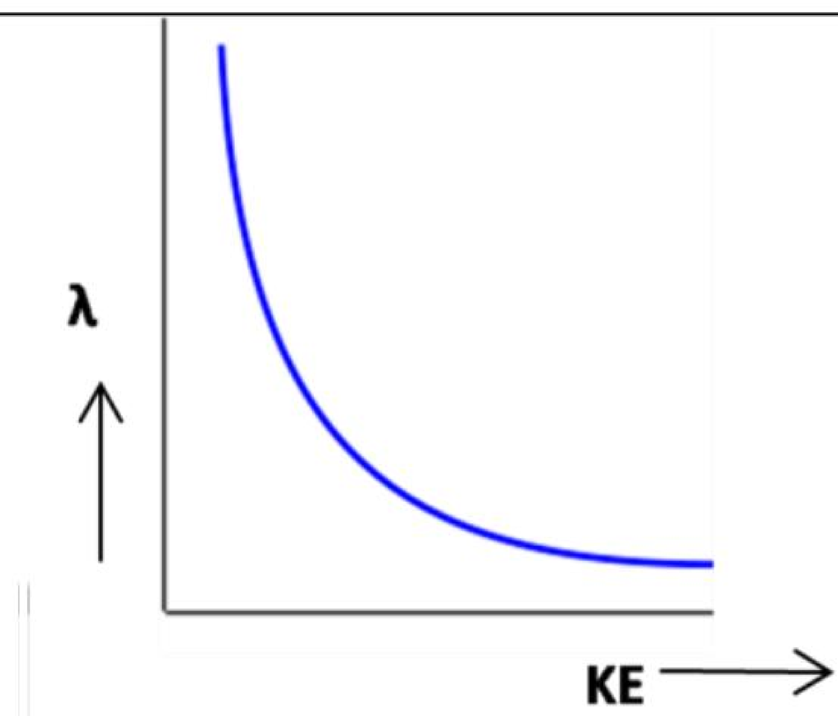
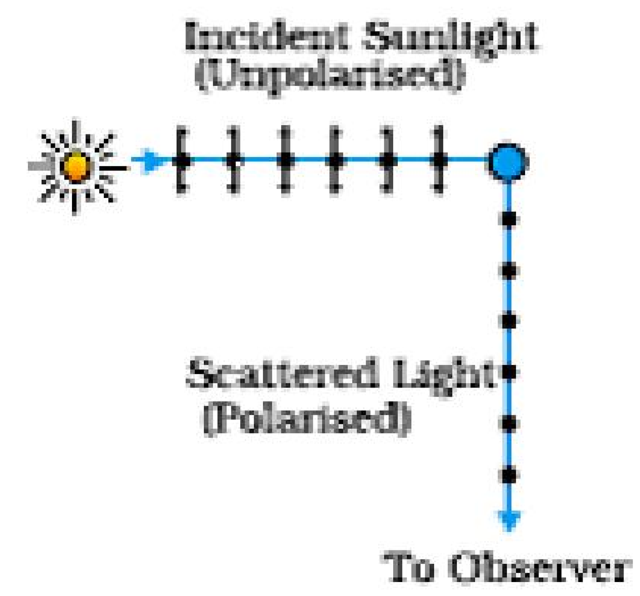
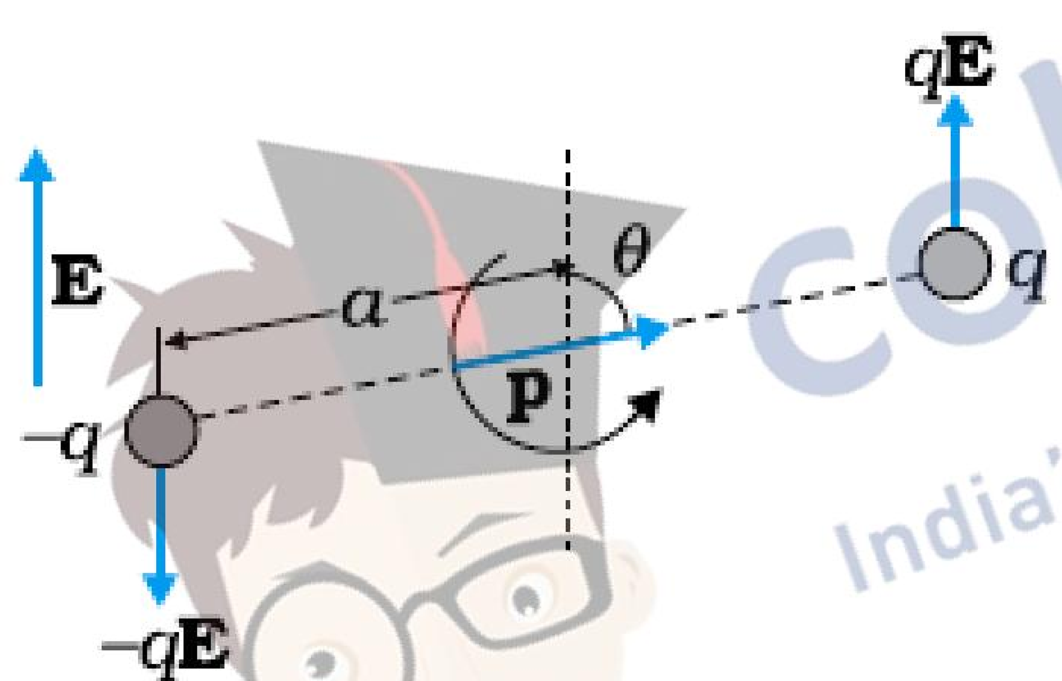
MARKING SCHEME
SET 55/1/1 (Compartment)

Q. No.	Expected Answer / Value Points	Marks	Total Marks
	Section A		
Set1,Q1 Set2,Q4 Set3,Q3	Kinetic energy will not be affected.	1	1
Set1,Q2 Set2,Q5 Set3,Q4	Clockwise on the side of the observer. [**Alternatively** :The candidate who draws diagram with arrow indicating the direction correctly, may also be given full credit.]	1	1
Set1,Q3 Set2,Q1 Set3,Q5	(i) Real (ii) magnified	½ + ½	1
Set1,Q4 Set2,Q2 Set3,Q1		1	1
Set1,Q5 Set2,Q3 Set3,Q2	To avoid overlapping of the two signals	1	1
	Section B		
Set1,Q6 Set2,Q10 Set3,Q8	Derivation of Relationship between current density and resistivity 2 Drift velocity $v_d = \frac{eE}{m}\tau$ ($\tau =$ relaxation time) The current $I = neA\, v_d$ (n = number of charge carriers per unit volume.) $= \lvert j \rvert A$ $j = \frac{ne^2}{m}\tau E$ $j = \frac{1}{\rho}E$	 ½ ½ ½ ½	2
Set1,Q7 Set2,Q6 Set3,Q9	Unpolarised light and linearly polarized light ½ + ½ Diagram & description ½ + ½ For unpolarised light electric vector associated with light, is oscillating randomly in all directions in a plane perpendicular to the direction of propagation of light. In linearly polarised light oscillating electric vector gets aligned along one direction perpendicular to the direction of propagation of light.	 ½ ½	

	[Under the influence of the electric field of the incident wave, the electrons (of the scattering molecules), accelerated parallel to the double arrows, do not radiate energy towards the observer. Hence, the scattered light gets polarized.] 	½ + ½	2
Set1,Q8 Set2,Q7 Set3,Q10	Reason for dispersion 1 Dependence of focal length of the lens on colour 1 The refractive index of the glass of the prism is different for different wavelengths(colours). Hence, different colours get bent along different directions. Using lens maker's formula $\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right), n_{21} = \frac{n_2}{n_1}$ As the refractive index of the medium with respect to air (medium 1) depends on the wavelength or colour of light, focal length of the lens would change with colour.	1 1	2
Set1,Q9 Set2,Q8 Set3,Q6	Calculation of the value of Plank's constant 2 According to Einstein's photoelectric equation $V_o = \frac{h}{e}\nu - \frac{\phi_o}{e}$ In the given graph: Stopping potential V_o = 1.23 V Change in frequency $\Delta\nu = 3 \times 10^{14}$Hz (Alternatively : slope of the line = $\frac{h}{e}$) $\frac{h}{e} = \frac{V_o}{\Delta v} = \frac{1.23}{3 \times 10^{14}}$ $\therefore h = \frac{1.23 \times 1.6 \times 10^{-19}}{3 \times 10^{14}}$J-s = 6.6×10^{-34} J-s	½ ½ ½ ½	2
Set1,Q10 Set2,Q9 Set3,Q7	Completion of nuclear reaction (a) 1 Completion of nuclear reaction (b) 1 (a) $^{10}_{5}\text{B} + ^{1}_{0}n \rightarrow ^{4}_{2}\text{He} + ^{7}_{3}\text{Li}$ (b) $^{94}_{42}\text{MO} + ^{2}_{1}\text{H} \rightarrow ^{95}_{43}\text{Te} + ^{1}_{0}n$ [**Note:** For reaction (a) even if the candidate writes $^{7}_{3}$X, award 1 mark] **OR**	1 1	

