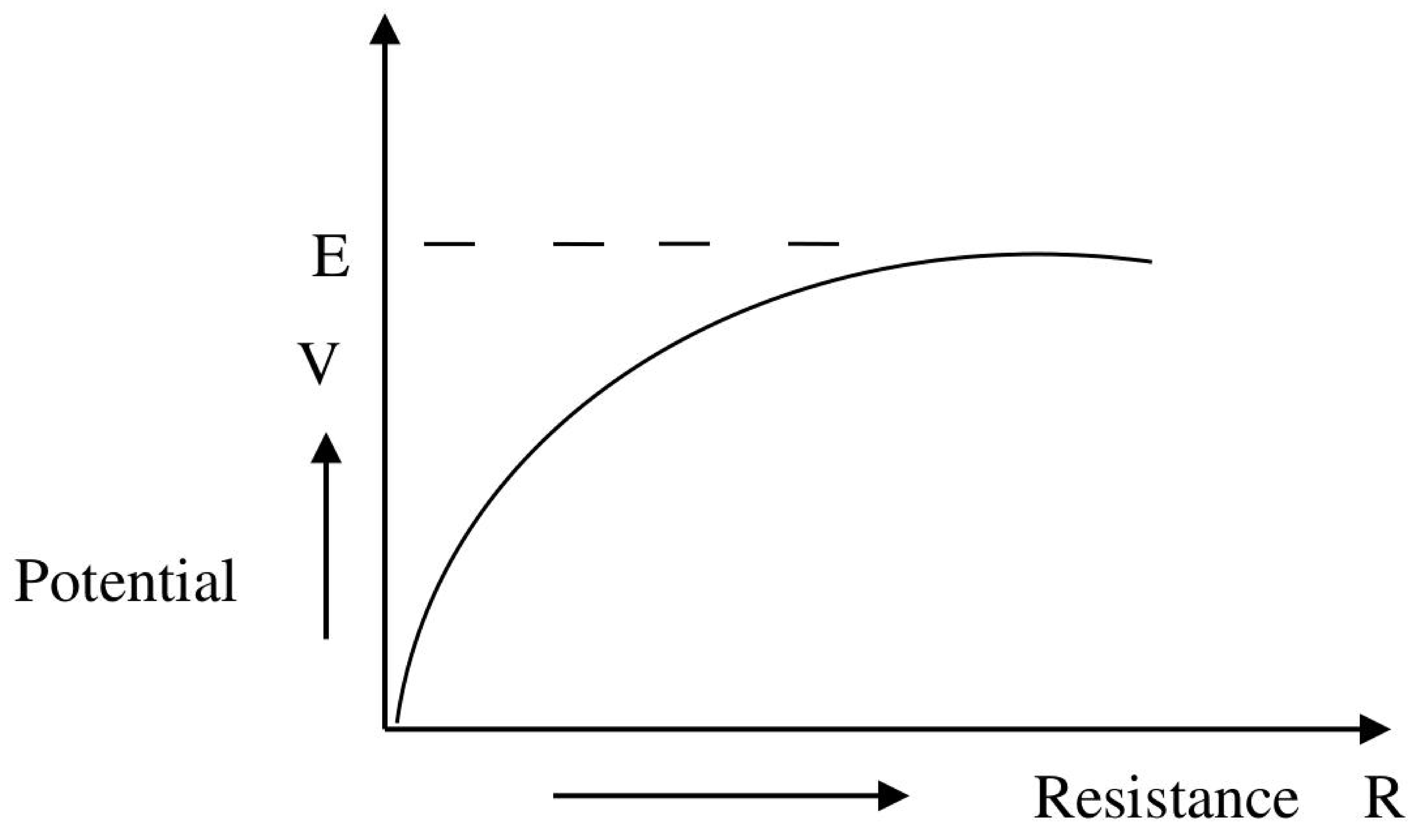
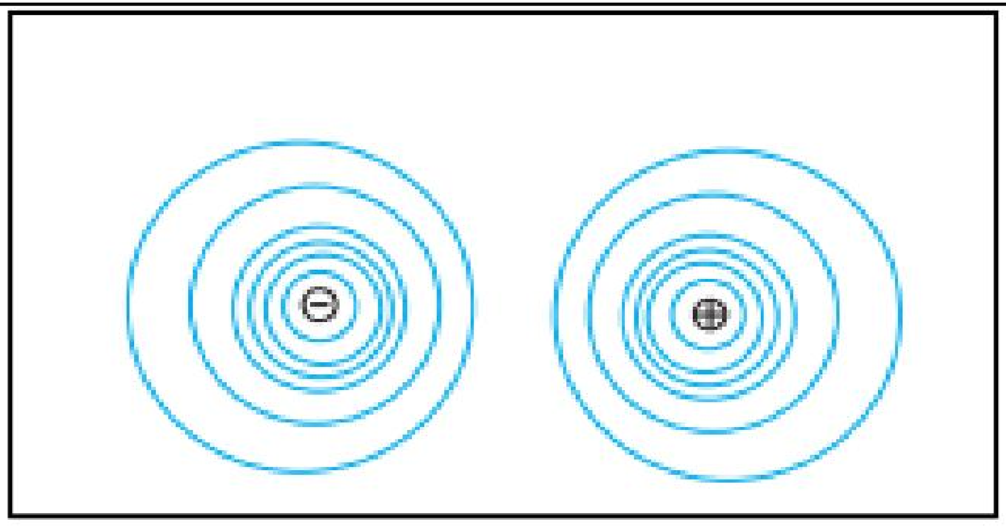
Marking Scheme: Physics (042)

Code :55/C/1

Q.No.	VALUE POINTS/ EXPECTED ANSWERS	Marks	Total Marks
	SECTION- A		
1.	(C) Remains unchanged	1	1
2.	(C) $\frac{F}{2}$	1	1
3.	(B) evr	1	1
4.	(C) $\left(\frac{r_1}{r_2}\right)^2$	1	1
5.	(C) Perpendicular to each other and in the same phase.	1	1
6.	(A) $+\frac{d}{4}$	1	1
7.	(C) 1	1	1
8.	(C) A neutron is converted into a proton and the created electron is ejected from the nucleus.	1	1
9.	(C) III	1	1
10.	(D) Number of both the free electrons and holes increases equally.	1	1
11.	Lower	1	1
12.	$\frac{h}{\pi}$ OR 9×10^{14}J	1	1
13.	Red	1	1
14.	2π	1	1
15.	90°	1	1
16.	X Alternatively Slope = $\frac{1}{R}$ R= $\rho \frac{l}{A}$ $R_x > R_y$ (Award half mark of this question, if a student writes the correct answer in terms of Resistance.)	1	1

17.	$[ML^2T^{-2}A^{-2}]$	1	1
18.	 Alternatively $V = E - Ir$ $V = E - \left(\frac{E}{R+r}\right)r$ (Award half mark of this question to the student if he/she write just formula.)	1	1
19.	Virtual (Note: Award half mark if a child shows that focal length will become negative using Lens maker formula and does not conclude about nature of image.)	1	1
20.	X is α-particle (Note: Award half mark when a child finds out the correct atomic number and mass number of D_2 i.e 70 & 176) OR curves 1 & 2	1	1
	SECTION- B		
21.	(a) Depiction of equipotential surfaces 1 (b) Finding the amount of work done 1 **(a)**		

	 (b) W= q_0 Δ V As a small test charge q_o is moving along x-axis which is equipotential line for a given system, therefore $\Delta V = 0$ Hence W=0	1 $^1/_2$ $^1/_2$	2
22.	(a) Sequence of color bands — 1 (b) Two properties of wire — $(\frac{1}{2}+\frac{1}{2})$ (a) Yellow , Violet, Orange and Silver (Note: if student does not write silver award half mark of this part.) (b) (1) Low temperature coefficient of Resistivity. (2) High Resistivity	1 $^1/_2$ $^1/_2$	2
23.	(a) Calculation of Impedance of Circuit — $1^1/_2$ (b) Calculation of peak value of current — $^1/_2$ (a) $X_c = \frac{1}{\omega C} = 100\ \Omega$ $X_L = \omega L = 400\ \Omega$ $R = 400\ \Omega$ $Z = \sqrt{R^2 + (X_L - Xc)^2} = 500\ \Omega$ (b) $I_o = \frac{V_0}{Z} = \frac{40}{500} = 0.08$ A	$^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$	2

24.

Reason for Infrared Radiation referred as heat waves	1
Name the Radiation which lies	
(a) Shorter Wavelength side	$^1/_2$
(b) Longer Wavelength side	$^1/_2$

Water molecules present in most material readily absorb IR waves After Absorption thermal motion increases. Due to which, they heat up & heat their surroundings. — 1

(a) Visible — $^1/_2$

(b) Microwave — $^1/_2$

Total: 2

25.

