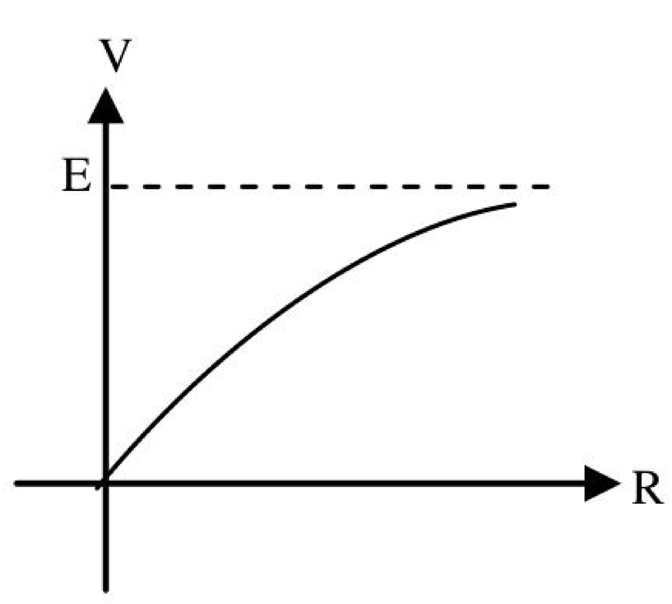
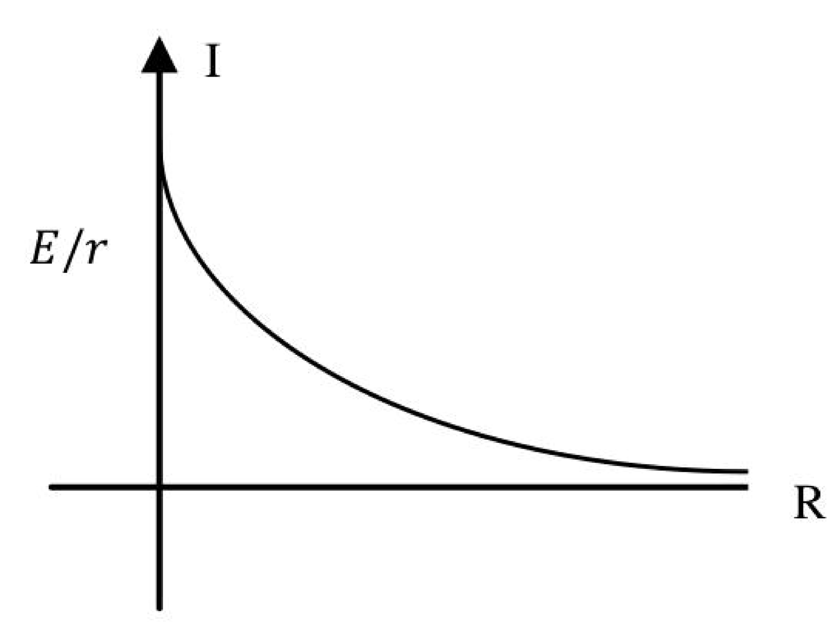
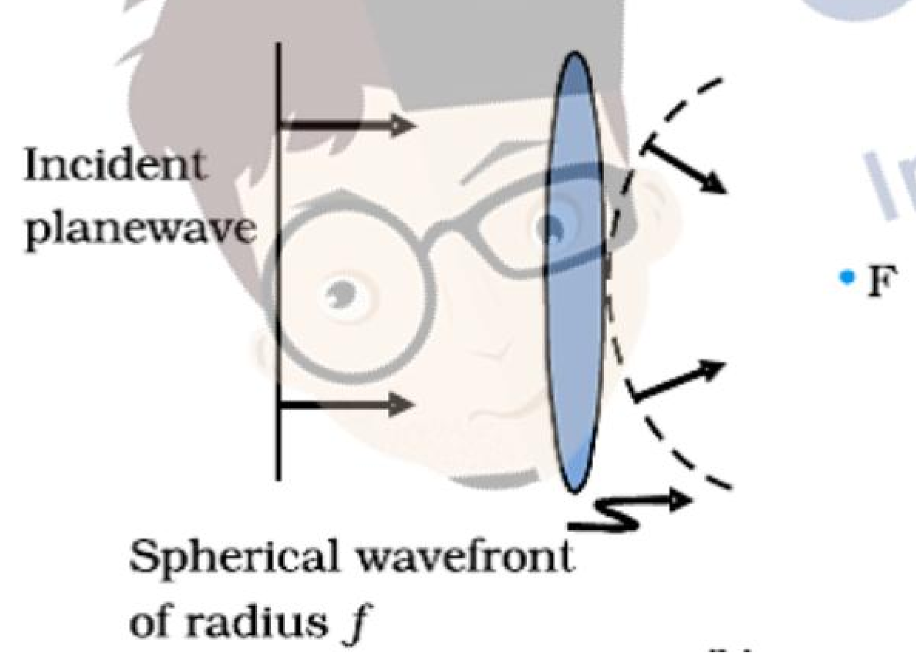
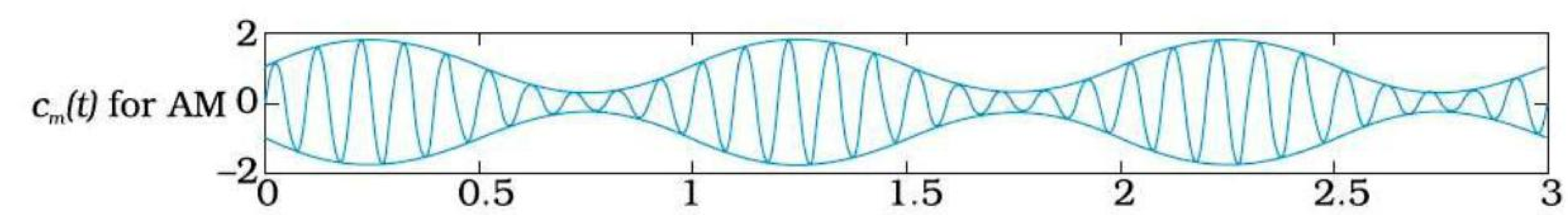
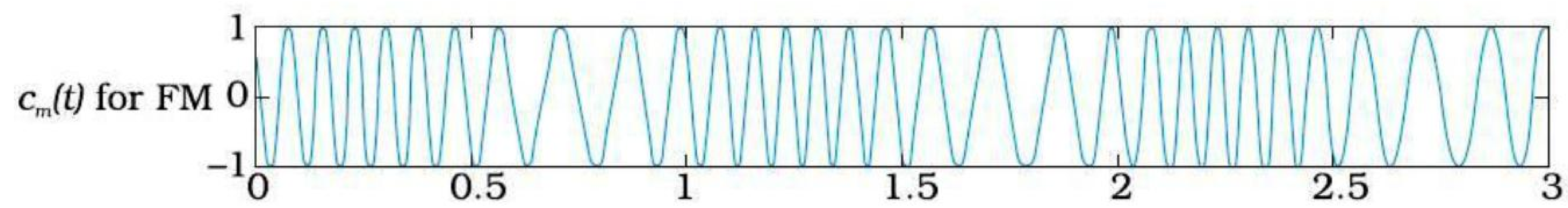
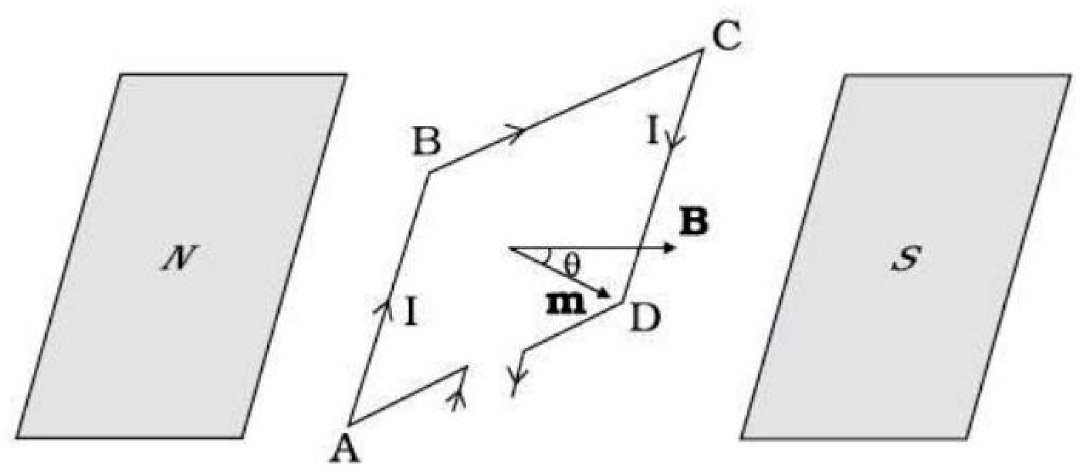
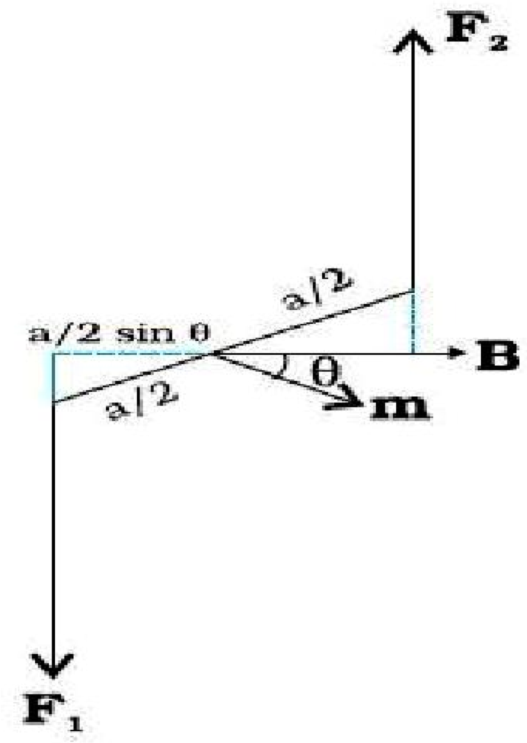
MARKING SCHEME
SET 55/1/A

