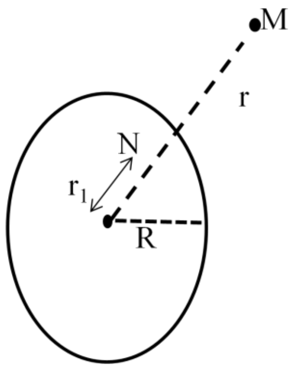
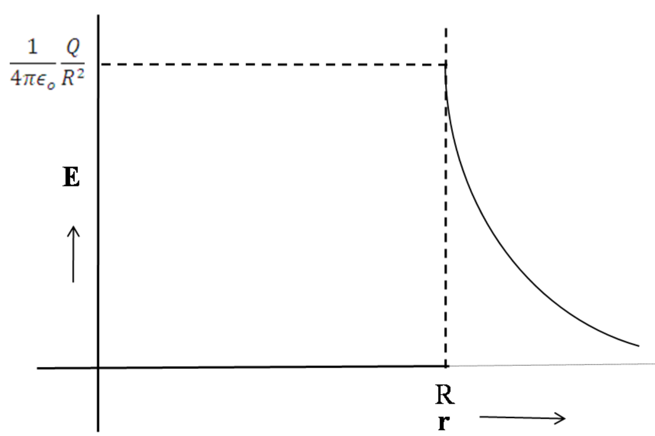
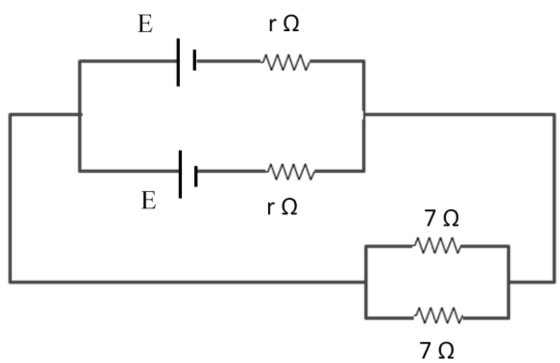
MARKING SCHEME

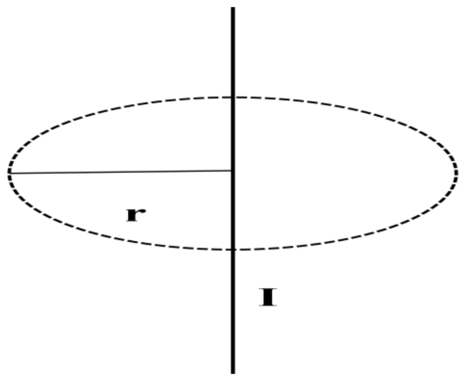
Q. No.	Expected Answer / Value Points	Marks	Total Marks
Set1,Q1 Set2,Q2 Set3,Q4	**SECTION A** Zero / No work done / None	1	1
Set1,Q2 Set2,Q5 Set3,Q3	Drift velocity per unit field $(\mu_m = {}^{v_d}/_{E})$ $\mu_n \propto \tau$ (directly proportional to relaxation time)	½ ½	1
Set1,Q3 Set2,Q4 Set3,Q2	Charged particle moves inclined to the magnetic field (angle between $\vec{\vartheta}$ and $\vec{B}$ is neither ${}^{\pi}/_{2}$ nor 0) (component of $\vec{\vartheta}$, parallel to $\vec{B}$, is not zero.)	1	1
Set1,Q4 Set2,Q1 Set3,Q5	(some) light gets deviated / scattered / absorbed Scattering of light	½ ½	1
Set1,Q5 Set2,Q3 Set3,Q1	$\nu_{side\ bands} = \nu_c \pm \upsilon_m$ = 2005 kHz ; 1995 kHz (Give full 1 mark if the student straightaway writes the answer as 2005 kHz and 1995 kHz)	½ ½	1
Set1,Q6 Set2,Q8 Set3,Q7	**SECTION B** Formulae: 1 Substitution and calculation: 1 $R = \rho \frac{l}{A}\,;\, I = neAv_d$ $\therefore \rho = \frac{V}{nelv_d}$ Alternatively, $\left(j = \sigma E = \frac{E}{\rho}\ or\ \frac{E}{j} = \rho \quad \therefore \rho = \frac{V}{lnev_d}\right)$ (Award this 1 mark even if the student writes the formula for ρ directly as such) $\therefore \rho = \frac{5}{0.1 \times 8 \times 10^{28} \times 1.6 \times 10^{-19} \times 2.5 \times 10^{-4}} \Omega - m$ $= 1.56 \times 10^{-5}\ \Omega - m$ $\simeq 1.6 \times 10^{-5}\ \Omega - m$	½ ½ ½ ½	2

