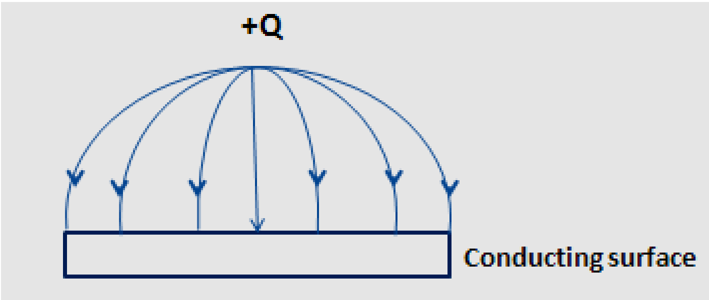
MARKING SCHEME
SET 55/1/B

Q. No.	Expected Answer / Value Points	Marks	Total Marks
Section A			
Set1,Q1 Set2,Q5 Set3,Q2	It is a measure of the sharpness of resonance. **Alternatively**, $Q = \frac{1}{w_o CR} / \frac{W_0 L}{R}$ No unit	½ ½	1
Set1,Q2 Set2,Q4 Set3,Q5	To convert one form of energy into another. (**Alternatively**, To convert other forms of energy into electrical energy)	1	1
Set1,Q3 Set2,Q2 Set3,Q4		1	1
Set1,Q4 Set2,Q3 Set3,Q1	Medium A	1	1
Set1,Q5 Set2,Q1 Set3,Q3	Line A represents parallel combination, Its slope is more(or It corresponds to a lower value of resistance)	½ + ½	1
Section B			
Set1,Q6 Set2,Q7 Set3,Q10	Finding the angle of incidence 2 It is the case of minimum deviation $\mu = \frac{\sin i}{\sin r} = \frac{\sin i}{\sin\left(\frac{A}{2}\right)}$ $\Leftrightarrow \frac{\sqrt{3}}{2} = \sin i$ $\Leftrightarrow i = 60^o$ **Alternatively,** Deviation produced by prism here is minimum. $\therefore \mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}}$ $\therefore \frac{\sqrt{3}}{2} = \sin\left(\frac{60+\delta_m}{2}\right)$ $\Rightarrow 60^o \times 2 = 60^o + \delta_m$ $\delta_m = 60^o$	½ ½ ½ ½ ½ ½	

	$A + \delta_m = i + e = 2i$	½	
	$\Rightarrow i = 60^o$	½	
	OR		2
	Finding the focal length — 1 ½ Value of refractive index — ½		
	Lens maker's formula		
	$\frac{1}{f}$ = (n-1) $\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$	½	
	$\therefore \frac{1}{20}$ = (1.5-1) $\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$		
	$\therefore \frac{1}{R_1} - \frac{1}{R_2} = \frac{1}{10}$	½	
	$\therefore \frac{1}{f'} = \left(\frac{1.5}{1.65} - 1\right)\left(\frac{1}{10}\right)$		
	$f = -110\ cm$	½	
	Refractive index of the medium should be 1.5 (i.e. same as that of material of lens)	½	2
Set1,Q7 Set2,Q10 Set3,Q8	Determination of K.E — ½ Wave length for ground state — 1 Nature of change — ½		
	In Ground state		
	K.E = E_1 = 13.6eV = 2.18 x 10^{-18}J	½	
	$\lambda_1 = \frac{h}{\sqrt{2mK}}$ = 0.33nm	1	
	[Note: Award 1½ marks if student evaluates λ_1 directly without calculating E_1]		
	Alternatively, $2\pi r_n = n\lambda_n$ $\therefore \lambda_{ground\ state} = 2\pi r_1 = 2\pi \times 0.53A^o$ $\cong 3.33\ A^o \cong 0.33\ nm$		
	In first excited state, the de Broglie wavelength will increase.	½	2
Set1,Q8 Set2,Q6 Set3,Q9	i) Finding the K.E & P.E in Ground state — ½ +½ ii) Finding the K.E & P.E in Second excited state — ½ +½		

