13-3 What is momentum?

Objective

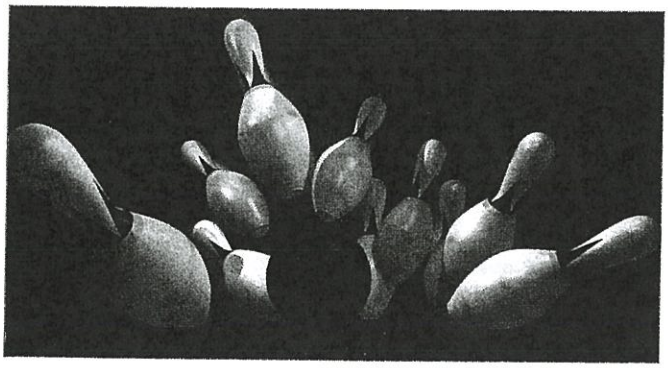
Define and describe how to calculate momentum.

Key Terms

momentum: a property of all moving objects

law of conservation of momentum: total momentum of any isolated system always remains the same

Momentum Picture a bowling ball with a mass of 5 kg rolling toward the pins at the end of the alley. In the next alley, a ball with a mass of 8 kg is rolling toward the pins with the same velocity. Which ball do you think is likely to knock over more pins? If you answered the ball with the greater mass, you are correct. As long as the two bowling balls are moving with the same velocity, the ball with the greater mass will strike the pins with greater energy. The combined effect of the mass and velocity of an object is momentum. **Momentum** is a property of all moving objects.



▲ **Figure 13-8** Momentum is transferred from the ball to the pins.

1 **IDENTIFY:** What two factors determine momentum?

Calculating Momentum The momentum of an object can be found by multiplying its mass by its velocity.

$$\text{momentum} = \text{mass} \times \text{velocity}$$

Let's look at the two bowling balls described earlier. Suppose the velocity of each ball is 20 m/s. Find the momentum of the 5-kg ball.

$$5 \text{ kg} \times 20 \text{ m/s} = 100 \text{ kg-m/s}$$

The 5-kg ball has a momentum of 100 kg-m/s. Now find the momentum of the 8-kg ball.

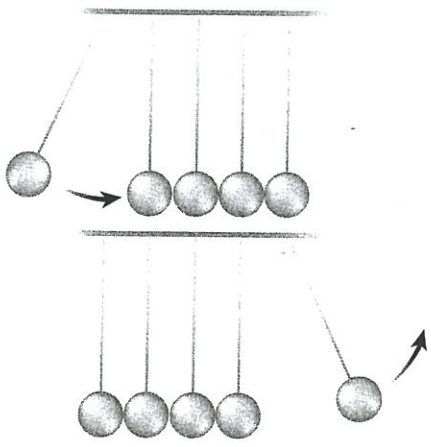
$$8 \text{ kg} \times 20 \text{ m/s} = 160 \text{ kg-m/s}$$

The 8-kg ball has a momentum of 160 kg-m/s. The ball with more momentum will knock over more pins.

2 **CALCULATE:** Find the momentum of a 10-kg object moving at a velocity of 20 m/s.

Conservation of Momentum When one moving object collides with another object, the motion of both objects changes. For example, when a bowling ball strikes the pins, the bowling ball slows down. It loses momentum. The pins move. The pins gain momentum. The important thing to remember is that the total momentum of the ball and the pins remains the same. In any isolated system, momentum can be transferred but cannot be lost. This is the **law of conservation of momentum.**

Figure 13-9 demonstrates this idea. If a sphere on the left is swung and strikes the row of spheres, a sphere on the other end will move. The momentum of the first sphere is transferred through the row of spheres to the sphere at the other end. No momentum is lost.



▲ **Figure 13-9** Momentum is conserved as it is transferred from sphere to sphere.

Name _____ Class _____ Date _____

13-3 What is momentum?

Lesson Review

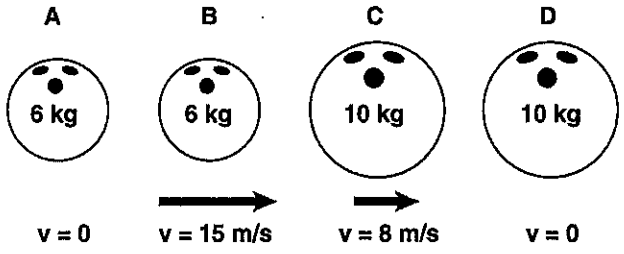
Circle the term in parentheses that best completes each statement.

1. All (stationary / moving) objects have momentum.
2. When momentum is transferred from one object to another, the total amount of momentum in the system (is / is not) conserved.
3. Momentum is calculated by multiplying (mass / weight) times velocity.
4. If two baseballs with the same mass are thrown at different velocities, the ball with a greater velocity has a (smaller / greater) momentum.
5. When a bowling ball hits a pin and knocks it down, (mass / momentum) is transferred from the ball to the pin.
6. A 6-kg puppy running at 5 m/s has a momentum of (11 k-m/s / 30 kg-m/s).
7. When a truck driver slows down in a construction zone, the truck's momentum will (increase / decrease).
8. If a car and a truck are traveling at the same speed, the (car / truck) has less momentum.

Skill Challenge

Skills: *interpreting diagrams, applying*

The diagram below shows four bowling balls. Use the diagram to answer the following questions.



1. Which bowling balls have momentum? _____
2. Which ball has the greatest momentum? _____
3. What is the momentum of that ball? _____
4. Of the balls that have momentum, which has the smallest momentum? _____
5. What is the momentum of that ball? _____