كتاب الطالب الوحدة الأولى Motion and Forces منهج انسباير

Grade 3 · Unit 1

Inspire Science

Forces Around Us

McGraw Hill Education

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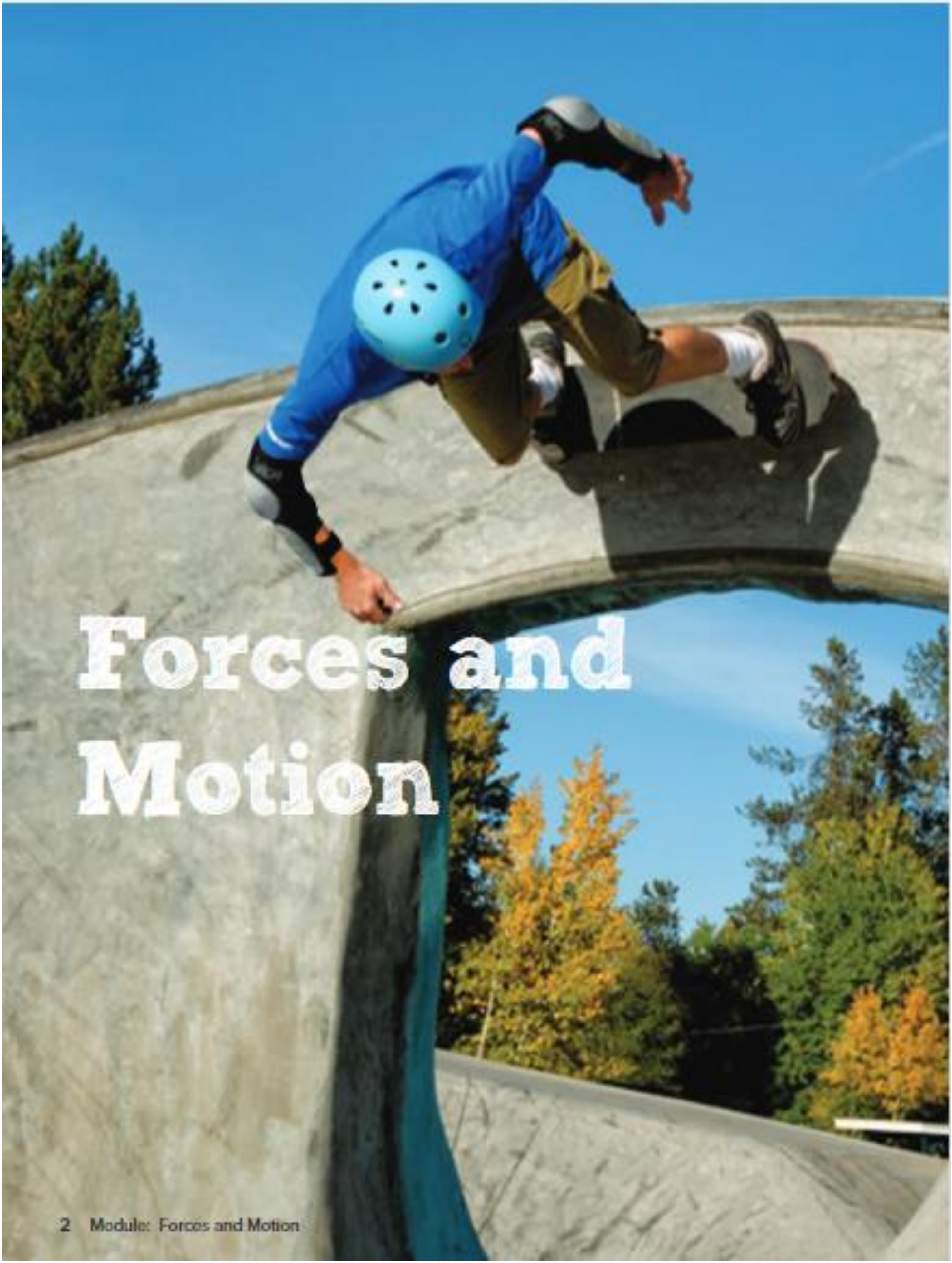
Forces and Motion

Electricity and Magnetism



Forces and Motion

ENCOUNTER
THE PHENOMENON

What did the skateboarder have to do to get to the top of the ramp?

GO ONLINE
Check out *Skateboarders* to see the phenomenon in action.

Talk About It

Look at the photo and watch the video of the skateboarders. What questions do you have about the phenomenon? Talk about your observations with a partner.

Did You Know?

The very first skateboards had handles and were developed in California.

STEM Module Project Launch
Engineering Challenge

Design a Skatepark

You have been hired as an architectural designer. At the end of this module, you will develop a design for a skatepark. Your goal will be to design, build, and test a model that is able to get a marble from one side of the park to the other.

Lesson 1
Motion

Lesson 2
Forces Can Change Motion

Architectural designers apply their knowledge of motion, forces, and design to create playgrounds and skateparks.

What do you think you need to know before you can design a skatepark?

SAM
Architectural Drafter

STEM Module Project

Plan and Complete the Engineering Challenge Use what you learn throughout the module to complete the challenge.

PAGE KEELEY SCIENCE PROBES

LESSON 1 LAUNCH

How Does It Move?

Three friends were playing soccer. They each had a different idea about the ball's motion. This is what they said:

Desmond: *The way I kick the ball determines how far the ball will go.*

Aliyah: *The way I kick the ball determines where it will go and how far.*

Megan: *It doesn't matter how I kick the ball; it will move where the ball wants to go.*

Who do you agree with most? ______________________________

Explain why you agree.