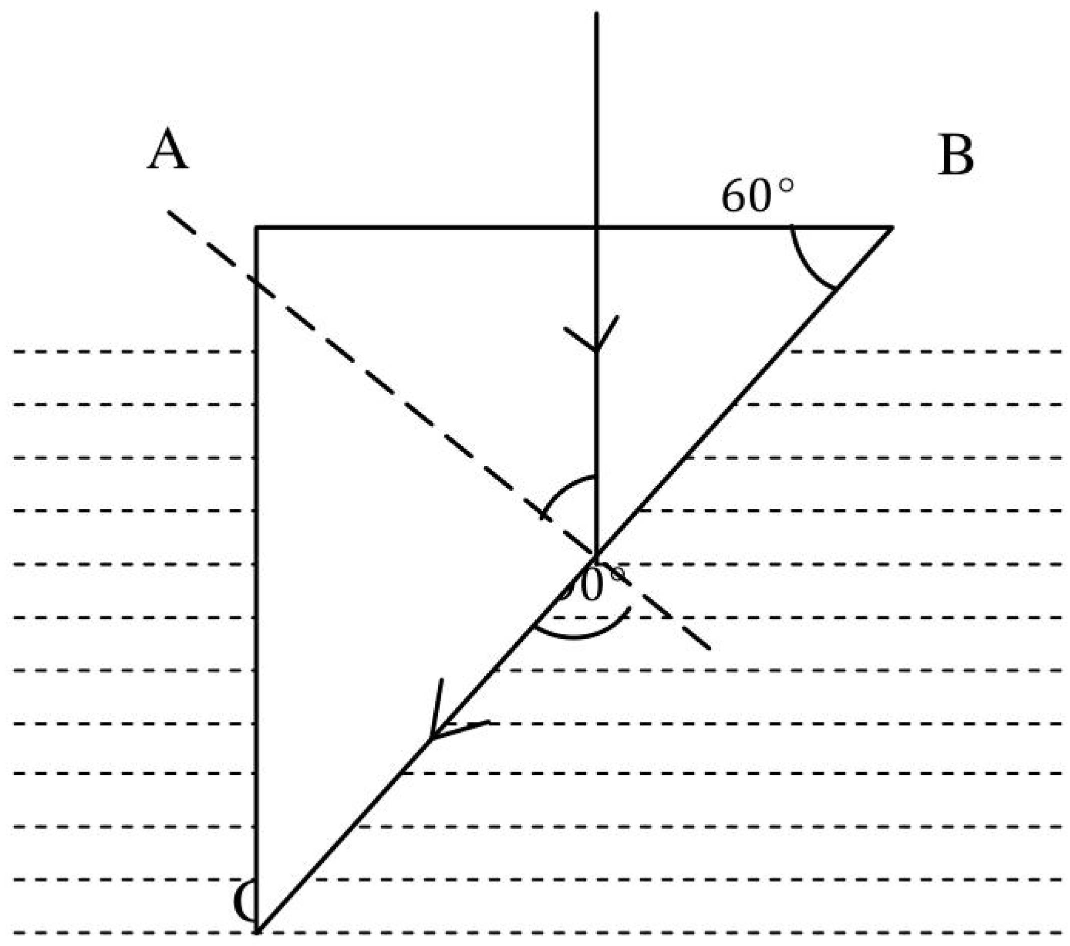
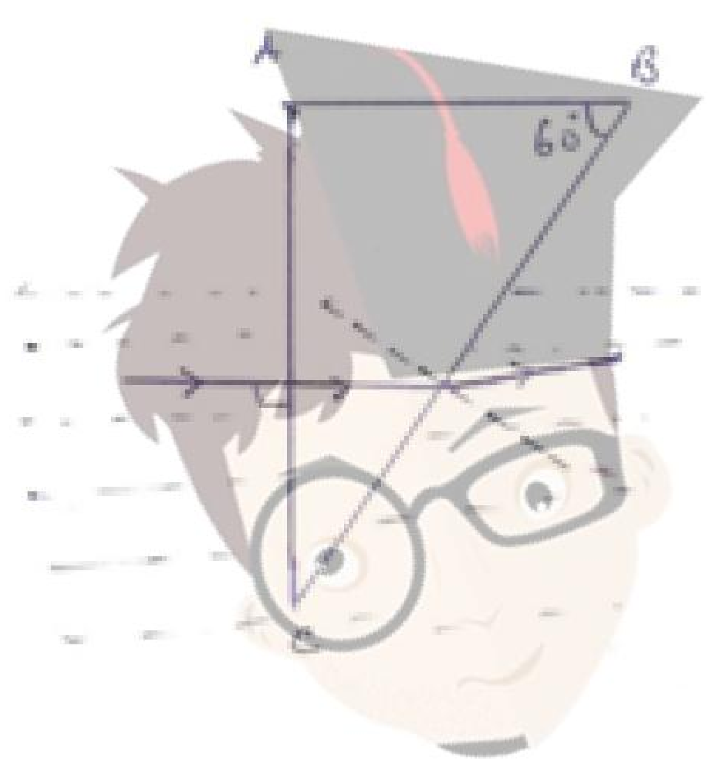
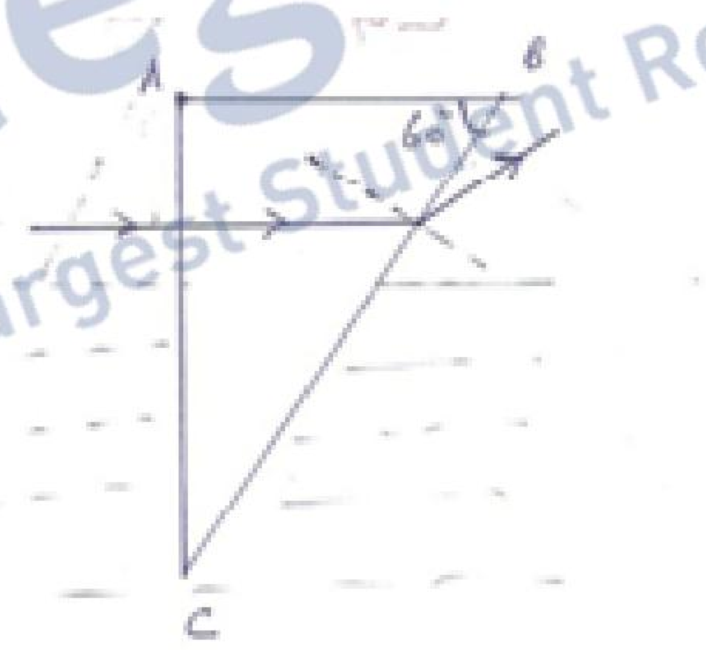
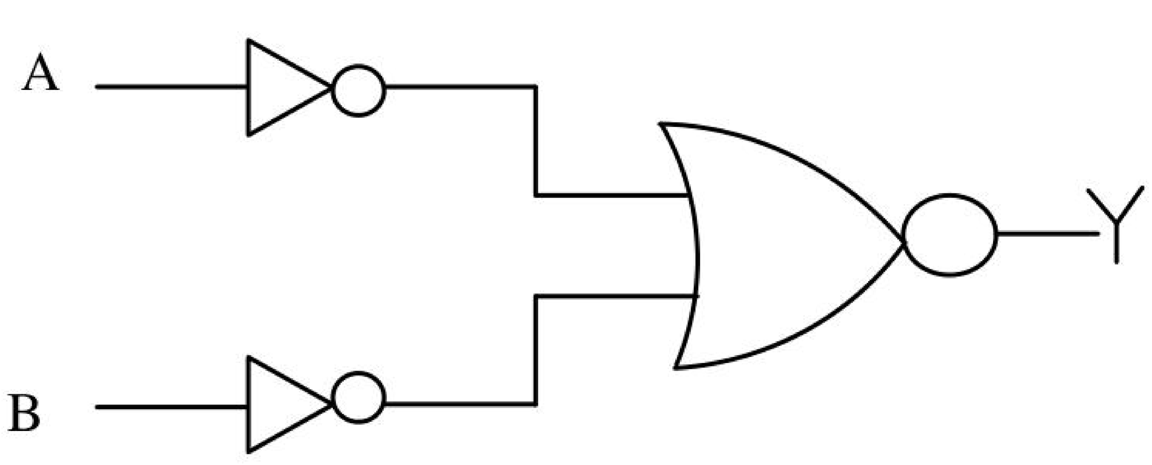
Q. No.	Expected Answer / Value Points	Marks	Total Marks
	Section - A		
Set -1,Q1 Set- 2,Q5 Set-3, Q2	Dielectric Constant of a medium is the ratio of intensity of electric field in free space to that in the dielectric medium. **Alternatively** It is the ratio of capacitance of a capacitor with dielectric medium to that without dielectric medium. **Alternatively** Any other equivalent definition S.I. Unit : No Unit	½ ½	1
Set -1, Q2 Set- 2, Q4 Set-3, Q5	$T_1 > T_2$ Slope of T_1 is higher than that of T_2. (or Resistance, at T_1, is higher than that of T_2)	½ ½	1
Set -1, Q3 Set- 2,Q2 Set-3, Q4	No induced current hence no direction.	½ ,½	1
Set -1, Q4 Set- 2,Q3 Set-3, Q1.	Critical angle depends upon the refractive index (n) of the medium and refractive index is different for different colours of light.	½ +½	1
Set -1, Q5 Set- 2,Q1 Set-3, Q3.	It rejects dc and **sinusoids** of frequency ω_m, $2\omega_m$ and $2\omega_c$ and retain frequencies ω_c, $\omega_c \pm \omega_m$. (**Alternatively:** It allows only the desired/ required frequencies to pass through it)		1
	Section - B		
Set -1, Q6 Set- 2,Q7 Set-3, Q10	Graph of V vs R — 1 Graph of I vs R — 1 (i) V vs R: $V = \frac{ER}{R+r}$  (ii) I vs R: $I = \frac{E}{R+r}$  (Award ½ mark in each if child writes only formulae)	1 1	2

