Ch. 4 Prob. 26 (#1)

$\theta_1 = 14.5°$

a) Find the angle of the second-order minimum.

Begin with $D \sin\theta = m\lambda$

with the first-order minimum

$D_1 \sin\theta_1 = 1 \cdot \lambda_1$

and the second-order minimum

$D_2 \sin\theta_2 = 2 \cdot \lambda_2$

But the wavelength does not change. Neither the size of the slit.

Therefore $D_1 = D_2 = D$ & $\lambda_1 = \lambda_2 = \lambda$

our equations now become

$D \sin\theta_1 = \lambda$ & $D \sin\theta_2 = 2\lambda$

Divide the first equation by the second gives

$$\frac{D \sin\theta_1 = \lambda}{D \sin\theta_2 = 2\lambda} \rightarrow \frac{D \sin\theta_1}{D \sin\theta_2} = \frac{\lambda}{2\lambda}$$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{1}{2}$$

Solve for $\theta_2 \rightarrow$ $\cancel{\sin\theta_2}$ $2\sin\theta_1 = \sin\theta_2$

$$\theta_2 = \sin^{-1}(2\sin(14.5°)) = \boxed{30.1°}$$

b) Find the angle of the 3rd-order minimum.

Use the same process results in

$$\frac{\sin\theta_1}{\sin\theta_3} = 1/3 \rightarrow \theta_3 = \sin^{-1}(3\sin(14.5))$$

$$= \boxed{48.7°}$$

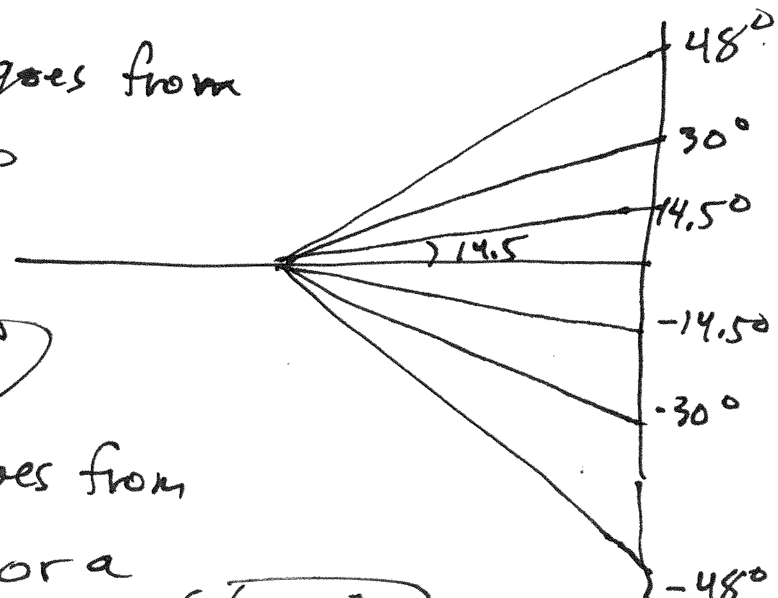
c) Is there a 4th-order minimum?

Use the same process as part a gives

$$\frac{\sin\theta_1}{\sin\theta_4} = \frac{1}{4} \rightarrow \theta_4 = \sin^{-1}(4\sin(14.5))$$
$$= \sin^{-1}(1.0015)$$

can't take the arcsin of a number greater than 1.00, so there is no 4th-order minimum.

d) Illustrate how the angular width of the central maximum is ~2x the angular width of the next maximum



The central peak goes from -14.5° to 14.5° or a difference in angle of 29°

The next peak goes from 14.5° to 30° or a difference in angle of 15.5°

This is roughly ½ the width of the central peak.