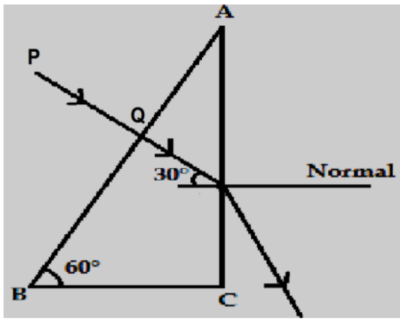
Q. No.	Expected Answer / Value Points	Marks	Total Marks
	SECTION-A		
SET1,Q1 SET2,Q4 SET3,Q5	No work is done / $W = qV_{AB} = q \times 0 = 0$	1	1
SET1,Q2 SET2,Q1 SET3,Q3	A diamagnetic specimen would move towards the weaker region of the field while a paramagnetic specimen would move towards the stronger region./ A diamagnetic specimen is repelled by a magnet while a paramagnetic specimen moves towards the magnet./ The paramagnetic get aligned along B and the diagrammatic perpendicular to the field.	1	1
SET1,Q3 SET2,Q5 SET3,Q2	Transmitter, Medium or Channel and Receiver.	1	1
SET1,Q4 SET2,Q3 SET3,Q1 .	It is due to least scattering of red light as it has the longest wavelength/ As per Rayleigh's scattering, the amount of light scattered $\propto \frac{1}{\lambda^4}$	1	1
SET1,Q5 SET2,Q2 SET3,Q4	E = 2V $r = 2\Omega$	½ ½	1
	SECTION B		
SET1,Q6 SET2,Q9 SET3,Q8.	Definition- 1 Reason- ½ Role of bandpass filter- ½ Modulation index is the ratio of the amplitude of modulating signal to that of carrier wave Alternatively $\mu = A_m / A_c$ Reason- To avoid distortion. Role- A bandpass filter rejects low and high frequencies and allows a band of frequencies to pass through.	 1 ½ ½	 2

SET1,Q7 SET2,Q10 SET3,Q6	Path of emergent ray 1 Naming the face ½ Justification ½  Face-AC Here $i_c = \sin^{-1}(\frac{2}{3})$ $= \sin^{-1}(0.6)$ $\angle \boldsymbol{i}$ on face AC is 30º which is less than $\angle \boldsymbol{i_c}$.Hence the ray get replaced here.	1 ½ ½	2
SET1,Q8 SET2,Q6 SET3,Q7	Formulae of Kinetic energy and deBrogliea wavelength ½ +½ Calculation and Result ½+½ Kinetic Energy for the second state- $E_k = \frac{13.6eV}{n^2} = \frac{13.6eV}{4} = 3.4X1.6X10^{-19}J$ De Broglies wavelength $\lambda = \frac{h}{\sqrt{2mE_k}}$ $= \frac{6.63X10^{-34}}{\sqrt{2X9.1X10^{-31}X3.4X1.6X10^{-19}}}$ = 0.067nm	½ ½ ½ ½	2
SET1,Q9 SET2,Q8 SET3,Q10	Definition 1 Formula ½ Calculation and Result ½ The minimum energy, required to free the electron from the ground state of the hydrogen atom, is known as Ionization Energy.	1	

	$E_o = \frac{me^4}{8\in_o^2 h^2}$ $i.e., E_o \propto m$ Therefore, Ionization Energy will become 200 times OR Formula 1 Calculation and Result ½+½ $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{\propto^2}\right)$ For shortest wavelength, n = α Therefore, $\frac{1}{\lambda} = \frac{R}{4} \Rightarrow \lambda = \frac{4}{R} = 4x10^{-7}m$	½ ½ 1 ½ ½	 2 2
SET1,Q10 SET2,Q7 SET3,Q9	a) Relation for terminal potential ½ b) Justification ½ c) Explanation (parallel and series) ½ + ½ a) Effective resistance of the circuit R_E= 6Ω $\therefore I = \frac{12A}{6} = 2A$ Terminal potential difference across the cell, V=E-ir Also p.d. across 4Ω resistor =4X2V= 8V Hence the volmeter gives the same reading in the two cases. b) In series -current same In parallel – potential same	 ½ ½ ½ ½	 2
	SECTION C		
SET1,Q11 SET2,Q15 SET3,Q22	Definition- ½ i.Diagram of Equipotential Surface ½ ii.Diagram and reason ½ +½ iii.Answer and Reason ½+½ Surface with a constant value of potential at all points on the surface.	 ½	

