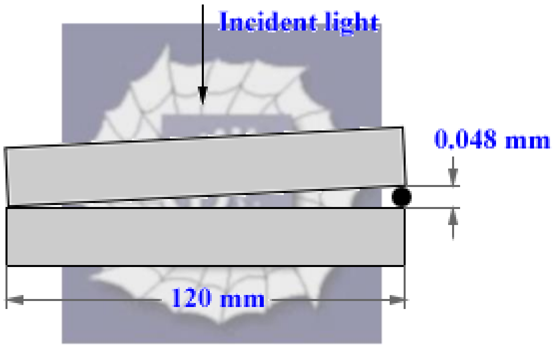
642.

Problem 45.39 (RHK)

A broad source of light $(\lambda = 680 \text{ nm})$ *illuminates normally two glass plates* 120 mm *long that touch one end are separated by a wire* 0.048 mm *in diameter at the other end* (*see the figure*). *We have to find the number of bright fringes that appear over the* 120-mm *distance*.



Solution:

There is an air wedge between the two glass plates. The glass plates are joined at one end, and are separated by a wire of 0.048 mm diameter at their other end. So the minimum gap of the air gap is 0.0 mm and its maximum gap is 0.048 mm. The length of the air gap is 120 mm. The plates are illuminated by a broad source of monochromatic light of wavelength 680 nm.

Fringes will be seen because of interference of waves reflected from the bottom side of the top plate and those reflected from the top of the bottom plate. As the refractive index of glass is more than that of air, there will be an additional phase change in the waves that are reflected from the top of the bottom plate.

Let the thickness of the air wedge where interference fringe is seen be *d* m. The condition for constructive interference is

$$\frac{2d \times 2\pi}{\lambda} = (2m+1)\pi, m = 0,1,2,3,...$$

The first fringe will correspond to $m = 0$. We note that the length of the air gap in the wedge where the first fringe is formed will be

$$d_1 = \frac{\lambda}{4} = \frac{680}{4} \text{ nm} = 170 \text{ nm}.$$

As already mentioned the maximum width of the air wedge is 0.048 mm. We will find the integer *m* for $d = 48 \times 10^{-6}$ m which satisfies the condition for fringe formation.

We note that the nearest integer to

$$\frac{4 \times 48 \times 10^{-6}}{2 \times 680 \times 10^{-9}} - \frac{1}{2} = 140.6 \text{ is } 140.$$

As the first fringe corresponds to $m = 0$ and the last fringe formed in the air wedge corresponds to $m = 140$, 141 fringes will appear over the 120-mm long air wedge.