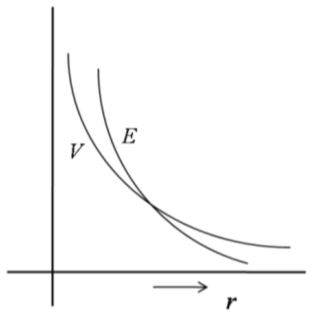
MARKING SCHEME
SET 55/1 (Compartment)

Q. No.	Expected Answer / Value Points	Marks	Total Marks
	Section A		
Set1,Q1 Set2,Q2 Set3,Q4	 [Accept any (non-linear) shape of the curves showing that E decreases at a faster rate than V]	½ + ½	1
Set1,Q2 Set2,Q5 Set3,Q3	Average power over full cycle of the ac voltage source.	1	1
Set1,Q3 Set2,Q4 Set3,Q2	At an angle of incidence = i_B	1	1
Set1,Q4 Set2,Q1 Set3,Q5	becquerel One becquerel activity corresponds to 'one decay/disintegration per second'.	½ ½	1
Set1,Q5 Set2,Q3 Set3,Q1	(i) Point to Point Communication (ii) Broadcast	½ ½	1
	Section B		
Set1,Q6 Set2,Q8 Set3,Q7	(i) Writing the expression for P.E. at a distance '*d*' 1 (ii) Obtaining the expression for '*d*' 1 (i) At the distance, d, the K.E., *K*, gets converted into P.E. of the system. $\text{P.E. at distance } d = \frac{1}{4\pi\epsilon_o}\frac{(2e)(Ze)}{d}$ $\therefore \frac{1}{4\pi\epsilon_o}\frac{2Ze^2}{d} = K$ $\therefore d = \frac{1}{4\pi\epsilon_o}\frac{2Ze^2}{K}$ **OR** (i) Writing the 'Bohr relation' for wavelengths ½ (ii) Writing the formula for most energetic spectral line of a. Balmer Series ½ b. Paschen Series ½ (iii)Finding the ratio ½	 ½ ½ ½ ½	

	As per the Bohr's Model, the wavelengths are given by $\frac{hc}{\lambda} = (\text{const})\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ For the most energetic line of Balmer series: $\frac{hc}{\lambda_B} = (\text{const})\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) \rightarrow \frac{\text{const}}{4}$ For the Paschen Series: $\frac{hc}{\lambda_P} = (\text{const})\left(\frac{1}{3^2} - \frac{1}{\infty^2}\right) \rightarrow \frac{\text{const}}{9}$ $\therefore \frac{\lambda_P}{\lambda_B} = \frac{9}{4}$ [Also, accept alternative forms of the initial formula/alternative approach]	½ ½ ½ ½	2
Set1,Q7 Set2,Q10 Set3,Q8	(i) Writing the form of the wave equation ½ (ii) Writing the two possible forms ½ + ½ (iii) Relation between the peak value ½ For the e.m. wave, propagating along the z axis, we have $E = E_o \sin(kz \mp \omega t)$ and $B = B_o \sin(kz \mp \omega t)$ The two possible forms are : $E_x = E_o \sin(kz - \omega t)$ $B_y = B_o \sin(kz - \omega t)$ And $E_y = E_o \sin(kz + \omega t)$ $B_x = B_o \sin(kz + \omega t)$ We have $E_o = cB_o$ [Do not deduct any marks if the student uses any of the two signs (− r +) in the two sets of expression.]	½ ½ ½ ½	2
Set1,Q8 Set2,Q9 Set3,Q6	Naming the two waves ½ + ½ One application of each ½ + ½ Y_1 → Microwaves Microwave oven, Aircraft Navigator or any other Y_2 → Ultraviolet waves Sterlize surgical instruments, food preservation or any other	½ ½ ½ ½	2
Set1,Q9 Set2,Q6 Set3,Q10	(i) Writing the two formulae ½ + ½ (ii) Calculating the de Broglie wavelength ½ + ½ K= Energy of the photon $= \frac{hc}{\lambda}$ de Broglie wavelength, $\lambda_B = \frac{h}{p} = \frac{h}{\sqrt{2mk}}$	½ ½	

