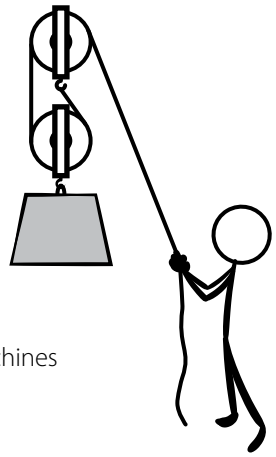
Core Knowledge® SCIENCE

# Simple Machines



compound machines

## Teacher Guide

pulley

wheel and axle

lever

# Simple Machines

## Teacher Guide

Core Knowledge®

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# Simple Machines

## Table of Contents

# Simple Machines

## Teacher Guide

Core Knowledge Science™ 1

UNIT 4

# Introduction

## About this Unit

### The Big Idea

This unit focuses on the scientific concept of simple machines and how they reduce the effort needed to perform certain tasks.

Students are familiar with several simple machines through exposure in day-to-day life. Students understand that they can move things on wheels, but they probably have not considered that wheels are attached to axles and that when one turns, so does the other. Nor have they considered how a wheel and axle can make a task easier. Students have certainly experienced inclined planes but likely have never considered how a ramp contributes to the ease of lifting something upward.

In this unit, students will identify simple machines—the ramp (inclined plane), wheel and axle, pulley, lever, wedge, screw, and gears. Students will explore where these devices are found and experience how they can make a given task easier. Students will also learn that simple machines are combined to make compound machines, which themselves can be familiar and be operated simply.

Students in Grade 1 have not yet learned the scientific definitions of *force* and *work*. Nor do they yet have the capacity to quantify forces or distances. Students will experience the concept of mechanical advantage but are not expected to define that term nor quantify it in any way. It is sufficient at this grade level for students to describe what they observe in terms of easier versus harder tasks, more or less effort.

In this unit, students investigate with simple machines to solve a problem. They will further explore forces in Grade 3 Unit 1 *Investigating Forces*.

### Note to Teachers and Curriculum Planners

This unit introduces Grade 1 students to real-world examples and fundamental concepts of simple machines and their applications in devices that reduce effort. The following are preliminary considerations for planning and instruction relative to this unit:

- While Grade 1 students will explore levers, they are not expected to distinguish classes of levers. And while students will be introduced to the notion that multiple pulleys used in combination further reduce effort required to lift a load, they are not expected to quantify the effort nor comparisons.

## Note to Core Knowledge Teachers

Thanks to ongoing research in the field, our understanding of how children learn continues to evolve. In the subject area of science, in particular, students benefit not just from 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 *2010 Core Knowledge Sequence*. The result of this effort is the revised *K–5 Core Knowledge Science 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.

NGSS does not prescribe a unit specifically about simple machines, but the Core Knowledge Foundation retains this content in the *Core Knowledge Science Sequence*. You may notice that this unit differs slightly in organization from the NGSS units in the CKSci program. Lessons in the NGSS CKSci units are comprised of multiple segments that build to students' demonstration of a complex Performance Expectation. Because *Simple Machines* is not designed to support any specific NGSS Performance Expectation, the instructional episodes are not grouped into multipart lessons. As such, they are identified simply as *lessons* instead of *lesson segments*.

**Online Resources**

To download the *Core Knowledge Science Sequence*, use the links found in the Online Resources Guide.

**www.coreknowledge.org/cksci-online-resources**

This science unit, aligned to the *Core Knowledge Science Sequence*, 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; and,
- connecting scientific learning to concepts across various disciplines, such as mathematics and literacy.

## Related NGSS Dimensions*

This unit, *Simple Machines,* provides the opportunity to further reinforce the following NGSS Dimensions.

**Engineering and Design Performance Expectations:**

**K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

**K-2-ETS1-2.** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

**K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

**Science and Engineering Practices:**

- Asking questions (for science) and defining problems (for engineering)
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence

**Crosscutting Concepts:**

- Cause and effect
- Structure and function

**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**

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**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.

# Building Science Knowledge

## What Students Should Already Know

The concept of progressions, articulated in the National Research Council's *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, is very much aligned to the Core Knowledge principle of building new knowledge on prior knowledge. According to the NRC, students build "progressively more sophisticated explanations of natural phenomena" over the course of many years of schooling. "Because learning progressions extend over multiple years, they can prompt educators to consider how topics are presented at each grade level so that they build on prior understanding and can support increasingly sophisticated learning." In schools following NGSS recommendations, teachers can build on the "prior understandings" captured in the following summaries of NGSS Disciplinary Core Ideas:

### PS2.A: Forces and Motion

- 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.

### PS2.B: Types of Interactions

- When objects touch or collide, they push on one another and can change motion.

### PS3.C: Relationship Between Energy and Forces

- A bigger push or pull makes things speed up or slow down more quickly.

### ETS1.A: Defining Engineering Problems

- A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems have many acceptable solutions.

## 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 throughout the unit.

## Lesson 1: A Trip to Old Time Farm

- Identify examples of things people use to perform tasks with less effort.

## Lesson 2: What Is a Ramp?

- Describe what a ramp is.
- Explain how a ramp works.
- Identify tasks for which ramps are helpful.

## Lesson 3: What Is a Wheel and Axle?

- Describe what a wheel and axle is.
- Explain how a wheel and axle works.
- Identify tasks for which the wheel and axle is helpful.

## Lesson 4: What Is a Pulley?

- Describe what a pulley is.
- Explain how a pulley works.
- Identify tasks for which a pulley is helpful.

## Lesson 5: Exploring Catapults

- Contrast the effort involved in performing tasks with and without various simple machines.

## Lesson 6: What Is a Lever?

- Describe what a lever is.
- Explain how levers can work.
- Identify tasks for which levers are helpful.

## Lesson 7: What Are a Wedge and a Screw?

- Describe what a wedge is.
- Explain how a wedge redirects a force (a push or pull).
- Identify tasks for which wedges are helpful.
- Characterize a screw as a wedge spiraled around a cylinder (rod or tube shape).

### Lesson 8: Exploring Gears

- Observe and describe the shapes of gears.
- Explain how gears connect and move, including pushing or pulling.

### Lesson 9: Science in Action: Meeting a Toolmaker

- Define *compound machine*.
- Identify simple machines in examples of compound machines.

### Lesson 10: Using Simple Machines to Solve Problems

- Define a problem that can be solved with the use of simple machines.
- Collaborate to sketch a solution to the problem
- Compare solutions to predict which will work better.

## 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 *Simple Machines* Student Book includes seven 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**

# Using the Teacher Guide

## Pacing

The *Simple Machines* unit is one of five units in the Grade 1 CKSci series. We encourage teachers to complete all units during the school year. In contrast to the NGSS-aligned units composed of multi-session lessons built in support of Performance Expectations, each Core Lesson in this unit 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. Each lesson 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 page 10, 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 fifteen days teaching the *Simple Machines* unit so that you have time to teach the other units in the Grade 1 CKSci series.

## The Core Lessons

- Lesson time: Most Core Lessons constitute one classroom session of thirty to forty-five minutes. Some lessons cover two or three days of instruction. Some single-day activities and performance tasks might require setting aside a longer block of time.
- Lesson order: The lessons are coherently sequenced to build from one to the next, linking student engagement across lessons and helping students build new learning on prior knowledge.

| **Unit Big Question:** How do simple machines make farm chores easier? | | **Lesson Questions** |
|---|---|---|
| **Lesson 1** | A Trip to Old Time Farm | What kinds of devices do people use to make tasks easier? |
| **Lesson 2** | What Is a Ramp? | What is a ramp, and how does using a ramp make moving something easier? |
| **Lesson 3** | What Is a Wheel and Axle? | What is a wheel and axle, and how does using a wheel and axle make moving something easier? |
| **Lesson 4** | What Is a Pulley? | What is a pulley, and how does using a pulley make moving something easier? |
| **Lesson 5** | Exploring Catapults | How does a catapult move heavy objects? |
| **Lesson 6** | What Is a Lever? | What is a lever, and how does using a lever make moving something easier? |
| **Lesson 7** | What Are a Wedge and a Screw? | What are a wedge and a screw, and how does each change the direction of a push or pull? |
| **Lesson 8** | Exploring Gears | How do gears interact? |
| **Lesson 9** | Science in Action: Meeting a Toolmaker | What is a compound machine? |
| **Lesson 10** | Using Simple Machines to Solve Problems (two class sessions) | How can you use simple machines to make squirrels work for their treats? |

## Activity Pages

**Activity Pages**

**AP 1.1**
**AP 2.1**
**AP 3.1**
**AP 4.1**
**AP 5.1**
**AP 6.1**
**AP 7.1**
**AP 8.1**
**AP 9.1**
**AP 10.1**

Black line reproducible masters for Activity Pages, as well as an Answer Key, are included in Teacher Resources on pages 65–75. The icon shown to the left appears throughout the Teacher Guide wherever Activity Pages (AP) are referenced.

Lesson 1—Things That Make Work Easier (AP 1.1)

Lesson 2—Find the Ramp (AP 2.1)

Lesson 3—Find the Wheels and Axles (AP 3.1)

Lesson 4—Raise the Flag! (AP 4.1)

Lesson 5—Pom-pom Catapult (AP 5.1)

Lesson 6—Move That Rock! (AP 6.1)

Lesson 7—Hold That Door! (AP 7.1)

Lesson 8—Turning Gears (AP 8.1)

Lesson 9—Parts of a Bike (AP 9.1)

Lesson 10—Name That Machine! (AP 10.1)

## 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**

## 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, and each lesson poses a more specific sub-question as students are introduced to new science content. Use these questions to engage students in conversation and help them think about how their own real-world experiences relate to the topic. |
| **Encourage scientific thinking.** | 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.<br><br>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. |
| **Use continuous Core Vocabulary instruction.** | 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.<br><br>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 76–77. |
| **Emphasize observation and experience.** | Lessons employ various ways for students to learn, including watching, listening, reading, doing, discussing, and writing. |

| | |
|---|---|
| **Use science practices.** | 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. |
| **Make frequent connections.** | 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. |
| **Monitor student progress.** | 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. |

## 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 78–82, 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, available at

**www.coreknowledge.org/cksci-online-resources**

# Materials and Equipment

The unit 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 lessons 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 are also required in many lesson segments but are not repeated below.

## Lesson 1 A Trip to Old Time Farm

- chart paper
- marker
- crayons, pencils, or markers (1 set per student)

## Lesson 2 What Is a Ramp?

- chart paper
- marker
- stiff board, at least 4 feet long
- small box or crate loaded with books
- highlighters (1 per student)

## Lesson 3 What Is a Wheel and Axle?

- small box or crate loaded with books
- scooter board
- hand truck or wheelchair
- highlighters (1 per student)
- markers (1 set per student)

## Lesson 4 What Is a Pulley?

- metal or plastic pulley system with a few feet of rope or twine to fit in the groove
- hook, carabiner, or length of rope
- bucket with a handle, half filled with some heavy solid objects or water

## Lesson 5 Exploring Catapults

- wood tongue depressors (1 per pair)
- fat, round markers or highlighters (1 per pair)
- plastic teaspoons (1 per pair)
- rubber bands (3 per pair)
- small pom-poms (1 per pair)

## Lesson 6 What Is a Lever?

- claw hammer
- wooden board with embedded nail
- plastic or wooden rulers (1 per pair)
- washers or pennies dated after 1990 (10 per pair)
- pencils (1 per pair)
- scissors (1 per student)

## Lesson 7 What Are a Wedge and a Screw?

- small set of wooden blocks, including a rectangular prism and a wedge-shaped block

## Lesson 8 Exploring Gears

- children's toy gears set with all gears the same size

## Lesson 9 Science in Action: Meeting a Toolmaker

- child-sized single-gear bicycle (with or without training wheels)

## Lesson 10 Using Simple Machines to Solve Problems

- large sheets of drawing paper (1 per team)
- pencils and erasers (1 per student)
- markers (1 set per team)

# *Simple Machines* Pacing Guide

_____'s Class

**Note to Teacher:** *Simple Machines* is intended to be taught as the fourth unit of Grade 1 CKSci.

**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 |
|---|---|---|---|---|
| | | | | |

# UNIT 4

# Simple Machines

## Overview

**Big Question:** How do simple machines make farm chores easier?

| Lessons | Lesson Questions | Advance Preparation |
|---|---|---|
| **1.** A Trip to Old Time Farm | What kinds of devices do people use to make tasks easier? | Read Student Book, Chapter 1. |
| **2.** What Is a Ramp? | What is a ramp, and how does using a ramp make moving something easier? | Read Student Book, Chapter 2.<br>Identify locations for student investigation. |
| **3.** What Is a Wheel and Axle? | What is a wheel and axle, and how does using a wheel and axle make moving something easier? | Read Student Book, Chapter 3.<br>Gather materials for demonstration. (See Materials and Equipment, page 11.) |
| **4.** What Is a Pulley? | What is a pulley, and how does using a pulley make moving something easier? | Read Student Book, Chapter 4.<br>Gather materials and identify appropriate locations for student investigation. |
| **5.** Exploring Catapults | How does a catapult move heavy objects? | Gather materials for student investigation. |
| **6.** What Is a Lever? | What is a lever, and how does using a lever make moving something easier? | Read Student Book, Chapter 5.<br>Gather materials for student investigation. |
| **7.** What Are a Wedge and a Screw? | What are a wedge and a screw, and how does each change the direction of a push or pull? | Read Student Book, Chapter 6.<br>Gather materials for student investigation. |
| **8.** Exploring Gears | How do gears interact? | Acquire gear sets for student investigation. |
| **9.** Science in Action: Meeting a Toolmaker | What is a compound machine? | Read Student Book, Chapter 7. |
| **10.** Using Simple Machines to Solve Problems (2 days) | How can you use simple machines to make squirrels work for their treats? | Gather materials for group facilitation. |

## What's the Story?

Simple machines are objects or devices with few or no moving parts. They provide mechanical advantage in the execution of tasks by changing the strength, direction or distance of the input force required to move an object. Simple machines make the human experience of work easier by changing the effort that a person has to exert to perform a given task.

