P10.36

$$\omega_f = \omega_i + \alpha t: \quad 10.0 \text{ rad/s} = 0 + \alpha(6.00 \text{ s})$$

$$\alpha = \frac{10.00}{6.00} \text{ rad/s}^2 = 1.67 \text{ rad/s}^2$$

(a) $\sum \tau = 36.0 \text{ N} \cdot \text{m} = I\alpha: \quad I = \frac{\sum \tau}{\alpha} = \frac{36.0 \text{ N} \cdot \text{m}}{1.67 \text{ rad/s}^2} = \boxed{21.6 \text{ kg} \cdot \text{m}^2}$

(b) $\omega_f = \omega_i + \alpha t: \quad 0 = 10.0 + \alpha(60.0)$

$$\alpha = -0.167 \text{ rad/s}^2$$

$$|\tau| = |I\alpha| = (21.6 \text{ kg} \cdot \text{m}^2)(0.167 \text{ rad/s}^2) = \boxed{3.60 \text{ N} \cdot \text{m}}$$

(c) Number of revolutions $\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$

During first 6.00 s $\quad \theta_f = \frac{1}{2}(1.67)(6.00)^2 = 30.1 \text{ rad}$

During next 60.0 s $\quad \theta_f = 10.0(60.0) - \frac{1}{2}(0.167)(60.0)^2 = 299 \text{ rad}$

$$\theta_{\text{total}} = 329 \text{ rad}\left(\frac{1 \text{ rev}}{2\pi \text{ rad}}\right) = \boxed{52.4 \text{ rev}}$$

P10.37 For m_1,

$$\sum F_y = ma_y:$$
$$+n - m_1 g = 0$$

$$n_1 = m_1 g = 19.6 \text{ N}$$

$$f_{k1} = \mu_k n_1 = 7.06 \text{ N}$$

$$\sum F_x = ma_x:$$
$$-7.06 \text{ N} + T_1 = (2.00 \text{ kg})a \qquad (1)$$

For the pulley,

$$\sum \tau = I\alpha:$$
$$-T_1 R + T_2 R = \frac{1}{2} MR^2 \left(\frac{a}{R}\right)$$

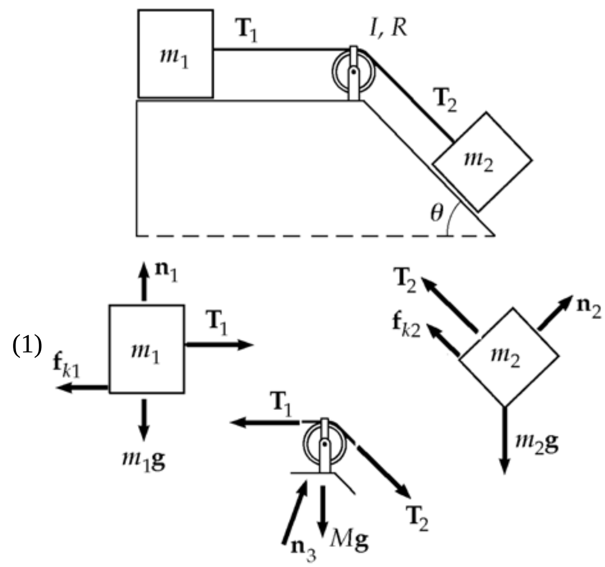

FIG. P10.37

$$-T_1 + T_2 = \frac{1}{2}(10.0 \text{ kg})a$$

$$-T_1 + T_2 = (5.00 \text{ kg})a \qquad (2)$$

For m_2,

$$+n_2 - m_2 g \cos\theta = 0$$

$$n_2 = 6.00 \text{ kg}\left(9.80 \text{ m/s}^2\right)(\cos 30.0°)$$
$$= 50.9 \text{ N}$$

$$f_{k2} = \mu_k n_2$$
$$= 18.3 \text{ N}:$$
$$-18.3 \text{ N} - T_2 + m_2 \sin\theta = m_2 a$$

$$-18.3 \text{ N} - T_2 + 29.4 \text{ N} = (6.00 \text{ kg})a \qquad (3)$$

(a) Add equations (1), (2), and (3):

$$-7.06 \text{ N} - 18.3 \text{ N} + 29.4 \text{ N} = (13.0 \text{ kg})a$$
$$a = \frac{4.01 \text{ N}}{13.0 \text{ kg}} = \boxed{0.309 \text{ m/s}^2}$$

