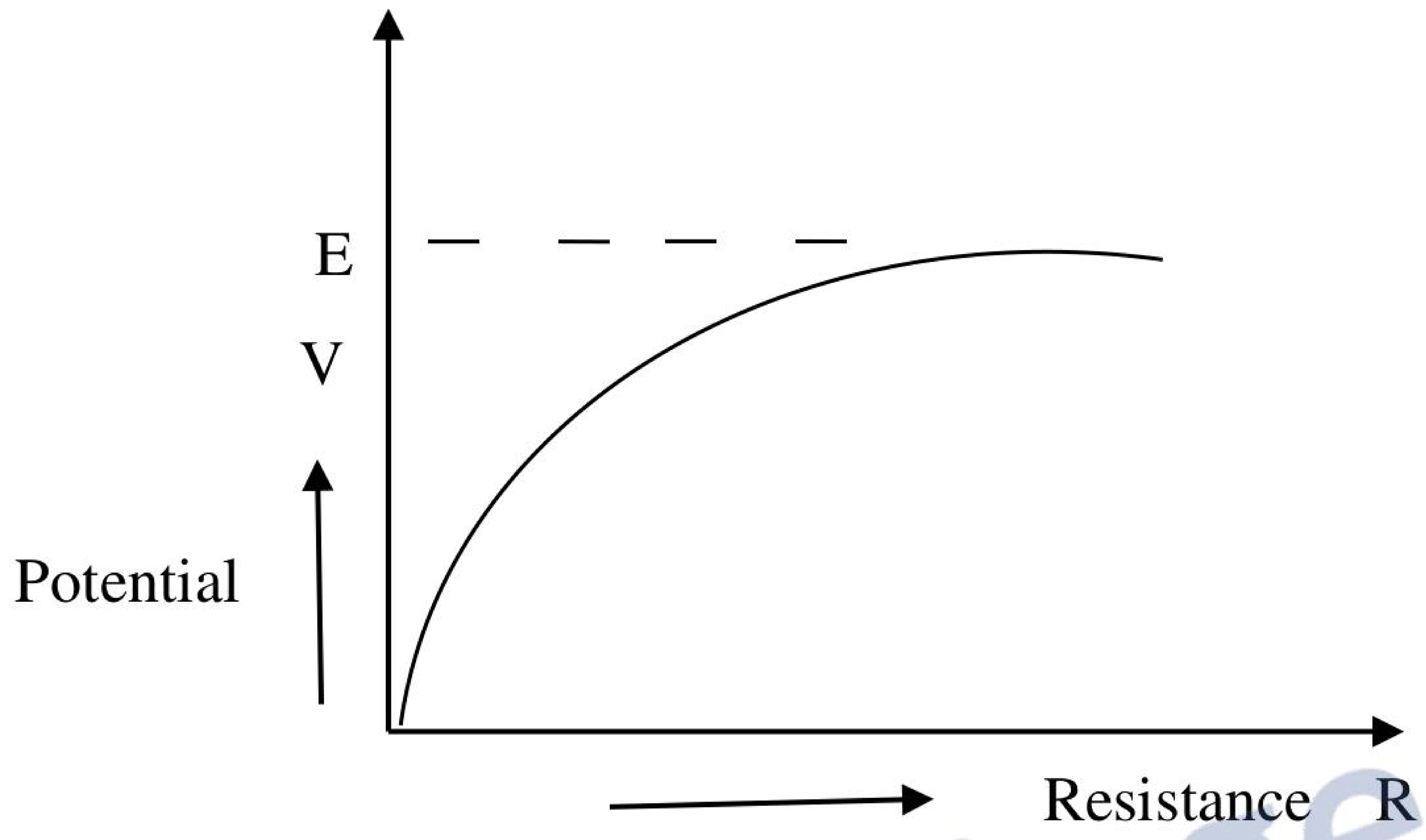
Marking Scheme: Physics (042)

Code :55/C/2

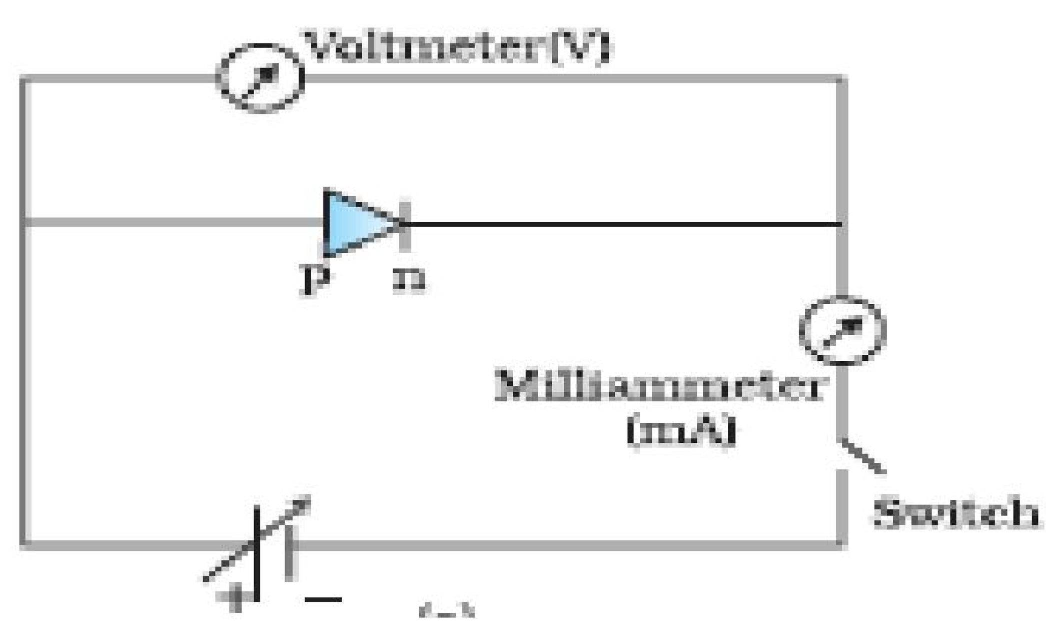
Q.No.	VALUE POINTS/ EXPECTED ANSWERS	Marks	Total Marks
	SECTION- A		
1.	(D) change on plates will remain the same	1	1
2.	(C) $\frac{F}{2}$	1	1
3.	(A) $\frac{E}{B}$	1	1
4.	(C) $\left(\frac{r_1}{r_2}\right)^2$	1	1
5.	(A) yellow, orange and red	1	1
6.	(D) Number of both the free electrons and holes increases equally.	1	1
7.	(C) III	1	1
8.	(C) 1	1	1
9.	(A) $+\frac{d}{4}$	1	1
10.	(D) β-particle	1	1
11.	Higher	1	1
12.	Red	1	1
13.	2π	1	1
14.	$\frac{h}{\pi}$ OR 9×10^{14} J	1	1
15.	90°	1	1
16.	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
17.	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
18.	X	1	1

	Alternatively Slope = $\rho \frac{l}{R}$ R= $\rho \frac{l}{A}$ $R_x > R_y$ (Note: Award half mark of this question, if a student writes the correct answer in terms of Resistance.)		
19.	 Alternatively V= E - Ir V=E - $\left(\frac{E}{R+r}\right)$r (Note: Award half mark of this question to the student if he/she write just formula.)	1	1
20.	Tm^2 or Weber When a magnetic field of one tesla is passing through an area of $1m^2$ normally, the flux is said to be of 1 Weber.	1	1
	SECTION- B		
21.	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. (b) It is easier to observe the change in the current with change in the light intensity, if	1 1	

reverse bias is applied.

OR

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



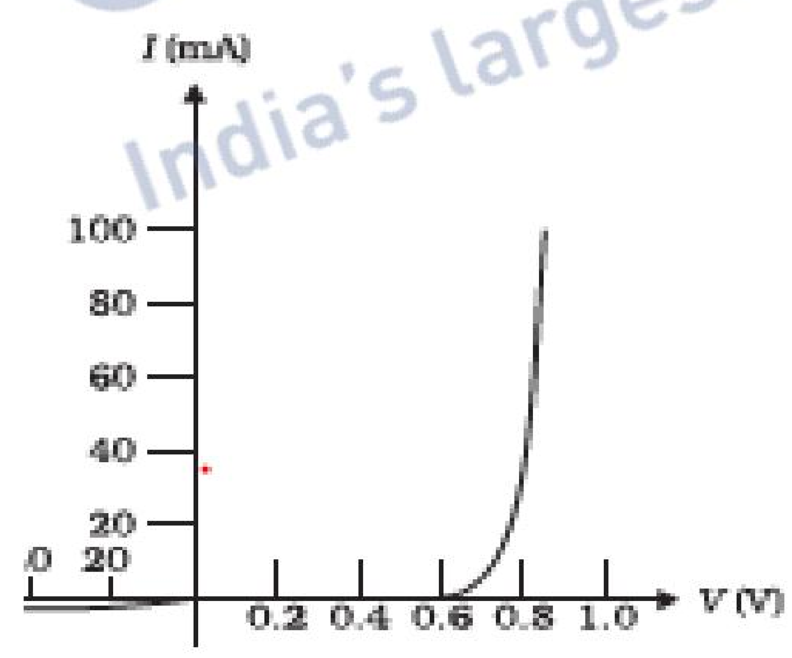
$1/2$

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. 1

As soon as supply voltage exceeds barrier potential instantaneously current begins to flow through junction and increases exponentially with forward bias.