	Explanation of conversion of mass into energy (vice versa) 1 Example 1 Since proton number and neutron number are conserved, the total rest mass of neutron and protons is the same on either side of the nuclear reaction. But total binding energy of nuclei on the left side need not be the same as that on the right hand side. The difference in binding energy causes a release of energy in the reaction. Example : ${}^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{3}_{2}\mathrm{He} + {}^{1}_{0}n + \text{energy}$ Or $({}^{235}_{92}\mathrm{U} + {}^{1}_{0}n \rightarrow {}^{144}_{56}\mathrm{Ba} + {}^{89}_{36}\mathrm{Kr} + 3{}^{1}_{0}n + \text{ energy})$ (Give full credit for any other one correct example.)	 1 1	 2
	Section C		
Set1,Q11 Set2,Q20 Set3,Q17	(i) Figure ½ (ii) Derivation of torque 1 ½ (iii) Identification of two pairs ½ + ½  The force on charge +q is $+q\vec{E}$ and on charge –q is $-q\vec{E}$. These, two parallel forces, acting in the opposite direction, constitute a couple resulting in the torque τ. Magnitude of torque= $qE \times 2a\sin\theta$ $= 2qa\,E\sin\theta$ Therefore, $\vec{\tau} = \vec{p} \times \vec{E}$ where $\vec{p} = 2q\vec{a}$ (ii) Two pairs of perpendicular vectors: (i) $\vec{\tau}$ is perpendicular to $\vec{p}$ (ii) $\vec{\tau}$ is perpendicular to $\vec{E}$	 ½ ½ ½ ½ ½ ½	 3
Set1,Q12 Set2,Q21 Set3,Q18	(a) Ratio of surface charge densities 2 (b) Identifying the constant quantity 1 We have, $V = \frac{q_1}{C_1} = \frac{q_2}{C_2}$	 ½	

	$$\frac{q_1}{4\pi\varepsilon_o R_1} = \frac{q_2}{4\pi\varepsilon_o R_1} \Rightarrow \frac{q_1}{R_1} = \frac{q_2}{R_2}$$	½	
	$$\frac{\sigma_1}{\sigma_2} = \frac{q_1}{4\pi\varepsilon_o {R_1}^2} \times \frac{4\pi\varepsilon_o {R_2}^2}{q_2}$$ $$= \frac{q_1}{q_2} \times \frac{{R_2}^2}{{R_1}^2}$$	½	
	$$= \frac{R_1}{R_2} \times \frac{{R_2}^2}{{R_1}^2} = \frac{R_2}{R_1}$$	½	
	(b) Current	1	3
Set1,Q13 Set2,Q22 Set3,Q19	Readings of ideal ammeter and ideal voltmeter in fig (a) and (b) 1 ½ + 1 ½		
	In circuit (a) Total emf=15 V Total Resistance = 2Ω Current *i*= (15/2)A = 7.5 A	½	
	Potential Difference between the terminals of 6 V battery *V=E-iR*	½	
	=[6-(7.5×1)]V =-1.5 V	1	
	In circuit (b) Effective emf=(9-6) V =3V Current i=(3/2)A=1.5 A	½	
	Potential Difference across 6V cell *V=E+iR* =6+1.5×1	½	
	=7.5 V	1	
	OR		
	Finding current through each resistor 3		
	Total emf in the circuit = 8V – 4V = 4V	½	
	Total resistance of the circuit = 8Ω	½	
	Hence current flowing in the circuit i = $\frac{V}{R}$ = $\frac{4}{8}$ A= 0.5 A	½	
	Current flowing through the resistors:	½	
	Current throgh 0.5Ω, 1.0Ω and 4.5Ω is 0.5 A Current through 3.0Ω is $\frac{1}{3}$A	½	
	Current through 6.0Ω is $\frac{1}{6}$A	½	3

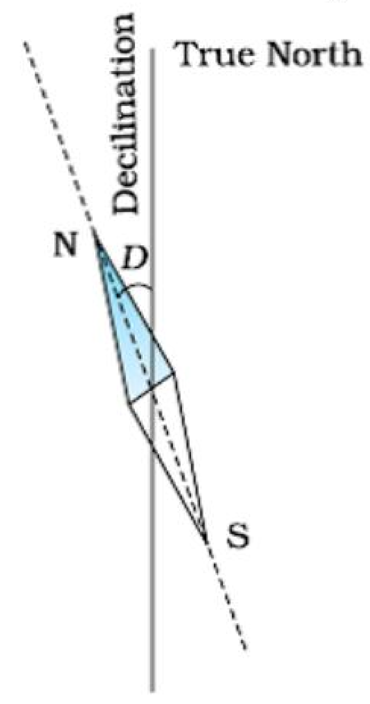
Set1,Q14
Set2,Q11
Set3,Q20

Definition of
- (i) Magnetic declination and diagram ½ + ½
- (ii) Angle of dip and diagram ½ + ½

Direction of compass needle at the
- (i) Poles ½
- (ii) Equator ½

Magnetic declination : Angle between the magnetic axis and geographical axis. ½

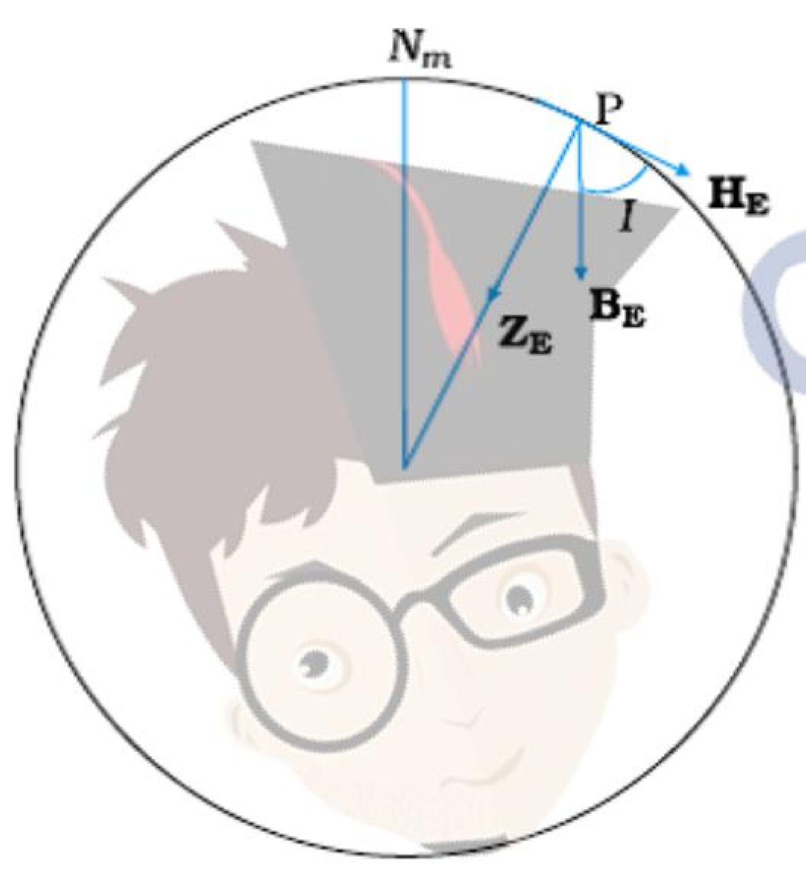
Alternatively: Angle between magnetic meridian and geographical meridian.



½

Angle of dip: It is the angle which the magnetic needle makes with the horizontal in the magnetic meridian. ½

Alternatively: The angle which the total magnetic field of the earth makes with the surface of the earth.



½

Direction of compass needle is vertical to the earth's surface at poles and is parallel to the earth's surface at equator. ½ + ½ 3

Set1,Q15
Set2,Q12
Set3,Q21

Derivation of magnetic energy 2
Comparison of magnetic energy per unit volume with
Electrostatic energy density 1

