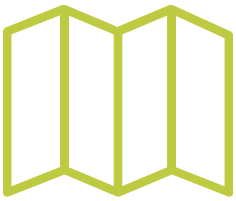


Lesson 6.1

Searching for Forces

Lesson Overview

Students explore a new book and different places in their school in order to find evidence of a variety of forces. The class visualizes various movements they have seen in order to begin to answer their new Investigation Question: *Where are forces in the world?* Students reflect on their experiences, which reinforces their understanding that when things move, it is evidence of forces being exerted. Then, they apply this understanding by searching for evidence of forces in the book *A Busy Day in Pushville* and by discussing with a partner the forces and movement shown in the book. At the end of the lesson, the class goes on a tour of the school and looks for examples of forces. Students record what they find in their Investigation Notebooks. The purpose of this lesson is for students to find examples of forces all around them and to apply their understanding of forces through these real-world examples.

Everyday Phenomenon: Objects move in the town of Pushville and in school.

Students learn:

- There are different forces in lots of places around us every day.
- Whenever we see an object start to move, stop moving, or change direction, that is evidence that something exerted a force on it.

Lesson at a Glance

ACTIVITY 1

Brainstorming Forces in the World (10 min)
Students deepen and apply what they have learned about forces in pinball machines to answer a new Investigation Question: *Where are forces in the world?* They activate prior knowledge about forces in the world by visualizing and brainstorming where forces exist.

TEACHER-LED DISCUSSION

2

Exploring A Busy Day in Pushville (15 min)
Students search for evidence of forces in a new book about people in the town of Pushville who do different jobs requiring forces. Students practice using a language frame to explain how the movement they observed is caused by a force.

READING

3

Going on a School Forces Tour (20 min)
The class goes on a tour through the school in search of evidence of forces. During the tour, students apply their understanding that objects move because of forces. This activity provides an On-the-Fly Assessment to informally assess students' understanding of movement as evidence of a force being exerted.

HANDS-ON

Materials & Preparation

Materials

For the Classroom Wall

- Chapter 6 Question: *Where are forces around us?*
- Partner Reading Guidelines

For the Class

- *A Busy Day in Pushville* big book
- 2 sentence strips*
- pocket chart (or whiteboard)*
- masking tape
- optional: Chapter 6 Home Investigation: Home Forces Tour copymaster

For Each Pair of Students

- 1 copy of *A Busy Day in Pushville* book

For Each Student

- optional: clipboard or hard surface to write on
- optional: Chapter 6 Home Investigation: Home Forces Tour student sheet
- *Pushes and Pulls* Investigation Notebook (page 18)

*teacher provided

Preparation

Before the Day of the Lesson

1. **Gather the following item (in your *Pushes and Pulls* kit) for the classroom wall:**
   - Chapter 6 Question: *Where are forces around us?*

VOCABULARY

- direction
- distance
- engineer
- exert
- force
- object
- visualize

DIGITAL RESOURCES

Explanation Language Frames: Lesson 6.1

Optional: Chapter 6 Home Investigation: Home Forces Tour copymaster

2. **Locate the following item (in your *Pushes and Pulls* kit):**
    - *A Busy Day in Pushville* big book
    - copies of *A Busy Day in Pushville* book
3. **Create key concept.** On a sentence strip, write "Whenever we see an object start to move, stop moving, or change direction, that is evidence that something exerted a force on it."
4. **Create the Explanation Language Frame.** Refer to Explanation Language Frames: Lesson 6.1 (located in Digital Resources) for guidance.
    - On a sentence strip, write "The __ moved because __ exerted a force on it."
5. **Arrange the Explanation Language Frame in the pocket chart or whiteboard.** There are no corresponding cards for this language frame.
6. **Prepare for the School Forces Tour.** The class will tour the school building for approximately 20 minutes, looking for examples of forces being exerted. Decide how you will have students record observations on page 18, School Forces Tour in the Investigation Notebook. Find out what activities will be taking place in various classes or areas of the school at the time of your hunt—such as art, music, recess or PE. Arrange visits to these areas of the school so students can hunt for a variety of movement. Consider bringing a camera to document the forces students point out.
7. **Preview *A Busy Day in Pushville*.** You will introduce the book in this lesson and read it in Lesson 6.2.
8. **Optional: Make copies of the Chapter 6 Home Investigation.** If you choose to administer the optional Home Investigation activity, print out the Chapter 6 Home Investigation: Home Forces Tour (in Digital Resources) and make enough copies so each student can get one copy to take home.
9. **Prepare for the On-the-Fly Assessment.** Included in Activity 3 is an On-the-Fly Assessment. The assessment provides an opportunity to informally assess students' understanding of movement as evidence of a force exerted. Select the hummingbird icon on the menu bar and then select ON-THE-FLY ASSESSMENT for details about what to look for and how you can use the information to maximize learning by all students.

Immediately Before the Lesson

1. **Write the Investigation Question on the board.** Write "Where are forces in the world?"
2. **Post the following on the classroom wall:**
    - Chapter 6 Question
3. **Have on hand the following items:**
    - prepared key concept

- *A Busy Day in Pushville* big book
- copies of *A Busy Day in Pushville* book
- marker
- masking tape
- *Pushes and Pulls* Investigation Notebooks
- optional: Chapter 6 Home Investigation: Home Forces Tour student sheets

At the End of the Day

1. **Review student work from the School Forces Tour.** The next lesson opens with a discussion of the forces students observed on the tour. Consider looking over student work in their notebooks to find examples you would like to highlight in class discussion.

Differentiation

Embedded Supports for Diverse Learners

Partner Read. Reading with a partner provides opportunities for students to assist each other with reading. During the Partner Read of *A Busy Day in Pushville*, students look at the pictures in order to find and discuss evidence of forces in action. Partner reading encourages discussion of the ideas in the book and provides an opportunity to use content-specific vocabulary with peers in a less structured context. In this lesson, the Partner Read also serves to prepare students to engage fully in the teacher-led Shared Reading of the same book in the following lesson.

Partner Reading guidelines. Students refer again to these guidelines to help them as they read with a partner. This structured approach to reading with a partner can help all students work together to read and understand the content.

Multimodal experience. This lesson includes a brainstorm, a hands-on experience, reading text, and opportunities for students to draw evidence of forces all around them. This multimodal instruction provides students with many opportunities to make sense of the science concepts and provides access points for different type of learners.

Potential Challenges in This Lesson

Classroom management. In this lesson, students leave the classroom to look for evidence of forces through the school. This could be a change to students' classroom routines, and they may be unsure of the behavioral expectations when they are no longer in their classroom.

Gathering a variety of evidence. On the School Forces Tour in Activity 3, students will have the opportunity to see evidence of forces all around them. Students may be more attuned to watching things that start moving or change directions, especially large movements such as activity on the playground. Be sure to provide a variety of experiences for observing movements to which students may be less attuned, such as things that stop moving, things moving slowly, or things moving over a short distance.

Specific Differentiation Strategies for English Learners

Preview occupations. Students consider the forces used by different people in the book *A Busy Day in Pushville*. You may wish to preview the pertinent vocabulary related to the various occupations that students will encounter—baker, firefighter, gardener, librarian. Engaging students in discussions about the work people are doing in the text can help students connect to the forces being exerted for each occupation.

