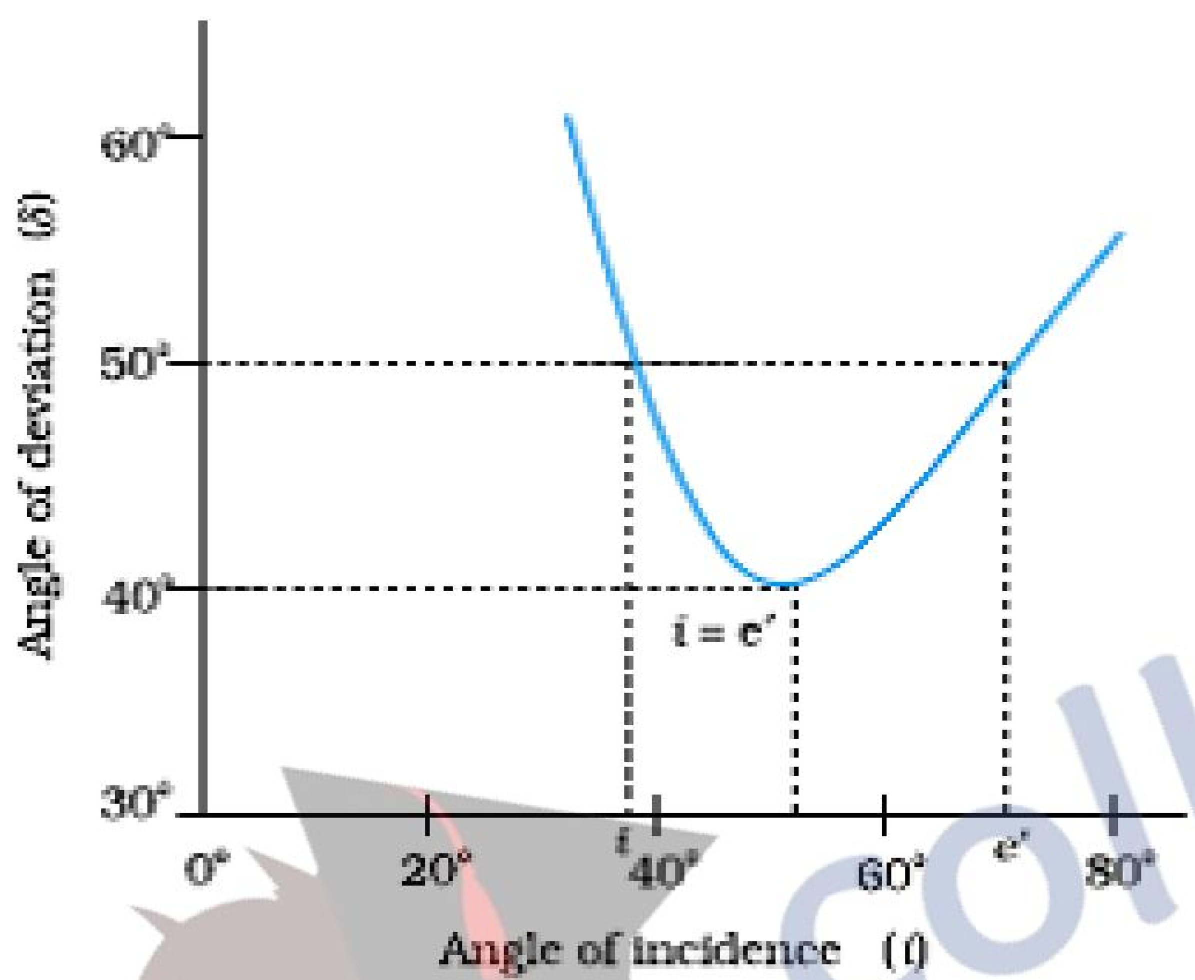
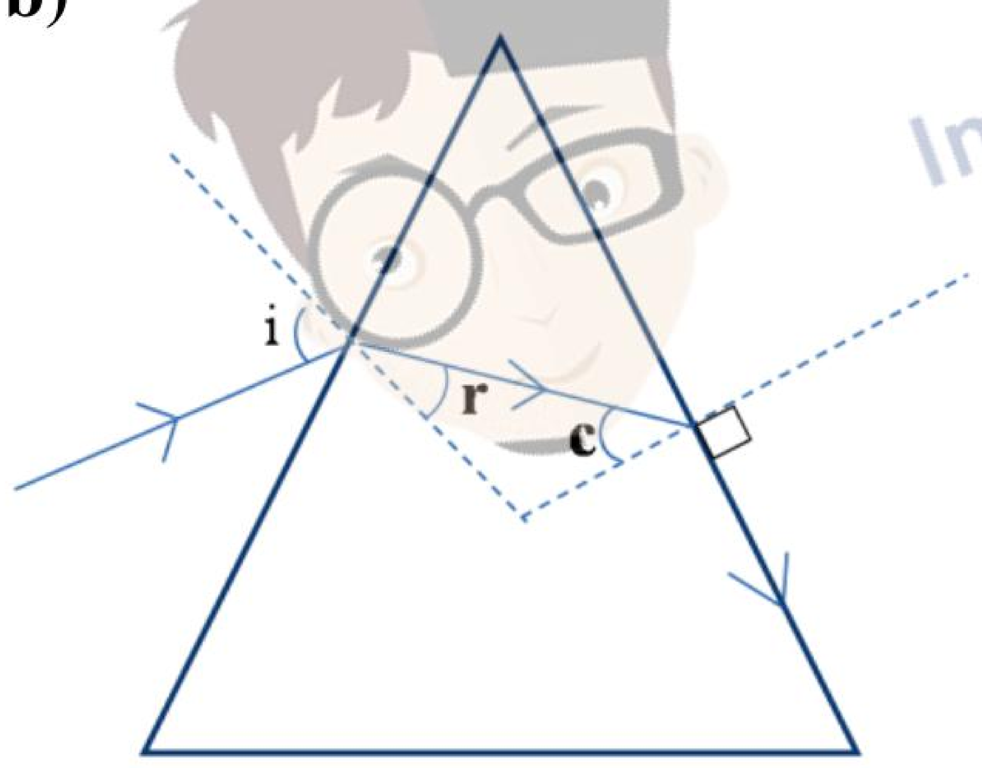
$$= \frac{1}{4\pi\epsilon_o}\frac{p\cos\theta}{r^2}$$ ½