(Note: Accept any other relevant explanation for working)

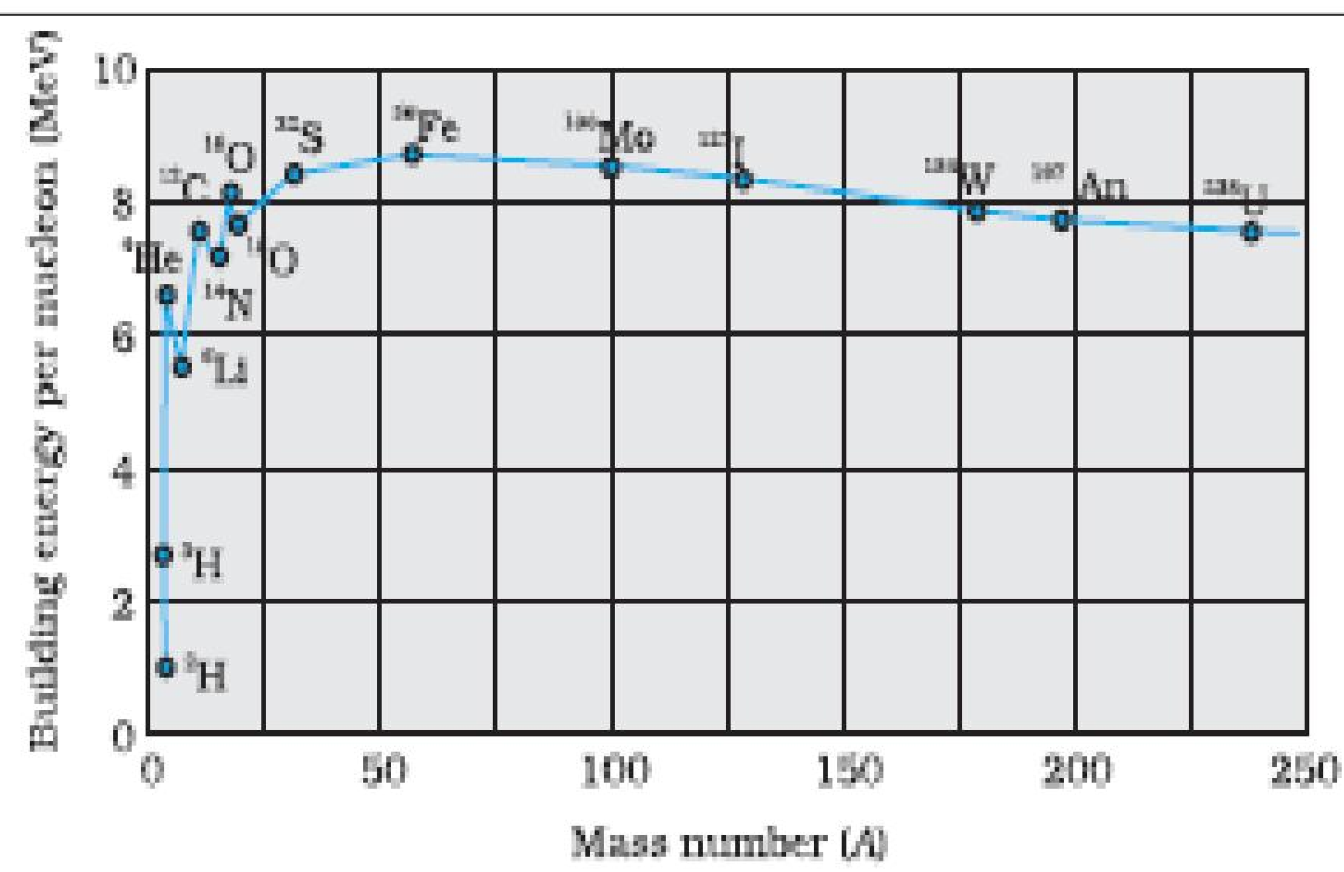
I-V characteristics $1/2$



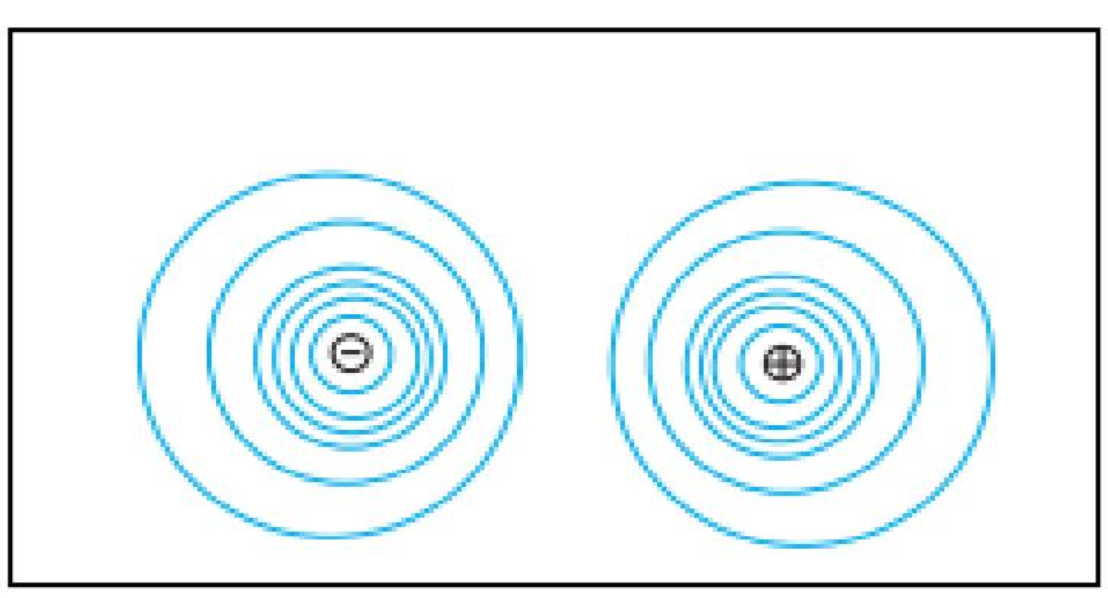
2

22.

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



1

	(Note: Please don't deduct marks, if a student does not mark all 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
23.	(a) Identify 'X' $1/2$ (b) Identification and Justification $1/2 + 1$ a) X is capacitor b) Ideal inductor ∵ In capacitor current leads by an angle $\pi/2$ with voltage while in inductor voltage leads by an angle $\pi/2$ with current	$1/2$ $1/2$ 1	2
24.	a) Identification of emwaves and one application 1 b) Identification of emwaves and one application 1 a) Gamma Rays Application : Food preservation /treatment of cancer /Brain Tumour b) Radio waves Application : In communication /Radio /T.V/Mobile (any one) (Note : Give credit of application part, if a student writes any other correct application.)	$1/2$ $1/2$ $1/2$ $1/2$	2
25.	(a) Depiction of equipotential surfaces 1 (b) Finding the amount of work done 1 (a) 	1	

	(a) $W = q_0 \Delta V$ 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	$1/2$ $1/2$	2
26.	(a) Sequence of color band — 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
27.	Formula for half life — $1/2$ Calculation of half life — 1 Calculation of Critical mass — $1/2$ $N = N_o \left(\frac{1}{2}\right)^n$ $\frac{1}{16} N_o = N_o \left(\frac{1}{2}\right)^n$ n = 4 t= n x $T_{1/2}$ $T_{1/2} = \frac{t}{n} = \frac{4}{4} = 1$ day $N = N_o \left(\frac{1}{2}\right)^n = N_o \left(\frac{1}{2}\right)^{\frac{t}{T1/2}}$ $4 = N_o \left(\frac{1}{2}\right)^6$ $N_o = 256$ g	$1/2$ $1/2$ $1/2$ $1/2$	

