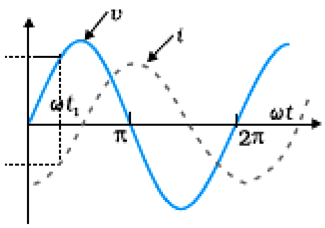
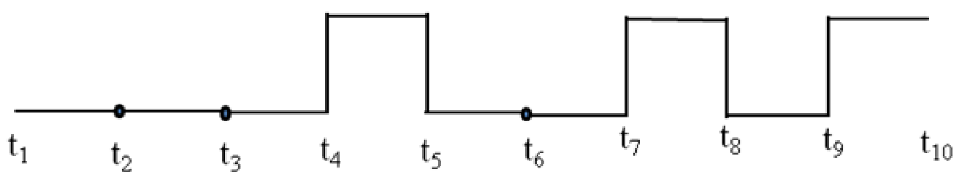
MARKING SCHEME

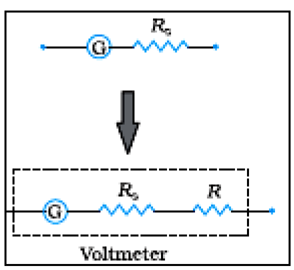
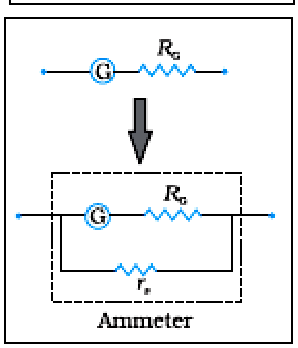
SET 55/1/E

Q. No.	Expected Answer / Value Points	Marks	Total Marks
	(SECTION A)		
Set1,Q1 Set2,Q5 Set3,Q2	Potentiometer 'Q' will be preferred Reason:- $Sensitivity \propto \frac{1}{potential\ \ gradient\ (k)}$ Since potential gradient is less, sensitivity is more. [Note: Also accept if the student just writes that potential gradient is less for potentiometer Q]	½ ½	1
Set1,Q2 Set2,Q3 Set3,Q1	 Graph of V Graph of I	½ ½	1
Set1,Q3 Set2,Q2 Set3,Q4	 [Note: If students write truth table correctly then award ½ mark.]	1	1
Set1,Q4 Set2,Q4 Set3,Q5	For a.c. source, circuit is complete due to the presence of displacement current in the capacitor. For steady dc, there is no displacement current, therefore, circuit is not complete. [Alternatively, Capacitive reactance $X_c = \frac{1}{2\pi f C} = \frac{1}{\omega C}$ So, capacitor allows easy path for a.c. source. For d.c, f= 0, so X_c = infinity, So capacitor blocks d.c]	½+½ ½+½	1
Set1,Q5 Set2,Q1 Set3,Q3	Conductivity of a conductor is the current flowing per unit area per unit electric field applied. [Alternatively, conductivity $\sigma = \frac{J}{E}$]	½	

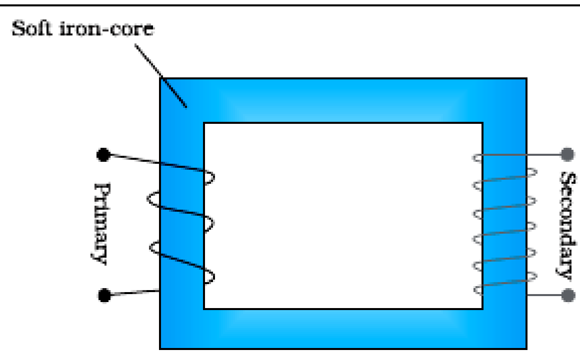
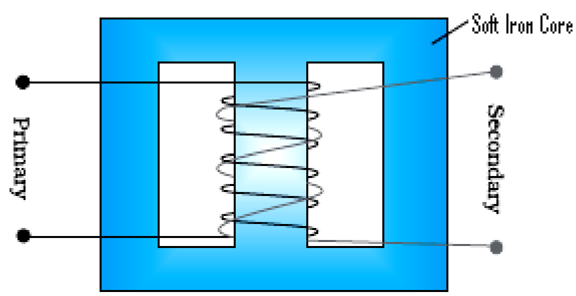
	Depends upon number density i.e. nature of material, and relaxation time i.e. temperature.	½	1
	(SECTION B)		
Set1,Q6 Set2,Q8 Set3,Q7	Derivation of expression for work done 2 Work done against the restoring torque $dw = \tau\, d\theta$ $dw = pE \sin\theta \, d\theta$ $\therefore, W = \text{pE} \int_{\theta 0}^{\theta 1} \sin\theta \, d\theta$ $= \text{pE} \cos\theta_0 - \cos\theta_1$	½ ½ ½ ½	2
Set1,Q7 Set2,Q9 Set3,Q6	de-Broglie wavelength ½ Condition of stationary orbits ½ Obtaining Bohr's Postulate of quantization of orbital angular momentum.1 de Broglie wavelength, $\lambda = \frac{h}{mv}$ For electron moving in the n^{th} orbit, $2\pi r = n\lambda$ $$\therefore 2\pi r = \frac{nh}{mv}$$ $\therefore$ mvr $= \frac{nh}{2\pi}$ = L (orbital angular momentum) This is Bohr's Postulate of quantization of orbital angular momentum.	½ ½ ½ ½	2
Set1,Q8 Set2,Q10 Set3,Q9	Explanation of the concept of Mobile Telephony ½ Explanation of working 1½ Concept of mobile telephony is to divide the service area into a suitable number of cells centred on an office MTSO (Mobile Telephone Switching Office) / Mobile telephony means that you can talk to any person from anywhere. <u>Explanation:</u> 1. Entire service area is divided into smaller parts called cells. 2. Each cell has a base station to receive and send signals to mobiles. 3. Each base station is linked to MTSO. MTSO co-ordinates between	½ ½ ½ ½	2

