Name: _____ Date: _____

Skill and Practice

4I Collisions and Conservation of Momentum

Read:

The law of conservation of momentum tells us that as long as colliding objects are not influenced by outside forces like friction, the total amount of momentum in the system before and after the collision is the same.

We can use the law of conservation of momentum to predict how two objects will move after a collision. Use the problem solving steps and the examples below to help you solve collision problems.

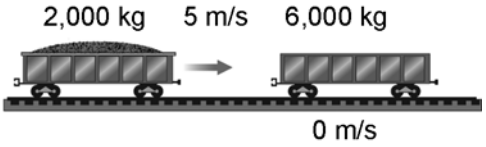
Problem Solving Steps

1. Draw a diagram.
2. Assign variables to represent the masses and velocities of the objects before and after the collision.
3. Write an equation stating that the total momentum before the collision equals the total after.
4. Plug in the information that you know.
5. Solve your equation.

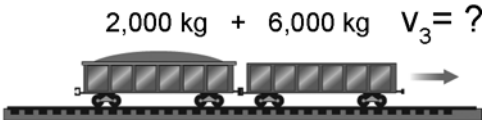
Example:

A 2,000-kilogram railroad car moving at 5 m/s collides with a 6,000-kilogram railroad car at rest. If the cars coupled together, what is their velocity after the inelastic collision?

Before collision



After collision



Looking for

v_3 = the velocity of the combined railroad cars after an inelastic collision

Given

Initial speed and mass of both cars:

m_1 = 2,000 kg, v_1 = 5 m/s

m_2 = 6,000 kg, v_2 = 0 m/s

Combined mass of the two cars:

$m_1 + m_2$ = 8,000 kg

Relationship

$m_1v_1 + m_2v_2 = (m_1 + m_2)v_3$

Solution

$$(2000 \text{ kg})(5 \text{ m/s}) + (6000 \text{ kg})(0 \text{ m/s}) = (2000 \text{ kg} + 6000 \text{ kg})v_3$$

$$10{,}000 \text{ kg-m/s} = (8000 \text{ kg})v_3$$

$$\frac{10{,}000 \text{ kg-m/s}}{8000 \text{ kg}} = v_3$$

$$10 \text{ m/s} = v_3$$

The velocity of the two combined cars after the collision is 10 m/s.

Practice:

1. What is the momentum of a 100-kilogram fullback carrying a football on a play at a velocity of 3.5 m/s?

---

2. What is the momentum of a 75.0-kilogram defensive back chasing the fullback at a velocity of 5.00 m/s?

---

3. A 2,000-kilogram railroad car moving at 5 m/s to the east collides with a 6,000-kilogram railroad car moving at 3 m/s to the west. If the cars couple together, what is their velocity after the collision?

---

4. A 4.0-kilogram ball moving at 8.0 m/s to the right collides with a 1.0-kilogram ball at rest. After the collision, the 4.0-kilogram ball moves at 4.8 m/s to the right. What is the velocity of the 1-kilogram ball?

---

5. A 0.0010-kg pellet is fired at a speed of 50.0m/s at a motionless 0.35-kg piece of balsa wood. When the pellet hits the wood, it sticks in the wood and they slide off together. With what speed do they slide?

---

6. Terry, a 70-kilogram tailback, runs through his offensive line at a speed of 7.0 m/s. Jared, a 100-kilogram linebacker, running in the opposite direction at 6.0 m/s, meets Jared head-on and “wraps him up.” What is the result of this tackle?

---

7. Snowboarding cautiously down a steep slope at a speed of 7.0 m/s, Sarah, whose mass is 50 kilograms, is afraid she won't have enough speed to travel up a slight uphill grade ahead of her. She extends her hand as her friend Trevor, who has a mass of 100 kilograms, is about to pass her traveling at 16 m/s. If Trevor grabs her hand, calculate the speed at which the friends will be sliding.

---

8. Tex, an 85.0 kilogram rodeo bull rider is thrown from the bull after a short ride. The 520-kilogram bull chases after Tex at 13.0 m/s. While running away at 3.00 m/s, Tex jumps onto the back of the bull to avoid being trampled. How fast does the bull run with Tex aboard?

---

9. Identical twins Kate and Karen each have a mass of 45 kg. They are rowing their boat on a hot summer afternoon when they decide to go for a swim. Kate jumps off the front of the boat at a speed of 3.00 m/s. Karen jumps off the back at a speed of 4.00 m/s. If the 70-kilogram rowboat is moving at 1.00 m/s when the girls jump, what is the speed of the rowboat after the girls jump?

10. A 0.10-kilogram piece of modeling clay is tossed at a motionless 0.10-kilogram block of wood and sticks. The block slides across a frictionless table at 15 m/s.

    a. At what speed was the clay tossed?

    b. The clay is replaced with a "bouncy" ball with the same mass. It is tossed with the same speed. The bouncy ball rebounds from the wooden block at a speed of 10 m/s. What effect does this have on the wooden block? Why?