$\Delta x = S_1P - S_2P$

for Maxima at P, $\Delta x = n\lambda$, $n = 0, 1, 2, 3$

Sol^n

1st $d\cos\theta = 2\lambda$

$\cos\theta = \frac{2\cancel{\lambda}}{3\cancel{\lambda}} = \frac{2}{3}$ $\cos^{-1}\left(\frac{2}{3}\right)$

2nd $3\lambda\cos\theta = \lambda$

$\cos\theta = \frac{1}{3}$ $\cos^{-1}\left(\frac{1}{3}\right)$

3rd $3\lambda\cos\theta = 0$

$\cos\theta = 0$ 90°

4th $3\lambda\cos\theta = 3\lambda$

$\cos\theta = 1$ 0°

for minima.

$d\cos\theta = (2n-1)\frac{\lambda}{2}$

$\cos\theta = (2n-1)\frac{d}{6}$ $(n = 1, 2, 3)$

YDSE → Young's Double Slit Experiment

* Interference is Based on Energy Conservation
* Redistribution of Energy takes place.
→ * For sustainable interference pattern we need 2, Coherent sources
→ Coherent sources are those for which phase diff remain Const. with time. or it may be Zero also.

→ In sustainable interference pattern intensity at a point remains Const. with time.
→ If we take 2 diff. Independent sources then phase diff. changes with time & hence intensity.

for 2 diff. sources.

$y_1 = A_1 \sin(kx - \omega_1 t + \phi_1)$

$y_2 = A_2 \sin(kx - \omega_2 t + \phi_2)$

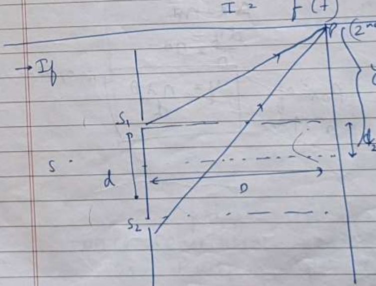
phase diff. $= (\omega_1 - \omega_2)t + (\phi_2 - \phi_1)$

$\phi = f(t)$

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

$I = f(t)$

→ If



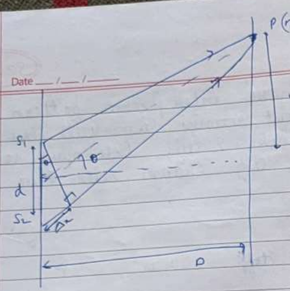
For 2nd Max

$\Delta x = 2\lambda$

$S_2P - S_1P = 2\lambda$

$\sqrt{D^2 + \left(y + \frac{d}{2}\right)^2} - \sqrt{D^2 + \left(y - \frac{d}{2}\right)^2} = 2\lambda$

$y = ?$



~~For pt P~~
let D >> d
For pt P
here ~~Δx = d~~
$\Delta x = d\sin\theta$

~~If there n^{th} Max P~~
If there n^{th} Max 'P'
then $d\sin\theta = n\lambda$

$\tan\theta = \frac{y}{D} \Rightarrow y = D\tan\theta$
put θ in ①

if θ is small ($y << D$), $\lambda << d$

then for pt P

$\Delta x = d\sin\theta = d\tan\theta = \frac{dy}{D}$

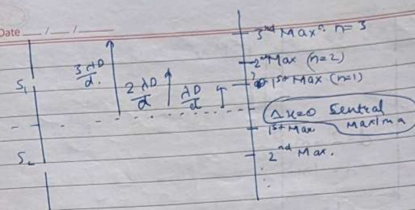
$\Delta x = \frac{dy}{D}$

if There is n^{th} Max at 'P'

$\Delta x = n\lambda$

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

Pos^n of n^{th} Max $\boxed{y = \frac{n\lambda D}{d}}$ $n = 0, 1, 2, 3 \ldots$

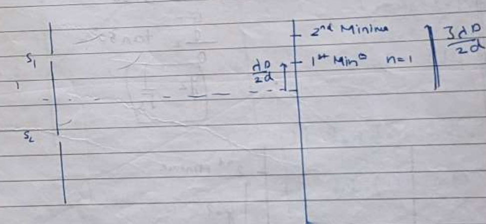


if there is n^{th} Minima at P.

