Understanding the Concepts

10.2. A comet is heading at high speed straight into the center of the Sun. Why is the angular momentum of the comet with respect to the Sun zero?

10.3. Why is a cyclist more stable on a rapidly moving bicycle than on one that is almost stationary?

10.8 A long, flexible, heavy bar can be very useful to a tightrope walker. Why?

10.24. A woman stands on the edge of a freely rotating platform. She walks toward the center along a radius. Will the speed of rotation of the platform change? If so, in what way, and what is the source of the torque?

10.27. In an industrial machine a cylinder is spinning without friction about its (fixed) axis, with angular speed \( \omega \). (Fig. 10–32). A small movement of its axis is allowed so that it comes into contact with a second identical cylinder, also free to spin about its fixed axis but initially at rest. As a result of friction between the surfaces, both end up spinning with equal and opposite angular velocity, magnitude \( \omega_f \). The net final angular momentum about, say, the axis of the first cylinder is therefore zero. What happened to the angular momentum?

10.30. Think about the demonstration in which someone spinning on a stool pulls in his or her arms and speeds up because of angular momentum conservation. In the process, does the energy of rotation decrease, remain constant, or increase?

Solve yourself problems

10.13. (II) A square, 20 cm on the side, is made of very light sticks. Four identical masses of \( m = 0.1 \text{ kg} \) form the corners of the square. The square rotates with an angular velocity of \( 8 \text{ rad/s} \) about an axis perpendicular to its plane through the center of the square. (a) Calculate the rotational inertia of the system about the rotation axis and use it to find the angular momentum about this axis. (b) Use the general definition of angular momentum to calculate the angular momentum of each mass with respect to the center of the square, and add these up. Compare the results of (a) and (b).

10.18. (I) A flagpole 2.2 m long is attached to a building. It makes an angle of \( 20^\circ \) with the horizontal. A mass of 18 kg is suspended from the end. What is the torque acting on the point of attachment to the building due to the suspended mass?

10.33. (II) A gob of clay, mass 100 g, falls from rest a distance 75 cm before striking and sticking to the edge of a wheel free to rotate about a horizontal axis through its center (Fig. 10–38). The wheel can be approximated as a solid disk of mass 10 kg and radius 50 cm. What is the angular speed of the wheel with the gob of clay attached?
10.47. (II) A wheel with massless spokes has mass 1 kg and radius 10 cm and is mounted on one end of a massless axle (Fig. 10–39). The axle rests on a pivot at a point 16 cm from the mounting point and 10 cm from the wheel. At the other end a mass of 0.8 kg is attached. The wheel spins at an angular frequency of 10 rad/s. What is the rate of precession?

10.51. (II) A child of mass 32 kg stands at the center of a platform of radius 2 m and rotational inertia \(450 \text{ kg} \cdot \text{m}^2\). The circular platform rotates about a frictionless shaft with angular speed of 0.8 rad/s. The child walks in a radial direction until he reaches the rim. What will the angular velocity of the platform be when that happens? What is the change in energy of the platform plus child? Identify the source of the work responsible for the change in rotational kinetic energy.

10.64. (II) A thin rod of mass \(M\), length \(\ell\), and constant density is standing on end on a rough table that forms the xy-plane. The rod begins to fall, with its top moving in the +x-direction, but as it falls, its point of contact does not move. As the rod hits the table, what are its (a) angular velocity, (b) angular momentum, and (c) kinetic energy?

**Hand-in Problems**

10.24. (II) A pulley system is used to lift a heavy mass. How much force must be applied to lift the object in Fig. 10–36 at a steady speed? Neglect friction at the axle.

10.30. (I) A skater twirls at 0.7 rev/s with her arms extended and holds a 3-kg mass in each hand; each mass is 0.8 m from the axis of rotation. She pulls the masses in along the radial direction until they are 0.4 m from the axis of rotation. Assuming that the rotational inertia of the arms is negligible and that the rotational inertia of the skater without the masses is \(2.3 \text{ kg} \cdot \text{m}^2\), what is the speed of rotation after the masses have been pulled in?

10.35. (I) An airplane engine develops 240 hp while turning the propeller at 3200 rev/min. What is the torque exerted on the propeller axis by the engine?

10.49. (II) A solid cylinder of mass 0.85 kg and radius 4.2 cm initially at rest rolls down a plane inclined at 28° with the horizontal and 1.5 m long. Use energy conservation to calculate the angular velocity of the cylinder at the bottom of the ramp; assume that all the kinetic energy of the cylinder is in rolling motion (that is, there is no sliding).

10.54. (II) A bullet of mass 15.0 g and velocity 350 m/s passes through a wheel at rest (Fig. 10–41). The wheel is a solid disk of mass 3.0 kg and radius 18 cm. The bullet passes through the wheel at a perpendicular distance of 14 cm from the center, and the bullet’s final velocity is 270 m/s. What are the wheel’s angular velocity, angular momentum, and kinetic energy? Is energy of motion conserved?