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MARKS									

→ Newton's corpuscular theory of light.

- Merits

- Demerits

→ Huygen's wave theory of light.

- Merits

- Demerits

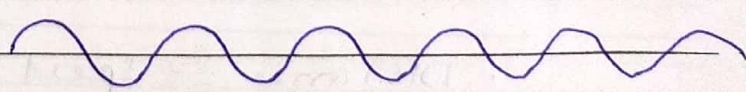
→ Planck's quantum theory of light.

$\because E \propto f$

$\therefore \boxed{E = hf}$

Where h is planck's constant. Value of h is 6.6×10^{-34} Js.

→ Dual nature of light

→ Wave nature 

→ Rectinear propogation of wave

Speed of light = 3×10^8 m/s

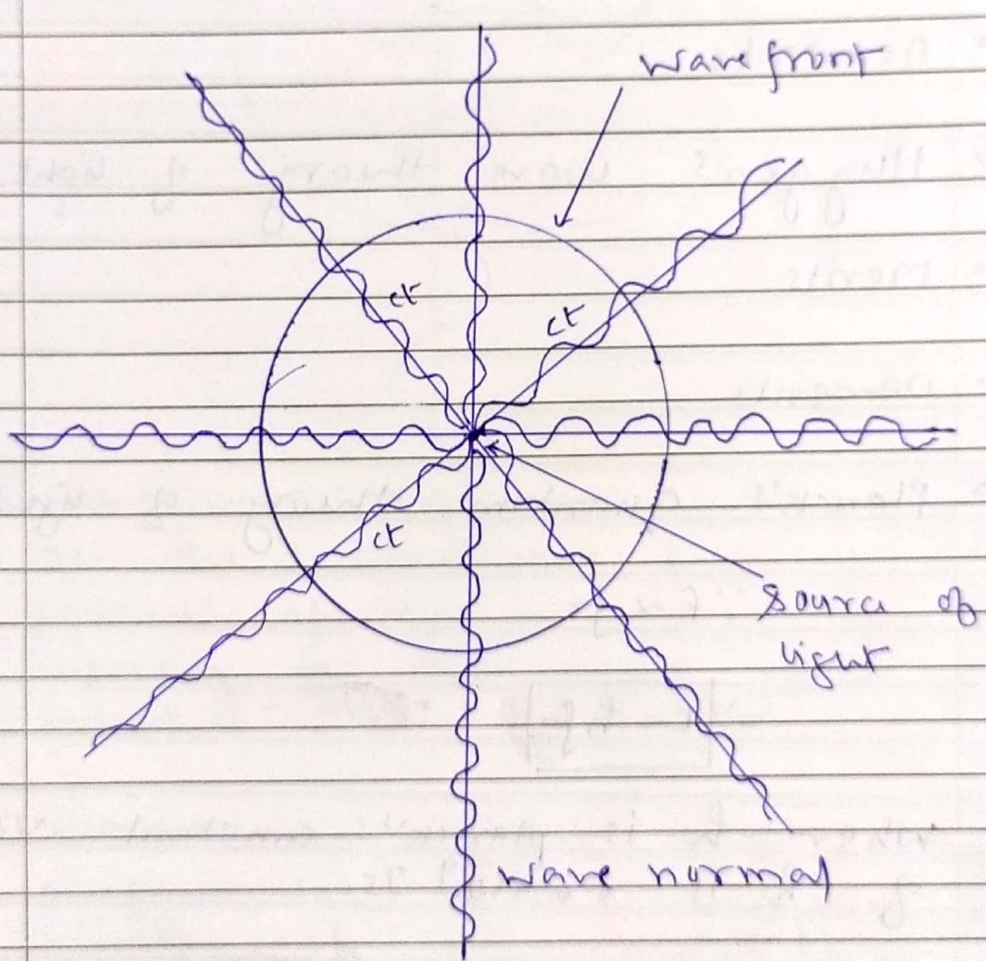
frequency of light = 10^{14} Hz

$\therefore \quad v = n\lambda$

$\therefore \quad \lambda = \frac{v}{n} = \frac{3 \times 10^8}{10^{14}} = 3 \times 10^{-6}$ m

Wave front OR wave surface

Wave normal OR Ray of light



$\therefore$ Speed = $\frac{\text{distance}}{\text{time}}$

$\therefore$ Distance = speed × time

$\therefore \quad \boxed{\text{Distance} = ct}$

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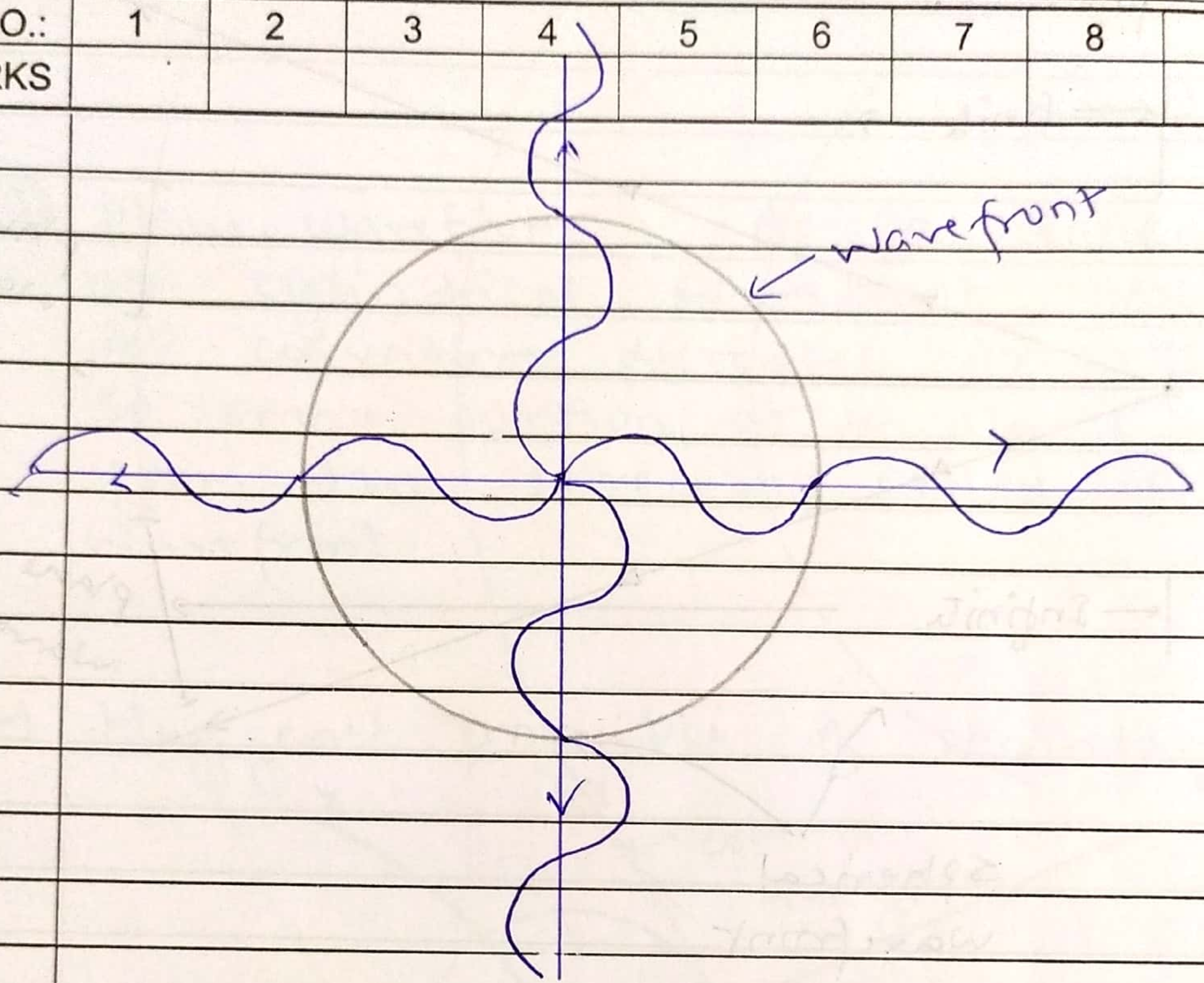
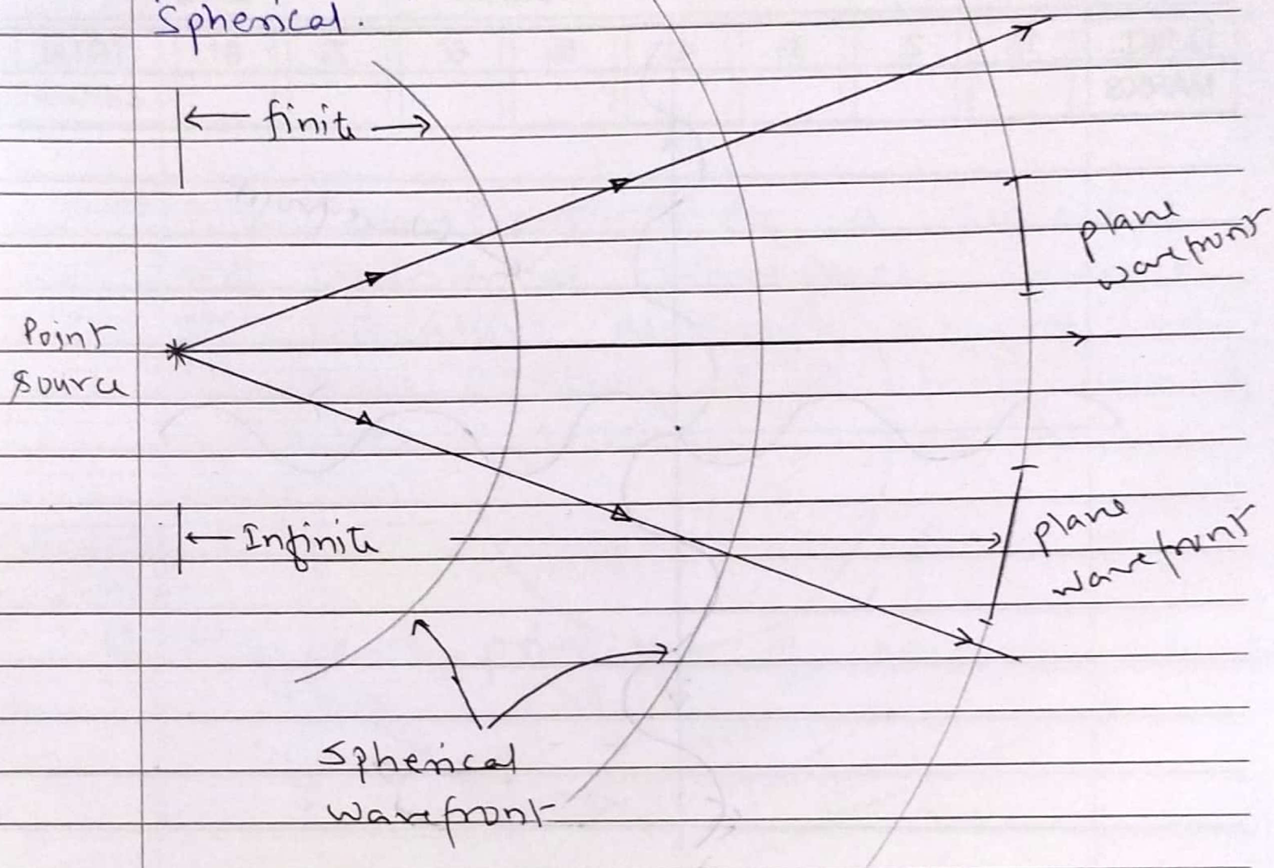


* Wavefront :- A wavefront is defined as the continuous locus of all such particles of the medium which are vibrating in the same phase at any instant.

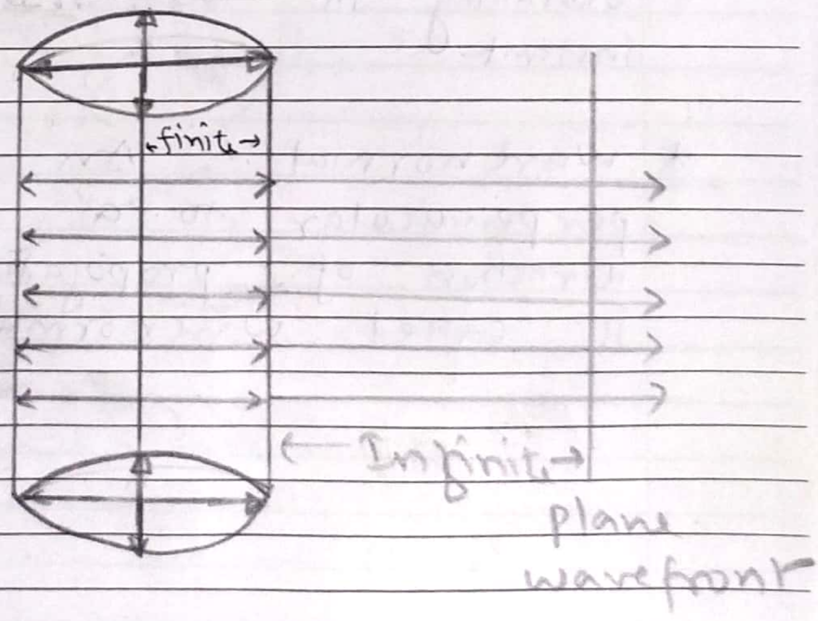
* Wave normal :- An arrow drawn perpendicular to a wavefront in the direction of propogation of a wave is called wave normal.