**In Lessons 1–4, 6, 7, and 9,** students listen and read along with teacher Read Aloud of Student Book Chapters 1–7. They identify as simple machines the ramp (inclined plane), wheel and axle, pulley, lever, and wedge (and screw). Reading about these simple machines is reinforced by teacher demonstrations. Students further explore the familiar environment and investigate through manipulation of objects and materials.

**In Lesson 5,** students explore catapults in a hands-on activity prior to reading about levers in Lesson 6. They experience the intuitive nature of using a mechanical arm to throw an object farther than they could with their own bodies.

**In Lesson 8,** students interact with gears to observe the cause-and-effect relationship between the movement of one and, subsequently, several parts. Turning one gear transfers the movement to other gears. Closer observation reveals that the direction of the rotation reverses with each transfer to a new gear.

**In Lesson 10,** students shift from observation to problem solving. They are challenged to engage in design thinking to apply what they have learned about the capabilities of simple machines in the design of a fun device that combines the functions of multiple machines.

In short, **a simple machine changes the direction or distance of a push or a pull. That change makes the performance of a task easier for a person.** Helping students spot the multitudes of ways they experience this (mechanical advantage) in their day-to-day lives lays the groundwork for engineering/design thinking and a problem-solving mindset as they continue learning.

LESSON 1

# A Trip to Old Time Farm

**Big Question:** How do simple machines make farm chores easier?

**Lesson Question:** What kinds of devices do people use to make tasks easier?

**Tie to the Anchoring Phenomenon:** A historical farm is a kind of living museum that allows visitors to see preindustrial farm buildings, equipment, and tools, as well as the crops and animals farmers raised. Explain to students that old-time farms did not have electrical- or gasoline-powered engines to run the equipment. Working the farm was very hard when using only hand tools or farm animals for power. Ask students what they would expect to see the farmers doing at an old-time farm.

## At a Glance

### Learning Objective

✓ Identify examples of objects people use to perform tasks with less effort.

### Instructional Activities

- sing along with a music video
- question generation
- teacher Read Aloud
- class discussion
- drawing and labeling

## Core Vocabulary

**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.

**easier** **work**

**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.

**chore** **effort** **machine** **task**

## Instructional Resources

Student Book

Ch. 1

**Student Book, Chapter 1**
"A trip to Old Time Farm"

Activity Page

AP 1.1

**Activity Page**
Things That Make Work Easier (AP 1.1)

## Materials and Equipment

**Collect or prepare the following items:**

- chart paper
- marker
- question board
- crayons, pencils, or markers for drawing and labeling (1 set per student)
- internet access and the means to project images/video for whole-class viewing

# The Core Lesson 1

## 1. Introduce the Big Question.

Online Resources

Share the Big Question with your class—**How do simple machines make farm chores easier?** Display this question where students can refer to it throughout the unit. (See **Know the Science**.)

To help students visualize a preindustrial farm and a farmer using simple machines, such as shovels and pitchforks, play a music video and have students sing along to "Old MacDonald Had a Farm." See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

Invite students to share what they know about life on an old-fashioned farm. Using chart paper and a marker, list all the chores (daily tasks) Old MacDonald has to do to care for the animals in the video. See the sample list below. Have students pantomime each chore as you list it.

**Old MacDonald's Farm Chores**

- » milking the cows
- » digging holes and shoveling manure
- » spreading hay with a pitchfork
- » washing the horses
- » feeding the chickens
- » feeding the dogs
- » building a doghouse
- » carrying milk to the cats

## Know the Science

TEACHER DEVELOPMENT

**Work and Simple Machines:** Simple machines are devices that have no or few moving parts and make it easier to pull, push, or lift objects. Pushes and pulls are *forces*. In science, force applied over a distance is called *work*. The amount of work done is determined by multiplying the amount of force exerted in the direction of motion by the distance the object moves. Simple machines make work easier by reducing the amount of force needed to move objects. Note: Students in Grade 1 are not expected to use these terms with precision.

Begin recording on the question board as students ask questions related to the anchoring phenomenon about farm chores on an old-time farm. Explain to students that they will add more questions in the coming days and record answers and explanations as they discover them. (See **Know the Standards**.)

## 2. Focus student attention on the Lesson Question.

**Differentiation**

**What kinds of devices do people use to make tasks easier?** Have students identify some of the chores that must be done in your school by you, students, or other school staff. Sample answers may include the following:

- washing the board
- moving chairs
- delivering tablets to the classroom
- sweeping and washing the floor
- carrying out the recycling
- washing the windows
- raising or lowering the blinds
- watering the plants

## 3. Read together: "A Trip to Old Time Farm"

**Student Book**

**Ch. 1**

While some advanced students may be able to read words on a given page of the Student Book, as a 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

**Pages 2–3**

**Differentiation**

**Ask students to turn to pages 2–3 of the Student Book and look at the illustration as you read aloud. Remind them that the title of this chapter is "A Trip to Old Time Farm," and tell them to pay special attention to what kinds of farm equipment an old-time farm does *not* have as you read.**

While students look at the illustration, remind them of the song about Old MacDonald's Farm. **Ask students** the following:

**LITERAL**—What structures are on Old Time Farm?

- a house, a barn, fences

## Know the Standards

**TEACHER DEVELOPMENT**

**SEP 1 Asking Questions and Defining Problems:** The focus of this unit is on asking questions about the designed world, including the tools and machines people use to get work and chores done. Use the question board to prompt students to ask questions based on their interactions with materials, text, and other media. Asking questions about designed objects will help prepare students to use simple machines in designing their own solutions to a problem in Lesson 10.

**INFERENTIAL**—What tools do many farms have today that they do *not* have at Old Time Farm?

» tractors and electricity

**SUPPORT**—For students who are not familiar with modern farming, locate online images using search terms such as "farming equipment today." Show students some of the complex machines, such as tractor-pulled plows, cultivators, hay balers, and harvesters. Explain that these tools powered by engines were not yet invented when Old Time Farm was built.

**Page 4**

**Ask students to turn to page 4 and look at the images as you read aloud.**

**CORE VOCABULARY**—Explain that, in science, **work** is done when something is moved by pushing or pulling.

**INFERENTIAL**—**Ask students,** Without a tractor to pull a plow, how will farmers on Old Time Farm prepare the soil for planting?

» They may have to push the plow themselves or have horses pull the plow.

» They may use a hoe.

**INFERENTIAL**—**Ask,** Without a big machine to carry things, how will farmers on Old Time Farm move the corn they pick to the barn to feed the animals?

» They may have to carry it in their arms.

» They may use a wheelbarrow or pull a wagon.

**INFERENTIAL**—**Ask,** Without a big machine to cut the hay and form the bales, how will farmers on Old Time Farm make hay bales?

» They may have to cut the hay with a knife.

» They may have to use their hands to tie up the hay with string or wires.

**Page 5**

**Ask students to turn to page 5 and look at the picture as you read aloud.**

**Differentiation**

**CORE VOCABULARY**—Explain to students that when physical work is **easier** it takes less effort to move an object. Contrast this scientific meaning with the meaning of the word used to describe some kinds of school work as easier than others. The difference in meaning is that some school assignments, such as answering questions, do not move objects.

**Online Resources**

**CHALLENGE**—Show students a video tour of students on a field trip to a historical farm. Have students observe the tools the farmers use and that are visible on the tour and infer how they are used to do work on the farm. See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

## 4. List objects that make tasks easier.

Activity Page

AP 1.1

Differentiation

Distribute Things That Make Work Easier (AP 1.1). Have students brainstorm in pairs and then draw and label tools or objects that they can use to move other objects. Make sure students understand that their examples can come from school, home, or anywhere else in their community.

Students will discuss their ideas in pairs or small groups but should record their ideas on their own Activity Pages.

> **EXTEND**—Once students complete their Activity Pages, have them explain why work was done in each example. Look for understanding that something was moved from one place to another.

## 5. Check for understanding.

**Formative Assessment**

Monitor Progress

Return to the Lesson Question. **Ask students,** What kinds of devices do people use to make tasks easier? Before they answer, have students review their list of school tasks from Step 2. If they have more suggestions for the list, add them now. Then have students star the tasks that require some kind of device to do the task well and answer the question. Possible answers include the following:

- shovels
- pitchforks
- carts and wagons
- brooms
- watering cans

Tell students that the class will next investigate tools called *simple machines* to help them answer the Big Question, **How do simple machines make farm chores easier?**

Collect Activity Page 1.1 and review student responses. Look for understanding that devices, tools, and other machines can be used to move objects and make work easier.

LESSON 2

# What Is a Ramp?

**Big Question:** How do simple machines make farm chores easier?

**Lesson Question:** What is a ramp, and how does using a ramp make moving something easier?

**Tie to the Anchoring Phenomenon:** In this lesson, students will look at one type of simple machine used on Old Time Farm. The barn was built alongside a hill so that an earth ramp can be used to move heavy loads, such as hay bales, from the lower level of the farm to the upper level of the barn.

## At a Glance

### Learning Objectives

- ✓ Describe what a ramp is.
- ✓ Explain how a ramp works.
- ✓ Identify tasks for which a ramp is helpful.

### Instructional Activities

- teacher Read Aloud
- class discussion
- student investigation

### Core Vocabulary

**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.

**ramp** **simple machine** **work**

**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.

**direction** **lift** **raise**

## Instructional Resources

Student Book

Ch. 2

**Student Book, Chapter 2**
"What Is a Ramp?"

Activity Page

AP 2.1

**Activity Page**
Find the Ramp (AP 2.1)

## Materials and Equipment

**Collect or prepare the following items:**

- chart paper
- marker
- question board
- stiff board, at least 4 feet long
- small box or crate loaded with books
- highlighters (1 per student)
- internet access and the means to project images/video for whole-class viewing

### Advance Preparation

Tour your school to locate examples of ramps that you can show students in Step 3.

# The Core Lesson 2

## 1. Introduce students to Lesson 2.

Ask a volunteer to state the Big Question that you'll be answering in this unit—**How do simple machines make farm chores easier?** Explain that this lesson will focus on a kind of simple machine called a *ramp*.

Introduce the Lesson Question, **What is a ramp, and how does using a ramp make moving something easier?** Invite students to tell what they know about ramps and where they have seen them used. Accept all responses.

## 2. Read together: "What Is a Ramp?"

Student Book

Ch. 2

While some advanced students may be able to read words on a given page of the Student Book as a 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 6**

**Ask students to turn to page 6 of the Student Book and look at the image as you read aloud. Remind them that the title of this chapter is "What Is a Ramp?" and tell them to pay special attention to the position of the ramp as you read.**

While students look at the image on page 6, remind them that Ryan and Papa are visiting Old Time Farm to learn how farmers did their work a long time ago.

**INFERENTIAL**—What kinds of machines do you think Ryan was expecting to see in the barnyard?

» He might be looking for a tractor or a truck.

Have students look at the image and point to the stone wall leading up to the upper-level door. Make sure they understand that they can walk along the earth at the top of the stone wall.

Online Resources

**SUPPORT**—Some students may have trouble visualizing the ramp surface and realizing that it is wide enough for a wagon to roll along. Show them an online image that shows the top surface of the ramp.

See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

**Page 7**

**Ask students look at the image on page 7 as you read aloud.**

**CORE VOCABULARY**—Explain that a **ramp** is an object that has a flat surface with one end of the ramp at a high place and the other end at a low place. (See **Know the Science 1**.)

**LITERAL**—**Ask students,** When Ryan thinks of machines, what examples does he recall?

» tractors, lawn mowers, and kitchen mixers

**INFERENTIAL**—**Ask,** What do these machines have that the ramp does not have?

» motors

**Page 8**

**Ask students to turn to page 8 as you read aloud.**

**LITERAL**—**Ask students,** What are the four ways people in the diagram are moving the heavy box? (See **Know the Science 2**.)

» pushing, pulling, lifting, and pulling it apart

## Know the Science

**TEACHER DEVELOPMENT**

**1. Ramp or Inclined Plane?** For Grade 1 students, the Student Book uses the word *ramp* instead of the scientific term *inclined plane*. Inclined planes can have a steep slope or a gentle slope. Students will find through exploration that gentle slopes make moving objects easier than steep slopes. Using an inclined plane requires less force than lifting straight up, but the force is applied over a longer distance.

**2. What Kinds of Motion Result in Work?** Forces (pushes and pulls) cause objects to change motion—either start or stop moving, increase or decrease speed, or change direction. Pushing moves objects away from you, pulling moves objects toward you, lifting raises objects above a surface, and splitting an object requires pulling its parts away from each other. No matter how hard you push or pull, there is no work done (in the sense used in physics) until the object moves from one place to another. For example, pushing on a wall that does not budge may be difficult, but it is not *work* to a physicist.

**CORE VOCABULARY**—Explain that a **simple machine** is an object that may have no moving parts or few moving parts but still makes it easier to move other objects.

**CORE VOCABULARY**—Remind students that **work** is done whenever something is moved from one place to another place.

**Page 9**

Differentiation

**Ask students to turn to page 9 and examine the photo closely as you read aloud.**

**LITERAL**—**Ask students,** How does the farmer get the hay to the upstairs rooms of the barn?

» The farmer carries the hay in his arms from the ground up to the high door by climbing the ladder.