	base station and TCO (Telephone Control Office)		
Set1,Q9 Set2,Q7 Set3,Q10	Formula ½ Calculation ½ Longest Wavelength ½ Identification of Series ½ $$\frac{1}{\lambda_{max}} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$ The energy of the incident photon = 12.5 eV Energy of ground state = -13.6eV ∴, Energy after absorption of photon can be -1.1eV This means that electron can go to the excited state $n_i = 3$. It emits photons of maximum wavelength on going to $n_f = 2$ i.e. $$\frac{1}{\lambda_{max}} = \left\{\frac{1}{2^2} - \frac{1}{3^2}\right\} R$$ $$\lambda_{max} = \frac{36}{5R}$$ $$= \frac{36}{5\times1.1\times10^7}$$ $$= 6.555 \times 10^{-7}\text{m} = 6555\ A^{\circ}$$ It belongs to Balmer Series. [Note:- (1) If student just writes the formula $$\frac{1}{\lambda_{max}} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$ for the wavelength of different levels in the Hydrogen spectrum and calculates λ_{max} for any series, award full 3 marks. (2) Also award full 3 marks if the student writes that the energy of the excited state cannot be 12.5eV] OR Formula 1 Calculation 1	½ ½ ½ ½	

	$$v = \frac{nh}{2\pi mr}$$ And $r = \frac{1}{k}\frac{n^2h^2}{4\pi^2 me^2}$ So, $v = k\,\frac{2\pi e^2}{nh}$ In first excited state n = 2 So velocity $v_2 = \frac{2\pi ke^2}{2h}$ $= 1.09 \times 10^6$ ms^{-1} OR Velocity of electron, $v_n = \frac{1}{137}\frac{c}{n}$ In first excited state n =2 So velocity in first excited state (v_2) $= \frac{1}{137}\frac{c}{2}$ $= 1.09 \times 10^6$ ms^{-1}	½ ½ ½ ½ 1 ½ ½	 2
Set1,Q10 Set2,Q6 Set3,Q8	(i) How are infrared waves produced ½ One important use ½ (ii) Reason (any one) 1 (i) Infrared waves are produced by hot bodies and molecules. Important use(Any one) To treat muscular strains/ To reveal the secret writings on the ancient walls/ For producing dehydrated fruits/ Solar heater/ Solar cooker Ozone layer protects us from harmful U-V rays	 ½ ½ 1	 2
	(SECTION C)		
Set1,Q11 Set2,Q15 Set3,Q12	(i) Electric Flux through the shell 1 (ii) Statement of Law 1 (iii) Force on charge at C $^1/_2$ Force on charge at A $^1/_2$ (i) Electric flux through a Gaussian surface, $\varphi = \frac{total\ enclosed\ charge}{\epsilon_0}$	 ½	

	Net charge enclosed inside the shell q=0 ∴ Electric flux through the shell $\frac{q}{\epsilon_o}$=0 Award ½ mark even when the student writes - Electric flux through the shell is zero as electric field inside the shell is zero. (ii) Gauss Law- Electric flux through a Gaussian surface is $^1/_{\epsilon_0}$ times the net charge enclosed with in it. Alternatively, $\oint \vec{E}.\overrightarrow{dS} = \frac{q}{E_0}$ (iii) Force on the charge at the centre i.e. Charget $^Q/_2 = 0$ $F_A = \frac{1}{4\pi E_0} \frac{2Q \times (Q + {}^Q/_2)}{x^2}$ $= \frac{1}{4\pi E_0} \frac{3Q^2}{x^2}$	½ 1 ½ ½	3
Set1,Q12 Set2,Q13 Set3,Q21	How galvanometer is converted in to a voltmeter and an Ammeter ½ + ½ Diagram for conversion of galvanometer into a voltmeter and an Ammeter. ½ + ½ Resistance of each arrangement ½ + ½ A galvanometer is converted into a voltmeter by connecting a high resistance 'R' in series with it. A galvanometer is converted into an ammeter by connecting a small resistance (called shunt) in parallel with it.  	½ ½ ½ ½	

