Strictly Confidential (For Internal and Restricted Use only)
Senior School Certificate Examination
Marking Scheme - Physics (Code 55/2/1, Code 55/2/2, Code 55/2/3)

1. The marking scheme provides general guidelines to reduce subjectivity in the marking. The answers given in the marking scheme are suggested answers. The content is thus indicated. If a student has given any other answer, which is different from the one given in the marking scheme, but conveys the meaning correctly, such answers should be given full weightage.
2. In value based questions, any other individual response with suitable justification should also be accepted even if there is no reference to the text.
3. Evaluation is to be done as per instructions provided in the marking scheme. It should not be done according to one's own interpretation or any other consideration. Marking scheme should be adhered to and religiously followed.
4. If a question has parts, please award in the right hand side for each part. Marks awarded for different part of the question should then be totaled up and written in the left hand margin and circled.
5. If a question does not have any parts, marks are to be awarded in the left hand margin only.
6. If a candidate has attempted an extra question, marks obtained in the question attempted first should be retained and the other answer should be scored out.
7. No marks are to be deducted for the cumulative effect of an error. The student should be penalized only once.
8. Deduct ½ mark for writing wrong units, missing units, in the final answer to numerical problems.
9. Formula can be taken as implied from the calculations even if not explicitly written.
10. In short answer type question, asking for two features / characteristics / properties if a candidate writes three features, characteristics / properties or more, only the correct two should be evaluated.
11. Full marks should be awarded to a candidate if his / her answer in a numerical problem is close to the value given in the scheme.
12. In compliance to the judgement of the Hon’ble Supreme Court of India, Board has decided to provide photocopy of the answer book(s) to the candidates who will apply for it along with the requisite fee. Therefore, it is all the more important that the evaluation is done strictly as per the value points given in the marking scheme so that the Board could be in a position to defend the evaluation at any forum.
13. The Examiner shall also have to certify in the answer book that they have evaluated the answer book strictly in accordance with the value points given in the marking scheme and correct set of question paper.
14. Every Examiner shall also ensure that all the answers are evaluated, marks carried over to the title paper, correctly totaled and written in figures and words.
15. In the past it has been observed that the following are the common types of errors committed by the Examiners
    - Leaving answer or part thereof unassessed in an answer script.
    - Giving more marks for an answer than assigned to it or deviation from the marking scheme.
    - Wrong transference of marks from the inside pages of the answer book to the title page.
    - Wrong question wise totaling on the title page.
    - Wrong totaling of marks of the two columns on the title page.
    - Wrong grand total.
    - Marks in words and figures not tallying.
    - Wrong transference to marks from the answer book to award list.
    - Answer marked as correct (√) but marks not awarded.
    - Half or part of answer marked correct (√) and the rest as wrong (×) but no marks awarded.
16. Any unassessed portion, non carrying over of marks to the title page or totaling error detected by the candidate shall damage the prestige of all the personnel engaged in the evaluation work as also of the Board. Hence in order to uphold the prestige of all concerned, it is again reiterated that the instructions be followed meticulously and judiciously.

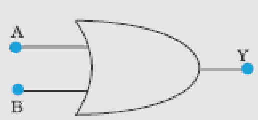
MARKING SCHEME

<table>
<tr><th>Q. No.</th><th>Expected Answer/ Value Points</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td></td><td>SECTION A</td><td></td><td></td></tr>
<tr><td>Set1 Q1</td><td>i) $V_A > V_B$
ii) $V_A < V_B$</td><td>½
½</td><td>1</td></tr>
<tr><td>Set1 Q2</td><td>Formula 1

$c = \frac{1}{\sqrt{\mu\epsilon}}$
[Alternatively,
$c = \frac{1}{\sqrt{\mu_0\mu_r\epsilon_0\epsilon_r}}$]</td><td>1</td><td>1</td></tr>
<tr><td>Set1 Q3</td><td>For writing yes ½
Justification ½

Yes
Justification: $m \, \alpha \, \frac{1}{f_0 f_e}$
And focal length depends on colour/μ.</td><td>½

½</td><td>1</td></tr>
<tr><td>Set1 Q4</td><td>Logic Symbol ½
Truth Table ½



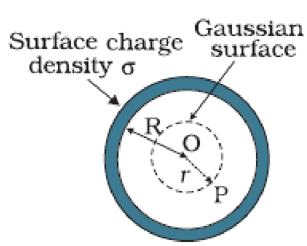
(a)
<table>
<tr><th colspan="2">Input</th><th>Output</th></tr>
<tr><th>A</th><th>B</th><th>Y</th></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
</table>
(b)</td><td>½

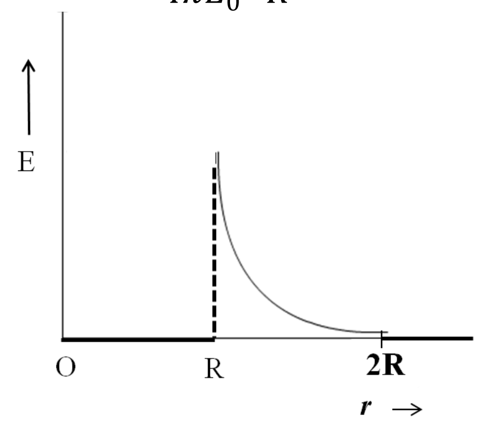
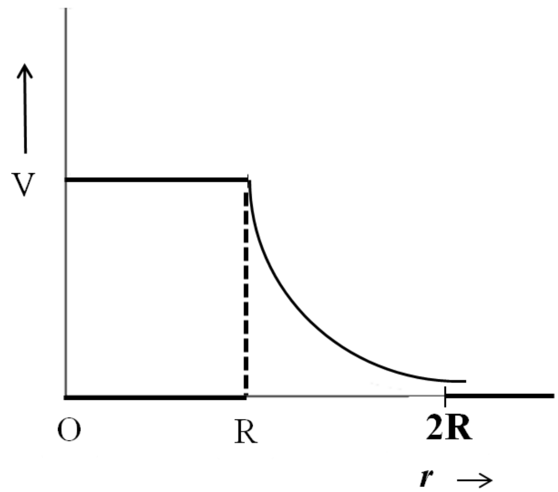
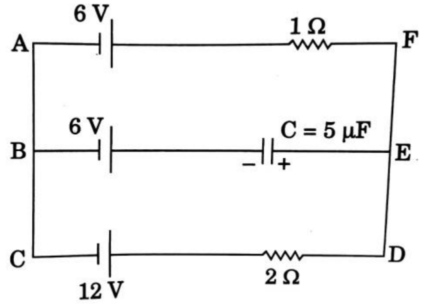
½</td><td>1</td></tr>
<tr><td>Set1 Q5</td><td>Writing Yes ½
Reason ½

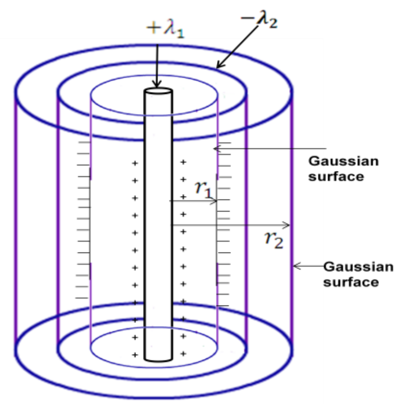
Yes
Reason - $v_{blue} > v_{red}$
[Alternatively:
Energy of blue light photon is greater than energy of red light photon.]</td><td>½
½</td><td>1</td></tr>
<tr><td></td><td>SECTION B</td><td></td><td></td></tr>
<tr><td>Set1 Q6</td><td>Conversion of phase difference to path difference ½
Formula for Intensity ½
Finding intensity values (½ + ½)</td><td></td><td></td></tr>
</table>

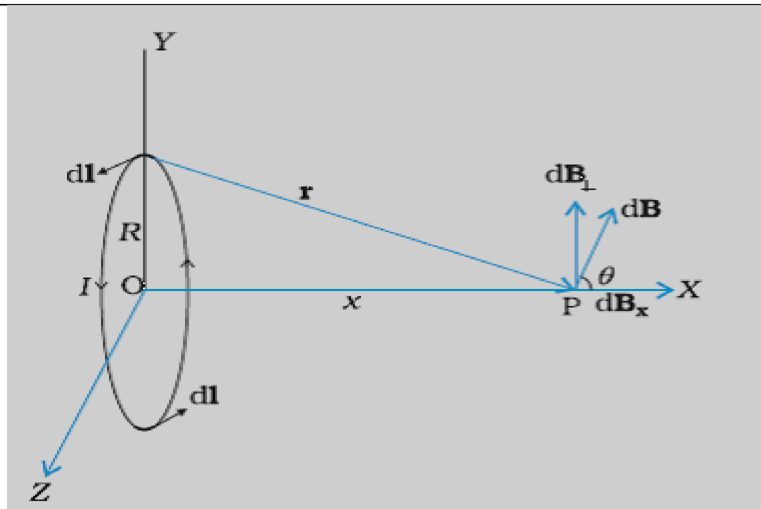
	Path difference $\lambda/4 \Rightarrow$ phase difference $\pi/2$ Path difference $\lambda/3 \Rightarrow$ phase difference $(2\pi/3)$ $$I = 4I_0 \cos^2\left(\phi/2\right)$$ i) $I_1 = 4I_0 \, X \, \frac{1}{2} = 2I_0$ ii) $I_2 = 4I_0 \, X \, \frac{1}{4} = I_0$	} ½ ½ ½ ½	2
Set1 Q7	Any two differences (1+1) **Any two** <table><tr><th>Intrinsic</th><th>Extrinsic</th></tr><tr><td>i) Pure semiconductor</td><td>i) Doped or impure</td></tr><tr><td>ii) $n_e = n_h$</td><td>ii) $n_e \neq n_h$</td></tr><tr><td>iii) Low conductivity at room temperature</td><td>iii)Higher conductivity at room temperature</td></tr><tr><td>iv)Conductivity depends on temperature</td><td>iv) Conductivity does not depend significantly on temperature.</td></tr></table>	**1+1**	**2**
Set1 Q8	Distinguishing the two nodes (½ + ½) One example of each (½ + ½) In point-to-point communication mode, communication takes place over a link between a single transmitter and a single receiver. In the broadcast mode, there are a large number of receivers corresponding to a single transmitter. Example: Point-to-point: telephone (any other) Broadcast: T.V., Radio (any other)	½ ½ ½ ½	**2**
Set1 Q9	Effect on brightness 1 Explanation 1 Brightness decreases Explanation:- Self inductance of solenoid increases; this increases the impedance of the circuit and hence current decreases . (Even if student just writes self inductance increases, award this 1 mark.)	**1** **1**	**2**

Set1 Q10	Formula ½ Image distance for $\|u\| \leq \|f + x\|$ ½ Image distance where $\|x\| \leq \|f\|$ 1		
	$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ (f is negative) U = -f $\Rightarrow \frac{1}{v} = 0 \Rightarrow v = \infty$ U = -2f $\Rightarrow \frac{1}{v} = \frac{-1}{2f} \Rightarrow v = -2f$ Hence if -2f < u < -f $\Rightarrow -2f < v < \infty$	½ ½ ½ ½	2
	[<u>Alternatively</u> $2f > u > f$ $-\frac{1}{2f} > -\frac{1}{u} > -\frac{1}{f}$ $\frac{1}{f} - \frac{1}{2f} > \frac{1}{f} - \frac{1}{u} > \frac{1}{f} - \frac{1}{f}$ $\frac{1}{2f} < \frac{1}{V} < 0$ 2f < V <∝]	½ ½ ½ ½	2
	OR		
	(a) Formula for magnification ½ Conditions for large magnification ½ (b) Any two reasons ½ + ½		
	(a) $m = -\frac{f_0}{f_e}$ By increasing f_0 / decreasing f_e	½ ½	
	(b) Any two (i) No chromatic aberration. (ii) No spherical aberration. (iii) Mechanical advantage – low weight, easier to support. (iv) Mirrors are easy to prepare. (v) More economical	½ + ½	2
	SECTION C		
Set1 Q11	a) Definition 1 Explanation ½ b) Determination of modulation index ½ Side bands (½ + ½)		
	a) $\mu = \frac{A_m}{A_c}$ $\mu \leq 1$ to avoid distortion of signal.	**1** ½	

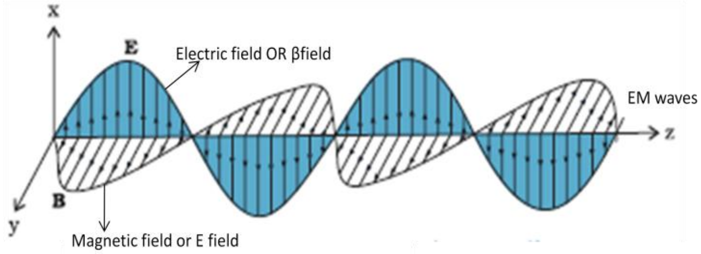
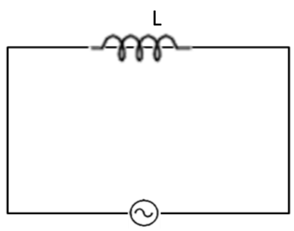
	b) $\mu = \frac{10V}{10V} = 1$ $v_c - v_m = (1000 - 10)kHz = 990kHz$ $v_c + v_m = (1000 + 10)kHz = 1010kHz$	½ ½ ½	3
Set1 Q12	Bohr quantum condition ½ Expression for Time period 2½ $mvr = \frac{nh}{2\pi}$ ---- Bohr postulate Also, $\frac{mv^2}{r} = \frac{1}{4\pi\epsilon_0}\frac{e^2}{r^2}$ $\Leftrightarrow mv^2 r = \frac{e^2}{4\pi\epsilon_0}$ $\therefore v = \frac{e^2}{4\pi\epsilon_0} X \frac{2\pi}{nh} = \frac{e^2}{2\epsilon_0 nh}$ $T = \frac{2\pi r}{v} = \frac{2\pi mvr}{mv^2}$ $= \frac{2\pi\left(\frac{nh}{2\pi}\right)}{m\left(\frac{e^2}{2\epsilon_0 nh}\right)^2}$ $= \frac{4n^3h^3\epsilon_0^2}{me^4}$ (Also accept if the student calculates T by obtaining expressions for both v and r.)	 ½ ½ ½ ½ ½ ½	3
Set1 Q13	Expression for electric field 1½ Expression for potential ½ Plot of graph (E $V_s r$) ½ Plot of graph (V V_s r) ½  By Gauss theorem $\oint \vec{E}.d\vec{s} = \frac{q}{E_0}$ q =0 in interval 0<x<R $\Longrightarrow E = 0$ E= $-\frac{dV}{dr}$	 ½ ½ ½ ½	