Formula for half life	$^1/_2$
Calculation of half life	1
Calculation of Critical mass	$^1/_2$

$N = N_o \left(\frac{1}{2}\right)^n$ — $^1/_2$

$\frac{1}{16} N_o = N_o \left(\frac{1}{2}\right)^n$

$n = 4$ — $^1/_2$

$t = n \times T_{1/2}$

$T_{1/2} = \frac{t}{n} = \frac{4}{4} = 1$ day — $^1/_2$

$N = N_o \left(\frac{1}{2}\right)^n = N_o \left(\frac{1}{2}\right)^{\frac{t}{T\frac{1}{2}}}$

$4 = N_o \left(\frac{1}{2}\right)^6$ — $^1/_2$

$N_o = 256$ g

Alternative Method

$N = N_o\, e^{-\lambda t}$ — $^1/_2$

$\frac{1}{16} N_o = N_o\, e^{-\lambda 4}$

$16 = e^{4\lambda}$

$4 \log_e 2 = 4\lambda$

$4 \times 2.303 \times 0.3010 = 4\lambda$

$\lambda = 0.693$ per day — $^1/_2$

Half life

$T_{1/2} = \frac{0.693}{\lambda} = \frac{0.693}{0.693} = 1$ day — $\frac{1}{2}$

$4 = N_o\, e^{-\lambda t}$

$N_o = 256$ g — $\frac{1}{2}$

(Note: Give full credit of this part, if student substitutes values correctly and is not able to calculate final answer.)

OR

Formula	$\frac{1}{2}$
Conversion of kinetic energy in Joule	$\frac{1}{2}$
Finding the distance of closest approach	1

$d = \frac{q_1 q_2}{4\pi\epsilon_0\, K}$ — $\frac{1}{2}$

kinetic energy= 5.12 MeV — $\frac{1}{2}$

$= 5.12 \times 1.6\times10^{-13}$ J

$= 8.192\times10^{-13}$ J

$d = \frac{q_1 q_2}{4\pi\epsilon_0\, K} = \frac{9\times10^{9}\times2e\times79e}{8.192\times10^{-13}}$ m — $\frac{1}{2}$

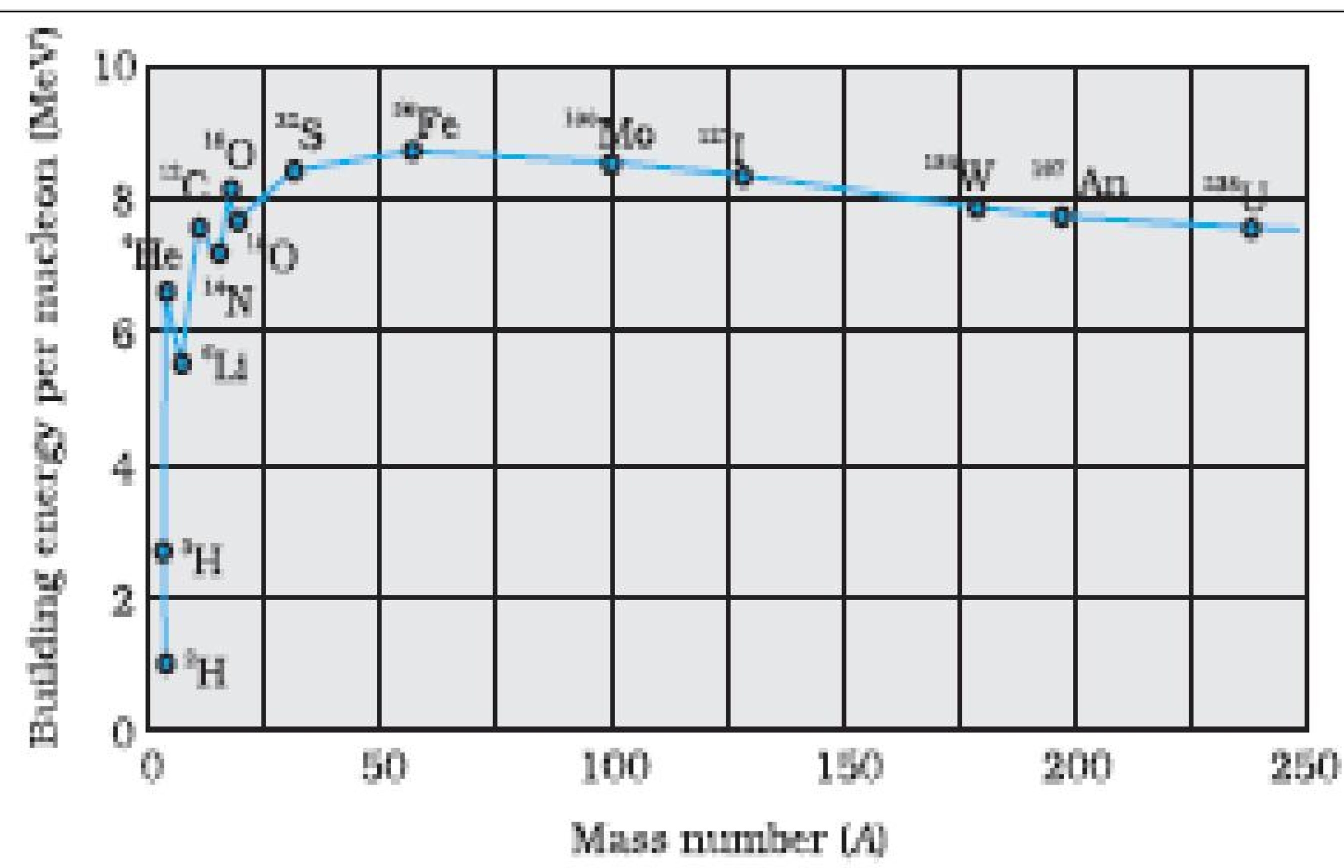
$= 4.443\times 10^{-14}$ m

$= 44.4 \times 10^{-15}$ m — $\frac{1}{2}$

Total: 2

26.

Binding energy curve	1
Explanation of middle flat portion of the curve	1



— 1

Note: please don't deduct marks if student does not mark all the nuclei on the curve.

The nuclei lying at the middle flat portion are more stable because their binding energy

	per nucleon is large and shows more stability.	1	2

27.

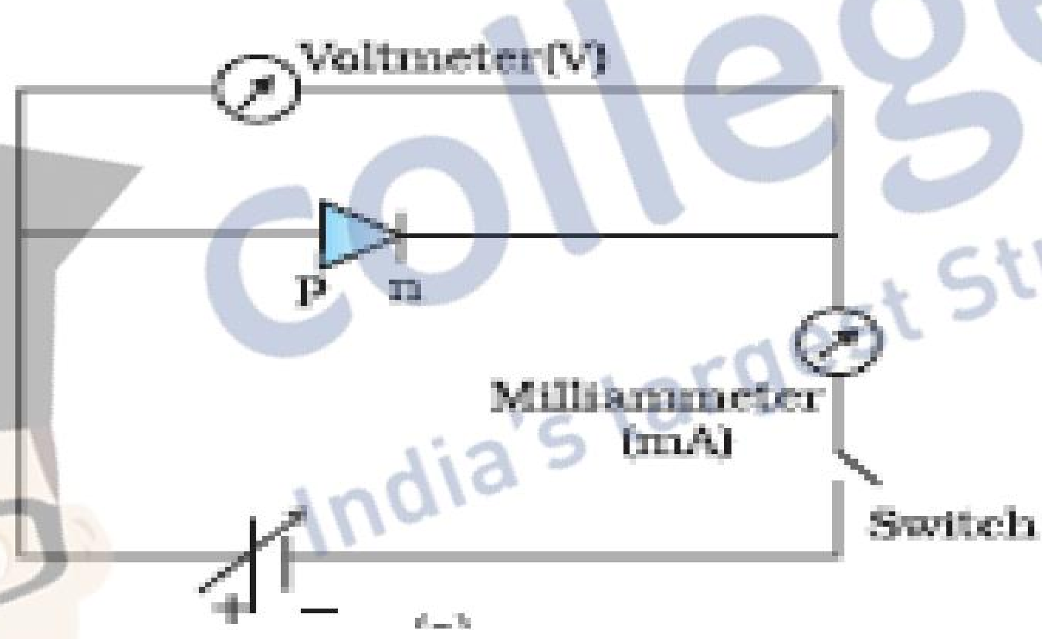
Reason for part (a)	1
Reason of part (b)	1

(a) Zener diode is fabricated by heavy doping of both p-side, and n-side of the junction. Due to this, depletion region formed is very thin and the electric field of the junction is extremely high. — 1

(b) It is easier to observe the change in the current with change in the light intensity, if reverse bias is applied. — 1

OR

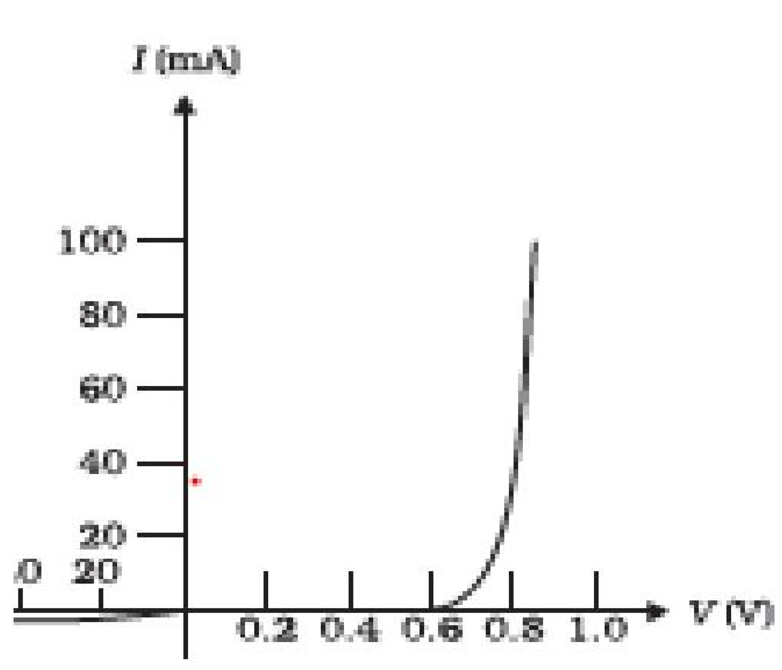
Circuit Diagram	$1/2$
Working of p-n junction	1
I-V Characteristics	$1/2$



$1/2$

In the forward bias the width of depletion layer decreases and barrier height is reduced. It supports the movement of majority charge carriers across the junction.
As soon as supply voltage exceeds barrier potential instantaneously current begins to flow through junction and increases exponentially with forward biasing voltage. — 1
(Note: Accept any other relevant explanation for working)

I-V characteristics



$1/2$ — 2

SECTION- C

28.

