18. The wavelength of the laser beam used in a compact disc player is 780 nm. Suppose that a diffraction grating produces first-order tracking beams that are 1.2 mm apart at a distance of 3.0 mm from the grating. Estimate the spacing between the slits of the grating.

For a diffraction grating the condition for bright spots is given by

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

Since we want the first order brights. Solve for the grating spacing

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

So we need the angle. We know the tangent is

$$\tan(\theta) = \frac{y}{L} = \frac{s/2}{L}$$

We need the angle between the central max and the first bright. So we need half the spacing of the two first order brights.

$$\theta = \tan^{-1}\left(\frac{s/2}{L}\right) = \tan^{-1}\left(\frac{1.2\ mm/2}{3.0\ mm}\right) = \tan^{-1}(0.200) = 11.3°$$

Now we can plug in for grating spacing

$$d = \frac{\lambda}{\sin(\theta)} = \frac{780\ x\ 10^{-9}\ m}{\sin(11.3°)} = 3.98\ x\ 10^{-6}\ m$$

$$\boxed{d = 4.0\ x\ 10^{-6}\ m}$$