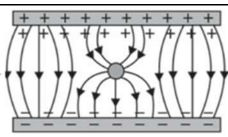
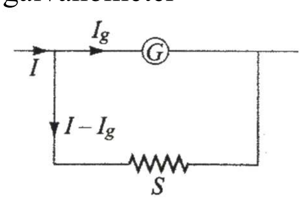
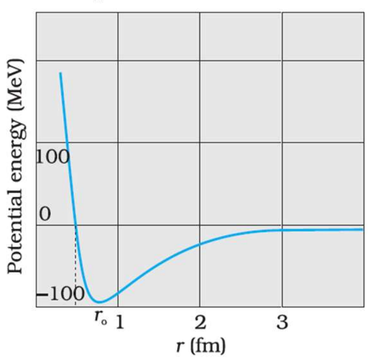
COMMON PRE-BOARD EXAMINATION 2024-25

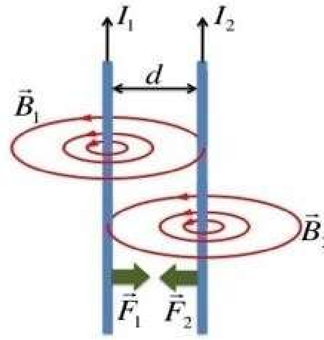
Subject: PHYSICS (042)

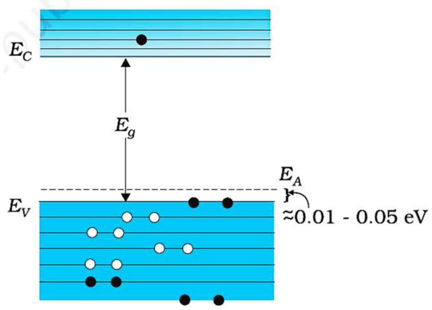
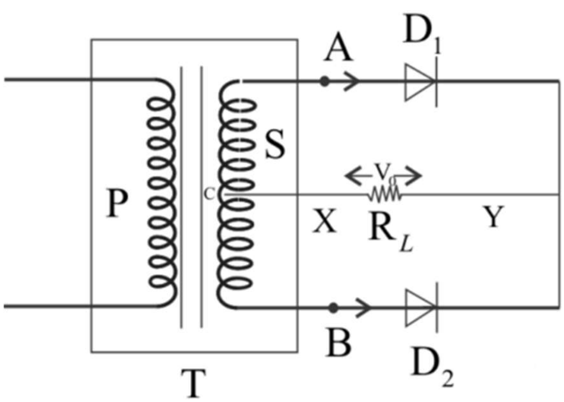
Class XII

