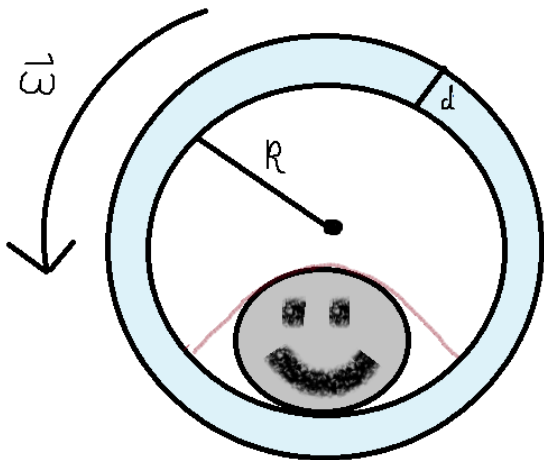


## 22-R-KIN-TW-8



Julie is taking her pet rock, Rocko, for a walk. Rocko is safely fastened to the side of a spherical ball with inner radius  $R = 5$  cm and thickness  $d = 0.5$  cm. If the ball has a mass of 0.5 kg and rotates about its center, what is the moment of inertia of the ball-rock system? Assume the rock is perfectly spherical with a mass of 2 kg and a radius of 1.25 cm.

**Solution:**

$$I_{\text{sphere}} = \frac{2}{5}mr^2$$

$$I_{\text{ball}} = I_{\text{outside}} - I_{\text{inside}}$$

$$= \frac{2}{5}m_{\text{ball}}(R + d)^2 - \frac{2}{5}m_{\text{ball}}R^2$$

$$= \frac{2}{5}m_{\text{ball}}((R + d)^2 - R^2) = \frac{2}{5}(0.5)(0.055^2 - 0.05^2) = 1.05 \cdot 10^{-4} \text{ [kg} \cdot \text{m}^2]$$

$$I_{\text{rock}} = I_G + mx^2$$

$$x = R - r = 0.05 - 0.0125 = 0.0375$$

$$I_{\text{rock}} = \frac{2}{5}m_{\text{rock}}r^2 + m_{\text{rock}}x^2 = \frac{2}{5}(2)(0.0125)^2 + (2)(0.0375)^2 = 29.375 \cdot 10^{-4} \text{ [kg} \cdot \text{m}^2]$$

$$I = I_{\text{ball}} + I_{\text{rock}} = 30.425 \cdot 10^{-4} \text{ [kg} \cdot \text{m}^2]$$