WEDGE SHAPED FILM

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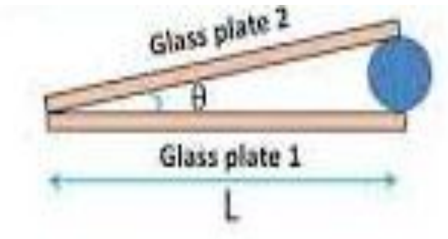
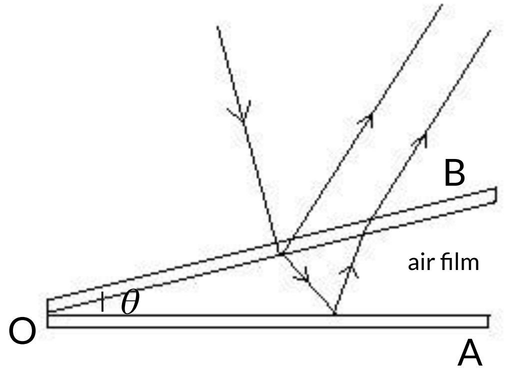
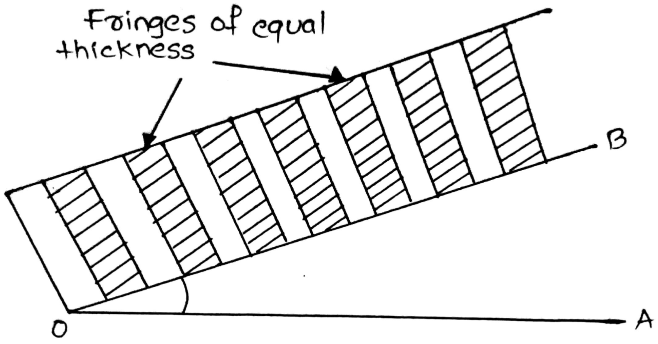
- A thin film having zero thickness at one end and progressively increasing to a particular thickness at the other end is called a wedge.
- A thin wedge of air film can be formed by two glasses slides on each other at one edge and separated by a thinspacer at the opposite edge.
- Consider two plane surfaces OA & OB inclined at an angle θ and enclosing a wedge shaped air film. The thickness of the air film increases from O to A .
- The locus of all points having the same thickness of air film is a straight line.
- When monochromatic light is incident on the wedge from above, it gets partly reflected from the glass- to-air boundary at the top of the air film . The other Part of the light is transmitted through the air film and gets reflected at the air-to- glass boundary





These two reflected rays interfere with each other and interference fringes are observed through the eyepiece . These are straight lines parallel to the edge of the wedge.



Total Path Difference = $2 \mu t \cos r + \lambda / 2$ (for thin films)

for air film $\mu = 1$ & for normal incidence $r = 0$

∴ Path difference = $2t + \lambda / 2$

$\Rightarrow$ If $2t + \frac{\lambda}{2} = n\lambda$ bright fringe is obtained.

$\Rightarrow$ If $2t + \frac{\lambda}{2} = (2n+1)\frac{\lambda}{2}$,

(or) $2t = n\lambda$ then dark fringe is formed .

Theory

If t_m & t_n corresponds to the thickness of air film of mth and nth dark fringes ,

then $$2t_m = m\lambda \quad \text{----------} \ (1)$$

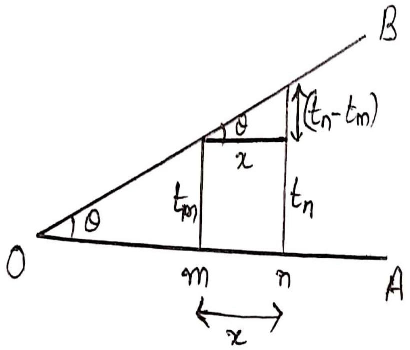
$$2t_n = n\lambda \quad \text{-----------} \ (2)$$

subtracting (2) from (1)

