HOMEWORK WEEK 7

29. SSM ***REASONING AND SOLUTION*** For a rigid body rotating about a fixed axis, Newton's second law for rotational motion is given by Equation 9.7, $\sum\tau = I\alpha$, where I is the moment of inertia of the body and α is the angular acceleration expressed in rad/s^2. Equation 9.7 gives

$$I = \frac{\sum\tau}{\alpha} = \frac{10.0\ \text{N}\cdot\text{m}}{8.00\ \text{rad/s}^2} = \boxed{1.25\ \text{kg}\cdot\text{m}^2}$$

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30. ***REASONING*** According to Newton's second law for rotational motion, $\Sigma\tau = I\alpha$, the angular acceleration α of the blades is equal to the net torque $\Sigma\tau$ applied to the blades divided by their total moment of inertia I, both of which are known.

SOLUTION The angular acceleration of the fan blades is

$$\alpha = \frac{\Sigma\tau}{I} = \frac{1.8\ \text{N}\cdot\text{m}}{0.22\ \text{kg}\cdot\text{m}^2} = \boxed{8.2\ \text{rad/s}^2} \qquad (9.7)$$

33. 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

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

42. ***REASONING AND SOLUTION*** Newton's law applied to the 11.0-kg object gives

$$T_2 - (11.0\ \text{kg})(9.80\ \text{m/s}^2) = (11.0\ \text{kg})(4.90\ \text{m/s}^2) \quad \text{or} \quad T_2 = 162\ \text{N}$$

A similar treatment for the 44.0-kg object yields

$$T_1 - (44.0\text{ kg})(9.80\text{ m/s}^2) = (44.0\text{ kg})(-4.90\text{ m/s}^2) \quad \text{or} \quad T_1 = 216\text{ N}$$

For an axis about the center of the pulley

$$T_2 r - T_1 r = I(-\alpha) = (1/2)\, Mr^2\,(-a/r)$$

Solving for the mass M we obtain

$$M = (-2/a)(T_2 - T_1) = [-2/(4.90\text{ m/s}^2)](162\text{ N} - 216\text{ N}) = \boxed{22.0\text{ kg}}$$