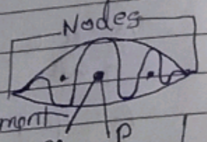
15/04/25

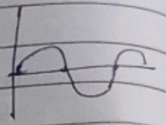
Heisenberg's Uncertainty Principle

(In term of Position and momentum)

Statement :- It is impossible to determine exact position and momentum of a particle simultaneously.

Let a moving particle is surrounded by two ways and their displacement eqn are given by





$y_1 = A\cos(\omega_1 t - K_1 x)$ — (1)

$y_2 = A\cos(\omega_2 t - K_2 x)$ — (2)

Equation of resultant wave

$\vec{y} = \vec{y}_1 + \vec{y}_2$

$y = A\left[\cos(\omega_1 t - K_1 x) + \cos(\omega_2 t - K_2 x)\right]$

$\cos A + \cos B = 2\cos\frac{(A+B)}{2} \cdot \cos\frac{A-B}{2}$

$y = 2A\cos\left(\frac{(\omega_1 + \omega_2)t}{2} - \frac{(K_1+K_2)x}{2}\right) \cdot \cos\left(\frac{(\omega_1 - \omega_2)t}{2} - \frac{(K_1 - K_2)x}{2}\right)$

let $\frac{\omega_1 + \omega_2}{2} = \omega$, $\frac{K_1 + K_2}{2} = K$

$\omega_1 - \omega_2 = \Delta\omega$, $K_1 - K_2 = \Delta K$

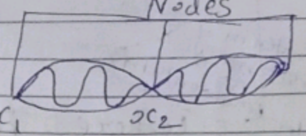
$y = 2A\cos(\omega t - Kx) \cdot \cos\left(\frac{\Delta\omega t}{2} - \frac{\Delta K x}{2}\right)$

By rearranging Eqn

$y = 2A\underbrace{\cos\left(\frac{\Delta\omega t}{2} - \frac{\Delta K x}{2}\right)}_{\text{Amplitude}} \cdot \underbrace{\cos(\omega t - Kx)}_{\text{phase}}$

for nodes

$\frac{\Delta\omega t}{2} - \frac{\Delta K x}{2} = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \frac{(2n+1)\pi}{2}$



for first node

$\frac{\Delta\omega t}{2} - \frac{\Delta K x_1}{2} = \frac{\pi}{2}$ — (4)

second node

$\frac{\Delta\omega t}{2} - \frac{\Delta K x_2}{2} = \frac{3\pi}{2}$ — (5)

By Sub. Eq (4) from (5)

$\frac{\Delta K}{2}(x_1 - x_2) = \pi$

$\Delta K \Delta x = 2\pi$

$\Delta\left(\frac{2\pi}{\lambda}\right)\Delta x = 2\pi$

$\Delta\left(\frac{P}{h}\right)\Delta x = 1$

De Broglie Hyp. $\lambda = \frac{h}{P}$

$\boxed{\Delta P \Delta x = h}$ — (6)

$\boxed{\Delta P \Delta x \geq \frac{\hbar}{2}}$

$\Delta P \Delta x \to h, \frac{h}{2\pi}, \frac{h}{4\pi}$

$\hbar$ = constant

$\hbar = \frac{h}{2\pi}$

$\hbar$ reduced planck's constant

After performing different experiment It is found that product of $\Delta p \Delta x$ is ~~greater~~ greater or equal to $\frac{h}{4\pi}$ hence final statement is

In term of position & momentum

$$\boxed{\Delta p \Delta x \geq \frac{\hbar}{2}}$$

16/04/25 where $\hbar = \frac{h}{2\pi}$

In terms of energy and time Heisenberg's principle is given by

$$\boxed{\Delta E \Delta t \geq \frac{\hbar}{2}}$$

WAVE FUNCTION :-

→ It is a quantity whose variation produces matter wave.

→ It consists of real & imaginary part and represented by ~~greek letter sign~~ ~~grip later psi~~. Greek letter (ψ) psi (ψ)

$$\psi = A + iB$$

→ $|\psi|^2$ represents the probability of finding a particle

→ Probability of finding a particle in a one dimensional box of length (L) is given by $\int_0^L |\psi|^2 dx$

wave eqn for free particle is given

WAVE EQUATION IN TERMS OF ENERGY AND MOMENTUM

$$\psi = A e^{-\frac{i}{\hbar}[Et - px]} \quad \text{--- (1)}$$

Energy and momentum operator

P.d. w.r.t. time eqn (1)

