12. Calculate the linear momentum for each of the following cases:

a. a proton with mass 1.67×10^{-27} kg moving with a velocity of 5.00×10^{6} m/s straight up

b. a 15.0 g bullet moving with a velocity of 325 m/s to the right

c. a 75.0 kg sprinter running with a velocity of 10.0 m/s southwest

d. Earth ($m = 5.98 \times 10^{24}$ kg) moving in its orbit with a velocity equal to 2.98×10^{4} m/s forward

(See Sample Problem 6A.)

14. A 2.5 kg ball strikes a wall with a velocity of 8.5 m/s to the left. The ball bounces off with a velocity of 7.5 m/s to the right. If the ball is in contact with the wall for 0.25 s, what is the constant force exerted on the ball by the wall?
(See Sample Problem 6B.)

24. A 65.0 kg ice skater moving to the right with a velocity of 2.50 m/s throws a 0.150 kg snowball to the right with a velocity of 32.0 m/s relative to the ground.

a. What is the velocity of the ice skater after throwing the snowball? Disregard the friction between the skates and the ice.

b. A second skater initially at rest with a mass of 60.0 kg catches the snowball. What is the velocity of the second skater after catching the snowball in a perfectly inelastic collision?

(See Sample Problem 6D.)

25. A tennis player places a 55 kg ball machine on a frictionless surface, as in **Figure 6-13.** The machine fires a 0.057 kg tennis ball horizontally with a velocity of 36 m/s toward the north. What is the final velocity of the machine?
(See Sample Problem 6D.)

Figure 6-13

26. After being struck by a bowling ball, a 1.5 kg bowling pin sliding to the right at 3.0 m/s collides head-on with another 1.5 kg bowling pin initially at rest. Find the final velocity of the second pin in the following situations:

a. the first pin moves to the right after the collision at 0.5 m/s

b. the first pin stops moving when it hits the second pin

(See Sample Problem 6D.)

31. Two carts with masses of 4.0 kg and 3.0 kg move toward each other on a frictionless track with speeds of 5.0 m/s and 4.0 m/s respectively. The carts stick together after colliding head-on. Find the final speed. (See Sample Problem 6E.)

32. A 1.20 kg skateboard is coasting along the pavement at a speed of 5.00 m/s when a 0.800 kg cat drops from a tree vertically downward onto the skateboard. What is the speed of the skateboard-cat combination? (See Sample Problem 6E.)

34. A railroad car with a mass of 2.00×10^4 kg moving at 3.00 m/s collides and joins with two railroad cars already joined together, each with the same mass as the single car and initially moving in the same direction at 1.20 m/s.

a. What is the speed of the three joined cars after the collision?

b. What is the decrease in kinetic energy during the collision?

(See Sample Problem 6F.)

35. An 88 kg fullback moving east with a speed of 5.0 m/s is tackled by a 97 kg opponent running west at 3.0 m/s, and the collision is perfectly inelastic. Calculate the following:

a. the velocity of the players just after the tackle

b. the decrease in kinetic energy during the collision

(See Sample Problem 6F.)

42. A moving object has a kinetic energy of 150 J and a momentum with a magnitude of 30.0 kg•m/s. Determine the mass and speed of the object.

44. A 3.00 kg mud ball has a perfectly inelastic collision with a second mud ball that is initially at rest. The composite system moves with a speed equal to one-third the original speed of the 3.00 kg mud ball. What is the mass of the second mud ball?

46. A 730 N student stands in the middle of a frozen pond having a radius of 5.0 m. He is unable to get to the other side because of a lack of friction between his shoes and the ice. To overcome this difficulty, he throws his 2.6 kg physics textbook horizontally toward the north shore at a speed of 5.0 m/s. How long does it take him to reach the south shore?

49. A 2150 kg car moving east at 10.0 m/s collides with a 3250 kg car moving east. The cars stick together and move east as a unit after the collision at a velocity of 5.22 m/s.

a. Find the velocity of the 3250 kg car before the collision.

b. What is the decrease in kinetic energy during the collision?

51. An 8.0 g bullet is fired into a 2.5 kg pendulum bob initially at rest and becomes embedded in it. If the pendulum rises a vertical distance of 6.0 cm, calculate the initial speed of the bullet.

56. A 55 kg pole-vaulter falls from rest from a height of 5.0 m onto a foam-rubber pad. The pole-vaulter comes to rest 0.30 s after landing on the pad.

a. Calculate the athlete's velocity just before reaching the pad.

b. Calculate the constant force exerted on the pole-vaulter due to the collision.

57. A 7.50 kg laundry bag is dropped from rest at an initial height of 3.00 m.

a. What is the speed of Earth toward the bag just before the bag hits the ground? Use the value 5.98×10^{24} kg as the mass of Earth.

b. Use your answer to part (**a**) to justify disregarding the motion of Earth when dealing with the motion of objects on Earth.