**INFERENTIAL**—**Ask,** How hard or easy is it to move the hay this way?

» It is hard because the hay is heavy and the farmer has to move his whole body and the hay upward by climbing the ladder.

**SUPPORT**—Fill a crate or small box with books or other heavy objects. Tape the lid closed so that, if the box is dropped, the contents will not spill out. Allow students to take turns using the box to act out lifting a bale of hay over their heads to mimic trying to reach the high doorway in a barn. **Ask,** How does it feel to lift the weight?

**Page 10**

Differentiation

**Ask students to turn to page 10 and examine the images closely as you read aloud.**

**INFERENTIAL**—**Ask students,** In which picture does the person have a more difficult time raising the box to a higher level?

» In the top picture, the person lifting the box has a harder job than the person in the bottom picture sliding the box up the ramp.

**SUPPORT**—Provide students with a stiff board they can use as a ramp and the small box loaded with books. Have them prop up one of the ends of the board on a desk or table to make a ramp. Then have students compare how hard it is to move the box to the table by lifting it with how hard it is to push it up the ramp.

**CORE VOCABULARY**—Remind students that a **ramp** is an object that has a slope like a hill.

**Page 11**

**Ask students to turn to page 11 as you read aloud.**

**LITERAL**—Have students point to the part of the ramp that is higher (on the right) and the part that is lower (on the left).

**INFERENTIAL**—**Ask students,** How does the person move himself and the wheelchair?

» He both pushes and pulls on the railing.

## 3. Take a walk to hunt for ramps.

**Differentiation**

Take the class on a walk around the school to hunt for ramps. If you have located them in advance, you can give students hints about where to look. Likely places in a school are the front entrance, the entrance where shipments are received, or a playground.

If students are struggling to find examples, have them describe what a ramp is and how it is used to a school staff member and ask them if they know of any examples.

If you can locate a ramp suitable for people in wheelchairs, discuss how a long ramp with a gentle slope makes it easier to move the wheelchair up to the level of the doorway.

> **CHALLENGE**—Show students a set of stairs, and challenge them to explain how it works in a similar way to a ramp. Guide them to understand that climbing stairs is easier than climbing up a ladder because the stairs are arranged to have a gentle slope.

## 4. Check for understanding.

**Activity Page**

**AP 2.1**

**Monitor Progress**

**Formative Assessment**

Distribute Find the Ramp (AP 2.1). Provide students with highlighters, and have them find and highlight the ramp in each illustration. Provide pencils so that they can draw something that might move up or down each type of ramp.

Circulate among the students as they work, and **ask questions** such as the following:

- Which object in this picture is a ramp?
- What things move up or down this kind of ramp?
- How is the ramp helpful to people?

See the Activity Page Answer Key for sample student responses. (See **Know the Standards**.)

Return students' attention to the Lesson Question, and discuss how all ramps are simple machines that make moving objects from a low place to a higher place easier. **Ask** if anything students learned about ramps surprised them.

Read aloud the Big Question, **How do simple machines make farm chores easier? Ask students** to use what they learned today to explain how ramps are used on Old Time Farm to make the farmers' work easier.

## Know the Standards

**TEACHER DEVELOPMENT**

**CCC 6 Structure and Function:** In Grades K–2, students learn *the shape and stability of structures of natural and designed objects are related to their functions* (1-LS1-1). This Crosscutting Concept is addressed when students look at the body parts of living things and when they choose materials to design solutions to design problems. Point out to students that all the ramps have a triangular shape (structure) when viewed from the side. This shape makes one side of the ramp higher than the other so that people can use it to move objects from a low position to a high position (function).

LESSON 3

# What Is a Wheel and Axle?

**Big Question:** How do simple machines make farm chores easier?

**Lesson Question:** What is a wheel and axle, and how does using a wheel and axle make moving something easier?

**Tie to the Anchoring Phenomenon:** Farmers must transport heavy loads on a farm—among them water, hay, animal feed, and harvested crops. Even though old-time farms did not have tractors, farmers used wagons, wheelbarrows, and carts to move heavy loads. Have students think about how farmers move heavy loads, such as loads of corn, from their fields to the barn.

## At a Glance

### Learning Objectives

- ✓ Describe what a wheel and axle is.
- ✓ Explain that a wheel and axle together make a simple machine.
- ✓ Explain how a wheel and axle works.
- ✓ Identify tasks for which the wheel and axle is helpful.

### Instructional Activities

- watch a music video
- teacher Read Aloud
- class discussion
- student investigation

### Core Vocabulary

**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.

**axle** **wheel**

**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.

**rotate**

## Instructional Resources

Student Book

Ch. 3

**Student Book, Chapter 3**
"What Is a Wheel and Axle?"

Activity Page

AP 3.1

**Activity Page**
Find the Wheels and Axles (AP 3.1)

## Materials and Equipment

**Collect or prepare the following items:**

- question board
- small box or crate loaded with books
- scooter board
- hand truck or wheelchair
- markers (1 set per student)
- internet access and the means to project images/video for whole-class viewing

### Advance Preparation

- Preview music videos about wheeled vehicles, and select one to show your students.
- Ask a physical education teacher to loan you a scooter board.
- If you can borrow a doorknob set that is not installed in a door, bring it to class.
- Invite a custodian to visit your class, and show students how a hand truck works. For the Challenge activity, invite a nurse to explain how a wheelchair works. Check with your school nurse first to see if there is a wheelchair in the building that they can demonstrate.

# The Core Lesson 3

## 1. Introduce students to Lesson 3.

Online Resources

Invite the class to say together the Big Question for this unit—**How do simple machines make farm chores easier?** Explain that this lesson will focus on a kind of simple machine that has two parts. The parts are called a *wheel* and an *axle*.

Introduce the Lesson Question, **What is a wheel and axle, and how does using a wheel and axle make moving something easier?** While they may be unfamiliar with axles, students should be able to name many uses of wheels in their lives. List their ideas.

Show students a music video about wheeled vehicles. See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

After showing it, invite students to sing along. Then **ask students,** What do all trucks have where they touch the ground?

» wheels

## 2. Read together: "What Is a Wheel and Axle?"

Student Book

Ch. 3

While some advanced students may be able to read words on a given page of the Student Book, as a 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 12**

Differentiation

**Ask students to turn to page 12 of the Student Book and look at the image as you read aloud. Remind them that the title of this chapter is "What Is a Wheel and Axle?" and tell them to pay special attention to the place where the wheel and axle connect as you read.**

Remind students that they have been reading about Ryan and Papa's visit to Old Time Farm, where they learn how farmers used to move loads from one place to another.

**CORE VOCABULARY**—Explain that a **wheel** and **axle** is a simple machine that has two round connecting parts that turn together. One is a large wheel, like a truck's wheel. The other is a smaller rod-shaped wheel that connects at the center of the big wheel. (See **Know the Science**.)

**LITERAL**—Have students point to the four wheels and two axles in the picture.

**CHALLENGE**—**Ask,** What other objects have wheels and axles? Challenge students to start a list that they can add to as they learn about more examples, such as

» trucks, cars, bicycles, buses, skateboards

**Page 13**

**Ask students to look at the images on page 13 as you read aloud.**

**INFERENTIAL**—**Ask students,** How many wheels are there on each object in the pictures?

» two wheels on the bike, but some students may correctly identify the gears as wheels, too

» four wheels each on the book cart, lawnmower, shopping cart, and car chassis

## Know the Science

TEACHER DEVELOPMENT

**How Does a Wheel and Axle Make Work Easier?** Suppose you have no doorknob and have to turn the spindle (axle) of a door latch with your fingers. If you turn the axle itself, the distance your hand moves is short, but it takes a lot of force to make the axle turn. However, if you attach a doorknob (wheel) to the axle and then move the knob, your hand rotates over a longer distance, but the force you must apply is much less.

**Pages 14–15**

**Ask students to turn to pages 14–15 and look at the images as you read aloud.**

Differentiation

**SUPPORT**—Invite students to share their experiences lifting and carrying pumpkins. Make sure all students understand that even small pumpkins can weigh a few pounds and be difficult to carry.

**INFERENTIAL**—**Ask,** How many pumpkins are in the wheelbarrows in the pictures?

» about four to six in each one

Have students act out putting the same four to six pumpkins in a cardboard box and pushing the box across the ground.

**LITERAL**—**Ask,** What makes the wheelbarrow more useful for moving the pumpkins?

» It has a wheel and axle that allow it to roll.

**SUPPORT**—Use the same small box or crate filled with books that was suggested for Support in Lesson 2. This time, have students push the box over a rug or carpet. Then place a board scooter under the box, and have them try moving the load again. **Ask,** Why is it easier to move the load with a board scooter?

» The wheels and axles let you roll, rather than slide, something over the ground.

**CORE VOCABULARY**—Remind students that an **axle** is part of a simple machine called a wheel and axle and is a rod that is longer than it is wide and is connected to a wheel so that they turn together.

**Page 16**

**Ask students to turn to page 16 and examine the images closely as you read aloud.**

Differentiation

**LITERAL**—**Ask students,** Which parts of the door set are like wheels?

» the knobs

**INFERENTIAL**—**Ask,** What would it be like to open a door if the knob were lost? Explain.

» It would be much harder to just turn the rod than the knob with the rod.

**EXTEND**—If you have a doorknob set you can show your students, allow them to identify the wheel (the knobs) and the axle (the rod/spindle). Allow students to compare how easy it is to rotate the knob and how difficult it is to rotate the rod when the knob is removed. Explain that the wide knob makes the work of moving the rod easier because the knob moves a greater distance and decreases the required force.

**Page 17**

**Ask students to point to the wheel and axle in the image on page 17 as you read aloud.**

INFERENTIAL—**Ask,** How is the water well similar to the diagram of the wheel and axle on page 15? (See **Know the Standards**.)

» The well also has a big round part and a rod-shaped part.

## 3. Observe a wheel and axle system.

**Differentiation**

Invite a member of your school staff to bring a hand truck to your class so that students can identify the wheels and axles.

Discuss how rolling a load on wheels take less effort than pushing a load across the floor.

**Ask students,** Why do you think this object is called a *hand* truck? How is it different from the trucks on the roads?

» the power for pushing or pulling the load comes from your hand instead of a motor

CHALLENGE—If you can locate a wheelchair, have students examine its parts and identify the wheel and axle systems. Then challenge students to explain why it is helpful that two of the wheels are very large. Discuss how larger wheels are easier to turn than smaller wheels so that the person using the chair can move forward with less effort.

## 4. Check for understanding.

**Activity Page**

**AP 3.1**

**Monitor Progress**

**Formative Assessment**

Distribute Find the Wheels and Axles (AP 3.1). Write "wheel and axle" on the board, and have students label each of the four pictures. Provide markers so that students can draw a straight line where the axles should be.

Circulate among the students as they work, and look for evidence that students know there are variations in how axles and wheels are combined. **Ask questions** such as

- Which object has one wheel and one axle?
  - » the wheelbarrow

## Know the Standards

**TEACHER DEVELOPMENT**

**SEP 8 Obtaining, Evaluating, and Communicating Information:** In Grades K–2, students *Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea*. Students apply this practice in this chapter, and they use evidence from images to decide how a particular device fits a particular class of simple machines. The concept of simple machines is rather abstract, so finding and talking about many examples will help build student mastery.

- Which object has two wheels and one axle?
  - » the hand truck
- Which object has two wheels and two axles?
  - » the kick scooter
- Which object has four wheels and two axles?
  - » the truck

See the Activity Page Answer Key for sample student responses.

Return students' attention to the Lesson Question, and have students explain how a wheel and axle makes work easier. Look for evidence of understanding that rolling a heavy load on wheels is easier than dragging it.

Invite a volunteer to read the Big Question, **How do simple machines make farm chores easier? Ask students,** How can the farmers at Old Time Farm use wheels and axles to move a load of hay up the ramp to the upper barn?

» They can put the hay on a wagon and roll the wagon up the ramp.

Review the question board, and ask students if they can answer any of the questions after this lesson. Allow them to add more questions to the question board.

LESSON 4

# What Is a Pulley?

**Big Question:** How do simple machines make farm chores easier?

**Lesson Question:** What is a pulley, and how does using a pulley make moving something easier?

**Tie to the Anchoring Phenomenon:** Today, farmers turn on a spigot, and the water comes gushing out. Electric pumps push water from underground up to the surface through pipes. At Old Time Farm, there are no electric pumps, but there are simple machines to making lifting water from a deep well easier.

## At a Glance

### Learning Objectives

- ✓ Describe what a pulley is.
- ✓ Explain how a pulley works.
- ✓ Identify tasks for which a pulley is helpful.

### Instructional Activities

- student investigation
- teacher Read Aloud
- class discussion

### Core Vocabulary

**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.

**lift** **pulley** **raise**

**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.

**groove**

## Instructional Resources

Student Book

Ch. 4

**Student Book, Chapter 4**
"What Is a Pulley?"

Activity Page

AP 4.1

**Activity Page**
Raise the Flag! (AP 4.1)

## Materials and Equipment

**Collect or prepare the following items:**

- question board
- metal or plastic pulley system with a few feet of rope or twine to fit in the groove
- hook, carabiner, or length of rope
- bucket with a handle, half filled with some heavy solid objects or water

### Advance Preparation

- Locate a flagpole with a pulley that you can visit and observe with students.
- Find a place where you can safely hang a pulley and have students try lifting a weighted bucket.

# The Core Lesson 4

## 1. Introduce students to Lesson 4.

Invite the class to say together the Big Question for this unit—**How do simple machines make farm chores easier?** Explain that this lesson will focus on a simple machine called a *pulley*.