Types of wavefront

1) Spherical wavefront :- When waves travelling in all directions from a point source then wavefronts are spherical.



2) Cylindrical wavefront :- When the source of light is linear in shape then wavefront is cylindrical.



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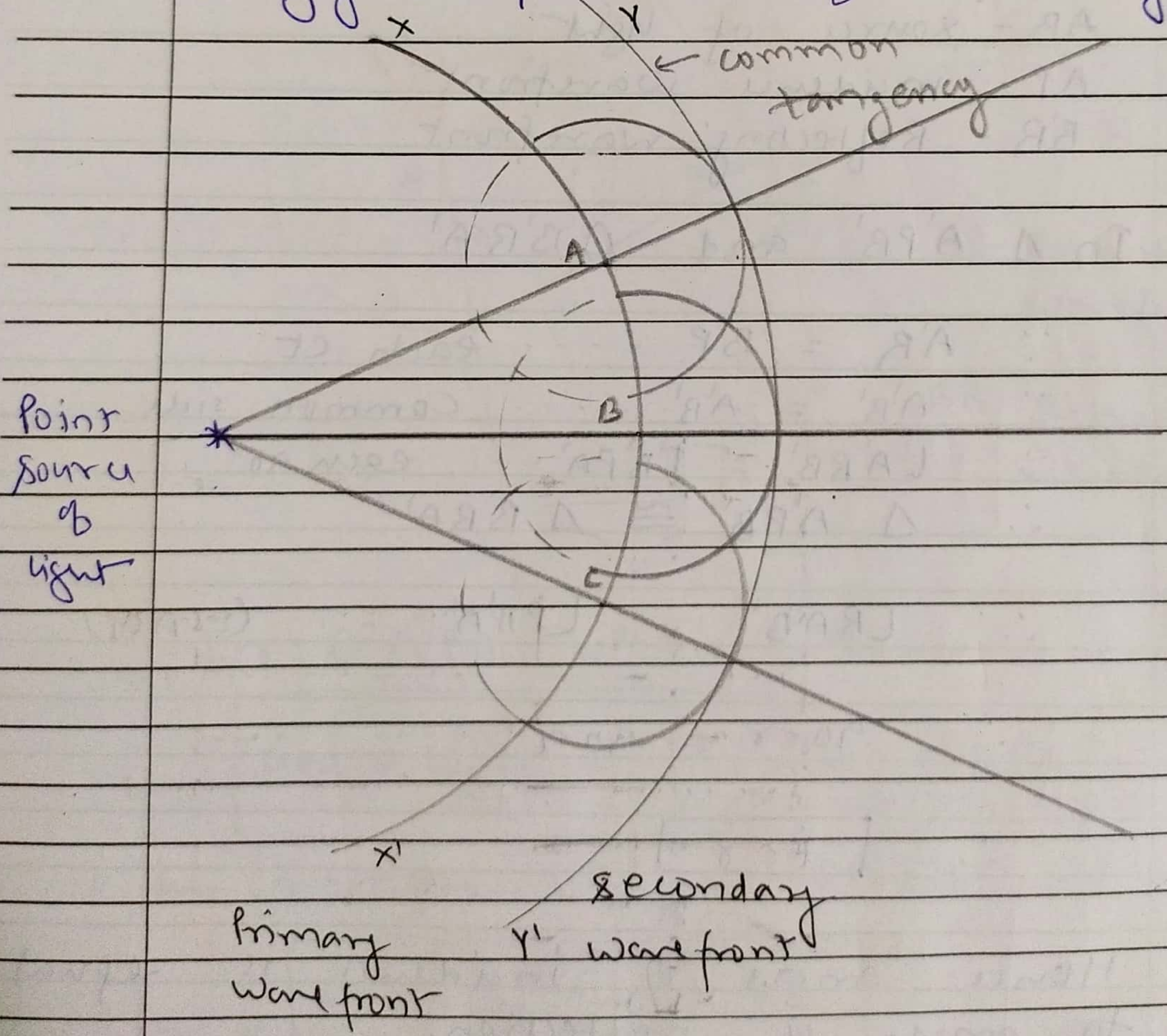
3) plane wavefront :- As a spherical or cylindrical wavefront advances, it's curvature decreases progressively, so small portion at a large distance from the source is called plane wavefront.

Huygen's principle of secondary wavelets

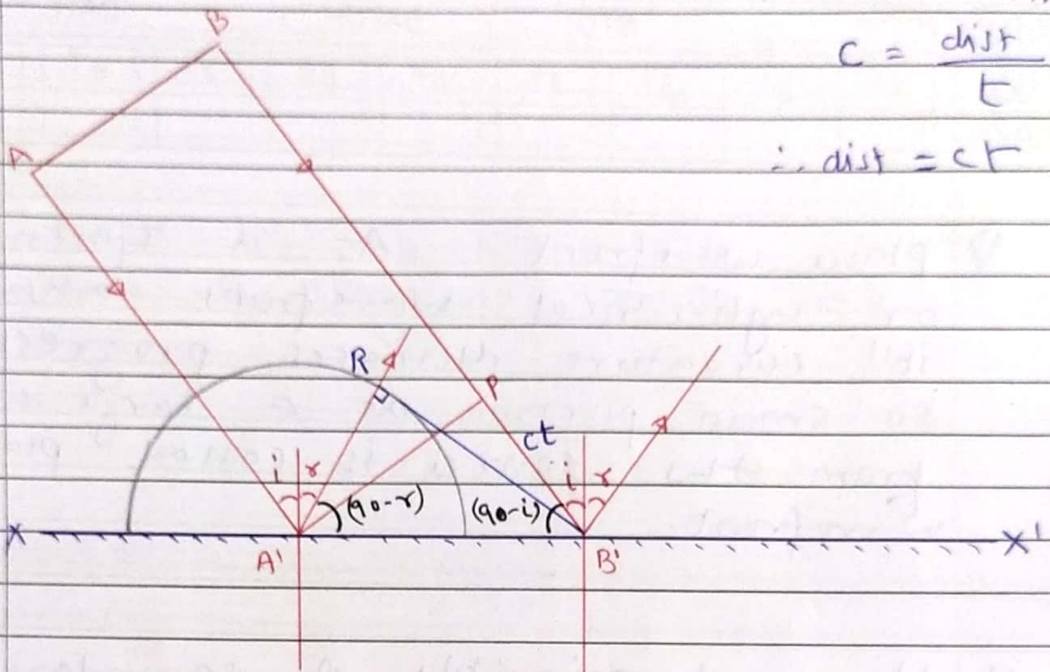


Prove law of reflection on the basis of Huygen's wave theory of light.

$\because$ Speed = $\frac{\text{distance}}{\text{time}}$

$c = \frac{\text{dist}}{t}$

$\therefore$ dist = ct



AB - source of light
A'P - incidence wavefront
B'R - Reflecting wavefront

In $\Delta A'PB'$ and $\Delta B'RA'$

$\because A'R = B'P$ .... each ct
$\because A'B' = A'B'$ .... common side
$\because \angle A'RB' = \angle B'PA'$ ... each $90°$
$\therefore \Delta A'PB' \cong \Delta B'RA'$

$\therefore \angle RA'B' = \angle PB'A'$ .... (CACT)

$\therefore 90 - r = 90 - i$

$\therefore \boxed{i = r}$

Hence angle of incidence is equal to angle of reflection.

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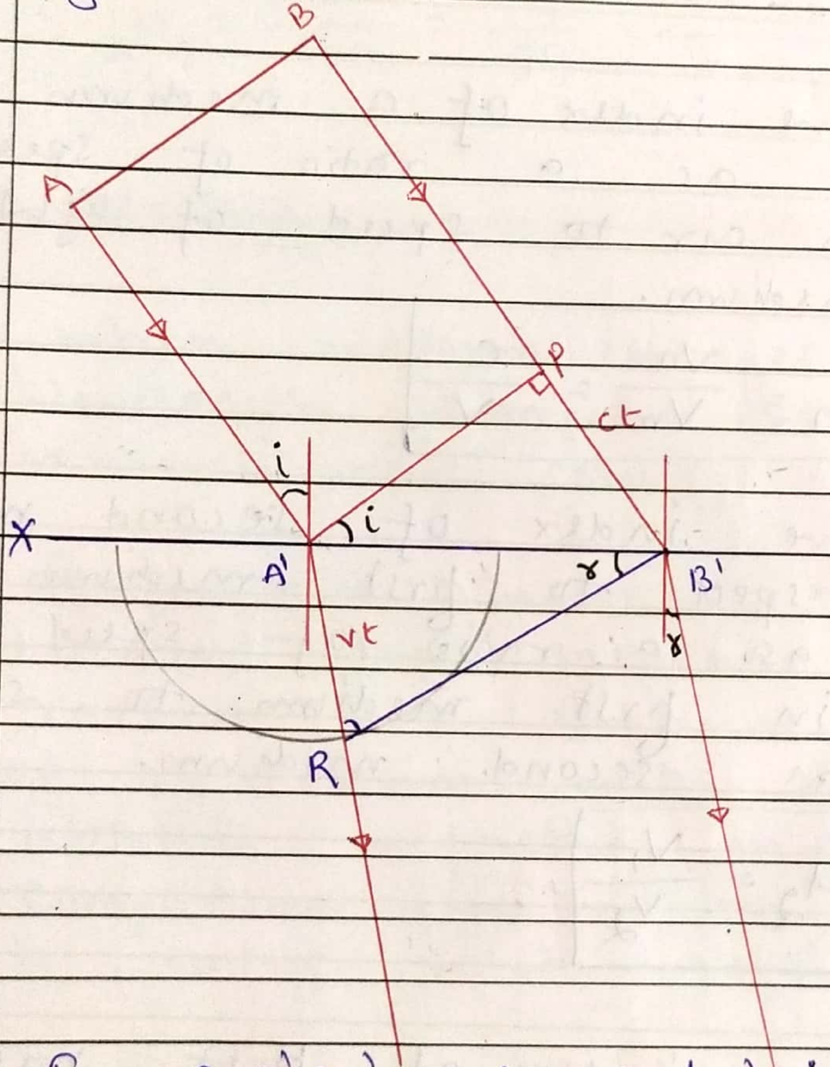
Prove law of refraction on the basis of Huygen's wave theory of light.



A'P - Incidence wavefront

B'R - Refracting wavefront

In $\Delta A'PB'$, $\angle P = 90°$ $\angle A' = i$

$$\therefore \boxed{\sin i = \frac{PB'}{A'B'} = \frac{ct}{A'B'}} \quad \text{--- (I)}$$

In $\Delta B'RA'$, $\angle R = 90°$ $\angle B' = r$

$$\therefore \boxed{\sin r = \frac{A'R}{A'B'} = \frac{vt}{A'B'}} \quad \text{--- (II)}$$

Divide eqn (i) by eqn (ii)

$$\therefore \frac{\sin i}{\sin r} = \frac{ct/A'B'}{vt/A'B'} = \frac{c}{v}$$

Since ratio $\frac{c}{v}$ is constant for all angle of incidence and called refractive index.

$$\therefore \boxed{\frac{\sin i}{\sin r} = \mu}$$

Refractive index of a medium is defined as a ratio of speed of light in air to speed of light in that medium.

$$\boxed{{}_a\mu_m = \frac{v_a}{v_m} = \frac{c}{v}}$$

→ Refractive index of second medium with respect to first medium is defined as a ratio of speed of light in first medium to speed of light in second medium.

$$\boxed{{}_1\mu_2 = \frac{v_1}{v_2}}$$

→ Refractive index of first medium with respect to second medium is defined as a ratio of speed of light in second medium to speed of light in first medium.

$$\boxed{{}_2\mu_1 = \frac{v_2}{v_1}}$$

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$$\therefore {}_1\mu_2 = \frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{n_1\lambda_1}{n_2\lambda_2} = \frac{\lambda_1}{\lambda_2} = \frac{{}_a\mu_2}{{}_a\mu_1}$$

$$\therefore {}_2\mu_1 = \frac{\sin i}{\sin r} = \frac{v_2}{v_1} = \frac{n_2\lambda_2}{n_1\lambda_1} = \frac{\lambda_2}{\lambda_1} = \frac{{}_a\mu_1}{{}_a\mu_2}$$

→ $v = n\lambda$

→ when medium changes velocity and wavelength changes but frequency remains the same

→ Refractive index is comparision between two mediums about their rarerness or denserness. Comparision of a medium with air is called absolute refractive index and comparision with any other medium is called relative refractive index.