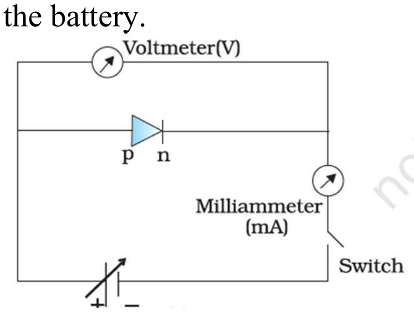
MARKING SCHEME

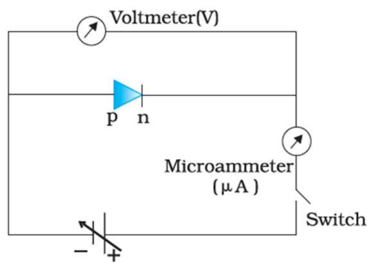
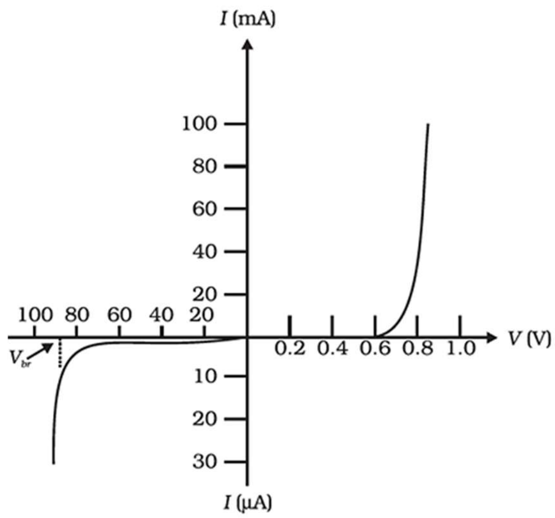
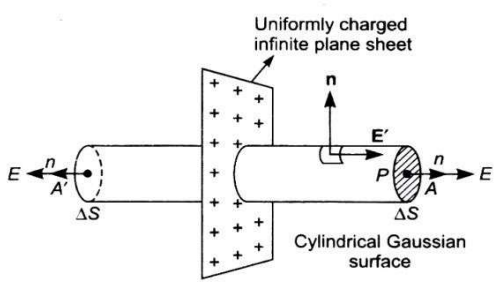
Q.NO.	VALUE POINTS/ EXPECTED ANSWERS	MARKS	TOTAL MARKS
	SECTION A		
1.	(C) 		1
2.	(B) E $\propto \frac{1}{r^2}$ and radially outward		1
3.	(D) copper strip decreases and that of germanium increases		1
4.	(A) Small and negative		1
5.	(C) $\vec{E} \times \vec{B}$		1
6.	(D) X is a capacitor and $X_C = R$		1
7.	(C) 12 cm		1
8.	(D) becomes 4 times		1
9.	(D) Ultraviolet rays		1
10.	(B) maximum in the forward direction and zero in the backward direction.		1
11.	(C) $n_f = 2$ and $n_i = 4$		1
12.	(B) 1.5×10^{16}		1
13.	(D) If both Assertion and Reason are false		1
14.	(C) If Assertion is true but Reason is false		1
15.	(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion		1
16.	(C) If Assertion is true but Reason is false		1
	SECTION B		
17.	The shortest wavelength in Paschen series of the spectral lines is obtained for $n_f = 3$ and $n_i = \infty$ $\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ $\lambda = 820$ nm	1 ½ ½	2
18.	To reduce the resistance of a galvanometer, a shunt resistor (low value resistance) is connected in parallel to the galvanometer  $S = \frac{I_g G}{I - I_g}$	½ ½ 1	2

19.	(a) $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$ $\frac{1}{4 \times 10^{-6}} = \frac{1}{20 \times 10^{-6}} + \frac{1}{C_2}$ $C_2 = 5 \times 10^{-6} = 5\mu F$ (b) Charge drawn from 12 V battery, Q = CV $Q = 48\mu C$	½ ½ ½ ½	2
20.	(a) path difference, Δx = SX - S'X = 4.5 cm $\Delta x = \left(n - \frac{1}{2}\right)\lambda$ As n = 2, $4.5 = \left(2 - \frac{1}{2}\right)\lambda$ $\lambda = 3\ cm$ **OR** (b) (i) Angular width of central maxima, $\theta = \frac{2\lambda}{a}$ Since, $\lambda_{orange} > \lambda_{green}$ So, $\theta_{orange} > \theta_{green}$ (ii) Screen moved closer to slit, i.e. D reduces No change in angular width	½ ½ ½ ½ ½ ½ ½ ½	2
21.	Variation of potential energy between a pair of nucleons as a function of their separation  **Any two** important conclusions of nuclear force- (i) The potential energy is minimum (attractive) between nucleons at a distance of 0.8 fm. (ii) Nuclear force is attractive for distance larger than 0.8fm. (iii) Nuclear force is repulsive if two nucleons are separated by distance less than 0.5 fm. (iv) Nuclear force decreases rapidly at r_o equilibrium position.	1 ½ + ½	2
	SECTION C		
22.	Finding the force per unit length between two parallel I-carrying conductors– 2 Definition of 1 ampere – 1		3

