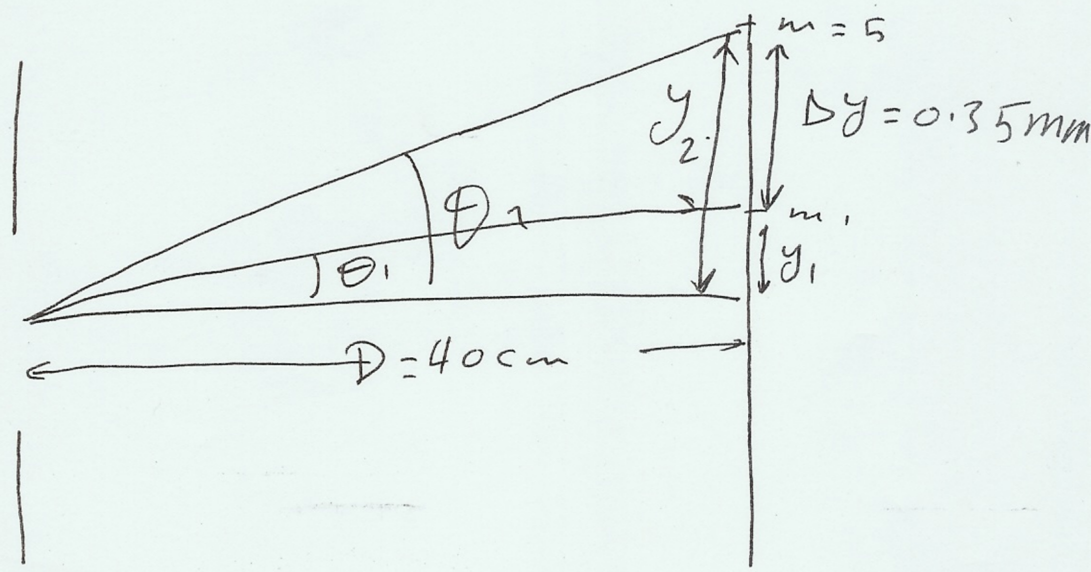
CH # 36
H.W. Solution

6



$a \sin\theta_1 = \lambda$ 1^{st} minima

$a \sin\theta_2 = 5\lambda$ 5^{th} minima

$$\frac{\sin\theta_2}{\sin\theta_1} = 5$$

or $$\frac{y_2}{\sqrt{D^2+y_2^2}} \cdot \frac{\sqrt{D^2+y_1^2}}{y_1} = 5 \quad (1)$$

but $y_2 - y_1 = \Delta y = 0.35 \times 10^{-3}$ m

$y_2 = y_1 + \Delta y$.

substitute in Eq #1

and find y_1.

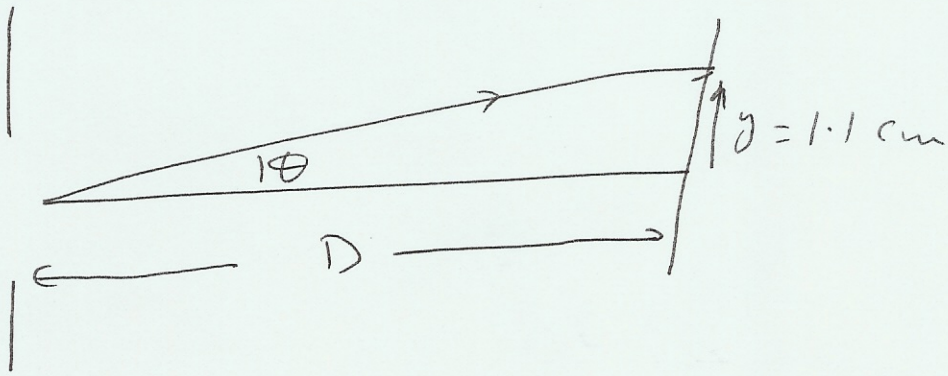
Knowing y_1 we can find

$\sin\theta_1$

then we can find

a.

#11



$a = 0.025$ mm.

$D = 3.5$ m

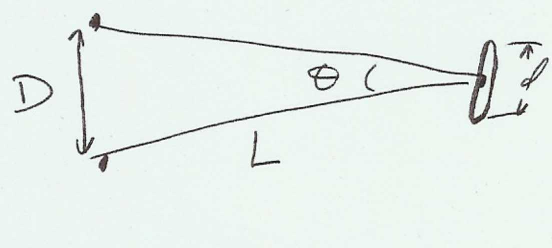
a. $\tan\theta = \dfrac{y}{D}$

b. $\alpha = \dfrac{\pi a}{\lambda}\sin\theta$.

c. $\dfrac{I(\theta)}{I_0} = \left(\dfrac{\sin\alpha}{\alpha}\right)^2$,

~~θ~~ α - is in radians.

#18.



$D = ?$
$L = 400$ km
$d = 5$ mm.

