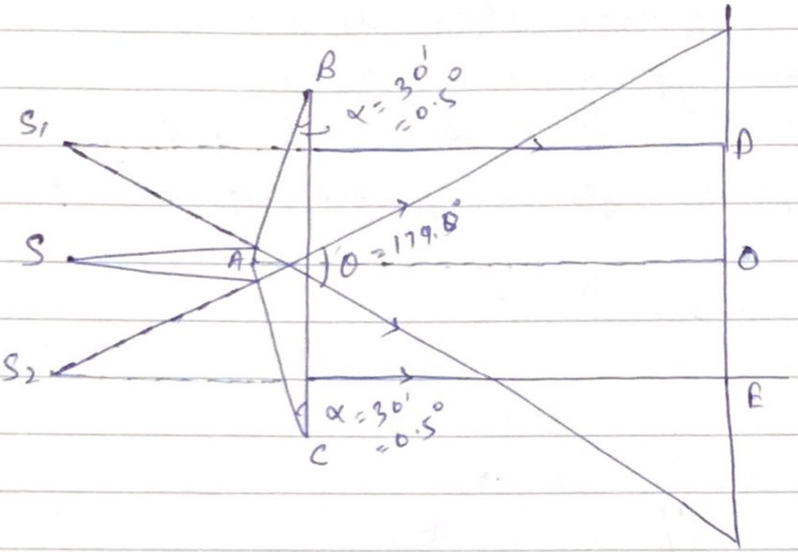
Fresnel's Biprism: The biprism is constructed as a single prism of obtuse angle of about 179. and remaining two acutee angle 30' or 0.5° each.



When light falls from source on upper portion of the prism, it bends downward and appers to wave from virtual source S_1, Similarly light falls on the lowering portion, of the prism, it bends upward and appears wave coming from virtual source S_2.

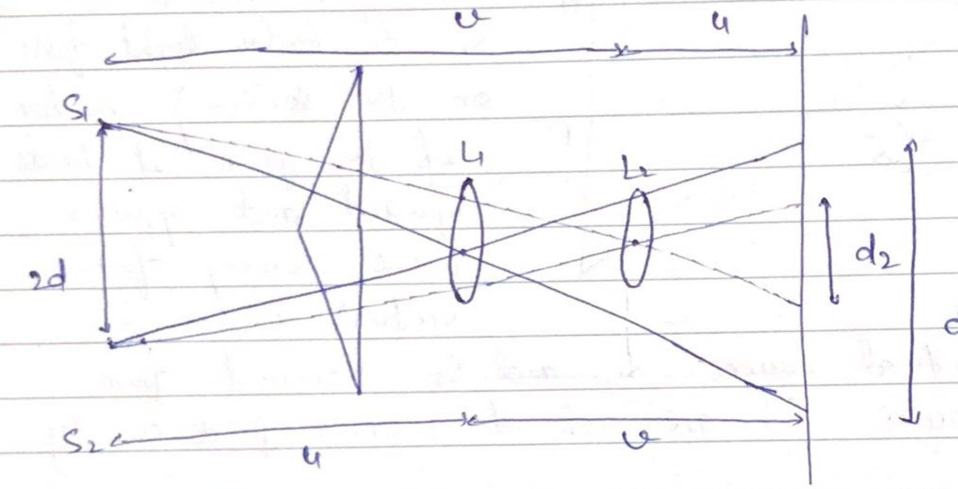
Thus the virtual source S_1 and S_2 derived from the light source S, are cohrent sources produce by the prism.

The point O on the screen is equidistant from S_1 and S_2, hence the path difference at O is zero, condition for maximum intensity. The dark and bright fringes are produced alternatively on both sides of O. The distance between any two dark or bright (consecutive) fringes is given by

$$\boxed{\beta = \frac{D\lambda}{2d}} \quad \text{or} \quad \boxed{\lambda = \beta \frac{2d}{D}}$$

Measurement of 2d: Displacement method / Deviation method

Displacement Method:- In displacement method a convex lens is placed between ~~bipr~~ biprism and the eyepiece in such a way that the images of two virtual sources S_1 and S_2 are seen in the eye-piece for two position of the lens.



