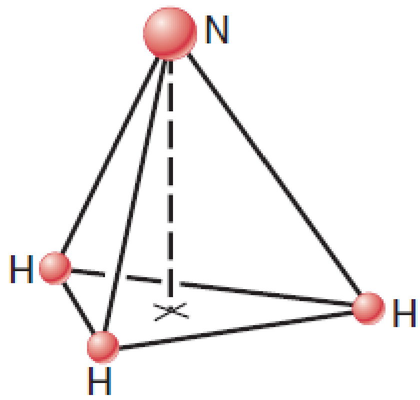
Tarea 1
Centro de masa y momento lineal

In the ammonia (NH_3) molecule, the three hydrogen (H) atoms form an equilateral triangle, the distance between centers of the atoms being 16.28×10^{-11} m, so that the center of the triangle is 9.40×10^{-11} m from each hydrogen atom. The nitrogen (N) atom is at the apex of a pyramid, the three hydrogens constituting the base (see Fig. 7-27). The nitrogen/hydrogen distance is 10.14×10^{-11} m and the nitrogen/hydrogen atomic mass ratio is 13.9. Locate the center of mass relative to the nitrogen atom.



Two particles P and Q are initially at rest 1.64 m apart. P has a mass of 1.43 kg and Q a mass of 4.29 kg. P and Q attract each other with a constant force of 1.79×10^{-2} N. No external forces act on the system. (*a*) Describe the motion of the center of mass. (*b*) At what distance from P's original position do the particles collide?

A dog weighing 10.8 lb is standing on a flatboat so that he is 21.4 ft from the shore. He walks 8.50 ft on the boat toward shore and then halts. The boat weighs 46.4 lb, and one can assume there is no friction between it and the water. How far is he from the shore at the end of this time? (Hint: The center of

Equation of Motion for Relativistic Particles and Systems with Variable Rest Mass," by Kalman B. Pomeranz, *American Journal of Physics,* December 1964, p. 955.)

A box, open at the top, in the form of a cube of edge length 40 cm, is constructed from thin metal plate. Find the coordinates of the center of mass of the box with respect to the coordinate system shown in Fig. 7-30.

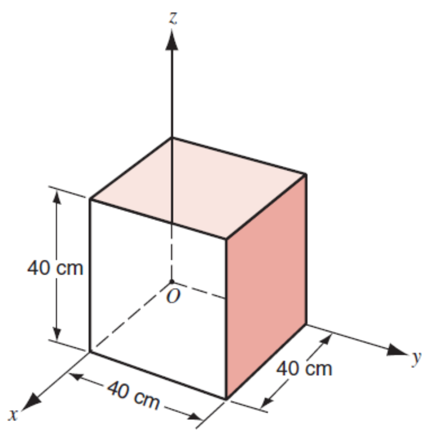


FIGURE 7-30. Exercise 15.

A man of mass m clings to a rope ladder suspended below a balloon of mass M; see Fig. 7-31. The balloon is stationary with respect to the ground. (a) If the man begins to climb the ladder at a speed v (with respect to the ladder), in what direction and with what speed (with respect to the Earth) will the balloon move? (b) What is the state of motion after the man stops climbing?

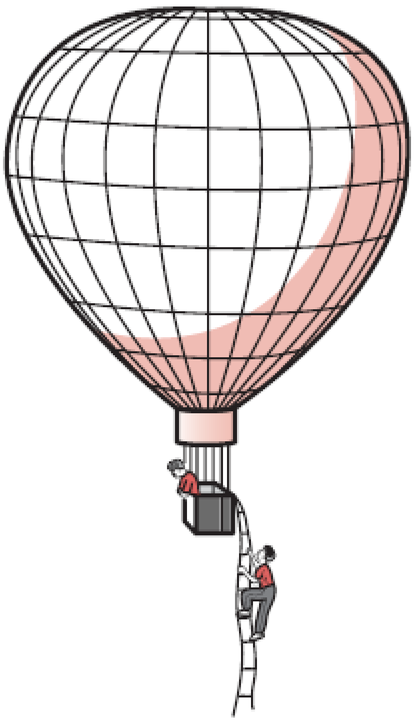


FIGURE 7-31. Problem 1.

A cylindrical storage tank is initially filled with aviation gasoline. The tank is then drained through a valve on the bottom. See Fig. 7-34. (*a*) As the gasoline is withdrawn, describe qualitatively the motion of the center of mass of the tank and its remaining contents. (*b*) What is the depth x to which the tank is filled when the center of mass of the tank and its remaining contents reaches its lowest point? Express your answer in terms of H, the height of the tank; M, its mass; and m, the mass of gasoline it can hold.

