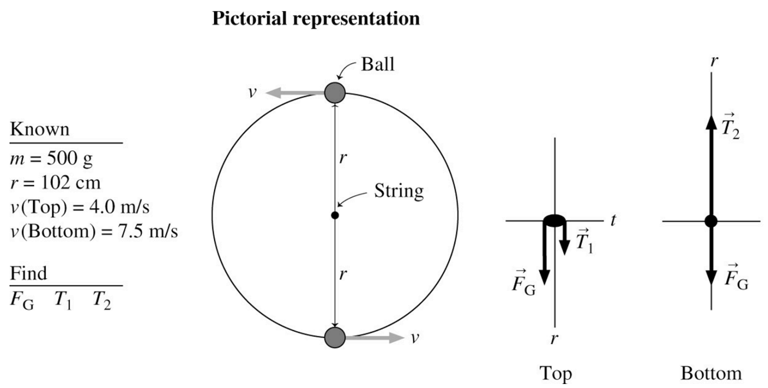
# Solutions to HW13, Chapter 8

NOTE! The problems in masteringphysics.com had their numbers altered slightly for each individual student. The solutions below use the same numbers as those used in the book for that problem!

**8.25. Model:** Model the ball as a particle that is moving in a vertical circle.
**Visualize:**




**Solve:** **(a)** The ball's gravitational force $F_G = mg = (0.500\text{ kg})(9.8\text{ m/s}^2) = 4.9\text{ N}$.

**(b)** Newton's second law at the top is

$$\sum F_r = T_1 + F_G = ma_r = m\frac{v^2}{r}$$

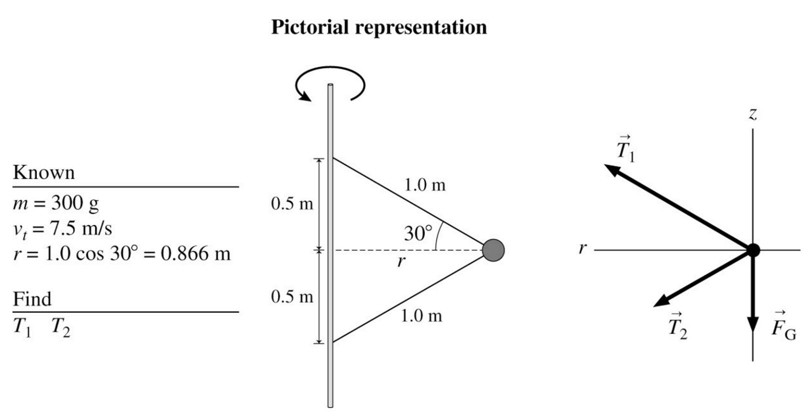
$$\Rightarrow T_1 = m\left(\frac{v^2}{r} - g\right) = (0.500\text{ kg})\left[\frac{(4.0\text{ m/s})^2}{1.02\text{ m}} - 9.8\text{ m/s}^2\right] = 2.9\text{ N}$$

**(c)** Newton's second law at the bottom is

$$\sum F_r = T_2 - F_G = \frac{mv^2}{r}$$

$$\Rightarrow T_2 = m\left(g + \frac{v^2}{r}\right) = (0.500\text{ kg})\left[9.8\text{ m/s}^2 + \frac{(7.5\text{ m/s})^2}{1.02\text{ m}}\right] = 32\text{ N}$$

**8.46. Model:** Use the particle model for a sphere revolving in a horizontal circle.
**Visualize:**




**Solve:** Newton's second law in the $r$- and $z$-directions is

$$\Sigma(F)_r = T_1\cos30° + T_2\cos30° = \frac{mv_t^2}{r} \qquad \Sigma(F)_z = T_1\sin30° - T_2\sin30° - F_G = 0 \text{ N}$$

Using $r = (1.0 \text{ m})\cos30° = 0.886 \text{ m}$, these equations become

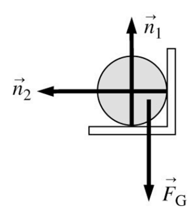
$$T_1 + T_2 = \frac{mv_t^2}{r\cos30°} = \frac{(0.300 \text{ kg})(7.5 \text{ m/s})^2}{(0.866 \text{ m})(0.866)} = 22.5 \text{ N}$$

$$T_1 - T_2 = \frac{mg}{\sin30°} = \frac{(0.300 \text{ kg})(9.8 \text{ m/s}^2)}{(0.5)} = 5.88 \text{ N}$$

Solving for $T_1$ and $T_2$ yields $T_1 = 14.2 \text{ N} \approx 14 \text{ N}$ and $T_2 = 8.3$ N.

