22.13. **Model:** A diffraction grating produces an interference pattern.
Visualize: The interference pattern looks like the diagram of Figure 22.8.
Solve: The bright interference fringes are given by

$$d\sin\theta_m = m\lambda \quad m = 0,\ 1,\ 2,\ 3,\ \ldots$$

The slit spacing is $d = 1\text{ mm}/500 = 2.00\times10^{-6}\text{ m}$ and $m = 1$. For the red and blue light,

$$\theta_{1\text{ red}} = \sin^{-1}\left(\frac{656\times10^{-9}\text{ m}}{2.00\times10^{-6}\text{ m}}\right) = 19.15^\circ \qquad \theta_{1\text{ blue}} = \sin^{-1}\left(\frac{486\times10^{-9}\text{ m}}{2.00\times10^{-6}\text{ m}}\right) = 14.06^\circ$$

The distance between the fringes, then, is $\Delta y = y_{1\text{ red}} - y_{1\text{ blue}}$ where

$$y_{1\text{ red}} = (1.5\text{ m})\tan 19.15^\circ = 0.521\text{ m}$$
$$y_{1\text{ blue}} = (1.5\text{ m})\tan 14.06^\circ = 0.376\text{ m}$$

So, $\Delta y = 0.145\text{ m} = 14.5\text{ cm}$.