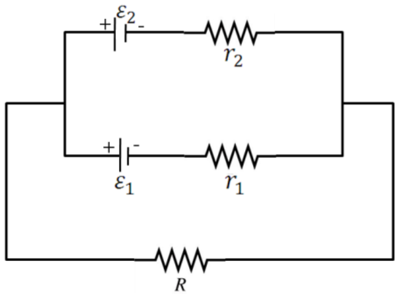
	$\therefore \lambda_B = \frac{h}{\sqrt{2m.\frac{hc}{\lambda}}}$ $= \sqrt{\frac{h\lambda}{2mc}}$ $= \left[\frac{6.63 \times 10^{-34} \times 5460 \times 10^{-9}}{2 \times 9.1 \times 10^{-31} \times 3 \times 10^{8}}\right]^{\frac{1}{2}}$ $= 25.75 \times 10^{-10}$m	½ ½	2
Set1,Q10 Set2,Q7 Set3,Q9	(i) Writing the reason 1 (ii) Using the Einstein mass energy relation 1 The numbers are conserved but the total mass is not conserved. The total mass of the free protons/neutrons is more than their total mass within the nucleus. The lost mass (=Δm), gets converted into energy as per the relation. $E = (\Delta m)c^2$ [Also, accept, alternative ways of explaining the phenomenon]	1 1	2
	Section C		
Set1,Q11 Set2,Q15 Set3,Q20	Writing the basic formula for electric field ½ (i) Obtaining the charge within the sphere of radius *r (0 < r < R)* 1 Expression for electric field ½ (ii) Expression for electric field (*r* >*R*) 1 We have $E = \frac{1}{4\pi\epsilon_o}\frac{q}{r^2}$, for a point charge Now(volume) charge density $\rho = \frac{Q}{\left(\frac{4\pi}{3}R^3\right)}$ (i) $\therefore$ Charge contained within a sphere of radius *r (0 < r < R)* $Q' = \rho.\frac{4\pi}{3}.r^3 = Q\left(\frac{r^3}{R^3}\right)$ $\therefore$ Electric Field $E = \frac{1}{4\pi\epsilon_o}\frac{Q'}{r^2} = \left(\frac{1}{4\pi\epsilon_o}.\frac{Q}{R^3}.r\right)$ (ii) For *r* > *R* Electric field = (Electric field due to a point charge Q at the centre) $= \frac{1}{4\pi\epsilon_o}\frac{Q}{r^2}$	½ 1 ½ 1	3

Set1,Q12
Set2,Q14
Set3,Q12

(i) Stating that the two cells must have been connected in parallel ½
Circuit diagram for the setup 1
(ii) Writing expressions for equivalent emf and equivalent resistance ½ + ½
(iii) Writing expression for current ½

Since $r_{eq} < r_1$, the two cells must have been connected in parallel. ½

The diagram of the setup is as shown



1

[Award (½ + ½ =1) mark even if the student directly draws the diagram of the setup]

Equivalent internal resistance $r = \frac{r_1 r_2}{(r_1+r_2)}$ ½

Equivalent emf, ε, is given by ½

$\varepsilon = \left(\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}\right) r$

The current, flowing through R, is

$I = \frac{\varepsilon}{(R+r)}$ ½

Where ε and r are given by the above expressions.

[Note: Award 2 marks if the student obtains / writes the expression $I = \frac{\varepsilon_1 r_1 + \varepsilon_2 r_1}{[R(r_1+r_2)+r_1 r_2]}$ for the current flowing through R]

3

Set1,Q13
Set2,Q13
Set3,Q18

Expression for magnetic force ½
No work is done 1
No change in magnitude of $\vec{v}$ ½
Definition of unit of magnetic field 1

The required expression is

$\vec{F} = q(\vec{v} \times \vec{B})$ ½

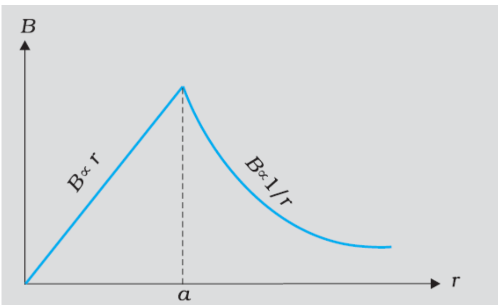
The magnetic force, at all instants, is, therefore, perpendicular to the instantaneous direction of $\vec{v}$, which is also the instantaneous direction of displacement($\overrightarrow{ds}$). ½

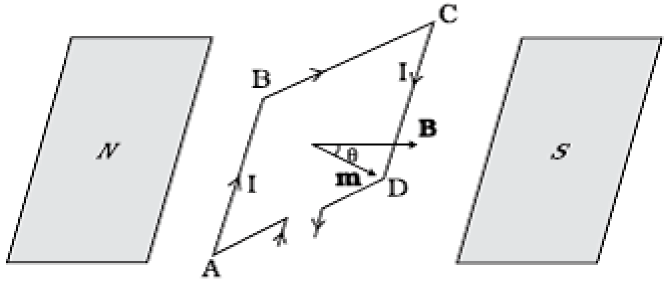
Since, $\vec{F}$ is perpendicular to $(\overrightarrow{ds})$, at all instants, work done $(= \vec{F}.\overrightarrow{ds})$ is zero. ½

