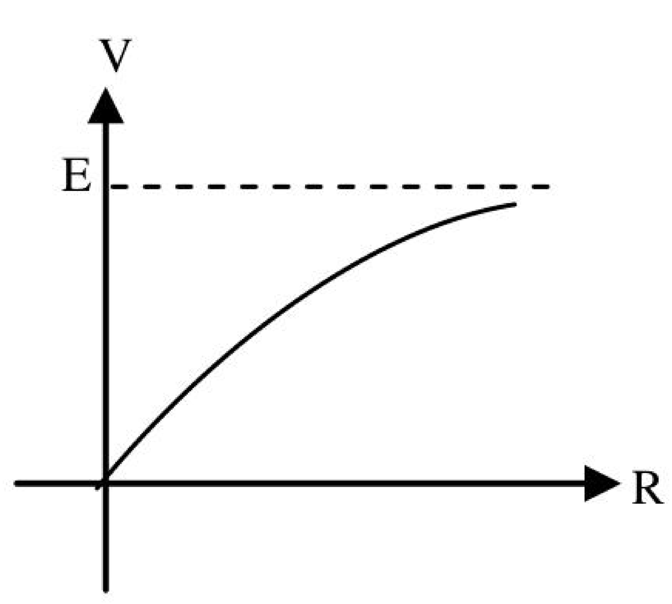
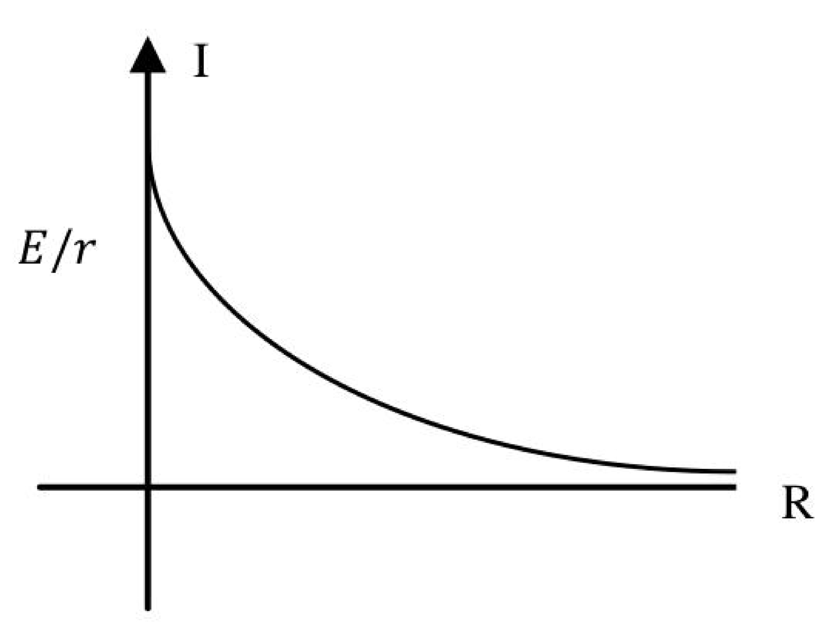
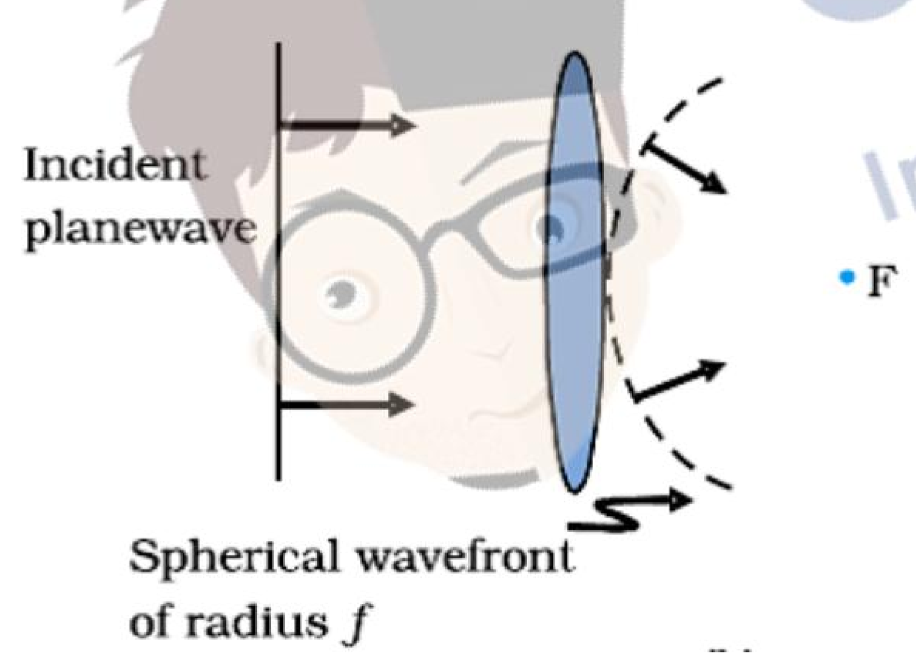
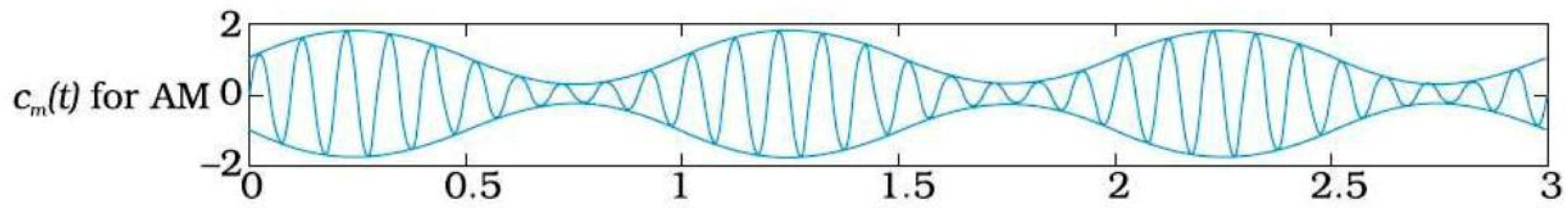
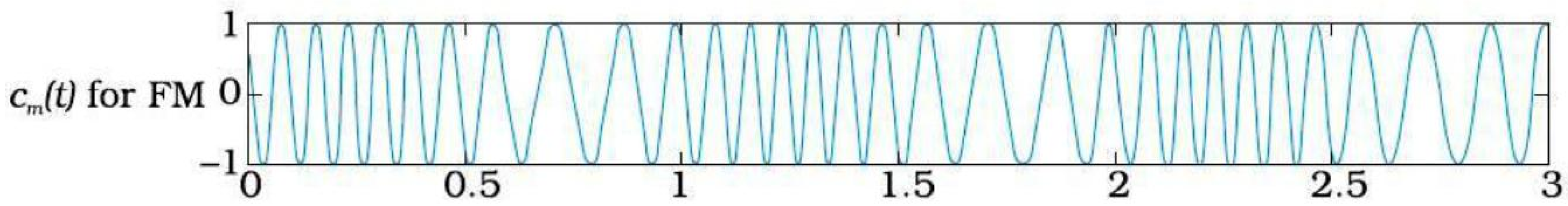