Energy operator

$$\frac{d\psi}{dt} = A \cdot e^{-\frac{i}{\hbar}[Et - px]} \cdot \left[-\frac{i}{\hbar} E\right]$$

$$\frac{d\psi}{dt} = -\frac{i}{\hbar} E \cdot A e^{-\frac{i}{\hbar}[Et - px]}$$

$$\frac{\partial\psi}{dt} = -\frac{i}{\hbar} E\psi$$

$$\frac{\partial\psi}{dt} = -\frac{i}{\hbar} E\psi \times \frac{i}{i}$$

$$\frac{d\psi}{dt} = \frac{E\psi}{i\hbar} \qquad i^2 = -1$$

$$E\psi = i\hbar \frac{d\psi}{dt}$$ — Energy Equation

$$\boxed{E = i\hbar \frac{d}{dt}}$$ → Energy operator

$\lambda = \frac{h}{mv}$ 16/04/25 9.1×10^{-31} kg

$v = \frac{h}{p}$ $p = mv$ $v = \frac{p}{m}$

P.d w.r.t (x) Position

momentum operator

$$\frac{d\psi}{dx} = A.e^{\frac{-i}{\hbar}[Et-Px]} \left[-\frac{i}{\hbar}(-p)\right]$$

$$\frac{d\psi}{dx} = A.e^{\frac{-i}{\hbar}[Et-Px]} \left[\frac{i}{\hbar}p\right]$$

$$\frac{d\psi}{dx} = \frac{i}{\hbar}P.\psi$$

$$\boxed{P\psi = \frac{\hbar}{i}\frac{d\psi}{dx}}$$ → momentum Equation

$$P = \frac{\hbar}{i}\frac{d}{dx}$$ → momentum operator

Heisenberg's uncertainty Principle

Q.1:- A microscope is used to find the location of an electron in distance ~~3mm~~ of $3\mathring{A}$. find the velocity of electron using Heisenberg's principle.

Sol^n

$\Delta x \Delta P \geq \frac{\hbar}{2}$ $\hbar = \frac{h}{2\pi}$

$\Delta x \Delta P = \frac{h}{4\pi}$

$\Delta x = 3\mathring{A} = 3\times10^{-10}$ m ; $m = 9.1\times10^{-31}$ kg

$h = 6.62\times10^{-34}$ J.s

$$(3\times10^{-10})\,\Delta P = \frac{6.62\times10^{-34}}{4\times3.14}$$

$\frac{d}{+}$ $\frac{1}{\pm}$ $\frac{n}{sec^2}$ 16/04/25 / 17/04/25

$$\Delta P = \frac{6.62\times10^{-34}}{4\times3.14\times3\times10^{-10}}$$ 9.1×10^{-31} kg $= 9.1\times10^{-34}$ m

$\Delta P = 5.1967\times10^{-24}$ $\Delta P = 0.17569\times10^{-24}$

$\Delta(mv) = .17569\times10^{-24}$

$P = mv$ $m(\Delta v) = .17569\times10^{-24}$

$v = \frac{P}{m}$ $\Delta v = \frac{.17569\times10^{-24}}{9.1\times10^{-31}}$

$v = \frac{5.1967\times10^{-24}}{9.1\times10^{-34}}$ $\Delta v = \frac{.17569\times10^{7}}{9.1}$

~~$v = 0.5710\times10^{10}$~~ Δv m/sec

$\Delta V = 1.929\times10^{5}$ m/sec

Schrodinger's Equation

→ Time dependent Equation

Let a moving particle of mass (m) is surrounded by group of wave, where wave eq^n in terms of energy & momentum

$\psi = A.e^{\frac{-i}{\hbar}[Et-Px]}$ —(1)

Energy eq^n

$E\psi = i\hbar\frac{d\psi}{dt}$ —(2)

momentum eq^n

$P\psi = \frac{\hbar}{i}\frac{d\psi}{dx}$ —(3)

wave eq^n

$\psi = A.e^{\frac{-i}{\hbar}[Et-Px]}$

Energy eq^n

$E\psi = i\hbar\frac{d\psi}{dt}$

Momentum eq^n

$P\psi = \frac{\hbar}{i}\frac{d\psi}{dx}$

$P = \frac{mv}{\varphi}$

Total energy of particle

E = Kinetic Energy + Potential Energy

$$E = \frac{1}{2}mv^2 + V$$

$$E = \frac{1}{2}mv^2 \times \frac{m}{m} + V$$

$$E = \frac{p^2}{2m} + V \quad \left\{ \because p = mv \right\}$$

By applying funcn ψ in Eqn

$$E\psi = \frac{p^2}{2m}\psi + V\psi \quad \text{--- (4)}$$

By placing values in Eqn (4)

$$i\hbar \frac{d\psi}{dt} = \frac{1}{2m}\left[\frac{\hbar^2}{i^2}\frac{d^2}{dx^2}\psi\right] + V\psi$$

→ Schrodinger's time dependent Eqn.