	For Ground state, K.E =13.6 eV (∵ K.E = - T.E) P.E = - 27.2 eV (∵ P.E = 2 T.E) For second Excited state (n=3) K.E = - $(-\frac{13.6}{9})$ eV = 1.51 eV P.E = -3.02 eV [Award ½ mark if the student does the calculations by taking n=2]	 ½ ½ ½ ½	2
Set1,Q9 Set2,Q8 Set3,Q7	Distinguishing between sky wave and space wave mode 1 Reason 1		
	Space Wave: In space wave mode, the waves travel in straight line directly from transmitter to receiver **Sky Wave**: Reflected by Ionosphere	1	
	Because frequencies is greater than 40 MHz penetrate the ionosphere. (**<u>Alternatively</u>**: There frequencies (greater than 40 MHz) are not reflected by the ionosphere)	1	2
Set1,Q10 Set2,Q9 Set3,Q6	Shift in balance point for part 'a' and 'b' 1 Reason 1 a) Balance Point will be shifted towards B. The potential gradient will decrease and hence the balancing length will increase. b) No effect on balance point. At balance point no current flows through resistor S.	 ½ ½ ½ ½	2
Section C			
Set1,Q11 Set2,Q20 Set3,Q15	Effect of dielectric on a) Electric field energy ½ +½ b) Charge ½ +½ c) Potential difference ½ +½ The capacitance of both the capacitors increases by a factor K. a) New Electric field energy values are: $= \frac{1}{2}K\,(C_1V_1^2)\text{and }\frac{1}{2}K(C_2V_2^2)$ b) New charges are: $= \frac{1}{2}KC_1V_1\text{and }\frac{1}{2}KC_2V_2$	 ½ + ½ ½ + ½	

	c) New P.Dvalues are: V_1 and V_2 (The battery remains connected to the capacitors) **Alternatively:** The student may assumes that the battery has been removed. a) New Electric field energy values are: $= \frac{1}{2}\frac{Q^2}{KC_1}$ and $\frac{1}{2}\frac{Q^2}{KC_2}$ b) New charges are: Q and Q as before c) New P.D values are: $\frac{Q}{KC_1}$ *and* $\frac{Q}{KC_2}$	½ + ½ ½ + ½ ½ + ½ ½ + ½	3
Set1,Q12 Set2,Q21 Set3,Q16	Definition of activity and SI unit — 1 Calculation of half life +Activity — 1½+½ The rate at which the nuclei of the radioactive sample disintegrate. [Alternatively, $R = \frac{-dN}{dt}$] SI Unit – becquerel (Bq)/ disintegration per second/ Half Life = 10 hrs. (Given : Activity becomes half after 10 hrs) Activity after 20 hrs (= 2× half life) $= \frac{1}{2^2} = \frac{1}{4}$ of intial activity ∴ Intial activity = 10000× 4 dps = 40000dps Alternatively : $R = R_0\, e^{-\lambda t}$ $10{,}000 = R_0\, e^{-\lambda \times 20}$ $5000 = R_0\, e^{-\lambda \times 30}$ By dividing $2 = e^{\lambda \times 10}$	½ ½ ½ ½ ½ ½	

	$\log 2 = 10\lambda$ $= \frac{\log 2}{T_{\frac{1}{2}}} \times 10$ $T_{\frac{1}{2}} = 10\ hour$ Initial activity = 10000 × $(2)^2$ = 40000 dps	 ½	 3
Set1,Q13 Set2,Q22 Set3,Q17	Answers of part (a), (b), (c) 1+1+1 (a) The intensity of inteferance fringes in double slit arrangement is modulated by the diffraction pattern of each slit. **Alternatively,** In double slit experiment the interference pattern on the screen is actually superposition of single slit diffraction for each slit. (b) Waves diffracted from the edges of the circular obstacle interfere constructively at the centre of the shadow producing a bright spot. (c) Resolving power = $\frac{2\mu Sin\theta}{1.22\lambda}$ ∴ Resolving power is inversely propotional to wavelength and directly proportional to the refractive index. Alternatively : (i) R.P ∝ $\frac{1}{\lambda}$ (ii) R.P∝ μ	 1 1 ½ ½	 3
Set1,Q14 Set2,Q16 Set3,Q18	Definition of Intensity of radiation 1 Calculation of work function 1 ½ Response to red light ½ Definition : It is defined as the number of photons (of given frequency)incident per unit area per unit time. [Alternatively, $I = nh\nu$) $\frac{hC}{\lambda} = \varphi_o + eV_o$ $\varphi_o = (\frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{2270 \times 10^{-10} \times 1.6 \times 10^{-19}}$ - 1.3)eV = 4.2 eV (also accept the answer in joules) For red light incident photon energy will be less than the work function, hence no emission of electrons.(Also accept : There would be no photoemission)	 1 ½ ½ ½ ½	 3