	$\Rightarrow V = constant = \frac{1}{4\pi E_0}\frac{Q}{R}$   [Even if a student draws E and V for 0<r<R award ½ + ½ mark.]	½ ½	3
Set1 Q14	Value of current 1 Value of voltage 1 Value of charge 1 		

	In loop ACDFA $I = \frac{12-6}{(1+2)} = 2A$ $V_{AF} = V_{BE}$ $\Longrightarrow 6 + 2 = 6 + V_c$ $\Longrightarrow V_c = 2V$ Charge Q=CV_c=$5\mu F\ X\ 2V = 10\mu C$	**1** ½ ½ **1**	**3**
Set1 Q15	Gauss's theorm ½ Diagram ½ Electric field between the cylinders 1 Electric field outside the cylinders 1 As Gauss's Law states $\oint \vec{E}\,.\,\overrightarrow{ds} = \frac{q}{\epsilon_0}$  (i) $\oint \overrightarrow{E_1}\,.\,\overrightarrow{ds} = \frac{\lambda_1 l}{\epsilon_0}$ $\Longrightarrow \overrightarrow{E_1} = \frac{\lambda_1}{2\pi\epsilon_0 r_1}\widehat{r_1}$ (ii)$\oint \overrightarrow{E_2}\,.\,\overrightarrow{ds} = \frac{(\lambda_1-\lambda_2)l}{\epsilon_0}$ $\Longrightarrow \overrightarrow{E_2} = \frac{(\lambda_1 - \lambda_2)}{2\pi\epsilon_0 r_2}\widehat{r_2}$	½ ½ ½ ½ ½ ½	**3**
Set1 Q16	Biot Savart's Law ½ mark Deduction of Expression 2 marks Direction of magnetic field ½ mark		

		½	
	$\overrightarrow{dB} = \frac{\mu_0}{4\pi} I \frac{\vec{dl} \times \vec{r}}{r^3}$ [OR $dB = \frac{\mu_0}{4\pi} \frac{Idl}{r^2}$]	½	
	Here $r^2 = x^2 + R^2$ dB= $\frac{\mu_0}{4\pi} \frac{I\, dl}{x^2 + R^2}$	½	
	$\sum dB_{\perp} = 0$	½	
	$dB_x = dB \cos\theta \quad where\ cos\theta = \frac{R}{(x^2+R^2)^{1/2}}$ $dB_x = \frac{\mu_0\, Idl}{4\pi} \quad \frac{R}{(x^2+R^2)^{\frac{3}{2}}}$	½	
	$\vec{B} = \int dB_x\, \hat{i} = \frac{\mu_0\, I\, R^2}{2(x^2+R^2)^{3/2}}\, \hat{\imath}$ Direction- Can be determined by right hand thumb rule. [Alternatively: By using vector form of Biot Savart law]	½	**3**
	OR (i) Magnitude of magnetic field at A — 1 Direction of magnetic field at A — ½ Magnitude of magnetic force on conductor 2 — 1 Direction of magnitude force on conductor 2 — ½	½	
	(i) $B_2 = \frac{\mu_0}{4\pi} \frac{2(3I)}{r} = \frac{\mu_0}{4\pi} \left(\frac{6I}{r}\right)$ into the plane of the paper/(⊗).	½	

	$B_3 = \frac{\mu_0}{4\pi}\frac{2(4I)}{3r} = \frac{\mu_0}{4\pi}\left(\frac{8I}{3r}\right)$ out of the plane of the paper/(⊙). $B_A = B_2 - B_3$ into the paper. $= \frac{\mu_0}{4\pi}\left(\frac{10I}{3r}\right)$ *into the paper*.(⊗) (ii) $F_{21} = \frac{\mu_0}{4\pi}\frac{2I\,(3I)}{r}$ away from wire1 (/towards 3) $F_{23} = \frac{\mu_0}{4\pi}\frac{2(3I)(4I)}{2r}$ away from wire 3 (towards 1) $F_{net} = F_{23} - F_{21}$ towards wire1 $= \frac{\mu_0}{4\pi}\frac{6(I)^2}{r}$ towards wire 1	½ ½ ½ ½	 **3**
Set1 Q17	Statement - 1 S.I Unit – ½ Formula- ½ Calculation of number of nuclei 1 (a) Statement : Rate of decay of a given radioactive sample is directly propotional to the total number of undecayed nuclei present in the sample. **[Alternatively:** $-\frac{dN}{dt} \propto N$ **]** Unit- becquerel(Bq) (b) $N = N_0 e^{-\lambda t}$ / $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$ $n = \frac{t}{T_{1/2}} = \frac{10}{20} = \frac{1}{2}$ $\Rightarrow N = 4\sqrt{2} \times 10^6 \times \left(\frac{1}{2}\right)^{1/2}$ $= 4\times 10^6$ nuclei	 **1** ½ ½ ½ ½	 **3**
Set1 Q18	(a) Explanation of production of em waves 1½ (b) Depiction of em waves 1½ (a) An oscillating charge produces an oscillating electric field in space, which produces an oscillating magnetic field, which in turn, is a source of oscillating electric field and so on. Thus, oscillating electric and magnetic fields generate each other, they then propagate in space.	 1½	

	[Alternatively, if a student writes Electromagnetic waves are produced by oscillating electric and magnetic fields / oscillating charges produce em waves. Award 1 mark **]**  	1½	**3**
Set1 Q19	Derivation of instantaneous current 2 Derivation of average power dissipated 1 Given $V = V_0 \sin wt$ $V = L\frac{di}{dt} \Rightarrow di = \frac{V}{L}dt$  $\boldsymbol{v = v_0 \sin wt}$ $\therefore di = \frac{V_0}{L} \sin wt\, dt$ Integrating $i = -\frac{V_0}{wL} \cos wt$ $\therefore i = -\frac{V_0}{wL} \sin(\pi/2 - wt) = I_0 \sin(\pi/2 - wt)$ where $I_0 = \frac{V_0}{wL}$ Average power $P_{av} = \int_0^T vidt$ $=\frac{-V_0^2}{wL} \int_0^T \sin wt \cos wt\, dt$ $=\frac{-V_0^2}{2wL} \int_0^T \sin(2\,wt)dt$ $=0$	½ ½ ½ ½ ½ ½	**3**

<table>
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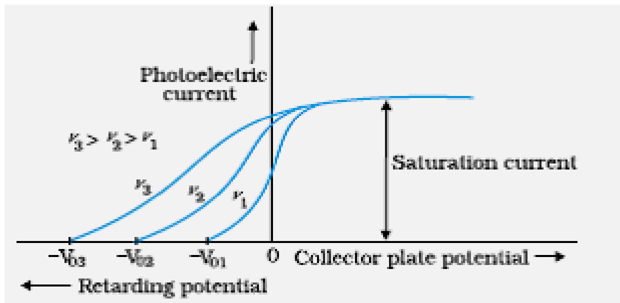
<tr>
<td>Set1 Q20</td>
<td>

a) Graph of photo current vs collector potential for different frequencies 1
b) Einstein's photo electric equation ½
Explanation of graph ½
c) Graph of photocurrent with collector potential for different intensities 1

(a)



(b) According to Einstein's photoelectric equation

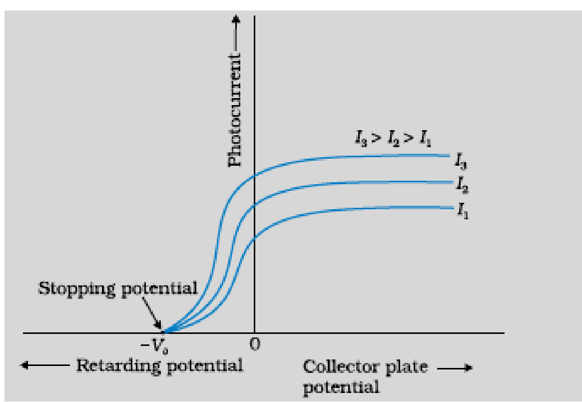
$$K_{max} = h\nu - \emptyset_0$$

If V_0 is stopping potential then

$$eV_0 = h\nu - \emptyset$$

Thus for different value of frequency(ν) there will be a different value of cut off potential V_0.

(c)



</td>
<td>1

½

½

1</td>
<td>3</td>
</tr>
<tr>
<td>Set1 Q21</td>
<td>

(a) Condition for charge going undeflected 1
(b) Formula for radius 1½
Calculation of radius ½

(a) The force experienced $\vec{F} = q(\vec{v}\ X\ \vec{B})$
The charge will go undeflected when $\vec{v}$ is parallel or

</td>
<td>½</td>
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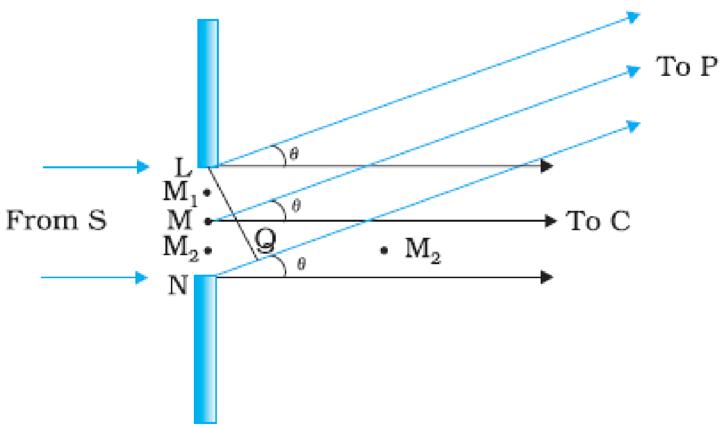
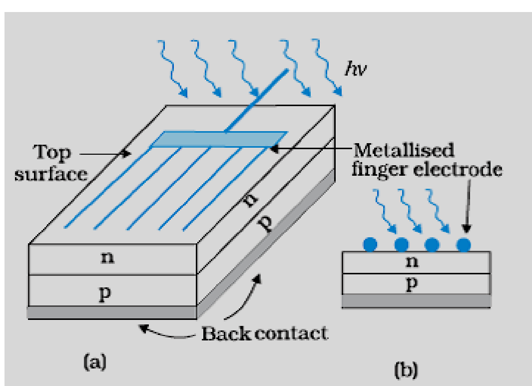
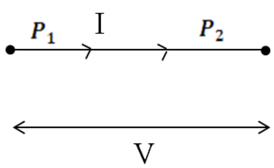
</table>

	antiparallel to $\vec{B} \because \vec{F} = 0$. **[**Alternatively**,** If $\vec{v}$ makes an angle of 0^0 or 180^0 with $\vec{B}$.**]** (b) The radius of electron $$eV = \frac{1}{2}mv^2$$ $$\frac{mv^2}{r} = qvB$$ $$\therefore r = \frac{1}{B}\sqrt{\frac{2mV}{e}}$$ $$= \left[\sqrt{\frac{2 X 9.1 X 10^{-31} X 10^4}{1.6 X 10^{-19}}} X \frac{1}{0.04}\right] m$$ $$= 8.4 X 10^{-3} m$$	½ ½ ½ ½ ½	 **3**
Set1 Q22	Diagram ½ Path Difference ½ Condition for minima ½ Condition for maxima ½ Width of central maxima ½ Width of secondary maxima ½  The path difference $NP - LP = NQ$ $= a \sin\theta \simeq a\theta$ By dividing the slit into an appropriate number of parts, we find that points P for which i) $\theta = \frac{n\lambda}{a}$ are points of minima. ii) $\theta = \left(n + \frac{1}{2}\right)\frac{\lambda}{a}$ are points of maxima	 ½ ½ ½ ½	

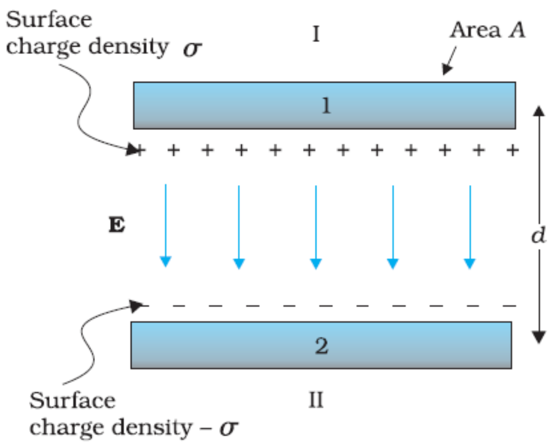
	Angular width of central maxima, $\theta = \theta_1 - \theta_{-1}$ $= \frac{\lambda}{a} - \left(-\frac{\lambda}{a}\right)$ $\theta = \frac{2\lambda}{a}$ Angular width of secondary maxima = $\theta_2 - \theta_1$ $= \frac{2\lambda}{a} - \frac{\lambda}{a} = \frac{\lambda}{a}$ $= \frac{1}{2}$ X Angular width of central maxima	½ ½	3
Set1 Q23	Values displayed 1 + 1 Usefulness of solar panels ½ Name of semiconductor device ½ Diagram of the device ½ Working of device ½ a) Value displayed by mother: Inquisitive / scientific temperament / wants to learn / any other. Value displayed by Sunil: Knowledgeable / helpful/ considerate b) Provide clean / green energy Reduces dependence on fossil fuels, Environment friendly energy source. c) Solar Cell  (full marks for any one figure out of a &b) **Working:** When light falls on the device the solar cell generates an emf.	1 1 ½ ½ ½ ½	4

Set1 Q24	a) (i) Principle of potentiometer 1 How to increase sensitivity ½ (ii) Name of potentiometer ½ Reason ½ b) Formula ½ (i) Ratio of drift velocities in series 1 (ii) Ratio of drift velocities in parallel 1		
	a) (i) The potential difference across any length of wire is directly proportional to the length provided current and area of cross section are constant i.e., $E(l) = \phi l$ where ϕ is the potential drop per unit length.	**1**	
	It can be made more sensitive by decreasing current in the main circuit /decreasing potential gradient / increasing resistance put in series with the potentiometer wire.	½	
	ii) Potentiometer B	½	
	Has smaller value of $V/_l$ (slope / potential gradient).	½	
	b) In series, the current remains the same.	½	
			