~~Schrodinger time Independent Eqn~~

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Schrodinger's time independent Eqn

from Eqn (1) $\psi = A e^{-\frac{i}{\hbar}[Et - Px]}$

$\cancel{\psi = A e^{-\frac{i}{\hbar}E}}$

$\psi = A e^{-\frac{i}{\hbar}Et} \cdot e^{\frac{i}{\hbar}Px}$

$\psi = A \cdot e^{\frac{i}{\hbar}Px} \cdot e^{-\frac{i}{\hbar}Et}$

$\psi = \psi_0 \cdot e^{-\frac{i}{\hbar}Et}$ — (5)

Partial diff. w.r.to t

$\frac{d\psi}{dt} = \psi_0 \cdot e^{-\frac{i}{\hbar}Et}\left[-\frac{i}{\hbar}E\right]$

$\frac{d\psi}{dt} = -\frac{i}{\hbar}E\,\psi_0\, e^{-\frac{i}{\hbar}Et}$ — (6)

By diff. Eqn (5) w.r.to x

$\frac{d\psi}{dx} = \frac{d\psi_0}{dx}\, e^{-\frac{i}{\hbar}[Et]}$

double diff. w.r.to x

$\frac{d^2\psi}{dx^2} = \frac{d^2\psi_0}{dx^2} \cdot e^{-\frac{i}{\hbar}[Et]}$ — (7)

By Placing values from (5), (6), (7) in (4)

$i\hbar\left[-\frac{i}{\hbar}E\psi_0 e^{-\frac{i}{\hbar}Et}\right] = -\frac{\hbar^2}{2M}\frac{d^2\psi_0}{dx^2} \cdot e^{-\frac{i}{\hbar}[Et]} + V\psi_0 e^{-\frac{i}{\hbar}Et}$

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By dividing the Eqn by $e^{-\frac{i}{\hbar}Et}$

$E\psi_0 = -\frac{\hbar^2}{2M}\frac{d^2\psi_0}{dx^2} + V\psi_0$

$\frac{\hbar^2}{2m}\cdot\frac{d^2\psi_0}{dx^2} = (V-E)\psi_0$

$\frac{d^2\psi_0}{dx^2} = \frac{2m}{\hbar^2}(V-E)\psi_0$

$\frac{d^2\psi_0}{dx^2} + \frac{2m}{\hbar^2}[E-V]\psi_0 = 0$

Schrodinger's time independent Eqn.

$\int_0^L |\psi|^2 = 1$ Probability

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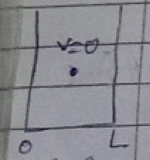
Application of Schrodinger's Eqn

Q1 Deduce the energy eigenvalues and wave funcn of a particle moving in one dimensional Box.

Let a particle of mass (m) is moving inside a one dimentional Box of length (L). Inside the box potential energy is zero.



$0<x<L$

$\int_0^L |\psi|^2 = 1$

Schrodinger's time independent Eqn

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}(E-V)\psi = 0 \text{ ; but } V=0$$

$$\frac{d^2\psi}{dx^2} + \frac{2mE}{\hbar^2}\psi = 0$$

Let $K^2 = \frac{2mE}{\hbar^2}$ ☆

$$\frac{d^2\psi}{dx^2} + K^2\psi = 0 \quad -(1)$$

Standard Soln of Eqn

$$\psi = A\sin Kx + B\cos Kx \quad -(2)$$

By applying boundary condition

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$\lambda = \frac{h}{mv}$, $\lambda = \frac{h}{\sqrt{2mE}}$, $K = \frac{2\pi}{\lambda}$, $K = \frac{2\pi\sqrt{2mE}}{h}$

at $x=0$, $\psi=0$

$0 = A\sin 0 + B\cos 0$

$0 = B$

$B = 0 \quad -(3)$

At $x = L$, $\psi = 0$

$0 = A\sin KL + 0$

$A\sin KL = 0 \Rightarrow \sin KL = 0 \Rightarrow \sin KL = \sin n\pi$

$KL = n\pi \Rightarrow K = \frac{n\pi}{L} \quad -(4)$

By Placing value

let $K^2 = \frac{2mE}{\hbar^2}$

$$\frac{n^2\pi^2}{L^2} = \frac{2mE}{\hbar^2}$$

$$E_n = \frac{n^2\pi^2\hbar^2}{2mL^2}$$ Energy Eigen value

from Eqn (2)