Rate of work done

$$\frac{dW}{dt} = |\varepsilon| I$$

$$= \left(LI\,\frac{dI}{dt}\right)$$

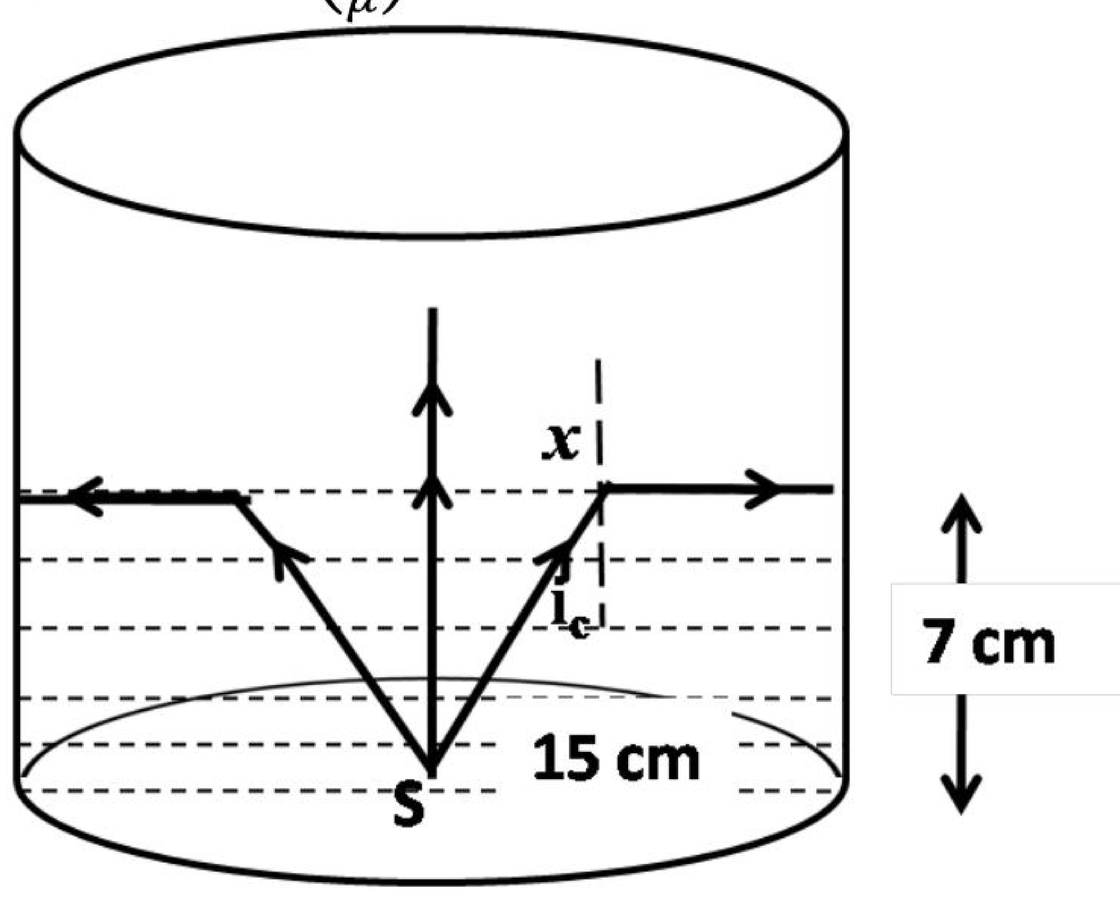
$$dW = LIdI$$ ½

Total amount of work done

$$\int dW = \int LIdI$$

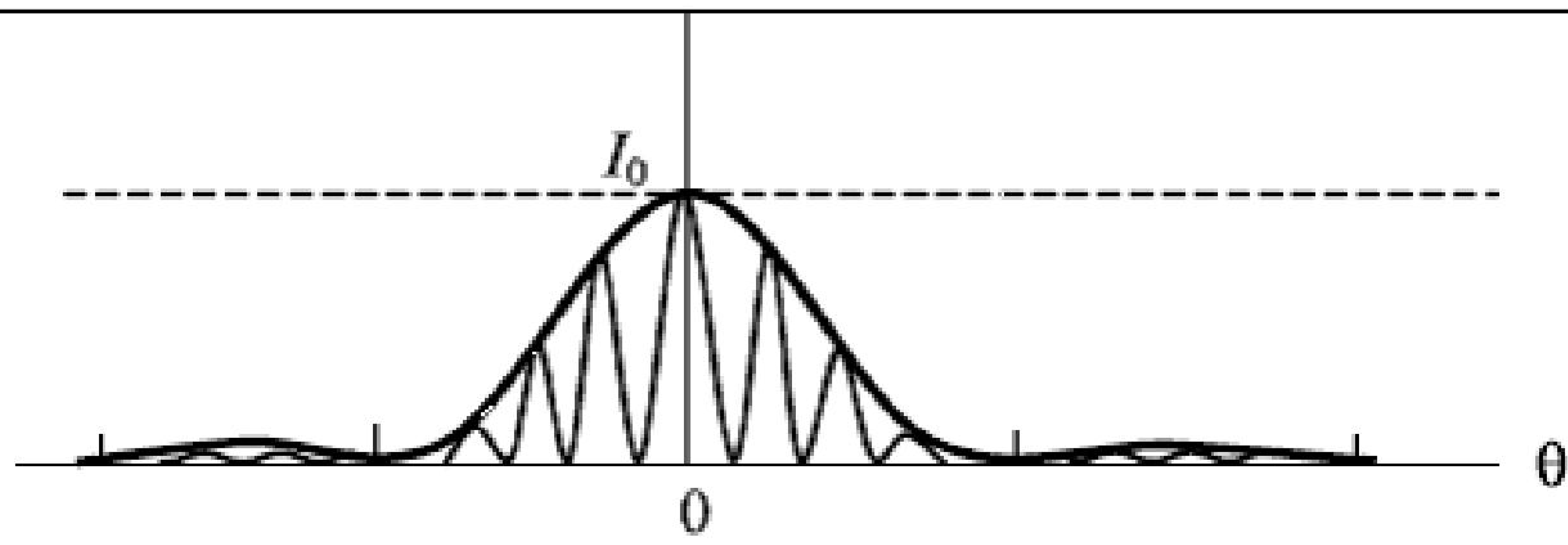
$$W = \frac{1}{2}LI^2$$ ½

	For the solenoid : Inductance, $L = \mu_0 n^2 Al$; also B = $\mu_0 nI$ $\therefore$ W = $U_B = \frac{1}{2}LI^2$ $\frac{1}{2}(\mu_o n^2 A\ell)\left(\frac{B}{\mu_o n}\right)^2$ $= \frac{B^2 A\ell}{2\mu_o}$ ⇨ Magnetic energy per unt volume = $\frac{B^2}{2\mu_o}$ Also, Electrostatic energy stored per unit volume = $\frac{1}{2}\varepsilon_o E^2$	½ ½ ½ ½	3
Set1,Q16 Set2,Q13 Set3,Q22	(i) Calculation of rms value of current 2 (ii) Calculation of total average power consumed. 1 (i) $X_L = \omega L = 100 \times 80 \times 10^{-3} = 8\,\Omega$ $X_C = \frac{1}{\omega C} = \frac{1}{100 \times 250 \times 10^{-6}}\,\Omega$ $= 40\,\Omega$ Total Impedence (Z) = $X_C - X_L$ = 32 Ω $I_{rms} = \frac{240}{32}$ A= 7.5A (ii) Average power consumed = 0 (As there is no ohmic resistance in the current.)	½ ½ ½ ½ 1	3
Set1,Q17 Set2,Q14 Set3,Q11	Answers of part (i) and (ii) 1 ½ + 1 ½ (i) It absorbs ultraviolet radiations from sun and prevents them from reaching on the earth's surface causing damage to life. Identification : ultraviolet radiations **one correct application** (=sanitization, forensics) (ii) Water molecules present in most materials readily absorbs infra red waves. Hence, their thermal motion increases. Therefore, they heat their surroundings. They are produced by hot bodies and molecules. Incoming visible light is absorbed by earth's surface and radiated as infra red radiations. These radiation are trapped by green house gases.	½ ½ ½ ½ ½ ½	3

Set1,Q18 Set2,Q15 Set3,Q12	Definition of critical angle ½ Drawing of Ray diagram 1 Calculation of area of water surface. 1 ½ For an incident ray, travelling from an optically denser medium to optically rarer medium, the angle of incidence, for which the angle of refraction is 90°, is called the critical angle. **Alternatively:** $\mu = \frac{1}{\sin i_c}$ $i_c = \sin^{-1}\left(\frac{1}{\mu}\right)$  $\mu = \frac{1}{\sin i_c}$ $\sin i_c = \frac{3}{4}$ $\cos i_c = \frac{\sqrt{7}}{4}$ $\tan i_c = \frac{3}{\sqrt{7}}$ From figure, $\tan i_c = \frac{x}{7} \Rightarrow \frac{3}{\sqrt{7}} \Rightarrow \frac{x}{7} \Rightarrow x = 3\sqrt{7}$cm Area = $\pi x^2 = 63\pi$ cm^2	½ 1 ½ ½ ½	3
Set1,Q19 Set2,Q16 Set3,Q13	Selection of lens for objective and eyepiece of (i) Telescope 1 ½ (ii) Microscope 1 ½ (i) Telescope L_2 : objective L_3 : eyepiece Reason : Light gathering power and magnifying power will be larger. (ii) Microscope L_3 : objective L_1 : eyepiece Reason : Angular magnification is more for short focal length of objective and eyepiece.	½ ½ ½ ½ ½ ½	3

Set1,Q20
Set2,Q17
Set3,Q14

Explanation by drawing a suitable diagram	1
Two basic features distinguishing interference pattern from diffraction pattern	1+1



½

The diagram, given here, shows several fringes, due to double slit interference, ‘contained’ in a broad diffraction peak. When the seperation between the slits is large compared to their width, the diffraction pattern becomes very flat and we observe the two slit interference pattern. ½

[Note: The students may be awarded 1 mark even if they just draw the diagram.]

Two basic features:

(i) The interference pattern has a number of equally spaced bright and dark bands while differaction pattern has a central bright maximum which is twice as wide as the other maxima. 1

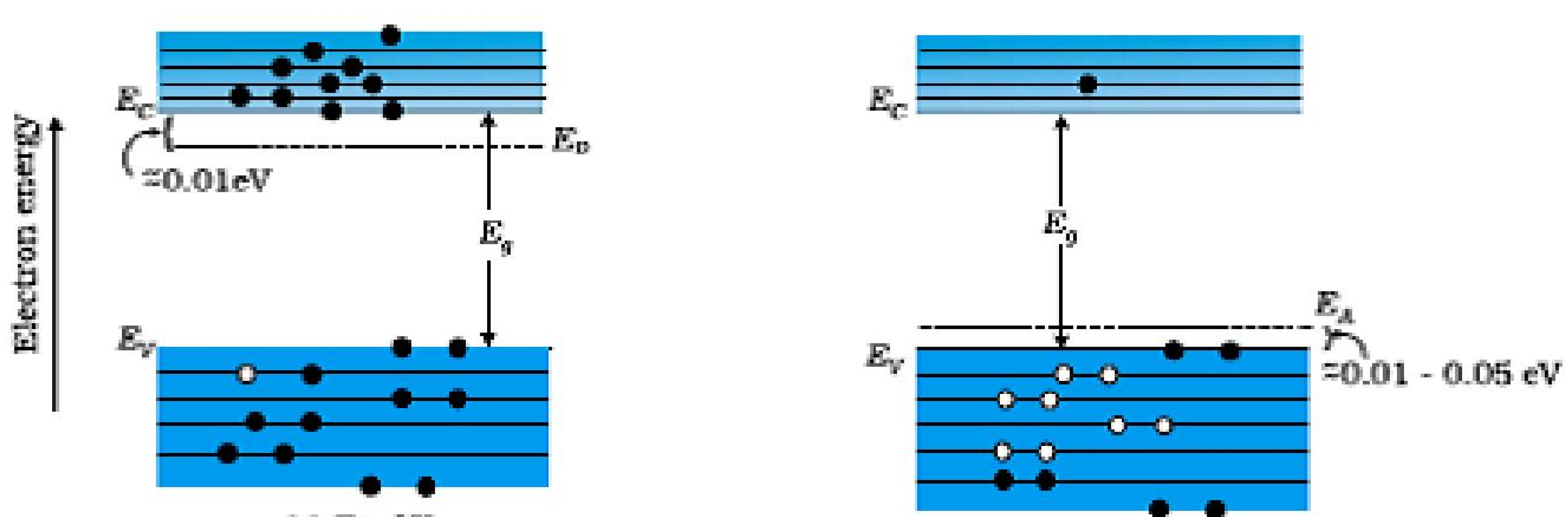
(ii) Interference pattern is the superimposition of two waves slits originating from two narrow sects. The differaction pattern is a superposition of a continuous family of waves originating from each point on a single slit. 1

(iii) For a single slit of width ‘a’ the first null of differaction pattern occurs at an angle of $\frac{\lambda}{a}$. At the same angle of λ/a, we get a maxima for two narrow slits seperated by a distance a.