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OR

Photo electric equation	1
Explanation of observations (any two)	1+1

Incident photon energy($h\nu$) is used up in two ways:
(1) A part of this energy is used to remove the electrons.
(2) Remaining part of the energy imparts KE to the emitted electrons

$h\nu = \phi_o + (K.E)$

$h\nu - \phi_o = \frac{1}{2}mv^2 = eV_o$

Explanation :
(i)Maximum KE depends on frequency and not on intensity.
(ii) There exists a threashold frequency ν_0 (for which $h\nu_o = \phi_o$) below which no photoemission takes place.
(iii)Basic elementary process involved is absorption of photon by e^-. This process is instantaneous.
(Any Two)
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½

1+1</td>
<td>3</td>
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<td>Set1,Q15
Set2,Q17
Set3,Q11</td>
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Answers of parts (a), (b) & (c)	1+1+1

a) Microwaves

b) Electric charges can acquire energy and momentum from e.m. waves.

c) $U = U_E + U_B = \frac{1}{2}\epsilon_0 E^2 + \frac{B^2}{2\mu_o}$
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1

½ + ½</td>
<td>3</td>
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<td>Set1,Q16
Set2,Q18
Set3,Q12</td>
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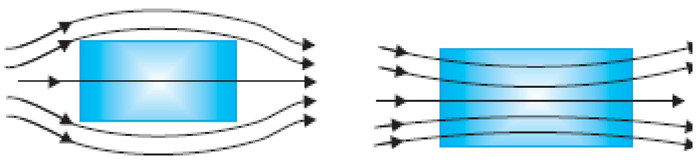
Drawing of magnetic field lines	1+1
Explanation	½ + ½



Explanation : For diamagnetic material resultant magnetic moment in an atom is zero. In presence of external magnetic field, they acquire a net magnetic moment in a direction opposite to applied field. (or get repellled)

In paramagnetic material there is a permanent magnetic dipole moment of atoms. The external magnetic field tends to align these along its own direction. (or attracts them).
</td>
<td>1 + 1