Set -1, Q7 Set- 2,Q10 Set-3, Q8	de Broglie Relation ½ Dependence of λ on n 1 de Broglie wavelength $\lambda = \frac{h}{mv}$ $\therefore\ \lambda \propto \frac{1}{v}$; $v \propto \frac{1}{n}$ $\therefore \lambda \propto n$ $\therefore$ *de* Broglie wavelength will increase **Alternative method** As $2\pi r_n = n\lambda$; $\lambda = \frac{2\pi r_n}{n}$ $(\lambda \propto \frac{r_n}{n})$ $r_n \propto n^2$ $\therefore\ \lambda \propto \frac{n^2}{n} \Rightarrow \lambda \propto n$ $\therefore$ *de* Broglie wavelength will increase (Note: Accept any other alternative method)	½ 1 ½ 1 ½ ½	2 2
Set -1, Q8 Set- 2,Q6 Set-3, Q9	Definition of Wave front 1 Diagram 1 <u>Wave front</u> : It is the locus of points which oscillate in phase. Or It is a surface of constant phase.  **Or** a) Characteristics & reason ½+½ b) Ratio of Velocity 1 a) Frequency does not change, as frequency is a characteristic of the source of waves. (**Alternatively:** $\frac{v_1}{\lambda_1} = \frac{v_2}{\lambda_2} = n$) b) The ratio of velocities of wave in two media of refractive indices μ_1 and μ_2 is $\frac{\mu_2}{\mu_1}$. (**Alternatively:** $\frac{v_1}{v_2} = \frac{\mu_1}{\mu_2}$)	1 1 ½+½ 1	 2 2

Set -1, Q9 Set- 2,Q8 Set-3, Q7	Diagrams of AM and FM 1 Reason 1   <u>Why FM is preferred over AM'?</u> Low noise/ disturbance// reduced channel interference// more power can be transmitted// high fidelity. (Any one reason)	½ ½ 1	 2
Set -1,Q10 Set- 2,Q9 Set-3, Q6	Formula ½ Calculation & result 1½ Distance of the closest approach $r_o = \frac{1}{4\pi\epsilon_0} \cdot \frac{2ze^2}{E_{\propto}}$ $= \frac{2 \times 9\times10^{9} \times 80 \times (1.6 \times 10^{-19})^2}{4.5 \times 10^{6} \times 1.6 \times 10^{-19}}$ $= 5.12 \times 10^{-14}\ m$	½ 1 ½	 2
Section – C			
Set -1,Q11 Set- 2,Q20 Set-3, Q15	Diagram ½ Force on each arm ½ Calculation of moment of couple 1 Orientation in stable equilibrium 1		