[Any two of the above distinguishing features.] 3

Set1,Q21
Set2,Q18
Set3,Q15

Distinction between n – type and p-type semi conductors on the basis of	
Energy band diagrams	2
Comparison of conductivities	1



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

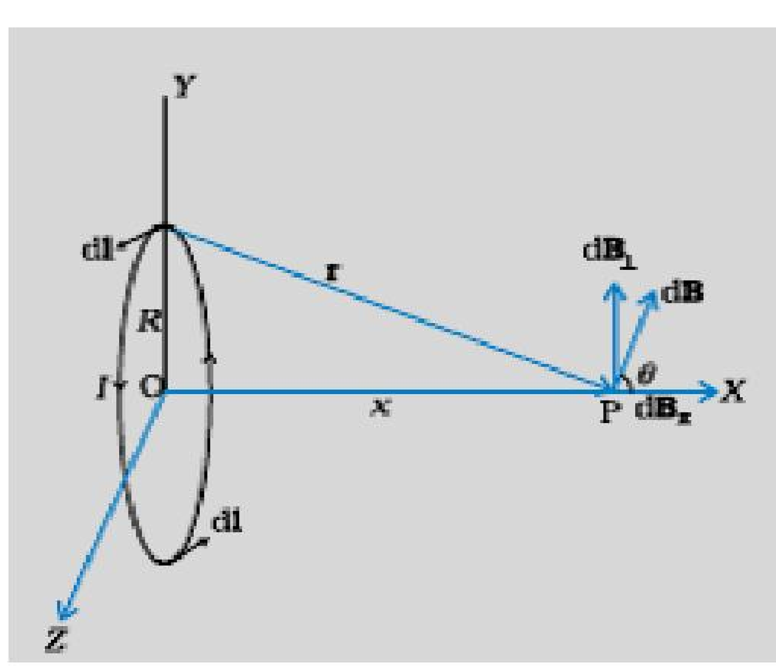
(b) T > 0K

½

½

(i) In n - type semi conductors an extra energy level (called donor energy level) is produced just below the bottom of the conduction band, while in the p-type ssemiconductor, this extra energy band (called acceptor energy level) is just above the top of the balance band. 1

(ii) In n – type semiconductors, most of the electrons come from the donor impurity while in p-type semi conductor, the density of holes in

	the valence band is predominantlly due to the impurity in the extrinsic semiconductors. **[Any one of the above, or any one, other, correct distinguishing feature.]** At absolute zero temperature conductivities of both type of semi-conductors will be zero. For equal doping, an n-type semi conductor will have more conductivity than a p-type semiconductor, at room temperature.	½ ½	3
Set1,Q22 Set2,Q19 Set3,Q16	(a) Identification of X and Y ½ + ½ Their functions ½ + ½ (b) Distinction between point to point and broadcast mode. 1 (a) X : Transmitter Y: Channel Their functions: Transmitter : To convert the message signal into suitables form for transmission through channel. Channel : It sends the signal to the reciever. (b) In point to point mode, communication takes place between a single transmitter and receiver. In broadcast mode, large number of receivers are connected to a single transmitter.	½ ½ ½ ½ 1	3
	Section D		
Set1,Q23 Set2,Q23 Set3,Q23	(i) Qualities / values of Rohit. 1 (ii) Advantage of CFLs/ LEDs over traditional incandescent lamps. 1 (iii) Role of earthing in reduction of electricity bills 1 (i) Co-operative attitude and scientific temperament. **(or any other two correct values.)** (ii) a) Low operational voltage and less power. b) fast action and no warm up time required. **(Any one)** (iii) In the absence of proper earthing, the consumer can get (extra) charges for the electrical energy NOT consumed by the devices in her/his premises.	1+ 1 1 1	4
	Section E		
Set1,Q24 Set2,Q26 Set3,Q26	(a) Derivation of the expression 2 (b) Magnetic field lines due to the coil 1 (c) Magnetic field at the center of the loop 2 (a) 	½	

According to Biot- Savart law,

$$d\vec{B} = \frac{\mu_o}{4\pi}\frac{I(\vec{dl}\times\vec{r})}{r^3}$$ ½

$$dB = \frac{\mu_o}{4\pi}\frac{I\,dl}{(x^2+R^2)} \qquad \left[\because \left|\vec{dl}\times\vec{r}\right| = r\,dl;\; r = (x^2+R^2)^{\frac{1}{2}}\right]$$

From figure

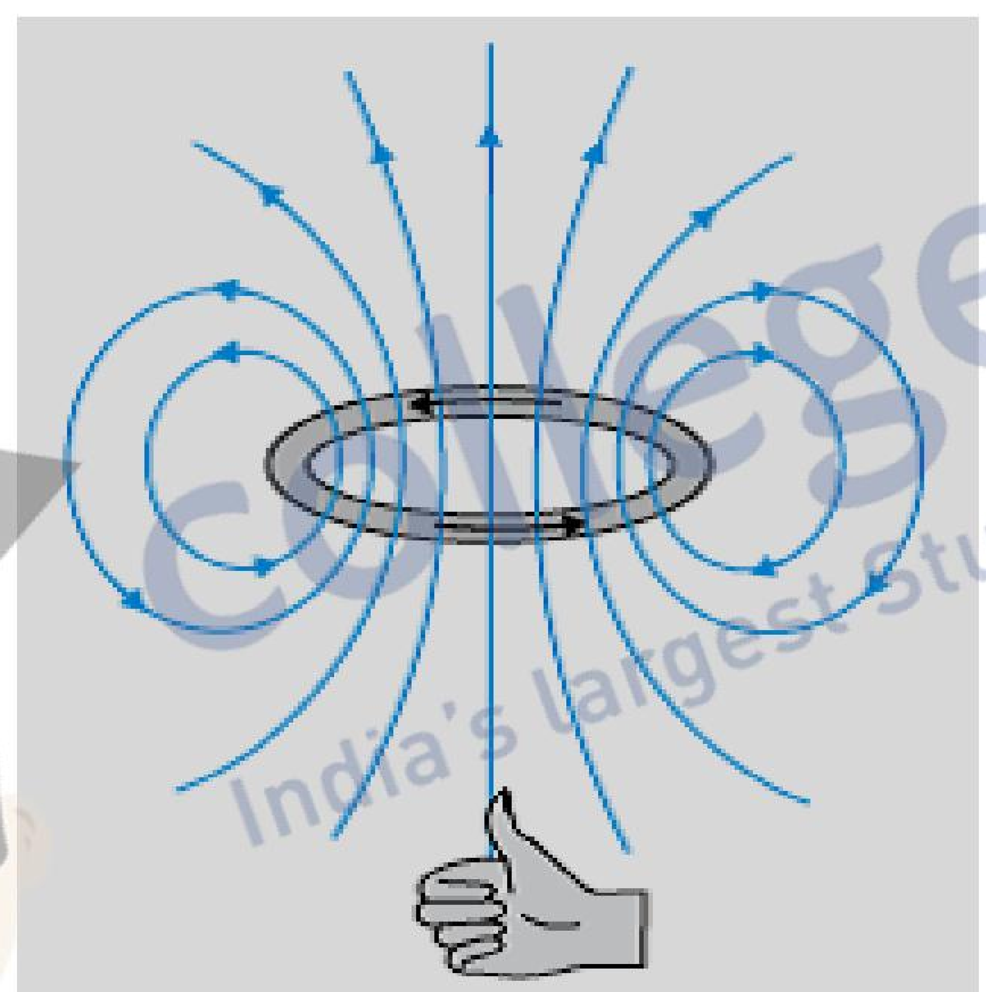
$$\cos\theta = \frac{R}{(x^2+R^2)^{\frac{1}{2}}}$$

∴ Net contribution along x-direction

$$B = \sum dB\cos\theta = \int dB\cos\theta$$ ½

$$= \int_0^{2\pi R}\frac{\mu_o I dl}{4\pi}\frac{R}{(x^2+R^2)^{\frac{3}{2}}}$$ ½

$$\vec{B} = \frac{\mu_o I R^2}{2\,(R^2+x^2)^{\frac{3}{2}}}\,\hat{\imath}$$



1

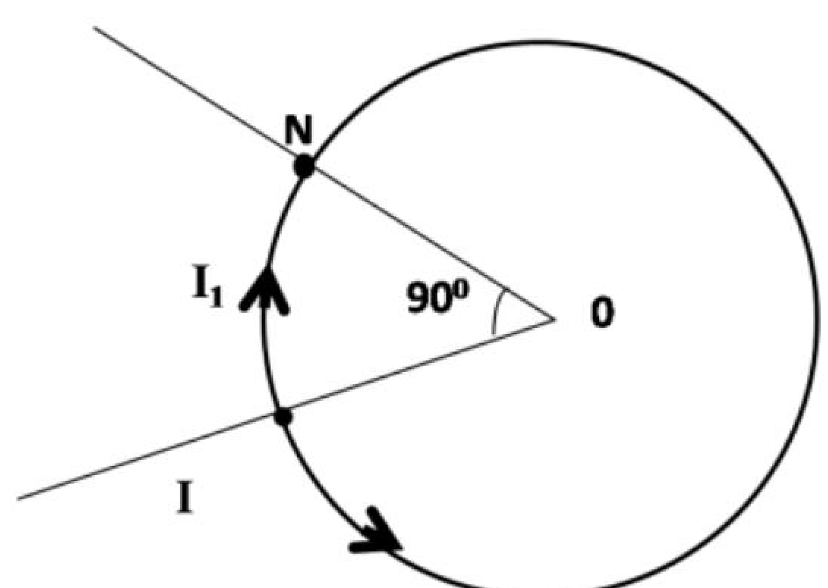
(b) Let current I be divided at point M into two parts I_1 and I_2 ; in bigger and smaller parts of the loop respectively.