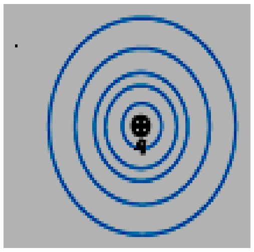
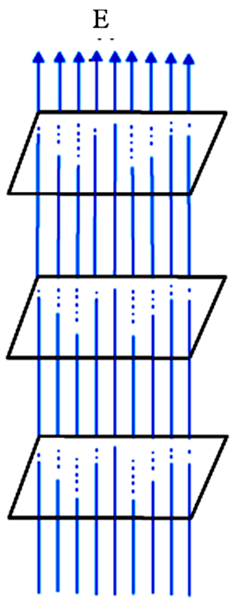
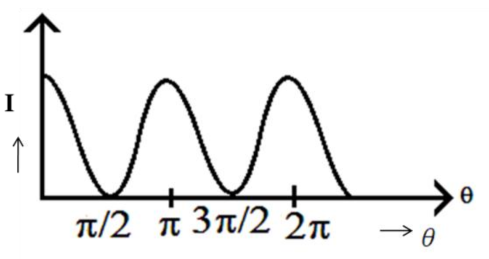
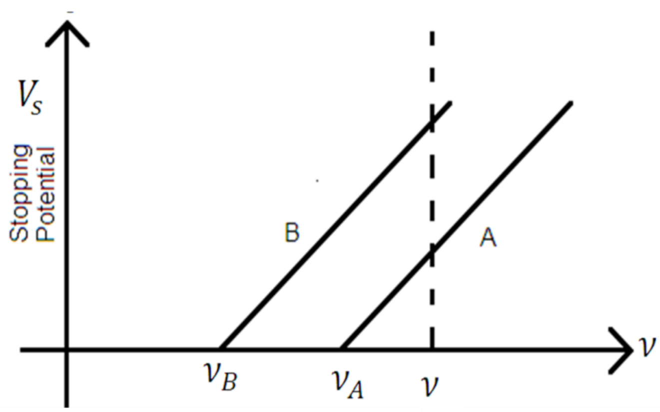
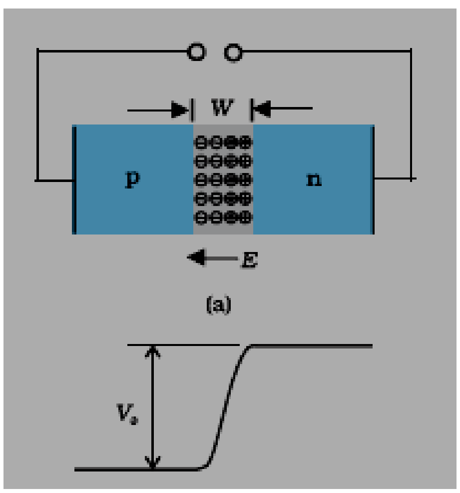
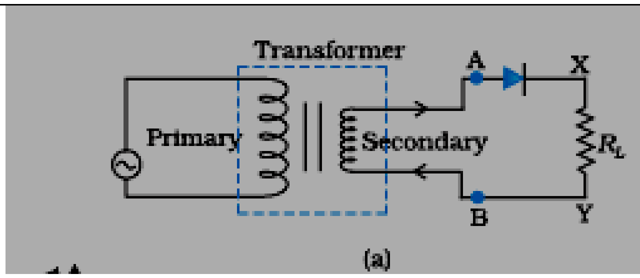
	i.   ii. $V \propto \frac{1}{r}$/ iii.No If the field lines are tangential, work will be done in moving a charge on the surface which goes against the definition of equipotential surface.	½ ½ ½ ½ ½	3
SET1,Q12 SET2,Q14 SET3,Q12	Statement 1 Plotting the graph 1 Calculating value of (μ)refractive index 1 i.When the pass axis of a poloroid makes an angle θ with the plane of polarisation of polorised light of intensity I_o incident on it, then the intensity of the tramsmitted emergent light is given by $I = I_o \cos^2\theta$ **Note: If the student writes the formula I=$I_o \cos^2\theta$ and draws the**	1	

	diagram give 1mark. i.  iii.$\mu = \tan i_\beta$ $= \tan 60^0 = \sqrt{3} = 1.7$	1 ½ ½	3
SET1,Q13 SET2,Q13 SET3,Q14	Sketch of the Graph 1 (i) Stopping Potential and Reason ½+ ½ (ii) Dependence of Slope and Explanation ½+ ½  (i) For material B From the graph for the same value of 'ν', stopping potential is more for material 'B'/ [$V_0 = \frac{h}{e}(\nu - \nu_0)$ $\therefore$, V_0 is higher for lower value of ν_0] (ii) No As slope is given by $\frac{h}{e}$ which is constant.	1 ½ ½ ½ ½	3