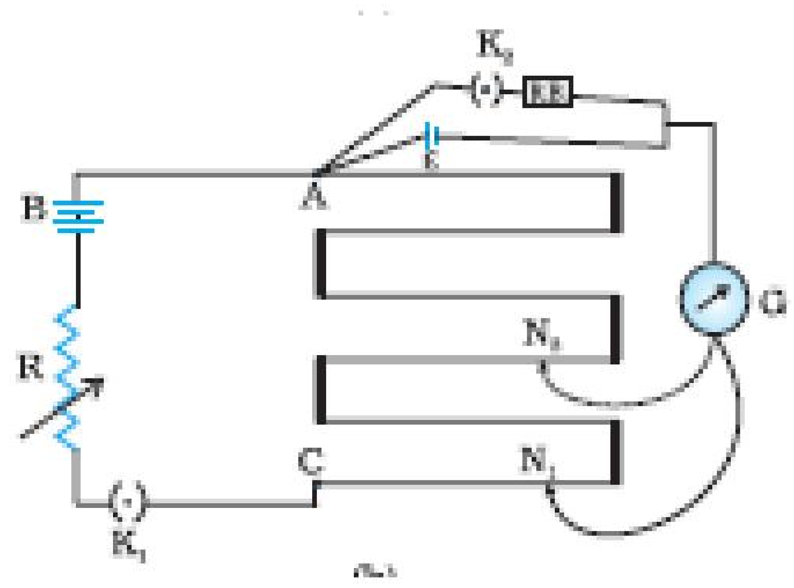
	Alternative Method $N = N_o\, e^{-\lambda t}$ $\frac{1}{16} N_o = N_o\, e^{-\lambda 4}$ $16 = e^{4\lambda}$ $4 \log_e 2 = 4\lambda$ 4x 2.303 x 0.3010 = 4 λ λ = 0.693 per day Half life $T_{1/2} = \frac{0.693}{\lambda} = \frac{0.693}{0.693} = 1$ day $4 = N_o\, e^{-\lambda t}$ N_o = 256 g (Note: Give full credit of this part if a student substitute values correctly and is not able to calculate final answer.) OR Formula — $^1/_2$ Conversion of kinetic energy in Joule — $^1/_2$ Finding the distance of closest approach — 1 $d = \frac{q_1 q_2}{4\pi\epsilon_0 K}$ kinetic energy= 5.12 MeV $= 5.12 \times 1.6\times10^{-13}$ 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 $= 4.443\times 10^{-14}$ m $= 44.4 \times 10^{-15}$ m	$^1/_2$ 1/2 1/2 1/2 $^1/_2$ $^1/_2$ 1/2 1/2	2
	SECTION- C		

28.

a)	Explanation of internal resistance	1/2
b)	Circuit Diagram and determination of internal resistance	2 ½

a) The opposition offered by the electrolyte and electrodes of the cell to the flow of current is called internal resistance. 1/2

b)



1

The cell (emf E) whose internal resistance is to be determined is connected across a resistance box through a key K_2 , as shown in figure above . With key k_2 open. Balance point is obtained at length l_1(AN_1)

Then,

$\in \; = \varphi l_1$ -------------- (1) 1/2

When Key k_2 is closed the cell sends a current (I) through the resistance box (R) . If V is the terminal potential difference of the cell and Balance is obtained at length l_2 (AN_2)

$V = \varphi l_2$ -------------- (2)

From (1) and (2)

We have

$\frac{\in}{V} = \frac{l_1}{l_2}$ -------------------(3)

But

$\in \; = V - Ir$ and $V = IR$

$\frac{\in}{V} = \frac{r+R}{R}$ -------------------- (4) 1/2

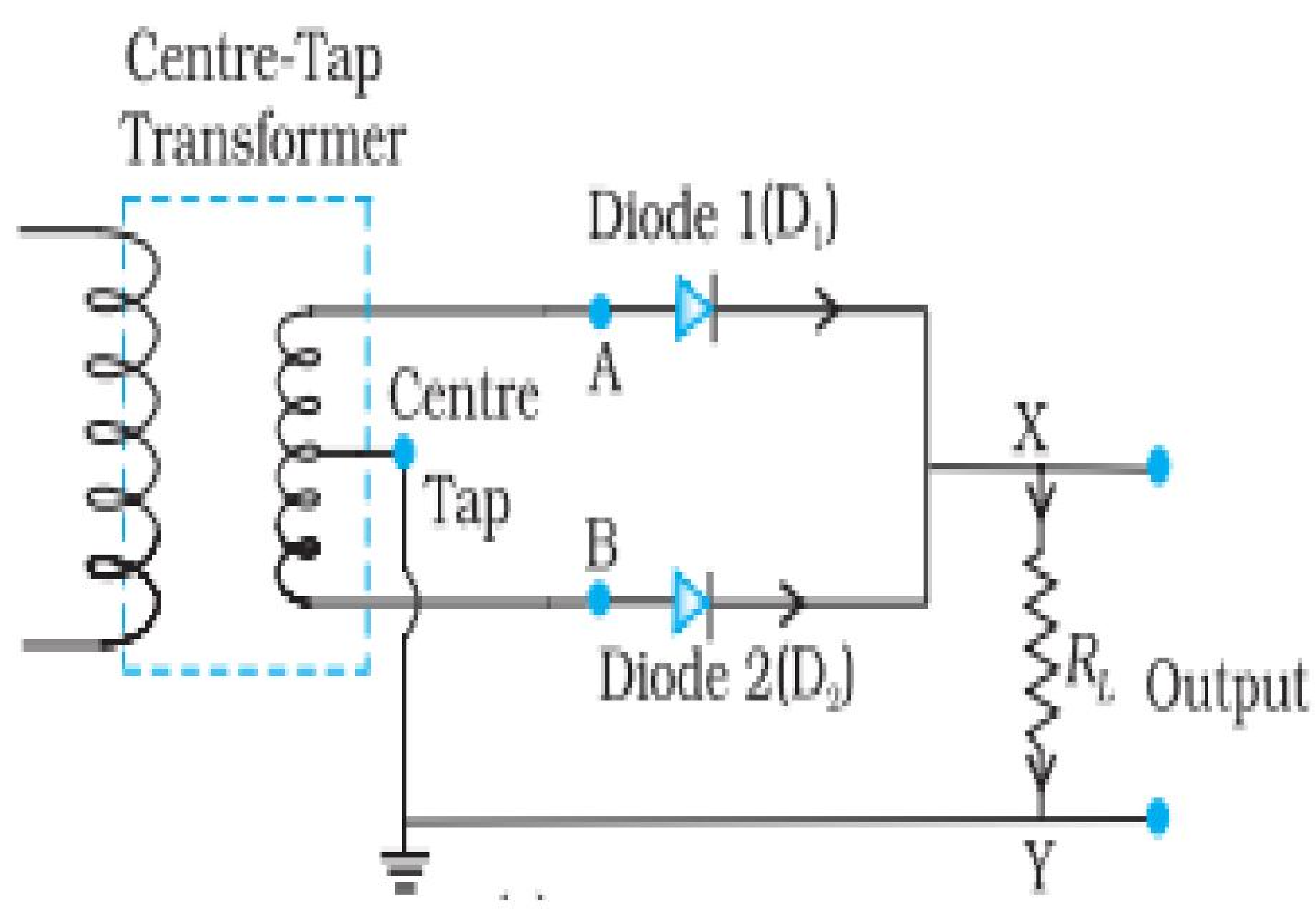
From equation (3) and (4)

$\frac{r+R}{R} = \frac{l_1}{l_2}$

$r = R\left(\frac{l_1}{l_2} - 1\right)$ 1/2 3

29.

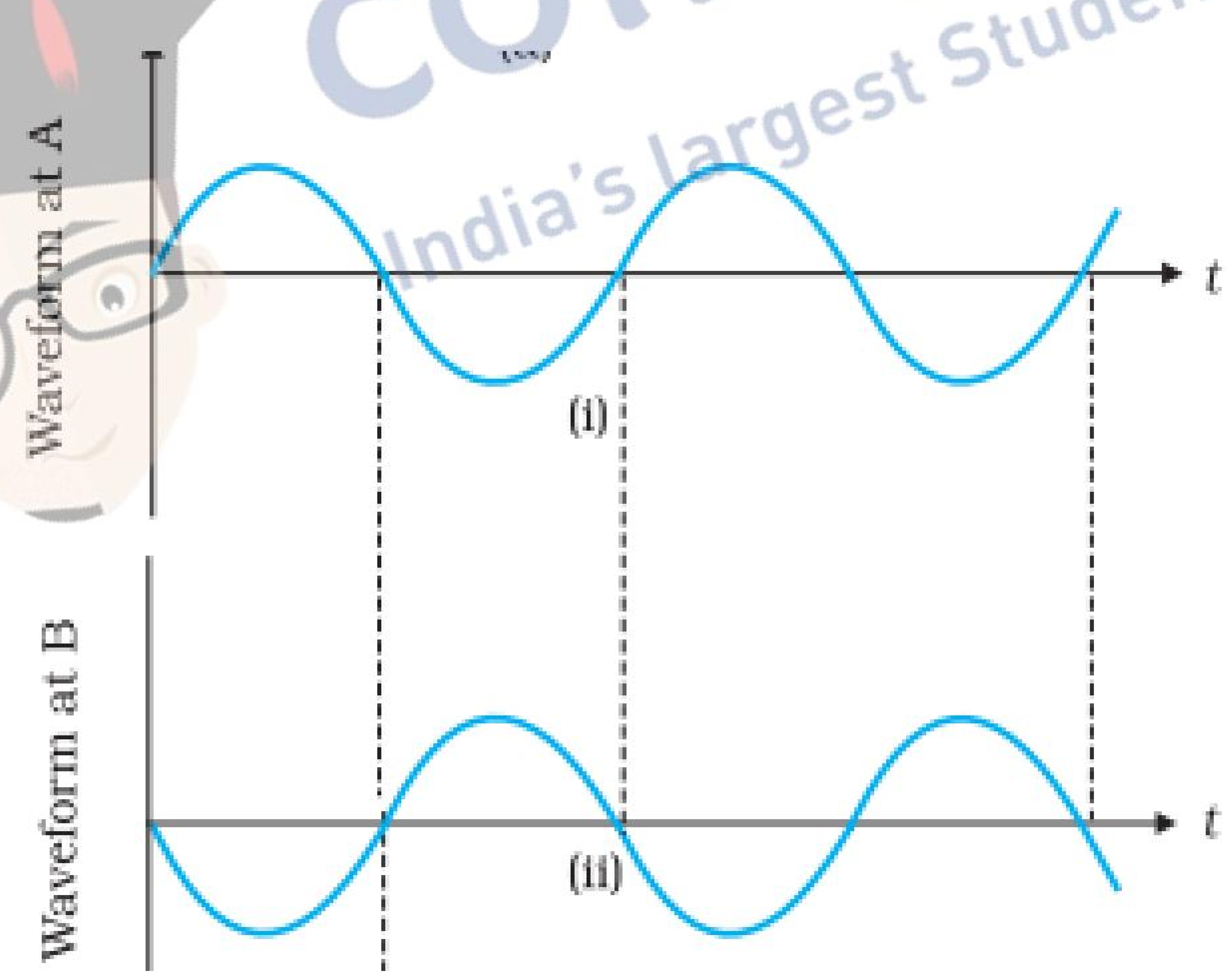
Circuit Diagram	1
Working of full wave rectifier	1
Drawing of input and output waveforms	1



