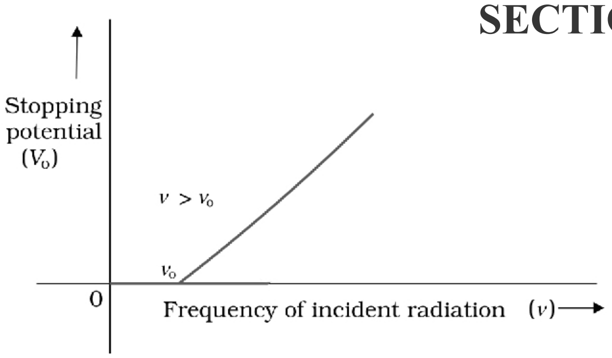
Sl. No.	Value Points / Expected Answers	Marks	Total
	SECTION - A		
Q1.		1	1
Q2.	(i) Electron (ii) Ions	½ ½	1
Q3.	Because of line of sight nature of propagation of space wave, the antenna is mounted at height to avoid the blockage of waves due to curvature of the earth.	1	1
Q4.	Repulsive **OR** Surface charge density on inner surface $= -\dfrac{Q}{4\pi R_1^2}$ Surface charge density on Outer surface $= +\dfrac{Q}{4\pi R_2^2}$	1 ½ ½	1 1
Q5.	The ozone layer absorbs the UV radiations. OR When e.m. waves falls on charged particles they set the charges into motion. This illustrates that the e.m waves have energy and momentum. **Alternatively** When the sun shines on your hand, you feel energy being absorbed from the e.m waves **Alternatively** The radio & TV signals carry energy from one place to another (Give full marks if student explains on the basis of any one of above example) **Example** – photo electric effect	1	1
	SECTION - B		
Q6.	i) Calculation of force between wires 1½ ii) Nature of force ½ Force per unit length between straight current carrying conductors, $F = \dfrac{\mu_0 I_1 I_2}{2\pi r}$	 ½	2

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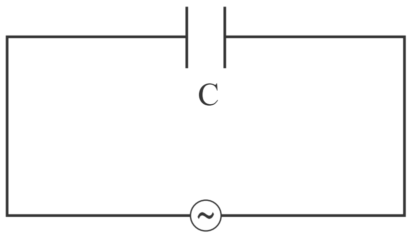
Sl. No.	Value Points / Expected Answers	Marks	Total
	$= \frac{4\pi \times 10^{-7} \times 2 \times 5}{2\pi \times 10 \times 10^{-2}}$	½	
	$= 20 \times 10^{-6}$		
	$= 2 \times 10^{-5}$ N/m	½	
	Attractive in nature	½	

Q7.

i)	Expression for net charge	½
ii)	Expression for displacement current	½
iii)	Expression for conduction current	½
iv)	Result	½

When the capacitor is getting charged, we have



$V = V_0 sinwt$

Electric flux $= \phi_E(t)$

$= \frac{Q(t)}{\varepsilon_0}$

Now $Q(t) = CV(t)$

$= Cv_0 \sin\omega t$ — ½

$\therefore$ Displacement current $i_d = \varepsilon_0 \frac{d\phi_E}{dt}$

$= \varepsilon_0 , \frac{1}{\varepsilon_0} . \frac{d}{dt} (CV_0 \sin\omega t)$

$= \omega C V_0 \cos\omega t$

$= \omega C V_0 \sin(\omega t + \pi/2)$ — ½

Also, Conduction current i_c leads the voltage by $\pi/2$

$\therefore \quad i_c = \frac{V_0}{(1/\omega C)} \sin(\omega t + \pi/2)$

$= \omega C V_o \sin\omega t$ — ½ — Total: 2

Hence $i_d = i_c$ — ½

Note 1 : Award two marks even if the student just writes "with an a.c. source, the conduction current, as well as the displacement current, are present at all instants. As per Maxwell's explanation instantaneous displacement current = instantaneous conduction current"

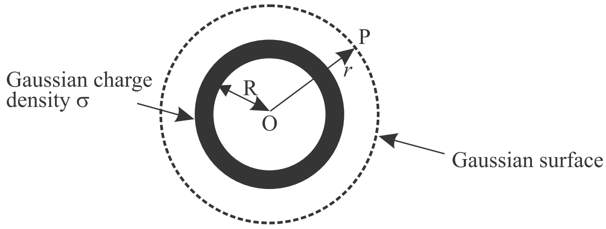
Note 2 : Award 2 marks if even if the student just writes "As per Maxwell's explanation, displacement current = conduction current, at all instants"

Note 3 : Award 2 marks if the student proves conduction current = displacement current, with a d.c source.

Sl. No.	Value Points / Expected Answers	Marks	Total

Q8.

i) Labelled diagram	½
ii) Flux through Gaussian surface	½
iii) Calculation & Result	½+½



½

Flux through the small section of Gaussian surface

$$\phi = \oint \vec{E}.\vec{ds}$$

$$\therefore \phi = \oint Eds \cos\theta$$

$$\because E \parallel \vec{ds}, \ \theta = 0$$

$$\therefore \phi = E.4\pi R^2 \quad \text{.......... (1)}$$

½

Applying Gauss's theorem

$$\phi = \frac{q}{\varepsilon_0} \quad \text{.......... (2)}$$

from equations 1 and 2

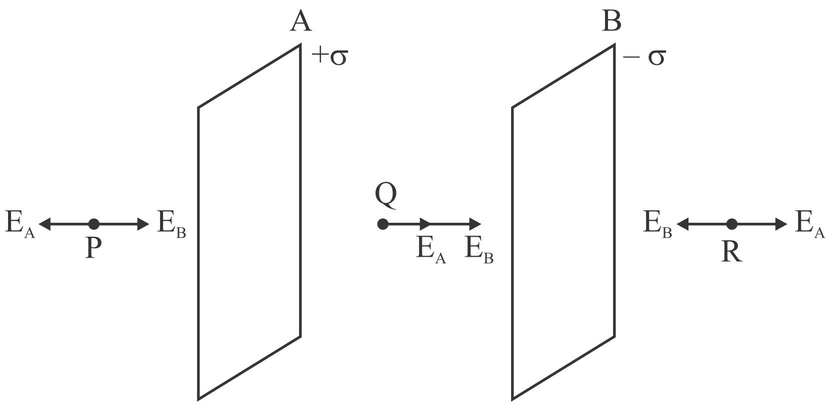
$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R^2}$$

