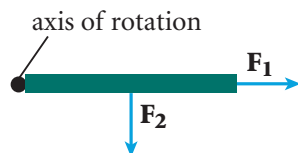


## Conceptual Questions

33. Which of the forces acting on the rod shown below will produce a torque about the axis at the left end of the rod?



34. Two forces equal in magnitude but opposite in direction act at the same point on an object. Is it possible for there to be a net torque on the object? Explain.
35. You are attempting to move a large rock by using a long lever. Is it more effective to place the lever's axis of rotation nearer to your hands or nearer to the rock? Explain.
36. A perpetual motion machine is a machine that, when set in motion, will never come to a halt. Why is such a machine not possible?

## Practice Problems

For problems 37–38, see Sample Problem E.

37. A bucket filled with water has a mass of 54 kg and is hanging from a rope that is wound around a 0.050 m radius stationary cylinder. If the cylinder does not rotate and the bucket hangs straight down, what is the magnitude of the torque the bucket produces around the center of the cylinder?
38. A mechanic jacks up the front of a car to an angle of  $8.0^\circ$  with the horizontal in order to change the front tires. The car is 3.05 m long and has a mass of 1130 kg. Gravitational force acts at the center of mass, which is located 1.12 m from the front end. The rear wheels are 0.40 m from the back end. Calculate the magnitude of the torque exerted by the jack.

## MIXED REVIEW

39. A  $2.00 \times 10^3$  kg car rounds a circular turn of radius 20.0 m. If the road is flat and the coefficient of static friction between the tires and the road is 0.70, how fast can the car go without skidding?
40. During a solar eclipse, the moon, Earth, and sun lie on the same line, with the moon between Earth and the sun. What force is exerted on
- the moon by the sun?
  - the moon by Earth?
  - Earth by the sun?
- (See the table in Appendix F for data on the sun, moon, and Earth.)
41. A wooden bucket filled with water has a mass of 75 kg and is attached to a rope that is wound around a cylinder with a radius of 0.075 m. A crank with a turning radius of 0.25 m is attached to the end of the cylinder. What minimum force directed perpendicularly to the crank handle is required to raise the bucket?
42. If the torque required to loosen a nut that holds a wheel on a car has a magnitude of  $58 \text{ N}\cdot\text{m}$ , what force must be exerted at the end of a 0.35 m lug wrench to loosen the nut when the angle is  $56^\circ$ ? (Hint: See Figure 18 for an example, and assume that  $\theta$  is  $56^\circ$ .)
43. In a canyon between two mountains, a spherical boulder with a radius of 1.4 m is just set in motion by a force of 1600 N. The force is applied at an angle of  $53.5^\circ$  measured with respect to the vertical radius of the boulder. What is the magnitude of the torque on the boulder?
44. The hands of the clock in the famous Parliament Clock Tower in London are 2.7 m and 4.5 m long and have masses of 60.0 kg and 100.0 kg, respectively. Calculate the torque around the center of the clock due to the weight of these hands at 5:20. The weight of each hand acts at the center of mass (the midpoint of the hand).
45. The efficiency of a pulley system is 64 percent. The pulleys are used to raise a mass of 78 kg to a height of 4.0 m. What force is exerted on the rope of the pulley system if the rope is pulled for 24 m in order to raise the mass to the required height?
46. A crate is pulled 2.0 m at constant velocity along a  $15^\circ$  incline. The coefficient of kinetic friction between the crate and the plane is 0.160. Calculate the efficiency of this procedure.