	$I = neA_1V_{d1} = neA_2V_{d2}$	½	
	$\therefore \frac{V_{d1}}{V_{d2}} = \frac{A_2}{A_1}$	½	
	In parallel potential difference is same but currents are different.		
	$V = I_1R_1 = neA_1V_{d1}\frac{\varrho l}{A_1} = ne\varrho V_{d1}l$	½	
	Similarly, $V = I_2R_2 = ne\varrho V_{d2}l$		
	$I_1R_1 = I_2R_2$ $\therefore \frac{V_{d1}}{V_{d2}}=1$	½	5
	OR		
	(a) Definition of capacitance 1 Obtaining capacitance 2 (b) Ratio of capacitances 2		
	a) Capacitance equals the magnitude of the charge on each plate needed to raise the potential difference between the plates by unity.	**1**	

OR

[The capacitance is defined as

$$c = \frac{q}{V}]$$



Consider parallel plates of area A

Plate separation d, the potential difference applied across it is V. The electric field

$$E = \frac{\sigma}{\epsilon_0} = \frac{q}{\epsilon_0 A}$$ ½

Electric field = potential gradient

$$\therefore E = \frac{V}{d}$$ ½

Hence, $\frac{V}{d} = \frac{q}{\epsilon_0 A}$ ½

$c = \frac{q}{V} = \frac{\epsilon_0 A}{d}$ ½

b) The capacitance without dielectric is

$$C_0 = \frac{\epsilon_0 A}{d}$$ ½

The capacitance of the capacitor, partially filled with dielectric constant K, thickness t is

$$c = \frac{\epsilon_0 A}{\left(d - t + {}^{t}/_{k}\right)}$$ ½

Given $t = \frac{3d}{4}$ $\therefore c = \frac{\epsilon_0 A}{d - \frac{3d}{4}}$

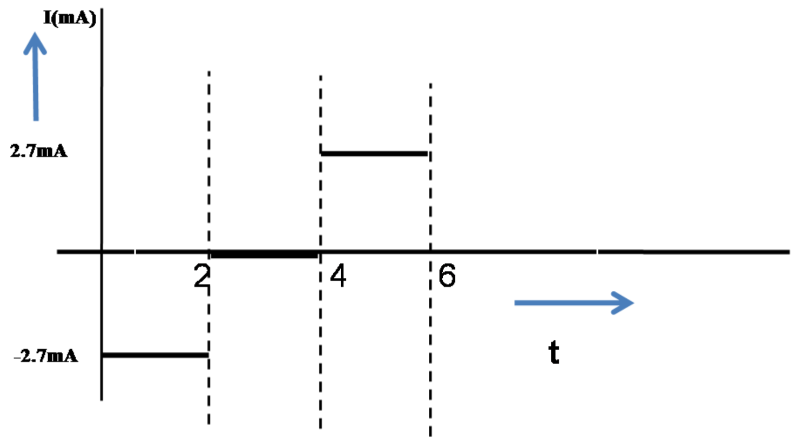
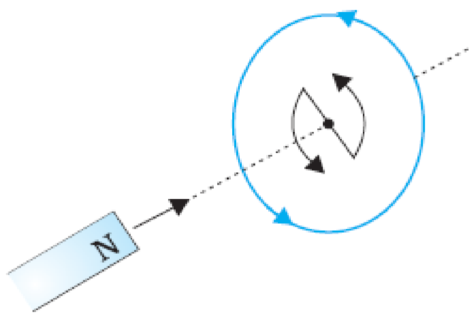
$$\therefore c = \left(\frac{4k}{k+3}\right)\frac{\epsilon_0 A}{d}$$ ½

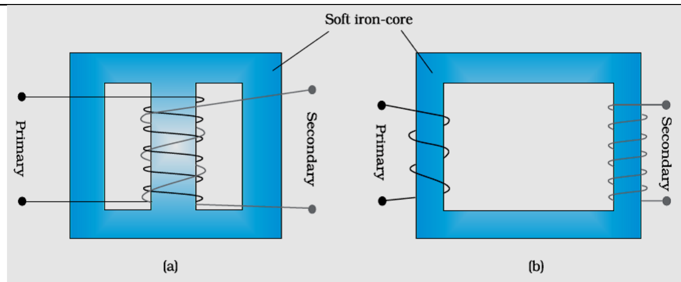
$$\therefore \frac{c}{c_0} = \frac{4k}{k+3}$$ ½

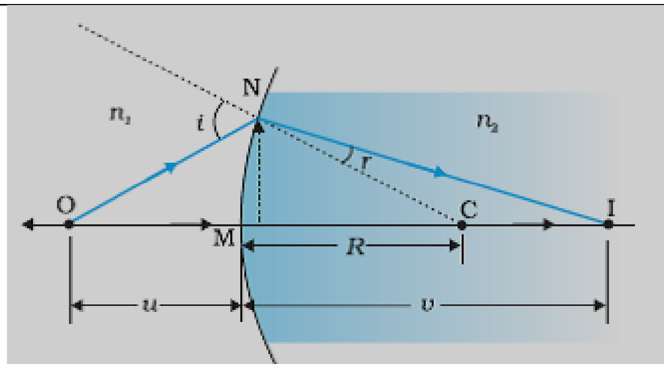
[Alternatively,

The capacitance, with dielectric, can be treated as a series

	combination of two capacitors. $C_1 = K\frac{\epsilon_0 A}{\left(\frac{3}{4}d\right)}$ $C_2 = \frac{\epsilon_0 A}{\left(\frac{1}{4}d\right)}$ $\therefore C = \frac{C_1C_2}{C_1+C_2} = \frac{\left(K\frac{\epsilon_0 A}{\left(\frac{3}{4}d\right)}\right)\left(\frac{\epsilon_0 A}{\left(\frac{1}{4}d\right)}\right)}{\frac{\epsilon_0 A}{d}\left[\frac{4}{3}k+4\right]}$ $= \frac{4}{(3+k)}\frac{\epsilon_0 A}{d} = \frac{4}{(3+k)}\ C_0$ $\frac{c}{c_0} = \frac{4}{k+3}$]	½ ½ ½ ½	5
Set1 Q25	a) Statement of Faraday's Law 1 b) Calculation of current 2 Graph of current 1 c) Lenz's Law 1 (a) Faraday's law: The magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit. [Alternately: $e = -\frac{d\emptyset}{dt}$] (b) Area=$\pi R^2 = \pi\ X\ 1.44\ X\ 10^{-2} m^2$ $= 4.5\ X\ 10^{-2} m^2$ For 0<t<2 Emf $e_1 = \frac{d\emptyset_1}{dt} = -A\frac{dB}{dt}$ $=-4.5\ X\ 10^{-2} X\ \frac{1}{2}$ $I_1 = -\frac{e_1}{R} = -\frac{2.25\ X\ 10^{-2}}{8.5} = -2.7\ mA$ For 2<t<4 $I_2 = \frac{e_2}{R} = 0$ For 4<t<6 $I_3 = -\frac{e_3}{R} = +2.7\ mA$	1 ½ ½ ½ ½	

		1	
	(c)  If a north pole of the bar magnet moves towards the coil the magnetic flux through the coil increases. Hence induced current is counter clockwise (to oppose the increase in flux, by producing a north pole.) In this situation the bar magnet experiences a repulsive force, therefore work has to be done to move the magnet towards the coil. It is this work that gets converted into electrical energy. **OR** a) Diagram ½ Principle ½ Relation between voltage, number of turns, and Currents 2 ½ (b) Input power ½ Output power ½ Output voltage ½	1	5

		½	
	Working principle		
	- Whenever current in one coil changes an emf gets induced in the neighboring coil /Principle of mutual induction	½	
	Voltage across secondary.		
	$$V_s = e_s = -N_s \frac{d\phi}{dt}$$	½	
	Voltage across primary		
	$$V_p = e_p = -N_p \frac{d\phi}{dt}$$	½	
	$\frac{V_s}{V_p} = \frac{N_s}{N_p}$ (here $N_s > N_p$)	½	
	In an Ideal transformer		
	Power Input= Power Input	½	
	$I_p V_p = I_s V_s$		
	$\frac{V_s}{V_p} = \frac{I_p}{I_s}$		
	$\therefore \frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$	½	
	(b) Input power, $P_i = I_i . V_i = 15 \times 100$	½	
	=1500 W	½	
	Power output, $P_0 = P_i \times \frac{90}{100} = 1350\ W$		
	$\Longrightarrow I_0 V_0 - 1350W$	½	**5**
	Output voltage, $V_0 = \frac{1350}{3} V = 450\ V$		
Set1 Q26	a) Diagram — 1 Derivation of the relation — 2 b) Lens Maker's formula – — ½ Calculation of f in water – — 1½		

		**1**	
	For small angles		
	tan $\angle NOM = \frac{MN}{OM}$: tan $\angle NCM = \frac{MN}{NC}$		
	and tan $\angle NIM = \frac{MN}{MI}$		
	For ΔNOC, i is exterior angle, therefore		
	i = $\angle NOM + \angle NCM = \frac{MN}{OM} + \frac{MN}{MC}$	½	
	Similarly r = $\frac{MN}{MC}$ - $\frac{MN}{MI}$	½	
	For small angles Snells law can be written as		
	n_1i = $n_2 r$		
	$\therefore \frac{n_1}{OM} + \frac{n_2}{MI} = \frac{n_2 - n_1}{MC}$	½	
	∴ OM= - u, MI = +v MC= +R (using sign conversion)		
	$\therefore \frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$	½	
	(b) Lens Maker's formula is		
	$$\frac{1}{f_a} = \left(\frac{n_2 - 1}{n_1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$	½	
	$$\therefore \frac{1}{20} = (1.6 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$		
	$$\therefore \left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{20 \times 0.6} = \frac{1}{12}$$	½	

Let f be the focal length of the lens in water

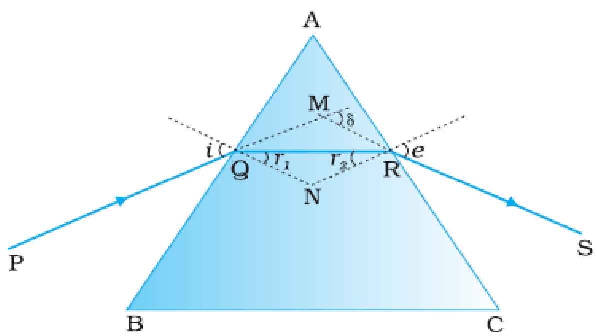
$$\therefore \frac{1}{f'} = \frac{1.6-1.3}{1.3}\left(\frac{1}{R_1}-\frac{1}{R_2}\right) = \frac{0.3}{12 \times 1.3}$$ ½

Or $f' = \frac{120 \times 1.3}{3} = 52cm$ ½ **5**

OR

(a)	Diagram	½
	Obtaining the relation	3
(b)	Numerical	1½

(a)



½

From fig $\angle A + \angle QNR = 180^0$------- (1) ½

From triangle ΔQNR $r_1 + r_2 + \angle QNR = 180^0$ --(2)

Hence from equ (1) &(2)

$$\therefore \angle A = r_1 + r_2$$ ½

The angle of deviation ½

$\delta = (i - r_1)$+(e-r_2)= i+e-A

At minimum deviation i=e and r_1=r_2

$$\therefore r = \frac{A}{2}$$ ½

And i$=\frac{A+\delta m}{2}$ ½

Hence refractive index

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin A/2}$$ ½

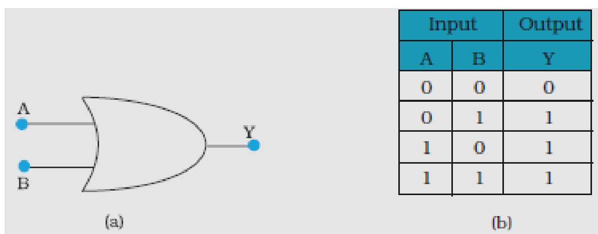
(b) From Snell's law $\mu_1 \sin i = \mu_2\, sinr$ ½

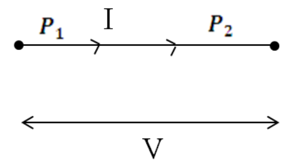
Given $\mu_1 = \sqrt{2}$, μ_2=1 and r= 90^0 (just grazing)

$\therefore \sqrt{2}$ sin i= 1 sin $90^0 \Longrightarrow \sin i\ \frac{1}{\sqrt{2}}$ ½ **5**

$$or\ i = 45^0$$ ½

MARKING SCHEME

Q. No.	Expected Answer/ Value Points	Marks	Total Marks
Q1	Writing Yes ½ Reason ½ Yes Reason - $v_{blue} > v_{red}$ **[**Alternatively: Energy of blue light photon is greater than energy of red light photon.**]**	 ½ ½	 **1**
Q2	Logic Symbol ½ Truth Table ½ 	 ½ ½	 **1**
Q3	i) $V_A > V_B$ ii) $V_A < V_B$	½ ½	**1**
Q4	Formula 1 $c = \frac{1}{\sqrt{\mu\epsilon}}$ **[**Alternatively, $c = \frac{1}{\sqrt{\mu_0\mu_r\epsilon_0\epsilon_r}}$ **]**	 **1**	 **1**
Q5	For writing yes ½ Justification ½ Yes Justification: $m \; \alpha \; \frac{1}{f_0 f_e}$ And focal length depends on colour/μ.	 ½ ½	 **1**
Q6	Ratio of drift velocities in series 1 Ratio of drift velocities in parallel 1 In series, the current remains the same.		

