# Momentum Problem Set 2

Elastic Collision Problems

1. A toy truck, with mass 20.0 g, travels along a level tabletop at 0.50 m/s. A miniature car, with mass 5.00 g, speeds headlong toward the toy truck at 0.75 m/s. Immediately after the collision, the toy truck continues in its original direction at 0.10 m/s. What is the velocity of the miniature car?

2. Tyrell throws his 0.20-kg football in the living room and knocks over his mother's 0.80-kg antique vase. After 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 Tyrell 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 more or less massive than 0.80 kg?

3. An alpha particle makes a head on collision with a stationary helium atom. Show the alpha particle will stop and the helium atom will move off with the original speed of the alpha particle. (Assume an alpha particle and helium nucleus have the same mass)

4. Jamal is at the state fair playing some of the arcades. At one booth, he throws a 0.5- kg ball with the velocity of 21.0 m/s in order to hit a 0.20-kg bottle sitting on a shelf, and when he makes contact the bottle goes flying forward at 30.0 m/s.

a.) What is the velocity of the ball after it hits the bottle?
b.) If the bottle were more massive, how would this affect the final velocity of the ball?

5. Lloyd rolls a 7.0-kg bowling ball down the alley for the league championship. One pin is still standing, and Lloyd hits it head-on with a velocity of 9.0 m/s. The 2.0-kg pin acquires a forward velocity of 14.0 m/s. what is the new velocity of the bowling ball?

6. Running at 2.0 m/s, Bruce, the 45.0-kg quarterback, collides with Biff, the 90.0-kg tackle, who is traveling at 7.0 m/s in the other direction. Upon collision, Biff continues to travel forward at 1.0 m/s. How fast is Bruce knocked backwards?

7. Tubby and his twin brother Chubby have a combined mass of 200.0 kg and are zooming along in a 100.0-kg amusement park bumper car at 10.0 m/s. They bump Melinda's car, which is sitting still. Melinda has a mass of 25.0 kg. After the elastic collision, the twins continue ahead with a speed of 4.12 m/s. How fast is Melinda's car bumped across the floor?

Impulse Problems:

1. A 1000 kg car accidentally drops from a crane and crashes at 30 m/s to the ground below and comes to an abrupt halt. What impulse acts on the car when it crashes?

2. A force of 186 N acts on a 7.3-kg bowling ball for 0.40 seconds. What is the bowling ball's change in momentum? What is the change in velocity?

3. The momentum of a 30.0-g sparrow with a speed of 12 m/s is 0.36 kg*m/s. What will be its momentum 12s later if a constant 0.02 N force due to air resistance acts on it?

4. A 0.15-kg rubber ball's velocity just before impact with a floor is 6.5 m/s down, and just after is 3.5 m/s straight up. If the ball is in contact with the floor for 0.025 s, what is the magnitude of the average force applied by the floor on the ball?

5. Before collision, a 25-kg object was moving at +12 m/s. Find the impulse that acted on the object if, after collision, it moved at the following velocities.

a. +8.0 m/s

b. -8.0 m/s

6. Auto companies frequently test the safety of automobiles by putting them through crash tests to observe the integrity of the passenger compartments. If a 1000-kg car is sent toward a cement wall with a speed of 14 m/s and the impact brings it to a stop in $8.00 \times 10^{-2}$ seconds, with what average force is it brought to rest?

7. Rhonda, who has a mass of 60.0 kg, is riding at 25.0 m/s in her sports car when she must suddenly slam on the brakes to avoid hitting a dog crossing the road. She is wearing her seatbelt, which brings her body to a stop in 0.400 seconds.

a. What average force did the seatbelt exert on her?

b. If she had not been wearing her seatbelt, and the windshield had stopped her in $1.0 \times 10^{-3}$ seconds, what average force would the windshield have exerted on her?

c. How many times greater is the stopping force of the windshield than the seatbelt?

8. An 80-kg man and his car are suddenly accelerated from rest to a speed of 5 m/s as a result of a rear-end collision. Assuming the time taken to be 0.3s, find the
a) impulse on the man and
b) the average force exerted on him by the back seat of his car

9. A 0.145-kg baseball is moving at 35m/s when it is caught by a player.

a. Find the change in momentum of the ball.

b. If the call is caught with the mitt held in a stationary position so that the ball stops in 0.050 s, what is the average force exerted on the ball?

c. If, instead, the mitt is moving backward so that the ball takes 0.500 s to stop, what is the average force exerted by the mitt on the ball?