Set1,Q7 Set2,Q10 Set3,Q8	Formulae ½ + ½ Conclusions in the two cases ½ + ½ (i) $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mqV}}$ $\because$ (mq) is more for $\alpha -$ particle, we have $\lambda_{proton} > \lambda_{\propto -particle}$ (Also, accept if the student writes $\frac{\lambda_{proton}}{\lambda_{\alpha}} = 2\sqrt{2}\ (or\ \sqrt{8})$) (ii) K.E. = q V $\because$ q is less for proton, we have $(K.E)_{proton} < (K.E)_{\alpha-particle}$ (Also accept if the student writes $\frac{(K.E.)_{\propto}}{(K.E.)_{\rho}}$ =2)	½ ½ ½ ½	2
Set1,Q8 Set2,Q9 Set3,Q6	Indicating the transition 1 Calculation of frequency 1 When the electron jumps from the orbit with n=3 to n=2 (Longest wavelength of the Balmer series / First line of the Balmer series) $h\vartheta = E_3 - E_2 = \frac{E_1}{9} - \frac{E_1}{4}$ $= \frac{-5}{36}E_1 = \frac{-5}{36} \times (-13.6\ eV)$ $=\frac{5}{36} \times 13.6 \times 1.6 \times 10^{-19}\ J$ $\therefore\ \vartheta = \frac{5 \times 13.6 \times 1.6 \times 10^{-19}}{36 \times 6.63 \times 10^{-34}}$ Hz $\simeq 4.57 \times 10^{14}$ Hz. (If the student just writes $\vartheta = \frac{-5}{36}\frac{E_1}{h}$, award ½ mark) **(Alternatively,** $\frac{1}{\lambda}= R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)=\frac{5}{36}R$ $\therefore\ \vartheta = \frac{c}{\lambda}$ $= c \times \frac{5}{36}R$ $= 3 \times 10^8 \times \frac{5}{36} \times 1.097 \times 10^7 Hz$ $\simeq 4.57 \times 10^{14} Hz$)	1 ½ ½ ½ ½	2

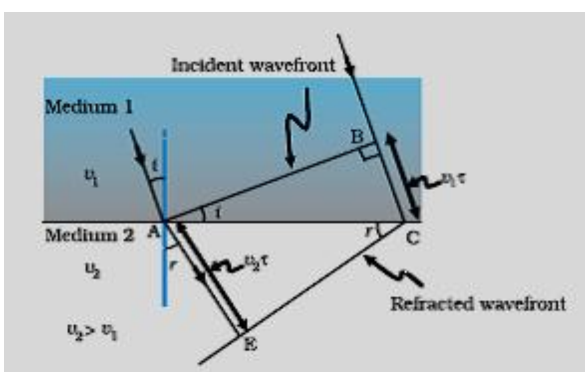
	OR Formula 1 Calculation of λ 1 $\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right)$ $\therefore \lambda = \frac{1}{R}$ $= \frac{1}{1.097 \times 10^7}$ m $\simeq 9.116 \times 10^{-8}\, m$ $\simeq 912\, A^0\ (91.2\, nm)$	½ ½ 1	2
Set1,Q9 Set2,Q6 Set3,Q10	Two Reasons 1+ 1 If base band signal were to be transmitted directly 1. The height of the antennae needed will be impractically large. 2. The effective power radiated would be too low. 3. There would be a high probability of different signals getting mixed up with one another. (Any two)	1+1	2
Set1,Q10 Set2,Q7 Set3,Q9	Identifying that θ is the angle of minimum deviation ½ Formula ½ Calculation of θ 1 Since AQ = AR, we have QR|| BC $\therefore$ θ is the angle of minimum deviation. (Alternatively: Since AQ=AR, we get $\angle r_1 = \angle r_2$ $\therefore$ θ is the angle of minimum deviation.) $\mu = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\left(A/2\right)}$ $\therefore \sqrt{3} = \frac{\sin\left(\frac{60+\delta m}{2}\right)}{\sin 30^0}$ $\therefore \frac{\sqrt{3}}{2} = \sin\left(\frac{60+\delta m}{2}\right)$ $\therefore \frac{60+\delta m}{2} = 60$ or $\delta m = 60^0$	½ ½ ½ ½	2

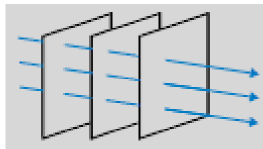
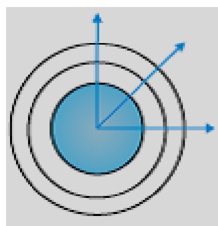
	SECTION C		
Set1,Q11 Set2,Q17 Set3,Q22	Statement of Gauss's Law ½ Calculation of field (i) Outside the shell 1 (ii) Inside the shell 1 Graph ½		
	We have by Gauss's law $\oint \vec{E}.\overrightarrow{dS} = \frac{Q_{enclosed}}{\epsilon_0}$	½	
	Let Q be the total charge on the shell (i) For the point M outside the shell, we have		
			
	$E.4\pi r^2 = \frac{Q}{\epsilon_0}$	½	
	$\therefore E = \frac{1}{4\pi\epsilon_o}\frac{Q}{r^2}$	½	
	(ii) For the point N inside the shell, as charge enclosed inside the shell is zero.	½	
	$E.4\pi r_1^2 = 0$	½	
	$\therefore E = 0$ The graph is as shown		
		½	3

