

# Pushes and Pulls

## Teacher Guide



push



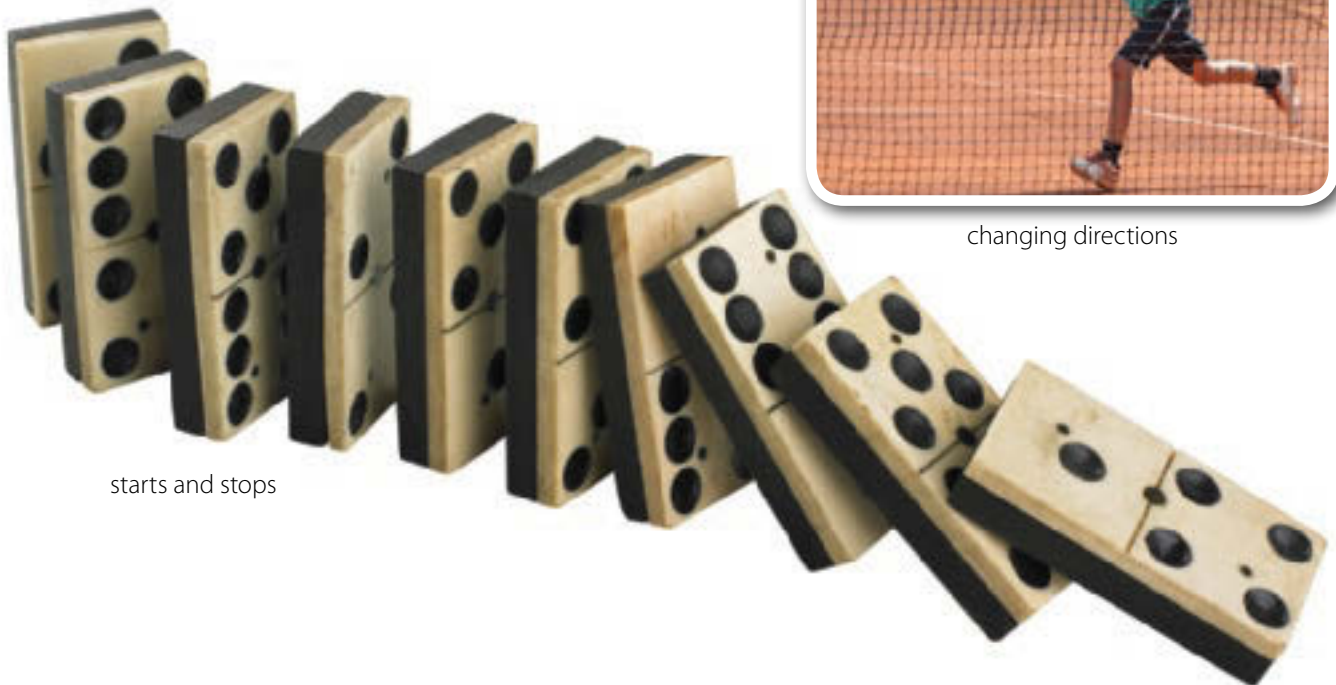
designing things that move



pull



changing directions



starts and stops



# Pushes and Pulls

## Teacher Guide



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**Pushes and Pulls**  
**Teacher Guide**  
Core Knowledge Science™ K

# Introduction

### ABOUT THIS UNIT

#### The Big Idea

This unit focuses on the scientific concept of using pushes and pulls to put objects in motion, increase or decrease the object's speed, change direction, or stop motion.

Students are familiar with various games that involve the movement of objects, such as a ball. They may not make the connection that the motion of a ball is affected by the strength and direction of pushes and pulls on the ball. Students will explore this concept with both visible and invisible pushes and pulls, contact and noncontact forces. They will recognize that motion is affected by the strength and direction of pushes and pulls, the characteristics of objects, and the surface on which objects are moved. Students will learn how motion changes and develop an understanding that pushes and pulls of all different types are the cause of all changes in movement.

In this unit, students investigate what causes changes in motion by exploring pushes and pulls. Students will then use prior knowledge and information gained from their observations during various tests to design a miniature golf course. Students explore concepts that include the following:

- Pushes and pulls can have different strengths and directions.
- Pushing and pulling on an object can change the speed or direction of its motion and can start or stop it.

Engineers and engineering designers use knowledge of forces and motion as they develop solutions to problems and make things that are useful to people. This series of lessons incorporates learning goals that support the principles and practices of engineering design, such as defining problems and evaluating and optimizing possible solutions.



## Note to Teachers and Curriculum Planners

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This unit introduces Grade K students to real-world examples and fundamental concepts of forces, which will be explored in greater depth in later grades. Students will learn about the different strengths and direction of pushes and pulls, learn that pushing and pulling on an object can change the direction and speed of its motion, and explore how forces are associated with cause-and-effect relationships. The following are preliminary considerations for planning and instruction relative to this unit:

- While the unit involves Grade K students in exploring strength and direction of push and pull forces, it does not include exploring direction and strength at the same time. However, understanding of how and why objects move is investigated.

The energy of motion is explored in greater depth in Grade 4 Unit 1, *Energy Transfer and Transformation*. Grade 4 students extend their learning of motion and forces to investigate collisions between objects.

## Note to Core Knowledge Teachers

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Thanks to ongoing research in the field, our understanding of how children learn continues to evolve. In the subject area of science, students benefit from not just reading about concepts and ideas, but from hands-on experiences. Following the release of the Next Generation Science Standards (NGSS), the Core Knowledge Foundation used this opportunity to update and enhance the science portion of the *Core Knowledge Sequence*.

While there have been some shifts in the grade levels at which certain topics are recommended, the fundamental principles of pedagogy inherent to the Core Knowledge approach, such as the importance of building a sequential, coherent, and cumulative knowledge base, have been retained.

### Online Resources



To learn more about the changes and to access resources for this unit, please use the links found in the Online Resources Guide.

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

This science unit embodies Core Knowledge's vision of best practices in science instruction and knowledge-based schooling, such as the following:

- building students' knowledge of core ideas in life, physical, and Earth sciences, as well as engineering design
- developing scientific practices that give students firsthand experience in scientific inquiry, engineering, and technology
- connecting scientific learning to concepts across various disciplines, such as mathematics and literacy



## What are the relevant NGSS Performance Expectations for this unit?\*

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This unit, *Pushes and Pulls*, has been informed by the following Grade K Performance Expectations for the NGSS topic *Pushes and Pulls*. Students who demonstrate understanding can do the following:

**K-PS2-1** Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

**K-PS2-2** Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

### Online Resources



For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

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\*NEXT GENERATION SCIENCE STANDARDS (NGSS) is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards were involved in the production of this product, and their endorsement is not implied.

### Sources:

NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

National Research Council. 2012. *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on a Conceptual Framework for New K–12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

### A Special Note to Kindergarten Teachers Before Starting This Unit

#### Why Study Science in Kindergarten?

For many Kindergarten teachers, the suggestion that science should be a part of the Kindergarten curriculum may seem questionable. For many teachers, the instructional time is devoted to teaching reading and math fundamentals to students.

The study of science in Kindergarten, however, is consistent with the Core Knowledge approach to learning. Learning science provides students with the experiences necessary to accelerate an almost innate sense of excitement and wonder about the natural world around them. Now is the time they can grasp a more precise language, one that allows them to describe the living and nonliving environment they encounter every day.

Albert Einstein said, “Curiosity has its own reason for existing.” It is the nature of children to be curious about the world around them, and Kindergarten is the right time to witness, promote, and accelerate that curiosity in a systematic way.

Teaching science to young children affords them the opportunity to take a deeper look at the world around them. Most young students’ scientific knowledge is derived from their personal experiences, that is, from interactions with the air, water, land, and matter around them. All these lead to a student’s wonder about life, earth, space, and physical science.

#### Before Starting *Pushes and Pulls*

Students come to Kindergarten classrooms across the country with a wide range of prior experiences. Some students have attended preschool, while others have not. Some have grown up in cities away from nature. Others have grown up in the country, intimately involved in nature.

Some have had teachers and/or family members who have been reading aloud and sharing the wonderful world of animals and plants with them for several years, while others have not. Some have traveled to other cities, states, and countries, while others may know only their own family and neighborhood.

Draw out students. Give them the opportunity to express what they know about the natural world, about rocks, the stars, motion, giraffes, or matter. You can assess the prior knowledge students have about science, and since science deals with everything around a child, the wealth of their background in science should not be underestimated.

*Pushes and Pulls* is one of four units in the Kindergarten CKSci series that we encourage teachers to use over the course of the school year. Kindergarten

teachers who begin the year with a unit will have time to complete all four of the Kindergarten CKSci units in an academic year. Additional guidance regarding pacing is provided in each CKSci Teacher Guide.

## What Students Need to Learn

For this unit, the Core Knowledge Science Sequence specifies the following content and skills. Specific learning objectives are provided in each lesson segment throughout the unit. NGSS References, including Performance Expectations, Disciplinary Core Ideas, and Crosscutting Concepts, are included at the start of each lesson segment as appropriate.

### Lesson 1. Pushing and Pulling

SEGMENTS 1–5

- Observe and describe different types of motion.
- Relate the effect of different pushes and pulls to the motion of objects.
- Compare different pushes and pulls on different objects.
- Explore changing the direction of the motion of objects.

### Lesson 2. Changing Motion of Objects with Pushes and Pulls

SEGMENTS 1–4

- Identify the effects of different types of pushes and pulls on speed and direction.
- Explain the effects of different types of pushes and pulls on the motion of objects.
- Describe collisions as events that stop or change the direction of objects in motion.
- Construct a solution to the problem of how to demonstrate the effects of different pushes and pulls on the motion of an object.

### Lesson 3. Magnetism: A Noncontact Force

SEGMENTS 1–3

- Describe noncontact pushes and pulls caused by gravity and magnetism.
- Identify the effects of invisible pushes and pulls on the motion of objects.
- Explain everyday uses of invisible forces.
- Construct a solution to the problem of how to demonstrate the effects of invisible pushes and pulls on the motion of an object.

## What Teachers Need to Know

Supportive information on the content standards and the science they address is provided throughout the lessons at points of relevance:

**Know the Standards:** These sections, found later in this Teacher Guide, explain what to teach and why, with reference to NGSS and Core Knowledge expectations, as well as connections to relevant math and reading language arts standards.

**Know the Science:** These sections provide supporting, adult-level, background information or explanations related to specific science concepts, examples, or Disciplinary Core Ideas.

## USING THE STUDENT BOOK

Student Book



The *Pushes and Pulls* Student Book includes six chapters, intended to be read aloud by the teacher as the students look at images on each page.

As you will note when you examine the Student Book, minimal text is included on each page. Instead, colorful photos and engaging illustrations dominate the Student Book pages. The design of the Student Book in this way is intentional because students in Kindergarten–Grade 2 are just learning to read. At these grade levels, students are learning how to decode written words, so the complexity and amount of text that these young students can actually read is quite limited.

While some advanced students may be able to read words on a given page of the Student Book, as a general rule, students should not be expected or asked to read aloud the text on the Student Book pages. The text in the Student Book is there so that teachers and parents can read it when sharing the Student Book with students.

The intent of the Grades K–2 CKSci lessons is to build students' understanding and knowledge of science concepts, as well as of associated practices and skills. It is for this very reason that in Grades K–2 CKSci, the core content of each lesson is reinforced to students using a teacher Read Aloud, accompanied by example images and diagrams. Cognitive science research has clearly documented the fact that students' listening comprehension far surpasses their reading comprehension well into the late elementary and early middle school grades. Said another way, students are able to understand and grasp far more complex ideas and text that they hear read aloud than they would ever be able to read or comprehend when they read to themselves. For a more thorough discussion of listening and reading comprehension and the underlying cognitive science research, teachers may want to refer to Appendix A of the Common Core State Standards for English Language Arts, noting in particular the Speaking and Listening section of the appendix.

Use this link to download the CKSci Online Resources for this unit, where the specific link to this appendix can be found:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## Pacing

The *Pushes and Pulls* unit is one of four units in the Grade K CKSci NGSS series. To meet NGSS Performance Expectations we encourage teachers to complete all units during the school year. To be sure all NGSS Performance Expectations are met, each Core Lesson segment should be completed, and each requires thirty to forty-five minutes of instruction time. The time it takes to complete a full lesson depends on class size and individual circumstances.

Within the Teacher Guide, each Core Lesson is composed of multiple numbered segments, generally four to six. Each segment concludes with a Check for Understanding, providing the teacher with an opportunity for formative assessment. At the end of this unit Introduction, you will find a blank Pacing Guide on pages 15–16, which you may use to plan how you might pace the lessons, as well as when to use the various other resources in this unit. We strongly recommend that you preview the unit in full before beginning and create your pacing guide before teaching the first lesson. As a general rule, we recommend that you spend no more than twenty-four days teaching the *Pushes and Pulls* unit so that you have time to teach the other units in the Grade K CKSci series.

## The Core Lessons

- Lesson time: Each Core Lesson segment constitutes one classroom session of thirty to forty-five minutes. Some activities and performance tasks will require setting aside a longer block of time.
- Lesson order: The lesson segments are coherently sequenced to build from one to the next, linking student engagement across lessons and helping students build new learning on prior knowledge.

<b>Unit Opener: Introduction to the Unit Phenomenon and Problem</b>	<b>Unit Opener: Pushes and Pulls</b>	<b>Big Question: How can pushes and pulls change the motion of objects?</b>
<b>Lesson 1: Pushing and Pulling</b> (K-PS2-1)	<b>1.1</b> Pushing and Pulling	<b>Lesson 1 Guiding Question:</b> What do pushes and pulls do?
		<b>1.1</b> What happens when something moves?
	<b>1.2</b> Types of Pushes and Pulls (two class sessions)	<b>1.2</b> What happens when you push or pull different objects in different ways?
	<b>1.3</b> Motion Everywhere	<b>1.3</b> How can I describe pushes and pulls?
	<b>1.4</b> Changing Direction	<b>1.4</b> What happens when you push or pull different objects in different ways?
	<b>1.5 Lesson 1 Roundup:</b> Different Pushes and Pulls	<b>1.5</b> What do pushes and pulls do?

<b>Lesson 2: Changing Motion of Objects with Pushes and Pulls</b> (K-PS2-2)	<b>2.1</b> Starting and Stopping	<b>Lesson 2 Guiding Question:</b> How do pushes and pulls change motion?
		<b>2.1</b> How are pushes and pulls related to the starting and stopping of moving things?
	<b>2.2</b> Golf Pushes and Pulls	<b>2.2</b> How do pushes and pulls change motion in a miniature golf course?
	<b>2.3</b> Pushes and Pulls Everywhere (two class sessions)	<b>2.3</b> How do pushes and pulls change motion?
	<b>2.4 Lesson 2 Roundup:</b> Tee Time	<b>2.4</b> Does our miniature golf course change the speed and direction of a ball the way we planned it to?
<b>Lesson 3: Magnetism: A Noncontact Force</b> (K-PS2-2)	<b>3.1</b> No-Touch Forces	<b>Lesson 3 Guiding Question:</b> Can objects that are not touching push and pull each other?
		<b>3.1</b> How can magnets push and pull?
	<b>3.2</b> Invisible Pushes and Pulls	<b>3.2</b> What are some invisible pushes and pulls?
	<b>3.3 Lesson 3 Roundup:</b> Invisible Tee Time	<b>3.3</b> How can we use invisible pushes and pulls to improve our miniature golf course?
<b>Unit Supplement</b>	Science in Action (two class sessions)	Who are some people who work in this type of science, and what do they do?

## Activity Pages

### Activity Pages



AP UO.1  
AP 1.1.1  
AP 1.2.1  
AP 1.2.2  
AP 1.3.1  
AP 1.4.1

Black line reproducible masters for Activity Pages and a Unit Assessment, as well as an Answer Key, are included in Teacher Resources on pages 140–157. The icon shown to the left appears throughout the Teacher Guide wherever Activity Pages (AP) are referenced.

The Activity Pages can be organized into a learning portfolio for each student to demonstrate their progress relative to NGSS expectations and as student work products.

Make sufficient copies for your students in advance of each lesson segment.

Unit Opener—Motion (AP UO.1)

Lesson 1—Pushing and Pulling (AP 1.1.1)

Lesson 1—Push and Pull (AP 1.2.1)

Lesson 1—Pushing Shapes (AP 1.2.2)

Lesson 1—A Push or a Pull? (AP 1.3.1)

Lesson 1—Changing Direction (AP 1.4.1)



- Lesson 1—Hitting the Spot (AP 1.5.1)
- Lesson 2—Start and Stop (AP 2.1.1)
- Lesson 2—My Miniature Golf Hole Plan (AP 2.2.1)
- Lesson 2—My Miniature Golf Hole (AP 2.2.2)
- Lesson 2—Push Me or Pull Me? (AP 2.3.1)
- Lesson 2—Tee Time (AP 2.4.1)
- Lesson 3—Magnetic or Not? (AP 3.1.1)
- Lesson 3—Invisible Pushes and Pulls (AP 3.2.1)
- Lesson 3—Invisible Tee Time (AP 3.3.1)

## Online Resources for Science

### Online Resources



For each CKSci unit, the Teacher Guide includes references to online resources (including external websites and downloadable documents) to enhance classroom instruction. Look for the icon on the left.

Use this link to download the CKSci Online Resources for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

The Online Resources Guide also links to lists of additional recommended children's books that support the content of this unit.

## Teaching Strategies

### Start with the familiar.

Lead with an experience. Begin each lesson with a demonstration, activity, or question about a phenomenon to engage students and focus their attention on the topic. Start with the familiar. Every science topic introduced to students relates in some way to their known world and everyday experiences. The purpose of every lesson is to build a bridge between what is familiar to students and broader knowledge about the way the world works.

### Ask driving questions.

The unit is governed by a Big Question, related to the unifying phenomenon. Each multipart lesson is built around a lesson Guiding Question. And then at the beginning of each Teacher Guide lesson segment, you will find a driving question and Core Lesson segment devoted to encouraging students to think about this question as they are introduced to new science content. Use this opportunity to engage students in conversation, to think about how their own real-world experiences relate to the topic, or to participate in a demonstration that relates to the driving question.



<b>Encourage scientific thinking.</b>	<p>Approach the lessons with students not as learning about science, but as learning about the world with a scientific mind. Science learning models science practice.</p> <p>Throughout the lessons, encourage students to ask questions about what they observe, do, and read. Record relevant questions in a prominent place in the classroom. Guide students back to these questions as opportunities to answer them emerge from readings, demonstrations, and activities.</p>
<b>Use continuous Core Vocabulary instruction.</b>	<p>During instruction, emphasize Core Vocabulary terms and their meanings in context rather than relying on isolated drill for memorization of definitions. Through scaffolded questioning, encourage students to come up with definitions in their own words and to use the words in their own sentences.</p> <p>Core Vocabulary words for each lesson, as well as Language of Instruction, other key terms teachers are encouraged to use in discussing topics with students, are provided at the start of each lesson. You can find Core Vocabulary and Language of Instruction definitions in the Glossary on pages 158–159.</p>
<b>Emphasize observation and experience.</b>	<p>Lessons employ various ways for students to learn, including watching, listening, reading, doing, discussing, and writing. To meet the NGSS Performance Expectations, which are multidimensional standards, students must not only gain factual knowledge associated with Disciplinary Core Ideas, but also use the content knowledge they acquire.</p>
<b>Use science practices.</b>	<p>Give students opportunities to discover new content knowledge through investigation and to use their new knowledge both in problem-solving exercises and as evidence to support reasoning. Students learn what science and engineering practices are by engaging in those same practices as they learn.</p>
<b>Make frequent connections.</b>	<p>Use a combination of demonstrations and reading materials, rich with examples, to help students recognize how the science concepts they are learning apply in their everyday lives. Prompt students to relate lesson content to their own experiences, to relate the new and unfamiliar to the familiar, and to connect ideas and examples across disciplines. Refer to the Crosscutting Concepts cited in the lessons, often included in the NGSS References listed at the start of each lesson.</p>
<b>Monitor student progress.</b>	<p>Use verbal questioning, student work, and the Check for Understanding assessments at the end of each lesson to monitor progress during each lesson and to measure understanding at the conclusion of the unit. Many lessons provide tips to help you support students who need further explanations or clarifications.</p>

## Instructional Design

The unit is composed with several integrated features that support three-dimensional learning for all students and development for teachers. Within each lesson, icons appear in the column to the left to indicate certain features in the instructional support.

<b>Differentiation</b>	<p>Adjustments to instruction appear in the text, indicated by <b>SUPPORT</b>, <b>EXTEND</b>, and <b>CHALLENGE</b> notations.</p> <p><b>SUPPORT</b>—Reading, writing, listening, and/or speaking alternatives appear for students who are English language learners, have special needs, or read below the grade level. Extra support is suggested for students who struggle to meet targeted expectations.</p> <p><b>EXTEND</b>—Extensions are suggested for students with high interest or who have already met the performance expectations.</p> <p><b>CHALLENGE</b>—Additional, relevant, and interesting exercises are suggested for students to explore that exercise math, reading, or science skill/comprehension that pushes beyond the grade level.</p>
<b>Teacher Development</b>	Information in the instructional text, Know the Science boxes, and Know the Standards boxes is provided to support ongoing teacher development with regard to both content and the teaching process.
<b>Monitor Progress</b>	Opportunities for formative assessment appear throughout the instructional support. These instances are most consistently noted in a Check for Understanding that concludes each lesson segment.
<b>Math Connection</b>	Connections to math standards are highlighted in the instructional text and in Know the Standards boxes.
<b>Language Arts Connection</b>	Connections to Reading and Language Arts standards are highlighted in the instructional text and in Know the Standards boxes.
<b>Building Progressions</b>	Prior expected student learning and how the prior learning will be built upon are explained throughout the instructional support and in Know the Standards boxes.



DCI  
SEP  
CCC  
PE

Opportunities for students to develop and use specific elements of NGSS Disciplinary Core Ideas (DCI), Science and Engineering Practices (SEP), and Crosscutting Concepts (CCC) are highlighted throughout the instructional support text.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit. Use the following link to download any of the CKSci Online Resources Guides:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

### Icon Key:

**DCI PS2.A** Forces and motion

**DCI PS2.B** Types of interactions

**DCI PS3.C** Relationship between energy and forces

- SEP 1** Asking questions (for science) and defining problems (for engineering)
- SEP 2** Developing and using models
- SEP 3** Planning and carrying out investigations
- SEP 4** Analyzing and interpreting data
- SEP 5** Using mathematics and computational thinking
- SEP 6** Constructing explanations (for science) and designing solutions (for engineering)
- SEP 7** Engaging in argument from evidence
- SEP 8** Obtaining, evaluating, and communicating information
- CCC 1** Patterns
- CCC 2** Cause and effect
- CCC 3** Scale, proportion, and quantity
- CCC 4** Systems and system models
- CCC 5** Energy and matter: flows, cycles, and conservation
- CCC 6** Structure and function
- CCC 7** Stability and change

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3D Learning

Student performance in a given task related to making sense of a phenomenon or designing a solution requires integrated elements of the SEPs, CCCs, and DCIs. At certain points of instruction, the Teacher Guide identifies when all three dimensions are integrated for student learning and as support for the teacher.

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## Effective and Safe Classroom Activities

Online Resources



Conducting safe classroom demonstrations and activities is essential to successful elementary science education. The following resources provide Core Knowledge's recommendations for developing effective science classroom activities.

These resources, included at the back of the Teacher Guide on pages 160–164, consist of the following:

- Classroom Safety for Activities and Demonstrations
- Strategies for Acquiring Materials
- Advance Preparation for Activities and Demonstrations
- What to Do When Activities Don't Give Expected Results

These resources may also be accessed within the CKSci Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## MATERIALS AND EQUIPMENT

The unit, like all hands-on science, requires a large variety of materials to support various ways of learning (including doing, discussing, listening, watching, reading, and writing). Prepare in advance by collecting the materials and equipment needed for all the demonstrations and hands-on investigations.

- Roll paper, poster board, or a bulletin board should be dedicated at the beginning of the unit to serve as a question board to cumulatively document and return to student questions. The question board is referred to in the materials for lesson segments in which it is used but is not repeated in the materials listed here.
- Internet access and the means to project images/videos for whole-class viewing is also required in many lesson segments but not repeated below.

### Unit Opener

- none needed

### Lesson 1 Pushing and Pulling

#### Lesson 1.1

- variety of playground or sports equipment

#### Lesson 1.2

##### Day 1

- cubes, such as toy blocks or math manipulatives (1 per student or pair)
- string (12" length per cube)
- smooth surface (access to about 24-inch length on a table or floor for each student or pair)
- rough surface (access to about 24-inch length such as a rug, place mat, or rug sample for each student or pair)

##### Day 2

- all materials from Day 1
- cubes, spheres, and triangular prisms (1 set per student or pair)
- 24-inch boards (1 per student or pair)
- books or blocks to support one end of the boards (2–3 per student or pair)
- 12-inch pans of water (1 per student or pair)

#### Lesson 1.3

- cubes, such as toy blocks or math manipulatives (1 per student or pair)
- question board

#### Lesson 1.4

- playground equipment: large and small bouncy balls

#### Lesson 1.5

- golf play set including golf club, cup, and ball
- rectangular block
- indoor golf course as shown using interlocking 1-foot square foam tiles or squares numbered 0–7

### Lesson 2 Changing Motion of Objects with Pushes and Pulls

#### Lesson 2.1

- foam balls or soft bouncy balls, such as rubber kick balls (1 per pair)
- arrange for a playground or gym space to run around

#### Lesson 2.2

- golf play set including golf club, cup, and ball (1 set per pair)
- cardboard boxes, bricks, or blocks to construct the perimeter of the hole
- cardboard boxes to serve as obstacles
- crayons

### **Lesson 2.3**

- none needed

### **Lesson 2.4**

- question board
- golf play set including golf club, cup, and ball (1 set per pair)
- cardboard boxes, bricks, or blocks to construct the perimeter of the hole
- cardboard boxes to serve as obstacles
- modeling clay or removable tape

## **Lesson 3 Magnetism: A Noncontact Force**

### **Lesson 3.1**

- variety of magnets, which can include magnetic screwdriver, refrigerator magnets, magnetic signs, magnetic pickup tool, horseshoe magnet, bar magnet (at least 1 per student)
- variety of magnetic (steel nuts, paper clips, keys, scissors, spoon) and nonmagnetic (wood block, pencil, penny, plastic bricks, marbles, aluminum foil square) objects (at least 1 per student)
- magnetic marbles (5 per student)
- box or plastic container (1 per student)

### **Lesson 3.2**

- magnetic marbles (at least 2 per student)
- bar or horseshoe magnets (2 per student)

### **Lesson 3.3**

- golf play set including golf club, cup, and ball (1 set per pair)
- cardboard boxes, bricks, or blocks to construct the perimeter of the hole
- cardboard boxes to serve as obstacles
- variety of magnets
- metal balls or magnetic marbles

### **Science in Action**

- calculator (1 per group)
- index cards (3 per group)
- marker (1 per group)
- container with lid (1 per group)
- binder clip (1 per group)
- stapler (1 per group)
- handheld hole punch (1 per group)
- tape in a dispenser (1 per group)

## PUSHES AND PULLS PACING

\_\_\_\_\_’s Class

**Note to Teacher:** *Pushes and Pulls* is intended to be taught as the first unit of Kindergarten CKSci. As a general rule, we recommend that you spend a minimum of sixteen days and a maximum of twenty-four days teaching the *Pushes and Pulls* unit so that you have time to teach the other units in the Kindergarten CKSci series.

