10.2:  
\[ \tau_1 = -(8.00 \text{ N})(5.00 \text{ m}) = -40.0 \text{ N} \cdot \text{m}, \]
\[ \tau_2 = (12.0 \text{ N})(2.00 \text{ m}) \sin 30^\circ = 12.0 \text{ N} \cdot \text{m}, \]

where positive torques are taken counterclockwise, so the net torque is \(-28.0 \text{ N} \cdot \text{m}\), with the minus sign indicating a clockwise torque, or a torque into the page.

10.3: Taking positive torques to be counterclockwise (out of the page),
\[ \tau_1 = -(0.090 \text{ m}) \times (180.0 \text{ N}) = -1.62 \text{ N} \cdot \text{m}, \]
\[ \tau_2 = (0.09 \text{ m})(26.0 \text{ N}) = 2.34 \text{ N} \cdot \text{m}, \]
\[ \tau_3 = \left(\sqrt{2}\right)(0.090 \text{ m})(14.0 \text{ N}) = 1.78 \text{ N} \cdot \text{m}, \]
so the net torque is \(2.50 \text{ N} \cdot \text{m}\), with the direction counterclockwise (out of the page). Note that for \(\tau_3\) the applied force is perpendicular to the lever arm.

10.18:  
\[ \alpha = \frac{\tau}{I} = \frac{Fl}{\frac{1}{2}MI^2} = \frac{3F}{Ml}. \]

10.21: From Eq. (10.11), the fraction of the total kinetic energy that is rotational is
\[ \frac{(1/2)I_{cm}\omega^2}{(1/2)Mv_{cm}^2 + (1/2)I_{cm}\omega^2} = \frac{1}{1 + \left(M/I_{cm}\right)v_{cm}^2/\omega^2} = \frac{1}{1 + \frac{MR^2}{I_{cm}}}, \]
where \(v_{cm} = R\omega\) for an object that is rolling without slipping has been used.

a) \(I_{cm} = (1/2)MR^2\), so the above ratio is \(1/3\).  
b) \(I = (2/5)MR^2\), so the above ratio is \(2/7\).  
c) \(I = 2/3MR^2\), so the ratio is \(2/5\).  
d) \(I = 5/8MR^2\), so the ratio is \(5/13\).

10.26:  
\[ \text{a)} \]

The angular speed of the ball must decrease, and so the torque is provided by a friction force that acts up the hill.

\[ \text{b)} \]
The friction force results in an angular acceleration, related by \(I\alpha = fR\). The equation of motion is \(mg \sin \beta - f = ma_{cm}\), and the acceleration and angular acceleration are related by \(a_{cm} = Ra\) (note that positive acceleration is taken to be down the incline,
and relation between \( a_{cm} \) and \( \alpha \) is correct for a friction force directed uphill).

Combining,

\[
mg \sin \beta = ma \left(1 + \frac{I}{mR^2}\right) = ma (7/5),
\]

from which \( a_{cm} = (5/7)g \sin \beta \).  

C) From either of the above relations between if \( f \) and \( a_{cm} \),

\[
f = \frac{2}{5} ma_{cm} = \frac{2}{7} mg \sin \beta \leq \mu n = \mu mg \cos \beta,
\]

from which \( \mu_s \geq (2/7) \tan \beta \).

10.19: The acceleration of the mass is related to the tension by \( Ma_{cm} = Mg - T \), and the angular acceleration is related to the torque by \( I \alpha = \tau = TR \), or \( a_{cm} = T / M \), where \( \alpha = a_{cm} / RSt \) and \( I = MR^2 \) have been used.

A) Solving these for \( T \) gives \( T = Mg / 2 = 0.882 \) N.  

B) Substituting the expression for \( T \) into either of the above relations gives \( a_{cm} = g / 2 \), from which \( t = \sqrt{2h/a_{cm}} = \sqrt{4h/g} = 0.553 \) s.  

C) \( \omega = v_{cm} / R = a_{cm} t / R = 33.9 \) rad/s.

10.38: The moment of inertia is proportional to the square of the radius, and so the angular velocity will be proportional to the inverse of the square of the radius, and the final angular velocity is

\[
\omega_2 = \omega_1 \left(\frac{R_1}{R_2}\right)^2 = \left(\frac{2 \pi \text{ rad}}{(30 \text{ d})(86,400 \text{ s/d})} \left(\frac{7.0 \times 10^4 \text{ km}}{16 \text{ km}}\right)^2 \right) = 4.6 \times 10^3 \text{ rad/s}.
\]

10.40: The skater’s initial moment of inertia is

\[
I_1 = (0.400 \text{ kg} \cdot \text{m}^2) + \frac{1}{2} (8.00 \text{ kg})(1.80 \text{ m})^2 = 2.56 \text{ kg} \cdot \text{m}^2,
\]

and her final moment of inertia is

\[
I_2 = (0.400 \text{ kg} \cdot \text{m}^2) + (8.00 \text{ kg})(25 \times 10^{-2} \text{ m}) = 0.9 \text{ kg} \cdot \text{m}^2.
\]

Then from Eq. (10.33),

\[
\omega_2 = \omega_1 \frac{I_1}{I_2} = (0.40 \text{ rev/s}) \frac{2.56 \text{ kg} \cdot \text{m}^2}{0.9 \text{ kg} \cdot \text{m}^2} = 1.14 \text{ rev/s}.
\]

Note that conversion from rev/s to rad/s is not necessary.