$\psi = A\sin Kx + B\cos Kx$

By Placing values of B and K from eqn 3 & 4

$$\psi = A\sin\frac{n\pi x}{L} \quad -(5)$$

Probability of particle inside the box

$\sin^2 x = \frac{1-\cos 2x}{2}$

$$\int_0^L |\psi|^2 dx = 1$$

$$\int_0^L A^2 \sin^2 \frac{n\pi x}{L}\, dx = 1$$

$$\frac{A^2}{2}\int_0^L \left[1 - \cos\frac{2n\pi x}{L}\right] dx = 1$$

$$\frac{A^2}{2}\left[x - \frac{\sin\frac{2n\pi x}{L}}{\frac{2n\pi}{L}}\right]_0^L = 1$$

$$\frac{A^2}{2}\left[L - 0\right] = 1$$

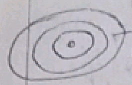
$$\frac{A^2}{2} L = 1$$

$$A^2 = \frac{2}{L}$$

$$A = \sqrt{\frac{2}{L}} \quad \text{— (6)}$$

By Placing value in Eqn (5) we get

$$\psi = \sqrt{\frac{2}{L}} \sin\frac{n\pi x}{L} \quad \text{— wave funcn}$$



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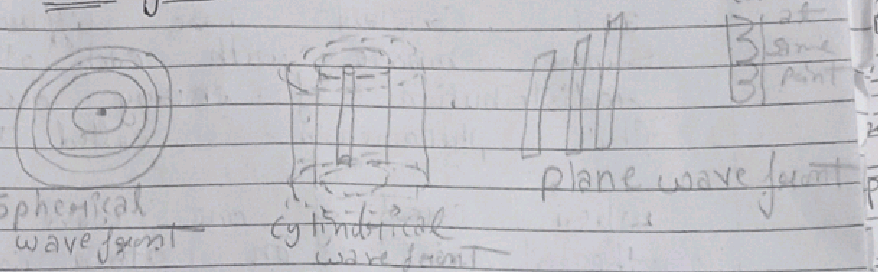
Unit- wave optics :-

It is a branch of Physics where we assum that light is having wave nature

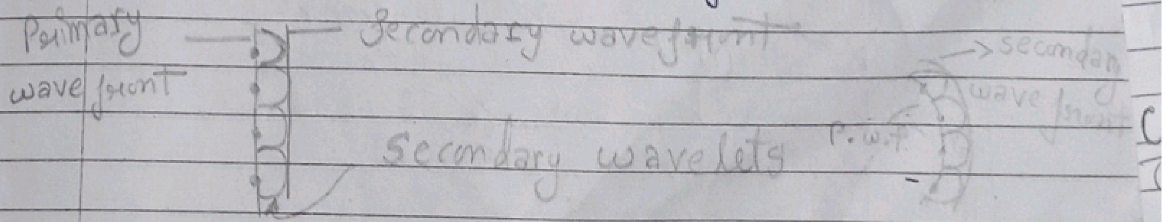
wave front :-



A wave front is a surface that connects all the points where the wave is at the same Phase

Huygen's Principle for Propagation of wave

According to this principle every point on a propagating wave front acts as a new source of producing Secondary Spherical wavelets and If we draw a tangent on it then this will be a new wave front



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- same direcⁿ
→ same frequency
→ consto phase diffe

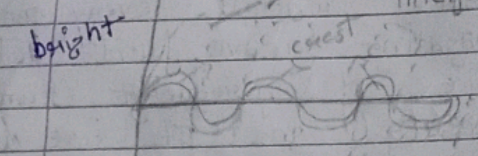
Interference :-

→ when two or more than two light waves are moving in the same direction and having same frequency and constant phase difference ~~super~~ with each other then super impose redistribution of energy occurs this phenomenon is called Interference

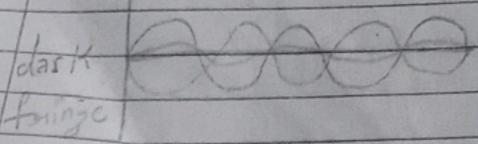
when crest of one wave lies over the crest on other wave then constructive interference occurs

when crest of one wave lies over the trough of other wave then distructive interference occurs

① constructive interference → same direcⁿ
→ same frequency
→ const. phase diffe



② Distructive Interference



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Parth diff. $\boxed{\Delta = n\lambda}$

$\Delta = 0$
$\Delta = \lambda$
$\Delta = 2\lambda$
$\Delta n\lambda$

$\lambda + \frac{\lambda}{2}$

$\frac{3\lambda}{2}$

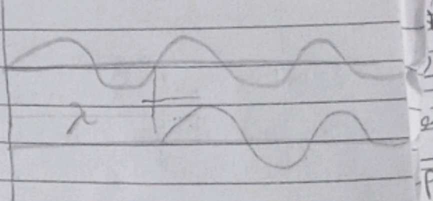
Condition for Constructive and distructive interference