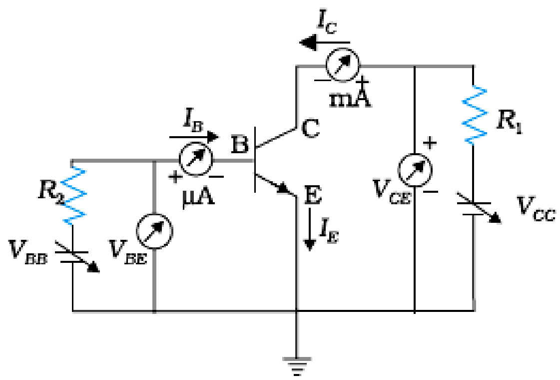
	Resistance of voltmeter, R_V = G + R Resistance for Ammeter, $R_A = \frac{G\,r_s}{G+r_s}$	½ ½	 3
Set1,Q13 Set2,Q14 Set3,Q17	(i) Total Internal Reflection (definition) ½ Conditions for T.I.R 1 (ii) Finding the relation between critical angle and Refractive Index 1 (iii) Phenomenon based on Total Internal Reflection ½ (i) When a ray of light travels from a denser medium into a rarer medium at an angle greater than the critical angle, it reflects back into the denser medium. This phenomenon is called total internal reflection. Conditions for total internal reflection (a) Light should travel from denser medium to rarer medium. (b) Angle of incidence should be greater than critical angle. (ii) $\frac{1}{\mu} = \frac{\sin i}{\sin r}$, for total internal reflection to occur $i \geq i_c$ at critical angle, angle of refraction $r = 90^\circ$, hence $\frac{1}{\mu} = \frac{\sin i_c}{\sin 90^\circ}$ $$\Rightarrow \mu = \frac{1}{\sin i_c}$$ (iii) Mirage/ sparkling of diamond/ optical fiber/ totally reflecting Prism/ shinning of air bubbles in water.(any one)	 ½ ½ ½ ½ ½ ½	 3
Set1,Q14 Set2,Q21 Set3,Q16	Global Positioning System 1 Brief explanation of the Working Principle 2 Global Positioning System is method of identifying location or position of any point or a person on earth using a system of 24 satellites, which are continuously orbiting, observing, monitoring and mapping the earth. <u>Working Principle:</u> (i) The unique location of GPS user is determined by measuring its distance from at least three GPS satellites. (ii) Using these values of distances, obtained from three satellites, a microprocessor, fitted in GPS device, determines the exact location.	 1 1 1	 3

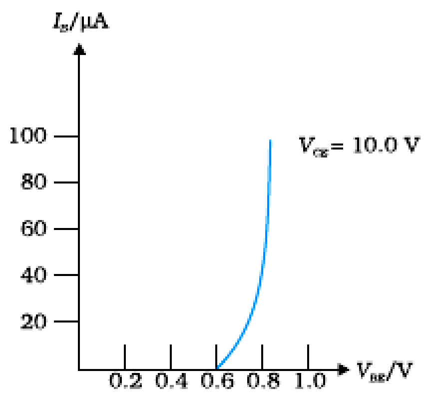
Set1,Q15 Set2,Q18 Set3,Q15	Formula for Activity 1 Calculation & result 2 Activity, R $= \lambda N$ $= \frac{0.693}{T_{1/2}} N$ Activity (R) = $\frac{0.693}{1.42\times10^{17}}$ x N Number of nuclei present in 1 gram sample of $^{238}_{92}U = 2503 \times 10^{20}$ $\Rightarrow R = \frac{0.693}{1.42\times10^{17}}$ x $\frac{6.0 \times 10^{26}}{238 \times 10^{3}}$ s^{-1} $= 1.23 \times 10^{4}$ s^{-1}	½ ½ ½ ½ ½ ½	3
Set1,Q16 Set2,Q20 Set3,Q19	Schematic arrangement ½ Principle ½ Relation between Primary and Secondary Voltages 1 Relation between currents in Primary and Secondary Coils 1  Alternatively,  When the current through the primary coil changes, the magnetic flux through	½	