½

½</td>
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<td>Set1,Q17
Set2,Q19
Set3,Q13</td>
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Explanation of two processes with diagram	1+1
Definition of depletion region & barrier potential	½ + ½
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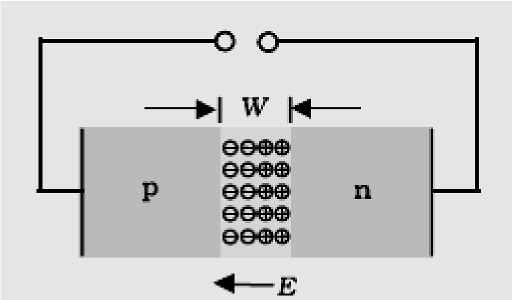
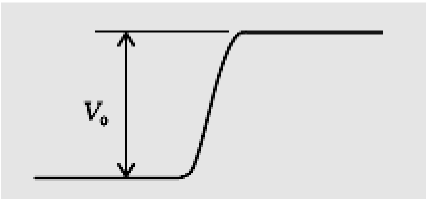
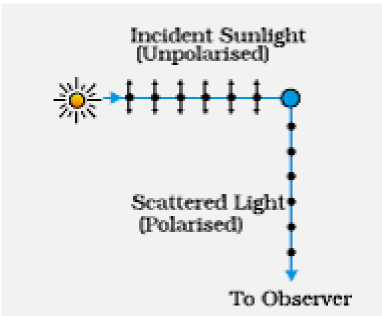
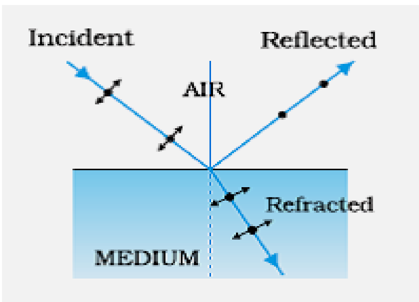
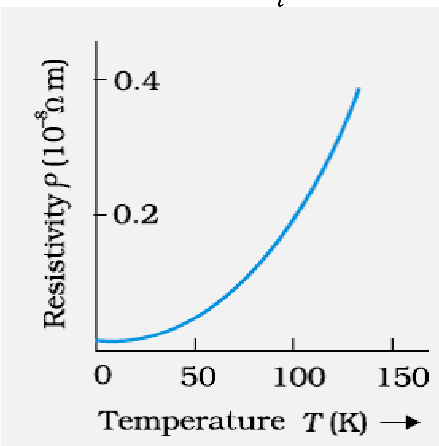
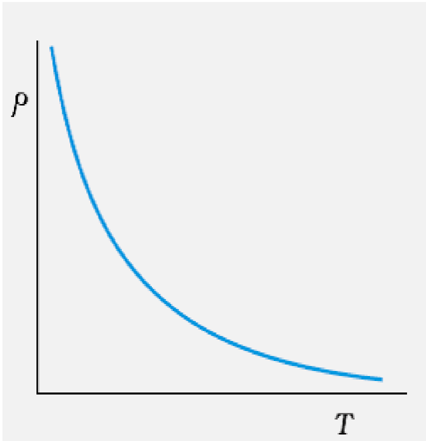
	Two important processes involved during the formation of p-n jumction are (i) Diffusion (ii) Drift	½ + ½	
	<u>Diffusion</u> is the movement of the majority charge carriers across the junction. **<u>Alternatively</u>**, Diffusion results in the formation of negative and positive space charge regions around the junction	½	
	<u>Drift</u> is the movement of the minority charge carriers across the junction.  **<u>Alternatively,</u>** 	½	
	Depletion Region: The <u>depletion layer</u> is the negative and positive space charge region formed around the junction. **<u>Alternatively</u>**: Depletion region : Space Charge region on either side of the junction together is known as depletion region.	½	
	Barrier Potential : The loss of electron from n region and gain of electron by p region causes a difference of potential across the junction. This is known as barrier potential. **<u>Alternatively</u>**: The potential developed across the junction, that opposes the flow of (majority) charge carriers.	½	3
Set1,Q18 Set2,Q11 Set3,Q14	i) Fabrication ½ ii) Working 1 ½ iii) Advantage ½ +½		
	LED is fabricated by: (i) Heavy doping of both th p and n regions. (ii) providing a transparent cover so that light can come out. **(Any one point)**	½	
	Working: When the diode is forward biased electrons are sent from $n \rightarrow p$ and holes from $p \rightarrow n$. At the junction boundary, the excess minority carriers on either side of junction recombine with majority carriers.	½ + ½ +	

	This releases energy in the form of photon $hv = Eg$. **Advantages (any two)** Low operational voltage Long life Fast on /off switching capability No warm up time required	½ ½ + ½	3
Set1,Q19 Set2,Q12 Set3,Q21	Block diagram 2 Calculation of A_m 1 [Full credit for this part maybe given to the student.] $A_c = 12V$ $\mu = \frac{A_m}{A_c} = \frac{75}{100} = 0.75$ A_m = 0.75× 12 = 9 V	 2 ½ ½	3
Set1,Q20 Set2,Q13 Set3,Q22	a) Explanation of the phenomenon using diagram 1½ b) Explanation of polarisation of Reflected light. Derivation of Brewster's Law 1½  The basic phenomenon / process which occurs is polarisation. The incident unpolarised sun ligh encounte the molecules of earth's atmosphere. Under the influence of electric field of incident wave the e^- in the molecule acquires component of motion in both these direction. If an observer is looking 90^0 to the direction of the Sun ,charge accelarating parallel to double arrow do not radiate energy towards the observer.[Their accelaration has no transverse component.] This explain polarisation of scattered light from sky. b) 	½ ½ ½ ½	