1

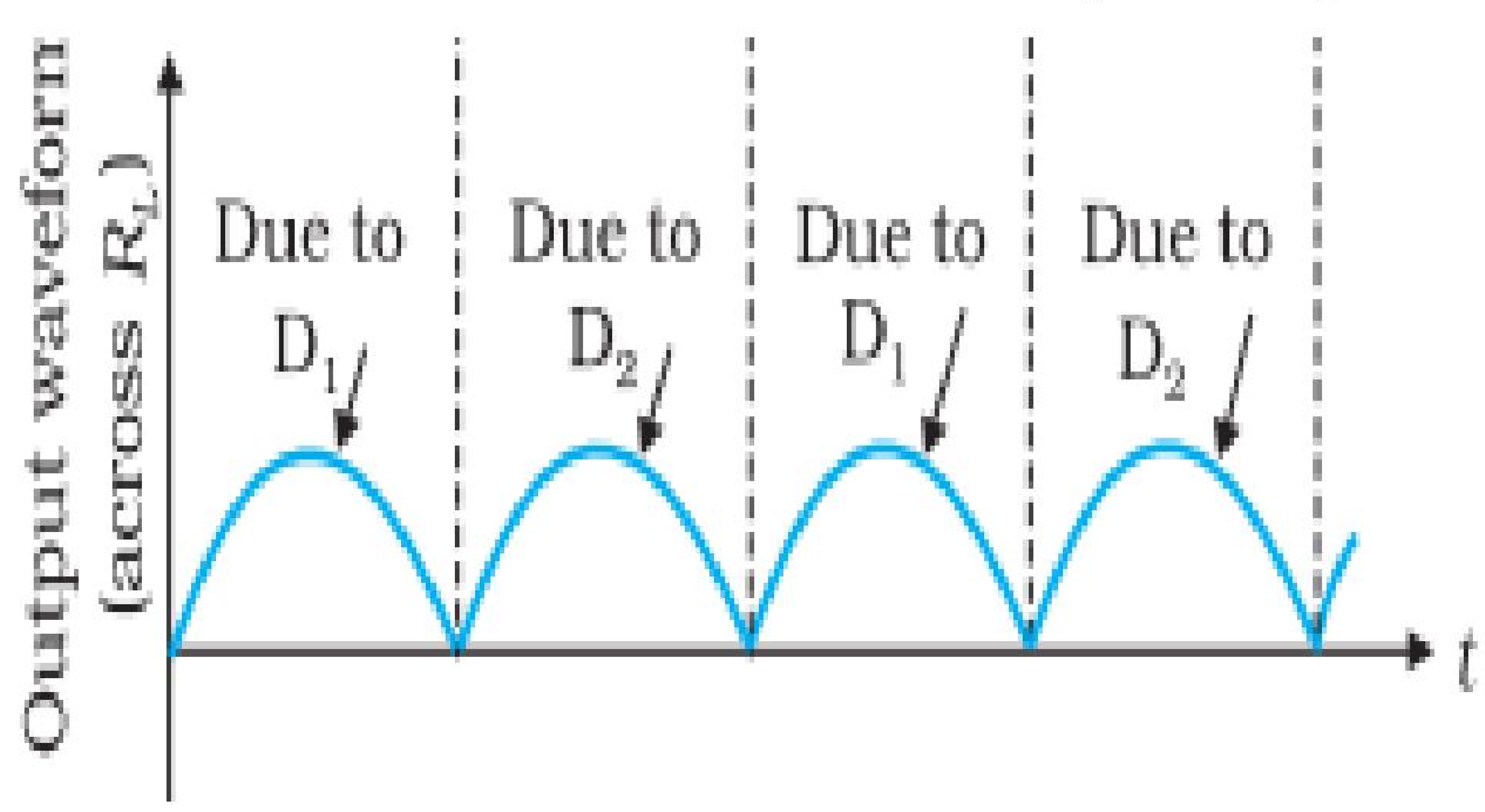
Working: The input voltage to A with respect to the centre tap at any instant is positive, At that instant voltage at B being out of phase will be negative. So diode D_1 gets forward biased and conducts while D_2 being reversed biased and does not conduct. Hence during this positive half cycle, we get an output current. 1/2

In the course of the ac cycle when voltage at A becomes negative with respect to centre 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. 1/2



½

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



½

3

30.

a) Calculation of work function	1½
b) Calculation of number of photoelectrons emitted per second	1½

a) $\lambda = 300$ nm , $V_0 = 1.5$ V

$eV_0 = \frac{hc}{\lambda} - \varphi$

$\varphi = \frac{hc}{\lambda} - eV_0$ — 1/2

$= \left(\frac{6.63\ X\ 10^{-34}\ X\ 3\ X\ 10^{8}}{300\ X\ 10^{-9}\ X\ 1.6\ X\ 10^{-19}} - 1.5\right)$ eV — 1/2

$= \left(\frac{6.63}{1.6\ V} - 1.5\right)$ eV

$= 4.14 - 1.5$ eV

$= 2.64$ eV — 1/2

b) Energy of Photon $E = \frac{hc}{\lambda}$

$= \frac{6.63\ X\ 10^{-34}\ X\ 3\ X\ 10^{8}}{300\ X\ 10^{-9}}$

$= 6.63\ X\ 10^{-19}$ J — 1/2

No. of photons/sec

$n = \frac{P}{E} = \frac{100}{6.63\ X 10^{-9}}$

$= 1.51\ X\ 10^{20}$ — 1/2

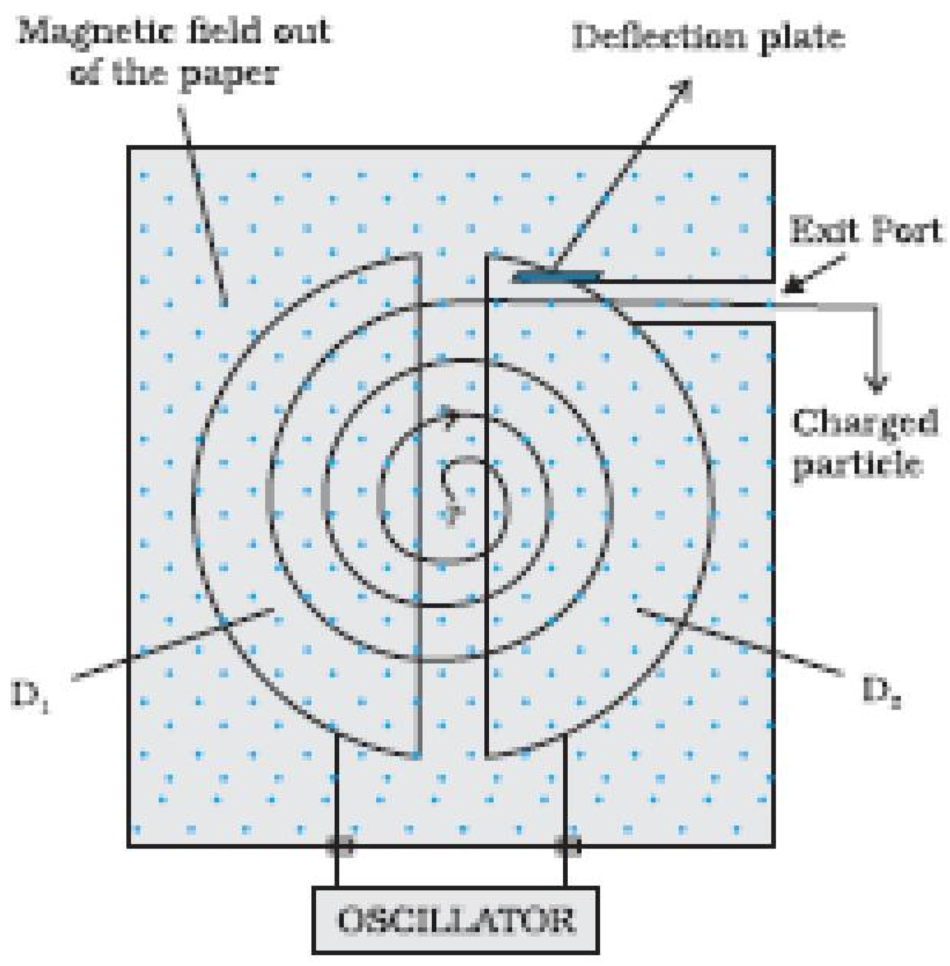
No. of electrons ejected / sec $= 1.51\ X\ 10^{20}\ X\ \frac{60}{100}$