### Week 1

Day 1	Day 2	Day 3	Day 4	Day 5

### Week 2

Day 6	Day 7	Day 8	Day 9	Day 10

### Week 3

Day 11	Day 12	Day 13	Day 14	Day 15

**Week 4**

**Day 16**                      **Day 17**                      **Day 18**                      **Day 19**                      **Day 20**

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**Week 5**

**Day 21**                      **Day 22**                      **Day 23**                      **Day 24**                      **Day 25**

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# UNIT 1

## Pushes and Pulls

### OVERVIEW

**Big Question:** How can pushes and pulls change the motion of objects?

**Anchoring Phenomenon:** Sports games are fun because of objects in motion. The driving question we explore in this unit is “How can pushes and pulls change motion of objects?” To answer this question in depth over the course of the unit, students will explore **pushes and pulls** as they construct a miniature golf course. In answering this question, students explore both visible and invisible pushes and pulls, contact and noncontact forces. They recognize that motion is affected by the strength and direction of pushes and pulls, the characteristics of objects, and the surface on which objects are moved. Students learn how motion changes and develop an understanding that pushes and pulls of all different types are the cause of all changes of movement.

**Student Book storyline:** Kamal’s scooter rolls to a stop when he stops pushing it forward. Kamal learns about pushes and pulls as he investigates how to change the motion of objects.

**Long-term project:** Students will explore pushes and pulls as they construct a miniature golf course.

### AT A GLANCE

#### Introductory Class Session Pushes and Pulls

Students explore pushes and pulls as they begin to think about what affects motion. Throughout the unit, they will use prior knowledge, observations, and hands-on experience to begin to understand how objects in motion start, stop, speed up, slow down, and change direction through direct and indirect contact. They will employ this understanding as they construct and demonstrate movement in a miniature golf course.

#### Unit Opener Objective

- ✓ Observe objects in motion.

#### NGSS References

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practice:** 1 Asking Questions and Defining Problems

**Crosscutting Concept:** 2 Cause and Effect

Students will consider different types of movement to determine their causes.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

**Language of Instruction:** The Language of Instruction consists of terms not considered a part of Core Vocabulary that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

**record**

## Instructional Activities

- class discussion
- question generation
- teacher Read Aloud

## Materials and Equipment

**Collect or prepare the following items:**

- question board

## Instructional Resources

Student Book



Ch. 1

Activity Page



AP UO.1

**Student Book, Chapter 1**

"A Scooter Race"

**Activity Page**

Motion (AP UO.1)

## THE UNIT OPENER

### 1. Introduce the Anchoring Phenomenon.

Introduce the unit by writing the **Big Question** on the board—**How can pushes and pulls change motion of objects?** Then ask each student to do a simple demonstration of a push and a pull. For example, they can push a pencil away from them and pull it toward them.

- Discuss how pushes and pulls are different.
  - » A push is away from you. A pull is toward you.
- Ask students to think of things they push and pull, and record their ideas on the question board.
  - » for example, push: a grocery cart, an open door, a closed drawer, someone on a swing; pull: a wagon, a closed door, an open drawer
- Tell students that in this unit, they will be exploring what causes pushes and pulls and how a push or pull changes how and which way things move.

## 2. Read together: “A Scooter Race.”

While some advanced students may be able to read words on a given page of the Student Book, as a general rule students should not be expected or asked to read aloud the text on the Student Book pages. The text in the Student Book is there so that teachers and parents can read it when sharing the Student Book with students.

### Read Aloud Support

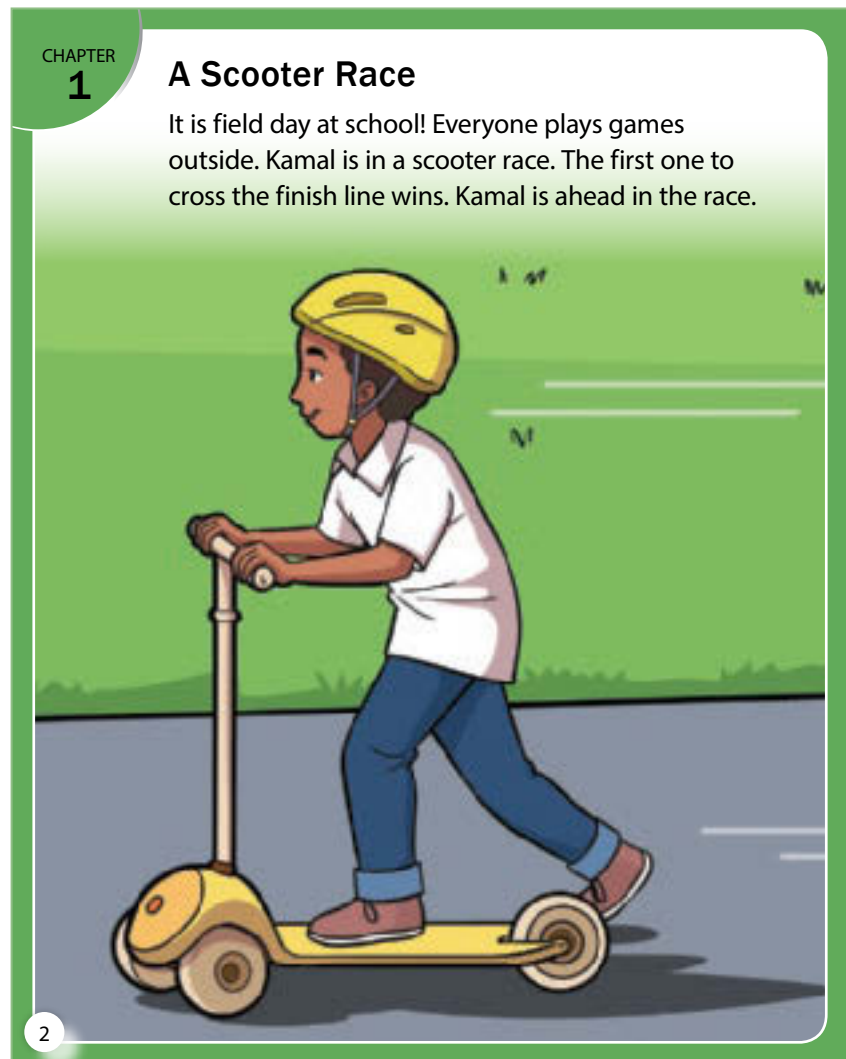
#### Page 2

Student Book



Ch. 1

**Ask students to turn to page 2 of the Student Book and look at the picture as you read aloud. Remind them that the title of this chapter is “A Scooter Race,” and tell them to pay special attention to how things move as you read.**



**Ask students to look at the picture on page 2 as you read aloud.**

- Explain that field day, usually at the end of the school year, is a fun day when student teams play sports games to relax after the year's work is done.

**LITERAL**—How many of you have ridden a scooter?

**LITERAL**— Is Kamal pushing or pulling?

» pushing

**INFERENTIAL**—What would happen if he stopped pushing?

» The scooter would slow down and then stop.

**SUPPORT**—Sing or recite a verse or two of the Woody Guthrie rhyme “Put Your Finger in the Air” as students follow the cues. At the end of each verse, discuss what movement took place. Have students repeat the movement and explain how their fingers and hands moved from one place to another.

### Page 3

**Ask students to look at the picture on page 3 as you read aloud.**

Kamal will soon roll across the finish line. He places both feet on his scooter. But something unexpected happens! Maddy pushes past Kamal. She wins the race!



3

- Why did Maddy win the race?
  - » She pushed harder than the others.

**LITERAL**—What objects move in the picture?

» The scooters and the children.

**CORE VOCABULARY**—Explain that to move means to change position. When something moves, it goes from one place to another.

**Pages 4–5**

**Ask students to look at the pictures on pages 4 and 5 as you read aloud.**

Field day at school has many races and games. They all have something that moves. Scooters are fun because they move.



A ball moves when the girl kicks.



4

- Discuss different types of games you can play on a field day.
  - » kickball, racing, tag
- Ask students how movement makes sports fun.
  - » If nothing moved, everyone would just stand and do nothing.
- Compare the different movements in the pictures.
  - » Two kids are pushing their scooters to make them move forward. The girl is kicking the soccer ball.

Fun things on a playground move. Kids move on swings. Kids move on seesaws. Fun things at home can move, too. Wagons can move. Bicycles can move. How many fun moving things can you think of?



5

- What is being pushed in the pictures?
  - » the scooters, the ball, the swing, the seesaw, the bike
- What is being pulled in the pictures?
  - » the swing, the wagon

**LITERAL**—Describe the movements in each picture.

- » The scooters and ball move forward. The swing is moving forward and backward. The seesaw is moving up and down. The bike is moving forward. The wagon is moving forward.

### 3. Generate questions.

Activity Page



AP UO.1

Distribute Motion (AP UO.1), and coach students through completing it. Review their work as a class, and add student responses to the question board lists of pushes and pulls.



SEP 1

CCC 2

DCI PS2.A

- Ask each student to think of a question they have about the pushes and pulls they have encountered. Add these questions to the question board. (See **Know the Standards.**)
  - » Why do some things move farther and faster than others? How can you make something stop moving? Can things move by themselves?

## 4. Check for understanding.

Activity Page



AP UO.1

Monitor Progress

Review the questions recorded so far on the question board. Ask students to summarize what they understand about pushes and pulls and movement.

### Formative Assessment

Review student responses in the discussion and to Motion (AP UO.1) to determine student understanding of the following concepts:

- A push is away from you.
- A pull is toward you.
- When something moves, it goes from one place to another.

### Tie to the Anchoring Phenomenon

In the next lessons, students will observe and explore how different strengths of pushes and pulls affect the motion of objects. They will use this growing understanding to build a miniature golf course, in which they can demonstrate how to affect the movements and direction of objects by the types of pushes and pulls they exert.

## Know the Standards

## TEACHER DEVELOPMENT

**Asking Questions and Defining Problems:** These are key practices in all academic pursuits. In Kindergarten, asking questions builds on prior experience and progresses to simple descriptive questions. Students should be encouraged to ask questions based on their observations to find more information about the world. Using words such as *who*, *what*, *when*, *where*, *why*, and *how* helps build understanding and scientific practices.



# LESSON 1

## Pushing and Pulling

### OVERVIEW

**Guiding Question:** What do pushes and pulls do?

Lesson 1 Segments	Segment Questions	Advance Preparation
<b>1.1 Pushing and Pulling</b> Students engage in pushing and pulling and observe what causes objects to move.	What happens when something moves?	Prepare for playground or gym experience. See Materials and Equipment.
<b>1.2 Types of Pushes and Pulls</b> (2 days) Students investigate pushing and pulling with different amounts of force on Day 1 and with different-shaped objects on Day 2.	What happens when you push or pull different objects in different ways?	Gather materials for student investigation. See Materials and Equipment.
<b>1.3 Motion Everywhere</b> Students watch videos of pushes and pulls in sports and read about how things move.	How can I describe pushes and pulls?	Read Chapter 2 in the Student Book.
<b>1.4 Changing Direction</b> Students engage in changing the direction of motion as they play a game.	What happens when you push or pull different objects in different ways?	Prepare for playground or gym experience. See Materials and Equipment.
<b>1.5 Lesson 1 Roundup: Different Pushes and Pulls</b> Students plan and carry out an investigation of the effects of different pushes and pulls.	What do pushes and pulls do?	Prepare test course. See Materials and Equipment.

### What's the Story?

**Summary:** In Lesson 1 (Segments 1–5), students explore the cause and effect of pushes and pulls. They begin to understand that all change in movement is the result of a push or a pull. The stronger the push or pull, the more change in motion the object undergoes. They recognize the shape of objects and that other forces, such as friction and gravity, have effects on motion as well. Students also engage in changing the direction of motion (K-PE-PS2-1).

**Learning Progression:** Lesson 1 builds on intuitive student understandings of how to predict and control motion.

**Guiding Phenomenon:** Understanding and controlling motion are critical to living in the world. They are also foundational to playing physical games. The amount of force used in a push or pull, as well as the direction, determines whether a basketball goes into a basket, whether a soccer ball is passed from player to player down a field and into the goal, or whether a golf ball goes into a cup (K-PE-PS2-1).

## Learning Objectives

**By the end of Lesson 1, students will**

- Observe and describe different types of motion.
- Relate the effect of different pushes and pulls to the motion of objects.
- Compare different pushes and pulls on different objects.
- Explore changing the direction of the motion of objects.

## NGSS Standards and Dimensions

**Performance Expectation:** K-PS2-1 Motion and Stability: Forces and Interactions

Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

<p><b>Science and Engineering Practice</b></p> <p><b>3 Planning and Carrying Out Investigations</b></p> <p>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</p> <p>With guidance, plan and conduct an investigation in collaboration with peers.</p>	<p><b>Disciplinary Core Idea</b></p> <p><b>PS2.A Forces and Motion</b></p> <p>Pushes and pulls can have different strengths and directions.</p> <p>Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.</p>	<p><b>Crosscutting Concept</b></p> <p><b>2 Cause and Effect</b></p> <p>Simple tests can be designed to gather evidence to support or refute student ideas about causes.</p>
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For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## LESSON 1.1

# Pushing and Pulling

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** What do pushes and pulls do?

**Today's Question:** What happens when something moves?

**Tie to the Anchoring Phenomenon:** Students engage with moving objects as firsthand experience with types and causes of motion that occur in sports games and other activities.

## AT A GLANCE

### Learning Objectives

- ✓ Experience and observe motion.
- ✓ Compare different types of pushes and pulls.
- ✓ Ask cause-and-effect questions about motion.

### Instructional Activities

- class discussion
- question generation
- student investigation

### NGSS References

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practice:** 1 Asking Questions and Defining Problems

**Crosscutting Concept:** 2 Cause and Effect

Students will apply forces, pushes and pulls, to cause a change in movement and compare motion of objects.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## Core Vocabulary and Language of Instruction

**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

cause

contact

effect

touch

motion

move

pull

push

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

**force**

**object**

## Instructional Resources

Activity Page



AP 1.1.1

### Activity Page

Pushing and Pulling (AP 1.1.1)

## Materials and Equipment

### Collect or prepare the following items:

- question board
- variety of playground or sports equipment

## THE CORE LESSON 1.1

### 1. Introduce students to Lesson 1.

NGSS Elements



SEP 1

CCC 2

DCI PS2.A

3D Learning

Monitor Progress

Students ask and answer questions about their experiences and observations of the cause and effect of different forces and motions.

Have students look at the question board. Lead the class in reading the **Big Question** that you'll be answering in this unit—**How can pushes and pulls change the motion of objects?**

Tell students that, before they can answer the unit's Big Question about how pushes and pulls change motion, they first need to understand what pushes and pulls are and how they work. In Lesson 1, they will learn about pushes and pulls in order to apply their understanding to the Big Question. Write the **Lesson 1 Guiding Question** where students can see it:

#### What do pushes and pulls do?

- Record student responses to this question.
  - What makes something move?
    - » Something falls. Something is pushed. Something is pulled.
- Demonstrate and have students demonstrate a push by pushing a pencil, book, or paper across a desk or floor.
- Demonstrate and have students demonstrate a pull by pulling an item.
- Discuss the differences between pushes and pulls.
  - » A pull is toward you. A push is away from you.

- Explain that students are going to go to the playground or gym and experience motion. Ask them each to pick one activity to observe and collect evidence about one type of motion. When they return, you will ask each student to describe what caused a motion and what made it stop. (See **Know the Science 1.**)

## Tie to the Anchoring Phenomenon

Students experience the joy of motion and observe the causes and effects of different pushes and pulls, including upon objects related to sports, games, and other recreational activities.

## 2. Gather evidence.

NGSS Elements



SEP 1

CCC 2

DCI PS2.A

Monitor Progress

Allow students to play on playground equipment and/or use sports equipment for a maximum of ten minutes. Pick a number of activities that will allow students to try out pushes and pulls, such as pushing and pulling each other on the swings or rolling, passing, and kicking a ball to each other. Ask them to choose one activity to observe and gather evidence.

**SUPPORT**—Circulate as students explore motion, and ask targeted questions such as the following:

- What is moving?
  - » me, the ball, the swing
- What caused the movement?
  - » a push, a pull, falling, sliding

## 3. Focus student attention on Today's Question.

Activity Page



AP 1.1.1

### What happens when something moves?

- Return to the classroom, and have students sit quietly. Then ask the following questions, and record relevant answers on the question board.
  - What can you observe that is moving now?
    - » for example, the clock, papers moving due to a breeze, a fish in an aquarium, a person breathing

## Know the Science

## TEACHER DEVELOPMENT

**1. Causes of Motion:** All changes in motion, whether in speed or in direction, are caused by a force acting on an object. A force is a push or pull. Some forces are not visible, like wind and gravity. But they cause objects to change their motion. The stronger the force, the faster and farther an object will move. Grade K students do not need to know how forces like gravity or bodily systems like respiration work. The concept that things change their motion because of a push or pull is the key concept. The cause is a push or pull. The effect is a change in motion.



SEP 1

CCC 2

DCI PS2.A

Differentiation

- What is causing the change in the motion?
  - » for example, wind, falling, motor, physical energy
- Model cause and effect for students. Place a ball on a desktop or other surface where the entire class can observe. Tell students you are going to apply a force to the ball and that this will be the cause. The effect is what happens after the cause. Push the ball, and ask:
  - What effect happened when I used a force on the ball?
    - » The ball started rolling.
- Have students complete Pushing and Pulling (AP 1.1.1), in which they draw their observations of the cause and effect of movement in the activity. (See **Know the Science 2.**)
- Ask students to present their observations from the activity by asking these questions of each student.
  - What did you observe moving?
    - » for example, a ball, a swing, a person on the slide
  - What caused the change in the motion?
    - » a push or a pull
- Discuss how the movements students observed in the quiet classroom and the movements they observed in the activity are the same and different.
  - » Movements were caused by a push or pull or some force.
  - » Movements went in different directions at different speeds.
  - » Some movements are caused by pushes. Others are caused by pulls.

**SUPPORT**—Some students may benefit from further demonstrating the physical activity of pushing and pulling different objects in order to secure the difference between the two types of forces. A discussion of examples such as wind as pushing and a vacuum as pulling may provide further understanding.

## Know the Science

## TEACHER DEVELOPMENT

**2. Newton's First Law:** Newton's first law holds that an object in a state of motion will remain in that state of motion unless acted on by an external force. A rolling ball would continue to roll forever except that the force of friction with the floor and the force of air resistance slow the ball's forward movement. Note that the same ball sitting on a desk is also in a state of motion—that of no motion. Gravity pulls the ball down toward Earth's center, and the desk opposes the motion of the ball. Two equal forces are acting on the ball, just in opposing directions, so the ball is motionless and remains motionless.

## 4. Check for understanding.

Activity Page



AP 1.1.1

### Formative Assessment

Review student responses in the discussion and to Pushing and Pulling (AP 1.1.1) to determine student understanding of the following concepts:

- Changes in movement are caused by a push or pull on an object.
- A push is away from you. A pull is toward you.

See the Activity Page Answer Key for correct answers and sample student responses.

Science starts when someone asks a question. Encourage students to ask questions about movement as well as the causes and effects of motion phenomena. Record student questions on the question board.

### Tie to the Anchoring Phenomenon

Tell students that they will be designing a miniature golf course later in the unit and that as part of the design, they will need to consider how they want the ball to roll through the different parts of the course. Ask students to think about one way a ball could roll.

- Ask students to think about one way a ball could roll if it weren't rolling in a straight line.
  - » bounce off a wall; roll down a slope; roll up a hill
- Draw some student suggestions that could be posted around the room as students continue to build on their understanding of pushes and pulls with the goal of building a miniature golf course.



## LESSON 1.2

# Types of Pushes and Pulls

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** What do pushes and pulls do?

**Today's Question:** What happens when you push or pull different objects in different ways?

**Tie to the Anchoring Phenomenon:** Students build on their understanding of how pushes and pulls cause a change in motion as they explore pushing and pulling different-shaped objects with different levels of force.

## AT A GLANCE

### Learning Objectives

- ✓ Describe how strong and weak pushes and pulls affect the motion of an object.
- ✓ Investigate things that affect motion of pushed and pulled objects
- ✓ Describe how the same-strength push or pull affects objects of different shapes.

### Instructional Activities

#### Day 1

- student investigation
- student observation
- class discussion

#### Day 2

- student investigation
- student observation
- class discussion
- question generation

### NGSS References

**Performance Expectation:** K-PS2-1 Motion and Stability: Forces and Interactions

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practice:** 3 Planning and Carrying Out Investigations

**Crosscutting Concept:** 2 Cause and Effect

Students will explore how pushes and pulls cause change in movement, as well as compare pushing and pulling different-shaped objects with different levels of force.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

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## Core Vocabulary and Language of Instruction

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**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

**distance**      **farther**      **fast**      **gravity**  
**hard**      **slow**      **soft**      **speed**

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

**closer**      **careful**      **friction**      **move**  
**pull**      **push**

## Instructional Resources

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### Activity Pages



AP 1.2.1  
AP 1.2.2

### Activity Pages

Push and Pull (AP 1.2.1)

Pushing Shapes (AP 1.2.2)

## Materials and Equipment

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### Collect or prepare the following items:

#### Day 1

- question board
- cubes, such as toy blocks or math manipulatives (1 per student or pair)
- string (12" length per cube)
- smooth surface (access to about 24-inch length of smooth surface on a table or floor for each student or pair)
- rough surface (access to about 24-inch length of rough surface such as a rug, place mat, or rug sample for each student or pair)

#### Day 2

- question board
- all materials from Day 1
- cube, sphere, and triangular prism (1 set per student or pair)
- 24-inch boards (1 per student or pair)
- books or blocks to support one end of the boards (2–3 per student or pair)
- 12-inch pans of water (1 per student or pair)

## Advance Preparation—Day 1

- Cubes or blocks, spheres or balls, and triangular prisms are readily available in kindergarten math manipulative kits.
- Attach strings to cubes beforehand so students can experience pulling an object. Tape or glue 12-inch lengths of strings to the cubes.
- Determine where all students will be able to experience pulling and pushing cubes on different types of surfaces in the classroom or outdoors.

## Advance Preparation—Day 2

- Prepare a shallow sheet-cake-size pan of water beforehand so students can experience pushing and pulling different shapes through water.
- Set up the four different centers—a smooth surface, a rough surface, a ramp, and a pan of water—in a common area.
- Consider rotating students through the four different centers.

## 1. Day 1: Focus student attention on Today's Question.

NGSS Elements



SEP 3

SEP 4

CCC 2

DCI PS2.A

3D Learning

In this lesson, students carry out investigating the cause and effect of using different amounts of force and different-shaped objects on different surfaces.

### What happens when you push or pull different objects in different ways?

- Review with students the difference between a push and a pull.
  - » A push is away from you. A pull is toward you.
- Review with students how pushes and pulls are the same.
  - » Pushing and pulling change the motion of objects. The force of the push or pull is the cause. The change in the motion of the object is the effect.
- Explain that scientists use careful tests to make observations about how things work. In this lesson segment, students will investigate to see how different amounts of pushing and pulling affect the movement of a cube across different surfaces. Students will use an activity page to record the effects of different pushes and pulls.

**SUPPORT**—Ask students to think of how they can demonstrate a simple push and a pull in the classroom. Then as time allows, have each student demonstrate a push and pull, describing what is happening as they demonstrate each push and pull.

  - » For example, some may push a chair in, pull a door or drawer closed, or push or pull a book or crayon on the desk.

## Tie to the Anchoring Phenomenon

In this series of lesson segments, students are becoming aware that any change in motion is the result of pushes and pulls not only on the playground but everywhere. In this segment, students recognize that the amount of force on an object has an effect on how strong the change in motion is. They also experience how the surface affects the movement of an object.

## 2. Conduct an investigation.

### Activity Page



AP 1.2.1

### NGSS Elements



SEP 3

CCC 2

DCI PS2.A

- Have an area with a smooth surface, such as a tile floor, and an area with a textured surface, such as a rug or playmat.
- Distribute Push and Pull (AP 1.2.1). Explain that students will carefully test pushing and pulling a cube using different levels of force on two different flat surfaces. The Activity Page will help them keep track of their tests.
- Demonstrate filling out the Activity Page.
  - Give a cube a gentle push across a smooth surface. Put a check in the “Little Force” column on the Activity Page.
  - Then use more force, and put a check in the “Force” column.
  - Finally use even more force, and put a check in the “Big Force” column.
  - After each series of tests, demonstrate thinking aloud to see which test made the cube move the most. Circle the check under the column that made the cube move the most.
- Have students think about their results with the following prompts:
  - » I wonder which block went farther than the others.
  - » I wonder which block went a shorter distance than the others.
- Tell students they will repeat the tests pushing on a rough surface and then using the cube with the string to pull on a smooth and rough surface.
- Have students conduct their tests, as you prepared either for pairs or individuals, and complete the Activity Page.

**SUPPORT**—Circulate around the room as students conduct the tests, making sure they record the results after each test. Ensure that every student experiences pushing and pulling so they can contribute to the discussion.