____

____

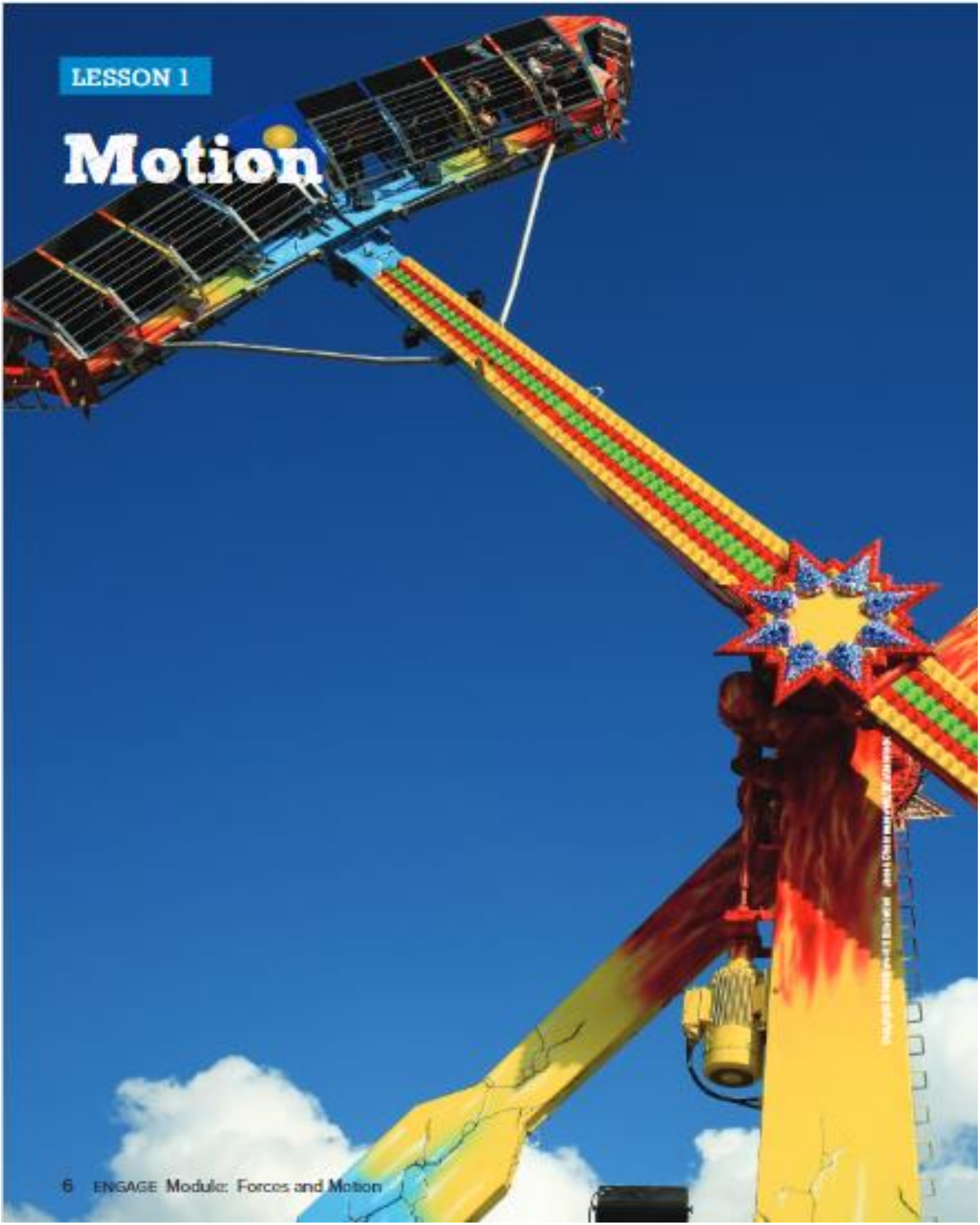
____

____

You will revisit the Page Keeley Science Probe later in the lesson.

LESSON 1

Motion



ENCOUNTER
THE PHENOMENON

Why does the ride move like that?

GO ONLINE

Check out *Carnival* to see the phenomenon in action.

Talk About It

Look at the photo and watch the video of the carnival in action. What questions do you have about the phenomenon? Talk about your questions and observations with a partner. Record or illustrate your thoughts below.

Did You Know?

The California State Fair is set up in only four days and has more than 600,000 visitors.

INQUIRY ACTIVITY

Hands On

Moving Marbles

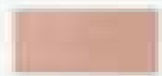
In the video, you observed a carnival ride that moves in a circle. In this activity, you will determine how an object on a curved path moves.

Make a Prediction How will a curved track affect the direction a marble travels? What will happen when a marble is rolled on an open floor?

