

Imagine rolling a bowling ball down one lane at a bowling alley and rolling a playground ball down another lane at the same speed. The more massive bowling ball exerts more force on the pins than the playground ball exerts because the bowling ball has more momentum than the playground ball does. When we think of a massive object moving at a high velocity, we often say that the object has a large momentum. A less massive object with the same velocity has a smaller momentum.

On the other hand, a small object moving with a very high velocity may have a larger momentum than a more massive object that is moving slowly does. For example, small hailstones falling from very high clouds can have enough momentum to hurt you or cause serious damage to cars and buildings.

Did you know?

Momentum is so fundamental in Newton's mechanics that Newton called it simply "quantity of motion." The symbol for momentum, **p**, comes from German mathematician Gottfried Leibniz. Leibniz used the term *progress* to mean "the quantity of motion with which a body proceeds in a certain direction."

SAMPLE PROBLEM A

Momentum

PROBLEM

A 2250 kg pickup truck has a velocity of 25 m/s to the east. What is the momentum of the truck?

SOLUTION

Given: $m = 2250 \text{ kg}$ $\mathbf{v} = 25 \text{ m/s to the east}$

Unknown: $\mathbf{p} = ?$

Use the definition of momentum.

$$\mathbf{p} = m\mathbf{v} = (2250 \text{ kg})(25 \text{ m/s east})$$

$$\mathbf{p} = 5.6 \times 10^4 \text{ kg} \cdot \text{m/s to the east}$$

TIP

Momentum is a vector quantity, so you must specify both its size and direction.

PRACTICE A

Momentum

1. A deer with a mass of 146 kg is running head-on toward you with a speed of 17 m/s. You are going north. Find the momentum of the deer.
2. A 21 kg child on a 5.9 kg bike is riding with a velocity of 4.5 m/s to the northwest.
 - a. What is the total momentum of the child and the bike together?
 - b. What is the momentum of the child?
 - c. What is the momentum of the bike?
3. What velocity must a 1210 kg car have in order to have the same momentum as the pickup truck in Sample Problem A?