Young Double Slit Experiment

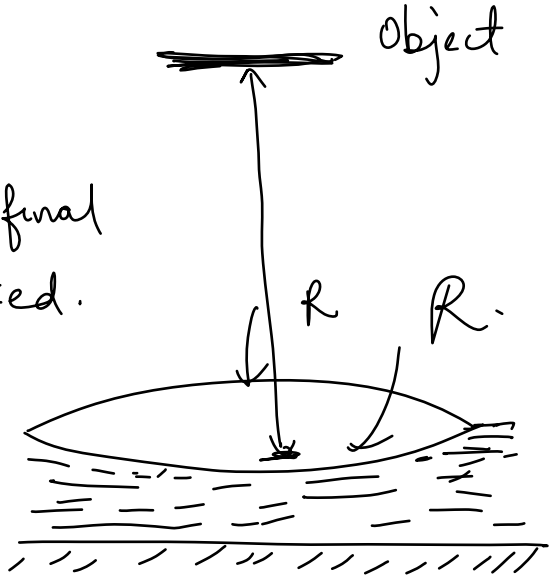
ϕ, $I = 4I_0^2 \cos^2 \frac{\phi}{2}$

$\phi = 0, 2\pi, \pi, n\pi$

Intensity will be maximum.

$\phi = (2n+1)\frac{\pi}{2}$; $I = 0$

"Centre of Curvature"
object is placed if the final formed is real & inverted.



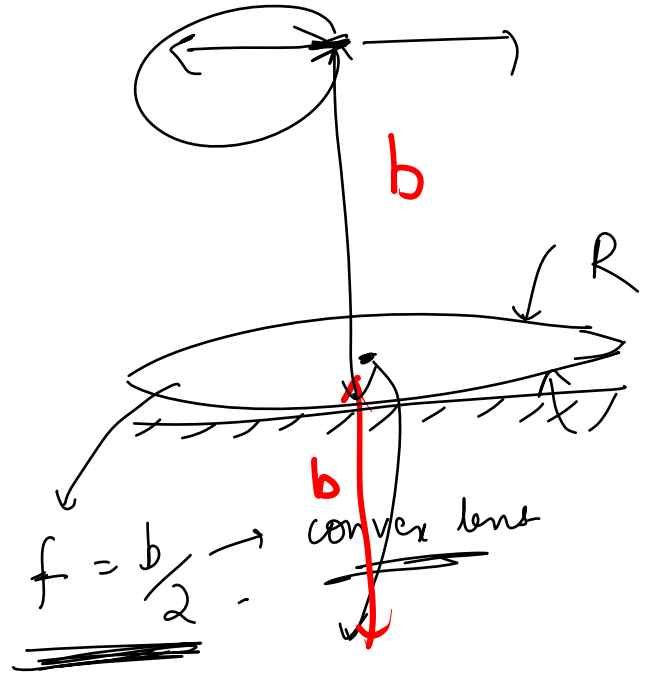
Liquid filled, 'a'

On removing the liquid, if the exp. is repeated, 'b'

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{b} - \frac{1}{b} = \frac{1}{f}$$

$$\frac{2}{b} = \frac{1}{f}, \quad f = b/2$$



convex lens

1st lens → Refraction

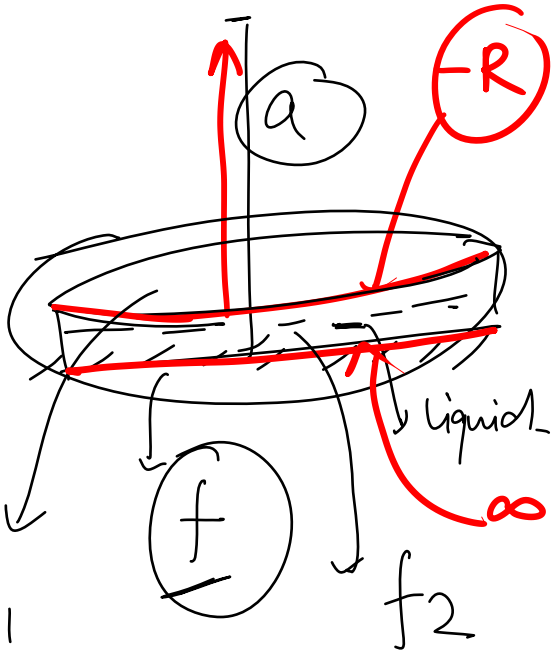
Plane Mirror → Reflect.