*These answers are meant to be used by evaluators

	 Force on each perpendicular arm $F_1 = F_2 = I\,b\,B$ Moment of couple = $I\,b\,B.a\sin\theta$ $\tau = I\,ab\,B\,sin\theta$ $\tau = \mathrm{I}\,AB\,sin\theta \quad \vec{\tau} = \mathrm{I}\,\vec{A}\times\vec{B}$ When the plane of the loop is perpendicular to the magnetic field, the loop will be in stable equilibrium ($\vec{A} \parallel \vec{B}$), $\Longrightarrow \theta = 0°$ (If the student follows the following approach, award ½ marks only) $\vec{M}$ = Equivalent magnetic moment of the planer loop = $\mathrm{I}\vec{A}$ ∴ Torque = $\vec{M} \times \vec{B} = \mathrm{I}\vec{A}\times\vec{B}$ $\lvert Torque \rvert$ = IAB$sin\theta$	½ ½ 1 ½ ½	3
Set -1,Q12 Set- 2,Q21 Set-3, Q16	Production of em waves 1 Source of energy 1 Identification ½+½ Electromagnetic waves are produced by accelerated / oscillating charges which produces oscillating electric field and magnetic field (which regenerate each other). Source of the Energy: Energy of the accelerated charge. (or the source that accelerates the charges) Identification: (1) Infra red radiation (2) X - rays	1 1 ½ ½	3
Set -1,Q13 Set- 2,Q22 Set-3, Q17	a) To draw path of light ray in prism ½ Formula and calculation of refractive index of liquid 1½ b) Tracing the path of the ray 1		

	a)  $sini_c = \frac{1}{\mu_{mg}} = \frac{\mu_m}{\mu_g}$ ⇨ $\mu_m = \mu_g sini_c$ $=1.5 \times \frac{\sqrt{3}}{2}$ $(i_c = 60°)$ $= 1.299 \simeq 1.3$ (b)  **Alternatively** 	½ ½ ½ ½ 1	3
Set -1,Q14 Set- 2,Q16 Set-3, Q18	Logic circuit – 1 Truth Table - 1 Identification - 1 To draw the logic circuit 	1	

Truth Table

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

1

Identification : AND gate — 1 — 3

Or

Identification of logic operation in circuit (a) & (b)	½+½
Truth table for circuit (a) & (b)	½+½
Identification of equivalent gates	½+½

Logic Operation a) Y = A.B — ½

b) Y = A+B — ½

Truth Table

a)

A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

½

b)

A	B	Y
0	0	0
1	0	1
0	1	1
1	1	1

½

Identification

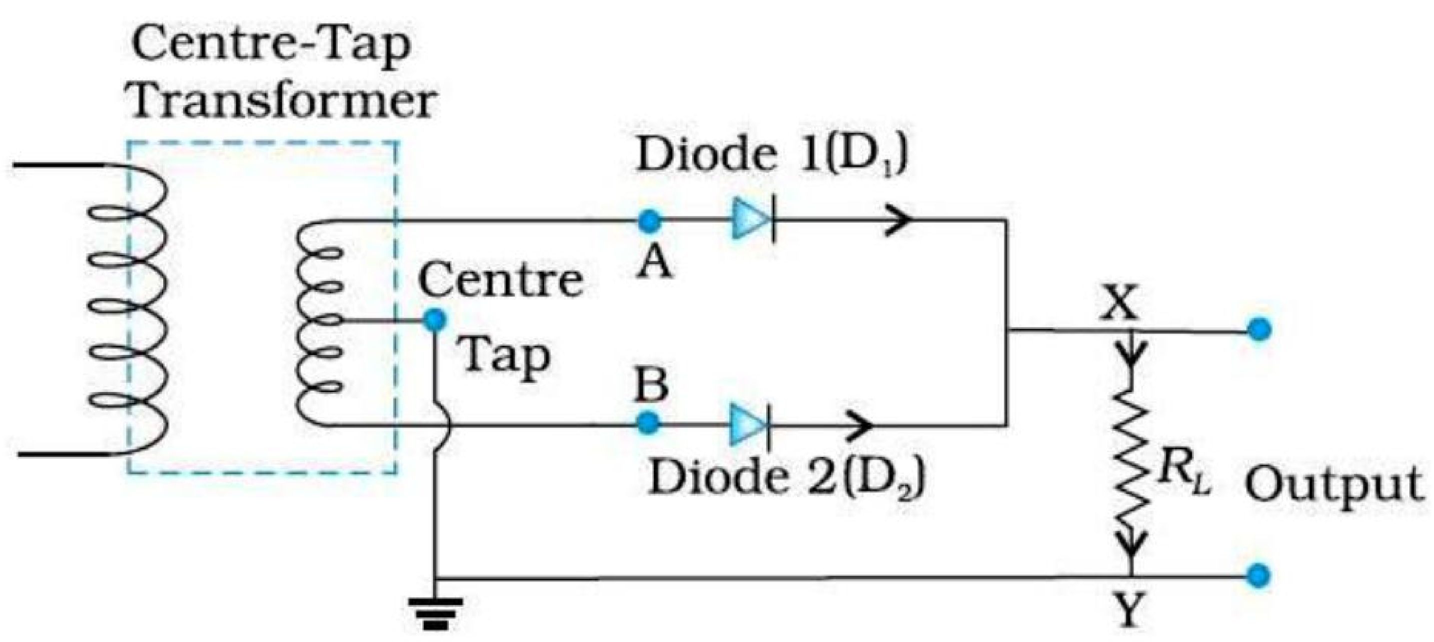
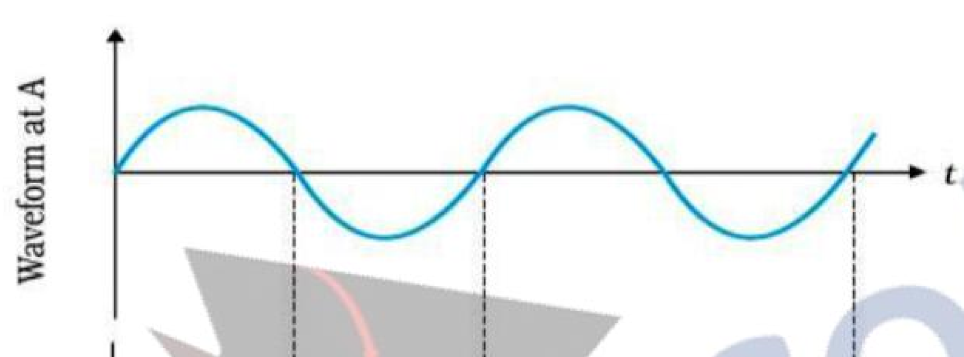
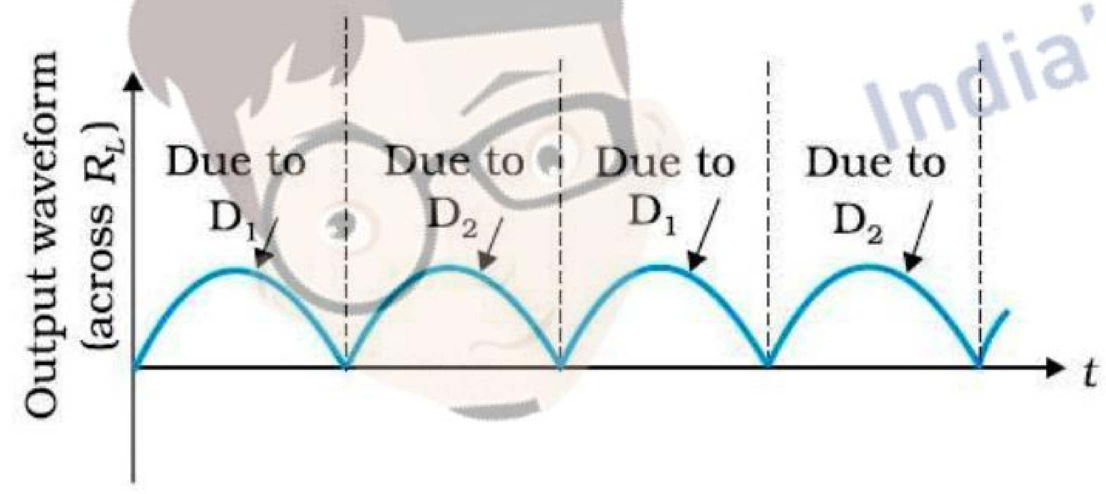
a) AND gate — ½