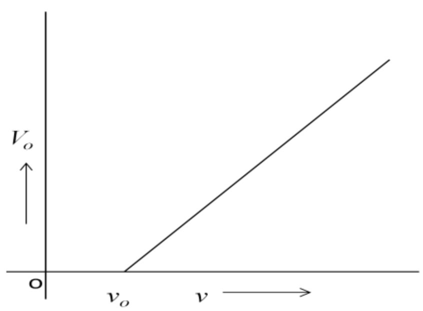
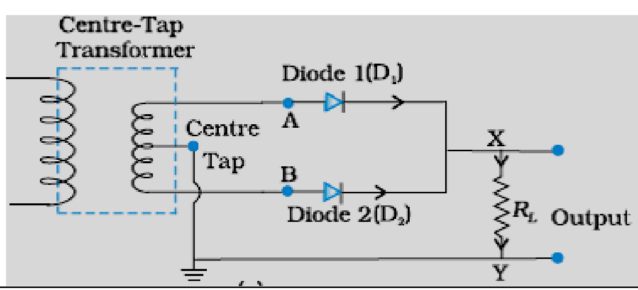
Set1,Q12 Set2,Q19 Set3,Q21	Formulae 1 Calculation of r 2		
	We have, for a single cell, $$r = \left(\frac{E}{V} - 1\right)R$$	1	
	$\therefore$ *For the parallel combination, as given in the question,* $\frac{r}{2} = \left(\frac{E}{V} - 1\right)\frac{R}{2}$	½	
	$\therefore r = \left(\frac{1.5}{1.4} - 1\right) \times 7\Omega$	½	
	$= \frac{0.1}{1.4} \times 7\ \Omega$	½	
	=0.5Ω	½	
	(Alternatively,  	½	
	$I = \frac{V}{(R/2)}$	½	
	And $E = V - I(r/2)$	½	
	This gives $I = \frac{1.4}{7/2}$A = 0.4A	½	
	$\therefore\ \frac{r}{2} = \frac{1.5-1.4}{0.4}$ = 0.25	½	
	$\therefore r = 0.5\Omega$) (Note: If the student just draws the circuit diagram of the setup but does not do any calculations, award 1 mark only.)	½	3

Set1,Q13 Set2,Q21 Set3,Q20	Statement of Ampere's Circuital law 1 Finding Magnetic Field 1 ½ Differences between the two types of field lines ½		
	According to Ampers's circuital law, " The line integral of the magnetic field, around a closed loop, equals μ_o times the total current passing through the surface enclosed by that loop."	1	
	Alternatively, $\oint \vec{B}.\vec{dl} = \mu_o I$ For the infinite current carrying wire, we get		
	B.$\oint dl = \mu_o I$	½	
	or B$2\pi r = \mu_o I$	½	
	or B=$\frac{\mu_o I}{2\pi r}$	½	
			
	The magnetic field lines form closed loops while the electric field lines originate from positive charges and end at negative charges.	½	3
	OR		
	Principle of cyclotron 1 Independence of time period from speed 1 ½ Necessity of this property ½		
	The cyclotron uses both electric and magnetic fields, in combination, to increase the energy of the charged particles.	1	
	(Alternatively: Cyclotron uses (i) A magnetic field to make the charged particles move in a circular path. (ii) An alternating electric field which accelerates the charged particles as they repeatedly cross it in a way that makes them gain energy continuously.) We have		
	$\frac{mv^2}{r} = qvB$	½	

	$\therefore r = \frac{mv}{qB}$ $Also\ T = \frac{2\pi r}{v}$ $\therefore T = \frac{2\pi m}{qB}$ $\therefore T\ is\ independent\ of\ v, the\ speed\ of\ the\ charged\ particles.$ This property ensures that if the frequency of the applied alternating electric field matches the cyclotron frequency, the particle whould keep on getting accelerated every time it crosses the gap between the dees. **(Alternatively** : Because of the property, the applied alternating electric field can be made to accelerate the charged particles continuously. This property ensures that the resonance condition can be satisfied and the particle gets accelerated continously. This property ensures that we can have $\vartheta = \vartheta_c$, the resonance condition.)	 ½ ½ ½	 3
Set1,Q14 Set2,Q14 Set3,Q19	Showing that the average power, over a complete cycle is zero 2 Effect on brightness of bulb 1 (i) Let the applied voltage be $$V = V_0 sin\omega t$$ The current through an ideal capacitor , would then be $$I = I_0 sin\left(\omega t + \frac{\pi}{2}\right) = I_0 cos\omega t$$ $\therefore P_{inst} = VI$ $\therefore P_{AV} = \frac{1}{T}\int_0^T VIdt$ $\therefore P_{AV} = \frac{V_0 I_0}{2}\langle sin2\omega t\rangle$ = 0 **(Alternatively** , For an ideal capacitor, the current leads voltage in phase by $^{\pi}/_{2}$. $\therefore P = \frac{E_0}{\sqrt{2}}\frac{I_0}{\sqrt{2}}cos\emptyset = \frac{E_0 I_0}{2}cos\frac{\pi}{2}$ = 0) (ii) The brightness of the bulb would also reduce gradually. **(Alternatively**: $X_c = \frac{1}{\omega C}$ $\therefore X_c$ increases as C decreases.Hence, with decreasing C, the brightness of the bulb would decrease.)	 ½ ½ ½ ½ 1	 3