Explanation of part (a)	1
Explanation of part (b)	1
Explanation of part (c)	1

(a) Electric field increases — 1

$E=\frac{V}{l}=\frac{IR}{l}=\frac{I\rho l}{Al}=\frac{I\rho}{A}$

As area (A) decreases from end A to end B, E increases

(b) current density increases — 1

$J=\frac{I}{A}$

As area (A) decreases, current density (J) increases — 1

(c) Mobility of electron remain same

$\mu=\frac{V_d}{E}=\frac{eE\tau}{mE}=\frac{e\tau}{m}$

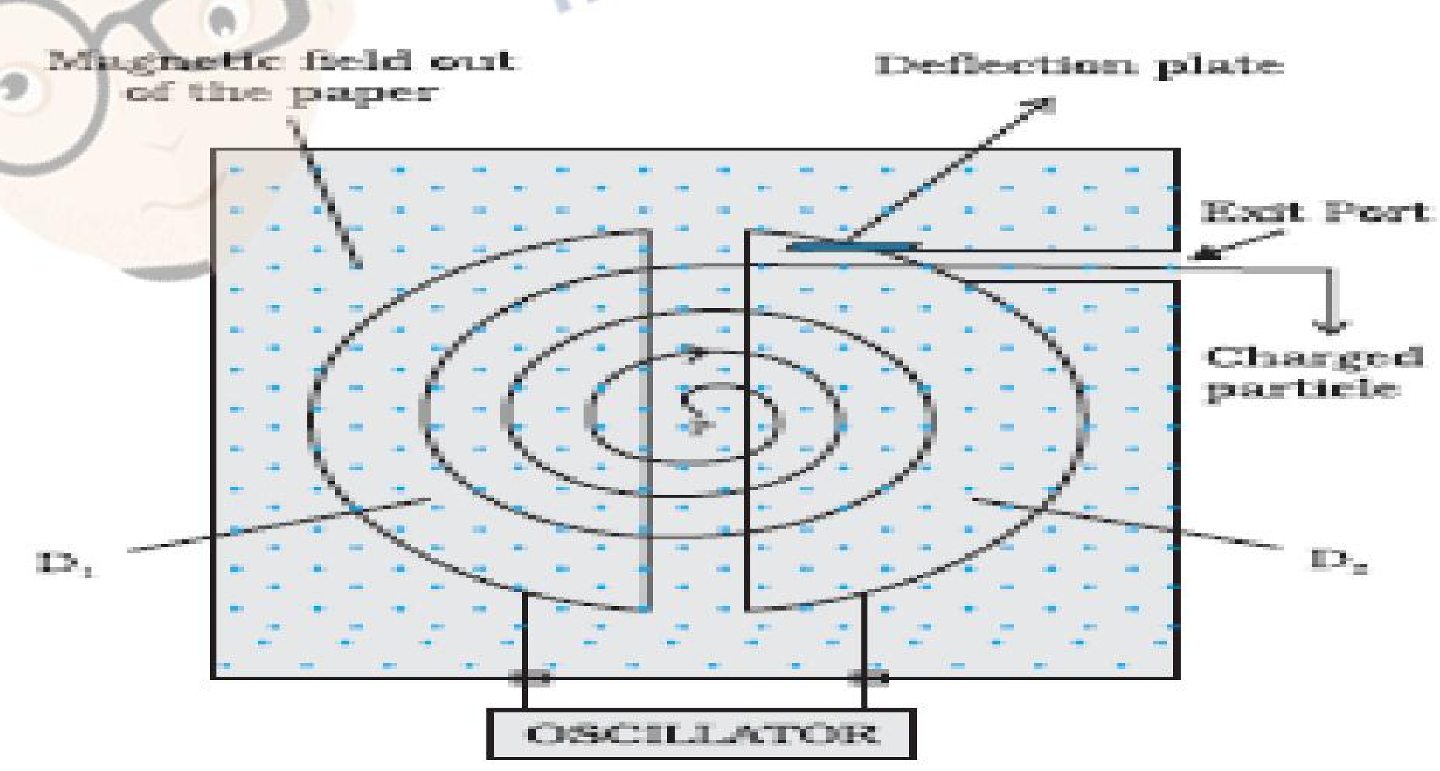
Since 'e', 'τ' and 'm' are constant therefore (μ) is constant.

(Note: please do not deduct the marks if a student does not write the explanation and just writes the answers.) — 3

29.

(a) Labeled diagram	1
Explanation of Working	1
(b) Explanation of motion on ions	1

(a)



— 1

Working: The charged particle is allowed to move under the influence of crossed electric and magnetic field, the magnetic field provides the circular path to the particle and Rotate it inside two semi circular discs, when it jumps from one disc to another disc particle is accelerated by the electric field and each time the acceleration increases the energy of the particle. — 1

(b) Ions will not get accelerated. — 1

3

30.

	(a) Working Principle of ac generator — 1 Derivation of expression for induced emf — 1 (b) Function of Slip Rings — 1		
	(a) It is based upon the principle of electromagnetic induction.	1	
	Magnetic Flux $\Phi = NBA \cos\theta$ $\Phi = NBA \cos\omega t$	$\frac{1}{2}$	
	According to Faradays law Emf e= $\frac{-d\Phi}{dt} = \frac{-d(NBA\cos\omega t)}{dt}$ e = NBA ω sin ωt	$\frac{1}{2}$	
	(b) it helps current to change its direction after every half rotation.	1	
	OR		
	Explanation of parts (a),(b) & (c) — (1+1+1)		
	(a) As power P=V I, In step-up voltage transformer output voltage (V) is more than the input voltage. Hence output current is less than the input current.	1	
	(b) To minimize the eddy currents.	1	
	(c) Input power is more than the output power because in actual transformer small energy loses occur due to flux leakage, resistance of winding, eddy current and hysteresis etc.	1	3
31.	(a) Finding the focal length of mirror — 1 $\frac{1}{2}$ (b) Calculation of displacement and direction — 1 $\frac{1}{2}$		
	(a) For virtual image m=+2 m = 2 = $\frac{-v}{u}$	$\frac{1}{2}$	
	u= -10cm v= -2u = 20 cm Using mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$	$\frac{1}{2}$	
	$\frac{1}{f} = \frac{1}{20} - \frac{1}{10}$ f = -20 cm	$\frac{1}{2}$	

(b) For real image

m= -2

m= -2 = $\frac{-v}{u}$ — $\frac{1}{2}$

v=2u

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$\frac{1}{-20} = \frac{1}{2u} + \frac{1}{u}$

2u= - 60

u= -30 cm — $\frac{1}{2}$

∴ displacement of object = 30 – 10

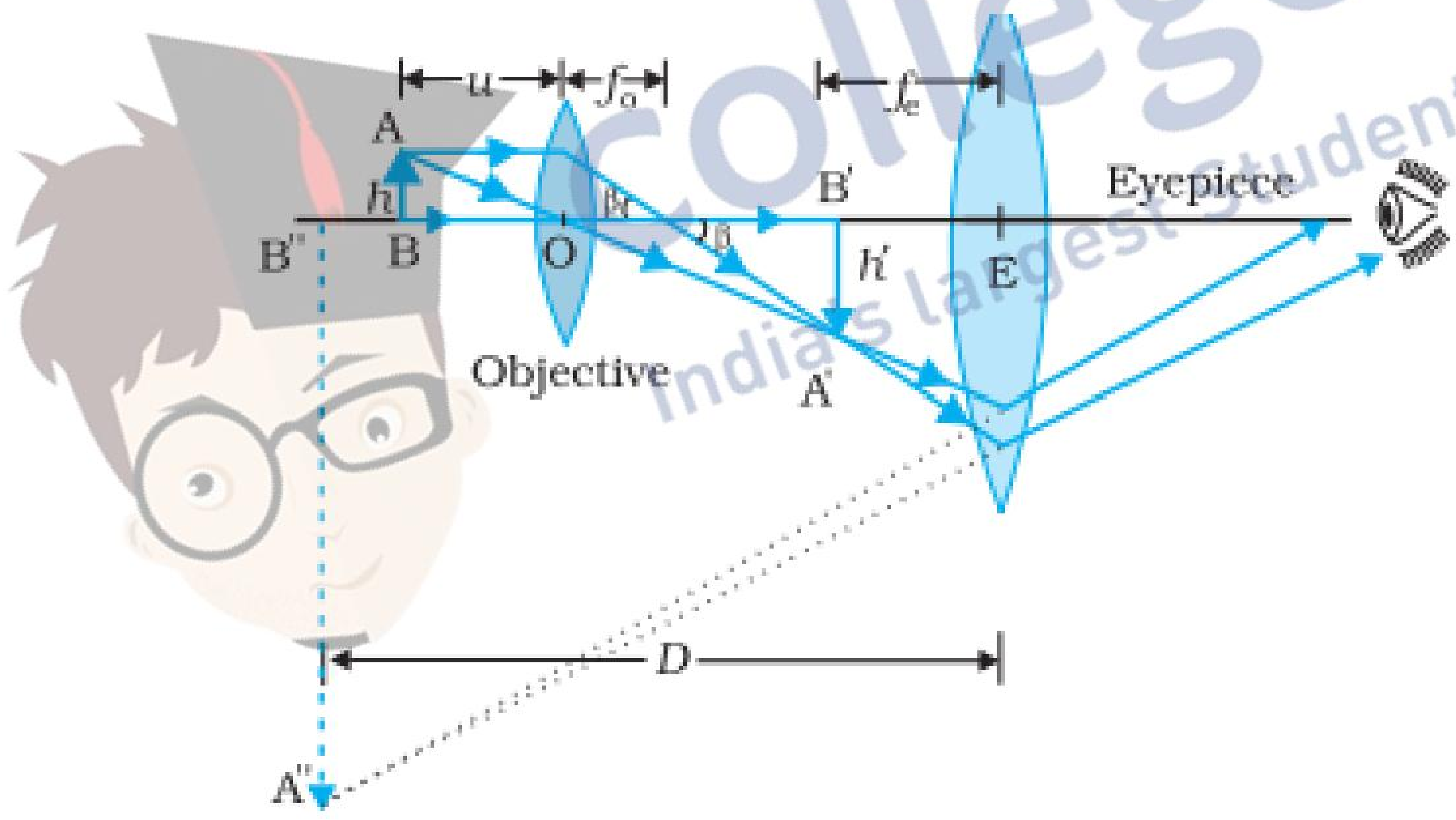
= 20 cm Away from mirror — $\frac{1}{2}$

