KEY CONCEPT

10.1 An object in motion changes position.

BEFORE, you learned

- Objects can move in different ways
- An object's position can change

NOW, you will learn

- How to describe an object's position
- How to describe an object's motion

VOCABULARY

position p. 313
reference point p. 314
motion p. 315

EXPLORE Location

How do you describe the location of an object?

PROCEDURE

1. Choose an object in the classroom that is easy to see.
2. Without pointing to, describing, or naming the object, give directions to a classmate for finding it.
3. Ask your classmate to identify the object using your directions. If your classmate does not correctly identify the object, try giving directions in a different way. Continue until your classmate has located the object.

WHAT DO YOU THINK?

What kinds of information must you give another person when you are trying to describe a location?

Position describes the location of an object.

VOCABULARY
Make a description wheel in your notebook for *position*.

Have you ever gotten lost while looking for a specific place? If so, you probably know that accurately describing where a place is can be very important. The **position** of a place or an object is the location of that place or object. Often you describe where something is by comparing its position with where you currently are. You might say, for example, that a classmate sitting next to you is about a meter to your right, or that a mailbox is two blocks south of where you live. Each time you identify the position of an object, you are comparing the location of the object with the location of another object or place.

CHECK YOUR READING Why do you need to discuss two locations to describe the position of an object?

Describing a Position

RESOURCE CENTER
CLASSZONE.COM
Learn more about how people find and describe position.

You might describe the position of a city based on the location of another city. A location to which you compare other locations is called a **reference point.** You can describe where Santiago, Chile, is from the reference point of the city Brasília, Brazil, by saying that Santiago is about 3000 kilometers (1860 mi) southwest of Brasília.

You can also describe a position using a method that is similar to describing where a point on a graph is located. For example, in the longitude and latitude system, locations are given by two numbers—longitude and latitude. Longitude describes how many degrees east or west a location is from the prime meridian, an imaginary line running north-south through Greenwich, England. Latitude describes how many degrees north or south a location is from the equator, the imaginary circle that divides the northern and southern hemispheres. Having a standard way of describing location, such as longitude and latitude, makes it easier for people to compare locations.

Describing Position

There are several different ways to describe a position. The way you choose may depend on your reference point.

1 Reference Point: Brasília

To describe where Santiago is, using Brasília as a reference point, you would need to know how far Santiago is from Brasília and in what direction it is.

2 Reference Point: 0° longitude, 0° latitude

In the longitude and latitude system, a location is described by how many degrees north or south it is from the equator and how many degrees east or west it is from the prime meridian.

READING VISUALS Compare and contrast the two ways of describing the location of Santiago as shown here.

Measuring Distance

If you were to travel from Brasília to Santiago, you would end up about 3000 kilometers from where you started. The actual distance you traveled, however, would depend on the exact path you took. If you took a route that had many curves, the distance you traveled would be greater than 3000 kilometers.

The way you measure distance depends on the information you want. Sometimes you want to know the straight-line distance between two positions. Sometimes, however, you might need to know the total length of a certain path between those positions. During a hike, you are probably more interested in how far you have walked than in how far you are from your starting point.

When measuring either the straight-line distance between two points or the length of a path between those points, scientists use a standard unit of measurement. The standard unit of length is the meter (m), which is 3.3 feet. Longer distances can be measured in kilometers (km), and shorter distances in centimeters (cm).

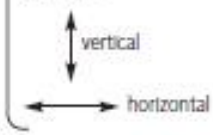
COMPARE How does the distance each person has walked compare with the distance each is from the start of the maze?

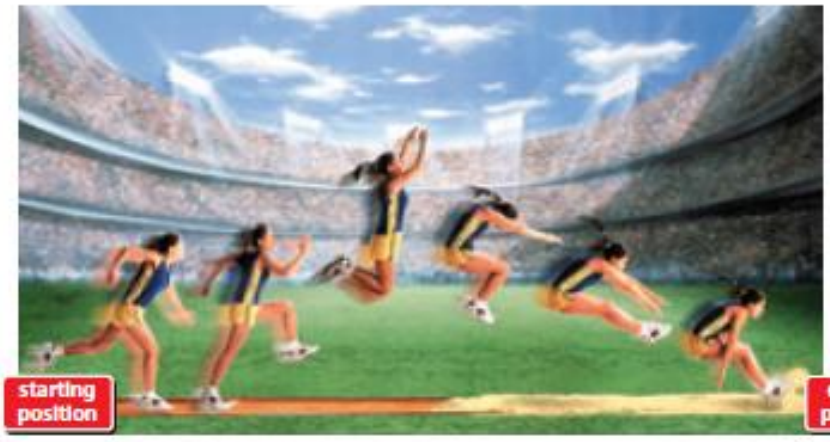
Motion is a change in position.

The illustration below shows an athlete at several positions during a long jump. If you were to watch her jump, you would see that she is in motion. **Motion** is the change of position over time. As she jumps, both her horizontal and vertical positions change. If you missed the motion of the jump, you would still know that motion occurred because of the distance between her starting and ending positions. A change in position is evidence that motion happened.

REMINDER

Horizontal and *vertical* describe directions, as shown.





