Answers to Even Numbered Problems

2. 0.642 N\text{m} counterclockwise

4. \( F_y + R_y - F_y = 0, \quad F_x - R_x = 0, \quad F_y \cos \theta - F_x \ell (\cos \theta) - F_x \ell \sin \theta = 0 \)

6. \(-168\ \text{N\ m}\)

8. \(x_{cg} = 6.69 \times 10^{-3} \ \text{m},\ y_{cg} = 0\)

10. 139 grams

12. \((-1.5 \ \text{m}, -1.5 \ \text{m})\)

14. \(x_{cg} = 0.459 \ \text{m},\ y_{cg} = 0.103 \ \text{m}\)

16. \(T = 1.68 \times 10^3 \ \text{N},\ R = 2.34 \times 10^3 \ \text{N},\ \theta = 21.2^\circ\)

18. 567 N (left end), 333 N (right end)

20. (b) \(T = 343 \ \text{N},\ H = 171 \ \text{N},\ V = 683 \ \text{N}\)  
   (c) 5.14 m

22. (a) 392 N  
   (b) \(H = 339 \ \text{N (to right), V = 0}\)

24. (a) 267 N (to right), 1.30 kN (upward)  
   (b) \(\mu_s = 0.324\)

26. \(T = 1.47 \ \text{kN},\ H = 1.33 \ \text{kN (to right), V = 2.58 \ \text{kN (upward)}}\)

28. 2.8 m

30. 149 N m, 66.0 N m, 215 N m

32. 0.30

34. (a) 872 N  
   (b) 1.40 kN

36. (a) 5.35 m/s\(^2\) downward  
   (b) 42.8 m  
   (c) 8.91 rad/s\(^2\)

38. 30.3 rev/s

40. 10.9 rad/s

42. (a) \(1.37 \times 10^8 \ \text{J}\)  
   (b) 5.10 h
44. 36 rad/s

46. 0.91 km/s

48. 1.17 rad/s

50. (a) 1.9 rad/s  (b) \( KE_1 = 2.5 \text{ J}, KE_2 = 6.4 \text{ J} \)

52. (a) 3.6 rad/s  (b) \( 5.4 \times 10^2 \text{ J}, \) work done by the man as he walks inward

54. 12.3 m/s²

56. The weight must be 508 N or more. The person could be a child. We assume the stove is a uniform box with feet at its corners. We ignore the masses of the backsplash and the oven door. If the oven door is heavy, the minimum weight for the person would be somewhat less than 508 N.

58. (a) 1.04 kN  (b) 973 N at 67.7° above the horizontal to the right

60. (a) 46.8 N  (b) 0.234 kg·m²  (c) 40.0 rad/s

62. \( T_1 = 11.2 \text{ N}, T_2 = 1.39 \text{ N}, F = 7.23 \text{ N} \)

66. (a) 61.2 J  (b) 50.8 J

68. (a) \( 3.75 \times 10^3 \text{ kg·m}^2/\text{s} \)  (b) 1.88 kJ  (c) \( 3.75 \times 10^3 \text{ kg·m}^2/\text{s} \)
    (d) 10.0 m/s  (e) 7.50 kJ  (f) 5.62 kJ

70. \( T_{\text{right}} = 1.59 \text{ kN}, T_{\text{left}} = 1.01 \text{ kN} \)

72. 24 m

74. \( \frac{3}{8}w \)

76. 9.00 ft

78. (a) A smooth (frictionless) surface cannot exert a force parallel to itself. Thus, a smooth vertical wall can exert only horizontal forces, normal to its surface.
    (b) \( L \sin \theta \)  (c) \( (I/2) \cos \theta \)  (d) 2.5 m

82. Strut AB: 7200 N compression; Strut AC: 6200 N tension; Strut BC: 7200 N tension;
    Strut BD: 12000 N compression; Strut CD: 7200 N tension; Strut CE: 6200 N tension;
    Strut DE: 7200 N compression;
84. \(5.7 \text{ rad/s}\)
8.3 First resolve all of the forces shown in Figure P8.3 into components parallel to and perpendicular to the beam as shown in the sketch below.

\[ \tau_o = +\left[ (25 \text{ N}) \cos 30^\circ \right] (2.0 \text{ m}) - \left[ (10 \text{ N}) \sin 20^\circ \right] (4.0 \text{ m}) = +30 \text{ N} \cdot \text{m} \]

