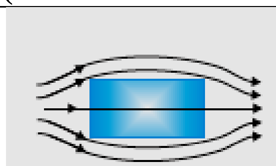
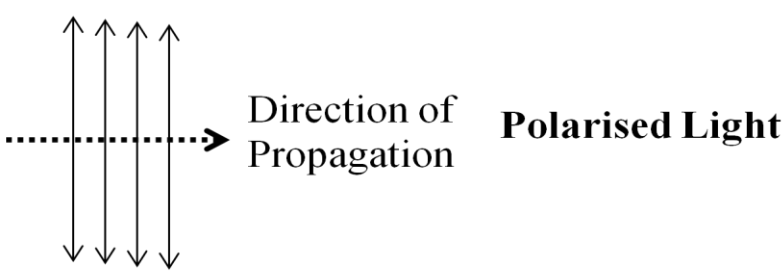
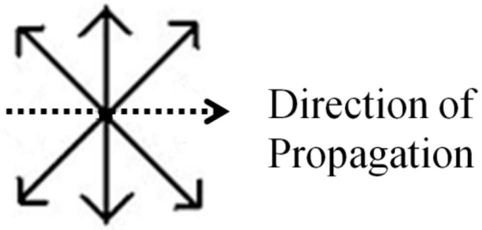
MARKING SCHEME

Q. No.	Expected Answer / Value Points **SECTION -A**	Marks	Total Marks
Set1,Q1 Set2,Q4 Set3,Q3	$V_A - V_B > 0$ $\Longrightarrow V_A > V_B$ Q is positive (Even if a student writes the answer directly full marks to be given.)	 ½ ½	 1
Set1,Q2 Set2,Q5 Set3,Q4		1	1
Set1,Q3 Set2,Q1 Set3,Q5	$I_D = 0.25\ A$	1	1
Set1,Q4 Set2,Q2 Set3,Q1	Any one of the following or any other (i) Magnetic braking in trains. (ii) Electromagnetic damping in certain galvanometers. (iii) Induction furnace to produce high temperature. (iv) Electric power meters (in which the disc rotates due to eddy currents.)	1	1
Set1,Q5 Set2,Q3 Set3,Q2	Electric flux $\Delta\phi$,through an area element $\overrightarrow{\Delta S}$, is defined by $\Delta\phi = \vec{E}.\overrightarrow{\Delta S} = E\Delta S\ cos\theta$ where θ is the angle between $\vec{E}$ and $\overrightarrow{\Delta S}$. S.I unit of electric flux is $NC^{-1}m^2$. **Alternatively,** (Vm)	½ ½	 1
	SECTION B		
Set1,Q6 Set2,Q9 Set3,Q8	(i) Bohr's (third) postulate 1 (ii) Number of spectral lines ½ Names of series ½ (i) Bohr's (third) postulate: An electron might make a transition from one of its specified non- radiating orbits to another of lower energy. When it does so, a photon is emitted having energy equal to the energy difference between the initial and final states. The frequency of the emitted photon is given by $h\upsilon = E_i - E_f$ (ii) Six spectral lines can be emitted. $\left.\begin{array}{l}4 \rightarrow 1\\ 3 \rightarrow 1\\ 2 \rightarrow 1\end{array}\right\}$ Lyman series $\left.\begin{array}{l}4 \rightarrow 2\\ 3 \rightarrow 2\end{array}\right\}$ Balmer series $4 \rightarrow 3$ Paschen series	1 ½ ½	

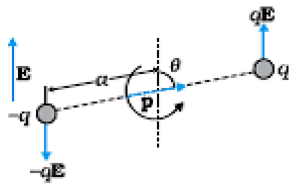
	[**NOTE:**Award this ½ mark if the student identifies any one of the three series correctly.) OR de Broglie relation ½ Condition for standing waves ½ Relation for r_n 1 Wavelength associated with electron in its orbit is given by de- Broglie relation $\lambda = \frac{h}{p} = \frac{h}{mv_n}$ Only those waves survive which form standing waves. For electron moving in n^{th} circular orbit of radius r_n $2\pi r_n = n\lambda$; n=1,2,3…. $\therefore 2\pi r_n = \frac{nh}{m\vartheta_n}$ or $r_n = \frac{nh}{2\pi m\vartheta_n}$	 ½ ½ ½ ½	2 2
Set1,Q7 Set2,Q10 Set3,Q9	Name of 'X' 1 Function of repeater 1 'X' is a transducer. A repeater is a combination of a receiver and a transmitter. [A repeater picks up the signal from the transmitter , amplifies and transmits it to the receiver sometimes with a change in carrier frequency .Repeaters are used to extend / increase the range of a communication system.]	 1 1	 2