Materials


2 books


masking tape

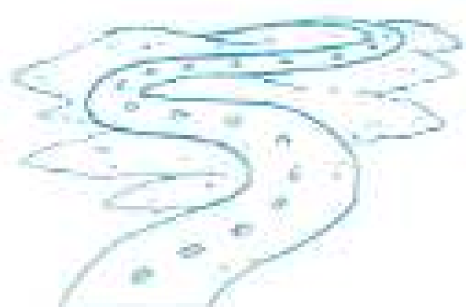

cardboard


marble


cardstock

Carry Out an Investigation

1. Working with your group, use the materials to create a ramp that will cause the marble to move in a curved path.
2. Place the marble at the top of the ramp. Release the marble and observe the direction it moves.
3. **Record Data** In your data table, record the direction the marble moved on the curved ramp.
4. Now clear a space on the floor, and place the marble on the floor.
5. Revisit your prediction about the direction the marble will move when you roll it on the open floor.
6. **Record Data** Push the marble, and record the results in the data table.



	observations
curved ramp	
open floor	

Communicate Information

7. Compare the way the marble moved on the ramp and on the open floor.

8. Explain why it was hard to predict the direction the marble would go on the open floor.

Talk About It

What would happen if you created a ramp that started in the same place and split into two different ramps? Which way would the marble roll?

VOCABULARY

Look for these words as you read:

direction

distance

motion

position

speed

Describe an Object's Position

Position Think back to the *Moving Marble* activity. What position was the marble in when you started? Where did the marble end up after it was pushed down the ramp? When you describe the position of something, you compare it to the objects around it. **Position** is the location of an object. You can use words like *above*, *below*, *next to*, and *far away from* to describe the position of an object. Look at the boy on the beach. Draw an X on the inner tubes that are above the polka-dotted pink inner tube.

Distance The amount of space between two objects or places is **distance**. Millimeters, centimeters, meters, and kilometers are examples of units used in the metric system to measure distance. In the US customary system, distance might be measured in inches, yards, or miles. You can use a ruler or a meterstick to measure distance.

Direction When describing position, you must use both distance and direction. **Direction** tells which way a line points from one object or place to another. The words *north*, *south*, *east*, and *west* describe direction. You can also use words such as *left*, *right*, *up*, *down*, *forward*, and *backward* to describe direction. With a partner, describe the position of the pink inner tube on the previous page, using distance and direction.

1. **MATH Connection** How could you find the distance from your desk to the door?

2. Draw a diagram of the *Moving Marble* activity. Label the position of the marble at the start and end. Draw an arrow to identify the direction the marble rolled. Label the distance from start to stop with a line.

Motion

Look at the pictures of the dog in different positions. First, you can see that the dog is on the ground. Next, you see the dog come completely off the ground. What happened to the dog? It moved. You know that the dog moved because its position changed. **Motion** is the process of changing position.

GO ONLINE Watch the video *Patterns in Motion* to compare how different things move.

You can observe motion in different ways. Some objects move in a straight line. Other objects can move round and round, back and forth, or in a zigzag pattern.

Measuring Motion

GO ONLINE Explore *Draw the Pattern* to learn more about different patterns.

Distance There are many ways that you can measure motion. One way is to measure the distance that an object moves. As you learned on the previous page, distance is the measurement between an object's starting position and its current position. You can measure larger distances in units such as meters, yards, miles, or kilometers.

Time Suppose it took you three minutes to walk from your classroom to the playground yesterday. Today it took you five minutes to walk to the playground. You moved the same distance, but your motion today took more time. The time it takes to move a distance is one way to describe motion.

Speed Distance and time can be used to find speed. **Speed** is the measure of how fast or slow something moves. An object that is moving fast goes a distance in a short amount of time. It takes a longer time for a slower object to move the same distance.

REVISIT PAGE KEELEY SCIENCE PROBES Revisit the Page Keeley Science Probe on page 5.

Direction Direction points out the path from one position to another. Suppose you walk the length of a soccer field. Then, you turn around and walk the whole length back. Is your motion the same both times? Even if the distance and time are the same, the motion is different. You walk different directions back and forth across the field. The direction an object moves is part of the way you describe its motion.

Predicting Motion

Measurements of motion may help you predict future motion. Look at the picture of the girl on the swing. You can predict when she will change direction. You can also predict how much time it will take her to swing back and forth. Draw an arrow predicting the direction the girl will swing next.

What is the **pattern of motion** when you are on a swing? How can you **predict the patterns of motion** of the girl swinging in the photo?

Reread the first and second paragraph on page 12. Circle the different types of motion. Label the different types of motion using words and arrows to show the direction.

GO ONLINE Explore the PhET simulation *Forces and Motion Basics*. Collaborate with a partner. What patterns do you see?

STEM Connection

What Does a Statistician Do?

Statisticians collect and study data to help solve real-world problems. Statisticians are hired to study data in business, education, and other fields. With the right data, there is often enough information for people to find solutions to their problems.

Statisticians who work for car companies might collect data about the speed of the cars–how quickly they accelerate, how far they can go, and how long it takes. Statisticians who work for universities might collect data about how long it takes students to graduate.

It's Your Turn

Think like a statistician. Complete the activity on the next page and explore the relationship between distance and time.

Talk About It

How do you think a statistician might be involved in designing a skatepark?

INQUIRY ACTIVITY

Hands On

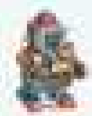
Movement of a Wind-Up Toy

Materials

meterstick

stopwatch

masking tape



wind-up toy

You have learned that you can measure the space between an object's starting position and its new position. Now let's look at the distance an object, such as a wind-up toy, travels in a given amount of time.

Make a Prediction How far will the wind-up toy travel in 10 seconds? How far will it travel in 20 seconds? Record your prediction in centimeters.

Carry Out an Investigation

1. Place a piece of tape on your desk. This is the starting line.
2. Wind up the toy and place it at the starting line. Be sure to wind up the toy all the way. Get your stopwatch ready.
3. **Record Data** As you release the toy, start the timer. Stop the toy after 10 seconds, and mark the spot with tape. Use a meterstick to measure how far the toy went.
4. Repeat two more times, and write the distance the toy traveled for each trial.
5. Repeat this activity, but this time, stop the toy after 20 seconds.