INVESTIGATE Changing Position

How are changes in position observed?

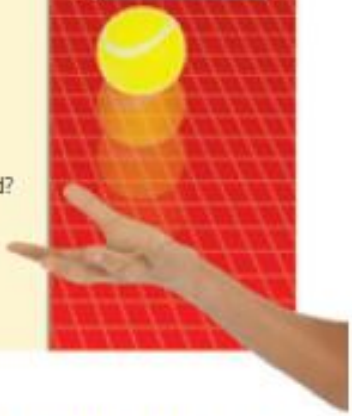
SKILL FOCUS
Observing

MATERIALS
- small ball
- paper
- pencil

TIME
20 minutes

PROCEDURE

1. Begin walking while tossing a ball straight up and catching it as it falls back down toward your hand. Observe the changes in the position of the ball as you toss it while walking a distance of about 4 m.
2. Make a sketch showing how the position of the ball changed as you walked. Use your own position as a reference point for the ball's position.
3. Watch while a classmate walks and tosses the ball. Observe the changes in the position of the ball using your own position as a reference point. Make a sketch showing how the ball moved based on your new point of view.



WHAT DO YOU THINK?

- Compare your two sketches. How was the change in position of the ball you tossed different from the change in position of the ball that your partner tossed?
- How did your change in viewpoint affect what you observed? Explain.

CHALLENGE How would the change in position of the ball appear to a person standing 4 m directly in front of you?

Describing Motion

A change in an object's position tells you that motion took place, but it does not tell you how quickly the object changed position. The speed of a moving object is a measure of how quickly or slowly the object changes position. A faster object moves farther than a slower moving object would in the same amount of time.

The way in which an object moves can change. As a raft moves along a river, its speed changes as the speed of the river changes. When the raft reaches a calm area of the river, it slows down. When the raft reaches rapids, it speeds up. The rafters can also change the motion of the raft by using paddles. You will learn more about speed and changing speed in the following sections.

APPLY Describe the different directions in which the raft is moving.

Relative Motion

If you sit still in a chair, you are not moving. Or are you? The answer depends on the position and motion of the person observing you. You do not notice your position changing compared with the room and the objects in it. But if an observer could leave Earth and look at you from outer space, he could see that you are moving along with Earth as it travels around the Sun. How an observer sees your motion depends on how it compares with his own motion. Just as position is described by using a reference point, motion is described by using a frame of reference. You can think of a frame of reference as the location of an observer, who may be in motion.

Consider a student sitting behind the driver of a moving bus. The bus passes another student waiting at a street sign to cross the street.

1. To the observer on the bus, the driver is not changing his position compared with the inside of the bus. The street sign, however, moves past the observer's window. From this observer's point of view, the driver is not moving, but the street sign is.
2. To the observer on the sidewalk, the driver is changing position along with the bus. The street sign, on the other hand, is not changing position. From this observer's point of view, the street sign is not moving, but the driver is.

OUTLINE
Add relative motion to your outline, along with supporting details.

I. Main Idea
  A. Supporting Idea
    1. Detail
    2. Detail
  B. Supporting Idea

Relative Motion

READING VISUALS Describe the motion of an object on a moving bus to both a person on the bus and a person on the sidewalk.

APPLY In the top picture, the train is moving compared with the camera and the ground. Describe the relative motion of the train, camera, and ground in the bottom picture.

When you ride in a train, a bus, or an airplane, you think of yourself as moving and the ground as standing still. That is, you usually consider the ground as the frame of reference for your motion. If you traveled between two cities, you would say that you had moved, not that the ground had moved under you in the opposite direction.

If you cannot see the ground or objects on it, it is sometimes difficult to tell if a train you are riding in is moving. If the ride is very smooth and you do not look out the window at the scenery, you might never realize you are moving at all.

Suppose you are in a train, and you cannot tell if you are stopped or moving. Outside the window, another train is slowly moving forward. Could you tell which of the following situations is happening?

- Your train is stopped, and the other train is moving slowly forward.
- The other train is stopped, and your train is moving slowly backward.
- Both trains are moving forward, with the other train moving a little faster.
- Your train is moving very slowly backward, and the other train is moving very slowly forward.

Actually, all four of these possibilities would look exactly the same to you. Unless you compared the motion to the motion of something outside the train, such as the ground, you could not tell the difference between these situations.

CHECK YOUR READING How does your observation of motion depend on your own motion?

10.1 Review

KEY CONCEPTS

1. What information do you need to describe an object's location?
2. Describe how your position changes as you jump over an object.
3. Give an example of how the apparent motion of an object depends on the observer's motion.

CRITICAL THINKING

4. **Infer** Kyle walks 3 blocks south from his home to school, and Jana walks 2 blocks north from her home to Kyle's home. How far and in what direction is the school from Jana's home?
5. **Predict** If you sit on a moving bus and toss a coin straight up into the air, where will it land?

CHALLENGE

6. **Infer** Jamal is in a car going north. He looks out his window and thinks that the northbound traffic is moving very slowly. Ellen is in a car going south. She thinks the northbound traffic is moving quickly. Explain why Jamal and Ellen have different ideas about the motion of the traffic.