Set1,Q8 Set2,Q6 Set3,Q10	Energy of photon ½ de-Broglie relation ½ KE of electron ½ Desired relation ½ Energy of photon $E = h\nu = \frac{hc}{\lambda} \Longrightarrow \frac{h}{\lambda} = \frac{E}{c}$ de Broglie wavelength of electron $\lambda = \frac{h}{p}$ Kinetic energy of electron, $K = \frac{p^2}{2m}$ $= \frac{h^2}{2m\lambda^2}$ $= \left(\frac{h}{2m\lambda}\right)\left(\frac{h}{\lambda}\right)$ $= \left(\frac{h}{2m\lambda}\right)\left(\frac{E}{c}\right)$ $\Longrightarrow E = \left(\frac{2mc\lambda}{h}\right)K$	½ ½ ½ ½	2
Set1,Q9 Set2,Q7 Set3,Q6	Polarized light ½ Unpolarized light ½ Intensity dependent on orientation ½ Percentage of intensity transmitted ½ If the direction of vibration of electric field vector/plane of vibration of electric field vector ,does not change with time, the light is polarized. Whereas, if the direction of vibration of electric field vector/plane of vibration of electric field vector changes randomly in very short intervals of time / with time, the light is unpolarised. **(<u>Alternatively:</u>** 	½ ½ ½	

	**Unpolarised**) Yes, it depends upon orientation of Polaroid because electric field vibrations , that are not in the direction of pass axis of Polaroid, are absorbed. Hence , intensity changes. (**<u>Alternatively</u>** , $$I = I_0 cos^2\theta$$ θ = angle between vibrations in light and axis of polaroid sheet) $I = I_0 cos^2 60^o = \frac{I_0}{4}$ $\Rightarrow \frac{I}{I_0} \times 100 = \frac{1}{4} \times 100 = 25\%$	½ ½ ½	2
Set1,Q10 Set2,Q8 Set3,Q7	Resistance of the two rod combination ½+ ½ Calculation of potential difference 1 $R_1 = \rho \frac{l}{A}$ $R_2 = \rho \frac{2l}{A/2} = 4R_1$ $I = \frac{V}{R_1} = \frac{V_2}{R_2}$ $\Longrightarrow \frac{V}{R_1} = \frac{V_2}{4R_1}$ $\Longrightarrow V_2 = 4V$	½ ½ ½ ½	2
	SECTION C		
Set1,Q11 Set2,Q19 Set3,Q16	(a) Definition , Vector form and direction of torque ½+ ½ (b)Effect of non uniform field 1 (c) Effect of increasing field 1 a. $\tau = pE \sin\theta$; $\theta =$ angle between dipole moment($\vec{p}$) and electric field($\vec{E}$) $\vec{\tau} = \vec{p} \times \vec{E}$	½	

Direction of torque is perpendicular to the plane containing $\vec{p}$ and $\vec{E}$ given by right hand screw rule. ½

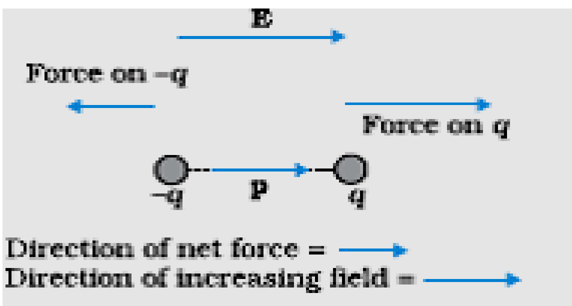
(Alternatively,



Direction of torque is out of the plane of the paper.) ½

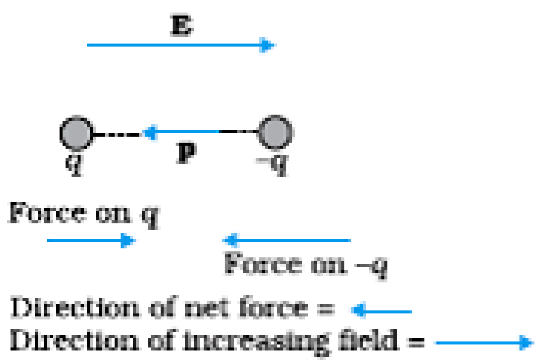
b. If the field is non uniform the net force on the dipole will not be zero. There will be translatory motion of the dipole. 1

c.(i) Net force will be in the direction of increasing electric field.