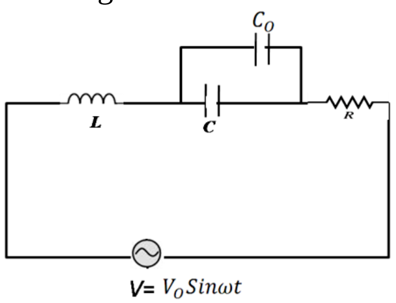
There being no work done, there can be no change in the magnitude of $\vec{v}$. ½

From $\vec{F} = q(\vec{v} \times \vec{B})$, we get

$|\vec{F}| = F = qvB \sin\theta$

	$\therefore F = B$ if $q = 1$, $v = 1$ and $\theta = \frac{\pi}{2}$		
	Hence, the magnetic field, $\vec{B}$, at a point equals one tesla if a charge of one coulomb, moving with a velocity of 1 m/s, along a direction perpendicular to the direction of $\vec{B}$, experiences a force of one newton.		
	[**Note**: Also accept if the student just writes that $\lvert\vec{B}\rvert$= 1 tesla	1	
	if $\lvert\vec{F}\rvert$ = one newton, for q = 1 coulomb, v = 1m/s and $\theta = \frac{\pi}{2}$]		3
Set1,Q14 Set2,Q12 Set3,Q13	Statement of Ampere's Circuital Law ½ Obtaining expression for $B\ (r)$ when $r < R$ 1 $r > R$ ½ Drawing the graph 1		
	As per Ampere's Circuital law : $\oint \vec{B}.d\vec{l} = \mu_o I$	½	
	(i) For $r < a$ I_e = current enclosed by Amperian circuital loop of radius r $= I.\frac{\pi r^2}{\pi a^2} = \frac{Ir^2}{a^2}$	½	
	$\therefore B \oint dl = \mu_o . I_e = \frac{\mu_o I r^2}{a^2}$ Or $B = \frac{\mu_o I r^2}{a^2}.\left(\frac{1}{2\pi r}\right) = \left(\frac{\mu_o}{2\pi}\frac{I}{a^2}\right) r$	½	
	(ii) For $r > a$ $\oint \vec{B}.d\vec{l} = \mu_o I$ $\therefore B.2\pi r = \mu_o I$ $or\ B = \frac{\mu_o I}{2\pi r}$	½	
	The graph of, $B\ (r)$ vs r, is as shown 	1	
	OR		
	Expression for the force on a current carrying wire ½ Obtaining the expression for the torque 2 Obtaining $\vec{\tau} = \vec{m} \times \vec{B}$ ½		

	The force, on a wire of length l, carrying a current I, in a magnetic field $\vec{B}$, is given by $\vec{F} = I\,(\vec{l} \times \vec{B})$ For a rectangular loop, places as shown, in a magnetic field $\vec{B}$,  $\lvert$Force on arm BC$\rvert$= $\lvert$Force on arm DA$\rvert$=$IlB\sin\alpha$ Where α = angle between side BC and $\vec{B}$ These two forces add up to zero as they are collinear(along the axis of the coil) and act in opposite directions. $\lvert$Force on arm AB$\rvert$= $\lvert$Force on arm CD$\rvert$=IbB These two equal and opposite forces are not collinear. The perpendicular distance between their lines of action is , as shown, $2 \times \frac{a}{2}\sin\theta = a\sin\theta$ ∴ Torque acting on the coil, has a magnitude τ, where $\tau = (IbB) \times (a\sin\theta) = IAB\sin\theta$ (A= ab = area of the coil) In vector form, $\vec{\tau} = I(\vec{A} \times \vec{B})$ But $I\vec{A} = \vec{m}$, as given ∴ $\vec{\tau} = \vec{m} \times \vec{B}$ [**Note**: Award these 3 marks, as per the given sequence, even if the student does the derivation by taking the coil in the (special) position where its two arms are parallel and the other two arms are perpendicular to the direction of $\vec{B}$]	½ ½ ½ ½ ½ ½	3
Set1,Q15 Set2,Q11 Set3,Q16	a) Definition of self inductance ½ Definition of henry ½ b) Writing two factors each for (i) Self inductance ½ + ½ (ii) Mutual inductance ½ + ½ a) The self inductance, L, of a coil equals the magnetic flux linked with it, when a unit current flows through it. One henry is the self inductance of a coil for which the magnetic flux, linked with it, due to a current of 1A, flowing in it, equals one weber. [**NOTE:** Also accept these two definitions based on $\varepsilon = -L\frac{dl}{dt}$] b) Self inductance of a coil depends on (i) Its geometry (area and length of a coil) (ii) Number of turns (iii) Medium within the coil **(Any Two)**	½ ½ ½ +½	