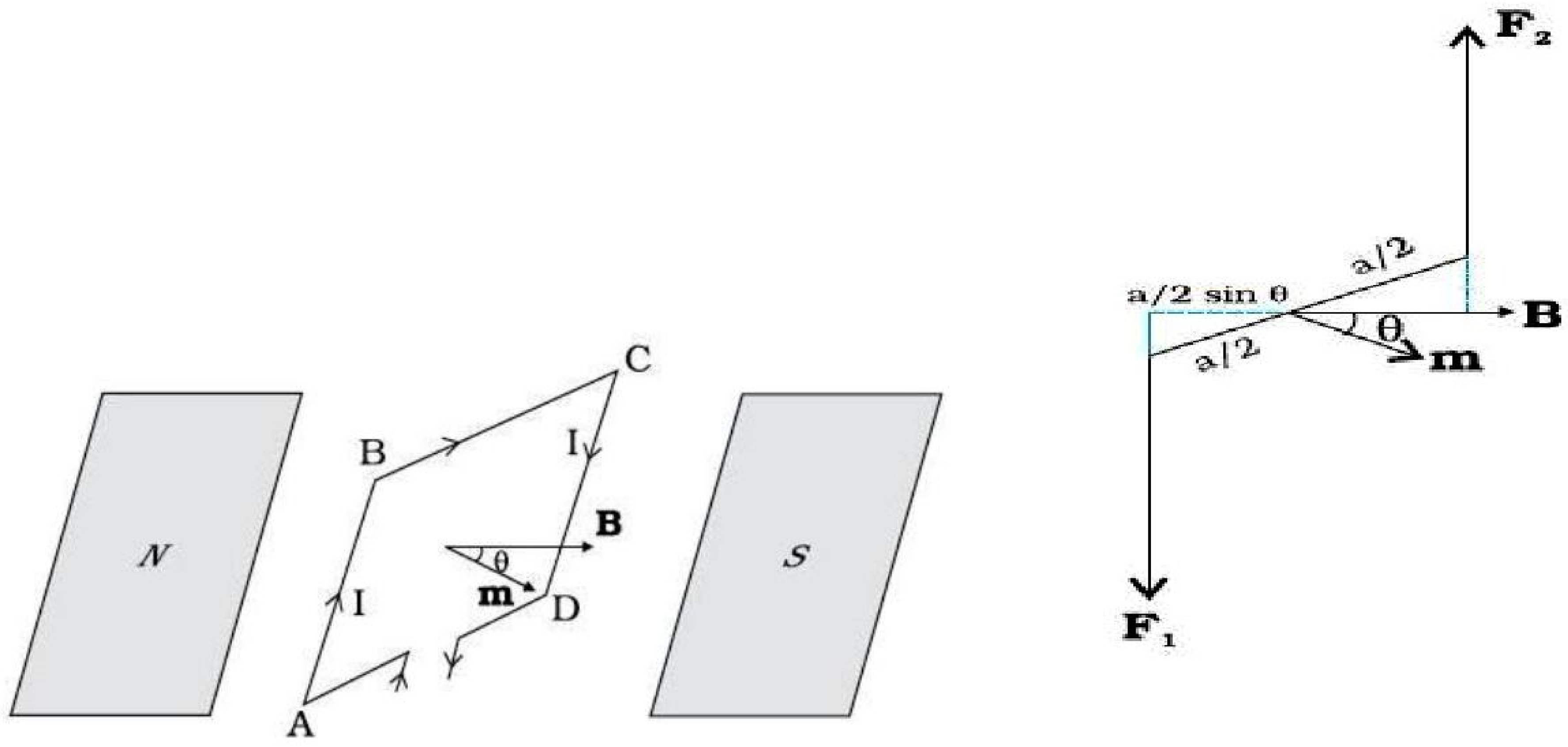
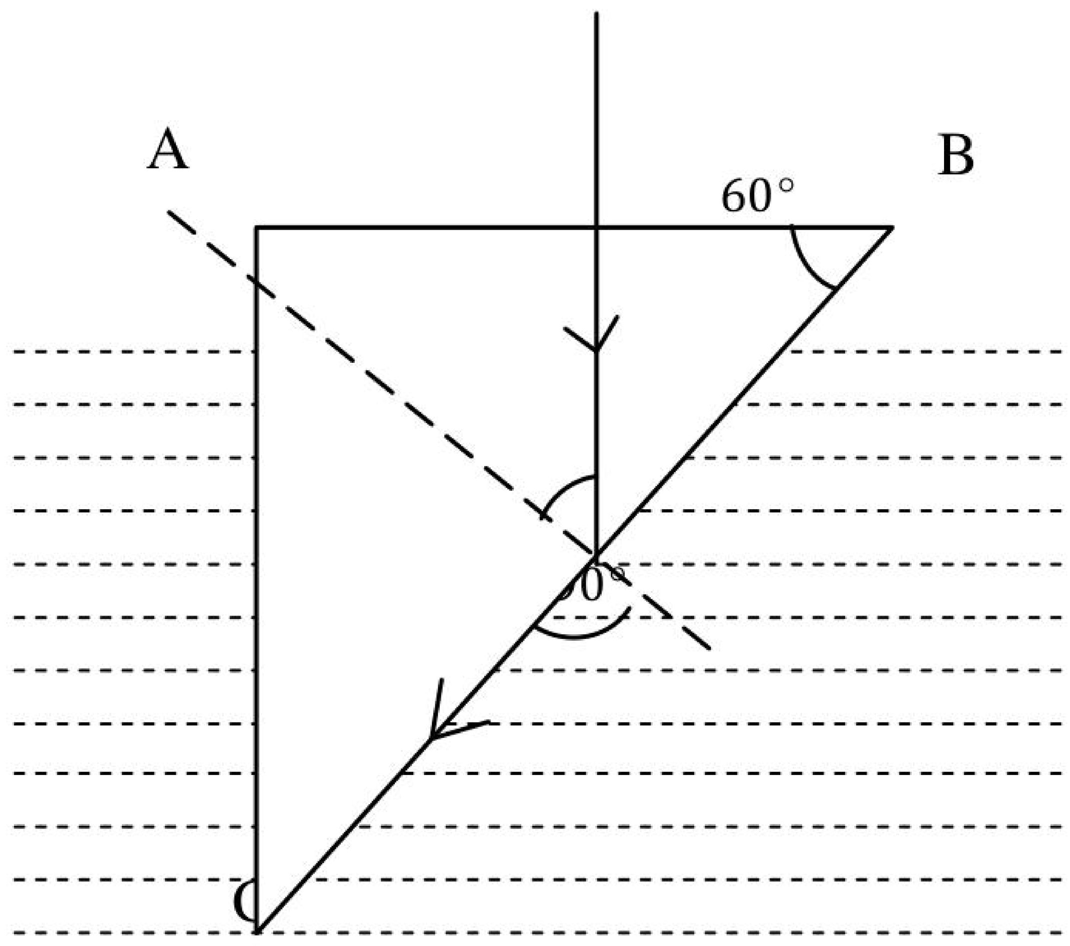
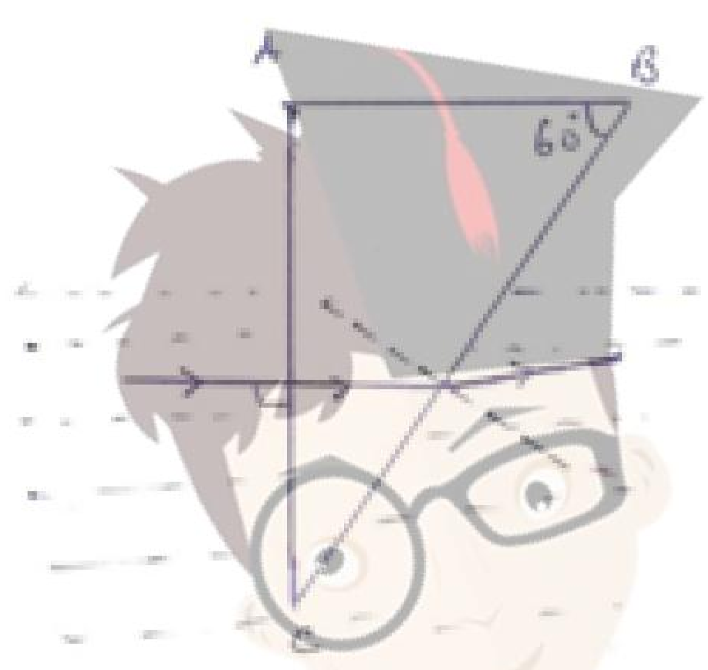
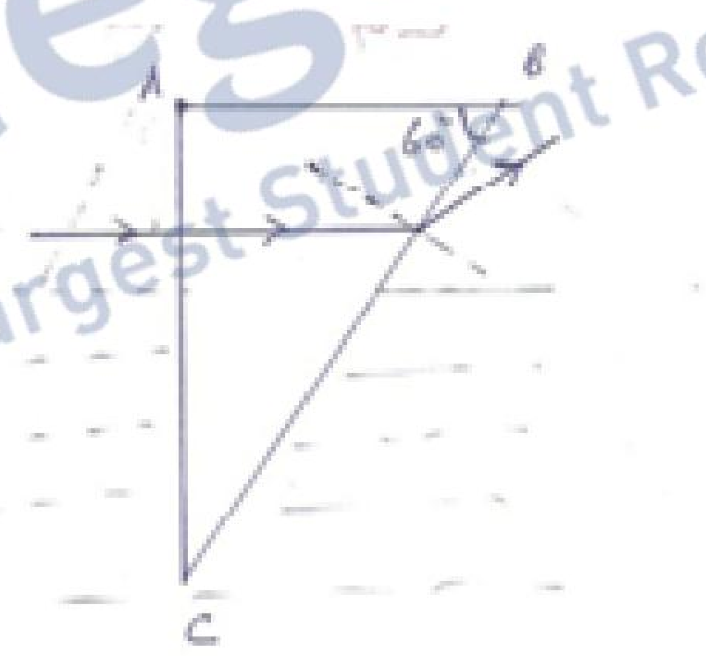
MARKING SCHEME
SET 55/1/A