Multiple vocabulary words. Students will use the words *direction*, *distance*, *exert*, *force*, *object*, and *evidence* to discuss key concepts. It may be challenging for some students to make sense of so many words, especially since they are using these words to synthesize what they have been learning throughout the chapter. You might wish to consider providing visual supports and spending extra time reviewing these words if you think this will be a challenge for your students. You can also provide the Spanish cognates and the definition of each word in Spanish.

Focus on the word *evidence*. This lesson relies on students' understanding of the word evidence as they make sense of the connection between forces and movement. In Activity 1, you will review the meaning of *evidence* with the class by using realia and providing examples and a definition. It may be worth previewing this vocabulary word with English learners. You could use the modeling activity with a pencil in Activity 1, or you could use different examples that would be familiar to students. You can also point out the Spanish cognate and definition for students. The word *evidence* in Spanish is *evidencia. La evidencia es información que nos ayuda a encontrar la respuesta a una pregunta.*

Specific Differentiation Strategies for Students Who Need More Support

Additional modeling of finding and discussing evidence. Students are asked to provide evidence when finding forces in the book and later during the School Forces Tour. To help them understand and answer the questions more effortlessly (*How do you know there was a force? What is your evidence? I found evidence of a force! I saw Ruby's chair move back. That is evidence of a force.*), students may benefit from time to practice. Additionally, you can model examples as you experience them. For example: *I found evidence of a force! I saw __. That is evidence of a force.*

Rehearse the Explanation Language Frame. Giving students the opportunity to practice by using the Explanation Language Frame before they read can reduce the cognitive load of keeping many things in mind as students follow the Partner Reading Guidelines, interpret images to visualize movement, and search for evidence of forces. You can refer to familiar images or videos as you prompt students to rehearse using the explanation language frame (*The _____ moved because _____ exerted a force on it.*).

Supporting students in recording. On the School Forces Tour, students draw and/or write about the evidence of forces they encounter. Students may be distracted outside the classroom, or they may be unfamiliar with the task at hand. If you have students who need more support, you can explicitly model thinking aloud and recording information in your notebook during the walk.

Specific Differentiation Strategies for Students Who Need More Challenge

Categorize evidence. For students who would benefit from going further, you can help them set up a three-column table. Label the columns "Stop moving," "Start moving," and "Change direction." Students can then record the different types of movement they find on the School Forces Tour in the different categories.

Standards

Key

Practices Disciplinary Core Ideas Crosscutting Concepts

3-D Statement

The class reads *A Busy Day in Pushville* and tours the school searching for evidence to answer the question of where else in the world types of force are being exerted (cause and effect).

Next Generation Science Standards (NGSS)

NGSS Practices

- **Practice 1:** Asking Questions and Defining Problems
- **Practice 3:** Planning and Carrying Out Investigations
- **Practice 6:** Constructing Explanations and Designing Solutions
- **Practice 7:** Engaging in Argument from Evidence
- **Practice 8:** Obtaining, Evaluating, and Communicating Information

NGSS Disciplinary Core Ideas

- **PS2.A: Forces and Motion**:
  - Pushes and pulls can have different strengths and directions. (K-PS2-1, K-PS2-2)
- **PS2.A: Forces and Motion**:
  - Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1, K-PS2-2)

- **ETS1.A: Defining and Delimiting Engineering Problems**:
  - Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)

NGSS Crosscutting Concepts

- Cause and Effect

Common Core State Standards for English Language Arts (CCSS-ELA)

- **CCSS.ELA-LITERACY.RI.K.3:** With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.
- **CCSS.ELA-LITERACY.RI.K.7:** With prompting and support, describe the relationship between illustrations and the text in which they appear (e.g., what person, place, thing, or idea in the text an illustration depicts).
- **CCSS.ELA-LITERACY.RI.K.10:** Actively engage in group reading activities with purpose and understanding.
- **CCSS.ELA-LITERACY.SL.K.1:** Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups.
- **CCSS.ELA-LITERACY.SL.K.2:** Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.
- **CCSS.ELA-LITERACY.SL.K.4:** Describe familiar people, places, things, and events and, with prompting and support, provide additional detail.
- **CCSS.ELA-LITERACY.L.K.6:** Use words and phrases acquired through conversations, reading and being read to, and responding to texts.

Common Core State Standards for Mathematics (CCSS-Math)

CCSS-Math Practices

- **CCSS.MATH.PRACTICE.MP1:** Make sense of problems and persevere in solving them.
- **CCSS.MATH.PRACTICE.MP2:** Reason abstractly and quantitatively.

CCSS-Math Content

- **CCSS.MATH.CONTENT.K.G.1:** Identify and describe shapes. Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.

1 TEACHER-LED DISCUSSION
Brainstorming Forces in the World

Brainstorming Forces in the World

10 MIN

The class works to brainstorm evidence of forces in the world.

Instructional Guide

1. Connect to prior learning. Remind students that they recently finished designing their Class Pinball Machine so that it could move the pinball in all the ways they wanted it to—just like in the video.

Point to the What We Know About Forces chart.

We have learned a lot of things about how to make a pinball, and other objects, move in different ways. What are some things we have learned?
[You need a force to make something start to move. A gentle/strong force makes something move a short/long distance. A force to the right/left makes an object move to the right/left. You can make an object change direction by making it hit a still object or a moving object.]

As students share, affirm and rephrase their contributions in the language of the key concepts of this unit.

2. Reflect on the work of engineers. Refer to the What Engineers Do chart.

Engineers like us find out about problems, design solutions by learning, planning, making, and testing our designs, and then share and explain what we learned with others.

Scientists and engineers use what they learn to think about the world in new ways.

You have become experts on knowing about forces, and you have shown with your Box Models and writing that you know a lot about forces in pinball machines. But I wonder, can we only exert forces in pinball machines?
[No.]

3. Read the Chapter 6 Question aloud.

Of course, there are many forces around us, not just in pinball machines. We will figure out where all these forces are to help answer the question *Where are forces around us?*

4. Introduce the Investigation Question. Explain that, in order to figure out where forces might be around us, students will investigate another question.

Read the Investigation Question aloud, pointing to each word as you read it.

Where are forces in the world?

5. Set purpose for the brainstorm activity. Let students know that today they will look for forces in the world by reading a book and looking all around the school for evidence of forces.

6. Review the word *evidence* by demonstrating with pencil and paper.

What is evidence?

We have been talking about evidence for the past few weeks. We know that evidence is information that helps us figure out the answer to a question. Let's do an example of finding evidence.

Push your pencil across a piece of paper, as if you were writing.

Is there a force being exerted?
[Yes.]

What is our evidence?
[The pencil is moving.]

We can say that there is a force being exerted, and our evidence is what we see: that the pencil is moving.

Starting to move is evidence of a force.

7. Visualize evidence of forces in the world.

Our question is *Where are forces in the world?* We know any time something starts to move, that is evidence of forces. We know we cannot see forces, but we can see things move.

Let us close our eyes and visualize evidence of forces.

Think about what we have done with forces in science class, and also in the world around you. Where are there forces? In other words, where have you seen objects being pushed, pulled, thrown, kicked, hit, or moved in some way?

Give students a few moments to think to themselves.

8. Partner talk. After students take a few moments to visualize things that move, have them turn to a partner and share.

9. Share and record examples of movements. Regain students' attention and call on volunteers to share. Write student contributions as a list on the board. As students share movements they visualized, ask how it is evidence of a force.

When that happened, was there a force being exerted?
[Yes.]

How do you know? What was your evidence?
[I pictured it moving; I know it moves because when someone hits the ball it changes directions.]

