CHAPTER 8

Investigate Force and Motion

Check it out!

What do forces have to do with a playground?

SC.5.P.13.1 Identify familiar forces that cause objects to move, such as pushes or pulls, including gravity acting on falling objects.

SC.5.P.13.2 Investigate and describe that the greater the force applied to it, the greater the change in motion of a given object.

SC.5.P.13.3 Investigate and describe that the more mass an object has, the less effect a given force will have on the object's motion.

SC.5.P.13.4 Investigate and explain that when a force is applied to an object but it does not move, it is because another opposing force is being applied by something in the environment so that the forces are balanced.

Chapter Preview

What will you learn?

Take Note!

After watching the video, think about your experiences you have had with forces and motion. Look through the chapter. Make a list of observations and questions you have about how forces and mass affect patterns of motion.

Before each lesson, write an "I can" statement.

In your own words, tell what you are going to learn about.

LESSON 1 SC.5.P.13.1

I can ...

LESSON 2 SC.5.P.13.2 SC.5.P.13.3 SC.5.P.13.4

I can ...

PAGE KEELEY SCIENCE PROBES

Knocking Down the Pins

Frank

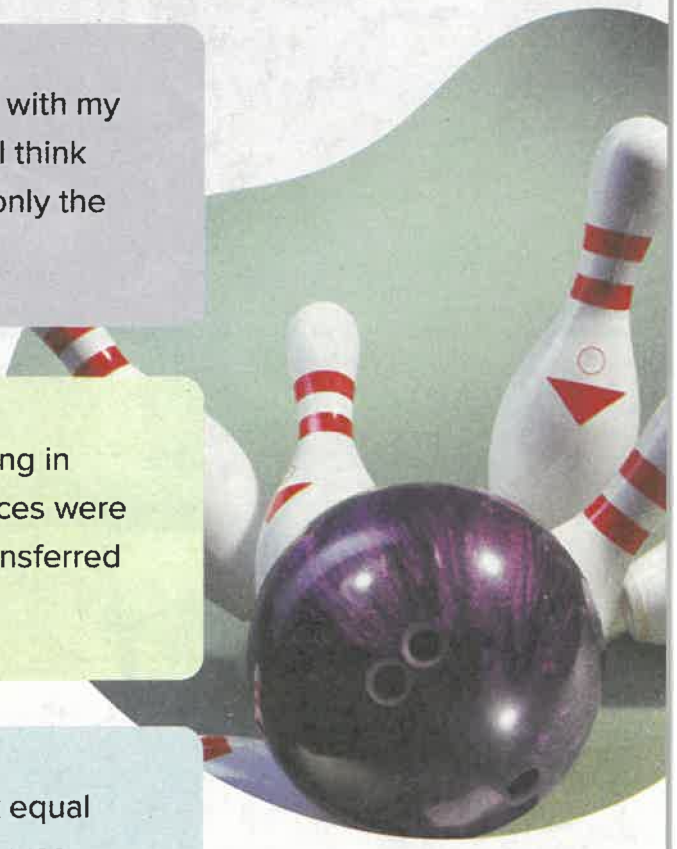
Woohoo! I'm at the bowling alley with my family and I just bowled a strike! I think equal forces were involved, but only the bowling ball had energy.

Simone

We were just talking about bowling in science class! I think unequal forces were involved and that energy was transferred from the ball to the pins.

Ali

Oh yeah, I remember that. I think equal forces were involved and energy was transferred.



Alma

Congrats on the strike! I think unequal forces were involved in your strike, but only the ball had energy.

Who do you think has the best idea? Explain your thinking.

Essential Question

How do forces transfer energy and cause patterns of motion?

Watch *It's All Downhill from Here.*

What forces do you observe?

What do you wonder about patterns of motion? Jot it down!

Hands-On Investigation

Toy Car Crashes

SC.5.N.1.3

Get your notebook and go explore!

Interactive Word Wall

energy transfer

equal forces

friction

gravity

unequal forces

Different Forces

Claim, Evidence, Reasoning

How did forces affect the motion of the toy car? Check your claim. Can you back it up? Keep reading and underline evidence.