			
	$I = neA_1V_{d1} = neA_2V_{d2}$	½	
	$\therefore \frac{V_{d1}}{V_{d2}} = \frac{A_2}{A_1}$	½	
	In parallel potential difference is same but currents are different. $V = I_1R_1 = neA_1V_{d1}\frac{\varrho l}{A_1} = ne\varrho V_{d1}l$	½	
	Similarly, $V = I_2R_2 = ne\varrho V_{d2}l$ $I_1R_1 = I_2R_2$ $\therefore \frac{V_{d1}}{V_{d2}}$=1	½	2
Q7	Distinguishing the two nodes (½ + ½) One example of each (½ + ½)		
	In point-to-point communication mode, communication takes place over a link between a single transmitter and a single receiver.	½	
	In the broadcast mode, there are a large number of receivers corresponding to a single transmitter.	½	
	Example: Point-to-point: telephone (any other)	½	
	Broadcast: T.V., Radio (any other)	½	2
Q8	Formula ½ Image distance for $\|u\| \leq \|f + x\|$ ½ Image distance where $\|x\| \leq \|f\|$ 1		
	$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ (f is negative)	½	
	U = -f $\Rightarrow \frac{1}{v} = 0 \Rightarrow v = \infty$	½	
	U = -2f $\Rightarrow \frac{1}{v} = \frac{-1}{2f} \Rightarrow v = -2f$	½	
	Hence if -2f < u < -f $\Rightarrow -2f < v < \infty$	½	2
	[<u>Alternatively</u>		
	$2f > u > f$ $-\frac{1}{2f} > -\frac{1}{u} > -\frac{1}{f}$	½	
	$\frac{1}{f} - \frac{1}{2f} > \frac{1}{f} - \frac{1}{u} > \frac{1}{f} - \frac{1}{f}$	½	
	$\frac{1}{2f} < \frac{1}{V} < 0$	½	2

<table>
<tr><td></td><td>2f < V <∝]
OR
(a) Formula for magnification ½
Conditions for large magnification ½
(b) Any two reasons ½ + ½

(a) $m = -\frac{f_0}{f_e}$

By increasing f_0 / decreasing f_e

(b) Any two
(i) No chromatic aberration.
(ii) No spherical aberration.
(iii) Mechanical advantage – low weight, easier to support.
(iv) Mirrors are easy to prepare.
(v) More economical</td><td>½

½

½

½ + ½</td><td>2</td></tr>
<tr><td>Q9</td><td>Conversion of phase difference to path difference ½
Formula for Intensity ½
Finding intensity values (½ + ½)

Path difference ${}^{\lambda}/_{4} \Rightarrow$ phase difference ${}^{\pi}/_{2}$
Path difference ${}^{\lambda}/_{3} \Rightarrow$phase difference $(2\,{}^{\pi}/_{3})$
$$I = 4I_0 \cos^2\left({}^{\emptyset}/_{2}\right)$$
i) $I_1 = 4I_0 \; X \; \frac{1}{2} = 2I_0$

ii) $I_2 = 4I_0 \; X \; \frac{1}{4} = I_0$</td><td>} ½

½

½

½</td><td>2</td></tr>
<tr><td>Q10</td><td>Any two differences 1+1

Any two differences
<table><tr><th>S.no</th><th>n- type semiconductor</th><th>p- type semiconductor</th></tr><tr><td>1</td><td>Pentavalent impurity is added</td><td>Trivalent impurity is added</td></tr><tr><td>2</td><td>Electrons are the majority charge carrier/
($n_e \gg n_h$)</td><td>Holes are the majority charge carriers /
($n_h \gg n_e$)</td></tr><tr><td>3</td><td>New energy level formed near conduction band</td><td>New energy level formed near valence band.</td></tr></table></td><td>1+1</td><td>2</td></tr>
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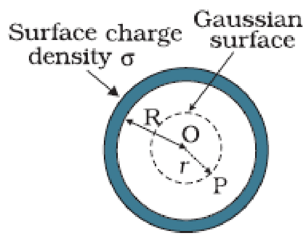
Q11

Expression for electric field	1½
Expression for potential	½
Plot of graph (E $V_s r$)	½
Plot of graph (V V_s r)	½



By Gauss theorem ½

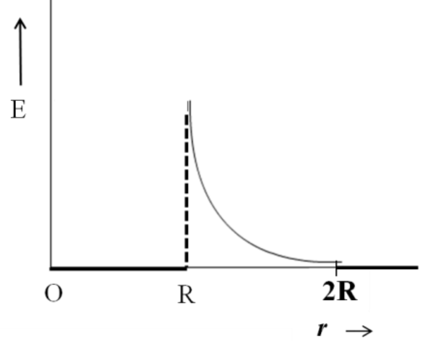
$\oint \vec{E}.d\vec{s} = \frac{q}{E_0}$ ½

q =0 in interval 0<x<R ½

$\Longrightarrow E = 0$ ½

$E = -\frac{dV}{dr}$

$\Longrightarrow V = constant = \frac{1}{4\pi E_0}\frac{Q}{R}$



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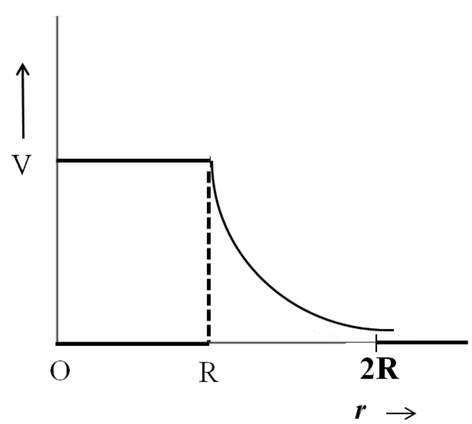
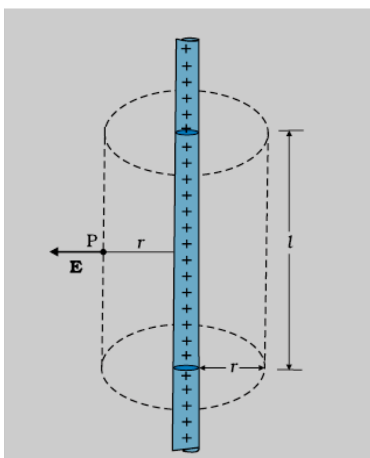


½

	[Even if a student draws E and V for 0<r<R award ½ + ½ mark.]		**3**
Q12	Definition of electric flux ½ S.I. unit ½ Deducing the expression 2 The electric flux is defined as $$\phi_E = \vec{E}.\vec{A} = EA\cos\theta$$ Its S.I unit is (N m^2C^{-1}) The Gaussian surface is cylindrical and field is radial. At the cylindrical part of the surface, $\vec{E}$ is normal to the surface at every point and its magnitude is constant (since it depends only on r). By Gauss's theorem : $\oint \vec{E}.d\vec{S} = \frac{q}{\epsilon_0}$ $\therefore E\ (2\pi rl) = \frac{\lambda l}{\epsilon_0}$ or $E = \frac{\lambda}{2\pi\epsilon_0 r}$ 	½ ½ ½ ½ ½ ½	**3**
Q13	(i) Ratio of radii with equal momenta 1 ½ (ii) Ratio of radii with same accelerating potential 1 ½ (i) $\frac{mv^2}{r} = qvB$ $\therefore r = \frac{mv}{qB} = \frac{p}{qB}$ $(p = mv)$ For proton $r_p = \frac{p}{q_pB}$ For α particles $r_\alpha = \frac{p}{q_\alpha B}$	½ ½	

$\therefore \frac{r_p}{r_\alpha} = \frac{q_\alpha}{q_p} \quad = 2$ ½

ii) $r = \frac{mv}{qB} = \frac{1}{B}\sqrt{\frac{2mV}{q}}$ ½

for proton $r_p = \frac{1}{B}\sqrt{\frac{2m_p V}{q_p}}$

and for α particles $r_\alpha = \frac{1}{B}\sqrt{\frac{2m_\alpha V}{q_\alpha}}$ ½

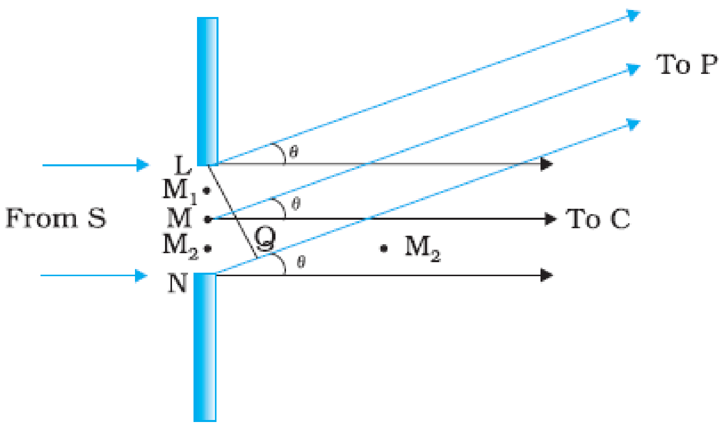
$\therefore \frac{r_p}{r_\alpha} = \sqrt{\frac{m_p}{q_p}\frac{q_\alpha}{m_\alpha}}$

$= \sqrt{\frac{2}{4}} = \frac{1}{\sqrt{2}}$ ½

3

Q14

Diagram	½
Path Difference	½
Condition for minima	½
Condition for maxima	½
Width of central maxima	½
Width of secondary maxima	½



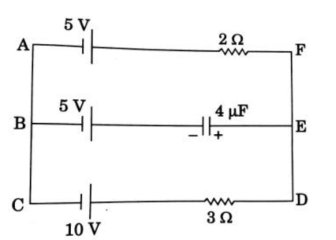
½

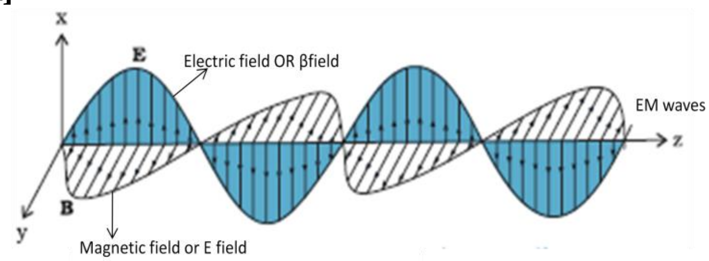
The path difference
$NP - LP = NQ$
$= a\sin\theta \simeq a\theta$ ½

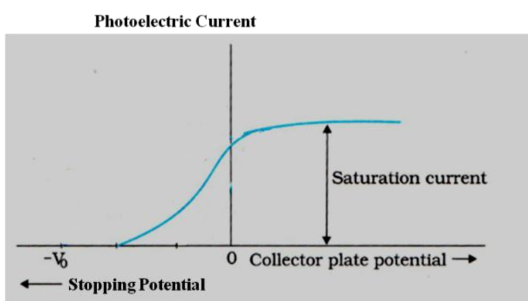
By dividing the slit into an appropriate number of parts, we find that points P for which

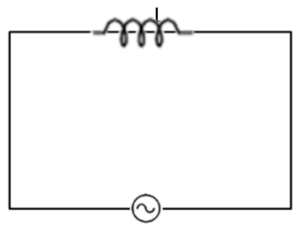
i) $\theta = \frac{n\lambda}{a}$ are points of minima. ½

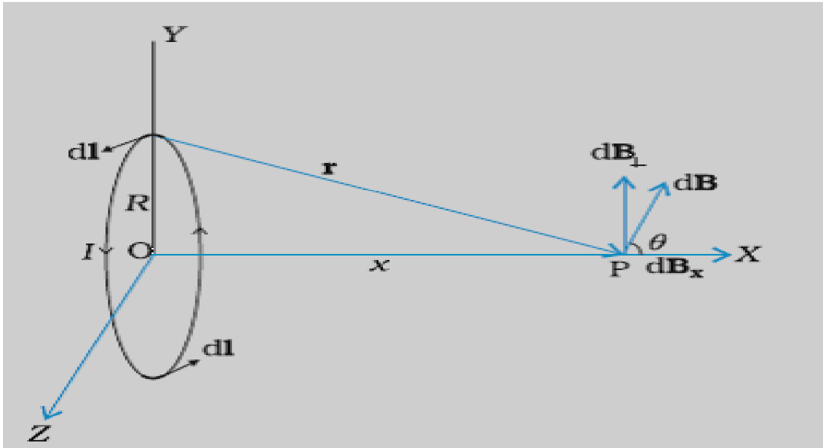
ii) $\theta = \left(n + \frac{1}{2}\right)\frac{\lambda}{a}$ are points of maxima ½

	Angular width of central maxima, $\theta=\theta_1-\theta_{-1}$ $=\frac{\lambda}{a}-\left(-\frac{\lambda}{a}\right)$ $\theta=\frac{2\lambda}{a}$ Angular width of secondary maxima = $\theta_2-\theta_1$ $=\frac{2\lambda}{a}-\frac{\lambda}{a}=\frac{\lambda}{a}$ $=\frac{1}{2}$ X Angular width of central maxima	½ ½	3
Q15	Bohr quantum condition ½ Expression for Time period 2½ $mvr=\frac{nh}{2\pi}$ ---- Bohr postulate Also, $\frac{mv^2}{r}=\frac{1}{4\pi\epsilon_0}\frac{e^2}{r^2}$ $\Leftrightarrow mv^2r=\frac{e^2}{4\pi\epsilon_0}$ $\therefore v=\frac{e^2}{4\pi\epsilon_0}X\frac{2\pi}{nh}=\frac{e^2}{2\epsilon_0 nh}$ $T=\frac{2\pi r}{v}=\frac{2\pi mvr}{mv^2}$ $=\frac{2\pi\left(\frac{nh}{2\pi}\right)}{m\left(\frac{e^2}{2\epsilon_0 nh}\right)^2}$ $=\frac{4n^3h^3\epsilon_0^2}{me^4}$ (Also accept if the student calculates T by obtaining expressions for both v and r.)	½ ½ ½ ½ ½ ½	3
Q16	Calculation of current 1 ½ Calculation of potential across capacitor 1 ½ In steady state branch BE is eliminated $I=\frac{10\text{V}-5\text{V}}{(3+2)\Omega}$ A $=1$ A  For loop EBCDE $-v_c-5+10-3\times 1=0$	½ ½ ½ ½	

	$- -V_c + 10 - 8 = 0$ $\therefore V_c = 2$ volt	½ ½	**3**
Q17	(a) Explanation of production of em waves 1½ (b) Depiction of em waves 1½ (a) An oscillating charge produces an oscillating electric field in space, which produces an oscillating magnetic field, which in turn, is a source of oscillating electric field and so on. Thus, oscillating electric and magnetic fields generate each other, they then propagate in space. [Alternatively**,** if a student writes Electromagnetic waves are produced by oscillating electric and magnetic fields / oscillating charges produce em waves. Award 1 mark**]** 	1½ 1½	**3**
Q18	a) Process of $\bar{\beta}$ decay 1 Explanation of emission of β particles 1 Reason ½ b) Correct identification ½ (a) A nucleus, that spontaneously decays by emitting an electron, or a positron, is said to undergo β decay [Alternatively ${}^{A}_{Z}\text{X} \longrightarrow {}_{Z+1}^{A}\text{Y} + e^{-} + \bar{\nu}$ (antineutrino) ${}^{A}_{Z}\text{X} \longrightarrow {}_{Z-1}^{A}\text{Y} + e^{+} + \nu$ (neutrino)] [Any one] During β decay, nucleons undergo a transformation. We can have $n \longrightarrow p + e^{-} + \bar{\upsilon}$ $\longrightarrow$ A neutron converts into a proton and an electron [Alternatively $p \longrightarrow n + e^{+} + \nu$ [A proton converts into a neutron and a positron] It is because the neutrinos, or antineutrino, carry off different amounts of energy.	**1** **1** ½	