SET1,Q14 SET2,Q12 SET3,Q19	(a) Basic nuclear process 1 (b) (i) value of x, y, z 1 (ii) value of a, b, c 1 a. Basic nuclear reaction $P \rightarrow n + e^{+} + \nu$ b.(i) $x = \beta^{+}/{}^{0}_{1}e$, y =5, z =11 (ii) a=10, b=2, c=4	1 1 1	 3
SET1,Q15 SET2,Q11 SET3,Q21	(i) Relation for drift velocity 2 (ii) Effect of temperature 1 i. When a potential difference is applied across a conductor, an electric field is produced and free electrons are acted upon by an electric force **(= -Ee)**. Due to this, electrons accelerate and keep colliding with each other and acquire a constant (average) velocity v_d $\therefore, F_e = -Ee$ $\therefore, F_e = \frac{-eV}{l}$ As a=$\frac{-F}{m}$ = $\frac{-eV}{m}$ as v = u+at u = 0 , t = τ (relaxation time) v_d = -a τ $v_d = \frac{-eV}{lm}\tau$ ii. Decreases, as time of relaxation decreases.	½ ½ ½ ½ ½, ½	 3
SET1,Q16 SET2,Q22 SET3,Q15	Proof for average power 1½ Effect on brightness ½ Explanation 1		

	i) $P_{av} = I_{av} \times e_{av} \cos\emptyset$ For an ideal inductor, $\phi = \frac{\pi}{2}$ $\therefore P_{av} = I_{av} \times e_{av} \cos\frac{\pi}{2}$ $P_{av} = 0$ ii) Brightness decreases Because as iron rod is inserted inductance increases. Thus, current decreases and brightness decreases.	½ ½ ½ ½ ½ ½	3
SET1,Q17 SET2,Q21 SET3,Q16	i.Diagram of Formation ½ Explanation of formation of Depletion region ½ Barrier potential ½ ii.Circuit diagram of Half wave rectifier ½ Explanation 1 i.  i.Due to diffusion and drift, the electrons and holes move across the junctions, creating a final stage in which a region is created across the junction wall, which gets devoid of the mobile charge carriers. This region is called depletion region; the potential difference across the region is called Barriers potential ii	½ ½+½	

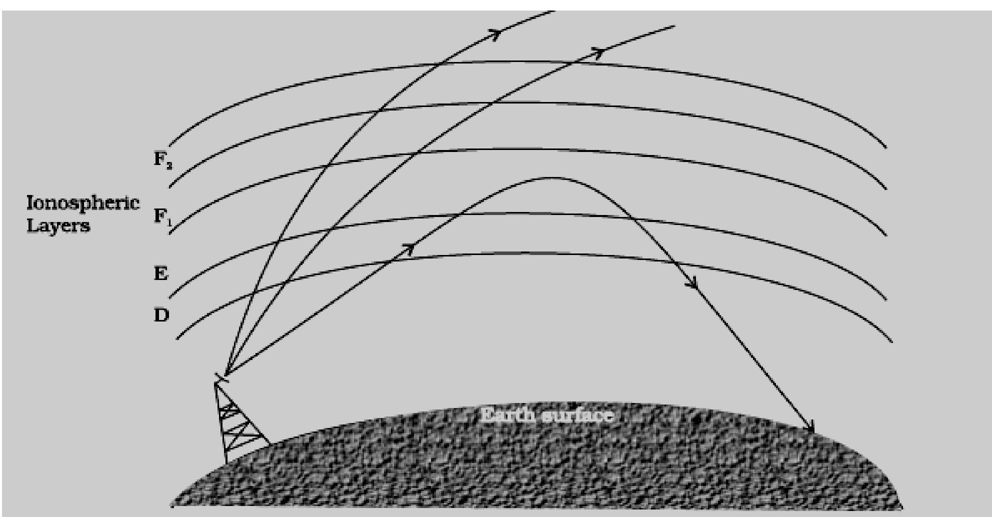
<table>
<tr><td></td><td>

(a)</td><td>½</td><td></td></tr>
<tr><td></td><td>Working- If an alternating voltage is applied across a diode in series with a load, a pulsating voltage will appear across the load only during that half cycle of the ac input during which the diode is forward biased.</td><td>½</td><td></td></tr>
<tr><td></td><td>Therefore, in the positive half – cycle of ac input there is a current through the load resistor R_L and we get an output voltage whereas half – cycle.There is no output during the negative half cycle. Thus, the output voltage is restricted to only one direction and is said to be rectified.