	When unpolarised light is incident at polarising angle, at the interface of a refracting medium, the reflected ray being perpendicular to the refracted ray is completely polarised. Now $\mu = \frac{\sin i}{\sin r}$ $\therefore \mu = \frac{sin\ i_p}{sin\ (90 - i_p)}$ $(\because i_p + r = 90^o)$ $\therefore \mu = \tan i_p$ This is Brewter's Law	½ ½	3
Set1,Q21 Set2,Q14 Set3,Q19	i) Derivation of the Average power in inductor 1½ ii) Ratio of Power factors P_1 and P_2 1½ For an ideal inductor connected to ac source $V = V_o \sin \omega t$ $I = I_o sin\left(\omega t - \frac{\pi}{2}\right)$ $P_{avg} = \frac{1}{T}\int_o^T V_0 I_0 \sin \omega t \cos \omega t\ dt$ $= \frac{1}{T}\frac{V_0 I_0}{2}\int_o^T \sin 2\omega t\ dt$ $= \frac{1}{T}\frac{V_0 I_0}{2}\left[\frac{\cos 2\omega t}{2\omega}\right]_O^T = 0$ (Also accept any other correct method) Power factor cosØ = R/Z For LR circuit, at X_L = R Z = $\sqrt{R^2 + R^2}$ Z = R$\sqrt{2}$ P_1= cosϕ = $\frac{R}{R\sqrt{2}} = \frac{1}{\sqrt{2}}$ For LCR circuit $X_L = X_c$ Z = $\sqrt{R^2}$ = R	½ ½ ½ ½ ½	

	Power factor $P_2 = \frac{R}{R} = 1$ $=> \frac{P_1}{P_2} = 1:\sqrt{2}$ [Award 1½mark if the student writes directly : $P_1 = \frac{1}{\sqrt{2}}$ *and* $P_2 = 1$ $\therefore \frac{P_1}{P_2} = \frac{1}{\sqrt{2}}$]	½	3
Set1,Q22 Set2,Q15 Set3,Q20	Definition of resistivity — 1 Graphs — ½ +½ Explanation — ½ +½ Resistivity of a conductor is defined as the resistance of a material (of a Conductor) of unit length and unit area of cross section. (**Alternatively**, $\rho = \frac{RA}{l}$)	1	
	 Conductor  Semiconductor	½ + ½	
	In conductor with increase in temperatures relaxtion time decreases, but number density of charge carriers is not dependent on temperature. Hence, ρ increases.	½	
	In semiconductors number density of charge carriers increases with temperature, it dominates the decrease in relaxtion time. Hence, ρ decreases.	½	3
	Section D		
Set1,Q23 Set2,Q23 Set3,Q23	Values displayed — 2 Answer of part (b) — ½ Maximum & Minimum force — 1 +½		
	a) Asha and her family helpful, concern for others , caring nature (any two) Doctor was generous, helping nature, caring (any two) (Any other alternative correct value should be accepted)	1 1	
	b) High magnetic field required. / (Expensive set up needed) Any other correct answer [Note: Full credit of ½ mark may be given [for this part to all students]	½	

$\vec{F} = q|\vec{V} \times \vec{B}|$

$F_{max} = qvB = 1.6 \times 10^{-19} \times 10^4 \times 0.1\ N$ ½

$= 1.6 \times 10^{-16} N$ ½

$F_{min} = 0$ ½

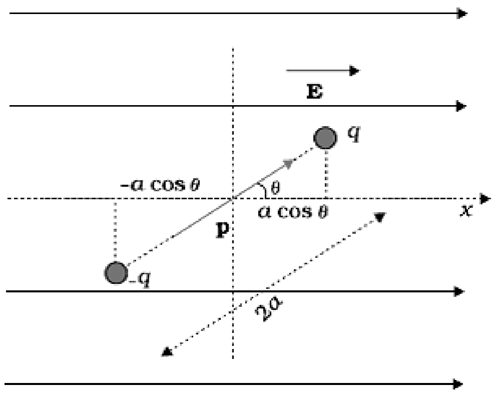
4

Section E

Set1,Q24
Set2,Q26
Set3,Q25

a)	Derivation of potential energy of dipole	2
	Angle for stable and unstable equilibrium	½ + ½
b)	Dependence of potential on r	2

a)



