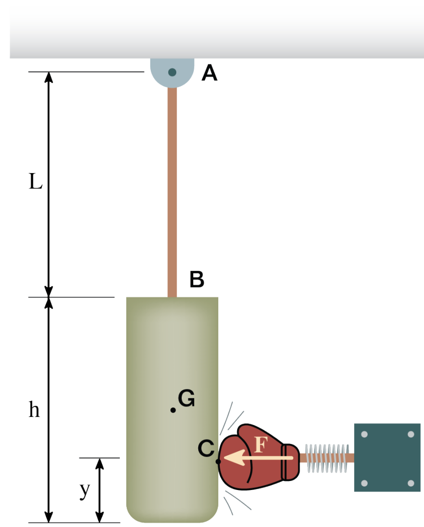
22-R-KIN-JL-10

An engineer decides to go to the gym to show off how strong the new punching machine that he built is. Everyone else in the gym is so intimidated that they back away. You watch as the engineer approaches the punching bag you were using. The punching bag can be approximated by a cylinder with height $h = 12$ m and a radius of 0.5 m. The engineer's punching machine punches the punching bag with a force that mesmerizes everyone, but you won't worry about how much force went into the punch today. The punching bag has a constant density of $\rho = 650$ kg/m^3 and is attached to the pin at A by a member of length $L = 6$ m. You may neglect the mass and moment of inertia of the member connecting the bag to pin A. Find the radius of gyration about the point A.



Solution

The mass moment of inertia at the point A is:

$$I_A = I_{bag}$$

$$I_A = (I_G)_{bag} + md^2$$

$$I_A = \frac{1}{12}m(3r^2 + h^2) + m(L + \frac{h}{2})^2$$

$$I_A = m\left(\frac{1}{12}(3r^2 + h^2) + (L + \frac{h}{2})^2\right)$$

The radius of gyration about point A is:

$$k_A = \sqrt{\frac{I_A}{m}} \implies I_A = mk_A^2$$

Equating the values for I_A gives:

$$mk_A^2 = m\left(\frac{1}{12}(3r^2 + h^2) + (L + \frac{h}{2})^2\right)$$

$$k_A = \sqrt{\frac{1}{12}(3r^2 + h^2) + (L + \frac{h}{2})^2}$$

$$= \sqrt{\frac{1}{12}(3 \cdot 0.5^2 + 12^2) + (6 + \frac{12}{2})^2} = 12.492 \quad \text{[m]}$$