\text{or } \tau_o = 30 \text{ N} \cdot \text{m} \text{ counterclockwise}

(b) \[ \tau_c = +\left[ (30 \text{ N}) \sin 45^\circ \right] (2.0 \text{ m}) - \left[ (10 \text{ N}) \sin 20^\circ \right] (2.0 \text{ m}) = +36 \text{ N} \cdot \text{m} \]

\text{or } \tau_c = 36 \text{ N} \cdot \text{m} \text{ counterclockwise}

8.8 If the mass of a hydrogen atom is 1.00 \text{ u} (that is, 1 unit), then the mass of the oxygen atom is 16.0 \text{ u}.

\[ x_{cg} = \frac{\sum m_i x_i}{\sum m_i} = \frac{(16.0 \text{ u})(0) + 2(1.00 \text{ u})\left[ (0.100 \text{ nm}) \cos 53.0^\circ \right]}{16.0 + 2 \cdot 1.00} \text{ u} = 6.69 \times 10^{-3} \text{ nm} \]

\[ y_{cg} = \frac{\sum m_i y_i}{\sum m_i} \]

\[ \left( 16.0 \text{ u})(0) + (1.00 \text{ u})\left[ (0.100 \text{ nm}) \sin 53.0^\circ \right] + (1.00 \text{ u})\left[ -(0.100 \text{ nm}) \sin 53.0^\circ \right] \text{ u} \cdot \text{nm} \right) = 0 \]

8.11 Consider the remaining plywood to consist of two parts: \( A_1 \) is a 4.00-ft by 4.00-ft section with center of gravity located at (2.00 ft, 2.00 ft), while \( A_2 \) is a 2.00-ft by 4.00-ft section with center of gravity at (6.00 ft, 1.00 ft). Since the plywood is uniform, its mass per area \( \sigma \) is constant and the mass of a section having area \( A \) is \( m = \sigma A \). The center of gravity of the remaining plywood has coordinates given by:

\[ x_{cg} = \frac{\sum m_i x_i}{\sum m_i} = \frac{\sigma A_1 x_1 + \sigma A_2 x_2}{\sigma A_1 + \sigma A_2} = \frac{(16.0 \text{ ft}^2)(2.00 \text{ ft}) + (8.00 \text{ ft}^2)(6.00 \text{ ft})}{(16.0 \text{ ft}^2) + (8.00 \text{ ft}^2)} = 3.33 \text{ ft} \]
and \[ y_{cg} = \frac{\sum m_j y_j}{\sum m_j} = \frac{\phi A_1 y_1 + \phi A_2 y_2}{\phi A_1 + \phi A_2} = \frac{(16.0 \text{ ft})^2 (2.00 \text{ ft}) + (8.00 \text{ ft})^2 (1.00 \text{ ft})}{(16.0 \text{ ft})^2 + (8.00 \text{ ft})^2} = 1.67 \text{ ft} \]

8.13 In each case, the distance from the bar to the center of mass of the body is given by

\[ x_{cg} = \frac{\sum m_j x_j}{\sum m_j} = \frac{m_{am,s} x_{am,s} + m_{torso,torso} x_{torso} + m_{thighs,thighs} x_{thighs} + m_{legs,legs} x_{legs}}{m_{am,s} + m_{torso,torso} + m_{thighs,thighs} + m_{legs,legs}} \]

where the distance \( x \) for any body part is the distance from the bar to the center of gravity of that body part. In each case, we shall take the positive direction for distances to run from the bar toward the location of the head.

Note that: \[ \sum m_j = (6.87 + 33.57 + 14.07 + 7.54) \text{ kg} = 62.05 \text{ kg} \]

With the body positioned as shown in Figure P8.13b, the distances \( x \) for each body part is computed using the sketch given below:

\[
\begin{align*}
\ell_{thighs} & = x_{thighs} - x_{cg} = +0.239 \text{ m} \\
\ell_{torso} & = x_{torso} - x_{cg} = +0.548 \text{ m} + 0.337 \text{ m} = 0.885 \text{ m} \\
\ell_{thighs} & = x_{thighs} - x_{cg} = (+0.548+0.601+0.151) \text{ m} = 1.30 \text{ m} \\
\ell_{legs} & = x_{legs} - x_{cg} = (+0.548+0.601+0.374+0.227) \text{ m} = 1.75 \text{ m}
\end{align*}
\]

With these distances and the given masses we find: \[ x_{cg} = \frac{+62.05 \text{ kg} \cdot \text{m}}{+62.05 \text{ kg}} = +1.01 \text{ m} \]