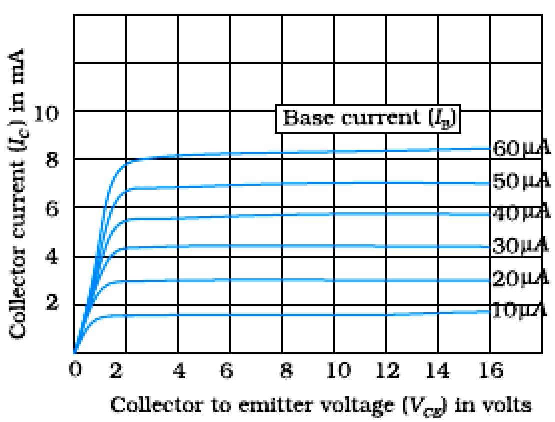
	the secondary changes. This produces an induced emf in the secondary coil/ it works on mutual induction. $\varepsilon_s = - N_s \frac{d\,\varphi}{dt}$ $\varepsilon_p = - N_p \frac{d\,\varphi}{dt}$ $\frac{\varepsilon_s}{\varepsilon_p} = \frac{N_s}{N_p}$ $i_s\ \varepsilon_s = i_p\ \varepsilon_p$ (for ideal transformer) $\frac{i_s}{i_p} = \frac{\varepsilon_p}{\varepsilon_s}$	½ ½ ½ ½ ½	3
Set1,Q17 Set2,Q19 Set3,Q11	(a) Formula ½ Calculation & result ½+½ (b) Formula ½ Calculation & result ½+½ (a) $\beta = \frac{\lambda D}{d}$ $= \frac{500 \times 10^{-9} \times 1}{10^{-3}}$ $= 0.5$ mm or 5 x 10^{-4}m (b) $\beta_0 = \frac{2\lambda D}{a} = 10\ \beta$ $a = \frac{2 \times 500 \times 10^{-9} \times 1}{10 \times 5 \times 10^{-4}}$ $a = 2\ \times 10^{-4}$ m or 0.2 mm	½ ½ ½ ½ ½ ½	3

<table>
<tr>
<td>Set1,Q18
Set2,Q11
Set3,Q13</td>
<td>

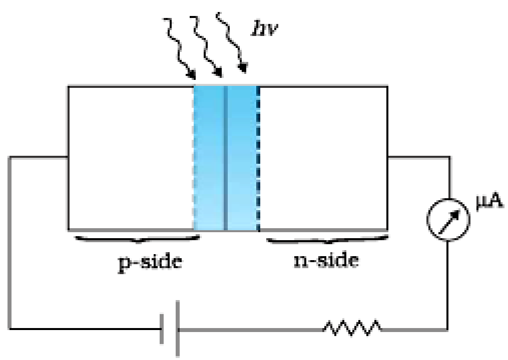
Circuit Diagram	1
Transistor action (brief explanation)	1
Shape of Input and output characteristics	½+½

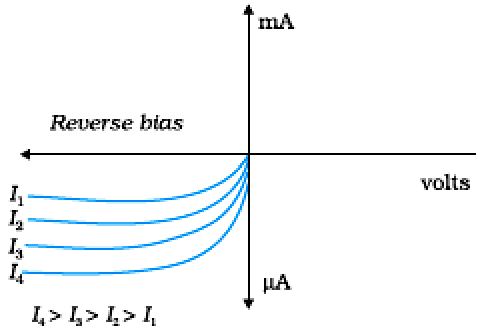
</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>


</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transistor works only when its emitter base junction is forward biased and collector emitter junction is reversed biased. Due to this the majority charge carriers from the emitter, accelerate to collector side and create I_e, I_b and I_c such that $I_e = I_b + I_c$</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>


</td>
<td>½</td>
<td></td>
</tr>
<tr>
<td></td>
<td>


</td>
<td>½</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</table>

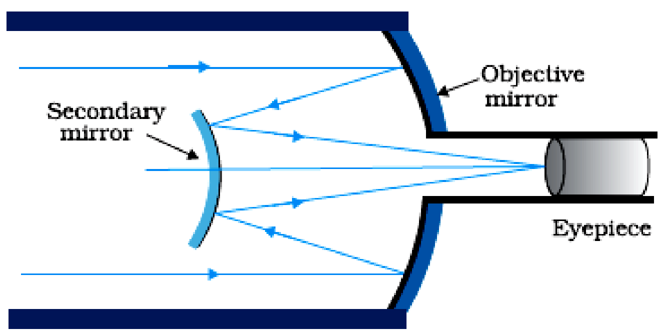
Set1,Q19 Set2,Q22 Set3,Q20	Identification of materials having same Intensity of incident radiation ½+½ Explanation ½ Identification of materials that correspond to different intensities. ½+½ Explanation ½		
	(1, 2) correspond to same intensity but different material.	½	
	(3, 4) correspond to same intensity but different material.	½	
	As saturation currents are same and stopping potentials are different.	½	
	(1, 3) correspond to different intensity but same material.	½	
	(2, 4) correspond to different intensity but same material.	½	
	As stopping potentials are same but saturation currents are different.	½	3
Set1,Q20 Set2,Q17 Set3,Q22	(i) Working with circuit diagram 1+1 (ii) Characteristics of a photodiode for different illumination intensities ½ (iii) Reason for operating photodiode in reverse bias ½		
	(i) 	½	
	(a) When light with energy $h\nu > (energy\ gap)\ E_g$ falls on photodiode, electron-hole pairs are generated.	½	
	(b) Due to electric field at the junction, electrons and holes are separated before they combine.	½	
	(c) Electrons are collected on n-side and holes are collected on p-side giving rise to an emf and current flows in external load.	½	