½

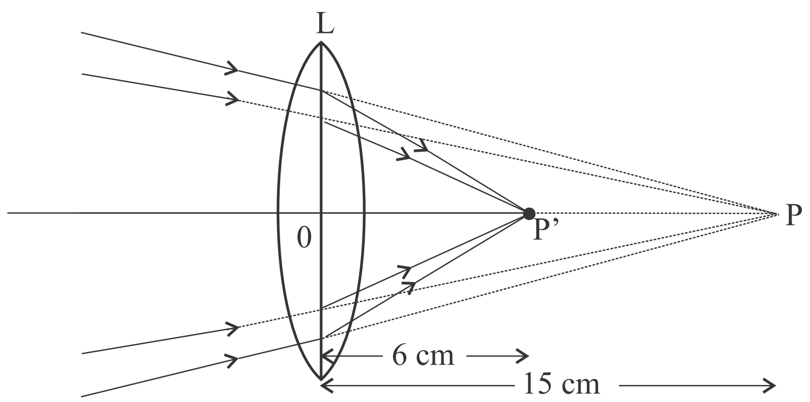
Total: 2

OR

i) Electric field at a point due to a plane sheet of charge	½
ii) Diagram with direction of field	½
iii) Electric field between the sheets	½
iv) Electric field outside the sheets	½

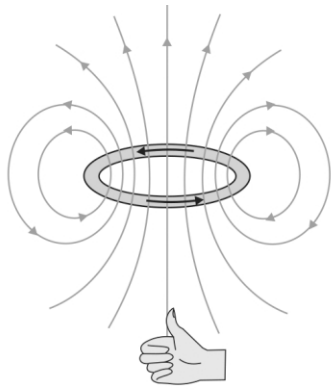


½

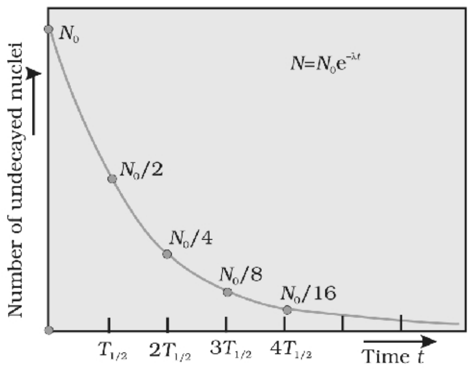
Sl. No.	Value Points / Expected Answers	Marks	Total
	Now Electric field Intensity due to a plane sheet of charge		
	$E = \frac{\sigma}{2\varepsilon_0}$	½	
	Here		
	$E_A = \frac{+\sigma}{2\varepsilon_0}$ and $E_B = \frac{-\sigma}{2\varepsilon_0}$		2
	(i) Electric field at Point Q (In between the sheets)		
	$\vec{E} = \vec{E}_A + \vec{E}_B = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} = \frac{\sigma}{\varepsilon_0}$	½	
	(ii) Field at the point P or R		
	$\vec{E} = \vec{E}_A + \vec{E}_B = \frac{\sigma}{2\varepsilon_0} - \frac{\sigma}{2\varepsilon_0} = 0$	½	
Q9.	Name of the optical instruments ½ + ½ Examples ½ + ½		
	Microscope is used for magnifying the object	½	
	Telescope is used for resolving the two distant objects kept close to each other	½	2
	Example Micro-organisms are magnified by the microscopes for their visibility	½	
	Celestial bodies/Distant objects are distinguished by telescope.	½	
Q10.	i) Ray diagram ½ ii) Lens formula ½ iii) Substitution of values with sign convention ½ iv) Calculation and Result ½		
		½	
	$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ (lens formula)	½	2
	Here u = +15cm ; f = +10 cm	½	
	$\therefore \frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{10} + \frac{1}{15}$		
	$\Rightarrow$ v = 6 cm	½	
	OR		

Sl. No.	Value Points / Expected Answers	Marks	Total
	i) Formula for magnification ½ ii) Mirror formula ½ iii) Substitution of values with sign convention ½ iv) Calculation and Result ½		
	Here, m = +3 and f = -15 cm		
	$m = \frac{v}{u} = 3 \quad \therefore \quad v = 3u$	½	
	$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$	½	2
	$\frac{1}{-15} = \frac{1}{3u} + \frac{1}{u}$	½	
	$\Rightarrow \quad u = -20$ cm	½	
Q11.	i) Calculation of input voltage 1 ii) Calculation of base current 1		
	$r_o = 2k\Omega = 2 \times 10^3\,\Omega$		
	$V_{CE} = 2V$	½	
	$I_C = \frac{V_{CE}}{r_o} = \frac{2}{2 \times 10^3} = 10^{-3}$ A	½	2
	$\beta = \frac{I_C}{I_B}$		
	Base current $I_B = \frac{I_C}{\beta} = \frac{10^{-3}}{100} = 1 \times 10^{-5}$ A = 10 μA	½	
	$r_i = 1k\Omega = 1 \times 10^3\,\Omega$		
	$V_{in} = I_B \times r_i$ $= 10 \times 10^{-6} \times 10^3$ $= 10 \times 10^{-3}V$ $= 10$ mV	½	
Q12.	i) Calculation of path difference ½ ii) Condition for constructive interference ½ iii) Expression for fringe width 1		
	The path difference $S_2P - S_1P = \left(\frac{y_n d}{D} + \frac{\lambda}{4}\right)$	½	
	For constructive interference		
	Path difference = n λ where n=0,1,2,3	½	
	$\frac{y_n d}{D} + \frac{\lambda}{4} = n\lambda$		2