½

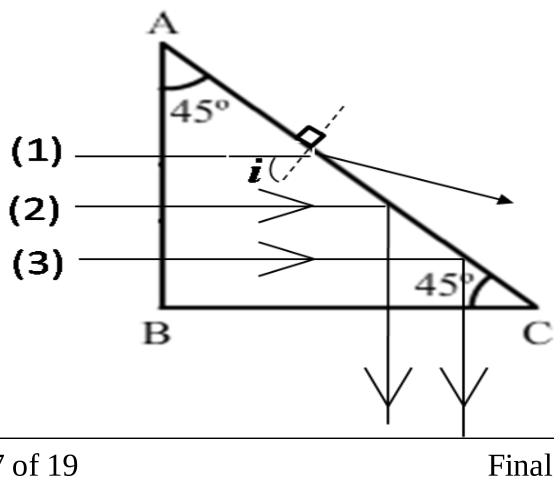
(ii)Net force will be in the direction opposite to the increasing field.[or in the direction of decreasing field]



½

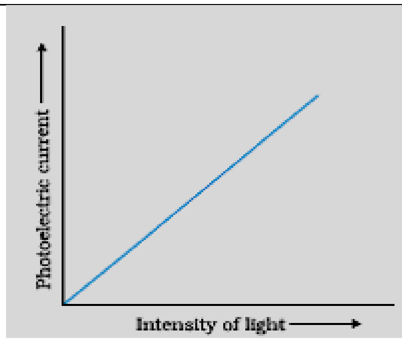
3

Set1,Q12 Set2,Q20 Set3,Q17	(a) Nature and direction of path ½+½ (b) Nature of path ½ (c) Direction and magnitude of electric field 1 ½		
	a. The charge q describes a circular path ; anticlockwise in XY plane.	½+ ½	
	b. The path will become helical.	½	
	c. Direction of Lorentz magnetic force is –Y	½	
	∴ Applied electric field should be in +Y direction .		
	$F_E = F_m$	½	
	$\Longrightarrow qE = qvB$	½	
	$\Rightarrow E = vB$		3
Set1,Q13 Set2,Q21 Set3,Q18	(i) Highest frequency segment ½ Production of waves ½ One use of waves ½ (ii) Segment near high frequency end of visible ½ One use of this segment ½ Its harmful effect ½		
	(i) γ rays.	½	
	Produced in nuclear reactions and emitted by radioactive decay of nucleus.	½	
	Used in medicine to destroy cancer cells.	½	
	(ii) Ultra violet rays	½	
	Used in LASIK eye surgery , UV lamps to kill germs in water purifier (any one use or any other)	½	
	Causes sunburn / skin cancer / harms eyes when exposed to direct UV rays (any one)	½	3
Set1,Q14 Set2,Q22 Set3,Q19	Lens formula ½ Image distance for L_1 1 Object distance for L_2 ½ Focal length of L_2 1		

	For L_1 $$\frac{1}{v_1}-\frac{1}{u_1}=\frac{1}{f_1}$$ $$\Rightarrow \frac{1}{v_1}=\frac{1}{20}-\frac{1}{15}=-\frac{1}{60}$$ $$\Rightarrow v_1=-60\ cm$$ For lens L_2 u = (-20 – 60)cm = - 80 cm v = 80 cm $\therefore |u|=|v|$ = 2 f_2 $\Rightarrow f_2=\frac{80}{2}=40\ cm$	½ 1 ½ ½ ½	3
Set1,Q15 Set2,Q11 Set3,Q20	Condition for TIR ½ Value of μ for TIR 1 Conclusion for rays 1,2,3 1 Ray diagram ½ i = 45^0 (on face AC) For TIR $i > i_c$ $\Rightarrow \sin i > \sin i_c$ $\Rightarrow \frac{1}{\sin i} < \frac{1}{\sin i_c}$ $\Rightarrow \mu > \frac{1}{\sin i}$ $\because \mu=\frac{1}{\sin i_c}$ $\mu > \sqrt{2}$ = 1.414 for TIR $\therefore$ Ray (1) is refracted from AC And rays (2) and (3) are internally reflected. 	½ 1 1 ½	3

