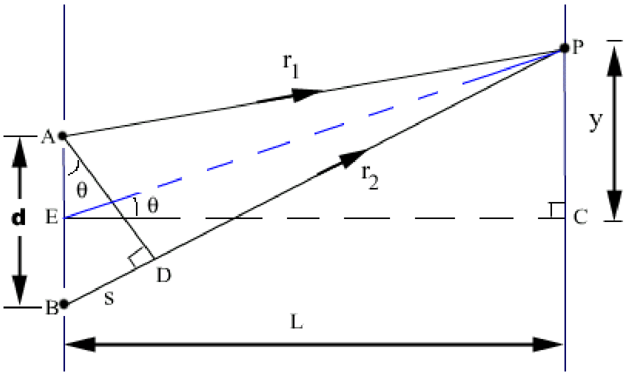
Answer on Question #61921, Physics / Optics

c) Discuss, with necessary theory, how is interference pattern in Young's double slit experiment modified when a thin glass plate is introduced in the path of one of the interference waves

Solution:

Two closely spaced slits produce a double-slit interference pattern.



The formula for bright fringe spacing is

$$\Delta y_1 = \frac{\lambda L}{d} m$$

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 *(n-1)t*, the interference pattern undergoes a shift *s*.

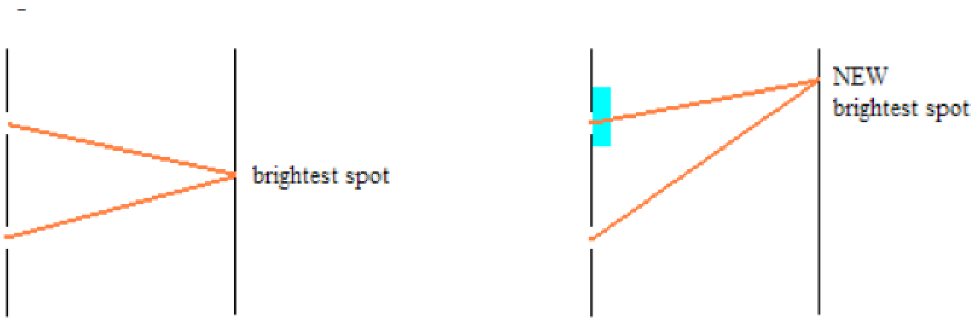


Fig. Equal effective path lengths without (left) and with (right) glass slide.

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.

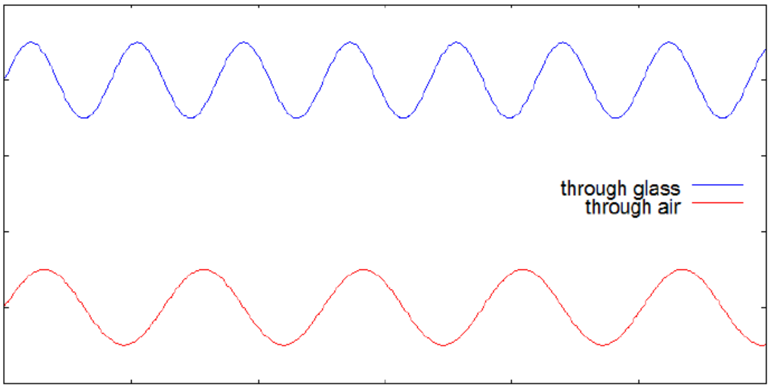


Fig. Difference in wavelengths traveling through air and glass

If the glass has a thickness t, then there are $\frac{t}{\lambda/n}$ 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

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

Shift of pattern $s = y_{bright} = \frac{\lambda L}{d} m = \frac{\lambda L}{d}\frac{t}{\lambda}(n-1) = \frac{L}{d}(n-1)t.$

Answer: 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 *(n-1)t*, the interference pattern undergoes a shift $s = \frac{L}{d}(n-1)t$