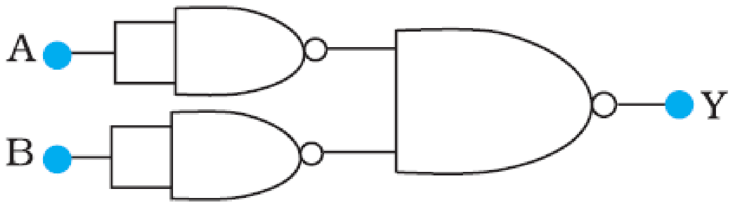
	c) Mutual inductance of a given pair of coils depends on (i) Their geometries (ii) Their distance of separation (iii) Number of turns in each coil. (iv) Nature of medium in the intervening space. **(Any Two)**	½ +½	3
Set1,Q16 Set2,Q22 Set3,Q17	Correct modified circuit diagram 1 Obtaining expression for C_o in terms of W, L and C 2 The current leads the voltage in phase. Hence , $X_C > X_L$ For resonance, we must have New value of $X_C = X_L$ We, therefore, need to decrease $X_C \left(\frac{1}{\omega c}\right)$. This requires an increase in the value of C. Hence, capacitor C_o should be connected in parallel across C. The diagram of the modified circuit is as shown.  For resonance, we then have $\frac{1}{\omega(C+C_o)} = \omega L$ $\therefore\ C_o = \left[\frac{1}{\omega^2 L} - C\right]$	½ ½ 1 ½ ½	3
Set1,Q17 Set2,Q21 Set3,Q19	Two distinct features ½ + ½ Explanation of these two features on the basis of the 'photon' picture 1+1 The two required distinct features are : (i) Maximum K.E. of emitted photoelectrons, is independent of the intensity of incident light (of a given frequency). (ii) No photoemission takes place from a given photo emitting surface if the frequency (wavelength) of the incident light is less than (more than) a critical or threshold frequency (wavelength). We can understand these features on the basis of the photon theory as follows. (i) Increase in intensity increases only the number of incident photons but does not increase the energy (=$h\nu$) of these photons. Hence, there is no increase in the maximum K.E. of, the emitted photoelectrons. (ii) No photo emission can take place if the energy of the incident photon (=$h\nu = \frac{hc}{\lambda}$) is less than the work function of the photo emitting surface. Hence, there is a minimum (maximum) critical or threshold frequency (wavelength) for given photo emitting surface.	½ ½ ½ +½ ½ +½	3

Set1,Q18
Set2,Q20
Set3,Q21

a) Identifying the required gate in each case	½ + ½
b) Drawing the logic circuits for the two cases	½ + ½
c) Writing the truth table for each of the two designs	½ + ½

a) The gate that gives a 'low' output only when both its inputs are low, is an OR gate ½

The required design is as follows.



½

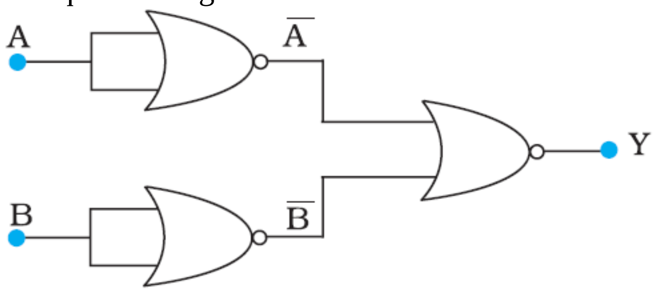
The 'truth table' is as follows

Input		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

½

b) The gate that gives a high output only when both the inputs are high, is an AND gate. ½

The required design is as follows:



½

The 'truth table' is as follows.

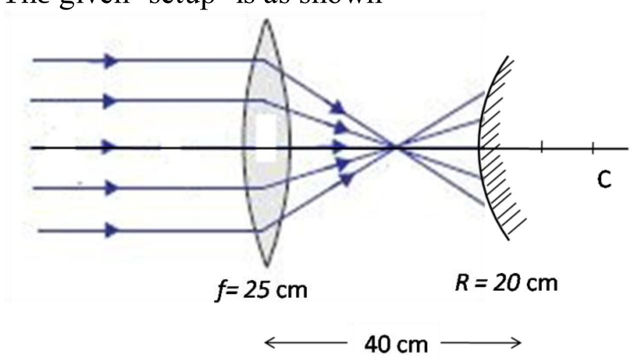
Input		Output
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