Set1,Q16 Set2,Q12 Set3,Q21	(i) Working principle of solar cell 1 Three basic processes 1 (ii) Why Si and GaAs are preferred materials? 1 (i) When solar cell is illuminated with light photons of energy $(h\nu)$greater than the energy gap (E_g) of the semiconductor , then electron hole pairs are generated due to absorption of photons. The three basic processes involved in the generation of emf : (a) generation of e-h pairs due to light (with $h\nu > E_g$) close to the junction ; (b) separation of electrons and holes due to electric field of the depletion region (c) the electrons reaching the n side are collected by the front contact and holes reaching p side are collected by back contact, (ii) Solar radiation has maximum intensity of photons of energy = 1.5eV Hence semiconducting materials Si and GaAs , with band gap ≈ 1.5 eV , are preferred materials for solar cells.	1 1 1	3
Set1,Q17 Set2,Q13 Set3,Q22	Energy stored in 12μf capacitor 1 Energy stored in 3 μf capacitor 1 ½ Total energy drawn from battery ½ (i) $E = \frac{1}{2}CV^2 = \frac{6}{2} \times 10^{-6}V^2 = 3 \times 10^{-6}V^2$ $\therefore V^2 = \frac{E}{3\times10^{-6}}$ Energy stored in 12μf capacitor $= \frac{1}{2}CV^2$ $= \frac{1}{2} \times 12 \times 10^{-6} \times \frac{E}{3\times10^{-6}}$ = 2E (ii) Charge on 6μf capacitor, $Q_1 = \sqrt{2EC}$ $\left[\because E = \frac{1}{2}\frac{Q^2}{C}\right]$ $= 2\sqrt{3E} \times 10^{-3}C$ Charge on 12μf capacitor, $Q_2 = \sqrt{2CE}$ $= \sqrt{2 \times 12 \times 10^{-6} \times 2E}$	½ ½ ½	

	$= 4\sqrt{3E}10^{-3}C$ Charge on 3 μf capacitor, Q = Q_1+ Q_2 $= 6\sqrt{3E}10^{-3}$ Energy stored in 3 μf capacitor = $\frac{1}{2}\frac{Q^2}{C}$ = $\frac{1}{2}\frac{36\times3E\times10^{-6}}{3\times10^{-6}}$ = 18E **(Alternatively:** **(**ii) capacitance of parallel combination = 18 μf Charge on parallel combination, Q = CV = 18 x $10^{-6}V$ Charge on 3 μf = Q = 3 x $10^{-6}V_1$ (=)18 x $10^{-6}V$ = 3 x $10^{-6}V_1$ (=)$V_1 = 6V$ ∴ Energy stored in 3 μf capacitor = $\frac{1}{2}CV_1^2$ $=\frac{1}{2}\times 3\times 10^{-6}\times\frac{E\times36}{3\text{ x }10^{-6}}$ = 18 E) (iii) Total energy drawn = E + 2E + 18E = 21E	½ ½ ½ ½ ½ ½	3
Set1,Q18 Set2,Q14 Set3,Q11	(i) Definition of activity 1 (ii) Derivation 2 (i) Number of radioactive nuclei decaying per second at any time. (ii) $R_1 = \lambda_1 N_1 = \frac{0.693}{T_1}N_1$ $R_2 = \lambda_2 N_2 = \frac{0.693}{T_2}N_2$ $\frac{R_1}{R_2} = \frac{N_1}{N_2}\times\frac{T_2}{T_1}$	 1 ½ ½ 1	3
Set1,Q19 Set2,Q15 Set3,Q12	Graph of photocurrent with intensity 1 Numerical 2 (i)		



1

(ii)Energy of a photon $E = \frac{hc}{\lambda}$ Joule

$$= \frac{hc}{e\lambda} \; eV$$

½

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{1.6 \times 10^{-19} \times 3.3 \times 10^{-7}} \text{ eV}$$

$$= 3.75 \text{ eV}$$

½

Since W_0 of M_0 is greater than E, ∴ M_0 will not give photoemission. ½

There will be no effect of bringing source closer in the case of M_0.In case of Na, photocurrent will increase. ½ ½

3

OR

Definition of cut off frequency	1
Finding ratio $\frac{v_1}{v_2}$	2

Cut off frequency : It is that maximum frequency of incident radiation below which no photo emission takes place from a photo electric material. 1

