

9.2 Momentum and the Impulse-Momentum Theorem

9.3 Solving Impulse and Momentum Problems

6. For each of the following situations, use both words and pictures to
- Describe what happens in the language of force, acceleration, and action/reaction.
 - Describe what happens in the language of impulse and momentum.
- a. A moving blob of clay hits a stationary bowling ball.

Force description:

Momentum description:

- b. A falling rubber ball bounces off the floor.

Force description:

Momentum description:

- c. Two equal masses are pushed apart by a compressed spring between them.

Force description:

Momentum description:

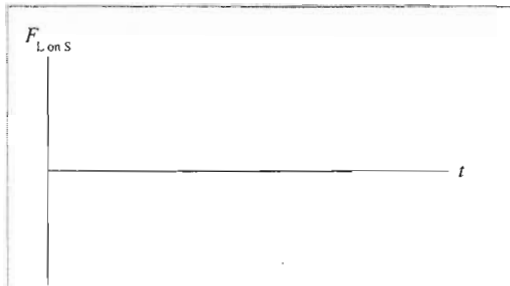
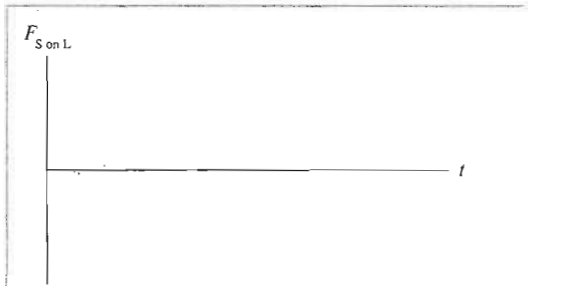
7. A small, light ball S and a large, heavy ball L move toward each other, collide, and bounce apart.



- a. Compare the force that S exerts on L to the force that L exerts on S. That is, is $F_{S \text{ on } L}$ larger, smaller, or equal to $F_{L \text{ on } S}$? Explain.

- b. Compare the time interval during which S experiences a force to the time interval during which L experiences a force. Are they equal, or is one longer than the other?

- c. Sketch a graph showing a *plausible* $F_{S \text{ on } L}$ as a function of time and another graph showing a plausible $F_{L \text{ on } S}$ as a function of time. Be sure think about the *sign* of each force.



- d. Compare the impulse delivered to S to the impulse delivered to L.

- e. Compare the momentum change of S to the momentum change of L.

- f. Compare the velocity change of S to the velocity change of L.

- g. What is the change in the *sum* of the momenta of the two balls? Is it positive, negative, or zero?

Exercises 8–11: Prepare a pictorial representation for these problems, but *do not* solve them.

- Draw pictures of “before” and “after.”
- Define symbols relevant to the problem.
- List known information, and identify the desired unknown.

8. A 50 kg archer, standing on frictionless ice, shoots a 100 g arrow at a speed of 100 m/s. What is the recoil speed of the archer?



9. The parking brake on a 2000 kg Cadillac has failed, and it is rolling slowly, at 1 mph, toward a group of small innocent children. As you see the situation, you realize there is just time for you to drive your 1000 kg Volkswagen side-on into the Cadillac and thus save the children. With what speed should you impact the Cadillac to bring it to a halt?



10. Dan is gliding on his skateboard at 4 m/s. He suddenly jumps backward off the skateboard, kicking the skateboard forward at 8 m/s. How fast is Dan going as his feet hit the ground? Dan's mass is 50 kg and the skateboard's mass is 5 kg.



11. While riding bumper cars at the fair, Bob's car collides directly with the back of Joe's car while both cars are moving to the right. Before the collision, Joe's car was traveling at 1.8 m/s and Bob's at 2.0 m/s. The combined mass of Joe and his car is only 80 kg, and the combined mass of Bob and his car is 100 kg. Immediately after the collision, Joe's car moves right at 2.0 m/s. How fast and in which direction does Bob's car move?

12. Identical blocks A and B are pushed to the right continuously by identical constant forces from the start to the finish shown below. At the starting line, block A is initially moving to the right, but block B is stationary. Which block undergoes a larger change in its momentum? Explain.