There are different forces in lots of places around us every day!

10. Summarize student responses. After students have shared a variety of examples of evidence of forces, summarize the list. Point out different kinds of movement you notice, such as objects that start to move, stop moving, or change direction.

Teacher Support

Background

Science Note: Forces and Evidence of Forces
While this lesson has students searching for forces, forces themselves are invisible! Searching for forces is possible because you can see evidence of forces—you can observe objects moving because forces have been exerted on them. Therefore, modeling in this lesson has been written to avoid phrases such as *I see a force*. As you speak to students, be careful to model talking about seeing *evidence* of forces, rather than seeing forces. As students speak, they are likely to say that they see forces when they see objects moving. Confirm that students have found a force, but revoice their contributions by using the term *evidence of forces*.

Rationale

Pedagogical Goals: Explanation Language Frames
Students have had many opportunities to use the Explanation Language Frames with a large degree of support and teacher modeling. At this point in the unit, we expect that students will use this language more independently as they discuss evidence of forces. You may want to have the Explanation Language Frames and accompanying cards on hand for those students who may need more support.

Background

Science Note: Movement Without an Obvious Object Exerting the Force
Students may be able to easily identify objects that are moving, but they might not be aware of what is exerting a force on the objects to make them move. For example, students might mention a moving car or a sled going down a hill. If you choose, you can use this as an opportunity to highlight the potential of new knowledge and observations to prompt new questions. You can say something such as *That is definitely a situation where something is starting to move, and we*

know that is evidence that a force was exerted. However, it does not seem like there is something pushing or pulling on the car as it starts to move. I wonder what exerts that force? This is beyond the scope of this unit; the complex concepts of gravity and magnetism appear in the Next Generation Science Standards for the first time in the third-grade standards.

2 READING
Exploring A Busy Day in Pushville

Exploring A Busy Day in Pushville

15 MIN

Pairs look through the *A Busy Day in Pushville* illustrations to find and discuss evidence of forces in action in the book.

Instructional Guide

1. Introduce the book. Display the *A Busy Day in Pushville* big book. Let students know now that they have brainstormed forces in the world, they will work with a partner to find even more evidence of forces in this book.

2. Review visualizing. Remind students they have used the strategy of visualizing to help them understand forces throughout the unit. Ask for volunteers to explain what visualizing is. [Making a picture or a movie in your mind.]

3. Think aloud to visualize an example of someone exerting a force. Point to the image of the woman pushing the baby carriage on the cover. Model thinking aloud about the force exerted in the image.

When I look at the cover, I can see many examples of movement taking place. When I look at this woman, I can visualize her pushing the baby stroller down the street. I can visualize the stroller moving in the direction she is pushing.

That sounds like evidence of forces to me. I know that when something starts to move, that means a force being exerted.

4. Point to the Explanation Language Frame. Let students know that, to talk about forces like an engineer, they will use the language frame *The ___ moved because ___ exerted a force on it.*

An engineer would explain it like this: The baby stroller moved because the woman exerted a force on it.

5. Set expectations for reading the book. Refer to the Partner Reading Guidelines chart to remind students of the expectations. Also remind students of their purpose—to search for forces in Pushville.

6. Assign partners and distribute books. As students explore the images in the book, circulate and listen to student conversation. Offer support for finding and explaining evidence of forces, as needed, including modeling use of the posted language frame.

7. Gather students' attention and return to the discussion area. Call on volunteers to share evidence of forces they found in the book's illustrations.

How did you know there was a force? What was your evidence?

8. Post key concept. Read the key concept aloud, pointing to each word as you read it.

Whenever we see an object start to move, stop moving, or change direction, that is evidence that something exerted a force on it.

Teacher Support

Background

About the Book: *A Busy Day in Pushville*
A Busy Day in Pushville is written from the perspective of a young girl who sees people using pushes and pulls in their jobs and activities all around town as she goes to the library with her dad. After she and her dad come home, she also notices pushes and pulls as they paint and draw, make dinner, and more. Students are encouraged to look for evidence of forces throughout the book. *A Busy Day in Pushville* is used as a Shared Reading at the end of the unit to help students synthesize information and explain all the different kinds of forces they have learned about in the unit. The book provides a bridge to an activity in which students search for evidence of forces in the school.

Instructional Suggestion

Student Thinking: Selecting Examples from *A Busy Day in Pushville*
If you find that students need additional support finding examples of forces in the text, you can flag pages in the books beforehand. Before distributing copies of the book to students, flag a few clear examples of forces by placing sticky notes on those illustrations. Ask students to describe the forces they visualize in those illustrations. Provide students with an additional sticky note and invite them to find and discuss an additional example.

3 HANDS-ON
Going on a School Forces Tour

Going on a School Forces Tour

20 MIN

The class walks through the school, pausing at designated locations to find and record evidence of forces.

Instructional Guide

1. Introduce the School Forces Tour.

You found evidence of forces in many of the illustrations in *A Busy Day in Pushville*. Now we will walk through the school and find evidence of forces right here in our school! You will draw pictures of the forces you find in your notebook.

2. Remind students to look for evidence.

Remember that evidence is information that helps us figure out the answer to a question. Our question is *Where are forces in the world?* We know forces are something we cannot see. We need to look for evidence that forces have been exerted.

What kind of evidence are we going to look for?
[Things moving.]

When something starts moving, stops moving, or changes direction, that is evidence a force has been exerted.

3. Project and introduce the notebook page. Project page 18. Read the directions aloud to students and indicate the boxes and lines where students can record their evidence. Model an example of how you might record observations.

For example, have a student stand, sit down in a chair, and then stand back up. Say *I found evidence of a force! I saw Ruby's chair move back. That is evidence a force was exerted.*

In the box, draw a picture of a chair and a person. Write "chair and a person" under the box.

4. Set expectations for the School Forces Tour. Remind students of any established routines for moving and speaking in common areas of the school. Explain that you will spend a few minutes at each stop, so each student should quickly choose what to draw, doing their best to draw and write what they see. They will have more time to discuss and finish their drawings and writing later in today's class.

5. Distribute notebooks. Assist students in finding page 18, School Forces Tour, as needed.

6. Embark on the School Forces Tour. Consider finding evidence of forces in your school by visiting some of the following areas:

- The art room (students exerting forces on drawing tools)
- A location where you can see the custodian exerting forces while cleaning
- The main office (office workers exerting forces on computer keyboards, putting items in mailboxes, or lifting the lid of the copy machine)
- The gym or an indoor-recess area (students exerting forces on balls)
- The library (students exerting forces on books by taking them off the shelf or by turning the pages)

7. On-the-Fly Assessment: Students share evidence of forces. As you arrive at new places on the tour, ask students to share where they see forces.

Where do you see forces exerted here?

What is your evidence that there is a force there?

8. Return to the classroom. Allow students a few minutes to share their reactions to the School Forces Tour.

9. Collect Investigation Notebooks and conclude the lesson. Let students know that you will begin the next lesson with a discussion of the School Forces Tour.

Embedded Formative Assessment

On-the-Fly Assessment 15: Providing Evidence of Forces

Look for: Your questions during the School Forces Tour present an opportunity to informally assess students' understanding of motion as evidence of a force being exerted. In general, when you ask students for evidence of a force they've identified as exerted on an object, they should describe the movement of the object. They may also identify a more specific aspect of the force (e.g., strength, direction) and support it with evidence (e.g., distance traveled, direction moved), but it is most important that they describe movement as evidence of a force.