If there is a flagpole on the school grounds, take students there. Point out that the top of the pole is much higher than any person can reach. **Then ask,** How is the flag placed at the top of the pole each morning? Accept all reasonable answers, but make sure students see the rope that hangs down to within reach of an adult and the device (pulley) at the top of the pole.

Point out that the device is called a *pulley*, and introduce the Lesson Question, **What is a pulley, and how does using a pulley make moving something easier?**

## 2. Read together: "What Is a Pulley?"

Student Book

Ch. 4

While some advanced students may be able to read words on a given page of the Student Book, as a 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

**Pages 18–19**

Differentiation

**Ask students to turn to pages 18–19 of the Student Book and look at the images as you read aloud. Remind them that the title of this chapter is "What Is a Pulley?" and tell them to pay special attention to the two parts of a pulley as you read.**

Remind students that they are continuing to read the story of Ryan and Papa's visit to Old Time Farm, where they have just seen an old water well that uses a wheel and axle to lift the pail of water.

**SUPPORT**—The word **groove** may be unfamiliar to some students. Make sure they understand that it is a long, narrow, low area around the outside of a pulley wheel.

**CORE VOCABULARY**—Explain that a **pulley** is a simple machine made of a wheel with a groove around it and a rope.

**LITERAL**—How many parts does a pulley have, and what are they?

» two—a grooved wheel and a rope

**CORE VOCABULARY**—Make sure students understand that the pulley in the diagram allows the user to pull downward on a rope to **lift** the bucket upward. (See **Know the Science.**)

**Pages 20–21**

**Have students look at the images on pages 20–21 as you read aloud.**

Differentiation

**INFERENTIAL**—Point to the picture of the flagpole and **ask,** How is the pulley on the barn like the pulley on our flagpole?

» Both are used to lift something up higher than a person standing on the ground can lift it.

**CORE VOCABULARY**—Explain that to **raise** an object means to move it to a higher position.

**SUPPORT**—Invite students to ask questions about how the sailboat and exercise machines use pulleys. If needed, do a quick online search to view images that show what objects are lifted and how high up the objects are lifted.

## Know the Science

TEACHER DEVELOPMENT

**How Do Pulleys Work?** The pulley system explored in this lesson is the simplest type, called a fixed pulley. The pulley wheel is affixed to some anchored surface, and pulling the rope allows the user to raise an object to the height of the wheel. A fixed pulley only changes the direction of the force. In a farm well, the farmer pulls downward on the pulley chain or rope, and the bucket is pulled upward as the pulley changes the direction of the force. In a moveable pulley system, one end of the rope is attached to the secure place, and the wheel moves along the rope; this system makes work easier by requiring less force. Compound pulleys like this use two or more wheels and one rope; these systems can change the direction of the force *and* the amount of effort needed to move the load. A compound pulley is also called a block and tackle.

**Page 22**

**Differentiation**

**Ask students to turn to page 22 and look at the images as you read aloud.**

**LITERAL—Ask,** Where are the pulleys in the photos?

» on the T-shaped bar near the roof and at the top of the crane arm

**INFERENTIAL**—How does using the pulley make the task of lifting the shingles easier?

» The workers do not have to climb up and down a ladder carrying heavy shingles. They can stay where they are, and the worker on the ground can pull down on the rope to lift the shingles up to the worker on the roof.

**CHALLENGE**—Challenge students to explain the advantages of affixing a pulley to the top of a crane. If they are not sure, remind students that the arm on a crane can move. Discuss how the crane can carry the load from side to side as well as upward from the ground.

**Page 23**

**Ask students to examine the pictures on page 23 closely as you read aloud.**

**LITERAL—Ask students,** How are the pulley wheels in the photo connected?

» One rope is wound around all.

**LITERAL—Ask,** How do two or more pulleys affect the effort needed to lift the load?

» They make it easier to lift the load.

## 3. Investigate using a pulley.

- Make sure the rope is sitting in the groove of the wheel with equal lengths on both sides of the wheel.
- Use a hook, carabiner, or length of rope to hang the pulley from a convenient spot in your classroom or on a playground. This can be a broomstick laid between two tables, a strong hook on the wall or ceiling, or a tall railing on a playground structure. Explain to students that the pulley can be hung from a high place anywhere, as long as you have enough rope to reach over the pulley and back down to the floor or ground. (See **Know the Standards**.)
- **SAFETY:** Supervise students closely while using rope or cord. Caution students never to wrap ropes or cords around their necks or to play with them in a way in which they could become tangled.

## Know the Standards

**TEACHER DEVELOPMENT**

**CCC 6 Structure and Function:** Highlight the concept that the shape of a designed object is related to its function. Point out that the wheel on the pulley has a round shape to allow the rope to move easily over it as it turns. Also discuss how the groove in the wheel is designed to hold the rope in place.

- Place some solid weights in a bucket, and fill it no more than halfway. If you are outdoors and not concerned about spills, it might be fun to put water in the bucket to model the Old Time Farm well.
- Tie one end of the rope to the handle of the bucket.
- Allow students to take turns raising and lowering the bucket by pulling down on the rope and slowly releasing the rope.
- **SAFETY:** Caution students to use a hand-over-hand motion to release the rope, instead of letting it slide through their hands and risk irritating their skin. You may also choose to provide students with a set of work gloves to share.
- Make sure students understand that a pulley used in this way changes the direction of their effort. **Ask students,** What can you do with a pulley?
  - » You can pull down to lift something up.

## 4. Check for understanding.

**Activity Page**

**AP 4.1**
**Differentiation**
**Monitor Progress**

**Formative Assessment**

Distribute Raise the Flag! (AP 4.1), and have students follow the directions to label the illustration. Circulate among the students to ask questions about how the pulley works and how it is helpful.

See the Activity Page Answer Key for sample student responses.

> **EXTEND**—Have students draw their own diagram for using a pulley to move hay from the ground to the loft at Old Time Farm.

Return students' attention to the Lesson Question, and have students explain how a pulley makes work easier. Look for evidence of understanding of the following:

- A pulley is made of a grooved wheel and rope.
- You attach a load to the rope and pull on the other end of the rope to raise or lower the load.
- It is easier to pull down on a rope to raise something than to carry it up to a high place.

Invite a volunteer to read the Big Question, **How do simple machines make farm chores easier? Ask students,** How might the farmers at Old Time Farm use pulleys?

- » to lift hay into the loft of the hay barn
- » to lift water out of the well

Review the question board, and ask students if they can answer any of the questions after this lesson. Allow them to add more questions to the question board.

LESSON 5

# Exploring Catapults

**Big Question:** How do simple machines make farm chores easier?

**Lesson Question:** How does a catapult move heavy objects?

**Tie to the Anchoring Phenomenon:** As Ryan and Papa explore Old Time Farm, they find a seesaw and a latch on a shed that are both levers. This lesson invites students to explore a type of lever called a *catapult* with a hands-on activity before they read about how levers are used at Old Time Farm.

## At a Glance

### Learning Objective

✓ Contrast the effort involved in performing a task with and without a simple machine.

### Instructional Activities

- watch a video
- conduct and test a device
- discuss and record results

## Core Vocabulary

**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.

**launch**

**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.

**catapult** **distance** **fulcrum**

## Instructional Resources

Activity Page

AP 5.1

**Activity Page**
Pom-pom Catapult (AP 5.1)

## Materials and Equipment

**Collect or prepare the following items:**

- wood tongue depressors (1 per pair)
- fat, round markers or highlighters (1 per pair)
- plastic teaspoons (1 per pair)
- rubber bands (3 per pair)
- small pom-poms (1 per pair)
- internet access and the means to project images/video for whole-class viewing

# The Core Lesson 5

## 1. Introduce the Lesson Question.

Online Resources

Differentiation

**How does a catapult move heavy objects?** Explain that a catapult is a machine without a motor that can **launch**, or throw, objects farther than people can throw them.

Show a video about Punkin Chunkin. After watching it through once, play it again, pausing to allow students to ask questions. See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

> **SUPPORT**—For students who need help with foundational reading skills, pause the video where text is displayed, and have students use grade-level phonics to decode the words.

Spark the discussion by **asking students** the following:

- What is the object the teams want to move?
  - » a pumpkin
- What parts do the catapult machines designed by the teams have?
  - » They have a basket or net to hold the pumpkin, a long straight piece of wood to swing the pumpkin, and a base to hold all the parts. The long beam is balanced on a single point so it can move up and down.
- What can the teams do with the catapults that they cannot do by just throwing the pumpkin with their arms?

» They can throw pumpkins much farther with a catapult than they can with their arms. (See **Know the Science**.)

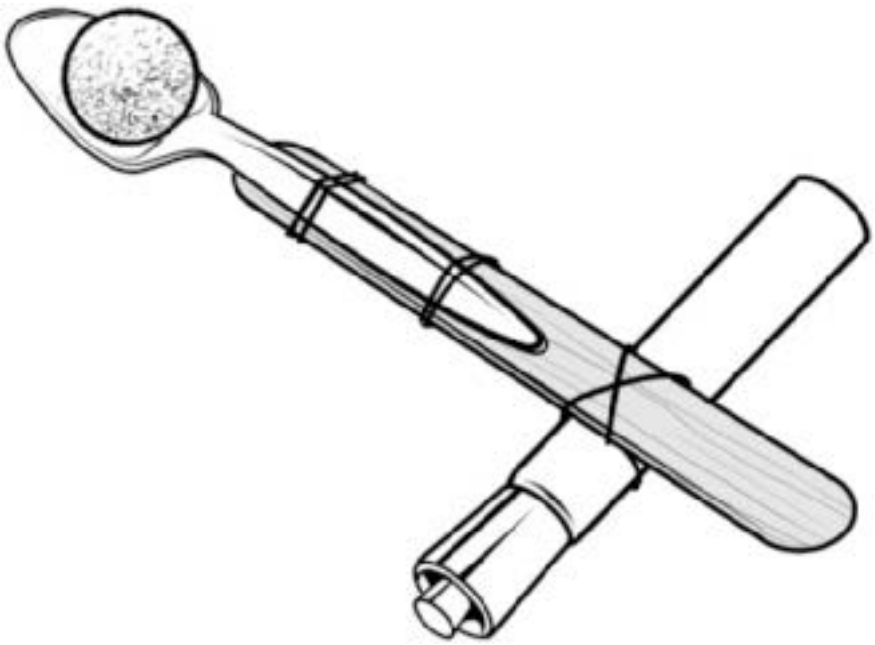
Ask a volunteer to state the Big Question that you'll be answering in this unit—**How do simple machines make farm chores easier?** Point out to students that while an old-time farm might not have one of these machines, catapults have been around for thousands of years.

## 2. Construct and test a device.

**Differentiation**

Show students how to construct a catapult as shown in the image by making your own as a model.

- Use two rubber bands to attach the plastic spoon to the tongue depressor.
- Attach a round marker or highlighter at a right angle under the tongue depressor with another rubber band. Make sure the connection is tight so that there is little movement where they cross. Explain to students that this point is called the *fulcrum*.



**SUPPORT**—Some students may not have the fine motor skills needed to attach the rubber bands effectively. Consider making a few catapults in advance and providing them to teams that are struggling.

## Know the Science

**TEACHER DEVELOPMENT**

**What Are Catapults?** Catapults were first designed to hurl arrows and heavy stones at an enemy during a battle. The central part of many types of catapults is a lever, or a long arm that pivots around a point called the *fulcrum*. Depending on the design, the power to launch the load may come from tension applied to the arm or counterweights placed on the end of the arm opposite the load.

Give each team a pom-pom. Have students place it in the bowl of the spoon and then press down on the other end of the tongue depressor to launch it. **SAFETY:** Make sure students aim away from other students' faces.

Have students practice using their catapults and adjusting the parts to increase the distance the pom-pom travels. Suggest that students move the marker so that it touches the tongue depressor in a different spot (changing the position of the fulcrum). (See **Know the Standards**.)

**CHALLENGE**—Challenge students to draw and label a design for a catapult that could toss something heavier than a pom-pom. Have students think about what elements of the design should stay the same and what elements should change.

**EXTEND**—If you wish to hold a competition between teams, provide a measuring tape or yardstick so that students can measure the distance from their landed pom-pom to a predetermined target. The team with the pom-pom that lands closest to the target wins the round. Repeat the rounds, and add up the points to find the winning team.

## 4. Check for understanding.

Activity Page

AP 5.1

Monitor Progress

**Formative Assessment**

Distribute Pom-pom Catapult (AP 5.1), and have students follow the directions to label the illustration and answer the question. Discuss with students the direction of their effort at one end of the tongue depressor (pushing down) and the direction the other end moved to throw the pom-pom into the air (pushing up).

See the Activity Page Answer Key for sample student responses.

Return to the Lesson Question. **Ask,** How does a catapult move heavy objects? Guide a discussion to bring out the following concepts:

- Catapults have a long part that moves to throw the object.
- The long beam pivots at one point (the fulcrum).
- If you press down on one end of that part, the other end goes up and throws the object.
- The parts of a catapult can be adjusted to change how well the object is thrown.
- A larger catapult than the ones students made today can throw larger objects, such as pumpkins.

## Know the Standards

TEACHER DEVELOPMENT

**CCC 2 Cause and Effect:** Grades K–2 students will be good at tinkering with their catapults to alter the design but may need practice talking about their ideas and how they tested them. **Ask students** to give evidence from their observations of each test to connect the changes (causes) they made with the results (effects).

LESSON 6

# What Is a Lever?

**Big Question:** How do simple machines make farm chores easier?

**Lesson Question:** What is a lever, and how does using a lever make moving something easier?

**Tie to the Anchoring Phenomenon:** Today's farmers have many power tools to make their work easier. At Old Time Farm, there are no power tools, but the farmers use a simple machine called a *lever* for all kinds of tasks that keep the farm running.