b) $\frac{1}{4\pi\epsilon_o}\frac{4\mu C}{x^2} = \frac{1}{4\pi\epsilon_o}\frac{1\mu C}{(2-x)^2}$ **1**

	$\therefore \frac{x}{2} = 2 - x$ $\therefore 3x = 4 => x = \frac{4}{3}m$	½	5
Q25	a) Average Power dissipation is zero 2 b) Numerical 3 a) Instantaneous Power = $vi = V_o sinwt\ I_o coswt$ Average power, P = $\frac{1}{T}\int_o^T vidt$ $= \frac{V_o I_o}{2T}\int_o^T 2\, sinwt\, coswt\, dt$ $= \frac{V_o I_o}{2T}\int_o^T sin2wt\, dt$ $= 0$ b) i. $\omega_o = \frac{1}{\sqrt{LC}}$ $= \frac{1}{(200 \times 10^{-3} \times 400 \times 10^{-6})^{\frac{1}{2}}}$ $= \frac{1}{\sqrt{8 \times 10^{-5}}} s^{-1} = \frac{10^3}{\sqrt{80}} s^{-1} \simeq 111 s^{-1}$ $I = \frac{V}{R} = \frac{50}{10} = 5\,A$ ii. $Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{10}\sqrt{\frac{200\times10^{-3}}{400\times10^{-6}}} = \sqrt{5}$	 ½ ½ ½ ½ ½ ½ 1 1	 5
	OR a) Derivation of induced emf 2 ½ b) Numerical 2 ½ a)  $\phi_B = Blx$ $\varepsilon = \frac{-d\phi_B}{dt}$ $= -Bl\frac{dx}{dt}$ $= Blv$ b) $\omega = 360 \times \frac{2\pi}{60} = 12\,\pi$	 ½ ½ ½ ½ ½ ½	

	$\varepsilon = \frac{1}{2}B_H l^2 \omega$ $\therefore 400 \text{ x } 10^{-3} = \frac{1}{2}.B_H \times (60 \times 10^{-2})^2 \times 12\pi$ $\therefore B_H = \frac{5}{27\pi} = 0.06\text{T}$ No change in emf if no. of spokes is increased.	½ ½ ½ ½	5
Q26	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 $\therefore L_1L_2 = 2f_1 + f_2$ = (3 x 30)cm = 90cm L_2L_3 can be any distance **OR** a) Derivation of expression for refractive index 2 Graph 1 b) Numerical 2 **a)**  $\angle A + \angle QNR = 180^o$ $r_1 + r_2 + \angle QNR = 180^o$ $\therefore r_1 + r_2 = \angle A$	½ ½ ½ ½ ½ ½ ½ ½ ½ ½ ½ ½	5

*These answers are meant to be used by evaluators

	$\delta = (i - r_1) + (e - r_2)$		
	$\delta = i + e - A$		
	For minimum derivation,		
	$\delta = D_m,\ i = e$ and $r_1 = r_2$		
	$\therefore 2r = A => r = \frac{A}{2}$	½	
	$D_m = 2i - A => i = \frac{A+D_m}{2}$		
	$\therefore n = \frac{n_2}{n_1} = \frac{\sin i}{\sin r}$	½	
	$= \frac{sin\left(\frac{A+D_m}{2}\right)}{\sin\frac{A}{2}}$		
		1	
	b)		
			
	Sin c = $\frac{1}{n} = \frac{1}{\sqrt{2}}$	½	
	$\Rightarrow c = 45^0$	½	
	$r + c = 60^0 \quad => r = 15^0$		
	$n = \frac{\sin\ i}{\sin\ r}$		
	$\Rightarrow \sqrt{2} = \frac{\sin\ i}{\sin\ 15^0}$	½	
	$\Rightarrow i = sin^{-1}[\sqrt{2}\sin 15^0]$	½	5