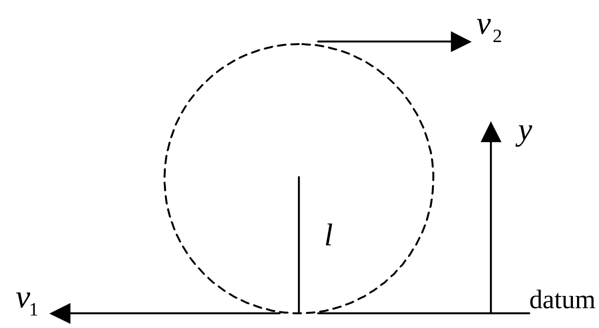
Rod vs Rope

From the discussion in class, we found that for a rod and a rope swinging in a vertical circle, the criteria for each to make a full revolution was that for the rod the velocity at the top had to be just slightly greater than zero while for the rope the tension at the top had to be just slightly greater than zero. Let's see if we can use kinetics to compare the required velocities at the bottom of the circle:



Use COE(FT) to relate an object at two different times and locations

$$\Delta E_{sys} = W = 0 \quad \Rightarrow \quad E_{K2} + E_{G2} = E_{K1} + E_{G1}$$

$$\frac{1}{2}mv_1^2 + 0 = \frac{1}{2}mv_2^2 + mg(2l)$$

Solving for v_1

$$v_1 = \sqrt{v_2^2 + 4gl} \qquad (1)$$

For the slender rod, the velocity at the top, v_2, must be just slightly greater than zero, thus substituting v_2=0 into (1) will give us the velocity that v_1 must be just slightly greater than:

$$\boxed{v_{1,rod} = \sqrt{4gl}}$$

For the rope, the tension at the top must be just slightly greater than zero, thus we need to use COLM(RF) and kinetics to relate velocity to tension:

$$\sum F_n = ma_n \quad \Rightarrow \quad mg = ma_n = m\frac{v_2^2}{r} \quad \therefore \quad v_2^2 = gr$$

Substituting into (1) and recognizing the radius of curvature to be l,

$$\boxed{v_{1,rope} = \sqrt{5gl}}$$