	<u>Force between two parallel current elements-</u> Consider two straight parallel current carrying conductors 1 and 2 (carrying currents in same direction) separated by a distance ‘d’.  The magnetic field due to first conductor having current, I_1 is given by, $B_1 = \frac{\mu_0 I_1}{2\pi d}$ Since conductor 2 is in the field of conductor 1, it will experience a force given by $F_2 = B_1 I_2$ $F_2 = \mu_0 \frac{I_1 I_2 l}{2\pi d}$ Hence force acting per unit length of conductor 2 is given by, $\frac{F_2}{l} = \mu_0 \frac{I_1 I_2}{2\pi d}$ Similarly first conductor experiences a force due to the current in conductor 2 and is given by $\frac{F_1}{l} = \mu_0 \frac{I_1 I_2}{2\pi d}$ Two parallel straight conductors attract when current flowing through them is in same direction and repel if currents are in opposite directions. **<u>SI unit of current</u> -** One ampere is that current which when passed through two infinitely long parallel conductors separated by a distance of 1m produces a force of $2\text{x}10^{-7}$ N/m.	½ ½ ½ ½ 1	
23.	For the 1st refracting surface, $u_1 = \infty$ $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$ $\Rightarrow \frac{\mu_2}{v_1} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} - - - (1)$ For the 2nd refracting surface, $u_2 = v_1$, $v_2 = f$ $\frac{\mu_3}{f} - \frac{\mu_2}{v_1} = \frac{\mu_3 - \mu_2}{R} - - - (2)$	½ ½ 1	3

	Adding eqn. (1) and (2), $\frac{\mu_3}{f} = \frac{\mu_3 - \mu_1}{R}$ $f = \frac{\mu_3 R}{\mu_3 - \mu_1}$	1	
24.	(a) Energy band diagram of p-type semiconductor – 1 (b) Converting full wave rectifier to half wave rectifier - 2 (a) Energy band diagram of p-type semiconductor -  (b) $T > 0$K (b) Converting full wave rectifier to half wave rectifier - To convert a full wave rectifier to half wave rectifier we have to change the connection of resistance, R_L.  From the above diagram if we change the connection of the end X of the resistor, R_L from point C (center point of transformer) to the point B, then will be no current flowing through D_2 in the second half. The output received will be due to D_1 diode only and it will be similar to the half wave rectifier output.	1 ½ 1 ½	3
25.	(a) Biot – Savart Law statement – 1 (b) To find the magnetic field at P – 2 (a) Biot – Savart law : The magnitude of magnetic field $'dB'$ due to current element $'dl'$ at a point P is directly proportional to the current, the length of the current element dl, sine of angle between dl and 'r' and inversely proportional to the square of the distance 'r'.	1	3

	(b) Magnetic field due to the two coils at point P, $$B = 2\left[\frac{\mu_o N I R^2}{2(R^2 + x^2)^{3/2}}\right]$$ $$B = 2\left[\frac{\mu_o N I R^2}{2\left(R^2 + \frac{R^2}{4}\right)^{3/2}}\right]$$ $$B = \frac{8\mu_o N I}{(5)^{3/2} R}$$	1 ½ ½	
26.	Let d be the diameter of the disc. The spot shall be invisible if the incident rays from the dot at O to the surface at d/2 are at the critical angle. $$\sin i = \frac{1}{\mu} - - - (1)$$ From ΔOCB, $\sin i = \frac{d/2}{\sqrt{h^2 + \frac{d^2}{4}}} - - - (2)$ Equating eqn. (1) and (2), $$\frac{d}{\sqrt{4h^2 + d^2}} = \frac{1}{\mu}$$ $$d = \frac{2h}{\sqrt{\mu^2 - 1}}$$	1 1 ½ ½	3
27.	Forward bias circuit with explanation and characteristics– 1 ½ Reverse bias circuit with explanation and characteristics – 1 ½ Forward bias circuit – p- end is connected to positive terminal and n-end to negative terminal of the battery.  The direction of applied dc voltage is opposite to the direction of barrier potential. Potential drop across the junction decreases. The depletion region becomes thin. The barrier height decreases. The diode offers low resistance during forward bias. Reverse bias circuit – p-end of the diode is connected to negative terminal and n- end to positive terminal of the battery.	½ ½	3

