Answer on Question #66908, Physics / Optics

Two slits are spaced 0.3 mm apart and are placed 50cm from a screen. Suppose the entire apparatus is immersed in water. What is the distance between the second and third dark lines of the interference pattern when the slits are illuminated with the light of 600 nm wavelength?

Find: Δx – ?

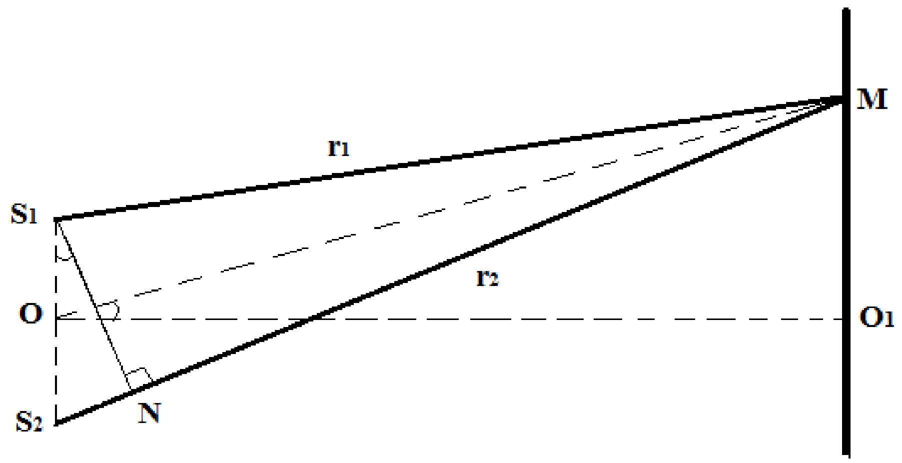
Given:

$d=0.3\times10^{-3}$ m

L=0.5 m

n=1.33

$\lambda=600\times10^{-9}$ m



S_1 and S_2 are the point sources

d is the distance between S_1 and S_2

Zero interference maximum is in point O_1.

L is the distance between the point sources and screen

Choose on screen the point M, where there is a dark line.

Dark line responsible the interference minimum.

Condition of interference minimum:

$n\Delta r = (2k+1)\frac{\lambda}{2}$ (1),

where Δr is the geometric difference at which the waves come to the point M from S_1 and S_2, n is the absolute index of refraction, λ is the wavelength of light, k=0, ±1, ±2, … (the number of minimum)

From Figure $\Rightarrow$ the similarity of triangles (by two angles):

$\Delta OO_1M \sim \Delta S_1NS_2$

$\frac{S_1S_2}{MO} = \frac{S_2N}{O_1M}$ (2)

Of (2) and Figure $\Rightarrow \frac{d}{MO} = \frac{\Delta r}{x}$ (3)

Since d<<L, then $MO \approx L$ (4)

(4) in (3): $\frac{d}{L} = \frac{\Delta r}{x}$ (5)

Of (5) $\Rightarrow \Delta r = \frac{d}{L}x$ (6)

(6) in (1): $n\frac{d}{L}x_k = (2k+1)\frac{\lambda}{2}$ (7)

Of (7) $\Rightarrow x_k = \frac{(2k+1)\frac{\lambda}{2}}{n\frac{d}{L}}$ (8)

Of (8) $\Rightarrow x_k = \frac{(2k+1)\lambda L}{2nd}$ (9)

Of (9) $\Rightarrow x_{k+1} = \frac{(2(k+1)+1)\lambda L}{2nd}$ (10)

$\Delta x = x_{k+1} - x_k$ (11)

(9) and (10) in (11): $\Delta x = \frac{\lambda L}{nd}$ (12)

Of (12) $\Rightarrow$ $\Delta x = 0.752\times10^{-3}$ m

Answer:

0.752×10^{-3} m