	Trial 1	Trial 2	Trial 3
Distance Traveled in 10 seconds			
Distance Traveled in 20 seconds			

Communicate Information

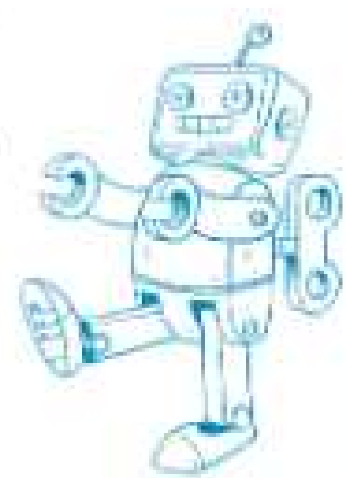
6. Do your findings support your prediction? Explain.

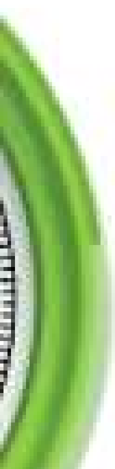
7. Look at the data you collected. Compare the distance the toy traveled in 10 seconds and 20 seconds. What patterns do you notice?

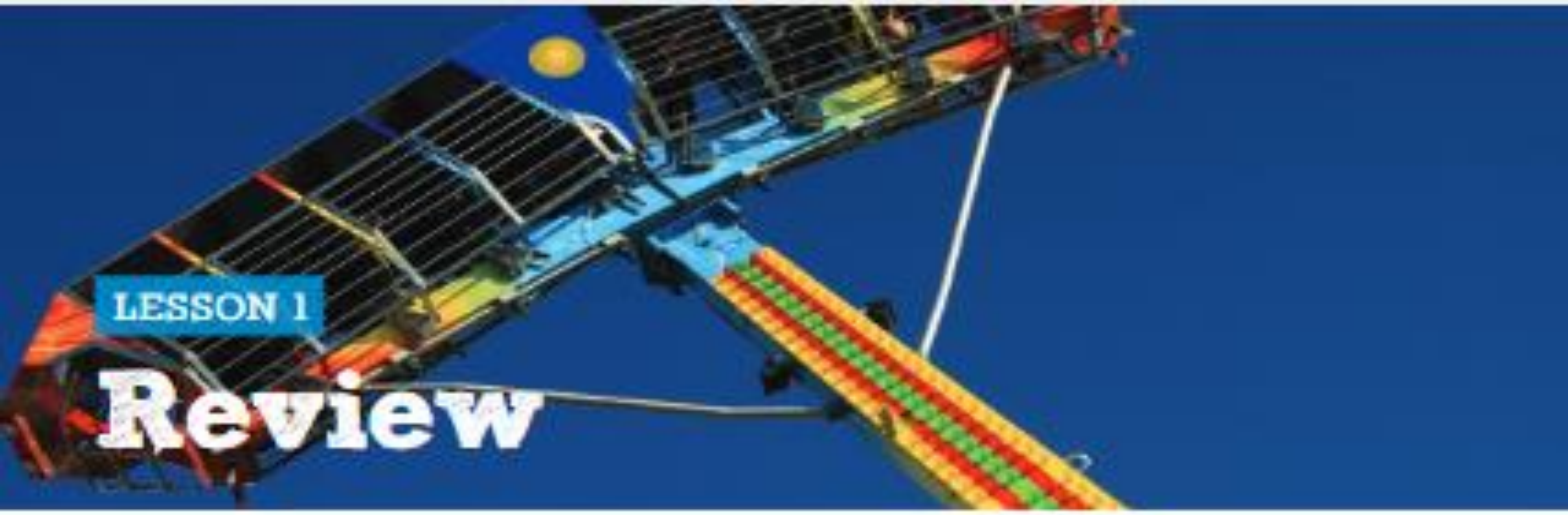
8. How far do you think the wind-up toy will travel in 25 seconds? Explain your reasoning.

Talk About It

You used a meterstick and stopwatch to measure distance and time during the activity. Discuss other tools and strategies you can use to measure the motion of the toy.







LESSON 1

Review

EXPLAIN THE PHENOMENON

Why does the ride move like that?

Summarize It

Explain patterns in motion. How can you measure the patterns of motion? What patterns in motion can you observe and measure in your classroom?

REVISIT PAGE KEELEY SCIENCE PROBES

Revisit the Page Keeley Science Probe on page 5. Has your thinking changed? If so, explain how it has changed.

Three-Dimensional Thinking

1. A ball is moving in a zigzag pattern, but you need it to go straight to reach the goal. How do you change the ball's motion?

   A. I leave it alone. It will go straight when I want it to.

   B. I have to push the ball in a straight line to make it reach the goal.

   C. I have to pull the ball toward me and bounce it on the ground toward the goal.

2. The data below shows the distance a toy car traveled down three different ramps.

	Ramp 1	Ramp 2	Ramp 3
Distance Traveled in 20 seconds	4 cm	12 cm	5 cm

Which ramp is most likely the tallest? Explain how you know.

3. Two objects start at the same location and travel at the same speed for one minute, but they end up in different locations. How did their motions differ?

Extend It

You are a principal of a school and need to have the gym set up for a magic show. Use direction, position, and distance to describe your gym setup. Once completed, give your plan to a classmate to draw your setup on a separate sheet of paper. Explain the outcome below.