With the body positioned as shown in Figure P8.13c, we use the following sketch to determine the distance \( x \) for each body part:
With these distances, the location (relative to the bar) of the center of gravity of the body is:

\[ x_{cg} = \frac{0.924 \text{ kg} \cdot \text{m}}{62.05 \text{ kg}} = 0.015 \text{ m} \]

8.21 We call the tension in the cord at the left end of the sign, \( T_1 \), and the tension in the cord near the right end \( T_2 \). Consider the torques about an axis perpendicular to the page and through the left end of the sign.

\[ \Sigma \tau = -w(0.50 \text{ m}) + T_2(0.75 \text{ m}) = 0, \text{ so } T_2 = \frac{2}{3} w \]

From \( \Sigma F_y = 0, \ T_1 + T_2 - w = 0, \) or \( T_1 = w - T_2 = w - \frac{2}{3} w = \frac{1}{3} w \)

8.23 Consider the torques about an axis perpendicular to the page and through the left end of the plank.

\[ \Sigma \tau = 0 \text{ gives } \]

\[-(700 \text{ N})(0.500 \text{ m}) - (294 \text{ N})(1.00 \text{ m}) + (T_1 \sin 40^\circ)(2.00 \text{ m}) = 0 \]

or \( T_1 = \frac{501 \text{ N}}{2} \)
Then, $\Sigma F_y = 0$ gives $-T_1 + T_1 \cos 40^\circ = 0$, or

$$T_1 = \left( 501 \text{ N} \right) \cos 40^\circ = 384 \text{ N}$$

From $\Sigma F_y = 0$, $T_2 - 994 \text{ N} + T_1 \sin 40^\circ = 0$,

or $T_2 = 994 \text{ N} - \left( 501 \text{ N} \right) \sin 40^\circ = 672 \text{ N}$

8.25 The required dimensions are:

$$d_1 = \left( 4.00 \text{ m} \right) \cos 50^\circ = 2.57 \text{ m}$$
$$d_2 = d \cos 50^\circ = 0.643 \ d$$
$$d_3 = \left( 8.00 \text{ m} \right) \sin 50^\circ = 6.13 \text{ m}$$

$\Sigma F_y = 0$ yields $F_1 - 200 \text{ N} - 800 \text{ N} = 0$

or $F_1 = 1.00 \times 10^3 \text{ N}$

When the ladder is on the verge of slipping,

$$f = \left( \mu \right)_{\text{max}} = \mu \cdot F_1$$

or $f = (0.600)(1.00 \times 10^3 \text{ N}) = 600 \text{ N}$

Then, $\Sigma F_x = 0$ gives $F_2 = 600 \text{ N}$ to the left.

Finally, using an axis perpendicular to the page and through the lower end of the ladder, $\Sigma \tau = 0$ gives

$$-(200 \text{ N})(2.57 \text{ m}) - (800 \text{ N})(0.643) d + (600 \text{ N})(6.13 \text{ m}) = 0$$

or

$$d = \frac{(3.68 \times 10^3 - 550) \text{ N} \cdot \text{m}}{0.643(800 \text{ N})} = 6.15 \text{ m}$$

when the ladder is ready to slip.

8.27 First, we resolve all forces into components parallel to and perpendicular to the tibia, as shown. Note that $\theta = 40^\circ$ and

$$w_y = (30 \text{ N}) \sin 40^\circ = 19.3 \text{ N}$$

$$F_y = (12.5 \text{ N}) \sin 40^\circ = 8.03 \text{ N}$$

and $T_y = T \sin 25^\circ$

Using $\Sigma \tau = 0$ for an axis perpendicular to the page and
through the upper end of the tibia gives
\[
(T \cdot \sin 25^\circ) \frac{d}{5} - (19.3 \text{ N}) \frac{d}{2} - (8.03 \text{ N}) d = 0, \quad \text{or} \quad T = 209 \text{ N}
\]

8.31 (a) \[\tau = F \cdot r = (0.800 \text{ N})(30.0 \text{ m}) = 24.0 \text{ N} \cdot \text{m}\]

(b) \[\alpha = \frac{\tau}{2I} = \frac{24.0 \text{ N} \cdot \text{m}}{0.750 \text{ kg}(30.0 \text{ m})^2} = 0.0356 \text{ rad/s}^2\]

(c) \[a_t = r\alpha = (30.0 \text{ m})(0.0356 \text{ rad/s}^2) = 1.07 \text{ m/s}^2\]

