NCERT 12.10. Q2

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Q:In a Young's double-slit experiment, the slits ar e separated by 0.28 mm and the screen is placed 1.4 m away. The distance between the central bright fringe and the fourth bright fringe is measured to be 1.2 cm. Determine the wavelength of light used in the experiment.

Solution:

Consider Young's double-slit experiment with two slits separated by a distance d, illuminated by light of wavelength λ. The interference pattern on a screen located at a distance L from the slits exhibits bright and dark fringes.

Let m be the order of the fringe. The path difference (Δx) between light waves from the two slits reaching a point on the screen is given by:

$$\Delta x = m\lambda$$

The angle (θ) between the central maximum and the m-th bright fringe can be expressed as:

$$\tan\theta = \frac{\Delta x}{L}$$

Now, the distance (Δy_m) between the central bright fringe ($m = 0$) and the m-th bright fringe on the screen is given by:

$$\Delta y_m = L\tan\theta$$

Substitute the expression for $\tan\theta$ using the path difference:

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

Therefore, the distance between the central bright fringe and the m-th bright fringe is given by the formula:

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

$$\lambda = \frac{\Delta y_m d}{mL}$$

Given:

$$d = 0.28mm \quad = 28\times10^{-5}$$

$$L = 1.4m$$

$$m = 4$$

$$\Delta y_4 = 1.2cm = 12\times10^{-3}$$

$$\therefore\ \lambda = \frac{\Delta y_m d}{mL}$$

$$= \frac{12\times10^{-3}\times28\times10^{-5}}{4\times1.4}$$

$$= 6\times10^{-7}$$

$$= 600nm$$

Therefore,the value of wavelength is 600nm.

Variable	Description	Value
d	Distance between two slits	0.28mm
λ	wavelength of light	none
m	order of fringe	4
θ	Angle between central maximum and nth bright fringe	none
Δx	Path difference between light from two slits	none
L	Distance between screen and slits	1.4m
Δy_m	Distance between central bright fringe and mth bright fringe	none

TABLE 0
VARIABLES AND THEIR VALUES