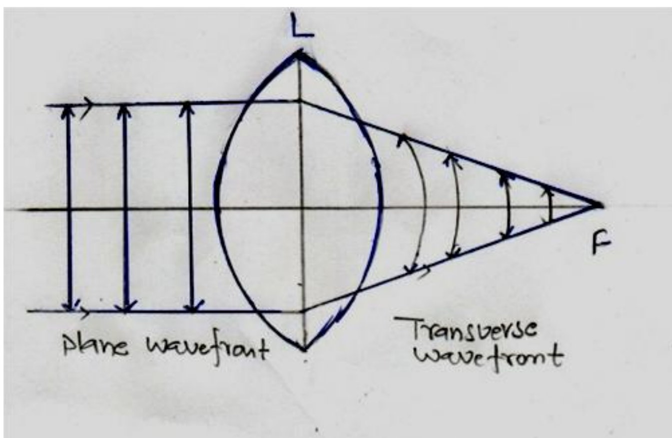
.

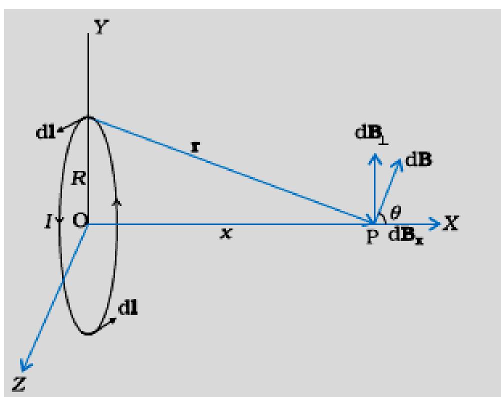
[Note-If the student draws only the input and output wave form, then award ½ marks only]</td><td>½</td><td>3</td></tr>
<tr><td>SET1,Q18
SET2,Q20
SET3,Q13</td><td>

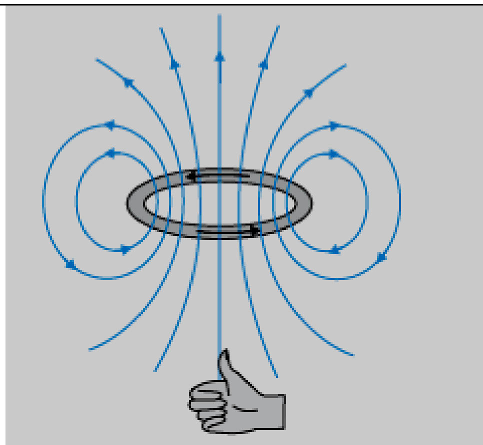
a)	Mode of propagation	½
	Labeled diagram	1
	Explanation	½
b)	Reason	1

a) Sky wave propagation</td><td>½</td><td></td></tr>
<tr><td></td><td>
</td><td>1</td><td></td></tr>
<tr><td></td><td>Long distance communication can be achieved by reflection of radio waves by the ionosphere, back towards the Earth. This ionosphere layer acts as a reflector only for a certain range of frequencies.(fewMHz to 30MHz)</td><td>½</td><td></td></tr>
<tr><td></td><td>b) Electromagnetic waves of frequencies higher than 30MHz, penetrate the ionosphere and escape whereas the waves less than 30MHz are</td><td>1</td><td>3</td></tr>
</table>

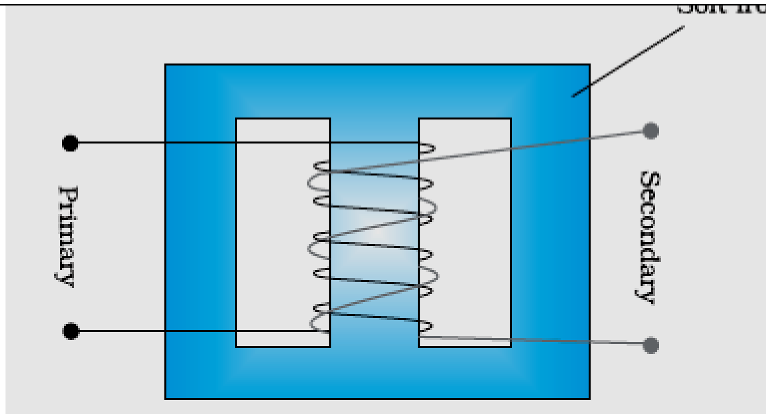
	reflected back to the earth by the ionosphere.		
SET1,Q19 SET2,Q19 SET3,Q17	i. Identification 1+1 ii. Momentary deflection of galvanometer Reason ½ Expressions ½ i. a. Microwaves b. X-rays ii Due to conduction current in the connecting wires and a displacement current between the plates $$I_d = \epsilon_0 \frac{d\emptyset_E}{dt}$$	1 1 ½ ½	3
SET1,Q20 SET2,Q18 SET3,Q11	i. Collection current ½ +½ ii. Base Current ½ +½ iii. Base voltage ½ +½ i. Input signal Voltage AC Collector Current- $i_c = \frac{V_{ce}}{R_c} = 1.0mA$ Base Current- $i_b = \frac{i_c}{\beta} = \frac{1.0mA}{100}$ = **0.01mA** Base signal Voltage= i_bR = 0.01mA x1kΩ =10mv	½ +½ ½ +½ ½ +½	3