bright fringe

Condition for constructive interference

Path diff. $\boxed{\Delta = n\lambda}$

$\Delta = 0$
$\Delta = \lambda$
$\Delta = 2\lambda$



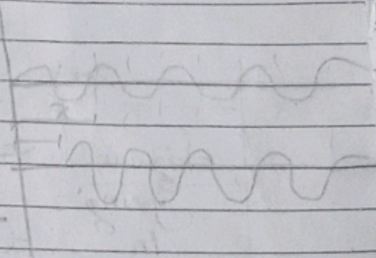
Condition for distructive interference

dark fringe

$\Delta = (2n+1)\lambda/2$

$\Delta = \lambda/2$

$\Delta = 3\lambda/2$



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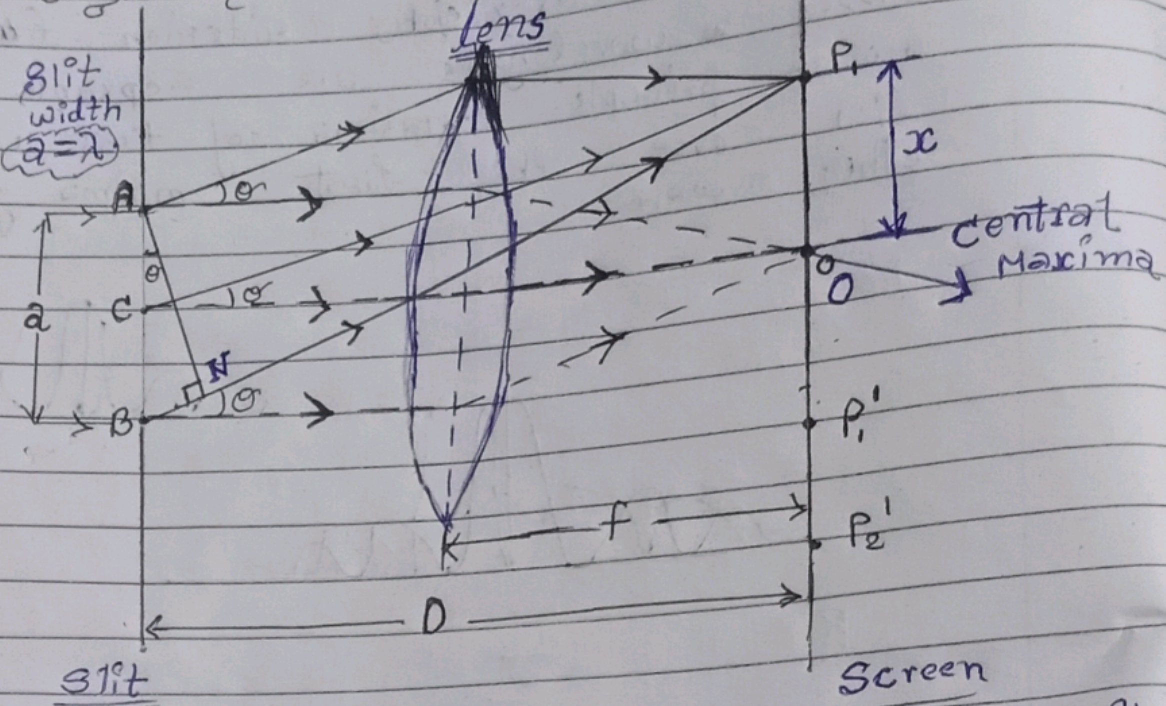
Q.1 Explain the Fraunhofer diffraction due to a single slit with necessary analysis.



→ We will investigate the resultant intensity at points O and P_1 on the screen

→ At point O, we get bright central image, because secondary wavelets from points is equidistant from C.

→ Above and below 'O' there is alternate maxima & minima

→ Intensity of alternate maxima decreases and alternate minima goes to zero

Here, AB is wave front,

→ BN is Path difference of waves ~~Reading~~ Reaching P_1

→ In ΔBNA, BN = Path difference = Δ

$$\sin\theta_n = \frac{BN}{AB} = \frac{\Delta}{a} \quad \left\{\because \sin\theta = \frac{P}{H}\right\}$$

$$\therefore \boxed{BN = \Delta = a\sin\theta_n} \text{ — (i)}$$

→ Now

AB is divided into two parts

If $AB = \lambda$, $AC = CB = \lambda/2$

(1) for Minimum Intensity at P_1 [secondary Minima]

Path diff. = Even multiple of $\lambda/2$

$$\therefore BN = a\sin\theta_n = \frac{2n\lambda}{2}$$

$$\therefore \sin\theta_n = \frac{2n\lambda}{2a} \quad \{n = \pm 1, 2, 3, ---\}$$

$$\therefore \theta_n = \frac{2n\lambda}{2a} \quad \left\{\begin{array}{l}\text{If } \theta \text{ is small} \\ \text{then } \sin\theta \approx \theta\end{array}\right\}$$

$$\theta_1 = \pm\frac{\lambda}{a}, \quad \theta_2 = \pm\frac{2\lambda}{a}, \quad ---- \text{ etc}$$

(2) for Maxima Intensity of P_1 [secondary Maxima]