Now what? If you notice that students do not know how to respond when you invite them to offer evidence, you can do some prompting in the moment, scaffolding their responses. For example, you might say *We know that when we see something start moving, stop moving, or change direction, that is evidence of a force. What do you see happening to the cart that is evidence that a force is exerted on it?* If students describe something other than movement as evidence (e.g., *I can see him pushing it*), acknowledge their thinking and redirect their responses. For example, you could say *Right. We have learned that pushing is one way that forces are exerted, and, in general, we know what a push looks like. What is most important to look for as evidence of a force is whether something moves—starts moving, stops moving, or changes direction. What do you see moving?* If you notice that a few students are not sure how to respond, you may want to pause in a place where you can see many moving objects, model identifying a force based on movement as evidence for the class, and invite students to identify others forces based on movement as evidence.

Teacher Support

Instructional Suggestion

Classroom Management: Variations for the School Forces Tour
You can extend the tour to include the area outside your school. You can also invite adult volunteers to accompany you on the tour. Students are often very eager to share what they observed. Time permitting, allow students to share their observations along the way. Remind them to record their observations in their notebooks.

Instructional Suggestion

Providing More Experience: Home Investigation
This optional activity invites students to look for light sources inside or outside of their homes. Home Investigations can encourage interaction and discussion between students and their families around science concepts, which has been found to be beneficial for student learning. See optional: Chapter 6 Home Investigation: Home Forces Tour copymaster (in Digital Resources). Make one copy for each student and review the instructions with students.

Possible Responses

Investigation Notebook
School Forces Tour (page 18)

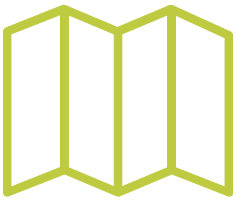
Answers will vary.

Image examples in the boxes:

- a person standing up after sitting in a chair
- a person kicking a ball
- a broom pushing dirt
- a copier pushing out paper

Writing examples on the lines below the boxes:

- "chair and a person"
- "person and a ball"
- "broom and dirt"
- "copier and printer"



Lesson 6.2

A Busy Day in Pushville

Lesson Overview

In this final lesson of the unit, students apply and reflect on what they have learned about the Unit Question: *Why do things move in different ways?* Students discuss how objects they observed in the School Forces Tour provide evidence of different kinds of forces being exerted. Then, they participate in a Shared Reading of *A Busy Day in Pushville*, which provides opportunities for them to describe the forces shown in the book in terms of strength and direction. Students go on a gallery walk to review artifacts and learning activities from each chapter, and partners discuss what they learned. The purpose of this lesson is for students to extend what they learned about different forces in the classroom to all the forces around them and reflect on the cumulative understanding they built throughout the unit. This lesson includes activities that might benefit from additional time to allow the teacher to guide a comprehensive review of the unit (e.g., teaching the lesson over two days or extending the time frame for Activity 3).

Everyday Phenomenon: Objects move in the town of Pushville and in school.

Students learn:

- You cannot see forces, but you can see evidence that they have been exerted.

Lesson at a Glance

ACTIVITY

1

Discussing the School Forces Tour (15 min)
Students share the evidence of forces they observed and recorded during the School Forces Tour. They use an Explanation Language Frame to explain how those movements happened because of forces.

TEACHER-LED DISCUSSION

2

Shared Reading: A Busy Day in Pushville (15 min)
During a Shared Reading, partners describe the different kinds of forces—left, right, strong, and gentle—that they find in the book's illustrations and text. Pulling together their ideas from the whole unit, students explain that objects started moving, moved a certain distance, or moved a certain direction because of the force exerted.

READING

3

Reflecting on the Unit (15 min)
Students consolidate their understand of forces and motion by reflecting on artifacts and learning activities from each chapter of the unit. This activity includes an opportunity for students to self-assess their learning by talking with a partner.

STUDENT-TO-STUDENT DISCUSSION

Materials & Preparation

Materials

For the Classroom Wall

- What We Know About Forces chart
- What Engineers Do chart
- Pinball Machine Design Goals chart

For the Class

- Class Pinball Machine
- rugball
- tennis ball and target
- demonstration Box Model with materials (wooden stick bumpers, rubber bands, shoelace)
- Box Model Mats 1–3
- *Talking About Forces* big book
- *Forces in Ball Games* big book
- *Building with Forces* big book
- *Room 4 Solves a Problem* big book
- *A Busy Day in Pushville* big book
- Forces Cards set
- Force Investigation objects from Lesson 1.3 (e.g., a pipe cleaner, shoelace, sheet of tissue or paper towel, a small math manipulative, a flat marble, a large metal nut, and wooden stick, etc.)
- optional: completed Investigation Notebook diagram examples

For Each Student

- *Pushes and Pulls* Investigation Notebook

*teacher provided

VOCABULARY

- direction
- distance
- exert
- force
- object

DIGITAL RESOURCES

Preparation

Before the Day of the Lesson

1. **Gather artifacts from each chapter.** In Activity 3, the class will refer to the various class charts, books, and artifacts as they reflect on the unit. Depending on how you managed all the class charts during the unit, gather them together in the discussion area, refer to them posted on the classroom wall, or take pictures of the chart and put them in a slideshow. The artifacts to which you will refer are:
    - **Chapter 1:** *Talking About Forces* big book, Forces Investigation objects
    - **Chapter 2:** Forces Cards set, *Forces in Ball Games* big book
    - **Chapter 3:** *Building with Forces* big book, tennis balls and target
    - **Chapter 5:** *Room 4 Solves a Problem* big book
    - **Chapter 6:** *A Busy Day in Pushville* big book
    - **All chapters:** *Pushes and Pulls* Investigation Notebook, Class Pinball Machine, Box Model and materials, rugball, What Engineers Do chart, What We Know About Forces chart, Pinball Machine Design Goals chart
2. **Prepare to debrief the School Forces Tour.** If you took pictures on the tour, upload them so you can project them for the class.
3. **Prepare for the unit reflection gallery walk.** At the end of this lesson, students will walk around the classroom in pairs as they reflect on the work they have done during the unit. You will need to set up five stations with artifacts from each chapter. Use the list of materials above as a guide, but feel free to supplement with other materials you used in each chapter that will be meaningful to your students. Decide how you will direct students to move to each station.
4. **Locate exemplar diagrams.** During the gallery walk in Activity 3, it will be helpful to provide student diagrams to jog students' memories about what they did in their box models. Look through Investigation Notebooks to find exemplar diagrams for each chapter. Feel free to find more than one diagram for each chapter in order to maximize the number of students whose work is featured. Since students will be using their notebooks during Activity 1 in this lesson, consider how you might place notebooks out before students begin the gallery walk or, alternatively, make color copies for each station in advance.
5. **Preview *A Busy Day in Pushville*.** You will read this book aloud during Activity 2.

Immediately Before the Lesson

1. **Set up gallery walk stations.** Using the materials list above, set up a station for each chapter in an area of the classroom away from the discussion area.
2. **Have on hand the following items:**

- *A Busy Day in Pushville* big book
- *Pushes and Pulls* Investigation Notebooks

Differentiation

Embedded Supports for Diverse Learners

Returning to a familiar text. To help students apply their understanding about forces, they engage in a Shared Reading of *A Busy Day in Pushville*. Inviting students to read text more than once, for different purposes, helps them deepen their understanding of information they encounter in the text. This second read gives students the opportunity to connect ideas about strength and distance of forces to the familiar illustrations and descriptions from the text that you read with students.

