NCERT 12.10 5Q

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Question: In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is K units. What is the intensity of light at a point where path difference is $\lambda/3$?

Solution:

Parameter	Description	Value
$y_i(t)$	Equation of light from $S_{i^{\text{th}}}$	$A\sin(\omega t - kx_i)$
k	Wave number	$\frac{2\pi}{\lambda}$
I	Intensity of wave	kA^2
$\Delta x = x_1 - x_2$	Path difference	λ
		$\frac{\lambda}{3}$
K	Intensity of light at $\Delta x = \lambda$	
A	Amplitude of wave from source	

TABLE 1

From Table 1:

$$y(t) = A\sin(2\pi f t - kx_1) + A\sin(2\pi f t - kx_2) \tag{1}$$

$$y(t) = 2A\cos\left(\frac{k\Delta x}{2}\right)\sin\left(2\pi f t - \frac{k(x_1 + x_2)}{2}\right) \tag{2}$$

From Table 1 & equation (2):

$$\therefore I \propto 4A^2\cos^2\left(\frac{k\Delta x}{2}\right) \tag{3}$$

From Table 1 & equation (3):

$$\frac{K}{I_r} = \frac{4A^2\cos^2\left(\frac{2\pi}{2}\right)}{4A^2\cos^2\left(\frac{\pi}{3}\right)} \implies I_r = \frac{K}{4} \tag{4}$$

Hence, the Intensity of light at a point where path difference is $\frac{\lambda}{3}$ is $\frac{K}{4}$ units.

Parameter	Description	Value
I_r	Net Intensity of light at $\Delta x = \frac{\lambda}{3}$	$\frac{K}{4}$

TABLE 2