Magnetic field of current I_1 at point O ½

$\overrightarrow{B_1} = \frac{\mu_o I_1}{2R}\times\frac{1}{4}\ \otimes$

Magnetic field of current I_2 at point O

$\overrightarrow{B_2} = \frac{\mu_o I_2}{2R}\times\frac{3}{4}\odot$



Net magnetic field $\vec{B} = \overrightarrow{B_1} + \overrightarrow{B_2}$

$$\left|\vec{B}\right| = \frac{\mu_o I_1}{8R} - \frac{\mu_o I_2}{8R} \text{ ------------------ (1)}$$ ½

But $I_1=3I_2$ (As resistance of bigger part is three times that of the smaller part of the loop.) ½

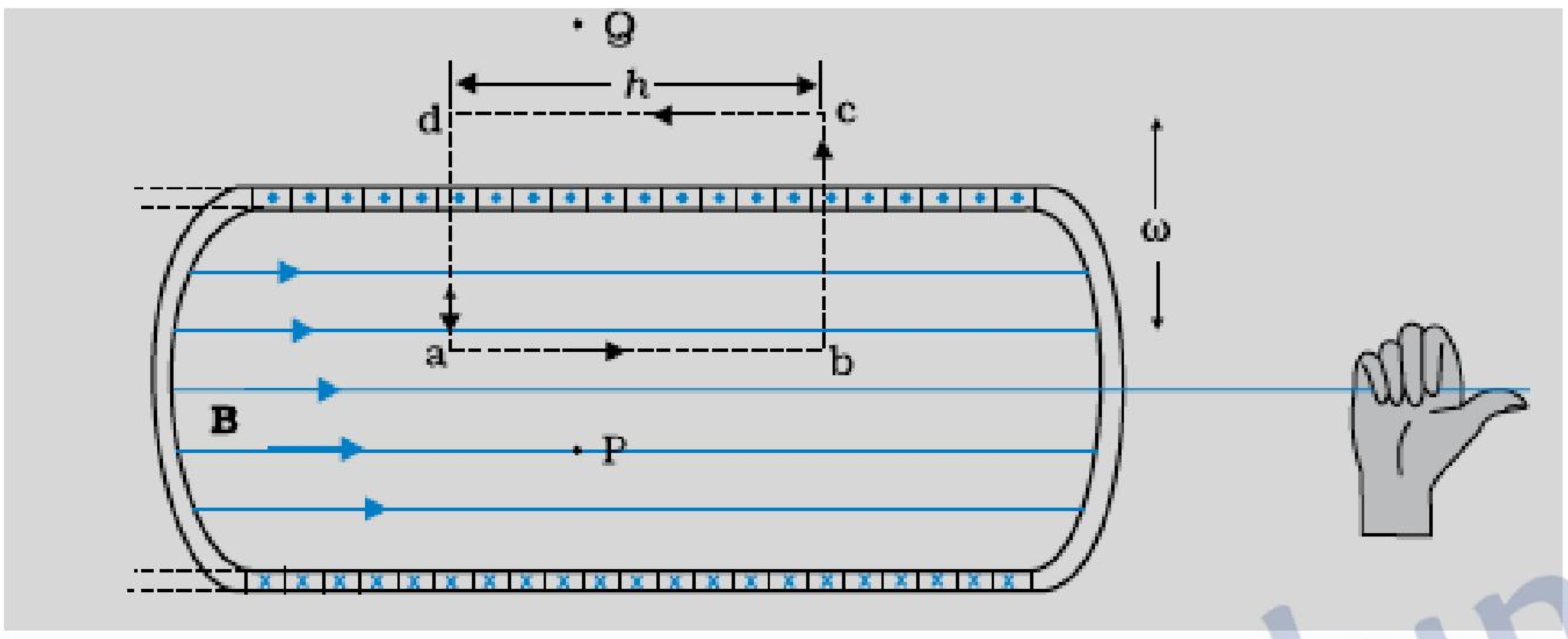
Substituting $I_1=3I_2$ in equation (1)

$\Rightarrow \left|\vec{B}\right| = 0$ ½ 5

OR

(a) Derivation of expression of magnetic field inside solenoid	3
(b) Finding the magnitude and direction of Magnetic field	2

Any surface carrying current can be divided into small line elements, each of length '*dl*'. Considering the tangential components of the magnetic field and finding $\vec{B}.\vec{dl}$, sum of all elements tends to the integral, which can be expressed in the following form. : $\oint \vec{B}.\vec{dl} = \mu_o i$, This form is known as Ampers's circuital law. ½



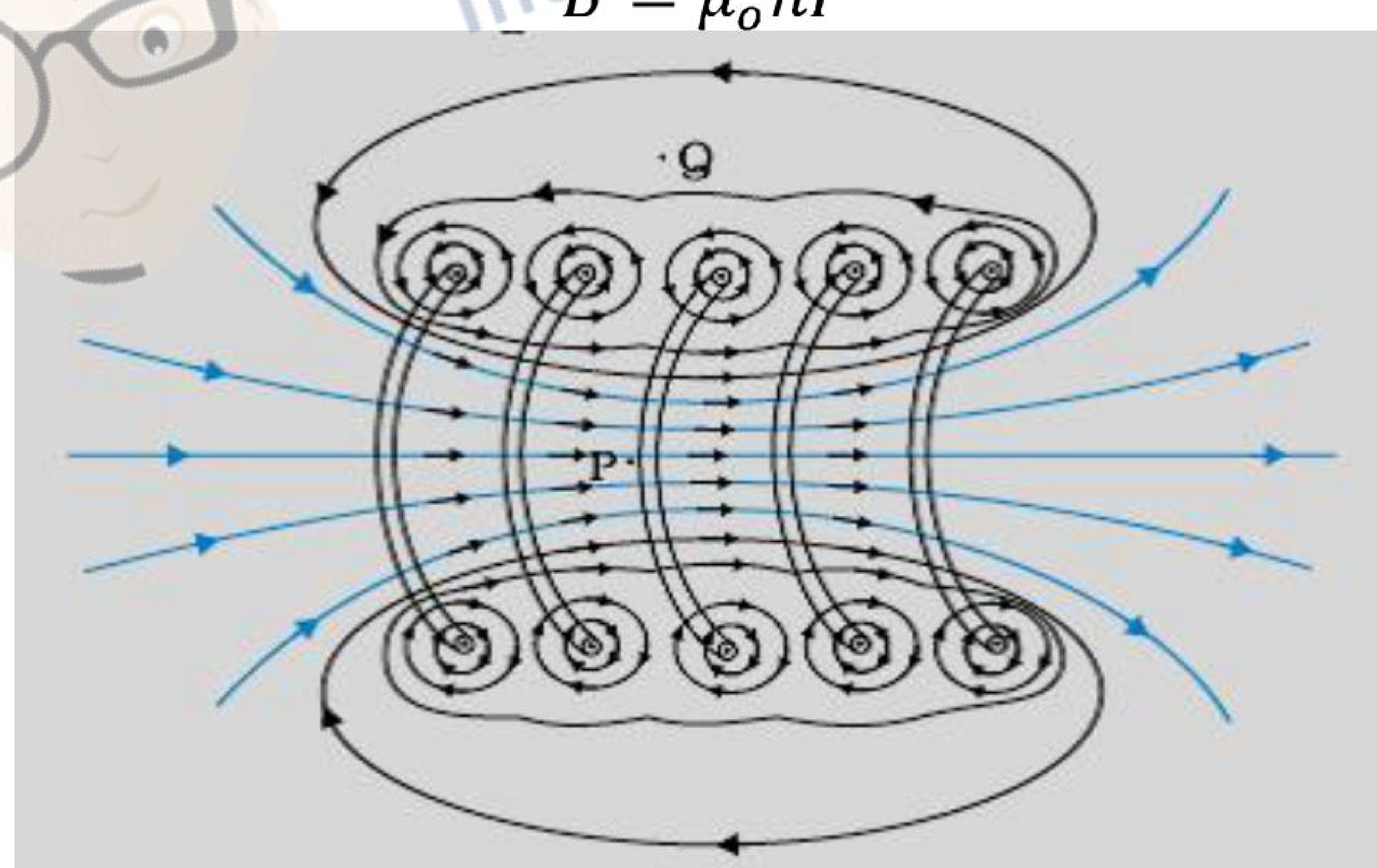
½

Let '*n*' be the number of turns per unit length. Then total number of turns in the length '*h*' is *nh*.
Hence, total enclosed current = *nhI*
Using Ampere's circuital law

