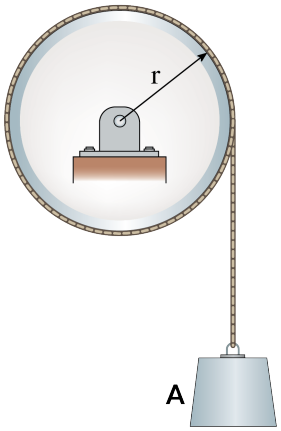
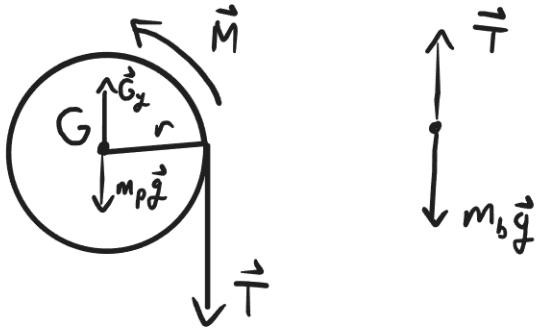
22-R-IM-TW-36



A 30 kg mass is suspended from a pulley of mass 40 kg, radius $r = 0.75$ m, and radius of gyration of $k = 0.375$ m. A constant moment (not shown) acts on the pulley so that it stays in rotational equilibrium. If the rope connecting the mass to the pulley is cut, what will the angular velocity of the pulley be 10 seconds after the rope is cut? (Use $g = 9.81$ m/s^2)

Solution:



Initial equilibrium state:

$$I_G = m_p k^2 = 5.625 \ [\text{kg} \cdot \text{m}^2]$$
$$\sum (F_y)_{\text{block}} : \ T = m_b g$$
$$\sum (M_G)_{\text{pulley}} : \ M = rT = r m_b g$$

Motion after the rope is cut at time $t_1 = 0$

$$H_{G,2} - H_{G,1} = \int_0^{t_2} M d\tau$$
$$H_{G,1} = 0$$
$$I_{G,2}\omega = M t_2 = r m_b g t_2$$

$$\vec{\omega} = \frac{r m_b g t_2}{I_G} \hat{k} = 392.4 \hat{k} \text{ [rad/s]}$$