## At a Glance

### Learning Objectives

- ✓ Describe what a lever is.
- ✓ Explain how levers work.
- ✓ Identify tasks for which levers are helpful.

### Instructional Activities

- watch a video
- teacher Read Aloud
- class investigation
- class discussion
- modeling

### Core Vocabulary

**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.

**arm** **fulcrum** **lever**

**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.

**pry**

## Instructional Resources

Student Book

Ch. 5

**Student Book, Chapter 5**
"What Is a Lever?"

Activity Page

AP 6.1

**Activity Page**
Move That Rock! (AP 6.1)

## Materials and Equipment

**Collect or prepare the following items:**

- question board
- claw hammer
- wooden board with embedded nail
- plastic or wooden rulers (1 per pair)
- washers or pennies dated after 1990 (10 per pair)
- pencils (1 per pair)
- internet access and the means to project images/video for whole-class viewing

# The Core Lesson 6

## 1. Introduce students to Lesson 6.

Online Resources

Invite the class to say together the Big Question for this unit—**How do simple machines make farm chores easier?** Explain that this lesson will focus on a simple machine called a *lever*.

Show students a video of children on a seesaw at a playground. See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

Then introduce the Lesson Question, **What is a lever, and how does using a lever make moving something easier?** Tell students the video showed a lever that kids play on. **Ask** if they can name that *lever*.

» a seesaw or teeter-totter

## 2. Read together: "What Is a Lever?"

Student Book

Ch. 5

While some advanced students may be able to read words on a given page of the Student Book, as a 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

**Pages 24–25**

Differentiation

**Ask students to turn to pages 24–25 of the Student Book and look at the images as you read aloud. Remind them that the title of this chapter is "What Is a Lever?" and tell them to pay special attention as you read about how a lever moves.**

Recap the story so far of Ryan and Papa's trip to Old Time Farm. Students should recall that they have seen barns with ramps, a water bucket raised from a well with a wheel and axle, and a barn with a pulley next to the hay loft.

**LITERAL**—What parts do you see on the old seesaw?

» a long piece of wood, a wide piece of wood under it, and two handles

**SUPPORT**— In recent years, seesaws have disappeared from many school and public playgrounds due to safety concerns. For this reason, your students may not be familiar with them. Explain that one child sits on one end of the board first and keeps the board level so that another child can climb on to the seat on the other end. When the second child sits down, the downward force causes the child opposite them to rise into the air. As each child takes turns using their legs to push their bodies in an upward motion, the board moves up and down.

**CORE VOCABULARY**—Using a ruler and a pencil, demonstrate that a **lever** is a simple machine with two parts: a board or rod, and a **fulcrum** that the board rests upon. Point to the two ends of the ruler, and explain that they are called the **arms** of the lever. (See **Know the Science**.)

**Page 26**

**Ask students to turn to page 26 and look at the image as you read aloud.**

**LITERAL**—**Ask,** What part of the latch does someone push down on to open the gate?

» the arm on the left side

**INFERENTIAL**—**Ask students,** Where is the fulcrum?

» It is the bolt through the wooden fence plank.

**Page 27**

**Ask students to examine the illustrations on page 27 closely as you read aloud.**

**Differentiation**

**INFERENTIAL**—**Ask,** Which takes less effort: using a shovel or just using your hands to dig up dirt?

» The task is much easier using a shovel.

## Know the Science

**TEACHER DEVELOPMENT**

**Different Kinds of Levers:** This lesson focuses on a type of lever called a first-class lever. Levers with the fulcrum between the load and effort arms (such as a seesaw) are first-class levers. However, there are other types of levers. If the load is between the fulcrum and the effort arm (as in a wheelbarrow), it is a second-class lever. If the effort force is exerted at a point between the fulcrum and the load (a hockey stick), it is a third-class lever. While there is no need to classify levers with Grade 1 students, it may help to know the variations of this simple machine.

**EXTEND**—Show students a claw hammer and a nail partly embedded in a wooden board. Demonstrate how to position the hammer to remove the nail with the claw. Challenge students to identify the lever arms (the handle and claw of the hammer) and the fulcrum (the part of the hammer that rests on the board) and to explain how the effort is applied (pushing down on the hammer handle causes the claw to lift up the nail).

**Pages 28–29** **Have students look at the images on pages 28–29 as you read aloud.**

**LITERAL**—Have students point to the part of the broom that is the fulcrum.

» Students should point to the person's lower hand.

**INFERENTIAL**—**Ask,** How can the fulcrum move on a broom?

» It can move if the person doing the sweeping grabs another part of the handle.

**INFERENTIAL**—**Ask students,** How is the balance scale in the picture like a seesaw?

» Both have arms you can put a person or weights on. Both have a fulcrum in the center.

## 3. Experiment with a lever.

**Differentiation**

Explain to students that they can model the balance scale they saw on Student Book page 29.

Distribute a pencil, a ruler, and ten washers or pennies to act as weights to each pair of students.

1. Have students lay the pencil on a level desk or table and the ruler across it so that the two ends of the ruler move up or down.
2. Stack five weights, and place them on one end of the ruler.
3. Have students add weights one by one to the other end of the ruler until the first set of weights is lifted. If it takes five weights, explain that they pressed down with five-weight effort.
4. Then have students move the fulcrum (pencil) so that one arm of the ruler is longer than the other and repeat steps 2 and 3.

Invite students to share their interpretation of why the model is a lever and how moving the fulcrum on a lever affects the amount of effort needed to complete a task.

» It is a lever because it has a long board and a fulcrum and the arms move on either side of the fulcrum.

» When we move the fulcrum closer to the end of the ruler with the stack of five pennies, it takes fewer pennies to raise them up.

- Students will add weights again until the five weights are lifted. **Ask students** to report if it took more or fewer weights this time.

  **SUPPORT**—Make sure students understand that when fewer weights are needed to lift the load, it means the task is easier. Conversely, more weights mean it is harder to lift the load.

Make sure students understand that moving the fulcrum closer to the object they want to move means less effort is needed to lift a load.

## 4. Check for understanding.

Activity Page

AP 6.1
Differentiation
Monitor Progress

**Formative Assessment**

Distribute Move That Rock! (AP 6.1), and have students follow the directions to label the illustration. Circulate among the students to ask questions about the parts of the lever, how it works, and how it makes tasks easier. (See **Know the Standards**.)

See the Activity Page Answer Key for sample student responses.

**CHALLENGE**—Have students examine a pair of scissors, trace it on paper, and label their drawings to show the two levers and the single fulcrum. Also have students draw arrows to show the direction of their effort when they use scissors and which way the other arm of each lever moves. Finally, **ask students,** Why do you think this tool is called "a pair of scissors?"

Have a volunteer read the Lesson Question and explain what a lever is and how it makes work easier. Look for evidence of understanding of the following:

- A lever is a simple machine with a long board or rod and a point it touches called the *fulcrum*.
- Levers make it easier to lift loads or pry things apart.
- Sometimes levers make work easier by changing the direction of the effort, such as by pushing down on a lever to lift an object.

Return to the Big Question, **How do simple machines make farm chores easier? Ask students**, What chores do the farmers use levers for at Old Time Farm?

» to open gates, to dig in the dirt, to repair broken fences, to sweep the porch, to weigh foods

Review the question board, and ask students if they can answer any of the questions after this lesson. Allow them to add more questions to the question board.

## Know the Standards

TEACHER DEVELOPMENT

**CCC 6 Structure and Function:** Reinforce the concept that the design of a tool relates to its function. Point out that all the levers that students have seen have a long part (the arms) and a smaller strong point on which they turn (the fulcrum). Because levers often move very heavy objects, the arms are designed to be very sturdy and not bend.

LESSON 7

# What Are a Wedge and a Screw?

**Big Question:** How do simple machines make farm chores easier?

**Lesson Question:** What are a wedge and a screw, and how does each change the direction of a push or pull?

**Tie to the Anchoring Phenomenon:** By now students are beginning to understand that not all machines have motors and that some just use the power from human effort. Remind students to look for ways people supply power for the simple machines on Old Time Farm.

## At a Glance

### Learning Objectives

- ✓ Describe what a wedge is.
- ✓ Explain how a wedge changes the direction of a force (a push or pull).
- ✓ Identify tasks for which wedges are helpful.
- ✓ Characterize a screw as a wedge spiraled around a cylinder (rod or tube shape).

### Instructional Activities

- watch a video
- teacher Read Aloud
- class discussion
- student investigation
- label a diagram

### Core Vocabulary

**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.

**screw** **wedge**

**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.

**forward** **spiral** **split**

## Instructional Resources

Student Book

Ch. 6

**Student Book, Chapter 6**
"What Are a Wedge and a Screw?"

Activity Page

AP 7.1

**Activity Page**
Hold That Door! (AP 7.1)

## Materials and Equipment

**Collect or prepare the following items:**

- small set of wooden blocks, including a rectangular prism and a wedge-shaped block
- internet access and the means to project images/video for whole-class viewing

# The Core Lesson 7

## 1. Introduce students to Lesson 7.

Online Resources

Invite the class to read together the Big Question for this unit—**How do simple machines make farm chores easier?** Recap with students the simple machines they have seen so far at Old Time Farm—the ramp, wheel and axle, pulley, and lever. Explain that this lesson will focus on two more simple machines called a *wedge* and a *screw*.

Show students a video about different kinds of boats. See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

Tell students to look at the shape of the front of each boat. Point out that that shape is called a *wedge*. Then introduce the Lesson Question, **What are a wedge and a screw, and how does each change the direction of a push or pull?**

## 2. Read together: "What Are a Wedge and a Screw?"

Student Book

Ch. 6

While some advanced students may be able to read words on a given page of the Student Book, as a 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

**Pages 30–31**

Differentiation

**Ask students to turn to pages 30–31 of the Student Book and look at the images as you read aloud. Remind them that the title of this chapter is "What Are a Wedge and a Screw?" and tell them to pay special attention as you read about how things move when someone uses a wedge.**

Invite students to recap the storyline in this unit of Ryan and Papa's trip to Old Time Farm. Discuss how the machines farmers use at Old Time Farm are different from those used on farms today.

**LITERAL**—What is the tool called that is used to split wood on Old Time Farm?

» a wedge

**CORE VOCABULARY**—Explain to students that a **wedge** is a simple machine that makes it easier to spilt or separate things. (See **Know the Science**.)

**INFERENTIAL**—When using a wedge, which end touches the object you want to split?

» The narrow, pointed end

**SUPPORT**— Have students put their arms and hands together in front of their bodies to form a wedge. Discuss how this position might help them move through a crowd of people.

**Pages 32–33** **Ask students to turn to pages 32–33 and look at the images as you read aloud.**

Differentiation

**LITERAL**—**Ask,** What is a chisel?

» a small wedge used to shape wood

Point out to students that other materials, such as stone, can also be shaped with a chisel.

**SUPPORT**—Give pairs of students a slab of modeling clay, a square block of wood, and a plastic dinner knife. Have them try to split the clay slab in half using one of the flat sides of the block. Then have them try again with the cutting edge of the knife. They can also compare the back edge of the knife to the cutting edge of the knife. Elicit inferences about shapes that make the best splitting tools.

**Pages 34–35** **Have students look at the images on pages 34–35 as you read aloud.**

Differentiation

**INFERENTIAL**—**Ask students,** How are the nail and screw similar? How are they different?

» They have the same long narrow shape with a head on one end and a point on the other end. They differ in that the nail has a smooth part in between the head and the point and the screw has a spiral edge in between.

## Know the Science

**TEACHER DEVELOPMENT**

**Wedges, Screws, and Ramps:** If you place two ramps back to back, you have made a wedge. If you take two ramps, place them back to back, and wrap them around a narrow rod, you have made a screw.

**INFERENTIAL**—**Ask,** How well would it work if you turned the nail around so that the head of the nail was against the wood? Explain.

» You could not hammer the nail into the wood this way. The point works better because it is a wedge.

**CORE VOCABULARY**—Explain to students that a **screw** is a simple machine that has a wedge wrapped in a spiral around a stick shape.

**EXTEND**—Have students practice using screw-top jars and testing how well the top holds when it is screwed in place. Point out that screws are usually stronger for holding materials together than nails and discuss why.

## 3. Test objects to use as a doorstop.

**Ask students**, How can we find out whether a wedge is the best tool for keeping a door open?

» We can do a test.

- Show students a door that closes automatically unless it is held open. Explain that you want to keep it open while students are busy in the classroom.
- Display a variety of wooden building blocks. Offer a rectangular prism-shaped block to hold the door open, and try it with the students.
- When that block does not work, have students choose other block shapes to test. They should find that the narrow end of a wedge-shaped block can be pushed under the door. The block itself may not be able to hold the door open because it is lightweight and made of wood, but you can demonstrate how a true doorstop works to help students make the connection. Make sure to show the two objects side by side.
- Have students discuss how the wedge works by pushing up against the bottom of the door and at the same time pushing down against the floor.

## 4. Check for understanding.

Activity Page

AP 7.1
Monitor Progress

**Formative Assessment**

Distribute Hold That Door! (AP 7.1), and have students follow the directions to label the illustration and answer the question. (See **Know the Standards**.)

See the Activity Page Answer Key for sample student responses.

## Know the Standards

TEACHER DEVELOPMENT

**CCC 6 Structure and Function:** Point out to students that wedges, nails, and screws all have a pointy end that moves to push objects apart. This is another example of how the shape (structure) of a simple machine is related to what it is designed to do (function).

**CHALLENGE**—Challenge students to explain how a wedge, such as the one used to hold the door open on AP 7.1, is different from a ramp. Guide the discussion to highlight the point that a ramp makes work easier by changing the distance something moves, while a wedge makes work easier by changing the direction of a pushing force.