→ Principle of reversibility : Path of a ray of light is reversible.

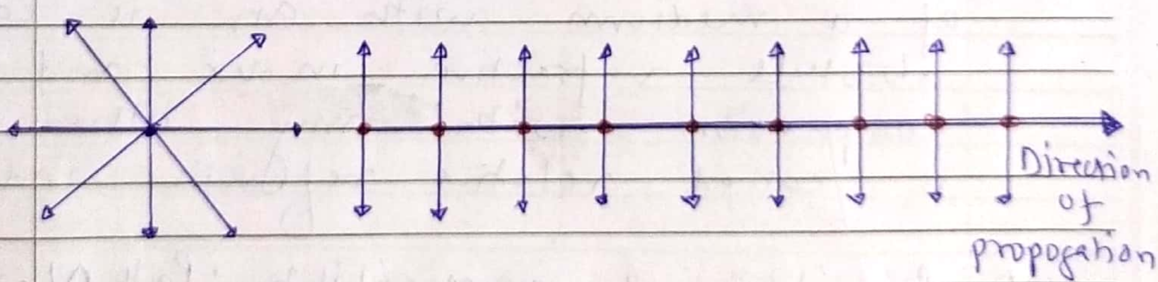
$$\boxed{{}_1\mu_2 = \frac{1}{{}_2\mu_1}}$$

* **Polarisation of wave :-** The phenomenon of restricting the oscillations of a wave to just one direction in the transverse plane is called polarisation of wave.

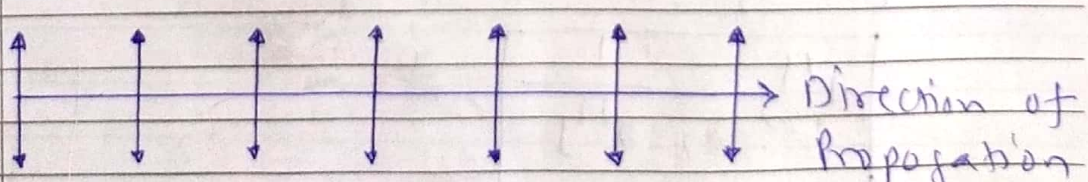
* **Unpolarised light :-** A light which has vibrations in all directions in a plane perpendicular to the direction of propogation is said to be unpolarised light.

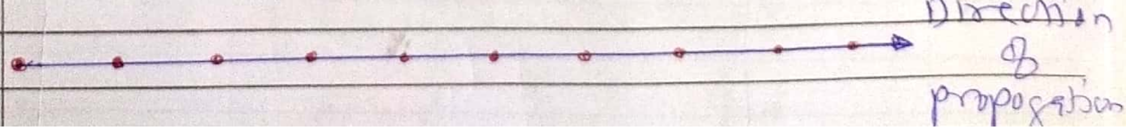
* **plane polarised wave :-** If the electric field vector of a light wave vibrates just in one direction perpendicular to the direction of wave propogation is called plane polarised wave.

* **Unpolarised ray of light**



* **Plane polarised ray of light.**





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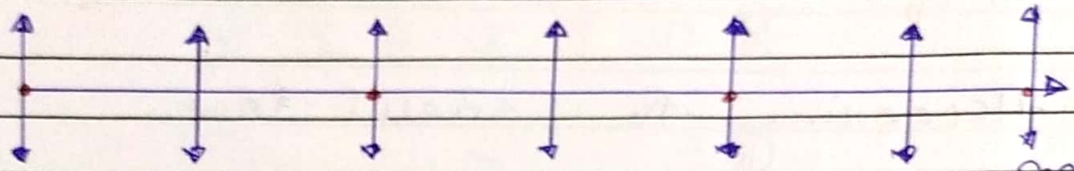
MARKS									

* Partial polarised ray of light



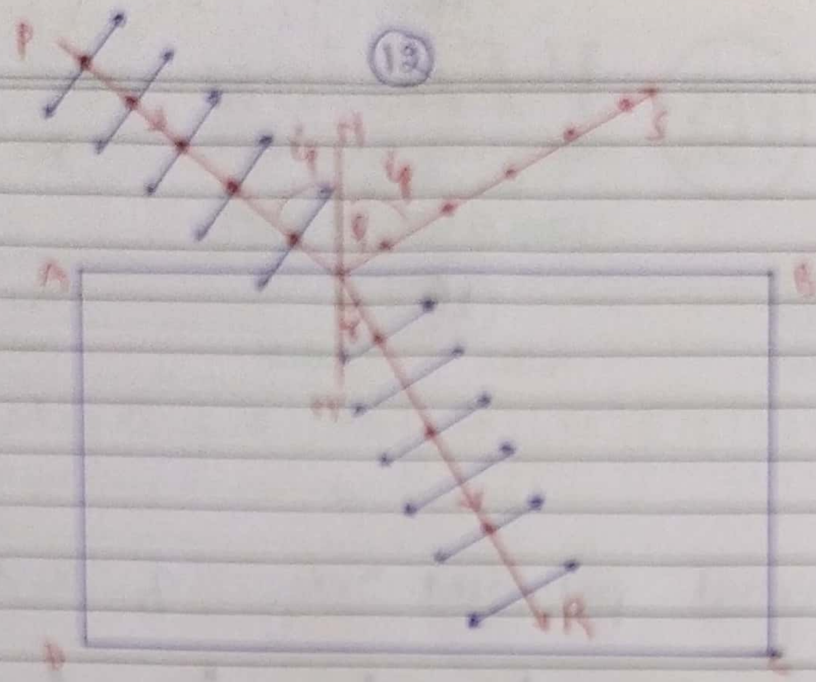
* Polarising angle :- The angle of incidence at which a beam of unpolarised light falling on a transparent surface is reflected as a beam of completely plane polarised light is called polarising angle.

* At polarising angle, the reflected and transmitted rays are perpendicular to each other.

* Brewster's law :- P.T.O.

→ State and prove Brewster's law.

Statement :- Brewster's law states that the tangent of the polarising angle of incidence of a transparent medium is equal to it's refractive index.



According to snell's law.

$$\therefore \frac{\sin i_p}{\sin r} = \mu$$

since $i_p + r = 90°$ $\Rightarrow$ $r = 90 - i_p$

$$\therefore \frac{\sin i_p}{\sin(90 - i_p)} = \mu$$

$$\frac{\sin i_p}{\cos i_p} = \mu$$

$$\therefore \boxed{\tan i_p = \mu}$$

Hence Brewster's law is proved.

Scattering of light :- According to Rayleigh's intensity of scattering (I) is invesely propostional to four power of wavelength.

$$\boxed{I \propto \frac{1}{\lambda^4}}$$

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Since visible range is —

V I B G Y O R

$$\boxed{\lambda_V < \lambda_R}$$

Doppler effect :- Apparent change in frequency due to relative motion between source and observer is called doppler effect.

→ Red shift ...... $[n' = n[1 - v/c]$

→ Blue shift ..... $[n' = n[1 + v/c]$

→ $n' = n\left[1 \pm \frac{v}{c}\right]$

Where, n' - apparent frequency

n - Actual frequency

v - speed of observer or source

c - speed of light.

II Intensity is defined as amount of energy passes through unit area in unit time. ~~called~~

$$I = E/At$$

since $E = \frac{1}{2} m\omega^2 a^2$ i.e. total energy of oscillating body.

$$\therefore I = \frac{\frac{1}{2} m\omega^2 a^2}{At}$$

$$\therefore I = \frac{\frac{1}{2} m (4\pi^2 n^2) a^2}{At}$$

$$\therefore I = \frac{2\pi^2 n^2 a^2 (\rho V)}{At}$$

$$\therefore I = \frac{2\pi^2 n^2 a^2 \rho (AL)}{At}$$

$$\therefore I = 2\pi^2 n^2 a^2 \rho (L/t)$$

since $L/t = v$ i.e. velocity

$$\therefore I = 2\pi^2 n^2 a^2 \rho v$$

$$\therefore I = (2\pi^2 n^2 \rho v) a^2$$

since $2\pi^2 n^2 \rho v$ is constant

$$\therefore \boxed{I \propto a^2}$$

Hence intensity is directly proportional to square of amplitude.

$$\therefore \boxed{\frac{I_1}{I_2} = \left(\frac{a_1}{a_2}\right)^2}$$

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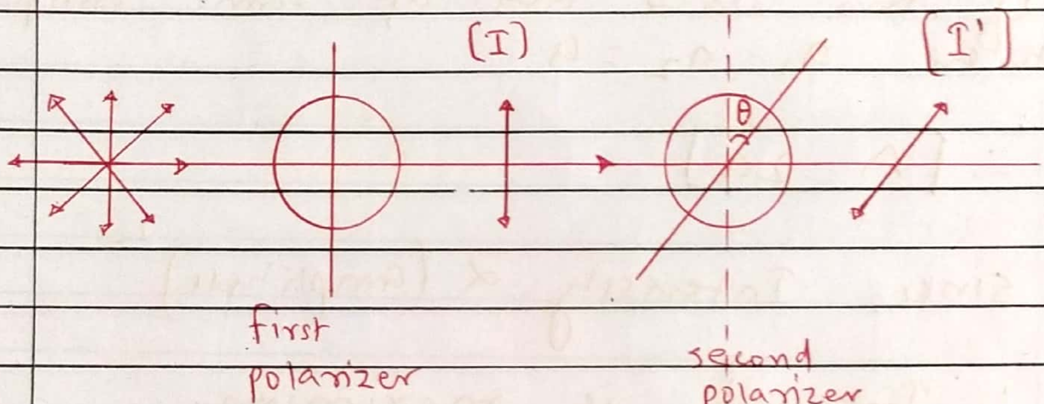
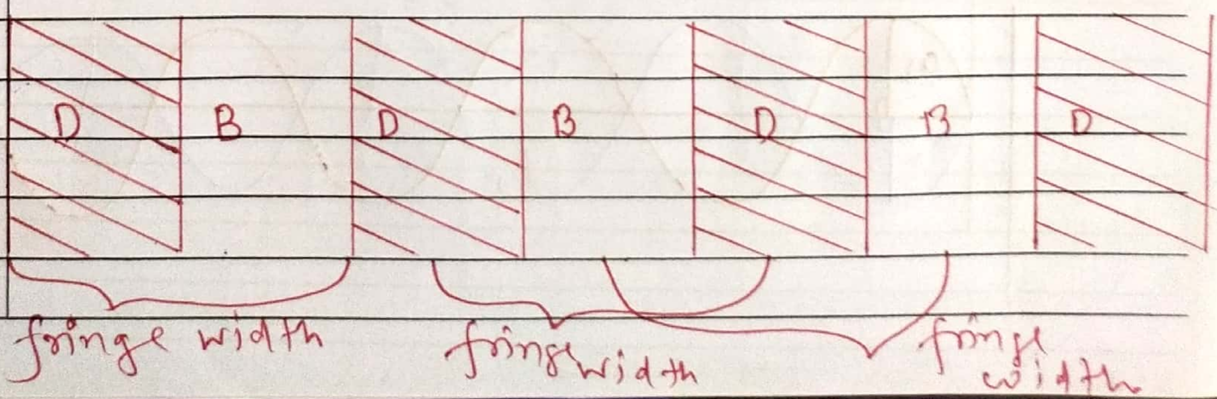
* According to malus the intensity of a linearly polarised wave after it passes through a polarizer is given by

$$\boxed{I' = I\cos^2\theta}$$

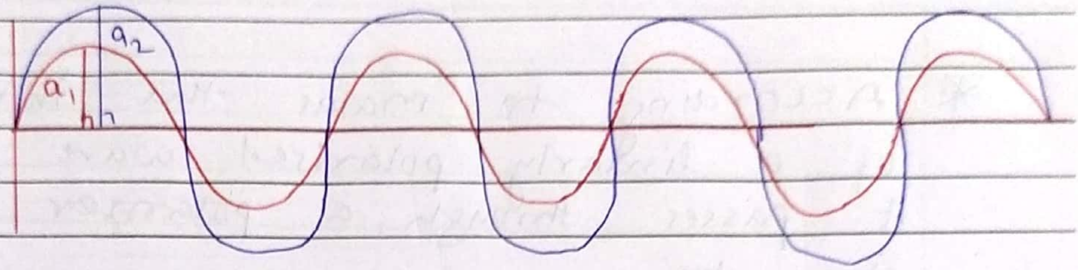
It is called malus law.