Total: 3

32.

(a) Ray Diagram	$1\frac{1}{2}$
(b) Expression of magnifying power	$1\frac{1}{2}$

Ray diagram — $1\frac{1}{2}$



Note: deduct half mark, if a student does not mark the direction of propagation of the rays)

Expression for magnification

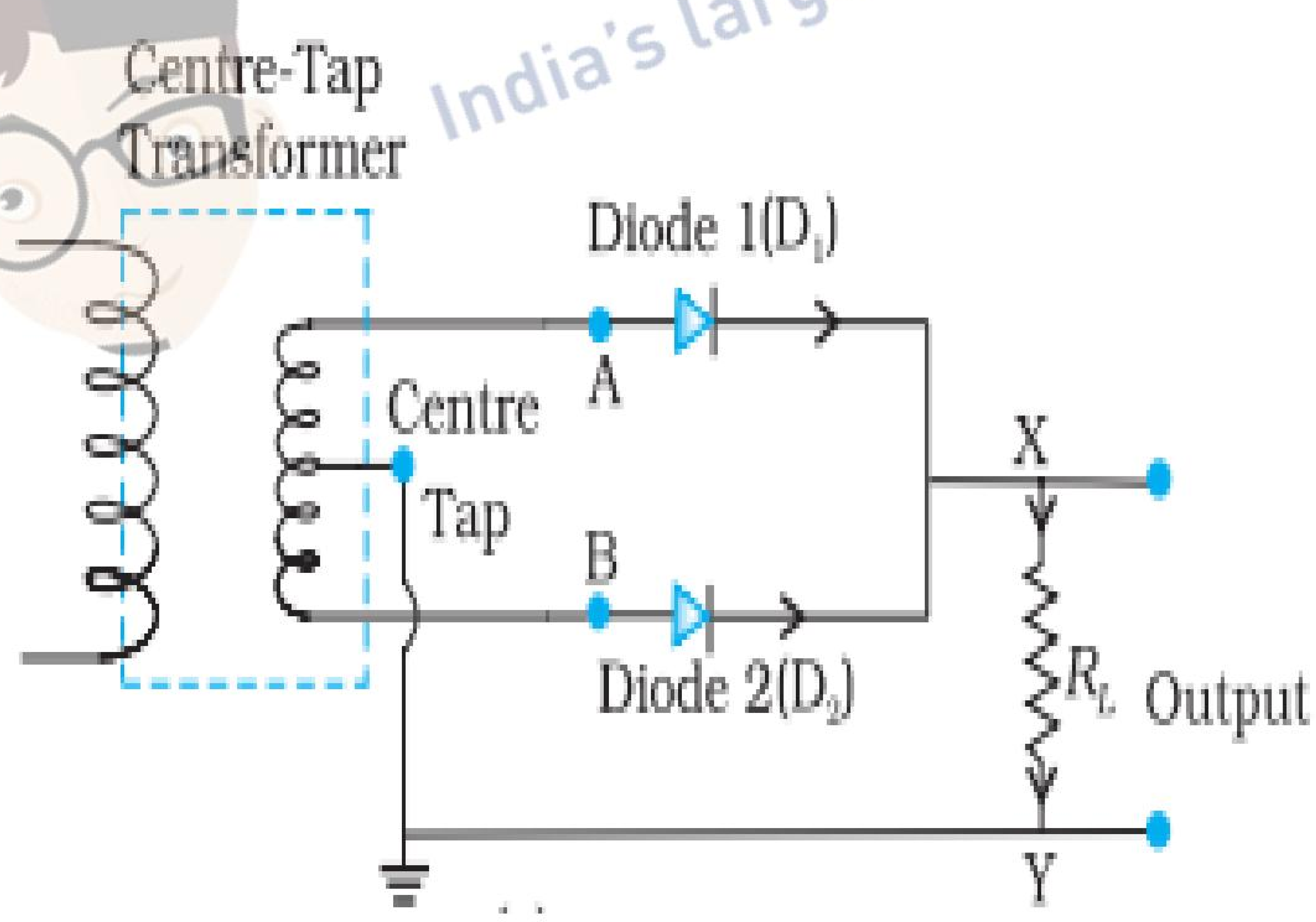
$m_o = \frac{h'}{h} = \frac{L}{f_o}$ — $\frac{1}{2}$

where we have used the result

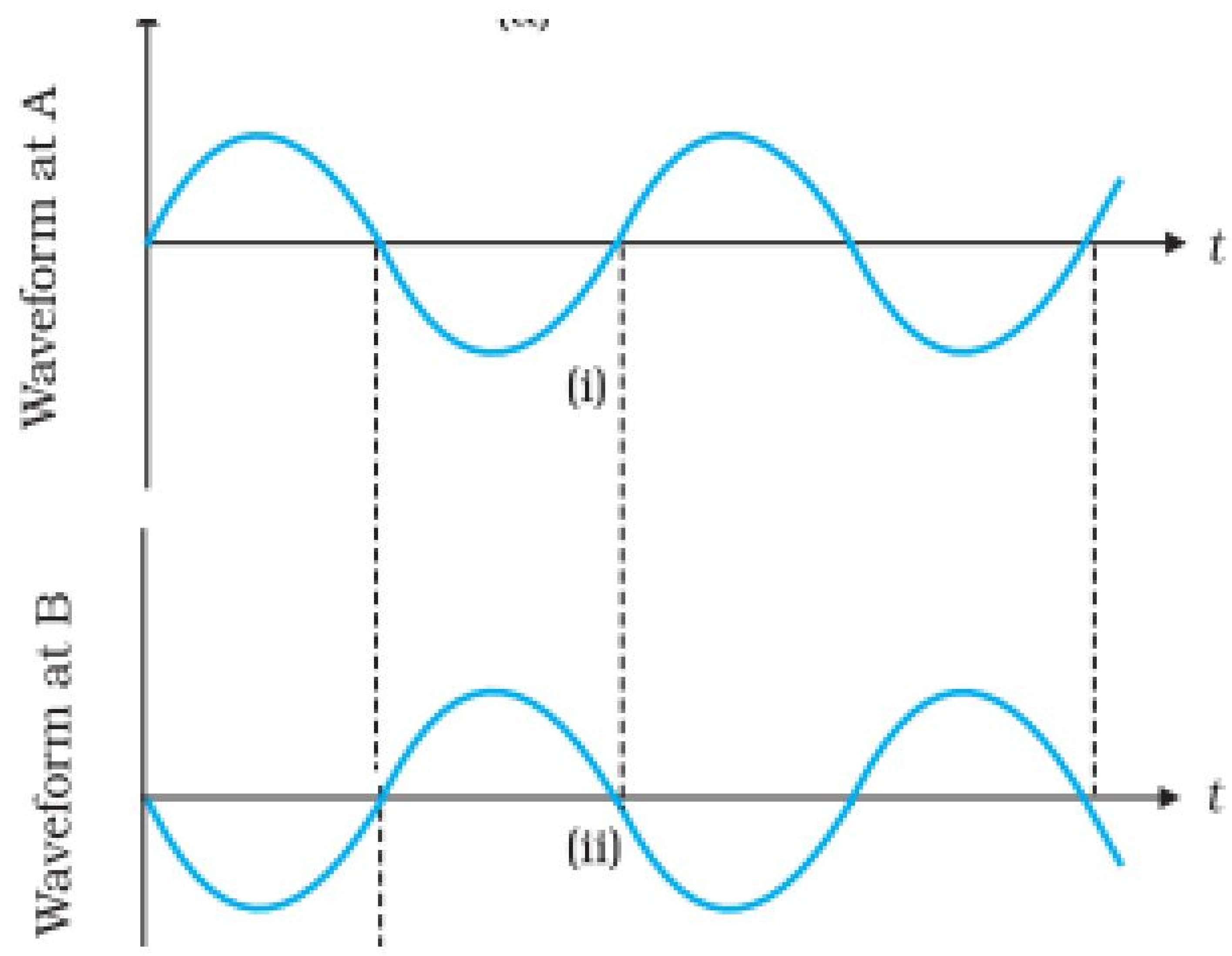
$\tan\beta = \left(\frac{h}{f_o}\right) = \frac{h'}{L}$

$m_e = \left(1 + \frac{D}{f_e}\right)$ — $\frac{1}{2}$

Magnifying power of microscope at near point.

