Name _____ Date _____ Class _____

Key Concept Builder

LESSON 3

Newton's Second Law

Key Concept What is Newton's second law of motion?

Newton's second law of motion describes the relationship between an object's change in velocity over time, or acceleration, and unbalanced forces exerted on the object. To change an object's velocity, unbalanced forces must change the object's speed, direction, or both.

Directions: *On the line before each item, write* S *if it describes a change of speed,* D *if it describes a change of direction, or* B *if it describes a change of both factors.*

_____ **1.** a car braking at a traffic light

_____ **2.** a child on a merry-go-round as it starts up

_____ **3.** a child on a merry-go-round in mid cycle

_____ **4.** an ice skater making a jump

_____ **5.** an elevator beginning to descend

_____ **6.** a ball dropped from waist height

_____ **7.** a bouncing ball

_____ **8.** the tip of a spinning fan blade

_____ **9.** a moving sewing-machine needle

_____ **10.** a swinging pendulum

Key Concept Builder **LESSON 3**

Newton's Second Law

Key Concept What is Newton's second law of motion?

Newton's second law of motion describes the relationship between an object's change in velocity over time, or acceleration, and unbalanced forces exerted on the object. Often, gravity is the dominant force affecting an object's velocity.

Directions: *Put a check mark on the line before each example in which gravity is the main force influencing the object's velocity.*

_____ **1.** a spaceship blasting off

_____ **2.** a spaceship in orbit

_____ **3.** a pitched ball on the way to the plate

_____ **4.** a dropped ball

_____ **5.** a comet moving around the Sun

_____ **6.** the rotation of Earth

_____ **7.** the movement of the tides

_____ **8.** a rock sinking to the bottom of a lake

_____ **9.** windmill blades turning

_____ **10.** a rock formation collapsing

Name _____ Date _____ Class _____

Key Concept Builder **LESSON 3**

Newton's Second Law

Key Concept What is Newton's second law of motion?

Newton's Second Law Equation

$$\text{Acceleration (in m/s}^2\text{)} = \frac{\text{net force (in N)}}{\text{mass (in kg)}}$$

$$a = \frac{F}{m}$$

$$F = m \times a$$

$$m = \frac{F}{a}$$

Directions: *Use the equation to answer each question.*

1. A boy throws a 1-kg rock with a force of 5 N. What is the acceleration of the rock when he lets go of it?

_____

2. A toy boat accelerates through calm water at 2.5 m/s^2 powered by a motor exerting a net force of 5 N. What is the mass of the boat?

_____

3. A net force pushing a 15-kg wagon on a level road results in an acceleration of 2 m/s^2. What is the net force?

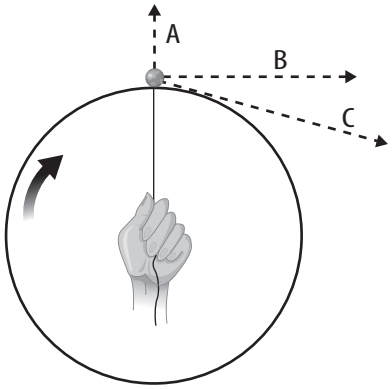
_____

Name _____ Date _____ Class _____

Key Concept Builder **LESSON 3**

Newton's Second Law

Key Concept How does centripetal force affect circular motion?



Directions: *The diagram shows a ball on a string being swung around in a circle. Use the diagram to answer each question.*

1. What force keeps the ball moving in a circle?

_____

2. What is producing this force?

_____

3. Why is the ball accelerating?

_____

_____

4. In which direction is it accelerating?

_____

5. If the ball broke away from the string at the position shown, would it move away on line A, B, or C?

_____

6. What causes it to take this path?

_____

7. After breaking away from the string, what is the main force that would be acting on the ball?

_____

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 4

Newton's Third Law

Key Concept What is Newton's third law of motion?

Directions: *On each line, write the term from the word bank that correctly completes each sentence. Each term is used only once.*

action	**conserved**	**elastic**	**equal**	**force pair**	**inelastic**
mass	**momentum**	**opposite**	**reaction**	**velocity**	

1. Newton's third law of motion states that, when one object exerts a force on a second object, the second object exerts a(n) _____ force in the _____ direction.

2. These two forces are called a(n) _____.

3. When you push against an object, that push is called the _____ force.

4. The force that the object exerts on you is called the _____ force.

5. A moving object's _____ is a measure of how difficult it is to stop it.

6. That quantity is a product of the object's _____ and _____. In the absence of outside forces, it is always _____.

7. In a(n) _____ collision, objects bounce away from each other.

8. In a(n) _____ collision, objects do not bounce away from each other.

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 4

Newton's Third Law

Key Concept What is Newton's third law of motion?

Directions: *Each of the following object pairs exerts forces on each other. Write* A *on the line next to objects that exert the action force and write* R *next to objects that exert the reaction force.*

1. swimmer's hands _____/water _____

2. a starting block _____/a runner's foot _____

3. a baseball bat _____/a baseball _____

4. water under a paddle _____/a paddle pushing a boat _____

5. a table _____/a cat jumping off a table _____

6. an arrow _____/a target _____

7. an airplane wing pushing down on air _____/air pushing up on a wing _____

8. a girl sitting in a chair _____/a chair supporting a girl _____

9. a windmill _____/wind _____

10. a pencil _____/a piece of paper _____

Name _____ Date _____ Class _____

Key Concept Builder  **LESSON 4**

Newton's Third Law

Key Concept Why don't the forces in a force pair cancel each other?

Directions: *Read the scenario with a partner. Then answer each question on the lines provided.*

Antonio has been learning about Newton's third law, but he's a bit confused as he prepares to carry out a task. His father has asked him to load a small wagon with unwanted tools from the garage and pull it to the front of the building for the yard sale.

As Antonio stands holding the handle of the wagon, he thinks, "According to Newton's third law, when I exert a pulling force on the wagon, the wagon pulls back with equal force. Therefore, the forces should cancel each other, and I shouldn't be able to pull the wagon. But obviously I can pull it. I don't understand."

1. Why can Antonio pull the wagon?

2. What additional force on the wagon could make it impossible for Antonio to pull it?

Name _____ Date _____ Class _____

Key Concept Builder

LESSON 4

Newton's Third Law

Key Concept What is the law of conservation of momentum?

Momentum Equation

momentum (in kg•m/s) = mass (in kg) × velocity (in m/s)

$$p = m \times v$$

Directions: *Answer each question or respond to each statement on the lines provided.*

1. Use the equation above to calculate the momentum of a 0.145-kg baseball being thrown at a speed of 40 m/s.

_____

2. Would an oil ship moving at a speed of 10 km/h have more or less momentum than a car moving at a speed of 100 km/h? Explain your answer.

_____

_____

3. **Consider** two kinds of collisions—between two billiard balls on a pool table and between two football players, one of them tackling the other. Which collision is elastic, and which one is inelastic? Explain your answer.

_____

_____

_____

_____

_____

_____

4. When moving objects collide, their total momentum is conserved unless an outside force acts on them. What outside force brings most colliding objects, such as billiard balls, to a stop?

_____