Refraction

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{a} - \left(\frac{-1}{a}\right) = \frac{1}{f}$$

$$f = \frac{a}{2}$$



$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{2}{a} = \frac{2}{b} + \frac{1}{f_2}$$

$$\boxed{f = \frac{2}{a} - \frac{2}{b}}$$

focal length of liquid = $\left[\frac{2}{a} - \frac{2}{b}\right]$.

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

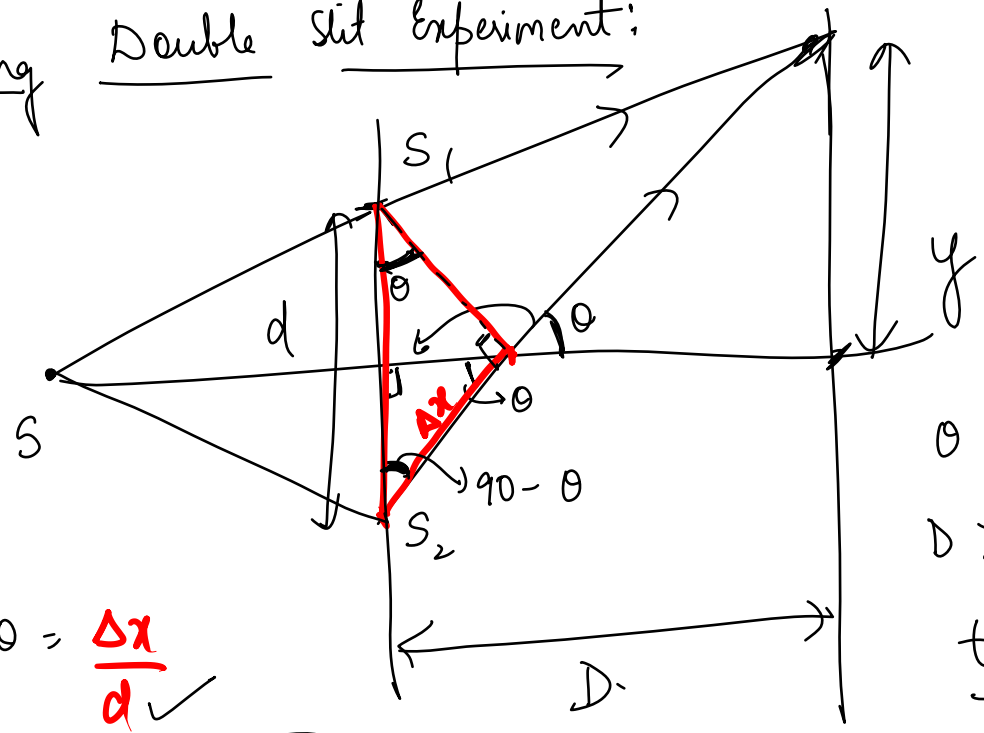
$$\frac{2}{a} - \frac{2}{b} = (\mu - 1)\left(-\frac{1}{R} - \frac{1}{\infty}\right)$$

$\infty \to 0$

$$-\left(\frac{2}{a} - \frac{2}{b}\right) R = \mu - 1$$

$$\mu = 1 + \frac{2R}{a} + \frac{2R}{b}$$

Young Double Slit Experiment:



$\sin\theta = \frac{\Delta x}{d}$ ✓

$\boxed{\Delta x = d\sin\theta}$

$\Delta\phi$ = Phase diff

$\Delta\phi = k\Delta x$

$= \frac{2\pi}{\lambda} \times d\sin\theta$

θ is very small

$D >>> d$

$\tan\theta = \frac{y}{D}$

θ is very small

$\tan\theta \sim \sin\theta$

$\boxed{\Delta\phi = \frac{2\pi}{\lambda} \frac{dy}{D}}$

$$\Delta\phi = \frac{2\pi}{\lambda} d\frac{y}{D}$$

Constructive Interference $\longrightarrow$ Light fringes, $\Delta\phi = 2n\pi$

Destructive Interference $\longrightarrow$ Dark fringes

$$\Rightarrow \frac{2\pi}{\lambda}\frac{dy}{D} = (2n-1)\pi \quad (n = 1),$$

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

$\longrightarrow$ First Bright fringe, $y = \frac{\lambda D}{d}$

$n = 1$

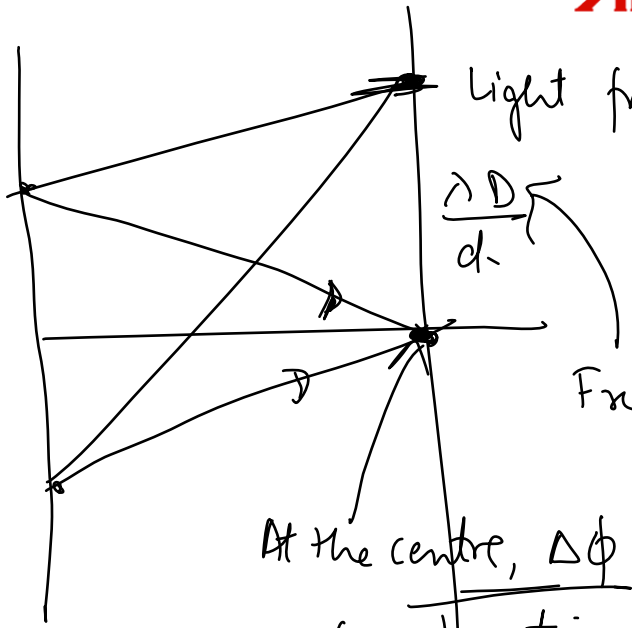
1st fringe $= \frac{\lambda D}{d}$ → on both the sides

2nd fringe =

$n = 2$

$\Delta\phi = \frac{2\pi}{\lambda} \frac{dy}{D} = 2 \times 2\pi$

$y = \frac{2\lambda D}{d}$ → second fringe.



Ques Two slits are made 1mm apart and the screen is placed one meter away. What is the fringe separation when blue green light of wavelength 500 nm is used?

Ans

$$\text{Fringe Width} = \frac{\lambda D}{d}$$

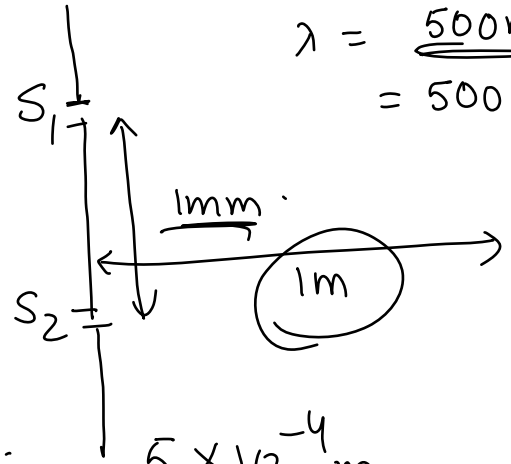
$d = 1\text{mm} = 10^{-3}\text{ m}.$

$D = 1\text{m}$

$$\Rightarrow \frac{500 \times 10^{-9} \times 1}{10^{-3}}$$

$$\Rightarrow 500 \times 10^{-6}\text{ m} = 5 \times 10^{-4}\text{ m}.$$

$$\lambda = \frac{500\text{nm}}{} = 500 \times 10^{-9}\text{ m}.$$



$d \sin\theta \Rightarrow n\lambda$

$K\Delta x = 2n\pi$ → Phase diff.

$K(d\sin\theta) = 2n\pi$

$\frac{2\pi}{\lambda} \times d\sin\theta = 2n\pi$

$d\sin\theta = n\lambda$ → No. of fringes.

$n = \frac{d\sin\theta}{\lambda}$

Total no. of bright fringes $= \left[\frac{d}{\lambda}\right]$ (maxima).

The number of dark fringes $= \left[\frac{d}{\lambda} + \frac{1}{2}\right]$.

Ques In Young's double slit experiment, the slits are separated by 0.3mm and the screen is placed 1.5m away. The distance between the central bright fringe and the fourth bright fringe is = 1.2cm. Determine the wavelength of light use.