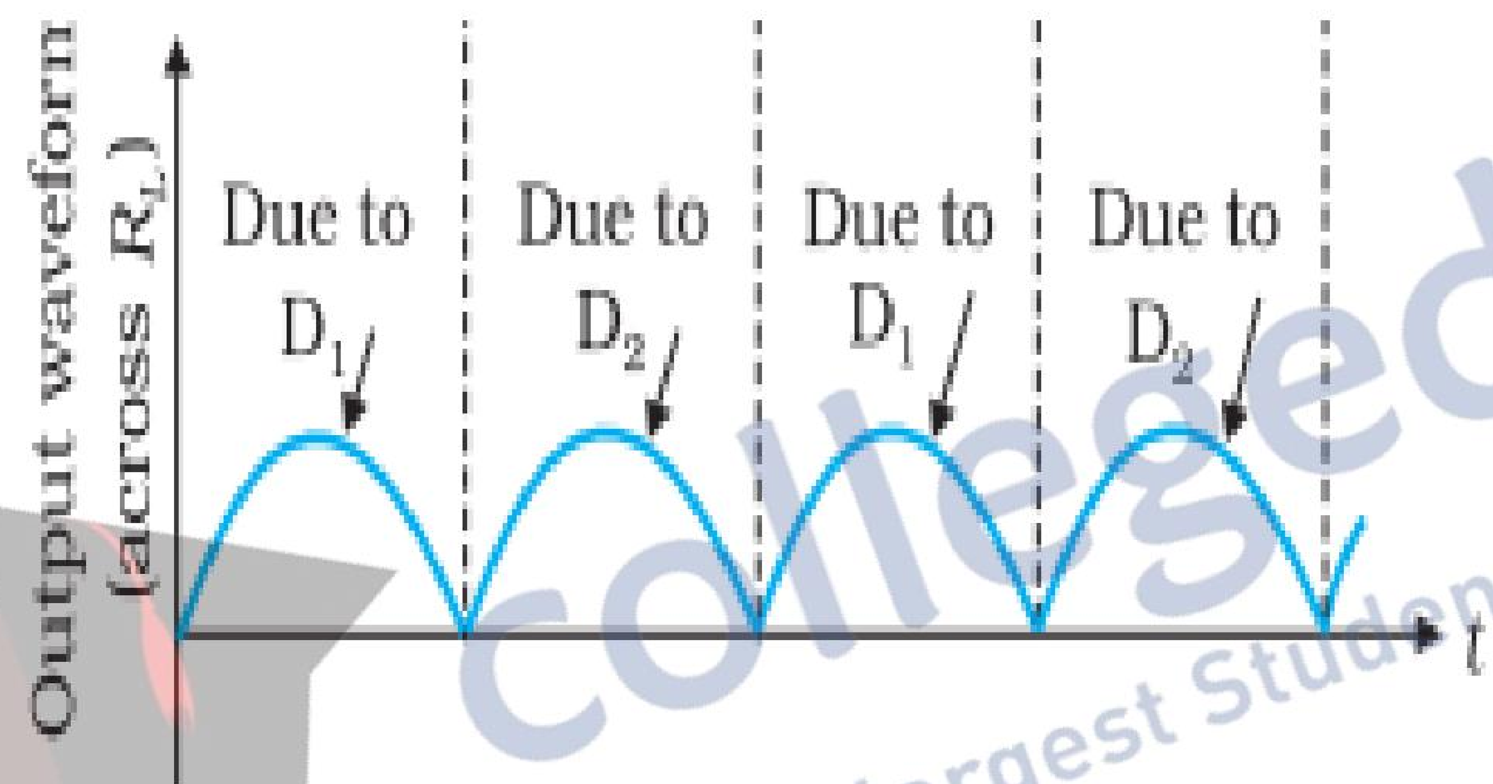
	$m = m_o\, m_e$ $m = \frac{L}{f_o}\left(1 + \frac{D}{f_e}\right)$	$^1/_2$	3
33.	(a) Calculation of kinetic energy — 2 (b) Effect of intensity of light — 1 (a) $E_{max} = \frac{hc}{\lambda} - \phi_0$ $= \left(\frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{2000 \times 10^{-10} \times 1.6 \times 10^{-19}} - 4.2 \right)$ eV $= \left(\frac{19.89}{3} - 4.2 \right)$ eV $= (6.22 - 4.2)$ eV $= 2.02$ eV (b) No effect	$^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$ 1	3
34.	Circuit Diagram — 1 Working of full wave rectifier — 1 Draw input and output waveform — 1  Working: The input voltage to A with respect to the centre tap at any instant is positive, At that instant voltage at B being out of phase will be negative. So diode D_1 gets forward biased and conducts while D_2 being reversed biased is not conducting. Hence during this positive half cycle we get an output current. In the course of the ac cycle when voltage at A becomes negative with respect to centre	1 $^1/_2$ $^1/_2$	

tap, the voltage at B would be positive. In this part of the cycle diode D_1 would not conduct but D_2 conduct and gives an output current.



½

Note: Please don't deduct mark, if a student draws only one input



½

3

SECTION- D

35.

(a) Derivation of expression for Capacitance	2
(b) Expression for the Force experienced	1
(c) Calculation of total charge stored	2

(a)

Electric field believes the plates of parallel plate capacitor.

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

We know $V = Ed = \frac{\sigma}{A\epsilon_0} d$ ½

As capautance $C = \frac{Q}{V}$ ½

$C = \frac{\epsilon_0 A}{d}$ ½

(b) Electric Field due to the positive plate on the negative plate

$E = \frac{\sigma}{2\epsilon_0} = \frac{\sigma}{2A\epsilon_0}$ ½

Hence Force experienced by negative plate due to positive plate

$F = -qE = -q \times \frac{q}{2A\epsilon_0} = -\frac{q^2}{2A\epsilon_0}$ ½

-ve sign shows attractive force.

(c) C_2, C_3 and C_4 are connected in series. ½

$$\frac{1}{Cs} = \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12}$$

Cs = 4 μF

Equivalent capacitance of the Network

$C = C_s + C_4$

= 4μF + 12 μF

= 16 μF ½

Total charge Q=CV ½

$= 16 \times 10^{-16} \times 100$ ½

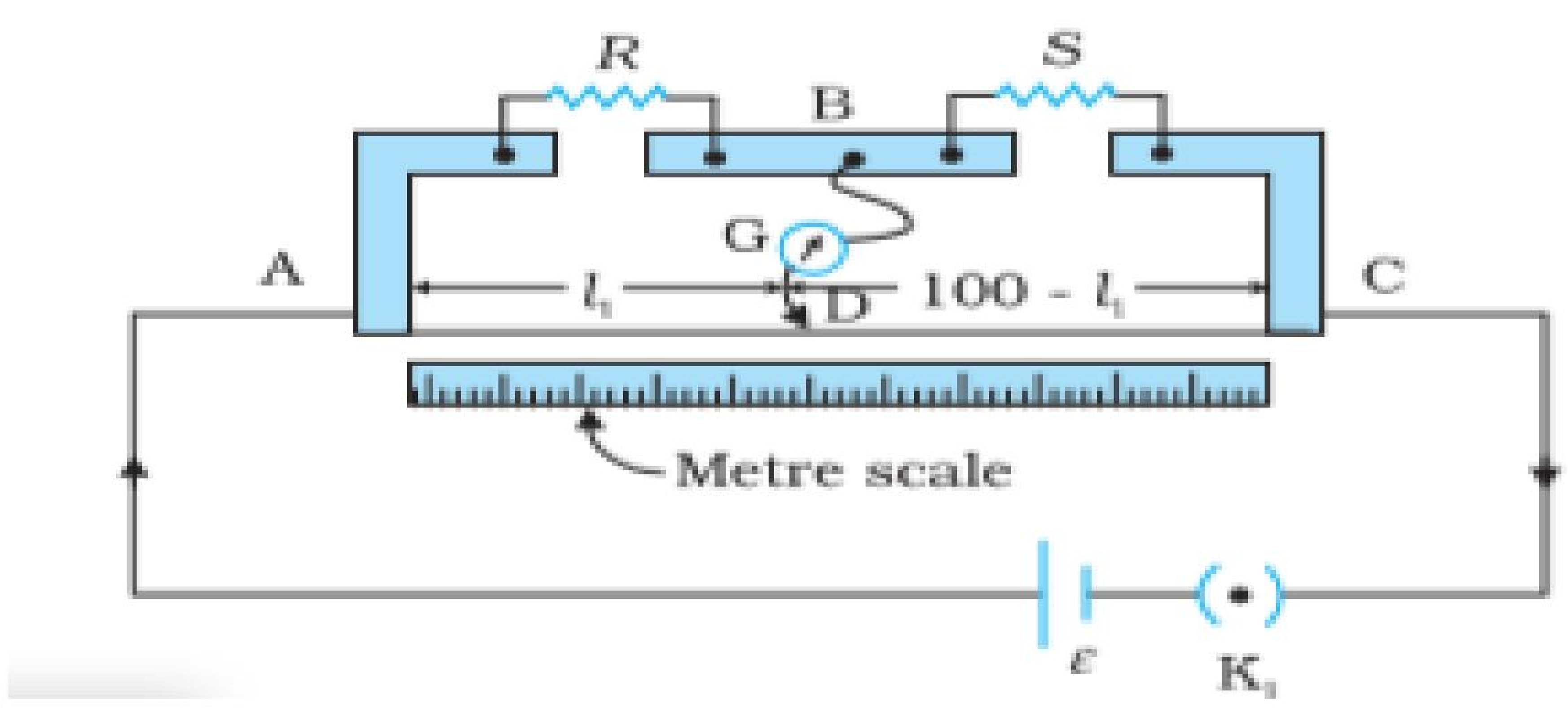
Q=1600 μC

OR

a)	Principle of Wheatstone Bridge	1
	Circuit Diagram	1
	Determination of specific resistance	1
b)	Calculation of potential difference between A & C	2