Sl. No.	Value Points / Expected Answers	Marks	Total
	Position of n^{th} bright fringe	½	
	$y_n = (n - \frac{1}{4}) \frac{\lambda D}{d}$		
	Fringe width $\beta = y_n - y_{n-1}$		
	$\boxed{\beta = \frac{\lambda D}{d}}$	½	
	Note : If the student solves the question by taking the path difference $S_2P - S_1P = \frac{\lambda_n d}{D}$; 1 Mark may be awarded		
Q13.	i) Derivation of P.E. & K.E. — 1 + 1 ii) Relation between K.E., P.E. and total energy — ½ + ½		
	Velocity of electron in n^{th} orbit		
	$v_n = \frac{e^2}{nh\varepsilon_o}$	½	
	Expression for K.E. $= \frac{1}{2} mv^2$		
	$= \frac{1}{2} \frac{me^4}{n^2h^2\varepsilon_o^2}$	½	3
	Expression for P.E. $= - \frac{me^4}{n^2h^2\varepsilon_o^2}$	½	
	Total Engery = K.E. + P.E.		
	$= \frac{1}{2} \frac{me^4}{n^2h^2\varepsilon_o^2} - \frac{me^4}{n^2h^2\varepsilon_o^2} = \frac{1}{2} \frac{me^4}{n^2h^2\varepsilon_o^2}$	½	
	Total Energy = - K.E.	½	
	and Total Energy $= \frac{P.E.}{2}$	½	
Q14.	i) Figure — 1 ii) Magnetic Field — ½ + ½ iii) Calculation of Direction — ½ + ½		

Sl. No.	Value Points / Expected Answers	Marks	Total
	(a) 	1	3
	(b) $d\vec{B} = \frac{\mu_0 I (d\vec{l}\times\vec{r})}{4\pi \; r^3}$	½	
	Where, $\vec{r} = (0-0)\hat{i} + (d-0)\hat{j} + (0-0)\hat{k}$		3
	$= (d)\hat{j}$		
	$\lvert\vec{r}\rvert = d$		
	$d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{(dl(\hat{i}) \times (d)\hat{j})}{4\pi \; d^3}$		
	$= \frac{\mu_0 I (dl)\hat{k}}{d^2}$	½	
	(ii) $\vec{r} = (d)\hat{k}$	½	
	$\lvert\vec{r}\rvert = d$		
	$d\vec{B} = \frac{\mu_0 I (dl)(d)\hat{k}}{d^3}$		
	$= \frac{\mu_0 I (dl)(-\hat{j})}{d^2}$	½	
	Alternatively		
	Here, $\theta = 90^0$	½	
	Magnetic field at (0, d,0)		
	$dB = \frac{\mu_0}{4\pi} \frac{I\,dl \sin\theta}{d^2}$	1	
	$= \frac{\mu_0}{4\pi} \frac{I\,dl}{d^2}$ (Parallel to + Z axis)	1	
	Magnetic field at (0,0,d)		
	$\frac{\mu_0}{4\pi} \frac{I\,dl}{d^2}$		
	(Towards - Y axis)	½	
Q15.	i) Graph 1 ii) Definition of half life 1 iii) Relation between half life and mean life 1		

Sl. No.	Value Points / Expected Answers	Marks	Total



Marks: 1 — Total: 3

The time internal in which both Number of Nuclei and decay rate reduce to half of their initial values is called half life. 1

The half life $T_{½} = \frac{0.693}{\lambda}$ .... (i)

The average life or mean life

$\tau = \frac{1}{\lambda}$ .... (ii) ½

From (1) & (2)

$$T_{½} = \frac{0.693}{\lambda} = 0.693\tau$$

$$T_{½} = 0.693\tau$$ ½

Q16.

a) i) Effect on balancing length with decrease in R_1 with justification	½+½
ii) Effect on balancing length with increase in R_2 with justification	½+½
b) Reason for preferring Potentiometer over voltmeter.	1

a) i) When R_1 is decreased, the balancing length decreases. ½
Justification - When R is decreased, I through the potentiometer increases. Hence potential gradient increases. Therefore balancing length decreases.

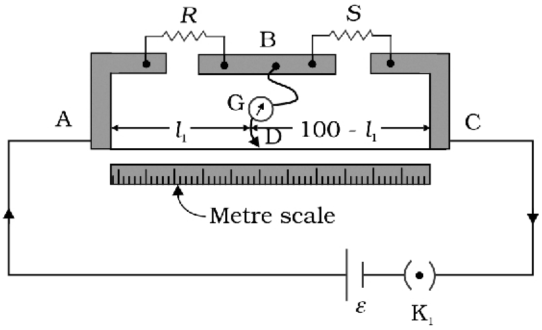
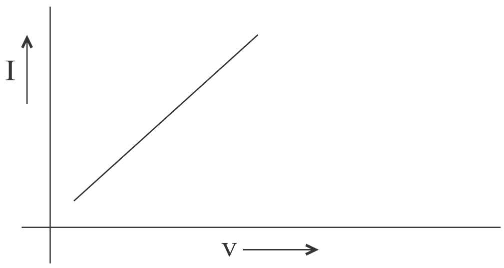
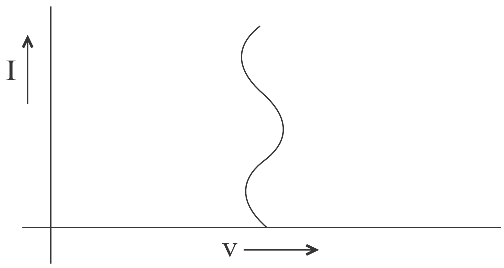
ii) When R_2 is increased, balancing length decreases ½

