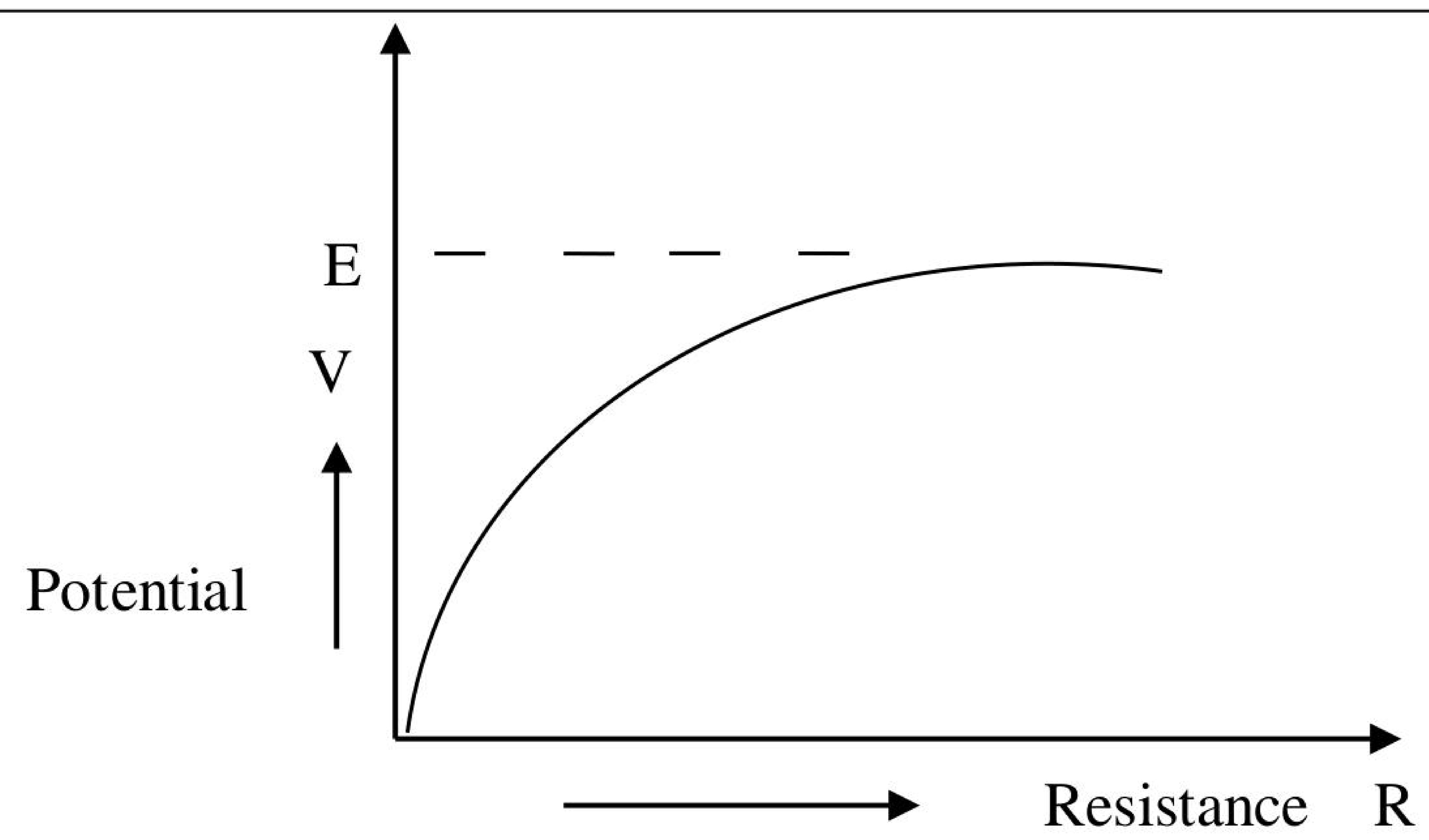
Marking Scheme: Physics (042)

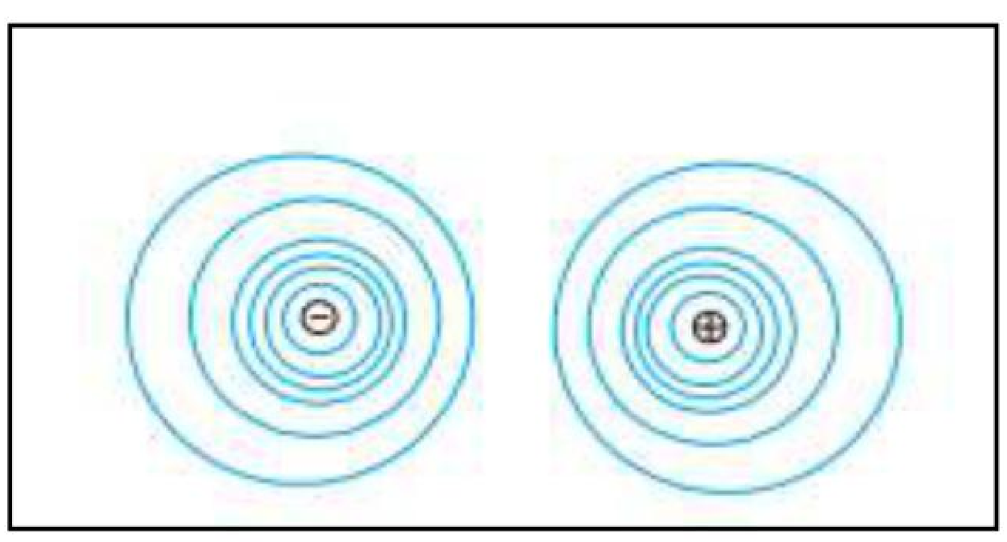
Code :55/C/3

Q. No.	VALUE POINTS/ EXPECTED ANSWERS	Marks	Total Marks
	SECTION A		
1	(D) Number of both the free electrons and holes increases equally.	1	1
2	(C) III	1	1
3	(c) $\frac{F}{2}$	1	1
4	(A) + $\frac{d}{4}$	1	1
5	(C) 1	1	1
6	(C) $(\frac{r_1}{r_2})^2$	1	1
7	(A) charge on the capacitor will increase	1	1
8	(A) Linear momentum	1	1
9	(D) 2:1	1	1
10	$(A)\ \pi: 4$	1	1
11	90°	1	1
12	2π	1	1
13	$\frac{h}{\pi}$ OR 9×10^{14}J	1	1
14	Red	1	1
15	electrons	1	1
16		1	

*These answers are meant to be used by evaluators

	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
17	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
18	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
19	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
20	When a charge of one coulomb develop potential of one volt between the plates of capacitor its capacity is said to be one farad.	1	1
	SECTION B		
21	(a) Identification 1/2 One Application 1/2 (b) Identification 1/2 (c) One Application 1/2 (a) X-rays Application:1. To detect fracture in the bone 2. To study crystal structure	1/2 1/2	

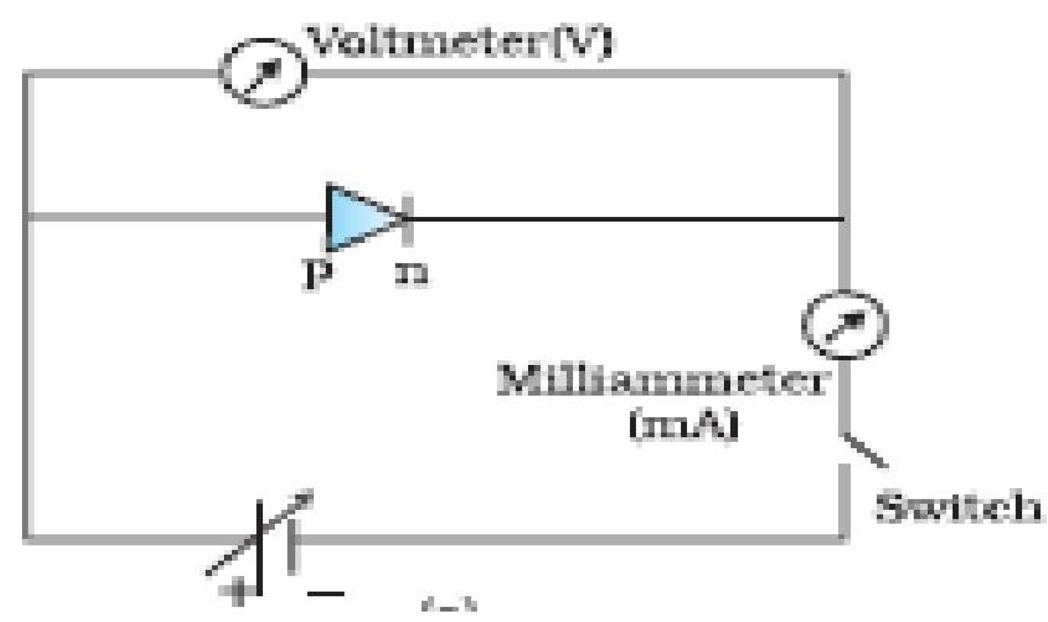
*These answers are meant to be used by evaluators