	(b) The daughter nuclei have more binding energy per nucleon.	½	**3**
Q19	Sky wave propagation 1 Frequency range, reason 1 Frequency range through free space 1 In sky wave propagation, long distance communication is achieved by ionospheric reflection of radio waves back towards the earth. The frequency range is from a few Mega hertz to 30/40 Mega hertz. The ionospheric layers can act as a reflector over the frequency range (3 MHz to 30/40 MHz). Higher frequencies penetrate through it. The frequency range for communication of radio waves through free space is the entire range of radio frequencies, i.e. a few hundred kHz to a few GHz. (waves having frequency beyond 40 MHz)	**1** **1** **1**	**3**
Q20	(a) Plotting of graph ½ Marking saturation current ½ Marking stopping potential ½ (b) Photoelectric equation ½ Calculation of increases in stopping potential 1 (a) Graph:  (b) We know that $eV_0 = h\upsilon - \phi$ $\therefore eV_1 = h\upsilon_1 - \phi$ and $eV_2 = h\upsilon_2 - \phi$ Increase in potential $\therefore V_2 - V_1 = \frac{h}{e}(\upsilon_2 - \upsilon_1)$ $= \frac{6.63 \times 10^{-34}}{1.6 \times 10^{-19}}(8 \times 10^{15} - 4 \times 10^{15})\text{V}$ $= 16.5$ V	½+½+½ ½ ½	**3**

Q21	Derivation of instantaneous current — 2		
	Derivation of average power dissipated — 1		
	Given $V = V_0 \sin wt$		
	$V = L\frac{di}{dt} \Longrightarrow di = \frac{V}{L}dt$	½	
			
	$\boldsymbol{v = v_0 \sin wt}$		
	$\therefore di = \frac{V_0}{L}\sin wt\ dt$	½	
	Integrating $i = -\frac{V_0}{wL}\cos wt$	½	
	$\therefore i = -\frac{V_0}{wL}\sin(\pi/2 - wt) = I_0\sin(\pi/2 - wt)$	½	
	where $I_0 = \frac{V_0}{wL}$		
	Average power		
	$P_{av} = \int_0^T vidt$	½	
	$=\frac{-V_0^2}{wL}\int_0^T \sin wt \cos wt\ dt$		
	$=\frac{-V_0^2}{2wL}\int_0^T \sin(2\,wt)dt$		
	$=0$	½	**3**
Q22	Biot Savart's Law — ½		
	Deduction of Expression — 2		
	Direction of magnetic field — ½		



½

$\overrightarrow{dB} = \frac{\mu_0}{4\pi}\ \mathrm{I}\,\frac{\vec{dl}\times\vec{r}}{r^3}$ ½

[OR $dB = \frac{\mu_0}{4\pi}\ \frac{Idl}{r^2}$]

Here $r^2 = x^2+R^2$

dB= $\frac{\mu_0}{4\pi}\ \frac{I\ dl}{x^2+R^2}$ ½

$\sum dB_\perp = 0$

dB_x= dB cos θ $\quad where\ cos\theta = \frac{R}{(x^2+R^2)^{1/2}}$ ½

$dB_x = \frac{\mu_0\, Idl}{4\pi}\ \frac{R}{(x^2+R^2)^{\frac{3}{2}}}$

$\vec{B} = \int dB_x\ \hat{i} = \frac{\mu_0\, I\, R^2}{2(x^2+R^2)^{3/2}}\ \hat{\imath}$ ½

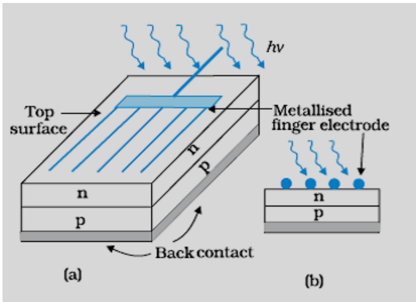
Direction- Can be determined by right hand thumb rule. ½ **3**

[Alternatively: By using vector form of Biot Savart law]

OR

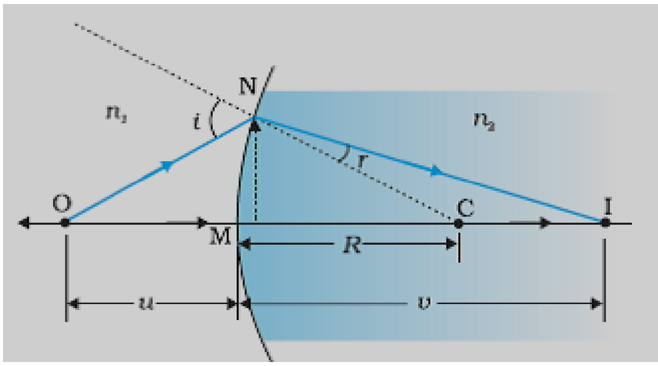
(i)	Magnitude of magnetic field at A	1
	Direction of magnetic field at A	½
(ii)	Magnitude of magnetic force on conductor 2	1
	Direction of magnitude force on conductor 2	½

(i) $B_2 = \frac{\mu_0}{4\pi}\ \frac{2(3I)}{r} = \frac{\mu_0}{4\pi}\left(\frac{6I}{r}\right)$ into the plane of the paper/(⊗). ½

	$B_3 = \frac{\mu_0}{4\pi}\frac{2(4I)}{3r} = \frac{\mu_0}{4\pi}\left(\frac{8I}{3r}\right)$ out of the plane of the paper/(⊙).	½	
	$B_A = B_2 - B_3$ into the paper.		
	$= \frac{\mu_0}{4\pi}\left(\frac{10I}{3r}\right)$ into the plane of the paper.(⊗)	½	
	(ii) $F_{21} = \frac{\mu_0}{4\pi}\frac{2I\,(3I)}{r}$ away from wire1 (/towards 3)	½	
	$F_{23} = \frac{\mu_0}{4\pi}\frac{2(3I)(4I)}{2r}$ away from wire 3 (towards 1)	½	
	$F_{net} = F_{23} - F_{21}$ towards wire1		
	$= \frac{\mu_0}{4\pi}\frac{6(I)^2}{r}$ towards wire 1	½	3
Q23	Values displayed — 1 + 1 Usefulness of solar panels — ½ Name of semiconductor device — ½ Diagram of the device — ½ Working of device — ½		
	a) Value displayed by mother: Inquisitive / scientific temperament / wants to learn / any other.	1	
	Value displayed by Sunil: Knowledgeable / helpful/ considerate	1	
	b) Provide clean / green energy Reduces dependence on fossil fuels,	½	
	Environment friendly energy source.	½	
	c) Solar Cell 	½	
	(full marks for any one figure out of a &b) **Working:** When light falls on the device the solar cell generates an emf.	½	4

Q24

a) Diagram	1
Derivation of the relation	2
b) Lens Maker's formula –	½
Calculation of f in water –	1½



1

For small angles

$\tan \angle NOM = \frac{MN}{OM}$: $\tan \angle NCM = \frac{MN}{NC}$

and $\tan \angle NIM = \frac{MN}{MI}$

For ΔNOC, i is exterior angle, therefore

$i = \angle NOM + \angle NCM = \frac{MN}{OM} + \frac{MN}{MC}$ ½

Similarly $r = \frac{MN}{MC} - \frac{MN}{MI}$ ½

For small angles Snells law can be written as

$n_1 i = n_2 r$

$\therefore \frac{n_1}{OM} + \frac{n_2}{MI} = \frac{n_2 - n_1}{MC}$ ½

∴ OM= - u, MI = +v MC= +R (using sign conversion)

$\therefore \frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$ ½

(b) Lens Maker's formula is

$$\frac{1}{f_a} = \left(\frac{n_2 - 1}{n_1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$ ½

$$\therefore \frac{1}{20} = (1.6-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\therefore \left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{20 \times 0.6} = \frac{1}{12}$$ ½

Let f be the focal length of the lens in water

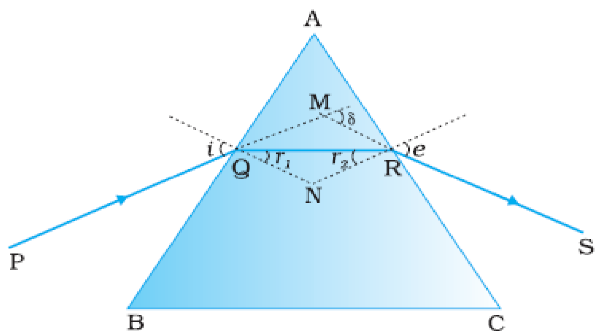
$$\therefore \frac{1}{f'} = \frac{1.6-1.3}{1.3}\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{0.3}{12 \times 1.3}$$ ½

Or $f' = \frac{120 \times 1.3}{3} = 52cm$ ½ **5**

OR

(a)	Diagram	½
	Obtaining the relation	3
(b)	Numerical	1½

(a)



½

½

From fig $\angle A + \angle QNR = 180^0$------- (1)

From triangle $\Delta QNR \quad r_1 + r_2 + \angle QNR = 180^0$ --(2)

Hence from equ (1) &(2)

$$\therefore \angle A = r_1 + r_2$$ ½

The angle of deviation

$\delta = (i - r_1)$+(e-r_2)= i+e-A ½

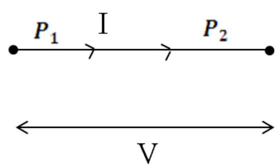
At minimum deviation i=e and r_1=r_2

$$\therefore r = \frac{A}{2}$$ ½

And i= $\frac{A+\delta m}{2}$ ½

Hence refractive index

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin A/2}$$ ½

	(b) From Snell's law $\mu_1 \sin i = \mu_2\, sinr$ Given $\mu_1 = \sqrt{2}, \mu_2$=1 and r= 90^0 (just grazing) $\therefore \sqrt{2}$ sin i= 1 sin $90^0 \Rightarrow \sin i\ \frac{1}{\sqrt{2}}$ $or\ i = 45^0$	½ ½ ½	5
Q25	a) (i) Principle of potentiometer — 1 How to increase sensitivity — ½ (ii) Name of potentiometer — ½ Reason — ½ b) Formula — ½ (i) Ratio of drift velocities in series — 1 (ii) Ratio of drift velocities in parallel — 1		
	a) (i) The potential difference across any length of wire is directly proportional to the length provided current and area of cross section are constant i.e., $E(l) = \phi l$ where ϕ is the potential drop per unit length.	**1**	
	It can be made more sensitive by decreasing current in the main circuit /decreasing potential gradient / increasing resistance put in series with the potentiometer wire.	½	
	ii) Potentiometer B	½	
	Has smaller value of V/l (slope / potential gradient).	½	
	b) In series, the current remains the same.	½	
			
	$I = neA_1V_{d1} = neA_2V_{d2}$	½	
	$\therefore \frac{V_{d1}}{V_{d2}} = \frac{A_2}{A_1}$	½	
	In parallel potential difference is same but currents are different.		
	$V = I_1R_1 = neA_1V_{d1}\frac{\varrho l}{A_1} = ne\varrho V_{d1}l$	½	
	Similarly, $V = I_2R_2 = ne\varrho V_{d2}l$ $I_1R_1 = I_2R_2$ $\therefore \frac{V_{d1}}{V_{d2}}$=1	½	5
	OR		

Value points	Marks
(a) Definition of capacitance	1
Obtaining capacitance	2
(b) Ratio of capacitances	2

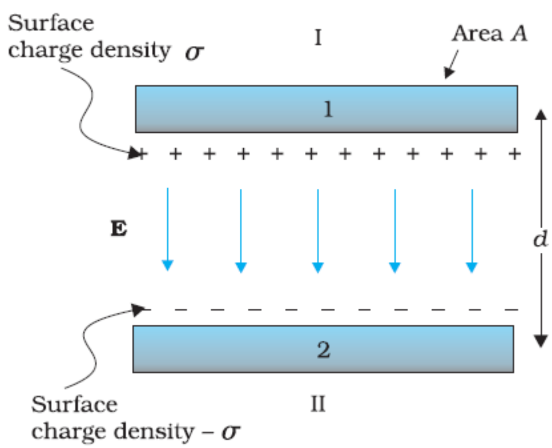
1

a) Capacitance equals the magnitude of the charge on each plate needed to raise the potential difference between the plates by unity.

OR

[The capacitance is defined as

$$c = \frac{q}{V}]$$



Consider parallel plates of area A ½

Plate separation d, the potential difference applied across it is V.