		½	
	The direction of the applied dc voltage is same as the direction of barrier potential. Potential drop across the junction increases. The depletion layer becomes thick. The diode offers high resistance during reverse bias. The barrier height increases.	½	
		½ + ½	
28.	(a) (i) Definition of electric flux and SI unit– ½ + ½ (ii) Finding the electric field of a uniformly charged plane sheet – 2		3
	(i) Electric flux- It is defined as the total number of electric field lines passing normally through the surface. It is a scalar quantity.	½	
	Its SI unit is Nm^2/C or Vm.	½	
	(ii) Consider a uniformly charged infinite thin plane sheet with charge density σ. Construct a cylindrical (or rectangular parallelepiped) Gaussian surface. It has 3 faces.	½	
		½	
	Flux linked with each face of cylinder is given by, $\emptyset_1 = EA\cos\theta = EA\ (as\ \theta = 0)$ $\emptyset_2 = EA\cos\theta = EA\ (as\ \theta = 0)$ $\emptyset_3 = EA\cos\theta = 0\ (as\ \theta = 90)$ Total flux linked with the cylindrical surface is given by,	½	

$$\emptyset = \emptyset_1 + \emptyset_2 + \emptyset_3 = 2EA$$

Applying Gauss law,

$$\emptyset = \frac{q}{\varepsilon_0}$$

$$2EA = \frac{\sigma A}{\varepsilon_0}$$

$$E = \frac{\sigma}{2\varepsilon_0}$$ ½

The electric field is directed outward for a positive plate sheet

OR

(b)

(i) Calculating the flux through the cube – 2
(ii) Calculating the charge within the cube – 1

(i) $\phi_L = \bar{E}_L \cdot \bar{A}$ ½

$$\phi_L = -(500 \times 0.1) \times (0.1)^2 = -0.5\ Nm^2/C$$ ½

$$\phi_R = \bar{E}_R \cdot \bar{A}$$

$$\phi_R = (500 \times 0.2) \times (0.1)^2 = 1\ Nm^2/C$$ ½

Net flux, $\varphi = \phi_L + \phi_R$

$$\varphi = -0.5 + 1 = 0.5\ Nm^2/C$$ ½

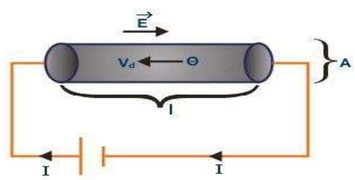
(ii) $\phi = \frac{q}{\varepsilon_0}$ ½

$$q = \varepsilon_0 \phi = 4.4 \times 10^{-12}\ C$$ ½

	SECTION D		
29.	(i) (C) Helical (ii) (B) 1.2 Am^2 (iii) (A) Circle (iv) (a) (D) force experienced by the proton is zero **OR** (b) (C) North	1 1 1 1 1	4
30.	(i) (B) 1:1 (ii) (B) The cut-off potential will increase (iii) (A) 3×10^{16} (iv) (a) (A) product of the slope of the line and charge on the electron **OR** (b) (B) 0.51 eV	1 1 1 1 1	4

<table>
<tr><td></td><td>SECTION E</td><td></td><td></td></tr>
<tr><td>31.</td><td>I

(a) To obtain expression for drift velocity – 2
Reason for steady drift – 1

(b) (i) Variation of current density – 1
(ii) Variation of electric field – 1</td><td></td><td>5</td></tr>
<tr><td></td><td>(a) <u>Drift velocity-</u>
Let us consider a metal conductor of length ‘l’ connected to a battery as shown in the figure.</td><td>½</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The free electrons experience a force ($F = -q\vec{E}$).
The acceleration of the electron is given by $a = -e\vec{E}/m$.</td><td>½</td><td></td></tr>
<tr><td></td><td>Thus the free electrons, apart from its thermal velocity, acquire additional velocity. At any instant, the velocity acquired by the electrons can be written as $v_1 = u_1 + at_1$,
$v_2 = u_2 + at_2, \ldots$
These velocities are in different directions and each electron describes a curved path between successive collisions. As a result, the free electrons drift towards the positive end of the conductor with an average velocity called drift velocity v_d.
$$\vec{v}_d = \vec{a}\ \tau$$
$$\vec{v}_d = \frac{-e\vec{E}}{m}\tau$$</td><td>½</td><td></td></tr>
<tr><td></td><td>$$v_d = \frac{eE\tau}{m} = \frac{eV\tau}{ml}$$</td><td>½</td><td></td></tr>
<tr><td></td><td>Reason - Each ‘free’ electron does accelerate, increasing its drift speed until it collides with a positive ion of the metal. It loses its drift speed after collision but starts to accelerate and increases its drift speed again only to suffer a collision again and so on. On the average, therefore, electrons acquire only a drift speed.</td><td>1</td><td></td></tr>
<tr><td></td><td>(b)As thickness continuously decreases from end A to B of a conductor connected to a battery, the current remains constant, however,
(i) The current concentration in end A is less, hence current density here is less as compared to higher concentration of current with region B which is smaller area, leading to an increased current density. (J = I/A)
$J_A < J_B$</td><td>½
½</td><td></td></tr>
<tr><td></td><td>(ii) Electric field , E = σ J and J = I/A
Since $J_A < J_B$
So, $E_A < E_B$</td><td>½
½</td><td></td></tr>
</table>