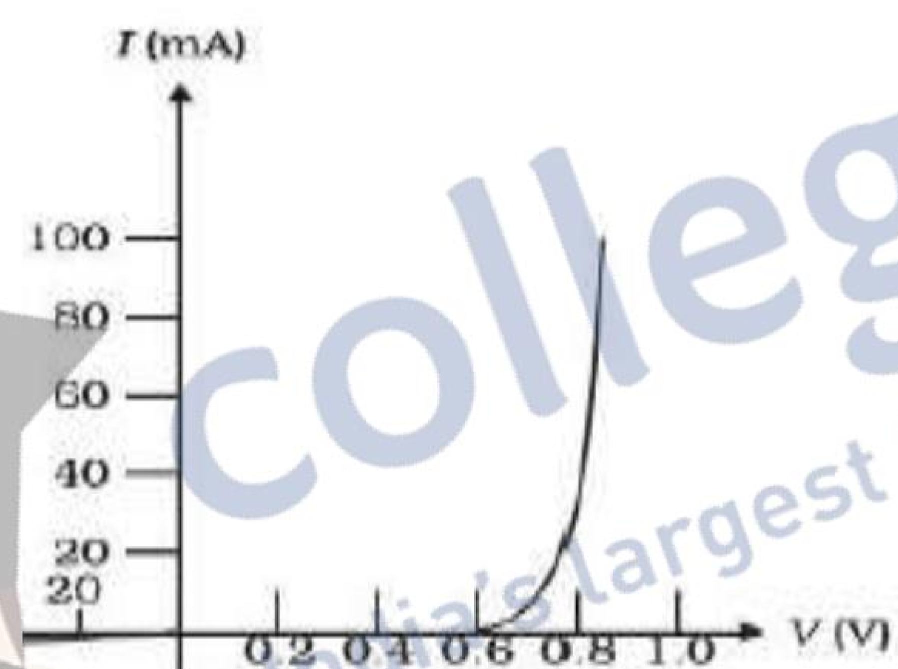
	3. In the treatment of cancer(Any one application) Give full credit to any other correct application. (b) Gamma rays Application: Used in cancer and tumor treatment	 1/2 1/2	 2
22	Definition of quality factor — 1 Two methods to double the quality factor — 1/2 + 1/2 It is the ratio of resonant angular frequency to the bandwidth of a series LCR circuit **Alternatively** Q-factor = $\frac{\omega o}{2\Delta\omega}$ **Alternatively** It is the ratio of potential difference across inductor or capacitor to the potential difference across resistor at resonance. **Alternatively** Q-factor $= \frac{1}{R}\sqrt{\frac{L}{C}}$ **Alternatively** It is the factor which determines the sharpness/ selectiveness of series LCR circuit. **Methods** 1. By reducing the resistance to half its initial value 2. By doubling the value of inductance and reducing the value of capacitance to half	 1 1/2 1/2	 2
23	(a) Depiction of equipotential surfaces — 1 (b) Finding the amount of work done — 1 **(a)**  (b) W=q_0 Δ V	 1	

*These answers are meant to be used by evaluators

	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	$\frac{1}{2}$ $\frac{1}{2}$	2
24	(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 $\frac{1}{2}$ $\frac{1}{2}$	2
25	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 reverse bias is applied. OR Circuit Diagram — $\frac{1}{2}$ Working of p-n junction — 1 I-V Characteristics — $\frac{1}{2}$	1 1 $\frac{1}{2}$	

*These answers are meant to be used by evaluators

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

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.
(Note: Accept any other relevant explanation for working)
I-V characteristics

</td>
<td>1
$^1/_2$</td>
<td>2</td>
</tr>
<tr>
<td>26</td>
<td><table>
<tr><td>Formula for half life</td><td>$^1/_2$</td></tr>
<tr><td>Calculation of half life</td><td>1</td></tr>
<tr><td>Calculation of Critical mass</td><td>$^1/_2$</td></tr>
</table>
$N = N_o \left(\frac{1}{2}\right)^n$
$\frac{1}{16} N_o = N_o \left(\frac{1}{2}\right)^n$
$n = 4$
$t = n \times T_{1/2}$
$T_{1/2} = \frac{t}{n} = \frac{4}{4} = 1$ day</td>
<td>$^1/_2$
$^1/_2$
$^1/_2$</td>
<td></td>
</tr>
</table>

$N = N_o \left(\frac{1}{2}\right)^n = N_o \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$ ½

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

$N_o = 256$ g

Alternative Method ½

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

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

$16 = e^{4\lambda}$

$4 \log_e 2 = 4\,\lambda$ ½

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

$\lambda = 0.693$ per day

Half life ½

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

$4 = N_o\, e^{-\lambda t}$ ½

$N_o = 256$ g

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

OR

Formula	½
Conversion of kinetic energy in Joule	½
Finding the distance of closest approach	1

½

$$d = \frac{q_1 q_2}{4\pi\epsilon_0 K}$$ ½

kinetic energy= 5.12 MeV

$= 5.12 \times 1.6 \times 10^{-13}$ J

$= 8.192 \times 10^{-13}$ J ½

$$d = \frac{q_1 q_2}{4\pi\epsilon_0 K} = \frac{9\times10^9 \times 2e \times 79e}{8.192\times10^{-13}} \text{ m}$$ ½

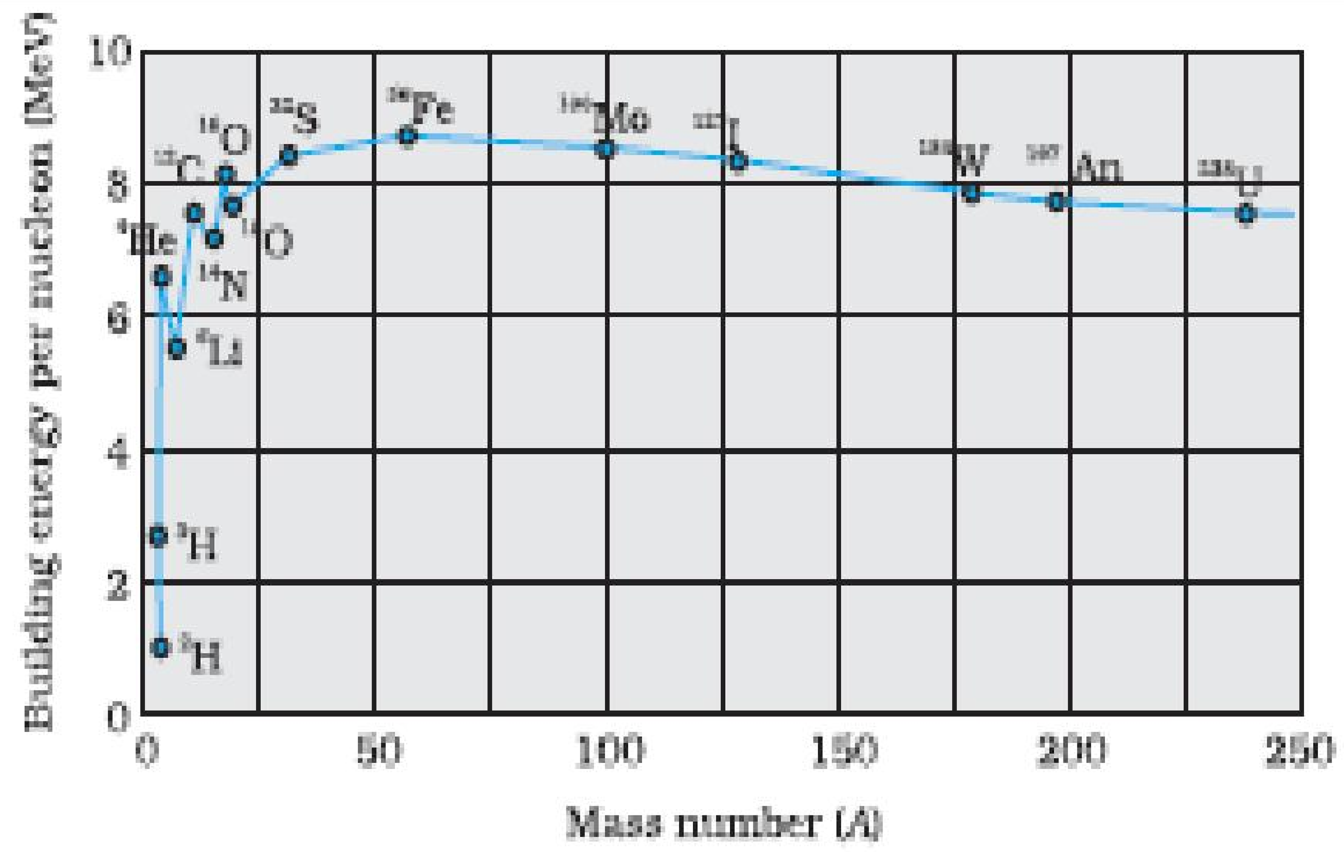
$= 4.443 \times 10^{-14}$ m

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

27

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

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



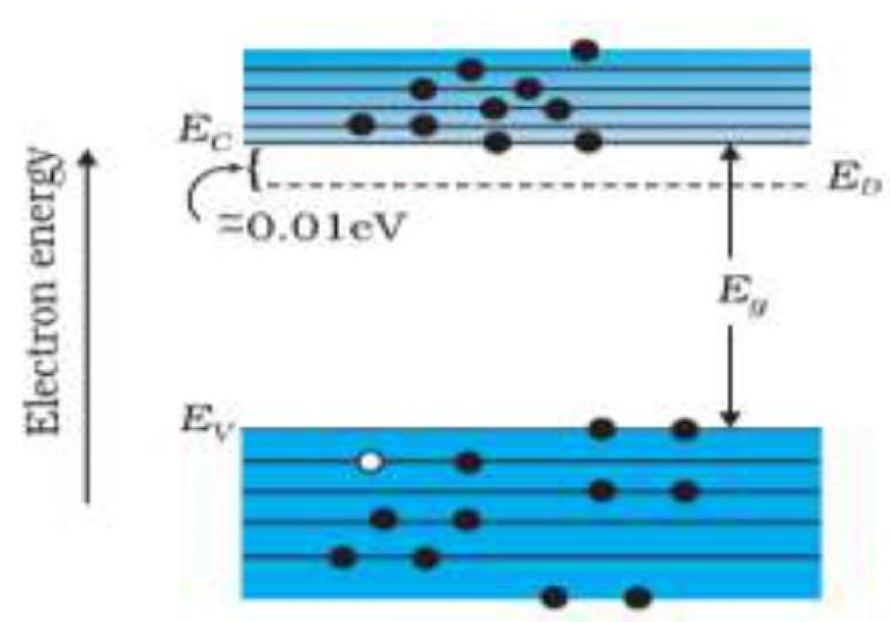
Note: please don't deduct marks if student does not mark all the nuclei on the curve.