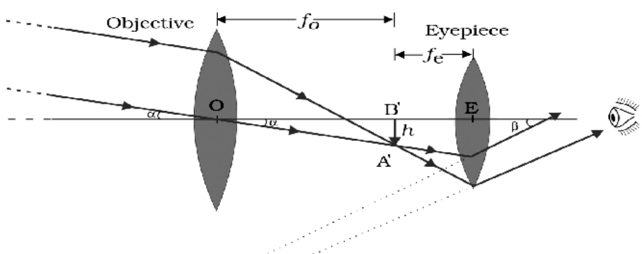
Justification : When R_2 is increased, current $I = \frac{E}{r+R_2}$ decreases. This increases V (= E–Ir) hence balancing length increases. 1

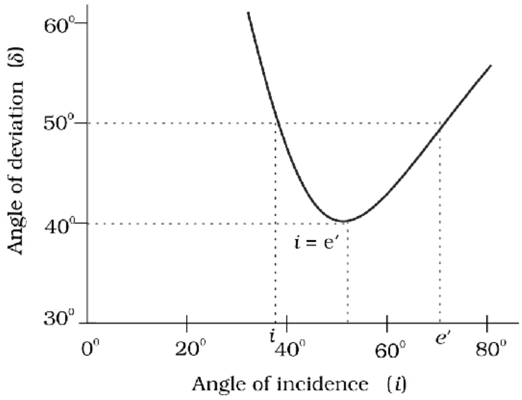
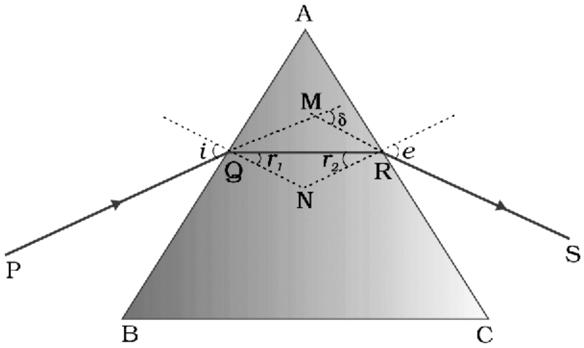
At balance, Potentiometer draws no current from the voltage source, measurement of emf/potential difference will be more accurate or any suitable justification. 1

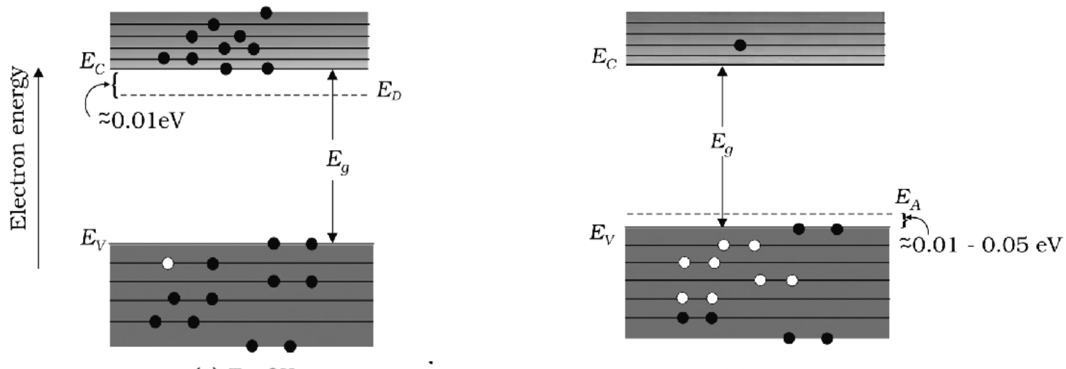
OR

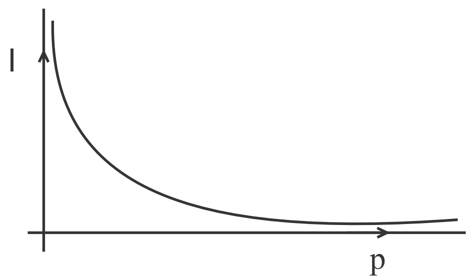
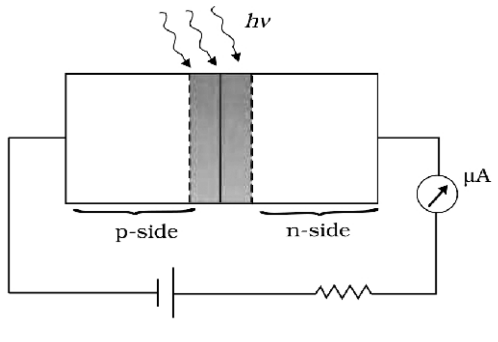
i) Principle of meter bridge	1
ii) Circuit diagram	1
iii) Determination of unknown resistance	1