Set1,Q15 Set2,Q22 Set3,Q18	Production of e.m. waves ½ Source of energy ½ Expressions for electric and magnetic fields ½ + ½ Any two properties ½ + ½ ε.M. waves are produced by accelerated /oscillating charges. Source of energy is the source that accelerates the charges Expression for the electric and magnetic fields (for an e.m. wave propagating along the z – axis) can be $E_x = E_0 \sin(kz - wt)$ $B_y = B_0 \sin(kz - wt)$ **Properties (any two)** (i) Transverse nature (ii) Have a definite speed (for all frequencies) in vaccum (iii) Can be polarized (iv) Can show the phenomenon of interference and diffraction (v) Can transport energy from one point to another (vi) Have oscillating electric and magnetic fields along mutually perpendicular directions (vii) Have a momentum associated with them. (viii) Their speed , in a medium , depends upon the values of μ and ε for that medium.	½ ½ ½ ½ ½ + ½	3
Set1,Q16 Set2,Q15 Set3,Q17	(i) Derivation of Snell's law 2 (ii) Sketches to differentiate between plane wavefront and spherical wavefront 1 (i)  We have BC=$\vartheta_1 \tau$ and $AE = \vartheta_2 \tau$ Also $\sin i = \frac{BC}{AC}$ and $\sin r = \frac{AE}{AC}$	½ ½ ½	

	$\therefore \frac{\sin i}{\sin r} = \frac{BC}{AE} = \frac{\vartheta_1}{\vartheta_2} = \frac{n_2}{n_1}$ = a constant This is Snell's law. (ii) Plane wavefront  Spherical wavefront 	½ ½ ½	3
Set1,Q17 Set2,Q11 Set3,Q16	Two properties of Photon ½ + ½ Writing Einstein's equation ½ Definition of stopping potential (V_0) ½ Definition of Threshold frequency (υ_0) ½ Plot between V_0 and υ ½ Properties of Photon (i) For a radiation of frequency υ, each photon has an energy, $E = h\upsilon$, associated with it (ii) The energy of a photon is independent of the intensity of incident radiation. (iii) During the collision of a photon, with an electron, the total energy of the photon gets absorbed by the electron. (Any two) Einstein's photoelectric equation is $K_{max} = h\upsilon - \phi_0$ or $eV_0 = h\upsilon - \phi_0$ (a) Stopping potoential, V_0, equals that value of the negative potential for which $\lvert eV_0 \rvert = K_{max}$	½ + ½ ½ ½	

	(**Alternatively:** The stopping potential (V_0) equals that (least) value of the (negative) plate potential that just stops the most energetic emitted photoelectrons from reaching the plate.) (b) Threshold frequency (ϑ_0) equals that value of the frequency of incident radiation for which $K_{max} = 0$. (**Alternatively:** For a given photosensitive surface, its threshold frequency is the minimum value of the frequency of incident radiation for which photoelectrons can be just emitted from that surface or that maximum frequency of incident radiation below which no photo emission takes place.) The plot, between V_0 and ϑ, has the form shown: 	1 ½	3
Set1,Q18 Set2,Q20 Set3,Q15	(i) Naming the two processes — ½ + ½ (ii) Circuit diagram — 1 Input and output waveforms — ½ Unidirectional nature of output voltage/current — ½ (i) Diffusion and Drift [Also accept if the student writes a) Appearance of a BARRIER POTENTIAL across the junction. b) Formation of a DEPLETION REGION on either side of the junction.] (ii) Circuit diagram 	½ + ½ 1	

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<tr>
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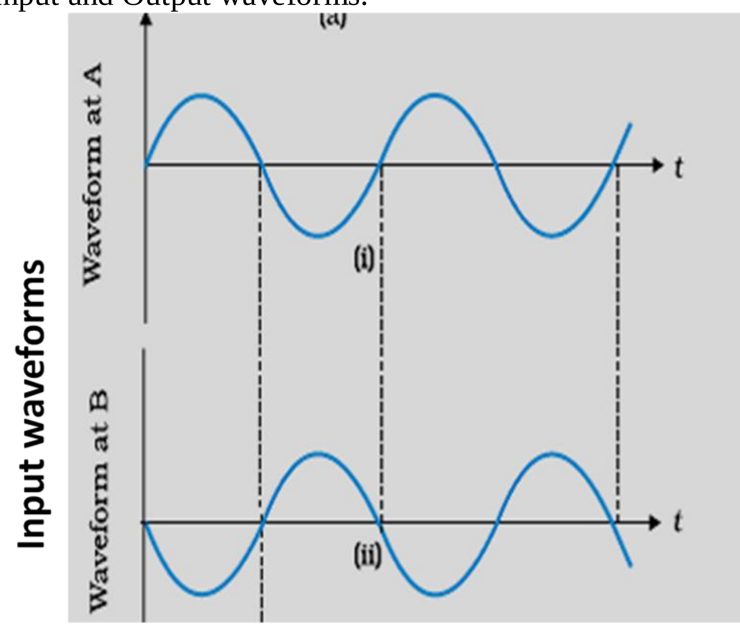
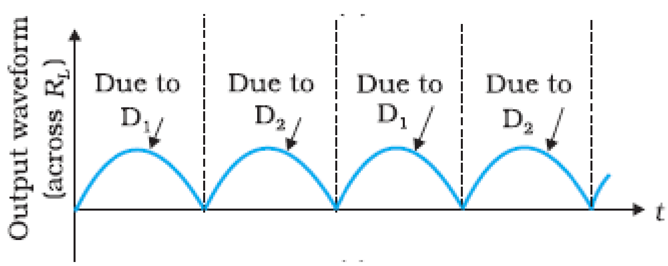
<td>Input and Output waveforms.


[Note: Award this ½ mark even if the student draws the output waveform only.]