More than wind is pushing the windsurfer.

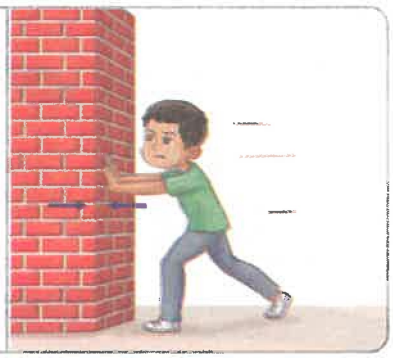
Have you ever pushed or pulled an object as hard as you could, but it still wouldn't budge? The harder you push, the harder the object pushes back at you.

A force can be a push or pull and can change the direction or speed of an object's motion. But forces act on nonmoving objects, too. Forces that act together on an object without changing its motion are called **equal forces**. Forces are considered balanced when they are equal and in opposite directions.

One force that acts on both moving and nonmoving objects is gravity. **Gravity** is a noncontact force that pulls objects. Here on Earth, the effect of gravity is a downward force, or a force pulling toward the center of Earth.

An object is in motion when it is moving. When the forces on an object are not balanced, then the object changes its motion. Unbalanced forces are also called unequal forces. **Unequal forces** are forces that do not cancel each other out and that cause an object to change its motion. They can be in the same, or opposite directions, and might cause an object to start or stop moving. Unequal forces could also cause a change in the speed or direction of motion. Both equal and unequal forces result in predictable patterns of motion.

The forces are equal between the boy and the wall. The forces are equal in strength but opposite in direction.



The force of the boy's push is greater than the box. The forces are unequal, so the box moves.

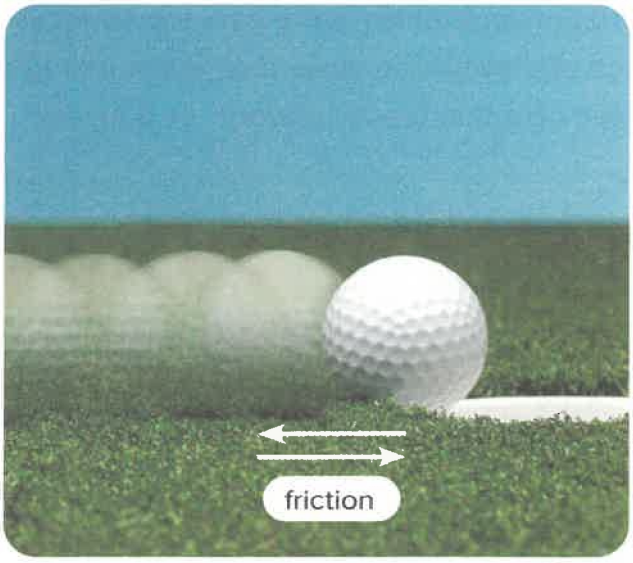
A Rolling Ball: As a ball rolls across flat grass, the force of friction is acting upon it and affecting its motion. **Friction** is a force between surfaces that slows objects or stops them from moving. Due to the friction between the ball and the grass, the ball slows down.

The amount of friction can cause predictable patterns of motion. Ice provides only a little friction, so a hockey puck can slide a long distance across ice. Gravel and sand provide much more friction. A rolling ball might stop quickly on gravel or sand.

Friction can also oppose a force on a nonmoving object. This type of friction is called static friction. It explains why a ball might not roll down a slight slope. A stronger force will be needed to overcome the force of friction and cause motion.

Lifting Weights: A weight lifter first pulls a heavy barbell off the ground. Then, they push the weight above their head. At the top of their lift, there is a brief moment when the motion of the barbell does not change. While the weight lifter holds this position, the downward force of gravity on the barbell is equally as strong as the upward force from the lifter's arms.

Soon the lifter will relax their arms and apply less force. The barbell will begin moving downward, the direction that gravity pulls it.



The barbell is not moving. Draw the missing arrows to show the equal forces on the barbell.