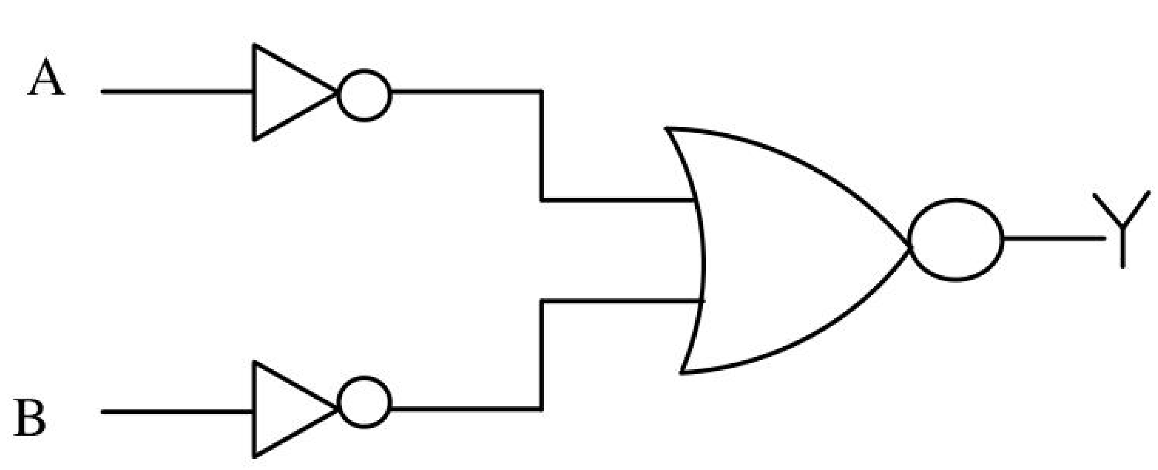
Q. No.	**Expected Answer / Value Points**	**Marks**	**Total Marks**
	Section - A		
Set -1,Q1 Set- 2,Q5 Set-3, Q2	Dielectric Constant of a medium is the ratio of intensity of electric field in free space to that in the dielectric medium. **Alternatively** It is the ratio of capacitance of a capacitor 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 $\lambda = \frac{h}{mv}$		
	$\therefore\ \lambda \propto \frac{1}{v}\ ;\ v \propto \frac{1}{n}$	½	
	$\therefore \lambda \propto n$	1	2
	$\therefore$ *de* Broglie wavelength will increase	½	
	Alternative method		
	As $2\pi r_n = n\lambda\ ;\ \lambda = \frac{2\pi r_n}{n} (\lambda \propto \frac{r_n}{n})$	1	
	$r_n \propto n^2$		
	$\therefore\ \lambda \propto \frac{n^2}{n} \Rightarrow \lambda \propto n$	½	
	$\therefore$ *de* Broglie wavelength will increase	½	2
	(Note: Accept any other alternative method)		
Set -1, Q8 Set- 2,Q6 Set-3, Q9	Definition of Wave front 1 Diagram 1		
	Wave front : It is the locus of points which oscillate in phase. Or It is a surface of constant phase.	1	
		1	2
	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:** $\frac{v_1}{\lambda_1} = \frac{v_2}{\lambda_2} = n$)	½+½	
	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	2

