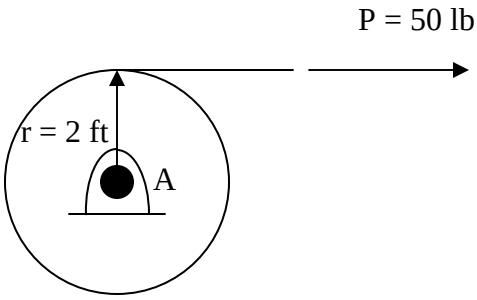
Problem 1

Given:

- k_A = 2 ft
- Weight of the disk = 400 lb
- Disk is initially at rest

Determine: The disk's angular velocity after 2 seconds.



$$I_A \omega_1 + \Sigma \int M_A dt = I_A \omega_2$$

$$0 + (50\,lb)(2\,ft)(2\,sec) = \left[\left(\frac{400\,lb}{32.2}\right)(2\,ft)^2\right] \omega_2$$

$$\omega_2 = 4{,}025\ rad/s$$

Problem 2

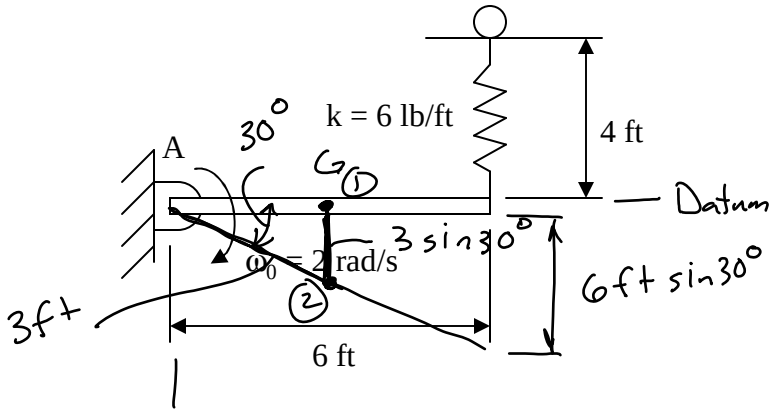
Given:

-The bar weighs 50 lb

-The spring has an unstretched length of 2 ft, and always remains vertical

-I_A = 18.63 slugs-ft^2

Determine: The angular velocity of the bar when it has rotated downward 30 degrees below the horizontal.



$T_1 + V_1 = T_2 + V_2$

$T_1 = \frac{1}{2} I_A \omega_0^2 = \frac{1}{2}(18.63)(2\ rad/s)^2 = 37.26\ N\cdot m$

$V_1 = \frac{1}{2}(6\ lb/ft)(2\ ft)^2 = 12\ N\cdot m$

$T_2 = \frac{1}{2} I_A \omega_2^2 = \frac{1}{2}(18.63)\omega_2^2 = 9.315\omega_2^2$

$V_2 = -(50\ lb)(3\ ft)(\sin 30^\circ) + \frac{1}{2}(6\ lb/ft)(2\ ft + 6\sin 30^\circ)^2$

$= 0\ N\cdot m$

$37.26 + 12 = 9.315\omega_2^2 + 0$

$\omega_2 = 2.3\ rad/s$

Problem 3

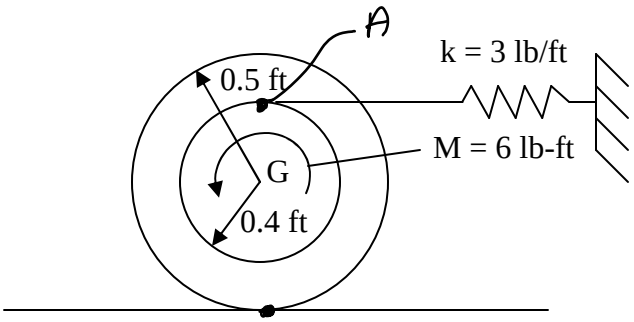
Given:

- $k_G = 0.375$ ft

- The rigid body spool has a weight of 15 lb

-The spring is initially unstretched

Determine: If the spool rolls without slipping and starts from rest, the angular velocity after the center of mass has moved 2 ft.



$$T_1 + \Sigma U_{1-2} = T_2$$

$T_1 = 0$

$$\Sigma U_{1-2} = M\theta - \frac{1}{2}ks^2$$

$$= (6\ \text{lb·ft})(4\ \text{rad}) - \frac{1}{2}(3\ \text{lb/ft})(3.6\ \text{ft})^2$$

$$= 4.56\ \text{lb·ft}$$

$$s_G = r_G\theta$$

$$\theta = \frac{s_G}{r_G} = \frac{2\ \text{ft}}{0.5\ \text{ft}}$$

$$= 4\ \text{rad}$$

$$s_A = r_A\theta$$

$$s_A = (0.9\ \text{ft})(4\ \text{rad})$$

$$= 3.6\ \text{ft}$$

$$T_2 = \frac{1}{2}I_G\omega^2 + \frac{1}{2}mv_G^2$$

$$= \frac{1}{2}\left[\left(\frac{15\ \text{lb}}{32.2}\right)(0.375\ \text{ft})^2\right]\omega_2^2 + \frac{1}{2}\left(\frac{15\ \text{lb}}{32.2}\right)\left((0.5\ \text{ft})\omega_2\right)^2$$

$$T_2 = 0.0910\,\omega_2^2$$

$$0 + 4.56 = 0.0910\,\omega_2^2$$

$$\boxed{\omega_2 = 7.08\ \text{rad/s}}$$

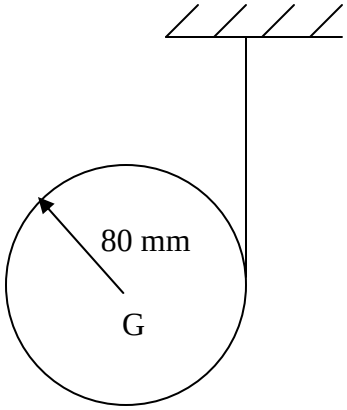
Problem 4

Given:

- $k_G = 0.0566$ m

- The rigid body spool has a mass of 2 kg

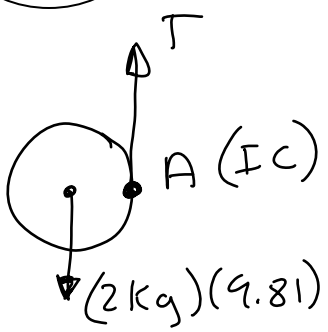
Determine: The angular velocity after ~~1~~ 3 second. The spool starts from rest.



$$(H_A)_1 + \Sigma \int M_A dt = (H_A)_2$$

$$(H_A)_1 = 0$$

$$\Sigma \int M_A dt = (19.62 \text{ Newtons})(0.08\text{m})(3\text{sec})$$



$$(H_A)_2 = I_G \omega + d m v_G$$

$$= \left[(2\text{kg})(0.0566\text{m})^2\right]\omega + (0.08\text{m})(2\text{kg})(0.08\omega)$$

$$0 + (19.62)(0.08)(3) = (2)(0.0566)^2\omega + (0.08)(2)(0.08\omega)$$

$$\boxed{\omega = 245 \text{ rad/s}}$$