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

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

pos^n of n^{th} Minima $\boxed{y = (2n-1)\frac{\lambda D}{2d}}$



fringe width : Distance b/w 2 consecutive Max^n or Min^n is known as Fringe width (β)

$\beta = \frac{\lambda D}{d} \neq f(n)$

Saathi

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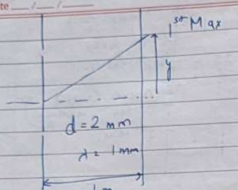
Q.



sol^n $\cancel{1^{st}\ Max = y = \frac{\lambda D}{d} = \frac{1}{2} m}$

$\lambda <<< d$ × $\quad$ λ & d are comparable

at P $\quad \Delta x = d \sin\theta$

$\lambda = 2 \sin\theta$

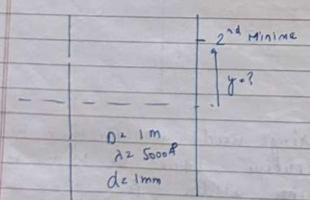
$\frac{1}{2} = \sin\theta$

$\theta = 30^\circ$

$\frac{y}{D} = \tan 30^\circ$

$\boxed{y = \frac{1}{\sqrt{3}}}$

Q.



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sol^n $\lambda = 5000\ Å = \boxed{5\times10^{-7}\ m <<< d = 10^{-3}}$

$\Delta x = \frac{dy}{D} \qquad \frac{3\times\lambda}{2} = \frac{y}{10^{-3}}$

$\frac{dy}{D} = \frac{3\lambda D}{2d}$

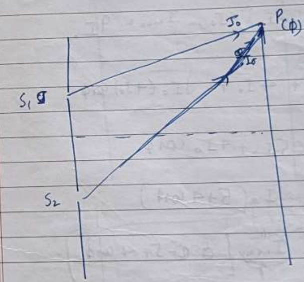
$y = \frac{3\lambda D}{2d}$

$y = \frac{3}{2}\times\frac{5\times10^{-7}}{10^{-3}}$

$= 7.5\times10^{-4}\ m$

$= 0.75\ mm$

*



$A_1 = \Phi_1$

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

$I_1 = I_2 = I_0$ (say)

$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2 = 4I_0$

$I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2 = 0$

$I = I_0 + I_0 + 2\sqrt{I_0 I_0}\cos\phi$

$I = 2I_0(1+\cos\phi)$

$I = 4I_0\cos^2\frac{\phi}{2}$

$\boxed{I = I_{max}\cos^2\frac{\phi}{2}}$

$\frac{2\pi}{\lambda}\Delta x \frac{\Delta x}{2}$

$$I = I_{Max} \cos^2\left[\frac{\pi}{\lambda}(\Delta x)\right]$$

$$= I_{Max} \cos^2\left[\frac{\pi}{\lambda}(d\sin\theta)\right]$$

$$= I_{Max} \cos^2\left[\frac{\pi}{\lambda}\frac{dy}{D}\right]$$

$$I = I_{Max} \cos^2\left[\frac{\pi y}{\beta}\right]$$

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

$I_1 = I_0,\ I_2 = 4I_0,\ I_{Max} = 9I_0$

$$I = I_0 + 4I_0 + 2\sqrt{I_0(4I_0)}\cos\phi$$

$$I_0 = 5I_0 + 4I_0\cos\phi$$

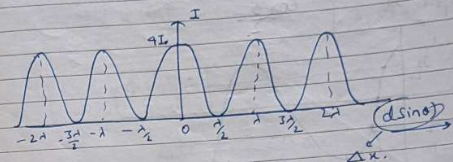
$$I = I_0(5 + 4\cos\phi)$$

$I_{Max} = 9I_0$

$$I = \frac{I_{Max}}{9}\left[\cancel{5}\ \cancel{\phi}\ 5 + 4\cos\phi\right]$$

$$I = \frac{I_{Max}}{9}\left[1 + \cos^2\left(\frac{\phi}{2}\right)\right]$$

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



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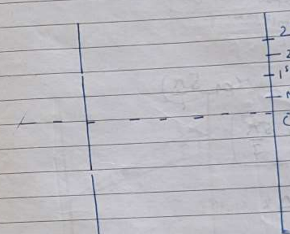
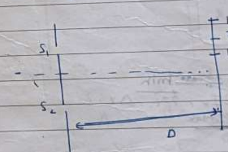


2nd Max	2λ	4π	$4I_0$
2nd Min	$3\lambda/2$	3π	0
1st Max	λ	2π	$4I_0$
Minima	$\lambda/2$	π	0
C.M.	0	0	$4I_0$
	Δx	ϕ	Int

Q.



