

CH10 Exercises:

1. (10.7) A machinist is using a wrench to loosen a nut. The wrench is 25 cm long, and he exerts a 17 N force at the end of the handle at  $37^\circ$ . (a) What torque does the machinist exert about the center of the nut? (b) What is the maximum torque he could exert with this force, and how should the force be orientated?
2. (10.9) The flywheel of an engine has moment of inertia  $1.6 \text{ kg}\cdot\text{m}^2$  about its axis of rotation. What constant torque is required to bring it up to an angular speed of 400 rev/min in 8 s, starting from rest?
3. (10.15) A wheel rotates without friction about a stationary horizontal axis at the center of the wheel. A constant tangential force equal to 80 N is applied to the rim of the wheel. The wheel has radius 0.12 m. Starting from rest, the wheel has an angular speed of 12 rev/s after 2 s. What is the moment of inertia of the wheel?
4. (10.17) A 2.2 kg hoop 1.2 m in diameter is rolling to the right without slipping on a horizontal surface at a steady 2.6 rad/s. (a) How fast is its center moving? (b) What is the total kinetic energy of the hoop? (c) Find the velocity of each of the following point, as viewed by a person on the ground: (i) the highest point on the hoop; (ii) the lowest point on the hoop; (iii) a point on the right side of the hoop, midway between the top and the bottom.
5. (10.23) A 392 N wheel comes off a moving truck and rolls without slipping along a highway. At the bottom of a hill it is rolling at 25 rad/s. The radius of the wheel is 0.6 m, and its moment of inertia about its rotation axis is  $(0.8)MR^2$ . Friction does work on the wheel as it rolls up the hill to a stop, a height  $h$  above the bottom of the hill; this work has absolute value 2600 J. Calculate  $h$ .
6. (10.27) A soccer ball of diameter 22.6 cm and mass 426 g rolls up a hill without slipping, reaching a maximum height of 5 m above the base of the hill. We can model this ball as a thin walled hollow sphere. (a) At what rate was it rotating at the base of the hill? (b) How much rotational kinetic energy did it have then?
7. (10.29) A merry-go-round has radius 2.4 m and moment of inertia  $2100 \text{ kg}\cdot\text{m}^2$  about a vertical axle through its center, and it turns with negligible friction. (a) A child applies a 18 N force tangentially to the edge of the merry-go-round for 15 s. If the merry-go-round is initially at rest, what is its angular speed after this 15 s interval? (b) How much work did the child do on the merry-go-round? (c) What is the average power supplied by the child?
8. (10.31) A 2.8 kg grinding wheel is in the form of a solid cylinder of radius 0.1 m. (a) What constant torque will bring it from rest to an angular speed of 1200 rev/min in 2.5 s? (b) Through what angle has it turned during that time? (c) Use  $W = \tau\Delta\theta$  to calculate the work done by

torque. (d) What is the grinding wheel's kinetic energy when it is rotating at 1200 rev/min? Compare your answer to the result in part (c).

9. (10.37) Find the magnitude of the angular momentum of a second hand on a clock about an axis through the center of the clock face. The clock hand has a length of 15 cm and a mass of 6 g. Take the second hand to be a slender rod rotating with constant angular velocity about one end.
10. (10.45) A large wooden turntable in the shape of a flat uniform disk has a radius of 2 m and a total mass of 120 kg. The turntable is initially rotating at 3 rad/s about a vertical axis through its center. Suddenly, a 70 kg parachutist makes a soft landing on the turntable at a point near the outer edge. (a) Find the angular speed of the turntable after the parachutist lands. (Assume that you can treat the parachutist as a particle.) (b) Compare the kinetic energy of the system before and after the parachutist lands. Why are these kinetic energies not equal?
11. (10.49) A thin, uniform metal bar, 2 m long and weighing 90 N, is hanging vertically from the ceiling by a frictionless pivot. Suddenly it is struck 1.5 m below the ceiling by a small 3 kg ball, initially traveling horizontally at 10 m/s. The ball rebounds in the opposite direction with a speed of 6 m/s. (a) Find the angular speed of the bar just after the collision. (b) During the collision, why is the angular momentum conserved but not the linear momentum?
12. (10.52) A certain gyroscope precesses at a rate of 0.5 rad/s when used on earth. If it were taken to a lunar base, where the acceleration due to gravity is 0.165g, what would be its precession rate?
13. (10.55) A grindstone in the shape of a solid disk with diameter 0.52 m and a mass of 50 kg is rotating at 850 rev/min. You press an against the rim with a normal force of 160 N, and the grindstone comes to rest in 7.5 s. Find the coefficient of friction between the axe and the grindstone.
14. (10.59) Consider an Atwood machine for which two masses are tied together and suspended vertically by a rope over a wheel (pulley) that has a radius of 0.12 m. Let the moment of inertia of the wheel about its axis be  $0.22 \text{ kg}\cdot\text{m}^2$ , and the masses of block A and block B be 4 kg and 2 kg, respectively. Find the linear acceleration of blocks A and B, and the angular acceleration of the wheel.