b) OR gate — ½

3

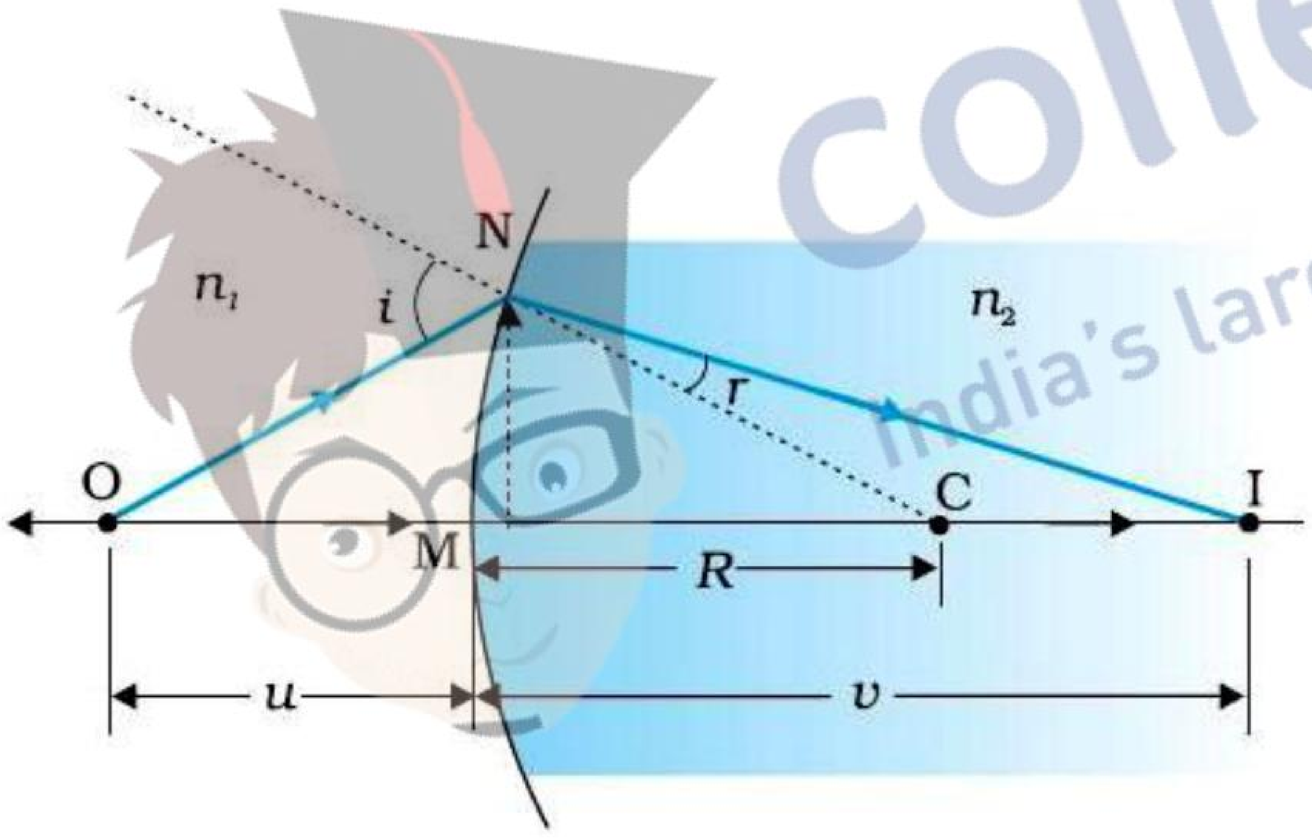
Set -1,Q15
Set- 2,Q17
Set-3, Q11

Circuit diagram	1
Working	½
Wave forms and Input & Output	½+½
Characteristic property	½

	Circuit Diagram  	1	
	Description of Working- During the positive half of input ac diode D_1 get forward bias and D_2, reverse biased and during negative half of input ac, polarity get reversed, D_2 get forward bias and D_1 reverse bias. Hence, output is obtained across R_L during entire cycle of ac.	½	
	Wave forms Input  	½	
	Output  	½	
	Characteristic property Diode allows the current to pass only when it is forward based.	½	3
Set -1,Q16 Set- 2,Q18 Set-3, Q12	Explanation of (i), (ii) and (iii) with justification 1×3 (i) Drift velocity will become half as $v_d \propto V$ (ii) Drift velocity will become half as $v_d \propto \frac{1}{L}$ (iii) Drift velocity will remain the same as v_d is independent of diameter (D).	½+½ ½+½ ½+½	3
Set -1,Q17 Set- 2,Q19 Set-3, Q13	Determination of magnetic field 1½ Determination of kinetic energy in MeV 1½		

	Magnetic field $B = 2\pi mv/q$ $= \frac{2 \times 3.14 \times 1.67 \times 10^{-27} \times 10^{7}}{1.6 \times 10^{-19}} = 0.66T$ Final velocity of proton $v = R \times 2\pi v = 0.6 \times 2 \times 3.14 \times 10^{7}$ $= 3.77 \times 10^{7} m/s$ Energy $= \frac{1}{2}mv^{2} = \frac{1}{2} \times 1.67 \times 10^{-27} \times (3.77 \times 10^{7})^{2} j$ $= 7.4\ MeV$	½ 1 ½ ½ ½	3
Set -1,Q18 Set- 2,Q11 Set-3, Q14	a) Calculation of distance of third bright fringe 1 b) Calculation of distance from the central maxima 2 a) Distance of third bright fringe-$y_3 = \frac{n\lambda D}{d}$ $= \frac{3 \times 520 \times 10^{-9} \times 1}{1.5 \times 10^{-3}}$ $= 1.04 \times 10^{-3} m \simeq 1\ mm$ b) Let n^{th} maxima of $650nm$ coincides with the $(n+1)^{th}$ maxima of $520nm$ $\therefore n \times 650 \times 10^{-9} = (n+1)520 \times 10^{-9}$ $\Rightarrow n = 4$ $\therefore$ The least distance of the point is given by $y = \frac{nD\lambda_1}{d}$ $= \frac{4 \times 1 \times 650 \times 10^{-9}}{1.5 \times 10^{-3}} m = 1.733 \times 10^{-3} m \simeq 1.7mm$	½ ½ ½ ½ 1	3
Set -1,Q19 Set- 2,Q12 Set-3, Q21	a) Pointing out and Reason of two processes 1+1 b) Identification of radioactive radiations ½+½ a) Nuclear fission of E to D and C; as there is a increase in binding energy per nucleon b) Nuclear fusion of A and B into C; as there is a increase in binding energy per nucleon b) First step - ∝ particle Second step – β particle	½ + ½ ½ + ½ ½ ½	3