8.36 The moment of inertia of the reel is
\[I = \frac{1}{2} MR^2 = \frac{1}{2}(5.00 \text{ kg})(0.600 \text{ m})^2 = 0.900 \text{ kg} \cdot \text{m}^2\]

Applying Newton’s second law to the falling bucket gives
\[29.4 \text{ N} - T = (3.00 \text{ kg})a_t\]

Then, Newton’s second law for the reel gives
\[\tau = TR = I\alpha = I \left( \frac{a_t}{R} \right)\]

or
\[T = \frac{Ia_t}{R^2} = \frac{(0.900 \text{ kg} \cdot \text{m}^2)}{(0.600 \text{ m})^2} a_t = (2.50 \text{ kg})a_t\]

(a) Solving equations (1) and (2) simultaneously gives
\[a_t = \frac{5.35 \text{ m/s}^2}{\text{downward}}\]

(b) \[\Delta y = v_0 t + \frac{1}{2} a_t t^2 = 0 + \frac{1}{2}(5.35 \text{ m/s}^2)(4.00 \text{ s})^2 = 42.8 \text{ m}\]

(c) \[\alpha = \frac{a_t}{R} = \frac{5.35 \text{ m/s}^2}{0.600 \text{ m}} = \frac{8.91 \text{ rad/s}^2}{0.600 \text{ m}}\]

8.40 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, \(v = \omega r\) 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
\[
\left(KE_t + KE_r + PE_r\right) = \left(KE_t + KE_r + PE_r\right)_i
\]
\[ \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2 + m g y_r = 0 + 0 + m g y_i \]

or

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

This gives

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

8.44 Using conservation of mechanical energy,

\[ \left( KE_{\text{trans}} + KE_{\text{rot}} + PE_g \right)_{f} = \left( KE_{\text{trans}} + KE_{\text{rot}} + PE_g \right)_{i} \]

or

\[ \frac{1}{2} M v_c^2 + \frac{1}{2} I \omega^2 + 0 = 0 + 0 + M g L \sin \theta \]

Since \( I = \frac{2}{5} M R^2 \) for a solid sphere and \( v_c = R \omega \) when rolling without slipping, this becomes

\[ \frac{1}{2} M R^2 \omega^2 + \frac{1}{5} M R^2 \omega^2 = M g L \sin \theta \]

and reduces to

\[ \omega = \sqrt{\frac{10 g L \sin \theta}{7 R^2}} = \sqrt{\frac{10 (9.8 \text{ m/s}^2)(6.0 \text{ m}) \sin 37^\circ}{7 (0.20 \text{ m})^2}} = 36 \text{ rad/s} \]

8.49 The moment of inertia of the cylinder before the putty arrives is

\[ I = \frac{1}{2} M R^2 = \frac{1}{2} (1.00 \text{ kg})(1.00 \text{ m})^2 = 5.00 \text{ kg} \cdot \text{m}^2 \]

After the putty sticks to the cylinder, the moment of inertia is

\[ I_f = I_i + m x^2 = 5.00 \text{ kg} \cdot \text{m}^2 + (0.250 \text{ kg})(0.900 \text{ m})^2 = 5.20 \text{ kg} \cdot \text{m}^2 \]

Conservation of angular momentum gives

\[ I_f \omega_f = I_i \omega_i \]

or

\[ \omega_f = \left( \frac{I_i}{I_f} \right) \omega_i = \left( \frac{5.00 \text{ kg} \cdot \text{m}^2}{5.20 \text{ kg} \cdot \text{m}^2} \right)(7.00 \text{ rad/s}) = 6.73 \text{ rad/s} \]
8.51 The initial angular velocity of the puck is
\[ \omega_i = \frac{\omega}{\tau} = \frac{0.800 \, \text{m/s}}{0.400 \, \text{m}} = 2.00 \, \text{rad/s} \]

Since the tension in the string does not exert a torque about the axis of revolution, the angular momentum of the puck is conserved, or \( I_i \omega_i = I_r \omega_r \).