½

Torque experienced by an electric dipole

$\tau = pE\sin\theta$ ½

Work done by external torque

$w = \int_{\theta_1}^{\theta_2} PE\sin\theta\, d\theta$ ½

$= PE[-\cos\theta]_{\theta_1}^{\theta_2}$ ½

$U = PE[\cos\theta_1 - \cos\theta_2]$

When $\theta_1 = 90^0$, and $\theta_2 = \theta$

$\Rightarrow U = -\vec{P}.\vec{E}$

For stable equillibrium $\theta = 0^0$ ½

Unstable equillibrium $\theta = 180^0$ ½

(b)

$V_p = V_q + V_q + V_{-2q}$

$= \frac{kq}{r-a} + \frac{kq}{r+a} - \frac{2kq}{r}$ ½

$= kq\left(\frac{r+a+r-a}{r^2-a^2}\right) - \frac{2kq}{r}$

$= \frac{2kqr}{r^2-a^2} - \frac{2kq}{r}$

$= 2kq\left[\frac{r}{r^2-a^2} - \frac{1}{r}\right]$ ½

$= 2kq\left[\frac{r^2-r^2+a^2}{r(r^2-a^2)}\right] = \frac{2kqa^2}{r(r^2-a^2)}$ ½

For r>> a

$V_p = \frac{2kqa^2}{r^3}$

$V_p \propto \frac{1}{r^3}$ ½ 5

OR

a)	Electric flux and its SI unit	1+½
b)	Calculation of Electric flux	1
c)	Derivation of electric field due to infinite plane sheet	2 ½

a) Electric flux equals the surface integral of electric field over the given surface. 1

(**Alternatively**, $\phi_E = \int \vec{E}\,.\,\vec{ds}$)

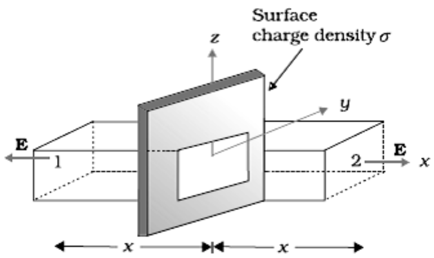
S.I Unit Nm^2/C (Alternatively: V-m) ½

b) By Gauss's Law

$\oint \vec{E}\,.\,\vec{ds} = \frac{q}{\epsilon_0}$ (q = charge enclosed) ½

Here the charge enclosed in the cube = q

$\therefore \phi_E = \oint \vec{E}\,.\,\vec{ds} = \frac{q}{\epsilon_0}$ ½ c)



[½]

$\phi = \oint \vec{E}.\vec{ds} = \int_{s1} \vec{E}.\vec{ds} + \int_{s2} \vec{E}.\vec{ds} + \int_{s3} \vec{E}.\vec{ds}$ [½]

= EA + EA + 0 = 2EA [1]

By Gauss Law,

$2\,E\,A = \frac{q}{\epsilon_0}$ [½]

$\therefore\ E = \frac{q}{2\epsilon_0} = \frac{\sigma A}{2\epsilon_0 A} = \frac{\sigma}{2\epsilon_0}$ [½]

∴ E is independent of x

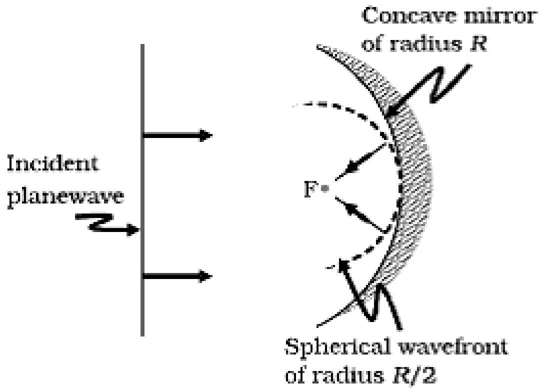
[5]