Sl. No.	Value Points / Expected Answers	Marks	Total
	Principle of meter bridge : - It works on the principle of balance condition of wheatstone bridge i.e $\frac{P}{Q} = \frac{R}{S}$	1	
	Circuit diagram 	1	3
	When the jockey is moved along the wire, at one position of jockey, the galvanometer will show no deflection. Let the distance of the jockey from the end A at the balanced point be l_1 then $\frac{R}{S} = \frac{l_1}{100-l_1}$ $R = S\left(\frac{l_1}{100-l_1}\right)$	1	
Q17.	a) Graph between V and I with external resistance R — 1 b) Behaviour of Hg at 4K — 1 c) Identification and result — 1		
	a) Note : Award this 1 mark even if the student draw the following or some other non linear graph **OR** 	1	
	b) At a temperature of 4 K, the Resistance of Hg becomes zero. Note - Award this 1 mark if the student writes that Hg becomes a super conductor at temperature of 4 K	1	3
	c) Region BC ; since current is decreasing with increasing voltage **Alternately** :The graph has negative slope for this region.	1	
Q18.	i) Conversion of a galvanometer into an ammeter — 1½ ii) Formula for shunt — ½ iii) Calculation and Result — 1		
	a) By connecting a small resistance called shunt (S) in parallel to coil of the galvanometer The value of S is related to the maximum current (I) to be measured as $S = I_g G / I - I_g$. (Note : If the student just draws the diagram, full marks may be awarded).	1½	
	b) $G = 15\,\Omega$ $I_g = 4 \times 10^{-3}A$		

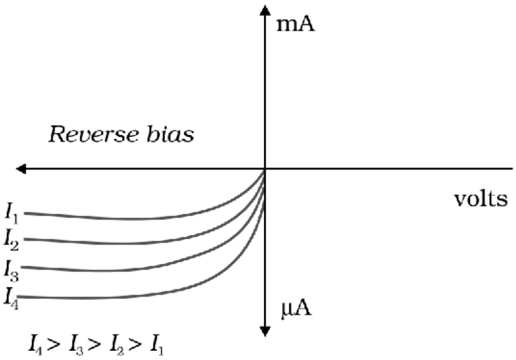
Sl. No.	Value Points / Expected Answers	Marks	Total
	$I = 6A$		3
	$I_g G = (I-I_g)S$	½	
	$S = \frac{I_g G}{I-I_g} = \frac{4\times10^{-3}\times15}{6 - 4\times10^{-3}}$	½	
	$= 0.01\Omega$	½	
	OR		
	i) Conversion of a galvanometer into a voltmeter 1½ ii) Formula ½ iii) Calculation and results 1		
	a) A galvanometer may be converted into voltmeter by connecting a high value resistance R in series with coil of the galvanometer. The value of (R) is related to the maximum voltage (V) to be measured as $R = \frac{V}{I_g} - g$	1½	
	Note - Award full marks if a student just draws the labelled diagram.		
	b) $I_g = \frac{V}{R_g + R}$	½	3
	$\frac{V}{R_g + 980} = \frac{V}{2(R_g + 470)}$	½	
	$2R_g + 940 = R_g + 980$		
	$R_g = 40\Omega$	½	
Q19.	i) Expression for Force and its direction 1½+½ ii) Expression/Calculation of Power 1		
	a) The induced emf in the moving conductor MNOP $e = Blv$	½	
	The induced current, $i = \frac{e}{R} = \frac{Blv}{R}$		
	Force on the arm 'ON', $F = Bil$	½	3
	$= \frac{B^2l^2v}{R}$	½	
	The force is directed in the direction opposite to velocity of rod (v)	½	
	Note : Award the last half mark if the student write F = 0 as B = 0 in the position shown		
	b) Power $P = F \times v$	½	
	$= \frac{B^2l^2v}{R}$	½	
	Note : Award the last half mark if the student write P = 0 as B = 0 in the position shown		
Q20.	i) Labelled ray diagram 1½ ii) Formula for angular magnification ½ iii) Importance and limitations 1		
		1½	

Sl. No.	Value Points / Expected Answers	Marks	Total
	Angular magnification $m = \frac{-f_0}{f_e}$ or $\frac{f_0}{f_e}$	½	3
	Important considerations :		
	For achieving large resolution, the objective of large aperture is required.	½	
	Consequent Limitation : Heavy, hence difficult to make and support by their edge / suffers with chromatic aberrations (any one of above)	½	
	OR		
	i) Graph between δ and I — 1 ii) Derivation of expression for refractive index — 2		
	a) 	1	
		½	
	Since $n_{21} = \frac{\sin i}{\sin r}$	½	3
	From the figure and calculations $r_1 + r_2 = A$ At minimum deviation i.e. $\delta = \delta m$, $i = e$ and $r_1 = r_2 = r$ $\therefore \quad r = A/2$ .... (eq^n 1) From the figure $\delta = (i - r_1) + (e - r_2)$		
	$\therefore \quad \delta_m = (i + e) + (r_1 + r_2)$	½	
	$i = \frac{A + \delta_m}{2}$ .... (eq^n 2)		
	$\therefore \quad n_{21} = \frac{\sin i}{\sin r} = \frac{\text{Sin}\,\frac{A+\delta_m}{2}}{\sin A/2}$	½	

Sl. No.	Value Points / Expected Answers	Marks	Total
Q21	i) Energy band diagram (i) n type and (ii) p type 1+1 ii) Role of Acceptor and Donor energy level 1		
	(a) $T > 0K$ (b) $T > 0K$	2	3
	The donor energy level decreases the energy gap between conduction band and valence band. As a result the conduction band will get more electrons from the donor impurity with very small supply of energy. Whereas in p type semiconductor the holes from acceptor level sinks down into valence band	½ ½	
Q22	a) Purpose and inference 1½ b) Ratio of accelerating potential 1½		
	a) Purpose of Davisson Germer Experiment was to verify the wave nature of electron.	1	
	It confirms the de Broglie relations for matter waves / Diffraction effect of electron beams from crystal	½	
	b) de Broglie wavelength		
	$\lambda = \frac{h}{\sqrt{2mqV}}$	½	
	$\therefore \frac{h}{\sqrt{2m_p eV_p}} = \frac{h}{\sqrt{2m_\alpha eV_\alpha}}$	½	3
	$\therefore \frac{V_p}{V\alpha} = \frac{8}{1}$	½	
	OR		
	a) i) de Broglie wavelength associated with electron and proton with justification ½+½ ii) Momentum associated with e & p and justification ½+½ b) i) Relation between momentum and de Broglie wavelength & Graph ½+½		
	a) i) Since $\lambda = \frac{h}{\sqrt{2mqV}}$		