Because of (i) the use of the centre tap transformer and (ii) the manner in which the load is connected, the voltage across/current through, the load has the same direction during both halfs of the input wave.</td>
<td>½

½</td>
<td>3</td>
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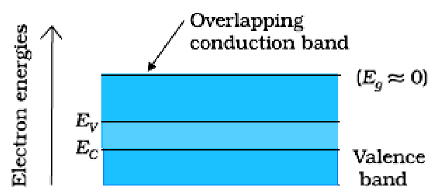
<tr>
<td>Set1,Q19
Set2,Q12
Set3,Q14</td>
<td>(i) Distinguishing on the basis of energy band diagram ½+½
(ii) Identifying the gate 1
Truth Table ½
Logic symbol ½

(i) 
Conductor</td>
<td>½</td>
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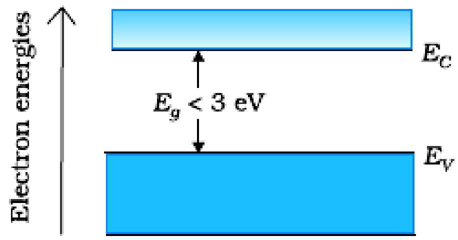


Semiconductor ½

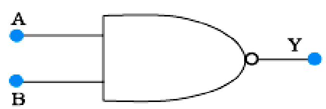
(i) The gate is a NAND gate 1

Truth Table of NAND gate

Input		Output
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

½

Logic Symbol



½ 3

Set1,Q20
Set2,Q18
Set3,Q13

Space wave propagation	1
Factors that limit the range of propagation	½
Derivation of the expression	1½

Space Wave Propagation

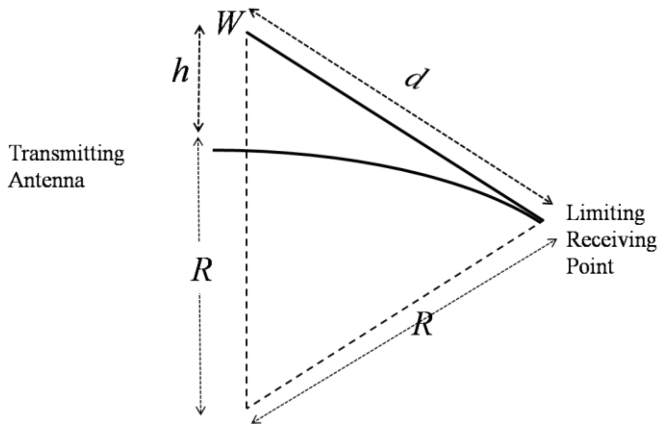
The mode of propagation in which radio waves travel, along a straight line, from the transmitting to the receiving antenna. 1

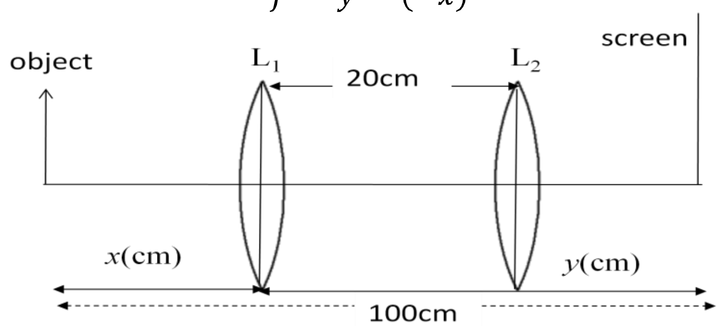
Limiting Factors

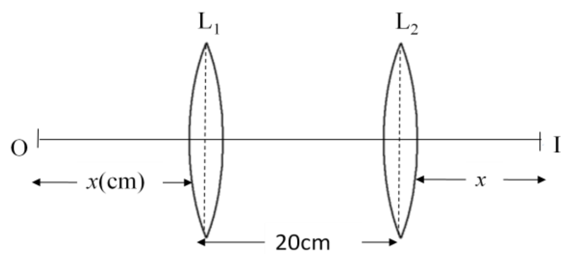
(i) Curvature of the earth

(ii) Insufficient height of the receving antenna ½

(Award this ½ mark if the student writes any one of these two factors)

	<u>Derivation</u>  	½	
	From the figure, we have $$(R+h)^2 = R^2 + d^2$$ Or $$2Rh \cong d^2 (\, as\ h^2 << 2Rh)$$ $$\therefore, d = \sqrt{2Rh}$$	½	
	For a transmitting antenna of height h_T, and a receiving antenna of height h_R, the maximum line of sight distance becomes $$d_M = \sqrt{2Rh_T} + \sqrt{2Rh_R}$$ **[NOTE:** Give 1 mark if the student writes the expression for d_M]	½	3
Set1,Q21 Set2,Q13 Set3,Q12	(i) Derivation of the mathematical expression 2½ (ii) Relation between mean life and decay constant ½		
	(i) Let there be N_0 radioactive nuclei at t =0. If N is the number of nuclei left over at t=t, we have $$\frac{-dN}{dt} \propto N$$ $$or\ \frac{-dN}{dt} = \lambda N \ \ (\lambda = decay\ constant)$$	½	
	$$\therefore\ \frac{dN}{N} = -\lambda\, dt$$	½	
	$$or\ lnN = -\lambda t + constant$$	½	
	∴ At t=0, we have $$lnN_0 = constant$$	½	