(Alternatively, That minimum frequency of incident radiation at which photons are just emitted with zero kinetic energy.**)**

$$K_{max} = hf - W_0$$ ½

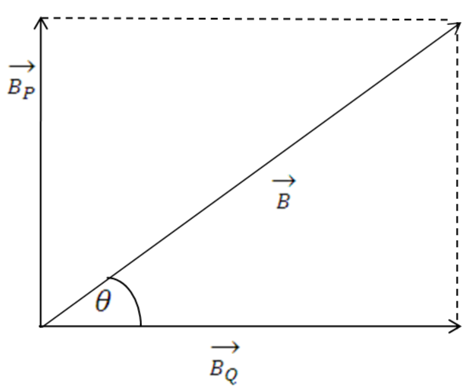
$$\frac{1}{2} m{v_1}^2 = 2hf - hf = hf$$ ½

$$\frac{1}{2} m{v_2}^2 = 5hf - hf = 4hf$$ ½

$$\therefore \frac{{v_1}^2}{{v_2}^2} = \frac{1}{4}$$

$$\Rightarrow \frac{v_1}{v_2} = \frac{1}{2}$$ ½

3

Set1,Q20 Set2,Q16 Set3,Q13	Distinction between point to point and broadcast ½+ ½ Example of each ½+ ½ Mobile telephony 1 (a) In point to point communication mode , communication takes place over a link between a single transmitter and a receiver. In broadcast mode , there are a large number of receivers corresponding to a single transmitter. Examples : Point to point : telephony Broadcast : radio / Television (b) The service area is divided into a suitable number of hexagonal cells centered on MTSO (Mobile Telephone Switching Office). Each cell contains a low-power transmitter called a base station and caters to a large number of mobile receivers / cell phones.When a mobile receiver crosses one base station it is handed over to another base station . It is called handover or handoff.	½ ½ ½ ½ 1	3
Set1,Q21 Set2,Q17 Set3,Q14	Vector diagram ½ Expression for magnetic field ½ +½ Magnitude of resultant field 1 Direction ½  (**Alternatively**: The student may just write the directions of $\overrightarrow{B_p}$, $\overrightarrow{B_Q}$ and the resultant field.)	½	

	$B_p = \frac{\mu_0}{4\pi}.\frac{2\pi I}{R}$ $B_Q = \frac{\mu_0}{4\pi}.\frac{2\pi(\sqrt{3}I)}{R}$ $B = \sqrt{{B_P}^2 + {B_Q}^2}$ $= \frac{\mu_0}{4\pi}.\frac{2\pi I}{R}\sqrt{1+3}$ $= \frac{\mu_0 I}{R}$ $\tan\theta = \frac{B_p}{B_Q} = \frac{1}{\sqrt{3}}$ $\Rightarrow \theta = 30^0$	½ ½ ½ ½ ½	3
Set1,Q22 Set2,Q18 Set3,Q15	(i) Definition and unit ½ + ½ (ii) Formula – Magnetic field inside solenoid ½ Formula – Induced emf in loop ½ Calculation of induced emf in loop 1 (i) Self inductance is the amount of magnetic flux linked with a coil when a unit current flows through it. **(Alternatively ,** It is the amount of emf induced in a coil when current through it changes at the rate of 1 A per second.) S.I. unit : henry(H) (ii) Magnetic field inside the solenoid , $B = \mu_0$n I Induced emf in the loop , $\epsilon = \frac{d\phi_B}{dt}$ $= A\frac{dB}{Dt}$ $= \mu_0 nA\frac{dI}{dt}$ $= 4\pi \times 10^{-7} \times 1500 \times 2 \times 10^{-4} \times \frac{(4-2)}{0.1}$V $= 7.5 \times 10^{-6}\ V$	½ ½ ½ ½ 1	3

SECTION D

Set1,Q23 Set2,Q23 Set3,Q23				

(i)	Values displayed (any two)	½ + ½
	Inculcation of these values	1
(ii)	Function of amplifier	1
(iii)	Name of device	1

(i)	Inquisitive , loving , scientific temperament (or any other two values)	½ + ½	
	By encouraging students to ask questions . By giving them tasks / projects and allowing students to use different media to find the solution to the given task, (any other)	½ + ½	
(ii)	It is a device which produces an amplified copy of the signal.	1	
(iii)	Transistor.	1	4