OPEN INQUIRY

What questions do you still have?

Plan and carry out an investigation to answer one of your questions.

KEEP PLANNING

STEM Module Project

Engineering Challenge

Now that you have learned about position and motion, go to your Module Project to explain how the information will help you build your skatepark.

LESSON 2 LAUNCH

Golf Ball

Three friends are playing golf. They each have different ideas about the forces that act on a golf ball. This is what they think:

Finn: *Forces act on the golf ball only when the golfer hits the ball.*

Pete: *Forces act on the golf ball only when the ball is on the tee.*

Tad: *Forces act on the golf ball when it is on the tee and when the golfer hits the ball.*

Who has the best idea about forces? ______________________________

Explain why you think it is the best idea.

____

____

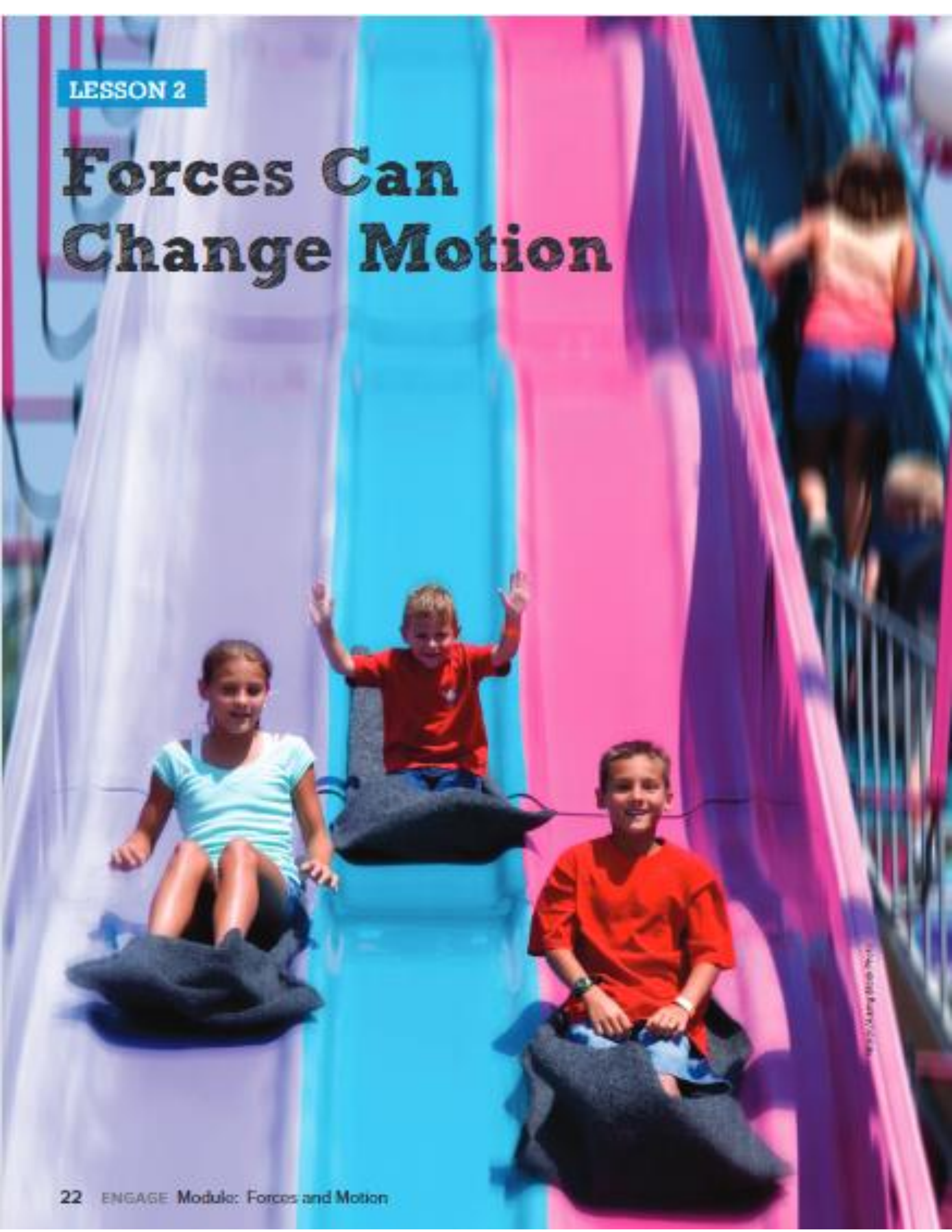
____

____

You will revisit the Page Keeley Science Probe later in the lesson.

LESSON 2

Forces Can Change Motion



ENCOUNTER THE PHENOMENON

How are they going down the slide so fast?

GO ONLINE

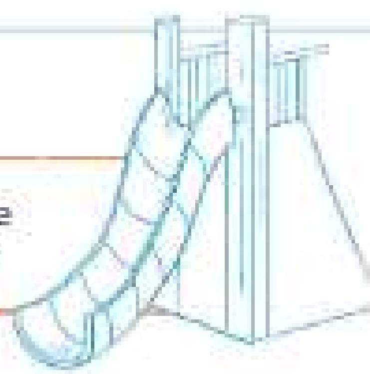
Check out *Slides* to see the phenomenon in action.

Talk About It

Look at the photo and watch the video of the kids going down the slide. What questions do you have about the phenomenon? Talk about your questions and observations with a partner.