The nuclei lying at the middle flat portion are more stable because their binding energy per nucleon is large and shows more stability.</td><td>1

1</td><td>2</td></tr>
<tr><td></td><td>SECTION C</td><td></td><td></td></tr>
<tr><td>28</td><td>

(a) Explanation of energy bands	1
(b) (i) conversion into p-type	½
(ii) conversion into n-type	½
c) Diagram	½ +1/2

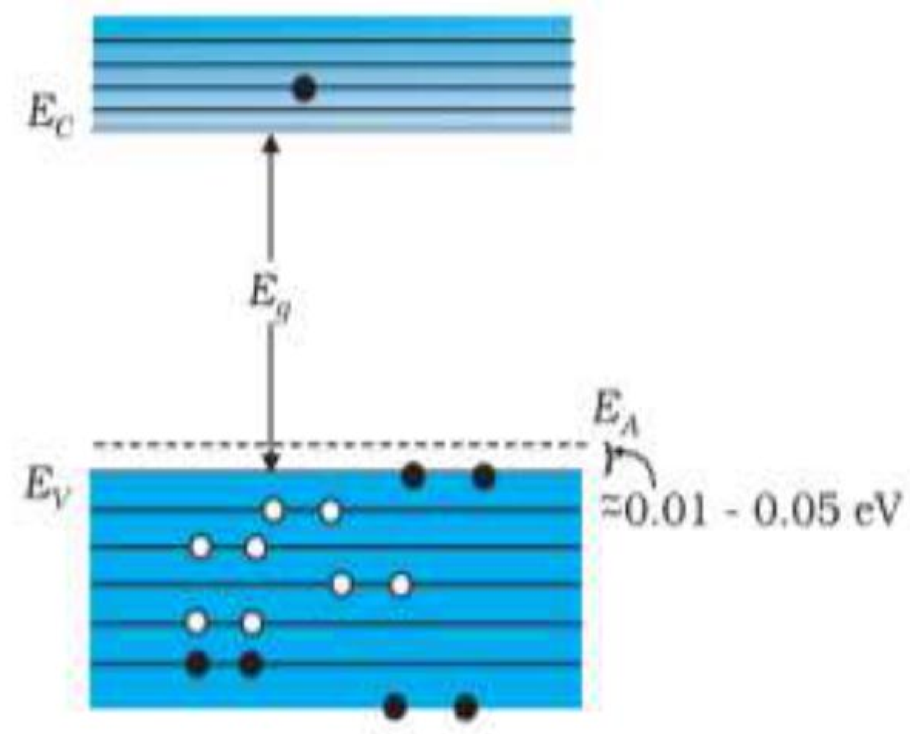
(a) In silicon semiconductor there are two energy bands,conduction band and valence band separated by energy band gap.balance band is filled completely or partially with electron while conduction band is empty
(b) (i) by adding trivalent /13th Group element
(ii) by adding pentavalent /15th Group element



(a) $T > 0K$
one thermally generated electron-hole pair + 9 electrons from donor atoms</td><td>1

½
1/2

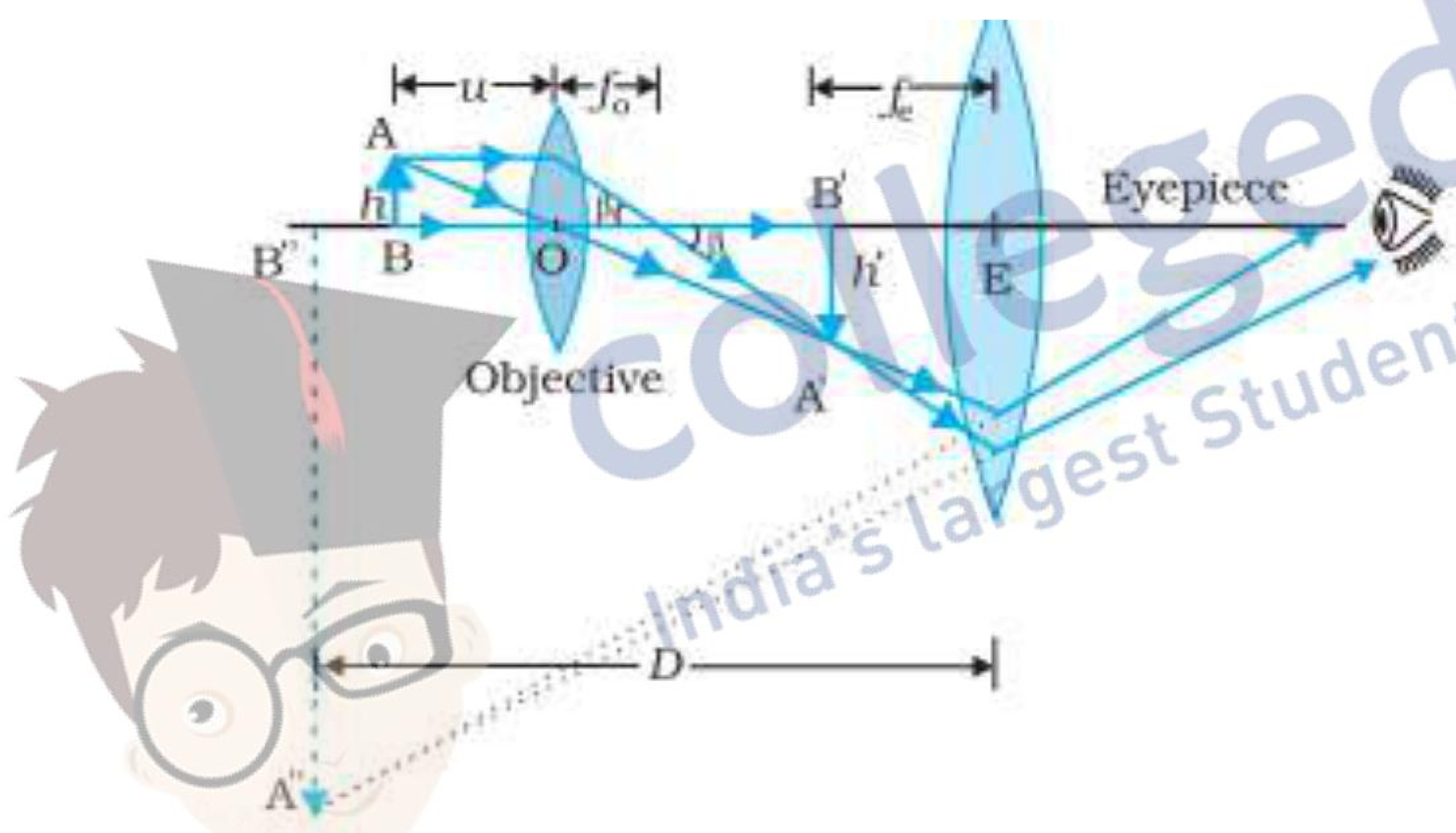
1/2</td><td></td></tr>
</table>

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

(b) $T > 0$K</td><td>1/2</td><td>3</td></tr>
<tr><td>Q29</td><td>

(a) Ray Diagram	$1\,^{1}/_{2}$
(b) Expression of magnifying power	$1\,^{1}/_{2}$

Ray diagram



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

rays)