Sl. No.	Value Points / Expected Answers	Marks	Total
	$\lambda \propto \frac{1}{\sqrt{m}}$ (For other variables constant)	½	
	$m_\rho > m_e$		
	Therefore $\lambda_{electron} > \lambda_{proton}$	½	
	ii) momentum $p = \frac{h}{\lambda}$	½	
	$\therefore \lambda_{electron} > \lambda_{proton}$ $\therefore$ momentum of electron is lesser.	½	3
	b) $\lambda = \frac{h}{p}$	½	
	Graph between p & λ		
		½	
Q23	i) Point of consideration in fabrication of Photodiode ½ ii) Working of photodiode with diagram 1½ iii) VI graph - Role of photodiode in detecting the optical signal ½+½		
	A photodiode is fabricated with a transparent window to allow light to fall on the diode. and the generation of e-h pairs takes place in or near the depletion region of the diode.	½	
		1	
	Working of photodiode - When photodiode is illuminated with light of suitable frequency, the electron hole pairs are generated near depletion region due to its specific fabrication. The junction potential separates electrons and holes before their recombination and e^- releases to n^- side and holes reaches to p^- side to the direction of electric field and hence current flows across the photodiode when connected with load.		

Sl. No.	Value Points / Expected Answers	Marks	Total



(b)

Marks: 1 — Total: 3

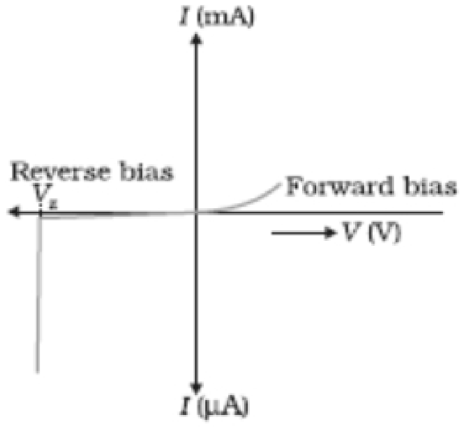
If reverse bias is applied across the photodiode, the photo current changes with the change in intensity of light. Hence, it can be used to detect the optical signals — ½

Q24.

i)	Fabrication of Zener Diode	1
ii)	I-V Characteristics	1
iii)	Working of Zener Diode as a voltage regulator	1

a) Zener Diode is fabricated by heavily droping of p & n side of the junction — 1

b) I-V Characteristic



(b)

— 1 (Total: 3)

c) Working of Zener Diode as Voltage regulator :
In reverse bias, above the breakdown voltage, the voltage remains constant though current through Zener Diode varies over a wide range. — 1

Q25

a)	Sharpness of resonance	½
	Relation of sharpness with Q factor	½
	Factor affecting the sharpness	½
	Identification of graph	½
b)	Finding of the frequency	1
	Calculation of maximum current	1
	Calculation of inductive and capacitance reactance	½+½

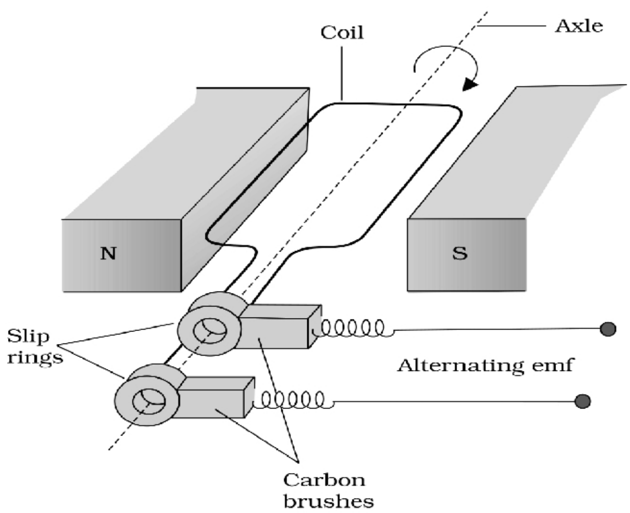
a) The circuit would be set to have a high Sharpness of Resonance, if the current in the circuit drops rapidly as the frequency of the applied AC source shifts from its resonant value. (Also accept Sharpness of Resonance = $\omega_0/2\Delta\omega$). — ½

Sharpness of Resonance is measured by the quality factor $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$ — ½

Sl. No.	Value Points / Expected Answers	Marks	Total
	Note : Accept the answer if the student write sharpness of resonance = Q- factor		
	Sharpness of resonance for given value L and C / value of ω_r depends on R.	½	
	R is minimum for circuit C	½	
	b) $v = \frac{1}{2\pi\sqrt{LC}}$	½	
	$= \frac{1}{2\times3.14\sqrt{8\times2\times10^{-6}}}$		
	$= \frac{1000}{8\times3.14}$		
	= 39.81 or 40 Hz (Approximately)	½	
	$V_0 = 200$ V		
	$i_0 = \frac{V_0}{Z} = \frac{V_0}{R}$ ($\because$ Z=R at resonance)	½	
	$= \frac{200}{100}$		
	= 2 Ampere	½	
	At resonance		
	$X_L = X_C$		
	$X_L = \omega L = 2\pi v L$	½	
	$= 2\pi\times39.81\times8$		
	$= 2000\ \Omega$	½	5
	OR		

a)	Schematic Diagram of AC Generator	1
	Working	½
	Expression for emf	1
	Graphical representation	½
b)	i) Calculation of max and average induced emf	½+½
	ii) Calculation of max. current and average power loss	½+½