$$\frac{2d}{d_1} = \frac{u}{v} \quad \text{——} (1)$$

$$\frac{2d}{d_2} = \frac{v}{u} \quad \text{——} (2)$$

Combining (1) & (2), we get

$$\boxed{2d = \sqrt{d_1 d_2}}$$

*

Deviation Method: The deviation produced (δ) in the path of a ray by a thin prism is given by

$$\delta = (\mu - 1)\alpha$$

α is the refracting angle of the prism

In case of biprism

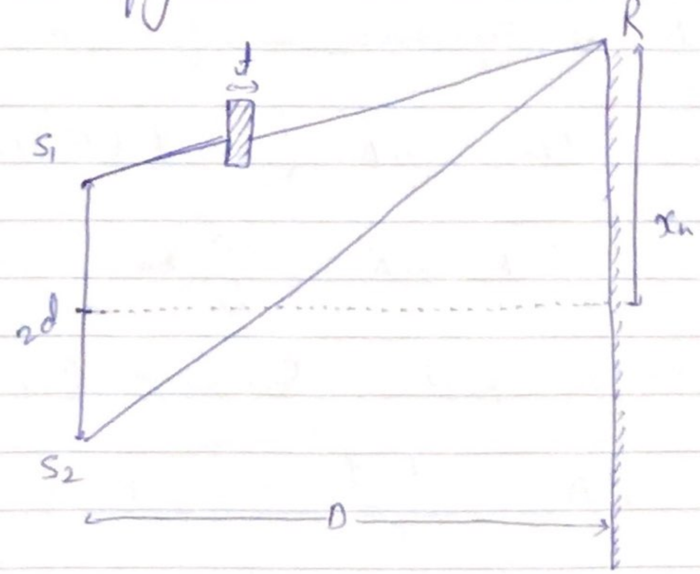
$$2d = 2a(\mu - 1)\alpha$$

$a \rightarrow$ is the distance of prism from source.

Displacement of fringes: (Determination of the thickness when a thin of thin sheet of transparent material):

Fresnel's biprism set up can also be used to determine the thickness of a thin sheet of transparent material.

For this a thin sheet of transparent material is introduced in the path of of the interfering beams. as shown in fig.



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let the thickness of the material is t and the refractive index is μ

for path difference S_1R a distance $(S_1R - t)$ is transversed in air and a distance t is transversed in refractive index μ. The time taken by light to cover the distance S_1R given by the following expression

$$T = \frac{(S_1R - t)}{c} + \frac{t}{v} \qquad \text{since } \mu = \frac{c}{v}$$

$$v = \frac{c}{\mu}$$

$$\therefore \quad T = \frac{(S_1R - t)}{c} + \frac{\mu t}{c}$$

$$T = \frac{S_1R + (\mu - 1)t}{c} \quad \text{—— (1)}$$

Equation (1) implies that the path S_1R is equivalent to a path $S_1R + (\mu - 1)t$ in air. The path diffrence at R is expressed as follows

$$PD = S_2R - [S_1R + (\mu - 1)t] \quad \text{—— (2)}$$

$$S_2R - S_1R = \frac{2d}{D} x_n \quad \text{—— (3)}$$

using equation (1), (2) & (3), we get

$$PD = \frac{2x_n d}{D} - (\mu -)t \quad \text{—— (4)}$$

for n^{th} maxima; $PD = n\lambda$

Hence

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

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

$$x_n = \frac{D}{2d}\left[n\lambda + (\mu - 1)t\right] \quad \text{—— (5)}$$

In the absence of transparent material, $t = 0$ equation (5), becomes

$$x_{n0} = \frac{D n\lambda}{2d} \quad \text{—— (6)}$$

Displacement S of the n^{th} maxima with introducing the plate becomes as follows;

$$S = x_n - x_{n0} = \frac{D}{2d}\left[n\lambda + (\mu - 1)t\right] - \frac{D}{2d} n\lambda$$

$$\boxed{S = \frac{D}{2d}(\mu - 1)t} \quad \text{—— (7)}$$

The experession for S is independent of the order n of the fringe.