(a) Principle: If four resistors R_1, R_2, R_3 and R_4 are connected in the four sides of a quadrilateral. The galvanometer is connected in one of the diagonal and battery is connected across another diagonal then the conductors. 1

$\frac{R_1}{R_2} = \frac{R_3}{R_4}$ provides no current flows through the galvanometer



1

For specific resistance when no current flows in galvanometer

$$\frac{R}{S} = \frac{R_{AD}}{R_{DC}} \quad \text{……….. 1}$$

$$\frac{R_{AD}}{R_{DC}} = \frac{l}{100-l} \quad \text{……….. 2}$$

From equation 1 & 2

$$\frac{R}{S} = \frac{l}{100-l}$$

$$R = S\left(\frac{l}{100-l}\right)$$ ½

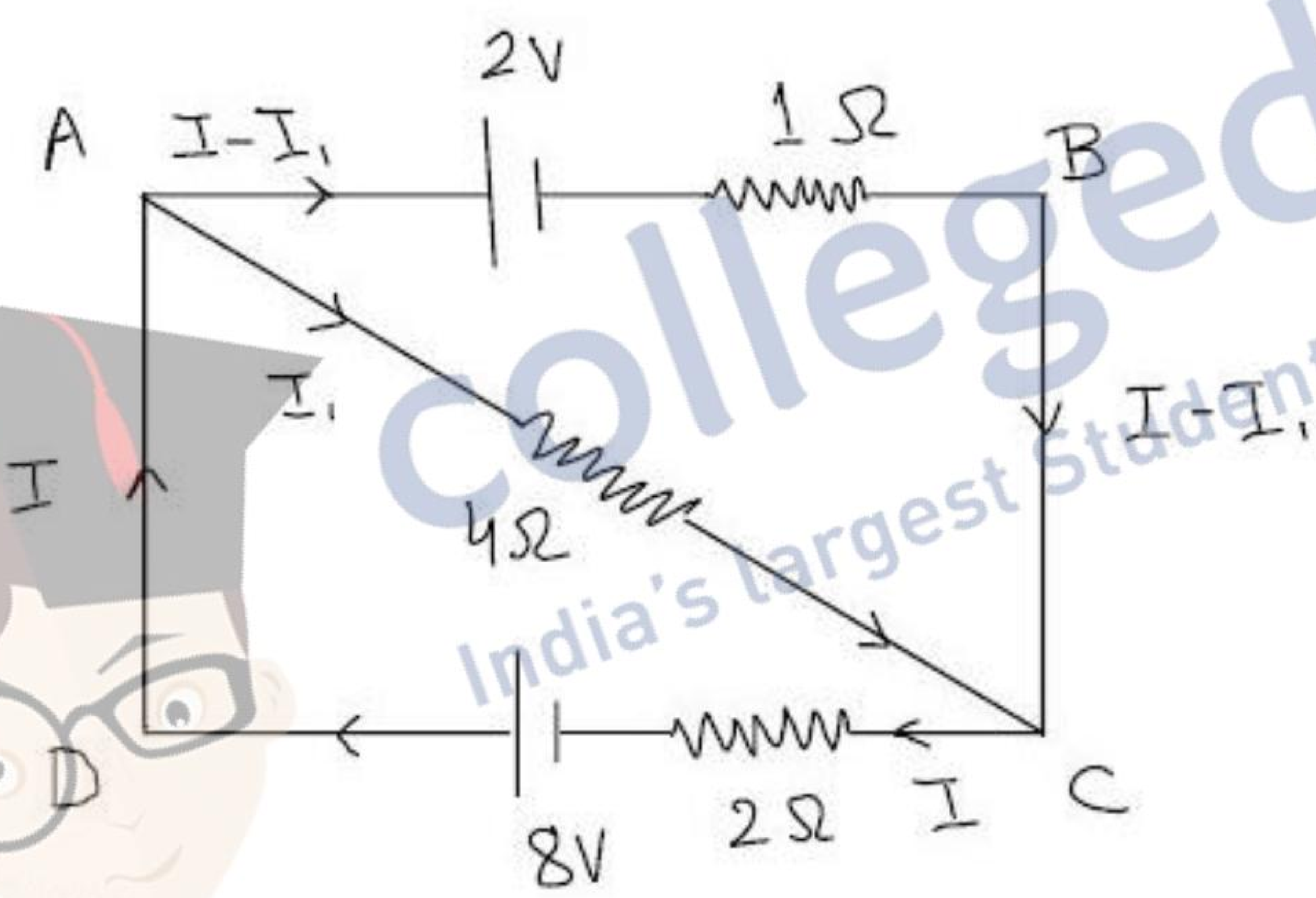
Resistivity of the wire ½

$$\rho = \frac{RA}{L} = R\frac{\pi r^2}{L}$$

where L = Length of unknown resistance wire

r = radius of unknown resistance wire

(b)



In loop ACDA

$4I_1 + 2I = 8$ ½

$2I_1 + I = 4$ ……….. (1)

In loop ABCA

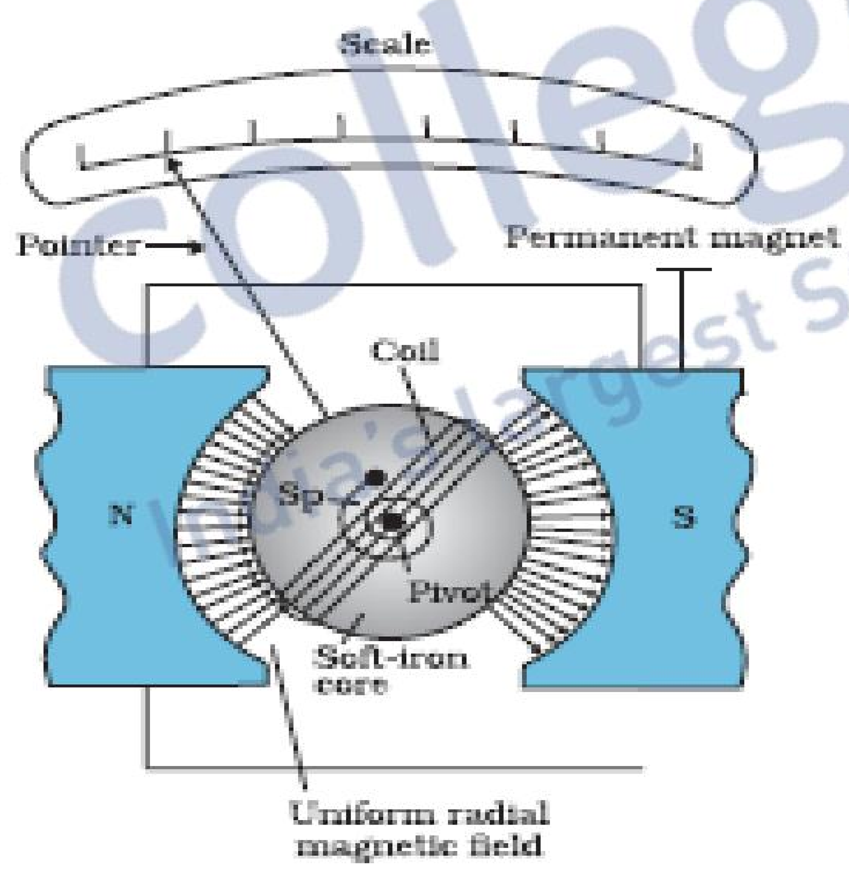
$(I-I_1) \times 1 - 4I_1 = -2$

$I - I_1 - 4I_1 = -2$

$I - 5I_1 = -2$

$5I_1 - I = 2$ ……….. (2) ½

By adding Equation (1) & (2)

	$5I_1 - I = 2$ $2I_1 + I = 4$ $7I_1 \quad = 6$ $I_1 = \frac{6}{7}A$ $V = I_1R = \frac{6}{7} \times 4$ $V = \frac{24}{7}$ volt	$^1/_2$ $^1/_2$	5
36.	(a) Diagram of moving coil galvanometer — 1 Working — 1 Justification for using radial magnetic field — $^1/_2$ (b) Calculation of Resistance — $2\,^1/_2$ **(a)**  Working: when a current flow through the coil, a torque acts on it. τ=NIAB Where symbols have their usual meaning. since the field is radial by design, we have taken $\sin\theta$ =1 in the above expression for torque. The magnetic torque NIAB tends to rotate the coil. A spring provide a counter torque $k\emptyset$ that balances the magnetic torque NIAB; resulting in a steady angular deflection $\emptyset$. In equilibrium $k\,\emptyset$= NIAB Where k is the tensional constant of the spring. The deflection $\emptyset$ is indicated on the scale by a pointer attached to the spring. We have	 1 $^1/_2$	

$$\phi = \left(\frac{NAB}{k}\right)I$$ $\frac{1}{2}$

To calibrate the scale of galvanometer/to make scale linear $\frac{1}{2}$

(b) $R = \frac{V}{I_g} - G$

$R_1 = \frac{V}{I_g} - G \quad = 2000 = \frac{V}{I_g} - G$ .... (1) $\frac{1}{2}$

