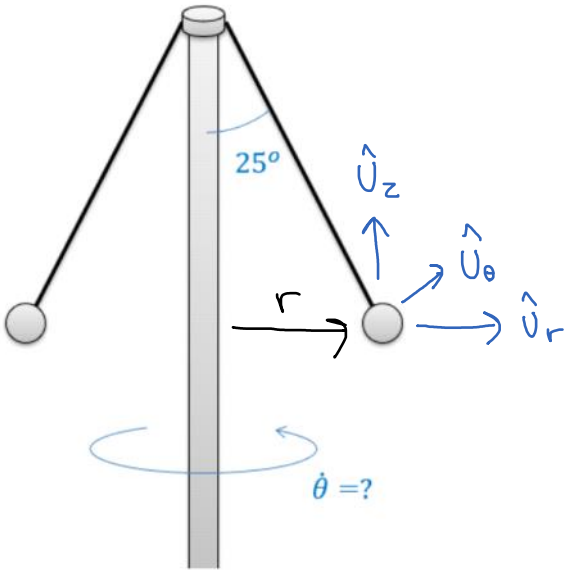
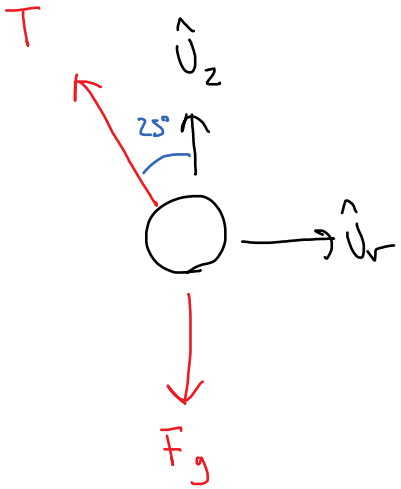
Problem 1

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?





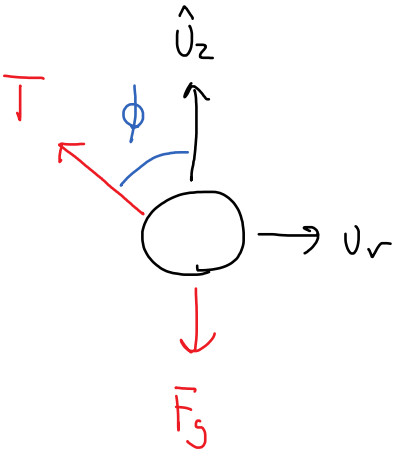
$$\Sigma F_z = T\cos(25) - (.5)(9.81) = 0$$

$$T = 5.41\ N$$

$$\Sigma F_r = -T\sin(25) = m\left(\ddot{r}^{\,0} - r\dot{\theta}^2\right)$$

$$r = .75\sin(25)$$

$$\dot{\theta} = \sqrt{\frac{(5.41)\sin(25)}{(.5)(.75\sin(25))}} = \boxed{3.80\ \text{rad/s}}$$



$100 \text{ rpm} \rightarrow 10.472 \text{ rad/s}$

$a_r = \ddot{r} - r\dot{\theta}^2 = -82.25 \sin\phi$

$.75 \sin\phi$

$\sum F_z = T\cos(\phi) - (.5)(9.81) = 0$

$T = \frac{4.905}{\cos(\phi)}$

$\sum F_r = -T\sin(\phi) = m\left(-82.25\sin\phi\right)$

$\frac{4.905}{\cos\phi} = (.5)(82.25)$

$\cos\phi = .119$

$\boxed{\phi = 83.15^\circ}$