Invite a student to read the Lesson Question that you introduced in Step 1 and explain how wedges and screws change the direction of a push or a pull. Look for evidence of understanding of the following:

- A wedge looks like a ramp or two ramps back to back.
- When a wedge or screw moves forward, it pushes objects sideways or up and down.
- Wedges are helpful to break apart wood or to hold open doors.
- A screw is like a nail with a wedge spiraled around it.

Remind students of the video showing different kinds of boats that you showed in Step 1. **Ask,** What does the wedge do as the boat moves forward?

» It pushes the water to the sides of the boat as it moves.

Return to the Big Question, **How do simple machines make farm chores easier? Ask students,** For what chores do the farmers use wedges at Old Time Farm?

» to split firewood

LESSON 8

# Exploring Gears

**Big Question:** How do simple machines make farm chores easier?

**Lesson Question:** How do gears interact?

**Tie to the Anchoring Phenomenon:** Ryan and Papa did not see any gears on Old Time Farm, but there were probably some there. If the farmhouse has an old pendulum clock, for example, there are gears inside the clock. If the farm has an old-time grain mill, the mill uses gears to change the directions of rotating parts. The mill is not a simple machine, but gears are.

## At a Glance

### Learning Objectives

✓ Observe and describe the shapes of gears.

✓ Explain how gears connect and move, including pushing and pulling.

**NOTE:** Gears are not typically included on lists of simple machines, and they are not addressed in the student reader. However, simple gears allows students to experience how a mechanism can change a force.

### Instructional Activities

- watch a video
- small-group exploration
- record results
- class discussion

### Core Vocabulary

**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.

**gear**

**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.

**clockwise** **counterclockwise** **interact** **pattern**

## Instructional Resources

Activity Page

AP 8.1

**Activity Page**
Turning Gears (AP 8.1)

## Materials and Equipment

**Collect or prepare the following items:**

- children's toy gears set with all gears the same size
- internet access and the means to project images/video for whole-class viewing

### Advance Preparation

- Decide how you will divide the gear set materials between your students. Each group should get several gears, a crank handle, and at least one gear base.

# The Core Lesson 8

## 1. Introduce the Lesson Question.

Online Resources

**How do gears interact?** Explain to students that **gears** are parts of many machines, including bicycles. (See **Know the Science 1**.)

Show a video about a gear exhibit. See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

Discuss with students how the gears interact and how they affect the motion of the bars or rods attached to them.

Invite students to share what they know about gears. If they need prompts, **ask** the following:

- What shape are gears?
- How do gears move?
- What kinds of machines have gears in them?

## Know the Science

TEACHER DEVELOPMENT

**1. What Are Gears?** A gear is a wheel with teeth around the edge. Gears work in interlocking pairs so that when one gear turns, the other one does too, transferring force from one wheel to another. Gears that touch always reverse the direction of the force. Depending on the relative sizes of gears, they can also increase or decrease the amount of force needed. All the gears in the recommended set are the same size. They turn with the same amount of force and at the same speed but in the opposite direction. Point out to students that the gears on a bicycle are not touching but are connected by a chain.

Ask a volunteer to state the Big Question that you'll be answering in this unit—**How do simple machines make farm chores easier?**

Invite students to recap what they have learned so far about how old-time farmers used ramps, wheels and axles, pulleys, levers, wedges, and screws.

## 2. Explore gears in small groups.

**Activity Page**

**AP 8.1**

**Differentiation**

- Arrange students into small groups, and distribute a gear base, a crank handle, and two or more gears from the class set to each group.
- Have students compare the diameter and number of teeth on the two gears you gave them to determine that they are identical (except, possibly, for their color).
- Encourage students to try out the gears to learn how they work. Have them first build flat layouts on the base. Later, using pillar connectors, they can create gear structures that work above the base.
- **Ask students,** When you crank one gear, what does it do to the gear touching it?
  - » It pushes the second gear to make it turn in the opposite direction.

  **SUPPORT**—If students have difficulty explaining the difference in the direction of motion of the spinning gears, show them an analog clock with moveable hands. Explain that when the gear teeth move like the hands of a clock, the motion is called *clockwise*. When gears move in the opposite direction, the motion is called *counterclockwise*. Encourage students to use these terms in their discussions.
- **Ask,** How is this change in motion a pattern?
  - » It happens the same way every time I try it. (See **Know the Standards**.)
- Distribute Turning Gears (AP 8.1), and have students follow the directions to label the illustration and answer the question.

  **SUPPORT**—If any students are struggling, have them lay their gears on the Activity Page to see the relationship between them and the diagram more clearly.

## Know the Standards

**TEACHER DEVELOPMENT**

**CCC 2 Cause and Effect:** This activity continues to develop students' understanding of the Crosscutting Concept *cause and effect* introduced in Lesson 5 ("Exploring Catapults"). Students should recognize the pattern in how cranking one gear causes the gear touching it to turn in the opposite direction. Encourage students to use the word *pattern* to describe these consistent results as they explore the gear set.

**CHALLENGE**—Explain to students that to connect, gears must have the same size teeth. Have students think about a large and a small gear, both having the same size teeth. **Ask** students to predict which gear will have fewer teeth and why.

» The small gear will have fewer teeth because the distance around the wheel is shorter and cannot fit as many teeth as the large gear.

## 3. Check for understanding.

**Formative Assessment**

Restate the Lesson Question, **How do gears interact?** Guide a discussion based on students' work with the gear set to bring out the following concepts:

- A gear looks like a wheel with teeth around its edge.
- If you turn one gear, the gear touching it also turns, but in the opposite direction.
- This interaction is a pattern that we see again and again.

Online Resources

Monitor Progress

**EXTEND**—Download an app called *Crazy Gears* for your students to explore. Students can move up levels of difficulty as they manipulate gears, cogwheels, and chains to solve puzzles. The parts connect in realistic ways, following the rules of physics. See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

Review students' work on Activity Page 8.1, referring to the Activity Page Answer Key for sample student responses.

Remind students of the Big Question in this unit—**How do simple machines make farm chores easier?** Share with students that when old-time farmers cut their wheat, they took the wheat seeds (kernels) to a mill to be ground into flour. Flour is used to make breads, pie crusts, noodles, and other goods. Many years ago, the mills were powered by flowing water from a stream or river. The moving water pushed a big water wheel and caused it to turn. The water wheel was connected to gears that turned two big stones. Wheat placed between the two moving stones was crushed and ground into fine, powdery flour. With the use of gears, the task of grinding flour took farmers less effort and less time. (See **Know the Science 2**.)

## Know the Science

**TEACHER DEVELOPMENT**

**2. How Did Old-Time Water Wheels Work?** Watch a narrated animation with more details about how the water wheel transfers force from the moving water to the stones to grind grains. See the Online Resources Guide for a link to this resource:

**www.coreknowledge.org/cksci-online-resources**

LESSON 9

# Science in Action: Meeting a Toolmaker

**Big Question:** How do simple machines make farm chores easier?

**Lesson Question:** What is a compound machine?

**Tie to the Anchoring Phenomenon:** It's likely that more of the machines that are used on historical farms such as Old Time Farm are compound machines than simple machines. As you explore this lesson with your students, make sure they understand that a compound machine may have two of the same kind of simple machine (a block and tackle) or two or more different kinds of simple machines (a shovel).

## At a Glance

### Learning Objectives

- ✓ Define *compound machine*.
- ✓ Identify simple machines in examples of compound machines.

### Instructional Activities

- watch a video
- teacher Read Aloud
- class discussion
- label a diagram

### Core Vocabulary

**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.

**combine** **tool**

**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.

**compound machine**

## Instructional Resources

Student Book

Ch. 7

**Student Book, Chapter 7**
"Science in Action: Meeting a Toolmaker"

Activity Page

AP 9.1

**Activity Page**
Parts of a Bike (AP 9.1)

## Materials and Equipment

**Collect or prepare the following items:**

- question board
- child-sized single-gear bicycle (with or without training wheels)
- internet access and the means to project images/video for whole-class viewing

**Differentiation materials:**

- garden trowel

# The Core Lesson 9

## 1. Introduce students to Lesson 9.

Remind students that, so far in this unit, they have looked at several kinds of simple machines. Tell them that today they will find out that simple machines are often **combined**, or put together, into more complicated machines.

Then introduce the Lesson Question, **What is a compound machine?** Tell students that when they read books, they may find a word that is made up of two words. These are called *compound* words. Share examples, such as *football*, *playground*, and *teaspoon*.

Based on what they know about compound words, **ask students** to predict what a compound machine is. Have students keep their ideas in mind as you move on to using the Student Book.

## 2. Read together: "Science in Action: Meeting a Toolmaker."

Student Book

Ch. 7

While some advanced students may be able to read words on a given page of the Student Book, as a 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

**Pages 36–37**

Differentiation

**Ask students to turn to pages 36–37 of the Student Book and look at the images as you read aloud. Remind them that the title of this chapter is "Science in Action: Meeting a Toolmaker." Tell them to pay special attention as you read to noticing how simple machines are combined.**

**CORE VOCABULARY**—Explain to students that a **tool** is any object that helps someone do a job. A tool, such as an axe like the one the blacksmith makes, can be a simple machine. A simple machine can also be a tool.

**LITERAL**—What kinds of simple machines does the blacksmith at Old Time Farm make?

» wedges and levers

**SUPPORT**—Help students recall the names of the simple machines they have learned about in previous lessons by listing them on chart paper: ramps, wheels and axles, pulleys, levers, wedges, and screws. This list will be a useful reference during the activity in Step 3.

**EXTEND**—Show students a garden trowel, and challenge them to use what they read about the shovel to describe the simple machines in a trowel and how they work.

» The handle of the trowel is a lever because you press down on it against the ground (the fulcrum) to dig. The blade is a wedge that pushes the dirt aside.

**Pages 38–39**

**Ask students to turn to pages 38–39 and look at the images as you read aloud.**

**LITERAL**—Have students point to the levers and fulcrums in the images as you read page 38.

**INFERENTIAL**—**Ask,** How does Ryan know the plow is a compound machine?

» because it is made of two simple machines—a wedge and a wheel and axle

**Pages 40–41**

**Explain to students that this section of the chapter is about Archimedes. Ask students to examine the pictures on page 41 closely as you read aloud.**

**LITERAL**—**Ask,** What is Archimedes famous for? (See **Know the Science**.)

» He is famous for writing about how simple machines work and inventing a screw to lift water.

**INFERENTIAL**—**Ask,** Which task is easier, climbing up and down a hill carrying heavy buckets of water or standing in one place and turning a handle around and around?

» The task is easier if you can just stand still and turn a handle.

Online Resources

**EXTEND**—Show students a video of a modern-day water screw, such as one used to move water from a stream at a low elevation to a river at a higher elevation. Stop the video at several places to discuss how water moves from a natural stream into a receiving basin and is then carried uphill by the screw. See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

## 3. Analyze the parts of a bicycle.

Activity Page

AP 9.1
Differentiation

Point out to students that bicycles are machines that allow people to travel faster and farther with less effort. Have your students gather in a circle around the bicycle. Explain that they will use claim-evidence-reasoning (CER) thinking to discuss which simple machines are part of it. (See **Know the Standards**.)

- Distribute Parts of a Bike (AP 9.1) to each student.
- Have students take turns naming the parts of the bicycle.
- Point to the wheels, and **ask students,** What claim can you make about this part being a simple machine?
  - » It is a wheel and axle.
- **Ask,** What evidence do you have from learning about Old Time Farm to support your claim?
  - » It looks and works like the wheels on the wheelbarrow and the farm wagon.

## Know the Science

TEACHER DEVELOPMENT

**Mechanical Advantage:** Simple machines reduce the force needed to do work. In other words, they provide a *mechanical advantage* to the user. Archimedes was a mathematician who first described the principle of mechanical advantage, which is calculated by dividing the amount of force the simple machine produces by the amount of force the user applies. A value of one means there is no mechanical advantage, as when you use a single pulley to lift a weight. A value greater than one means there *is* a mechanical advantage—for example, when you push a load up a ramp instead of lifting and carrying it. A water screw, such as Archimedes's screw, can have a mechanical advantage of fifteen, so this machine is a very helpful way to lift water.

## Know the Standards

TEACHER DEVELOPMENT

**SEP 7 Engaging in Argument from Evidence:** This Science and Engineering Practice is closely related to the CER thinking strategy many schools apply across the curriculum. The Next Generation Science Standards learning progressions for Grades K–2 identify several ways that young children should use evidence in their arguments, including listening actively to others' arguments and agreeing or disagreeing based on evidence.

**SUPPORT**—Invite a volunteer to show the class how each wheel is connected to an axle on the bicycle.

- **Ask the other students,** Do you agree or disagree with this argument?
- When all students agree, have them complete the first row of the table on Activity Page 9.1.

Repeat the CER/argument process until students identify several simple machines on the bicycle, as described in the table below. Have them record on their activity pages as you go.

| Part of a Bicycle | Similar Machine on Old Time Farm | Kind of Simple Machine |
|---|---|---|
| wheels | wheelbarrow, farm wagon | wheel and axle |
| pedals | gate latch | lever |
| gears connected by a chain | old barn with a pulley, block and tackle, well | pulley |
| handlebars | seesaw, gate latch | lever |
| brake handles | gate latch | lever |

## 4. Check for understanding.

**Differentiation**
**Monitor Progress**

**Formative Assessment**

Review students' work on Parts of a Bike (AP 9.1), and compare it to the Activity Page Answer Key for sample student responses.