SET1,Q21 SET2,Q17 SET3,Q18	Definition- wave front 1 Statement- Huygen’s Principle 1 Labelled diagram 1		
	Definition- Locus of all points which oscillate in phase.	1	
	i. Huygen’s Principle- Each point of the wave front is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions. These travel with the same velocity as that of the original wave front.	½	
	ii. The shape and position of the wave front, after time ‘t’, is given by the tangential envelope to the secondary wavelets.	½	
		½ + ½	3
	OR		
	i. Reason for no change in frequency after reflection and the refraction of light- ½+½ ii. Reduction in Energy 1 iii. Factors determining the intensity of light 1		
	i.Reflection and refraction arise through interaction of incident light with atomic constituents of matter which vibrate with the same frequency as that of the incident light. Hence frequency remains unchanged.		
	ii.No. [Energy carried by a wave depends on the amplitude of the wave, not on the speed of wave propagation].		
	iii.For a given frequency, intensity of light in the photon picture is		

	determined by the number of photon incident normally on a crossing an unit area per unit time.	½ +½ ½ +½ 1	 3
SET1,Q22 SET2,Q16 SET3,Q20	Explanation for magnetic field on the axis of current loop 2 Drawing- magnetic field lines 1 i.  $\overrightarrow{dB} = \frac{\mu_o \overrightarrow{dl} X \vec{r}}{4\pi r^3}$ $dB_x = \frac{\mu_0 I dl\, R}{4\pi(x^2+R^2)^{\frac{3}{2}}}$ $\vec{B} = B_x \hat{\imath} = \frac{\mu_o I R^2}{2(x^2 R^2)^{\frac{3}{2}}} \hat{\imath}$ ii.	½ ½ ½ ½	

		1	3
	SECTION D		
SET1,Q23 SET2,Q23 SET3,Q23	a. Principle and working 1+1 b. Two values, each, displayed by i. Ram ½+½ ii.School teacher ½+½ a. Principle: Whenever a coil is rotated in a magnetic field, an emf is induced in it due to the change in magnetic flux linked with it. Working- As the coil rotates, its inclination (θ) with respect to the field changes. Hence sinosodial /varying emf(=$e_o \sin\omega t$) is obtained./May also be explained graphically. **[Note- Give full marks if the student obtains the expression for induced emf mathematically**.] b. Values Ram- Scientific aptitude, curiosity, keenness to learn, positive approach, etc(any two) Teacher- Dedication, concern for students, depth of knowledge, generous, positive attitude towards queries, motivational approach.(any two)	1 ½ +½ ½ +½	3

	SECTION E		
SET1,Q24 SET2,Q26 SET3,Q25	i. Labelled diagram 1 Principle 1 ii. Expression for the turn ratio in terms of voltage ½ iii. Ratio of primary and secondary currents in terms of turns 1 iv. Current drawn by primary Formula- ½ Calculation and result ½ +½ i.Labelled diagram SOFT IRON CORE	1	



1

1

1

½

Principle-
When the current flowing through the primary coil changes, an emf is induced in the secondary coil due to the change in magnetic flux linked with it.