The electric field ½

$$E = \frac{\sigma}{\epsilon_0} = \frac{q}{\epsilon_0 A}$$ ½

Electric field = potential gradient

$$\therefore E = \frac{V}{d}$$ ½

Hence, $\frac{V}{d} = \frac{q}{\epsilon_0 A}$

$c = \frac{q}{V} = \frac{\epsilon_0 A}{d}$ ½

b) The capacitance without dielectric is

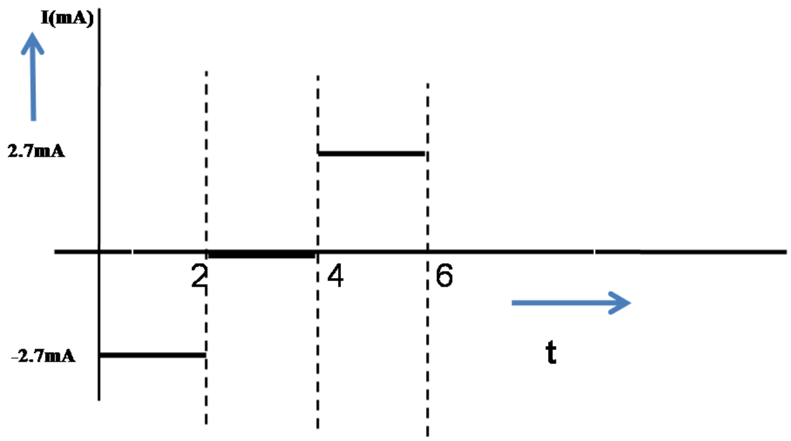
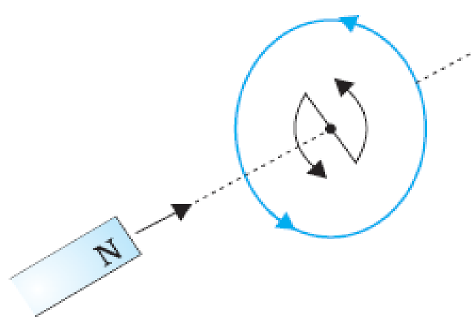
$$C_0 = \frac{\epsilon_0 A}{d}$$ ½

The capacitance of the capacitor, partially filled with dielectric constant K, thickness t is

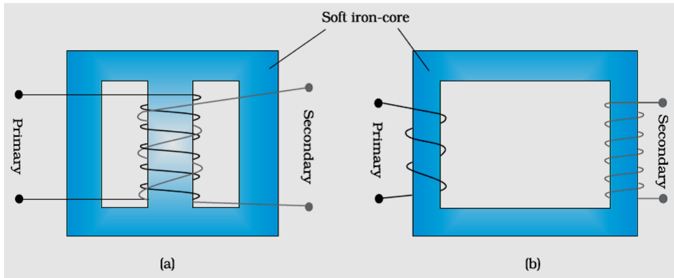
$$c = \frac{\epsilon_0 A}{\left(d - t + {}^{t}/_{k}\right)}$$ ½

Given $t = \frac{3d}{4} \therefore c = \frac{\epsilon_0 A}{d - \frac{3d}{4}}$ ½

	$\therefore c = \left(\frac{4k}{k+3}\right)\frac{\epsilon_0 A}{d}$ $\therefore \frac{c}{c_0} = \frac{4k}{k+3}$ [Alternatively, The capacitance, with dielectric, can be treated as a series combination of two capacitors. $C_1 = K\frac{\epsilon_0 A}{\left(\frac{3}{4}d\right)}$ $C_2 = \frac{\epsilon_0 A}{\left(\frac{1}{4}d\right)}$ $\therefore C = \frac{C_1 C_2}{C_1 + C_2} = \frac{\left(K\frac{\epsilon_0 A}{\left(\frac{3}{4}d\right)}\right)\left(\frac{\epsilon_0 A}{\left(\frac{1}{4}d\right)}\right)}{\frac{\epsilon_0 A}{d}\left[\frac{4}{3}k + 4\right]}$ $= \frac{4}{(3+k)}\frac{\epsilon_0 A}{d} = \frac{4}{(3+k)} C_0$ $\frac{c}{c_0} = \frac{4}{k+3}$]	½ ½ ½ ½	5
Q26	a) Statement of Faraday's Law — 1 b) Calculation of current — 2 Graph of current — 1 c) Lenz's Law — 1 (a) Faraday's law: The magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit. [Alternately: $e = -\frac{d\emptyset}{dt}$] (b) Area=$\pi R^2 = \pi \, X \, 1.44 \, X \, 10^{-2} m^2$ $= 4.5 \, X \, 10^{-2} m^2$ For 0<t<2 Emf $e_1 = \frac{d\emptyset_1}{dt} = -A\frac{dB}{dt}$ $= -4.5 \, X \, 10^{-2} X \frac{1}{2}$ $I_1 = -\frac{e_1}{R} = -\frac{2.25 \, X \, 10^{-2}}{8.5} = -2.7 \, mA$ For 2<t<4 $I_2 = \frac{e_2}{R} = 0$	1 ½ ½ ½	

	For 4<t<6 $$I_3 = -\frac{e_3}{R} = +2.7\ mA$$	½	
		1	
	(c)  If a north pole of the bar magnet moves towards the coil the magnetic flux through the coil increases. Hence induced current is counter clockwise (to oppose the increase in flux, by producing a north pole.) In this situation the bar magnet experiences a repulsive force, therefore work has to be done to move the magnet towards the coil. It is this work that gets converted into electrical energy.	1	5
	OR		

a) Diagram	½
Principle	½
Relation between voltage, number of turns, and Currents	2 ½
(b) Input power	½
Output power	½
Output voltage	½



½

Working principle

- Whenever current in one coil changes an emf gets induced in the neighboring coil /Principle of mutual induction

½

Voltage across secondary.

$$V_s = e_s = -N_s \frac{d\phi}{dt}$$

Voltage across primary

½

$$V_p = e_p = -N_p \frac{d\phi}{dt}$$

$\frac{V_s}{V_p} = \frac{N_s}{N_p}$ (here $N_s > N_p$) ½

In an Ideal transformer ½

Power Input= Power Input

$$I_p V_p = I_s V_s$$

$$\frac{V_s}{V_p} = \frac{I_p}{I_s}$$ ½

$$\therefore \frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

½

(b) Input power, $P_i = I_i . V_i = 15 \times 100$

=1500 W

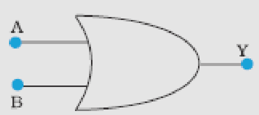
Power output, $P_0 = P_i \times \frac{90}{100} = 1350\ W$ ½

$\Longrightarrow I_0 V_0 - 1350W$ ½

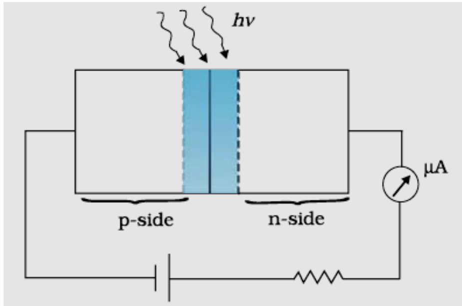
Output voltage, $V_0 = \frac{1350}{3} V = 450\ V$

½ **5**

MARKING SCHEME

Q. No.	Expected Answer/ Value Points	Marks	Total Marks
Q1	For writing yes ½ Justification ½ Yes Justification: $m \; \alpha \; \frac{1}{f_0 f_e}$ And focal length depends on colour/μ.	½ ½	1
Q2	Writing Yes ½ Reason ½ Yes Reason - $v_{blue} > v_{red}$ **[**Alternatively**:** Energy of blue light photon is greater than energy of red light photon.**]**	½ ½	1
Q3	Logic Symbol ½ Truth Table ½  (a) Input | Output A | B | Y 0 | 0 | 0 0 | 1 | 1 1 | 0 | 1 1 | 1 | 1 (b)	½ ½	1
Q4	i) $V_A > V_B$ ii) $V_A < V_B$	½ ½	1
Q5	Formula 1 $c = \frac{1}{\sqrt{\mu\epsilon}}$ **[**Alternatively, $c = \frac{1}{\sqrt{\mu_0\mu_r\epsilon_0\epsilon_r}}$ **]**	**1**	**1**
Q6	Formula ½ Image distance for $\|u\| \leq \|f + x\|$ ½ Image distance where $\|x\| \leq \|f\|$ 1 $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ (f is negative)	½	

	U = -f $\Rightarrow \frac{1}{v} = 0 \Rightarrow v = \infty$ U = -2f $\Rightarrow \frac{1}{v} = \frac{-1}{2f} \Rightarrow v = -2f$ Hence if -2f < u < -f $\Rightarrow -2f < v < \infty$ [<u>Alternatively</u> $2f > u > f$ $-\frac{1}{2f} > -\frac{1}{u} > -\frac{1}{f}$ $\frac{1}{f} - \frac{1}{2f} > \frac{1}{f} - \frac{1}{u} > \frac{1}{f} - \frac{1}{f}$ $\frac{1}{2f} < \frac{1}{V} < 0$ 2f < V <$\propto$] **OR** (a) Formula for magnification ½ Conditions for large magnification ½ (b) Any two reasons ½ + ½ $$m = -\frac{f_0}{f_e}$$ By increasing f_0 / decreasing f_e (a) Any two (i) No chromatic aberration. (ii) No spherical aberration. (iii) Mechanical advantage – low weight, easier to support. (iv) Mirrors are easy to prepare. (v) More economical	½ ½ ½ ½ ½ ½ ½ ½ ½ ½ + ½	2 2 2
Q7	Formulae ½+½ Finding Intensity ½ + ½ Phase difference= $\frac{2\pi}{\lambda} \times$ Path diffrence Path difference $\frac{\lambda}{6} \Rightarrow$ phase difference $= \frac{\pi}{3}$ Path difference $\frac{\lambda}{2} \Rightarrow$ phase difference= π $$I = 4I_0 \cos^2\left(\frac{\emptyset}{2}\right)$$ i. $I_1 = 4I_0 \times \frac{3}{4} = 3I_0$ ii. $I_2 = 4I_0 \times 0 = 0$	½ ½ ½ ½	2

Q8	Circuit Diagram 1 Working 1  	1	
	When photodiode is illuminated with light (photons), with energy $(h\nu > E_g)$, electron-hole pairs are generated near the depletion region of the diode. The direction of electric field is such that electrons reach n-side and holes reach p-side and give current(in reverse direction)	**1**	**2**
Q9	Distinguishing the two nodes (½ + ½) One example of each (½ + ½)		
	In point-to-point communication mode, communication takes place over a link between a single transmitter and a single receiver.	½	
	In the broadcast mode, there are a large number of receivers corresponding to a single transmitter.	½	
	Example: Point-to-point: telephone (any other)	½	
	Broadcast: T.V., Radio (any other)	½	**2**
Q10	Effect on brightness 1 Explanation 1		
	Brightness decreases	**1**	
	Explanation:- Self inductance of solenoid increases; this increases the impedance of the circuit and hence current decreases . (Even if student just writes self inductance increases, award this 1 mark.)	**1**	**2**

Section: C

Q11

i.	Formula	½
	Finding ratio	1
ii.	Formula	½
	Finding ratio	1

i. $r = \frac{mv}{qB}$ — **½**

For proton $r_p = \frac{m_p v}{q_p B}$

For α particle $r_\alpha = \frac{m_\alpha v}{q_\alpha B}$

$$\frac{r_p}{r_\alpha} = \frac{m_p}{q_p}\frac{q_\alpha}{m_\alpha} = \frac{1}{2}$$ **1**

ii. $r = \frac{\sqrt{2mK}}{qB}$ — **½**

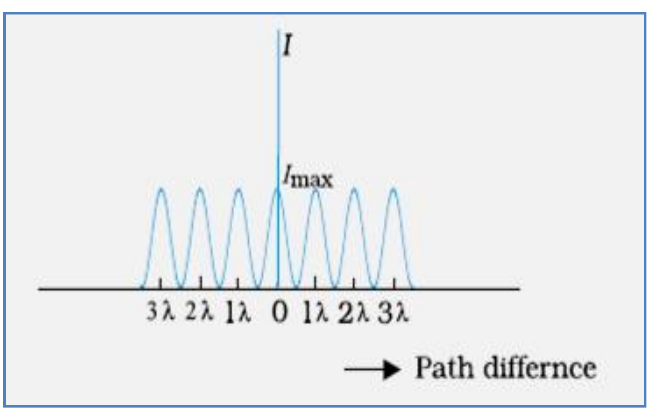
$$r_p = \frac{\sqrt{2m_p K}}{q_p B}$$

$$r_\alpha = \frac{\sqrt{2m_\alpha K}}{q_\alpha B}$$

$$\frac{r_p}{r_\alpha} = \frac{q_\alpha}{q_p}\sqrt{\frac{m_p}{m_\alpha}} = \frac{1}{1}$$ **1** — **3**

Q12

Intensity distribution graph for interference	1
Intensity distribution graph for diffraction	1
Any two differences	½ + ½



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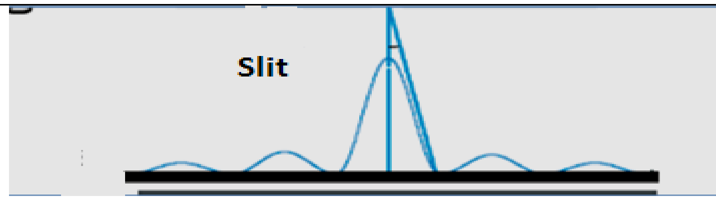


1

Any two differences

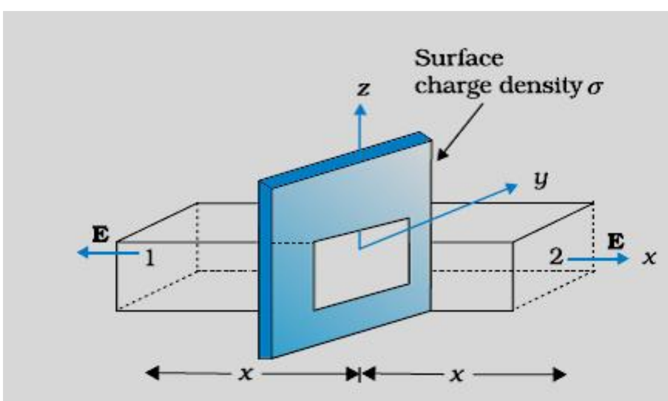
S.No	Interference	Diffraction
1	All fringes are equal in width	Central bright maxima is twice as wide as the other maxima.
2	Intensity of all bright fringes is same.	Intensity falls as we go to successive maxima away from centre.
3	Conditions for maxima and minima are opposite to diffraction pattern.	Condition for maxima and minima are opposite to interference pattern.
4	Pattern is formed by superposing two waves originating from two narrow slits.	Diffraction pattern is a superposition of wavelets originating from different parts of a single wavefront.