Expression for magnification

$m_o = \frac{h'}{h} = \frac{L}{f_o}$

where we have used the result

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

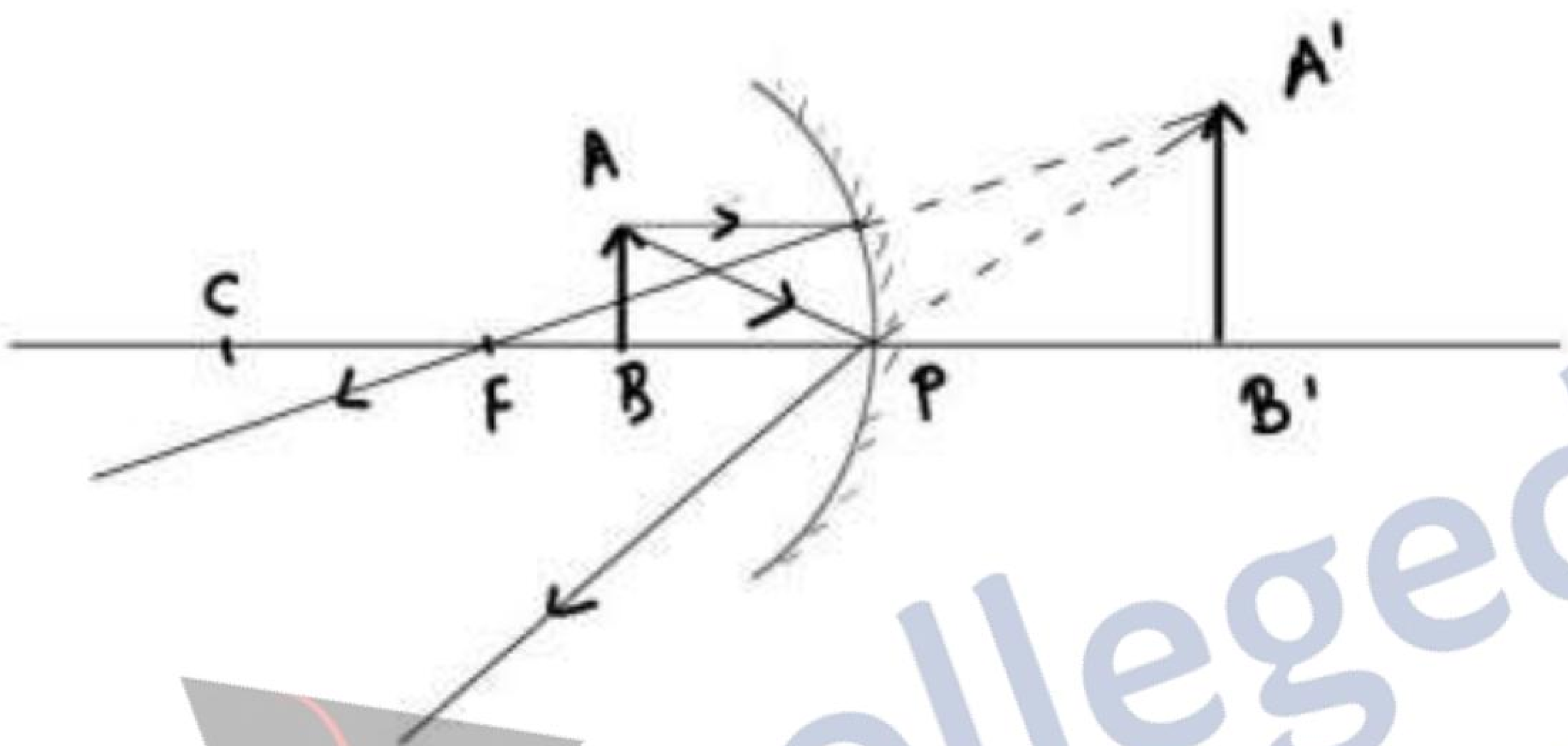
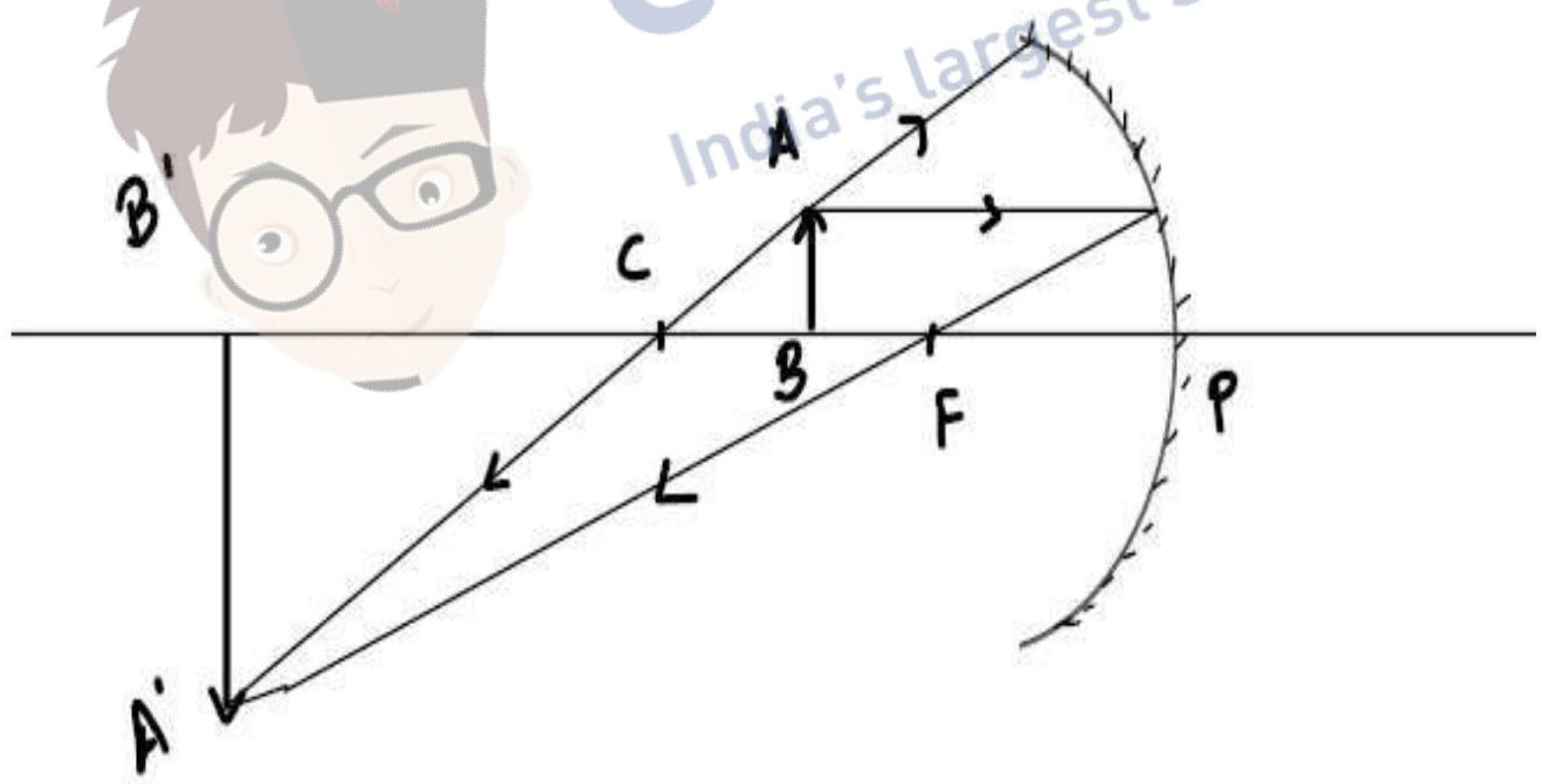
$m_e = (1 + \frac{D}{f_e})$

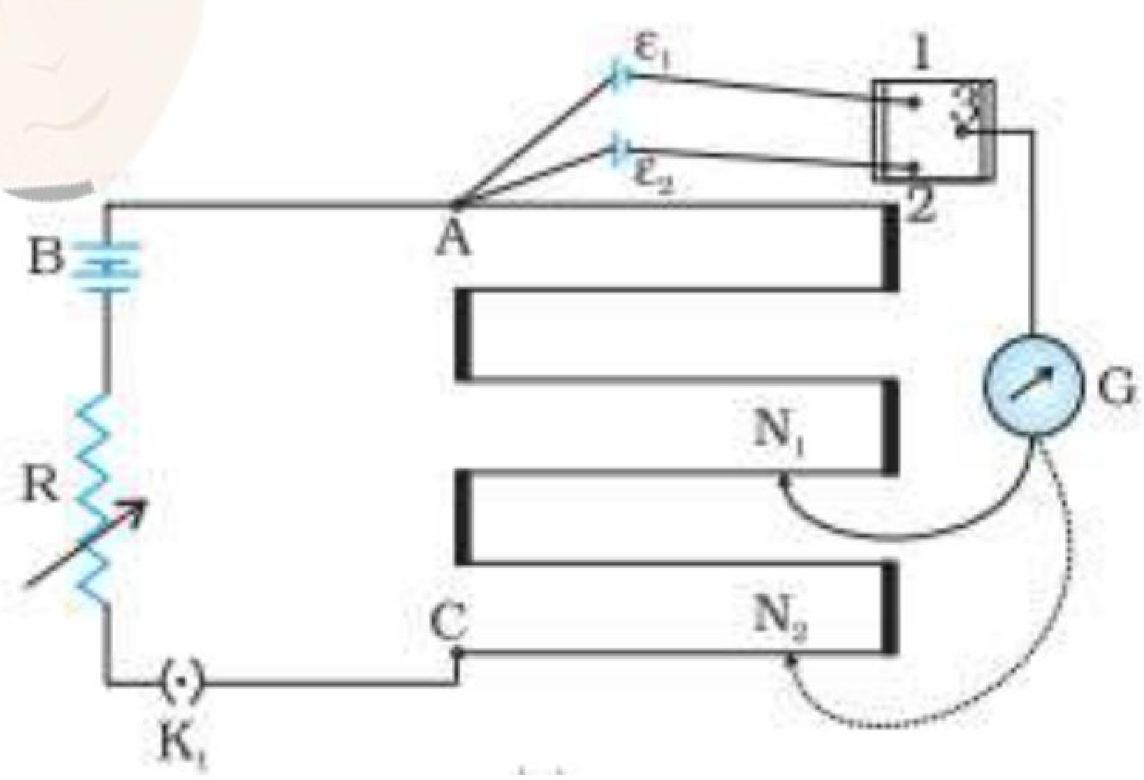
Magnifying power of microscope at near point.

