Quiz 7

Problem 1 (Ch. 35, Problem # 7)

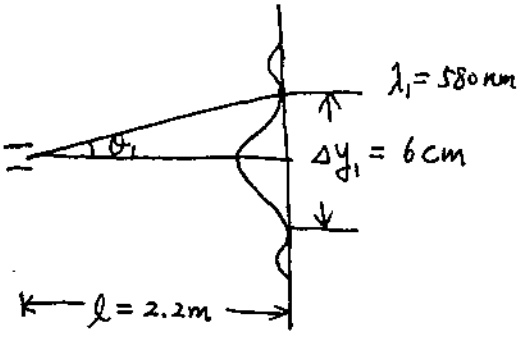
If a slit diffracts 580-nm light so that the diffraction maximum is 6 cm wide on a screen 2.2 m away, what will be the width of the diffraction maximum for light with a wavelength of 460 nm?

Solution: $\tan\theta_1 = \frac{\frac{1}{2}\Delta y_1}{\ell} \Rightarrow \theta_1 \approx 0.78^\circ$

$\sin\theta_1 = \frac{\lambda_1}{D} \Rightarrow 42,537\ \text{nm} = D$

$\sin\theta_2 = \frac{\lambda_2}{D} \Rightarrow \theta_2 = 0.62^\circ$

$\tan\theta_2 = \frac{\frac{1}{2}\Delta y_2}{\ell} \Rightarrow \Delta y_2 = 2\ell\tan\theta_2 = \boxed{4.8\ \text{cm}}$



Problem 2 (Ch. 35, Problem # 35)

Red laser light from He-Ne laser ($\lambda = 632.8$ nm) is used to calibrate a diffraction grating. The light creates a second-order fringe at 53.2° after passing through the grating. The light of an unknown wavelength λ creates a first-order fringe at 20.6°. Find λ.

Solution: $\begin{cases}\theta_1 = 20.6^\circ \\ \lambda_1 = ?\end{cases}$, $\begin{cases}\theta_2 = 53.2^\circ \\ \lambda_2 = 632.8\ \text{nm}\end{cases}$

$$\begin{cases} d\sin\theta_1 = 1\cdot\lambda_1 \\ d\sin\theta_2 = 2\cdot\lambda_2 \end{cases}$$

$$\Rightarrow \frac{\lambda_1}{2\lambda_2} = \frac{\sin\theta_1}{\sin\theta_2} \Rightarrow \lambda_1 = 2\frac{\sin\theta_1}{\sin\theta_2}\cdot\lambda_2 = 2\cdot\frac{\sin 20.6^\circ}{\sin 53.2^\circ}\cdot 632.8\ \text{nm} = \boxed{556\ \text{nm}}$$

Problem 3 (Ch. 35, Problem # 42)

The first-order line of 589-nm light falling on a diffraction grating is observed at a 16.5° angle. How far apart are the slits? At what angle will the third order be observed?

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

$d\sin\theta_1 = 1\cdot\lambda$

$\Rightarrow d = \frac{\lambda}{\sin\theta_1} = \frac{589\ \text{nm}}{\sin 16.5^\circ} = 2.07\ \mu\text{m}$

$\Rightarrow \theta_3 = \sin^{-1}\left(\frac{3\cdot\lambda}{d}\right)$

$= \sin^{-1}\left(\frac{3\times 589\ \text{nm}}{2074\ \text{nm}}\right) = 58.4^\circ$