Gallery walk of lesson artifacts. The use of class charts, investigation materials, Explanation Language Frames, vocabulary cards, and key concepts provide students with support as they discuss their understanding of the unit's content with their peers. This discussion gives students a chance to synthesize all they have learned during the unit and enables them to arrive at a deeper understanding of forces.

Teacher prompts. Providing verbal and visual cues helps students formulate their oral explanations. As you invite students to reflect on their learning, you will give specific prompts. For a list of questions you can ask students who need supportive prompting in order to discuss their understanding, see Supporting Discussions: Explanation Language Frames in the Teacher Support tab in Activity 1.

Potential Challenges in This Lesson

Discussion-focused. In Activity 3, students will provide oral explanations. Despite many embedded supports in this lesson, some students may require additional assistance explaining their ideas about forces and identifying a cause and effect. Consider who those students might be and how to provide any additional scaffolding.

Recalling several concepts. Keeping many ideas in mind during a cumulative review of several key concepts may be challenging for some students. You may wish to consider how you can support students who may benefit from breaking this task into smaller parts or over a few days.

Specific Differentiation Strategies for English Learners

Asking and answering questions. You may want to reframe your questions to provide English learners with language models for responding to questions. Asking a question by using the same verb tense that would be required to answer a question can reduce the linguistic demand on English learners. For example, rather than beginning questions by asking, "Why did the ball move?", you could ask students to explain by saying,"Explain to me why the ball moved." Students could then use the same verb form when responding (*The ball moved because* __.) Providing this kind of language support can help English learners be successful when responding to oral prompts.

Specific Differentiation Strategies for Students Who Need More Support

Choose partners strategically. This lesson provides many opportunities for student learning and reflection to occur through discussion and partner activities. For the partner discussion during the Shared Listening activity, you can think ahead to create good working partnerships for pairs to describe different kinds of forces to each other.

Discussing forces. Some students may require additional assistance to explain their ideas about why objects started moving or moved a certain distance or direction because of the force exerted. Remind students that cause and effect is when one thing makes another thing happen. Ask students to describe the kinds of forces that are being exerted. If necessary, you can recast students' responses by using familiar vocabulary (e.g., *left, right, strong, gentle*) to describe the forces exerted to make an object move.

Specific Differentiation Strategies for Students Who Need More Challenge

Specific language. Encourage students to use specific language about the forces that cause the movements they observe. Refer to the What We Know About Forces chart as students discuss the School Forces Tour in Activity 1. Encourage students to use the language on the chart to describe the forces as strong/gentle or aiming to the left/right. Or, they can use a combination of descriptors.

Extend the discussion to forces at home. Invite students to use causal language (__ *because* __.) to explain forces they observed at home or in their community. Then, ask students to discuss those forces (e.g., *When I went home and saw my dog pushing her toy around with her nose, I knew the toy moved because my dog's nose exerted a force on it!*). If you chose to distribute the Chapter 6 Home Investigation: Home Forces Tour to students at the end of the previous lesson, you may want to see what students recorded in order to prompt this discussion.

Standards

Key
Practices Disciplinary Core Ideas Crosscutting Concepts

3-D Statement

Students share evidence and construct explanations of forces they found on their School Forces Tour. They do a shared read of *A Busy Day in Pushville* to identify, visualize, and describe additional evidence of the forces shown in the books' illustrations in terms of strength, distance, and direction (cause and effect).

Next Generation Science Standards (NGSS)

NGSS Practices

- **Practice 6:** Constructing Explanations and Designing Solutions
- **Practice 8:** Obtaining, Evaluating, and Communicating Information

NGSS Disciplinary Core Ideas

- **PS2.A: Forces and Motion**:
  - Pushes and pulls can have different strengths and directions. (K-PS2-1, K-PS2-2)
- **PS2.A: Forces and Motion**:
  - Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1, K-PS2-2)
- **ETS1.A: Defining and Delimiting Engineering Problems**:
  - Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)

NGSS Crosscutting Concepts

- Cause and Effect

Common Core State Standards for English Language Arts (CCSS-ELA)

- **CCSS.ELA-LITERACY.RI.K.2:** With prompting and support, identify the main topic and retell key details of a text.
- **CCSS.ELA-LITERACY.RI.K.3:** With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.
- **CCSS.ELA-LITERACY.RI.K.7:** With prompting and support, describe the relationship between illustrations and the text in which they appear (e.g., what person, place, thing, or idea in the text an illustration depicts).
- **CCSS.ELA-LITERACY.RI.K.10:** Actively engage in group reading activities with purpose and understanding.
- **CCSS.ELA-LITERACY.SL.K.1:** Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups.
- **CCSS.ELA-LITERACY.SL.K.1.B:** Continue a conversation through multiple exchanges.
- **CCSS.ELA-LITERACY.SL.K.2:** Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.

Common Core State Standards for Mathematics (CCSS-Math)

CCSS-Math Practices

- **CCSS.MATH.PRACTICE.MP1:** Make sense of problems and persevere in solving them.

- **CCSS.MATH.PRACTICE.MP2:** Reason abstractly and quantitatively.

CCSS-Math Content

- **CCSS.MATH.CONTENT.K.MD.1:** Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.
- **CCSS.MATH.CONTENT.K.MD.2:** Describe and compare measurable attributes. Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference.
- **CCSS.MATH.CONTENT.K.G.1:** Identify and describe shapes. Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.

1 TEACHER-LED DISCUSSION
Discussing the School Forces Tour

Discussing the School Forces Tour

15 MIN

Students share where they saw evidence of forces on the School Forces Tour.

Instructional Guide

1. Gather students in the discussion area. Introduce the activity.

Yesterday, we saw evidence of forces all around us! You may have seen some of the same evidence or different evidence of forces as your classmates.

2. Distribute Investigation Notebooks. Assist students in finding page 18, School Forces Tour, as needed.

3. Partners share observations from the School Forces Tour. Ask students to share their notebook pages with a partner to remind them of what they and their classmates saw. If you took pictures on the tour, consider showing a brief slideshow.

4. Call on a student to share a force. Remind students that you cannot see forces, but you can see evidence they have been exerted.

What is one example of a force being exerted in the school?

What is your evidence a force was exerted?
[The object started to move. The object changed direction.]

As students share, restate students' statements in terms of forces and evidence. For example, if students shared watching a fourth grade class making posters with markers, say *We know a force was exerted on the markers. Our evidence is the markers moved.*

5. Point to the Explanation Language Frame. Read it aloud.

The ____ moved because ____ exerted a force on it.

Ask students to explain why the object moved. For example, if you ask *Why did the marker move?* a student might say *The marker moved because the fourth grader exerted a force on it.*

6. Call on additional students to share examples. Repeat the above procedure to guide students to use the language frame to describe the movement they saw as being caused by a force exerted. To increase independent use of the Explanation Language Frame, you may consider having partners share instead.

Point out examples illustrating any of the following:

- objects starting to move (throwing a ball, writing, standing up)
- stopping movement (catching a ball, holding a door from closing)
- changing direction (kicking a ball, writing with markers on a whiteboard)

7. Review the key concept. Point to the key concept from Lesson 6.1 and read it aloud, pointing to each word as you read it.

Whenever we see an object start to move, stop moving, or change direction, that is evidence that something exerted a force on it.