½

3

Set1,Q19
Set2,Q19
Set3,Q14

Reason for each case	1+1+1

	a) The ionosphere can act as a 'reflector' only for e.m. waves of frequencies upto 30 to 40MHz. Higher frequency e.m. waves penetrate the atmosphere and escape. b) The range is (fairly) limited because the e.m. waves loose energy (fairly rapidly) when they glide over the surface of the earth. c) This is because of the presence of a network of base stations' / cells' which keep on passing the signals from one base station / cell to the other.	1 1 1	3
Set1,Q20 Set2,Q18 Set3,Q22	Finding charge stored ½ Writing new value of capacitance ½ Finding energy stored before and after the dielectric insertions 2 Charge stored, $Q= CV= 20\times 10^{-6} \times 100\text{C}$ $= 2000\mu\text{C}$ New value of capacitance = $5 \times 20\mu\text{F}$ $= 100\ \mu F$ Energy stored in a capacitor $=\frac{1}{2}\frac{Q^2}{C}\left(=\frac{1}{2}CV^2=\frac{1}{2}QV\right)$ (i) $\therefore$ Energy stored before dielectric $=\frac{1}{2}\times\frac{[2000\times 10^{-6}]\times(2000\times 10^{-6})}{20\times 10^{-6}}$ $= 0.1$ J (ii) Energy stored after the dielectric is introduced ($\therefore$ there is no change in the value of Q) $=\frac{1}{2}\times\frac{2000\times 10^{-6}\times 2000\times 10^{-6}}{100\times 10^{-6}}$ J $= 0.02$ J	½ ½ ½ ½ ½ ½	3
Set1,Q21 Set2,Q17 Set3,Q15	Diagram of the setup 1 Finding the position of the image formed by the convex lens ½ Finding the position of the final image 1 ½ The given 'setup' is as shown  The object, being at infinity, the image formed by the convex lens, is at its focus, i.e. 25 cm from the lens For the convex mirror, Object distance = (40 - 25) cm = 15 cm	1 ½	

| Radius of curvature | = R = 20 cm
$\therefore u$ = -15cm; R = +20cm
Using the mirror formula: ½
$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}=\frac{2}{R}$,
We get
$\frac{1}{v}=\frac{2}{20}-\left(-\frac{1}{15}\right)=\frac{1}{10}+\frac{1}{15}=\frac{1}{6}$ ½
$\therefore v=+6\text{cm}$ ½
The final image is, therefore, a virtual image that appears to be formed (behind the convex mirror) at a distance of 6 cm from it. **3**

Set1,Q22
Set2,Q16
Set3,Q11

Finding v_o *and* ω for the applied voltage	½ + ½
Calculating the peak value of current in each case	½ + ½
Writing the expression for current for the (i) Inductor (ii) capacitor	½ + ½

For the applied volatge
V= 70.7sin(1000 t), we have
V_o= 70.7 volts ½
$\omega = 1000\ s^{-1}$ ½
<u>For the inductor</u>
$i_o=\frac{V_o}{\omega L}=\frac{70.7}{1000\times 200\times 10^{-3}}$ A

= 35.35×10^{-2}A
= 0.3535A ½
$\therefore$ Expresion for current is ½
$i=(0.3535)\sin\left(1000t-\frac{\pi}{2}\right)$
<u>For the capacitor</u>

$$i_o=\frac{V_o}{\left(\frac{1}{\omega C}\right)}=V_o.\omega C$$

= $70.7\times 1000\times 5\times 10^{-6}$A ½
= 353.5×10^{-3}A = 0.3535 A
$\therefore$ Expression for current is
I = 0.3535 $\sin\left(1000t+\frac{\pi}{2}\right)$ ½ **3**

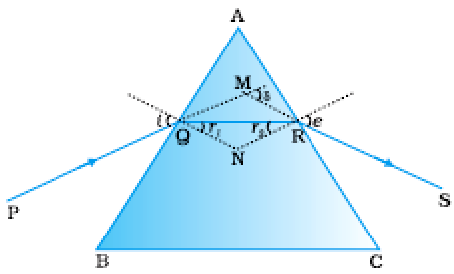
Section D

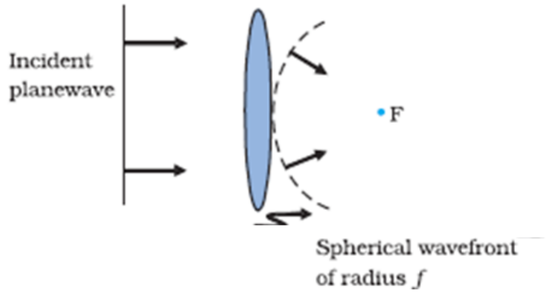
Set1,Q23
Set2,Q23
Set3,Q23

a) Phenomenon	1
b) Conditions	1
c) Two values displayed by Ravi and old man	2

a) Ravi was referring to the phenomenon of total Internal Reflection 1
Alternatively:
Development of techniques for rapid transmission of e.m. waves /setting up of linking network
(or development of mobile telephony)

b) Conditions required for the occurrence of total internal reflection:

	1. Angle of incidence > Critical Angle 2. Light should travel from denser to rarer medium **Alternatively:** (i) Setting up of appropriate transmission cable network/antennas (ii) Availability of appropriate transducers (or setup of mobile cell network) c) <u>Ravi</u> Helpful (concerned) nature <u>oldman</u> Thankful (Grateful)	½ ½ 1 1	 4
	Section E		
Set1,Q24 Set2,Q25 Set3,Q26	a) Identifying the device ½ Ray diagram 1 Obtaining the expression for μ 2 ½ b) Drawing the shape of the wavefront 1 a) The device is a prism. The Ray diagram, for this device is as shown,  For the quadrilateral AQNR, we have $\angle A + \angle QNR = 180^o$ For triangle QNR, we have $\angle r_1 + \angle r_2 + \angle QNR = 180^o$ $\therefore (r_1 + r_2) = A$ Also, form ΔMQR, we have $\angle\delta = \angle MQR + \angle MRQ$ $= (\angle i - \angle r_1) + (\angle e - \angle r_2)$ $\therefore \angle\delta = i + e - (r_1 + r_2) = (i + e - A)$ When $\delta = \delta_m$, we must have $i = e$ and $r_1 = r_2$ $\therefore \delta_m = 2i - A$ or $i = \frac{\delta_m + A}{2}$ Also, $r_1 + r_2 = 2r_1 = A$ or $r_1 = \left(\frac{A}{2}\right)$ $\therefore \mu = \frac{Sin\ i}{Sin\ r} = \frac{Sin\ (A+\delta_m)}{Sin(\frac{A}{2})}$ b) The required shape of the wavefront is as shown	 ½ 1 ½ ½ ½ ½ ½	



1

5

OR

a)	Naming the phenomenon	½
	Condition for : Central Maxima	1
	Secondary Maxima	1
	Minima	1
b)	Reason	1
c)	Effect on the size of the central band	½

The phenomenon observed is the phenomenon of diffraction ½

a) At the central maxima: The contributions due to the secondary wavelets , from all parts of the wave front(at the slit), arrive in phase at the central maxima, At the central maxima θ =0 1

At the secondary maxima

It is only the contributions from (nearly) 1/3 (or 1/5, or 1/7,…) of the incident wavefront that do not get cancelled at the locations of the secondary maxima. These occur at points for which

$\theta \cong \left(n+\frac{1}{2}\right)\frac{\lambda}{a}$ (n=0,1,2,3,….) ½

At the minima

The contributions, from 'corresponding pairs', of the sub-parts of the incident wavefront, cancel each other and the net contribution, at the location of the minima, is zero. The minima occur at points for which

$\theta = n\frac{\lambda}{a}$(n=1,2,3,….) 1

[Note: Award these (1+1+1) marks if the student draws the diagram shown and writes the conditions, for θ, for the three cases.] ½

b) There is a significant fall in intensity at the secondary maxima because the intensity there, is only due to the contribution of (nearly)(1/3 or 1/5 or 1/7,……) of the incident wavefronts. 1

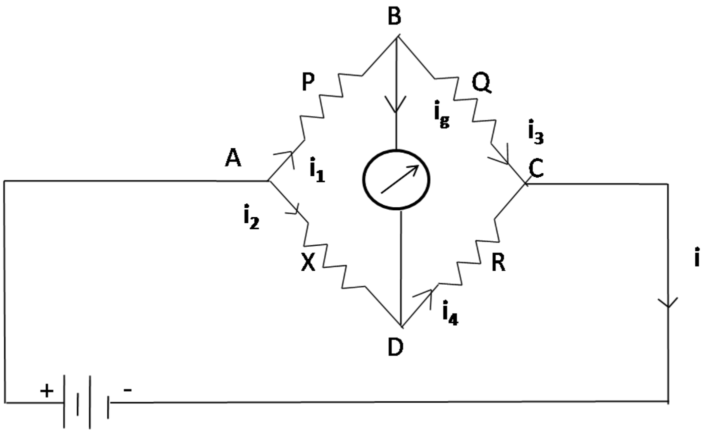
c) The size of the central maxima would get halved when width of the slit is doubled. ½

5

Set1,Q25
Set2,Q26
Set3,Q24

(a)	Obtaining the condition	2
(b)	Brief description of the device	1
	Circuit Diagram	1
	Finding the unknown resistance	1

The given circuit can be redrawn as shown:



½

It is, therefore, a wheatstone bridge. ½

Using Kirchoff's laws, we get (when i_g=0)

