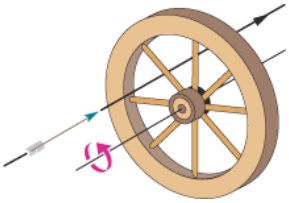
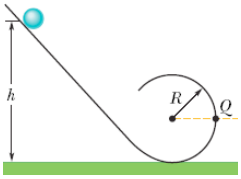
Chapter 10 – Problem Day

6. A hollow sphere of radius 0.15 m, with rotational inertia $I = 0.040\ \text{kg}\cdot\text{m}^2$ about a line through its center of mass, rolls without slipping up a surface inclined at 30° to the horizontal. At a certain initial position, the sphere's total kinetic energy is 20 J. (a) How much of this initial kinetic energy is rotational? (b) What is the speed of the center of mass at the initial position? When the sphere has moved 1.0 m up the incline from its initial position, what are (c) its total kinetic energy and (d) the speed of its center of mass?

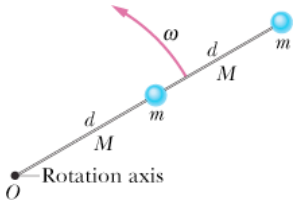
7. The wheel in the figure has eight equally spaced spokes and a radius of 30 cm. It is mounted on a fixed axle and is spinning at 2.5 rev/s. You want to shoot a 20-cm-long arrow parallel to this axle and through the wheel without hitting any of the spokes. Assume that the arrow and the spokes are very thin. (a) What minimum speed must the arrow have? (b) Does it matter where between the axle and rim of the wheel you aim? If so, what is the best location?



8. In the figure, a solid brass ball of mass 0.280 g will roll smoothly along a loop-the-loop track when released from rest along the straight section. The circular loop has radius R = 14.0 cm, and the ball has radius $r << R$. (a) What is h if the ball is on the verge of leaving the track when it reaches the top of the loop? If the ball is released at height $h = 6.00R$, what are the (b) magnitude and (c) direction of the horizontal force component acting on the ball at point Q?

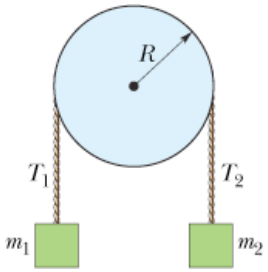


39. In the figure, two particles, each with mass m_1 = 0.85 kg, are fastened to each other, and to a rotation axis at O, by two thin rods, each with length d = 5.6 cm and mass M = 1.2 kg. The combination rotates around the rotation axis with angular speed of 0.3 rad/s. Measured about O, what are the combination's (a) rotational inertia and (b) kinetic energy?



40. Four particles of mass 0.50 kg each are placed at the vertices of a 2 m by 2 m square and held there by four massless rods, which form the sides of the square. What is the rotational inertia of this rigid body about an axis that (a) passes through the midpoints of opposite sides and lies in the plane of the square, (b) passes through the midpoint of one of the sides and is perpendicular to the plane of the square, and (c) lies in the plane of the square and passes through two diagonally opposite particles?

55. In the figure, block 1 has mass m_1 = 460 g, block 2 has mass m_2 = 500 g, and the pulley, which is mounted on a horizontal axle with negligible friction, has radius R = 5 cm. When released from rest, block 2 falls 75.0 cm in 5.00 s without the cord slipping on the pulley. (a) What is the magnitude of the acceleration of the blocks? What are (b) tension T_2 and (c) tension T_1? (d) What is the magnitude of the pulley's angular acceleration? (e) What is its rotational inertia?



57. A pulley, with a rotational inertia of 0.001 kg·m² about its axle and a radius of 10 cm, is acted on by a force applied tangentially at its rim. The force magnitude varies in time as $F = 0.5t + 0.3t^2$, with F in newtons and t in seconds. The pulley is initially at rest. At t = 3 s what are (a) its angular acceleration and (b) its angular speed?

63. A meter stick is held vertically with one end on the floor and is then allowed to fall. Find the speed of the other end just before it hits the floor, assuming that the end on the floor does not slip. (*Hint:* Consider the stick to be a thin rod and use the conservation of energy principle.)

Chapter 10 Answers

6a) 8 J
6b) 3 m/s
6c) 6.9 J
6d) 1.76 m/s

7a) 4 m/s

8a) 0.378 m
8b) 0.01962 N
8c) towards center of loop

39a) 0.023 $kg \cdot m^2$
39b) 0.0011 J

40a) 2 $kg \cdot m^2$
40b) 6 $kg \cdot m^2$
40c) 2 $kg \cdot m^2$

55a) 0.06 m/s^2
55b) 4.875 N
55c) 4.540 N
55d) 1.2 rad/s^2
55e) 0.0138 $kg \cdot m^2$

57a) 420 rad/s^2
57b) 500 rad/s

63) 5.425 m/s