Answer on Question #71008, Physics / Optics

In a double slit interference arrangement, fringes are produced with monochromatic light of wavelength 550 nm. A thin plate of glass (μ = 1.5) is placed in the path of one of the interfering beams. The central band of fringe system moves into position occupied by the third bright band from the centre. Calculate the thickness of the glass plate.

Solution:

The condition for maximum (bright spot) is

$$d \sin\theta = n\lambda$$

where n is order of interference.

When a transparent glass plate of thickness *t* and refractive index *n* is placed in one of the incoming wave path, due to the increase of the path by *(μ-1)t*, the interference pattern undergoes a shift *s*.

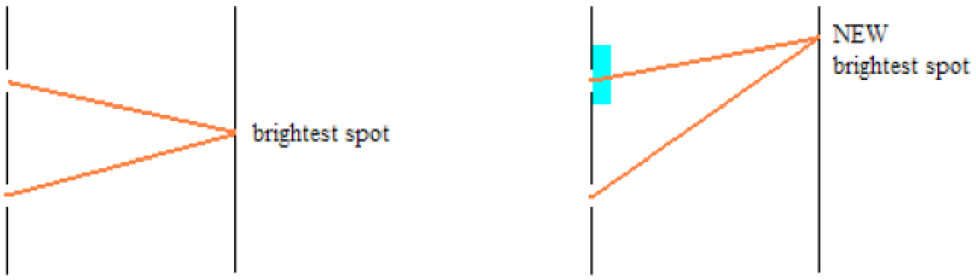

Fig. Equal effective path lengths without (left) and with (right) glass slide.

Once the glass slide is in place, the central point moves. This is due to there being more wavelengths inside the glass slide than in the air in front of the second slit.

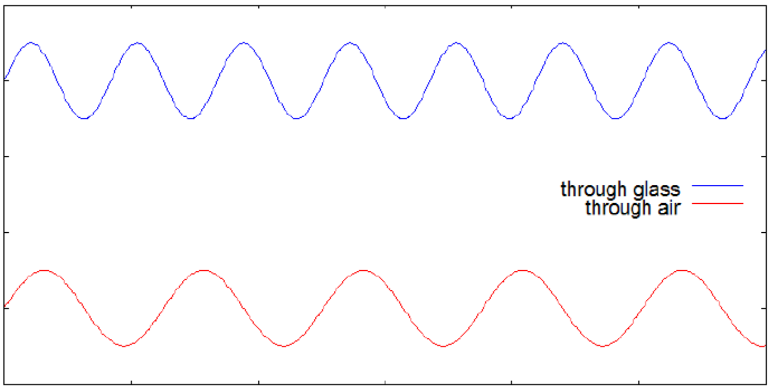

Fig. Difference in wavelengths traveling through air and glass

If the glass has a thickness t, then there are $\frac{t}{\lambda/\mu}$ complete wavelengths that travel through it, while there are $\frac{t}{\lambda/1}$ wavelengths that travel through the same thickness of air.

The number of fringes shifted is

$$n = \left| \frac{t}{\lambda/\mu} - \frac{t}{\lambda} \right| = \frac{t}{\lambda}(\mu - 1)$$

So,

$$t = \frac{n\lambda}{\mu - 1} = \frac{3 \times 550 \times 10^{-9}}{1.5 - 1} = 3.3 \times 10^{-6}\ m$$

Answer: $3.3 \times 10^{-6}\ m$