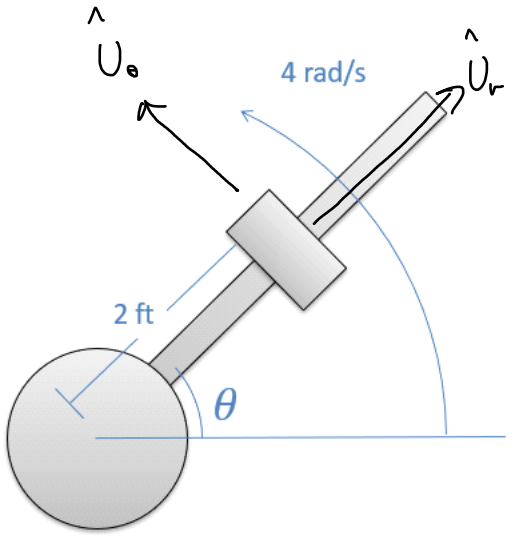
Problem 2

Kinetics with Polar Coordinates
Practice Problem

- 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?



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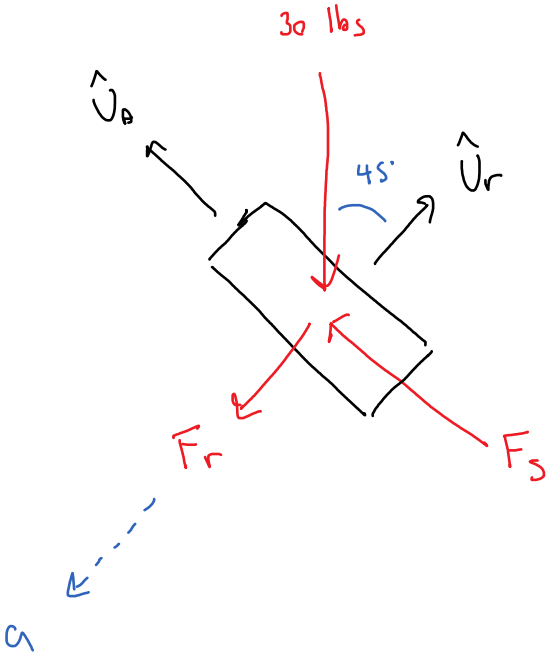
7



before release

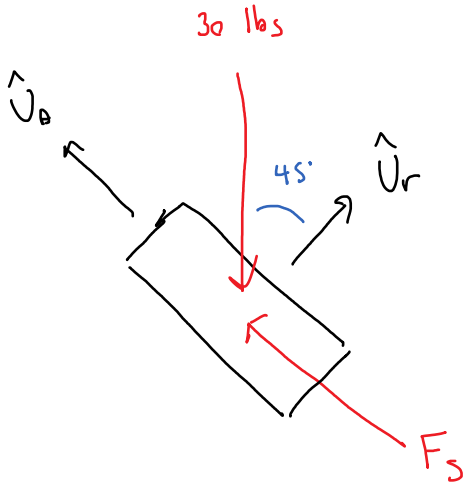
$$\sum F_r = -F_r - 30\cos(45) = m\left(\ddot{r} - r\dot{\theta}^2\right)$$

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

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

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

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



$$\boxed{F_r = 0}$$

$$\Sigma F_\theta = F_s - 30\sin(45) = m\left(\cancel{r\ddot{\theta}} + \cancel{2\dot{r}\dot{\theta}}^{\,0}\right)$$

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

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

$\ddot{r}$?

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