Set -1, Q9 Set- 2,Q8 Set-3, Q7	Diagrams of AM and FM 1 Reason 1		
		½	
		½	
	<u>Why FM is preferred over AM'?</u> Low noise/ disturbance// reduced channel interference// more power can be transmitted// high fidelity. (Any one reason)	1	2
Set -1,Q10 Set- 2,Q9 Set-3, Q6	Formula ½ Calculation & result 1½		
	Distance of the closest approach $r_o = \frac{1}{4\pi\epsilon_0}\cdot\frac{2ze^2}{E_\infty}$	½	
	$= \frac{2\times 9\times10^{9}\times80\times(1.6\times10^{-19})^2}{4.5\times10^{6}\times1.6\times10^{-19}}$	1	
	$= 5.12\ \times 10^{-14}\ m$	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		

	 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 = $\vec{M} \times \vec{B} = \mathrm{I}\vec{A}\times\vec{B}$ $\lvert Torque \rvert = \mathrm{IAB}sin\theta$	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) 		
	$$sin i_c = \frac{1}{\mu_{mg}} = \frac{\mu_m}{\mu_g}$$	½ ½	
	⇨ $\mu_m = \mu_g sin i_c$ $=1.5 \times \frac{\sqrt{3}}{2} \quad (i_c = 60°)$ $= 1.299 \simeq 1.3$	½ ½	
	(b)  **Alternatively** 	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)