[Note- Give ½ mark to the student who writes only mutual induction only.] ½ + ½

ii. $\frac{Vs}{Vp} = \frac{Ns}{Np}$

½

iii. For an ideal transformer,

$$i_p V_p = i_s V_s \;\therefore\; \frac{i_p}{i_s} = \frac{V_s}{V_p} = \frac{N_s}{N_p}$$

iv. We have ½ 5

$$i_p V_p = i_s V_s = 550\text{w}$$

Vp=220V

$$i_p = \frac{550}{220} = \frac{5}{2} = 2.5\text{A}$$

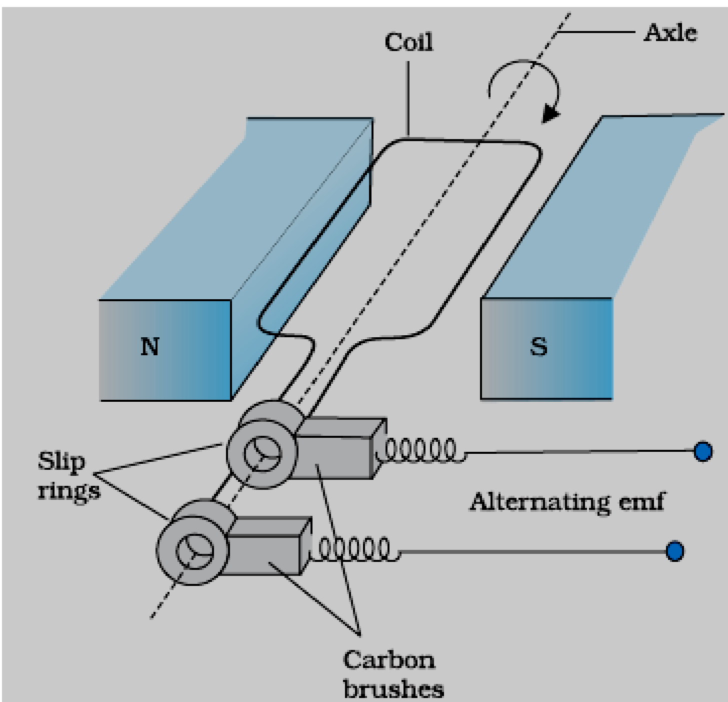
OR

a.	Meaning of Mutual Inductance	1
	Expression	1½
b.	Proof	2
	Diagram	½

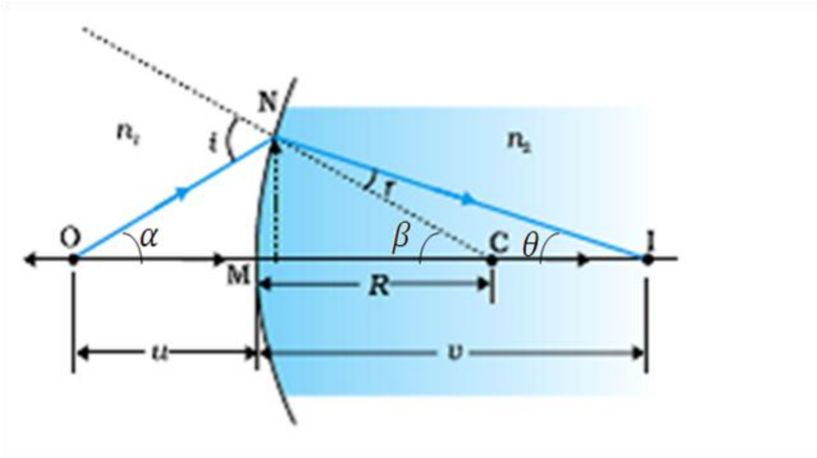
1

½

a. Mutual Inductance is the property of a pair of coils due to which an emf induced in one of the coils due to the change in the current in the other coil. ½

	Mathematically $e_2 = -\frac{Mdi_1}{dt}$ $\therefore M = -\frac{e_2}{di_1/dt}$ Let a current I_2 flow through the outer circular coil. Then $B_2 = \mu I_2/2r_2$ $\therefore \emptyset_1 = \pi r^2 B_2 = \frac{\mu\pi r_1^2}{2r_2} I_2 = M_{12}I_2$ Thus $M_{12} = \frac{\mu\pi r_1^2}{2r_2} = M_{21}$ b.  Flux at any time ‘t’. $\emptyset_B = BAcos\theta = BAcos\omega t$ From Farday’s Law, induced emf $e = -N\frac{d\emptyset_B}{dt} = NBA\frac{d}{dt}(\cos\omega t)$ Thus the instantaneous value of emf is E= NBAωsinωt For maximum value of emf sin$\omega t = \pm 1$ i.e, $e_0 = NBAw = 2\pi fNBA$	½ ½ ½ ½ ½	5

SET1,Q25 SET2,Q24 SET3,Q26 Q25.	i. Derivation of $\frac{n_2}{v} - \frac{n_1}{u} = \frac{(n_2-n_1)}{R}$ 1½ $\frac{1}{f} = \left(\frac{n_2-n}{n_1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ 1½ ii. Formula ½ Calculation and result 1½		