* Interference of light :- Interference of light is defined as the modification in the intensity of light produced by the superposition of two or more light waves.



* Constructive interference :- when two waves arrive at a point in the same phase i.e. crest of one wave co-incides with crest of another wave then it is called constructive interference.



let A be the resultant amplitude then it is given by

$\boxed{A = a_1 + a_2}$

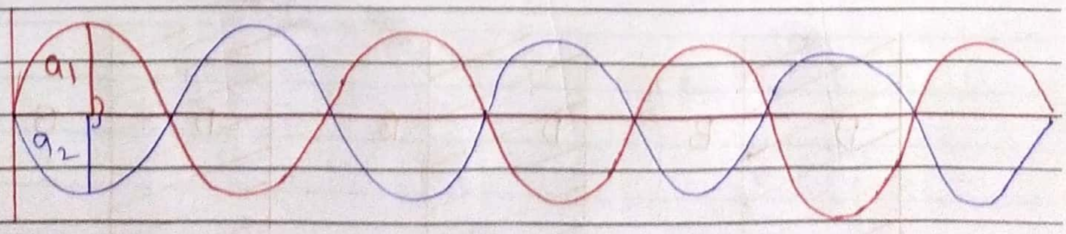
If two wave are of same amplitude then $a_1 = a_2 = a$

$\therefore \boxed{A = 2a}$

since, Intensity $\propto$ (amplitude)^2

$\therefore$ Intensity is maximum.

* Destructive interference :- When two waves arrive at a point in opposite phase i.e. crest of one wave co-incides with trough of another wave then it is called distructive interference.



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MARKS									

Let A be the resultant amplitude then it is given by

$\because \boxed{A = a_1 - a_2}$

If two amplitudes are in ~~opposite~~ ~~dire~~ same magnitude.

$\boxed{A = a - a = 0}$

since Intensity $\propto$ (amplitude)^2

$\therefore$ Intensity is minimum.

* If two waves arrive at a point with phase difference ϕ then resultant amplitude is given by

$\because A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

$\therefore A^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$

$\therefore \boxed{I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\phi}$

When $\phi = 0$ then $I = I_{max}$

$\therefore I_{max} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}$

$= (\sqrt{I_1})^2 + (\sqrt{I_2})^2 + 2\sqrt{I_1}\sqrt{I_2}$

$= (\sqrt{I_1} + \sqrt{I_2})^2$

$= (A_1 + A_2)^2$

when $\phi = 180$ then $I = I_{min}$

$$\therefore I_{min} = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\,(-1)$$

$$\therefore I_{min} = (\sqrt{I_1})^2 + (\sqrt{I_2})^2 - 2\sqrt{I_1}\sqrt{I_2}$$

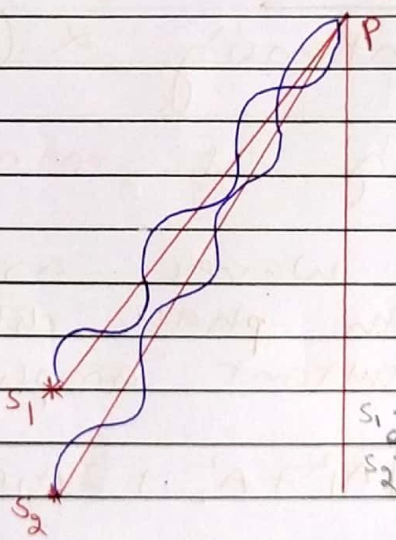
$$= (\sqrt{I_1} - \sqrt{I_2})^2$$

$$= (A_1 - A_2)^2$$

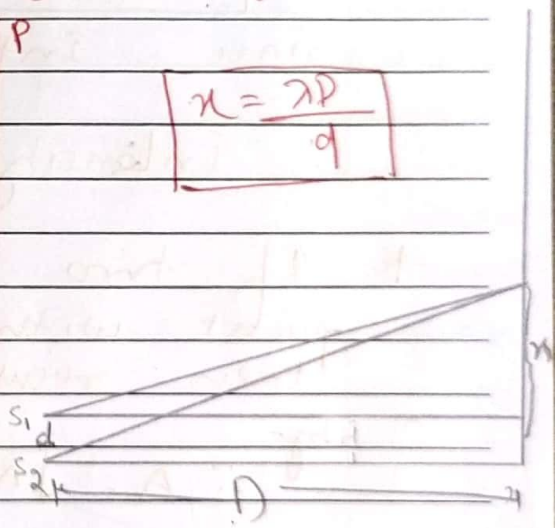
$$\therefore \boxed{\frac{I_{max}}{I_{min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2}$$

Conditions for steady interference pattern

1)



$$\boxed{x = \frac{\lambda D}{d}}$$



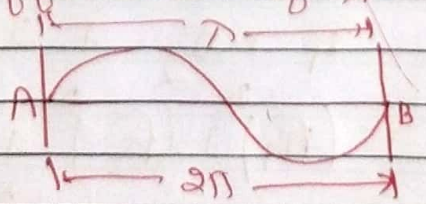
Path difference $= S_2P - S_1P$

$= 3.5\lambda - 3\lambda$

$= 0.5\lambda = \lambda/2$

$\therefore$ phase difference $= \pi$

Since phase difference of 2π corresponds path difference of λ.



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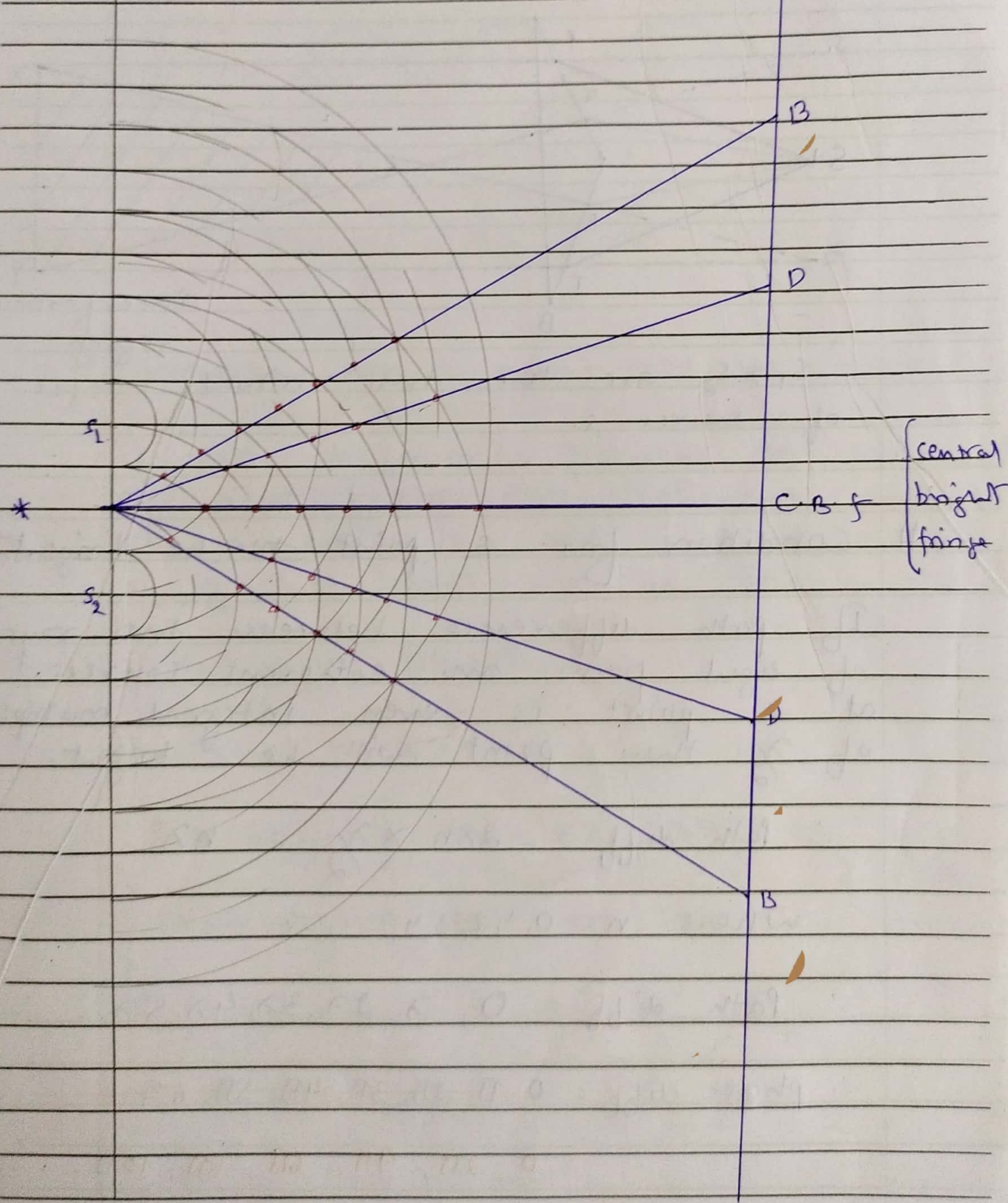
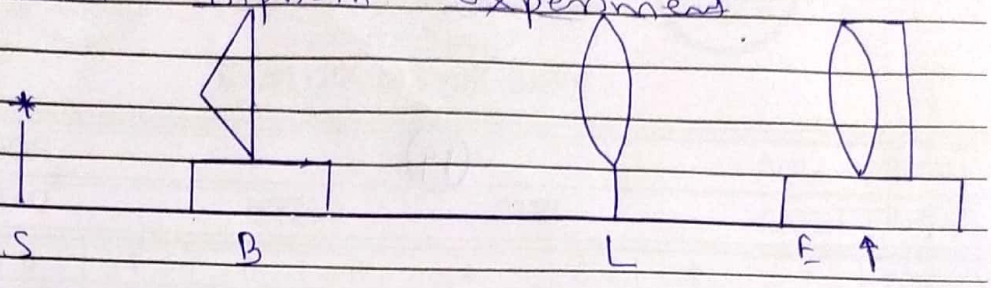
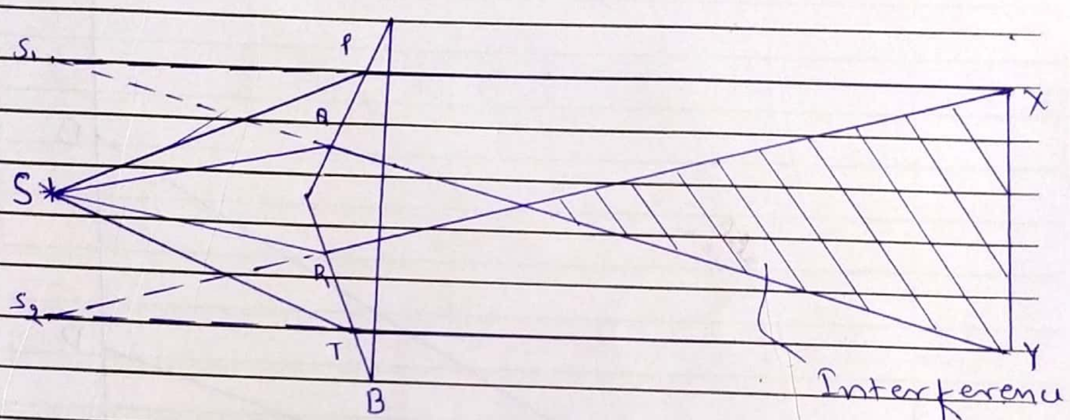
Young's double slit experiment



Fresnel's Biprism experiment





S_1 & S_2 are the two virtual images of source S.

Condition for a point to be bright.

If path difference between two rays of light from two coherent sources, at a point is even integral multiple of $\lambda/2$ then point will be bright.

$\therefore$ Path diff $= 2 \times n \times \lambda/2 = n\lambda$

where $n = 0, 1, 2, 3, 4, \ldots$

$\therefore$ Path diff $= 0, \lambda, 2\lambda, 3\lambda, 4\lambda, 5\lambda, \ldots$

$\therefore$ phase diff $=$ ~~$0, \pi, 2\pi, 3\pi, 4\pi, 5\pi, 6\pi \ldots$~~

$= 0, 2\pi, 4\pi, 6\pi, 8\pi, 10\pi \ldots$

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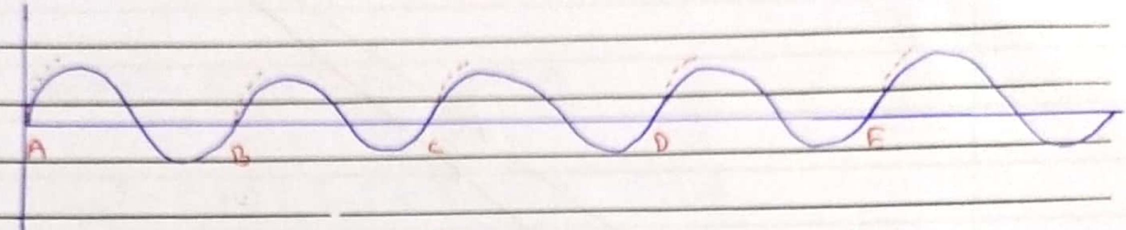


Path diff = 0 $\quad \lambda \quad 2\lambda \quad 3\lambda \quad 4\lambda$ ....

