

13-6 What is Newton's third law of motion?

INVESTIGATE

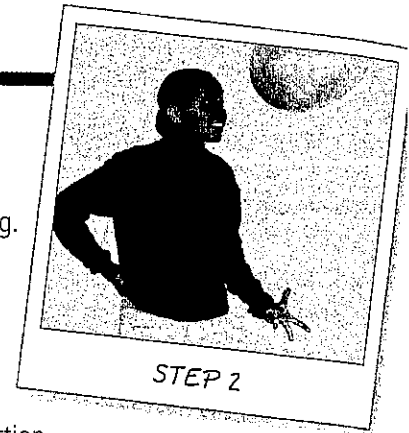


Observing Newton's Third Law

HANDS-ON ACTIVITY

1. Blow up a balloon. Hold the neck of the balloon tightly to prevent air from escaping.
2. Hold the balloon at arm's length and observe which direction the neck of the balloon is facing.
3. Release the balloon and observe what happens.

THINK ABOUT IT: What happened when you released the balloon? What do you think caused this to happen? How was the behavior of the balloon related to the direction in which the neck of the balloon was facing?



Objective

Describe Newton's third law of motion.

Key Terms

action force: force acting in one direction

reaction force: force acting in the opposite direction

Action and Reaction Forces always act in pairs. The two forces act in opposite directions. When you push on an object, the object pushes back with an equal force. When the basketball player in Figure 13-19 shoots the ball, he pushes against it. This is the **action force**.



▲ Figure 13-19 When the player exerts a force on the ball, the ball exerts an equal force on him.

The ball pushes back against the player with force of the same size. This **reaction force** will cause the wheelchair to move backwards. Notice that the two forces act on different objects. The action force acts on the ball. The reaction force acts on the player.

▶ **CONTRAST:** How are action and reaction forces different?

Newton's Third Law Newton's third law of motion describes action and reaction forces. The law states that for every action force, there is an equal and opposite reaction force. Imagine hitting a tennis ball. The racket exerts a force on the ball. This is the action force. The ball exerts an equal and opposite force on the racket. This is the reaction force.



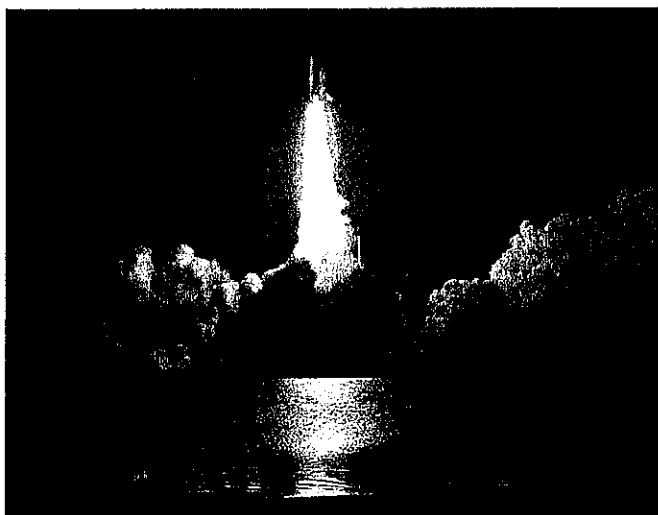
◀ Figure 13-20 The tennis racket is about to exert an action force on the ball.

Newton's third law explains how many sports injuries are caused. The more force you use to hit a tennis ball, the more reaction force your arm receives from the racket. Every time your feet hit the ground when you are running, the ground hits your feet with an equal and opposite force.

2 **STATE:** What does Newton's third law of motion state?

Balloons and Rockets Newton's third law explains how balloons and rocket engines work. When the neck of an inflated balloon is released, the stretched rubber material pushes against the air in the balloon. The air rushes out of the neck of the balloon. The action of the air rushing from the balloon pushes against the balloon, moving it in the opposite direction.

When rocket fuel is burned, hot gases are produced. These gases expand rapidly and are forced out of the back of the rocket. This is the action force. The gases exert an equal and opposite force on the rocket itself. This is the reaction force. This force pushes the rocket upward.



▲ Figure 13-21 Action and reaction forces during liftoff

3 **INFER:** What effect would blowing more air into a balloon have on the motion of the balloon when released?

✓ CHECKING CONCEPTS

1. Forces always act in _____.
2. A table exerts an upward _____ on objects resting on the table.
3. For every action force, there is an equal and _____ reaction force.
4. In a rocket engine, the _____ force pushes the rocket upward.
5. Action forces and reaction forces always act on _____ objects.

💡 THINKING CRITICALLY

6. **INFER:** An object resting on a table weighs 100 N. With what force is the object pushing on the table? With what force is the table pushing on the object?
7. **CLASSIFY:** When you walk, your feet push against the ground. At the same time, the ground pushes against your feet. Which is the action force? Which is the reaction force?
8. **HYPOTHESIZE:** When you walk, you move forward. Does Earth move in the opposite direction? Explain your answer.

Web InfoSearch

VentureStar In 1996, NASA started plans to develop a replacement for the space shuttle. This replacement, called VentureStar, was to have many improvements over the present shuttle. At present, this project has been postponed. It may be revived in the future.

SEARCH: Use the Internet to find out what types of improvements NASA plans to incorporate in its next generation of space shuttles. What is the X-33? Why does NASA call the VentureStar a Reusable Launch Vehicle? Start your search at www.conceptsandchallenges.com. Some key search words are X-33, Reusable Launch Vehicle, VentureStar, and Lockheed Martin VentureStar.