Return to the Lesson Question, **What is a compound machine?** Have students answer with examples. Look for evidence of understanding of the following:

- A compound machine is a device made up of two or more simple machines.
- A bicycle is a compound machine.
- Shovels, scissors, pliers, and plows on a farm are compound machines.
- Archimedes's water screw is a compound machine.

**CHALLENGE**—Challenge students to think of other examples of compound machines by thinking about the sports equipment and toys they play with. Have students draw a spider map graphic organizer around the term *compound machines* and add examples as they think of them.

Review the question board, and ask students if they can answer any of the questions after this lesson. Allow students to suggest revisions or additions to the questions on the question board.

LESSON 10

# Using Simple Machines to Solve Problems

**Big Question:** How do simple machines make farm chores easier?

**Lesson Question:** How can you use simple machines to make squirrels work for their treats?

**Tie to the Anchoring Phenomenon:** Old Time Farm has many simple machines for Ryan and Papa to see and for your students to read about. In this lesson, students will draw upon those examples to design a solution to a problem that farmers and anyone else who has observed the antics of squirrels will understand.

## At a Glance

### Learning Objectives

- ✓ Define a problem that can be solved with the use of simple machines. Collaborate to sketch a solution to the problem.
- ✓ Compare solutions to predict which ones will work best.

### Instructional Activities (Two Days)

- watch a video
- class discussion
- drawing
- showcasing designs

### Core Vocabulary

**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.

**problem** **solution**

**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.

**design** **showcase**

## Instructional Resources

Activity Page

AP 10.1

**Activity Page**
Name That Machine! (AP 10.1)

## Materials and Equipment

**Collect or prepare the following items:**

- question board
- large sheets of drawing paper (1 per team)
- pencils and erasers (1 per student)
- markers (1 set per team)
- internet access and the means to project images/video for whole-class viewing

### Advance Preparation

Decide where and how student teams will showcase their designs to allow all other teams to view them. Also allocate time for each team to answer questions. Options may include hanging the sketches in a school hallway or taking digital photographs and displaying them electronically.

# The Core Lesson 10

## Day 1: 1. Introduce the Lesson Question.

Online Resources

Show a video about squirrels eating, in which the squirrel must work to get its treat. See the Online Resources Guide for a link to the recommended resource:

**www.coreknowledge.org/cksci-online-resources**

Discuss with students how the squirrel has to lift the lid and hold it up while it reaches for the peanut. Make sure students see that the wooden lid is connected to a hinge. Point out that the hinge is a kind of lever.

Ask a volunteer to state the Big Question that students have answered in this unit—**How do simple machines make farm chores easier?**

Briefly recap with students what they have learned about how old-time farmers used ramps, wheels and axles, pulleys, levers, wedges, and screws as simple machines and as compound machines.

Introduce the Lesson Question, **How can you use simple machines to make squirrels work for their treats?**

Explain that the farmers at Old Time Farm like to feed the squirrels but the squirrels empty the feeders too quickly. The farmers want to use a feeder that makes the squirrels do some work before they can get to the seeds and nuts inside. (See **Know the Standards**.)

## 2. Define the problem.

**Differentiation**

- Tell students that something you want to change can be described as a **problem**.
- In a class discussion, guide students to restate the Lesson Question problem in their own words.
- List what students know about the problem, and share facts about tree squirrels, such as what they eat (seeds and nuts), how they move (climbing and jumping from tree to tree), how they store food for winter (they dig holes in the ground and bury nuts), how they break open hard-shelled nuts (with very sharp wedge-shaped front teeth), and how they hold nuts to look them over (in their front handlike paws). (See **Know the Science**.)
- Invite students to ask questions about tree squirrels. If needed, use a search engine to find answers.

  **SUPPORT**—Depending on where your school is located, your students may be more or less familiar with tree-dwelling squirrels. If needed, consider making up a fact sheet about local squirrels that students can use to learn more about these animals.

## Know the Standards

**TEACHER DEVELOPMENT**

**ETS1-1 Engineering Design:** The Disciplinary Core Ideas for engineering fall under three categories—Defining and Delimiting Engineering Problems, Developing Possible Solutions, and Optimizing the Design. In Grades K–2, students learn that that there are many ways to solve an engineering problem, to gather information before starting the work on a solution, the importance of communicating their designs clearly, and understanding that solutions can be tested and compared.

## Know the Science

**TEACHER DEVELOPMENT**

**What Makes Squirrels Problem Solvers?** University psychologists have concluded that each time a squirrel finds a nut, it makes a decision to store it for winter or eat it right away. Therefore, squirrels are problem solvers. Squirrels are also very adept at solving the problem of how to extract nuts and seeds from bird feeders and can usually defeat even the best human-designed squirrel-proof feeders. Squirrels can jump up to five feet vertically and ten feet or more laterally. Students should take this into consideration when designing placement of their feeders.

## 3. Sketch a solution.

**Differentiation**

- Arrange students into small teams. Explain to students that there is more than one way to solve a problem. Have each team talk about the simple machines that a squirrel could use and how students can incorporate them into their squirrel feeder design.

  **SUPPORT**—Some students may not readily recall all the kinds of simple machines. Display a list of the six kinds of simple machines students have explored, or provide Student Book Chapter 7 for them to use as a reference.

- Distribute a large sheet of drawing paper, pencils, and erasers to each team. Suggest that students sketch lightly with a pencil so that they can erase and redraw as needed. Make sure students understand that their sketches should have labels that will help communicate their design **solution** to the rest of the class.
- Give students markers to finalize their sketches.

## 4. Showcase and compare solutions.

**Differentiation**

- When teams have completed their sketches, show them where and how to display them.
- Allow time for each student to view all the solutions and make comparisons.
- Give each team time to talk about how they solved the problem using simple machines and answer questions from the rest of the class.
- Facilitate the discussions by **asking students** the following:
  - Which simple machine(s) did this team use?
  - What tasks do the squirrels have to do before they can get a treat?
  - How does this solution compare to those of other teams?

  **CHALLENGE**—For those students who have a good grasp of the design process, challenge them to suggest ways to change some designs to make them even more challenging for the squirrels.

## 5. Check for understanding.

**Differentiation**
**Monitor Progress**

**Activity Page**

**AP 10.1**

**Return to the Lesson Question and ask students,** How can you use simple machines to make squirrels work for their treats? Guide a discussion to review how students solved an engineering problem and compared their solutions. Look for understanding of the following:

- People use simple machines to solve problems and to do work.
- A situation that people want to change can be stated as a problem.
- Solutions to a problem can be shown in labeled drawings.
- There is more than one way to solve a problem.
- Solutions can be compared to decide which one will work best.

**EXTEND**—Have students design a new playground with structures that use simple machines to let kids exercise in fun ways. Allow them to search online for playground structures to give them ideas they can use in their designs.

**Summative Assessment Opportunity**

Distribute Name That Machine! (AP 10.1), and have students work independently to complete the matching activity. Review students' work, and allow them to use Chapter 7 in the Student Book to make corrections.

Remind students of the Big Question in this unit—**How do simple machines make farm chores easier?** Point out that students had to think about this question to solve this lesson's problem about feeding squirrels. Allow students to answer the question, and listen for the understanding that simple machines make it easier for farmers to carry heavy loads, lift loads into hay lofts, split wood logs, raise water from wells, dig in the ground, plant seeds, and so on.

Direct students' attention to the question board to discuss which questions they are able to answer after exploring simple and compound machines in this unit.

UNIT 4

# Teacher Resources

**Activity Pages**

Name _____ Date _____

Activity Page 1.1 Use with Lesson 1

## Things That Make Work Easier

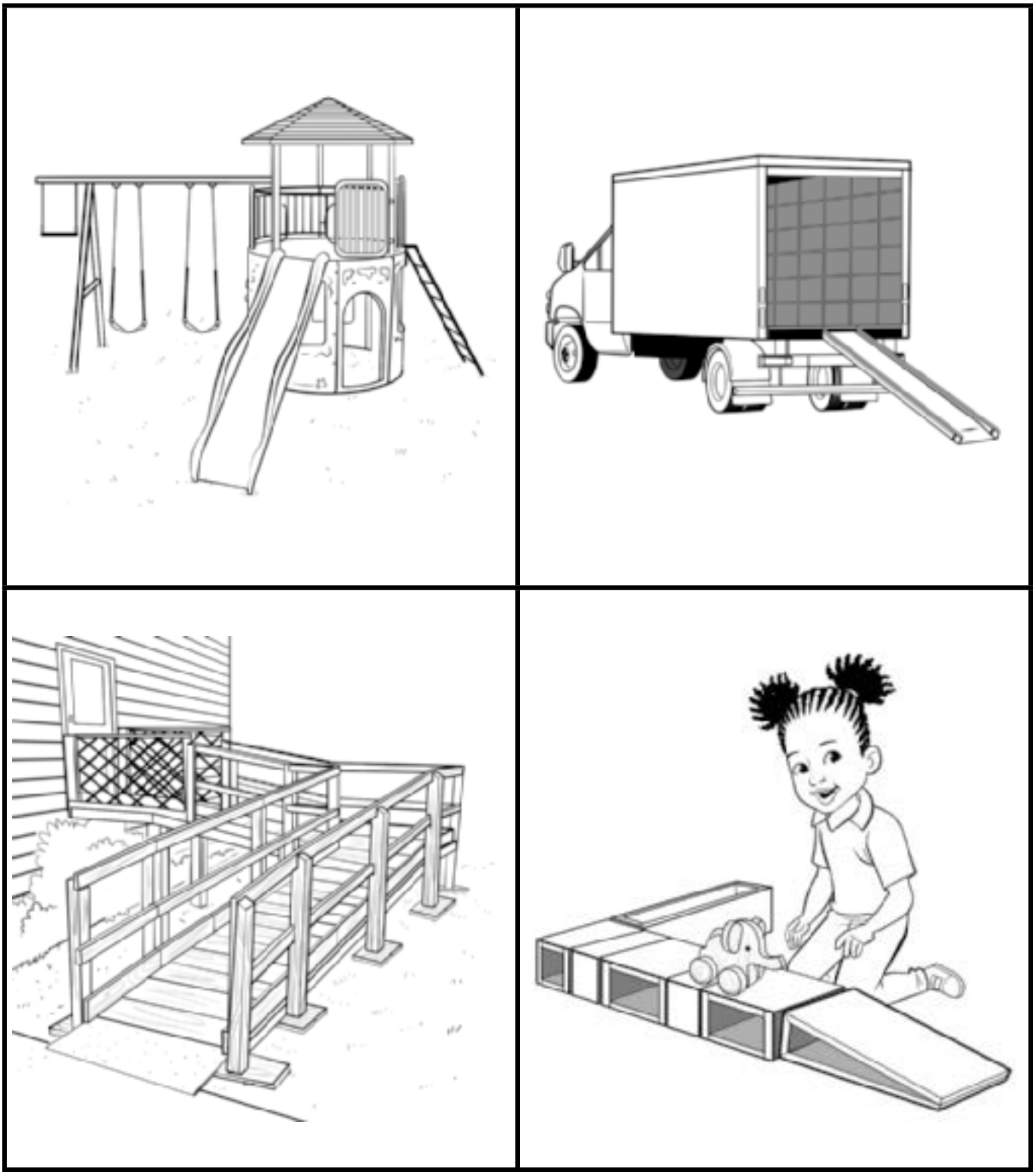
**You do work when you move something. Draw and label pictures of four things you use to move objects.**

Name _____ Date _____

Activity Page 2.1 Use with Lesson 2

## Find the Ramp

**Each picture has a ramp. Highlight the ramp, and draw what might move up or down on it.**

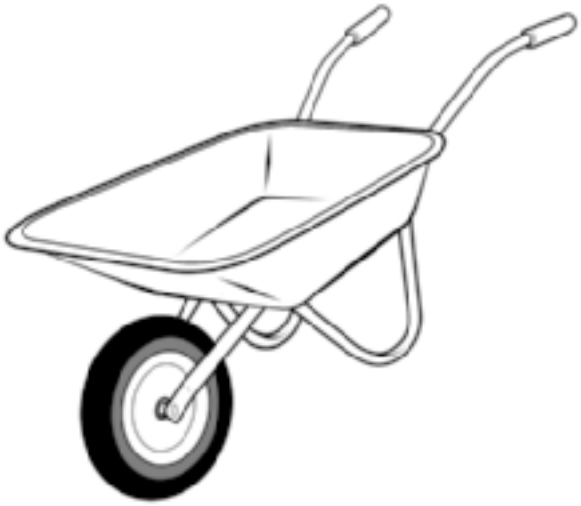


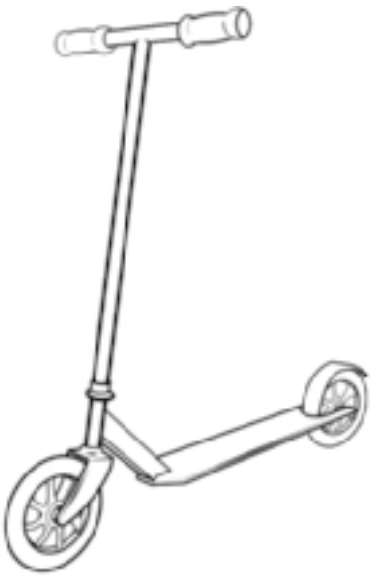
Name _____ Date _____

Activity Page 3.1 Use with Lesson 3

## Find the Wheels and Axles

**Each object shown below has one or more wheels and axles. Label the wheels. Then draw a straight line and label where the axles should be.**





Name _____ Date _____

Activity Page 4.1 Use with Lesson 4

## Raise the Flag!

**Show how a flag is raised using a pulley.**

1. **Write a title: Using a Pulley.**
2. **Label the wheels and rope.**
3. **Draw an arrow to show the direction the rope is pulled.**
4. **Draw an arrow to show the direction the flag moves along the pole.**