	$lnN = -\lambda t + lnN_0$ $or\ ln\left(\frac{N}{N_0}\right) = -\lambda t$ $\therefore N = N_0 e^{-\lambda t}$ (ii) Mean life= $\frac{1}{decay\ constant}$ (Alternatively, $\tau = \frac{1}{\lambda}$)	½ ½	3
Set1,Q22 Set2,Q16 Set3,Q11	(i) Calculating the focal length of the lens 2 (ii) Calculating the focal length of the combination 1 (i) For first position of the lens , we have $$\frac{1}{f} = \frac{1}{y} - \frac{1}{(-x)}$$  For second position of the lens , we have $$\frac{1}{f} = \frac{1}{y-20} - \frac{1}{(-(x+20))}$$ $\frac{1}{y} + \frac{1}{x} = \frac{1}{(y-20)} + \frac{1}{(x+20)}$ $\frac{x+y}{xy} = \frac{(x+20)+(y-20)}{(y-20)(x+20)}$ $\therefore xy = (y-20)(x+20)$ $= xy - 20x + 20y - 400$ $\therefore x - y = -20$ Also , x + y =100 ∴ x = 40 cm and y = 60 cm $\therefore \frac{1}{f} = \frac{1}{60} - \frac{1}{-40} = \frac{2+3}{120} = \frac{5}{120}$ $\therefore f = 24\ cm$	½ ½ ½ ½	

	Alternatively ,		
	We have		
	$f = \frac{D^2 - d^2}{4D}$	1	
	$= \frac{100^2 - 20^2}{4 \times 100}$	½	
	$= \frac{120 \times 80}{400}$	½	
	= 24 cm		
	Alternatively,		
	For the two positions of the lens , the values of the magnitudes of u and v , get interchanged.	½	
	Hence , $\lvert u + v \rvert = 100$	½	
	$\lvert u - v \rvert = 20$, This gives $\lvert u \rvert = 60$ $\lvert v \rvert = 40$	½	
	$\therefore f = 24\, cm$	½	
	Alternatively ,		
		½	
	$2x + 20 = 100$		
	$\therefore x = 40$cm	½	
	For lens at position L_1 ; u = - x = -40cm	½	
	v = 20 + 40 = 60cm	½	
	This gives f = 24 cm		
	(i) For combination of two lenses in contact .		
	Net Power of combination ,		
	$P = P_1 + P_2$	½	
	$P_1 = +P$, $P_2 = -P$		
	So P= 0 and F= infinite	½	
	Alternatively , $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$	½	

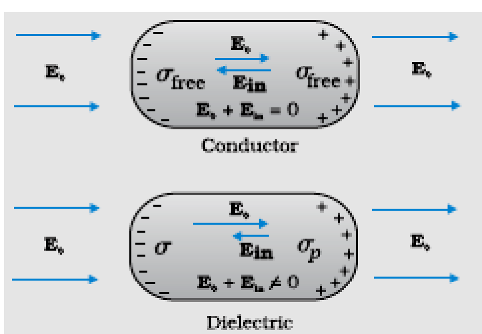
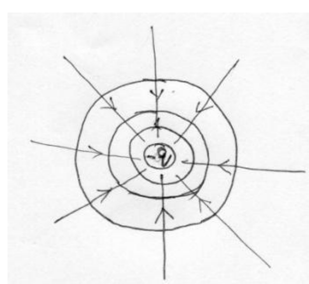
	$= \frac{1}{f} + \left(\frac{-1}{f}\right) = 0$ F = infinite	½	
Set1,Q23 Set2,Q23 Set3,Q23	(a) Values displayed ½ + ½ + ½ (b) Possible reason ½ (c) Formula for force ½ Max. value 1 Min. value ½ a) Value displayed by Seema : Helpful , considerate Family : Concerned , Affectionate Doctor : Humane nature (any one in all three cases) b) Expensive machinery/technique c) $F = qvB\sin\theta$ $F_{max} = qvB = 1.6 \times 10^{-19} \times 10^{4} \times 0.1$ $= 1.6 \times 10^{-16}$N F_{min}=zero (for $\theta = 0^0$)	 ½ ½ ½ ½ ½ 1 ½	 4
Set1,Q24 Set2,Q25 Set3,Q26	**SECTION E** a) Difference between the behaviours of the two (½ + ½) Modification of electric field. 1 b) (i) Charge stored + justification ½ + ½ (ii) field strength + justification ½ + ½ (iii) energy stored + justification ½ + ½ a)  No electric field inside a conductor . (Give full credit to diagram. Give ½ mark if explanation only is given without	½ + ½	

