Additional Exercises

A-1: Bernie, whose mass is 70.0 kg, leaves a ski jump with a velocity of 21.0 m/s. What is Bernie's momentum as he leaves the ski jump?

A-2: Ethel is sitting on a park bench feeding the pigeons when a child's ball rolls toward her across the grass. Ethel returns the ball to the child by hitting it with her 2.0-kg pocketbook with a speed of 20 m/s. If the impact lasts for 0.4 s, with what force does Ethel hit the ball?

A-3: When Reggie stepped up to the plate and hit a 0.150-kg fast ball traveling at 36.0 m/s, the impact caused the ball to leave his bat with a velocity of 45.0 m/s in the opposite direction. If the impact lasted for 0.002 s, what force did Reggie exert on the baseball?

A-4: The U.S. Army's parachuting team, the Golden Knights, are on a routine jumping mission over a deserted beach. On a jump, a 65-kg Knight lands on the beach with a speed of 4.0 m/s, making a 0.20-m deep indentation in the sand. With what average force did the parachuter hit the sand? (Read more about the Golden Knights at http://www.goldenknights.com)

A-5: The late news reports the story of a shooting in the city. Investigators think that they have recovered the weapon and they run ballistics tests on the pistol at the firing range. If a 0.050-kg bullet were fired from the handgun with a speed of 400 m/s and it traveled 0.080 m into the target before coming to rest, what force did the bullet exert on the target?

A-6: About 50,000 years ago, in an area located outside Flagstaff, Arizona, a giant 4.5×10^7-kg meteor fell and struck Earth, leaving a 180-m-deep hole now known as Barringer crater. If the meteor was traveling at 20,000 m/s upon impact, with what average force did the meteor hit the earth? (Read more about Barringer crater at http://www.barringercrater.com)

A-7: In November 2007, astronaut Pam Melroy, history's second woman space shuttle commander, flew the space shuttle *Discovery* to the International Space Station to continue construction. To undock from the space station, Commander Melroy released hooks holding the two spacecraft together and the 76,700 kg shuttle pushed away from the space station with the aid of 4 large springs. a) If the 232,700 kg space station moved back at a speed of 0.50 m/s, how fast and in what direction did the space shuttle move? b) What is the relative speed of the two spacecraft as they separate? (Read more about astronaut Pam Melroy at http://www.jsc.nasa.gov/Bios/htmlbios/melroy.html)

A-8: Tyrrell throws his 0.20-kg football in the living room and knocks over his mother's 0.80-kg antique vase. After the collision, the football bounces straight back with a speed of 3.9 m/s, while the vase is moving at 2.6 m/s in the opposite direction. a) How fast did Tyrrell throw the football? b) If the football continued to travel at 3.9 m/s in the same direction it was thrown, would the vase have to be more or less massive than 0.80 kg?

A-9: A 300.-kg motorboat is turned off as it approaches a dock and it coasts in toward the dock at 0.50 m/s. Isaac, whose mass is 62.0 kg, jumps off the front of the boat with a speed of 3.0 m/s relative to the boat. What is the velocity of the boat after Isaac jumps?

A-10: Miguel, the 72.0-kg bullfighter, runs toward an angry bull at a speed of 4.00 m/s. The 550.-kg bull charges toward Miguel at 12.0 m/s and Miguel must jump on the bull's back at the last minute to avoid being run over. What is the new velocity of Miguel and the bull as they move across the arena?

A-11: The U.S.S. *Constitution*, the oldest fully commissioned war ship in the world, is docked in Boston, Massachusetts. Also known as "Old Ironsides" for her seemingly impenetrable hull, the frigate houses 56 pieces of heavy artillery. Mounted on bearings that allow them to recoil at a speed of 1.30 m/s are 20 carronades, each with a mass of 1000. kg. If a carronade fires a 14.5-kg cannonball straight ahead, with what muzzle velocity does the cannonball leave the cannon? (Read more about the U.S.S. *Constitution* at http://www.ussconstitution.navy.mil)

Challenge Exercises for Further Study

B-1: On a hot sumer afternoon, Keith and Nate are out fishing in their rowboat when they decide to jump into the water and go for a swim. Keith, whose mass is 65.0 kg, jumps straight off the front of the boat with a speed of 2.00 m/s relative to the boat, while Nate propels his 68.0-kg body simultaneously off the back of the boat at 4.00 m/s relative to the boat. If the 100.-kg boat is initially traveling forward at 3.00 m/s, what is its velocity after both boys jump?

B-2: Lilly, whose mass is 45.0 kg, is ice skating with a constant speed of 7.00 m/s when she hits a rough patch of ice with a coefficient of friction of 0.0800. How long will it take before Lilly coasts to a stop?

B-3: In a train yard, train cars are rolled down a long hill in order to link them up with other cars as shown. A car of mass 4000. kg starts to roll from rest at the top of a hill 5.0 m high, and inclined at an angle of 5.0° to the horizontal. The coefficient of rolling friction between the train and the track is 0.050. What velocity would the car have if it linked up with 3 identical cars sitting on flat ground at the bottom of the track? (*Hint:* The equation for rolling friction is just like the one for sliding friction.)