$\theta_R = 1.22\dfrac{\lambda}{d}$

But $\theta_R = \dfrac{D}{L}$

$\therefore \dfrac{D}{L} = 1.22\dfrac{\lambda}{d}$

$D = 1.22\dfrac{\lambda L}{d}$

#18 cont

$$D = 1.22 \times \frac{550 \times 10^{-9} \times 400 \times 10^{3}}{5 \times 10^{-3}}$$

$$= 1.22 \times \frac{550}{5} \times 400 \times 10^{-3}$$

$$= 53.68\ m$$

c. He can resolve the length of the wall.

c. NO

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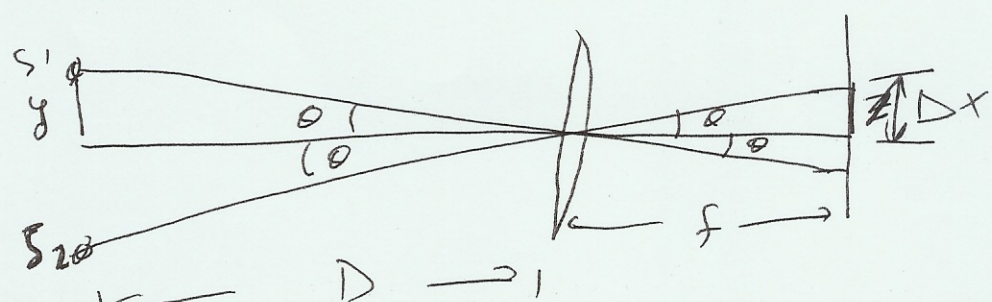
#27



a. $\theta = \theta_R = 1.22 \frac{\lambda}{d} = 1.22 \times \frac{550 \times 10^{-9}}{76 \times 10^{-2}}$

$= 8.83 \times 10^{-7}$ rad.

b. $\theta = \frac{y}{D}$, D = 10 Light year

$= 10 \times 3 \times 10^{8} \times 360 \times 24 \times 3600$

$y = D \times \theta = 8.83 \times 10^{-7} \times 3 \times 10^{9} \times 360 \times 24 \times 3600$

$= \cancel{26.41 \times 10^{+12}}$ $= \cancel{2649\ m}$

#27 cont.

Distance between S1 and S2

$= 2y = 8.4 \times 10^7$ km.

c. $\theta = \frac{\Delta x}{f}$

$\Delta x = f \times \theta$

$= 14 \times 8.83 \times 10^{-7} = 123.6 \times 10^{-7}$ m

$= 123.6 \times 10^{-4}$ mm

diameter of the 1st ring

is $= 2\Delta x$

$= 2 \times 1.23 \times 10^{-2}$ mm

$= \sim \cancel{24.6}\ 2.46 \times 10^{-2}$ mm

$\simeq .025$ mm

#33.

$$d\sin\theta = m\lambda$$

a. $$a\sin\theta = \lambda$$

$$m = \frac{d}{a} = \frac{0.15\times10^{-3}}{30\times10^{-6}} = 5$$

Note that the fifth bright fringe is exactly at the diffraction minima, so it will be eliminated.

So the total bright fringe in either half of the differaction envelope is 4.

So the total number including the central maxima is 9.

b. $$I = I_0\left(\frac{\sin\alpha}{\alpha}\right)^2\left(\cos(\beta)\right)^2$$

$$\alpha = \frac{\pi a}{\lambda}\sin\theta$$

$$\beta = \frac{\pi d}{\lambda}\sin\theta$$

For the third bright fringe, we have

$$d\sin\theta = 3\lambda$$

$$\sin\theta = \frac{3\lambda}{d}$$

$$\therefore \alpha = \frac{\pi a}{\lambda}\cdot\frac{3\lambda}{d} = \frac{3\pi a}{d} \text{ radians.}$$

$$\beta = \frac{\pi d}{\lambda}\cdot\frac{3\lambda}{d} = 3\pi$$

$$\therefore \frac{I}{I_0} = \left(\frac{\sin\left(\frac{3\pi a}{d}\right)}{\quad}\right)^2\cos^2(3\pi) = \left(\frac{\sin\left(\frac{3\pi a}{d}\right)}{\quad}\right)^2$$

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N = number of rulings

$= \dfrac{\text{width}}{\text{distance between them}}$

$= \dfrac{300 \times 10^{-3}}{900 \times 10^{-9}} = \frac{1}{3} \times 10^{6}$

$= 33333$

a. $d \sin\theta = m\lambda$

$\theta = \frac{\pi}{2}$

$m = \frac{d}{\lambda} = \dfrac{300 \times 10^{-3}}{600 \times 10^{-6}} = 0.5 \times 10^{3}$

$= 500$

b. $\Delta\theta_{hw} = \dfrac{\lambda}{Nd\cos\theta}$

$\lambda = 600 \times 10^{-9}\,m$

$N = 1000$

$d = 900 \times 10^{-9}\,m$

$\sin\theta = \frac{\lambda}{d}$

$\cos\theta = \sqrt{1 - (\frac{\lambda}{d})^2}$

$\Delta\theta_{hw} =$

$\therefore$ the angular width of the full centeral maxima

$= 2(\Delta\theta_1) = -$

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$R = \dfrac{\lambda_{avg}}{\Delta\lambda} = \dfrac{656.3}{0.18}$ --

$R = N \quad , m = 1$

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$2d \sin\theta = \lambda$

$d = 39.8 \times 10^{-12}$ m

$\sin\theta = \frac{1}{2}$

$\therefore \lambda = 39.8 \times 10^{-12}$ m

$= 39.8$ pm

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