<table>
<tr>
<td></td>
<td>(ii)


(iii)It is easier to observe the change in the current, with change in the light intensity, when reverse bias is applied.</td>
<td>½

½</td>
<td>

3</td>
</tr>
<tr>
<td>Set1,Q21
Set2,Q16
Set3,Q14</td>
<td>(a) Ray diagram of reflecting telescope 2
(b) Advantages of reflecting type telescope over refracting telescope 1

(a)


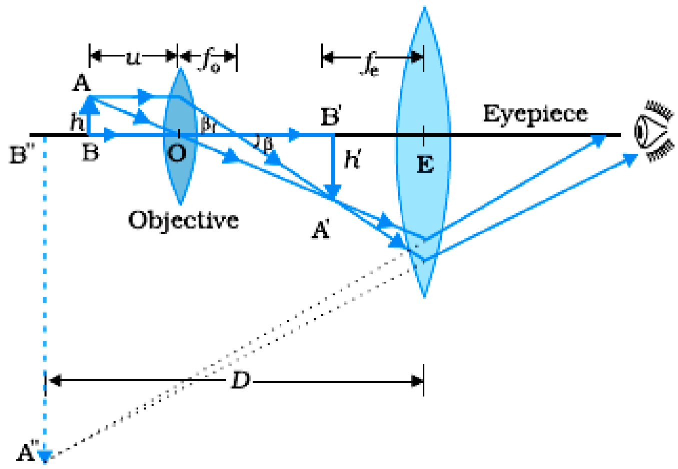
(b) <u>Advantages (any two)</u>

(i) There is no chromatic aberration in a mirror.
(ii) Brighter image
(iii) High resolving Power
(iv) Large light gathering power
(v) Large magnifying power

OR

(i) Ray diagram of a compound microscope 1½
(ii) Expression for resolving power of compound microscope. 1
How can resolving power of microscope be increased. ½</td>
<td>2

½+½</td>
<td></td>
</tr>
</table>

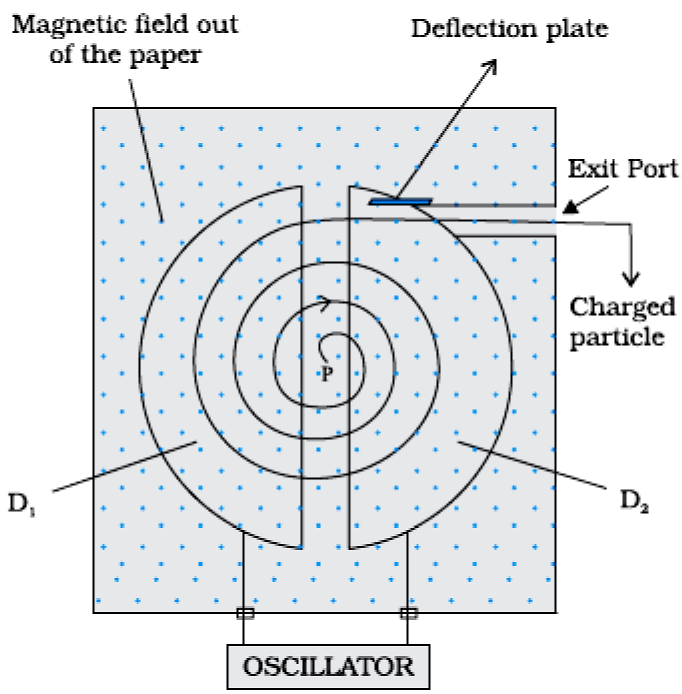
	(i)  Resolving power of compound microscope = $\frac{2\mu \sin\theta}{1.22\lambda}$ Resolving power can be increased by decreasing wavelength and by increasing refracting index of medium.	1½ 1 ½	3
Set1,Q22 Set2,Q12 Set3,Q18	Equivalent capacitance between Point A and B 2 Charge drawn from battery 1 $\because \frac{C_1}{C_2} = \frac{C_3}{C_4}$ This is the condition of balance so there will be no current across PR (50 µF capacitor) Now C_1 and C_2 are in series $C_{12} = \frac{C_1 C_2}{C_1 + C_2} = \frac{10\times20}{10+20} = \frac{200}{30} = \frac{20}{3}$ µF $\because$ C_3 and C_4 are in series $C_{34} = \frac{C_3 C_4}{C_3 + C_4} = \frac{5\times10}{5+10} = \frac{50}{15} = \frac{10}{3}$ µF Equivalent capacitance between A and B is $C_{AB} = C_{12} + C_{34} = \frac{20}{3} + \frac{10}{3} = 10$ µF	½ ½ ½ ½	