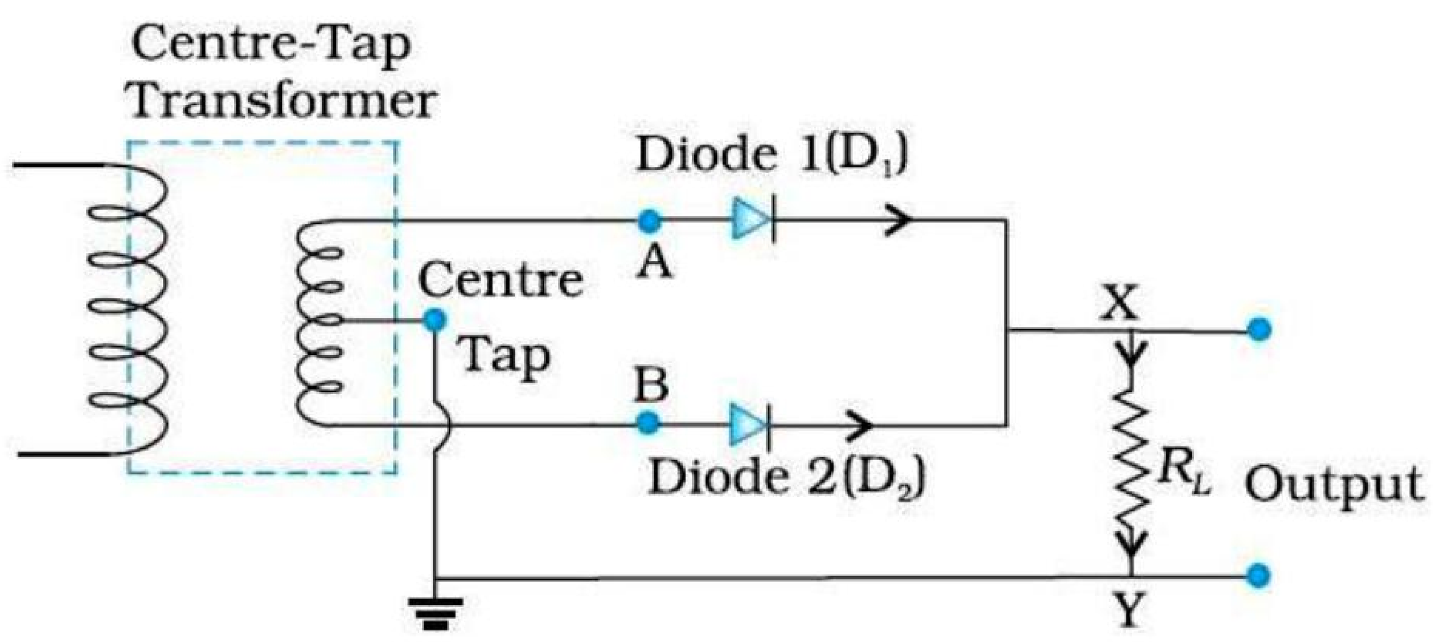
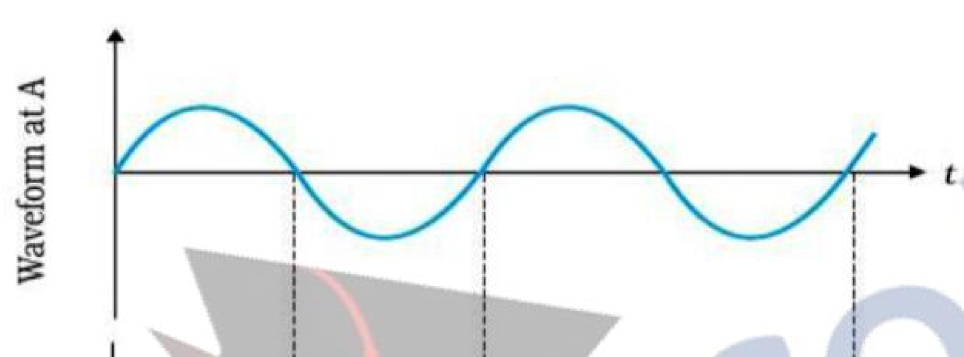
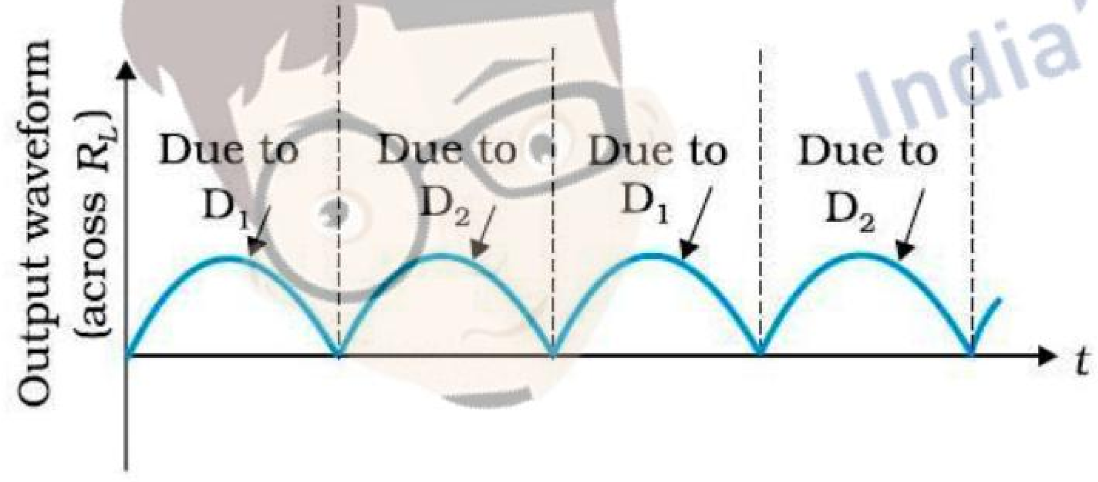
A	B	Y
0	0	0
1	0	1
0	1	1
1	1	1

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		

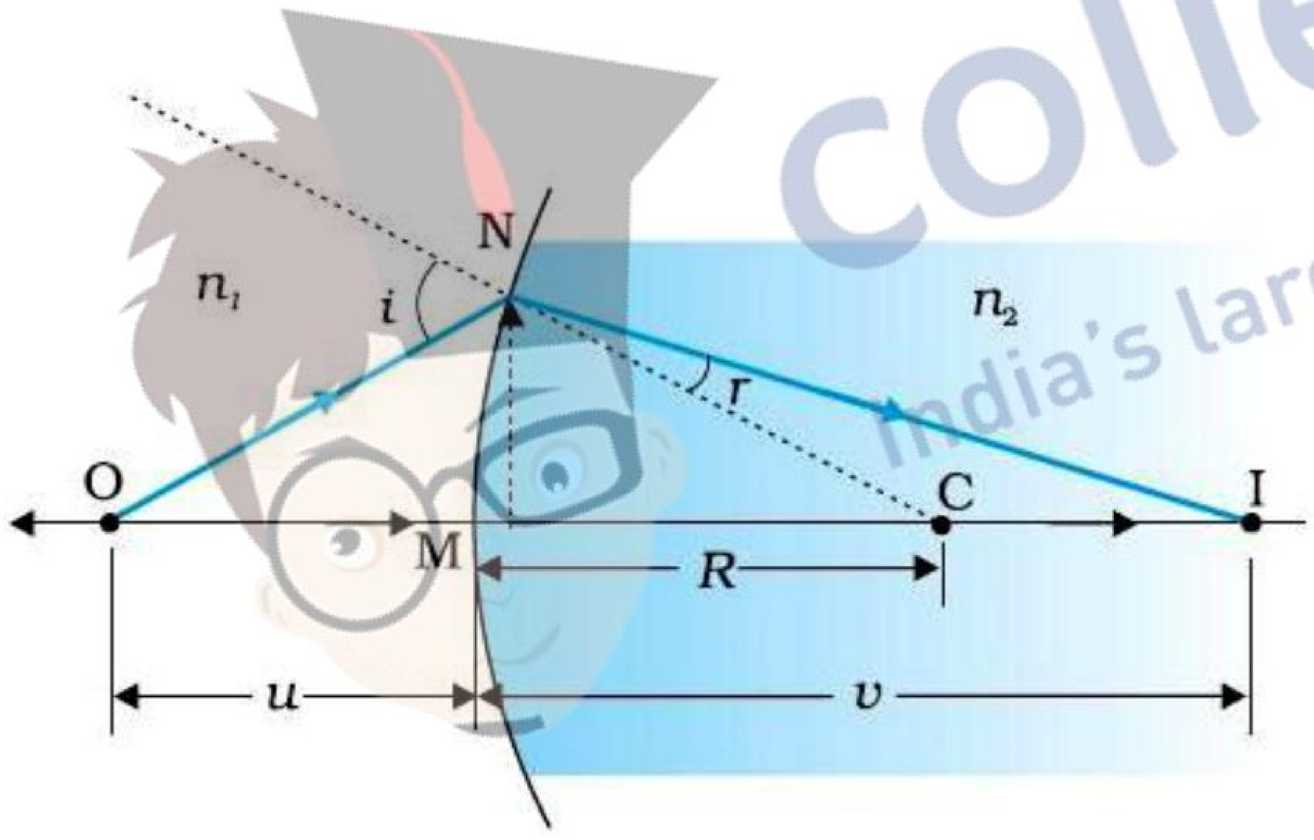
*These answers are meant to be used by evaluators