	diagram)		
	Induced electric field ,due to polarisation of dielectric, is in opposite direction to the applied field.	1	
	$$E_{net} = E_0 - E_\rho$$		
	(b)		
	(i) Charge remains same, as after disconnecting capacitor no transfer of charge take place.	½ + ½	
	(ii) Electric field, $E = \frac{\sigma}{\epsilon_0} = \frac{q}{\epsilon_0 A}$ remain same, as there is no change in charge.	½ + ½	
	(iii)Energy stored $= \frac{q^2}{2C} = \frac{q^2}{2\left(\frac{\epsilon_0 A}{d}\right)} = \frac{q^2 d}{2\epsilon_0 A}$	½	
	a. Energy will be doubled as separation between the plates(d) is doubled.	½	5
	OR		
	a) Why is electric field normal to the equipotential surface. 1 ½ Sketch of the equipotential surface and electric field lines. ½ + ½ b) Obtaining the expression for the work done. 2 ½		
	(a) If the field is not normal to an equipotential surface, it would have a non zero component along the surface. This would imply that work would have to be done to move a charge on the surface which is contradictory to the definition of equipotential surface.	1 ½	
	(Alternatively, Work done to move a charge dq, on a surface, can be expressed as $$dW = dq(\vec{E}.\vec{dr})$$	½	
	But *dW=0* on an equipotential surface	½	
	$\therefore \vec{E} \perp \vec{dr})$	½	
	Equipotential surfaces for a charge –q 	½ +½	
	(b) Work done to dissociate the system = -Potential energy of the system	½	

$$= \frac{-1}{4\pi\epsilon_0}\left[\frac{(-4q)(q)}{a} + \frac{(2q)(q)}{a} + \frac{(-4q)(2q)}{a}\right]$$ 1

$$= -\frac{1}{4\pi\epsilon_0 a}\left[-4q^2 + 2q^2 - 8q^2\right]$$ ½

$$= +\left[\frac{10q^2}{4\pi\epsilon_0 a}\right]$$ ½ 5

Set1,Q25
Set2,Q26
Set3,Q24

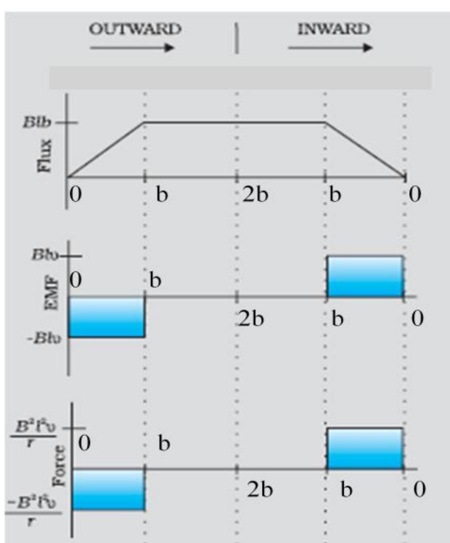
(a) Identification of phenomenon	½
Stating the factors	½ + ½
Law	½
(b) Sketch of change in	
i. Flux	1
ii. Emf	1
iii. Force	1

(a) The phenomenon involved is electromagnetic induction (EMI) ½
For the deflection:
Amount depends upon the speed of movement of the magnet. ½
Direction depends on the sense (towards, or away) of the movement of the magnet. ½
The law describing the phenomenon is :
The magnitude of the induced emf, in a circuit, is equal to the time rate of change of the magnetic flux through the circuit. ½

(Note: Also accept if a student writes: whenever magnetic flux linked with a conductor changes, an induced emf is setup in the conductor.)

(Alternatively, $\epsilon = -\frac{d\phi_B}{dt}$)

(b)

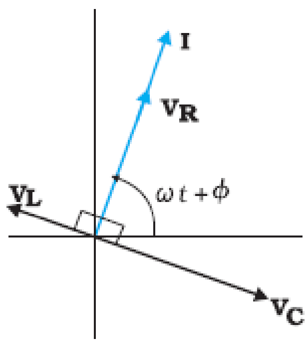


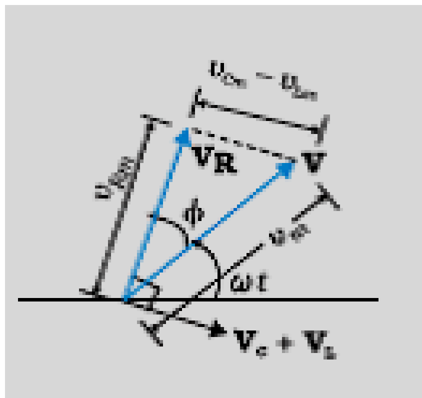
Flux 1
Emf 1
Force 1 5

OR

Phasor diagram	½
Derivation of expression for current	1 ½
Power dissipated	2
Reason for maximum power dissipation at resonance	1

Phasor diagram





½

Using the phasor diagram, we get

$v_m^2 = v_{Rm}^2 + (v_{Cm} - v_{Lm})^2$ ½

Or $v_m^2 = i_m^2[R^2 + (X_c - X_L)^2]$

$\therefore\ i_m = \frac{v_m}{\sqrt{R^2+(X_c-X_L)^2}}$ ½

Also, $\tan\phi = \frac{v_C - v_L}{v_R} = \frac{X_C - X_L}{R}$

∴ the expression, for current, is

$$i = i_m \sin(wt + \emptyset)$$ ½

(Note: Award these two marks even if the student draws the phasor diagram / does the derivation of $i = i_m \sin(wt - \emptyset)$ for $X_C < X_L$)

Power dissipated:

