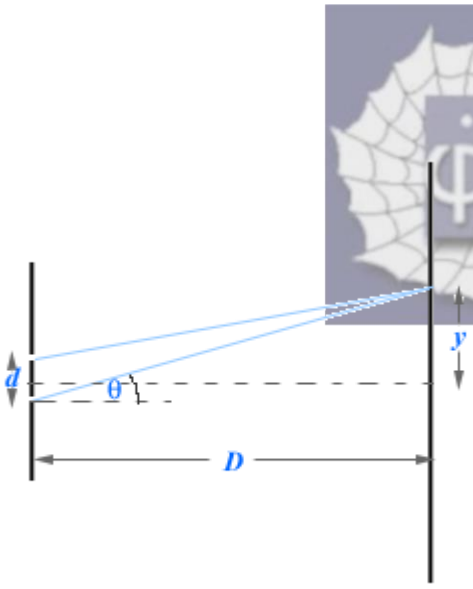
630.

Problem 45.9 (RHK)

If the distance between the first and the tenth minima of a double-slit pattern is 18 mm *and the slits are separated by* 0.15 mm *with the screen* 50 cm *from the slits, we have to find the wavelength of the lights used.*



Solution:

In a double-slit experiment the condition for interference minima is

$$d\sin\theta = (m+1/2)\lambda,\ m = 0,1,2,3...$$

We assume that the angle θ is small, and approximate

$$\sin\theta;\ \theta = \frac{y}{D},$$

where y is the distance of interference minima measured from the centre of the screen, as shown in the figure, and D is the distance of the screen from the slits.

We note that the first and the tenth minima satisfy the following conditions:

$$d\frac{y_1}{D}=\frac{\lambda}{2},$$

$$d\frac{y_{10}}{D}=\frac{19\lambda}{2}.$$

$$\therefore\ (y_{10}-y_1)\times\frac{d}{D}=9\lambda,$$

or

$$\lambda=(y_{10}-y_1)\times\frac{d}{9D}.$$

We are given that

$$(y_{10}-y_1)=18\text{ mm}=18\times10^{-3}\text{ m},$$

$$D=50\text{ cm}=0.5\text{ m, and}$$

$$d=0.15\text{ mm}=0.15\times10^{-3}\text{ m.}$$

Therefore,

$$\lambda=(y_{10}-y_1)\times\frac{d}{9D}=\frac{18\times10^{-3}\times0.15\times10^{-3}}{9\times0.5}\text{ m}$$

$$=0.6\times10^{-6}\text{ m}=600\text{ nm.}$$