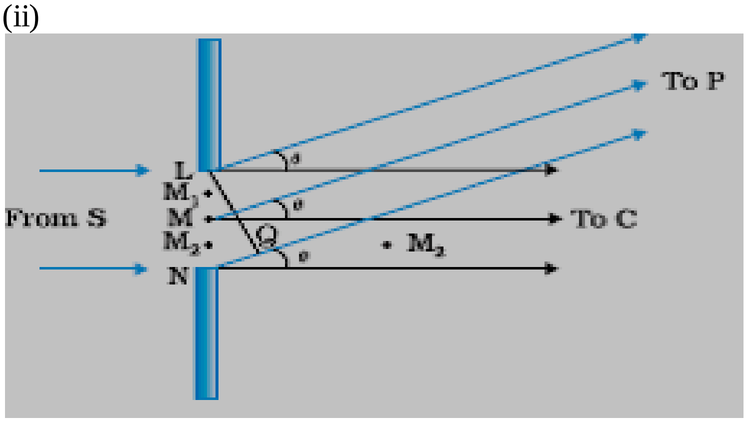
SECTION E

Set1,Q24
Set2,Q26
Set3,Q25

(i)	Condition for diffraction	½
(ii)	Diagram and explanation of fringe pattern	1+1½
(iii)	Derivation of width of central maxima	1
(iv)	Effect on size and intensity of central maxima	½ + ½

(i) Size of slit / aperture must be smaller than of the order of wavelength of light. ½

(ii)



1

Single slit diffraction is explained by treating different parts of the wavefront at the slit as sources of secondary wavelets. ½

At the central point C on the screen , θ is zero . All path differences are zero and hence all the parts of the slit contribute in phase and give maximum intensity at C.

At any other point P , the path difference between two edges of the slit is

$NP - LP = NQ$

$$= a\ sin\theta \ \approx a\theta$$

Any point P , in direction θ , is a location of minima if $a\theta = n\lambda$

This can be explained by dividing the slit into even number of parts. The path difference between waves from successive parts is 180^0 out of phase and hence cancel each other leading to a minima. ½

Any point P , in direction Q , is a location of maxima if $a\theta = \left(n + \frac{1}{2}\right)\lambda$

This can be explained by dividing the slit into odd number of parts. The contributions from successive parts cancel in pairs because of 180^0 phase difference .The unpaired part produces intensity at P , leading to a maxima. ½

(iii)If θ is the direction of first minima , then $a\theta = \lambda \ \Rightarrow \theta = \frac{\lambda}{a}$

Angular width of central maxima = 2 θ

$$= \frac{2\lambda}{a}$$ ½

Linear width of central maxima , $\beta = 2\theta.D$

$$= \frac{2\lambda D}{a}$$ ½

(iv) If ‘a’ is doubled , β becomes half ½

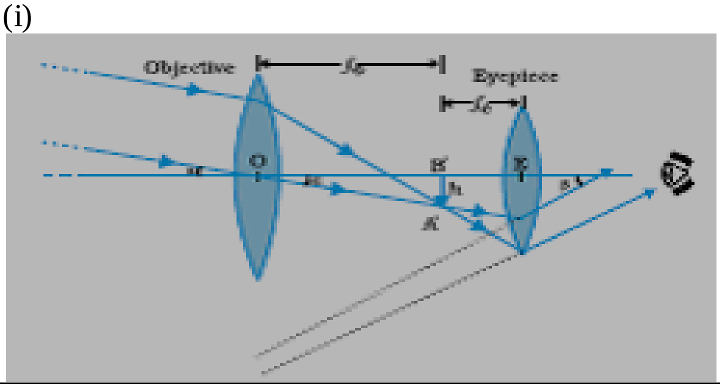
Intensity becomes 4 times. ½

5

OR

Diagram of telescope	2
Two aberration	½+ ½
Overcoming aberrations	½+ ½
Expression for resolving power and change	½+ ½

(i)



2

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<td>(ii) Spherical aberration . It can be corrected by using parabolic mirror objective.
Chromatic aberration. By using mirrors instead of spherical lenses because mirrors do not suffer from chromatic aberration.

(iii) $RP = \frac{a}{0.61\lambda}$

On increasing aperture ‘a’ , RP also increases.</td>
<td>½+ ½

½+ ½

½

½</td>
<td>5</td>
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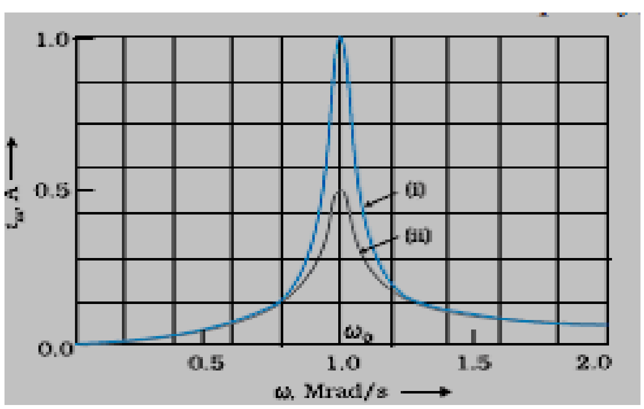
<tr>
<td>Set1,Q25
Set2,Q24
Set3,Q26</td>
<td>