	Charge drawn from battery (q) = CV = 10 x 10 μC = 100 μC or 10^{-4}C	½ ½	 3
	(SECTION D)		
Set1,Q23 Set2,Q23 Set3,Q23	(a.) Reason of transportation of Power at high voltages 1 (b.) Explanation 1 (c.) Two values displayed by (i) Shiv ½ +½ (ii) Uncle ½ +½ (a) To reduce power losses in the transmission line. (b) Since power loss is inversely proportional to power factor ($P = VI\cos\varphi$ where $\cos\varphi$ is power factor). To supply a given power at a given voltage, if $\cos\varphi$ is small, we have to increase current accordingly. This will lead to large power loss (I^2R) in transmission / $(Effective\ Power = \frac{True\ Power}{\cos\varphi})$ (c) Values displayed by (i) Shiv – understanding nature/ respecting elders/ helping nature/ caring/ etc. (ii) Uncle– knowledgeable/ helping nature/ caring/ etc.(Any two each)	 1 1 ½+½ ½+½	 4
	(SECTION E)		

Set1,Q24
Set2,Q26
Set3,Q25

(i)	Labelled diagram of cyclotron	1
(ii)	Showing the independence of time period on speed and radius	1½
	Significance of the property	½
(iii)	Calculation of radius of path	2

(i)



1

[Note: Deduct ½ mark of this diagram, if the student does not show the labeling.]

$$\therefore \frac{mv^2}{r} = qvB$$ ½

$$r = \frac{mv}{qB}$$ ½

$$T = \frac{2\pi r}{v} = \frac{2\pi m}{qB}$$ ½

This shows that time period is independent of speed and radius of circular path.

<u>Significance:</u> Due to this, the charged particle remains in phase with frequency of the applied voltage in cyclotron ½

Alternatively,

Significance: The applied voltage is adjusted so that the polarity of dees is reversed in the same time that it takes the ion to complete one half of the revolution.
[Alternatively,
It helps in achieving resonance conduction.]

(ii) $r = \frac{mv}{qB} = \frac{\sqrt{2mqV}}{qB}$ ½

$r = \frac{\sqrt{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19} \times 100}}{1.6 \times 10^{-19} \times 0.004}$ m ½

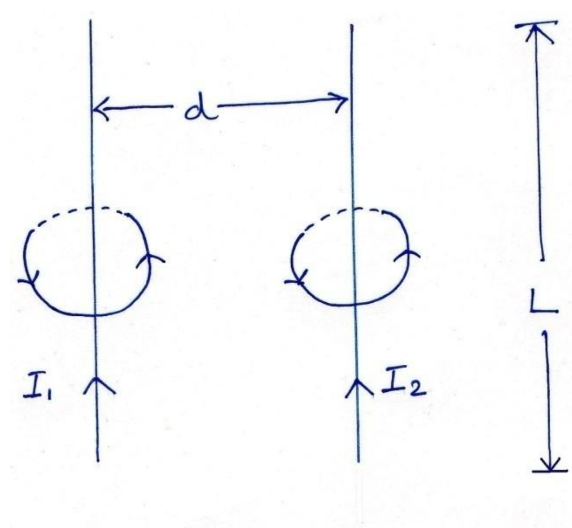
$r = \frac{5.4 \times 10^{-24}}{6.4 \times 10^{-22}}$ m ½

$r = 8.4 \times 10^{-3}$ m ½ 5

OR

(i)	Magnetic field lines due to straight, long, parallel conductors	1
(ii)	Expression for magnetic field produced	½
	Expression for force per unit length	1
(iii)	Direction of this force	½
(iv)	Direction of movement/ rotation of loop	½
	Reason for the same	1½

(i)



½ +½

(ii) $B_1 = \frac{\mu_0 I_1}{2\pi d}$ or $\frac{\mu_0 I_2}{2\pi d} = B_2$ ½

$$F = F_{12} = F_{21} = I_1 B_2 L = I_2 B_1 L$$ ½

$$= \left(\frac{\mu_0 I_1 I_2}{2\pi d}\right) L$$

Force per unit length

$\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi d}$ ½

(iii) Attractive force ½

(iv) Loop ABCD will move towards wire PQ. ½

Current in wire PQ and Current in arm AD are in the same direction, so they attract each other. ½

Current in wire PQ and Current in arm BC are in opposite direction, so they repel each other. ½

Contribution due to current in AB and CD nullify each other.