Set1,Q25
Set2,Q24
Set3,Q26

a) Definition of wave front	1
b) Diagram of wave fronts for	
(i) Reflection of plane wave by concave mirror	1
(ii) Refraction of plane wave by convex lens	1
c) Verification of Snell's Law/	2

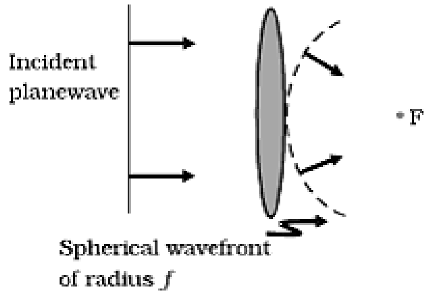
a) Locus of all the points which are in same phase / surface of constant phase [1]

b) (i)



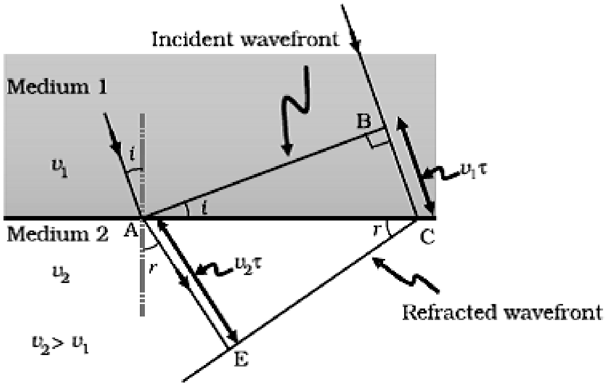
[1]

(ii)



1

c)



½

$\sin i = \frac{BC}{AC}$ $\quad\quad$ $\sin r = \frac{AE}{AC}$

$\frac{\sin i}{\sin r} = \frac{BC}{AC} = \frac{V_1 t}{V_2 t} = \frac{V_1}{V_2} = \frac{n_2}{n_1}$ ½

½

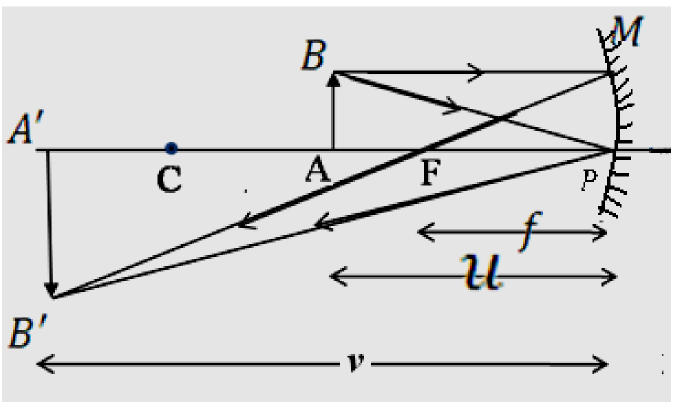
$\frac{\sin i}{\sin r} = \eta_{21}$ Snell's law

½

OR

a)	Ray diagram	1
	Derivation of mirror formula	2
b)	Calculation	2

5

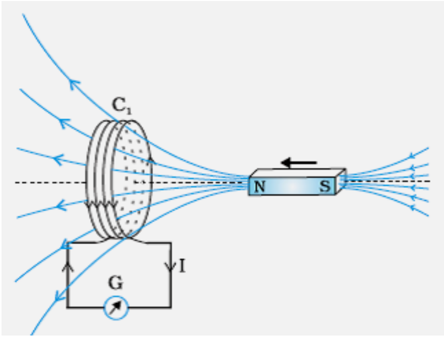


1

[Note: Deduct ½ mark if arrows are not indicated]

