6. If we make the units explicit, the function is

$$\theta = (4.0 \text{ rad/s})t - (3.0 \text{ rad/s}^2)t^2 + (1.0 \text{ rad/s}^3)t^3$$

but generally we will proceed as shown in the problem—letting these units be understood. Also, in our manipulations we will generally not display the coefficients with their proper number of significant figures.

(a) Equation 10-6 leads to $\omega = \frac{d}{dt}\left(4t - 3t^2 + t^3\right) = 4 - 6t + 3t^2.$

Evaluating this at t = 2 s yields ω_2 = 4.0 rad/s.

(b) Evaluating the expression in part (a) at t = 4 s gives ω_4 = 28 rad/s.

(c) Consequently, Eq. 10-7 gives

$$\alpha_{\text{avg}} = \frac{\omega_4 - \omega_2}{4 - 2} = 12 \text{ rad/s}^2.$$

(d) And Eq. 10-8 gives

$$\alpha = \frac{d\omega}{dt} = \frac{d}{dt}\left(4 - 6t + 3t^2\right) = -6 + 6t.$$

Evaluating this at t = 2 s produces α_2 = 6.0 rad/s^2.

(e) Evaluating the expression in part (d) at t = 4 s yields α_4 = 18 rad/s^2. We note that our answer for α_{avg} does turn out to be the arithmetic average of α_2 and α_4 but point out that this will not always be the case.

28. Since the belt does not slip, a point on the rim of wheel *C* has the same tangential acceleration as a point on the rim of wheel *A*. This means that $\alpha_A r_A = \alpha_C r_C$, where α_A is the angular acceleration of wheel *A* and α_C is the angular acceleration of wheel *C*. Thus,

$$\alpha_C = \left(\frac{r_A}{r_C}\right)\alpha_C = \left(\frac{10\text{ cm}}{25\text{ cm}}\right)(1.6\text{ rad/s}^2) = 0.64\text{ rad/s}^2.$$

With the angular speed of wheel *C* given by $\omega_C = \alpha_C t$, the time for it to reach an angular speed of ω = 100 rev/min = 10.5 rad/s starting from rest is

$$t = \frac{\omega_C}{\alpha_C} = \frac{10.5\text{ rad/s}}{0.64\text{ rad/s}^2} = 16\text{ s}.$$

36. The parallel axis theorem (Eq. 10-36) shows that I increases with h. The phrase "out to the edge of the disk" (in the problem statement) implies that the maximum h in the graph is, in fact, the radius R of the disk. Thus, R = 0.20 m. Now we can examine, say, the h = 0 datum and use the formula for I_{com} (see Table 10-2(c)) for a solid disk, or (which might be a little better, since this is independent of whether it is really a solid disk) we can the difference between the h = 0 datum and the $h = h_{max} = R$ datum and relate that difference to the parallel axis theorem (thus the difference is $M(h_{max})^2 = 0.10\ \text{kg}\cdot\text{m}^2$). In either case, we arrive at M = 2.5 kg.

53. Combining Eq. 10-45 ($\tau_{net} = I\alpha$) with Eq. 10-38 gives $RF_2 - RF_1 = I\alpha$, where $\alpha = \omega / t$ by Eq. 10-12 (with $\omega_o = 0$). Using item (c) in Table 10-2 and solving for F_2 we find

$$F_2 = \frac{MR\omega}{2t} + F_1 = \frac{(0.02)(0.02)(250)}{2(1.25)} + 0.1 = 0.140 \text{ N}.$$

67. Using the parallel axis theorem and items (*e*) and (*h*) in Table 10-2, the rotational inertia is

$$I = \tfrac{1}{12} mL^2 + m(L/2)^2 + \tfrac{1}{2} mR^2 + m(R + L)^2 = 10.83mR^2 ,$$

where $L = 2R$ has been used. If we take the base of the rod to be at the coordinate origin ($x = 0$, $y = 0$) then the center of mass is at

$$y = \frac{mL/2 + m(L + R)}{m + m} = 2R .$$

Comparing the position shown in the textbook figure to its upside down (inverted) position shows that the change in center of mass position (in absolute value) is $|\Delta y| = 4R$. The corresponding loss in gravitational potential energy is converted into kinetic energy. Thus,

$$K = (2m)g(4R) \quad \Rightarrow \quad \omega = 9.82 \text{ rad/s}$$

where Eq. 10-34 has been used.

98. Let T be the tension on the rope. From Newton's second law, we have

$$T - mg = ma \quad \Rightarrow \quad T = m(g + a).$$

Since the box has an upward acceleration a = 0.80 m/s^2, the tension is given by

$$T = (30 \text{ kg})(9.8 \text{ m/s}^2 + 0.8 \text{ m/s}^2) = 318 \text{ N}.$$

The rotation of the device is described by $F_{\text{app}}R - Tr = I\alpha = Ia/r$. The moment of inertia can then be obtained as

$$I = \frac{r(F_{\text{app}}R - Tr)}{a} = \frac{(0.20 \text{ m})[(140 \text{ N})(0.50 \text{ m}) - (318 \text{ N})(0.20 \text{ m})]}{0.80 \text{ m/s}^2} = 1.6 \text{ kg} \cdot \text{m}^2$$