DPP 04

SOLUTION

1. Width of central bright fringe $= \frac{2\lambda D}{d} = \frac{2 \times 500 \times 10^{-9} \times 80 \times 10^{-2}}{0.20 \times 10^{-3}} = 4 \times 10^{-3} m = 4\,mm.$

2. Distance between the first dark fringes on either side of central maxima = width of central maxima $= \frac{2\lambda D}{d}$

3. $y \simeq 2.5 \frac{\lambda f}{a} \Rightarrow \lambda = \frac{ay}{2.5f} = \frac{0.5 \times 2 \times 10^{-6}}{2.5 \times 1} = 400nm$

4. For first minima $\theta = \frac{\lambda}{a}$ or $a = \frac{\lambda}{\theta}$

5. Using $d \sin\theta = n\lambda$, for n = 1

6. Angular width $= \frac{2\lambda}{d} = \frac{2 \times 6000 \times 10^{-10}}{12 \times 10^{-5} \times 10^{-2}} = 1\,rad$

7. For n^{th} secondary maxima path difference

   $D \sin\theta = (2n + 1)\frac{\lambda}{2}$

   $a \sin\theta = \frac{3\lambda}{2}$

8. In a single slit, for a destructive interference, $d \sin\theta = n\lambda$

   For second minima, $d \sin\theta = 2\lambda$ .....(i)

   Here $\theta = 60°, \lambda = 6000 \times 10^{-8} cm$

   From eqn. (i), $d \sin 60° = 2 \times 6000 \times 10^{-8}$

   $d = 13.85 \times 10^{-5} cm$

   For first minima, n=1

   $d \sin\theta_1 = 1\lambda$ .....(ii)

   Using value of 'd' and 'λ' in eqn. (ii), we get

   $\sin\theta_1 = \frac{6000 \times 10^{-8} cm}{13.85 \times 10^{-5} cm} = 0.4332$

   $\theta_1 = 25.67° \simeq 25°$

9. If the angular position of second minima from central maxima is θ then,

   $\sin\theta = \frac{2\lambda}{a} = \frac{2 \times 550 \times 10^{-9}}{22 \times 10^{-7}} = \frac{1}{2}$

   $\theta = \frac{\pi}{6} rad$

10. For single slit diffraction, $\sin\theta = \frac{n\lambda}{b}$

    Position of nth minima from central maxima $= \frac{n\lambda b}{b}$

    When n = 2, then $x_2 = \frac{2\lambda D}{b} = 0.03$ ......(i)

When n = 4, then $x_4 = \dfrac{4\lambda D}{b} = 0.06$ …….. (ii)

Eqn. (ii) – Eqn. (i)

$x_4 - x_2 = \dfrac{4\lambda D}{b} - \dfrac{2\lambda D}{b} = 0.03$ or $\dfrac{\lambda D}{b} = \dfrac{0.03}{2}$

Then width of central maximum

$= \dfrac{2\lambda D}{b} = 2 \times \dfrac{0.03}{2} = 0.03\text{m} = 3\text{cm}$

11.   Here, $d = 0.1\text{mm}, \lambda = 6000\text{Å}, D = 0.5\text{m}$

For third dark band, $d \sin\theta = 3\lambda$; $\sin\theta = \dfrac{3\lambda}{d} = \dfrac{y}{D}$

$y = \dfrac{3D\lambda}{d} = \dfrac{3 \times 0.5 \times 6 \times 10^{-7}}{0.1 \times 10^{-3}} = 9 \times 10^{-3}\text{m} = 9\text{mm}$

12.   For diffraction pattern

$I = I_0 \left(\dfrac{\sin\phi}{\phi}\right)^2$ where ϕ denotes path difference.

For principal maxima, $\phi = 0$. Hence $\left(\dfrac{\sin\phi}{\phi}\right) = 1$

Hence intensity remains constant at I_0

$I = I_0(1) = I_0$