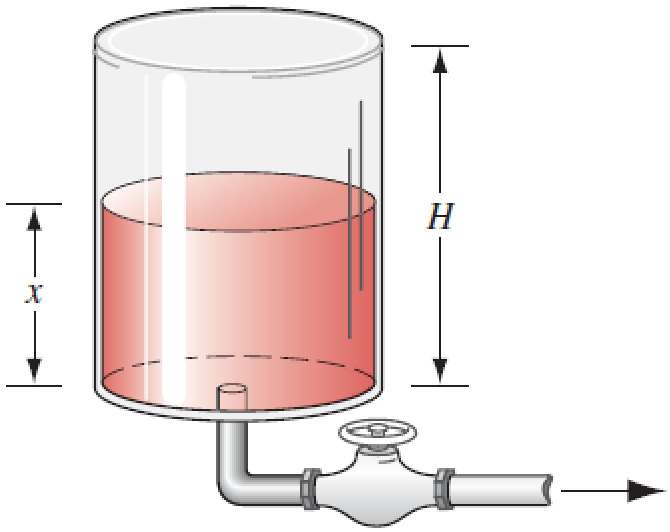


FIGURE 7-34. Problem 5.

A stream of water impinges on a stationary "dished" turbine blade, as shown in Fig. 6-26. The speed of the water is u, both before and after it strikes the curved surface of the blade, and the mass of water striking the blade per unit time is constant at the value μ. Find the force exerted by the water on the blade.

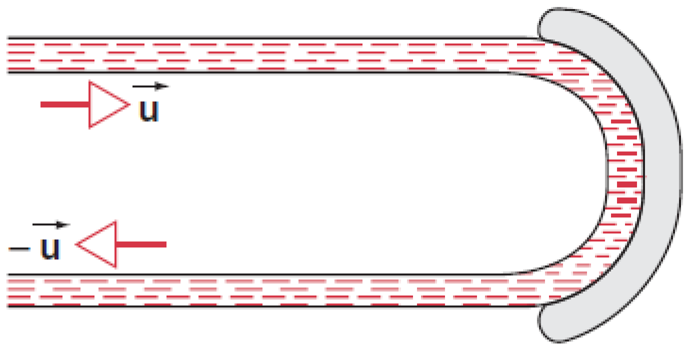
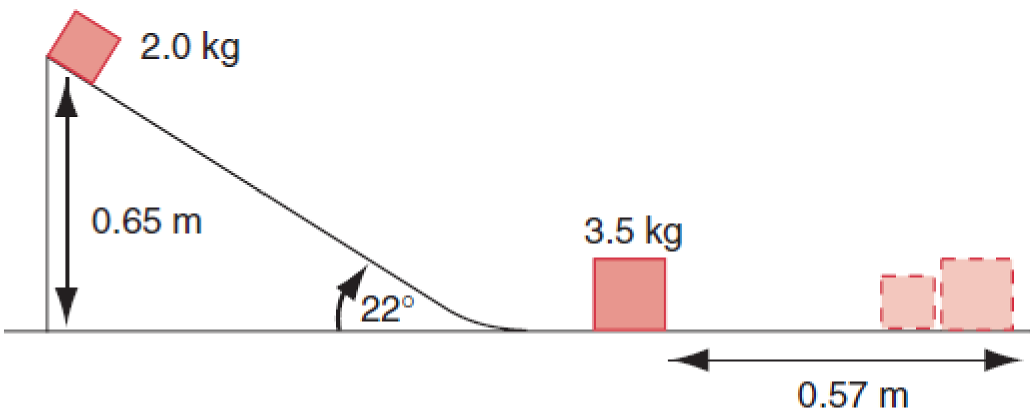


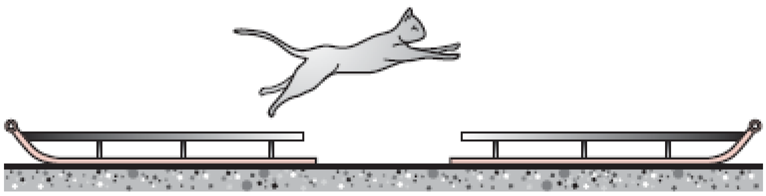
FIGURE 6-26. Problem 1.