8. Close the discussion. Explain that the class has started to answer the question *Where are forces in the world?* by searching for forces at school. To think about even more evidence of forces, now you will read about a student who found forces in her neighborhood, too.

Teacher Support

Rationale

Science Note: Language of Forces
As students debrief the School Forces Tour, it may be important to revisit the idea that forces are invisible. If you hear students using language referring to seeing forces (e.g., *I saw the force moving the* ___.), model the language that refers to what they saw as evidence of a force. Remind students that we cannot see forces, only the evidence of forces, which is the change of movement—starting, stopping, or changing direction.

Instructional Suggestion

Supporting Discussion: Explanation Language Frames
At this point in the unit, students may be able to use causal language to speak in complete sentences without extra support. However, if students need more guidance using causal language, consider using the Explanation Language Frames as you review students' observations from the School Forces Tour. Below are two examples of questions and possible responses:

- *What moved?* [The marker.]
- *What caused the marker to move?* [The student pushing it.]

- *We know that a push is a force. We know a force happens between two objects. We can say that the marker moved because the student exerted a force on it with his hand.*

2 READING
Shared Reading: A Busy Day in Pushville

Shared Reading: A Busy Day in Pushville

15 MIN

Partners engage in a Shared Reading of *A Busy Day in Pushville*, pantomiming and talking about the forces in the book.

Instructional Guide

1. Show the cover of *A Busy Day in Pushville*. Remind students they used the book in the last lesson to find evidence of forces being exerted.

2. Set the purpose for the Shared Reading. Let students know they will discuss the different kinds of forces in the book—strong and gentle forces, and forces in different directions—as you all read it together. Use the What We Know About Forces chart as reference during the discussion, as needed.

I will read the words as you visualize the different movements and forces. Visualize if the forces exerted might be strong or gentle, and what direction they are being exerted in. Then you will explain it to a partner.

3. Read page 3 aloud. Model how you would visualize and explain the forces exerted using a language frame.

I can see that the girl is pulling on her dad's hand this way, and I can visualize that he will start to move forward. So I could say, the man's hand moved because the girl exerted a force on it.

Point to the posted language frame *The __ moved because ___ exerted a force on it.* and have students repeat the explanation after you.

The man's hand moved because the girl exerted a force on it.

Next, point to the ___ *because* ___ language frame.

I can also talk about the direction of the forces like this: The man moved forward because the girl is exerting a force on his hand in this direction.

Have students repeat the explanation as you point to the language frame.

4. Review the Shared Listening routine. Let students know they will take turns speaking and listening to talk about evidence of forces after you read each page together.

5. Read pages 4 and 5. Ask all students to visualize and pantomime each of the baker's movements.

- Pick one thing the baker did. What evidence do you see of forces?
- Remember to talk about the direction or strength of the forces being exerted.
- Partner A will share while Partner B listens. Partner B will show they were listening carefully by telling Partner A what they heard them say.
  [The pan moved toward the baker because the baker exerted a force toward her on the pan.]

Call on one or two students to share what they or their partner noticed as evidence of forces. As needed, rephrase student contributions using explanation language, or remind students to use the posted language frame. Highlight instances where students discussed direction or strength of forces.

6. Read pages 6 and 7 as students pantomime.

- What evidence do you see of forces?
- Partner B will share while Partner A listens. Partner A will show they were listening carefully by telling Partner B what they heard them say.
  [The hose went to the right because the fireman exerted a force to the right.]

Have students share, highlighting examples of contributions that include different directions and strength of forces. Encourage use of the language frame to explain.

7. Continue reading through the end of the book. As you read, have students pantomime based on the movement in the text and illustrations. Pause as appropriate to have students explain the evidence of forces they found. You may decide to continue to use the Shared Listening routine, a partner share, or whole-class share to discuss ideas.

Teacher Support

Instructional Suggestion

Student Thinking: "Seeing" Forces
After revisiting *A Busy Day in Pushville*, you can invite students to discuss their visualizations of movement as evidence of forces. You can ask "Can we see a force?" Then, engage in a discussion about how we know there is a force, even when we cannot see one. We know this because we can observe the evidence that something moved—started to moved, stopped moving, changed direction.

3 STUDENT-TO-STUDENT DISCUSSION
Reflecting on the Unit

Reflecting on the Unit

15 MIN

Students visit stations with artifacts from each chapter of the unit. Partners take turns discussing what they have learned.

Instructional Guide

1. Set the purpose for the culminating reflection.

We have learned a lot about what makes things move in different ways. One of the things that engineers do is think back and describe the new things they have learned so they can understand and remember them better.

2. Read aloud the Unit Question. Remind students that when they started to learn about pushes and pulls they set out to figure out a really big question.

Why do things move in different ways?

All the questions we have asked in the unit and the learning we did to answer them were also helping us answer the big question.

3. Set expectations for the gallery walk. Explain to students that you have set up objects around the classroom and organized them by chapter. Describe how student partners will rotate to visit the stations for a minute or so, talking with their partner about each one before coming back to discuss as a class.

Model picking up and discussing the artifacts at a station by highlighting one object.

At this station, I see the *Talking About Forces* book. I remember how it was about different kids pushing and throwing and kicking things. We visualized how things moved and we learned about how forces are pushes and pulls.

4. Assign partners and begin the gallery walk. Allow students about one minute at each station. Circulate and listen for examples of learning activities that students are discussing that you would like to highlight in the whole-class discussion.

5. Gather students together in the discussion area.

We just walked around the class and looked at all these things we used to learn about pushes and pulls! What is something that you remember using? What did you learn from it?

After students have shared, highlight instances of how students read, talked, wrote, investigated, and visualized, just like scientists and engineers do.

You used all those activities to help figure out why objects move in different ways!

6. Refer to the What Engineers Do chart.

We worked as engineers to learn about new ideas and use what we learned to help us design a solution to our pinball machine problem.

7. Refer to the What We Know About Forces chart.

As we learned new things, we wrote down what we figured out on this chart.

All of the things we learned helped us figure out an answer to our big question: *Why do things move in different ways?*

8. Lead Shared Listening about forces.

Why do things move in different ways?

Partner A will share while Partner B listens. Partner B will show they were listening carefully by telling Partner A what they heard them say. Then Partner B will share while Partner A listens. Partner A will show they were listening carefully by telling Partner B what they heard them say.

After students have shared with partners, invite several students to share what they know about why things move in different ways.

9. Summarize the ideas students have learned about the work that engineers do.

We have learned that scientists and engineers look for causes and effects to explain how things happen. We have learned about what engineers do to learn new ideas to help them solve problems and how engineers work to design and test their solutions.

10. Direct students in a paired self-assessment.

We have figured out so many new ideas about forces and movement!

Take a moment to share with your partners. What is one idea that you know now that you did not know before?

Have students share with their partner one thing they have learned. Have their partner listen attentively, then have students trade roles.

After students have shared with partners, invite several students to share what they have learned with the class.

11. Conclude the unit. Congratulate students on all they have done and learned. Reinforce that they have discovered many new ideas about forces and movement in their roles as engineers. Let students know that their engineering skills will help them in the future as they continue to design solutions to new problems.

Teacher Support

Instructional Suggestion

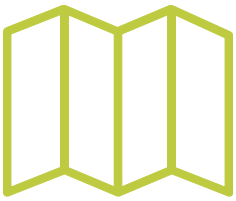
What One Teacher Did: Extended Unit Reflection
One teacher decided to follow the gallery walk with a discussion of the activities and learning of each chapter. Students first referred to the artifacts from each chapter to review what they remembered about the activities. They then used the Shared Listening routine to answer each Chapter Question. The gallery walk and subsequent reflection took place on a separate day from the other activities as a culminating celebration of the unit.