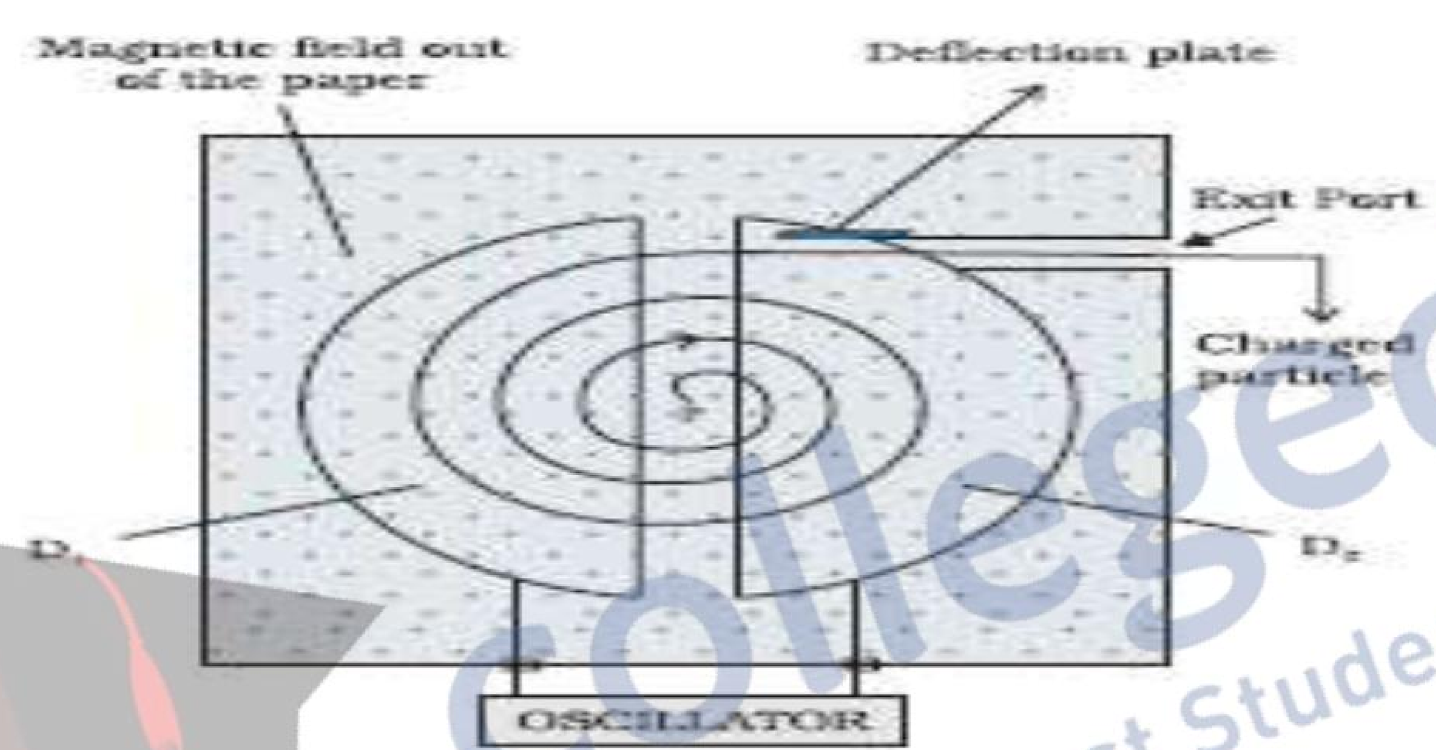
$m = m_o\, m_e$</td><td>$1^{1}/_{2}$

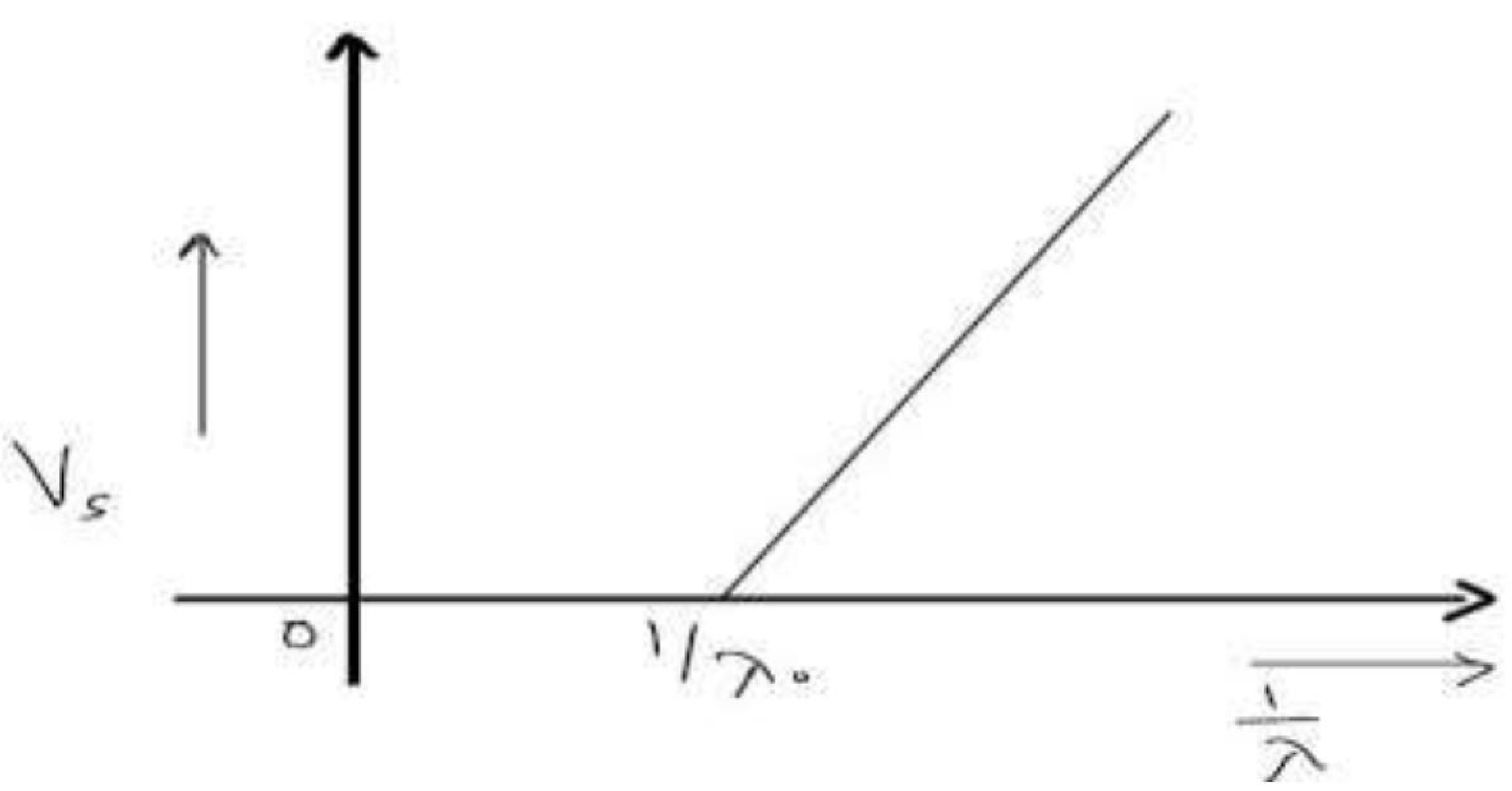
$^{1}/_{2}$

$^{1}/_{2}$</td><td></td></tr>
</table>

	$m = \frac{L}{f_o}\left(1+\frac{D}{f_e}\right)$	$1/2$	3
Q30	a) Diagram 1 ½ Diagram 2 ½ b) For formula $\frac{1}{f} = \frac{1}{V} + \frac{1}{u}$ For formula $\frac{v}{u} = m$ } ½ Calculation of distance of object for two cases ½ + ½ Calculation of distance ½		
	 	½	
	a)  	½	
	For three times enlarged virtual image f = -12 cm m = 3 $m = -\frac{v}{u}$ v = -3u	½	

	$\frac{1}{-12} = \frac{1}{-3u} + \frac{1}{u}$ 3u = - 24 u = -8 cm For three times enlarged real image f = -12 cm m = - 3 $m = -\frac{v}{u}$ v = 3u $\frac{1}{f'} = \frac{1}{v'} + \frac{1}{u'}$ $\frac{1}{-12} = \frac{1}{3u'} + \frac{1}{u'}$ $3u^1 = -48$ u′ = - 48 u′ = -16 cm Distance between two positions of objects d = u′ - u = 8 cm	½ ½ ½	3
Q31	Circuit diagram 1 Working for comparing e.m.f 1½ Preference potentiometer over voltmeter (Reason) 1/2  **Working :-** A current I flows through wire which can be varied by a variable Resistance (Rheostat ,R) in the circuit. Since the wire is uniform, the potential difference between A and any point at a distance l from A is $E_1 = \varphi l$ Where φ is the potential drop per unit length Circuit shows an application of the potentiometer to compare the emf of the two cells of emf E_1 and E_2 . The points marked 1,2,3 form a two way key. Consider first a position of key where 1 and 3 are connected so that the galvanometer is	1 ½	

	connected to E_1. The jockey is moved along the wire till at a points N_1 , at a distance l_1 from A , there is no deflection in the galvanometer. We can apply Kirchhoff's loop rule to the closed loop AN_1G31A and get $\Phi l_1 + 0 - E_1 = 0$ ----------------------(1) Similarly , if another emf E_2 is balanced against l_2 (AN_2) $\Phi l_2 + 0 - E_2 = 0$ ----------------------(2) From last two equation $\frac{E_1}{E_2} = \frac{l_1}{l_2}$ We prefer potentiometer because it does not draw any current from the voltage source being used.	½ ½ ½	3
Q32	(a) Labeled diagram 1 Explanation of Working 1 (b) Explanation of motion on ions 1 (a)  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. (b) Ions will not get accelerated.	1 1 1	3
Q33	(a) Working Principle of ac generator 1 Derivation of expression for induced emf 1 (b) Function of Slip Rings 1		

