74. Suppose a star the size of our Sun, but with mass 8.0 times as great, were rotating at a speed of 1.0 revolution every 12 days. If it were to undergo gravitational collapse to a neutron star of radius 11 km, losing three-quarters of its mass in the process, what would its rotation speed be? Assume that the star is a uniform sphere at all times, and that the lost mass carries off no angular momentum.

75. One possibility for a low-pollution automobile is for it to use energy stored in a heavy rotating flywheel. Suppose such a car has a total mass of 1400 kg, uses a uniform cylindrical flywheel of diameter 1.50 m and mass 240 kg, and should be able to travel 350 km without needing a flywheel "spinup." (*a*) Make reasonable assumptions (average frictional retarding force = 450 N, twenty acceleration periods from rest to 95 km/h, equal uphill and downhill, and that energy can be put back into the flywheel as the car goes downhill), and show that the total energy needed to be stored in the flywheel is about 1.7×10^8 J. (*b*) What is the angular velocity of the flywheel when it has a full "energy charge"? (*c*) About how long would it take a 150-hp motor to give the flywheel a full energy charge before a trip?

76. Figure 8–53 illustrates an H_2O molecule. The O–H bond length is 0.96 nm and the H–O–H bonds make an angle of 104°. Calculate the moment of inertia for the H_2O molecule about an axis passing through the center of the oxygen atom (*a*) perpendicular to the plane of the molecule, and (*b*) in the plane of the molecule, bisecting the H–O–H bonds.

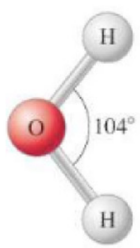

FIGURE 8–53 Problem 76.

77. A hollow cylinder (hoop) is rolling on a horizontal surface at speed $v = 3.3$ m/s when it reaches a 15° incline. (*a*) How far up the incline will it go? (*b*) How long will it be on the incline before it arrives back at the bottom?

78. A uniform rod of mass M and length L can pivot freely (i.e., we ignore friction) about a hinge attached to a wall, as in Fig. 8–54. The rod is held horizontally and then released. At the moment of release, determine (*a*) the angular acceleration of the rod, and (*b*) the linear acceleration of the tip of the rod. Assume that the force of gravity acts at the center of mass of the rod, as shown. [*Hint*: See Fig. 8–21g.]

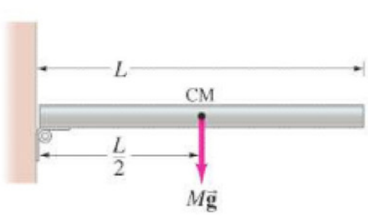

FIGURE 8–54 Problem 78.

79. A wheel of mass M has radius R. It is standing vertically on the floor, and we want to exert a horizontal force F at its axle so that it will climb a step against which it rests (Fig. 8–55). The step has height h, where $h < R$. What minimum force F is needed?

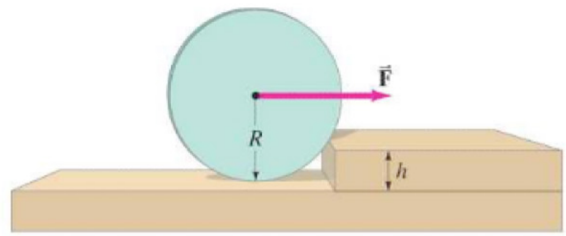

FIGURE 8–55 Problem 79.

80. A bicyclist traveling with speed $v = 4.2$ m/s on a flat road is making a turn with a radius $r = 6.4$ m. The forces acting on the cyclist and cycle are the normal force $(\vec{F}_N)$ and friction force $(\vec{F}_{fr})$ exerted by the road on the tires, and $m\vec{g}$, the total weight of the cyclist and cycle (see Fig. 8–56). (*a*) Explain carefully why the angle θ the bicycle makes with the vertical (Fig. 8–56) must be given by $\tan\theta = F_{fr}/F_N$ if the cyclist is to maintain balance. (*b*) Calculate θ for the values given. (*c*) If the coefficient of static friction between tires and road is $\mu_s = 0.70$, what is the minimum turning radius?

(a) (b)

FIGURE 8–56 Problem 80.

81. Suppose David puts a 0.50-kg rock into a sling of length 1.5 m and begins whirling the rock in a nearly horizontal circle above his head, accelerating it from rest to a rate of 120 rpm after 5.0 s. What is the torque required to achieve this feat, and where does the torque come from?

82. Model a figure skater's body as a solid cylinder and her arms as thin rods, making reasonable estimates for the dimensions. Then calculate the ratio of the angular speeds for a spinning skater with outstretched arms, and with arms held tightly against her body.