(i)	Frequency at maximum current	1
	Name of frequency	½
(ii)	Maximum current	1
(iii)	Graph	1
(iv)	Definition of sharpness of resonance	1
	Condition	½

(i) $\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{8\times2\times10^{-6}}}$ =250 rad / s **or** $\boldsymbol{f_0 = \frac{\omega_0}{2\pi} = \frac{125}{\pi}\ Hz}$

Resonant frequency

(ii) $I_{max} = \frac{V_0}{R} = \frac{200}{100}A = 2A$
(iii)



(iv) $\frac{\omega_0}{2\Delta\omega}$ is measure of sharpness of resonance , where ω_0 is the resonant frequency and $2\Delta\omega$ is the bandwidth.</td>
<td>1

½

1

1

1</td>
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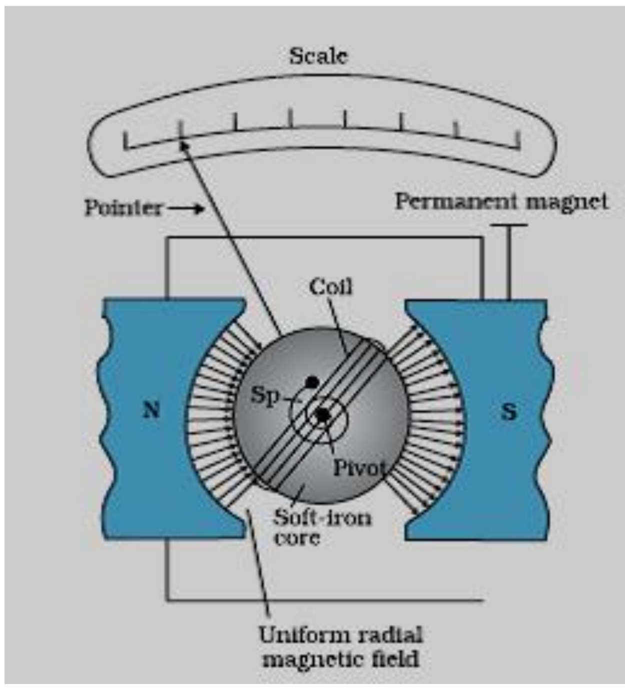
Circuit is more selective if it has greater value of sharpness / The circuit should have smaller band width $\Delta\omega$. ½ 5

OR

(i)	Principle , diagram , theory of galvanometer	½+1+1 ½
(ii)	Function of radial field , its production	½ + ½
(iii)	Current sensitivity , how it is increased	½ + ½

(i) A current carrying loop experience a torque in a magnetic field. ½



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Torque on the current coil , $\tau = NIAB \sin 90^0$ (in radial field) ½

Counter torque provided by the spring $= k\phi$ where ϕ is the deflection of the coil and k is torsional constant of the spring. ½

At equilibrium ,

$$k\phi = NIAB$$
$$\Rightarrow \phi = \left(\frac{NAB}{K}\right) I$$ ½

(ii)Radial field makes the scale of galvanometer linear or $I \propto \phi$ ½
It is produced by making pole pieces of the magnet cylindrical in shape. ½

(ii) Current sensitivity is defined as current per unit deflection. ½
Current sensitivity is increased by increasing the number of turns N. ½ 5

Set1,Q26
Set2,Q25
Set3,Q24

(i)	Calculation of R	2 ½
(ii)	Preference of potentiometer over voltmeter	1
(iii)	Circuit diagram	1 ½