$= 0 \quad 2\times\lambda/2 \quad 4\times\lambda/2 \quad 6\times\lambda/2 \quad 8\times\lambda/2$ ....

phase diff = 0 $\quad \pi \quad 2\pi \quad 6\pi \quad 8\pi$ ....

Condition for a point to be dark

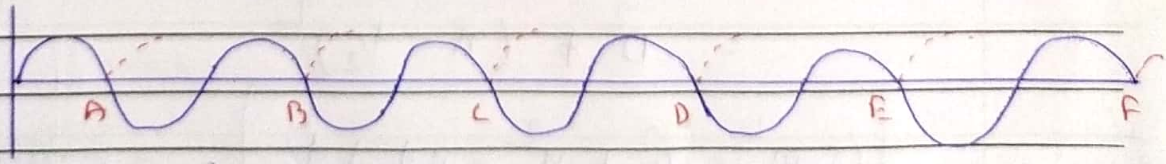
If path difference between two rays of light from two coherent sources, at a point is odd integral multiple of $\lambda/2$ then point will be dark.

$\therefore$ Path diff = $(2n-1)\dfrac{\lambda}{2}$

where n = 1, 2, 3, 4, 5, 6 ...

$\therefore$ Path diff = $\dfrac{\lambda}{2}, \dfrac{3\lambda}{2}, \dfrac{5\lambda}{2}, \dfrac{7\lambda}{2}, \dfrac{9\lambda}{2}, \dfrac{11\lambda}{2}$ ...

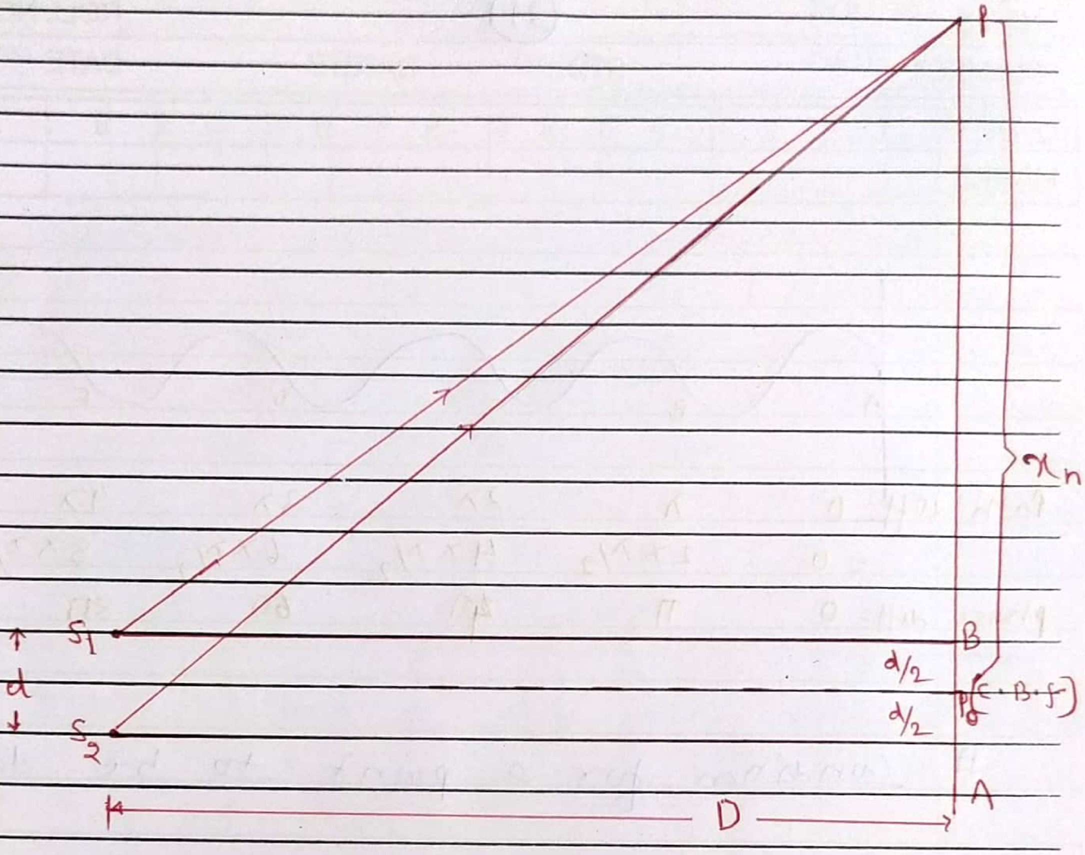
$\therefore$ Phase diff = $\pi, 3\pi, 5\pi, 7\pi, 9\pi, 11\pi$ ...



Path diff = $\lambda/2 \quad 3\lambda/2 \quad 5\lambda/2 \quad 7\lambda/2 \quad 9\lambda/2 \quad 11\lambda/2$

$\therefore$ phase diff = $\pi \quad 3\pi \quad 5\pi \quad 7\pi \quad 9\pi \quad 11\pi$

Expression for fringe width. OR show that fringe width is same for bright band as well as dark band.



In ΔS_2AP, $\angle A = 90^\circ$

$$\therefore (S_2P)^2 = (S_2A)^2 + (AP)^2$$

$$= D^2 + (x + d/2)^2$$

$$\boxed{(S_2P)^2 = D^2 + x^2 + xd + d^2/4} \quad \text{---- (I)}$$

In ΔS_1BP, $\angle B = 90^\circ$

$$\therefore (S_1P)^2 = (S_1B)^2 + (BP)^2$$

$$= D^2 + (x - d/2)^2$$

$$\boxed{(S_1P)^2 = D^2 + x^2 - xd + d^2/4} \quad \text{---- (II)}$$

Q. NO.:	1	2	3	4	5	6	7	8	TOTAL
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Subtract equation (i) from eqn (ii)

$\therefore (S_2P)^2 - (S_1P)^2 = 2xd$

$\therefore (S_2P - S_1P)(S_2P + S_1P) = 2xd$

$\therefore (S_2P - S_1P) = \dfrac{2xd}{S_2P + S_1P}$

Since d and x are very small compare to D.

$\therefore S_1P = S_2P = D$

$\therefore S_2P - S_1P = \dfrac{2xd}{2D}$

$\therefore \boxed{\text{Path diff} = \dfrac{xd}{D}}$ ---- (iii)

This formula is important for entrance exam

for point to be bright,

$\boxed{\text{Path diff} = n\lambda}$ ---- (iv)

from equations (iii) and (iv)

$\therefore \dfrac{xd}{D} = n\lambda$

$\therefore \boxed{x_n = \dfrac{n\lambda D}{d}}$

It is expression for n^{th} bright band from CBF.

$\therefore$ Distance of $(n+1)^{th}$ bright band from CBF is given by

$$\boxed{x_{n+1} = \frac{(n+1)\lambda D}{d}}$$

$\therefore$ fringe width $= x_{n+1} - x_n$

$$= \frac{(n+1)\lambda D}{d} - \frac{n\lambda D}{d}$$

$$\boxed{\text{fringe width} = \frac{\lambda D}{d}} \quad \ldots \text{(v)}$$

for point to be dark,

$$\boxed{\text{Path diff} = (2n-1)\lambda/2} \quad \ldots \text{(vi)}$$

from equations (iii) and (vi)

$$\frac{xd}{D} = (2n-1)\lambda/2$$

$$\therefore \boxed{x_n = \frac{(2n-1)\lambda D}{2d}}$$

It is distance of n^{th} dark band from CBF.

$\therefore$ Distance of $(n+1)^{th}$ dark band from CBF is given by

$$x_{n+1} = \frac{[2(n+1)-1]\lambda D}{2d} \quad \ldots$$

Most of the students make mistakes at this point

Q. NO.:	1	2	3	4	5	6	7	8	TOTAL
MARKS									

$$\therefore \boxed{x_{n+1} = \frac{(2n+1)\lambda D}{2d}}$$

$$\therefore \text{fringe width} = x_{n+1} - x_n$$

$$= \frac{(2n+1)\lambda D}{2d} - \frac{(2n-1)\lambda D}{2d}$$

$$= \frac{\lambda D}{2d}\left[1+1\right]$$

$$\therefore \boxed{\text{fringe width} = \frac{\lambda D}{d}} \quad \text{--- (vii)}$$

from eqns (v) and (vii) we can say fringe width is same for bright band as well as dark band.

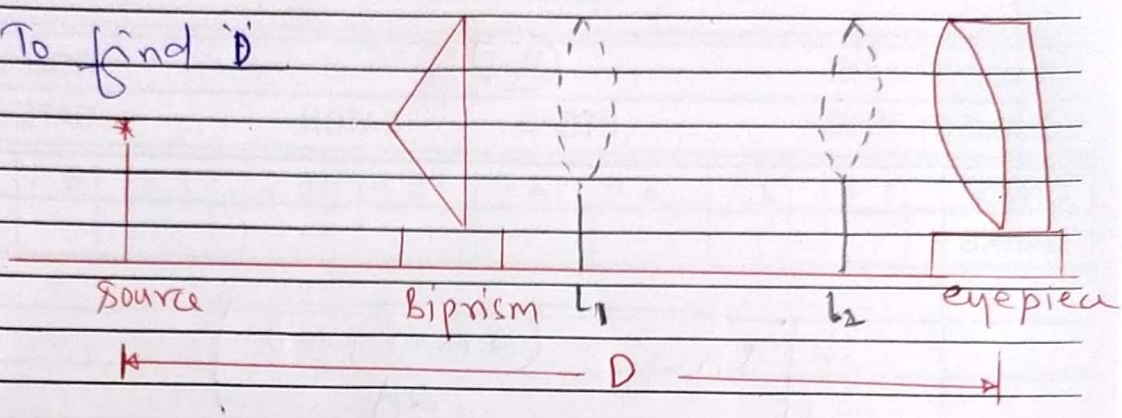
To find wavelength of light used by using fresnel's Biprism experiment.

Since fringe width in interference pattern is given by

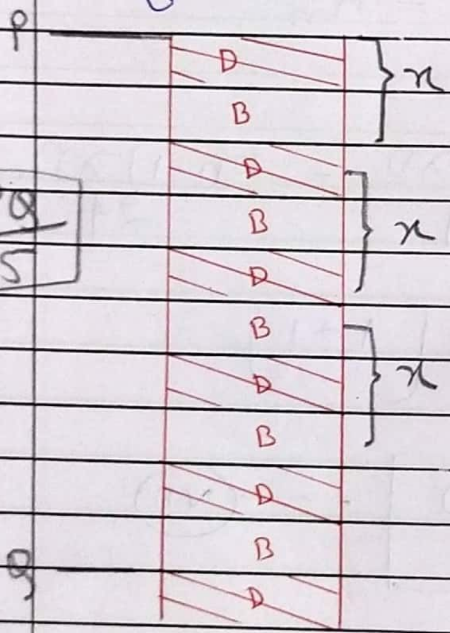
$$\boxed{x = \frac{\lambda D}{d}}$$

$$\therefore \boxed{\lambda = \frac{xd}{D}}$$

To find 'D'

