6.1 Impulse-Momentum Theorem

C1. A 2500 kg car traveling to the north is slowed down uniformly from an initial velocity of 20.0 m/s by a 6250 N braking force acting opposite the car’s motion. Use the impulse-momentum theorem to answer the following questions:
   a. What is the car’s velocity after 2.50 s?
   b. How far does the car move during 2.50 s?
   c. How long does it take the car to come to a complete stop?

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1. The speed of a particle is doubled.
   a. By what factor is its momentum changed?
   b. What happens to its kinetic energy?

2. A pitcher claims he can throw a 0.145 kg baseball with as much momentum as a speeding bullet. Assume that a 3.00 g bullet moves at a speed of $1.50 \times 10^3$ m/s.
   a. Is the pitcher’s claim valid?
   b. Which has greater kinetic energy, the ball or the bullet?

3. A 0.42 kg soccer ball is moving downfield with a velocity of 12 m/s. A player kicks the ball so that it has a final velocity of 18 m/s downfield. Find the constant force exerted by the player’s foot on the ball if the two are in contact for 0.020 s.

4. Would you rather catch a small ball at fast speed or a big ball at low speed?

6.2 Conservation of Momentum

1. Is it possible for Superman to hurl an asteroid away and stay in the same spot? Estimate.

2. A 5 kg fish swimming at 1 m/s swallows another 1-kg fish swimming toward it at a velocity that brings both fish to a halt immediately after the munchy lunchy. What is the velocity $v$ of the smaller fish before lunch?
6.2 Conservation of Momentum

3. Jocko, who has a mass of 80 kg and stands at rest on the ice, catches a 20-kg ball that is thrown to him at 10 kph. How fast does Jocko and the ball move across the ice?

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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.


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?

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?
Momentum Concepts 1.

When ever an interaction occurs in a system, forces occur in equal and opposite pairs. Which of the following do not always occur in equal and opposite pairs?

a) Impulses.
b) Accelerations.
c) Momentum changes.
d) But all of these occur in equal and opposite pairs.
e) None of these.

2. Strictly speaking, when a cannon is fired, the momentum of the ball compared to the momentum of the cannon is [more][less][the same].

Q. How does this relate the 3rd law with the conservation of momentum?

3. (a) Car A is on the left. Car B is on the right. If A is moving faster than B, which has more change in momentum? Which suffers more damage?

(b) (After we discuss b in class) If A and B initially were going at the same speed, does your answer in (b) indicate that it is better for A to speed up? To slow down? Come up with a mathematical comparison too.

4. Falling on or off a sled. (a) An empty sled is sliding on frictionless ice when Susan drops vertically from a tree down onto the sled. When she lands, does the sled speed up, slow down, or keep the same speed? (b) Later: Susan falls sideways off the sled. When she drops off, does the sled speed up, slow down, or keep the same speed?

6. A railroad tank car contains milk and rolls at a constant speed along a level track. The milk begins to leak out the bottom. The car then

(a) slows down.
(b) speeds up.
(c) maintains a constant speed.
(d) Need more information about the rate of the leak.

7. You are lying in bed and want to shut your bedroom door. You have a bouncy “superball” and a blob of clay, both with the same mass. Which one would be more effective to throw at your door to close it?

(a) The superball.
(b) The blob of clay.
(c) Both the same.
(d) Neither will work.