	In ΔABP and $\Delta A'B'P$ $\frac{AB}{A'B'} = \frac{AP}{A'P}$ In ΔMPF and $\Delta B'A'F$ $\frac{MP}{A'B'} = \frac{FP}{A'F}$ But $AB = MP$ $\therefore \frac{AP}{A'P} = \frac{FP}{A'P} = \frac{FP}{A'P - FP}$ $\frac{-u}{-v} = \frac{-f}{-(v-f)}$ $uv - uf = vf$ Dividing by uvf $\frac{1}{f} - \frac{1}{v} = \frac{1}{u}$ $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ b) Here the object is virtual and image is real $u = +12$cm (i) $\frac{1}{v} - \frac{1}{u} = \frac{1}{f} = \frac{1}{v} - \frac{1}{+12} = \frac{1}{20}$ $=> v = 7.5\ cm$ from the lens (ii) $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ $=> \frac{1}{v} - \frac{1}{12} = \frac{1}{-16}$ $=> v = 48\ cm$ from the lens	½ ½ ½ ½ ½ ½ ½ ½	5
Set1,Q26 Set2,Q25 Set3,Q24	a) Description with diagram — 1 +1 Statement of Faraday's law — 1 b) Answers and their justification parts (i) & (ii) — 1+1		

a)



(Also accept any other correct figure) — 1

When the bar magnet moves towards the coil, connected to a Galvanometer. The Galvanometer shows a deflection. This is due to change in the magnetic field/flux, linked with the coil. This shows that an emf is induced. — 1

The magnitude of emf induce is directly proportional to the rate of change of magnetic flux in the circuit . — 1

$$e = -\frac{d\phi}{dt}$$

b) (i) the emf induced $e = -B\ell v$ — ½

Emf will be more in case of square loop as the side perpendicular to the velocity is longer as compared to the rectangular loop. — ½

(ii) Current will be less in rectangular loop, as it has more resistance and less induced emf. — ½ + ½

[Note: also accept if the student says

(i) emf induced will be zero in both cases as long as the coils stay in the field. — ½ + ½

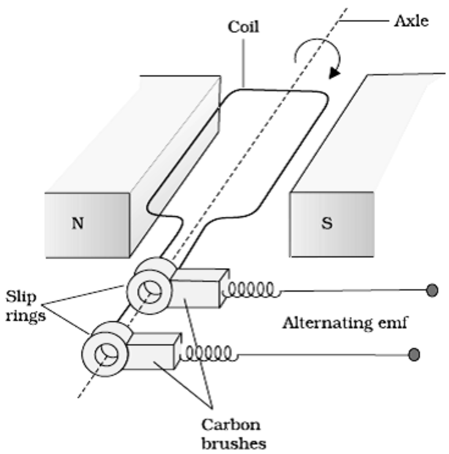
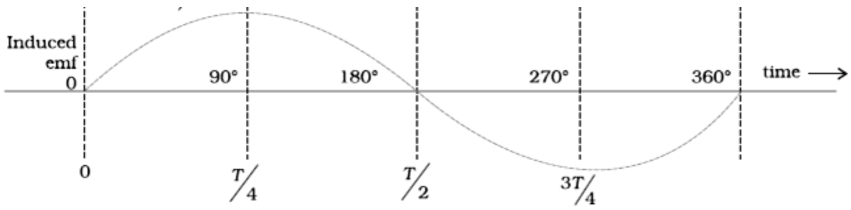
(ii) current will be zero in both the cases as long as the coils stays in the field. — ½ + ½

OR — 5

a.	Principle of a.c. generator	1
b.	Explanation of working with labeled diagram and obtaining the expression of emf	3
c.	Schematic diagram	1

a) Principle : Electromagnetic induction; effective area of the loop (= A cos θ), exposed to the magnetic field, keeps on changing as the coil rotates. — 1

[Alternatively: Whenever magnetic flux linked with a coil changes, an emf is setup in the coil]

	b) 	1 ½	
	Working When the coil is rotated with constant angular speed ω , the angle θ between magnetic field vector B and area vector A of the coil changes at any instant $\theta = wt$	½	
	Magnetic flux at any time 't' $\phi = BA\ cos\ \theta = BA\ Cos\ \omega t$	½	
	$\therefore induced\ emf$	½	
	$e = -N\frac{d\phi}{dt} = -N\frac{d}{dt}\ (BA\ cos\ \omega t)$ $e = \ NBAw\ sin\ \omega t$	1	
	c) 		5