Q- Light of wavelength 440nm illuminates two 35 cm glass slides. An object is placed between the ends of the slides causing an air wedge to form between the slides. 445.6 dark fringes per cm are seen on the slides. Determine the thickness of the air wedge.

Answer:

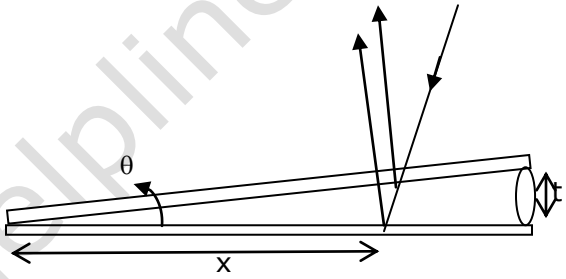
The object on one side of the slides is making the slides to tilt by an angle θ with each other and a wedge shaped air film is formed between the slides. The thickness of this air film is changing with the distance from the wedge angle. The lower surface of the film reflects a part of the light incident on it and a part of the refracted light is reflected from the upper surface of the lower slide and in that way we get two beams of light

1. The light reflected from the upper surface of the film, and
2. The light reflected from the lower surface of the film and then refracted from the film.

These two beams interfere and the resulting fringe pattern is observed in the region above the system.

Now the thickness of the air film is a function of x and as θ is very small (in radians), given by

$t = \theta x$



The path difference between the two beams at x is given by

$\delta = 2t + \lambda/2$

$= 2\theta x + \lambda/2$

Here $\lambda/2$ is the additional path difference, because at lower slide light is reflecting from denser medium (glass).

For the maximum intensity (bright line) of resulting wave at x this path difference should be an integer multiple of λ or

$2\theta x + \lambda/2 = n\lambda.$

And for the next maximum

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

Subtracting the two equations we get the distance between two consecutive maximum, or the fringe width β as

$2\theta \Delta x = 2\theta\beta = \lambda.$ ---------- (1)

Now as the number of fringes per cm is 445.6 per cm the fringe width will be

$\beta = 1/445.6$ cm $= 2.244*10^{-3}$ cm $= 2.244*10^{-5}$ m

Substituting in equation (1) we have

$$\theta = \frac{\lambda}{2\beta} = \frac{440*10^{-9}}{2*2.244*10^{-5}} = 9.804*10^{-3} \text{ rad.}$$

Hence the thickness of the object is given by

$d = L*\theta = 0.35*9.804*10^{-3} = 3.43*10^{-3}$ m