½ +½

3

Q13

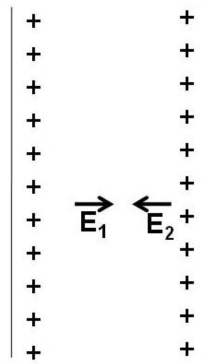
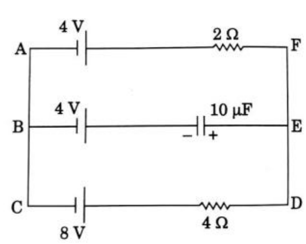
Derivation of expression for electric field	2
Proving that there is no electric field between plates	1



½

By Gauss's law $\oint \vec{E}.\vec{ds} = \frac{q}{\epsilon_0}$ ½

$\therefore 2EA = \frac{\sigma A}{\epsilon_0}$ ½

	$\therefore$ E = $\frac{\sigma}{2\epsilon_0}$ or $\vec{E} = \frac{\sigma}{2\epsilon_0}A$ Electric field between two identical charged sheets  $\because$ Both the sheets have same charge density, their electric fields will be equal and opposite in the region between the two sheets. Hence the net field is zero. **[** Alternatively $E_1 = \frac{\sigma}{2\epsilon_0}$ $E_2 = -\frac{\sigma}{2\epsilon_0}$ Resultant electric field between the plates= $E_1 + E_2$ $= \frac{\sigma}{2\epsilon_0} - \frac{\sigma}{2\epsilon_0}$ =0**]**	½ ½ ½	 **3**
Q14	Value of current 1 Value of voltage 1 Value of charge 1  In loop ACDFA		

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$$I = \left[\frac{8-4}{4+2}\right]\text{A} = \frac{2}{3}\text{A}$$

$$V_{AF} = V_{BE}$$

$$\Rightarrow 4 - 2 \times \frac{2}{3} = 4 - V_c$$

$$\Rightarrow V_c = \frac{4}{3}\text{ V}$$

Charge, $Q = CV_c$
$Q = (10\mu F \times \frac{4}{3})$
$= 13.33\ \mu C$
</td><td>**1**

½

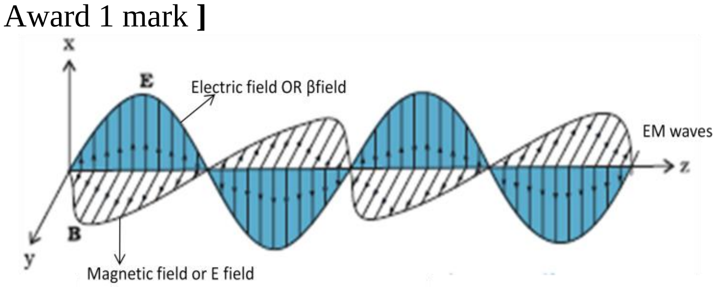
½

1</td><td>**3**</td></tr>
<tr><td>Q15</td><td>

(a) Explanation of production of em waves 1½
(b) Depiction of em waves 1½

(a) An oscillating charge produces an oscillating electric field in space, which produces an oscillating magnetic field, which in turn, is a source of oscillating electric field and so on. Thus, oscillating electric and magnetic fields generate each other, they then propagate in space.

[Alternatively**,** if a student writes
Electromagnetic waves are produced by oscillating electric and magnetic fields / oscillating charges produce em waves. Award 1 mark **]**



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1½</td><td>**3**</td></tr>
<tr><td>Q16</td><td>

(a) Derivation 2
(b) Formula ½
Calculation ½

(a) $N(t) = N_0\, e^{-\lambda t}$

When $t = T_{1/2} \Longrightarrow N(t) = \frac{N_0}{2}$

$$\therefore \frac{N_0}{2} = N_0\, e^{-\lambda}T_{1/2}$$
</td><td>½
½</td><td></td></tr>
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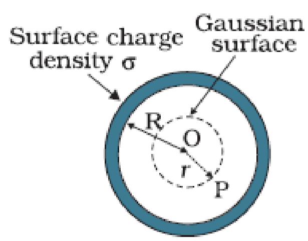
	$\Rightarrow \frac{1}{2} = e^{-\lambda}T_{1/2}$		
	$\Rightarrow -\lambda T_{\frac{1}{2}} = -ln2$	½	
	$\Rightarrow T_{\frac{1}{2}} = \frac{ln2}{\lambda} = \frac{0.693}{\lambda}$	½	
	(b) $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$ $n= \frac{t}{T_{1/2}}$	½	
	Given $\frac{N}{N_0} = \frac{1}{4} = \left(\frac{1}{2}\right)^n$		
	$\left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^2$		
	∴ Number of half lives= 2		
	$\Rightarrow \frac{1000}{T_{1/2}} = 2$		
	$\Rightarrow T_{\frac{1}{2}} = \frac{1000}{2} = 500$ years	½	
	[***Alternatively***		3
	1000 years = 2 half lives		
	∴ Half life = 500 years]		
Q17	Expression for electric field 1½ Expression for potential ½ Plot of graph (E $V_s r$) ½ Plot of graph (V V_s r) ½		
			
	By Gauss theorem	½	
	$\oint \vec{E}.d\vec{s} = \frac{q}{E_0}$	½	
	q =0 in interval 0<x<R		
	$\Rightarrow E = 0$	½	

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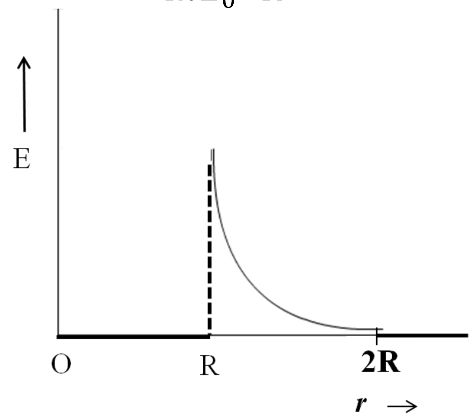
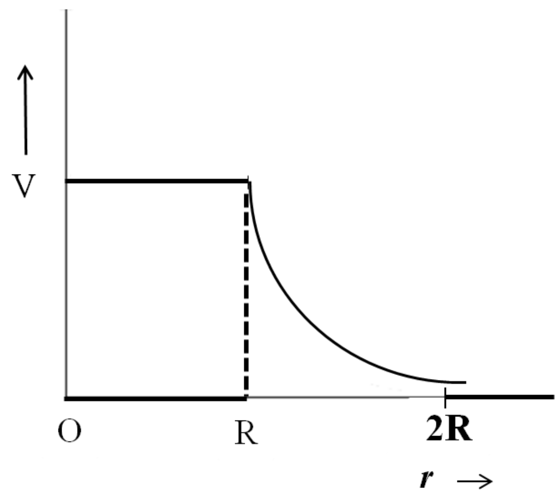
E= $-\frac{dV}{dr}$

$\Longrightarrow V = constant = \frac{1}{4\pi E_0} \frac{Q}{R}$





[Even if a student draws E and V for $0<r<R$ award ½ + ½ mark.]

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½

½</td>
<td>3</td>
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<td>Q18</td>
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Bohr quantum condition	½
Expression for Time period	2½

$mvr = \frac{nh}{2\pi}$ ---- Bohr postulate

Also, $\frac{mv^2}{r} = \frac{1}{4\pi\epsilon_0} \frac{e^2}{r^2}$

$\Leftrightarrow mv^2 r = \frac{e^2}{4\pi\epsilon_0}$

$\therefore v = \frac{e^2}{4\pi\epsilon_0} X \frac{2\pi}{nh} = \frac{e^2}{2\epsilon_0 nh}$

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½
½
½</td>
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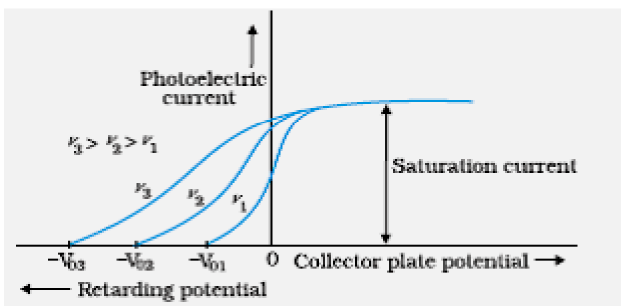
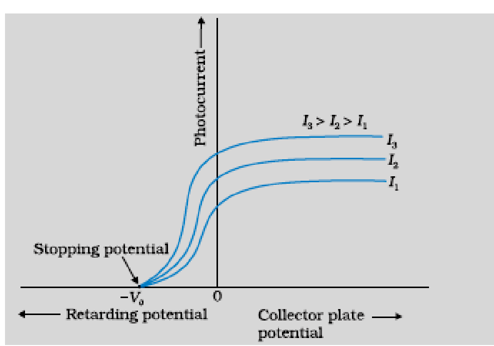
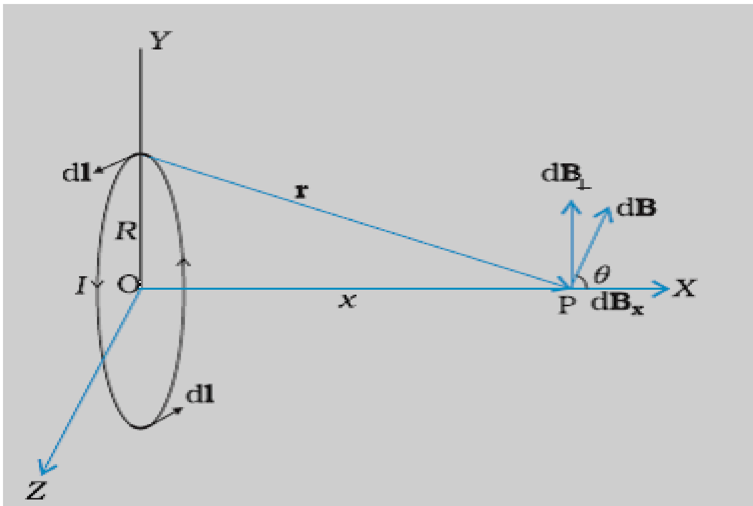
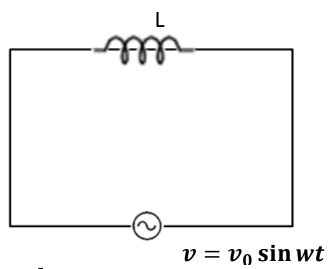
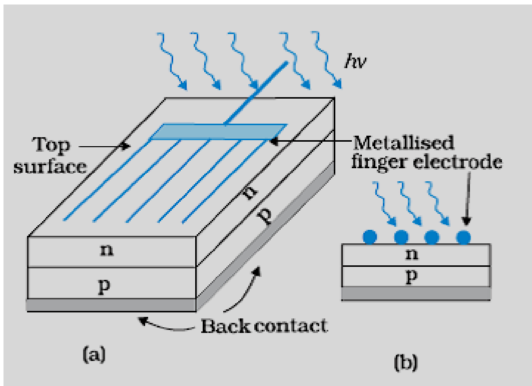
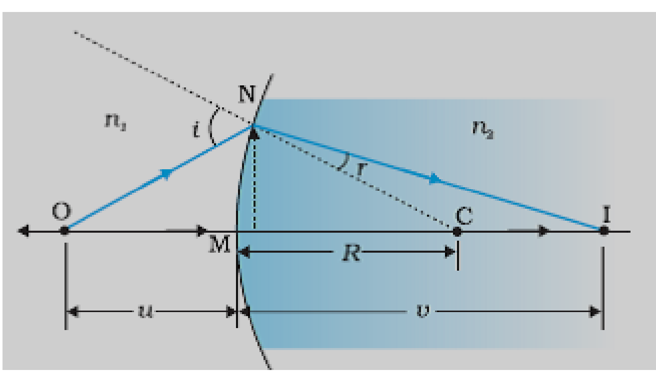
</table>

	$T = \frac{2\pi r}{v} = \frac{2\pi m v r}{m v^2}$ $= \frac{2\pi\left(\frac{nh}{2\pi}\right)}{m\left(\frac{e^2}{2\epsilon_0 n h}\right)^2}$ $= \frac{4n^3h^3\epsilon_0^2}{me^4}$ (Also accept if the student calculates T by obtaining expressions for both v and r.)	½ ½	3
Q19	a) Graph of photo current vs collector potential for different frequencies 1 b) Einstein's photo electric equation ½ Explanation of graph ½ c) Graph of photocurrent with collector potential for different intensities 1 **(a)**  **(b)** According to Einstein's photoelectric equation $K_{max} = hv - \emptyset_0$ If V_0 is stopping potential then $eV_0 = hv - \emptyset$ Thus for different value of frequency(v) there will be a different value of cut off potential V_0. **(c)**  	1 ½ ½ 1	3

Q20	Biot Savart's Law ½ mark Deduction of Expression 2 marks Direction of magnetic field ½ mark		
		½	
	$\overrightarrow{dB} = \frac{\mu_0}{4\pi}\, I\, \frac{\vec{dl} \times \vec{r}}{r^3}$ [OR $dB = \frac{\mu_0}{4\pi} \frac{Idl}{r^2}$]	½	
	Here $r^2 = x^2 + R^2$		
	dB= $\frac{\mu_0}{4\pi} \frac{I\, dl}{x^2 + R^2}$		
	$\sum dB_\perp = 0$	½	
	dB_x = dB cos θ $\quad where\ cos\theta = \frac{R}{(x^2+R^2)^{1/2}}$	½	
	$dB_x = \frac{\mu_0\, Idl}{4\pi} \quad \frac{R}{(x^2+R^2)^{\frac{3}{2}}}$		
	$\vec{B} = \int dB_x\, \hat{i} = \frac{\mu_0\, I\, R^2}{2(x^2+R^2)^{3/2}}\, \hat{\imath}$	½	
	Direction- Can be determined by right hand thumb rule. [Alternatively: By using vector form of Biot Savart law]	½	3
	OR		