$i_1=i_3$

and $i_2=i_4$

For the loop ABDA, we have ½

$-i_1P+i_2X=0$ or $i_1P=i_2X$

For the loop BCDB, we have ½

$-i_3Q+i_4R=0$ or $i_3Q=i_4R$

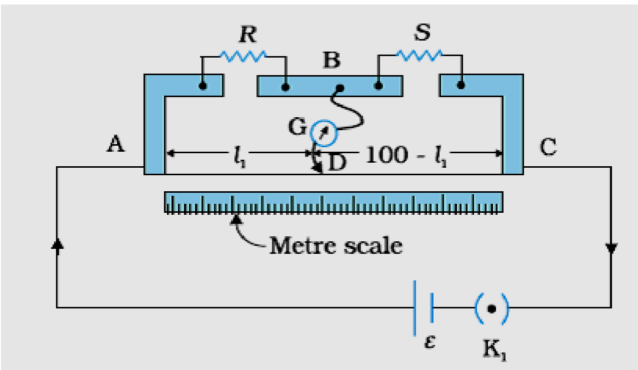
Dividing we get,

$$\frac{i_1P}{i_3Q}=\frac{i_2X}{i_4R}$$

$$or\ \frac{P}{Q}=\frac{X}{R}\ (\because i_1=i_3\ and\ i_2=i_4)$$ ½

(a) A simple device, based on the above condition, is the meter bridge. It has a (uniform crossection) wire of length 1m stretched taut between two thick metallic clamps. It has two gaps for connecting a resistance box and the unknown resistance. ½

The circuit diagram, for the meter bridge, is shown here.



1

We move the jockey, on the wire of the meter bridge, till we find a point at which the deflection in G, is zero. We can have

$$\frac{R}{l_1} = \frac{S}{l_2}$$

$$or\ S = R\left(\frac{l_2}{l_1}\right)$$ ½

Knowing r, and finding l_1 and l_2(=(100-l_1)), we can easily calculate S ½

5

OR

(a) Reason	½
Definition of drift velocity	1
Obtaining expression for current	2 ½
(b) Showing that $\rho \propto \frac{1}{\tau}$	1

(a) The free electrons, in a metal, (flowing by themselves), have a random distribution of their velocities. Hence the net charge crossing any cross section, in a unit time, is zero. ½

The <u>'drift velocity '</u>equals the average (time dependant) velocity acquired by free electrons, under the action of an applied (external) electric field. 1

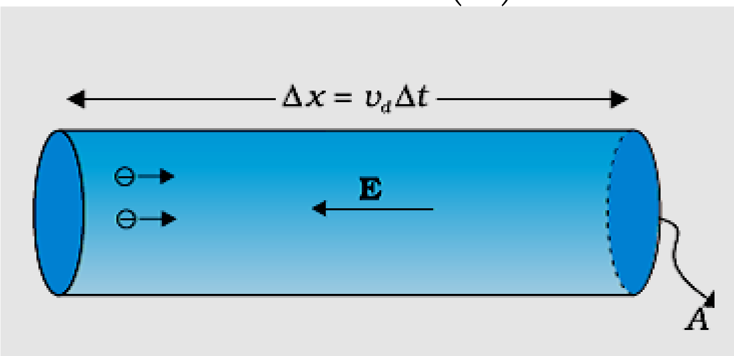
We have, for an applied electric field $\vec{E}$,

$$\vec{a} = -\frac{e\vec{E}}{m}$$ ½

$$\therefore\ \vec{v_d} = (\vec{v_i})_{average} = -\frac{e\vec{E}}{m}(t)_{average}$$ ½

The average time, between successive collisions, is called the 'relaxation time' and is denoted by τ

$$\therefore \vec{v_d} = -\left(\frac{e\vec{E}}{m}\right)\tau$$ ½



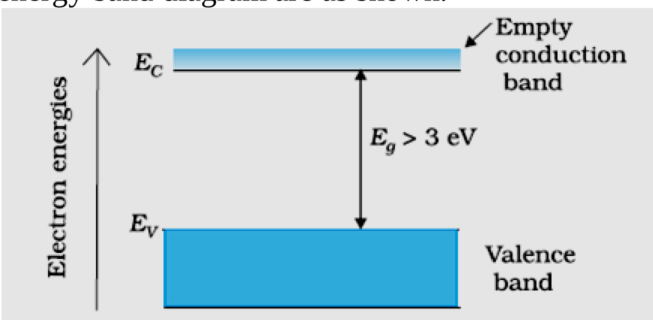
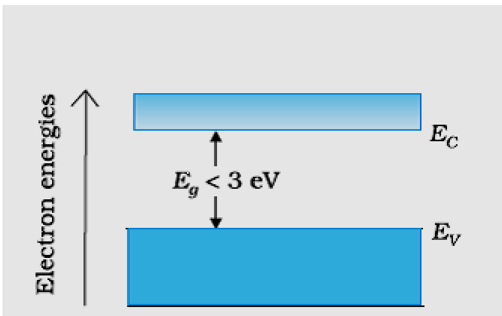
½