we get $$2(t_n - t_m) = (n - m)\lambda$$

$$(t_n - t_m) = (n - m)\lambda/2 \quad \text{----------} \ (3)$$

From the figure $$\tan(\theta) = (t_n - t_m)/x$$



Where x is the distance between m^{th} and n^{th} dark fringes

As the angle of the wedge is very small,

$$\tan(\theta) = \theta = (t_n - t_m)/x$$

$$t_n - t_m = x^*\theta \quad \text{-----------} \ (4)$$

from(3)&(4) $x\theta = (n-m)\lambda/2$

$$x/(n-m) = \lambda/2\theta$$

we know that $x/(n-m)$ = fringe width = β

$$\beta = \lambda/2\theta$$

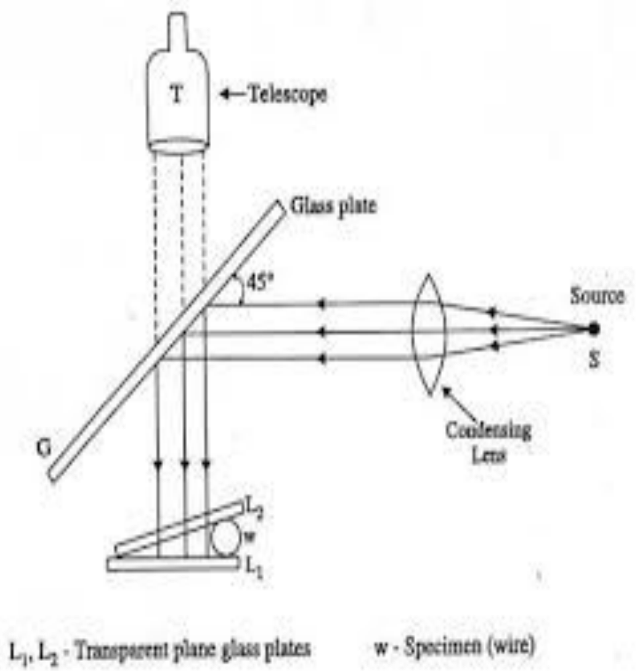
If there is a film of refractive index μ then

$$\boxed{\beta = \lambda/2\mu\theta} \quad \text{----------- (5)}$$

Here β is independent of 'n' . So all fringes are equally spaced.

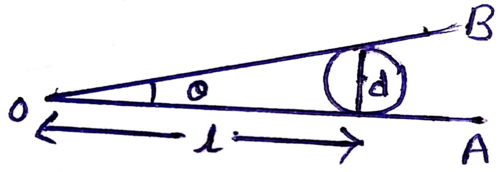
DETERMINATION OF DIAMETER OF THE WIRE :-

- If a wire is placed between two glass plates as shown in the fig. then wedge shaped air film is formed between these two glass plates.
- S is a monochromatic source of light.
- The light from S is made parallel by means of a convex lens. These parallel rays are allowed to incident on a plane glass plate 'G' which is making an angle 45° with the path of the beam
- The light reflected from G , falls on this combination and interference fringes are observed through a microscope.



The vertical cross wire is made to coincide with one of the bright fringes say m^{th} fringe and the reading is noted . The microscope is is moved until the crosswire coincides with the n^{th} fringe. Again the reading is noted . The difference of these two readings is equal to the distance moved by the microscope (x).

Then fringe width (**β**)   = x/n-m



If 'd' is the diameter of the wire , l is the distance between the Point of conact of the plates and wire then

$$\tan\theta = d/l$$

$$\theta = d/l \quad (\text{ since } \theta \text{ is small}) \text{ --------- } (6)$$

Fringe width $\beta = \lambda/2\mu\theta$ from eq(5)

$$\theta = \lambda/2\mu\beta \qquad \text{-----------}(7)$$

From (6) & (7)

$$\frac{\lambda}{2\mu\beta} = \frac{d}{l}$$

∴ Diameter of the wire

$$\boxed{d = \frac{\lambda l}{2\mu\beta}}$$

Using this formula ‘ d ‘ can be calculated.