How do forces make amusement park rides more exciting? Watch *Fast, Fun Forces.*

Predictable Patterns

WORD LAB GO ONLINE

Do you need practice?

Interactive Word Wall

Remember to update your graphic organizer!

The strength of a force can be measured with a tool called a spring scale. A spring scale uses a coiled wire, or spring, to measure force. The more the spring is either stretched or squeezed, the greater the force it measures. Just like rulers measure in inches or centimeters, spring scales measure force by a unit called newtons.

You also can use a spring scale to deliver a push with a certain amount of force. Simply pull the spring scale back to the desired measurement. Next, place the end of the spring scale next to an object. When you release the plunger, it will push with the amount of force you measured.

Spring scales can also be used to measure the gravitational force acting on an object, which is more commonly known as weight. You may have seen a spring scale in the produce aisle at the grocery store. When you place your fruit or vegetables in the pan, the spring is stretched down due to the pull of gravity. The scale then measures the force of gravity that pulls on the object in grams, pounds, or ounces!

Why might an engineer measure force when designing a playground?

_____

_____

_____

Claim, Evidence, Reasoning

Now that you've gathered evidence, write your reasoning. Discuss it!

Energy Transfers

All moving objects have energy of motion. When equal forces are applied to an object, its energy stays the same. But what happens when unequal forces cause motion to change, such as when a ball slows down to a stop? The answer involves energy transfer.

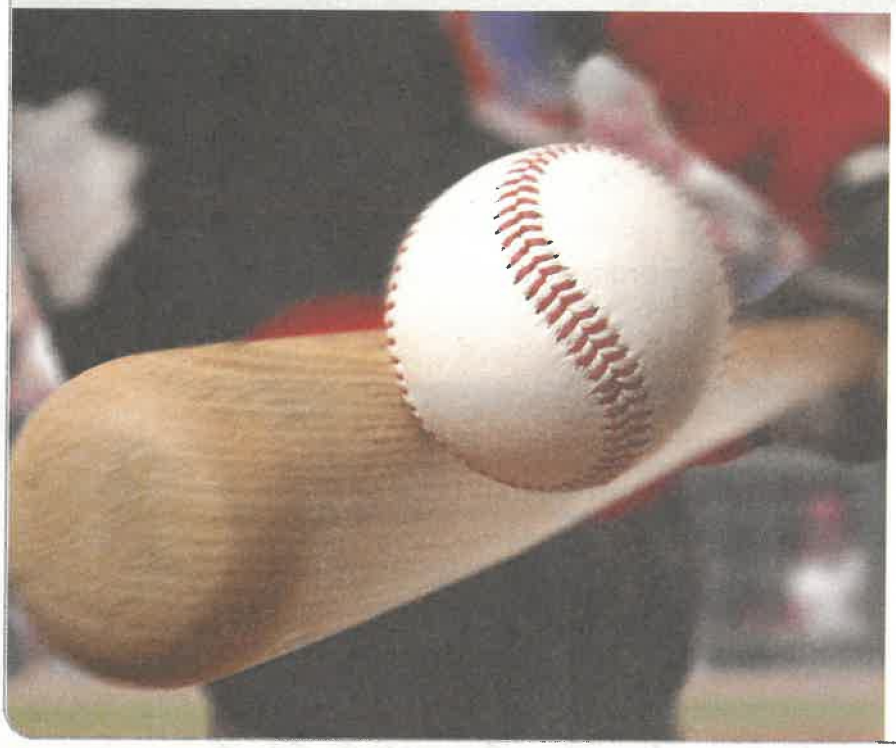
Energy transfer is the movement of energy from one object to another. A rolling bowling ball transferring some of its energy to the pins it strikes is a great example of energy transfer.

Energy transfers also may involve energy transformations, which you studied earlier. For example, a moving matchstick has energy of motion. Friction against another surface causes the energy to change form, eventually becoming the thermal and light energy of the lit match.

The friction between the ball and the grass slows the rolling ball to a stop.

What other forces occur in a game of soccer?