Set -1,Q20 Set- 2,Q13 Set-3, Q22	Three modes of propagation 1½ Brief explanation of reflection by Ionosphere 1 Effect of increased frequency range ½ Three modes of propagation i) Ground Waves ii) Sky Waves iii) Space Waves Ionosphere acts as a reflector for the range of frequencies from few MHz to 30 MHz . The ionospheric layers bend the radio waves back to the Earth. Waves of frequencies greater than 30 MHz penetrate the ionosphere and escape	 ½ ½ ½ 1 ½	 3
Set -1,Q21 Set- 2,Q14 Set-3, Q19	Definition of Stopping Potential and threshold frequency 1+1 Determination using Einstein's Equation 1 Stopping Potential: The minimum negative potential applied to the anode/ plate for which photoelectric current become zero. Threshold frequency: The minimum (cut off) frequency of incident radiation, below which no emission of photoelectrons takes place. By Einstein's Equation $eV_0 = hv - \phi_o$ For any given frequency $v > v_o, V_o$ can be determined. Stopping Potential $V_0 = \left(\frac{h}{e}\right) v - \frac{\phi_o}{e}$ as $\phi_0 = hv_0$ Threshold frequency, $V_0 = \frac{\phi_0}{h}$	 1 1 ½ ½	 3
Set -1,Q22 Set- 2,Q15 Set-3, Q20	Calculation of voltage across each capacitor in (a), (b) and (c) 1½ Explanation with reason for the change/no change 1½ (a) $V_L = 3V$ $V_R = 3V$ (L: Left, R: Right) (b) $V_L = 6V$ $V_R = 3V$ (c) $V_L = 2V$ $V_R = 3V$ <u>Reasons</u> (a) No change – (potential same on both capacitors as ($V_L = V_R$)) (b) Charge on left hand capacitor will decrease ($V_L > V_R$) (c) Charge on left hand capacitor will increase ($V_R > V_L$)	 ½ ½ ½ ½ ½ ½	 3

Set -1,Q23 Set- 2,Q23 Set-3, Q23	(a) Naming the principle involved 1 (b) Explanation 1 (c) Two qualities 2 (a) Metal detector works on the principle of resonance in ac circuits. (b) When a person walks through the gate of a metal detector, the impedance of the circuit changes, resulting in significant change in current in the circuit that causes a sound to be emitted as an alarm. (c) Two qualities (i) Following the rules/regulations (ii) Responsible citizen (iii) Scientific temperament (iv) Knowledgable (Any two)	1 1 1+1	4
	Section - E		
Set -1,Q24 Set- 2,Q26 Set-3, Q25	(a) Drawing labeled ray diagram 1½ (b) Deducing relation between u , v and R 2½ (c) Obtaining condition for real image 1  From the diagram : $\angle i = \angle NOM + \angle NCM$ $\angle r = \angle NCM - \angle NIM$ By Snell's law , $n_1 \sin i = n_2 \sin r$ Substituting for i and r. and simplifying, we get $\frac{n_1}{OM} + \frac{n_2}{MI} = \frac{n_2 - n_1}{MC}$ Substituting values of OM , MI and MC $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$	1½ ½ ½ ½ ½ ½	

(b)Condition for real image : v is positive ½

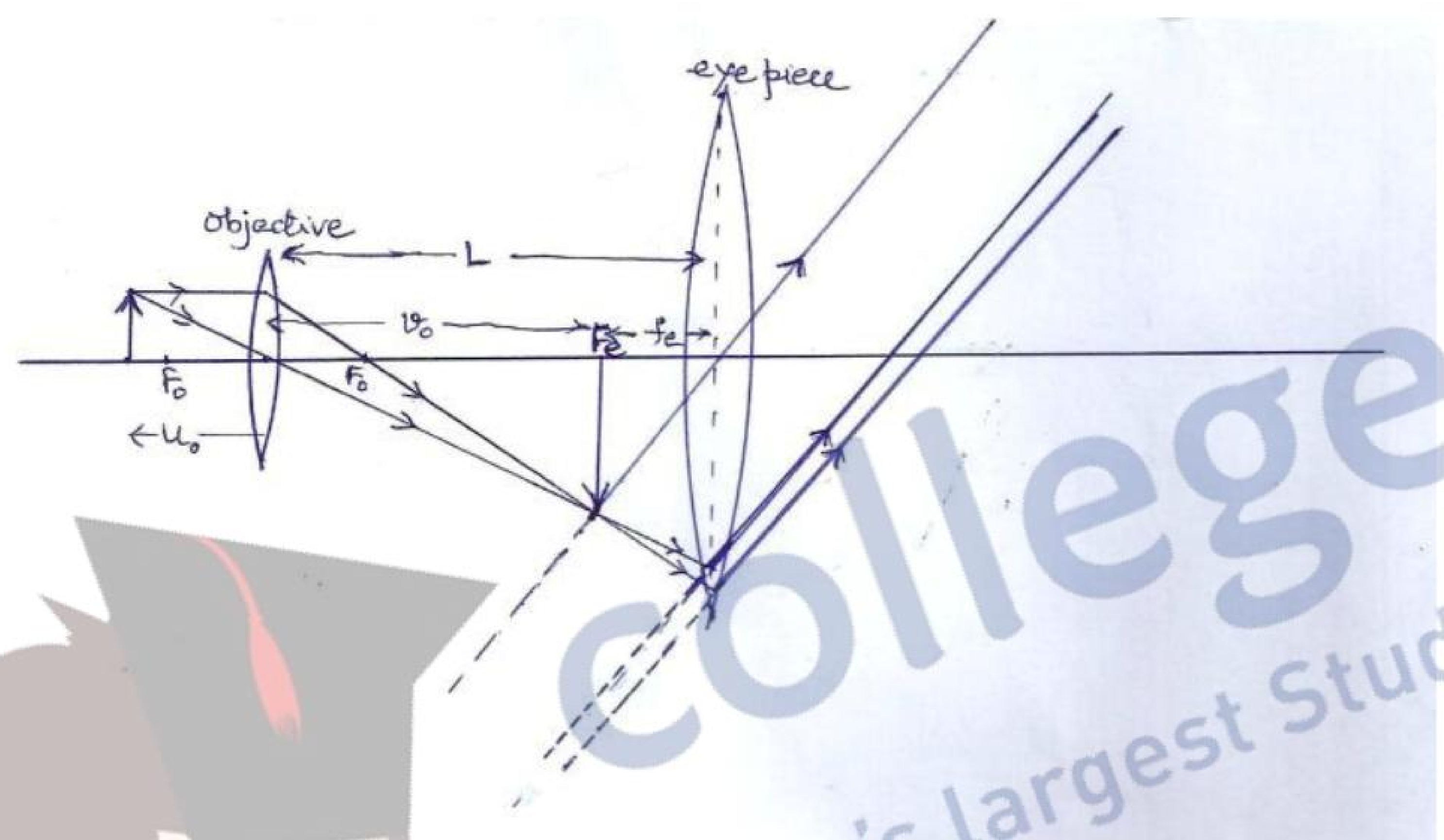
$$\therefore \frac{n_2}{v} > 0$$

From the derived relation , we have $\frac{n_1}{|u|} < \frac{n_2 - n_1}{R}$ ½ 5

$$\therefore |u| > \frac{n_1 R}{n_2 - n_1}$$

OR

(a)	Ray diagram	1½
	Derivation of expression for magnifying power	1½
(b)	Effect on resolving power in each case; with justification	1+1