$$\oint \vec{B}.\vec{dl} = \mu_o nhI$$ ½

$$Bh = \mu_o nhI$$

$$B = \mu_o nI$$ ½



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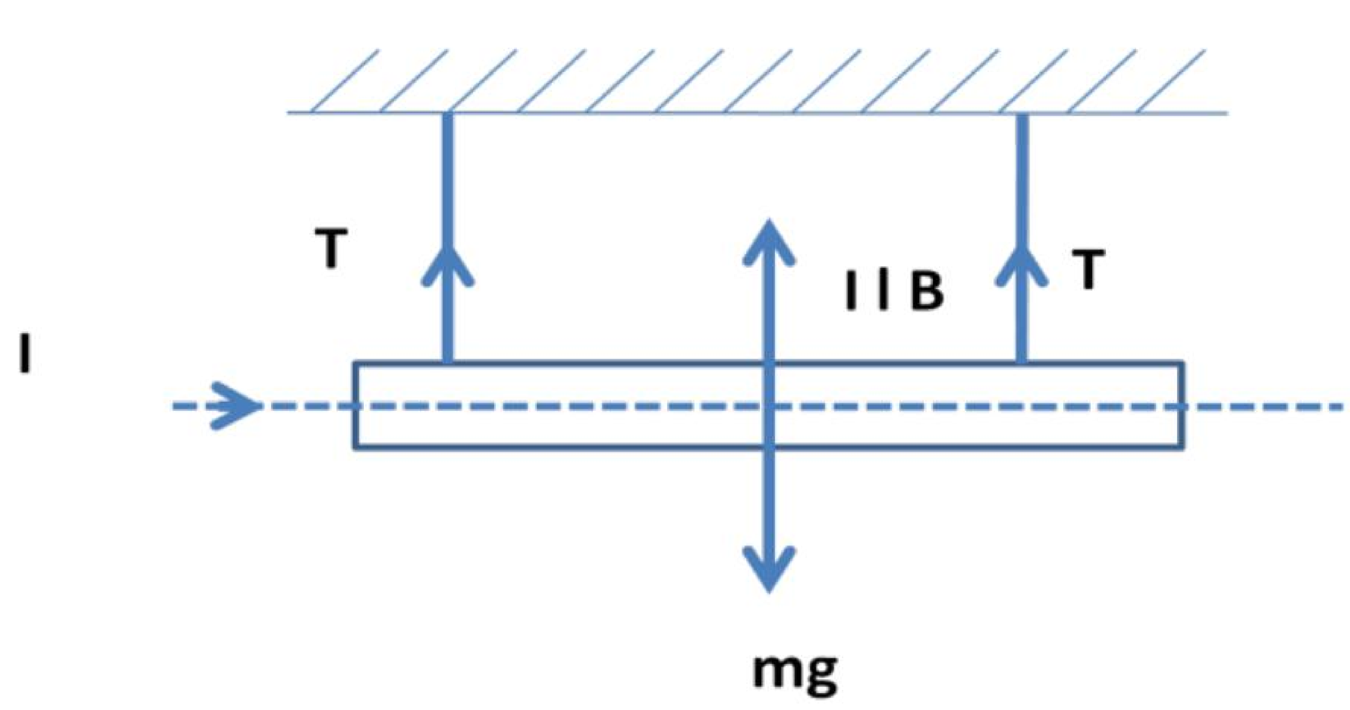
(b)



As per the given figure, magnetic field must be vertically inwards, to make tension zero, (If a student shows current in opposite direction the magnetic field should be set up vertically upwards. ½

For tension to be zero

$$IlB = mg$$ ½

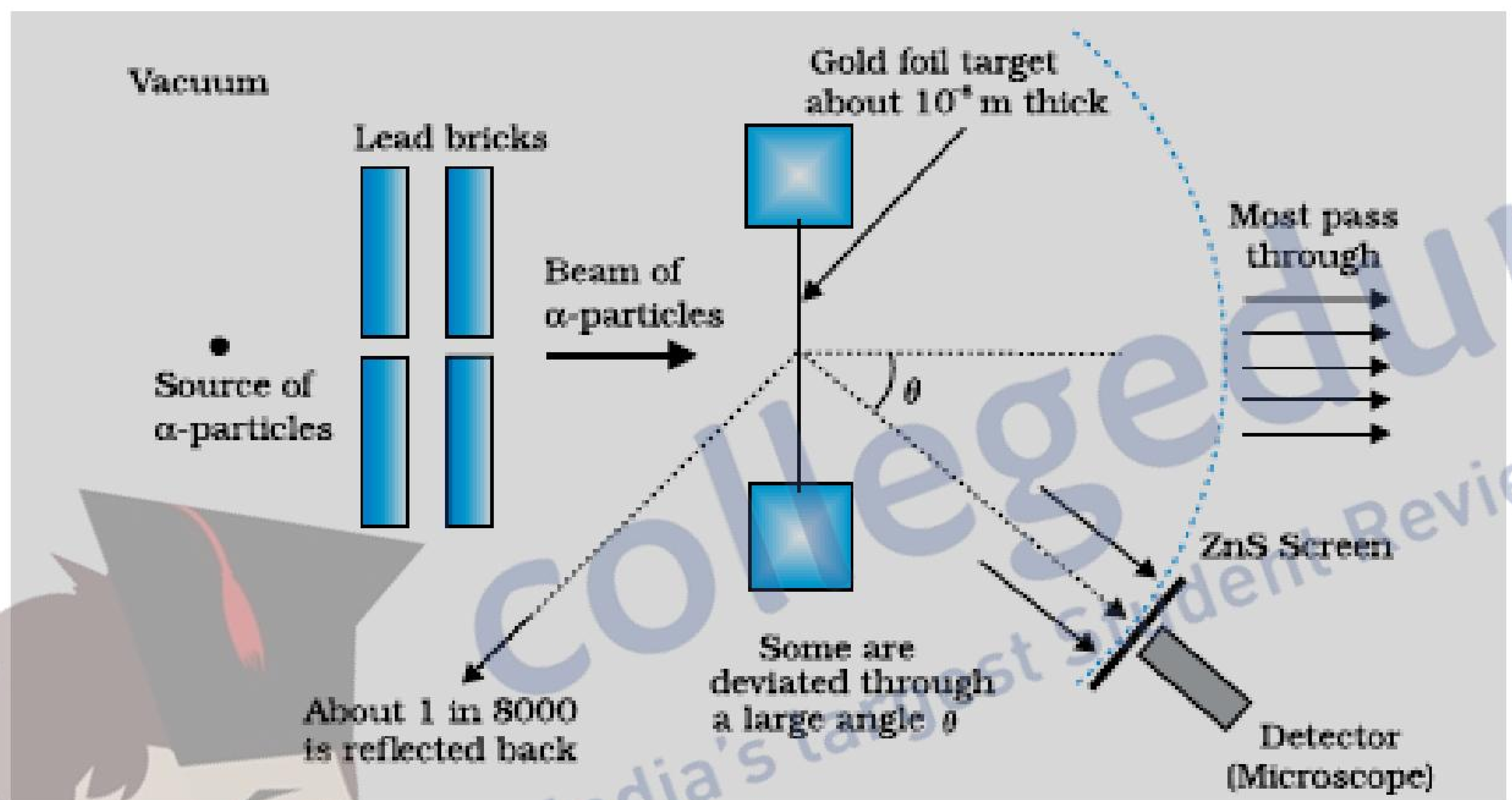
$$B = \frac{mg}{Il} = \frac{60\times10^{-3}\times9.8}{5.0\times0.45}\,\text{T}$$ ½

$$= 0.26\ \text{T}$$ ½ 5

Set1,Q25
Set2,Q24
Set3,Q25

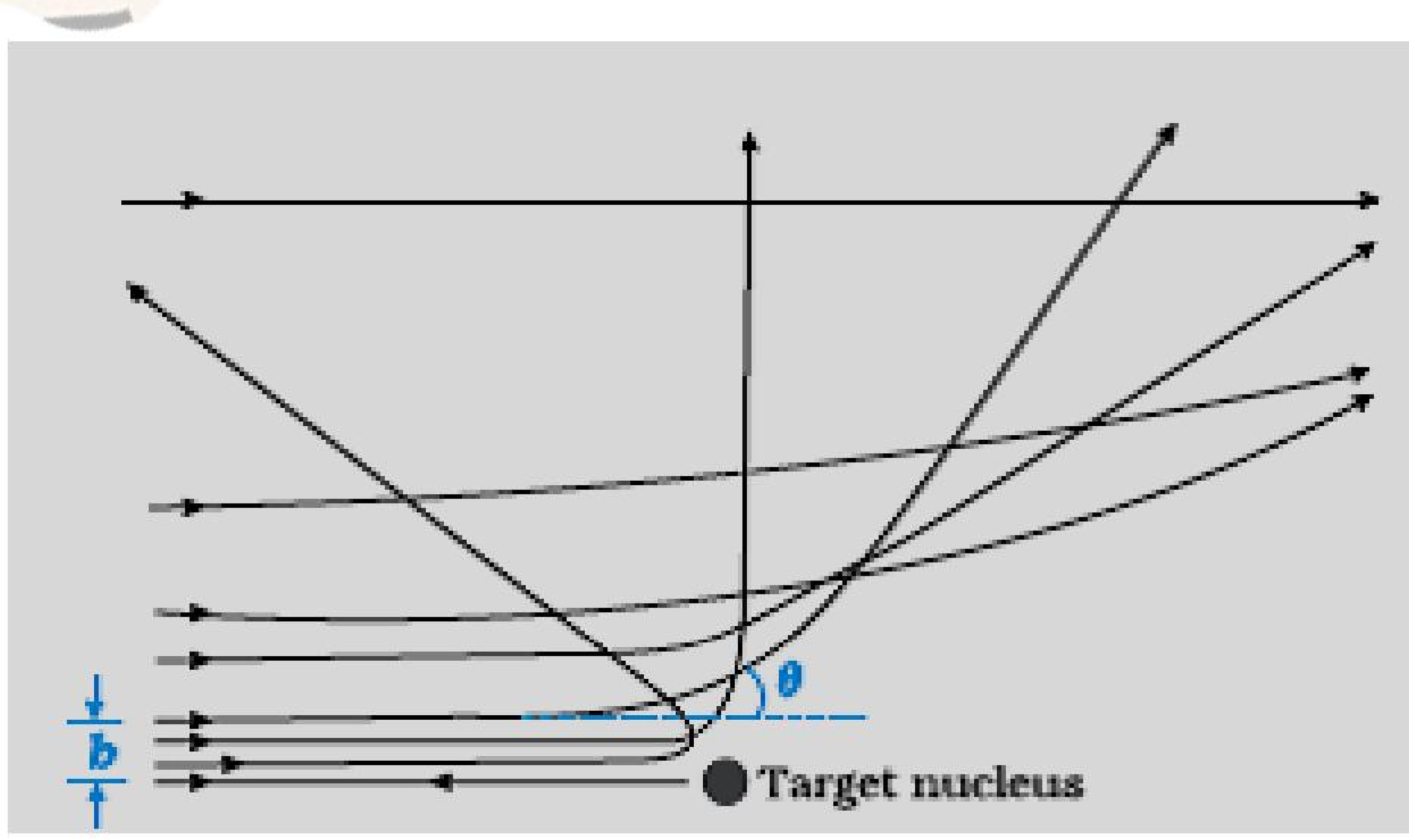
(a) Schematic arrangement of Greiger-Marsden Experiment	1
Reason	1
Trajectory of α-particles and significance of Impact Parameter	½ + ½
(b) Estimation of the distance of closest approach	2

(a)



1

For most of the α-particles, impact parameter is large, hence they suffer very small repulsion due to nucleus and go right through the foil. 1



½

It gives an estimate of the size of nucleus. ½

(b) K.E of the α-particle = potential energy possesed by beam at distance of closest approach.

