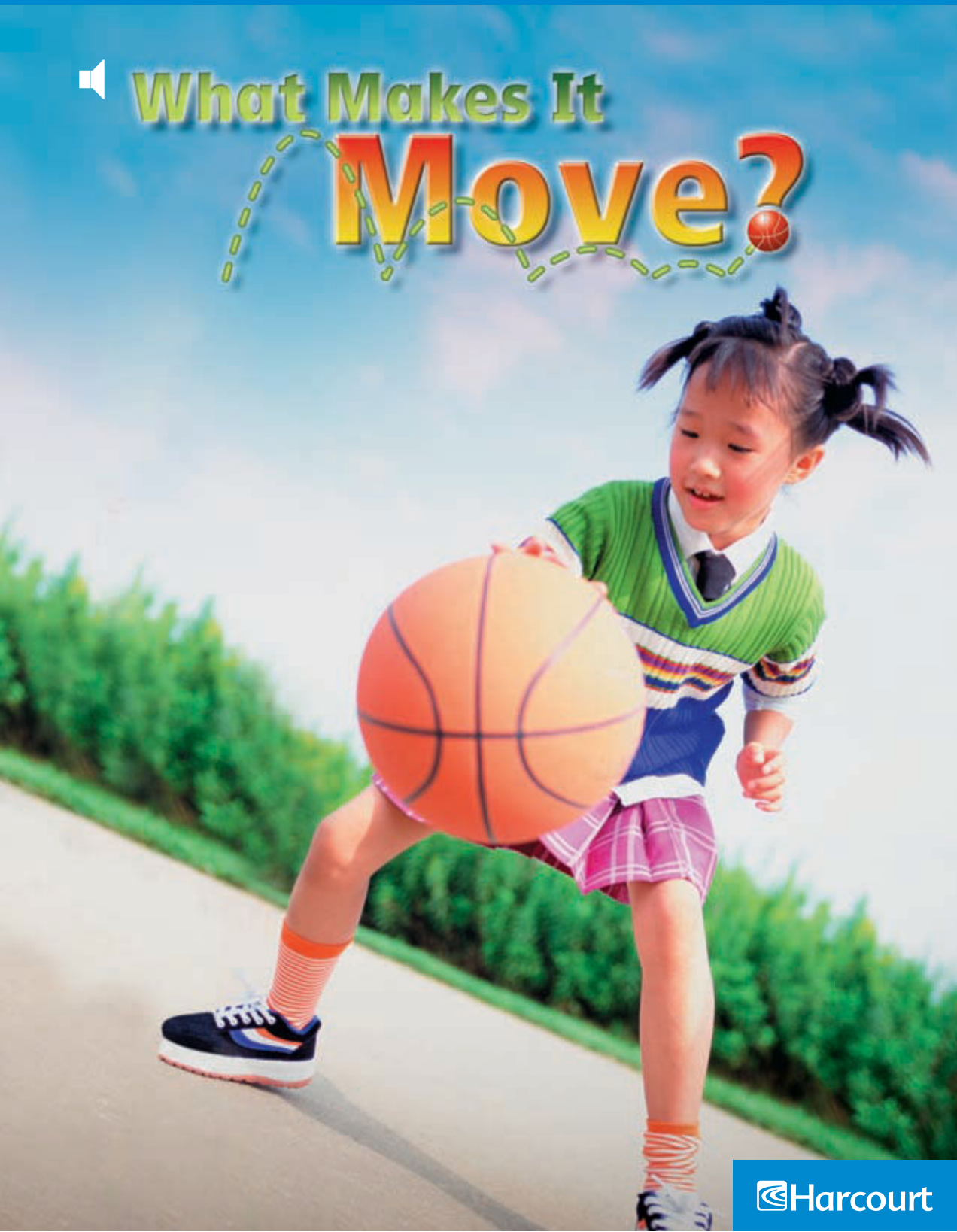
What Makes It Move?