$= 9.06\ X\ 10^{19}$ — 1/2

(NOTE : Award full marks for calculating number of electrons per second by alternative method) — 3

31.

Diagram of cyclotron	1
Principle of Cyclotron	1
a) Derivation of expression for cyclotron frequency	1/2
b) Expression for kinetic energy required	1/2



1

1/2

Principle :- In the crossed electric and magnetic fields a charged particle get accelerated and its frequency of revolution in the magnetic field is independent of its energy.

a) In cyclotron , the perpendicular magnetic field provides the required centripetal force. 1/2

$$\frac{mv^2}{r} = qvB$$

$$\Rightarrow r = \frac{mv}{Bq}$$

Time period of revolution

$$T = \frac{2\pi r}{v} = \frac{2\pi mv}{qBv} = \frac{2\pi m}{qB}$$ 1/2

$$\therefore \upsilon = \frac{1}{T} = \frac{qB}{2\pi m}$$

(Note :- Award half mark If student writes expression for frequency directly.)

(b) K.E= $\frac{1}{2}mv^2$

$\because$ v= $\frac{rqB}{m}$

K.E= $\frac{1}{2}\, m\left(\frac{rqB}{m}\right)^2$

1/2

K.E = $\frac{1}{2}\,\frac{r^2 q^2 B^2}{m}$ 3

32.

a) For calculating focal length of the mirror	1
b) For calculating displacement	2

u = -15 cm

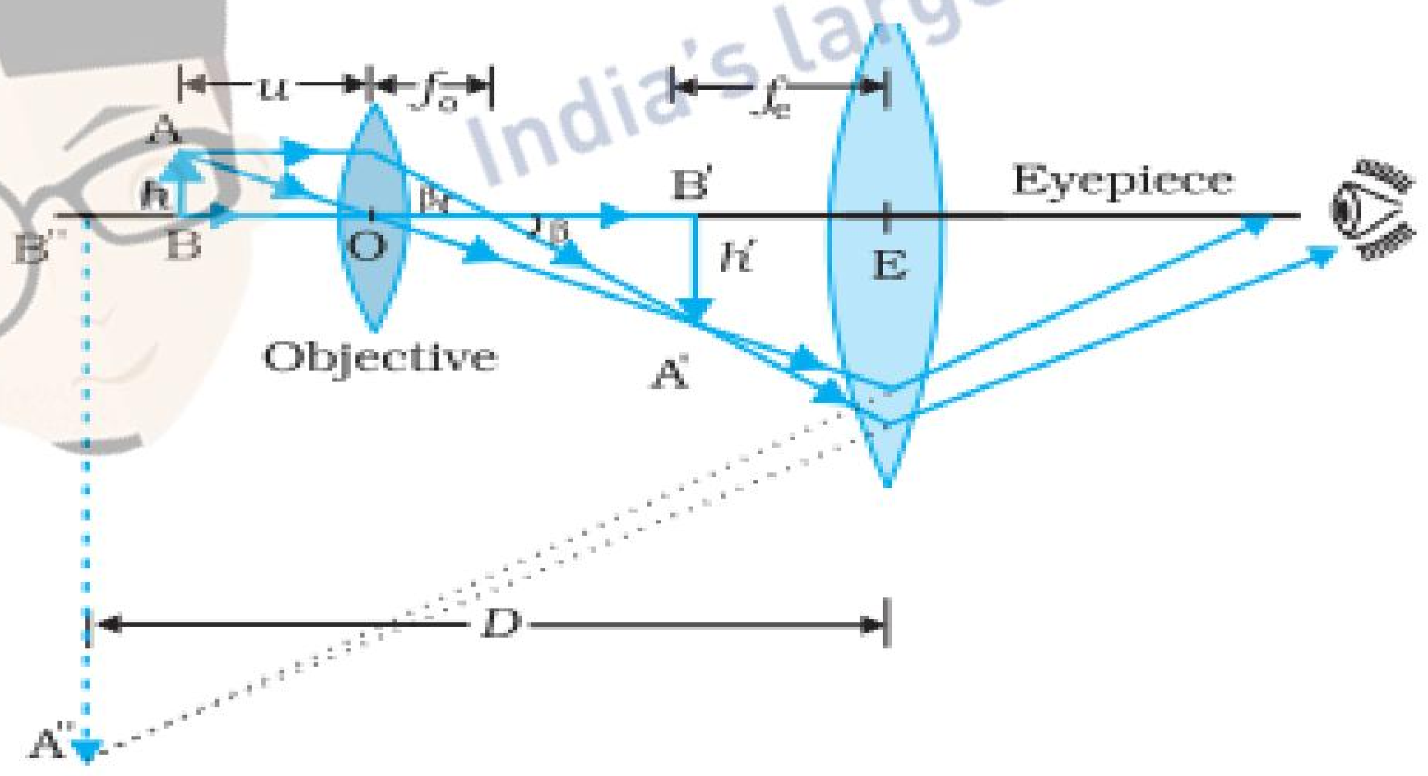
(a) For Virtual Image

m = $\frac{-V}{u}$ 1/2

2 = $\frac{-V}{u}$

*These answers are meant to be used by evaluators

	v= -2u=-2 x(-15)=30 cm From mirror formula $\frac{1}{V}+\frac{1}{u}=\frac{1}{f}$ $\frac{1}{30}-\frac{1}{15}=\frac{1}{f}$ $\frac{1-2}{30}=\frac{1}{f}$ f= - 30 cm (b) For Real Image m = -2 = $\frac{-v}{u}$ v=2u, f=-30 cm $\frac{1}{V}+\frac{1}{u}=\frac{1}{f}$ $\frac{1}{2u}+\frac{1}{u}=\frac{1}{-30}$ $\frac{1+2}{2u}=\frac{1}{-30}$ 2u=-90 u = - 45 cm Displacement of object = - 45 - (-15) = - 30 cm Away from the mirror	1/2 1/2 1/2 1/2 1/2	3
33.	(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 Magnetic Flux $\Phi = NBA \cos\theta$ $\Phi = NBA \cos\omega t$	1	

	According to Faradays law Emf $e = \frac{-d\Phi}{dt} = \frac{-d(\text{NBA} \cos \omega t)}{dt}$ $e = \text{NBA}\ \omega \sin \omega t$ (b) it helps current to change its direction after every half rotation. 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. (b) To minimize the eddy current. (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 1 1 1 1	3
34.	(a) Ray Diagram $1\ ^1/_2$ (b) Expression of magnification $1\ ^1/_2$ Ray diagram  (Note: deduct half mark, if a student does not mark the direction of the propagation of the ray) Expression for magnification $m_o = \frac{h'}{h} = \frac{L}{fo}$ where we have used the result $\tan \beta = (\frac{h}{fo}) = \frac{h'}{L}$ $m_e = (1 + \frac{D}{fe})$	1½ 1/2 1/2	

	Magnification 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
	SECTION- D		
35.	(a) (i) Ray diagram of TIR in optical fiber — 1 (ii) Ray diagram for TIR prism — 1 (b) Calculation for value of μ — 3		

(a) (i)

