Name _____ Date _____ Class _____

Newton's Third Law

Key Concepts

- What is Newton's third law of motion?
- How can you calculate the momentum of an object?
- What is the law of conservation of momentum?

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. One force can be thought of as the "action" and the other force as 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.

All moving objects have momentum. **Momentum** is a characteristic of a moving object that depends on both the mass and the velocity of the object. **You can calculate the momentum of a moving object by multiplying the object's mass and velocity.**

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

The unit for momentum is kilogram-meters per second (kg·m/s), since mass is measured in kilograms and velocity in meters per second. Like velocity, acceleration, and force, momentum is described by its direction as well as its quantity. The momentum of an object is in the same direction as its velocity. The more momentum a moving object has, the harder it is to change its velocity.

The total amount of momentum objects have is conserved when they collide. The **law of conservation of momentum** states that, in the absence of outside forces, the total momentum of objects that interact does not change. It is the same before and after the interaction. **The total momentum of any group of objects remains the same, or is conserved, unless outside forces act on the objects.** Friction would be an example of an outside force that might act on the objects.

Momentum is conserved when two objects, such as trains, collide. If one train traveling fast collides with a slower-moving train traveling in the same direction, the faster train slows down, and the slower train speeds up. If a moving train collides with a train at rest, the first train stops moving and the second train begins to move. If a moving train collides and locks with a train at rest, both cars will then move, but they will move more slowly than the first car did. In each of these examples, momentum is conserved.

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Newton's Third Law (pp. 393–399)

This section explains Newton's third law of motion. It also explains a law about moving objects.

Use Target Reading Skills

As you read, fill in the notetaking graphic organizer. Under "Notes," write key ideas, using phrases and abbreviations. Include a few important details. Use your notes to write a summary statement for each red heading. Under "Recall Clues and Questions," write study questions that your notes help you answer. Some notes for the first red heading are provided.

Newton's Third Law

Recall Clues and Questions	Notes
What is Newton's Third Law of Motion?	IF . . . one object exerts a force on another object THEN Example: Summary Statement:

Newton's Third Law of Motion (pp. 393–395)

1. What is Newton's third law of motion?

_____

_____

_____

_____

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Forces ▪ *Reading/Notetaking Guide*

Newton's Third Law *(continued)*

2. What is the name often given to the force exerted by the first object on a second object? _____
3. What is the name often given to the force exerted by the second object back on the first object? _____
4. The action and reaction forces in any situation will always be _____ and _____.
5. Explain why the equal action and reaction forces do not cancel each other when one person hits a ball.

_____

_____

_____

_____

_____

Momentum (pp. 396–397)

6. The product of an object's mass and velocity is its _____.
7. What is the equation you use to determine the momentum of an object?

_____

8. What is the unit of measurement for momentum?

_____

Conservation of Momentum (pp. 397–399)

9. What does the law of conservation of momentum state?

_____

_____

_____

10. Suppose a train car moving down a track at 10 m/s collides with another train car that is not moving. Explain how momentum is conserved after the collision.

_____

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Forces ▪ *Review and Reinforce*

Newton's Third Law

Understanding Main Ideas

Answer the following questions in the spaces provided.

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

_____

_____

2. How does the diagram at the right 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.

_____

_____

_____

_____

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

_____

_____

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

_____

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?

_____

_____

Building Vocabulary

Answer the following questions in the spaces provided.

6. What is momentum?

_____

_____

7. Describe the law of conservation of momentum.

_____

_____

_____