1½

(Award 1 mark if the student draws the diagram for image at distance of distinct vision, deduct ½ mark for not showing the direction of Propogation of ray)

Derivation:

- Magnification due to objective ½

$$m_o = \frac{L}{f_o}$$

- Magnification due to eyelens ½

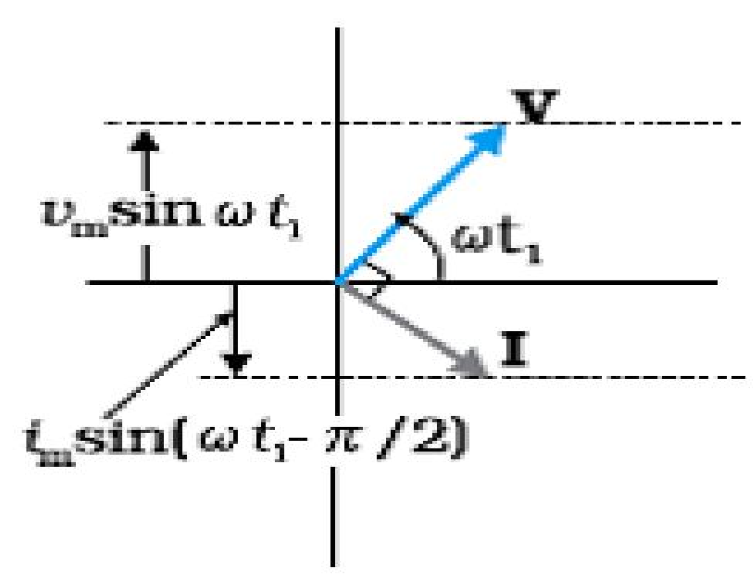
$$m_e = \frac{D}{f_e}$$

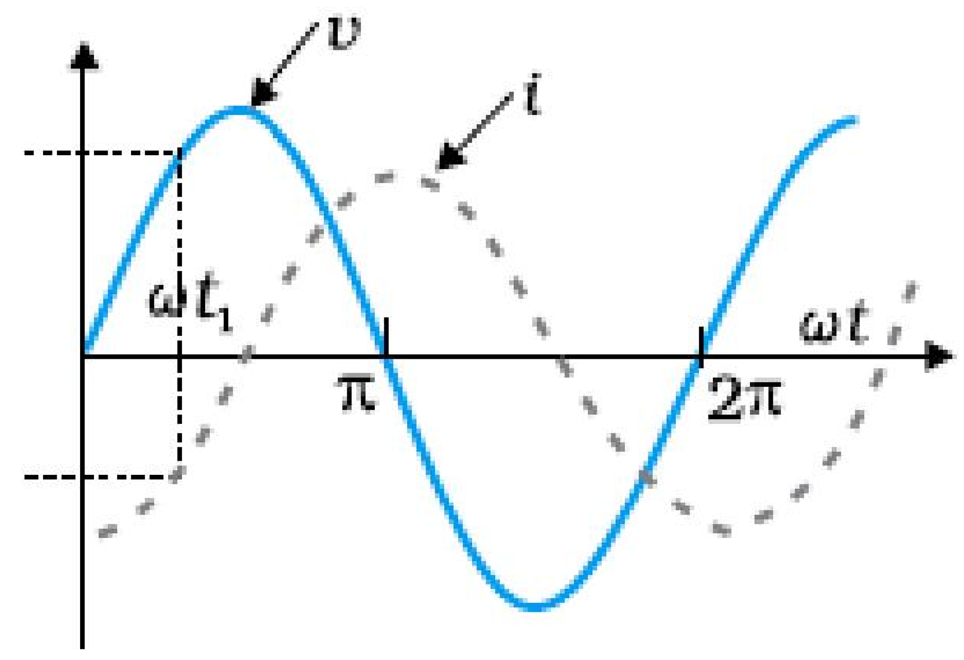
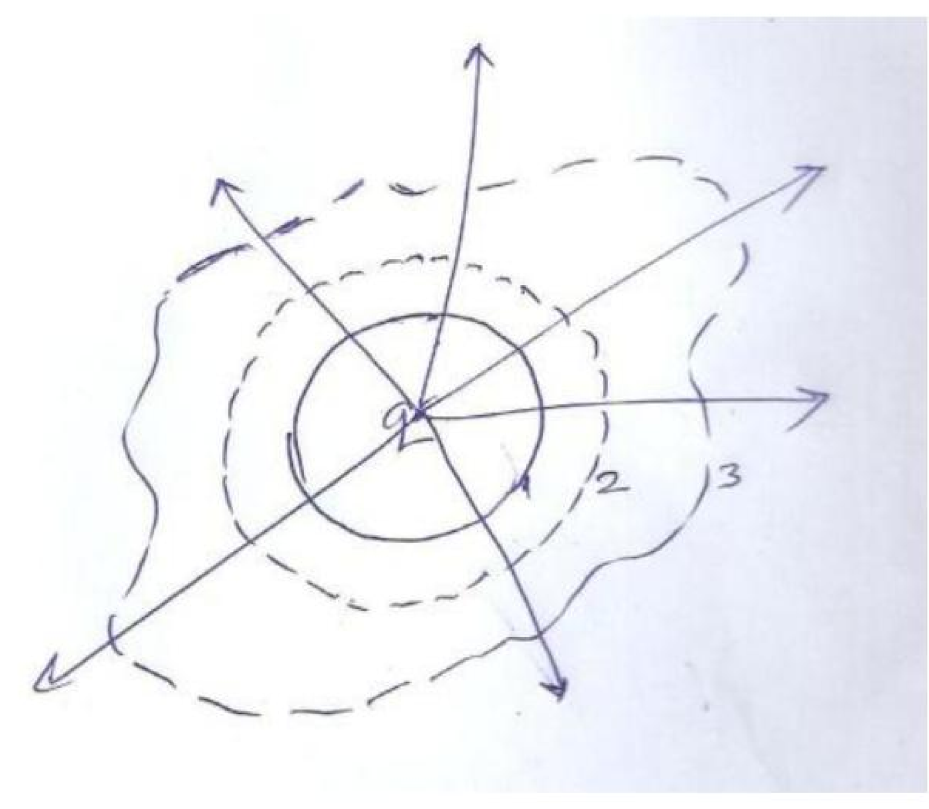
- Total magnification $m = m_o m_e$ ½

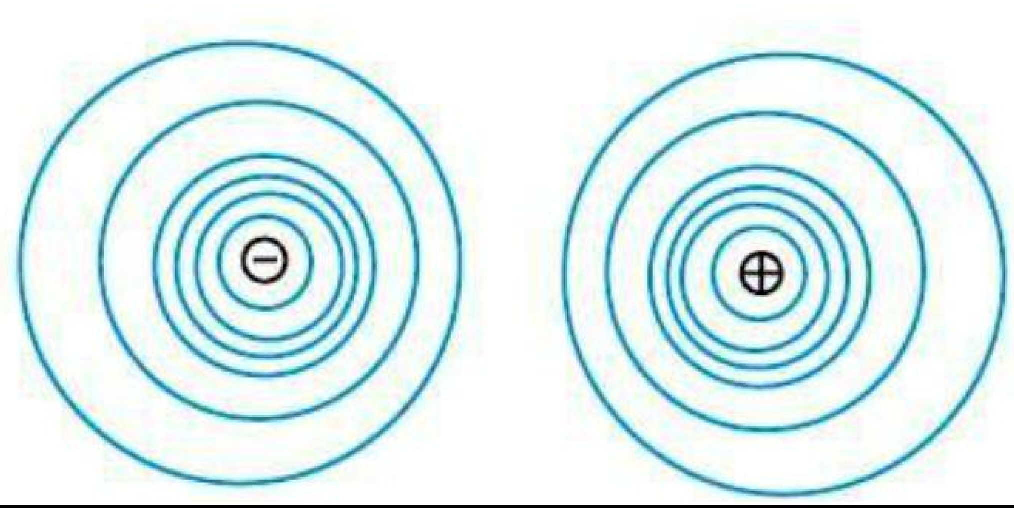
$$m_o = \frac{L}{f_o} \cdot \frac{D}{f_e}$$