Thus,
\[
\omega_r = \frac{I_i}{I_r} \omega_i = \left( \frac{m r_i^2}{m r_r^2} \right) \omega_i = \left( \frac{0.400 \, \text{m}}{0.250 \, \text{m}} \right)^2 (2.00 \, \text{rad/s}) = 5.12 \, \text{rad/s}
\]

The net work done on the puck is
\[
W_{\text{net}} = KE_f - KE_i = \frac{1}{2} I_r \omega_r^2 - \frac{1}{2} I_i \omega_i^2 = \frac{1}{2} \left[ (m r_r^2) \omega_r^2 - (m r_i^2) \omega_i^2 \right] = \frac{m}{2} \left[ r_r^2 \omega_r^2 - r_i^2 \omega_i^2 \right]
\]
or
\[
W_{\text{net}} = \frac{(0.120 \, \text{kg})}{2} \left[ (0.250 \, \text{m})^2 (5.12 \, \text{rad/s})^2 - (0.400 \, \text{m})^2 (2.00 \, \text{rad/s})^2 \right]
\]
This yields \( W_{\text{net}} = 5.99 \times 10^{-2} \, \text{j} \)

8.54 For one of the crew, \( \Sigma F_c = m \alpha \) becomes
\( n = m \left( \frac{\omega}{r} \right) = m \omega_i \)

We require \( n = m g \), so the initial angular velocity must be
\[ \omega_i = \sqrt{\frac{g}{r}} \]

From conservation of angular momentum, \( I_i \omega_i = I_r \omega_r \) or \( \omega_r = \left( \frac{I_i}{I_r} \right) \omega_i \)

Thus, the angular velocity of the station during the union meeting is
\[
\omega_r = \left( \frac{I_i}{I_r} \right) \sqrt{\frac{g}{r}} = \sqrt{\frac{5.00 \times 10^5 \, \text{kg} \cdot \text{m}^2 + 150(65.0 \, \text{kg})(100 \, \text{m})}{5.00 \times 10^5 \, \text{kg} \cdot \text{m}^2 + 50(65.0 \, \text{kg})(100 \, \text{m})}} \sqrt{\frac{g}{r}} = 1.12 \sqrt{\frac{g}{r}}
\]

The centripetal acceleration experienced by the managers still on the rim is
\[ a_c = r \omega_r^2 = r (12.3 \, \text{m/s}^2 (1.12)^2 \frac{g}{r} = (1.12)^2 (9.80 \, \text{m/s}^2) = 12.3 \, \text{m/s}^2 \]

8.60 (a) Consider the free-body diagram of the block given at the right. If the +x-axis is directed down the incline, \( \Sigma F_x = m \alpha \) gives

\[ m g \sin 37.0^\circ - T = m \alpha, \text{ or } T = m \left( g \sin 37.0^\circ - \alpha \right) \]
\[ T = (12.0 \text{ kg}) \left[ (9.80 \text{ m/s}^2) \sin 37.0^\circ - 2.00 \text{ m/s}^2 \right] \]

\[ = 46.8 \text{ N} \]

(b) Now, consider the free-body diagram of the pulley. Choose an axis perpendicular to the page and passing through the center of the pulley,

\[ \Sigma \tau = I \alpha \text{ gives } T \cdot r = \left( \frac{a_c}{r} \right), \text{ or} \]

\[ I = \frac{T \cdot r}{a_c} = \frac{(46.8 \text{ N})(0.100 \text{ m})^2}{2.00 \text{ m/s}^2} = 0.234 \text{ kg} \cdot \text{m}^2 \]

(c) \[ \omega = \omega_i + \alpha t = 0 + \left( \frac{a_c}{r} \right) = \left( \frac{2.00 \text{ m/s}^2}{0.100 \text{ m}} \right)(2.00 \text{ s}) = 40.0 \text{ rad/s} \]

8.61 If the ladder is on the verge of slipping, \( f = \left( \frac{f_i}{n} \right)_{\text{max}} = \mu_n \) at both the floor and the wall.

From \( \Sigma F_y = 0 \), we find \( f_z - n_z = 0 \)

or \( n_z = \mu_s n_s \)

Also, \( \Sigma F_y = 0 \) gives \( n_1 - w + \mu_s n_z = 0 \)

Using equation (1), this becomes

\[ n_1 - w + \mu_s \left( \mu_s n_1 \right) = 0 \]

or \( n_1 = \frac{w}{1 + \mu_s^2} = \frac{w}{1.25} = 0.800 \text{w} \) \( (2) \)

Thus, equation (1) gives \( n_2 = 0.500(0.800 \text{w}) = 0.400 \text{w} \) \( (3) \)

Choose an axis perpendicular to the page and passing through the lower end of the ladder. Then, \( \Sigma \tau = 0 \) yields

\[ -w \left( \frac{L}{2} \cos \theta \right) + n_1 (L \sin \theta) + f_2 (L \cos \theta) = 0 \]