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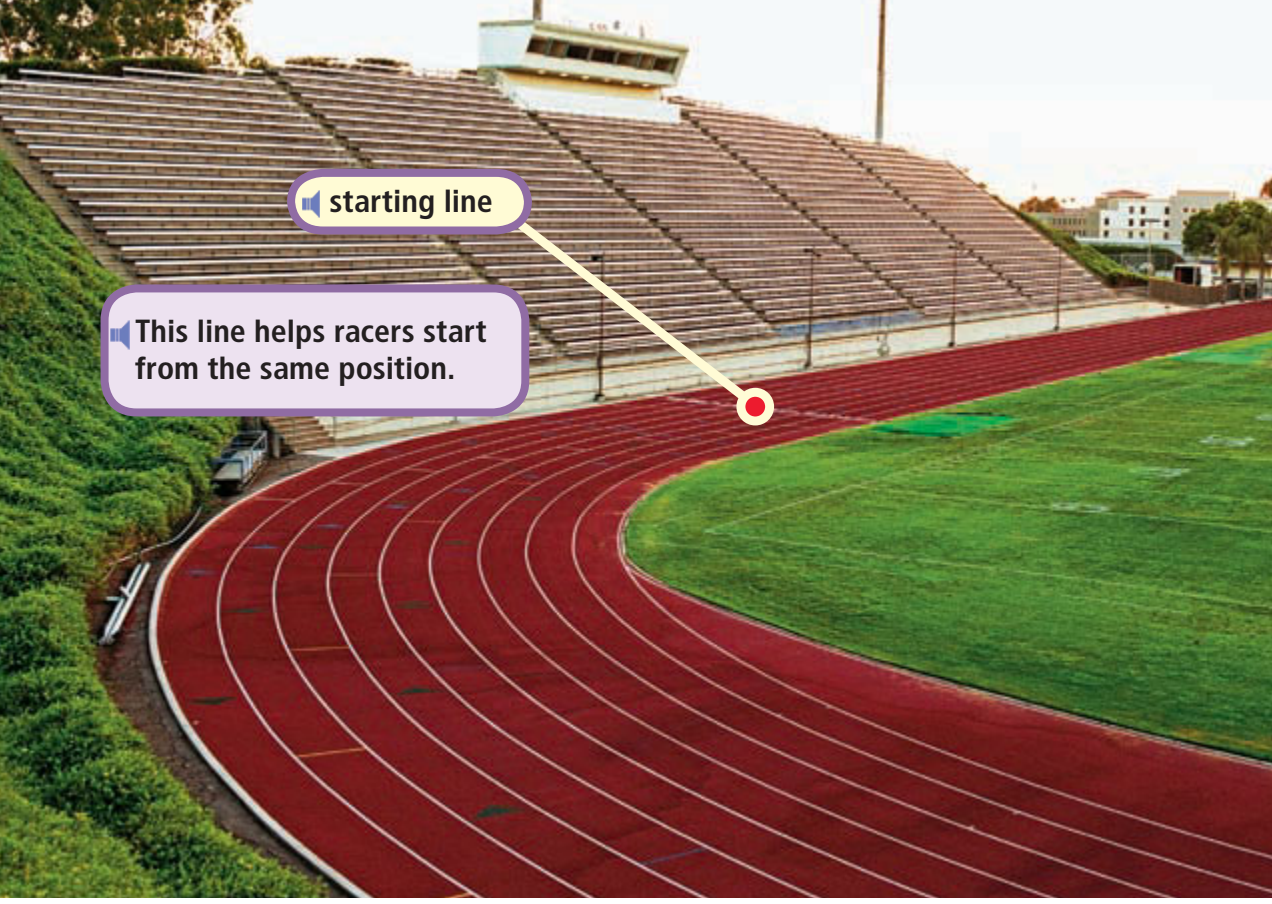
Are We Moving Yet?

