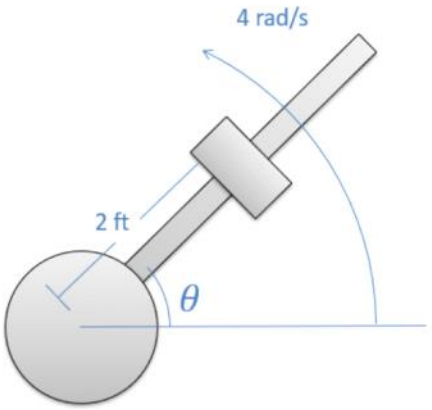
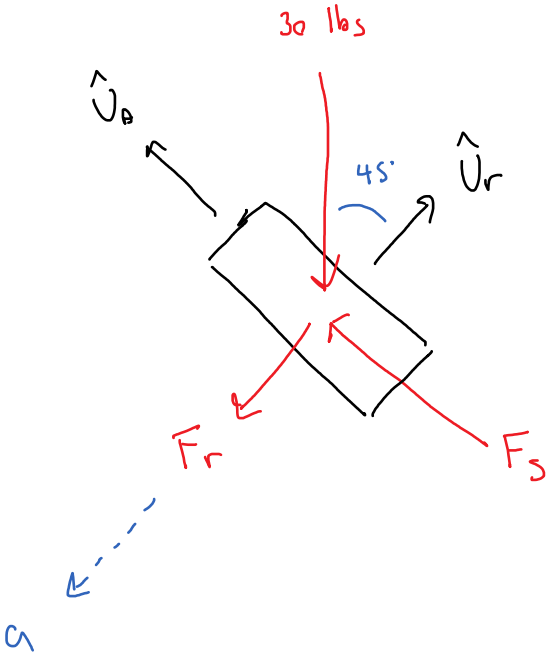
Problem 2

A catapult design consists of a steel weight on a frictionless rod. The rod spins at a constant rate of 4 radians per second and when theta is 45 degrees from horizontal, the 30 lb weight is released from its position 2 ft from the center of rotation of the shaft. What is the force the shaft exerts on the weight at the instant before and the instant after it is released? What is the acceleration of the weight along the shaft the instant after it is released?





before release

$$\sum F_r = -F_r - 30\cos(45) = m\left(\ddot{r} - r\dot{\theta}^2\right)$$

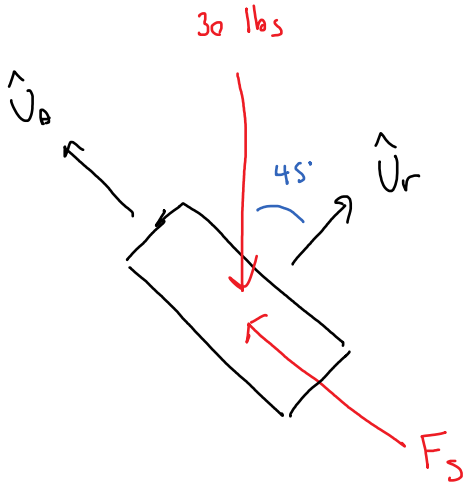
$m = \frac{30}{32.2}$, $r = 2$, $\dot{\theta} = 4$, $\ddot{r} = 0$

$$\boxed{F_r = 8.6 \text{ lbs}}$$

$$\sum F_\theta = F_s - 30\sin(45) = m\left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right)$$

$\ddot{\theta} = 0$, $\dot{r} = 0$

$$\boxed{F_s = 21.21 \text{ lbs}}$$



$$\boxed{F_r = 0}$$

$$\Sigma F_\theta = F_s - 30\sin(45) = m\left(\cancel{r\ddot{\theta}} + \cancel{2\dot{r}\dot{\theta}}\right)$$

$$\boxed{F_s = 21.2 \text{ lbs}}$$

$$\Sigma F_r = -30\cos(45) = m\left(\ddot{r} - r\dot{\theta}^2\right)$$

$\ddot{r}$?

$$\ddot{r} = -30\cos(45)\left(\frac{32.2}{30}\right) + (2)(4)^2 = \boxed{9.23 \text{ ft/s}^2}$$