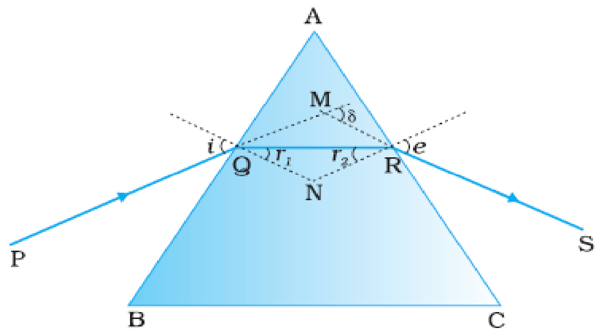
	(i) Magnitude of magnetic field at A 1 Direction of magnetic field at A ½ Magnitude of magnetic force on conductor 2 1 Direction of magnitude force on conductor 2 ½		
	(i) $B_2 = \frac{\mu_0}{4\pi}\frac{2(3I)}{r} = \frac{\mu_0}{4\pi}\left(\frac{6I}{r}\right)$ into the plane of the paper/(⊗).	½	
	$B_3 = \frac{\mu_0}{4\pi}\frac{2(4I)}{3r} = \frac{\mu_0}{4\pi}\left(\frac{8I}{3r}\right)$out of the plane of the paper/(⊙).	½	
	$B_A = B_2 - B_3$ into the paper. $=\frac{\mu_0}{4\pi}\left(\frac{10I}{3r}\right)$ into the plane of the paper.(⊗)	½	
	(ii) $F_{21} = \frac{\mu_0}{4\pi}\frac{2I\,(3I)}{r}$ away from wire1 (/towards 3)	½	
	$F_{23} = \frac{\mu_0}{4\pi}\frac{2(3I)(4I)}{2r}$ away from wire 3 (towards 1)	½	
	$\mathrm{F_{net}} = \mathrm{F_{23}} - \mathrm{F_{21}}$ towards wire1 $=\frac{\mu_0}{4\pi}\frac{6(I)^2}{r}$ towards wire 1	½	3
Q21	Definition of space wave propagation 1 Naming system of communication ½ Definition of radio horizon ½ Explanation 1		
	Propagation of waves, along a straight path from the transmitting antenna to receiving antenna, using line of sight (LOC) communication is called space wave propagation.	**1**	
	Relevant system of communication: Television broadcast, microwave links and satellite communication (any one)	½	
	'Radio horizon' equals the distance between the transmitting antenna and the point on the earth where the direct waves get blocked due to the curvature of the earth. **[** Also accept $d = \sqrt{2hR}$; h = height of transmitting antenna, R = Radius of the earth.**]**	½	
	At frequencies above 40 MHz, relatively smaller antennas are needed and communication is essentially limited to line of	**1**	

	sight paths. **[** Alternatively**,** At frequencies (more than 40 MHz), e.m. waves do not get bent or reflected by ionosphere. Therefore space wave propagation has to be used for frequencies above 40 MHz.**]**	**1**	**3**
Q22	Derivation of instantaneous current 2 Derivation of average power dissipated 1 Given $V = V_0 \sin wt$ $V = L\frac{di}{dt} \Rightarrow di = \frac{V}{L}dt$  $\therefore di = \frac{V_0}{L}\sin wt\ dt$ Integrating $i = -\frac{V_0}{wL}\cos wt$ $\therefore i = -\frac{V_0}{wL}\sin(\pi/2 - wt) = I_0 \sin(\pi/2 - wt)$ where $I_0 = \frac{V_0}{wL}$ Average power $P_{av} = \int_0^T vidt$ $= \frac{-V_0^2}{wL}\int_0^T \sin wt \cos wt\ dt$ $= \frac{-V_0^2}{2wL}\int_0^T \sin(2wt)dt$ $=0$	½ ½ ½ ½ ½ ½	**3**
Q23	Values displayed 1 + 1 Usefulness of solar panels ½ Name of semiconductor device ½ Diagram of the device ½ Working of device ½ a) Value displayed by mother:		

	Inquisitive / scientific temperament / wants to learn / any other. Value displayed by Sunil: Knowledgeable / helpful/ considerate b) Provide clean / green energy Reduces dependence on fossil fuels, Environment friendly energy source. c) Solar Cell  (full marks for any one figure out of a &b) **Working:** When light falls on the device the solar cell generates an emf.	**1** **1** ½ ½ ½ ½	 **4**
Q24	a) Diagram — 1 Derivation of the relation — 2 b) Lens Maker's formula – ½ Calculation of f in water – 1½  For small angles $\tan \angle NOM = \frac{MN}{OM}$: $\tan \angle NCM = \frac{MN}{NC}$	**1**	

	and tan $\angle NIM = \frac{MN}{MI}$		
	For ΔNOC, i is exterior angle, therefore		
	$i = \angle NOM + \angle NCM = \frac{MN}{OM} + \frac{MN}{MC}$	½	
	Similarly $r = \frac{MN}{MC} - \frac{MN}{MI}$	½	
	For small angles Snells law can be written as		
	$n_1 i = n_2 r$		
	$\therefore \frac{n_1}{OM} + \frac{n_2}{MI} = \frac{n_2 - n_1}{MC}$	½	
	∴ OM= - u, MI = +v MC= +R (using sign conversion)		
	$\therefore \frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$	½	
	(b) Lens Maker's formula is		
	$$\frac{1}{f_a} = \left(\frac{n_2 - 1}{n_1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$	½	
	$$\therefore \frac{1}{20} = (1.6 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$		
	$$\therefore \left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{20 \times 0.6} = \frac{1}{12}$$	½	
	Let f be the focal length of the lens in water		
	$$\therefore \frac{1}{f'} = \frac{1.6 - 1.3}{1.3}\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{0.3}{12 \times 1.3}$$	½	
	Or $f' = \frac{120 \times 1.3}{3} = 52cm$	½	5
	OR		
	(a) Diagram ½ Obtaining the relation 3 (b) Numerical 1½		

(a)



½

From fig $\angle A + \angle QNR = 180^0$------- (1) ½

From triangle ΔQNR $r_1 + r_2 + \angle QNR = 180^0$ --(2)

Hence from equ (1) &(2)

$$\therefore \angle A = r_1 + r_2$$ ½

The angle of deviation

$\delta = (i - r_1)$+(e-r_2)= i+e-A ½

At minimum deviation i=e and r_1=r_2

$$\therefore r = \frac{A}{2}$$ ½

And i= $\frac{A+\delta m}{2}$ ½

Hence refractive index

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin A/2}$$ ½

(b) From Snell's law $\mu_1 \sin i = \mu_2\, sinr$ ½

Given $\mu_1 = \sqrt{2}$, μ_2=1 and r= 90^0 (just grazing)

$\therefore \sqrt{2}$ sin i= 1 sin $90^0 \Longrightarrow \sin i\ \frac{1}{\sqrt{2}}$ ½

$$or\ i = 45^0$$ ½ **5**

Q25

a)	(i) Principle of potentiometer	1
	How to increase sensitivity	½
	(ii) Name of potentiometer	½
	Reason	½
b)	Formula	½
	(i) Ratio of drift velocities in series	1
	(ii) Ratio of drift velocities in parallel	1

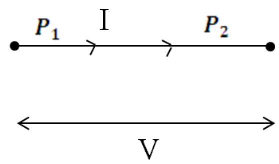
a) (i) The potential difference across any length of wire is directly proportional to the length provided current and area of cross section are constant i.e., $E(l) = \phi l$ where ϕ is the potential drop per unit length. **1**

It can be made more sensitive by decreasing current in the main circuit /decreasing potential gradient / increasing resistance put in series with the potentiometer wire. ½

ii) Potentiometer B ½

Has smaller value of V/l (slope / potential gradient). ½

b) In series, the current remains the same. ½



$$I = neA_1V_{d1} = neA_2V_{d2}$$ ½

$$\therefore \frac{V_{d1}}{V_{d2}} = \frac{A_2}{A_1}$$ ½

In parallel potential difference is same but currents are different.

$$V = I_1R_1 = neA_1V_{d1}\frac{\varrho l}{A_1} = ne\varrho V_{d1}l$$ ½

Similarly, $V = I_2R_2 = ne\varrho V_{d2}l$

$$I_1R_1 = I_2R_2$$ ½

$$\therefore \frac{V_{d1}}{V_{d2}} = 1$$

5

OR

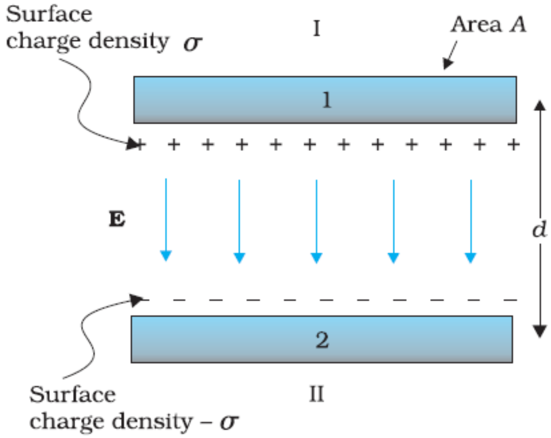
(a)	Definition of capacitance	1
	Obtaining capacitance	2
(b)	Ratio of capacitances	2

a) Capacitance equals the magnitude of the charge on each plate needed to raise the potential difference between the plates by unity. **1**

OR

[The capacitance is defined as

$$c = \frac{q}{V}]$$



Consider parallel plates of area A
Plate separation d, the potential difference applied across it is V. The electric field

$$E = \frac{\sigma}{\epsilon_0} = \frac{q}{\epsilon_0 A}$$

Electric field = potential gradient ½

$$\therefore E = \frac{V}{d}$$

Hence, $\frac{V}{d} = \frac{q}{\epsilon_0 A}$ ½

c$= \frac{q}{V} = \frac{\epsilon_0 A}{d}$ ½

½

b) The capacitance without dielectric is

$$C_0 = \frac{\epsilon_0 A}{d}$$

The capacitance of the capacitor, partially filled with dielectric constant K, thickness t is ½

$$c = \frac{\epsilon_0\ A}{\left(d - t + {}^{t}/_{k}\right)}$$

Given $t = \frac{3d}{4}$ $\therefore c = \frac{\epsilon_0 A}{d - \frac{3d}{4}}$ ½

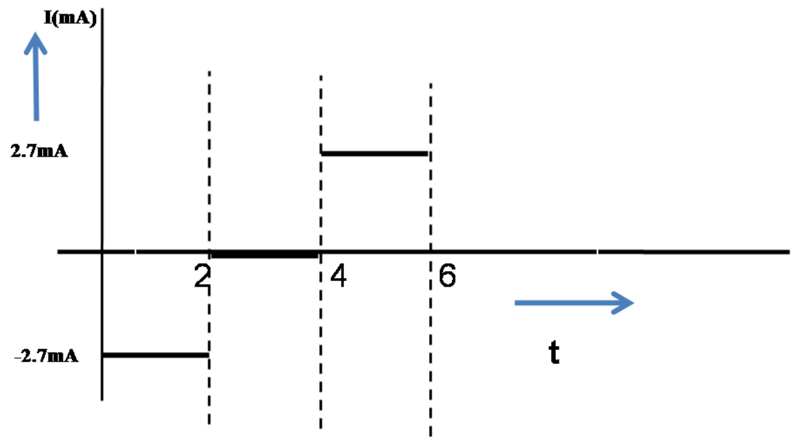
$$\therefore c = \left(\frac{4k}{k+3}\right)\frac{\epsilon_0 A}{d}$$

$$\therefore \frac{c}{c_0} = \frac{4k}{k+3}$$ ½

[Alternatively, ½

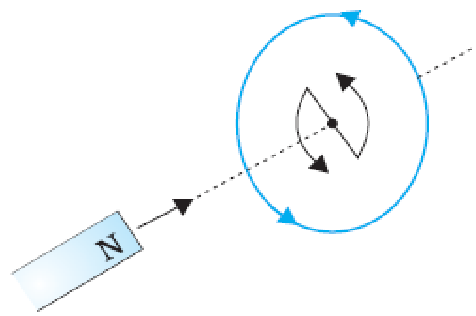
The capacitance, with dielectric, can be treated as a series combination of two capacitors.

	$C_1 = K\frac{\epsilon_0 A}{\left(\frac{3}{4}d\right)}$ $C_2 = \frac{\epsilon_0 A}{\left(\frac{1}{4}d\right)}$ $\therefore C = \frac{C_1 C_2}{C_1 + C_2} = \frac{\left(K\frac{\epsilon_0 A}{\left(\frac{3}{4}d\right)}\right)\left(\frac{\epsilon_0 A}{\left(\frac{1}{4}d\right)}\right)}{\frac{\epsilon_0 A}{d}\left[\frac{4}{3}k + 4\right]}$ $= \frac{4}{(3+k)}\frac{\epsilon_0 A}{d} = \frac{4}{(3+k)}\ C_0$ $\frac{c}{c_0} = \frac{4}{k+3}$]	½ ½ ½ ½	5
Q26	a) Statement of Faraday's Law 1 b) Calculation of current 2 Graph of current 1 c) Lenz's Law 1 (a) Faraday's law: The magnitude of the induced emf in a circuit is equal to the time rate of change of magnetic flux through the circuit. [Alternately: $e = -\frac{d\emptyset}{dt}$] (b) Area=$\pi R^2 = \pi\ X\ 1.44\ X\ 10^{-2} m^2$ $= 4.5\ X\ 10^{-2} m^2$ For 0<t<2 Emf $e_1 = \frac{d\emptyset_1}{dt} = -A\frac{dB}{dt}$ $= -4.5\ X\ 10^{-2} X \frac{1}{2}$ $I_1 = -\frac{e_1}{R} = -\frac{2.25\ X\ 10^{-2}}{8.5} = -2.7\ mA$ For 2<t<4 $I_2 = \frac{e_2}{R} = 0$ For 4<t<6 $I_3 = -\frac{e_3}{R} = +2.7\ mA$	**1** ½ ½ ½ ½	



1

(c)



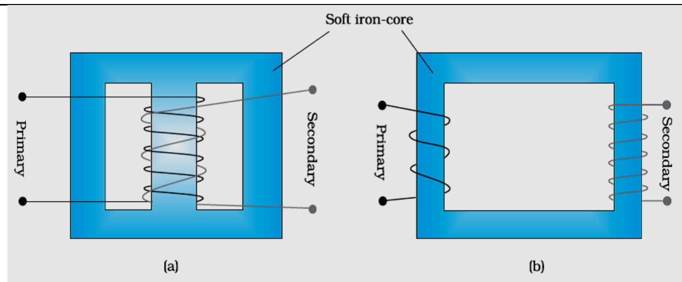
If a north pole of the bar magnet moves towards the coil the magnetic flux through the coil increases. Hence induced current is counter clockwise (to oppose the increase in flux, by producing a north pole.)

In this situation the bar magnet experiences a repulsive force, therefore work has to be done to move the magnet towards the coil. It is this work that gets converted into electrical energy.

1 5

OR

a) Diagram	½
Principle	½
Relation between voltage, number of turns, and Currents	2 ½
(b) Input power	½
Output power	½
Output voltage	½

		½	
	Working principle - Whenever current in one coil changes an emf gets induced in the neighboring coil /Principle of mutual induction	½	
	Voltage across secondary. $$V_s = e_s = -N_s \frac{d\phi}{dt}$$ Voltage across primary	½	
	$$V_p = e_p = -N_p \frac{d\phi}{dt}$$ $\frac{V_s}{V_p} = \frac{N_s}{N_p}$ (here $N_s > N_p$)	½	
	In an Ideal transformer	½	
	Power Input= Power Input $$I_p V_p = I_s V_s$$ $$\frac{V_s}{V_p} = \frac{I_p}{I_s}$$	½	
	$$\therefore \frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$	½	
	(b) Input power, $P_i = I_i . V_i = 15 \times 100$ =1500 W	½	
	Power output, $P_0 = P_i \times \frac{90}{100} = 1350\ W$ $\Longrightarrow I_0 V_0 - 1350W$	½	
	Output voltage, $V_0 = \frac{1350}{3} V = 450\ V$	½	**5**