Roll, bounce, spin, zigzag—all these words describe movement. You have seen many kinds of movement. A bowling ball rolls down the lane toward the pins. A basketball bounces when it hits the ground. An ice skater spins in a circle on the ice. A skier zigzags down a snowy hill. An elevator goes up from the bottom floor and down from the top floor.

The balls, skater, and skier are moving. How do you know? They do not stay in the same spot. They move from one place to another. They change positions.

Skiers leave a record of their motion in the snow. This skier was moving in a zigzag.



Motion is a change of position. Say you are walking from the classroom door to your seat. You change your position as you move through the room. You are in motion. Once you sit down, you are no longer in motion. Think about crossing a street. When the light says "Don't Walk," you do not move. When it says "Walk," you start to move, and your position changes.

Focus Skill **COMPARE AND CONTRAST** **What is the difference between a ball sitting on a table and a ball that has just been hit or thrown?**

Objects in Motion

Objects in motion have characteristics we can observe. For example, we can look at distance. **Distance** is how far it is from one location to another. An object in motion moves a certain distance from where it starts to where it stops. We can measure distance in inches, yards, and miles. Scientists measure distance in centimeters, meters, and kilometers.

In many countries, distance is measured in kilometers.

We can also look at the direction in which an object is traveling. *Up, down, east, west,* and *back and forth* are words that describe the direction of a moving object.

Another thing we can observe is time, or how long it takes for an object to move. An object that goes a long distance in a short time is moving fast. An object that takes more time to cover that same distance is moving more slowly. How long would it take you to run around the block? How long would it take you to walk around it? It takes you more time to walk the same distance than to run it.

We measure time in seconds, minutes, hours, days, weeks, months, and years.

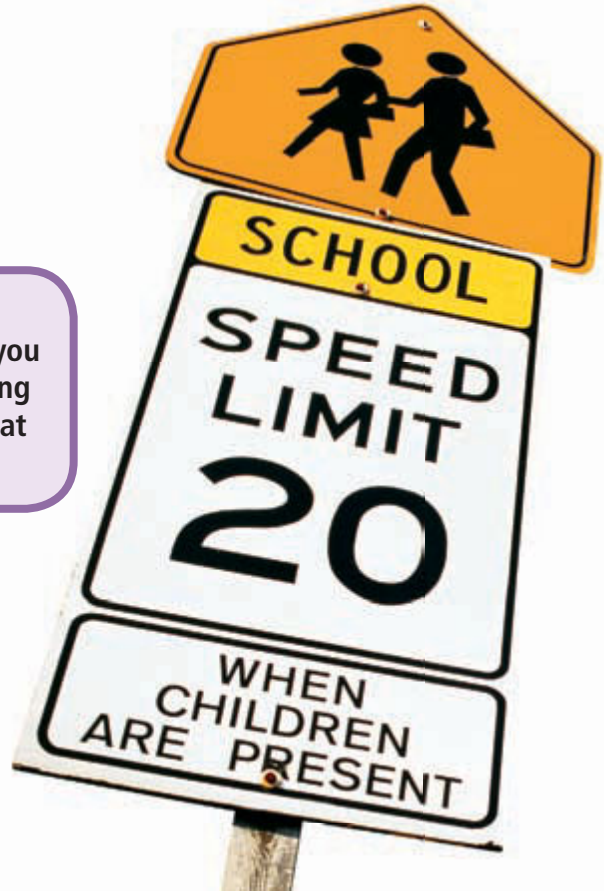
Focus Skill **COMPARE AND CONTRAST** **What is the difference between time and distance?**

Speed!

If we know an object's distance and its time, we can find out something else. We can find out its speed. **Speed** is the distance an object travels in a certain amount of time. When we talk about speed, we are talking about a relationship between distance and time. For example, speed limits for cars are given in miles per hour. The miles tell you the distance, and the hour is the unit of time.

Fast Fact

The National Weather Service of the National Oceanic and Atmospheric Administration describes wind by its speed, or how many miles it moves in an hour.



Speed limits change depending on where you are driving. Cars driving near schools must go at slower speeds.