### 3. Guide discussion.

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NGSS Elements



SEP 4

- Ask the following questions about the data students collected on the Activity Page. (See **Know the Standards.**)
  - What was the effect of all the very gentle pushes and pulls you made to the cube?
    - » Every push or pull made the cube move.
  - What was the effect of all the medium pushes and pulls you made to the cube?
    - » Every medium push or pull made the cube move more than the gentle pushes and pulls.
  - What was the effect of all the strongest pushes and pulls you made to the cube?
    - » The strongest pushes and pulls made the cube move the most.
  - How did the surface affect the movement of the cube?
    - » The cube did not move as far on the rough surface as it did on the smooth surface.

### 4. Check for understanding.

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Activity Page



AP 1.2.1

#### Formative Assessment

Review student responses in the discussion and to Push and Pull (AP 1.2.1) to determine student understanding of the following concepts:

- The stronger a push or pull, the more movement is caused.
- The surface affects the amount of movement.

See the Activity Page Answer Key for correct answers and sample student responses.

- Review the question and observations made on the question board. Encourage students to suggest additions for you to make to the board of any questions or new observations they have.

## Know the Standards

## TEACHER DEVELOPMENT

**K-PS2-1 Motion and Stability: Forces and Interactions:** In this lesson segment, the Force and Motion standard expectation is simply that kindergarteners understand that pushes and pulls can have different strengths and that a bigger push or pull makes things speed up or slow down more quickly. Concepts of measurement of speed and amount of force will be addressed in subsequent grade levels.

## Tie to the Anchoring Phenomenon

On Day 2 of this lesson, students will explore how different shapes are affected by pushes across different surfaces. This information will help them work toward building a miniature golf course in which they can demonstrate how to control the speed and direction of the movements by the types of pushes and pulls they exert.

### 1. Day 2: Refocus student attention on Today's Question.

NGSS Elements



SEP 3

SEP 4

CCC 2

DCI PS2.A

Monitor Progress

3D Learning

In this lesson, students carry out investigating the cause and effect of using different amounts of force and different-shaped objects on different surfaces.

#### What happens when you push or pull different objects in different ways?

- Review with students what they learned about the effect of the amount of force on the movement of an object.
  - » The stronger the push or pull, the more the motion of the object changes.
- Ask students to identify what in their tests shows that what they observed is true.
  - » The stronger pushes and pulls moved the cube farther than the weaker ones.
- Ask students how the rough and smooth surfaces affected the movement.
  - » The stronger pushes and pulls moved the cube more on any surface than weaker pushes and pulls, but the objects moved farther on smooth surfaces than rough.
- Explain that in this lesson segment, students will test to see how the shape of an object affects its movement across different surfaces. Students will use an activity page to record the effects of different pushes and pulls.
- Explain that students will choose a third object to push across the different surfaces. Have a variety of small, waterproof objects that can be safely pushed on hand for students to choose from. The Activity Page is set up so the object they choose can be identified in the chart. As students perform their tests, circulate around the room, and add the name of the object to their charts.

## Tie to the Anchoring Phenomenon

In this series of lesson segments, students are becoming aware that all changes in motion are the result of pushes and pulls, not only on the playground but everywhere. In this segment, students recognize that the shape of an object affects the amount of change in movement caused by a push or pull.

- Ask students how big and little pushes could be used to move a ball around a miniature golf course.
  - » Big pushes could move the ball a long distance. Small pushes could be used to move the ball a short distance.

## 2. Conduct an investigation.

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### Activity Page



AP 1.2.2

### NGSS Elements



SEP 3

CCC 2

DCI PS2.A

Monitor Progress

- Distribute Pushing Shapes (AP 1.2.2). Explain that students will carefully test pushing different shapes across four different surfaces. The Activity Page will help them keep track of their tests.
- Have an area set up with the four centers: a smooth surface, a rough surface, a ramp, and pan of water. A simple ramp can be set up with a twenty-four-inch board and a couple of books under one end.
- Demonstrate filling out the Activity Page.
  - Give a cube a gentle push across a smooth surface. Leave the cube in place. Then give the triangular prism a gentle push, and leave it in place. Finally give the sphere a gentle push.
  - After each set of tests, demonstrate thinking aloud to see which shape moved the farthest. Put an X in the box next to that shape.
  - Tell students they will repeat the tests pushing the three shapes on a rough surface, on a ramp, and across water.
- Have students conduct their tests, as you prepared for pairs or individuals, and complete the Activity Page.

**SUPPORT**—Circulate around the room as students conduct the tests, making sure they record the results after each set of tests. Ensure that every student experiences pushing each shape so they can contribute to the discussion.

## 3. Guide discussion.

---

### NGSS Elements



SEP 4

- Ask the following questions about the data students collected on the Activity Page. (See **Know the Science.**)
  - Which shape moved the farthest?
    - » the sphere or ball
  - How did the different surfaces, rough or smooth, affect the movement of the shapes?
    - » The shapes moved the least on the rough surface. They moved the most on the ramp.
    - » All the shapes moved the least in the water.

## 4. Check for understanding.

Activity Page



AP 1.2.2

### Formative Assessment

Review student responses in the discussion and to Pushing Shapes (AP 1.2.2) to determine student understanding of the following concepts:

- Different shapes respond differently to a push. Spheres move farther than cubes or triangular prisms.
- The surface affects the amount of movement.
- A cause, pushing a cube, leads to an effect, the cube moving.

See the Activity Page Answer Key for correct answers and sample student responses.

- Review the questions and observations made on the question board. Encourage students to suggest additions for you to make to the board of any questions or new observations they have.

### Tie to the Anchoring Phenomenon

On Day 2 of this lesson, students explored how different shapes are affected by pushes across different surfaces. This information will help them work toward building a miniature golf course in which they can demonstrate how to control and direct the movement and direction of objects by the types of pushes and pulls they use.

## Know the Science

## TEACHER DEVELOPMENT

**Gravity and Friction:** The concepts of gravity and friction will be developed in subsequent grades, but kindergarteners understand these concepts experientially. Gravity is the invisible force that pulls objects toward the surface of Earth. Friction also affects the movement of objects. An object in motion will slow down faster when more of the object is in contact with the surface, as well as on rougher surfaces, which create more friction than smooth surfaces. A sphere has less contact with a surface, so it encounters less friction.



## LESSON 1.3

# Motion Everywhere

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** What do pushes and pulls do?

**Today's Question:** How can I describe pushes and pulls?

**Tie to the Anchoring Phenomenon:** Students encounter many different types of pushes and pulls through experience, video, and reading to recognize that all motion is the result of forces acting on objects.

## AT A GLANCE

### Learning Objectives

- ✓ Observe and describe pushes and pulls.
- ✓ Contrast pushes and pulls.

### Instructional Activities

- teacher Read Aloud
- student observation
- class discussion
- question generation

### NGSS References

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practices:** 1 Asking Questions; 4 Analyzing and Interpreting Data; 8 Obtaining, Evaluating, and Communicating Information

**Crosscutting Concept:** 2 Cause and Effect

Students obtain information about different types of pushes and pulls so they can describe the causes and effects of those forces on the movement of objects.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## Core Vocabulary and Language of Instruction

**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

**move**      **pull**      **push**

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

**force**      **forward**      **gravity**      **motion**

### Instructional Resources

Student Book



Ch. 2

**Student Book,**  
**Chapter 2**  
“How Do Things Move?”

Activity Page



AP 1.3.1

**Activity Page**  
A Push or a Pull? (AP 1.3.1)

### Materials and Equipment

**Collect or prepare the following items:**

- cubes, such as toy blocks or math manipulatives (1 per student or pair)
- question board
- internet access and the means to project images/video for whole-class viewing

## THE CORE LESSON 1.3

### 1. Focus student attention on Today’s Question.

NGSS Elements



DCI PS2.A  
CCC 2  
SEP 8

**How can I describe pushes and pulls?** Give each pair of students a cube. Have them sit on opposite sides of a table or on the floor. Remind students of the investigation they conducted showing how the strength of a push or pull affected the movement.

- Ask students to demonstrate pushing by pushing the cube across the surface to the other student.
- Then ask them to demonstrate pushing it more forcefully.
- Then ask them to demonstrate pulling with a weak and strong force.
- Discuss how the forcefulness of the pushes and pulls affects the motion of the cube.

- » The stronger the force, the faster and farther the cube moves.
- » A little push makes it move a little.
- » When the cube is pushed very hard, it slides a long distance.

### Tie to the Anchoring Phenomenon

Students will encounter through reading and video many examples of pushes and pulls, including those in sports, games, and other recreational activities. (See **Know the Standards.**)

## 2. Read together: “How Do Things Move?”

Activity Page



AP 1.3.1

While some advanced students may be able to read words on a given page of the Student Book, as a general rule students should not be expected to read aloud the text on the Student Book pages. The text in the Student Book is there so that adults can read it when sharing the Student Book with students.

Student Book



Ch. 2

## Know the Standards

### TEACHER DEVELOPMENT

**Obtaining, Evaluating, and Communicating Information:** At the kindergarten level, students are expected to gather information through their senses and describe it. Science is based on gathering information using one’s senses and describing what is seen. These skills are also known as observation and evaluation. Creativity and imagination play a part in constructing explanations, but key to scientific processes are obtaining information and being able to communicate it. Students obtain and combine information in this lesson segment from listening to the reading of the Student Book, from viewing the video, and from direct observation and experience.

Ask students to turn to page 6 of the Student Book and look at the pictures as you read aloud. Remind them that the title of this chapter is “How Do Things Move?” and tell them to pay special attention as you read to how things in the pictures move.

CHAPTER  
2

## How Do Things Move?

Carnival rides are fun because they move! What are some ways that carnival rides move?



A Ferris wheel moves around and around.

A carousel horse moves up and down.



A swinging ride moves back and forth.

6

**LITERAL**—What are some ways the rides move?

- » around and around
- » up and down
- » back and forth

**CORE VOCABULARY**—Explain that to **move** is to go from one place to another. Movement, or motion, is the process of something changing position. Things that are moving are not holding still.

**EXTEND**—Ask students to think of other ways they can describe movement.

- » forward
- » backward
- » side to side
- » zigzag
- » over and under

**Page 7**

**Guide students to look at the pictures on page 7 as you read aloud.**

How do some other things move?

This unicycle can move.  
The girl makes it roll  
forward and backward.

These swings can move.  
The boys make them  
move back and forth.  
When people design and  
build things that move,  
they have to figure out  
how to get them to move  
and stop.



7

**LITERAL**—What is causing things to move in these pictures?

- » The girl is pushing the pedals to make the unicycle move.
- » People are pulling and pushing on the swing.

**INFERENTIAL**—What do people have to think about when they build things?

- » For something like a unicycle, designers have to figure out where a rider will sit. They have to figure out how to hold the wheel to the frame and seat but still allow the wheel to turn. They must figure out how the pedals will attach to the wheel so a rider could push on them with his or her feet.
- » For a swing set, designers have to make a place to sit on the swing. They have to figure out what kind of rope or chain is strong enough to hold the swing's seat to the frame. They have to make the frame strong enough to hold the weight of children on the swings. They need to make the frame in a shape so the swing set does not tip over.

**SUPPORT**—To help support student learning, draw the A-frame of a swing set. Then ask students to help design the rest of the swing set. Encourage students to explore their ideas as they are suggested.

- What should we use to connect the seat to the swing?
  - » We can have a rope tied to the top and bottom.
  - » We can use a chain because it is stronger.
  - » We can put a hose around the chain so fingers don't get pinched.

Have students draw on A Push or a Pull? (AP 1.3.1) a picture of one push they can see on page 7.

Activity Page



AP 1.3.1

### 3. View examples of pushes and pulls.

Online Resources



Pause reading the chapter to show students a video. See the Online Resources Guide for a link to the recommended video:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

Lead student observations as they watch the video. If the video has captions, read them aloud as the video plays.

Discuss Core Vocabulary and the following questions:

**CORE VOCABULARY**—Model a push. Explain that to **push** means to press on something to try to make it move. A push is a force to make something move away from whatever is doing the pushing.

**CORE VOCABULARY**— Model a pull. Explain that to **pull** means to tug on something to try to make it move. A pull is a force to make something move toward whatever is doing the pulling.

- What is the difference between a push and a pull?
  - » A push is away from the pusher. A pull is toward the puller.

NGSS Elements



DCI PS2.A  
CCC 2  
SEP 8

Activity Page



AP 1.3.1

- What examples of pushes did you see in the video?
  - » Students should identify examples of pushes such as pushing bike pedals, pushing a door open, pushing a swing, pushing a car, pushing a soccer ball, and pushing a nail.
- What examples of pulls did you see in the video?
  - » Students should identify examples of pushes such as pulling a wagon, a horse pulling a cart, pulling a rope, pulling a door, a dog pulling a woman, and pulling open a book.

**3D Learning:** Students obtain, evaluate, and communicate information about different types of pushes and pulls. They recognize that pushes and pulls are the forces that cause objects to move.

Have students draw on A Push or a Pull? (AP 1.3.1) a picture of one pull they saw in the video.

## 4. Continue reading together: “How Do Things Move?”

### Read Aloud Support

Student Book



Ch. 2

**Ask students to turn to page 8 of the Student Book and look at the pictures as you read aloud. Remind them that the title of this chapter is “How Do Things Move?” and tell them to look for examples of different kinds of pushes and pulls as you read.**

Ask students to look at the two pictures on page 8.

You know that some things move. But they do not move all the time. Sometimes they are still. They stay still until something makes them move. The lawnmower is sitting still.



Now the lawnmower is moving. What makes it move?



8

**LITERAL**—What makes the lawnmower move?

- » The man pushes it.
- » The man applies a push to the handle, making the mower move forward.

Monitor Progress

**EXTEND**—What other ways could the lawnmower move?

- » The man could pull it back.
- » It could roll down a hill.



Ask students to turn to page 9 of the Student Book and look at the pictures as you read aloud.

The lawnmower moved because someone pushed it. When things start to move, they are pushed or pulled. The grandparents push the child on the swing. The swing moves away from the grandparents.



The dog pulls the sled. The sled moves toward the dog.



9

**LITERAL**—Which object is being pushed, and who or what is pushing?

» The swing is being pushed by the grandparents.

**LITERAL**—Which object is being pulled, and who or what is pulling?

» The sled is being pulled by the dog.

Summarize these observations by asking students if people's hands are the only things that can push and pull on other things. Cite the dog in the bottom picture as an example of something other than a person that can apply a pull.

**Guide students to look at page 10 of the Student Book as you read aloud.**

Remind students about their playground experience in the first lesson segment. What kinds of pushes and pulls did you have on the playground?

- » I pushed my friend on the swing. The force made them move.
- » I pushed on the steps of the slide to get up it.
- » I pulled on the monkey bars to swing.

Objects can push or pull each other.

A bowling ball pushes the pins. The pins fall over. The pins can push other pins, too. Then the other pins fall over. Why do some pins stay still?

Why are some of the pins still standing?



10

**LITERAL**—What is being pushed or pulled in this picture?

- » The bowling pins are being pushed over.

If students hesitate, supply the hint that a bump is a kind of push.

**EXTEND**—Can you identify three different pushes that happen when a bowling ball hits pins like what we see in this picture?

- » The ball pushes on pins.
- » Some pins push on other pins.
- » Something had to push on the ball in the first place to make it start moving.

**Page 11**

**Ask students to turn to page 11 of the Student Book and look at the pictures as you read aloud.**

Water can push things from one place to another.  
Waves push shells onto a beach.



Water pushes these ducks downstream in a race.



11

**LITERAL**—How can water push things?

- » Water pushes things from one place to another.

**LITERAL**—What happens if you push on water?

- » The water moves away from me.
- » When I swim, I push on the water, and I move forward.

**EXTEND**—What happens when you pull on water?

- » The water slides through my hands.

You can't see air. But air can push things, too. Air pushes the flag. Air pushes dust around these pyramids. Air pushes tree leaves during a storm. Air pushes the pinwheel.



12

**LITERAL**—How is air pushing things in the pictures on this page?

- » Air (wind) pushes the flag to make it flap from the side of the flagpole.
- » Air pushes dust up from the ground and into the air in a sandstorm.
- » Air pushes tree leaves to sway around during windy weather.
- » Air from the girl's breath pushes on the pinwheel to make it spin.

**EXTEND**—Can you think of an example of air pulling things?

- » A vacuum cleaner works when air pulls dirt from the floor.

Ask students to turn to page 13 of the Student Book and look at the pictures as you read aloud.

Something invisible is pulling on everything around you. It is even pulling on you right now. That pull is called gravity. Gravity pulls everything down. When something falls to the ground, it is pulled by gravity.



The girl pushed the ball with her foot. Her kick pushed the ball up. How will gravity pull on the ball now? Gravity pulls the ball back down

A motor pushes this swinging boat ride up. Then gravity pulls it back down toward the ground.



13

## NGSS Elements



DCI PS2.A  
CCC 2  
SEP 8

**LITERAL**—If you drop a pencil, what happens to it?

» It falls straight to the ground.

**INFERENTIAL**—How is dropping a pencil similar to what you see in the pictures on this page?

» The pencil, soccer ball, and swinging boat are pulled toward the ground.

**EXTEND**—Does a person have to touch things in order for them to move?

» Wind, water, and gravity pull and push without a person touching them.

## Activity Page



AP 1.3.1

**Have students add pictures of two pushes and two pulls to A Push or a Pull? (AP 1.3.1).**

**Background for Teachers:** Students at this level are not assessed on gravity as a Core Vocabulary term. They experience gravity continuously, and they intuitively understand its effect on objects. The purpose of introducing gravity

here is simply to expose students to the notion that they cannot directly see all pushes and pulls. Gravity is an invisible pull, which they will learn about in a little more detail in Chapter 6.

## 5. Check for understanding.

Activity Page



AP 1.3.1

Call attention to the question board. Revisit the questions recorded so far, and ask students how the drawings they made of pushes and pulls on Activity Page 1.3.1 might answer any of those questions. Encourage students to suggest additions for you to make to the board of any questions or new observations they have.

Summarize the differences and similarities between pushes and pulls.

- » Differences: A push is away from you. A pull is toward you.
- » Similarities: Both are forces that make things move.

NGSS Elements



DCI PS2.A

CCC 2

SEP 4

Monitor Progress

### Formative Assessment

Review student responses in the discussion and to A Push or a Pull? (AP 1.3.1) to determine student understanding of the following concepts:

- Pushes happen away from you.
- Pulls happen toward you.
- Many objects can be pushed or pulled.
- You don't need to touch something for it to move. Water, wind, and gravity move objects without people touching them.

See the Activity Page Answer Key for correct answers and sample student responses.

### Tie to the Anchoring Phenomenon

In the reading and video, students encountered a variety of examples of pushes and pulls, including forces exerted by people and those by natural means, such as water, wind, and gravity. This develops students' understanding that pushes and pulls result in movement in the familiar activities in which students participate.



## LESSON 1.4

# Changing Direction

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** What do pushes and pulls do?

**Today's Question:** What happens when you push or pull different objects in different ways?

**Tie to the Anchoring Phenomenon:** Students experience the effects of different directions of pushes and pulls on the motion of an object through playful activities.

## AT A GLANCE

### Learning Objectives

- ✓ Observe and describe different directions of pushes and pulls and their effects.
- ✓ Contrast different directions of pushes and pulls and their effects.

### Instructional Activities

- student investigation
- student observation
- class discussion
- question generation

### NGSS References

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practice:** 1 Asking Questions and Defining Problems

**Crosscutting Concept:** 2 Cause and Effect

Students will observe and develop their own questions about how pushes and pulls in different directions affect the motion of objects.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## Core Vocabulary and Language of Instruction

**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

cause

change

direction

motion

move

pull

push

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

affect

back

down

effect

force

forward

left

result

right

up

### Instructional Resources

Activity Page



AP 1.4.1

#### Activity Page

Changing Direction (AP 1.4.1)

### Materials and Equipment

#### Collect or prepare the following items:

- question board
- playground equipment: large and small bouncy balls
- internet access and the means to project images/video for whole-class viewing

## THE CORE LESSON 1.4

### 1. Focus student attention on Today's Question.

NGSS Elements



SEP 1  
CCC 2  
DCI PS2.A

Students ask questions and then explore how to the change direction of objects in motion. They observe the cause and effect of changes in motion.

#### What happens when you push or pull different objects in different ways?

- Review with students the aim of different sports, such as basketball, soccer, baseball, or golf.
  - » In basketball, the aim is to get a ball to drop into a hoop; in soccer, the aim is to get a ball into a goal; in baseball, the aim is to pitch the ball to home plate within a zone and to hit a ball into the field to score runs; in golf the aim is to hit the ball into a cup.



#### Online Resources



#### 3D Learning

#### NGSS Elements



SEP 1

- Show a video of a team scoring a soccer goal. Have students describe how the motion of the ball changed direction to score the goal. See the Online Resources Guide for a link to the recommended video:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

- » The ball was kicked to another player and then bounced off the head into the goal.
- Ask students to suggest the best ways of achieving the object of scoring in one familiar sport.
- » In soccer or basketball, you could pass the ball to someone else.
- Ask students to suggest questions for the question board about how they can change the direction of motion as you record them. (See **Know the Science.**)

### Tie to the Anchoring Phenomenon

Students expand their understanding of the cause and effect of pushes and pulls as they explore changing the direction of the motion of objects. This understanding is fundamental to playing physical games in which a player tries to direct the movement of an object such as a ball or puck into a basket or other container to score points.

## 2. Gather evidence.

#### NGSS Elements



SEP 1

CCC 2

DCI PS2.A

Monitor Progress

- Organize a game of kickball, basketball, or any game in which the direction of movement is critical.
- Practice kicking a ball straight or, for example, to the left and to the right.
- Give each student a chance to direct the motion of the game ball to score. After each student has a chance, ask students how the player changed the motion.
- » For example, some students may use more or less force while others arch, roll, bounce, or deflect.
- Next, organize an activity where students bounce a bouncy ball (like a tennis ball, soccer ball, or rubber ball) against a wall. Give each student a chance to perform one of the following tasks. Encourage them to be creative and safe:

## Know the Science

## TEACHER DEVELOPMENT

**Ways to Change Motion:** Students intuitively know that pushing or pulling on an object can change the speed and/or direction of an object's motion and can start or stop its motion. People can predict in what direction an object will move depending on the type of push or pull that is applied. The amount of force applied, the shape of the object, and other conditions, such as wind, gravity, or friction, are all factors that affect the movement of objects.

**Option 1** Throw the ball against the wall so that it comes right back to you without bouncing.

**Option 2** Throw the ball so that it bounces first before it hits the wall and then comes right back to you.

**Option 3** Throw the ball against the wall so that it comes back to your left side.

**Option 4** Throw the ball against the wall so that it comes back to your right side.

**Option 5** Throw the ball against the wall so that it bounces after it hits the wall.

**Option 6** Throw the ball against the wall so that it rolls back to you.

**Option 7** Throw the ball so that it bounces off another object before it hits the wall.

**SUPPORT**—As students engage, be positive about all efforts whether they are successful or not. Explain that the point is to ask questions about how the types of pushes and pulls can change the direction of motion.

### 3. Guide discussion.

NGSS Elements



SEP 1

CCC 2

DCI PS2.A

Differentiation

What happens when you push or pull different objects in different ways?

- Post or write the four directions (up, down, left, right) at the front of the classroom.
- Hold a ball up in front of the classroom. Tell students you will move the ball in different directions and that they should identify in which direction you moved the ball.
- Have students demonstrate different directions by pointing their fingers as you prompt them.
  - up
  - down
  - right
  - left
- Discuss how they could get an object to move in each direction.
  - » Encourage students to consider deflection. For example, bounce a ball down to make it go up.

**SUPPORT**—If needed, review left and right directions with students by singing “The Hokey Pokey” as a group.

**CHALLENGE**—Some students might want to think about how to cause zigzag and circular movements. You can roll a marble inside a bowl or blow a pinwheel, for example. A zigzag motion could be caused by pushing a marble to one side of a ramp with guardrails on the sides. When it bounces off one side, it will hit the other side.

Distribute Activity Page Changing Direction (AP 1.4.1). Review the instructions for the activity. Students should draw a ball moving in four different directions with one direction in each box.

Activity Page



AP 1.4.1

## 4. Check for understanding.

---

Activity Page



AP 1.4.1

NGSS Elements



SEP 1

CCC 2

DCI PS2.A

Monitor Progress

### Formative Assessment

Review student responses in the discussion and to Changing Direction (AP 1.4.1) to determine student understanding of the following concepts:

- The type of push or pull affects how objects move or change direction.
- Objects move up or down or to the left or right depending on how a push or pull is applied.
- Objects change direction when they hit other objects.

See the Activity Page Answer Key for correct answers and sample student responses.

Review the questions and observations made on the question board. Encourage students to suggest additions for you to make to the board of any questions or new observations they have.

### Tie to the Anchoring Phenomenon

Students explore how they can make objects change the direction of movement with different types of pushes and pulls. Control over the direction of movement is critical to day-to-day life and most recreational activities. This information will help them work toward building a miniature golf course in which they can demonstrate how to control and direct the movement and direction of objects by the types of pushes and pulls they exert.

## LESSON 1.5

# Lesson 1 Roundup: Different Pushes and Pulls

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** What do pushes and pulls do?

**Today's Question:** What do pushes and pulls do?

**Tie to the Anchoring Phenomenon:** Students engage in investigating the effects of different pushes and pulls on the motion of various objects, like those used to play games and sports.

## AT A GLANCE

### Learning Objectives

- ✓ Compare the effects of different strengths of pushes and pulls on the motion of an object.
- ✓ Compare the effects of different directions of pushes and pulls on the motion of an object.

### Instructional Activities

- student investigation
- student observation
- class discussion
- question generation

### NGSS References

**Performance Expectation:** K-PS2-1

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practice:** 1 Asking Questions and Defining Problems

**Crosscutting Concept:** 2 Cause and Effect

Students plan and then investigate pushing and pulling to control the effect of the motion of an object.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

# Core Vocabulary and Language of Instruction

**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

compare                      pull                      push

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

at rest                      contrast                      direction                      faster  
force                      investigate                      slower                      strength

## Instructional Resources

Activity Page




AP 1.5.1

**Activity Page**  
Hitting the Spot (AP 1.5.1)

## Materials and Equipment

- question board
- golf play set including golf club, cup, and ball
- rectangular block
- indoor golf course as shown below using interlocking 1-foot square foam tiles or squares numbered 0–7

	7	
		
	2	
	1	
3	0	4
	5	
	6	
	Tester	

## Advance Preparation

- This activity can also be done in a carpeted area. The texture of the carpet will help slow down the balls as they roll. Smooth floors can also be used, but this will result in the balls rolling farther.
- Students will need an open area to conduct this activity.
- Have students work in pairs when possible, with one student suggesting direction and the other suggesting strength.
- If time allows, consider having students perform additional rounds of hitting the ball.