Did You Know?

London has the longest and tallest slide in the world. It takes about 40 seconds to go down!



INQUIRY ACTIVITY

Hands On

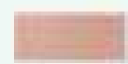
Forces Affect the Way Objects Move

You saw people going down a slide. A slide is one kind of ramp. Investigate how the height of a ramp will change a toy car's motion.

Make a Prediction How will the height of a ramp affect the motion of a toy car?

Materials


4 books


cardboard


masking tape


toy car


meterstick

Carry Out an Investigation

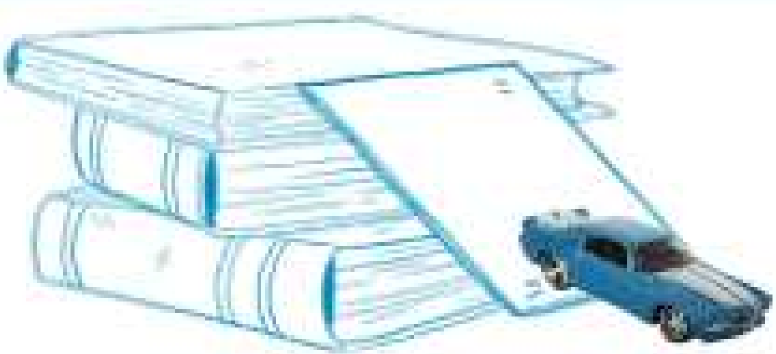
1. Stack two books on the floor. Lean a piece of cardboard along the top book to make a ramp. Tape the edge of the cardboard to the floor.
2. Place a toy car at the top of the ramp. Release the car.
3. **MATH Connection** Use the meterstick to measure the distance the car traveled.
4. **Record Data** Record the distance the car traveled in the data table.
5. Repeat steps 2–4 for a total of three trials.

6. Repeat steps 1–5 with a stack of four books.

	Distance Traveled in Centimeters		
	Trial 1	Trial 2	Trial 3
Two-book ramp			
Four-book ramp			

7. Compare the distances the toy car traveled with the two ramps. What pattern do you see?

8. Predict what would happen if your ramp had six books.



INQUIRY ACTIVITY

Communicate Information

9. Did your observations support your prediction? Explain.

10. Draw a real-world example of how the height of a ramp affects the motion of an object.

MAKE YOUR CLAIM

What makes a toy car slide down a ramp?

Make a claim. Use your investigation.

CLAIM

__________________ cause a toy car to slide down a ramp.

Cite evidence from the lesson.

EVIDENCE

The investigation showed that a toy car __________________.

Discuss your reasoning as a class. Tell about your discussion.

REASONING

The evidence supports the claim because __________________.

You will revisit your claim to add more evidence later in this lesson.

VOCABULARY

Look for these words as you read:

balanced forces

force

friction

unbalanced forces

Forces

Objects do not move by themselves. A force must be applied to an object to change its motion. A **force** is a push or a pull. When you push on a door handle, you apply a force. When you pull on a wagon handle, you apply a force.

Forces can be large or small. The force that a train engine uses to pull a train is large. The force that your hand uses to lift a feather is very small. It takes larger, stronger forces to move heavier objects than it does to move lighter objects.

GO ONLINE Watch the *Forces Can Change Motion* video to see the effects of different forces.

There is another type of force called **friction**. Friction is a force that occurs when one object rubs against another. Friction pushes against moving objects and causes them to slow down. Imagine you are running across the gym. You are able to stop because there is friction between your shoes and the floor. Now imagine you are running on ice. It is harder to stop because there is less friction because the ice is very smooth. Smooth surfaces have less friction. When there is less friction, it is harder for an object to slow down and stop.

More than one force can push or pull on an object at a time.

Balanced and Unbalanced Forces

Forces can set objects into motion. When you put a heavy backpack on your desk, the backpack does not move. Gravity pulls the backpack toward Earth, but your desk pushes up on the backpack with a force. The strength of that force is exactly equal to the pull of gravity. The forces are balanced.

Balanced forces are forces that cancel each other out when acting together on an object. Sometimes balanced forces are equal in size and opposite in direction, but forces do not have to be equal and opposite to be balanced. When an object is sitting still, all the forces acting on it are balanced. However, when objects are moving at a constant velocity, or speed, they are also balanced. Balanced forces do not cause a *change* in motion.

Suppose you push that heavy backpack across your desk. The backpack is moving. This is due to **unbalanced forces**. Forces that are not equal to each other are called unbalanced forces. If there is more than one force acting on an object, then the total of all the forces determines the direction of motion.

The forces applied to the stuffed bear are balanced, it is not moving.

The dogs are applying a greater force to the sled, so the sled is moving.

Talk About It

Which forces cause a change in motion?

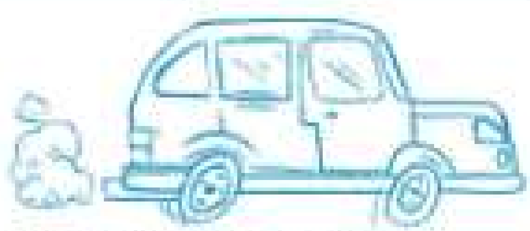
Changing Motion

GO ONLINE Explore the PhET simulation *Forces and Motion* to see the forces in tug of war.

Think back to your toy car. With a partner, brainstorm five ways you can make an object have motion. In the table, draw a picture using arrows to indicate direction. Label what force was applied and if the forces were balanced or unbalanced.