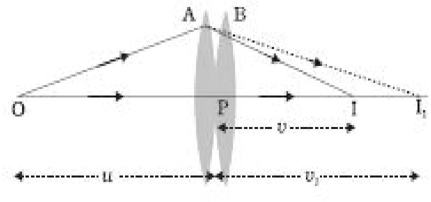
a)



Marks: 1

Sl. No.	Value Points / Expected Answers	Marks	Total
	Working of AC Generator -		
	Whenever coil placed in uniform magnetic field is rotated, flux linked with it changes, and an emf induces in the coil. The ends of the coil are connected to an external circuit by means of slip rings and brushes.	½	
	Flux linked with the coil of Area a, placed in uniform magnetic field 'B'		
	$\phi_B = BA\cos\theta$		
	or $\phi_B = BA\cos\omega t$ .... (eqⁿ1)		
	$\therefore$ From Faraday's law		
	e.m.f induced in the coil		
	$\varepsilon = -N\dfrac{d\phi_B}{dt}$	½	
	$-NBA\dfrac{d}{dt}\cos\omega t$		
	$\varepsilon = NBA\omega\sin\omega t$		
	or $\varepsilon = \varepsilon_0\sin\omega t$ where $\varepsilon_0 = NBA\omega$	½	
	Note Award full marks if student explains theoretically)		
	b) i) $r = 10$ cm, $N = 20$ turns, $\omega = 50$ rad s^{-1}		
	$B = 3.0 \times 10^{-2}$ T		
	$\varepsilon_0 = NBA\omega$		
	$= 20 \times 3 \times 10^{-2} \times \pi\left(10 \times 10^{-2}\right)^2 \times 50$		
	$= 0.942$ volt	½	
	$\varepsilon_{AV} = 0$, over a cycle	½	
	ii) $i_0 = \dfrac{e_0}{R} = \dfrac{0.942}{10}$	½	
	$= 0.094$ A		
	$P = \dfrac{1}{2}\varepsilon_0 \times I_0$	½	
	$= \dfrac{1}{2} \times 0.942 \times 0.094$		
	$= 0.045$ watt.	½	

Sl. No.	Value Points / Expected Answers	Marks	Total
Q26.	a. Relation for combined focal Length 2½ equivalent Power 2½ b. Calculation for Positive of image frame. 2		

a.  ½

For less A

$$\frac{1}{f_1} = \frac{1}{v_1} - \frac{1}{u}$$ eg. (I) ½

For less B eg. (ii) ½

$$\frac{1}{f_2} = \frac{1}{v} - \frac{1}{v_1}$$

Adding eqn. (i) & eqn. (ii) ½

$$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{v_1} - \frac{1}{u} + \frac{1}{v} - \frac{1}{v_1}$$

$$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{F}$$ ½

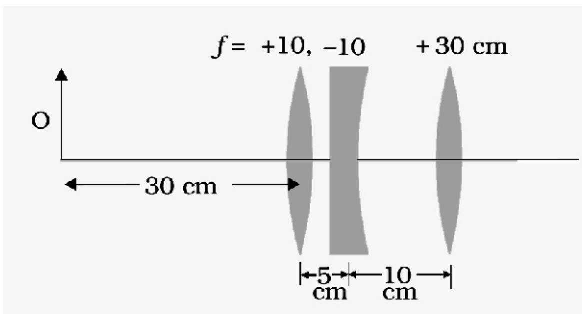
∴ equivalent power

$P = P_2 + P_2$ ½

b) Image formed by lense of f = +10 cm

$$\frac{1}{v_1} - \frac{1}{u_1} = \frac{1}{f_1}$$

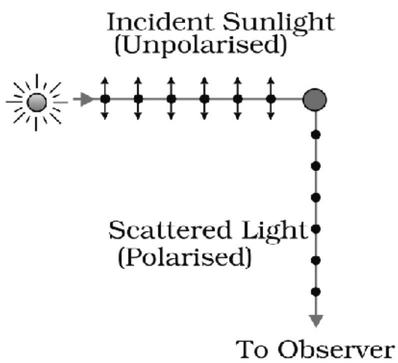
$$\frac{1}{v_1} - \frac{1}{30} = \frac{1}{10}$$



Sl. No.	Value Points / Expected Answers	Marks	Total
	$\therefore\ v_1 = 15$ cm	½	
	This image formed by the lens act as object from concave lens		
	$\therefore\ u_2 = 15\text{-}5 = 10$ cm		
	$\frac{1}{f_2} + \frac{1}{v_2} = \frac{1}{u_2}$		
	$\frac{1}{-10} = \frac{1}{v} - \frac{1}{10}$	½	
	$v = \infty$		
	Therefore virtual image forms at right of concave lens at $v = \infty$ and act as convex lens. (f = +30 cm)		
	$\therefore\ u_2 = 15 - 5 = 10$ cm	½	5
	$\frac{1}{v_3} = \frac{1}{4} - \frac{1}{f_3}$		
	$\frac{1}{v_3} = \frac{1}{\infty} = \frac{1}{30}$		
	$v_3 = 30$ cm	½	
	(If student calculate upto $v = \infty$, give full marks)		

OR

i)	Diagram	1
	Explanation	1
ii)	Variation of Intensity	½
	Graph	½
	No. of maxima and minima	½+½



Marks: 1

When light encounters the molecules of the atmosphere, the electrons in molecules acquire components of motion under the influence of electric field. Charges accelerated parallel to the double arrows do not radiate energy towards the observer since their acceleration has no transverse component. The radiation scattered by the molecules are thus polarized light. — 2

Sl. No.	Value Points / Expected Answers	Marks	Total

b) Suppose I_0 be the intensity of polarised light after passing through polarized P_1.