## THE CORE LESSON 1.5

### 1. Focus student attention on Today's Question.

NGSS Elements



SEP 1

CCC 2

DCI PS2.A

3D Learning

#### What do pushes and pulls do?

- Review with students how pushes and pulls affect the motion of an object.
  - » A push or pull can make an object move faster or slower.
  - » A push or pull can make an object move in different directions.
- Review the questions students have posed on the question board, and see if they are able to answer or add to their questions.
- Show students the “putting green” you have created. Explain that each student will have a turn to stand in the tester spot to see if they can push or pull the ball into a particular square. (See **Know the Standards.**)

#### Tie to the Anchoring Phenomenon:

Students utilize their understanding of different pushes and pulls as they investigate controlling the motion of an object while playing a game.

## Know the Standards

## TEACHER DEVELOPMENT

**Fair Tests:** Planning and carrying out investigations to test solutions to problems involves conducting fair tests to provide data that support explanations. A fair test is one that controls variables. A fair test can also be repeated and produce the same results.

## 2. Investigate.

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### Activity Page



AP 1.5.1

### NGSS Elements



PE K-PS2-1

SEP 1

CCC 2

DCI PS2.A

Monitor Progress

Differentiation

- Place a ball where the students can see it. Begin by introducing the concept of “at rest” as a state of motion. Explain that no force is acting on the ball to make it change its state of motion.
- Ask students how the state of motion will change when you apply a force in the form of a push to the ball.
  - » The ball will start rolling.
- Have students pair up and work together to plan how to move the ball into each square. Determine first if the tester will need to push or pull the ball. Encourage students to think and discuss the strength of their pushes or pulls. Use the Language of Instruction to help model your descriptions, using your students’ ideas. Discuss how to get past the obstacle to move the ball into Square 7.
  - » Encourage students to consider different solutions. For Square 7, they might consider adding another block to act as a wall, which can deflect and change the direction of the ball. They might also consider allowing another student to catch the ball and push it into Square 7.
- Give each student a turn to be the tester as you prompt with one numbered square to direct the motion of the ball forward.
- Distribute Hitting the Spot (AP 1.5.1). Have students use one to three checkmarks to record the amount of force needed to hit each spot.
- After each student has had a turn, ask students to describe the push or pull to determine if it was just right, too hard, too soft, or the wrong direction. If the ball did not move to the prompted square, ask students to suggest how to change the push or pull.
- Continue taking turns until all students have been successful in moving the ball into a prompted square.

**SUPPORT**—As students take turns, be positive about all efforts whether they are successful or not. Explain that the point is to investigate how the types of pushes and pulls can change the motion of an object.

**EXTEND**—Ask students to add additional squares or obstacles to the course and investigate the amount of force needed to move the ball into those squares.

## 3. Guide discussion.

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### Activity Page



AP 1.5.1

- Review the results of Hitting the Spot (AP 1.5.1). If students have different results, have them repeat the test and resolve their differences.
- Discuss the following questions.
  - What affected the movement of the ball?
    - » the amount and direction of the push or pull



- How did you decide to push or pull the ball to move it to a particular spot?
  - » If the spot was toward you, you pulled. If it was away from you, you pushed.
- Did the strength of the tester affect the movement into a spot?
  - » No, it took the same force no matter how strong the tester was.

## 4. Check for understanding.

### Activity Page



AP 1.5.1



### Formative Assessment

Review student responses in the discussion and to Hit the Spot (AP 1.5.1) to determine student understanding of the following concepts:

- The type of push or pull affects how objects move and change direction.
- Objects move up or down or to the left or right depending on the forces in the form of pushes or pulls that act on the objects.
- Objects change direction when they hit other objects.

See the Activity Page Answer Key for correct answers and sample student responses.

Review the questions and observations made on the question board. Encourage students to suggest additions for you to make to the board of any questions or new observations.

### Tie to the Anchoring Phenomenon

Students investigate to make objects change the direction of movement with different types of pushes and pulls. Day-to-day life and most recreational activities are dependent on the direction of movement. For example, when students ride a bike, the bike needs to travel in the same direction the student is facing. This information will help them work toward building a miniature golf course in which they can demonstrate how to control and direct the movements and direction of objects by the types of pushes and pulls they exert.



## LESSON 2

# Changing Motion of Objects with Pushes and Pulls

### OVERVIEW

**Guiding Question:** How do pushes and pulls change motion?

Lesson 2 Segments	Segment Questions	Advance Preparation
<b>2.1 Starting and Stopping</b> Students experience starting motion, stopping motion, and changing the direction of an object in motion.	How are pushes and pulls related to the starting and stopping of moving things?	Gather materials for the two demonstrations. See Materials and Equipment.  Prepare for playground or gym experience.
<b>2.2 Golf Pushes and Pulls</b> Students gather evidence about the effect different strengths and directions of pushes and pulls have on the speed and direction of objects in motion.	How do pushes and pulls change motion in a miniature golf course?	Gather materials for student investigation. See Materials and Equipment.
<b>2.3 Pushes and Pulls Everywhere</b> (2 days) Students generalize their understanding of pushes and pulls to common events and solving problems to recognize that all motion is the result of forces acting on objects.	How do pushes and pulls change motion?	Read Chapters 3 and 4 in the Student Book.
<b>2.4 Lesson 2 Roundup: Tee Time</b> Students demonstrate different types of pushes and pulls in their miniature golf course and analyze their designs.	Does our miniature golf course change speed and direction of a ball the way we planned it to?	Gather materials for student investigation. See Materials and Equipment.

### What's the Story?

**Summary:** In Lesson 2, students explore changes in motion, including starting, stopping, slowing down, speeding up, and changing direction. They collect and analyze data and then apply what they have learned through demonstrating changes in motion to a miniature golf course they create.

**Learning Progression:** Lesson 2 builds on student understandings from Lesson 1, in which students begin to understand that all movement is the result of a push or a pull. In Lesson 2, they develop understanding of changing direction as well as starting and stopping.

**Guiding Phenomenon:** Understanding, controlling, and starting and stopping motion are critical to living in the world. They are also foundational to playing physical games. The amount of force used in a push or pull, as well as the direction, determines whether a basketball goes into a basket, whether a soccer ball is passed from player to player down a field and into the goal, or whether a golf ball goes into a cup. Motion, including force and direction, makes sports fun (K-PE-PS2-2)!

## Learning Objectives

**By the end of Lesson 2, students will do the following:**

- Identify the effects of different types of pushes and pulls on speed.
- Identify the effects of different surfaces on the distance an object can travel.
- Explain the effects of different types of pushes and pulls on the motion of objects.
- Describe collisions as events that stop or change the direction of objects in motion.
- Construct a solution to the problem of how to demonstrate the effects of different pushes and pulls on the motion of an object.

## NGSS Standards and Dimensions

**Performance Expectation:** K-PS2-2 Motion and Stability: Forces and Interactions

Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

<p><b>Science and Engineering Practice</b></p> <p><b>4 Analyzing and Interpreting Data</b></p> <p>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.</p> <p>Analyze data from tests of an object or tool to determine if it works as intended.</p>	<p><b>Disciplinary Core Ideas</b></p> <p><b>PS2.A Forces and Motion</b></p> <p>Pushes and pulls can have different strengths and directions.</p> <p>Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.</p> <p><b>ETS1.A Defining Engineering Problems</b></p> <p>A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (secondary)</p>	<p><b>Crosscutting Concept</b></p> <p><b>2 Cause and Effect</b></p> <p>Simple tests can be designed to gather evidence to support or refute student ideas about causes.</p>
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For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## LESSON 2.1

# Starting and Stopping

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** How do pushes and pulls change motion?

**Today's Question:** How are pushes and pulls related to the starting and stopping of moving things?

**Tie to the Anchoring Phenomenon:** Students explore stopping, starting, and collisions, which are key to any sport or game. Understanding these concepts and how they relate to forces and motion will lead to better players and make playing sports more fun. Golf pros, baseball players, and other athletes carefully study and practice specific movements and collisions to become better players.

## AT A GLANCE

### Learning Objectives

- ✓ Identify starting, stopping, speeding up, slowing down, and redirection as changes in motion.
- ✓ Describe collisions as pushes that change motion.

### Instructional Activities

- student investigation
- class discussion
- question generation

### NGSS References

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practice:** 4 Analyzing and Interpreting Data

**Crosscutting Concept:** 2 Cause and Effect

Students experience and observe an object starting and stopping to analyze the cause and effect of changes in motion.

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## Core Vocabulary and Language of Instruction

**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

**bounce  
start**

**bump into  
stop**

**faster  
turn**

**slow**

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

**catch  
direction**

**collide  
move**

**collision  
pull**

**contact  
push**

## Instructional Resources

Activity Page



AP 2.1.1

### Activity Page

Start and Stop (AP 2.1.1)

## Materials and Equipment

### Collect or prepare the following items:

- question board
- foam balls or soft bouncy balls such as rubber kickballs (1 per pair)
- arrange for a playground or gym space to run around
- internet access and the means to project images/video for whole-class viewing

## THE CORE LESSON 2.1

### 1. Introduce students to Lesson 2.

Students observe stops and starts, ask questions, and then engage in stopping and starting motion with pushes and pulls.

- Review what students learned about motion in Lesson 1 by asking these questions:
  - What is the difference between a push and a pull?
    - » A push is away from you. A pull is toward you.
  - What do pushes and pulls have to do with motion?
    - » They change the speed or direction of motion.
  - How can you make something move farther and faster?
    - » Push or pull harder. Make sure the surface is smooth.

NGSS Elements



SEP 4

CCC 2

DCI PS2.A

3D Learning

- If a ball rolls off the edge of a table, what happens?
  - » the ball falls
- Is the ball falling a change in direction?
  - » yes
- Can objects move without being pushed or pulled?
  - » yes, until another force changes the motion of the object or the direction in which it is moving

Tell students that, before they can answer the unit's Big Question about changing motion, they first need to understand how pushes and pulls cause objects to start and stop. In Lesson 2, they will learn more about starting and stopping in order to apply their understanding to the Big Question. Write the **Lesson 2 Guiding Question** where students can see it:

### How do pushes and pulls change motion?

#### Tie to the Anchoring Phenomenon

In sports and daily living, controlling and predicting starting and stopping motion makes better players and makes activities more fun.

## 2. Gather information.

#### NGSS Elements



SEP 4

CCC 2

DCI PS2.A

#### Online Resources



- Begin the lesson by asking a student to throw you a foam ball to catch. Repeat the process a few times with different students, making sure the students are observing the actions carefully. Ask students how the ball started and stopped moving. (See **Know the Standards.**)
  - » Someone pushed it, and you caught it.
- Show three or four examples from a video of famous baseball catches. See the Online Resources Guide for a link to the recommended video.
 

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)
- Ask how the baseball started moving.
  - » The pitcher pushed it away.

## Know the Standards

### TEACHER DEVELOPMENT

**Analyzing and Interpreting Data:** Data are the facts collected during an investigation. They become the evidence used in an investigation. The interpretation of data is essential for answering the questions an investigation poses. For this lesson, students should start to develop the habit of not only identifying causes and effects, but recognizing that data, e.g., the ball moved up, provides evidence to support their statements, e.g., "What happens when I bounce the ball against the floor?"

- Ask how the baseball changed direction.
  - » It crashed into the bat, which pushed it away.
- Ask how the baseball stopped moving.
  - » A player caught it.

### 3. Gather data in hands-on interaction.

NGSS Elements



SEP 4

CCC 2

DCI PS2.A

Differentiation

- Organize a game of Red Light, Green Light in a gym or on a playground. To play, the teacher starts as the caller. Have students line up horizontally about fifteen feet away from you. Turn your back to the students, and say, “Green light.” They can move toward you by walking or running. Then quickly turn around and say, “Red light.” Anyone you catch moving is “out” and must sit down on the sideline. Repeat until one player touches you during “green light.” That player is now the caller. Play at least five rounds of the game with different players as callers.
- Next give each pair of students a ball, and have them play catch for a few minutes. Ask them to observe how the ball starts and stops even when they don’t catch the ball.
- Finally ask student pairs to start the movement of the ball by pulling instead of pushing. Remind students that a pull is toward their body.

**SUPPORT**—Pulling the ball might be a challenge for some. You might demonstrate a quarterback snap in which a player pulls a ball in front of them so it moves between their legs.

### 4. Guide discussion.

Activity Page



AP 2.2.1

NGSS Elements



SEP 4

CCC 2

DCI PS2.A

- Distribute Start and Stop (AP 2.1.1). Ask students to think of their experience on the playground or in the gym and draw a picture of something that started the ball moving and something that stopped the ball’s motion.
- Discuss student drawings by asking these questions:
  - How did you start and stop motion in the red light, green light game?
    - » I made my body start walking/running. Then I made my body stop.
  - Did you push or pull your body in the red light, green light game?
    - » I pushed. My feet pushed on the ground.
  - How did you start and stop motion in your game of catch?
    - » I pushed the ball to throw it, and my partner stopped it by catching it.
  - How did the ball stop if you didn’t catch it?
    - » It bounced on the floor or against the wall and then slowed down.

- What is the effect of bumping into something, or colliding? (See **Know the Science**.)
  - » Things change direction or stop.

## 5. Check for understanding.

Activity Page



AP 2.1.1

NGSS Elements



Monitor Progress

SEP 4

CCC 2

DCI PS2.A

### Formative Assessment

Review student responses in the discussion and to Start and Stop (AP 2.1.1) to determine student understanding of the following concepts:

- Pushes and pulls start motion.
- Objects change direction or stop when they hit, or collide with, other objects.

See the Activity Page Answer Key for correct answers and sample student responses.

Review the questions and observations made on the question board. Encourage students to suggest additions for you to make to the board of any questions or new observations they have.

### Tie to the Anchoring Phenomenon

In this activity, students experienced starting motion and then stopping it by causing a collision. Controlled movement and collisions are fundamental to sports and recreational activities. In baseball, a hitter is out if an outfielder catches the ball. In kickball, you are out if the person on first catches the ball before you get to the base.

## Know the Science

## TEACHER DEVELOPMENT

**Collisions:** A collision occurs when two objects contact each other. At least one object must be in motion before a collision. Although people usually think of violent collisions, such as automobile accidents, in science, collisions don't have anything to do with amount of force. Instead, every time something touches something else, even when a leaf falls to the ground, it is a collision. Collisions affect motion. When two objects collide, movement stops or changes direction. Catching a ball is a collision in which the motion of the ball stops. A ball hitting a wall is a collision in which motion changes direction.

## LESSON 2.2

# Golf Pushes and Pulls

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** How do pushes and pulls change motion?

**Today's Question:** How do pushes and pulls change motion in a miniature golf course?

**Tie to the Anchoring Phenomenon:** Students begin designing a miniature golf course to demonstrate their growing understanding of how pushes and pulls affect movement in physical activities.

## AT A GLANCE

### Learning Objectives

- ✓ Gather evidence about effects of varying pushes and pulls on motion of objects.
- ✓ Relate the strength of pushes and pulls to relative changes in speed of objects in motion.
- ✓ Relate the direction of pushes and pulls to changes in direction of objects in motion.

### Instructional Activities

- student investigation
- student observation
- class discussion

### NGSS References

**Performance Expectation:** K-PS2-2

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practices:** 4 Analyzing and Interpreting Data; 3 Planning and Carrying Out Investigations; 6 Constructing Explanations and Designing Solutions

**Crosscutting Concept:** 2 Cause and Effect

Students gather evidence about the effect different strengths and directions of pushes and pulls have on the speed and direction of objects in motion and then use that knowledge to begin design on their miniature golf course.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)



# Core Vocabulary and Language of Instruction

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**bounce**      **bump into**      **faster**      **slow**  
**start**      **stop**      **turn**

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

**collide**      **collision**      **contact**      **direction**  
**move**      **pull**      **push**

## Instructional Resources

Activity Pages



AP 2.2.1  
AP 2.2.2

**Activity Pages**  
My Miniature Golf Hole Plan  
(AP 2.2.1)  
  
My Miniature Golf Hole  
(AP 2.2.2)

## Materials and Equipment

**Collect or prepare the following items:**

- question board
- golf play set including golf club, cup, and ball (1 set per pair)
- cardboard boxes, bricks, or blocks to construct the perimeter of the hole
- cardboard boxes to serve as obstacles
- crayons
- internet access and the means to project images/video for whole-class viewing

## Advance Preparation

If space is an issue, the course can be scaled back to using marbles as golf balls and wooden blocks and/or plastic bricks for the perimeter of the hole.

## THE CORE LESSON 2.2

### 1. Focus student attention on Today's Question.

#### Online Resources



#### NGSS Elements



SEP 1

SEP 4

CCC 2

DCI PS2.A

#### How do pushes and pulls change motion in a miniature golf course?

- Ask if any students have ever played miniature golf or have a golf play set. Next, play a few minutes of this miniature golf course video to provide a shared experience. Then ask questions such as the following. See the Online Resources Guide for a link to the recommended video:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

- **What do you need to play miniature golf?**
  - » golf club, ball, tee, cup, sides, and maybe some obstacles
- **Why would you have to hit the ball harder or softer?**
  - » You must hit the ball harder when you are farther from the cup. You must hit it softer when you get close to the cup.
- **How does the ball change direction?**
  - » It bumps into the side or an obstacle.
- Explain that today students are going to work in pairs to design one hole for a miniature golf course.
- Create a “Plan and Evaluate” board for the task that they will design and demonstrate in another lesson segment. Explain that each pair of students will have to demonstrate each of the following in the hole they design:
  - hard push
  - soft push
  - pull
  - fast
  - slow
  - change in direction

#### Tie to the Anchoring Phenomenon

Controlling how pushes and pulls make things start and stop moving and change direction is important to developing proficiency in sports.

## 2. Introduce the miniature golf course plan.

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### Activity Page



AP 2.2.1

### NGSS Elements



SEP 1

SEP 4

SEP 6

CCC 2

DCI PS2.A

Differentiation

- Distribute My Miniature Golf Hole Plan (AP 2.2.1). Discuss the parts of a miniature golf course they saw in the video.
  - » cup or hole, sides, green, and obstacle
- Ask students to describe some of the shapes of the miniature golf holes they saw.
  - » straight, L shape, zigzag, curved
- Brainstorm different obstacles students might include in their plans.
  - » for example, a box with a hole for the ball to go through, a solid block that the ball has to go around
- Have students draw a plan for their miniature golf hole.

**SUPPORT**—Some students may have difficulty drawing. Have them describe their plan as you or an aide draws it on the board. Then have them copy it onto the Activity Page.

## 3. Implement the plan.

---

### NGSS Elements



SEP 3

SEP 4

SEP 6

CCC 2

DCI PS2.A

3D Learning

- Gather cardboard boxes or blocks to use as the sides of the holes, along with balls, clubs, and cups, and move to an area large enough for student pairs to construct their golf holes.
- Have pairs of students construct a miniature golf hole based on the plans they drew, using the materials provided. Emphasize that they can and should change their plans as needed as they construct their holes. Explain that they may have to take down their work but will record what they did so they can recreate it to demonstrate.
- After the hole is created, have them try playing the hole. They may want to make changes in the sides or obstacles.

In creating their miniature golf holes, students will interpret the data they have gathered about the effects of different forces on the motion of objects, how motion stops and changes direction. Designing a miniature golf course layout is a solution to the engineering problem they are trying to solve.

## 4. Draw the plan.

### Activity Page



AP 2.2.2

### NGSS Elements



SEP 3

CCC 2

DCI PS2.A

- Distribute My Miniature Golf Hole (AP 2.2.2). Have student pairs draw the miniature golf hole they set up. Include the number of pieces used to create the sides and the placement of any obstacles, as well as the cup. Provide different-colored crayons so students can color-code the different elements of their design.
- Have students include the ideal path for the ball to travel to the hole and an example of the path they were able to follow using the golf club and ball. (See **Know the Standards.**)
- If need be, have students tear down their work.

## 5. Check for understanding.

### Activity Pages



AP 2.2.1

AP 2.2.2

### NGSS Elements



SEP 4

SEP 6

CCC 2

DCI PS2.A

Monitor Progress

### Formative Assessment

As part of their analysis, ask students to compare their plans in My Miniature Golf Hole Plan (AP 2.2.1) and their recording of miniature golf holes they built in My Miniature Golf Hole (AP 2.2.2). Answers will vary to these questions:

- **How are they the same?**
- **How are they different?**
- **What changes did you make?**

Review the “Plan and Evaluate” board criteria.

## Know the Standards

### TEACHER DEVELOPMENT

**Performance Expectation: K-PS2-2 Motion and Stability: Forces and Interactions:** This Performance Expectation requires that students design a solution that involves having an object move a certain distance, follow a particular path, and change motion. The miniature golf course hole will allow students to demonstrate this Performance Expectation by beginning with a hard push to move the ball through the course, a soft push to get the ball into the cup, and obstacles that require a change in direction.

- Ask students if they will be able to demonstrate each of the elements playing the hole they created:
  - hard push
  - soft push
  - pull
  - fast
  - slow
  - change in direction
- If not, how will they change their design?
  - » For example, the design may not require a change in motion. They can include a curve or angle that the ball hits so it changes direction.

Review the questions and observations made on the question board. Encourage students to suggest additions for you to add to the board if they have any questions or new observations.

### **Tie to the Anchoring Phenomenon**

In this activity, students created and implemented a plan for a miniature golf course hole that will allow them to demonstrate the effect of different pushes and pulls on the movement of a golf ball.

## LESSON 2.3

# Pushes and Pulls Everywhere

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** How do pushes and pulls change motion?

**Today's Question:** How do pushes and pulls change motion?

**Tie to the Anchoring Phenomenon:** In this lesson, students expand their awareness of pushes and pulls so they can apply their growing knowledge in their construction of a miniature golf course.

## AT A GLANCE

### Learning Objectives

- ✓ Relate the strength of pushes and pulls to relative changes in speed of objects in motion.
- ✓ Relate the direction of pushes and pulls to changes in direction of objects in motion.

### Instructional Activities

Day 1

- teacher Read Aloud
- class discussion
- question generation

Day 2

- teacher Read Aloud
- class discussion
- question generation

### NGSS References

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practices:** 1 Asking Questions and Defining Problems; 8 Obtaining, Evaluating, and Communicating Information

**Crosscutting Concept:** 2 Cause and Effect

Students will make connections between the strength and direction of pushes and pulls to changes in the speed and direction of objects in motion.

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## Core Vocabulary and Language of Instruction

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**slow**

**start**

**stop**

**turn**

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**bounce**  
**contact**  
**pull**

**bump into**  
**direction**  
**push**

**collide**  
**fast**

**collision**  
**move**

### Instructional Resources

Student Book



Ch. 3, 4

**Student Book, Chapter 3**  
“Pushes and Pulls Are All Around You”

**Student Book, Chapter 4**  
“How Can Pushes and Pulls Solve Problems?”

Activity Page



AP 2.3.1

**Activity Page**  
Push Me or Pull Me? (AP 2.3.1)

### Materials and Equipment

**Collect or prepare the following items:**

Both days

- question board
- internet access and the means to project images/video for whole-class viewing

## 1. Day 1: Focus student attention on Today’s Question.

NGSS Elements



SEP 8

CCC 2

DCI PS2.A

Monitor Progress

**How do pushes and pulls change motion?**

- Pull a door or drawer open. Ask students whether you demonstrated a push or a pull.
  - » a pull
- Then push a chair or other object, and ask whether you demonstrated a push or a pull.
  - » a push

- Ask individual students to demonstrate a push or pull, and have the class identify which it is.
- Explain that today you are going to read about pushes and pulls all around. (See **Know the Standards 1.**)

### Tie to the Anchoring Phenomenon

Students have been focusing on pushes and pulls in sports activities as well as designing a miniature golf course. This lesson expands on student awareness of forces and motion in all aspects of life.

In this lesson segment, students will consider how to describe pushes and pulls as well as the causes and effects of a wide variety of movements. They will ask questions about forces and expand their understanding of how pushes and pulls can solve problems.

NGSS Elements



3D Learning

## 2. Read together: “Pushes and Pulls Are All Around You.”

Student Book



Ch. 3

While some advanced students may be able to read words on a given page of the Student Book, as a general rule students should not be expected or asked to read aloud the text on the Student Book pages. The text in the Student Book is there so that teachers and parents can read it when sharing the Student Book with students.

NGSS Elements



SEP 1

CCC 2

DCI PS2.A

## Know the Standards

## TEACHER DEVELOPMENT

**1. Cause and Effect:** Understanding about causal relations, the cause and effect of something happening, is a fundamental understanding in science. The readings emphasize that all events have causes, the reasons things happen. Identifying a cause of an event often follows after someone has discovered patterns in something happening. For example, if a door was hard to open only on humid days, there is a clear pattern. The next step would be to identify the cause. In the case of motion, all changes in motion are caused by a push or a pull. An object that was in motion and is now at rest is the result of a push or pull on that object. A major activity of science is to find the causes of phenomena.




Ask students to turn to page 14 of the Student Book and look at the pictures as you read aloud. Remind them that the title of this chapter is “Pushes and Pulls Are All Around You,” and tell them to pay special attention to whether there is a push or a pull in the picture as you read.

CHAPTER  
3


## Pushes and Pulls Are All Around You

Pushes and pulls happen all around you every day. You can see pushes and pulls at home.

You pull open the refrigerator doors to look for a snack. Then you push the door to close it.



You can push or pull a handle to turn water on and off.



14

Ask students to look at the two pictures on page 14 as you read aloud.

**EVALUATIVE**—Can you push and pull the same thing?

- » You can pull something open and push it closed. You can pull something on and push it off.

**CORE VOCABULARY**—Review that a **push** is away from you and a **pull** is toward you.

**SUPPORT**—Review the differences between pushes and pulls by modeling the two for students. Encourage students to follow along with an object of their choice.

**CHALLENGE**—Explain that *push* and *pull* are opposites. Ask students to think of other opposites, such as *up* and *down*, *open* and *closed*, and *in* and *out*.

You can see pushes and pulls in everyday life.



At a grocery store, a shopper pulls fruit from a shelf.



Another shopper pushes a cart.



A baker pulls racks of bread.



A deli worker pushes and pulls a blade to cut meat.

Think about pushes and pulls on a playground.