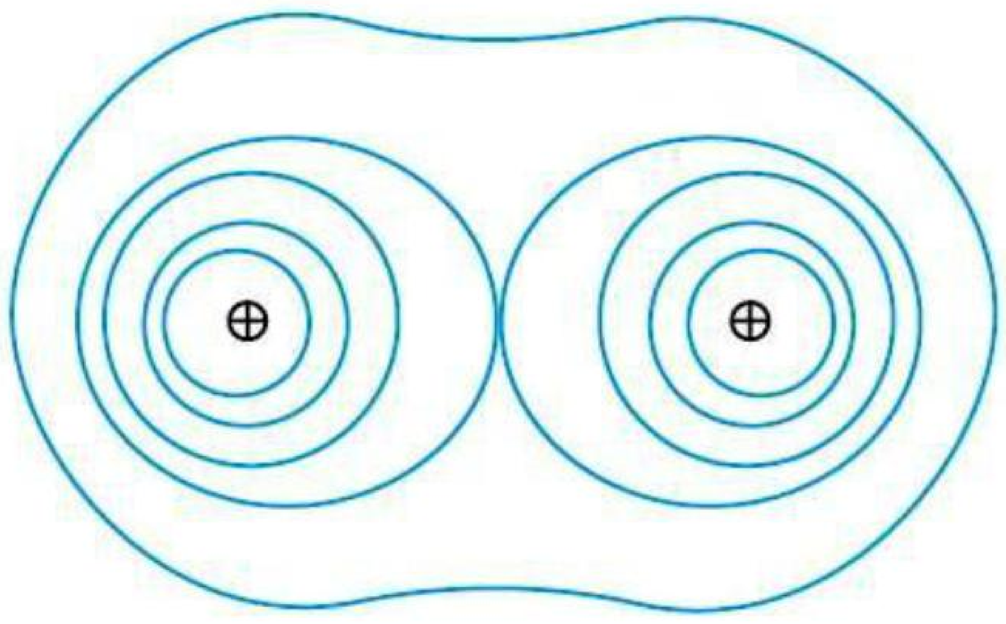
(b) The resolving power of microscope 1

(i) Will decrease with decrease of the diameter of objective lens as resolving power is directly proportional to the diameter 5

	(ii) Will decrease with increase of the wavelength of the incident light as resolving power is inversely proportional to the wave length	1	
Set -1,Q25 Set- 2,Q24 Set-3, Q26	(a) Faraday's law — 1 (b) Explanation with example — 2 (c) Derivation for induced emf — 2		
	(a) Faraday's law – "The magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit." (Alternatively : Induced emf = $\frac{-d\emptyset}{dt}$)	1	
	(b) A bar magnet experiences a repulsive force when brought near a closed coil and attractive force when moved away from the coil, due to induced current. Therefore, external work is required to be done in the process.	2	
	(c) Since workdone is moving the charge 'q' across the length 'l' of the conductor is W=qvBl	1	
	Since emf is the work done per unit charge $\mathcal{E} = \frac{\text{w}}{\text{q}}$ $\mathcal{E}$ = Blv	1	5
	OR		
	(a) Derivation for the current using phasor diagram — 1 Plot of graphs (i) and (ii) — 1+1 (b) Derivation for the average power — 2		
	Phasor diagram for the circuit:  	½	
	From the Phasor diagram: V makes an angle 'ωt' with axis, current 'I' lags behind the voltage 'V' by $\frac{\pi}{2}$, (makes an angle of – ($\frac{\pi}{2} - wt$) with the axis.) $\therefore, i = i_m \sin\left[-\left(\frac{\pi}{2} - \omega t\right)\right] = i_m \sin\left(\omega t - \frac{\pi}{2}\right)$ [Award this 1mark even if derivation is done by analytical method]	½	

	Graph showing variation of voltage and current as function of ωt  	1+1	
	Instantaneous power in LCR circuit: p = v × i = $v_m \sin \omega t \times i_m \sin(\omega t + \varphi)$ p = $\frac{v_m i_m}{2}$ $[\cos\varphi - \cos(2\omega t + \varphi)]$ average power $P_{av} = \frac{v_m i_m}{2} \cos\varphi$ $P_{av} = \frac{v_m}{\sqrt{2}} \frac{i_m}{\sqrt{2}} \cos\varphi$ $P = V_{eff} I_{eff} \cos\phi$	½ ½ ½ ½	5
Set -1,Q26 Set- 2,Q25 Set-3, Q24	a)Statement of Gauss law 1 Explanation with diagram 1 b)Magnitude and direction of net electric field in (i) and (ii) 1½ +1 ½		
	(a) Gauss Law: Electric flux through a closed surface is $\frac{1}{\epsilon_0}$ times the total charge enclosed by the surface. **Alternatively:** $\phi = \frac{1}{\epsilon_0}.q$	1	
	The term q equals the sum of all charges enclosed by the surface and remain unchanged with the size and shape of the surface. **Alternatively-** The total number of electric field lines emanating from the enclosed charge 'q' are same for all surfaces 1,2 &3	½	
	 	½	
	(b) We have $\lvert E_1 \rvert = \frac{\sigma}{\epsilon_o}$; $\lvert E_2 \rvert = \frac{2\sigma}{\epsilon_o}$ (i) Between the plates $E_{in} = E_1 + E_2$	1	

	$= \frac{\sigma}{2\epsilon_o} + \frac{2\sigma}{2\epsilon_o} = \frac{3\sigma}{2\epsilon_o}$ (Directed towards sheet '2')	½	
	(ii) Outside near the sheet '1' $E_{out} = E_2 - E_1$ $= \frac{2\sigma}{2\epsilon_o} - \frac{\sigma}{2\epsilon_o} = \frac{\sigma}{2\epsilon_o}$ (Directed towards sheet '2')	½	5
	OR		
	a) Definition of electrostatic potential and SI unit — 1+½ Derivation for the electrostatic potential energy — 1+½ b) Equipotential surface for (i) & (ii) — 1+1		5
	a) Electrostatic potential : Work done by an external force in bringing a unit positive charge from infinity to the given point	1	
	SI unit- volt or J/C) Net work done in moving charges $q_1 . q_2$ &q_3 from infinity to A, B and C respectively	½	
	$W = 0 + q_2V_{13} + q_3(V_{13}V_{23})$	½	
	$= \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r_{12}} + \frac{1}{4\pi\epsilon_0}(\frac{q_1q_3}{r_{13}} + \frac{q_2q_3}{r_{23}})$	½	
	But potential energy of the system is equal to the work done. $\therefore U = w = \frac{1}{4\pi\epsilon_0}(\frac{q_1q_2}{r_{12}} + \frac{q_1q_3}{r_{13}} + \frac{q_2q_3}{r_{23}})$ (Award these 1 mark if the student directly writes the expression for U)	½	
	(b) Equipotential surface due to (i) An electric dipole 	1	

	(ii) Two identical positive changes 	1	5