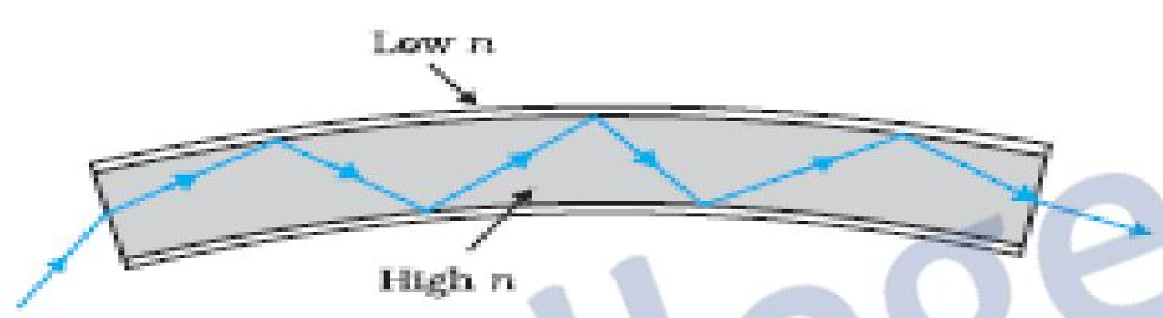
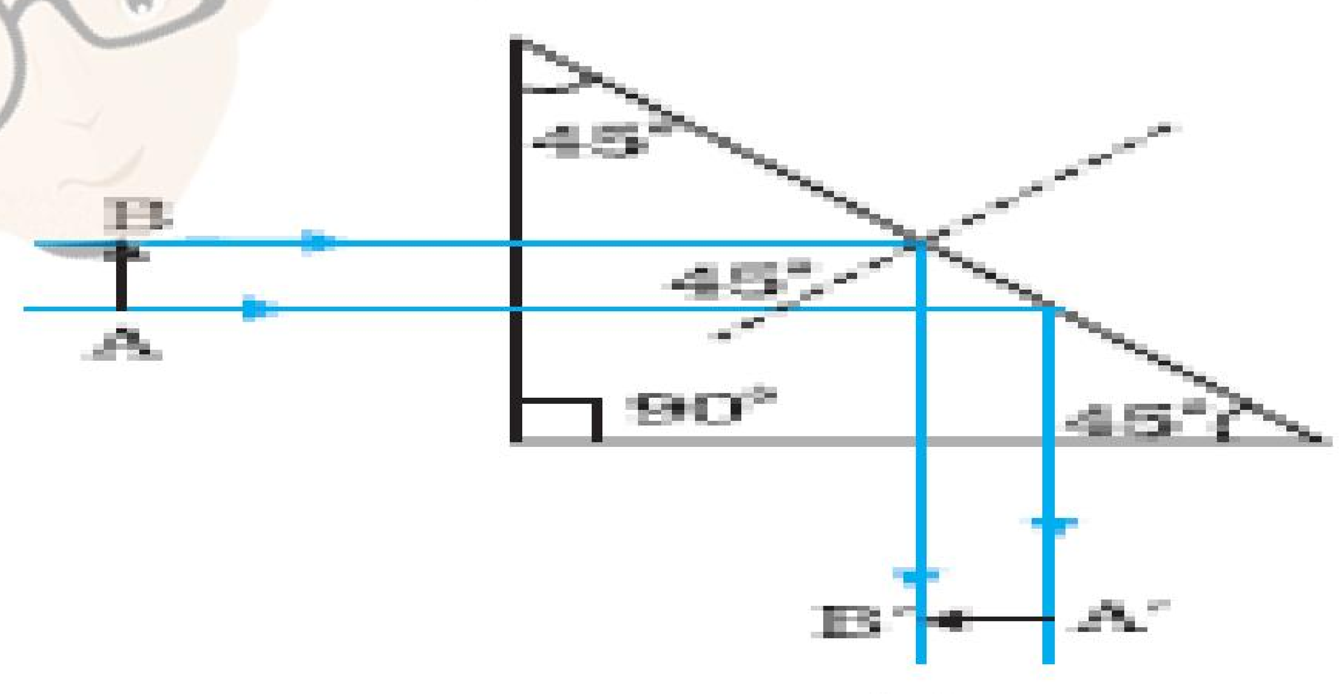


FIGURE 9.16 Light undergoes successive total internal reflections as it moves through an optical fibre.

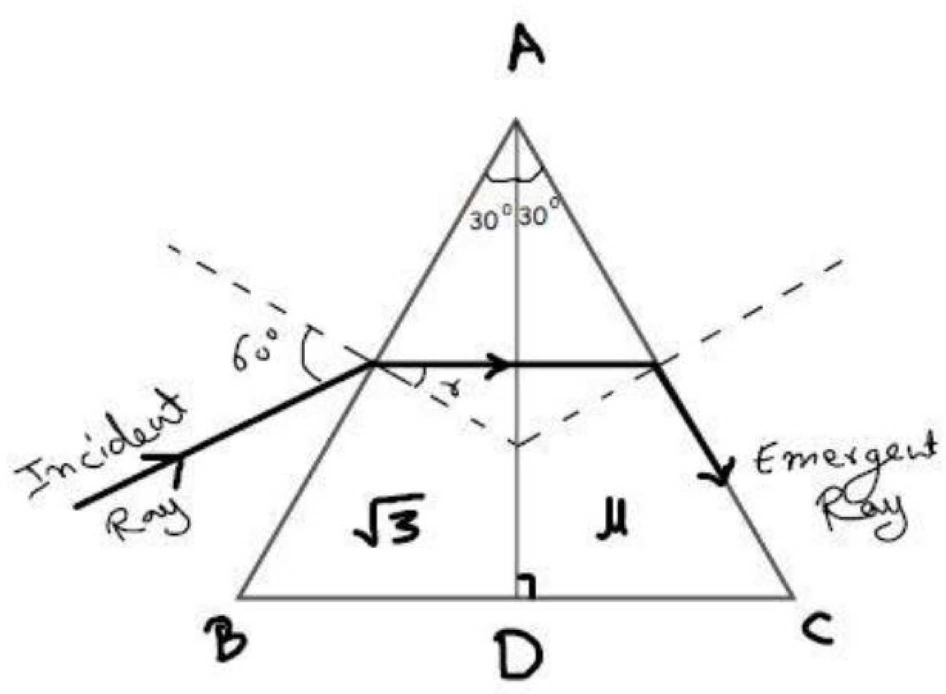
1

(ii)



1

(b)



From Snell's Law — 1/2

$\mu = \dfrac{\sin i}{\sin r}$

i =60° , $\mu = \sqrt{3}$ — 1/2

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

sinr = $\frac{1}{2}$ = sin 30° — 1/2

r = 30°

So, ray will go perpendicular to AD For IInd prism ADC — 1/2

$i_c = 30°$

$\therefore \ \sin i_c = \dfrac{1}{\mu}$ — 1/2

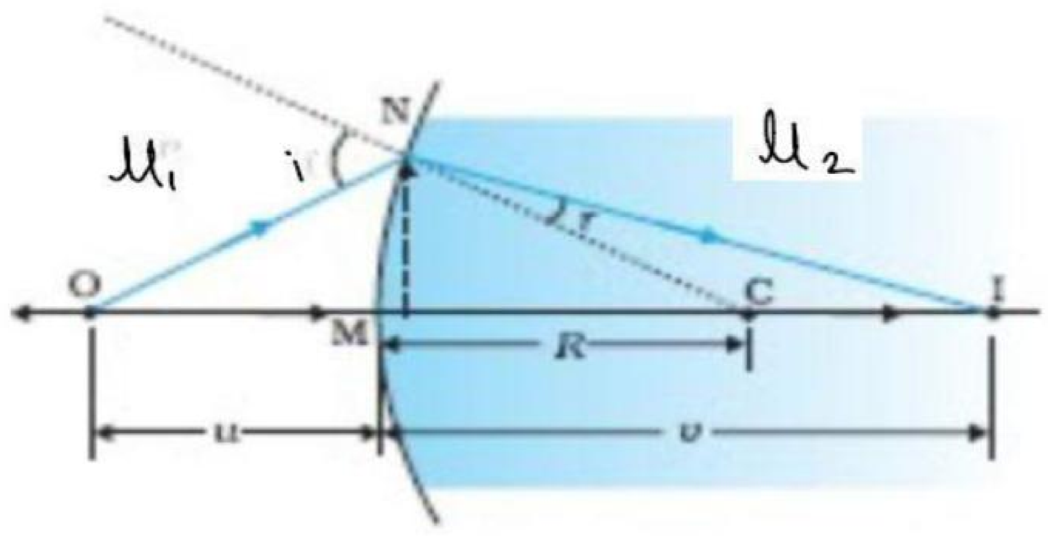
Sin 30° $= \dfrac{1}{\mu}$

$\mu = 2$ — 1/2

OR

(a) Derivation of the relation between μ_1 , μ_2 and R	3
(b) Finding the intensity of light transmitted by P_1 and P_2	2

(a)



1/2

Tan $\angle NOM = \frac{MN}{OM}$ 1/2

Tan $\angle NCM = \frac{MN}{MC}$

Tan $\angle NIM = \frac{MN}{MI}$

Now, for Δ NOC, L_i is the exterior angle

Therefore, $L_i = \angle NOM + \angle NCM$ 1/2

$i = \frac{MN}{OM} + \frac{MN}{MC}$ ……..(1)