To climb up the ladder, you use pushes and pulls. You push with your legs. You pull up with your arms.



You don't push to go down the slide. Gravity pulls you down a slide.

16

**EVALUATIVE**—What pushes and pulls do you see every day?

» for example, pushing a stroller, pulling a wagon or a chain on a lamp

Here are more pushes and pulls you might see every day. Pushes and pulls can make things move.

When a person zips your jacket, do they use a push or a pull?

The ball flies into the air. Who used a push to move the ball?



17

**LITERAL**—What is moving in the pictures?

» the ball and the people, the zipper and hand

**EVALUATIVE**—Do you push or pull a zipper?

» You can push it down and pull it up.

### 3. Read together: “How Can You Describe Pushes and Pulls?”

#### Read Aloud Support

#### Page 18

NGSS Elements



SEP 8  
CCC 2  
DCI PS2.A

Ask students to turn to page 18 of the Student Book and look at the picture as you read aloud. Remind them that the title of this section is “How Can You Describe Pushes and Pulls?” Tell them to pay special attention to words that describe pushes and pulls.

#### How Can You Describe Pushes and Pulls?

Pushes and pulls can be different strengths. They can also go in different directions. So you can describe pushes and pulls.

It takes a strong pull for this tractor to start to move a load of lumber.



- Ask students to look at the picture on page 18 as you read aloud.

**EVALUATIVE**—How do you describe pushes and pulls?

» For example, pushes and pulls make things move.

**CORE VOCABULARY**—Explain that to **move** means to change location from one place to another. *Movement* and *motion* are words related *move*.

**SUPPORT**—Have students demonstrate a movement by, for example, raising their hands. Discuss whether the movement was caused by a push or a pull.



### Weak or Strong

Some pushes and pulls are soft and weak. Some pushes and pulls are hard and strong.

A weak push will move this softball only a little. A soft hit is a weak push.

A strong push will make the same ball go far. A hard swing is a strong push.



Pushes and pulls change the speed of things that are moving.

Riders get into the water on tubes. The water pushes them to begin slowly moving.



A hard push makes a hockey puck move very fast. What happens to the puck when the boy pushes softly?

20

**INFERENTIAL**—What is the difference between a hard or strong push and a weak or soft push?

- » Hard pushes make things move farther or faster. Soft pushes make things move slower.

**CORE VOCABULARY**—Explain that like opposites *push* and *pull*, **faster** and *speed up* are the opposites of *slower* and **slow** down. Ask students to demonstrate standing up fast and sitting down slowly.

**Up and Down, Side to Side**

Pushes and pulls move things in different directions.

The spinning toy rolls down the string. When it gets to the bottom, the string pulls on the toy. The pull changes a toy's direction. The toy goes back up.



A push moves the saw blade forward. Then a pull changes the saw's direction to backward.

The ball is rolling toward the girls. Which one will push the ball with her stick? What will happen to the direction the ball is moving?



21

**LITERAL**—What directions are things moving in each picture?

» around, up and down, back and forth, forward

**EVALUATIVE**—What are other directions pushes and pulls can make things move?

» side to side, zigzag, backward, over, under



## 4. Read together: “Starts, Stops, and Turns.”

### Read Aloud Support

#### Page 22

NGSS Elements



SEP 8  
CCC 2  
DCI PS2.A

Ask students to turn to page 22 of the Student Book and look at the pictures as you read aloud. Remind them that the title of this section is “Starts, Stops, and Turns.” Tell them to pay special attention to what happens when things bump into each other.

#### Starts, Stops, and Turns

Look around the room you are in. Many objects are still. They are not moving. They are at rest. An object that is not moving stays at rest until it is pushed or pulled.

Some of these objects are moving. Some are at rest. What will cause the objects at rest to move?



22

- Ask students to look at the pictures on page 22 as you read aloud.

**LITERAL**—What will make the object in each picture move?

- » the push of the domino, the push of the golf club, the dog pushing, the wind pushing the pinwheel

**CORE VOCABULARY**—Explain that like opposites *push* and *pull* and *fast* and *slow*, **start** and **stop** are opposites. Ask students to demonstrate starting to raise their hands and then stopping.

Moving objects can bump into each other, too. At first the bat is at rest. Then the boy pushes the bat. What will happen when the bat bumps into the ball?



23

These balls are at rest.  
They are not moving.



A player pushes the  
white ball with the  
stick. The white ball  
was at rest. Now it  
is moving.

The white ball bumps  
into the colored balls.  
Now the balls move.  
The balls push on  
each other.



24

**INFERENTIAL**—What is happening in the pictures when a moving object bumps into another object?

» Objects move in different directions.

**CORE VOCABULARY**—Explain that to **bump into** something means that a moving object touches another object. If something is moving fast, you can break or bruise something. If a moving object **bounces**, it also touches something but does not break. Ask students to demonstrate gently bumping into a desk or chair. Then demonstrate a bounce by dropping a ball on a table or floor and watching it bounce.

Sometimes when objects bump into each other, they stop each other. One of these cars bumped into the other one. They once were moving. Now they are both at rest.



Football players push on each other. They slow each other down. Both were moving forward. Now neither one is moving forward.



Pushes and pulls can change the direction of something that is moving. Look at the tennis ball. Which way is it going? Which way do you think it will go after the racquet pushes it?



26

**LITERAL**—What can happen when things bump into each other?

» They can stop or change direction.

**EVALUATIVE**—When do you touch things to make them stop or change direction?

» For example, I touch my socks to put them on my feet. I touch the door to open it. I touch my fork to push it into my lunch to pull it into my mouth.

**CORE VOCABULARY**—Explain that to **turn** is to change direction.

A push or pull can make something turn. Ask students to demonstrate pushing or pulling an object such as a pencil to make it turn.

You know that pushes and pulls can be strong or weak. Weak and strong pushes and pulls change an object's motion in different ways. A strong push causes a big change to the motion of this ball.



A gentle push causes a smaller change to the motion of the same kind of ball.



27

**LITERAL**—What can you expect will happen when a ball is pushed strongly instead of weakly?

» It will go faster and farther.



## 1. Day 2: Refocus student attention on Today's Question.

Student Book



Ch. 4

NGSS Elements



SEP 8

CCC 2

DCI PS2.A

### How do pushes and pulls change motion?

- Ask students to describe a push or a pull they saw on the way to school.
  - » I pushed the school door open. I pulled my backpack on.
- Then pick up a book or other object, and ask whether you demonstrated a push or a pull.
  - » a pull
- Ask individual students to demonstrate a push or a pull, and have the class identify what it is.

## 2. Read together: “How Can Pushes and Pulls Solve Problems?”

Explain that today you are going to read about how pushes and pulls can be used to solve problems. (See **Know the Standards 2.**)

### Tie to the Anchoring Phenomenon

Students have been focusing on pushes and pulls in sports activities as well as designing a miniature golf course. This lesson builds on a more general understanding that pushes and pulls can be used to solve many different everyday problems.

In this lesson segment, students will consider the causes and effects of a wide variety of movements. They will ask questions about forces and expand their understanding of how pushes and pulls can solve problems.

NGSS Elements



3D Learning

## Know the Standards

## TEACHER DEVELOPMENT

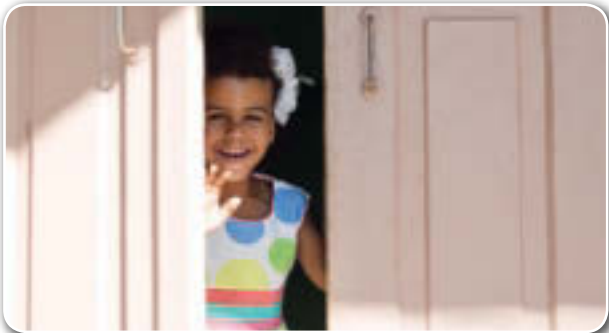
**2. Solving Problems:** Science is often used to solve design and engineering problems. The advantage to this approach is that the scientific method requires gathering and analyzing data. In this way, patterns can emerge, such as identifying which solution worked best.

Ask students to turn to page 28 of the Student Book and look at the pictures as you read aloud. Remind them that the title of this chapter is “How Can Pushes and Pulls Solve Problems?” Tell them to pay special attention to the problems presented.


CHAPTER  
4

## How Can Pushes and Pulls Solve Problems?

Pushes and pulls can solve problems. What are some ways pushes and pulls help you at home? You push and pull a door to open and close it. The problem is how to get outside. You solve the problem by using a pull. The door opens. A problem is solved!



Here is another problem. It is dark. How can you turn on a light to see? You can pull a cord to turn on a light. A problem is solved!



28

Ask students to look at the two pictures on page 28 as you read aloud.

**INFERENTIAL**—How can pushes and pulls solve problems?

» A push or pull can make something move so you get what you want.



Time for bed. The problem is getting up into the bed. You climb a ladder to get to the top bunk. A problem is solved! Is climbing pushing, pulling, or both?



How do you gather leaves?  
You pull them with a rake.

People use pushes and pulls to solve problems. People build things like doors and rakes so they can use pushes and pulls.

These inventions work using pushes and pulls, too. What problems do they help solve?



Does a snowplow push snow or pull it?

Painters use ropes to pull buckets of paint up to a rooftop. Can you think of an invention that could help solve that problem more easily?



Backhoes pull large amounts of dirt.

30

**INFERENTIAL**—What are some tools you use to help pushes and pulls solve problems?

» for example, a broom, a hairbrush, a hammer, a rope, a wagon

When people build things to solve problems, they go through steps. They have new ideas. They often draw their plans.

Here is a drawing of a plan that solves a problem. What is the problem? Does this plan solve the problem using pushes or pulls?



31

**INFERENTIAL**—What is the problem to solve in this picture?

» to move the bucket up to the tree house

**EVALUATIVE**—Does the plan solve the problem with pushes or pulls?

» pulls using a pulley to lift the bucket

## 2. Check for understanding.

Activity Page



AP 2.3.1

NGSS Elements



SEP 1

CCC 2

DCI PS2.A

Monitor Progress

### Formative Assessment

Distribute Push Me or Pull Me? (AP 2.3.1), and have students circle the objects they can push and put an X over things they can pull. Then discuss their answers.

- » They should mark each picture with a circle and X because each of the objects can be pushed and pulled.

Review student responses in the reading questions and to Push Me or Pull Me? (AP 2.3.1) to determine student understanding of the following concepts:

- Pushes and pulls are the cause of all movement.
- The strength of a push or pull makes objects move slower or faster.
- Objects in motion stop or change direction when they touch other objects.
- An object that is at rest is one that is not in motion. (See **Know the Science.**)

Review the questions and observations made on the question board. Encourage students to suggest additions for you to make to the board of any questions or new observations they have.

### Tie to the Anchoring Phenomenon

In this reading, students encountered the use of pushes and pulls in everyday life being applied to solve problems so they can generalize beyond the recreational activities they have been focusing on. Pose the problem: How can students get to the library on the second floor of a school? Have students brainstorm ways to get to the second floor and identify if a push or a pull would be required, such as students' feet pushing up steps or the cable in an elevator pulling the box up to the second floor.

## Know the Science

### TEACHER DEVELOPMENT

**Objects at Rest:** Newton's first law holds that an object in a state of motion will remain in that state of motion unless acted on by an external force. A rolling ball would continue to roll forever except for the force of gravity pulling the ball down and the force of friction with the floor and the force of air resistance slowing the ball's forward movement. Note that the same ball sitting on a desk is also in a state of motion—that of no motion. Gravity pulls the ball down toward Earth's center, and the desk opposes the motion of the ball. Two equal forces are acting on the ball, just in opposing directions, so the ball has no motion.

## LESSON 2.4

# Lesson 2 Roundup: Tee Time

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** How do pushes and pulls change motion?

**Today's Question:** Does our miniature golf course change the speed and direction of a ball the way we planned it to?

**Tie to the Anchoring Phenomenon:** In this lesson, students will begin playing a mini-golf course to demonstrate their growing understanding of how pushes and pulls affect movement in physical activities.

## AT A GLANCE

### Learning Objective

- ✓ Evaluate solutions designed to change speed or direction of objects with pushes and pulls.

### Instructional Activities

- student investigation

### NGSS References

**Performance Expectation:** K-PS2-2 Motion and Stability

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practices:** 1 Asking Questions and Defining Problems; 4 Analyzing and Interpreting Data

**Crosscutting Concept:** 2 Cause and Effect

Students will analyze data to determine if a design solution works as intended to change the speed and/or the direction of an object with a push or a pull.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## Core Vocabulary and Language of Instruction

**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

**build   draw   plan   test**

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

**compare materials   design problem   evaluate record   investigate solution**

## Instructional Resources

Activity Pages



AP 2.2.2 (from  
Lesson 2.2)  
AP 2.4.1

### Activity Pages

My Miniature Golf Hole (AP 2.2.2)  
Tee Time (AP 2.4.1)

## Materials and Equipment

### Collect or prepare the following items:

- question board
- golf play set including golf club, cup, and ball (1 set per pair)
- cardboard boxes, bricks, or blocks to construct the perimeter of the hole
- cardboard boxes to serve as obstacles
- modeling clay or removable tape

## Advance Preparation

- If space is an issue, the course can be scaled back to using marbles as golf balls and wooden blocks and/or plastic bricks for the perimeter of the hole.
- If time allows, have students try out each other's designs.

## THE CORE LESSON 2.4

### 1. Focus student attention on Today's Question.

NGSS Elements



SEP 1  
SEP 4  
CCC 2  
DCI PS2.A

Activity Pages



AP 2.2.2  
AP 2.4.1

#### **Does our miniature golf course change the speed and direction of a ball the way we planned it to?**

Review the designs that students made for the miniature golf course from Lesson 2.2.

- Review the “Plan and Evaluate” board for the task, and distribute Tee Time (AP 2.4.1), which lists the criteria. Explain that students will have to demonstrate each of the following types of pushes and pulls in the hole they created:
  - hard push
  - soft push
  - pull
  - fast
  - slow
  - change in direction
- Gather cardboard boxes or blocks to use as the sides of the holes along with balls, clubs, and cups, and move to an area large enough for student pairs to reconstruct their golf holes.
- Have pairs of students use My Miniature Golf Hole (AP 2.2.2) to rebuild their golf hole if they had to deconstruct it previously so that there is a complete course. Allow them to change their designs based on additional information.
- Allow students to practice playing their hole and attempting each type of push and pull. Encourage them to make adjustments if need be.
- The cups representing the hole should be set on their side so the ball can roll in. Have small amounts of modeling clay or removable tape available to hold the cups in place.

#### **Tie to the Anchoring Phenomenon**

Controlling how pushes and pulls make things start and stop moving and change direction is important to developing proficiency in sports.

## 2. Demonstrate.

### Activity Page



AP 2.4.1

### NGSS Elements



SEP 1

SEP 4

CCC 2

DCI PS2.A

Differentiation

- Have each pair of students demonstrate each of the types of pushes and pulls as they play their golf hole, as the rest of the class watches. They should take turns hitting the ball as they progress to getting it into the cup. Ask the pair to announce the type of push or pull they are demonstrating before each attempt.
- After each pair has completed the hole, regardless of how many strokes it takes to get the ball in the cup, discuss the demonstration with the class using these questions. (See **Know the Science**.)
  - **Which push was the hardest?**
  - **Which push was the softest?**
  - **Which push made the ball go the fastest?**
  - **Which push made the ball go the slowest?**
  - **How did they pull the ball?**
  - **When and how did the ball change direction?**
  - **Is the ball in motion when it is not moving?**
    - » Responses will depend on student demonstrations.
- When all students have completed their demonstrations, allow them to play each other's holes as time allows.

**SUPPORT**—Keep student focus on the types of pushes and pulls they are demonstrating rather than on how many strokes they use to complete the hole.

## 3. Discuss with students.

### NGSS Elements



SEP 4

CCC 2

DCI PS2.A

- With the class, compare the different holes that students created:
  - **Which hole took up the most space?**
  - **Which hole took up the least space?**
  - **Which hole took the most bounces to make?**
  - **Which hole took the fewest bounces to make?**
  - **Which hole was the easiest to complete and why?**
  - **Which hole was the most difficult to complete and why?**
    - » Responses will depend on student demonstrations.

## Know the Science

## TEACHER DEVELOPMENT

**Teaching Physical Science:** Many people have anxiety about learning physical science. Negative attitudes are typically learned. Basing scientific principles in natural phenomena that students intuitively understand will help them realize that this study is simply a way to describe and understand everyday events, which is the primary goal of science.





In demonstrating different pushes and pulls with their miniature golf holes, students interpret the data they have gathered about the effects of different forces on the motion of objects and how motion stops and changes direction. The designing of and building of their miniature golf holes is a solution to the engineering problem they are trying to solve.

## 4. Check for understanding.

### Formative Assessment



Review the “Plan and Evaluate” board criteria. Discuss the different ways students demonstrated each of the types of pushes and pulls:

- hard push
- soft push
- pull
- fast
- slow
- change in direction

Review student responses to determine student understanding of the following concepts:

- Pushes and pulls are the cause of all movement.
- The strength of a push or pull has the effect of making objects move slower or faster.
- Objects in motion stop or change direction when they collide with other objects.

Review the questions and observations made on the question board. Encourage students to suggest additions for you to make to the board of any questions or new observations they have.

### Tie to the Anchoring Phenomenon

In this activity, students demonstrated the effect of different pushes and pulls on the movement of objects in a recreational activity.

## LESSON 3

# Magnetism: A Noncontact Force

### OVERVIEW

**Guiding Question:** Can objects that are not touching push and pull each other?

Lesson 3 Segments	Segment Questions	Advance Preparation
<b>3.1 No-Touch Forces</b> Students experience starting motion, stopping motion, and changing the direction of an object in motion from a noncontact force.	How can magnets push and pull?	Gather materials for the activity. See Materials and Equipment.
<b>3.2 Invisible Pushes and Pulls</b> Students extend their understanding of forces that can make things move without touching.	What are some invisible pushes and pulls?	Read Chapter 5 in the Student Book.  Gather materials for the activity. See Materials and Equipment.
<b>3.3 Lesson 3 Roundup: Invisible Tee Time</b> Students apply their understanding of gravity and magnetism to the miniature golf course they designed and built.	How can we use invisible pushes and pulls to improve our miniature golf course?	Gather materials for the activity. See Materials and Equipment.

### What's the Story?

**Summary:** In Lesson 3, students explore how objects that are not touching other objects can move. They recognize that forces students cannot see, such as gravity and magnetism, are forces that can affect movement.

**Learning Progression:** Lesson 3 builds on student understandings from Lessons 1 and 2, in which students begin to figure out that all movement is the result of a push or a pull. In the lesson series of Lesson 3, they experience the effects of pushes and pulls of gravity and magnetism.

**Guiding Phenomenon:** Understanding, controlling, starting and stopping, and changing the direction of objects in motion are critical to everyday living. They are also foundational to playing physical games. Forces affect movement even when objects are not in contact with the force. Gravity, for example, affects all movement in the world. Understanding and accounting for the effects of gravity on jumping, falling, and hitting and throwing a ball has a direct effect on the outcome of games or recreational activities.

## Learning Objectives

**By the end of Lesson 3, students will be able to:**

- Describe noncontact pushes and pulls caused by gravity and magnetism.
- Identify the effects of invisible pushes and pulls on the motion of objects.
- Explain everyday uses of invisible forces.
- Construct a solution to the problem of how to demonstrate the effects of invisible pushes and pulls on the motion of an object.

## NGSS Standards and Dimensions

**Performance Expectation:** K-PS2-2 Motion and Stability: Forces and Interactions

Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concept
<b>4 Analyzing and Interpreting Data</b> Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. Analyze data from tests of an object or tool to determine if it works as intended.  <b>1 Asking Questions and Defining Problems</b> Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions. Ask questions based on observations to find more information about the natural and/or designed world(s).  Define a simple problem that can be solved through the development of a new or improved object or tool.	<b>PS2.A Forces and Motion</b> Pushes and pulls can have different strengths and directions.  Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.  <b>ETS1.A Defining Engineering Problems</b> A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (secondary)	<b>2 Cause and Effect</b> Simple tests can be designed to gather evidence to support or refute student ideas about causes.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## LESSON 3.1

# No-Touch Forces

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** Can objects that are not touching push and pull each other?

**Today's Question:** How can magnets push and pull?

**Tie to the Anchoring Phenomenon:** In this lesson, students explore how the invisible forces of gravity and magnetism can move objects even if they are not touching. All life activities, including sports activities, on Earth are affected by gravity. Balls fall and roll downhill. People stay on the ground when running and fall back down when they jump up. Although magnetism is not a critical part of most recreational activities, understanding this force confirms that magnetism can have the effect of objects moving even if they are not touching.

## AT A GLANCE

### Learning Objectives

- ✓ Demonstrate noncontact (invisible) pushes and pulls.
- ✓ Classify materials according to whether they are or are not attracted by a magnet.

### Instructional Activities

- student investigation
- class discussion
- question generation

### NGSS References

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practices:** 4 Analyzing and Interpreting Data; 1 Asking Questions and Defining Problems

**Crosscutting Concept:** 2 Cause and Effect

Students experience starting motion, stopping motion, and changing the direction of an object in motion from a noncontact force.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## Core Vocabulary and Language of Instruction

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**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

fall	magnet	metal	not touching
pull	push	touching	at rest

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

contact	force	gravity	invisible
magnetic	metallic		

## Instructional Resources

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Activity Page



AP 3.1.1

**Activity Page**

Magnetic or Not? (AP 3.1.1)

## Materials and Equipment

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**Collect or prepare the following items:**

- question board
- variety of magnets, which can include magnetic screwdriver, refrigerator magnets, magnetic signs, magnetic pickup tool, horseshoe magnet, bar magnet (at least 1 per student)
- variety of magnetic (steel nuts, paper clips, keys, scissors, spoon) and nonmagnetic (wood block, pencil, penny, plastic bricks, marbles, aluminum foil square) objects (at least 1 of each per student)
- magnetic marbles (5 per student)
- internet access and the means to project images/video for whole-class viewing
- box or plastic container (1 per student)

# THE CORE LESSON 3.1

## 1. Introduce students to Lesson 3.

NGSS Elements



SEP 1  
SEP 4  
CCC 2  
DCI PS2.A

Students gather, analyze, and interpret data related to the force of magnetism.

Ask a volunteer to state the **Big Question** that you'll be answering in this unit, which is posted somewhere in the room—**How can pushes and pulls change motion of objects?**

- Briefly review what students learned about motion in Lessons 1 and 2 by asking these questions:
  - What is the difference between a push and a pull?
    - » A push is away from you. A pull is toward you.
  - What do pushes and pulls have to do with motion?
    - » They make things move.
  - How can you make something move farther and faster?
    - » Push or pull harder. Make sure the surface is smooth.
  - Do things move without being pushed or pulled more?
    - » Yes. An object can be motion without any force acting on it.

Tell students that, to answer the unit's Big Question about changing motion, they will explore invisible forces that make things move without touching. Write the **Lesson 3 Guiding Question** where students can see it:

**Can objects that are not touching push and pull each other?**

### Tie to the Anchoring Phenomenon

In sports and daily living, knowing about noncontact forces like gravity makes better players and makes activities more fun.

## 2. Gather information.

NGSS Elements



SEP 4  
CCC 2  
DCI PS2.A

- Distribute one marble to each student. Have them lift it over their desk or table, and ask what will happen if they let it go.
  - » It will fall.
- Ask them to let go of the object and observe what happens. Then ask the following questions:
  - Did you push or pull the marble to make it fall?
    - » no
  - What made the object fall?
    - » Everything falls to the ground if you don't hold it up.

- Can you see the force that made the object fall?
  - » no
- Think of a time you fell. Which direction did you fall?
  - » down
- Did something push or pull you?
  - » No, I just fell.
- Demonstrate and then have students make a ramp by tilting one end of a book up.
  - What will happen if you put the marble at the high end and let go?
    - » It will roll down.
- Ask students to see if their prediction is correct by letting the marble roll down the book ramp.
  - What made the marble roll down and not up?
    - » Everything moves down.
- Explain that there are some forces you can't see that make things move without touching. One of those is gravity. Another is magnetism. (See **Know the Science.**)

## Know the Science

## TEACHER DEVELOPMENT

**Invisible Forces:** Invisible forces like gravity and magnetism extend student understanding of motion because these forces can change the motion of objects without touching them. But gravity and magnetism are not the same thing. Gravity is an attractive force between any two objects regardless of what they are made of. The planets are attracted to the sun, and the sun is attracted to each planet. Earth's moon is attracted to Earth, and Earth is attracted to the moon. Magnetism can cause objects to be attracted or repelled based on what the objects are made of. Both forces affect objects at a distance but get weaker when objects are farther apart. That's why we sense the pull of gravity from Earth but not from other planets.

### 3. Hands-on interaction.

#### Activity Page



AP 3.1.1

#### NGSS Elements



SEP 2

CCC 2

DCI PS2.A

#### Differentiation

- Distribute the magnetic and nonmagnetic materials to each student in the box or plastic container. Then give each student a magnet.
- Distribute Magnetic or Not? (AP 3.1.1) to each student, and explain that they will be sorting the materials depending on whether they are attracted to the magnet or not. (See **Know the Standards.**)
- Encourage them to explore the magnet and the materials. Then have them sort the materials into magnetic and nonmagnetic.
- Distribute at least five magnetic marbles to each student. Ask them to test to see whether they are magnetic or not.
- Then ask them to demonstrate how two magnetic marbles pull toward each other.
- Next ask them to demonstrate how two magnetic marbles push away from each other.
- Tell pairs of students to combine their magnetic marbles and see which ones are pulled together and which ones are pushed apart.

**EXTEND**—Allow students to explore the classroom, collecting items that are attracted to the magnet.

### 4. Guide discussion.

#### NGSS Elements



SEP 4

CCC 2

DCI PS2.A

- Discuss student sorting by asking these questions:
  - **How could you tell when something was attracted to the magnet?**
    - » I could feel a pull, and then the items stuck to the magnet.
    - » The metal marble moved to the magnet.
    - » I could stick the magnet to the metal cabinet.
  - **Could you see the magnetic force?**
    - » no
  - **What are the items that are attracted to the magnet made of?**
    - » They are all metal.

## Know the Standards

## TEACHER DEVELOPMENT

**Classification:** When students sort materials, they are classifying the materials. Classification is essential to science. Classification is the organizing of things into categories or classes based on shared characteristics or properties. For example, if you were sorting animals, you would have a group called “birds,” and they would be animals that lay eggs and have beaks, feathers, and wings. The birds could be further sorted into those that have talons, sharp claws for grasping, and those that do not have talons. Based on this classification, you could predict that birds with talons are carnivores.



