Name _____ Class _____ Date _____



# Summary

**THE BIG IDEA** **For every force, there is an equal and opposite force.**

## 7.1 Forces and Interactions

**A force is always part of a mutual action that involves another force.**

- A mutual action is an **interaction** between one thing and another.
- An example of interaction occurs when a hammer exerts a force on a nail, and the nail exerts a force on the hammer.

## 7.2 Newton's Third Law

**Newton's third law states that whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first object.**

- **Newton's third law** describes the relationship between two forces in an interaction. Newton's third law is often stated: "To every action there is always an equal opposing reaction."
- In an interaction, one force is called the **action force.** The other force is called the **reaction force.** The action and reaction forces are equal in strength and opposite in direction.
- When you walk on a floor, you push against the floor, and the floor simultaneously pushes against you.

## 7.3 Identifying Action and Reaction

**To identify a pair of action-reaction forces, first identify the interacting objects A and B, and if the action is A on B, the reaction is B on A.**

- When a boulder falls to Earth, the *action* is Earth exerting a force on the boulder, and the *reaction* is the boulder simultaneously exerting a force on Earth.
- A rocket accelerates because the rocket pushes exhaust gas and the exhaust gas pushes on the rocket.

## 7.4 Action and Reaction on Different Masses

**A given force exerted on a small mass produces a greater acceleration than the same force exerted on a large mass.**

- Recall that Newton's second law states that acceleration is proportional to the net force and inversely proportional to the mass.
- When a boulder falls toward Earth, Earth also moves toward the boulder. Because Earth has a huge mass, its acceleration toward the boulder is infinitesimally small. A rocket accelerates because it continually recoils from the exhaust gases ejected from its engine.

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# Exercises

## 7.1 Forces and Interactions (page 107)

1. A force is always part of a(n) _____ that involves another force.
2. Define **interaction.** _____
3. Describe the interaction forces between a nail and a hammer that hits it.

_____

_____

## 7.2 Newton's Third Law (page 108)

4. State Newton's third law.

_____

_____

5. Is the following sentence true or false? It doesn't matter which force we call *action* and which we call *reaction.* _____
6. Action and reaction forces are equal in _____ and opposite in _____.
7. Is the following sentence true or false? In every interaction, the forces always occur in pairs. _____
8. Complete the table by writing the reaction for each action.

| Action | Reaction |
|---|---|
| When you walk, you push against the floor. | |
| The tires of a car push against the road. | |
| When swimming, you push the water backward. | |
| A dog wags its tail. | |
| You push on a wall. | |
| When a batter swings, the bat exerts a force on the ball. | |

9. Use the idea of action and reaction forces to explain why a person trying to walk on ice may not have any forward motion.

_____

_____

_____

## 7.3 Identifying Action and Reaction (pages 108–109)

10. What are the two steps you can take to identify a pair of action-reaction forces?

    a. _____

    b. _____

11. Identify the action–reaction forces of a boulder falling off a cliff by answering the following questions.

    a. What are the two interacting objects? _____

    b. What is the action of A on B? _____

    c. What is the action of B on A? _____

12. Complete the table by identifying the reaction forces. In each case, specify the direction of the reaction force.

| Action | Reaction |
|---|---|
| As a car moves along a road, the tires of the car push backward against the road. | |
| As a spaceship moves through space, it pushes gas out behind. | |
| A ball rolls across a table and exerts a force against a second ball. | |

## 7.4 Action and Reaction on Different Masses (pages 110–111)

13. Is the following sentence true or false? If you drop a pencil, the pencil pulls Earth upward with a much smaller force than that with which Earth pulls the pencil downward. _____

14. State Newton's second law.

    _____

    _____

15. When a boulder falls off a cliff toward the ground, Earth accelerates toward the boulder. Circle the letter that explains why we don't sense this acceleration.

    a. The boulder's pull on Earth is much smaller than Earth's pull on the boulder.

    b. Earth's huge mass causes its acceleration to be infinitesimally small.

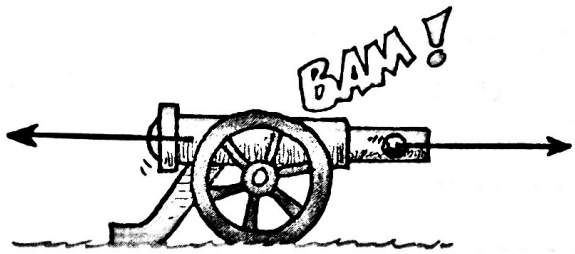
    c. Earth's acceleration is in the same direction as the boulder's acceleration.

    d. The boulder's acceleration is much smaller than the Earth's acceleration.

16. When a cannonball is fired from a cannon, the force the cannon exerts on the cannonball is exactly _____ and _____ to the force the cannonball exerts on the cannon.

17. Name the three factors that you must consider in order to understand why a cannonball moves much faster than the cannon when the cannonball is shot from the cannon.

_____




18. The picture above shows a cannonball being shot from a cannon. Explain why the change in velocity of the cannonball is much greater than the change in velocity of the cannon.

_____

_____

_____

19. How is the acceleration of a rocket similar to the acceleration of a cannonball that is fired from a cannon?

_____

_____

_____

_____

20. Is the following sentence true or false? A rocket is propelled by the impact of exhaust gases against the atmosphere. _____

21. The upward force that causes helicopters, birds, and airplanes to fly is called _____.

22. A helicopter has a lifting force because its blades are shaped to force air particles _____, and the air forces the blades _____.

*Match each condition on the left to the result on the right.*

| Condition | Result |
|---|---|
| _____ 23. Lift equals the helicopter's weight. | a. The helicopter moves downward. |
| _____ 24. Lift is greater than the helicopter's weight. | b. The helicopter moves upward. |
| _____ 25. Lift is less than the helicopter's weight. | c. The helicopter hovers in midair. |