

## SECTION 2-4

## SECTION SUMMARY

## Action and Reaction

**Guide for Reading**

- ◆ What is Newton's third law of motion?
- ◆ What is the law of conservation of momentum?

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Forces are not “one-sided.” Whenever one object exerts a force on a second object, the second object exerts a force back on the first object. The force exerted by the second object is equal in strength and opposite in direction to the first force. Newton called one force the “action” and the other force the “reaction.” Newton’s third law of motion describes the relationship between these two forces. **Newton’s third law of motion states that if one object exerts a force on another object, then the second object exerts a force of equal strength in the opposite direction on the first object.**

Newton’s third law refers to forces on two different objects. The action and reaction forces described by this law cannot be added together because they are each acting on a different object. Forces can be added together only if they are acting on the same object.

The **momentum** of an object is the product of its mass and its velocity.

$$\text{Momentum} = \text{Mass} \times \text{Velocity}$$

The unit for momentum is kilogram-meters per second ( $\text{kg}\cdot\text{m}/\text{s}$ ), since mass is measured in kilograms and velocity in meters per second. Like velocity and acceleration, momentum is described by its direction in addition to its magnitude. The momentum of an object is in the same direction as the velocity of the object.

When two objects collide in the absence of friction, momentum is not lost. The **law of conservation of momentum** states that the total momentum of the objects in an interaction is the same before and after the interaction. **The total momentum of any group of objects remains the same unless outside forces act on the objects.** Friction would be an example of an outside force that might act on the objects. A quantity that is *conserved* is the same after an event as it was before the event.

**SECTION 2-4**

**REVIEW AND REINFORCE**

**Action and Reaction**

**◆ Understanding Main Ideas**

*Answer the following questions in the space provided.*

1. What does it mean to say that momentum is *conserved*?

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2. How does the diagram illustrate Newton's third law of motion? In your answer, compare the force of the foot kicking the soccer ball with the force of the soccer ball on the foot.

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3. Could an elephant have the same momentum as a golf ball? Explain.

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4. What is the momentum of a 20-kg dog running at a speed of 8 m/s?

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5. Suppose you have two toy cars. Each has a mass of 0.04 kg. The cars have tape on their bumpers that will cause them to couple together. One car is stopped on the track. The other car, traveling at a velocity of 4 m/s, hits the first car. What is the momentum of the coupled cars?

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**◆ Building Vocabulary Skills**

*Answer the following questions in the spaces provided.*

7. What is momentum?

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8. Explain the law of conservation of momentum.

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