- **What items are not attracted to magnets?**
  - » They are wood and plastic and some metal.
- **Compare your sorting results with others. Did everyone find that the same materials were magnetic and not magnetic?**
  - » yes
- **Can you feel a pull between two magnetic marbles?**
  - » yes
- **Can you feel a push between two magnetic marbles?**
  - » yes

#### Online Resources



Show a video about magnets. See the Online Resources Guide for a link to the recommended video.

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## 5. Check for understanding.

#### Activity Page



AP 3.1.1

#### NGSS Elements



SEP 1

SEP 4

CCC 2

DCI PS2.A

Monitor Progress

### Formative Assessment

Review student responses in the discussion and to Magnetic or Not? (AP 3.1.1) to determine student understanding of the following concept:

- Some forces can make things move without touching.

Show a magnetic screwdriver and magnetic wand. Confirm student understanding by asking these questions:

- **How can magnets help us do things?**
  - » A magnet can hold something in place, like a screw on a screwdriver or a picture on a refrigerator. Magnets can be used to pick up metal objects.
- **How do you use gravity to get things done?**
  - » You pour liquids down into a glass. You can coast downhill on a bike.

See the Activity Page Answer Key for correct answers and sample student responses.

Review the questions and observations made on the question board. Encourage students to suggest additions for you to make to the board of any questions or new observations they have.

### Tie to the Anchoring Phenomenon

In this activity, students experienced the invisible forces of gravity and magnetism, which can cause movement without contact. Gravity plays a critical role in sports. A thrown basketball has to come down through the hoop. Running up a hill is harder because gravity pulls down as you try to run up.

## LESSON 3.2

# Invisible Pushes and Pulls

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** Can objects that are not touching push and pull each other?

**Today's Question:** What are some invisible pushes and pulls?

**Tie to the Anchoring Phenomenon:** In this lesson, students expand their awareness of pushes and pulls to noncontact forces that can push or pull objects without touching. They will apply their growing knowledge to playing miniature golf.

## AT A GLANCE

### Learning Objectives

- ✓ Describe characteristics of magnets.
- ✓ Identify familiar everyday uses of magnets.

### Instructional Activities

- teacher Read Aloud
- class discussion
- question generation

### NGSS References

**Disciplinary Core Idea:** PS2.A Forces and Motion

**Science and Engineering Practices:** 1 Asking Questions and Defining Problems; 8 Obtaining, Evaluating, and Communicating Information

**Crosscutting Concept:** 2 Cause and Effect

Students continue to explore starting motion, stopping motion, and changing the direction of different types of objects in motion from a noncontact force.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## Core Vocabulary and Language of Instruction

**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

**magnet**

**opposite ends**

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

**pole**

**problem**

**solution**

## Instructional Resources

Student Book



Ch. 5

Activity Page



AP 3.2.1

**Student Book, Chapter 5**  
"Invisible Pushes and Pulls"

**Activity Page**  
Invisible Pushes and Pulls  
(AP 3.2.1)

## Materials and Equipment

**Collect or prepare the following items:**

- question board
- magnetic marbles (at least 2 per student)
- bar or horseshoe magnets (2 per student)
- internet access and the means to project images/video for whole-class viewing

## THE CORE LESSON 3.2

### 1. Focus student attention on Today's Question.

NGSS Elements



CCC 2  
DCI PS2.A

**What are some invisible pushes and pulls?**

- Distribute at least two magnetic marbles to each student. Ask them to balance one marble on a flat, level surface, such as their desks.
- Model setting up a ramp for students. Place a hardcover book on a desk. Put a small object, such as an eraser, under one end of the book.
- Have students set up their ramps just as you modeled. Once students have their ramps set up, have them hold another marble at the high end of the book. Ask what will happen if they let go of the marble on the inclined plane.
  - » It will roll down.
- As a class, have students hold a marble at the high end of their ramps and let the marble go. Ask these questions:
  - **What happened to the marble?**
    - » It rolled down the ramp.
  - **What caused the one marble to roll?**
    - » The invisible force of gravity caused the marble to roll to the lowest place.
    - » The marble was pulled down the ramp.
  - **What caused the marble on the flat surface to stay put?**
    - » The desk held the marble up.

- **Why didn't the marble on the flat surface roll?**
  - » It was already at the lowest point.
- **Did everyone have the same experience? Will things always go to the lowest point?**
  - » yes
- Let students know that today they are going to read about invisible forces like gravity that can make things move. (See **Know the Science**.)

### Tie to the Anchoring Phenomenon

NGSS Elements



3D Learning

In this lesson segment, students focus on noncontact pushes and pulls. This lesson expands student awareness of motion caused by forces that are not seen, such as magnetism and gravity.

Students will consider the causes and effects of a wide variety of movements. They will ask questions about forces and expand their understanding of how pushes and pulls can solve problems.

## 2. Read together: “Invisible Pushes and Pulls.”

Student Book



Ch. 5

While some advanced students may be able to read words on a given page of the Student Book, as a general rule students should not be expected or asked to read aloud the text on the Student Book pages. The text in the Student Book is there so that teachers and parents can read it when sharing the Student Book with students.

## Know the Science

## TEACHER DEVELOPMENT

**When Does Gravity Pull on Things?** Gravity is acting on all objects on Earth all the time. That's why everything stays on the ground without being tied down. Gravity causes objects to fall when any support is removed. An acorn will fall from a tree when the twig holding it is weakened. It doesn't stay put or fly off. It falls because of gravity.

Ask students to turn to page 32 of the Student Book and look at the picture as you read aloud. Remind them that the title of this chapter is “Invisible Pushes and Pulls.” Tell them to think about invisible forces that are making things move.



NGSS Elements



SEP 8  
CCC 2  
DCI PS2.A

Ask students to look at the picture on page 32 as you read aloud.

**LITERAL**—Is the skier going up or down?

» down

**EVALUATIVE**—What is making the skier fall?

» gravity

**INFERENTIAL**—Can you see gravity?

» No, it is invisible.

Magnets produce invisible pushes and pulls, too.

Magnets can pull on some kinds of metal. This magnet can pull large pieces of metal up from a pile. That is a strong pull!



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## Online Resources



**LITERAL**—Is the big magnet pushing or pulling the metal?

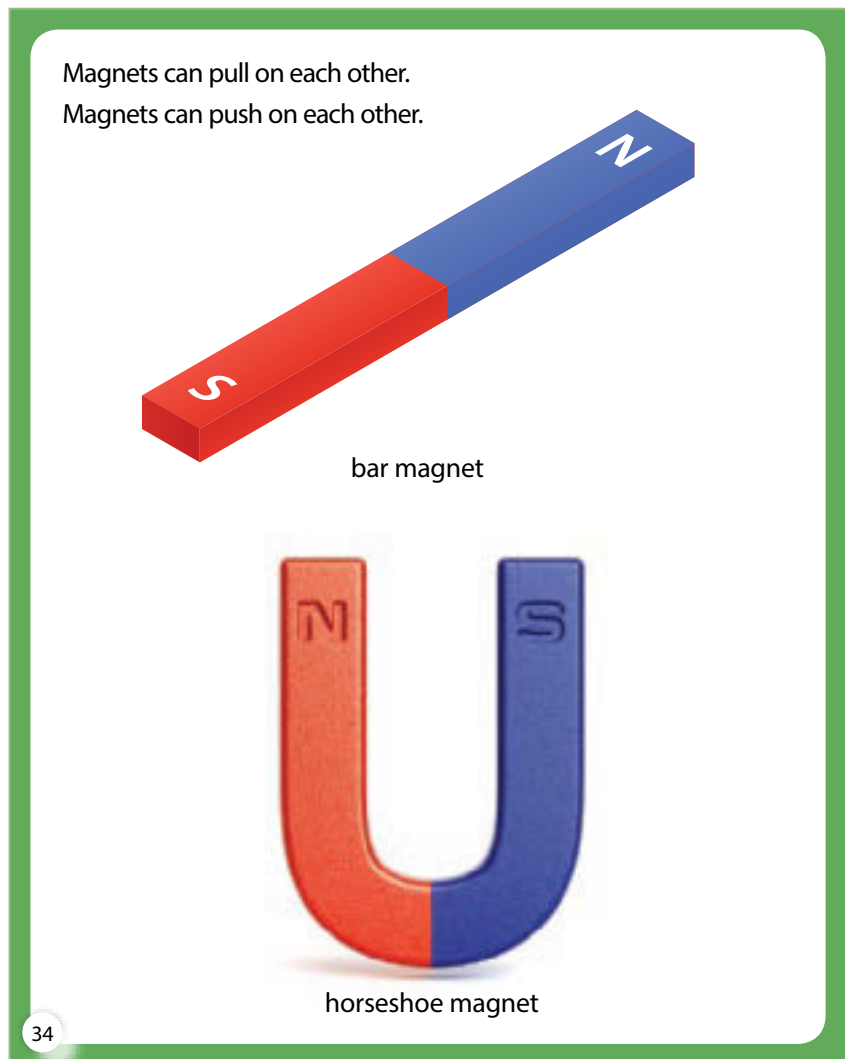
» pulling

- Show a video to provide a common experience with big magnets, such as a magnet grapple. See the Online Resources Guide for a link to the recommended video.

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

**EVALUATIVE**—What are some ways magnets can be useful?

» for example, picking up metal pins if you drop them or holding a screw in a screwdriver



- Distribute two horseshoe or bar magnets to each student. Ask them to demonstrate how magnets can pull on each other and how they can push on each other.

**EVALUATIVE**—Ask students to describe the force between the magnets.

» a push or pull

**LITERAL**—Do the magnets have to touch for you to feel the push or pull?

» no

**CORE VOCABULARY**—Explain that a **magnet** is a rock or piece of metal that can pull other magnets or metal toward itself. The force of magnets is called *magnetism*. Magnetism works over a distance, so objects don't have to be touching for magnetism to work. But if there is too much distance, a magnet is not strong enough to push or pull another object.

Magnets have two ends. One end is the north pole. The other end is the south pole. Both poles can pull some metal objects.

A north pole of one magnet pulls the south pole of another magnet. Different poles pull on each other.

A north pole of one magnet pushes on the north pole of another magnet. Two same poles push on each other.

Two north poles push each other.



Two south poles push each other.



A north pole and a south pole pull each other.



A south pole and a north pole pull each other.



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- With the two horseshoe or bar magnets that each student has, have them demonstrate how they can pull on each other. Ask them to see if they can keep the magnets from touching and feel the pull.
- Then ask them to show how the magnets can push against each other when the north pole of one magnet pushes against the north pole of the other magnet. Ask them to see if they have the strength to push the magnets together even when the magnetic field is pushing them apart.

**CORE VOCABULARY**—Explain that all magnets have **opposite ends**: a north pole and a south pole. In magnets, opposite poles attract and pull together, but the same poles push against each other.

**CHALLENGE**—Relate the two opposite poles of the magnets to other opposites students have learned. For example, *push* and *pull* are opposites. Ask students to think of other opposites, such as *up* and *down*, *open* and *closed*, and *in* and *out*.



Magnets can help solve problems. You might want to stick a drawing to your refrigerator. That is a problem! Use magnets to hold the picture against the refrigerator. The problem is solved!



Microphones have magnets inside of them. A magnet causes pushes and pulls to make the microphone work.



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**INFERENTIAL**—Why do people use magnetic letters and kitchen magnets?

» You can display messages that will stay in place.

**EVALUATIVE**—What are some other things that use magnets?

» for example, magnet closure on a purse or cabinet door, speakers, computers, televisions

Magnets are pushing and pulling tools we can use to help solve problems. Magnets help hold the train engine to the train car. Can you see the two magnets?



A magnetic rack can store tools. The metal strip is a magnet. It pulls on the metal parts of the tools.



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### **EVALUATIVE—How can you solve problems with magnets?**

- » for example, pick up spilled paper clips, hold a picture on a refrigerator, hold a door closed

## **6. Check for understanding.**

Activity Page



AP 3.2.1

### **Formative Assessment**

- Distribute Invisible Pushes and Pulls (AP 3.2.1), and have students circle the objects that are moving because of gravity and put a square around those that are moving because of magnetism. Then discuss their answers.
  - » Students should understand that things that are falling are moving due to gravity.
  - » Students should understand that magnetism is a force that can attract certain metals.



- Review student responses in the reading questions and to Invisible Pushes and Pulls (AP 3.2.1) to determine student understanding of the following concept:
  - Gravity and magnetism are invisible forces that can push and pull objects without touching.
- Review the questions and observations made on the question board. Encourage students to suggest additions for you to make to the board of any questions or new observations they have.

### Tie to the Anchoring Phenomenon

In this activity, students expanded their understanding of invisible forces that can push and pull objects without touching them. They encountered lots of examples of these forces in everyday life, so they can generalize beyond the recreational activities they have focused on.

## LESSON 3.3

# Lesson 3 Roundup: Invisible Tee Time

**Big Question:** How can pushes and pulls change motion of objects?

**Lesson Guiding Question:** Can objects that are not touching push and pull each other?

**Today's Question:** How can we use invisible pushes and pulls to improve our miniature golf course?

**Tie to the Anchoring Phenomenon:** In this lesson, students will modify their miniature golf course to incorporate the use of the invisible forces of gravity or magnetism.

## AT A GLANCE

### Learning Objective

- ✓ Demonstrate using magnetism or gravity to move objects using noncontact pushes and pulls.

### Instructional Activities

- student investigation

### NGSS References

**Performance Expectation:** K-PS2-2

**Disciplinary Core Idea:** PS2.A Forces and Motion; ETS1.A Defining Engineering Problems

**Science and Engineering Practice:** 4 Analyzing and Interpreting Data

**Crosscutting Concept:** 2 Cause and Effect

Students use their knowledge of magnetism or gravity to incorporate invisible forces to improve their miniature golf course design.

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

# Core Vocabulary and Language of Instruction

**Core Vocabulary:** Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms. However, these terms are not intended for isolated drill or memorization.

improve

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves. A Glossary at the end of this Teacher Guide lists definitions for both Core Vocabulary and Language of Instruction.

compare      design      evaluate      solution

## Instructional Resources

Activity Pages



AP 2.2.2  
AP 3.3.1

**Activity Pages**  
My Miniature Golf Hole (AP 2.2.2)  
Invisible Tee Time (AP 3.3.1)

## Materials and Equipment

**Collect or prepare the following items:**

- question board
- golf play set including golf club, cup, and ball (1 set per pair)
- cardboard boxes, bricks, or blocks to construct the perimeter of the hole
- cardboard boxes to serve as obstacles
- variety of magnets
- metal balls or magnetic marbles

### Advance Preparation

If space is an issue, the course can be scaled back to using marbles as golf balls and wooden blocks and/or plastic bricks for the perimeter of the hole.

## THE CORE LESSON 3.3

### 1. Focus student attention on Today's Question.

#### Activity Pages



AP 2.2.2

AP 3.3.1

#### NGSS Elements



SEP 4

CCC 2

DCI PS2.A

#### How can we use invisible pushes and pulls to improve our miniature golf course?

- Review the designs that students made for the miniature golf course on Activity Page 2.2.2 from Lesson 2.2.
- Remind students of the “Plan and Evaluate” board for the task, and review the different criteria they met when they built and played their golf holes:
  - hard push
  - soft push
  - pull
  - fast
  - slow
  - change in direction
- Distribute Invisible Tee Time (AP 3.3.1). Explain that today students will work on improving their golf holes by incorporating invisible forces to push or pull the ball toward the cup.

#### Tie to the Anchoring Phenomenon

In this lesson segment, students apply what they learned about gravity and magnetism into the design of their golf course.

### 2. Revise the miniature golf course plan.

#### NGSS Elements



SEP 1

SEP 4

CCC 2

DCI PS2.A

#### Differentiation

Lead a whole-class discussion about how the unseen forces of gravity and magnetism could be used in their golf course.

- How could gravity be used in a miniature golf course to stop the ball from moving forward?
  - » A ramp could be set up so you have to hit the ball uphill.
  - » A hole could be set at an angle so the ball doesn't roll to the hole.
- How could gravity be used in a miniature golf course to help the ball move forward?
  - » The plan could include ramps going down to make the ball roll.
- How would that change the way you play?
  - » For example, you would have to hit the ball harder to get over a bridge or softer if it starts on a ramp.

- How could magnetism be used in a miniature golf course to make it harder for the ball to move forward?
  - » For example, students could change to a metal golf ball and use magnetic sides, which would attract the ball.
- How could magnetism be used in a miniature golf course to help the ball move forward?
  - » For example, students could change to a metal golf ball and use a magnet near the cup to help the ball land in the cup.
- How would that change the way you play?
  - » For example, it would be easier to get the ball in the cup, or you would have to hit it harder to avoid the magnetic side.

Have students work with their original design partner and use Invisible Tee Time (AP 3.3.1) to modify the design of their golf hole to incorporate either gravity or magnetism.

**CHALLENGE**—Some students who are interested in the use of magnets in motors may recognize that electromagnets could be used in the modification of their design. For example, they may suggest a hair dryer or other machine that would affect the movement of the ball. Encourage these students to explore this idea. (See **Know the Science.**)

### 3. Test the new plan.

#### Activity Pages



AP 2.2.1  
AP 3.3.1

#### NGSS Elements



SEP 1  
SEP 4  
CCC 2

DCI PS2.A

#### Differentiation

- If time and space allow, gather cardboard boxes or blocks to use as the sides of the holes along with golf balls, clubs, and cups, and move to an area large enough for student pairs to reconstruct their golf holes.
- Have pairs of students use My Miniature Golf Hole (AP 2.2.2) to rebuild their golf hole if they had to deconstruct it previously so that there is a complete course. Allow them to change their designs based on additional information.
- Then have them incorporate the invisible force they selected into their design.
- Then have each pair of students play their hole and test their invisible force modification as the rest of the class watches. They should take turns hitting the ball as they progress to getting it into the cup.
- After each pair has completed the hole, regardless of how many strokes it takes to get the ball in the cup, discuss the demonstration with the class using these questions:

## Know the Science

## TEACHER DEVELOPMENT

**Electromagnets and Their Use:** Electromagnets are used in a wide variety of machines. An electric current produces a magnetic field if the wires wound into a coil. The magnetic field appears when the current is turned on and disappears when it is turned off. Many electric and battery-operated appliances and toys use electromagnets.

- **How did the invisible force affect the hole?**
- **Did it work?**
- **Did you have to change how hard or soft you pushed or pulled the ball because of the invisible force?**
  - » Responses will depend on student demonstrations.
- When all students have completed their demonstrations, allow them to play each other's holes as time allows.

**SUPPORT**—Keep student focus on the effect of the invisible forces rather than on how many strokes they use to complete the hole.

## 4. Compare the designs.

NGSS  
Elements



SEP 1  
SEP 4  
CCC 2  
DCI PS2.A

- With the class, compare the different holes that students created.
  - **Which type of invisible force affected play the most?**
    - » Gravity made the ball roll around more.
    - » The magnets made it easy to get the ball in the hole.
  - **For those who used magnetic forces, how would play change if you didn't have a metal ball?**
    - » The magnet near the hole would not pull on the ball.
    - » The ball would not stick to the sides.
  - **For those who used gravity, how would play change if you had a flat course?**
    - » I would not have to hit the ball up the ramp.
    - » The ball would not roll fast down the ramp and miss the hole.

NGSS Elements



3D Learning

In demonstrating invisible pushes and pulls with their miniature golf holes, students interpret the data they have gathered about the effects of different forces on the motion of objects and how motion stops and changes direction. The designing of and the building of their miniature golf course hole is a solution to the engineering problem they are trying to solve.

## 5. Check for understanding.

NGSS Elements



SEP 1  
SEP 4  
CCC 2  
DCI PS2.A  
Monitor Progress

### Formative Assessment

Review student responses to determine student understanding of the following concepts:

- Pushes and pulls are the cause of all movement.
- The strength of a push or pull has the effect of making objects move slower or faster.



- Objects in motion stop or change direction when they touch other objects.
- Some pushes and pulls are invisible and can change the motion of objects without touching them.

Review the questions and observations made on the question board. Encourage students to suggest additions for you to make to the board of any questions or new observations they have.

### **Tie to the Anchoring Phenomenon**

In this activity, students demonstrated the effect of invisible pushes and pulls on the movement of objects in a recreational activity.

# Science in Action

## Studying Pushes and Pulls

**Tie to the Anchoring Phenomenon:** Students join Kamal as he discovers more about how humans investigate the effects of gravity.

### AT A GLANCE

#### Learning Objective

- ✓ Sort objects that work with pushes and pulls.

#### Instructional Activities (2 Days)

- teacher Read Aloud
- student investigation

#### NGSS References

**Science and Engineering Practice:** 1 Asking Questions

**Understandings About the Nature of Science:** Science Is a Way of Knowing; Science Is a Human Endeavor; Scientific Investigations Use a Variety of Methods; Scientific Knowledge Is Based on Empirical Evidence

**Crosscutting Concept:** 2 Cause and Effect

For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

**Language of Instruction:** The Language of Instruction consists of terms that you should use when talking about any concepts in this exercise. Students will benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

astronaut  
laboratory  
sort

centrifuge  
observe  
space

gravity  
pull

investigate  
push

## Instructional Resources

Student Book



Ch. 6

**Student Book, Chapter 6**  
“Science in Action: Studying  
Pushes and Pulls”

## Materials and Equipment

**Collect or prepare the following items:**

- calculator (1 per group)
- index cards (3 per group)
- marker (1 per group)
- container with lid (1 per group)
- binder clip (1 per group)
- stapler (1 per group)
- handheld hole punch (1 per group)
- tape in a dispenser (1 per group)

### Advance Preparation

Remove staples from the staplers before giving them to students.

Prepare labels on index cards for the words *Push*, *Pull*, and *Both*, one set of cards for each group.

## 1. Day 1: Introduce the topic.

Remind students that they read about Kamal and learned about pushes and pulls throughout the unit. Explain that today they will read more about how these forces are studied by scientists.

## 2. Read together: “Science in Action: Studying Pushes and Pulls.”

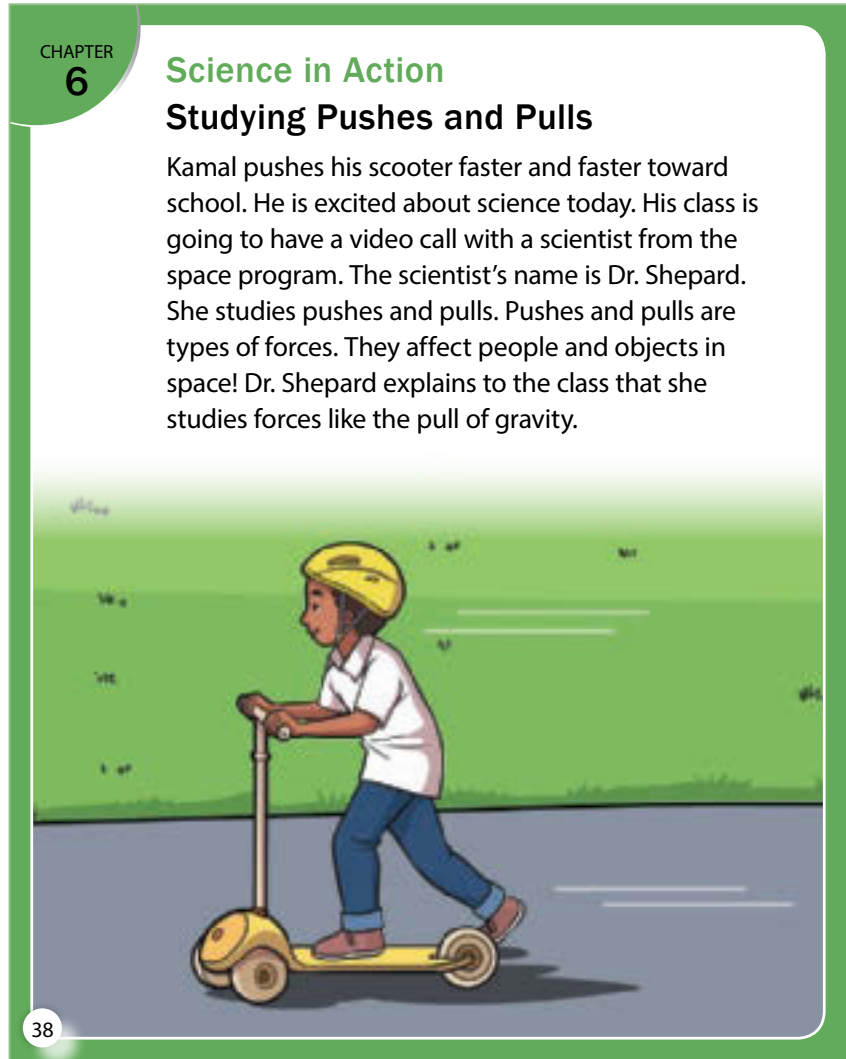
Student Book



Ch. 6

While some advanced students may be able to read words on a given page of the Student Book, as a general rule students should not be expected or asked to read aloud the text on the Student Book pages. The text in the Student Book is there so that teachers and parents can read it when sharing the Student Book with students.

Ask students to turn to page 38 of the Student Book and look at the picture as you read aloud. Remind them that the title of this chapter is “Science in Action: Studying Pushes and Pulls,” and tell them to pay special attention to the types of technology that they see in the pictures as you read.



NGSS Elements



Science Is  
a Human  
Endeavor

Ask students to look at the picture on page 38. Talk about where Kamal is going.

**LITERAL**—What is Kamal excited about?

» He is excited to have a call with a scientist from the space program.

Explain that **space** is the area that surrounds Earth and has planets, stars, moons, and other objects.

**LITERAL**—What does Dr. Shepard study?

» She studies forces that push and pull.

**SUPPORT**—Explain that Dr. Shepard is a doctor but not the kind who takes care of you when you are sick. *Doctor* is a title that goes in front of a person’s name when they have studied in college long enough to become an expert at what they do. (See **Know the Standards 1.**)

**Page 39**

**Ask students to look at the picture on page 39.** Explain that the picture shows an astronaut being strapped into a machine called a centrifuge for testing. Astronauts are specially trained on how to operate rockets and are tested to make sure they can fly them safely.