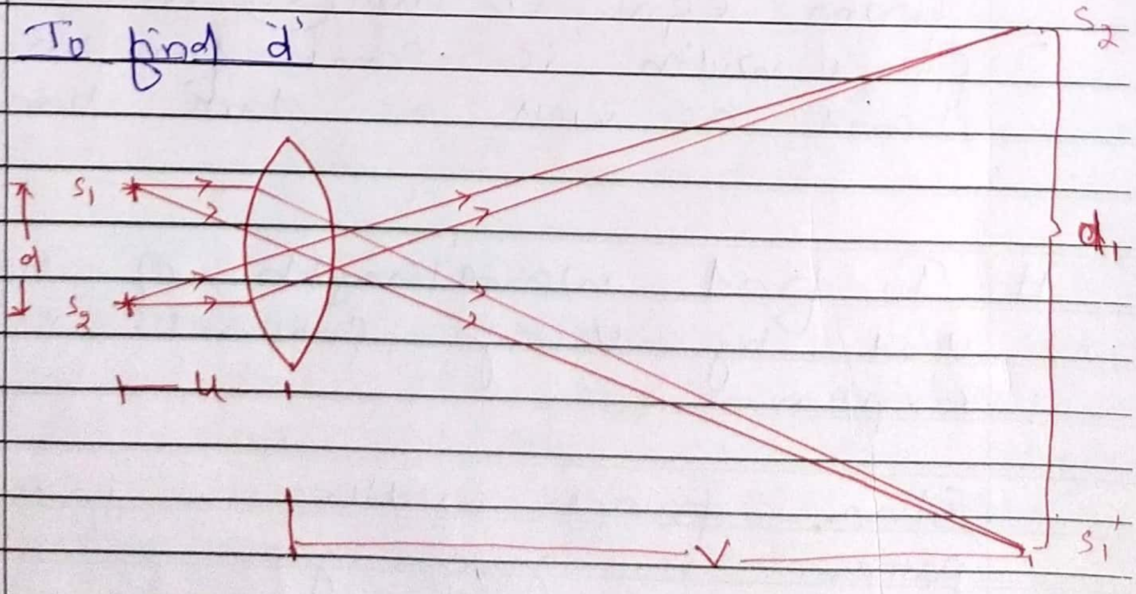


To find 'x'



$$\boxed{x = \frac{PQ}{5}}$$

To find 'd'



$$\boxed{\frac{d}{d_1} = \frac{u}{v}} \quad \text{--- (1)}$$

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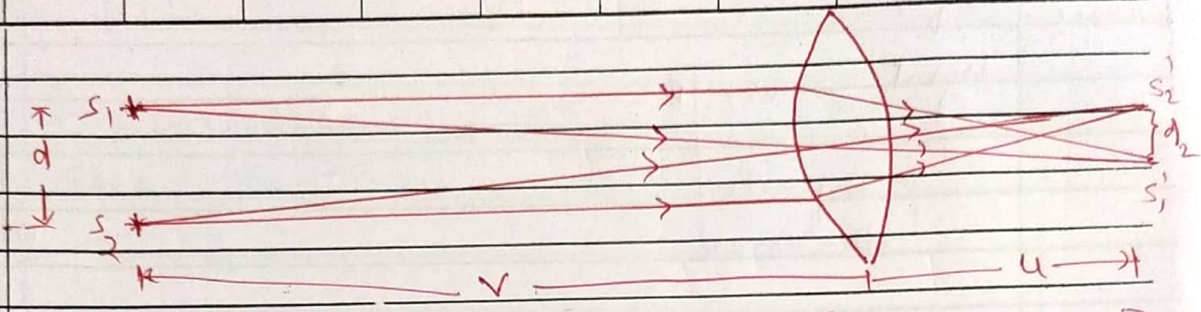

$$\boxed{\frac{d}{d_2} = \frac{v}{u}} \quad \text{---(II)}$$

{Due to conjugate foci}

from eqns (I) and (II)

$$\therefore \frac{d}{d_1} \times \frac{d}{d_2} = \frac{u}{v} \times \frac{v}{u}$$

$$\therefore \frac{d^2}{d_1 d_2} = 1$$

$$\therefore d^2 = d_1 d_2$$

$$\therefore \boxed{d = \sqrt{d_1 d_2}}$$

Diffraction :- The bendings of light near the edge of and obstracle or slit and spreading into the region of geometrical shadow is called diffraction of light.

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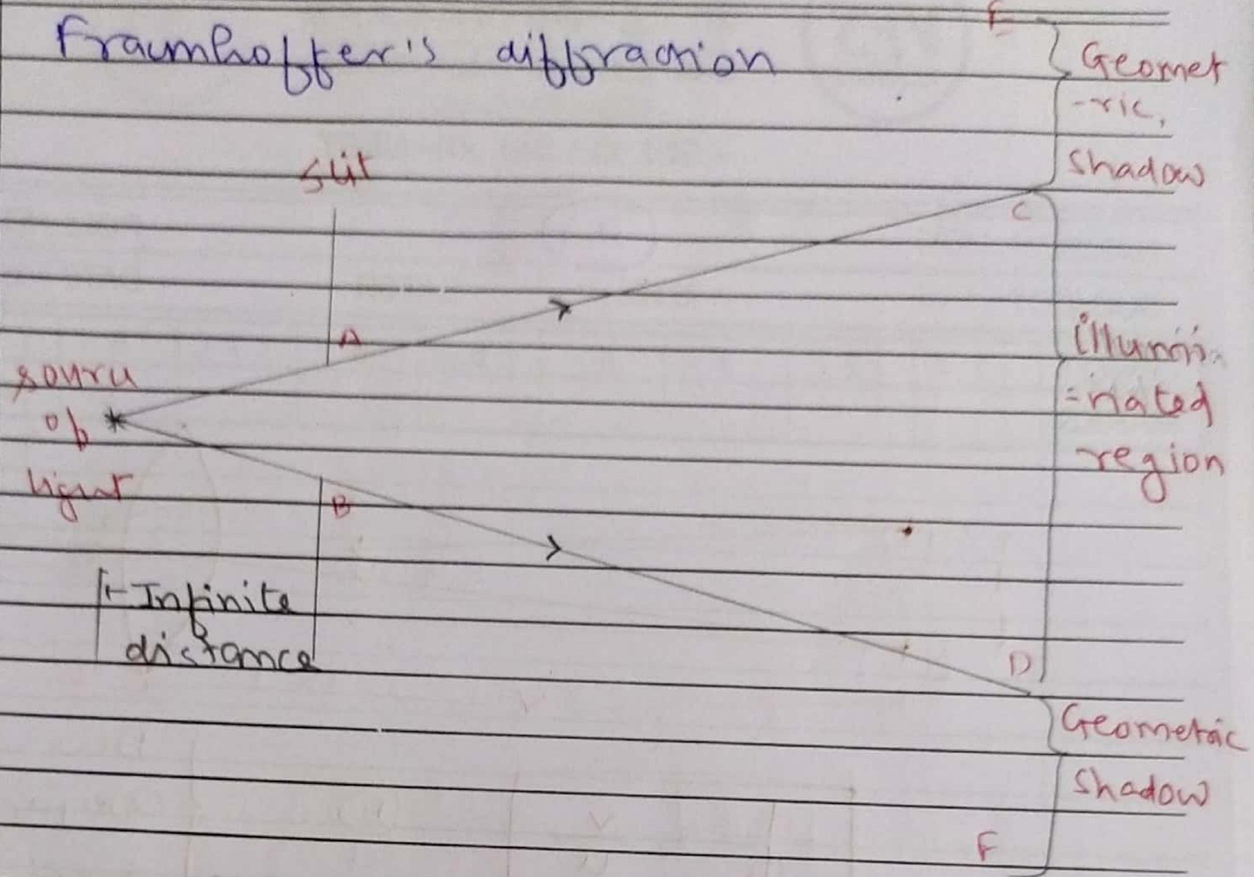
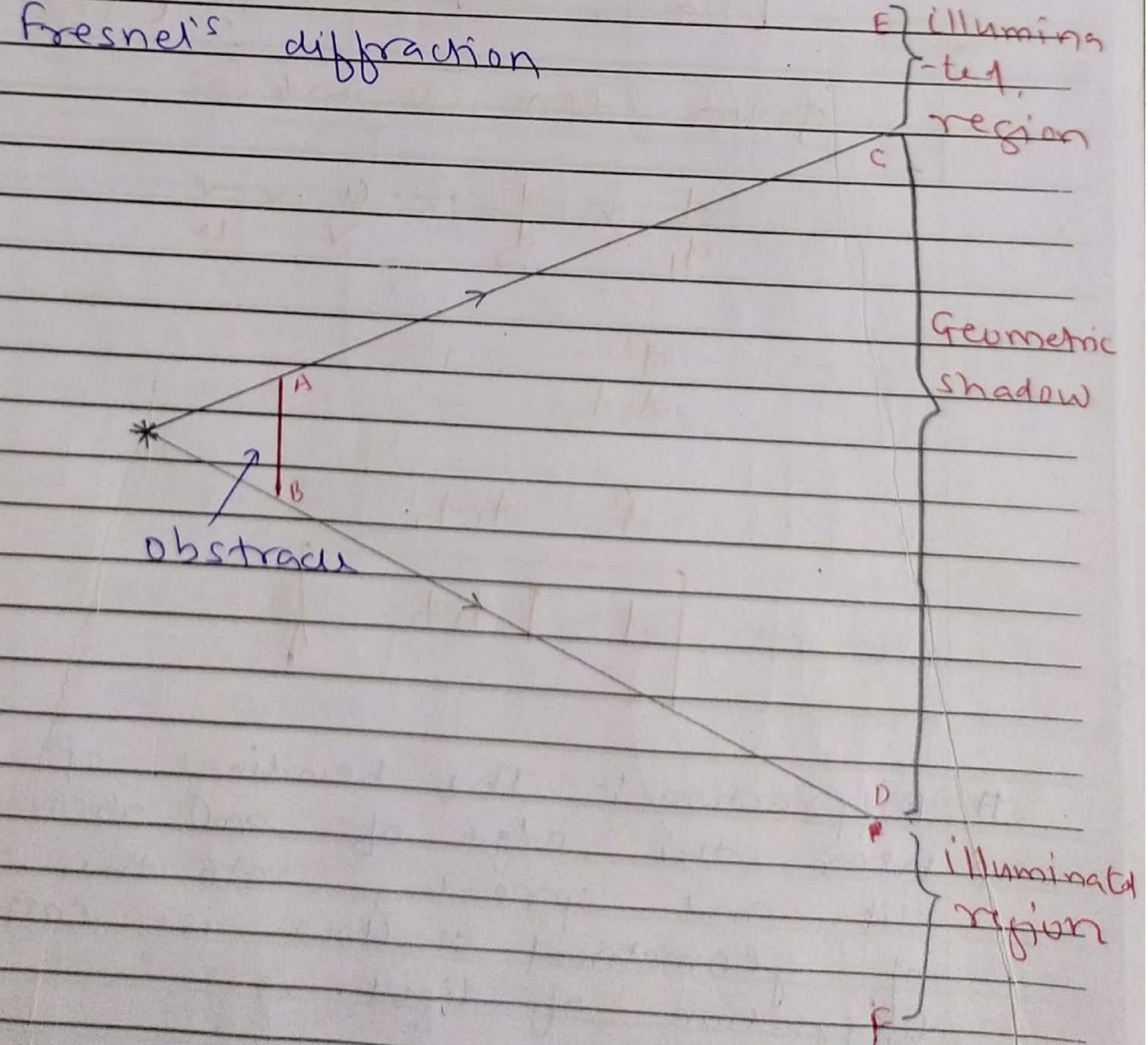
Fraunhoffer's diffraction



Fresnel's diffraction



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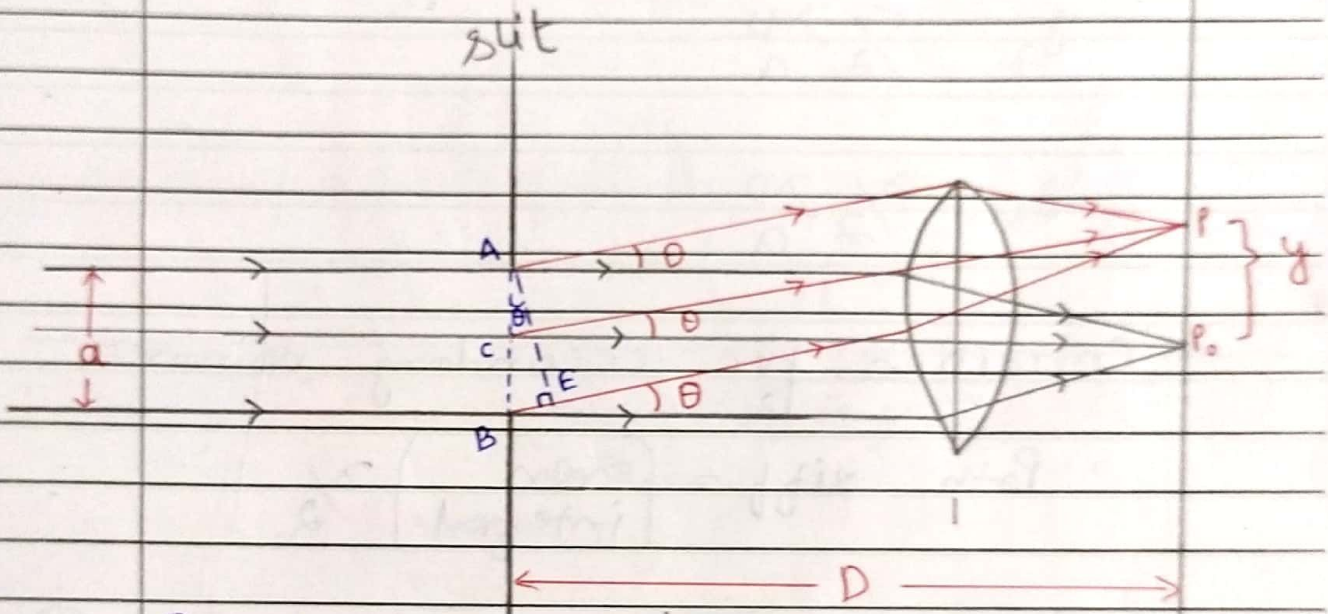
Fraunhoffer's diffraction pattern due to single slit.



