Answer on Question #67025, Physics / Optics

Light from a mercury lamp falls on two slits separated by 0.6 mm, and the resulting interference pattern is observed on a screen 2.5 m away from the slits. If the adjacent bright fringes are separated by 2.27 mm, what is the wavelength of the light?

Find: λ – ?

Given:

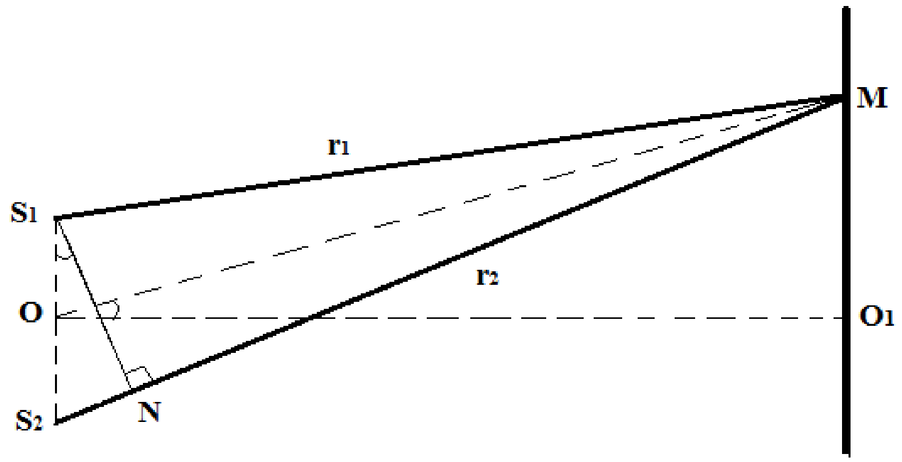
$d=0.6\times10^{-3}$ m

$L=2.5$ m

$\Delta x=2.27\times10^{-3}$ m

$n=1.0$

Solution:



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 maximum:

$n\Delta r = k\lambda$ (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):

$\Delta OO_1M \sim \Delta S_1NS_2$

$\frac{S_1 S_2}{MO} = \frac{S_2 N}{O_1 M}$ (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): $n \frac{d}{L} x_k = k\lambda$ (7)

Of (7) $\Rightarrow$ $x_k = \frac{k\lambda L}{nd}$ (8)

Of (7) $\Rightarrow$ $x_{k+1} = \frac{(k+1)\lambda L}{nd}$ (9)

$\Delta x = x_{k+1} - x_k$ (10)

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

Of (11) $\Rightarrow$ $\lambda = \frac{nd\Delta x}{L}$ (12)

Of (12) $\Rightarrow$ $\lambda = 544.8 \times 10^{-9}$ m

Answer:

544.8×10^{-9} m