This cheetah can run at more than 89 kilometers (55 miles) per hour but only for a short amount of time.

When we compare two objects traveling the same distance, we look to see which one finishes first. That is the one with the greater speed. Suppose a tortoise and a hare could both run a 50-meter (55-yard) dash. Which one would win? The hare has the greater speed, so it would finish first.

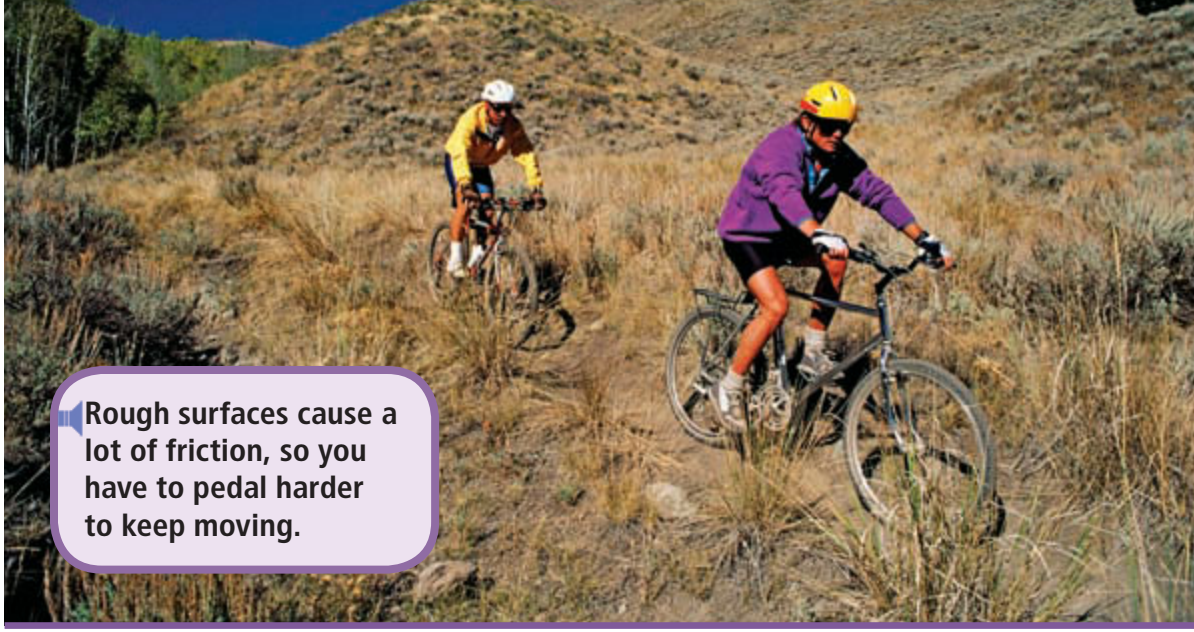
We can also look at speed another way. We can compare two objects that are traveling for the same amount of time. We look to see which one goes farther in that time. The one that travels farther has a greater speed. Suppose a hare races against a cheetah. If the hare and the cheetah run for an hour and the cheetah gets farther, it has the greater speed.

Focus Skill **MAIN IDEA AND DETAILS** **Why do you need to know distance and time to measure speed?**

Force Makes Motion

If you look around, you see things in motion. You may see cars on the road. You may see children playing and leaves moving in the wind. A bird flies by. A door opens and shuts. What makes these things start to move? All motion begins with a push or pull. A **force** is a push or a pull. You must apply a force to make an object move, change direction, or stop.

The force of the moving air makes the flags move.



Rough surfaces cause a lot of friction, so you have to pedal harder to keep moving.