½

Ray diagram showing real image formation as per prescription

$\theta_1 = \alpha + \beta$

$\theta_2 = \beta - \gamma$ $\quad\therefore \gamma = \beta - \theta$

½

For paraxial rays θ_1 and θ_2 are small

Therefore, $n_2 \sin\theta_2 = n_1 \sin\theta_2$ (Snells law)

Reduces to

At N $\frac{Sin i}{Sin r} \sim \frac{i}{r} = \frac{n_2}{n_1}$

$\therefore\ n_1 = rXn_2$

$(\alpha+\beta)n_1 = (\beta-\theta)n_2$

$$n_1\left(\frac{NM}{OM} + \frac{NM}{MC}\right) = \left(\frac{NM}{MC} - \frac{NM}{MI}\right)n_2$$

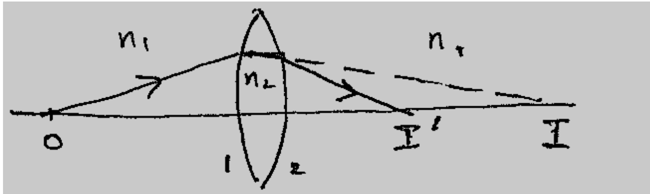
$$n_1\left(\frac{1}{-u} + \frac{1}{+R}\right) = \left(\frac{1}{+R} - \frac{1}{u}\right)n_2$$

½

$$\frac{n_2}{v'} - \frac{n_1}{u} = \frac{(n_2-n_1)}{R_1}$$

1

Appying above relations to refraction through a lens



½

For surface 1

$$\frac{n_2 - n_1}{R_1} = \frac{n_2}{v'} - \frac{n_1}{u} \qquad ...(i)$$

For surface 2

$$\frac{n_1 - n_2}{R_2} = \frac{n_1}{v} - \frac{n_2}{v'} \qquad ...(ii)$$

½

Adding eqn. (i) and (ii)

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

For u=∝ v=*f*

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

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

½

(iii) R = 20 cm n_2 = 1.5 n_1 = 1 u = -100 cm

$$\frac{n_2}{v} = \frac{(n_2 - n_1)}{R} + \frac{n_1}{u}$$

½

$$= \frac{0.5}{20cm} - \frac{1}{100cm}$$

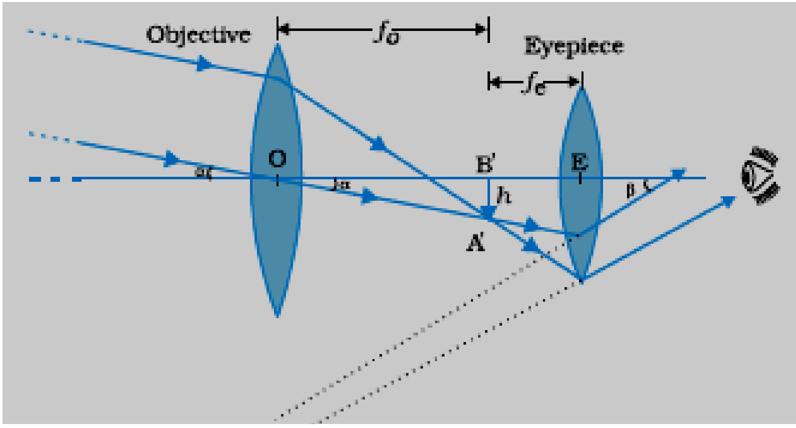
$$= \frac{1.5}{100} \text{ cm}$$

$\Longrightarrow V = 100cm$ a real image on the other side, 100 cm away from the surface. ½ 5

OR

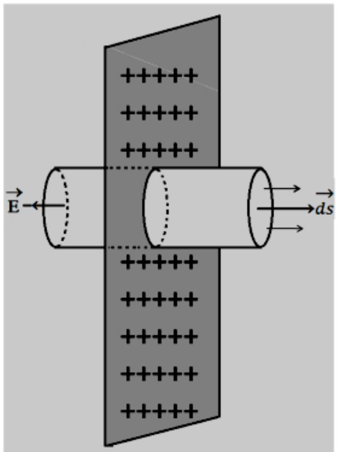
a.

i.Labelled ray diagram ofAstronomical Telescope	1½
Definition of magnifying Prism	1
ii. Identification of lenses	½+½
Justification	½+½
Reason	½