	Magnetic field $B = 2\pi m v / q$ $= \frac{2 \times 3.14 \times 1.67 \times 10^{-27} \times 10^{7}}{1.6 \times 10^{-19}} = 0.66T$ 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 $= \frac{1}{2} m v^2 = \frac{1}{2} \times 1.67 \times 10^{-27} \times (3.77 \times 10^{7})^2 j$ $= 7.4\ MeV$	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 - $\propto$ 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 $eV_0 = h\nu - \phi_o$ For any given frequency $\nu > \nu_o, V_o$ can be determined. Stopping Potential $V_0 = \left(\frac{h}{e}\right)\nu - \frac{\phi_o}{e}$ as $\phi_0 = h\nu_0$ 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) $V_L = 2V$ $V_R = 3V$ Reasons (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

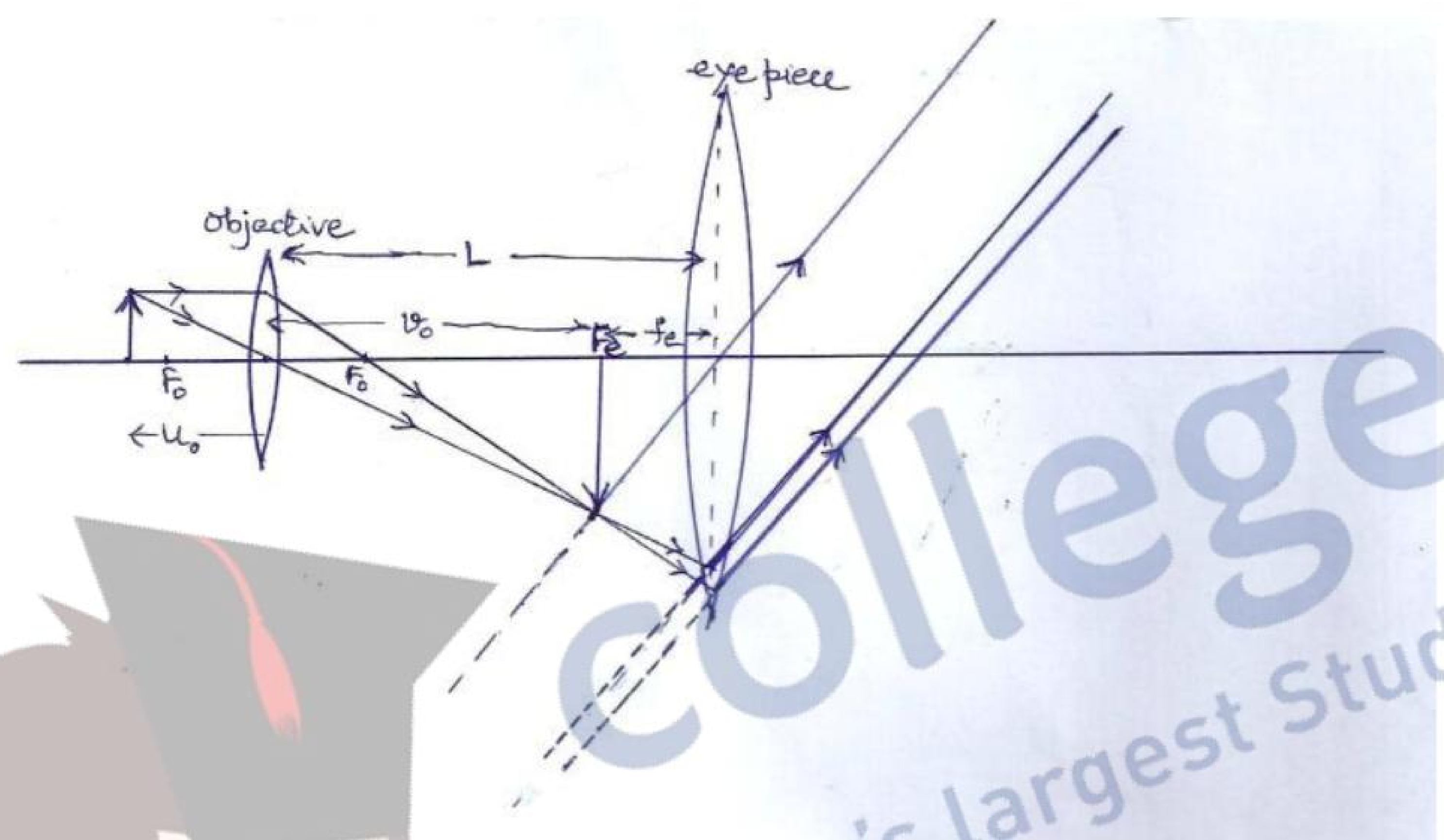
$$\therefore \frac{n_2}{v} > 0$$

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

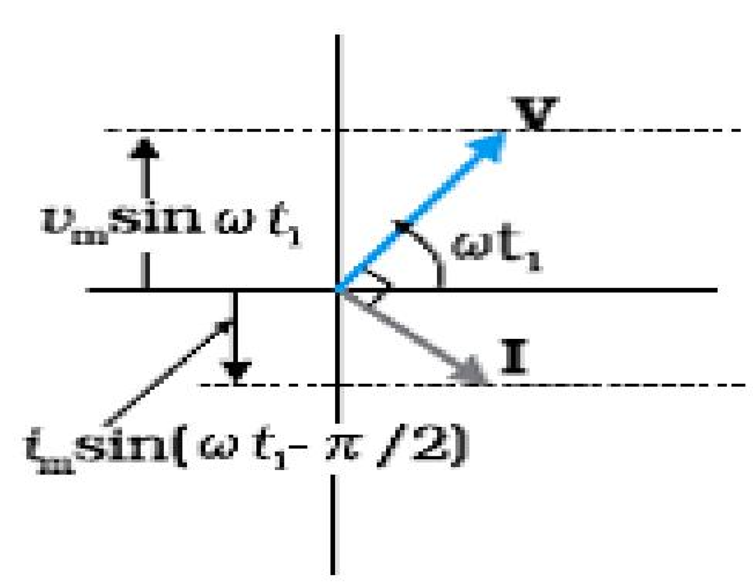
$$m_e = \frac{D}{f_e}$$

- Total magnification $m = m_o m_e$ ½

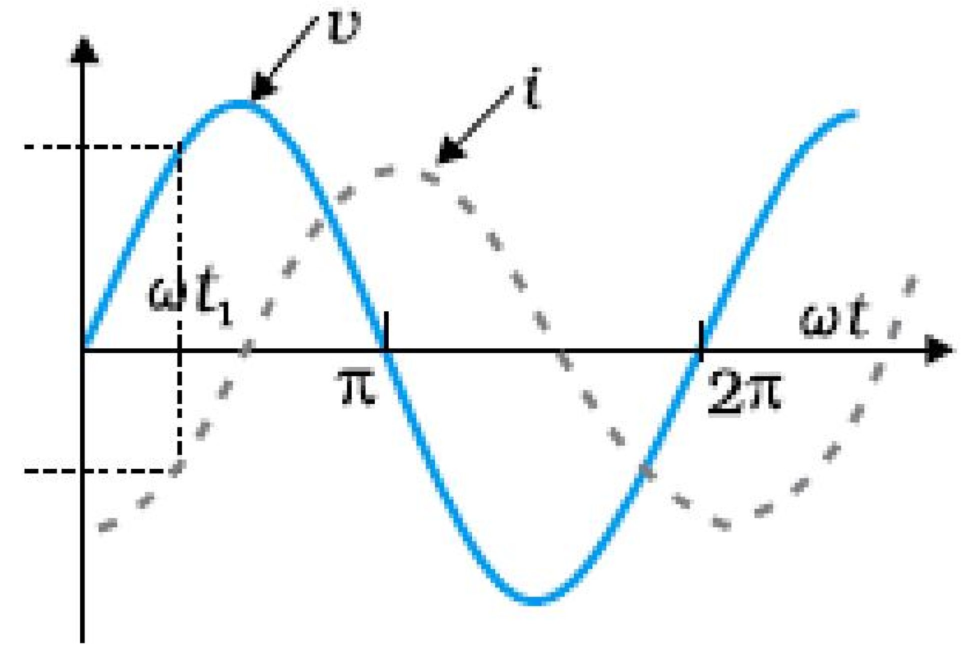
$$m_o = \frac{L}{f_o} \cdot \frac{D}{f_e}$$