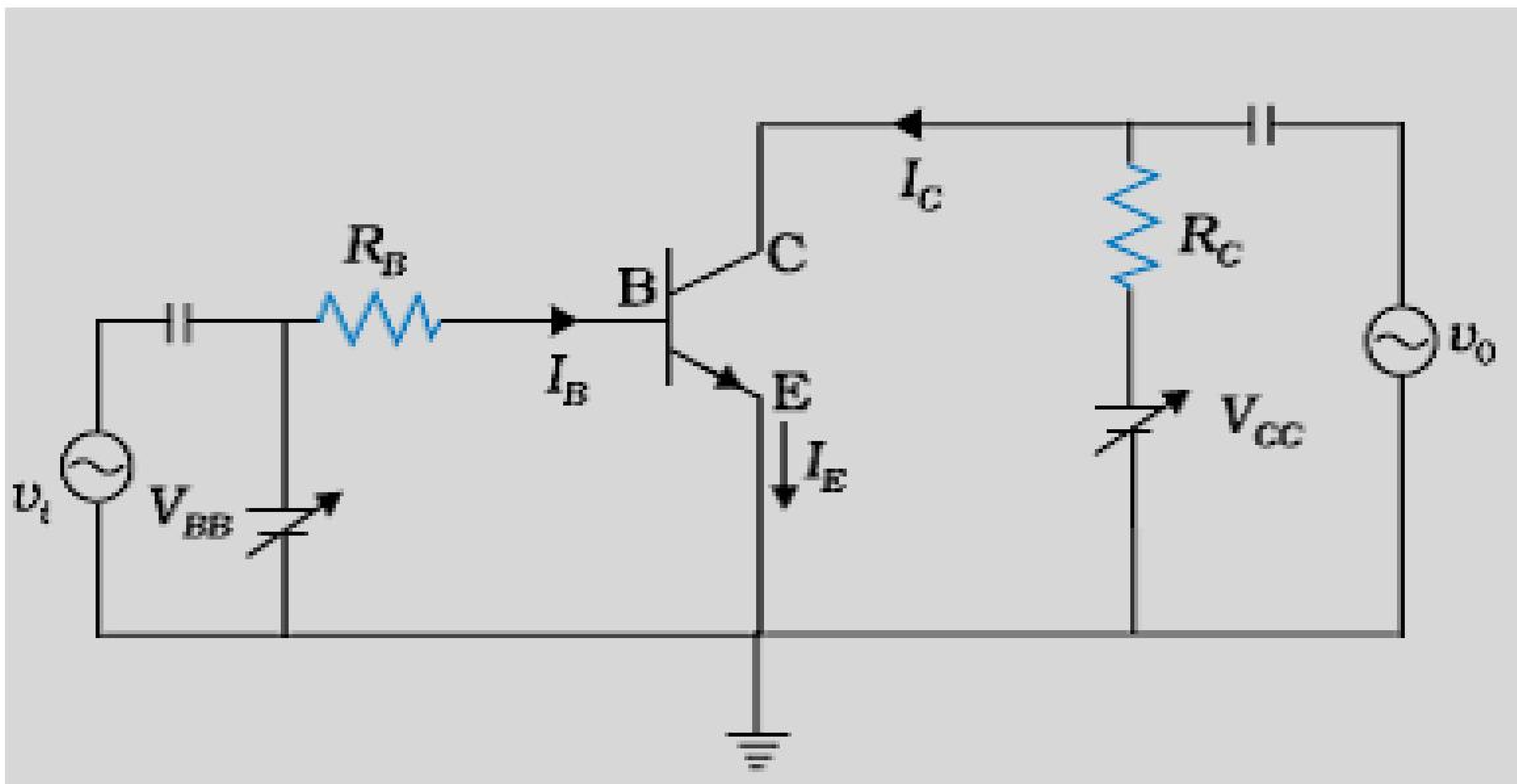
$$\frac{1}{2}mv^2 = \frac{1}{4\pi\epsilon_o}.\frac{(2e)(Ze)}{r_0}$$ ½

	$$7.7 \times 1.6 \times 10^{-13} = \frac{9 \times 10^9 \times 2 \times 2.56 \times 10^{-38} \times 80}{r_o}$$	½	
	$$r_o = \frac{9 \times 10^9 \times 2 \times 2.56 \times 10^{-38} \times 80}{7.7 \times 1.6 \times 10^{-13}} \text{ m}$$ $$= 299 \times 10^{-16} \text{ m}$$ $$= 29.9 \times 10^{-15}\text{m} \approx 30 \times 10^{-15}\text{m}$$	½	5
	OR		
	(a) Two important limitations of Rutherford model ½ + ½ Explanation of these limitations in Bohr's model ½ + ½ Calculation of wavelength of the H_α line 1 (b) Derivation of the expression for the radius of the n[th] orbit. 2		
	(a) (i) Electron moving in a circular orbit around the nucleus would get accelerated, therefore it would spiral into the nucleus, as it looses its energy.	½	
	(ii) It must emit a continuous spectrum.	½	
	According to Bohr's model of hydrogen atom,		
	(i) Electron in an atom can revolve in certain stable orbits without the emission of radiant energy.	½	
	(ii) Energy is released /absorbed only, when an electron jumps from one stable orbit to another stable orbit. This results in a discrete spectrum.	½	
	$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$ $$\frac{1}{\lambda} = 1.1 \times 10^7 \left(\frac{1}{4} - \frac{1}{9}\right)$$	½	
	$$\lambda = 656.3 \text{ nm}$$	½	
	(b) We have $\frac{mv^2}{r_n} = \frac{1}{4\pi\varepsilon_o} \cdot \frac{e^2}{{r_n}^2}$		
	$\Rightarrow r_n = \frac{e^2}{4\pi\varepsilon_o v_n^2}$ ------------------------------------(`1)	½	
	From Bohr's Postulates: $$mv_n r_n = \frac{nh}{2\pi}$$ $$v_n = \frac{nh}{2\pi m r_n}$$	½	
	Substituting for v_n, in equation (1), we get $$r_n = \frac{\varepsilon_o n^2 h^2}{\pi m e^2}$$	1	5

Set1,Q26
Set2,Q25
Set3,Q24

(a) Naming the device and working with proper circuit	2
Derivation of expression for voltage gain and power gain	1 ½
(b) Drawing of transfer characteristics	1
Region used for amplifier	½

(a) Common emitter amplifier ½



1

When the sinusoidal voltage is applied on the emitter base circuit, it gets amplified and its phase is reversed.

Input sinusoidal voltage:

$v_i = \Delta I_B(R_B + r_i) = \Delta I_B r$ ½

Also $\beta_{ac} = \frac{\Delta I_C}{\Delta I_B} \Rightarrow \Delta I_C = \beta_{ac}\Delta I_B$

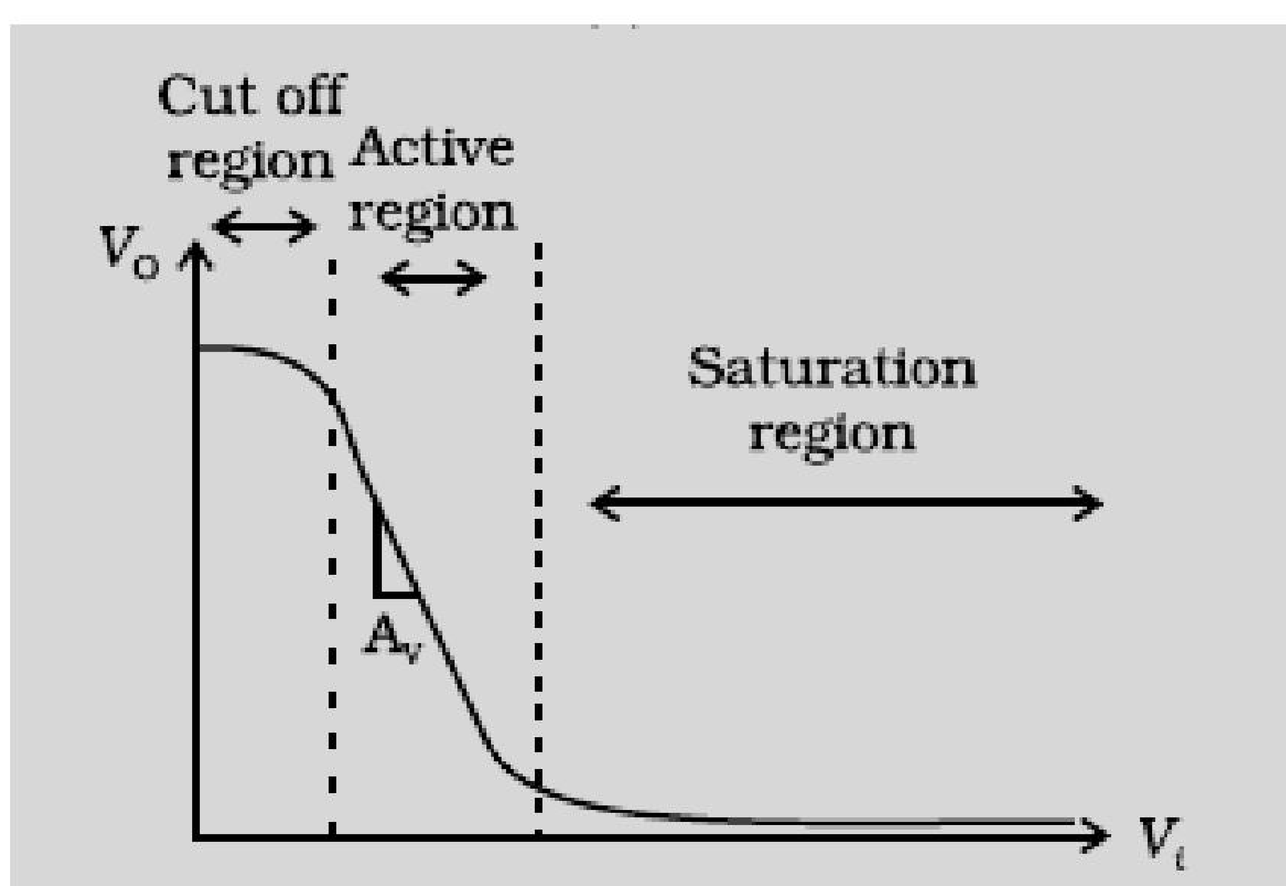
$\Delta V_{CE} = -R_L \Delta I_C = -R_L \beta_{ac} \Delta I_B = v_o$ ½