$R_2 = \frac{V}{I_g} - G \quad = 5000 = \frac{2V}{I_g} - G$ ....(2) $\frac{1}{2}$

$R = \frac{V}{2I_g} - G$ ....(3) $\frac{1}{2}$

from equation 1 & 2

$3000 = \frac{V}{I_g}$

From equation (1)

2000=3000-G

G= 1000 Ω $\frac{1}{2}$

$R = \frac{3000}{2} - 1000$

R= 1500 – 1000

R= 500 Ω $\frac{1}{2}$

OR

(a) (i) Expression for emf induced and polarity	$1\frac{1}{2} + \frac{1}{2}$
(ii) Magnitude and direction	$\frac{1}{2} + \frac{1}{2}$
(b) Calculation of mutual inductance	2

(a) (i) Magnetic flux linked with the loop at any instant of time is

$\phi_B = B(lx)$ $\frac{1}{2}$

$$\left|\frac{d\phi_B}{dt}\right| = Bl\frac{dx}{dt}$$

$$\left|\frac{d\phi_B}{dt}\right| = Bl_v \qquad \because \left(\frac{dx}{dt} = v\right)$$ $\frac{1}{2}$

According to Faradays Law of Electromagnetic induction

$$\left|\frac{d\phi_B}{dt}\right| = e$$

Hence e= B*l*v $\frac{1}{2}$

Alternative Method

(i) When rod moves outwards, according to Lorentz magnetic force

$\overrightarrow{F_m} = q(\vec{V} \times \vec{B})$ ½

Free electrons inside the conductor experience force towards the end X. the positive charge moves towards end y of the conductor due to accumulation of charges emf is developed across the conductor. Consider a charge 'q' at the end X, work done by magnetic field in moving it through the length 'l' of the conductor is

$W = F_m l$ ½

$= (qvB \sin\theta)\, l$

$W = qvBl \quad (\therefore \theta = 90°)$

According to definition of emf

$e = \frac{W}{q} = vBl$

Hence, emf e= vBl ½

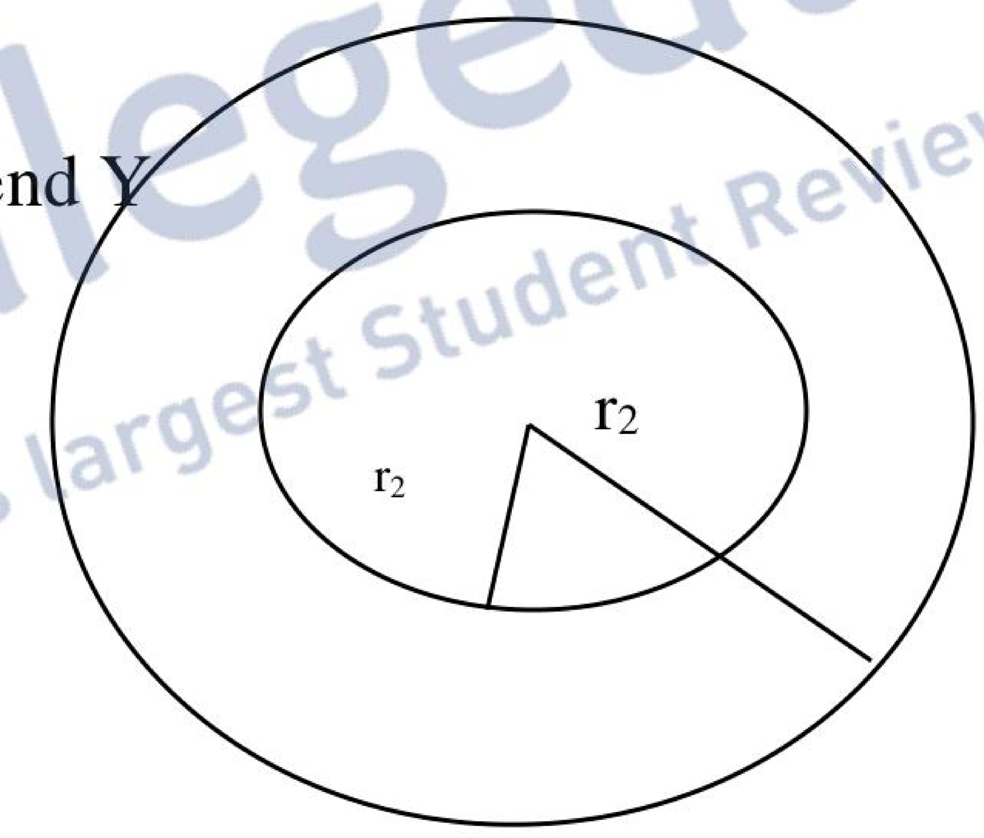
The end X of coil be at lower potential and Y will be at higher potential. ½

(ii) $I = \frac{e}{r}$

$I = \frac{Bvl}{r}$ ½

Direction of induced current is from end X to end Y ½

(b)



$M = \frac{\mu_o \pi r_1^2}{2r_2}$ ½

$= \frac{4\pi \times 10^{-7} \times \pi \times 0.5^2 \times 10^{-4}}{2 \times 11 \times 10^{-2}}$ H ½

$= 2 \times (0.25) \times 10^{-9} \times \frac{\pi^2}{11}$ H ½

$= 4.49 \times 10^{-10}$ H ½

5

37.

(a) (i) Ray diagram of TIR in optical fiber	1
(ii) Ray diagram for TIR in prism	1
(b) Calculation for value of μ	3

(a) (i)

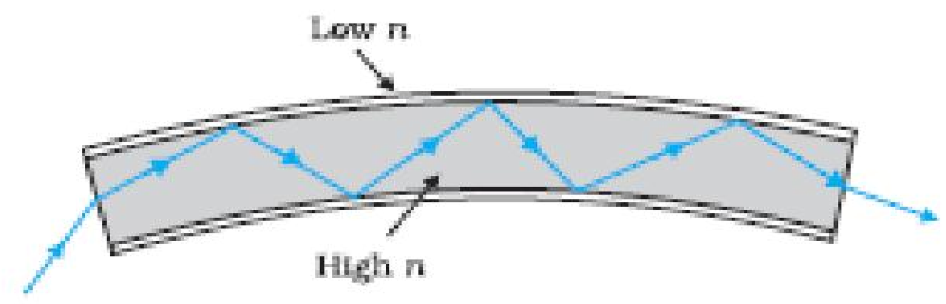
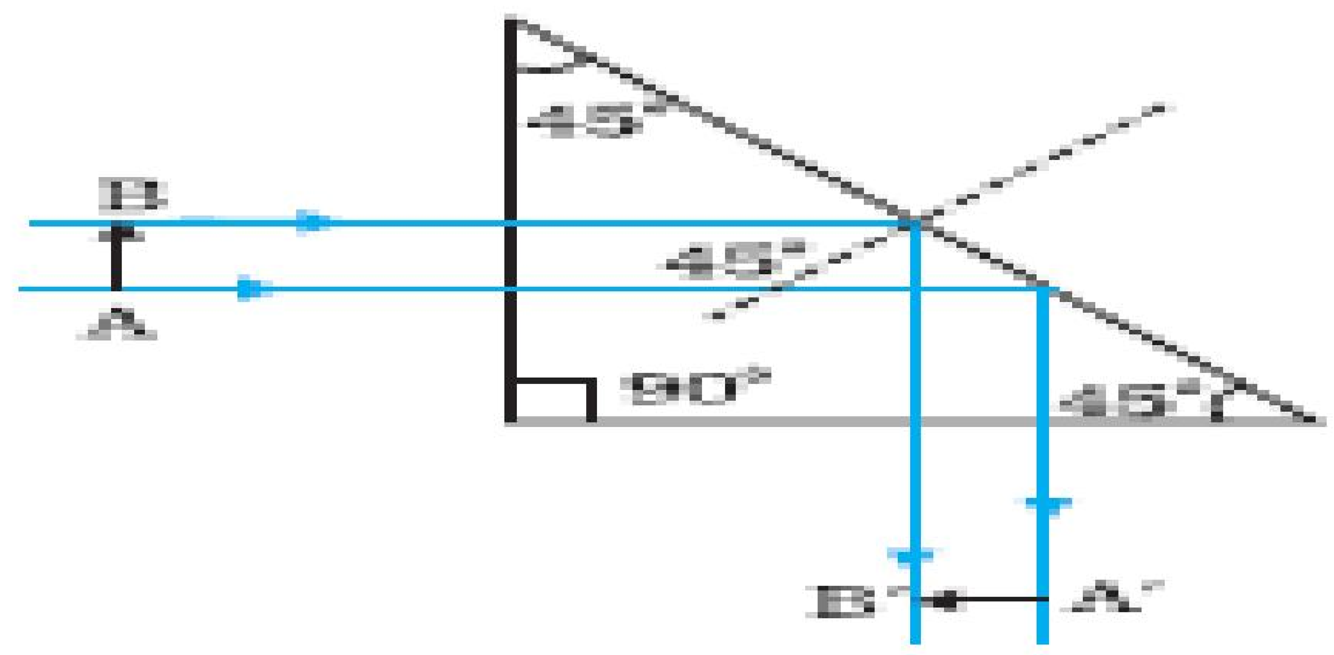


FIGURE 9.16 Light undergoes successive total internal reflections as it moves through an optical fibre.