Motion	Forces Acting on Object	Balanced or Unbalanced
Make an object remain still		☐ Balanced ☐ Unbalanced
Make an object move forward		☐ Balanced ☐ Unbalanced
Make an object move faster, forward		☐ Balanced ☐ Unbalanced

Motion	Forces Acting on Object	Balanced or Unbalanced
Make an object move sideways		☐ **Balanced** ☐ **Unbalanced**
Make an object move up		☐ **Balanced** ☐ **Unbalanced**
Make an object move down		☐ **Balanced** ☐ **Unbalanced**



REVISIT Revisit the Page Keeley Science Probe on page 21.

PAGE KEELEY SCIENCE PROBES

CLOSE READING

Inspect

Read the passage *Skateboarding.* Underline text evidence that tells what two things a skateboarder needs to do tricks.

Find Evidence

Reread How does a skateboarder get high enough to do a trick? Highlight the text that explains.

Notes

Skateboarding

Skateboarding is a sport that began in 1950 in California. Before there were skateparks, skateboarders practiced in empty swimming pools. Today, there are hundreds of thousands of skateparks in the United States.

Skateboarding is a fun sport that requires only a few pieces of equipment. A skateboard and protective gear makes someone ready to hit the park. Although skateboards can vary and have unique designs, all are made of three basic parts: a board, wheels, and trucks, which connect the wheels to the board and allow the board to turn.

To be safe, skateboarders have to wear helmets to protect their heads. They also wear gear to protect their wrists and knees.

There is science involved in designing a skatepark. Architectural designers apply principles of motion and force so that the skateboarders can get the speed they need.

Notice the many slopes of the skatepark in the photo on this page. When skateboarders push themselves down a slope, their speed increases. They go across a flat surface as they stand on the board. Leaning their body to one side or the other causes the wheels to move the direction they want, right toward another slope. Their speed remains the same because balanced forces are acting on the skateboard. When they go down another slope, they use unbalanced forces to increase their speed to carry them across another flat surface and up the next slope. With enough speed, they can get high enough to do their tricks in the air.

Make Connections

Talk About It

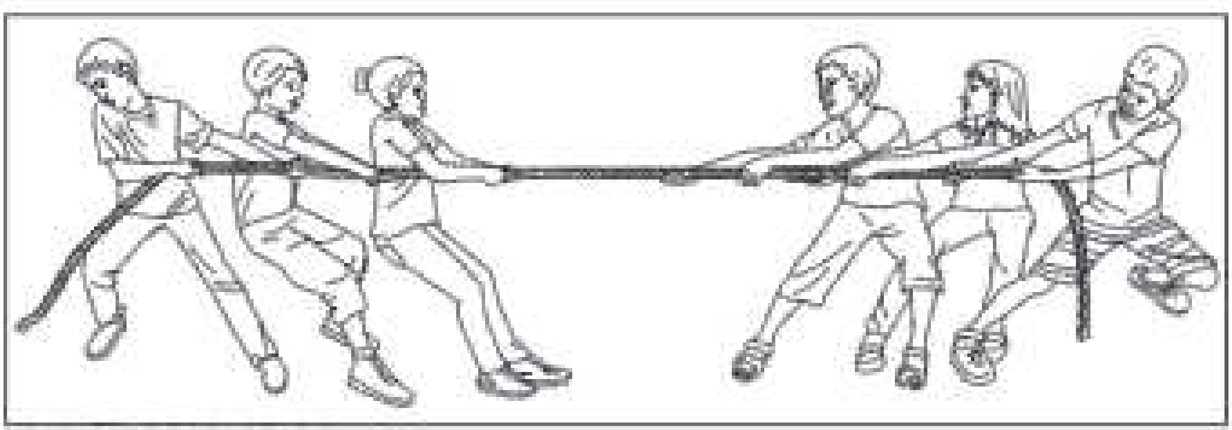
What does an architectural designer need to know about skateboarders in order to design a skatepark?

Notes

FOLDABLES

Cut out the Notebook Foldables tabs given to you by your teacher. Glue the anchor tabs as shown below. Use what you have learned throughout the lesson to describe the picture using vocabulary words.

Glue anchor tab here



STEM Connection

What Does a Landscape Designer Do?

Landscape Designers plan and design public spaces, residential areas, and college campuses. They are creative people who like to work on big projects. You might think landscape designers work only with plants and lawns, but they also know a lot about paving, walls, fencing, wood, concrete, and metal. They know about irrigation and water management, too.

Landscape designers also think a lot about motion and force. When they design spaces where people will work or play, they consider what objects will move through the spaces and the forces that will affect the movement of the objects.

It's Your Turn

As a landscape designer, what information would you need to build a skatepark? How could you find out how skateboarders move in a park, and how would your findings influence your design?

INQUIRY ACTIVITY

Hands On

On the Move

When playing with toy cars, some cars are faster than others. With a push on the floor, the car starts out fast. It then slows down and stops. Investigate how different materials can affect the speed and distance of a toy car.

Make a Prediction What would happen if a toy car rolls over different materials?

Materials

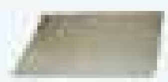

4 books


cardboard


masking tape


toy car


meterstick


sandpaper

cotton cloth

Carry Out an Investigation

1. Make the four-book ramp. Copy the data from the "Four-book ramp" row of the table on page 25 into the "Floor" row of the table on page 37.
2. Tape a layer of sandpaper at the bottom of the cardboard ramp. Release the car from the top of the ramp.
3. **Record Data** Measure and record the distance the car travels. Repeat for a total of three trials.
4. Remove the sandpaper. Tape a cotton cloth to the floor at the bottom of the cardboard ramp. Release the car from the top of the ramp.
5. **Record Data** Measure and record the distance the car travels. Repeat for a total of three trials.

