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General Physics I, Quiz 3
PHYS10400, Class year100
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Solution Q3

Chapter 9-11, Serway; ABSOLUTELY NO CHEATING!
Please write the answers on the blank space or on the back of this paper to save resources.

1. Momentum is conserved for the bullet-block system

$$\left(10.0\times10^{-3}\ \text{kg}\right)\upsilon = (5.01\ \text{kg})(0.600\ \text{m/s})$$
$$\upsilon = 301\ \text{m/s}$$

2. (a)

$$L = I\omega = \left(\frac{1}{2}MR^2\right)\omega$$
$$= \frac{1}{2}(3.00\ \text{kg})(0.200\ \text{m})^2(6.00\ \text{rad/s}) = 0.360\ \text{kg}\cdot\text{m}^2/\text{s}$$

(b)

$$L = I\omega = \left(\frac{1}{2}MR^2 + M\left(\frac{R}{2}\right)^2\right)\omega$$
$$= \frac{3}{4}(3.00\ \text{kg})(0.200\ \text{m})^2(6.00\ \text{rad/s}) = 0.540\ \text{kg}\cdot\text{m}^2/\text{s}$$

3. We take the positive direction in the direction of acceleration.

(a) For the counterweight,

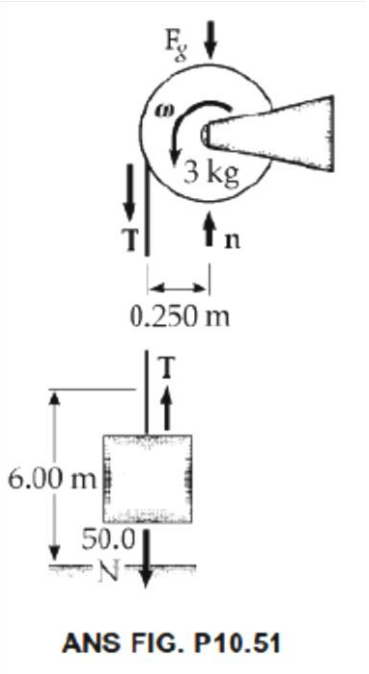
$\sum F_y = ma_y$ becomes $mg - T = ma$

For the reel $\sum \tau = I\alpha$ reads $TR = I\alpha = I\frac{a}{R} \rightarrow T = I\frac{a}{R^2}$

where $I = \frac{1}{2}MR^2$. Substituting for *I*, we have

$$T = I\frac{a}{R^2} = \left(\frac{1}{2}MR^2\right)\frac{a}{R^2} = \frac{M}{2}a \rightarrow a = \frac{2T}{M}$$

We solve for tension by substituting for *a*:



ANS FIG. P10.51

$$mg - T = ma$$

$$mg - T = m\frac{2T}{M} \rightarrow mg = T\left(1 + \frac{2m}{M}\right) = T\left(\frac{2m + M}{M}\right)$$

$$T = \frac{mMg}{2m + M} = \frac{(5.10)(3.00)(9.80)}{2(5.10) + 3.00} = 11.36 = 11.4\,\text{N}$$

(b)

$$mg - T = ma \rightarrow a = g - \frac{T}{m} = 9.80 - \frac{T}{5.10} = 7.57\,\text{m/s}^2$$

(c) $\upsilon_f^2 = \upsilon_i^2 + 2a(x_f - x_i) = 2ad \rightarrow \upsilon_f = \sqrt{2ad} = \sqrt{2(7.57)6.00} = 9.53\,\text{m/s}$

(d) Use conservation of energy for the system of the object, the reel, and the Earth:

$$(K + U)_i = (K + U)_f : mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2, \text{where}\,\omega = \upsilon / R$$

$$2mgh = m\upsilon^2 + I\left(\frac{\upsilon^2}{R^2}\right) = \upsilon^2\left(m + \frac{I}{R^2}\right)$$

$$\upsilon = \sqrt{\frac{2mgh}{m + (I/R^2)}} = \sqrt{\frac{2(50.0\,\text{N})(6.00\,\text{m})}{5.10\,\text{kg} + (0.0938/0.25^2)}} = 9.53\,\text{m/s}$$

The two methods agree on the final speed.