1. A 44 kg student on in-line skates is playing with a 22 kg exercise ball. Disregarding friction, explain what happens during the following situations.
   a. The student is holding the ball, and both are at rest. The student then throws the ball horizontally, causing the student to glide back at 3.5 m/s.
   b. Explain what happens to the ball in part (a) in terms of the momentum of the student and the momentum of the ball.
   c. The student is initially at rest. The student then catches the ball, which is initially moving to the right at 4.6 m/s.
   d. Explain what happens in part (c) in terms of the momentum of the student and the momentum of the ball.

2. A boy stands at one end of a floating raft that is stationary relative to the shore. He then walks in a straight line to the opposite end of the raft, away from the shore.
   a. Does the raft move? Explain.
   b. What is the total momentum of the boy and the raft before the boy walks across the raft?
   c. What is the total momentum of the boy and the raft after the boy walks across the raft?

3. High-speed stroboscopic photographs show the head of a 215 g golf club traveling at 55.0 m/s just before it strikes a 46 g golf ball at rest on a tee. After the collision, the club travels (in the same direction) at 42.0 m/s. Use the law of conservation of momentum to find the speed of the golf ball just after impact.

4. **Critical Thinking**   Two isolated objects have a head-on collision. For each of the following questions, explain your answer.
   a. If you know the change in momentum of one object, can you find the change in momentum of the other object?
   b. If you know the initial and final velocity of one object and the mass of the other object, do you have enough information to find the final velocity of the second object?
   c. If you know the masses of both objects and the final velocities of both objects, do you have enough information to find the initial velocities of both objects?
   d. If you know the masses and initial velocities of both objects and the final velocity of one object, do you have enough information to find the final velocity of the other object?
   e. If you know the change in momentum of one object and the initial and final velocities of the other object, do you have enough information to find the mass of either object?