Therefore intensity of polarised light after passing through P_2

$I = I_0 \cos^2\theta$

Since Polarised P_1 and P_2 are crossed, the angle between their pass axes will be (90-θ) — ½

$I = I_0 \cos^2\theta . \cos^2(90-\theta)$

$= I_0 \cos^2\theta . \sin^2$

$I = \frac{I_0}{4} \sin^2 2\theta$

1) When θ = 0

$I = \frac{I_0}{4} \sin^2 2.0 = 0$

2) When $\theta = \frac{\pi}{4}$

$I = \frac{I_0}{4} \sin^2 2\pi/2$

$= I_0 / 4$

3) When $\theta = \frac{\pi}{2}$

$I = \frac{I_0}{4} \sin^2 2\pi/2$

$I = 0$

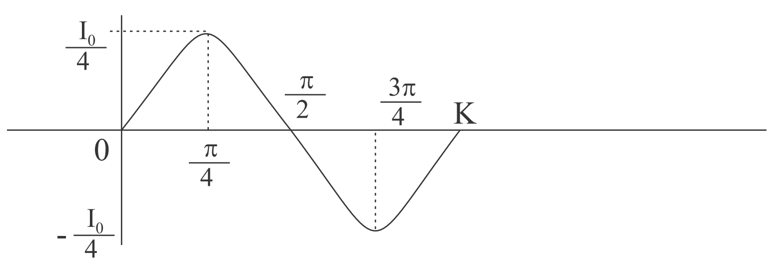
4) When $\theta = \frac{3\pi}{4}$

$I = \frac{I_0}{4} \sin^2 2 \times 3\pi/4 = -\frac{I_0}{4}$

5) When θ = n

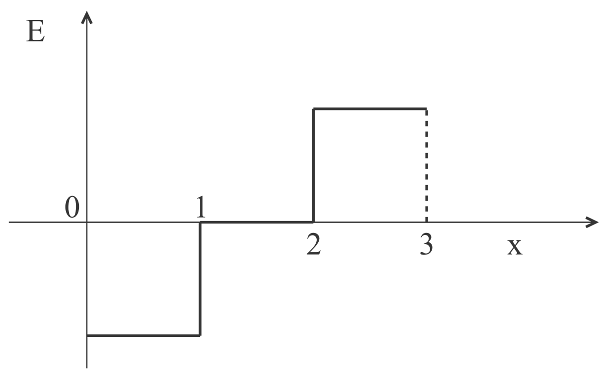
$I = \frac{I_0}{4} \sin 2\pi$

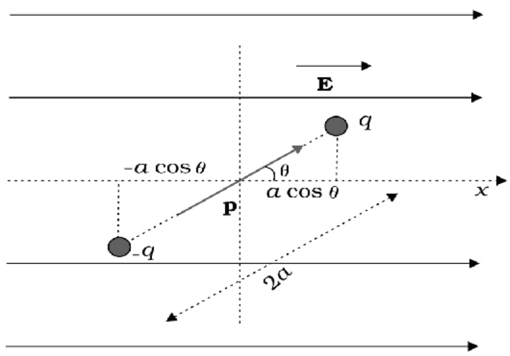
$I = 0$



½

Two maxima and two minima — ½+½

Sl. No.	Value Points / Expected Answers	Marks	Total
Q27	a) Explanation of charging of capacitor with DC battery — 1 b) i) Effect on electric field with justification — 1½ ii) Effect on energy stored in capacitor with justify. — 1½ c) Graph between E & x — 1		
	a) Charging of capacitor with dc battery whenever parallel plate capacitor is connected with dc source, plates start acquiring charge in accordance with the terminals of the battery till potential difference across the plate becomes equal to terminal potential of dc battery.	1	
	Note : Any other relevant explanation may also be accepted.		
	b) i) The electric field between the plates of parallel plate capacitor $E_0 = \frac{\sigma}{\varepsilon_0} = \frac{Q}{\varepsilon_0 A}$	½	
	If dielectric is inserted $E' = \frac{Q}{\varepsilon_0 A.K} = \frac{\varepsilon_0}{K}$	½	
	So, the electric field intensity decreases to 1/K times.	½	
	ii) Since Energy stores in the capacitor $U = \frac{Q^2}{2C} = \frac{Q^2 d}{2\varepsilon_0 A}$ .... (1)	½	
	Similarly $U' = \frac{Q^1}{2C'} = \frac{Q^2 d_1}{2K\varepsilon_0 A}$ $= \frac{2}{K}\left(\frac{Q^2 d_1}{2\varepsilon_0 A}\right)$		5
	$= \frac{2U}{K}$	½	
	$i<k<2$ Therefore energy stored between the plates increases	½	
	iii) 	1	

Sl. No.	Value Points / Expected Answers	Marks	Total
	OR		
	i) Derivation of Potential energy of an electric dipole. 2 ii) Condition for stable and unstable equilibrium 2 iii) Possibility and example ½+½		
	a) 	½	
	a) Since torque acting on dipole $\vec{\tau} = \vec{p} \times \vec{E}$ $\vec{\tau} = pE\sin\theta.\hat{n}$	½	
	work done $d\omega = \tau.d\theta$ $= pE\sin\theta d\theta$		
	$w = \int_{\theta_1}^{\theta_2} dw \quad pE\int_{\theta_1}^{\theta_2} \sin\theta\, d\theta$	½	
	$w = pE[-\cos\theta]_{\theta_1}^{\theta_2}$ $= pE[\cos\theta_1 - \cos\theta_2]$ if $\theta_1 = 0, \theta_2 = \theta$ $w = pE(1-\cos\theta)$	½	
	Conditions-		5
	For stable equilibrium - When electric dipole is parallel to electric field.	1	
	For unstable equilibrium - Anti Parallel to electric field.	1	
	b) No.	½	
	Inside equipotential surface	½	