In Δ AEB, $\angle E = 90^\circ$ $\angle BAE = \theta$.

$\because \sin\theta = \frac{BE}{AB}$

$\therefore BE = AB \sin\theta$

$\therefore BE = a\sin\theta$

Since θ is very small
$\therefore \sin\theta \approx \theta$

$\therefore$ Path diff $= a\cdot\theta$

Since, $\theta = y/D$

$\therefore$ $\boxed{\text{Path diff} = \frac{ay}{D}}$ — (I)

Condition for secondary maxima

$\therefore$ Path diff $=$ [~~even~~ odd integral] $\lambda/2$

$\therefore$ $\boxed{\text{Path diff} = (2n+1)\lambda/2}$ — (II)

where $n = 0, 1, 2, 3, 4, 5, \ldots$

from equations (i) and (ii)

$$\therefore \frac{ay}{D} = (2n+1)\frac{\lambda}{2}$$

$$\therefore \boxed{y = \frac{(2n+1)\lambda D}{2a}}$$

$$\therefore y_1 = \frac{3}{2}\frac{\lambda D}{a}$$

$$\therefore y_2 = \frac{5}{2}\frac{\lambda D}{a}$$

$$\therefore y_3 = \frac{7}{2}\frac{\lambda D}{a}$$

Condition for secondary minima

$$\therefore \text{Path diff} = \begin{bmatrix}\text{even}\\ \text{integral}\end{bmatrix}\frac{\lambda}{2}$$

$$\therefore \boxed{\text{Path diff} = 2n \times \frac{\lambda}{2} = n\lambda} \cdots \text{(iii)}$$

where $n = 1, 2, 3, 4, 5, \ldots$

from equations (i) and (iii)

$$\frac{ay}{D} = n\lambda$$

$$\therefore \boxed{y = \frac{n\lambda D}{a}}$$

$$\therefore y_1 = \frac{\lambda D}{a} \qquad y_3 = \frac{3\lambda D}{a} \ldots$$

$$y_2 = \frac{2\lambda D}{a}$$

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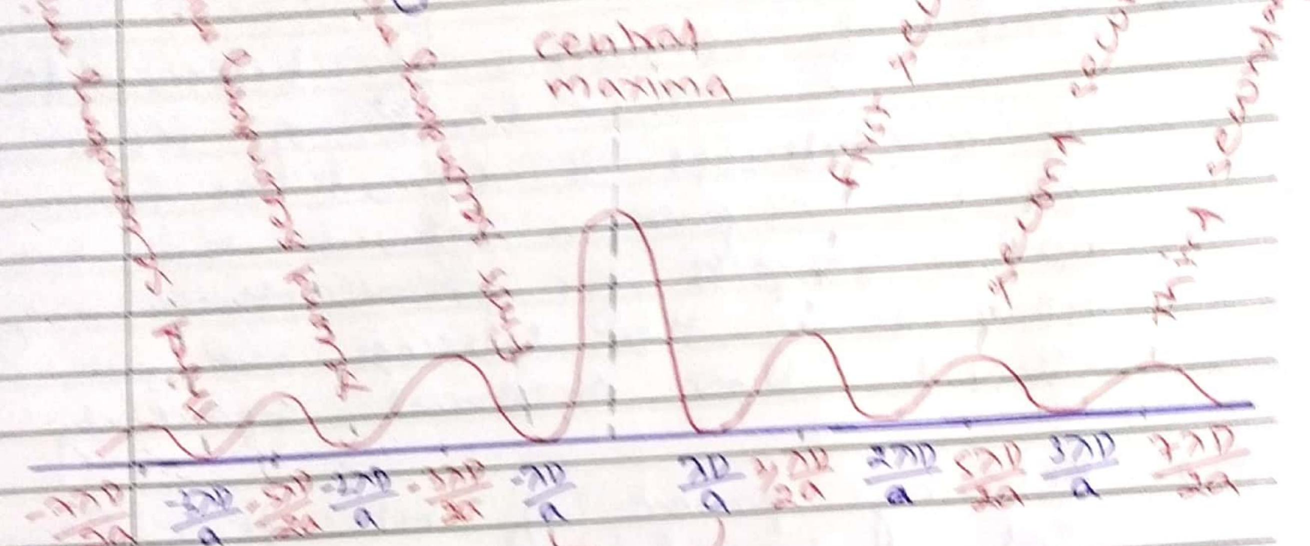
Intensity Variation

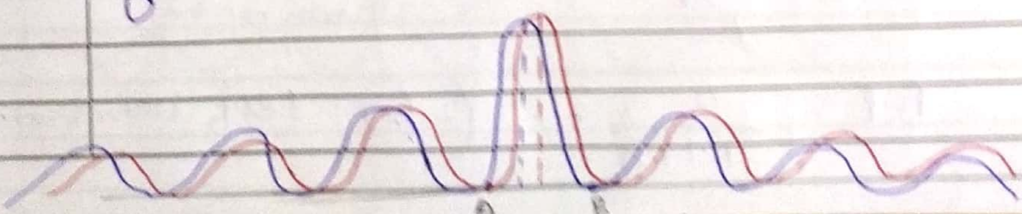


Width of central maxima $= \frac{\lambda D}{a} - \left(\frac{-\lambda D}{a}\right)$

$= \frac{2\lambda D}{a}$

Condition for not resolved :-

According to Rayleigh's criterion. The images of two point objects close to each other are regarded as not resolved if central maxima of one falls within first minima of the other.



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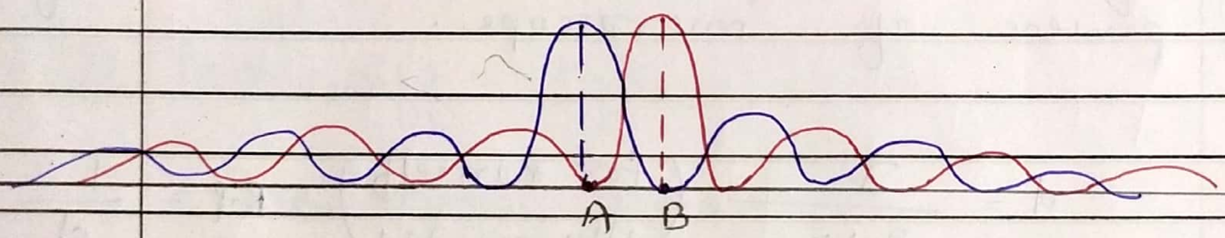
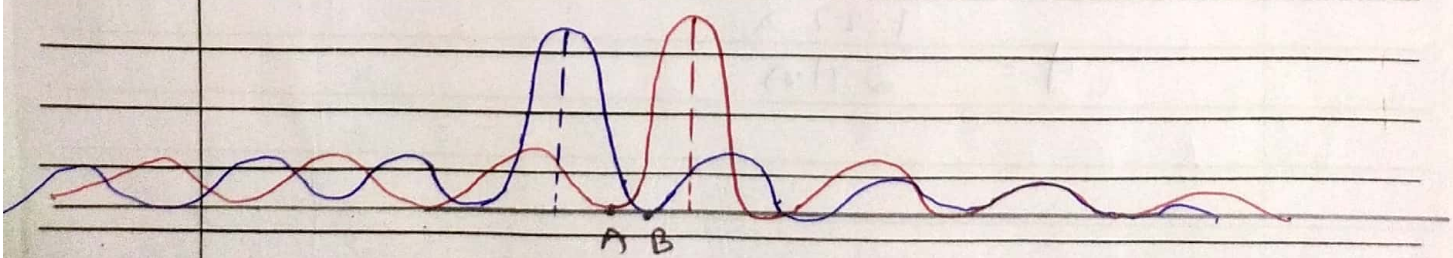
Condition for just resolved :-

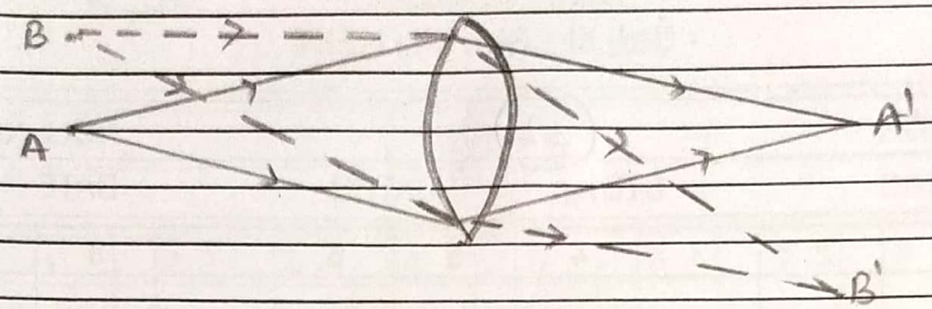
According to Rayleigh's criterion the images of two point objects close to each other are regarded as just resolved if central maxima of one falls on on first minima of the other.



Condition for well resolved :- According to Rayleigh's criterion, the images of the two points objects close to each other are regarded as well resolved if central maxima of one falls beyond first minima of the other.



Microscope



→ **Limit of resolution of microscope(d):–** The minimum distance by which two point objects are separated from each other so that their image as produced by the microscope are just seen separate is called the limit of resolution of microscope.

→ **Resolving power of microscope:–** Reciprocal of limit of resolution is called resolving power of microscope.

$$d = \frac{\lambda}{2\mu \sin\alpha} \quad \text{(for nonself illuminated)} \rightarrow R.P = \frac{1}{d}$$

$$R.P = \frac{2\mu \sin\alpha}{\lambda}$$

$$d = \frac{\lambda}{2N.A}$$

$$R.P = \frac{2N.A}{\lambda}$$

$\mu \sin\alpha = N.A$ (Numerical aperture)

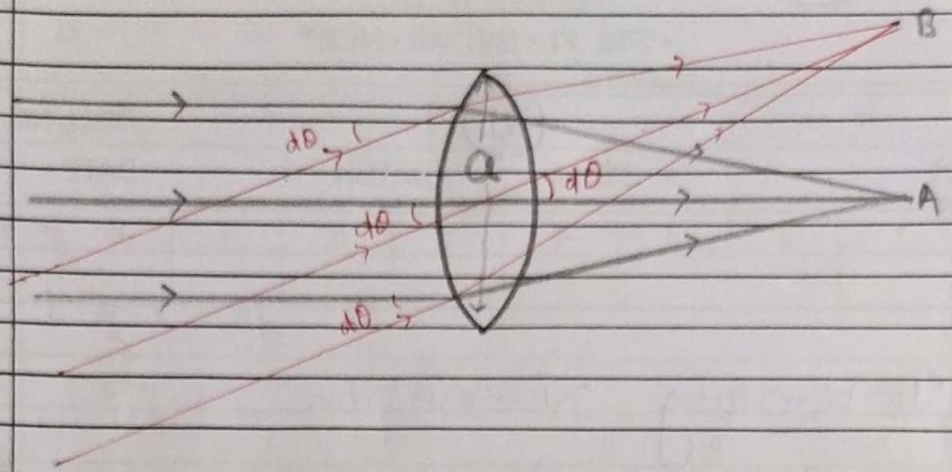
$$R.P = \frac{2\mu \sin\alpha}{1.22\lambda}$$

$$d = \frac{1.22\lambda}{2\mu \sin\alpha} \quad \text{(for self illuminated)}$$

$$R.P = \frac{2N.A}{1.22\lambda}$$

$$d = \frac{1.22\lambda}{2N.A}$$

Telescope



→ Limit of resolution of telescope($d\theta$) :- The limit of resolution of a telescope is defined as minimum angular separation between the two distant objects for which their images produced by the telescope are just resolved or observed separately.

→ Resolving power of telescope :- Reciprocal of limit of resolution of telescope is called resolving power of telescope.

$$d\theta = \frac{\lambda}{a}$$ ... (for nonself illuminated)

a - aperture of objective lens

$$d\theta = \frac{1.22\lambda}{a}$$ ... (for self illuminated)

$$R.P = \frac{1}{d\theta}$$

$$R.P = \frac{a}{\lambda}$$ ... (for non self illuminated)

$$R.P = \frac{a}{1.22\lambda}$$ ... (for self illuminated)

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List of formulae

1) Path diff $= m \times \lambda/2$

→ If m is even number then point is bright

→ If m is odd number then point is dark.