Making the substitutions \( n_2 = 0.400 \text{w} \) and \( f_2 = \mu_s n_2 = 0.200 \text{w} \), this becomes

\[ -w \left( \frac{L}{2} \cos \theta \right) + (0.400 \text{w})(L \sin \theta) + (0.200 \text{w})(L \cos \theta) = 0 \]
and reduces to  \[ \sin \theta = \left( \frac{0.500 - 0.200}{0.400} \right) \cos \theta \]

Hence,  \( \tan \theta = 0.750 \) and  \( \theta = 36.9^\circ \)

8.69

(a)  \[ L_1 = 2 M v \left( \frac{d}{2} \right) = M v d \]

(b)  \[ KE_1 = 2 \left( \frac{1}{2} M v' \right) = M v' \]

(c)  \[ L_r = L_1 = M v d \]

(d)  \[ v_r = \frac{L_r}{2 M v_r} = \frac{M v d}{2 M (d/4)} = 2v \]

(e)  \[ KE_r = 2 \left( \frac{1}{2} M v_r \right) = M (2v)^2 = 4M v^2 \]

(f)  \[ W_{net} = KE_r - KE_1 = 3M v^2 \]

8.74 Slipping occurs simultaneously at both the bottom and side contact points. Just before slipping occurs, both static friction forces must have their maximum values. When the cylinder is about to slip,  \( \xi = \mu_s n_1 = 0.5 n_1 \) and  \( \xi = \mu_s n_2 = 0.5 n_2 \). Choose an axis perpendicular to the page and passing through the center of the cylinder.

Then,  \( \Sigma \tau = 0 \Rightarrow \xi \cdot R + \xi \cdot R - F \cdot R = 0 \)

or  \( F = \xi + \xi \)  \hspace{1cm} (1)

From  \( \Sigma F_x = 0 \),  \( \xi = n_2 = \frac{\xi}{\mu_s} = 2 \xi \)  \hspace{1cm} (2)

Combining equation (2) with equation (1) gives  \( F = 2 \xi + \xi = 3 \xi \), or  \( \xi = \frac{F}{3} \). Then equation (2) yields  \( \xi = \frac{2F}{3} \)

From  \( \Sigma F_y = 0 \),  \( w = F + \xi + n_1 = F + \xi + \frac{\xi}{\mu_s} = F + \xi + 2 \xi = F + \xi + \frac{F}{3} + 2 \left( \frac{2F}{3} \right) \)

or  \( w = \frac{8F}{3} \). Solving for the applied force,  \( F = \frac{3w}{8} \).
Free-body diagrams for each block and the pulley are given at the right. Observe that the angular acceleration of the pulley will be clockwise in direction and has been given a negative sign. Since $\Sigma r \times F = I \alpha$, the positive sense for torques and angular acceleration must be the same (counterclockwise).

For $m_1$: $\Sigma F_y = m_1 a_y \Rightarrow T_1 - m_1 g = m_1 (-a)$

or $T_1 = m_1 (g - a)$ \hspace{1cm} (1)

For $m_2$: $\Sigma F_x = m_2 a_x \Rightarrow T_2 = m_2 a$ \hspace{1cm} (2)

For the pulley: $\Sigma \tau = I \alpha \Rightarrow T_2 r - T_1 r = I (-a/2)$

or $T_1 - T_2 = \left(\frac{I}{r^2}\right)a$ \hspace{1cm} (3)

Substitute Equations (1) and (2) into Equation (3) and solve for $a$ to obtain

$$a = \frac{m_1 g}{\left(\frac{I}{r^2}\right) + m_1 + m_2}$$

or

$$a = \frac{\left(4.00 \text{ kg}\right)\left(9.80 \text{ m/s}^2\right)}{\left(0.500 \text{ kg} \cdot \text{m}^2\right)/\left(0.300 \text{ m}\right)^2 + 4.00 \text{ kg} + 3.00 \text{ kg}} = \frac{3.12 \text{ m/s}^2}{\text{m}^2}$$

(b) Equation (1) above gives: $T_1 = \left(4.00 \text{ kg}\right)\left(9.80 \text{ m/s}^2 - 3.12 \text{ m/s}^2\right) = 26.7 \text{ N}$

and Equation (2) yields: $T_2 = \left(3.00 \text{ kg}\right)\left(3.12 \text{ m/s}^2\right) = 9.37 \text{ N}$