Name _____ Date _____ Class _____

Newton's Third Law

Guide for Reading

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

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. The first force is called the "action" and the other force is 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 is related to the mass and the velocity of the object. **The momentum of an object can by determined by multiplying the object's mass and its 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 and acceleration, momentum is described by its direction in addition to its quantity. The momentum of an object is in the same direction as the velocity of the object. The more momentum a moving object has, the harder it is to stop.

When two objects collide in the absence of friction, momentum is not lost. The **law of conservation of momentum** states that, in the absence of outside forces, the total momentum of the 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. A quantity that is *conserved* is the same after an event as it was before the event.

Momentum is conserved when two objects, such as trains, collide. If one train traveling fast collides with a slower-moving train on the same track, 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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Understanding Main Ideas

Answer the following questions in the spaces 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

Answer the following questions in the spaces provided.

6. What is momentum?

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7. Explain the law of conservation of momentum.

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