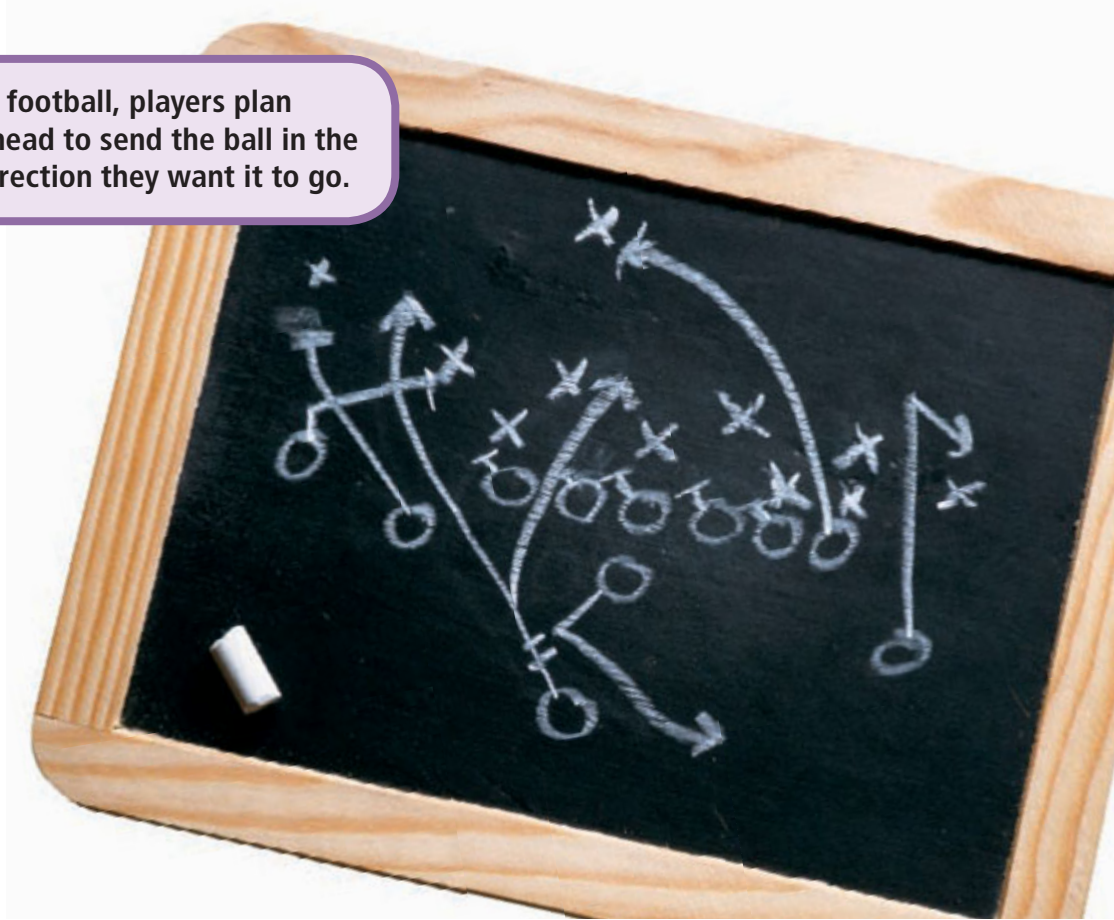
Once an object is moving, it will keep moving until another force stops it. Suppose you are riding your bike. As long as you push on the pedals, the bike will move. Once you stop applying the force, the bike will slow down. After a while, the bike will stop moving. The bike stops moving because there is another force acting on it. This force is friction. *Friction* is a force that stops objects or slows them down.

In the example of your bike, what caused the friction? It was the ground and the tires rubbing together. When you were pedaling, the force of your pushing was stronger than the friction. The bike kept moving. When you stopped pedaling, the force of friction slowed down the bike until it stopped.

Focus Skill **MAIN IDEA AND DETAILS** **What effect does friction have on motion?**

Which Way?

Forces can make a moving object change direction. In a basketball game, the ball changes direction all through the game. It bounces up and down when a player dribbles it. It curves up into the air when a player makes a shot. A ball can be moving one way and then suddenly begin to move in the opposite direction. What causes this? A player catches it and throws it the other way. The force of the players' catching and throwing the ball changes its direction. Basketball, like many other games, is played by two teams using force to send the ball in opposite directions.