Instructional Suggestion

Classroom Management: Using a Checklist
One way to help students be accountable for visiting all the stations during the gallery walk is to provide them with a checklist to use as they walk to the stations. On the checklist, you can use icons or color coding to help students match the station they are visiting to each checklist item. As students visit and discuss at each station, have them check off that station on the checklist.

Rationale

Pedagogical Goals: Student Self-Assessment
An important part of students learning to learn well is developing a sense of their own ideas and thinking. Providing regular opportunities for even very young students to think about their own learning can help develop students' habits of self-reflection, as well as support the development of their own theory of mind. This is the last time that students have the opportunity to share in pairs at least one idea that they have learned that they didn't know before.



Lesson 6.3

End-of-Unit Assessment

Lesson Overview

Students' Explanations

The End-of-Unit Assessment for the *Pushes and Pulls* unit is a one-on-one conversation between the teacher and individual students about various movements in the Class Pinball Machine. The teacher briefly plays the Class Pinball Machine, making the ball move in several specific ways. Students are asked to explain the different movements, accounting for different directions, distances, and changes in direction. The teacher follows up with probing questions as necessary. Students are also asked to describe an example of cause and effect. The purpose of these conversations is to gather detailed evidence of each student's three-dimensional understanding of unit-specific science concepts, the crosscutting concept of Cause and Effect, and the practice of constructing explanations and designing solutions. Plan on each one-on-one conversation taking approximately 10–15 minutes. One-on-one conversations may be scheduled across the week following the end of the unit.

Anchor Phenomenon: Pinball machines allow people to control the direction and strength of forces on a ball.

Students learn:

- We can find evidence of a force being exerted on an object by seeing if an object starts to move, stops moving, or changes direction.
- Scientists and engineers communicate their ideas to others.

Lesson at a Glance

ACTIVITY 1

Talking with Students About the Pinball's Movement
The teacher meets with students individually and plays the Class Pinball Machine. Students explain how the different movements are caused by different forces and then identify cause and effect.

TEACHER-LED DISCUSSION

Materials & Preparation

Materials

For the Class

- Class Pinball Machine

Preparation

Before the Day of the Lesson

1. **Prepare the Class Pinball Machine.** Set up the Class Pinball Machine with the launcher at the bottom and one bumper in the upper left corner. Refer to End-of-Unit Assessment Class Pinball Machine Setup (located in Digital Resources) as a guide.
2. **Practice the two movements used in the assessment.** During the assessment, you will launch the ball in the two ways shown in End-of-Unit Assessment Class Pinball Machine Setup (located in Digital Resources). The first launch should go to the right and travel a short distance. The second should go to the left and bounce off the bumper in the upper left corner. Consistently achieving angled launches using the launcher can be tricky—if necessary, you can also reposition the shoelace between launches so that it angles the ball right for the first launch and left for the second. For either method, you will need to be able to create the movements reliably.
3. **Print out and review End-of-Unit Assessment Questions.** Print out this list of questions (in Digital Resources) so you can have it on hand when you conduct your one-on-one conversations with students.
    - This document includes the questions that appear in Activity 1. By providing all questions and follow-up prompts in this document, you can avoid reading from your computer during the one-on-one conversations.
    - Preview Activity 1 before you conduct your assessment conversations so you can see all questions and possible student responses in one place.
4. **Review Assessment Guide: Assessing Students' End-of-Unit Explanations About the Movement of the Pinball in the Class Pinball Machine.** Familiarize yourself with the Assessment rubrics included in this Assessment Guide (in Digital Resources). After this lesson, when you review students' explanations, you can refer to the rubrics to see what you can learn about how well students were able to apply all they learned over the course of the unit.

VOCABULARY

- exert
- force
- direction
- distance

DIGITAL RESOURCES

Assessment Guide: Assessing Students' End-of-Unit Explanations About the Movement of the Pinball in the Class Pinball Machine

End-of-Unit Assessment Questions

End-of-Unit Assessment Class Pinball Machine Setup

- **Prepare a way to record notes about students' explanations.** Create a table in which to record notes about each student's explanation or simply record notes on separate sheets of paper, one for each student. You might also consider audio recording for a more detailed record of your conversations.

5. **Prepare a location for assessment conversations.** Choose a location where you and your students will be able to sit and talk in relative quiet and privacy.
    - Make sure that you will be able to sit next to the student with the Class Pinball Machine between or in front of you. You will need to be able to see both and point to the machine.

6. **Make a plan for conducting the one-on-one assessment conversations.** In whatever way will fit well with your classroom routines and procedures, make a plan for when you will talk with students and in what order. While it is important to assess young learners in a timely manner, the visual supports included in this assessment are designed to support students in remembering their work in the unit. As such, not all conversations need to happen on one day—conversations can be scheduled across the week following the end of the unit. An adult who is familiar with the unit, such as a classroom aide or someone else who was frequently present during lessons in this unit, can help with conducting these one-on-one conversations.
    - Make sure that other students have something to do while you are conducting the one-on-one conversations. One way is to use the unit materials to set up science centers. Example centers could include a center that allows students to further investigate their Box Models, another center could extend students experiences with the Explanation Language Frames and cards, and another center could have student pairs work with unit books, either rereading the text, discussing the pictures, or as inspiration to draw their own pictures of forces at work.

7. **Plan for students who need accommodations.** There may be students in your class who have individualized educational plans and require assessment modifications. If a student in your class requires additional time or another modification, you may want to come up with a plan for that student before this end-of-unit-assessment conversation. For example, you may want to have a student's aide support the student's participation in the conversation or provide other modifications as appropriate. For more information about modifying assessments for students with disabilities, see the note in the Differentiation section titled "Specific strategies to support students with disabilities.

At the End of the Day

1. **Review students' explanations.** While the one-on-one assessment conversations are still fresh in your mind, review your notes and refer to the rubrics in Assessment Guide: Assessing Students' End-of-Unit Explanations About the Movement of the Pinball in the Class Pinball Machine to assess students' explanations.

Differentiation

Embedded Supports for Diverse Learners

Teacher prompts. Providing verbal and visual cues helps students formulate their oral explanations. Before you invite students to explain the different forces that made the pinball move, you will model the kind of language that students have been practicing. Probing questions are provided for you to follow up with students who may need additional prompts to discuss their observations.

Familiar context for assessment. The context of the one-on-one assessment conversations positions students in the familiar role as pinball engineers and with the familiar task of observing the movement of objects in the Class Pinball Machine. Students are invited to share their observations and explain cause–and–effect relationships between the different forces that made the pinball move.

Potential Challenges in This Lesson

Discussion-focused. During the one-on-one assessment conversations, students will provide oral explanations. Despite many embedded supports, some students may require additional assistance to explain their ideas and identify a cause and effect. Consider who those students might be and how to provide additional scaffolding.

Specific Differentiation Strategies for English Learners

Physical materials to reference and kinesthetic response during discussion. Using physical materials can make it easier and more concrete for English learners to understand and respond to the prompts in the one-on-one assessment conversation. You can invite students to enhance their oral explanations by pointing, using hand signals, or using other kinesthetic responses that may make it easier for English learners to communicate their explanations.