Path diff = BN = odd multiple of $\lambda/2$ [Diffraction]

$$\therefore BN = a\sin\theta_n = \frac{(2n+1)\lambda}{2}$$

$$\therefore \sin\theta_n = (2n+1)\lambda/2a \quad \{n = \pm 1, 2, 3, --\}$$

$$\therefore \theta_n = (2n+1)\lambda/2a \quad \left\{\begin{array}{l}\text{If } \theta \text{ is small} \\ \sin\theta \approx \theta\end{array}\right\}$$

⇒ **As, Obliquity (Deviation) Increases, Intensity Decreases.**

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S – Source of light L – Screen $\Delta = (2n+1)\lambda/2$ $\Delta = 2\lambda$ $\Delta = 3\lambda/2$

Young's double slit Experiment

Q1. Explain Young's double slit Experiment and give conditions for constructive and distructive interference & calculate fringe width

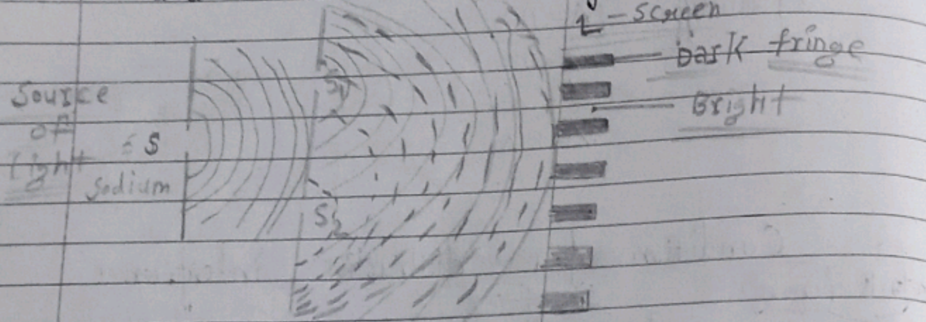

fig. Young's double slit Experiment

Figure shows experimental arrangement of young's double slit Experiment. In this figure A monochromatic source of light is placed near the (S).

S_1 & S_2 are two slits equidistant from slit S.

L is a screen.

Slit (S) is illuminated by monochromatic light source due to that a wavefront is incident on two slits S_1 & S_2 and divided into two parts

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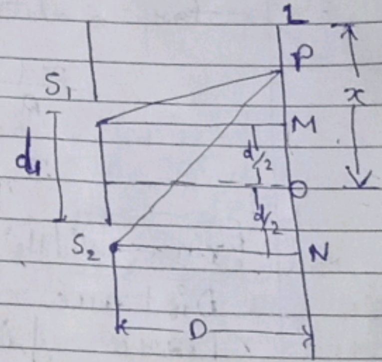
distance b/w two slits by micrometer

PBP HHB SGT

and divided into parts

Waves coming out from S_1 & S_2 are having same frequency, constant phase difference & same direction. So we will get interference pattern on the screen.

Conditions for constructive and distructive interference.



IN ΔS_1MP

$(S_1P)^2 = (S_1M)^2 + (PM)^2$

$(S_1P)^2 = D^2 + (x - d/2)^2$ — (1)

IN ΔS_2NP

$(S_2P)^2 = (S_2N)^2 + (PN)^2$

$(S_2P)^2 = D^2 + (x + d/2)^2$ — (2)

By sub eqn (1) from (2)

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

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

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

$S_1P \approx S_2P \approx D$

$\Delta = S_2P - S_1P = \frac{2xd}{2D}$

$$\Delta = \frac{xd}{D}$$

02/05/25 — Distance b/w 2 continuous bright / Dark fringe

$\Delta = \frac{xd}{D}$ = Path difference

for Constructive interference

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

$x_n = \frac{Dn\lambda}{d}$ — (3)

for destructive interference

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

$x_n = \frac{(2n+1)D\lambda}{2d}$ — (4)

Fringe Width

Distance between two 1 continuous bright or Dark fringe is known as fringe width

from Eq (3)

$x_n = \frac{Dn\lambda}{d}$

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

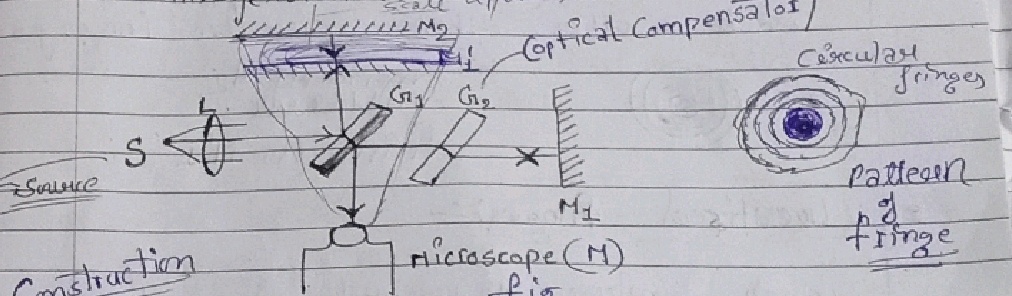
By Sub. Eq^n

$x_{n+1} - x_n = \frac{D\lambda}{d}$ → fringe width $= \beta$

02/05/25

MST-II Michelson's Interferometer

Q1 Explain formation of fringes by michelson's interferometer & explain followings
(1) Types of fringes form (2) Application of interferometer



fig

Construction

figure shows experimental demonstration of michelson's interferometer. In this figure (S) is a monochromatic source of light (L) is a convex lens G_1 & G_2 are two glass plates inclined at an angle 45°. G_1 is a semisilver glass plate and G_2 is called optical compensator. M_1 & M_2 are two mirrors where M_1 is fixed mirror and M_2 is movable M is a microscope