$\phi = ?$, $\Delta x = ?$

$$I = \frac{I_{Max}}{9}\{1 -$$

$$I = I_{Max}\cos^2\frac{\phi}{2}$$

$$\frac{3}{4} = \cos^2\frac{\phi}{2}$$

$$\pm\frac{\sqrt{3}}{2} = \cos\frac{\phi}{2}$$

$$\boxed{\phi = \frac{\pi}{3}}$$

$\frac{\pi}{180} = 1°$

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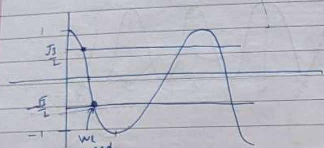
$\therefore$ ϕ lies in $\pi - 2\pi$ [1^{st} Max / 1^{st} Min]

$\cos\frac{\phi}{2} =$



we need this
since we get first $\frac{\sqrt{3}}{2}$ in 0 to 1^{st} Max.

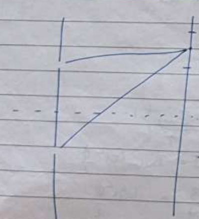
$\cos\frac{\phi}{2} = \cos\frac{5\pi}{6}$

$$\boxed{\phi = \frac{5\pi}{3}}$$

$\frac{5\cancel{\pi}}{3} = \frac{2\cancel{\pi}}{\lambda} \times \Delta x$

$$\boxed{\frac{5\lambda}{6} = \Delta x}$$

Q:



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$I = I_{max}\cos^2\frac{\phi}{2}$

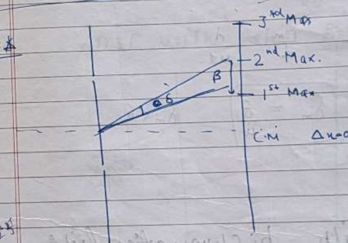
$\pm\frac{1}{\sqrt{2}} = \cos\frac{\phi}{2} \rightarrow$

$$\boxed{\phi = \frac{5\pi}{2}}$$

$\Delta\phi$ $\phi = \frac{2\pi}{\lambda}\Delta x$

$$\boxed{\frac{5\lambda}{4} = \Delta x}$$

Q:



$\beta =$ fringe width
$\beta = \frac{\lambda D}{d}$

Angular fringe width.

$$\boxed{\delta = \frac{\beta}{D} = \frac{\lambda}{d}}$$

As $\beta = \frac{\lambda D}{d}$.

$\beta \propto \lambda$

$\beta \propto D$

$\beta \propto \frac{1}{d}$
$d\downarrow \Rightarrow \beta\uparrow$

$\xrightarrow{\text{VIBGYOR}}$ $\lambda\uparrow$
$\longrightarrow \beta\uparrow$, $\beta_R > \beta_V$

$D\uparrow \Rightarrow \beta\uparrow$ But intensity $\downarrow$

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Pg-135 - Q:1,6
Pg-141 - 4,5,6,7
Pg-142, Q:2,4
Pg-136 - 1, -14,20,21,...

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if system is Immersed in liquid (μ)

$\lambda_m = \frac{\lambda}{\mu}$

$\beta_m = \frac{\lambda_m D}{d} = \frac{\lambda D}{\mu d}$

$\boxed{\beta_m = \frac{\beta}{\mu}}$

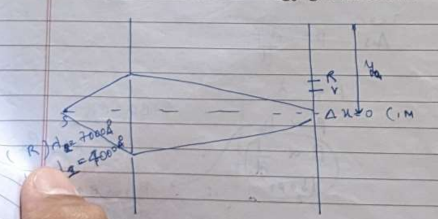
$\boxed{\beta_m < \beta}$

$\delta_m = \frac{\lambda_m}{d} = \frac{\lambda}{\mu d}$

$\boxed{\delta_m = \frac{\delta}{\mu}}$ $\delta_m < \delta$

Modern YDSE set with

YDSE with bichromatic light



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find the minimum order of Maximas which overlap

sol →

$y_{n_1} = y_{n_2}$

$n_1 \frac{\lambda_1 \cancel{D}}{\cancel{d}} = n_2 \frac{\lambda_2 \cancel{D}}{\cancel{d}}$

