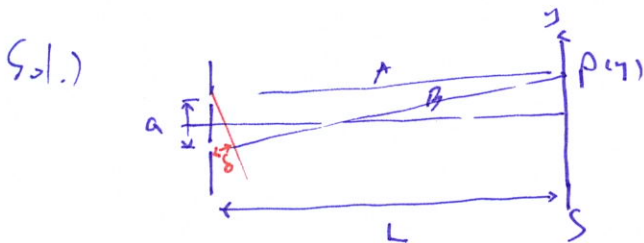


HW#4
 ECS103
 2021.03.29

In an interference experiment of the Young type, the distance between slits is 0.5 mm, and the wavelength of the light is 600 nm.

- If it is desired to have a fringe spacing of 1 mm at the screen, what is the proper screen distance?
- If a thin plate of glass ($n=1.5$) of thickness 100 microns is placed over one of the slits, what is the lateral fringe displacement at the screen?
- What path difference corresponds to a shift in the fringe pattern from a peak maximum to the same peak half-maximum?



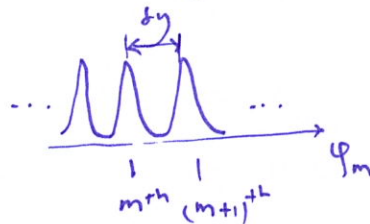
$$\delta = a \sin \theta \approx a \tan \theta = \frac{ay}{L}$$

(a)

Path length difference between A & B is δ .

→ Phase difference: $k\delta = \varphi$

→ Maximum fringes: $k\delta_m = 2m\pi, m = 0, 1, 2, \dots$



$dy = 1 \text{ mm}$

For $dy = 1 \text{ mm}$, $\delta_{m+1} - \delta_m = \frac{2\pi}{k} = \lambda$

$\Leftrightarrow \frac{a}{L} (y_{m+1} - y_m) = \frac{a}{L} dy (= \lambda)$

$\therefore L = \frac{a dy}{\lambda} = \frac{(0.5 \cdot 10^{-3}) \cdot 10^{-3}}{6 \cdot 10^{-7}} = 83 \text{ (cm)}$

(b) The glass-caused path length change: $n \cdot (100 \cdot 10^{-6}) = 150 \text{ } \mu\text{m}$.
 The path length difference between with and without the glass:

$(150 - 100) \cdot 10^{-6} = 50 \text{ } \mu\text{m}$

The path length difference between adjacent fringes: $\lambda (= 0.6 \text{ } \mu\text{m})$

→ $\therefore 83.3$ fringes move.

$$(c) \quad \bar{I} = 2\bar{I}_0(1 + \cos \varphi)$$

$$\cos\left(\frac{\varphi}{2} + \frac{\varphi}{2}\right) = \cos^2 \frac{\varphi}{2} - \sin^2 \frac{\varphi}{2} = 2\cos^2 \frac{\varphi}{2} - 1$$

$$\therefore \cos \varphi + 1 = 2\cos^2 \frac{\varphi}{2}$$

$$\rightarrow \bar{I} = 4\bar{I}_0 \cos^2 \frac{\varphi}{2} \quad \rightarrow \frac{1}{2} \bar{I} \quad \text{at} \quad \cos^2 \frac{\varphi}{2} = \frac{1}{2}$$

$$\therefore \cos \frac{\varphi}{2} = \frac{1}{\sqrt{2}} \quad \rightarrow \quad \underline{\underline{\varphi = \frac{\pi}{2}, \text{ or } 90^\circ, \text{ or } \frac{\lambda}{4} \text{ (150 nm)}}} \dots$$

* path difference : 150 nm.