Similarly,

$r = \angle NCM - \angle NIM$ 1/2

i.e $r = \frac{MN}{MC} - \frac{MN}{MI}$ ………..(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 1/2

$$\frac{\mu_1}{OM} + \frac{\mu_2}{MI} = \frac{\mu_2 - \mu_1}{MC} \quad \text{………..(3)}$$

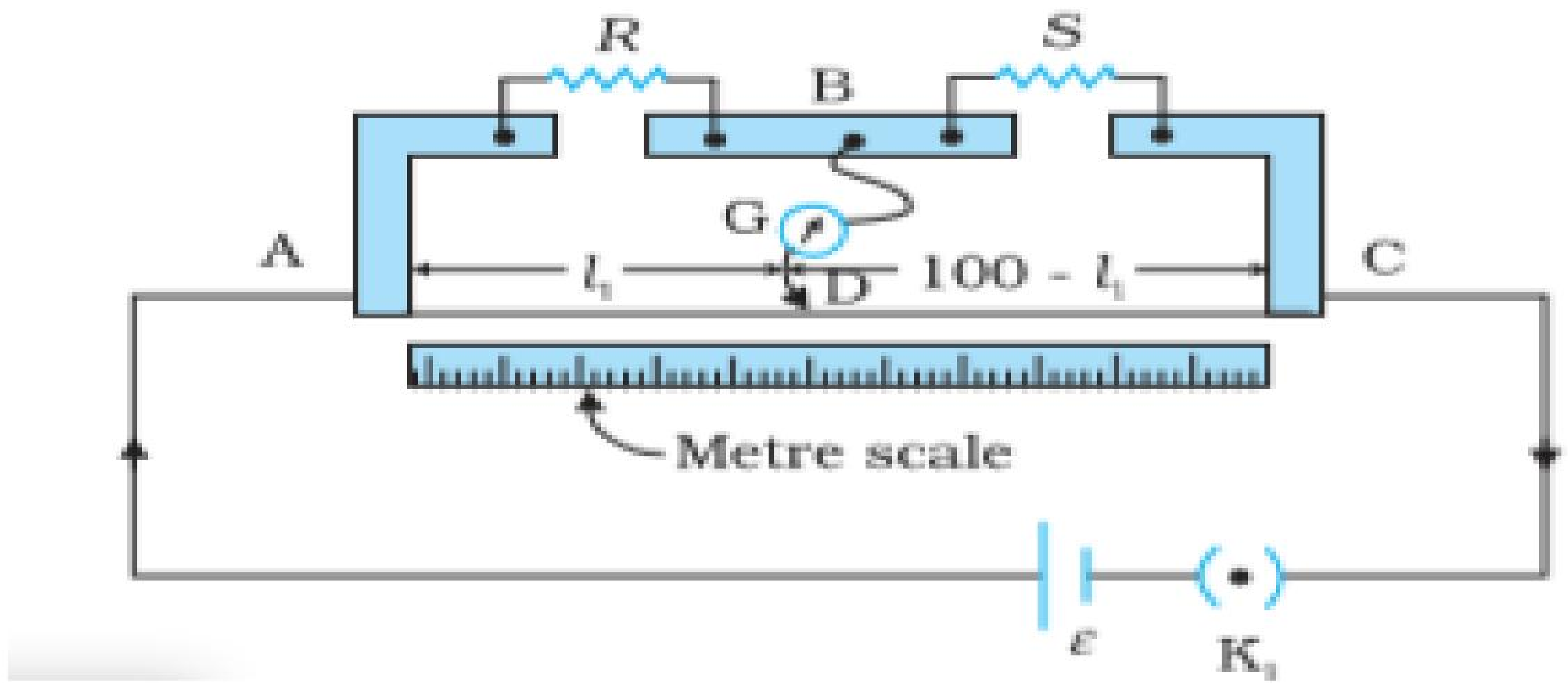
	Here OM= -u, MI=+v, MC= +R On substituting in equation 3, we get $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$ Note: Give full credit of this part, if a student takes medium of μ_1 as denser and μ_2 as rarer (b) According to Malus's law intensity of light transmitted from P_2 $I_{p_2} = I_o \cos^2\theta$ Where $I_o = \frac{2}{2}$ mW = 1mW Here $\theta = 60°$ I_{p_2} = (1 mW) $\cos^2 60°$ = 0.25 mW	1/2 1/2 1/2 1/2 1/2	5

36.	a) Derivation of expression for Capacitance 2 b) Expression for the Force experienced 1 c) Calculation of total charge stored 2	
	(a) Electric field between the parallel plate capacitor.	
	$E = \frac{\sigma}{\epsilon_0} = \frac{Q}{A\epsilon_0}$	1/2
	We know $V = Ed = \frac{\sigma}{A\epsilon_0} d$	1/2
	As capacitance $\frac{Q}{V} = C$	
	$C = \frac{A\epsilon_0}{d}$	1/2 1/2
	(a) Electric Field due to the positive plate on the negative plate	
	$E = \frac{\sigma}{2\epsilon_0} = \frac{\sigma}{2A\epsilon_0}$	1/2
	Hence Force experienced by negative plate due to positive plate $F = - qE = - q\times \frac{q}{2A\epsilon_0} = - \frac{q2}{2A\epsilon_0}$ -ve sign shows attractive force.	1/2
	(c) C_2 , C_3 and C_4 are connected in series. $\frac{1}{Cs} = \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12}$	1/2
	Cs =4 μF Equivalent capacitance of the Network $C = C_s + C_4$ = 4μF + 12 μF	
	= 16 μF	1/2
	Total charge Q=CV	1/2
	$=16 \times 10^{-16} \times 100$	
	Q=1600 μC	1/2
	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

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

1



1

For specific resistance when no current flows in galvanometer

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

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

From equation 1 & 2

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

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

1/2

Resistivity of the wire

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

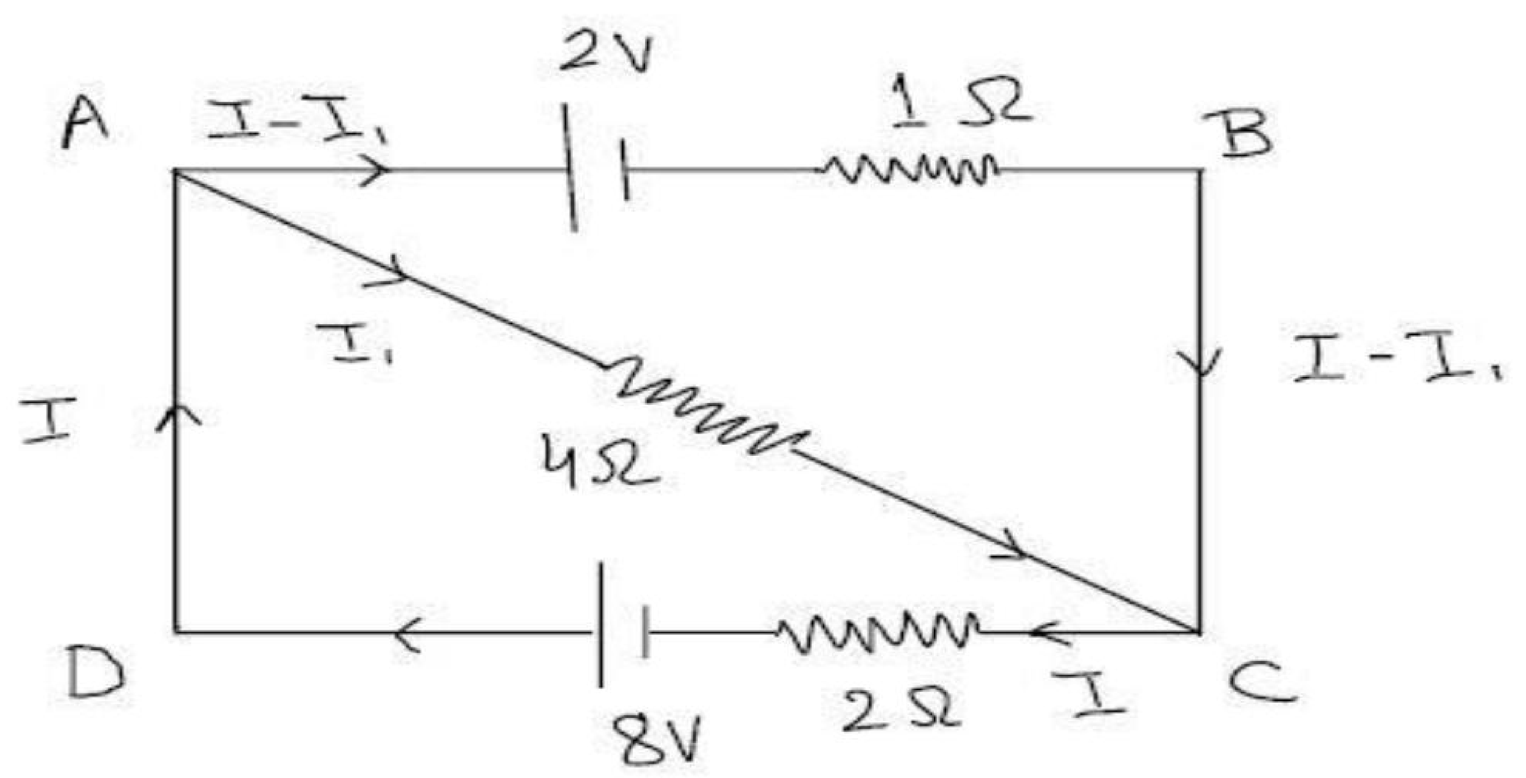
1/2

where L = Length of unknown resistance wire

r = radius of unknown resistance wire

(b)