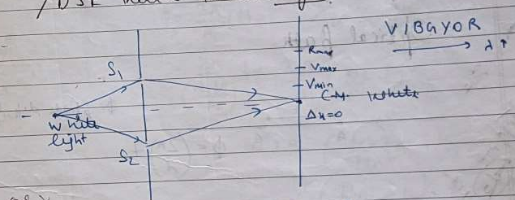
$\boxed{n_1 \lambda_1 = n_2 \lambda_2}$

$\boxed{\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{7}{4} = \frac{14}{8} = \frac{21}{12}}$ min^m order

For min^m
$(2n_1 - 1)\lambda_1 = (2n_2 - 1)\lambda_2$
$\frac{2n_1 - 1}{2n_2 - 1} = \frac{7}{4}$ } both should be odd.
$8n_1 - 4 = 14n_2 - 7$
will not overlap
no minima coincide

7^{th} Max^m of 4000Å overlap or coincide with 4^{th} Max^m of 7000Å

YDSE with white light



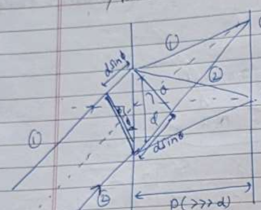
When white light is used Central Max^m will be white light, & first minima will be violet & nearest maxima will be violet & nearest colour appearing on screen will be red.

$I = I_{max} \cos^2 \frac{\Phi}{2}$

$= I_{max} \left(\frac{\pi y d}{\lambda D} \right)$

$\lambda \uparrow, I \uparrow$

YDSE with Oblique || beam.



CM = C[?] then CM then $\Delta x = 0$

$d \sin\phi = d \sin\theta$

$\theta = \phi$

$\Delta x = d \sin\phi$

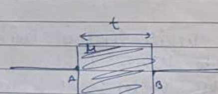
$D (>>> d)$

for 1^{st} Max^m $|d\sin\phi - d\sin\theta| = \lambda$

Optical path

ϕ: phase diff b/w A & B

$\phi = \left(\frac{2\pi}{\lambda}\right) t$



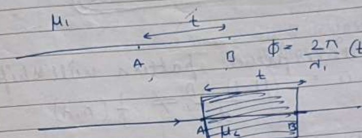
$\phi = \left(\frac{2\pi}{\lambda_m}\right) t = \frac{2\pi(\mu t)}{\lambda}$ optical path.

$\Delta x = \mu t - t$

$= (\mu - 1) t$

geometrically t length covers in the medium is equivalent to μt length of air which is called optical path.

→ The ray passing through the slab will cover extra length of $(\mu-1)t$.



$\phi = \frac{2\pi}{\lambda_1}(t)$

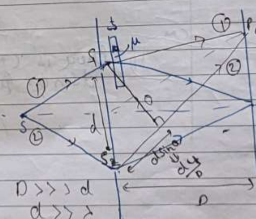
$\lambda \propto \frac{1}{\mu}$

$\phi = \frac{2\pi}{\lambda_2}(t)$ $\qquad \frac{\lambda_1}{\lambda_2} = \frac{\mu_2}{\mu_1}$

$= \frac{2\pi}{\left(\frac{\lambda_1 \mu_1}{\mu_2}\right)} t = \frac{2\pi}{\lambda_1}\left(\frac{\mu_2}{\mu_1} t\right)$

$\Delta x = \left(\frac{\mu_2}{\mu_1} t - t\right)$

$= \left(\frac{\mu_2}{\mu_1} - 1\right) . t$



C.M If here is Central Maxima.

