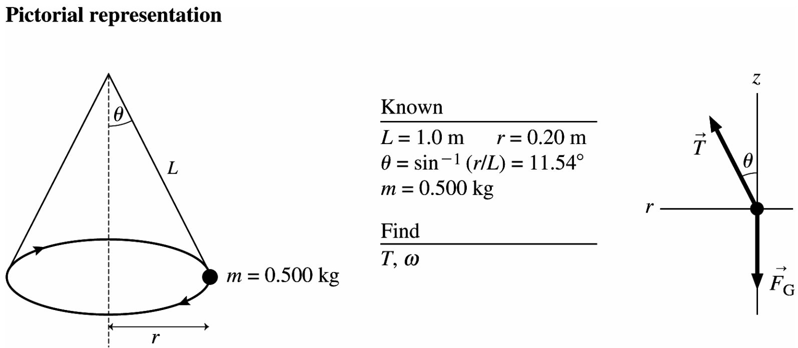
8.35. Model: Use the particle model for the ball in circular motion.

Visualize:



Solve: **(a)** The mass moves in a *horizontal* circle of radius $r = 20$ cm. The acceleration $\vec{a}$ and the net force vector point to the center of the circle, *not* along the string. The only two forces are the string tension $\vec{T}$, which does point along the string, and the gravitational force $\vec{F}_G$. These are shown in the free-body diagram. Newton's second law for circular motion is

$$\sum F_z = T\cos\theta - F_G = T\cos\theta - mg = 0 \text{ N} \quad \sum F_r = T\sin\theta = ma_r = \frac{mv^2}{r}$$

From the z-equation,

$$T = \frac{mg}{\cos\theta} = \frac{(0.500 \text{ kg})(9.8 \text{ m/s}^2)}{\cos 11.54°} = 5.00 \text{ N}$$

(b) We can find the tangential speed from the r-equation:

$$v = \sqrt{\frac{rT\sin\theta}{m}} = 0.63 \text{ m/s}$$

The angular speed is

$$\omega = \frac{v}{r} = \frac{0.63 \text{ ms}}{0.20 \text{ m}} = 3.15 \text{ rad/s} = 30 \text{ rpm}$$