(b) $T_1 = 2.00 \text{ kg}\left(0.309 \text{ m/s}^2\right) + 7.06 \text{ N} = \boxed{7.67 \text{ N}}$

$T_2 = 7.67 \text{ N} + 5.00 \text{ kg}\left(0.309 \text{ m/s}^2\right) = \boxed{9.22 \text{ N}}$

P10.38 $I = \frac{1}{2}mR^2 = \frac{1}{2}(100\text{ kg})(0.500\text{ m})^2 = 12.5\text{ kg}\cdot\text{m}^2$

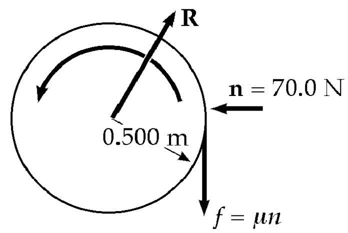

FIG. P10.38

$$\omega_i = 50.0\text{ rev/min} = 5.24\text{ rad/s}$$

$$\alpha = \frac{\omega_f - \omega_i}{t} = \frac{0 - 5.24\text{ rad/s}}{6.00\text{ s}} = -0.873\text{ rad/s}^2$$

$$\tau = I\alpha = 12.5\text{ kg}\cdot\text{m}^2\left(-0.873\text{ rad/s}^2\right) = -10.9\text{ N}\cdot\text{m}$$

The magnitude of the torque is given by $fR = 10.9\text{ N}\cdot\text{m}$, where f is the force of friction.

Therefore, $f = \frac{10.9\text{ N}\cdot\text{m}}{0.500\text{ m}}$ and $f = \mu_k n$

yields $\mu_k = \frac{f}{n} = \frac{21.8\text{ N}}{70.0\text{ N}} = \boxed{0.312}$

P10.46 Choose the zero gravitational potential energy at the level where the masses pass.

$$K_f + U_{gf} = K_i + U_{gi} + \Delta E$$

$$\frac{1}{2}m_1v^2 + \frac{1}{2}m_2v^2 + \frac{1}{2}I\omega^2 = 0 + m_1gh_{1i} + m_2gh_{2i} + 0$$

$$\frac{1}{2}(15.0 + 10.0)v^2 + \frac{1}{2}\left[\frac{1}{2}(3.00)R^2\right]\left(\frac{v}{R}\right)^2 = 15.0(9.80)(1.50) + 10.0(9.80)(-1.50)$$

$$\frac{1}{2}(26.5\text{ kg})v^2 = 73.5\text{ J} \Rightarrow v = \boxed{2.36\text{ m/s}}$$

P10.64 At the instant it comes off the wheel, the first drop has a velocity v_1, directed upward. The magnitude of this velocity is found from

$$K_i + U_{gi} = K_f + U_{gf}$$

$$\frac{1}{2}mv_1^2 + 0 = 0 + mgh_1 \text{ or } v_1 = \sqrt{2gh_1}$$

and the angular velocity of the wheel at the instant the first drop leaves is

$$\omega_1 = \frac{v_1}{R} = \sqrt{\frac{2gh_1}{R^2}}.$$

Similarly for the second drop: $v_2 = \sqrt{2gh_2}$ and $\omega_2 = \frac{v_2}{R} = \sqrt{\frac{2gh_2}{R^2}}$.

The angular acceleration of the wheel is then

$$a = \frac{\omega_2^2 - \omega_1^2}{2\theta} = \frac{\frac{2gh_2}{R^2} - \frac{2gh_1}{R^2}}{2(2\pi)} = \boxed{\frac{g(h_2 - h_1)}{2\pi R^2}}.$$