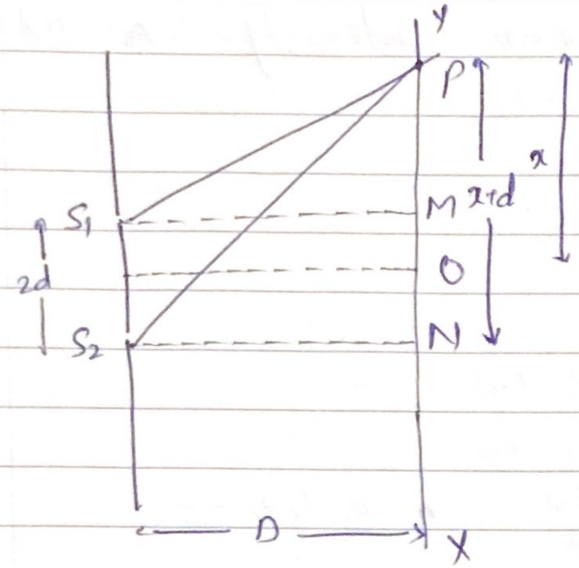
The equation (7) can be expressed in the following form

$$\boxed{t = \frac{S\,2d}{(\mu - 1)D}} \quad \text{—— (8)}$$

The above equation can be used to determine the value of thickness of transparent sheet.

Theory of Interference and Fringe Width:

Let there be a narrow source of light S are S_1 and S_2 be the narrow slits seperated by a distance 2d. S_1 and S_2 are thus cohrent sources. YX is a screen placed at a distance D from the cohrent sources. O is the foot of perpendicular drawn on YX from the mid of two source.



Consider a point P on the screen at a distance x from O. The path difference between the waves reaching at P from S_1 and S_2 is,

$$\Delta = S_2P - S_1P$$

Consider the right angle triangle S_2NP

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

$$= D^2 + (x+d)^2 \Rightarrow D^2\left[1 + \frac{(x+d)^2}{D^2}\right]$$

$$S_2P = D\left(1 + \frac{(x+d)^2}{D^2}\right]^{1/2} = D\left[1 + \frac{(x+d)^2}{2D^2} + \cdots\right]$$

$$S_2P = D\left[1 + \frac{(x+d)^2}{2D^2}\right] \quad \text{—— (1)}$$

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Similarly $S_1P^2 = S_1M^2 + PM^2$

$$S_1P^2 = D^2 + (x-d)^2 \Rightarrow D^2\left[1+\frac{(x-d)^2}{D^2}\right]$$

$$S_1P = D\left[1+\frac{(x-d)^2}{2D^2}\right]$$

$$\Delta = S_2P - S_1P = D\left[1+\frac{(x+d)^2}{2D^2} - 1 - \frac{(x-d)^2}{2D^2}\right]$$

$$\boxed{\Delta = \frac{2xd}{D}} = \text{Path difference.}$$

For bright fringe or maximum intensity, $\Delta = n\lambda$

$$n\lambda = \frac{2xd}{D}$$

$$\boxed{x = \frac{n\lambda D}{2d}}$$

For n^{th} bright fringe, $x = x_n$

$$\boxed{x_n = \frac{n\lambda D}{2d}} \qquad n = 0, 1, 2, \ldots$$

For dark fringe or minimum intensity,

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

$$\therefore \quad (2n+1)\frac{\lambda}{2} = \cancel{\frac{n\lambda D}{2d}} \quad \frac{2xd}{D}$$

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

for nth fringe, $\boxed{x_n = \frac{(2n+1)\lambda D}{4d}}$ $\qquad$ ~~x~~ $n = 0, 1, 2, \ldots$

* Now do part B, Fringe width, $\boxed{\beta = \frac{D\lambda}{2d}}$

(8)

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Fringe Width: The distance between any two consecutive bright or dark fringes is called the fringe width:

Position of n^{th} bright fringe is given by the following equation

$$x_n = \frac{D n \lambda}{2d} \quad \text{--- (I)}$$

for $(n+1)^{th}$ bright fringe

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

Distance between any two consecutive maxima, fringe width is called β i.e.

$$\beta = x_{n+1} - x_n$$

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

$$\boxed{\beta = \frac{D\lambda}{2d}}$$

Where $2d = \sqrt{d_1 d_2}$

or $2d = 2a(\mu - 1)\alpha$

Where is the distance of source from prism.