

Chapter 11 Problem 36 †

Given

$$m = 0.880 \text{ kg}$$

$$l = 0.74 \text{ m}$$

$$h = 0.43 \text{ m}$$

$$I_{cm} = 0.048 \text{ kg} \cdot \text{m}^2$$

$$v = 50 \text{ m/s}$$

Solution

a) Find the angular momentum about the pivot point.

First find the moment of inertia about the pivot point. Using the parallel-axis theorem

$$I = I_{cm} + mh^2 = 0.048 \text{ kg} \cdot \text{m}^2 + (0.88 \text{ kg})(0.43 \text{ m})^2$$

$$I = 0.211 \text{ kg} \cdot \text{m}^2$$

The angular velocity about the pivot point is

$$\omega = \frac{v}{r} = \frac{50 \text{ m/s}}{0.74 \text{ m}} = 67.6 \text{ rad/s}$$

The angular momentum is then

$$L = I \cdot \omega = (0.211 \text{ kg} \cdot \text{m}^2)(67.6 \text{ rad/s}) = 14.3 \text{ kg} \cdot \text{m}^2/\text{s}$$

b) Find the torque applied if this angular momentum is reached in 0.25 s.

Torque is the rate of change of angular momentum. Therefore, the average torque is

$$\tau = \frac{\Delta L}{\Delta t} = \frac{14.3 \text{ kg} \cdot \text{m}^2/\text{s}}{0.25 \text{ s}} = 57 \text{ N} \cdot \text{m}$$

†Problem from Essential University Physics, Wolfson