Gravity is a force that pulls objects toward the center of Earth. When astronauts are on Earth, gravity pulls them down, just like it does to all of us. When they are in space, they feel as if there is no force pulling them down at all. Changes of pushes and pulls on our bodies affect us in different ways. Dr. Shepard does investigations to find out how.



39

## Know the Standards

## TEACHER DEVELOPMENT

**1. Science Is a Human Endeavor:** Men and women of diverse backgrounds, such as Dr. Shepard, work as scientists.

Explain that **gravity** is a force that pulls objects toward the surface of Earth.

Explain that **astronauts** are people who are trained to travel beyond Earth's atmosphere.

**INFERENTIAL**—Why do you think astronauts feel a strong pull of gravity when they launch into space from Earth?

» Gravity is trying to pull them back down.

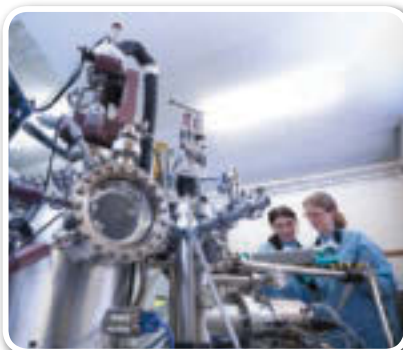
**INFERENTIAL**—Why do you think astronauts get tested before they fly a rocket?

» to make sure they can fly the rocket safely



**Ask students to look at the two pictures on page 40.** These are pictures of scientists doing investigations. There are many different ways for people to study science. (See **Know the Standards 2.**)

Investigations are experiments that scientists do to test their ideas. Scientists also do investigations to answer questions that they have. Dr. Shepherd can't go to space to find out about the effects of pushes and pulls on astronauts. Instead, she comes up with ways to test her ideas here on Earth. She works in laboratories, places where scientists use tools and equipment to test ideas.



40

Explain that **investigations** are experiments that scientists do to test their ideas and answer their questions. (See **Know the Standards 3.**)

Explain that a **laboratory** is a place where scientists use tools and equipment to test their ideas.

## Know the Standards

## TEACHER DEVELOPMENT

**2. Scientific Investigations Use a Variety of Methods:** There are many different ways that scientists can study the natural world. Some scientists study things by experiencing and observing them. Other scientists perform tests or create models that they can use to study their ideas. Dr. Shepard cannot go into space, so she creates environments that are like space on Earth to test her ideas there.

**3. SEP 1 Asking Questions:** Scientific investigations begin with a question about the natural world. Here, Dr. Shepard wonders about the different ways that changes of gravity affect humans. This is one of the questions that will influence her investigations.

**LITERAL**—Why does Dr. Shepard use a laboratory to study pushes and pulls?

» She cannot go into space herself.

**INFERENTIAL**—Why might Dr. Shepard not be able to go into space herself?

» It is hard to go to space. Only certain people can go.

## Page 41

NGSS Elements



Scientific  
Knowledge  
Is Based on  
Empirical  
Evidence

**Ask students to look at the picture on page 41.** Explain that the picture shows a centrifuge.

In a big lab, Dr. Shepard shows Kamal's class a machine called a centrifuge. An astronaut sits inside one end of the centrifuge. Then the machine spins around and around. The spinning causes the astronaut to feel as if strong pulls are acting on him. Dr. Shepard uses the centrifuge to investigate how a strong pull can affect an astronaut's body during a rocket launch. Her research helps other scientists that launch astronauts into space.



Explain that the **centrifuge** in this picture is designed for astronauts. The astronaut sits on one end of the centrifuge. Then the machine spins around.

**LITERAL**—Why does Dr. Shepard use the centrifuge?

» to study gravity



**LITERAL**—What does Dr. Shepard want to find out? (See **Know the Standards 4.**)

- » She wants to find out how the astronaut's body is affected during a rocket launch.

**LITERAL**—Is Dr. Shepard testing the astronaut in a rocket?

- » No, she is testing the astronaut in a laboratory.

## Page 42

**Ask students to look at the pictures on page 42.** Emphasize that the apple is falling down out of the hand.

To become a scientist herself, Dr. Shepard had to learn about pushes and pulls and gravity. Scientists always base their work on the discoveries of other scientists before them. Many scientists before Dr. Shepard have studied what happens when objects fall to the ground. They have observed how objects move when they are pushed and pulled. Dr. Shepard tells Kamal's class that her work depends on discoveries made by a scientist named Sir Isaac Newton.



42

## Know the Standards

## TEACHER DEVELOPMENT

**4. Scientific Knowledge Is Based on Empirical Evidence:** Gravity is a force that exists in nature, and the pull of gravity on objects toward Earth is a pattern that is known, seen, and expected. Dr. Shepard uses the patterns of gravity to make observations on how it acts on human bodies in different scenarios, such as rocket launches.

**LITERAL**—Is the apple being pulled or pushed down?

» The apple is being pulled down.

**LITERAL**—How can you tell the “Pull” sign is being pulled?

» There are motion marks behind it.

**LITERAL**—What do scientists base their work on?

» They base their work on work done by others before them.

**INFERENTIAL**—How is the apple like a rocket being launched?

» Both are being pulled by Earth’s gravity.

## Page 43

Ask students to look at the pictures on page 43.

NGSS Elements



Science Addresses  
Questions About  
the Natural and  
Material World

### Sir Isaac Newton

Sir Isaac Newton was an English scientist who lived over 400 years ago. He was the first scientist to explain gravity the way that scientists today understand it to work.

Newton wrote descriptions about how pushes and pulls make things move. His descriptions are called the laws of motion.

The first law of motion says that things that are sitting still will remain still until something pushes or pulls on them. Things that are moving keep moving the same way until a push or pull changes their motion.



43

**LITERAL**—Why is Isaac Newton important in understanding forces?

- » He explained how pushes and pulls make things move.

**INFERENTIAL**—Describe the motion of the marbles on the ground using the first law of motion.

- » The marbles are sitting still and will stay that way until something hits them.

**INFERENTIAL**—Use the first law of motion to describe what will happen to those marbles when the big marble is pushed into them?

- » The little marbles will get pushed and start moving.

## 1. Day 2: Facilitate the activity.

NGSS Elements



CCC 2

- Remind students that they previously read about scientist Dr. Shepard, who studies space. Tell them that today they will work on an activity where they get to be scientists.
- Have students form small groups, and distribute the materials. Explain that students have different objects in front of them. Tell them to imagine that they are looking at these objects for the very first time. They also have three cards in front of them: one for “Push,” one for “Pull,” and one for “Both.”
- Explain that students will sort the objects according to whether they work by a push or a pull or whether they can do both. They will use the cards to label each pile of objects. (See **Know the Standards 5.**)
- **Ask the class to come up with a question that will spark their investigation.** Remind students that scientific investigations begin with a question about what a scientist wants to answer.
  - » Our question is: How does each object move, with a push or with a pull?
- **Ask the class how they will investigate this.**
  - » We will test each object to see if it moves with a push or a pull.
- Encourage students to begin their investigations and tests. Circulate around the room as students work. Remind them that a push is when something moves away from them and that a pull is when something moves closer to them.

## Know the Standards

## TEACHER DEVELOPMENT

**5. CCC 2 Cause and Effect:** Students carry out simple tests to see how objects move (push or pull) to cause them to work.



- Prompt students to try using the objects in different ways, such as taking the lid off the container and putting the lid back onto the container. (See **Know the Standards 6.**)
- When the tests are complete, invite groups to share what objects work with a push and with a pull. (See **Know the Standards 7.**)

**SUPPORT**—Limit the number of objects that you give to students so they have less to sort.

**CHALLENGE**—Challenge students to make a prediction about whether each object uses a push or a pull. Then have students test them to see if their ideas are right.

**EXTEND**—Have students explore the classroom and make a list of other objects that move with a push and a pull.

## 2. Check for understanding.

### Formative Assessment

Review the ways in which students sort the objects, and ensure they understand the difference between pushes and pulls:

- pushes: calculator buttons, stapler, binder clip, hole punch
- pulls: tape dispenser
- both: container with lid, cap on a marker

## Know the Standards

## TEACHER DEVELOPMENT

**6. Scientific Investigations Use a Variety of Methods:** There are different ways to study the world. Students read about how scientists study gravity in laboratories. Today, students study pushes and pulls in a classroom by testing each object.

**7. Science Is a Way of Knowing:** Learning about pushes and pulls can help students know more about how everyday objects that they use move and work.

# Teacher Resources

**Activity Pages**

• Motion (AP UO.1)	140
• Pushing and Pulling (AP 1.1.1)	141
• Push and Pull (AP 1.2.1)	142
• Pushing Shapes (AP 1.2.2)	143
• A Push or a Pull? (AP 1.3.1)	145
• Changing Direction (AP 1.4.1)	146
• Hitting the Spot (AP 1.5.1)	147
• Start and Stop (AP 2.1.1)	148
• My Miniature Golf Hole Plan (AP 2.2.1)	149
• My Miniature Golf Hole (AP 2.2.2)	150
• Push Me or Pull Me? (AP 2.3.1)	151
• Tee Time (AP 2.4.1)	152
• Magnetic or Not? (AP 3.1.1)	153
• Invisible Pushes and Pulls (AP 3.2.1)	154
• Invisible Tee Time (AP 3.3.1)	155

<b>Activity Pages Answer Key: <i>Pushes and Pulls</i></b>	<b>156</b>
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Name \_\_\_\_\_

Date \_\_\_\_\_

Motion

Draw pictures of pulls and pushes.

Pulls	Pushes

Name \_\_\_\_\_

Date \_\_\_\_\_

Activity Page 1.1.1

Use with Lesson 1.1

## Pushing and Pulling

**Draw a picture of an object.**

**Draw what made it move.**

**Then draw the movement.**

Object	Cause	Effect

Name \_\_\_\_\_

Date \_\_\_\_\_

Push and Pull

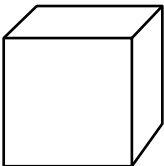
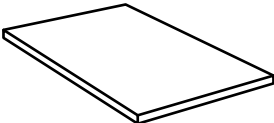

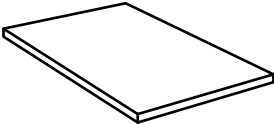
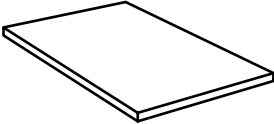
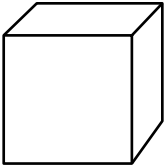
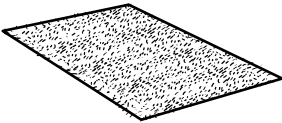

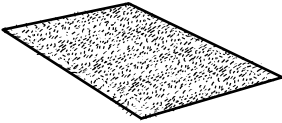
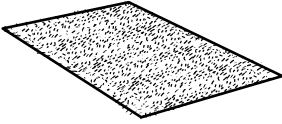
Make a check or X after each test. Circle the test with the most movement.

Item	Surface	Little Force	Force	Big Force



Pushing Shapes

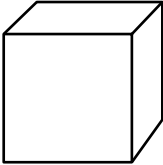
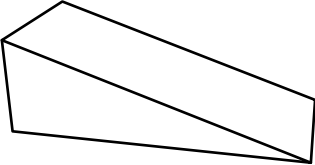

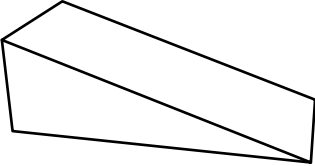
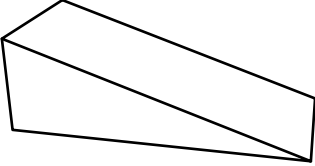
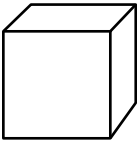
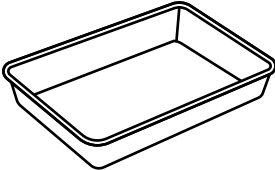

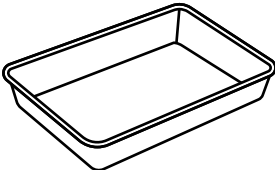
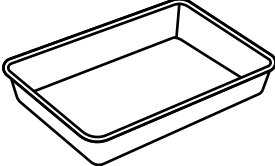
Make a check or X after each set of surface tests to show which shape moved the most.

Item	Surface	Little Force	Force	Big Force
				
				
<div>_____</div>				
				
				
<div>_____</div>				

Name \_\_\_\_\_

Date \_\_\_\_\_

Pushing Shapes

				
				
_____				
				
				
_____				

Name \_\_\_\_\_

Date \_\_\_\_\_

**A Push or a Pull?**

**Draw pictures of two different pushes you see.**

**Draw pictures of two different pulls you see.**

Pushes	Pulls

Name \_\_\_\_\_

Date \_\_\_\_\_

Changing Direction

Draw an arrow to show which direction the ball will go next.


Name \_\_\_\_\_


Date \_\_\_\_\_

Hitting the Spot

Put ✓✓✓ where you used the most force.

Put ✓✓ where you used a force.

Put ✓ where you used the least force.

	7	
		
	2	
	1	
3	0	4
	5	
	6	
	Tester	

Name \_\_\_\_\_

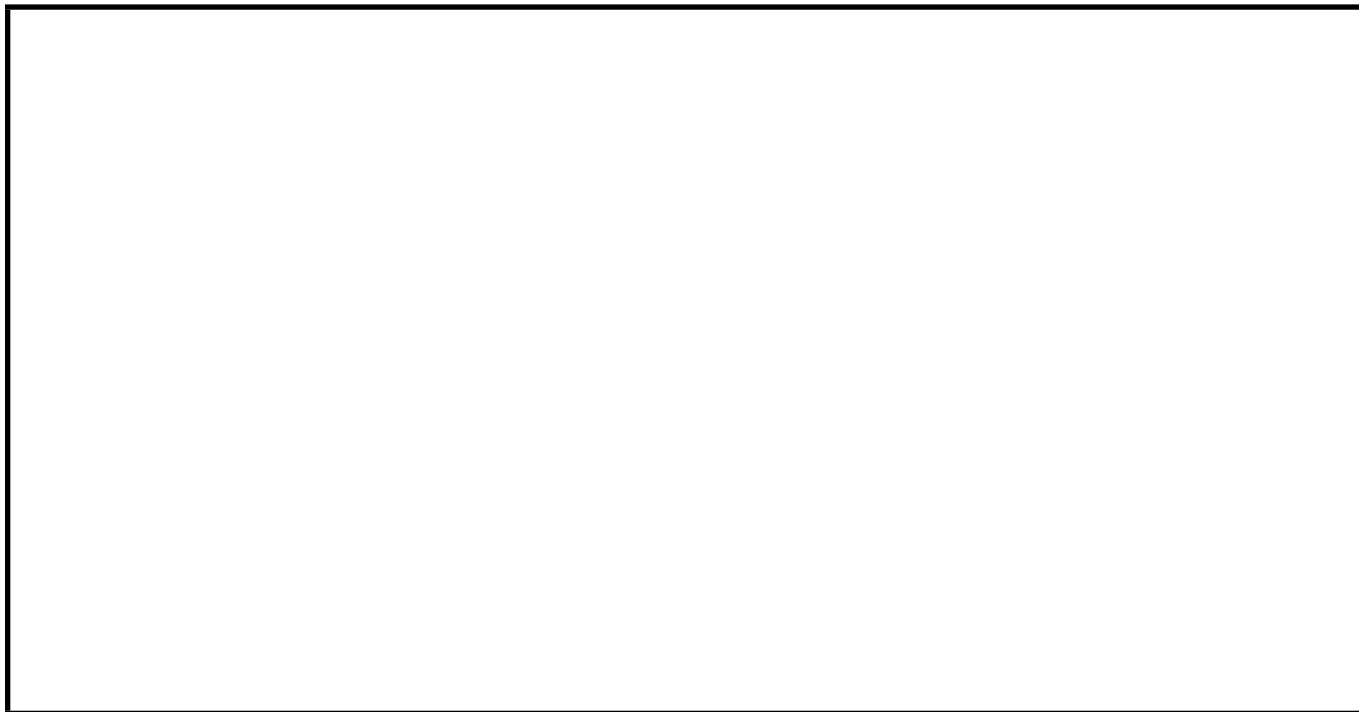
Date \_\_\_\_\_

Activity Page 2.1.1

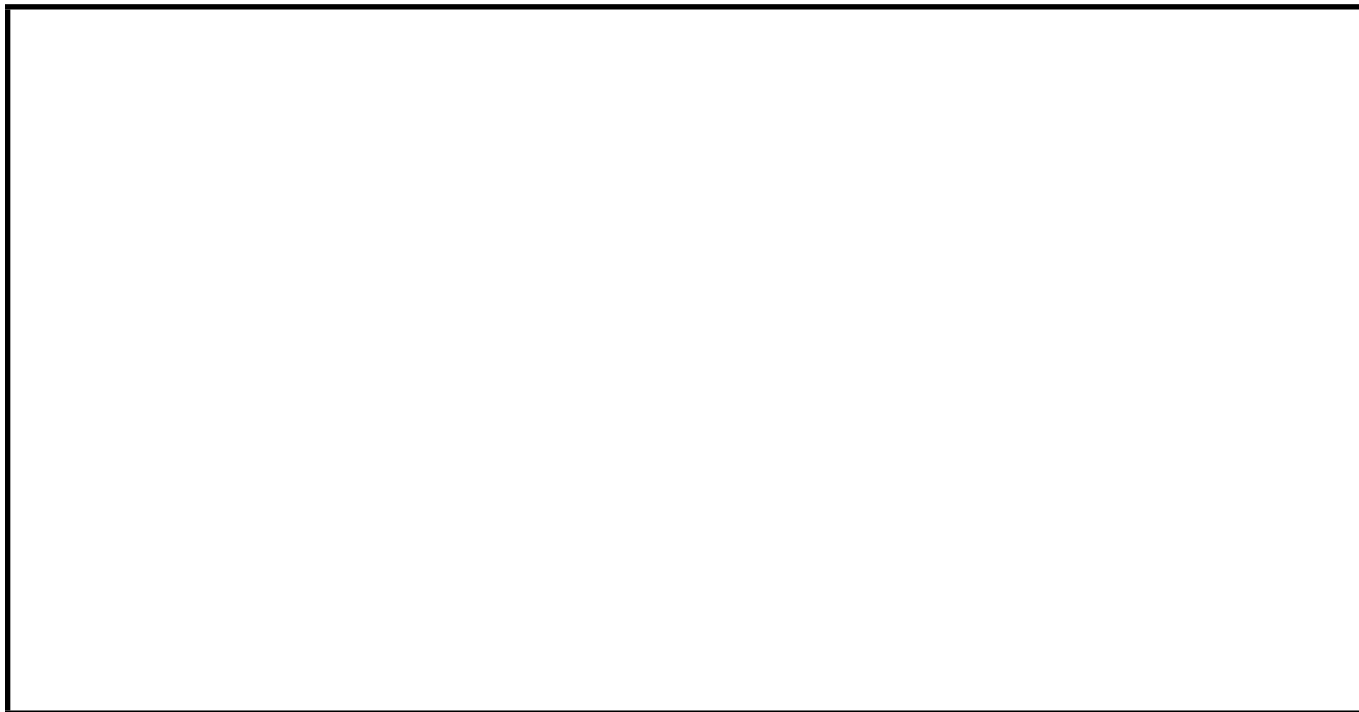
Use with Lesson 2.1

## Start and Stop

**Draw what started the ball moving.**

A large, empty rectangular box with a black border, intended for a student to draw what started the ball moving.

**Draw what stopped the ball moving.**

A large, empty rectangular box with a black border, intended for a student to draw what stopped the ball moving.

Name \_\_\_\_\_

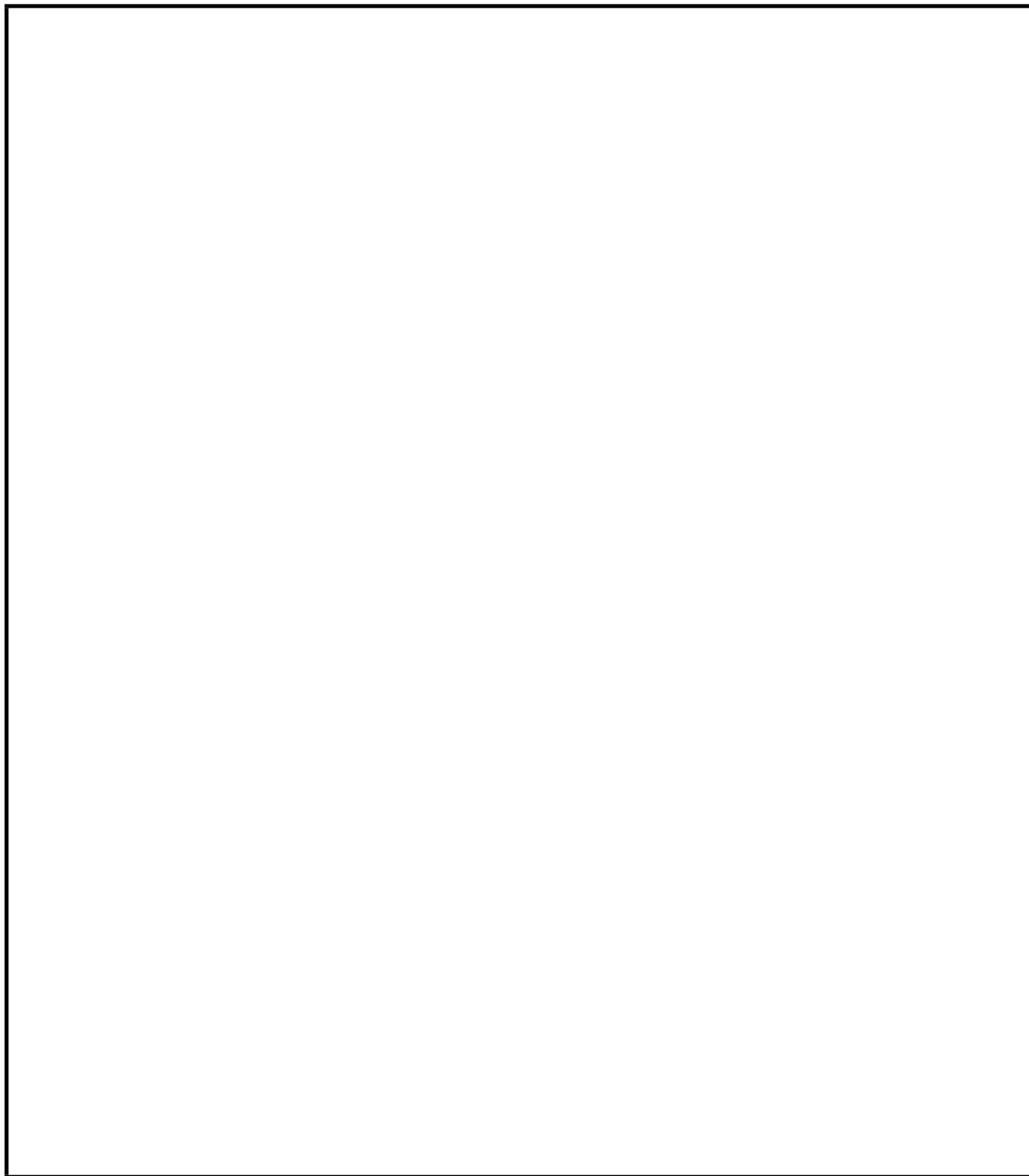
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Activity Page 2.2.1

Use with Lesson 2.2

## My Miniature Golf Hole Plan

**Draw your plan.**

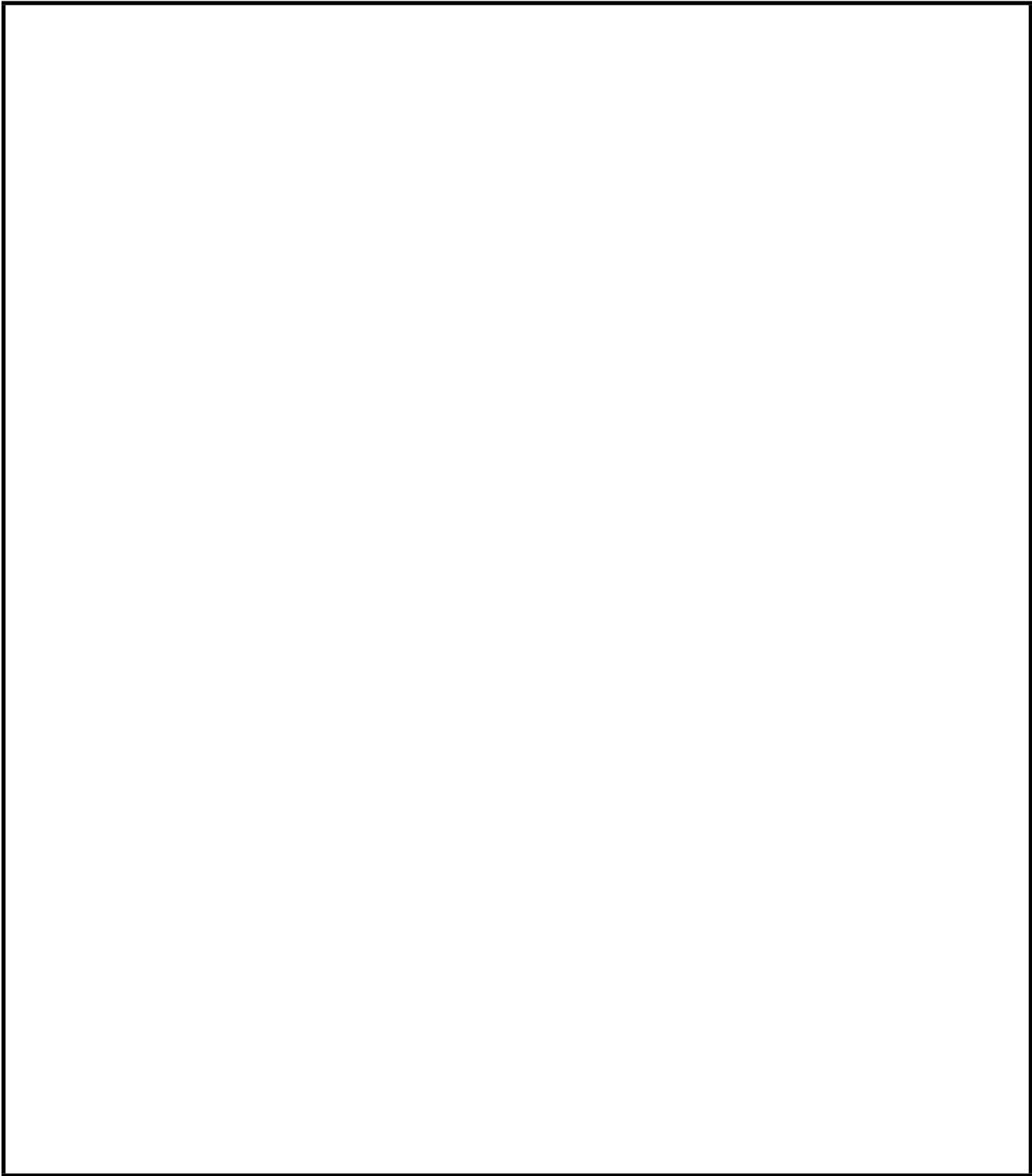


Name \_\_\_\_\_

Date \_\_\_\_\_

**My Miniature Golf Hole**

**Draw the miniature golf hole you built.**

A large, empty rectangular box with a black border, intended for a student to draw a miniature golf hole. The box occupies the majority of the page below the title and instructions.



