Problem 1

A device consists of two, one-half kilogram masses tethered to a central shaft. The tethers are each .75 meters long and each tether currently makes a 25 degree angle with the central shaft. Assume the central shaft is spinning at a constant rate. What is the rate at which the shaft is spinning? If we want it to spin at exactly 100 rpm, what should the angle of the tethers be?

\[ \Sigma F_z = T \cos(25^\circ) - (0.5)(9.81) = 0 \]

\[ T = 5.41 \text{ N} \]

\[ \Sigma F_r = -T \sin(25^\circ) = m \left( \ddot{r} - r \dot{\theta}^2 \right) \]

\[ r = 0.75 \sin(25^\circ) \]

\[ \dot{\theta} = \sqrt{\frac{(5.41) \sin(25^\circ)}{(0.5)(0.75 \sin(25^\circ))}} = 3.80 \text{ rad/s} \]
100 rpm \rightarrow 10.472 \text{ rad/s}

\[ \alpha_r = \dot{\omega} - r \ddot{\theta} = -82.25 \sin \phi \]

\[ \omega = 78 \sin \phi \]

\[ \sum F_z = T \cos (\phi) - (0.5)(9.81) = 0 \]

\[ T = \frac{4.905}{\cos (\phi)} \]

\[ \sum F_r = -T \sin (\phi) = M (-82.25 \sin \phi) \]

\[ \frac{4.905}{\cos \phi} = (0.5)(82.25) \]

\[ \cos \phi = 0.119 \]

\[ \phi = 83.15^\circ \]