In football, players plan ahead to send the ball in the direction they want it to go.

Gravity pulls the ball toward Earth because Earth has a much larger mass.

Usually, forces must touch objects to move them. The magnetic force of magnets, however, can push or pull objects made of iron and steel without touching them.

Gravity is another force that moves objects without touching them. **Gravity** is a force that pulls objects toward each other. The strength of an object's gravity depends upon how much matter an object has. The amount of matter in an object is its mass. Objects with a large mass weigh more. **Weight** is a measure of the force of gravity on an object.

Fast Fact

Even though things change on Earth every day, Earth's mass always stays about the same.

Focus Skill **MAIN IDEA AND DETAILS** What do we measure to find an object's weight?

Changing Force, Changing Motion

Forces change the motion of an object, but different forces have different effects. When you toss a ball gently, it doesn't go fast or far. When you throw it hard, the ball moves faster and farther.

If two horses were pulling this cart the net force would be twice as strong as the force of one horse.

If you make a force stronger, it will cause a greater change in motion. Suppose you are trying to push a box of books across the floor. You push with all your might, but the box doesn't budge. Your friend offers to help. Now the force is twice as strong. The sum of forces acting in the same direction is called the *net force*. Your energy plus your friend's energy equals the net force pushing on the box.

The direction of a force is also important. An object moves in the same direction as the force that pushes or pulls it. When you and your friend push on the box, it moves away from you. If you pulled on the box, it would move toward you.

Suppose your job was to move the box to the bookcase and put the books on the shelves. In what direction do the books move when you lift them out of the box?

Focus Skill **COMPARE AND CONTRAST** **How would the force of three tugboats compare with the force of one tugboat pushing a barge?**

The barge is moving in the direction that the tugboat is pushing it.

Force Meets Mass

How hard or easy it is to move an object, depends on what the object is. Which would be easier to pick up, an apple or a watermelon? An apple, of course, but why? It has less mass than a watermelon. The smaller the mass of an object, the easier it is to move.

Focus Skill

MAIN IDEA AND DETAILS

What is the relationship between mass and force?

Fast Fact

Did you know that watermelons can grow to have a mass of 91 kilograms (200 pounds)? Think about how hard it would be to pick up one that size!

It takes less force to move these boxes one at a time than to move all of them at once.

Summary

Motion is a change of position. When an object moves, we can measure its speed and the distance it travels. We can see its direction. It takes force to move an object and to stop it. Friction is a force that stops things or slows them down. Three things affect the motion of objects—the strength of the force, the direction of the force, and the mass of the object being moved. Gravity and magnetic force can move objects without touching them. The force of gravity depends on the amount of mass an object has. Because Earth is so large, its pull is very strong. Weight is a measure of the force of gravity on an object.

The car moves in the direction that the tow truck is pulling it.

Glossary

distance (DIS•tuhns) How far one location is from another (4, 5, 6, 7, 15)

force (FAWRS) A push or a pull (8, 9, 10, 11, 12, 13, 14, 15)

gravity (GRAV•ih•tee) A force that pulls two objects toward each other (11, 15)

motion (MOH•shuhn) A change of position (2, 3, 4, 8, 9, 12, 15)

speed (SPEED) The distance that an object moves in a certain period of time (6, 7, 15)

weight (WAYT) The measure of the force of gravity on an object (11)

Think and Write

1. Explain what causes motion.
2. **COMPARE AND CONTRAST** How are gravity and magnetic force alike and different?
3. **MAIN IDEA AND DETAILS** In what ways can a force change the motion of an object?
4. **Narrative Writing** Write a story about a bicycle race. Describe the race, using what you learned about how forces affect motion.

Hands-On Activity

With a partner, make a list of times when you need to use a lot of force and times when you need to use only a little force.

School-Home Connection

Tell a family member what you learned about forces and motion. Look for objects around your home, and tell how forces are used to set them in motion.

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