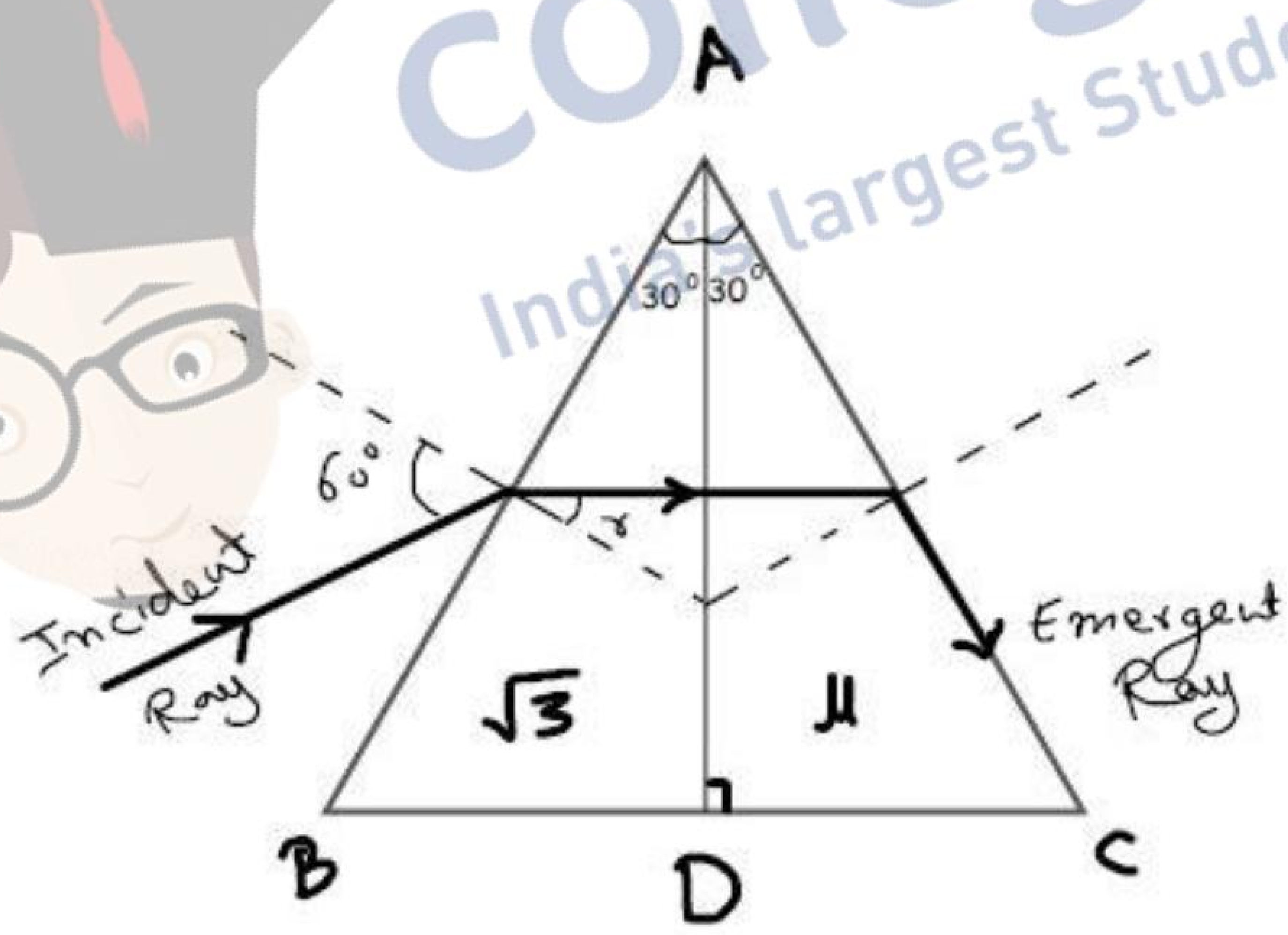
1

(ii)



1

(b)

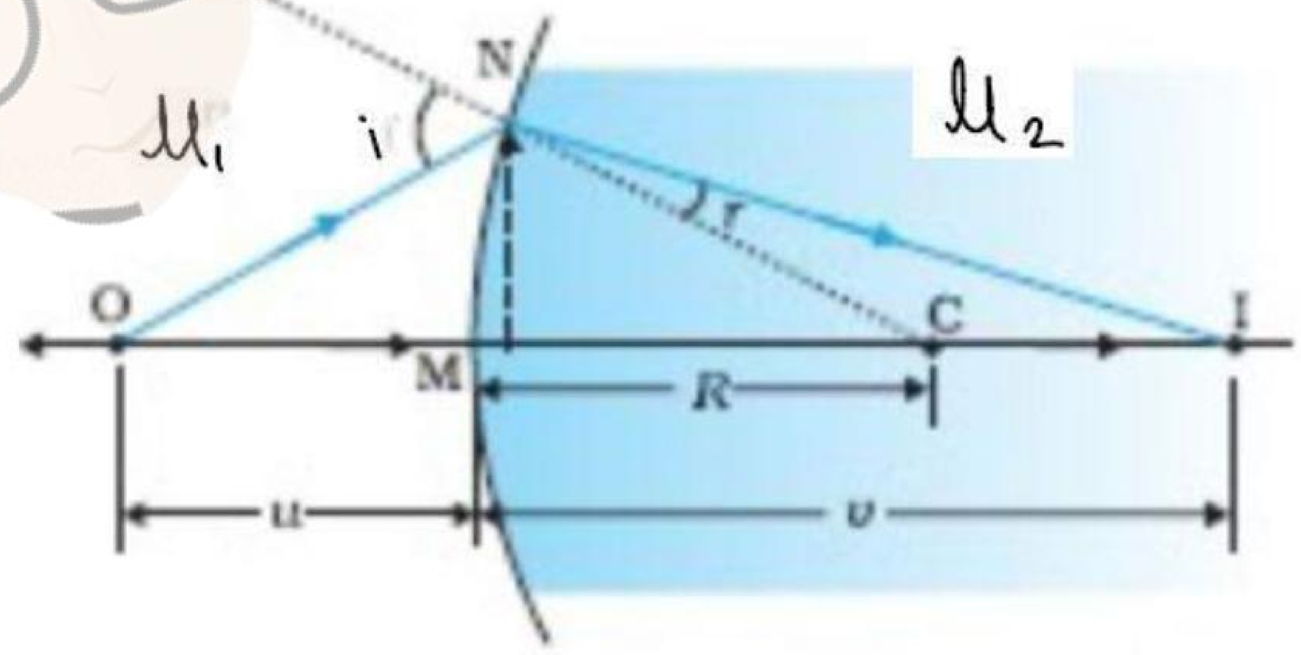


From Snell's Law

$\mu = \frac{\sin i}{\sin r}$ ½

i =60° , $\mu = \sqrt{3}$

$\sqrt{3} = \frac{\sin 60°}{\sin r} = \frac{\sqrt{3}}{2(\sin r)}$ ½

	sin r= $\frac{1}{2}$ = sin 30° r= 30° So, ray will go perpendicular to AD For IInd prism $i_c = 30°$ $\therefore\ \sin i_c = \frac{1}{\mu}$ $\text{Sin } 30° = \frac{1}{\mu}$ $\mu = 2$	 $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$	
	OR (a) Derivation of the relation between μ_1, μ_2 and R — 3 (b) Find the intensity of light transmitted by P_1 and P_2 — 2 (a)  $\tan \angle NOM = \frac{MN}{OM}$ $\tan \angle NCM = \frac{MN}{MC}$ $\tan \angle NIM = \frac{MN}{MI}$ Now, for Δ NOC, L_i is the exterior angle	 $^1/_2$ $^1/_2$	

	Therefore, $\angle i = \angle NOM + \angle NCM$		
	$\angle i = \frac{MN}{OM} + \frac{MN}{MC}$ ……..(1)	$1/2$	
	Similarly,		
	$r = \angle NCM - \angle NIM$		
	i.e $r = \frac{MN}{MC} - \frac{MN}{MI}$ ………..(2)	$1/2$	
	By snells law		
	$\mu_1 \sin i = \mu_2 \sin r$		
	For small angle		
	$\mu_1 i = \mu_2 r$		
	Substituting i and r from equation 1 & 2, we get		
	$\frac{\mu_1}{OM} + \frac{\mu_2}{MI} = \frac{\mu_2 - \mu_1}{MC}$ ………..(3)	$1/2$	
	Here		
	OM= -u, MI=+v, MC= +R		
	On substituting in equation 3, we get		
	$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$	$1/2$	
	Note: Give full credit of this part, if a student takes medium of μ_1 as denser and μ_2 as rarer		
	(b) According to Malus's law, intensity of light transmitted from P_2		
	$I_{p_2} = I_o \cos^2\theta$	$1/2$	
	Where $I_o = \frac{2}{2}$ mW = 1mW	$1/2$	

	Here $\theta = 60°$ $I_{p_2} = (1\text{ mW})\cos^2 60°$ $I_{p_2} = \frac{1}{4}\text{ mW} = 0.25\text{ mW}$	$^1/_2$ $^1/_2$	5