(i) Current through AB

$$I = \frac{\mathcal{E}_1}{R + R_{AB}} = \frac{2}{R + 15}$$

½

P.D. across AB, $V_{AB} = IR_{AB}$

$$= \left(\frac{2}{R + 15}\right).15$$

½

Potential gradient $k = \frac{V_{AB}}{AB} = \frac{30}{(R+15)\times 100}$

$$= \frac{0.3}{R + 15}$$

½

Balance length for cell E_2 (= 75mV) , $l = \frac{E_2}{k}$

$$\Rightarrow 30 = \frac{75 \times 10^{-3}(R + 15)}{0.3}$$

½

$$\Rightarrow \frac{9 \times 10^3}{75} = R + 15$$

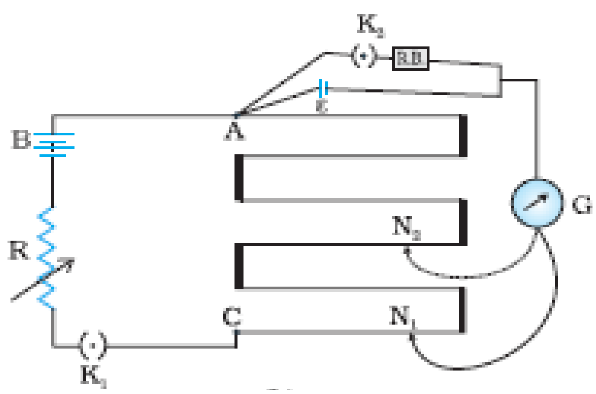
$$\Rightarrow R = 105\ \Omega$$

½

(ii) A potentiometer is preferred over a voltmeter because potentiometer does not draw current for any measurement unlike a voltmeter. 1

(Alternatively, Potentiometer compares the emf values while the voltmeter would only compare the terminal p.d.'s of the two cells.)

(iii)



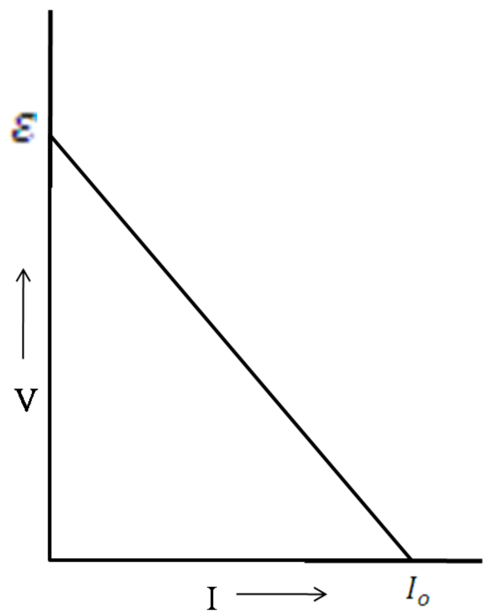
1 ½

5

OR

(i)	Graph of V vs I	1
	Emf	½
	Internal resistance	½
(ii)	Diagram	1
	Derivation of E	1
	and Internal resistance	1

(i)



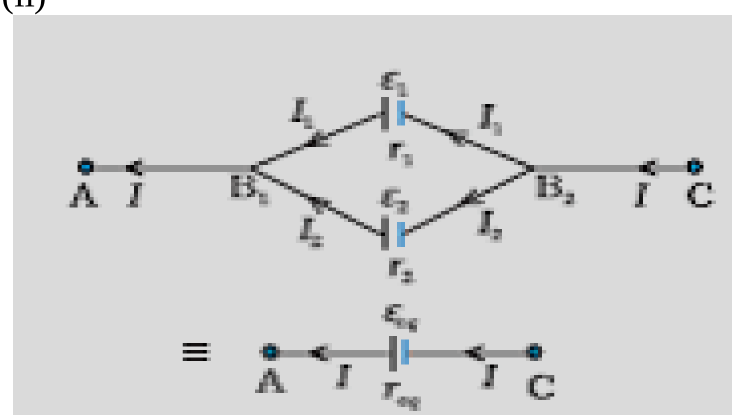
1

$V = \varepsilon - Ir$

When current is zero (I=0) , V= ϵ ½

And when V=0 , I =I_0 , $r = \frac{\epsilon}{I_0}$ ½

(ii)



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	$V = V(B_1) - V(B_2) = \varepsilon_1 - I_1 r_1$ $V = V(B_1) - V(B_2) = \varepsilon_2 - I_2 r_2$ $I = I_1 + I_2$ $= \frac{\varepsilon_1 - V}{r_1} + \frac{\varepsilon_2 - V}{r_2} = \left(\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}\right) - V\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$ $V = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2} - I\frac{r_1 r_2}{r_1 + r_2}$ On comparing with $V = \varepsilon_{eq} - I\, r_{eq}$ we get $\varepsilon_{eq} = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}$ $r_{eq} = \frac{r_1 r_2}{r_1 + r_2}$ **(Alternatively** , a student may write the last two results in the following form. $\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2}$ $\frac{\varepsilon_{eq}}{r_{eq}} = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}$)	½ ½ ½ ½	5