The instantaneous power, p, supplied by the source, is

p= ϑi

$= (\vartheta_m \sin wt)(i_m \sin(wt + \phi))$ ½

$= \frac{\vartheta_m i_m}{2}[\cos\phi - \cos(2wt + \phi)]$ ½

The average power, over a cycle, is, therefore

P=<p>=$\frac{V_m i_m}{2}(\cos\phi)$ ½

$= \mathrm{VI}\cos\phi$ ½

At resonance, we have

<table>
<tr>
<td></td>
<td>$X_c = X_L$
$\tan\phi = 0 \Longrightarrow \phi = 0^0$
$\therefore \cos\phi = 1$, its maximum value.
Hence P(=VI cos ϕ) has its maximum value at resonance.</td>
<td>½

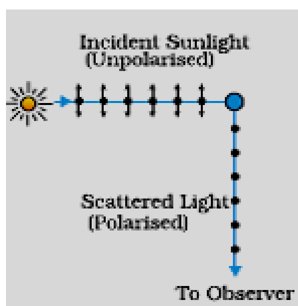
½</td>
<td>

5</td>
</tr>
<tr>
<td>Set1,Q26
Set2,Q24
Set3,Q25</td>
<td>

a)	Reason for variation	½
	Polarisation due to scattering	2
b)	Statement for Malus' law	½
	Calculation of intensities for	
	(i) $\theta = 30^o$	1
	(ii) $\theta = 60^o$	1

(a) As per Malus' law,
Transmitted intensity I=$I_o \cos^2\theta$
$\therefore$ The transmitted intensity will show a variation as per $\cos^2\theta$.

[Note: If the student writes that " unpolarised light will not show any variation in intensity, when viewed through a polaroid, which is rotated" award this ½ mark]



The electric field, of the incident wave, makes the electrons of the air molecules, acquire both components of motion. (↕ as well as •).

Charges accelerating parallel to ↕ , do not radiate energy towards the observer. Hence the radiation, scattered towards the observer gets linearly polarised.

(Note: Award these 2 marks even if the student just draws a well labelled diagram, without giving any explanation.)
</td>
<td>½

1

½

½</td>
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</table>

(b) We have, as per Malus's law:

$I = I_0 \cos^2 \theta$ — ½

$\therefore$ If the intensity of light, incident on P_1, is I_0, we have

I_1= Intensity transmitted through $P_1 = \frac{I_0}{2}$

I_2= Intensity transmitted throught $P_2 = \left(\frac{I_0}{2}\right) \cos^2 60^0 = \frac{I_0}{8}$ — ½

For $\theta = 30^0$, we have

Angle between pass axis of P_2 and P_3

= $(30^0 + 30^0) = 60^0$

or $(30^0 - 30^0) = 0^0$

$\therefore$ I_3 can be either $\frac{I_0}{32}$ or $\frac{I_0}{8}$. — 1

For $\theta = 60^0$, we have

Angle between pass axis of P_2 and P_3

= $(30^0 + 60^0) = 90^0$

or $(30^0 - 60^0) = -30^0$

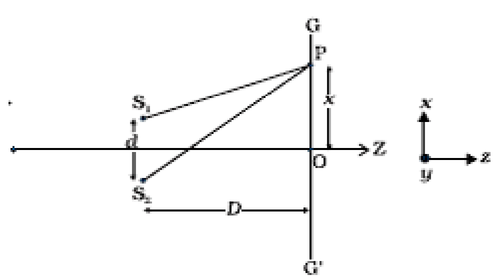
$\therefore$ I_3 can be either 0 or $\frac{3I_0}{32}$. — ½ — 5

[Note: Award the last (1+ ½) marks to the student even if he/she calculates I_3 for only the first (or second) values of the angle between the pass axis of P_2 and $P_{3.}$)

OR

a)	Expression for Path difference	2 ½
	Conditions for constructive and destructive interference	½ + ½
b)	Finding intensities at points where path difference is	
	(i) $\lambda/6$	½
	(ii) $\lambda/4$	½
	(iii) $\lambda/3$	½

(a)



½

	Path difference $= S_2P - S_1P$ Now $(S_2P)^2 - (S_1P)^2 = \left[D^2 + \left(x + \frac{d}{2}\right)^2\right] - \left[D^2 + \left(x + \frac{d}{2}\right)^2\right]$ $= 2\,xd$ where S_1S_2 =d and OP=x $\therefore\ S_2P - S_1P = \frac{2xd}{(S_2P + S_1P)}$ For x<<D and d<<D, we can write $S_2P + S_1P \backsimeq 2D$ Hence, Path difference= $S_2P - S_1P = \frac{2xd}{2D} = \frac{xd}{D}$ For constructive interference, we must have $\frac{xd}{D} = n\lambda$ $\therefore \mathrm{x} = \mathrm{x_n} = \frac{\mathrm{n\lambda D}}{\mathrm{d}}$ (n=0, $\pm1, \pm2, ...$) For destructive interference, we must have $\frac{xd}{D} = \left(n + \frac{1}{2}\right)\lambda$ $\therefore x = x'_n = \frac{\left(n+\frac{1}{2}\right)\lambda D}{d}$ (n=0, $\pm1, \pm2, ...$) (b) The general expression, for the intensity, at a point is $I = I_0 \cos^2 \emptyset/2$ (i) For path difference $= \lambda/6$, $\emptyset = 60^0$ I= $3I_0/4$ (ii) For path difference $= \lambda/4$, $\emptyset = 90^0$ I= $I_0/2$ (iii) For path difference $= \lambda/3$, $\emptyset = 120^0$ I= $I_0/4$	½ ½ ½ ½ ½ ½ ½ ½ ½	5