*These answers are meant to be used by evaluators



In loop ACDA

$4I_1 + 2I = 8$

$2I_1 + I = 4$ ……….. 1 — 1/2

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 — 1/2

By adding Equation (1) & (2)

$7I_1 = 6$ — 1/2

$I_1 = \frac{6}{7}A$

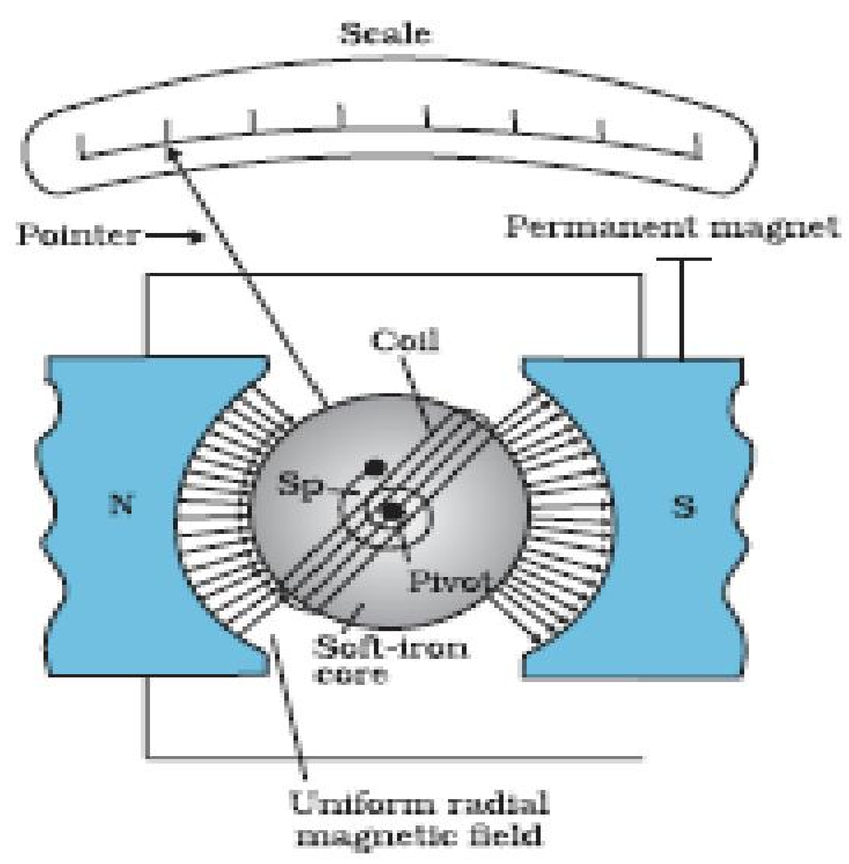
$V = I_1R = \frac{6}{7} \times 4$

$V = \frac{24}{7}$ volt — $^1/_2$ — 5

37.

(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)



1

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 sinθ =1 in the above expression for torque. The magnetic torque NIAB tends to rotate the coil. A spring provide a counter torque k∅ that balances the magnetic torque NIAB; resulting in a steady angular deflection ∅. In equilibrium

$$k\,\emptyset = NIAB$$

$^1/_2$

Where k is the tensional constant of the spring. The deflection ∅ is indicated on the scale by a pointer attached to the spring. We have

$$\emptyset = \left(\frac{NAB}{k}\right)I$$

$^1/_2$

To calibrate the scale of galvanometer/to make scale linear $^1/_2$

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

$R_1 = \frac{V}{I_g} - G \quad = 2000 = \frac{V}{I_g} - G$ ……… (1) $^1/_2$

$R_2 = \frac{V}{I_g} - G \quad = 5000 = \frac{2V}{I_g} - G$ ……….(2) $^1/_2$

$R = \frac{V}{2I_g} - G$ ……….(3) 1/2

	from equation 1 & 2 $3000 = \frac{V}{I_g}$ From equation (1) 2000=3000-G G= 1000 Ω R= $\frac{3000}{2}$ – 1000 R= 1500 – 1000 R= 500 Ω	½ ½	
	OR		
	(a) (i) Expression for emf induced and polarity — $1\,{}^1/_2 + {}^1/_2$ (ii) Magnitude and direction — ${}^1/_2 + {}^1/_2$ (b) Calculation of mutual inductance — 2		
	(a) (i) Magnetic flux linked with the loop at any instant of time is $\emptyset_B = B(lx)$ $\left\|\frac{d\emptyset_B}{dt}\right\| = Bl\frac{dx}{dt}$ $\left\|\frac{d\emptyset_B}{dt}\right\| = Bl_v \quad \because (\frac{dx}{dt} = v)$ According to Faradays Law of Electromagnetic induction $\left\|\frac{d\emptyset_B}{dt}\right\| = e$ Hence e= Blv	½ ½ ½	
	Alternative Method (i) When rod moves outwards, according to Lorentz magnetic force $\overrightarrow{F_m} = q(\vec{V} \times \vec{B})$ 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= $F_m l$ = (qvB sinθ) l W= qvBl ($\therefore \theta = 90°$) According to definition of emf	½ ½	

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

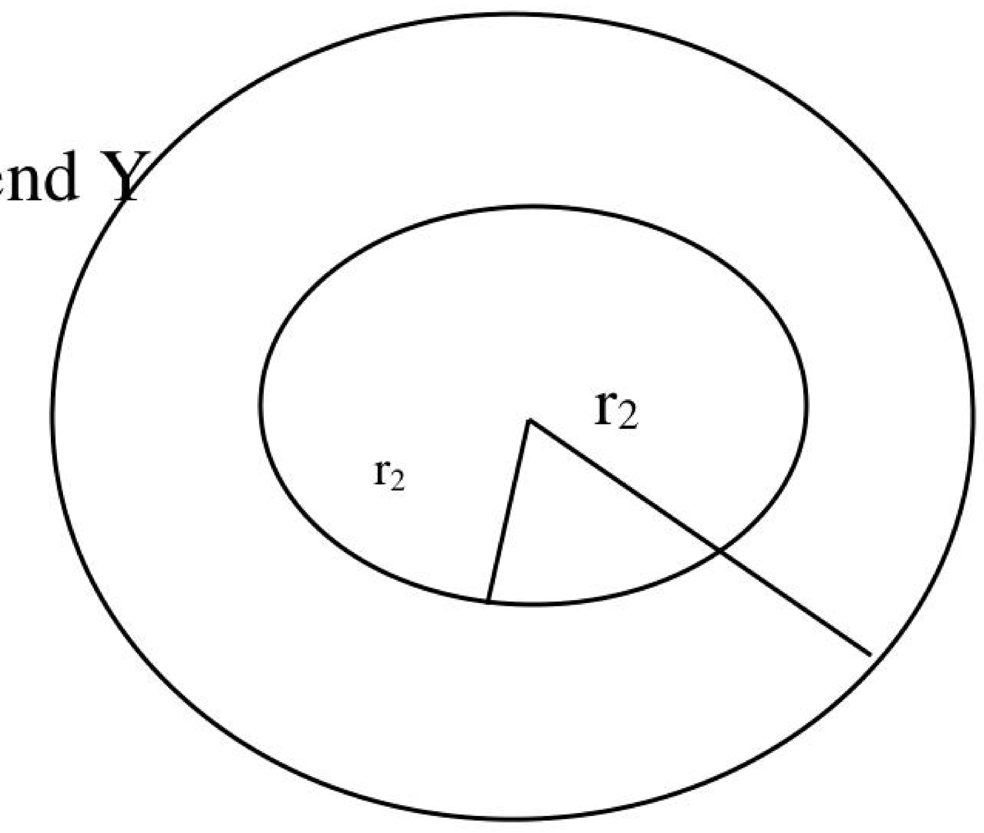
Hence, emf e= vBl — $^1/_2$

The end X of coil be at lower potential and Y will be at higher potential. — $^1/_2$

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

$I = \frac{Bvl}{r}$ — 1/2

Direction of induced current is from end X to end Y — 1/2



(b)

$M = \frac{\mu_0 \pi r_1^2}{2r_2}$ — 1/2

$= \frac{4\pi \times 10^{-7} \times \pi \times 0.5^2 \times 10^{-4}}{2 \times 11 \times 10^{-2}}$ H — 1/2

$= 2 \times (0.25) \times 10^{-9} \times \frac{\pi^2}{11}$ H — 1/2

$= 4.49 \times 10^{-10}$ H — 1/2

Total: 5