Read the Photo The bat is making contact with the ball. How is energy being transferred? Write a caption to explain.



Caption It!

Investigation Connection

In the investigation, the moving car transferred energy to the stationary car. Analyze your data. What patterns did you notice? Does your data explain patterns of motion? Explain.

STEM Connection IF/THEN

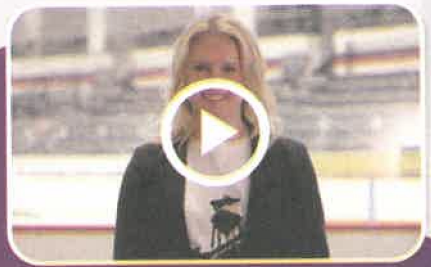
This Is What a Scientist Looks Like®

Meet an Architect and Goalie: Kimberly Sass

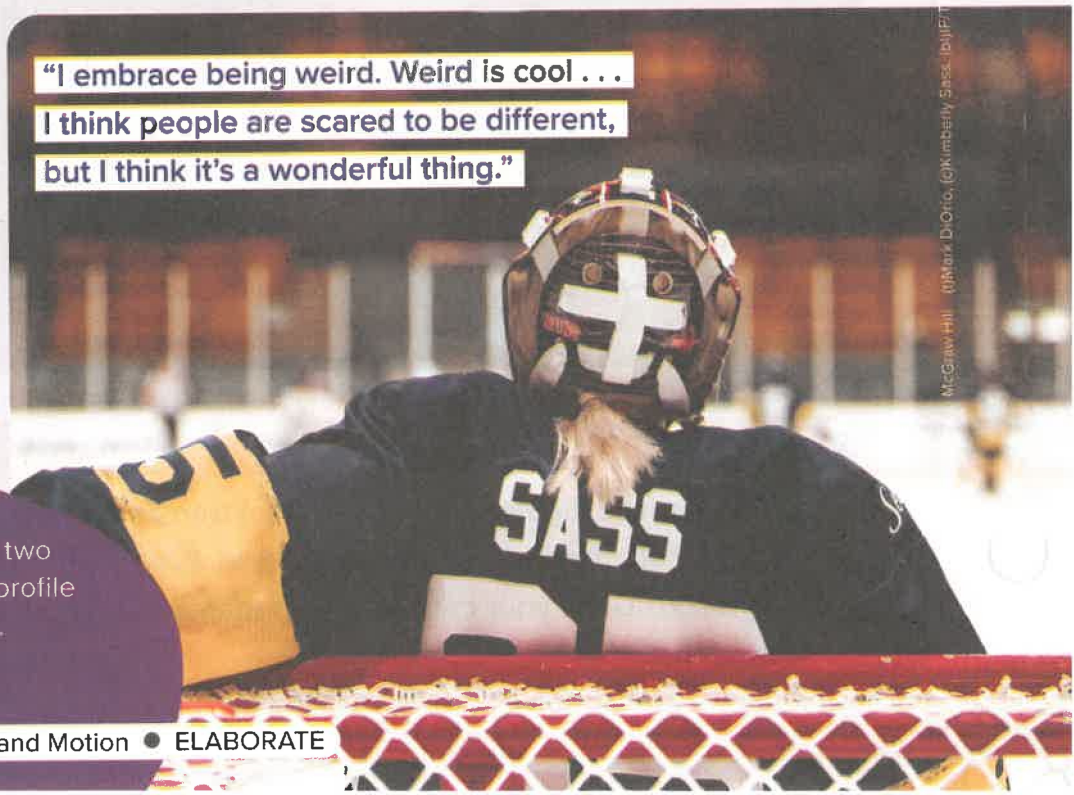
Kimberly Sass discovered architecture and ice hockey in college. Today, Kimberly Sass balances double careers. By day, she is an architectural job captain. At night, she tends the goal for a professional women's hockey team.

Q We are learning about equal and unequal forces. Can you tell us how you use these forces in hockey?

