32. (II) An oxygen molecule consists of two oxygen atoms whose total mass is 5.3×10^{-26} kg and whose moment of inertia about an axis perpendicular to the line joining the two atoms, midway between them, is $1.9 \times 10^{-46}\ \mathrm{kg \cdot m^2}$. From these data, estimate the effective distance between the atoms.

33. (II) To get a flat, uniform cylindrical satellite spinning at the correct rate, engineers fire four tangential rockets as shown in Fig. 8–44. If the satellite has a mass of 3600 kg and a radius of 4.0 m, what is the required steady force of each rocket if the satellite is to reach 32 rpm in 5.0 min?

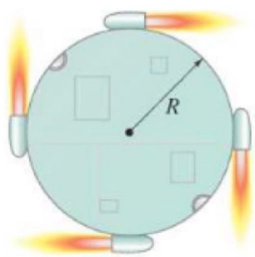

FIGURE 8–44 Problem 33.

34. (II) A grinding wheel is a uniform cylinder with a radius of 8.50 cm and a mass of 0.580 kg. Calculate (*a*) its moment of inertia about its center, and (*b*) the applied torque needed to accelerate it from rest to 1500 rpm in 5.00 s if it is known to slow down from 1500 rpm to rest in 55.0 s.

35. (II) A softball player swings a bat, accelerating it from rest to 3.0 rev/s in a time of 0.20 s. Approximate the bat as a 2.2-kg uniform rod of length 0.95 m, and compute the torque the player applies to one end of it.

36. (II) A teenager pushes tangentially on a small hand-driven merry-go-round and is able to accelerate it from rest to a frequency of 15 rpm in 10.0 s. Assume the merry-go-round is a uniform disk of radius 2.5 m and has a mass of 760 kg, and two children (each with a mass of 25 kg) sit opposite each other on the edge. Calculate the torque required to produce the acceleration, neglecting frictional torque. What force is required at the edge?

37. (II) A centrifuge rotor rotating at 10,300 rpm is shut off and is eventually brought uniformly to rest by a frictional torque of $1.20\ \mathrm{m \cdot N}$. If the mass of the rotor is 4.80 kg and it can be approximated as a solid cylinder of radius 0.0710 m, through how many revolutions will the rotor turn before coming to rest, and how long will it take?

38. (II) The forearm in Fig. 8–45 accelerates a 3.6-kg ball at $7.0\ \mathrm{m/s^2}$ by means of the triceps muscle, as shown. Calculate (*a*) the torque needed, and (*b*) the force that must be exerted by the triceps muscle. Ignore the mass of the arm.

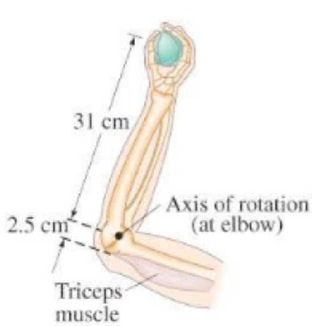

FIGURE 8–45 Problems 38 and 39.

39. (II) Assume that a 1.00-kg ball is thrown solely by the action of the forearm, which rotates about the elbow joint under the action of the triceps muscle, Fig. 8–45. The ball is accelerated uniformly from rest to 10.0 m/s in 0.350 s, at which point it is released. Calculate (*a*) the angular acceleration of the arm, and (*b*) the force required of the triceps muscle. Assume that the forearm has a mass of 3.70 kg and rotates like a uniform rod about an axis at its end.

40. (II) A helicopter rotor blade can be considered a long thin rod, as shown in Fig. 8–46. (*a*) If each of the three rotor helicopter blades is 3.75 m long and has a mass of 160 kg, calculate the moment of inertia of the three rotor blades about the axis of rotation. (*b*) How much torque must the motor apply to bring the blades up to a speed of 5.0 rev/s in 8.0 s?

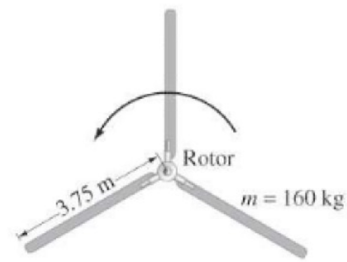

FIGURE 8–46 Problem 40.

41. (III) An *Atwood's machine* consists of two masses, m_1 and m_2, which are connected by a massless inelastic cord that passes over a pulley, Fig. 8–47. If the pulley has radius R and moment of inertia I about its axle, determine the acceleration of the masses m_1 and m_2, and compare to the situation in which the moment of inertia of the pulley is ignored. [*Hint*: The tensions F_{T1} and F_{T2} are not equal. We discussed this situation in Example 4–13, assuming $I = 0$ for the pulley.]

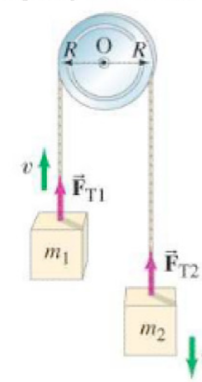

FIGURE 8–47 Problems 41 and 49. Atwood's machine.

42. (III) A hammer thrower accelerates the hammer (mass = 7.30 kg) from rest within four full turns (revolutions) and releases it at a speed of 28.0 m/s. Assuming a uniform rate of increase in angular velocity and a horizontal circular path of radius 1.20 m, calculate (*a*) the angular acceleration, (*b*) the (linear) tangential acceleration, (*c*) the centripetal acceleration just before release, (*d*) the net force being exerted on the hammer by the athlete just before release, and (*e*) the angle of this force with respect to the radius of the circular motion.

8–7 Rotational Kinetic Energy

43. (I) A centrifuge rotor has a moment of inertia of $3.75 \times 10^{-2}\ \mathrm{kg \cdot m^2}$. How much energy is required to bring it from rest to 8250 rpm?

44. (II) An automobile engine develops a torque of $280\ \mathrm{m \cdot N}$ at 3800 rpm. What is the power in watts and in horsepower?

45. (II) A bowling ball of mass 7.3 kg and radius 9.0 cm rolls without slipping down a lane at 3.3 m/s. Calculate its total kinetic energy.