	Distance Traveled		
	Trial 1	**Trial 2**	**Trial 3**
Floor			
Sandpaper			
Cotton cloth			

Communicate Information

6. Why did the car slow down when traveling on a sandpaper surface?

Talk About It

Compare your results with your classmates' results. What material would you use if you wanted an object to stop quickly? Why do you think some materials caused more friction than other materials?

COLLECT EVIDENCE

Add evidence to your claim on page 27 about how forces affect an object's motion.

LESSON 2

Review

EXPLAIN THE PHENOMENON

How are they going down the slide so fast?

Summarize It

Explain the effects of a force acting on an unmoving object.

REVISIT PAGE KEELEY SCIENCE PROBES

Revisit the Page Keeley Science Probe on page 21. Has your thinking changed? If so, explain how it has changed.

Three-Dimensional Thinking

1. How do forces change the motion of objects?

A. Forces can change the speed or direction of an object's motion.

B. The size of the force affects the speed of the object.

C. The direction of the force affects the direction of the object's motion.

D. All the above

E. None of the above

2. An egg is about to roll off the counter. How can you get the egg to stop without picking it up?

3. Explain why the amount of friction would be different on an icy surface and a dry, concrete surface. How does the amount of friction affect the movement of an object across both surfaces?

Extend It

You are the mayor of San Francisco, California. The trolley cars are in need of repair. How might you communicate with your citizens about the importance of repairing the cable car brakes? Think about what you have learned in this module to help explain force and motion.

Write a speech, draw a poster, create a flyer, or use media.

KEEP PLANNING

STEM Module Project

Engineering Challenge

Now that you have learned how forces can affect motion, go to your Module Project to explain how the information will affect your plan for the skatepark.

STEM Module Project
Engineering Challenge

Design a Skatepark

You have been hired as an architectural designer. Using what you have learned throughout this module, you will design a skatepark. Your goal will be to design, build, and test a model that will successfully get a marble from one end of the park to the other using parameters set by your teacher.

Planning after Lesson 1

Apply what you have learned about motion to your project planning.

How does knowing about motion affect your project planning?

Record information to help you plan your model after each lesson.

STEM Module Project
Engineering Challenge

Planning after Lesson 2

Apply what you have learned about forces that can change motion.

What factors should be considered when building your model of a skatepark?

Research the Problem

Research building designs by reading the Investigator article *Play It Safe!* Go online to teacher-approved websites, or by finding books on designing skateparks at your local library.

Source	Information to Use in My Project

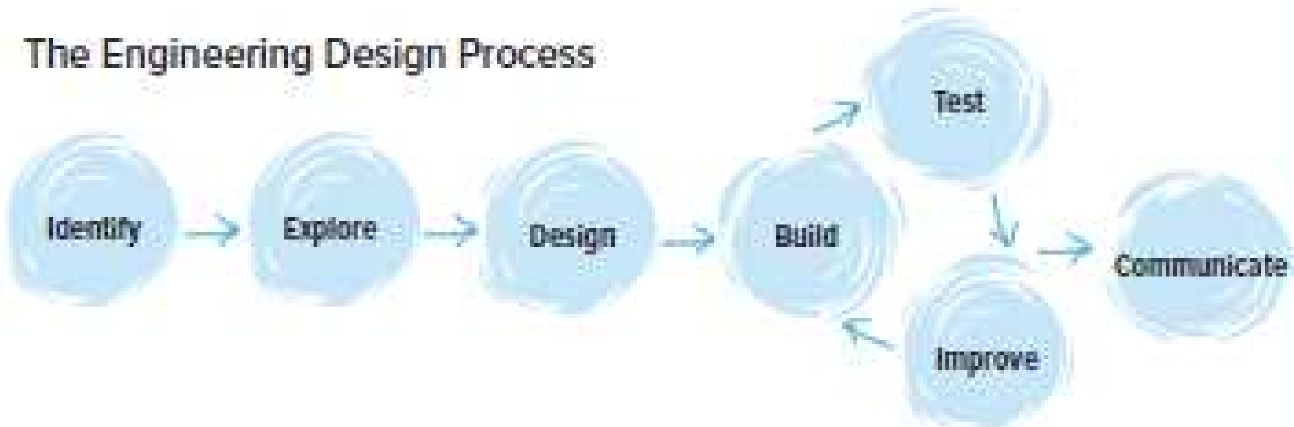
Sketch Your Model

Draw your ideas on a separate piece of paper. Select the best one to build and test.

Design a Skatepark

Look back at the planning you did after each lesson.
Use that information to complete your final module project.

The Engineering Design Process



GO ONLINE
to learn more about each step
of the Engineering Design Process.

Build Your Model

Design Goals

1. Read the goal for this project on page 41.
2. Write the procedure you will use to build and test your skatepark.
3. Choose the materials you will use. Record your materials on the list.
4. Use your procedure and project planning to build your model.

Materials

STEM Module Project
Engineering Challenge

Procedure:

Test Your Model

Build and test your model.
Record your observations and results.

MODULE WRAP-UP

REVISIT THE PHENOMENON

Describe how the results of your project can help you explain how the skateboarder is moving.

How has your thinking changed? Explain.