$\because$ Voltage gain $A_v = \frac{v_o}{v_i}, = -\beta_{ac}\frac{R_L}{r}$

Power gain $A_p = \beta_{ac} A_v$

$= \beta_{ac}^2 \frac{R_L}{r}$ ½

(b) ½



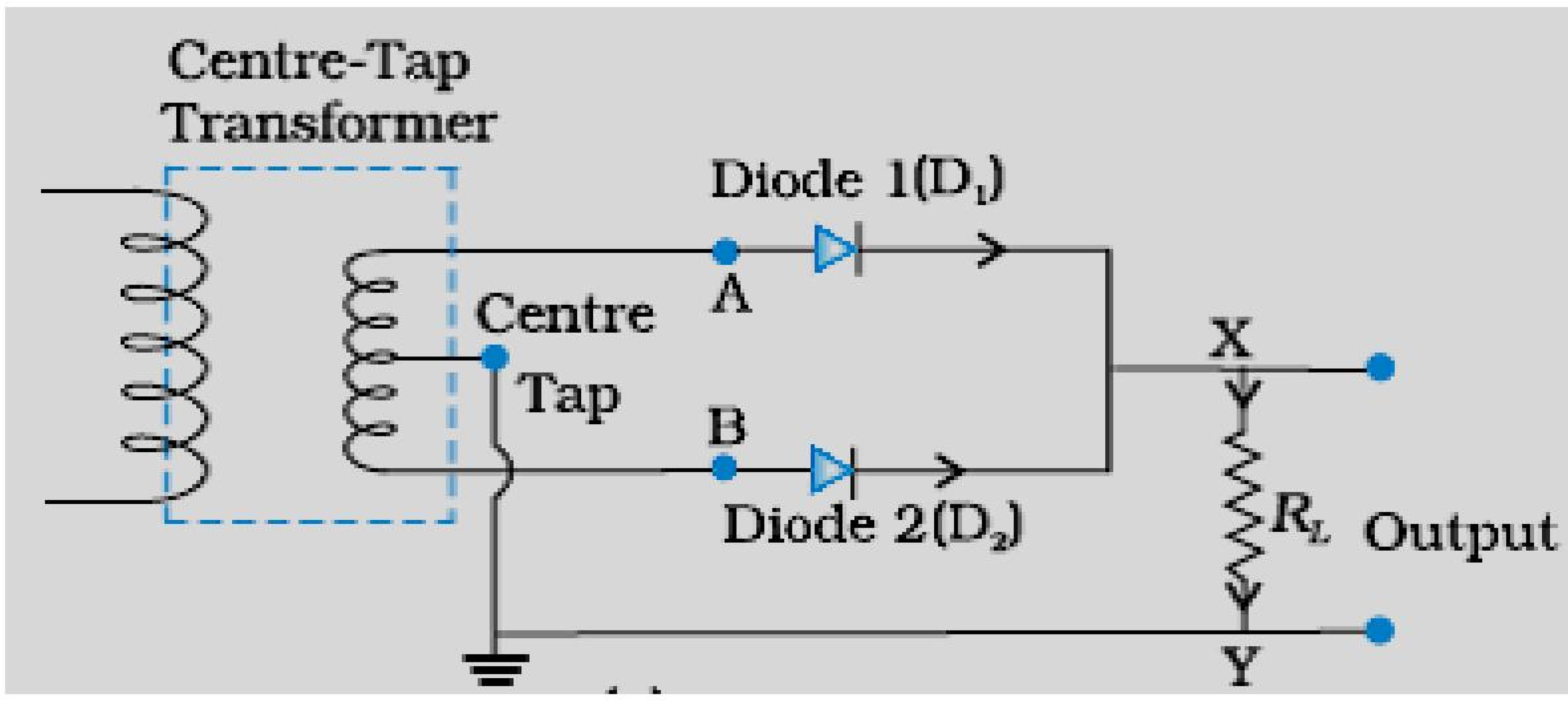
1

Transistor acts as an amplifier in the Active Region ½ 5

OR

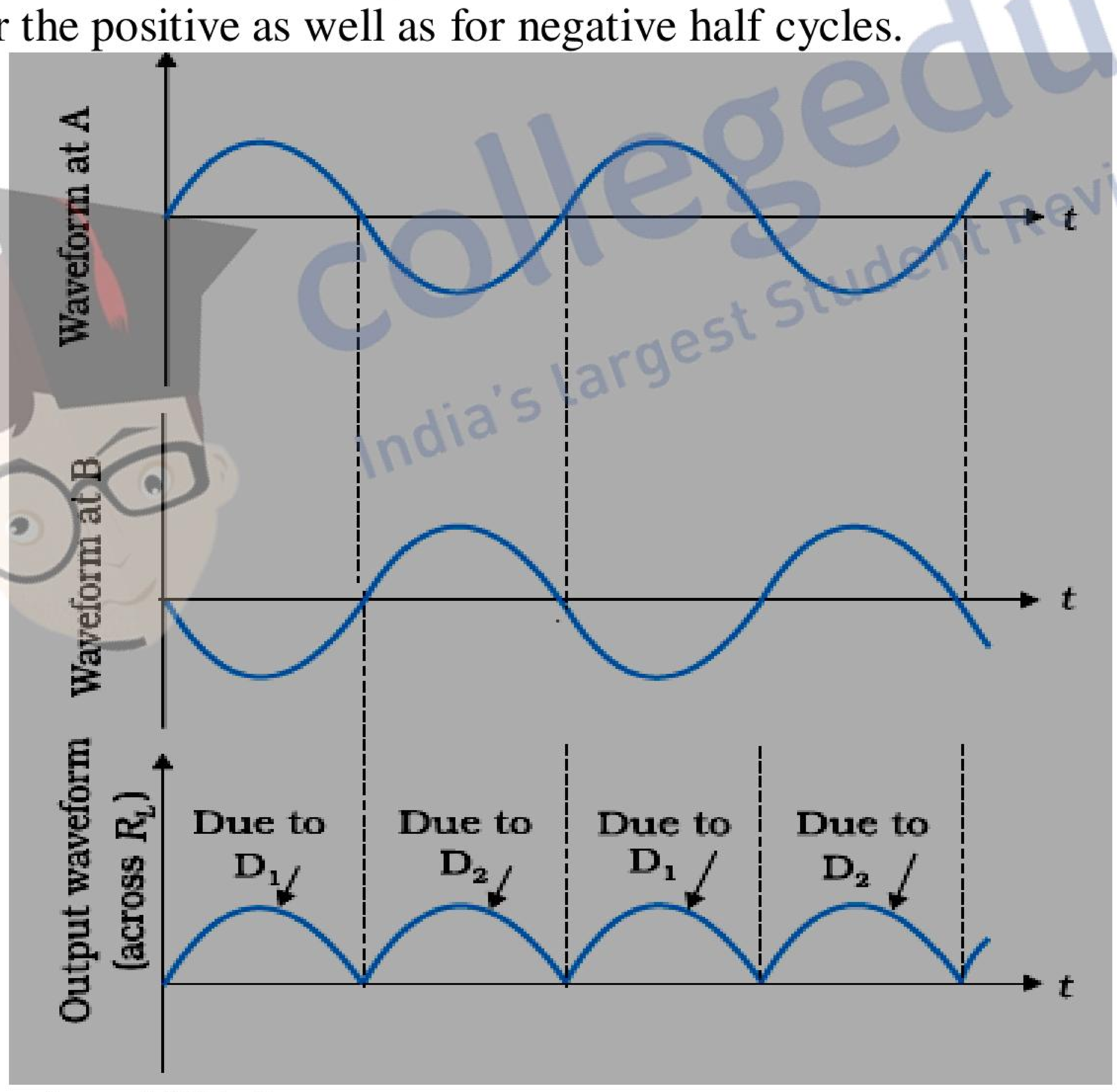
(a) Brief explanation of working of full wave rectifier	2
Drawing of input and output wave forms	1
(b) Identification of Logic gate	1
Truth table	

a)



1

For half cycle of input ac, one diode out of the two, will get forward biased and will conduct, while the other diode, being reverse biased, will not conduct. For other cycle of input signal, the diode, which was reverse biased, will get forward biased and will conduct, and the other diode will get reverse biased and will stop conducting. Hence we obtain a unidirectional output voltage for the positive as well as for negative half cycles. 1



½

½

(b) Identification: AND Gate 1

Truth Table:

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

1

5