A The sport of hockey and all the action in the game is a result of unequal forces and motion. For example, skating on the ice requires your body and legs to exert force to propel you laterally off your skate blade edge. Another example is shooting the puck! An example of equal forces would be a goalie catching the rubber puck that an opponent shot toward the net. The goalie's arm and catching glove exerts the same force as the puck that was shot in order to catch it and leave it motionless in the glove.



She works double time to pursue two passions. Watch Kimberly Sass's profile video to learn what motivates her.



Q In your position as goalie, how do you use force to create patterns of motion or transfer of energy?

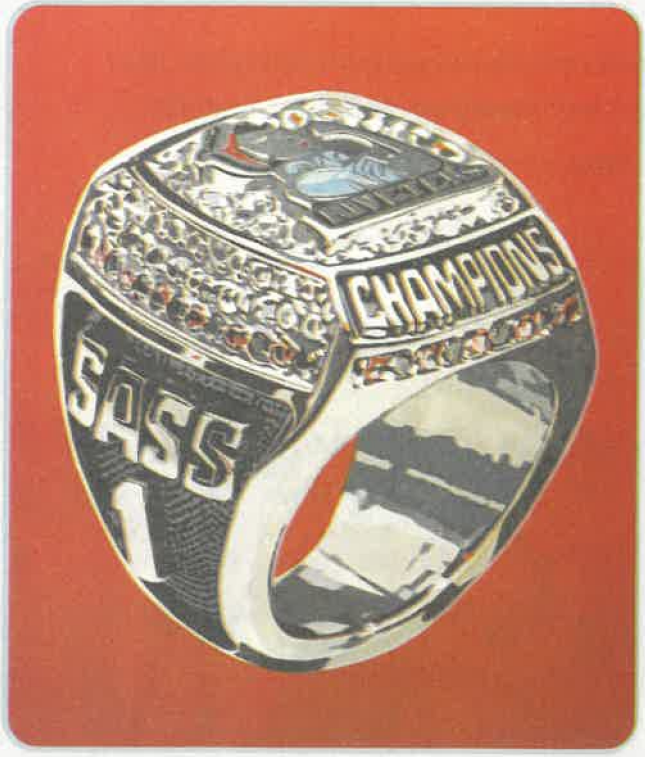
A During a breakaway (where a player from the opposing team approaches the goalie alone with the puck), you use motion and transfer of energy to your advantage. Goalies "challenge" the player on the breakaway. They skate out of their crease, stop, and then skate backward at a similar speed as the player. This backward momentum helps the goalie slide diagonally backward left or right to the goal post, depending on which direction the player chooses to fake.

Q What do architecture, hockey, and painting have in common?

A I think all three careers require extreme attention to detail and spatial awareness. As a goaltender, you have to be aware of the relationship of your body to the net and to the puck. Architecture requires spatial awareness and the ability to create spaces at the right scale and proportion for their respective uses. In art, adding layers of paint starting with larger brushstrokes and ending with smaller detailed brushstrokes results in a more realistic painting.

Q How do you balance two full-time careers?

A Balancing both architecture and professional hockey can be physically demanding and tiring, but I am proud that I made both careers work simultaneously. Architecture is more exercise for my brain, and I can exert more physical energy at hockey practice and games.

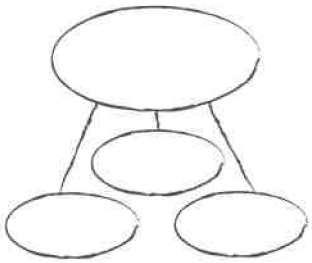


Write About It! ELA.K12.EE.1.1

1. Choose a writing prompt.
   - What is a sporting event that you have seen? How is the stadium of that sport different than an ice hockey stadium? How does the design relate to the sport that is played there?
   - Do you have a favorite sport or hobby? Are gravity and other forces at play? How do they affect your favorite sport or hobby?

2. Organize your information. Draw a Word Web (like this one) in your notebook.

Word Web



3. Use your Word Web to write a paragraph about stadium design or how gravity and other forces affect your favorite sport or hobby. Include words from the Interactive Word Wall in your writing.