Specific Differentiation Strategies for Students Who Need More Support

Discussing cause and effect. Some students may require additional assistance explaining their ideas about cause–and–effect relationships. Remind students that cause and effect is when one thing makes another thing happen. Ask students what is causing something to happen and what happened because of something. Then, you can recast students' responses, by using the language of cause and effect (e.g., __ *because* ___.).

Specific strategies to support students with disabilities. Accommodations and modifications play important roles in helping students with disabilities demonstrate what they know and can do. There may be students in your class who have Individualized Educational Plans (IEPs) or 504 Plans and require assessment accommodations or modifications. Accommodations (including alternate ways of presenting knowledge, responding to questions, additional time, or a change in location or scheduling of the assessment) do not reduce the learning or performance expectations. They allow students with disabilities to complete the assessment so that they are provided equitable access to the assessment. If a student in your class requires additional time or another accommodation, you may want to come up with a plan for that student before administering this End-of-Unit Assessment. For example, you may want to have a

student's aide support that student's participation in the on-on- one conversation or provide other accommodations as appropriate. On the other hand, modifications that adjust the assessment and change what is expected or measured should be used with caution, as they alter, lower, or reduce learning expectations for students with disabilities.

Specific Differentiation Strategies for Students Who Need More Challenge

Discussing cause and effect with more independence. After you have conducted the one-on-one conversations, suggest that students share their explanations with greater independence. Invite another class to observe students' designs as students explain the cause–and–effect relationship between forces and motion. Alternatively, you could have students draw and write their explanations and then share them with another adult in your school.

Standards

Key
Practices Disciplinary Core Ideas Crosscutting Concepts

3-D Statement

The teacher plays the Class Pinball Machine with individual students, moving the ball in specific ways to assess each student's ability to provide an example of cause and effect and construct explanations about the forces that made the pinball move, accounting for different directions, distances, and changes in direction (cause and effect; scale, proportion, and quantity; structure and function).

Next Generation Science Standards (NGSS)

NGSS Practices

- **Practice 6:** Constructing Explanations and Designing Solutions
- **Practice 8:** Obtaining, Evaluating, and Communicating Information

NGSS Disciplinary Core Ideas

- **PS2.A: Forces and Motion**:
  - Pushes and pulls can have different strengths and directions. (K-PS2-1, K-PS2-2)
- **PS2.A: Forces and Motion**:
  - Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1, K-PS2-2)
- **PS2.B: Types of Interactions**:
  - When objects touch or collide, they push on one another and can change motion. (K-PS2-1)

- **PS3.C: Relationship Between Energy and Forces**:
  - A bigger push or pull makes things speed up or slow down more quickly. (K-PS3.C)
- **ETS1.A: Defining and Delimiting Engineering Problems**:
  - Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)

NGSS Crosscutting Concepts

- Cause and Effect
- Scale, Proportion, and Quantity
- Structure and Function

Common Core State Standards for English Language Arts (CCSS-ELA)

- **CCSS.ELA-LITERACY.SL.K.4:** Describe familiar people, places, things, and events and, with prompting and support, provide additional detail.

Common Core State Standards for Mathematics (CCSS-Math)

CCSS-Math Practices

- **CCSS.MATH.PRACTICE.MP1:** Make sense of problems and persevere in solving them.
- **CCSS.MATH.PRACTICE.MP2:** Reason abstractly and quantitatively.

CCSS-Math Content

- **CCSS.MATH.CONTENT.K.MD.1:** Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.
- **CCSS.MATH.CONTENT.K.MD.2:** Describe and compare measurable attributes. Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference.
- **CCSS.MATH.CONTENT.K.G.1:** Identify and describe shapes. Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.

1 TEACHER-LED DISCUSSION
Talking with Students About the Pinball's Movement

Talking with Students About the Pinball's Movement

The teacher meets with students individually and plays Class Pinball Machine. Students explain how different movements are caused by forces.

Instructional Guide

1. Have students sit with you, one at a time, with the Class Pinball Machine between you.

2. Introduce the task—talking about forces exerted on the pinball. Point to the Class Pinball Machine.

We have learned a lot about how different kinds of forces make things, like the pinball, move in different ways. I am going to make the pinball move in our Class Pinball Machine, and I would like you to think and talk to me about the forces that are making the ball move.

3. Launch the pinball so it moves in two different ways.

- **First launch:** Use the launcher to launch the pinball very gently to the right, making it move a short distance but not reach any of the bumpers.
- **Describe and trace the movement.** Trace the path of the pinball with your finger as you describe what you did.

We saw the pinball move a short distance toward this side of the pinball machine, and then it stopped.

- **Second launch:** Launch the pinball a second time so it moves to the left, hits the bumper, and bounces off in another direction.
- **Describe and trace the movement.** Trace the path of the pinball with your finger as you describe what you did.

We saw the pinball move a long distance toward the other side, then it moved this way, and then it stopped.

4. Prompt the student to explain the forces that were exerted.

Talk to me about the different forces that made the pinball move like it did.
[The first time, the pinball moved a short distance toward this side of the machine because the launcher exerted a gentle force on the ball toward this side.]
[The second time, the pinball moved a long distance toward that side of the machine because the launcher exerted a strong force in that direction. The ball changed direction because the bumper exerted a force on the ball when the ball hit the bumper.]

5. Ask follow-up questions to probe for ideas that students did not explain. If students do not mention ideas that were the focus of the unit, they may still have some understanding of those ideas, even if they did not independently use them in their explanations. You can ask the following questions to probe for ideas that students did not include.

If the student does not mention the force from the bumper:

Were there any forces exerted on the ball after I launched it the second time? Why do you think so?
[Yes, the bumper exerted a force on the ball. I think so because the ball changed direction.]

If the student does not mention the direction of forces:

Why did the ball move in this direction when I pulled the launcher and in that direction after the ball hit the bumper?
[The launcher exerted a force on the ball. When the ball hit the bumper, the bumper exerted a force on the ball and made it change direction.]

If the student does not mention the strength of forces:

Why did the ball move only a short distance the first time but a long distance the second time?
[The first time, the launcher exerted a gentle force, so the ball only moved a short distance. The second time, the launcher exerted a strong force, so the ball moved a long distance, and then it hit the bumper.]

6. Prompt the student to give an example of cause and effect in the pinball's motion. Remind the student that cause and effect means something happens because another thing caused it.

Think about how the ball moved in the pinball machine. Can you describe an example of cause and effect?
[The ball moved a long distance because the launcher exerted a strong force on it.]

If the student has difficulty giving an example:

Can you use the word *because* to explain what made the ball move the way it did?
[The ball changed direction because the bumper exerted a force on it.]

If the student still has difficulty giving an example, launch the pinball one more time and provide the following scaffolding:

What caused the ball to move?
[The launcher.]

What happened to the ball when the launcher hit it?
[The ball started to move.]

How can we use the word *because* to explain what happened?
[The ball started to move because the launcher hit it.]

7. Prompt the student to provide evidence of the strength of a force. Launch the pinball two more times—the first time very gently so the ball moves only a short distance; the second time with a stronger force so the ball moves a longer distance.

I launched the ball two times. Which time do you think the force was stronger—the first time or the second time?
[The second time.]

What is your evidence that that force was stronger?
[The ball went a longer distance.]

If the student is not sure how to respond:

What did you see that made you think the force was stronger?
[The ball went a longer distance.]

8. Conclude the assessment conversations. Have students return to their seats after the one-on-one assessment conversations. Record any final notes about their explanations.

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