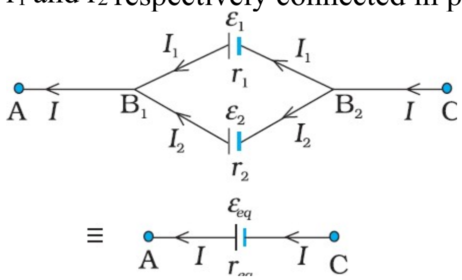
OR

II

(a) Obtaining expression for (i) emf and (ii) internal resistance – 3

(b) To find current during charging – 2

Let us consider two non-identical cells E_1 and E_2 having internal resistances r_1 and r_2 respectively connected in parallel as shown in the figure. ½



½

The current due to each cell is given by

$$I_1 = \frac{E_1 - V}{r_1} ----(1)$$

$$I_2 = \frac{E_2 - V}{r_2} ----(2)$$ ½

The net current across the combination is given by

$$I = I_1 + I_2 = \frac{E_1 - V}{r_1} + \frac{E_2 - V}{r_2}$$

$$I = \frac{E_1}{r_1} + \frac{E_2}{r_2} - V\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$ ½

Comparing above equation with $V = E_{eq} - Ir_{eq}$

where $\frac{E_{eq}}{r_{eq}} = \frac{E_1}{r_1} + \frac{E_2}{r_2}$ ½

$$\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2}$$ ½

(b) Net emf in the circuit, E'= V - E = 120 – 8 = 112V 1

So current in circuit,

$$I = \frac{net\ emf}{net\ resistance} = \frac{E'}{R + r} = \frac{112}{15.5 + 0.5} = 7A$$ 1

32. I 5

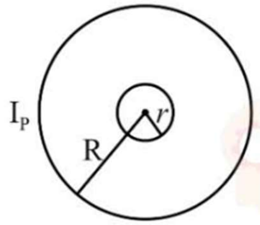
(a) Mutual inductance definition – 1
To find mutual inductance of two circular coaxial loops – 2

(b) To find induced current in the three time intervals – 2

(a) Mutual induction- It is phenomenon of inducing emf in one coil due to current changes in the neighboring coil. 1

Let a current I_P flow through the circular loop of radius R. The magnetic induction at the centre of the loop is, ½

½



$$B_p = \frac{\mu_0 I_p}{2R}$$

As, r << R, the magnetic induction B_P may be considered to be constant over the entire cross sectional area of inner loop of radius r. Hence magnetic flux linked with the smaller loop will be ½

$$\phi_s = B_p A_s = \frac{\mu_0 I_p}{2R}\,\pi r^2$$

$$\phi_s = M I_p$$

$$Hence, M = \frac{\phi_s}{I_p} = \frac{\mu \pi r^2}{2R}$$ ½

(b) Induced current

Area of the circular loop = πr^2

$A = 3.14 \times (0.12)^2 = 4.5 \times 10^{-2}\ m^2$

$$E = -\frac{d\phi}{dt} = -\frac{d}{d}\frac{(BA)}{t} = -A\frac{dB}{dt} = -A\frac{(B_2 - B_1)}{(t_2 - t_1)}$$ ½