(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 = $\frac{-d\phi}{dt}$) (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. (c) Since workdone is moving the charge 'q' across the length 'l' of the conductor is W=qvBl Since emf is the work done per unit charge $\mathcal{E} = \frac{W}{q}$ $\mathcal{E}$ = Blv **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:  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]	1 2 1 1 ½ ½	5

Graph showing variation of voltage and current as function of ωt



1+1

Instantaneous power in LCR circuit:

$p = v \times i$ ½

$= v_m \sin \omega t \times i_m \, sin(\omega t + \varphi)$ ½

$p = \frac{v_m i_m}{2}\,[\cos\varphi - \cos(2\omega t + \varphi)]$

average power $P_{av} = \frac{v_m i_m}{2} \cos\varphi$ ½

$P_{av} = \frac{v_m}{\sqrt{2}} \frac{i_m}{\sqrt{2}} \cos\varphi$

$P = V_{eff} I_{eff} \cos\phi$ ½ 5

Set -1,Q26
Set- 2,Q25
Set-3, Q24

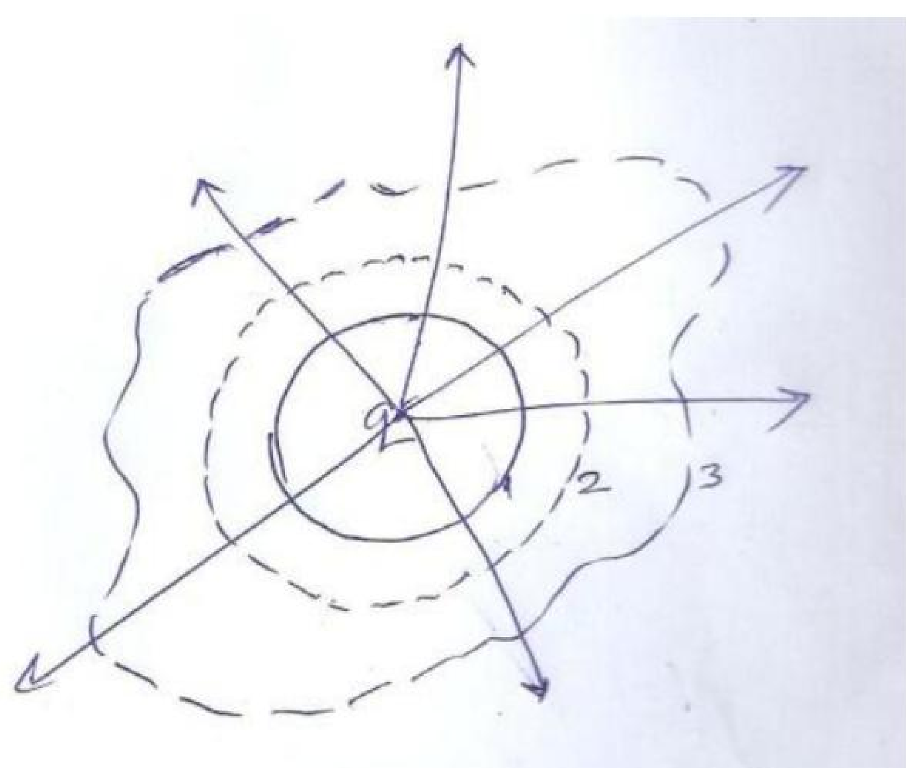
a)Statement of Gauss law	1
Explanation with diagram	1
b)Magnitude and direction of net electric field in (i) and (ii)	1½ +1 ½