Since arm AD is nearer than arm BC to arm PQ, so net force on the loop is attractive. Therefore, the loop will move towards the wire PQ. ½ 5

Set1,Q25
Set2,Q24
Set3,Q26

(a)	Explanation	2
(b)	Diagram	1
	Explanation	½
	Proof of relation $\mu = \tan i_\beta$	1

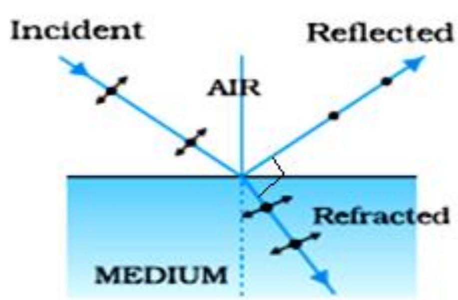
(a) When unpolarized light passes through a polariser, vibrations perpendicular to the axis of the polaroid are blocked. ½

Unpolarised light have vibrations in all directions. ½

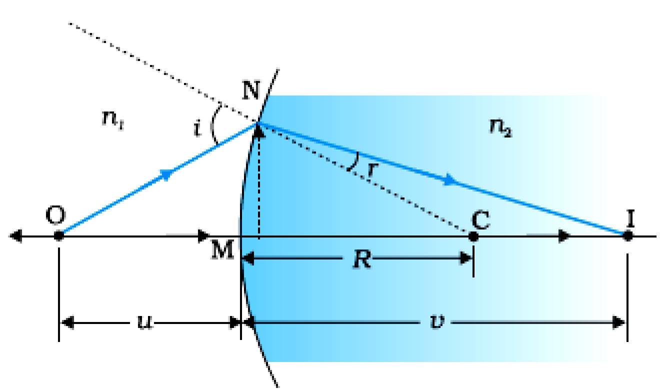
Hence, if the Polariser is rotated, the unblocked vibrations remain same with reference to the axis of Polariser ½

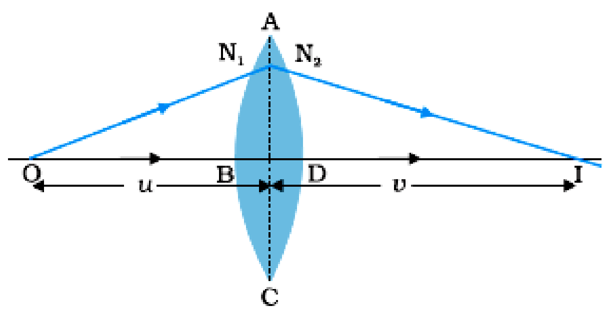
Hence for all positions of Polaroid, half of the incident light always get transmitted. Hence, the intensity of the light does not change. ½

(b)



1

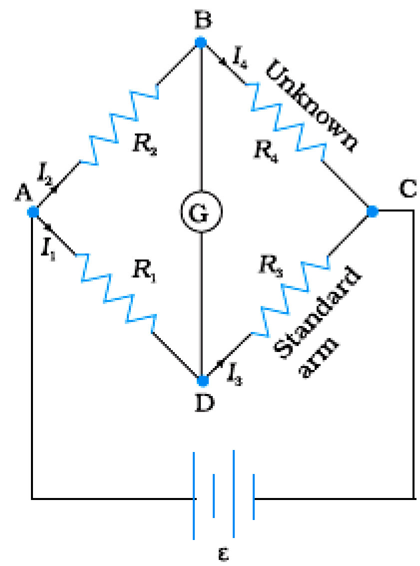
	When angle of incidence(i) is equal to the polarising angle(i_β), the reflected light is totally plane polarised. [<u>Alternatively</u>: When the refracted ray is perpendicular to the reflected ray, the reflected light is totally plane polarised.]	½	
	From $\mu = \frac{\sin i}{\sin r}$	½	
	For i=i_β, r = 90-i_β	½	
	So, $\mu = \frac{\sin i_\beta}{\sin(90-i_\beta)}$ $= \frac{\sin i_\beta}{\cos i_\beta}$		
	$\mu = \tan i_\beta$	½	5
	OR		
	(a) Derivation — 2 (b) Lens makers formula – derivation — 1½ Diagram — ½ (c) Focal length of the lens — ½ Explanation — ½		
	(a) 	½	
	$i = \frac{MN}{OM} + \frac{MN}{MC}$	½	
	$r = \frac{MN}{MC} - \frac{MN}{MI}$	½	