2) Path diff $= \frac{xd}{D}$

3) For bright band

$$x = \frac{n\lambda D}{d}$$

4) For dark band

$$x = \frac{(2n-1)\lambda D}{2d}$$

5) In General

$$x = \frac{\lambda D}{d}$$

6)
$$\frac{d}{d_1} = \frac{u}{v}$$

7)
$$d = \sqrt{d_1 d_2}$$

8) Diffraction

Path diff = $a\sin\theta = \frac{ay}{D}$

Path diff = $(2n+1)\frac{\lambda}{2}$ for secondary maxima

$y = \frac{(2n+1)\lambda D}{2a}$

$y_1 = \frac{3}{2}\frac{\lambda D}{a}$, $y_2 = \frac{5}{2}\frac{\lambda D}{a}$, $y_3 = \frac{7}{2}\frac{\lambda D}{a}$

Path diff = $2n \times \frac{\lambda}{2} = n\lambda$ --- for secondary minima

$y = \frac{n\lambda D}{a}$

$y_1 = \frac{\lambda D}{a}$, $y_2 = \frac{2\lambda D}{a}$, $y_3 = \frac{3\lambda D}{a}$

9) Microscope | Telescope

$d = \frac{\lambda}{2\mu\sin\alpha}$ [for nonself illuminated] $d\theta = \frac{\lambda}{a}$

$d = \frac{1.22\lambda}{2\mu\sin\alpha}$ [for self illuminated] $d\theta = \frac{1.22\lambda}{a}$

$R.P = \frac{2\mu\sin\alpha}{\lambda}$ [for non self illumi.] $R.P = \frac{a}{\lambda}$

$R.P = \frac{2\mu\sin\alpha}{1.22\lambda}$ [for self illuminated] $R.P = \frac{a}{1.22\lambda}$

10) ${}_1\mu_2 = \frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{n_1\lambda_1}{n_2\lambda_2} = \frac{\lambda_1}{\lambda_2} = \frac{{}_a\mu_2}{{}_a\mu_1}$

11) $v = n\lambda$

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12) When medium changes velocity and wavelength changes but frequency remains the same.

13) Malus law, $I' = I \cos^2\theta$

14) $\tan i_p = \mu = \frac{1}{\sin i_c}$

15) $n' = n\left[1 \pm \frac{v}{c}\right]$

16) $A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\theta}$

$A^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\theta$

$I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2}\cos\theta$

$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$

$= (A_1 + A_2)^2$

$\boxed{I_{min} = \sqrt{I_1} - \sqrt{I_2}}$

$= (A_1 - A_2)^2$

$\therefore \frac{I_{max}}{I_{min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2$

17) $\frac{I_1}{I_2} = \left(\frac{A_1}{A_2}\right)^2$

Numericals.

(13) **Data**

$[\lambda_V]_a = 400$ nm

$[\lambda_R]_a = 700$ nm

$_a\mu_g = 1.55$

to find

$[\lambda_V]_g = ?$

$[\lambda_R]_g = ?$

formula

$$_a\mu_g = \frac{\lambda_a}{\lambda_g}$$

Calculation

$$\because \ _a\mu_g = \frac{[\lambda_V]_a}{[\lambda_V]_g}$$

$$\therefore [\lambda_V]_g = \frac{[\lambda_V]_a}{1.55} = \frac{400}{1.55} = 258.06 \text{ nm}$$

$$\because \ _a\mu_g = \frac{[\lambda_R]_a}{[\lambda_R]_g}$$

$$\therefore [\lambda_R]_g = \frac{[\lambda_R]_a}{_a\mu_g} = \frac{700}{1.55} = 451.61 \text{ nm}$$

14) **Data**

$(\text{app dist})_1 = 3$ cm

$\mu_1 = 1.6$

$\mu_2 = 1.25$

to find

$(\text{app. distance})_2 = ?$

formula

$$\mu = \frac{\text{Real dist}}{\text{app. dist}}$$

Calculation

$(\text{app. dist})_1 \times \mu_1 = \text{Real dist}$

$\therefore (\text{app. dist})_2 \times \mu_2 = \text{Real dist}$

$\therefore (\text{app. dist})_1 \mu_1 = (\text{app. dist})_2 \mu_2$

$$\therefore (\text{app. dist})_2 = \frac{(\text{app. dist})_1 \times \mu_1}{\mu_2} = \frac{3 \times 1.6}{1.25} = 3.84 \text{ cm.}$$

15) **Data**

Real width $= 0.20^\circ$

$\mu = 1.33$

to find

App. width $= ?$

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formula

$M = \frac{\text{Real width}}{\text{app. width}}$

Calculation

$1.33 = \frac{\text{Real width}}{\text{app. width}}$

$\therefore \text{app. width} = \frac{\text{Real width}}{1.33}$

$= \frac{0.20}{1.33}$

$= 0.15^\circ$

16) Data

$a = 100\lambda$

$D = 50$ cm

$= \cancel{0.5 m}$

To find.

Distance between central maxima and adjacent maxima?

formula

Distance between central and first maxima $= \frac{3\lambda D}{2a}$

calculation

$\therefore$ Distance between central and first maxima

$= \frac{3\lambda D}{2a}$

$= \frac{3 \times \lambda \times \cancel{0.5}\ 50}{2 \times 100\lambda}$

$= \frac{3 \times \cancel{0.5}}{\cancel{200}} = \frac{150}{200}$

$= 0.75^\circ$

$= \left(\frac{0.75 \times \pi}{180}\right)^c$

$= 0.01^c$

(ii) Distance between these maxima

$= r\theta$

$= D \times 0.01$

$= 50 \times 0.01$

$= 0.5$ cm

$\boxed{s = r\theta}$

17) As both polaroids are perpendicular to each other. The intensity becomes half. At the same time another polaroid makes an angle of 50° with vertical

$\therefore$ Intensity $= \frac{I_0}{2}(\cos 40)^2$

$= \frac{I_0}{2} \times (0.7660)^2$

$= \frac{I_0}{2} \times 0.5867$

$= I_0 \times 0.2933$

Calculation

$\therefore \lambda = \frac{x d}{D}$

$= \frac{2\times10^{-4} \times 2\times10^{-3}}{1.2}$

$= 5\times10^{-7}$ m

$= 5000 \times 10^{-10}$ m

$\boxed{\lambda = 5000 \text{Å}}$

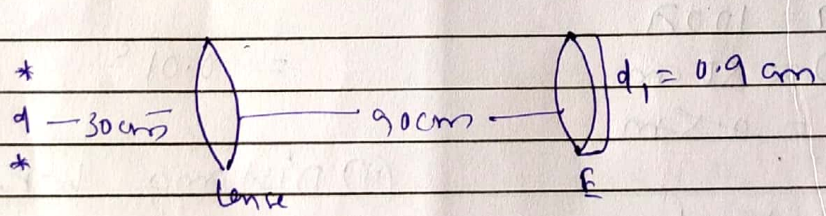
18) Data

$D = 1.2$ m

$x = \frac{0.4}{20}$ cm

$= 0.02$ cm

$= 2\times10^{-4}$ m



$\frac{d}{d_1} = \frac{30}{90} = 1/3$

$\therefore d = d_1/3 = \frac{0.9}{3} = 0.3$ cm

$= 3\times10^{-3}$ m

to find

$\lambda = ?$

formula

$x = \frac{\lambda D}{d}$

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19) Data

$D = 2m$

$a = 0.2 mm$

$= 2 \times 10^{-4} m$

width of central maxima (W_{CM})

$= 5 \times 2 = 10 mm$

$= 10 \times 10^{-3} m$

$= 10^{-2} m$

to find

$\lambda = ?$

formula

$$W_{CM} = \frac{2\lambda D}{a}$$

Calculation

$$10^{-2} = \frac{2 \times \lambda \times 2}{2 \times 10^{-4}}$$

$$\therefore \lambda = \frac{2 \times 10^{-6}}{4}$$

$= 0.5 \times 10^{-6} m$

$= 5000 \times 10^{-10} m$

$= 5000 A^{\circ}$

20) Data

$I_1 = 2I$

$I_2 = I$

to find

$$\frac{I_{max}}{I_{min}} = ?$$

formula

$$\frac{I_{max}}{I_{min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2$$

Calculation

$$\therefore \frac{I_1}{I_2} = \left(\frac{A_1}{A_2}\right)^2$$

$$\therefore \frac{2I}{I} = \left(\frac{A_1}{A_2}\right)^2$$

$$\therefore \frac{\sqrt{2}}{1} = \frac{A_1}{A_2}$$

$$\therefore \frac{A_1 + A_2}{A_1 - A_2} = \frac{\sqrt{2}+1}{\sqrt{2}-1}$$

$$\therefore \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2 = \left(\frac{2.414}{0.414}\right)^2$$

$$\therefore \boxed{\frac{I_{max}}{I_{min}} = 34}$$

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21) Data

$\lambda = 546\ nm$
$= 546 \times 10^{-9}\ m$

$a = 0.4\ mm$
$= 4 \times 10^{-4}\ m$

$D = 40\ cm$
$= 0.4\ m$

to find

$WCM = ?$

formula

$$WCM = \frac{2\lambda D}{a}$$

Calculation

$$W.C.M = \frac{2 \times 546 \times 10^{-9} \times 0.4}{0.4 \times 10^{-3}}$$

$= 1092 \times 10^{-6}\ m$

$= 1.092 \times 10^{-3}\ m$

$\approx 1.1\ mm$

22) Data

$\theta = 45°$

to find

$\frac{a}{\lambda} = ?$

formula

path diff $= a\sin\theta = n\lambda$

Calculation

$a\sin\theta = n\lambda$

for first minima
$n = 1$

$\therefore a\sin\theta = \lambda$

$$\therefore \frac{a}{\lambda} = \frac{1}{\sin\theta} = \frac{1}{\sin 45}$$

$$\therefore \frac{a}{\lambda} = \frac{1}{\left(\frac{1}{\sqrt{2}}\right)} = \sqrt{2} = 1.144$$

23) Data

$D = 2.5\ m$

$WCM = 6\ mm = 6 \times 10^{-3}\ m$

$\lambda_1 = 500\ nm = 500 \times 10^{-9}\ m$

$\lambda_2 = 50\ \mu m = 50 \times 10^{-6}\ m$

$\lambda_3 = 0.5\ nm = 5 \times 10^{-10}\ m$

to find

$a_1 = ?\quad a_2 = ?\quad a_3 = ?$

formula

$$WCM = \frac{2\lambda D}{a}$$

Calculation

$$\therefore a_1 = \frac{2\lambda_1 D}{WCM}$$

$$= \frac{2 \times 5 \times 10^{-7} \times 2.5}{6 \times 10^{-3}}$$

$= 4.16 \times 10^{-4}\ m$

$= 0.416 \times 10^{-3}\ m$

$\boxed{a_1 = 0.416\ mm}$

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* $\boxed{1 \text{ metre} = 39.37 \text{ inch}}$

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(ii) $a_2 = \frac{2\lambda_2 D}{WCM}$

$= \frac{2 \times 5 \times 10^{-5} \times 2.5}{6 \times 10^{-3}}$

$= 4.16 \times 10^{-2}$ m

$= 41.6 \times 10^{-3}$ m

$\boxed{a_2 = 41.6 \text{ mm}}$

(iii) $a_3 = \frac{2\lambda_3 D}{WCM}$

$= \frac{2 \times 5 \times 10^{-10} \times 2.5}{6 \times 10^{-3}}$

$= 4.16 \times 10^{-7}$ m

$\boxed{a_3 = 4.16 \times 10^{-4} \text{ mm}}$

24) Data

$\lambda = 5000 A°$

$= 5 \times 10^{-7}$ m

$a = 200$ inch

$= 5.08$ m

to find

$d\theta = ?$

formula

$d\theta = \frac{1.22\lambda}{a}$ (self illuminated)

Calculation

$d\theta = \frac{1.22\lambda}{a}$

$= \frac{1.22 \times 5 \times 10^{-7}}{5}$

$= 1.2 \times 10^{-7}$ rad

25) Data

$x_1 = 0.32$ mm

$\lambda_1 = 6000 A°$

$\lambda_2 = 4800 A°$

to find

$x_2 = ?$ $\Delta x = ?$

formula

$x = \frac{\lambda D}{d}$

Calculation

$\frac{x_1}{x_2} = \frac{\lambda_1}{\lambda_2}$

$\therefore \frac{0.32}{x_2} = \frac{6000}{4800}$

$\therefore x_2 = \frac{0.32 \times 4800}{6000}$

$\boxed{\cancel{x_2 = 0.064 \text{ mm}}}$

$\therefore \boxed{x_2 = 0.256\ mm}$

$\therefore \Delta x = x_1 - x_2$

$= 0.32 - 0.256$

$= 0.064\ mm$