(a) Gauss Law: Electric flux through a closed surface is $\frac{1}{\epsilon_0}$ times the total charge enclosed by the surface. 1

Alternatively: $\phi = \frac{1}{\epsilon_0} . q$

The term q equals the sum of all charges enclosed by the surface and remain unchanged with the size and shape of the surface. ½

Alternatively- The total number of electric field lines emanating from the enclosed charge 'q' are same for all surfaces 1,2 &3



½

(b) We have $|E_1| = \frac{\sigma}{\epsilon_o}; |E_2| = \frac{2\sigma}{\epsilon_o}$ 1

(i) Between the plates

$E_{in} = E_1 + E_2$

$= \frac{\sigma}{2\epsilon_o} + \frac{2\sigma}{2\epsilon_o} = \frac{3\sigma}{2\epsilon_o}$ ½

(Directed towards sheet '2')

(ii) Outside near the sheet '1' ½

$E_{out} = E_2 - E_1$

$= \frac{2\sigma}{2\epsilon_o} - \frac{\sigma}{2\epsilon_o} = \frac{\sigma}{2\epsilon_o}$ 5

(Directed towards sheet '2')

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) ½

Net work done in moving charges $q_1 . q_2$ &q_3 from infinity to A, B and C respectively

$$W = 0 + q_2 V_{13} + q_3 (V_{13} V_{23})$$ ½

$$= \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r_{12}} + \frac{1}{4\pi\epsilon_0} (\frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}})$$ ½

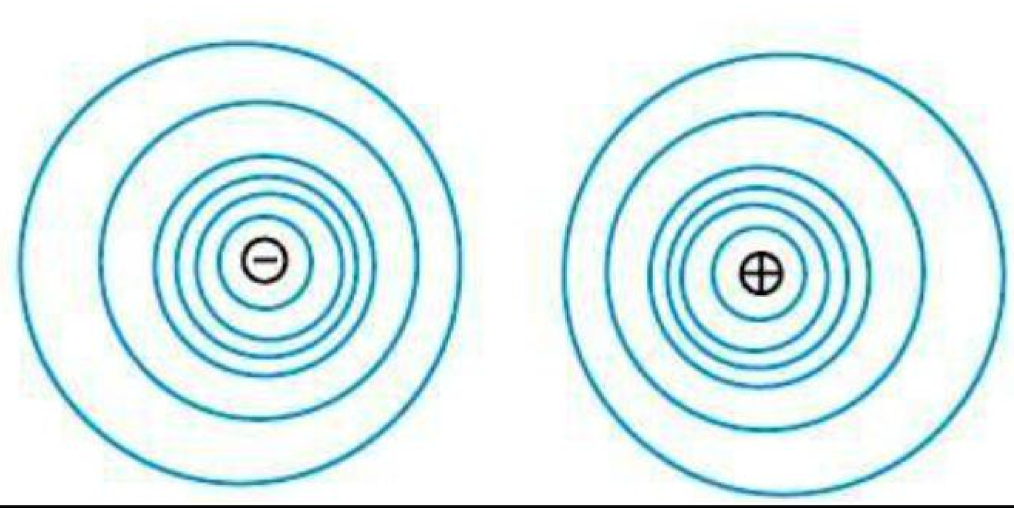
But potential energy of the system is equal to the work done.

$$\therefore U = w = \frac{1}{4\pi\epsilon_0} (\frac{q_1 q_2}{r_{12}} + \frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}})$$

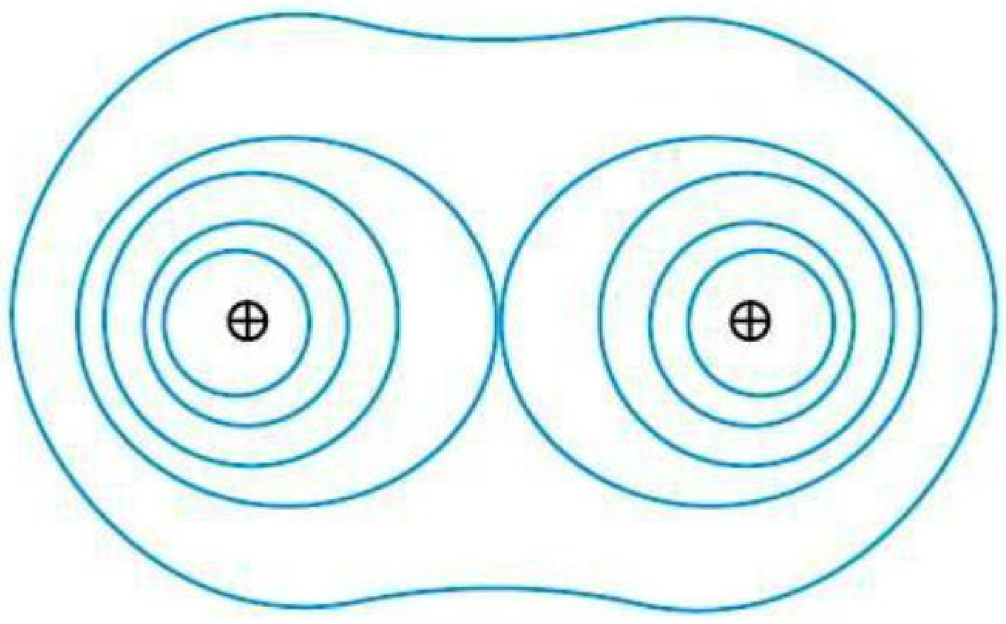
(Award these 1 mark if the student directly writes the expression for U) ½

(b) Equipotential surface due to

(i) An electric dipole



1

	(ii) Two identical positive changes 	1	5