Name \_\_\_\_\_

Date \_\_\_\_\_

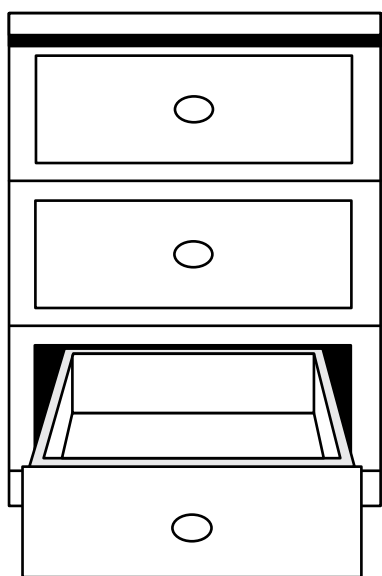
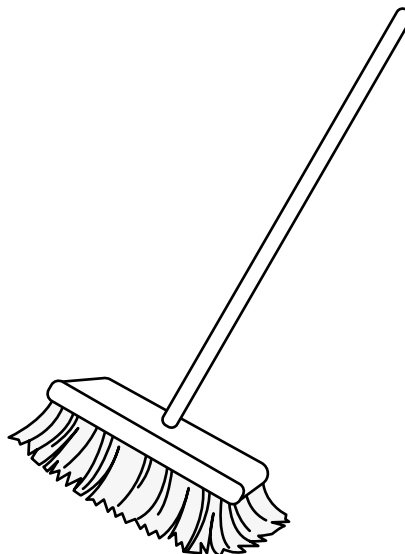
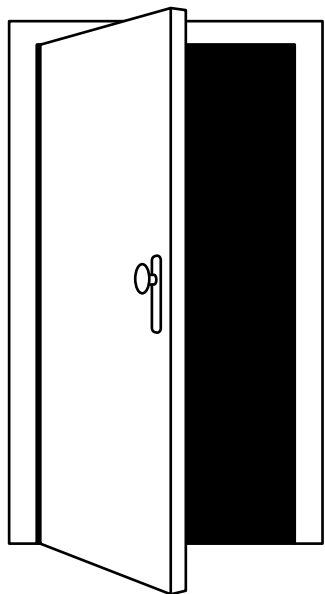
Activity Page 2.3.1

Use with Lesson 2.3

### Push Me or Pull Me?

Circle things you can push.

Put an X over things you can pull.



Name \_\_\_\_\_

Date \_\_\_\_\_

Tee Time

Check each step when done.

hard push	
soft push	
pull	
fast	
slow	
change in direction	

Name \_\_\_\_\_

Date \_\_\_\_\_

Magnetic or Not?

Sort the materials.

Not Magnetic	Magnetic

Name \_\_\_\_\_

Date \_\_\_\_\_

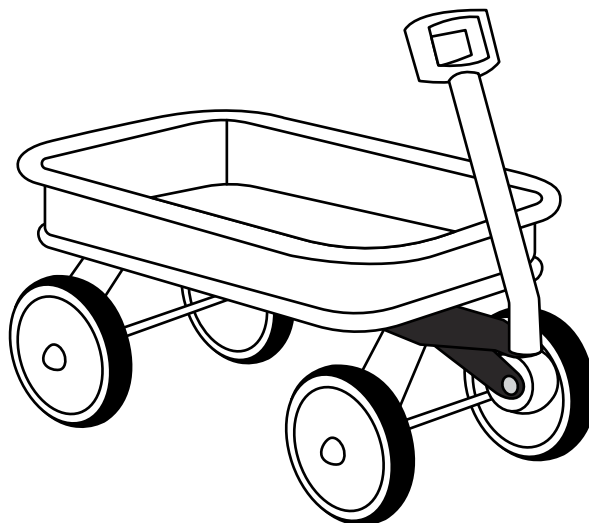
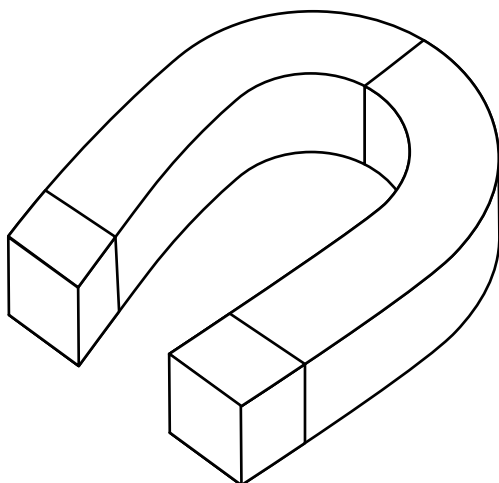
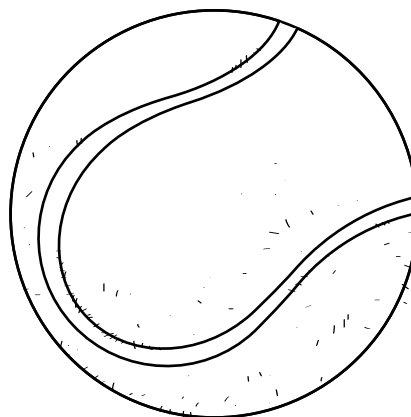
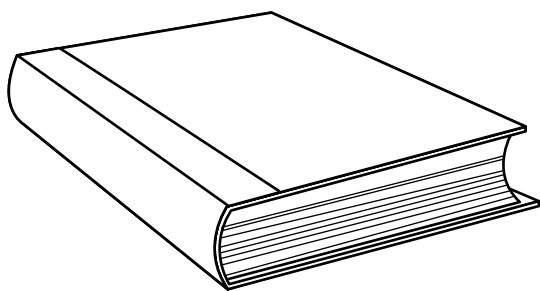
Activity Page 3.2.1

Use with Lesson 3.2

## Invisible Pushes and Pulls

Circle the things gravity pulls on.

Put an X over the things a magnet can pull.



Name \_\_\_\_\_

Date \_\_\_\_\_

Activity Page 3.3.1

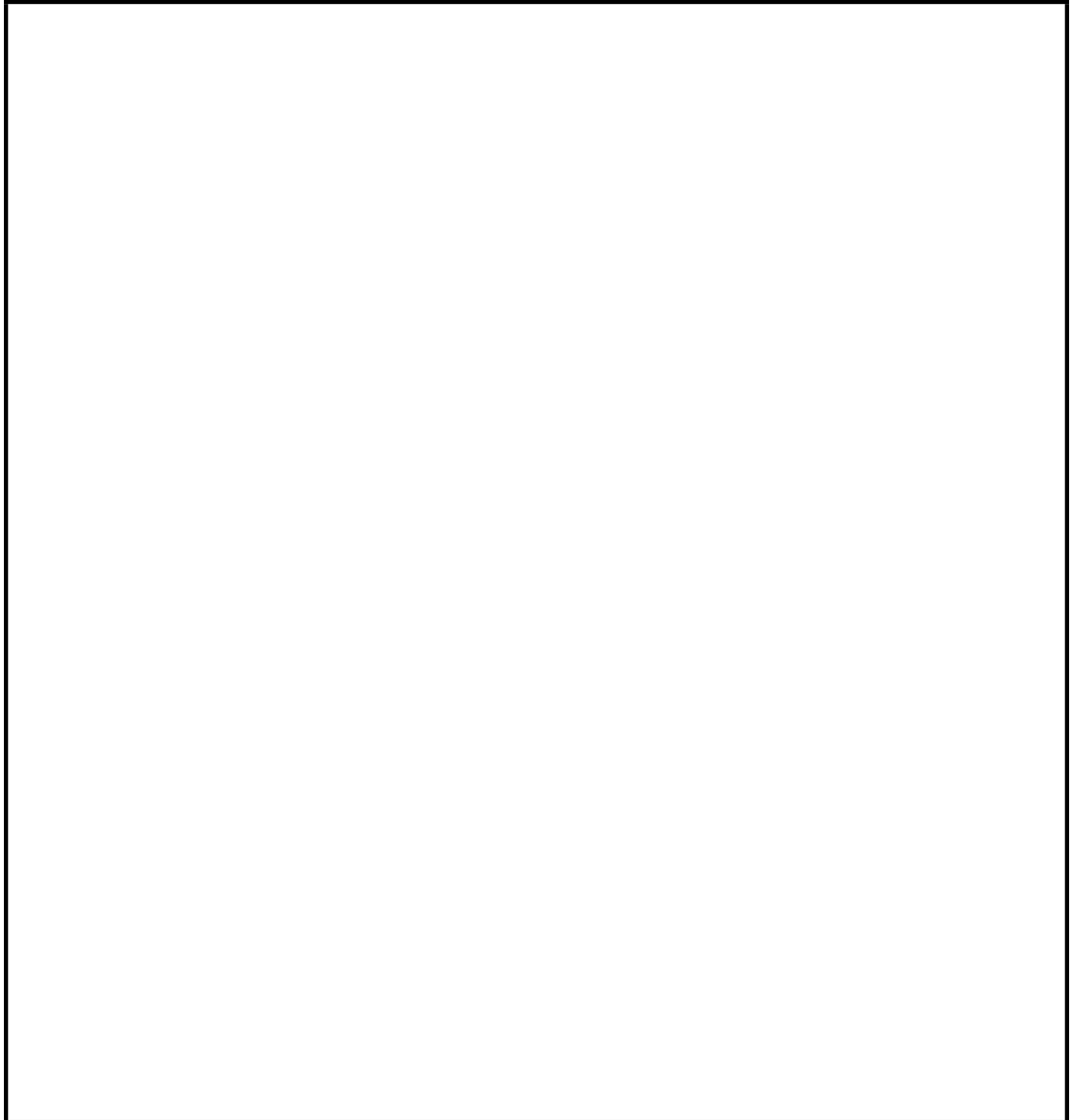
Use with Lesson 3.3

## Invisible Tee Time

**Draw your new plan.**

**Show where the invisible forces pull the ball.**

**Show where the invisible forces push the ball.**

A large empty rectangular box with a black border, intended for a student to draw their plan and show where invisible forces pull or push a ball.

## Activity Pages Answer Key: Pushes and Pulls

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This answer key offers guidance to help you assess your students' learning progress. Here you will find descriptions of the expectations and correct answers for each Activity Page of this unit.

### **Motion (AP UO.1) (page 140)**

Students should draw pulls such as pulling a wagon or pulling a door or drawer open. Students should draw pushes such as pushing a wagon or pushing a door or drawer closed.

### **Pushing and Pulling (AP 1.1.1) (page 141)**

Student drawings may show objects such as a ball, swing, or slide. The cause may be someone throwing a ball, pushing a swing, or pushing off a slide. The effect would then be a ball in motion, a person swinging on the swing, or a person sliding down a slide.

### **Push and Pull (AP 1.2.1) (page 142)**

Students should find that objects pushed and pulled on the smooth surface have the most movement and those objects pushed and pulled on a rough surface have less movement. The more force used to push or pull, the farther the objects moved.

### **Pushing Shapes (AP 1.2.2) (pages 143–144)**

Students should note that the sphere or ball moved the most and the cubic shapes moved the least. They should also note that the objects moved farthest and fastest on the ramps, the smooth surface, then the rough surface, and finally they moved the least in the water.

### **A Push or a Pull? (AP 1.3.1) (page 145)**

Student drawings may show pushing a swing, nail, or ball. Student drawings may show pulling a wagon, pulling a rope, or a horse pulling a wagon.

### **Changing Direction (AP 1.4.1) (page 146)**

Student drawings may include art such as a ball falling to the floor with an up arrow indicating the ball will bounce back up, a ball about to bounce off a wall on the right with an arrow on the left, someone about to pitch a ball to the right with an arrow pointed right, and a ball about to go into a basket with an arrow pointing down.

### **Hitting the Spot (AP 1.5.1) (pages 147)**

Students should note that Spot 6 needed the least force, that Spots 2 and 7 needed the most, and that all spots required some force to get the ball to the location.

### **Start and Stop (AP 2.1.1) (page 148)**

Student drawings should show something that would put the ball in motion, such as hands throwing the ball, and something stopping the ball, such as a hand catching the ball.

**My Miniature Golf Hole Plan (AP 2.2.1)**  
**(page 149)**

Student drawings should include a starting point, a hole, sides, and possibly an obstacle that would require a change in direction for the ball's travel.

**My Miniature Golf Hole (AP 2.2.2)**  
**(page 150)**

Students should draw the hole they constructed, and it should be similar to their plan from AP 2.2.1.

**Push Me or Pull Me? (AP 2.3.1)**  
**(page 151)**

Students should circle and put an X over all four objects.

**Tee Time (AP 2.4.1)**  
**(page 152)**

Students should check each example after they have demonstrated how their miniature golf hole uses an example of each.

**Magnetic or Not? (AP 3.1.1)**  
**(page 153)**

not magnetic: coin, plastic brick, marble; magnetic: paper clip, machine nut, spoon

**Invisible Pushes and Pulls (AP 3.2.1)**  
**(page 154)**

Students should circle all four objects and put an X over the horseshoe magnet and the toy wagon.

**Invisible Tee Time (AP 3.3.1)**  
**(page 155)**

Student plans should show the places where invisible forces push and pull the ball.

## Glossary

**Green words and phrases** are Core Vocabulary for the unit. **Bold-faced words and phrases** are additional vocabulary terms related to the unit that you should model for students during instruction and that are often used within the Student Book, and these latter terms do not have specific page numbers listed. Vocabulary words are not intended for use in isolated drill or memorization.

### A

**affect, v.** to create a change in something

**astronaut, n.** a person who is trained to travel beyond Earth's atmosphere

**at rest, adj.** still, not in motion

### B

**back, n.** the opposite of the front-facing side of a thing or place

**bounce, v.** to move quickly away from a surface after striking it, without breaking

**build, v.** to make something by putting parts together

**bump into, v.** to contact each other when two moving objects meet

### C

**careful adj.** cautious, with the intention of avoiding risk, harm, or damage

**catch, v.** to capture

**cause, v.** to make something happen

**centrifuge, n.** a machine with containers that spin around a center point for the purpose of applying force to objects or materials in the containers

**change, v.** to become different

**closer, adj.** nearer to

**collide, v.** to hit with force when moving

**collision, n.** the occurrence of two objects making contact with each other

**compare, v.** to examine characteristics of two or more things, particularly looking for similarities

**contact, v.** to physically touch something

**contrast, v.** to look for differences between two things

### D

**design, n.** a plan to show how something is made or how a process should work

**direction, n.** the path along which something moves or the point toward which something is aimed

**distance, n.** the amount of space between two objects or places

**down, adv.** toward a lower position

**draw, v.** to make a mark or picture of something

### E

**effect, n.** a change that happens because of a cause

**evaluate, v.** to examine the details of something and determine the value or effectiveness of it

### F

**fall, v.** to move downward

**farther, adv.** at or to a greater distance

**fast, adj.** at a high rate of speed (faster, adj. at a higher speed than something else)

**force, n.** a push or pull on an object

**forward, adv.** toward the front

**friction, n.** the resistance of motion when something rubs against something else

### G

**gravity, n.** the invisible force that pulls objects down toward the surface of Earth

### H

**hard, adj.** solid and firm; does not break easily



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## I

**improve, v.** to make better

**investigate, v.** to observe and study something to collect information

**invisible, adj.** unable to be seen

---

## L

**laboratory, n.** a place equipped for studies, testing, and analysis (also lab)

**left, adj.** on the side of an object that is to the west as that object faces north; opposite of right

---

## M

**magnet, n.** a rock or piece of metal that can pull other magnets or metal toward itself

**magnetic, adj.** having the ability of a magnet to attract

**magnetic pole, n.** either of two ends of a magnet where the magnetic push or pull is the strongest

**materials, n.** matter that makes up different things

**metal, n.** material that is usually hard, shiny, and a good conductor of heat and electricity

**metallic, adj.** having properties of a metal

**motion, n.** the process of something changing position

**move, v.** to change position

**movement, n.** the process of changing position

---

## N

**not touching, adj.** not in physical contact

---

## O

**object, n.** a thing made of material

**observe, v.** to watch something and notice details about it

**opposite ends, n.** the farthest points directly across from each other on an object

---

## P

**plan, n.** a description or drawing of something to be done

**pole, n.** either of two related opposite ends of something

**problem, n.** a condition that falls short of satisfying a want or a need

**pull, n.** a force to make something move toward whatever is doing the pulling (v. to apply a pulling force)

**push, n.** a force to make something move away from whatever is doing the pushing (v. to apply a pushing force)

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## R

**record, v.** to collect and keep information

**result, n.** the outcome of something

**right, adj.** on the side of an object that is to the east as that object faces north; opposite of left

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## S

**slow, adj.** at a low speed (slower, adj. at a lower speed than something else)

**soft, adj.** easily changed in shape when touched; not hard or firm

**solution, n.** a process, action, or device that fixes a problem

**sort, v.** to separate according to type, class, etc., arrange, and group items based on their properties or characteristics

**space, n.** the region beyond Earth's atmosphere

**speed, n.** the rate something moves

**start, v.** to begin something

**stop, v.** to end something

**strength, n.** the condition of being strong and able to withstand a great amount of force

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## T

**test, v.** to determine the performance or reliability of something

**touch, v.** to be in contact with something (touching, adj. describing objects that are in contact with each other)

**turn, v.** to change direction

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## U

**up, adv.** toward a higher position

### Classroom Safety for Activities and Demonstrations

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In the Core Knowledge Science program (CKSci), activities and demonstrations are a vital part of the curriculum and provide students with active engagement related to the lesson content. The activities and demonstrations in this unit have been selected and designed to engage students in a safe manner. The activities and demonstrations make use of materials and equipment that are typically deemed classroom safe and readily available.

Safety should be a priority when engaged in science activities. With that in mind, observe the following safety procedures when the class is engaged in activities and demonstrations:

- Report and treat any injuries immediately.
- Check equipment prior to usage, and make sure everything is clean and ready for use.
- Clean up spills or broken equipment immediately using the appropriate tools.
- Monitor student behavior to ensure they are following proper classroom and activity procedures.
- Do not touch your eyes, ears, face, or mouth while engaging in an activity or demonstration.
- Review each step of the lesson to determine if there are any safety measures or materials necessary in advance.
- Wear personal protective equipment (e.g., safety goggles, aprons, etc.) as appropriate.
- Check for allergies to latex and other materials that students may have, and take appropriate measures.
- Secure loose clothing, hair, or jewelry.
- Establish storage and disposal procedures for chemicals as per their Safety Data Sheet (SDS), including household substances such as vinegar and baking soda.

Copy and distribute the Student Safety Contract, found on the next page. Have a read-along, and have students agree to the expectations for students when engaged in science activities prior to the start of the first unit.

#### Online Resources



For additional support for safety in the science classroom, follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## Student Safety Contract

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When doing science activities, I will do the following:

- Report spills, breakages, or injuries to the teacher right away.
- Listen to the teacher for special instructions and safety directions. If I have questions, I will ask the teacher.
- Avoid eating or drinking anything during the activity unless told to by my teacher.
- Review the steps of the activity before I begin. If I have questions, I will ask the teacher.
- Wear safety goggles when working with liquids or things that can fly into my eyes.
- Be careful around electric appliances and unplug them, just by pulling on the plug, when a teacher is supervising.
- Keep my hands dry when using tools and devices that use electricity.
- Be careful to use safety equipment like gloves or tongs when handling materials that may be hot.
- Know when a hot plate is on or off and let it cool before touching it.
- Roll or push up long sleeves, keep my hair tied back, and secure any jewelry I am wearing.
- Return unused materials to the teacher.
- Clean up my area after the activity and wash my hands.
- Treat all living things and the environment with respect.

I have read and agree to the safety rules in this contract.

\_\_\_\_\_ / \_\_\_\_ / \_\_\_\_ /

Student signature and date

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Print name

Dear Parent or Guardian,

During science class, we want to create and maintain a safe classroom. With this in mind, we are making sure students are aware of the expectations for their behavior while engaged in science activities. We are asking you to review the safety rules with your student and sign this contract. If you have any questions, please feel free to contact me.

\_\_\_\_\_ / \_\_\_\_ / \_\_\_\_ /

Parent or guardian signature and date

## Strategies for Acquiring Materials

The materials used in the Core Knowledge Science program (CKSci) are readily available and can be acquired through both retail and online stores. Some of the materials will be reusable and are meant to be used repeatedly. This includes equipment such as scales, beakers, and safety goggles, but also items such as plastic cups that can be safely used again. Often these materials are durable can be cleaned, and will last for more than one activity or even one school year. Other materials are classified as consumable and are not able to be used more than once, such as glue, baking soda, and aluminum foil.

### Online Resources



The Material Supply List for this unit's activities can be found online. Follow the links in the Online Resources Guide for this unit:

[www.coreknowledge.org/cksci-online-resources](http://www.coreknowledge.org/cksci-online-resources)

## Ways to Engage with Your Community

The total cost of materials can add up for an entire unit, even when the materials required for activities and demonstrations have been selected to be individually affordable. And the time needed to acquire the materials adds up too. Reaching out to your community to help support STEM education is a great way to engage parents, guardians, and others with the teaching of science, as well as to reduce the cost and time of collecting the materials. With that in mind, the materials list can be distributed or used as a reference for the materials teachers will need to acquire to teach the unit.

### Consider some of the following as methods for acquiring the science materials:

- **School Supply Drive**—If your school has a supply drive at any point in the year, consider distributing materials lists as wish lists for the science department.
- **Open Houses**—Have materials lists available during open houses. Consider having teams of volunteers perform an activity to show attendees how the materials will be used throughout the year.
- **Parent-Teacher Organizations**—Reach out to the local PTO for assistance with acquiring materials.
- **Science Fair Drive**—Consider adding a table to your science fair as part of a science materials drive for future units.
- **College or University Service Project**—Ask service organizations affiliated with your local higher education institutions to sponsor your program by providing materials.
- **Local Businesses**—Some businesses have discounts for teachers to purchase school supplies. Others may want to advertise as sponsors for your school/programs. Usually you will be asked for verifiable proof that you are a teacher and/or for examples of how their sponsorship will benefit students.

**Remember:** If your school is public, it will be tax exempt, so make sure to have a Tax Identification Number (TIN) when purchasing materials. If your school is private, you may need proof of 501(c)(3) status to gain tax exemption. Check with your school for any required documentation.

## Advance Preparation for Activities and Demonstrations

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Being properly prepared for classroom activities and demonstrations is the first step to having a successful and enriching science program. Advance preparation is critical to effectively support student learning and understanding of the content in a lesson.

### **Before doing demonstrations and activities with the class, do the following:**

- Familiarize yourself with the activity by performing the activity yourself or with a team, and identify any issues or talking points that could be brought up.
- Gather the necessary materials for class usage. Consider if students will gather their materials at stations or if you will preassemble the materials to be distributed to the students and/or groups.
- Identify safety issues that could occur during an activity or demonstration, and plan and prepare how to address them.
- Review the Teacher's Guide before teaching, and identify opportunities for instructional support during activities and demonstrations. Consider other Support and/or Challenge opportunities that may arise as you work to keep students engaged with the content.
- Prepare a plan for postactivity collection and disposal of materials/equipment.

### **While engaged in the activity or demonstration, do the following:**

- Address any emergencies immediately.
- Check that students are observing proper science safety practices as well as wearing any necessary safety gear, such as goggles, aprons, or gloves.
- When possible, circulate around the room, and provide support for the activity. Return to the Teacher Guide as students work, to utilize any Support and Challenge opportunities that will make the learning experience most meaningful for your students.

### **After the activity or demonstration, do the following:**

- Use your plan for students to set aside or dispose of their materials as necessary.
- Have students wash their hands after any activity in which they could come in contact with any potentially harmful substances.

When engaging students in activities and demonstrations, model good science practices, such as wearing proper safety equipment, never eating during an investigation, etc. Good science practices at a young age will lead to students observing good science practices themselves and being better prepared as they move into upper-level science classes.

## What to Do When Activities Don't Give Expected Results

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Science activities and experiments do not always go according to plan. Microwave ovens, super glue, and X-rays are just some of the discoveries made when people were practicing science and something did not go according to plan. In your classroom, however, you should be prepared for what to do when activities don't give the expected results or when an activity doesn't work.

**When going over an activity with an unexpected result, consider these points in discussion with your students:**

- Was there an error in following the steps in order? You or the student may have skipped a step. To help control for this, have students review the steps to an investigation in advance and make a check mark next to each step as they complete it.
- Did students design their own investigation? Perhaps their steps are out of sequence, or they missed a step when performing the activity. Review and provide feedback on students' investigation plan to ensure the work is done in proper sequence and that it supports the lesson's Big Question.
- When measurements were taken, were they done correctly? It is possible a number was written down incorrectly; a measurement was made in error, such as a wrong unit of measure or quantity; or the starting or ending point of a measurement was not accurate.
- Did the equipment or materials contribute to the situation? For example, chemicals that have lost their potency or a scale that is not measuring accurately can contribute to the success or failure of an activity.

One of the greatest gifts a student can learn when engaged in science is to develop a curiosity for *why something happened*. Students may find it challenging or frustrating to work through a problem during an activity, but guiding them through the problem to figure out *why* something happened will help them to develop a better sense of how to do science.



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# Core Knowledge Curriculum Series™

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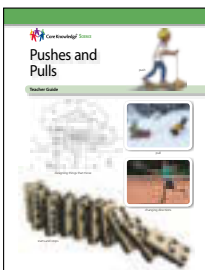
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Core Knowledge Science K



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