Because of the drift, we can write

$$I\Delta t = +neA|\vec{v_d}|\Delta t$$

$$= \frac{ne^2A}{m}\tau\ \Delta t\ |\vec{E}|$$

$$But\ I = |\vec{j}|A$$

	$\therefore \ \|\vec{j}\| = \frac{ne^2}{m}\tau\|\vec{E}\|$ $But\ \|\vec{j}\| = \sigma\|\vec{E}\|$ $\therefore \sigma = \text{conductivity} = \frac{ne^2}{m}\tau$ Also we can write, $I = neAv_d$ (b) We have $\rho = \frac{1}{\sigma} = \frac{m}{ne^2\tau}$ $\therefore \rho \propto \frac{1}{\tau}$	½ ½ ½	5
Set1,Q26 Set2,Q24 Set3,Q25	Energy band diagrams for the two cases — 1+1 Effect on energy bands — ½ + ½ Reasons — ½ + ½ Naming the two processes — ½ + ½ The required energy band diagram are as shown:   (a) When the semiconductor is doped with an acceptor impurity there is an additional energy level a little above the top of the valence band. (b) The donor impurity results in an additional energy level a little below the bottom of the conduction band. **(Also accept diagrammatic representations)** In the first case, electrons, from the valence band, easily jump over to the acceptor level, leaving 'holes' behind. Hence, 'holes' become the majority charge carriers.	1 1 ½ ½ ½	

In the second case,electrons from the donor level, easily 'jump over' to the conduction band. Hence, electrons become the majority charge carriers. ½

The two processes, involved in the formation of the p-n junction are:

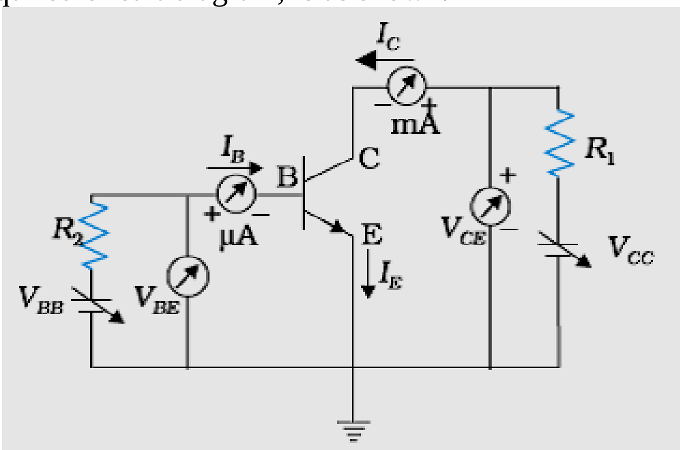
(i) Diffuson ½

(ii) Drift ½ 5

OR

(a) Circuit diagram	1 ½
Brief description	1
Drawing the characteristics	½ + ½
(b) Definitions	½ + ½ + ½

(a) The required circuit diagram, is as shown:

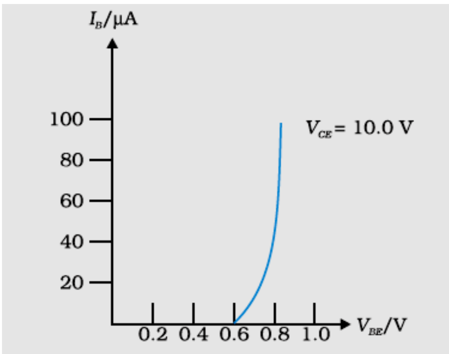


1 ½

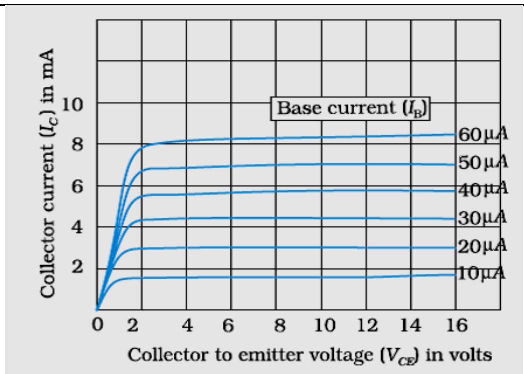
For obtaining input characteristics, keep V_{CE} constant and study the dependence of I_B on V_{BE}. ½

For obtaining output characteristics, keep I_B constant and study the dependence of I_C on V_{CE}. ½

The shapes of the two types of charcteristics are as shown:



½

	 (b) (i) Input Resistance: $$r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$$ (ii) Output Resistance: $$r_o = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)_{I_B}$$ (iii) Current amplification factor: $$\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$$	½ ½ ½ ½	5