		1½	
	Definition-It is the ratio of the angle subtended at the eye, by the final image, to the angle which the object subtends at the lens, or the eye.	1	
	b. i.Objective=.5D	½	
	Eye lens = 10D	½	
	This choice would give higher magnification as $M=\frac{f_o}{f_e}=\frac{P_e}{P_o}$	½ +½	
	ii. High resolving power/ Brighter image / lower limit of resolution **(any one)**	½	5

SET1,Q26
SET2,Q25
SET3,Q24

i. Derivation for electric field due to infinite plane Sheet of charge	2
Directions of field	½+½
ii. Formula	½
Calculation and result	1½



½

Symmetry of situation suggests that $\vec{E}$ is perpendicular to the plane a $\Rightarrow$Gaussian surface through P like a cylinder of flat caps parallel to the plane and one cap passing through P. the plane being the plane of symmetry for the Gaussian surface.

$$\oint \vec{E}.\vec{ds} = \int_{\text{through caps}} \vec{E}.\vec{ds}$$ ½

$\vec{E} \perp \vec{ds}$ for all over curved surface and hence $\vec{E}.\vec{ds} = 0$

$$\int_{\text{caps}} E ds = 2E\Delta s$$

Δs = area of each cap

By Gauss' law

$$\oint \vec{E}.\vec{ds} = \frac{q}{\in_o} = \frac{\sigma \Delta s}{\in_o}$$ ½

$$\therefore 2E\Delta s = \frac{\sigma \Delta s}{\in_o}$$

$$E = \frac{\sigma}{2\varepsilon_o}$$ ½

If σ is positive $\vec{E}$ points normally outwards/away from the sheet ½

If σ is (-)ve $\vec{E}$ points normally inwards/towards the sheet ½

$\therefore$

$$U_s = \frac{1}{2} C_s V_s^2$$ ½

$$U_p = \frac{1}{2} C_p V_p^2 J$$ ½

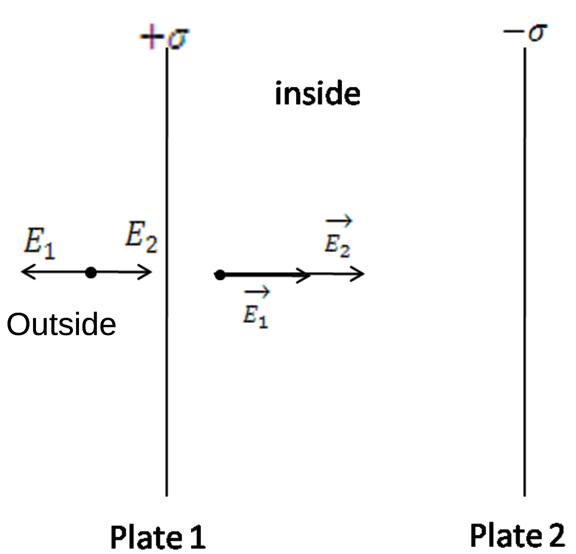
$$\Rightarrow \frac{V_{series}}{V_{parallel}} = \sqrt{\frac{C_{equivalent\ parallel}}{C_{equivalent\ series}}}$$ ½

$$= \sqrt{\frac{C_1 + C_2}{\frac{C_1 C_2}{C_1 + C_2}}}$$ ½

$$= \frac{C_1 + C_2}{\sqrt{C_1 C_2}} = \frac{3}{\sqrt{2}}$$

OR

i.Deriving the expression for Field between the plate &outside	½ +½
Direction of electric field inside and outside	½ +½
Potential difference between the plates	1
Capacitance	1
ii.Direction of flow of charge	½ +½



½ + ½

	Inside $\vec{E} = \vec{E_1} + \vec{E_2}$ $= \frac{\sigma+\sigma}{2E_0} = \frac{\sigma}{E_0}$ Outside $\vec{E} = \vec{E_2} - \vec{E_1}$ $= \frac{\sigma-\sigma}{2\epsilon_0} = 0$	½	
	b. Potential difference between plates $V = Ed = \frac{1}{\epsilon_o}\frac{Qd}{A}$	½ + ½	
	c. Capacitance $C = \frac{Q}{V} = \frac{\epsilon_0 A}{d}$	½ + ½	
	ii. As potential on and inside a charged sphere is given $V = \frac{1}{4\pi\epsilon_0}\frac{q}{r} = \frac{1}{4\pi\epsilon_0} \cdot \frac{4\pi r^2 \sigma}{r}$ $\therefore, V \propto r$	½	
	Hence, the bigger sphere will be at higher potential, so charge will flow from bigger sphere to smaller sphere.	½	5