- For 0 < t < 2s,

$$E_1 = -A\frac{(B_2 - B_1)}{(t_2 - t_1)} = -4.5 \times 10^{-2}\left(\frac{1-0}{2-0}\right) = -2.25\ \times 10^{-2} V$$ ½

$$I_1 = \frac{E_1}{R} = -2.6\ mA$$

- For 2s < t < 4s,

$$E_2 = 0, \qquad So,\ I_2 = 0$$ ½

- For 4s < t < 6s,

$$E_3 = -4.5 \times 10^{-2}\left(\frac{0-1}{6-4}\right) = 2.25\ \times 10^{-2} V$$ ½

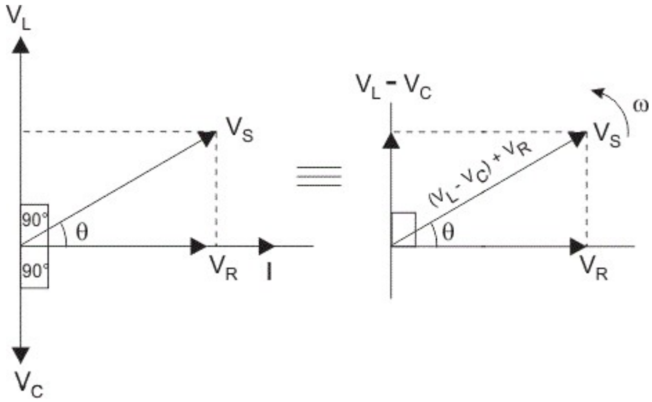
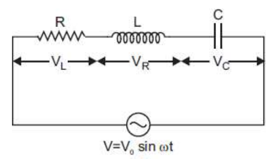
$$I_3 = \frac{E_3}{R} = 2.6\ mA$$

OR

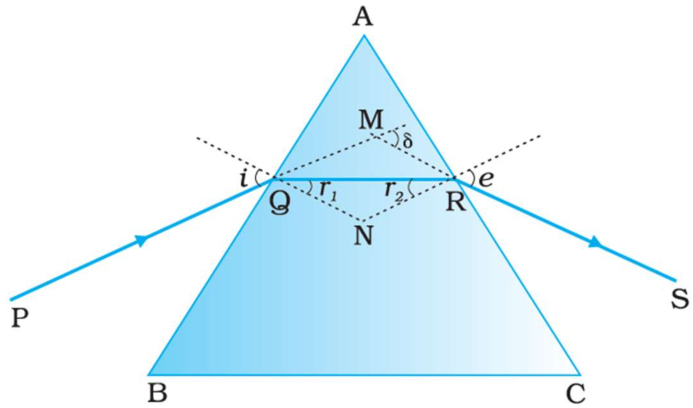
II

(a) Phasor diagram of LCR – 1
Expression for impedance and instantaneous current – 2

(b) Capacitance value – 1
Rms current value - 1

	 From phasor diagram (considering inductive LCR series circuit), $$v = \sqrt{v_R^2 + (v_L - v_C)^2}$$  Since common current flow in series circuit, $$iZ = \sqrt{(iR)^2 + (iX_L - iX_C)^2}$$ Impedance, $$Z = \sqrt{R^2 + (X_L - X_C)^2}$$ The instantaneous current in the circuit is hence given by, $$i = \frac{v_o}{Z}\sin(\omega t - \varphi)$$ $$i = i_o \sin(\omega t - \varphi)$$ (b) When current is in phase with the voltage, $X_C = X_L$ $$\frac{1}{\omega C} = \omega L$$ $$C = \frac{1}{\omega^2 L}$$ $$C = 25\mu F$$ Impedance when current and voltage are in phase, Z = R = 100Ω $$I_V = \frac{E_V}{Z} = \frac{E_V}{R} = \frac{200}{100} = 2A$$	1 ½ ½ ½ ½ ½ ½ ½ ½	
33.	I (a) Ray diagram showing refraction of a ray of light through a rectangular glass prism – 1 Obtaining the relation between μ, A and δ_m – 2 (b) (i) To find angle of deviation – 1 (ii) To find refractive index of prism - 1		5

