1. \[ \tau = rF \sin \theta = (0.500 \text{ m})(80.0 \text{ N}) \sin(60.0^\circ) = 36.4 \text{ N} \cdot \text{m} \] which is choice (a).

3. Assuming a uniform, solid disk, its moment of inertia about a perpendicular axis through its center is \( I = MR^2 / 2 \), so \( \tau = I \alpha \) gives

\[
\alpha = \frac{2\tau}{MR^2} = \frac{2(40.0 \text{ N} \cdot \text{m})}{(25.0 \text{ kg})(0.800 \text{ m})^2} = 5.00 \text{ rad/s}^2
\]

and the correct answer is (b).

7. The moment of inertia of a body is determined by its mass and the way that mass is distributed about the rotation axis. Also, the location of the body’s center of mass is determined by how its mass is distributed. As long as these qualities do not change, both the moment of inertia and the center of mass are constant. From \( \tau = I \alpha \), we see that when a body experiences a constant, nonzero torque, it will have a constant, nonzero angular acceleration. However, since the angular acceleration is nonzero, the angular velocity \( \omega \) (and hence the angular momentum, \( L = I \omega \)) will vary in time. The correct responses to this question are then (b) and (e).

2. If the bar is, say, seven feet above the ground, a high jumper has to lift his center of gravity approximately to a height of seven feet in order to clear the bar. A tall person already has his center of gravity higher than that of a short person. Thus, the taller athlete has to raise his center of gravity through a smaller distance.

12. (a) Consider two people, at the ends of a long table, pushing with equal magnitude forces directed in opposite directions perpendicular to the length of the table. The net force will be zero, yet the net torque is not zero.

(b) Consider a falling body. The net force acting on it is its weight, yet the net torque about the center of gravity is zero.

8.1 Since the friction force is tangential to a point on the rim of the wheel, it is perpendicular to the radius line connecting this point with the center of the wheel. The torque of this force about the axis through the center of the wheel is then \( \tau = rF \sin 90.0^\circ = rF \), and the friction force is

\[
f = \frac{\tau}{r} = \frac{76.0 \text{ N} \cdot \text{m}}{0.350 \text{ m}} = 217 \text{ N}
\]

8.4 The lever arm is \( d = (1.20 \times 10^{-2} \text{ m}) \cos 48.0^\circ = 8.03 \times 10^{-3} \text{ m} \), and the torque is

\[
\tau =Fd = (80.0 \text{ N})(8.03 \times 10^{-3} \text{ m}) = 0.642 \text{ N} \cdot \text{m} \text{ counterclockwise}
\]
8.8 (a) Since the beam is in equilibrium, we choose the center as our pivot point and require that

\[ \Sigma \tau_{\text{center}} = -F_{\text{Sam}}(2.80 \text{ m}) + F_{\text{Joe}}(1.80 \text{ m}) = 0 \]

or

\[ F_{\text{Joe}} = 1.56F_{\text{Sam}} \quad \text{[1]} \]

Also,

\[ \Sigma F_y = 0 \Rightarrow F_{\text{Sam}} + F_{\text{Joe}} = 450 \text{ N} \quad \text{[2]} \]

Substitute Equation [1] into [2] to get the following:

\[ F_{\text{Sam}} + 1.56F_{\text{Sam}} = 450 \text{ N} \quad \text{or} \quad F_{\text{Sam}} = \frac{450 \text{ N}}{2.56} = 176 \text{ N} \]

Then, Equation [1] yields \( F_{\text{Joe}} = 1.56(176 \text{ N}) = 274 \text{ N} \).

(b) If Sam moves closer to the center of the beam, his lever arm about the beam center decreases, so the force \( F_{\text{Sam}} \) must increase to continue applying a clockwise torque capable of offsetting Joe's counterclockwise torque. At the same time, the force \( F_{\text{Joe}} \) would decrease since the sum of the two upward forces equal the magnitude of the downward gravitational force.

(c) If Sam moves to the right of the center of the beam, his torque about the midpoint would then be counterclockwise. Joe would have to hold down on the beam in order to exert an offsetting clockwise torque.

8.20 Consider the torques about an axis perpendicular to the page through the left end of the scaffold.

\[ \Sigma \tau = 0 \Rightarrow T_1(0) - (700 \text{ N})(1.00 \text{ m}) - (200 \text{ N})(1.50 \text{ m}) + T_2(3.00 \text{ m}) = 0 \]

From which, \( T_2 = 333 \text{ N} \).

Then, from \( \Sigma F_y = 0 \), we have

\[ T_1 + T_2 - 700 \text{ N} - 200 \text{ N} = 0 \]

or

\[ T_1 = 900 \text{ N} - T_2 = 900 \text{ N} - 333 \text{ N} = 567 \text{ N} \]
As the bucket drops, it loses gravitational potential energy. The spool gains rotational kinetic energy and the bucket gains translational kinetic energy. Since the string does not slip on the spool, \( v = r \omega \) where \( r \) is the radius of the spool. The moment of inertia of the spool is \( I = \frac{1}{2} Mr^2 \), where \( M \) is the mass of the spool. Conservation of energy gives

\[
\left(KE_f + KE_r + PE_f\right)_f = \left(KE_i + KE_r + PE_i\right)_i
\]

\[
\frac{1}{2} m \omega^2 + \frac{1}{2} I \omega^2 + m g y_f = 0 + 0 + m g y_i
\]

or

\[
\frac{1}{2} m (r \omega)^2 + \frac{1}{2} \left(\frac{1}{2} M r^2\right) \omega^2 = m g (y_i - y_f)
\]

This gives

\[
\omega = \sqrt{\frac{2 m g (y_i - y_f)}{(m + \frac{1}{2} M) r^2}} = \sqrt{\frac{2 (3.00 \text{ kg}) (9.80 \text{ m/s}^2) (4.00 \text{ m})}{3.00 \text{ kg} + \frac{1}{2} (5.00 \text{ kg}) (0.600 \text{ m})}} = 10.9 \text{ rad/s}
\]

8.54

(a) \( L = I \omega = \left(MR^2\right) \omega = (2.40 \text{ kg}) (0.180 \text{ m})^2 (35.0 \text{ rad/s}) = 2.72 \text{ kg} \cdot \text{m}^2/\text{s} \)

(b) \( L = I \omega = \left(\frac{1}{2} MR^2\right) \omega = \frac{1}{2} (2.40 \text{ kg}) (0.180 \text{ m})^2 (35.0 \text{ rad/s}) = 1.36 \text{ kg} \cdot \text{m}^2/\text{s} \)

(c) \( L = I \omega = \left(\frac{2}{5} MR^2\right) \omega = \frac{2}{5} (2.40 \text{ kg}) (0.180 \text{ m})^2 (35.0 \text{ rad/s}) = 1.09 \text{ kg} \cdot \text{m}^2/\text{s} \)

(d) \( L = I \omega = \left(\frac{2}{3} MR^2\right) \omega = \frac{2}{3} (2.40 \text{ kg}) (0.180 \text{ m})^2 (35.0 \text{ rad/s}) = 1.81 \text{ kg} \cdot \text{m}^2/\text{s} \)