	$n_1 i = n_2 r$		
	$\frac{n_1}{OM} + \frac{n_2}{MI} = \frac{n_2 - n_1}{MC}$		
	$OM = -u, MI = +v, MC = +R$		
	$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$	½	
	(b) Applying above relation to refraction of light through a convex lens ABCD		
		½	
	For interface ABC $\frac{n_2}{v_1} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1}$	½	
	For interface ADC $\frac{n_1}{v} - \frac{n_1}{v_1} = \frac{n_1 - n_2}{R_2}$	½	
	$\therefore \frac{n_1}{v} - \frac{n_1}{u} = (n_2 - n_1)(\frac{1}{R_1} - \frac{1}{R_2})$	½	
	or $\frac{1}{f} = (n_{21} - 1)(\frac{1}{R_1} - \frac{1}{R_2})$	½	
	(c) Focal length = distance of the pin from the mirror.		
	The rays from the object after refraction from lens should fall normally on the Plane mirror. So they retrace their path. Hence, rays must be originating from focus and thus distance of the pin from the plane mirror gives focal lenth of the lens.	½	5

Set1,Q26
Set2,Q25
Set3,Q24

(i)	Principle	1
	Circuit diagram	1
	Derivation	1
(ii)	Determination of value of R	1
	Determination of value of S	1

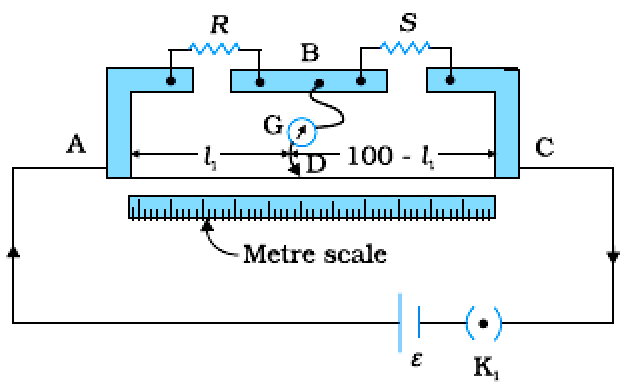
(i)



Let four resistors R_1, R_2, R_3 and R_4 be connected to form a quadilateral ABCD with a battery connected across A & C and a galvanometer between B & D. If galvanometer shows no deflection, then — 1

$$\frac{R_2}{R_1} = \frac{R_4}{R_3}$$

(ii)



1

If galvanometer shows no deflection

$$\frac{l_1}{(100 - l_1)} = \frac{R}{S}$$ ½

$$R = S\frac{l_1}{(100 - l_1)}$$ ½

(iii) As bridge is balanced

$$\frac{R}{S} = \frac{40}{60} = \frac{2}{3}$$ ½

Also, $\frac{R}{(\frac{30\,S}{30+S})} = \frac{50}{50} = 1$ ½

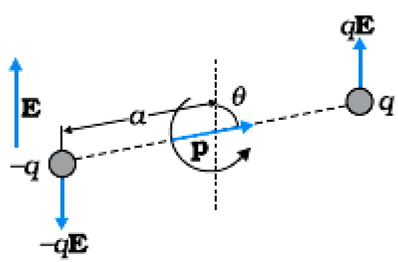
Solving, $R = 10\ \Omega$ ½

$S = 15\ \Omega$ ½ 5

OR

(a)	Expression for torque (derivation)	1½
	Direction of torque	½
	Expression in vector form	½
(b)	Proof $U(\theta) = -\vec{p}.\vec{E}$	1½
(c)	Work done	1

(a)



½

Magnitude of torque = magnitude of either force multiplied by the arm of the couple.

$= qE \times 2a \sin\theta$ ½

$= pE \sin\theta$ ½

Direction of torque is perpendicular to the plane containing $\vec{p}$ *and* $\vec{E}$. ½

	Vector form $\vec{\tau} = \vec{p} \times \vec{E}$ (b) Work done by external torque in rotating a dipole in uniform electric field is stored as the Potential energy of the system. $U(\theta_0 \rightarrow \theta) = W(\theta_0 \rightarrow \theta) = pE(\cos\theta_0 - \cos\theta_1)$ For $\theta_0 = \frac{\pi}{2}$ and $\theta_1 = \theta$ $U(\theta) = pE\left(\cos\frac{\pi}{2} - \cos\theta\right) = -pE\cos\theta = -\vec{p}.\vec{E}$ For rotating dipole from position of unstable equilibrium ($\theta_0 = 180^\circ$)to the stable equilibrium ($\theta = 0^\circ$) $\therefore W_{req} = pE(\cos 180^\circ - \cos 0^\circ)$ = pE (-1 -1) = -2pE	½ ½ ½ ½ ½ ½	 5