A 2.0-kg block is released from rest at the top of a 22° frictionless inclined plane of height 0.65 m (Fig. 6-35). At the bottom of the plane it collides with and sticks to a block of

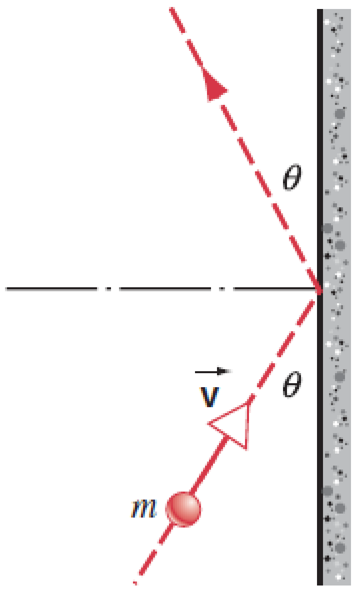
mass 3.5 kg. The two blocks together slide a distance of 0.57 m across a horizontal plane before coming to rest. What is the coefficient of friction of the horizontal surface?



Two 22.7-kg ice sleds are placed a short distance apart, one directly behind the other, as shown in Fig. 6-30. A 3.63-kg cat, standing on one sled, jumps across to the other and immediately back to the first. Both jumps are made at a speed of 3.05 m/s relative to the sled the cat is standing on when the jump is made. Find the final speeds of the two sleds.

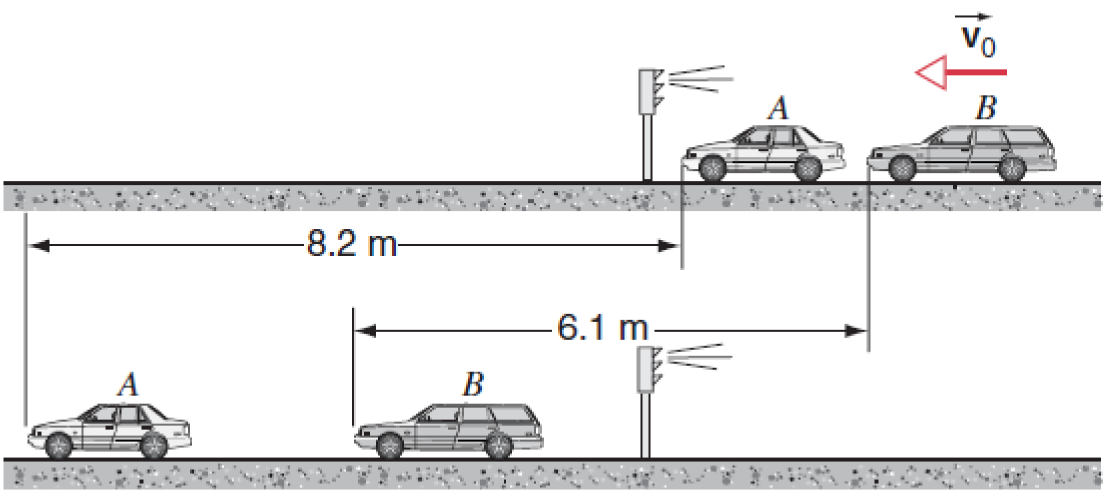


A 325-g ball with a speed v of 6.22 m/s strikes a wall at an angle θ of 33.0° and then rebounds with the same speed and angle (Fig. 6-27). It is in contact with the wall for 10.4 ms. (*a*) What impulse was experienced by the ball? (*b*) What was the average force exerted by the ball on the wall?



Show that, in the case of an elastic collision of a particle of mass m_1 with a particle of mass m_2, initially at rest, (*a*) the maximum angle θ_m through which m_1 can be deflected by the collision is given by $\cos^2 \theta_m = 1 - (m_2/m_1)^2$, so that $0 \le \theta_m \le \pi/2$ when $m_1 > m_2$; (*b*) $\theta_1 + \theta_2 = \pi/2$, when $m_1 = m_2$; (*c*) θ_1 can take on all values between 0 and π when $m_1 < m_2$.

Two cars *A* and *B* slide on an icy road as they attempt to stop at a traffic light. The mass of *A* is 1100 kg and the mass of *B* is 1400 kg. The coefficient of kinetic friction between the locked wheels of both cars and the road is 0.130. Car *A* succeeds in coming to rest at the light, but car *B* cannot stop and rear-ends car *A*. After the collision, *A* comes to rest 8.20 m ahead of the impact point and *B* 6.10 m ahead: see Fig. 6-36. Both drivers had their brakes locked throughout the incident. (*a*) From the distances each car moved after the collision, find the speed of each car immediately after impact. (*b*) Use conservation of momentum to find the speed at which car *B* struck car *A*. On what grounds can the use of momentum conservation be criticized here?



A ball with an initial speed of 10.0 m/s collides elastically with two identical balls whose centers are on a line perpendicular to the initial velocity and that are initally in contact with each other (Fig. 6-33). The first ball is aimed directly at the contact point and all the balls are frictionless. Find the velocities of all three balls after the collision. (Hint: With friction absent, each impulse is directed along the line of centers of the balls, normal to the colliding surfaces.)