Working

Light wave incident on glass plate G_1 is partially reflected toward mirror M_2 & partially transmitted towards mirror M_1. After reflection from mirror M_1 & M_2 this light waves reunite and give interference pattern at the microscope. This light waves having same frequency, constant phase difference and same direction.

path diff. produce in शून्य

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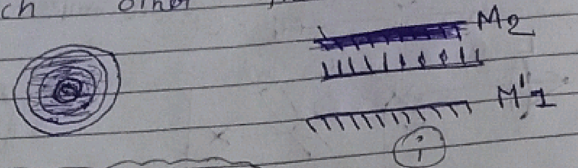
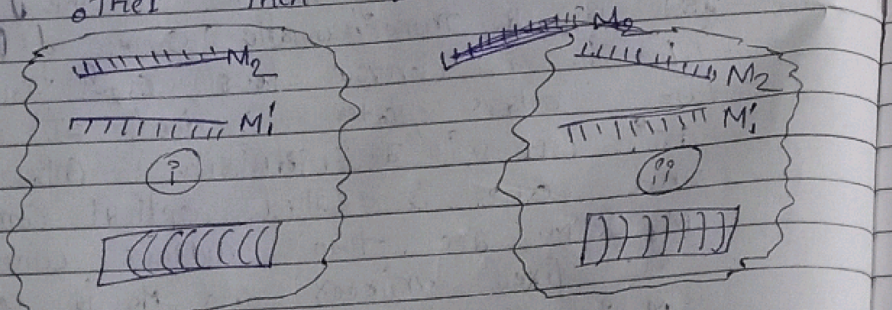
Types of fringe's formed by interferometer:

(1) Circular fringes:- when mirror and image m_2 of mirror (m_1) "m_1'" is parallel to each other then circular fringes formed



(2) Localized fringes:-

when mirror (M_2) and image of mirror (M_1) "M_1'" is not parallel to each other then localised fringes are formed



(3) Coloured fringes:- when white light is used in place of monochromatic light and two mirrors are exactly perpendicular to each other when Cocentric circle coloured fringes are formed.

$\frac{0}{\lambda}, \frac{\lambda}{\lambda}, \frac{2\lambda}{\lambda}$ path diffe.

05/05/25

$\frac{2d}{2\lambda}$ $\frac{2}{\lambda}$

Application of interferometer:-

(1) To find out wavelength of monochromatic light

(a) Let we move mirror M_2 upto distance "d" due to that path difference

$\Delta = 2d$ —(1)

If due to this movement n bright fringes crosses the field of view then effective path difference is

$\Delta = n\lambda$ —(2)

from eqn (i) & (ii) $\Delta = 2d$ —(1), $\Delta = n\lambda$ —(2)

$n\lambda = 2d$

$\lambda = \frac{2d}{n}$

(2) To find thickness of a transparent sheet

white coloured dispersion 06/05/25 1 Air, 1.3 H_2O, 1.5 glass

5890Å mono

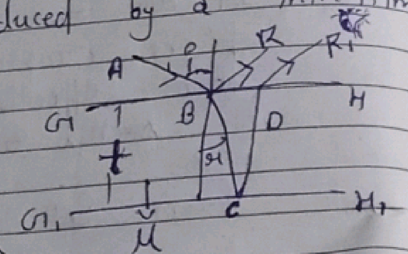
oil

Interference through thin film.

let GH and G_1H_1 are upper and lower layers of Eye film

t is the thickness and μ is refractive index of the film

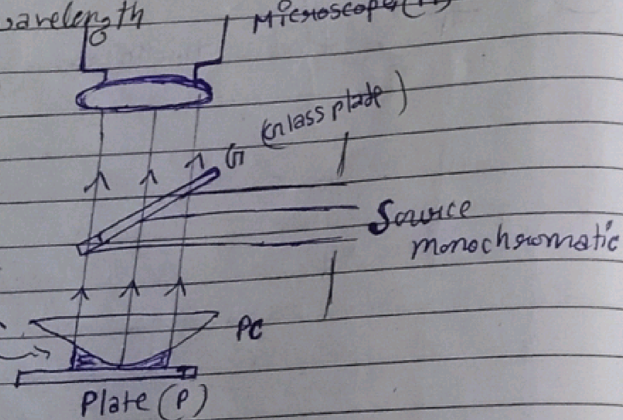
Path difference produced by a thin film is given by



$$\boxed{\Delta = 2\mu t \cos r \pm \lambda/2}$$

Newton's Ring

Q # Explain arrangement of Newton's Rings Experiment and derived the Expression for wavelength