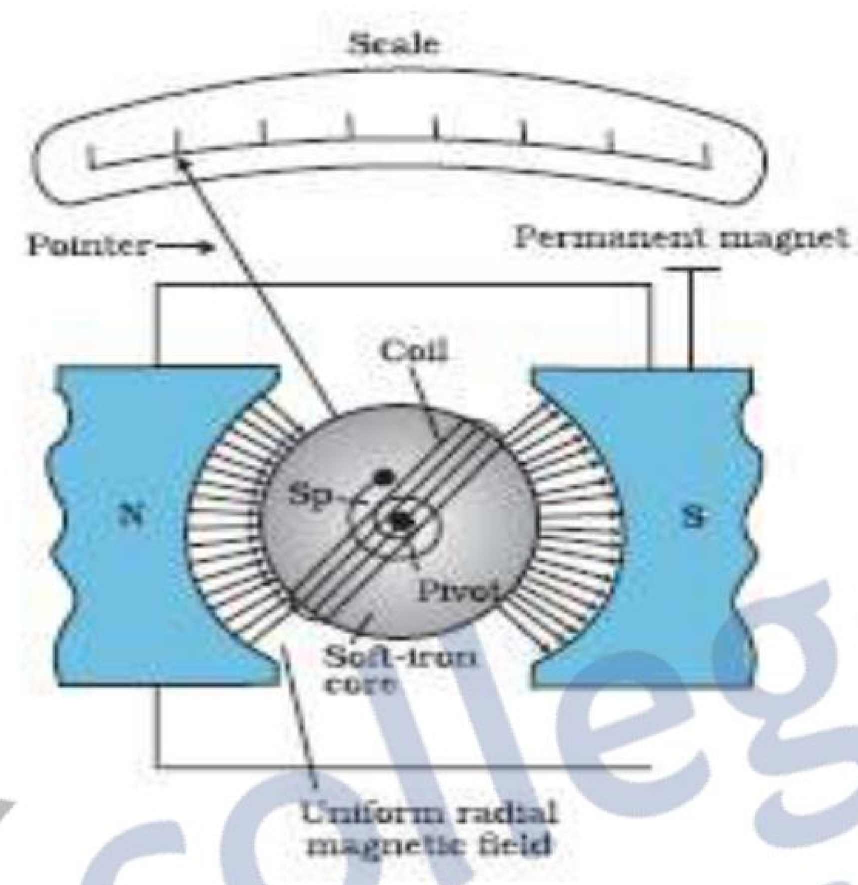
	(a) It is based upon the principle of electromagnetic induction. Magnetic Flux $\Phi = NBA\cos\theta$ $\Phi = NBA\cos\omega t$ According to Faradays law Emf $e = \frac{-d\Phi}{dt} = \frac{-d(NBA\cos\omega t)}{dt}$ $e = NBA\,\omega\sin\omega t$ (b) it helps current to change its direction after every 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 currents. (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 $1/2$ $1/2$ 1 1 1 1	3
Q34	a) Expression for stopping potential 1 b) Graph 1 c) Determination of Planck's constant ½ Determination of work function ½ a) $V_s = \frac{hc}{e}\left(\frac{\lambda_o - \lambda}{\lambda\lambda_o}\right)$  b) **c)** $h = \frac{e}{c} \times \textit{Slope of line}$	1 1	

	φ_o = hc × intercept of the line on X –axis or φ_o = e × intercept of the line on y –axis	½ ½	3
	SECTION -D		

Q35

(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$\emptyset$ 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 $^1/_2$

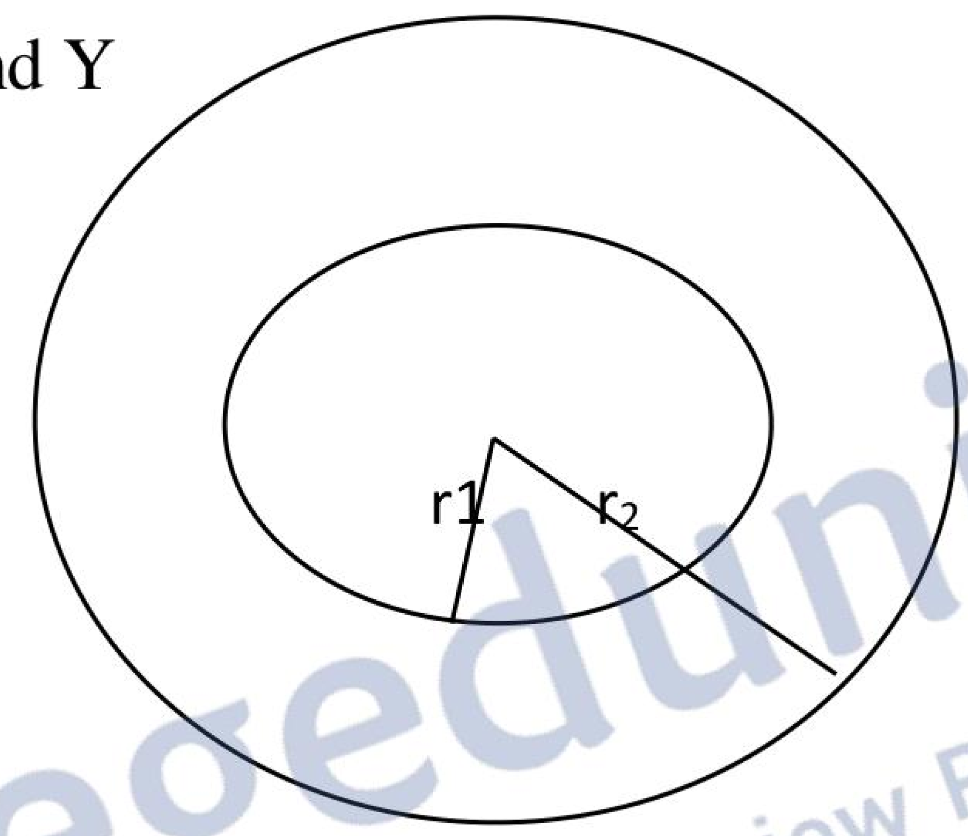
$$\emptyset = \left(\frac{NAB}{k}\right)I$$

