For $m = 2$:

$$\theta_2 = \sin^{-1}\left(\frac{2\lambda}{d}\right)$$

$$\theta_2 = \sin^{-1}\left(\frac{2(6.328 \times 10^{-7}\ \text{m})}{\dfrac{1}{150\ 500}\ \text{m}}\right)$$

$$\boxed{\theta_2 = 10.98°}$$

CALCULATOR SOLUTION

Because the minimum number of significant figures for the data is four, the calculator answers 5.464926226 and 10.98037754 should be rounded to four significant figures.

4. EVALUATE The second-order maximum is spread slightly more than twice as far from the center as the first-order maximum. This diffraction grating does not have high dispersion, and it can produce spectral lines up to the tenth-order maxima (where $\sin \theta = 0.9524$).

PRACTICE B

Diffraction Gratings

1. A diffraction grating with 5.000×10^3 lines/cm is used to examine the sodium spectrum. Calculate the angular separation of the two closely spaced yellow lines of sodium (588.995 nm and 589.592 nm) in each of the first three orders.

2. A diffraction grating with 4525 lines/cm is illuminated by direct sunlight. The first-order solar spectrum is spread out on a white screen hanging on a wall opposite the grating.

a. At what angle does the first-order maximum for blue light with a wavelength of 422 nm appear?

b. At what angle does the first-order maximum for red light with a wavelength of 655 nm appear?

3. A grating with 1555 lines/cm is illuminated with light of wavelength 565 nm. What is the highest-order number that can be observed with this grating? (Hint: Remember that $\sin \theta$ can never be greater than 1 for a diffraction grating.)

4. Repeat item 3 for a diffraction grating with 15 550 lines/cm that is illuminated with light of wavelength 565 nm.

5. A diffraction grating is calibrated by using the 546.1 nm line of mercury vapor. The first-order maximum is found at an angle of 21.2°. Calculate the number of lines per centimeter on this grating.