**8.53. Model:** Model the ball as a particle in uniform circular motion. Rolling friction is ignored.
**Visualize:**

**Pictorial representation**




**Solve:** The track exerts both an upward normal force and an inward normal force. From Newton's second law,

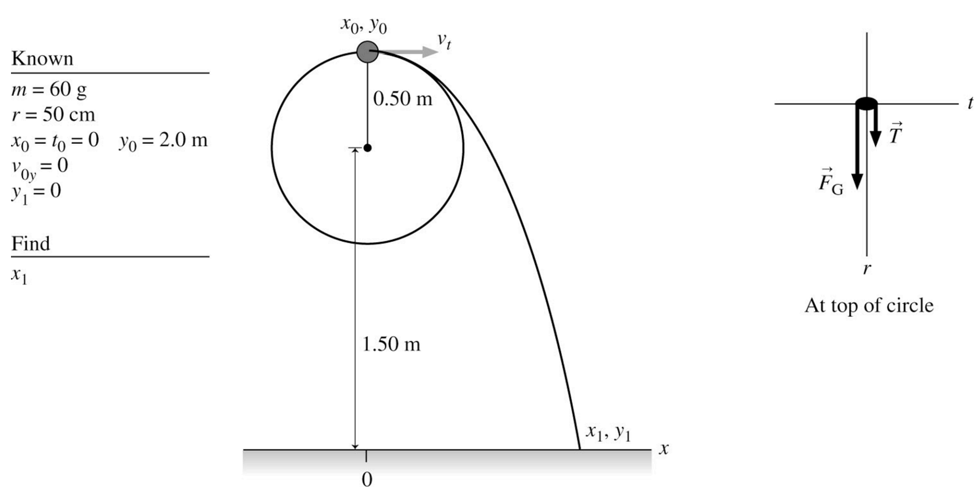
$$n_1 = mg = (0.030 \text{ kg})(9.8 \text{ m/s}^2) = 0.294 \text{ N, up}$$

$$n_2 = mr\omega^2 = (0.030 \text{ kg})(0.20 \text{ m})\left[\frac{60 \text{ rev}}{\text{min}} \times \frac{2\pi \text{ rad}}{1 \text{ rev}} \times \frac{1 \text{ min}}{60 \text{ s}}\right]^2 = 0.2369 \text{ N, in}$$

$$F_{net} = \sqrt{n_1^2 + n_2^2} = \sqrt{(0.294 \text{ N})^2 + (0.2369 \text{ N})^2} = 0.38 \text{ N}$$

**8.57. Model:** Use the particle model for a ball in motion in a vertical circle and then as a projectile.
**Visualize:**

**Pictorial representation**




**Solve:** For the circular motion, Newton's second law along the $r$-direction is

$$\sum F_r = T + F_G = \frac{mv_t^2}{r}$$

Since the string goes slack as the particle makes it over the top, $T = 0$ N. That is,

$$F_G = mg = \frac{mv_t^2}{r} \Rightarrow v_t = \sqrt{gr} = \sqrt{(9.8 \text{ m/s}^2)(0.5 \text{ m})} = 2.21 \text{ m/s}$$

The ball begins projectile motion as the string is released. The time it takes for the ball to hit the floor can be found as follows:

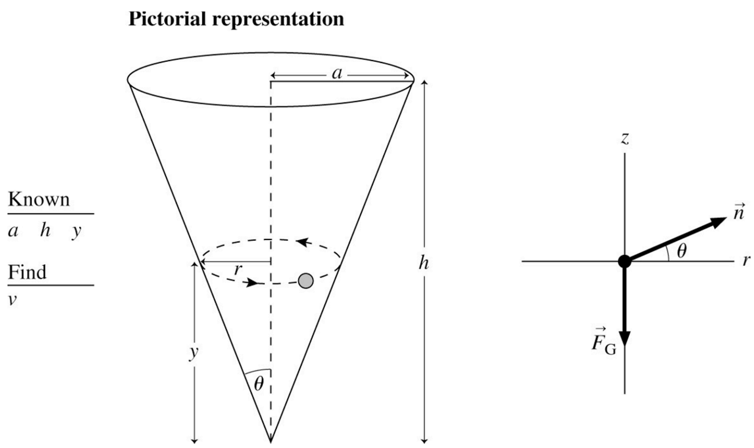
$$y_1 = y_0 + v_{0y}(t_1 - t_0) + \tfrac{1}{2}a_y(t_1 - t_0)^2 \Rightarrow 0 \text{ m} = 2.0 \text{ m} + 0 \text{ m} + \tfrac{1}{2}(-9.8 \text{ m/s}^2)(t_1 - 0 \text{ s})^2 \Rightarrow t_1 = 0.639 \text{ s}$$

The place where the ball hits the ground is

$$x_1 = x_0 + v_{0x}(t_1 - t_0) = 0 \text{ m} + (+2.21 \text{ m/s})(0.639 \text{ s} - 0 \text{ s}) = +1.41 \text{ m}$$

The ball hits the ground 1.4 m to the right of the point beneath the center of the circle.

**8.69. Model:** Use the particle model for the ball, which is in uniform circular motion.
**Visualize:**




**Solve:** From Newton's second law along $r$ and $z$ directions,

$$\sum F_r = n\cos\theta = \frac{mv^2}{r} \qquad \sum F_z = n\sin\theta - mg = 0 \Rightarrow n\sin\theta = mg$$

Dividing the two force equations gives

$$\tan\theta = \frac{gr}{v^2}$$

From the geometry of the cone, $\tan\theta = r/y$. Thus

$$\frac{r}{y} = \frac{gr}{v^2} \Rightarrow v = \sqrt{gy}$$