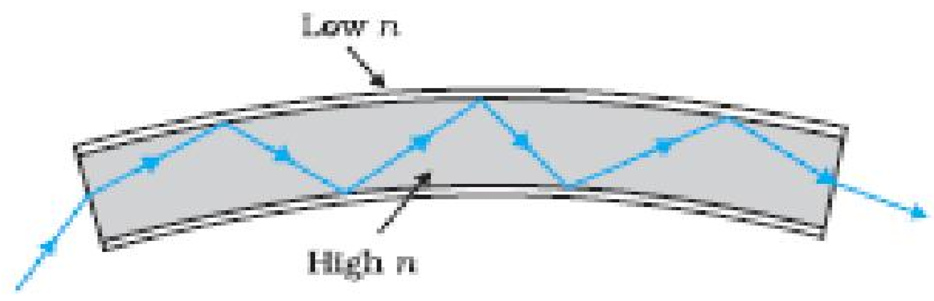
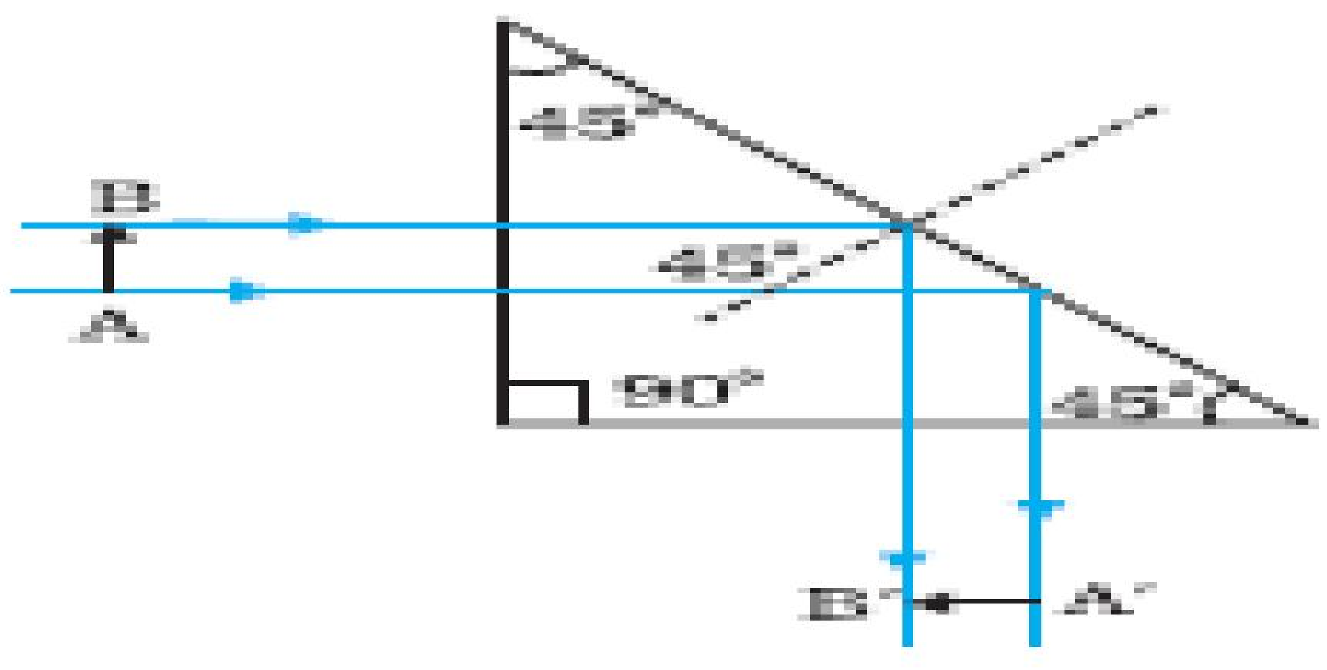
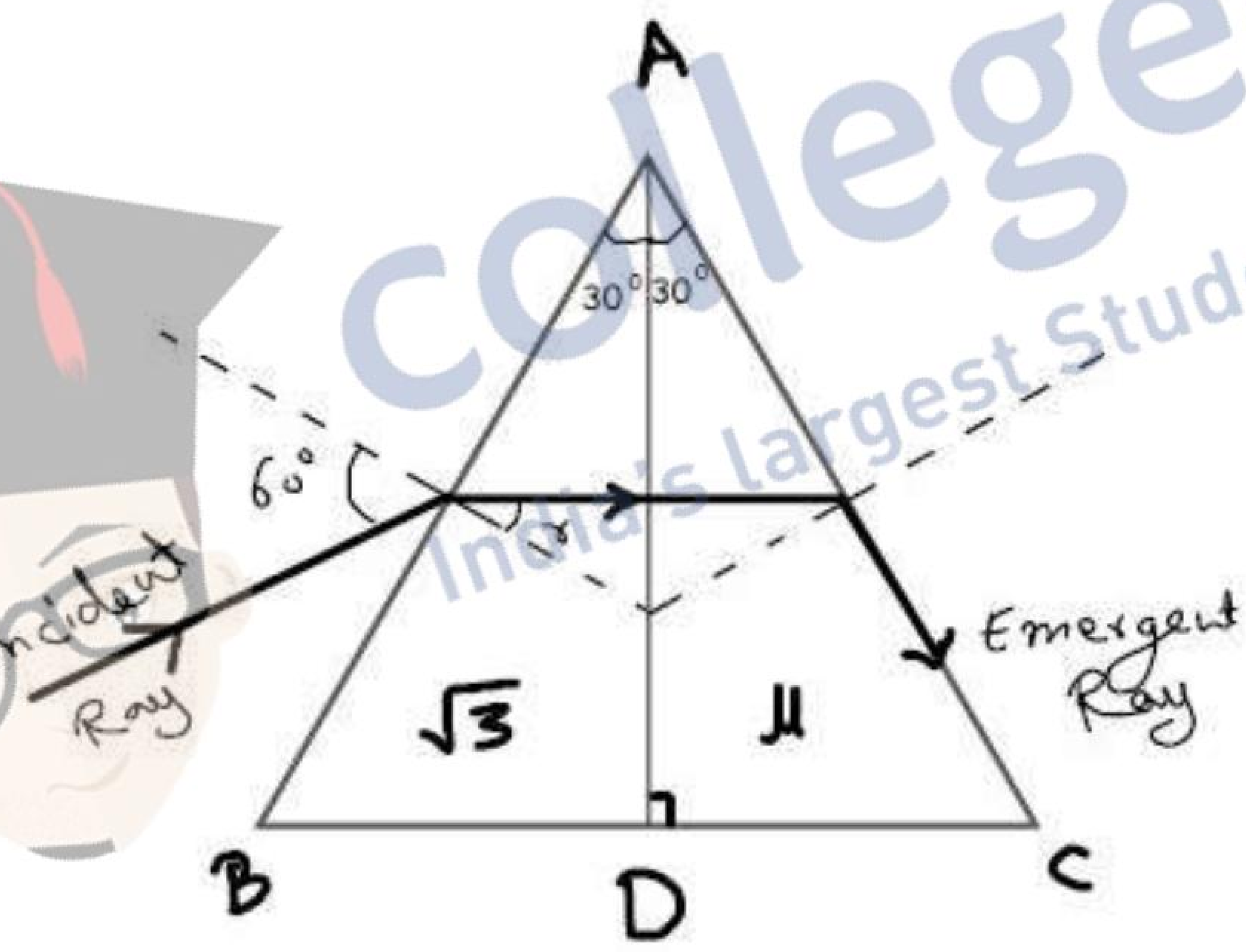
To calibrate the scale of galvanometer/to make scale linear $^1/_2$

(b) $R = \frac{V}{I_g} - G$ $^1/_2$

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

	$R_2 = \frac{V}{I_g} - G \quad = 5000 = \frac{2V}{I_g} - G$ ....(2) $R = \frac{V}{2I_g} - G$ ....(3) 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 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 $\phi_B = B(lx)$ $\left\lvert\frac{d\phi_B}{dt}\right\rvert = Bl\frac{dx}{dt}$ $\left\lvert\frac{d\phi_B}{dt}\right\rvert = Bl_v \quad \because (\frac{dx}{dt} = v)$ According to Faradays Law of Electromagnetic induction $\left\lvert\frac{d\phi_B}{dt}\right\rvert = e$ Hence e= Blv **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= $F_m l$	½ ½ ½ ½ ½ ½ ½ ½ ½	

	$= (qvB\ \sin\theta)\ l$ $W = qvBl \quad (\because \theta = 90°)$ According to definition of emf $e = \frac{W}{q} = vBl$ Hence, emf $e = vBl$ The end X of coil be at lower potential and Y will be at higher potential. (ii) $I = \frac{e}{r}$ $I = \frac{Bvl}{r}$ Direction of induced current is from end X to end Y  (b) $M = \frac{\mu_o \pi r_1^2}{2r_2}$ $= \frac{4\pi\times10^{-7}\times\pi\times0.5^2\times10^{-4}}{2\times11\times10^{-2}}$ H $= 2 \times (0.25) \times 10^{-9} \times \frac{\pi^2}{11}$ H $= 4.49 \times 10^{-10}$ H	$^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$	5
Q36	(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	$^1/_2$	
	$\mu = \dfrac{\sin i}{\sin r}$	$^1/_2$	
	i =60° , $\mu = \sqrt{3}$		
	$\sqrt{3} = \dfrac{\sin 60°}{\sin r} \quad = \dfrac{\sqrt{3}}{2(\sin r)}$	$^1/_2$	

sin r= $\frac{1}{2}$ = sin 30° ½

r= 30°

So, ray will go perpendicular to AD For II[nd] prism ½

$i_c = 30°$

$\therefore \ \sin i_c = \frac{1}{\mu}$ ½

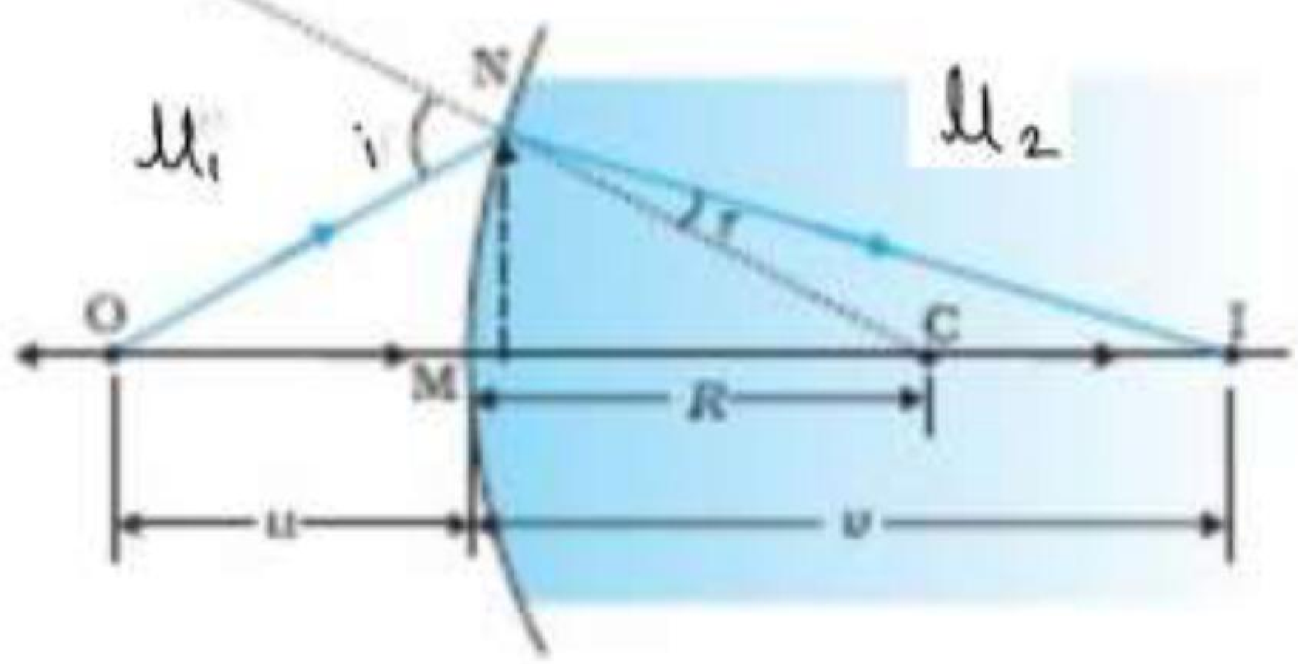
$\text{Sin } 30° = \frac{1}{\mu}$

$\mu = 2$

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) ½



½

$\tan \angle NOM = \frac{MN}{OM}$

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

	$\tan \angle NIM = \frac{MN}{MI}$		
	Now, for Δ NOC, L_i is the exterior angle	$1/2$	
	Therefore, $\angle i = \angle NOM + \angle NCM$		
	$\angle i = \frac{MN}{OM} + \frac{MN}{MC}$ ……..(1)		
	Similarly,	$1/2$	
	$r = \angle NCM - \angle NIM$		
	i.e $r = \frac{MN}{MC} - \frac{MN}{MI}$ ………..(2)		
	By snells law		
	$\mu_1 \sin i = \mu_2 \sin r$		
	For small angle		
	$\mu_1 i = \mu_2 r$	$1/2$	
	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)		
	Here		
	OM= -u, MI=+v, MC= +R	$1/2$	
	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	$1/2$	

