Homework week 1

31. ***REASONING AND SOLUTION***

a. The net torque on the disk about the axle is

$$\Sigma\tau = F_1R - F_2R = (0.314\text{ m})(90.0\text{ N} - 125\text{ N}) = \boxed{-11\text{ N}\cdot\text{m}}$$

b. The angular acceleration is given by $\alpha = \Sigma\tau/I$. From Table 9.1, the moment of inertia of the disk is

$$I = (1/2)\,MR^2 = (1/2)(24.3\text{ kg})(0.314\text{ m})^2 = 1.20\text{ kg·m}^2$$

$$\alpha = (-11\text{ N·m})/(1.20\text{ kg·m}^2) = \boxed{-9.2\text{ rad / s}^2}$$

33. $\boxed{\text{SSM}}$ ***REASONING AND SOLUTION***

a. The rim of the bicycle wheel can be treated as a hoop. Using the expression given in Table 9.1 in the text, we have

$$I_{\text{hoop}} = MR^2 = (1.20\text{ kg})(0.330\text{ m})^2 = \boxed{0.131\text{ kg}\cdot\text{m}^2}$$

b. Any one of the spokes may be treated as a long, thin rod that can rotate about one end. The expression in Table 9.1 gives

$$I_{\text{rod}} = \tfrac{1}{3}ML^2 = \tfrac{1}{3}(0.010\text{ kg})(0.330\text{ m})^2 = \boxed{3.6\times10^{-4}\text{ kg}\cdot\text{m}^2}$$

c. The total moment of inertia of the bicycle wheel is the sum of the moments of inertia of each constituent part. Therefore, we have

$$I = I_{\text{hoop}} + 50I_{\text{rod}} = 0.131\text{ kg}\cdot\text{m}^2 + 50(3.6\times10^{-4}\text{ kg}\cdot\text{m}^2) = \boxed{0.149\text{ kg}\cdot\text{m}^2}$$

70. ***REASONING AND SOLUTION*** The conservation of energy gives

$$mgh + (1/2)\,mv^2 + (1/2)\,I\omega^2 = (1/2)\,mv_0^{\,2} + (1/2)\,I\omega_0^{\,2}$$

If the ball rolls without slipping, $\omega = v/R$ and $\omega_0 = v_0/R$. We also know $I = (2/5)\,mR^2$. Substitution of the last two equations into the first and rearrangement gives

$$v = \sqrt{v_0^2 - \tfrac{10}{7}gh} = \sqrt{(3.50\text{ m/s})^2 - \tfrac{10}{7}\left(9.80\text{ m/s}^2\right)(0.760\text{ m})} = \boxed{1.3\text{ m/s}}$$