(a) Refraction of ray through prism -



1

In the quad, AQNR, two of the angles (at the vertices Q and R) are right angles. Therefore, the sum of the other angles of the quadrilateral is 180^0

$$\angle A + \angle QNR = 180^0$$

From the triangle QNR,

$$r_1 + r_2 + \angle QNR = 180^0$$ ½

Comparing above two equations, we get

$$r_1 + r_2 = A - - - (i)$$

The total deviation δ is the exterior angle of triangle MQR,

$$\delta = (i - r_1) + (e - r_2)$$

$$\delta = i + e - A - - - (ii)$$ ½

When $\delta = \delta_m, then\ i = e\ and\ r_1 = r_2$

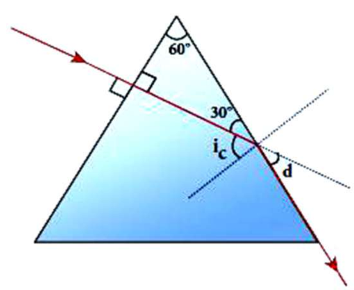
From ---(i), 2r = A or r = A/2 ½

From ---(ii), $\delta_m, = 2i - A$ or $i = \frac{(A+\delta_m)}{2}$

$$From\ Snell's\ law, \quad n = \frac{\sin i}{\sin r} = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$ ½

$(b)\ (i)\ \delta = i + e - A$ 1

$= 0 + 90 - 60 = 30^0$



(ii) The light inside the prism must be falling on the falling on the second face at critical angle as it graces the boundary,

$i_c = 90 – 30 = 60^0$

$n = \frac{1}{\sin i_c}$ 1

$n = \frac{1}{\sin 60} = \frac{2}{\sqrt{3}} = 1.154$

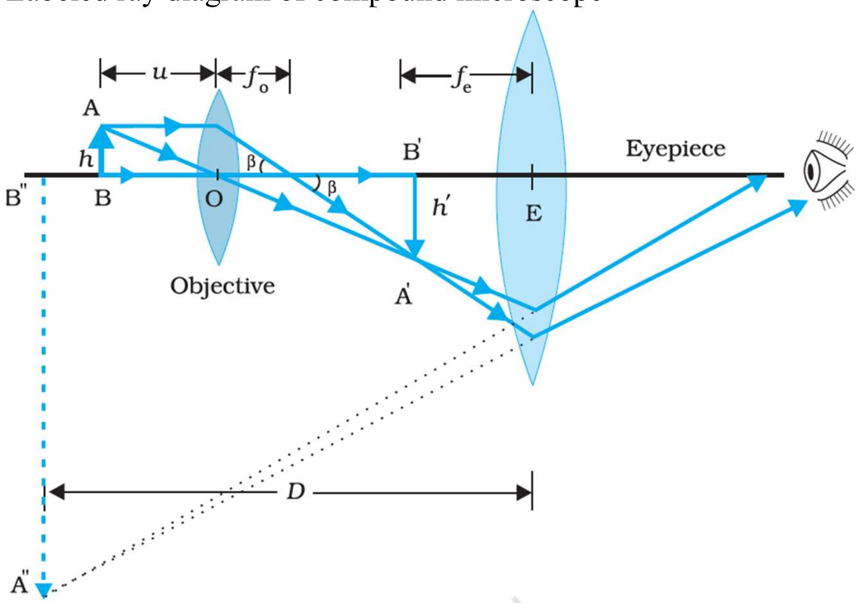
OR

II.

(a) Labeled Ray diagram of compound microscope – 1 ½
Derivation of magnifying power – 1 ½

(b) To find tube length of microscope - 2

	Labeled ray diagram of compound microscope -	1 ½	



The magnification obtained by eye-piece lens,

$$m_e = \left(1 + \frac{D}{f_e}\right)$$ ½

Magnification obtained by objective lens,

$$m_o = -\frac{v_o}{u_o}$$ ½

Hence total magnification power,

$$m = m_o \times m_e$$

$$m = -\frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right)$$ ½

(b)

f_o = 1cm, f_e = 2.5 cm, m = 300

$$|m| = \frac{L}{f_0} \cdot \frac{D}{f_e}$$ 1

$$300 = \frac{L}{1} \cdot \frac{25}{2.5}$$ 1

L= 30 cm