	(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) $\cos^2 60°$ $I_{p_2} = \frac{1}{4}$ mW = 0.25 mW	$^1/_2$ $^1/_2$	5
Q37	(a) Derivation of expression for Capacitance — 2 (b) Expression for the Force experienced — 1 (a) Electric field believes the plates of parallel plate capacitor. $E = \frac{\sigma}{\epsilon_0} = \frac{Q}{A\epsilon_0}$ We know $V = Ed = \frac{\sigma}{A\epsilon_0} d$ As capautance $C = \frac{Q}{V}$ $C = \frac{\epsilon_0 A}{d}$ (b) Electric Field due to the positive plate on the negative plate $E = \frac{\sigma}{2\epsilon_0} = \frac{\sigma}{2A\epsilon_0}$ 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. (c) C_2, C_3 and C_4 are connected in series. $\frac{1}{Cs} = \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12}$ Cs = 4 μF Equivalent capacitance of the Network $C = C_s + C_4$ = 4μF + 12 μF = 16 μF	 $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$ $^1/_2$	

Total charge $Q=CV$ $\frac{1}{2}$

$=16 \times 10^{-16} \times 100$ $\frac{1}{2}$

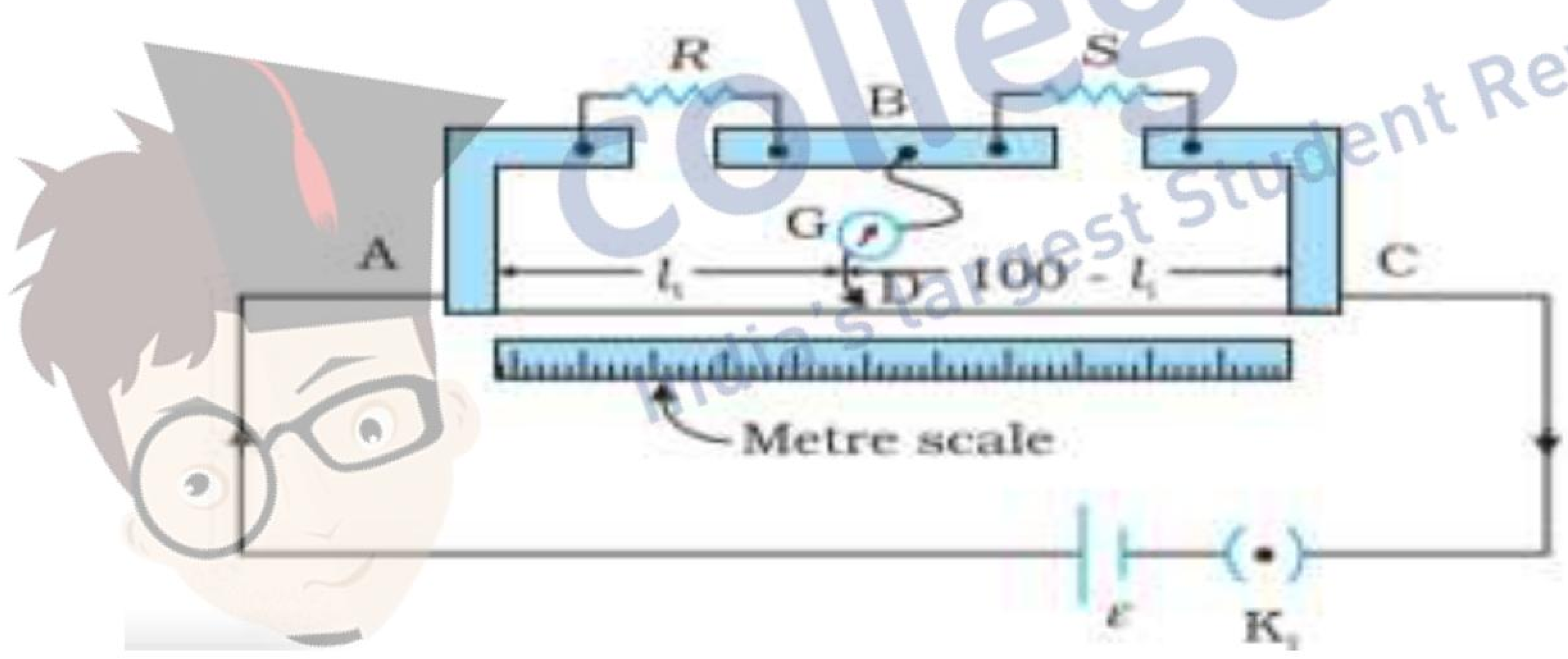
$Q=1600\ \mu C$

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

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

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

From equation 1 & 2 $\frac{1}{2}$

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

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

Resistivity of the wire

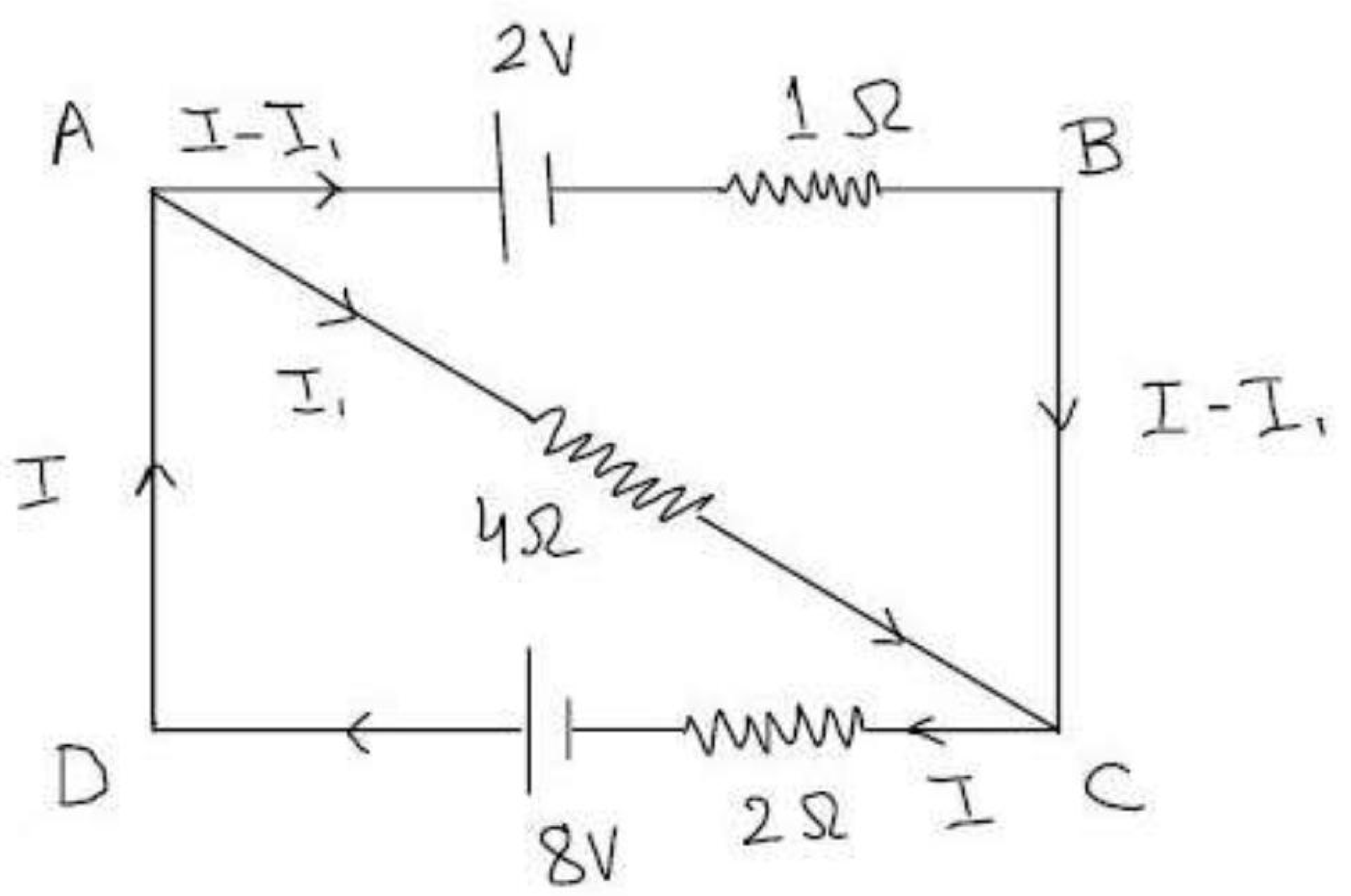
$$\rho = \frac{RA}{L} = R\frac{\pi r^2}{L}$$

where L = Length of unknown resistance wire

r = radius of unknown resistance wire

$^1/_2$

(b)



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)

$5I_1 - I = 2$

$\underline{2I_1 + I = 4}$

$7I_1 = 6$

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

$^1/_2$

$V = I_1 R = \frac{6}{7} \times 4$

$V = \frac{24}{7}$ volt

$^1/_2$

5