$\Delta x_{eff} = (\mu - 1) t$

$D >>> d$

$d >> \lambda$

$\Delta x_{eff} = 0$ $\quad \left[S_1P + (\mu-1)t = S_2P \right.$
$(\mu-1)t = S_2P - S_1P$

$\Rightarrow (\mu-1)t = \frac{dy}{D}$

$$\boxed{y = (\mu-1)\frac{tD}{d}}$$

Whole interference pattern will shift &
Shift is $= \frac{(\mu-1)tD}{d} \neq f(n,\lambda)$

No. of fringes shifted $= \frac{\text{Shift}}{\beta} = \frac{(\mu-1)tD}{d \times \frac{\lambda D}{d}}$

$= \frac{(\mu-1)t}{\lambda}$

No. of fringes $\propto \frac{1}{\lambda}$

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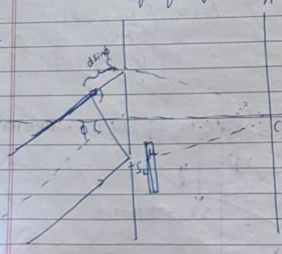
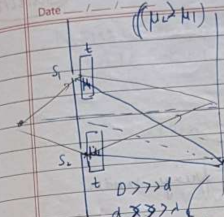


$(\mu-1)t = d\sin\phi$

If there is CM then
$d\sin\phi = (\mu-1)t$

$((\mu_2 > \mu_1)$



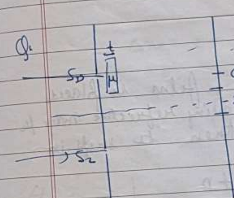
$(\mu_2-1)t - (\mu_1-1)t$

$\Delta x = (\mu_2-\mu_1)t$

If there is central maxima $\boxed{(\mu_2-\mu_1)t = \frac{dy}{D}}$

Central maxima will shift downward since
S_2 has covered extra distance.

Q.



find, Φ, Δx.

$2\cancel{I_0} = 4\cancel{I_0}\cos^2\frac{\phi}{2}$

$\pm\frac{1}{\sqrt{2}} = \cos\frac{\phi}{2}$

$$\boxed{\Phi = \frac{3\pi}{2}}$$

~~$\Delta x = \frac{3\pi}{2} = \frac{2\pi}{\lambda}\Delta x$~~

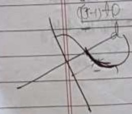
$$\boxed{\frac{3\lambda}{4} = \Delta x}$$

$\Phi = \frac{3\pi}{2} = \frac{2\pi}{\lambda}(\mu-1)t$

$10\,l^2$

$(\mu-1)t = \frac{dy}{D}$

$\frac{(\mu-1)tD}{d} = y$



$t = \frac{3}{4} \frac{\lambda}{(\mu-1)}$

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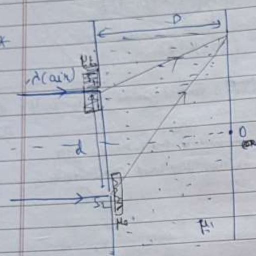


fringe width

$\beta = \frac{\lambda_1 D}{d} = \frac{\lambda D}{\mu_1 D}$

Now if a thin film is placed in front of S_1 having refractive index μ_2 & thickness t, then a shift in CM is

$$\frac{(\mu_2 - 1) t D}{d}$$

Q. → Now if another thin film of refractive index μ_3 ~~& refractive index μ_3 is placed in front~~ is placed in front of S_2 as shown, then C.M restore its posn then find relation b/w μ_1, μ_2 & μ_3

→ $(\mu_2 - 1)\cancel{t} = (\mu_3 - 1)\cancel{t}$

$\cancel{\mu_2}$ $(\mu_2 - 1)\cancel{t} = \left(\frac{\mu_3}{\mu_1} - 1\right)\cancel{t}$

$\boxed{\mu_1 \mu_2 = \mu_3}$

Now ratio of Intensity at pt O' in all three cases is

$I_1 : I_2 : I_3$

⇒ when No film is placed.

$I_1 = 4I_0$

When 1st film is placed

$\Delta x = (\mu_2 - 1)t$.

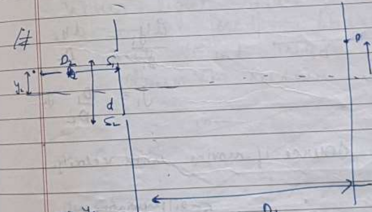
$I = 4I_0 \cos^2\left(\frac{\pi}{\lambda}(\mu_2 - 1)t\right)$

$\Delta x = 0$ ← When 2nd film is placed.

$I = 4I_0$

$\boxed{1 : \cos^2\left(\frac{\pi}{\lambda}(\mu_2 - 1)t\right) : 1}$

#



Path diff at P is.

$D_1 >>> y_1$

$D_2 >>> y_2$