$r \cdot r \ (2R-t)t$

$r^2 \approx 2rt$

fig.: Arrangement of ~~Newton's Rings~~

Center-dark fringe 07/05/25

$(2n+1)\lambda/2$ $r^2 \approx 2Rt$

Construction:

figure shows arrangment of Newton's Ring Experiment in this figure S is a monochromatic Source of light. P & PC are Glass plate and planoconvex lens respectively. G is a Glass plate inclined at an angle 45°. M is a microscope.

Working:

→ from Source (S) light is incident on the inclined glass plate (G). This glass plate reflect light waves in the direction of plane glass plate & planoconvex lens. from this combination light waves are reflected towards the microscope. This waves are having same frequency, Constant phase difference & same direction. So we will get interference pattern at the microscope.

We Know that path difference produced by a thin film is given by

$$\boxed{\Delta = 2\mu t \cos r + \lambda/2}$$

for air film $\mu = 1$, $r = 0$

$$\boxed{\Delta = 2t + \lambda/2} \quad \text{--- (i)}$$

let (r) radius of a fringe at the thickness of t & R be the radius of curvature $r^2 \approx 2Rt$

07/05/25

$r^2 \approx 2Rt$

$\frac{r^2}{R} = 2t$

from Eq^n (1)

$$\boxed{\Delta = \frac{r^2}{R} + \frac{\lambda}{2}} \quad -(2)$$

⇒ for Constructive interference

$(\Delta = n\lambda)$

from Eq^n (2)

$\frac{r^2}{R} + \frac{\lambda}{2} = n\lambda$

$\frac{r^2}{R} = n\lambda - \frac{\lambda}{2}$

$\frac{r^2}{R} = (2n-1)\lambda/2$

$r^2 = (2n-1)R\lambda/2$

for n^{th} diameter of bright fringe

$\frac{D^2}{4} = (2n-1)R\lambda/2$

$$\boxed{D_n^2 = (2n-1)R2\lambda} \quad (3)$$

⇒ for Distructive interference

$\Delta = (2n+1)\lambda/2$

from Eq^n (2)

$\frac{r^2}{R} + \lambda/2 = (2n+1)\lambda/2$

$\frac{r^2}{R} + \cancel{\lambda/2} = n\lambda + \cancel{\lambda/2}$

$\frac{r^2}{R} = n\lambda$

$r^2 = Rn\lambda$

$\frac{D^2}{4} = Rn\lambda$

for n^{th} diam of Dark fringe

$$\boxed{D_n^2 = 4nR\lambda} \quad (4)$$

~~$20 \times 5890 \times 10^{-10}$~~

08/05/25 NPTEL

Application of Newton's ring Experiment:-

→ Two find out wavelength of monochromatic light

we know that diameter of n^{th} dark ring (D_n) is given by

$D_n^2 = 4nR\lambda \quad -(1)$

for $(n+p)^{th}$ dark

$D_{n+p}^2 = 4(n+p)R\lambda \quad -(2)$

By Subs. Eq^n (1) from (2)

So we get $D_{n+p}^2 - D_n^2 = 4pR\lambda$

$$\lambda = \frac{D_{n+p}^2 - D_n^2}{4pR}$$

(Dec) 23

7marks In newton's rings mtd, the Dimeter of n^{th} & $(n+14)^{th}$ rings are 0.42 CM & 0.70cm respectively. If the radius of curvature of planoconvex lens is 100cm when calculate the wavelength of ~~light~~ light.

$n = ?$

$p = 14$

$R = 100cm$

$D_n = 0.42cm$

$D_{n+14} = 0.70cm$

$\lambda = \frac{0.49 - 0.1764}{4(14)(100)}$

$\lambda = \frac{0.3136}{5600}$

$\lambda = 0.000056$

$\lambda = 56 \times 10^{-6} cm$

$\lambda = 5600 \times 10^{-8}$ Cm

$\lambda = 5600$ Å

~~0.000056~~

$\lambda = 5600$ Å Ans

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PYQ

Ques:- Explain different mtd's for obtaining interference pattern.

Answer:-

There are two methods for obtaining interference pattern

Mtd ① **Division of wavefront**

→ In this method interference pattern is obtained by division of wavefront for example, Interference pattern obtained in young's double slit Experiment

Mtd ② **Division of amplitude**

→ In this method interference pattern is obtained by division of amplitude for Example, Interference pattern obtained in newtons ring Experiment.