Name _____ Date _____

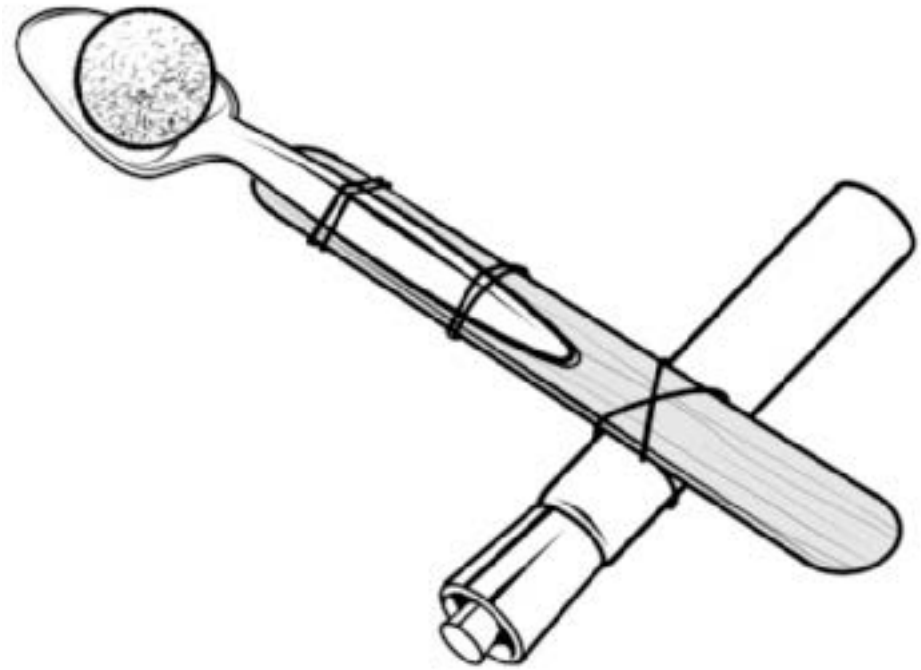
Activity Page 5.1 Use with Lesson 5

# Pom-pom Catapult

**Write, draw, or circle your answers for 1, 2, and 3.**

**1.** Label the picture with a **D** where you pushed down.

**2.** Label a **U** where the catapult pulled up.



**3.** What did you do to make the pom-pom go farther?

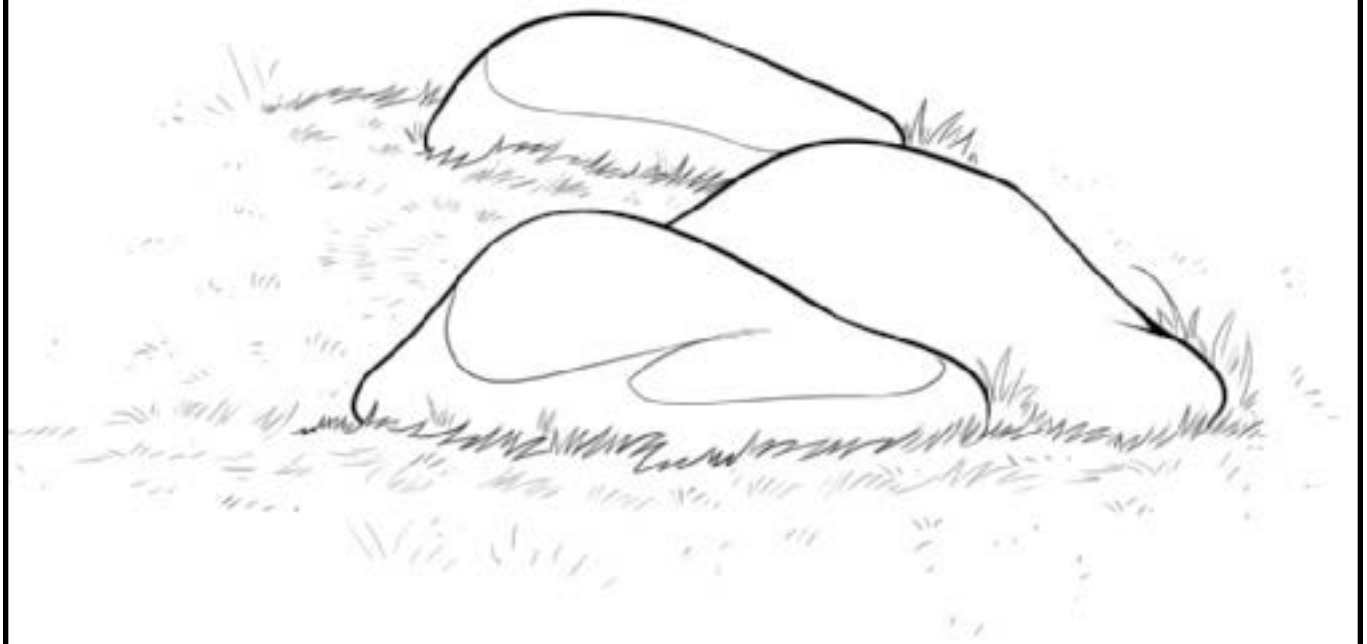
push harder push softer

Name _____ Date _____

Activity Page 6.1 Use with Lesson 6

## Move That Rock!

**The farmers on Old Time Farm want to plant a flower garden behind the barn. But there are big rocks in the ground! Draw pictures, arrows, and labels to show how to use a lever to move the rocks.**

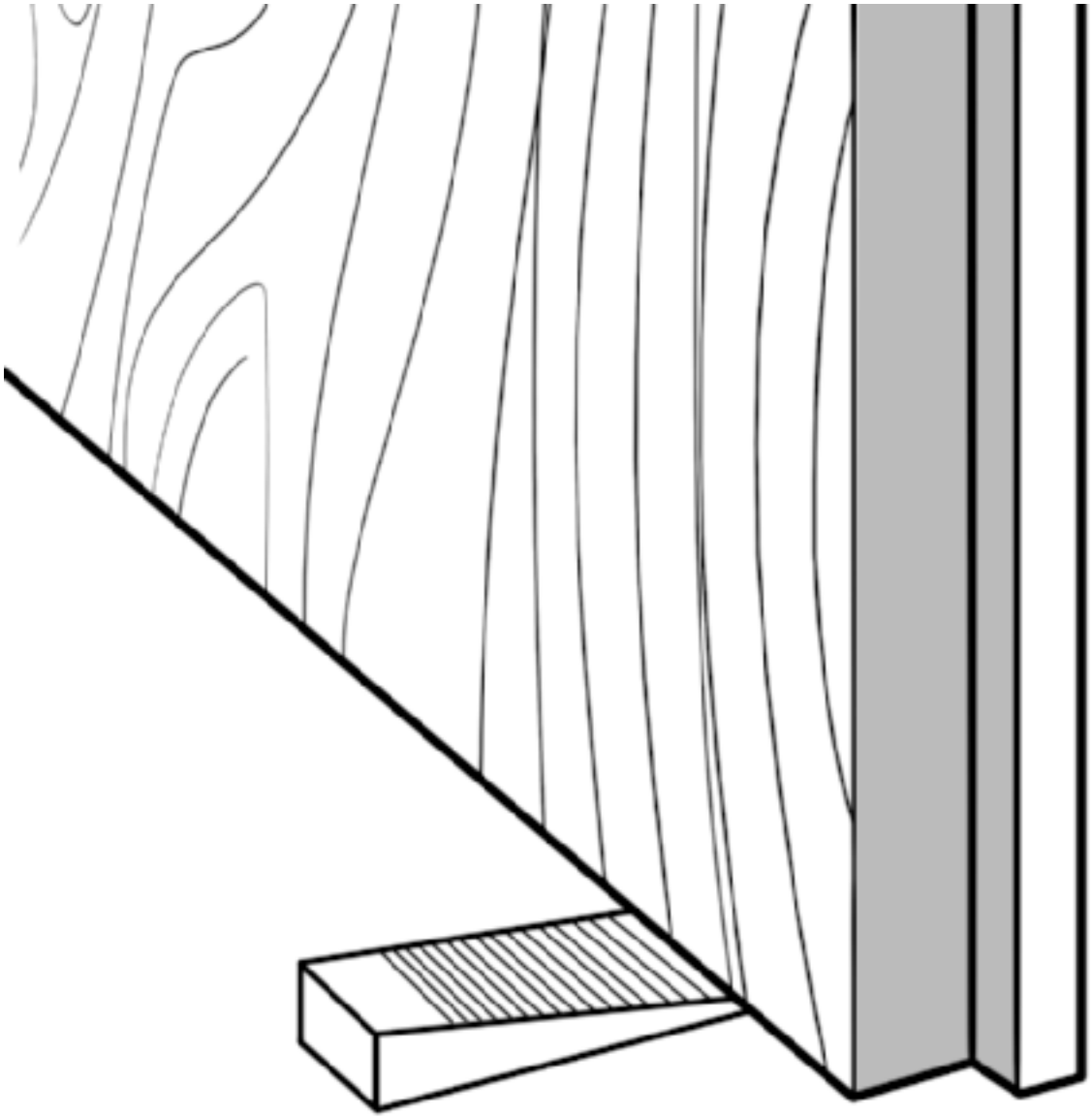


Name _____ Date _____

Activity Page 7.1 Use with Lesson 7

## Hold That Door!

**Label the floor, door, and wedge. Draw arrows to show the two directions the wedge pushes to hold the door. Then answer the question.**



How do you move the wedge into place to hold the door?

_____

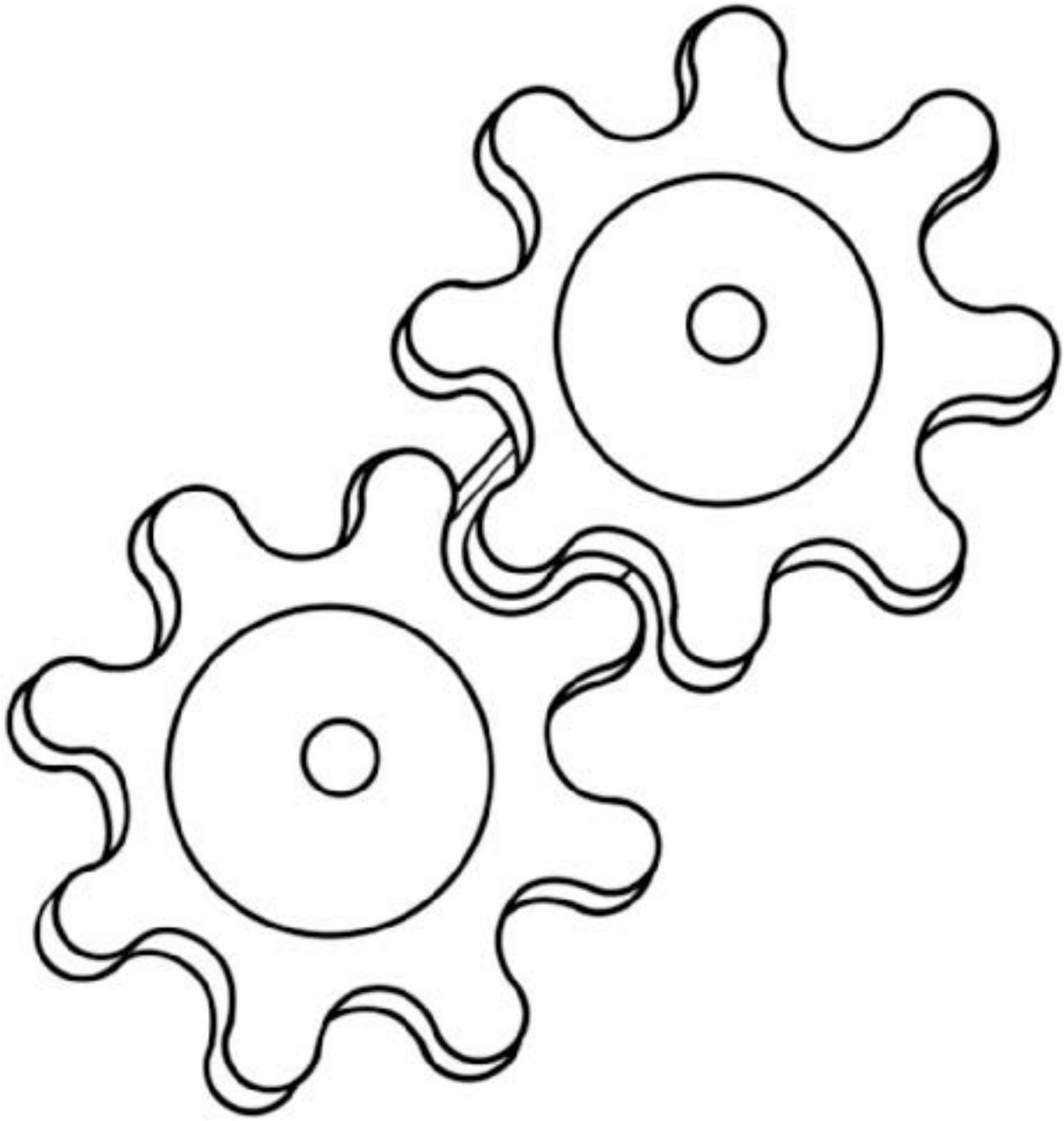
_____

Name _____ Date _____

Activity Page 8.1 Use with Lesson 8

## Turning Gears

1. **Draw and label a handle on one gear.**
2. **Draw an arrow to show which way you would turn the gear.**
3. **Draw an arrow to show which way the other gear would move.**



4. **What kind of simple machine is a gear most like?**

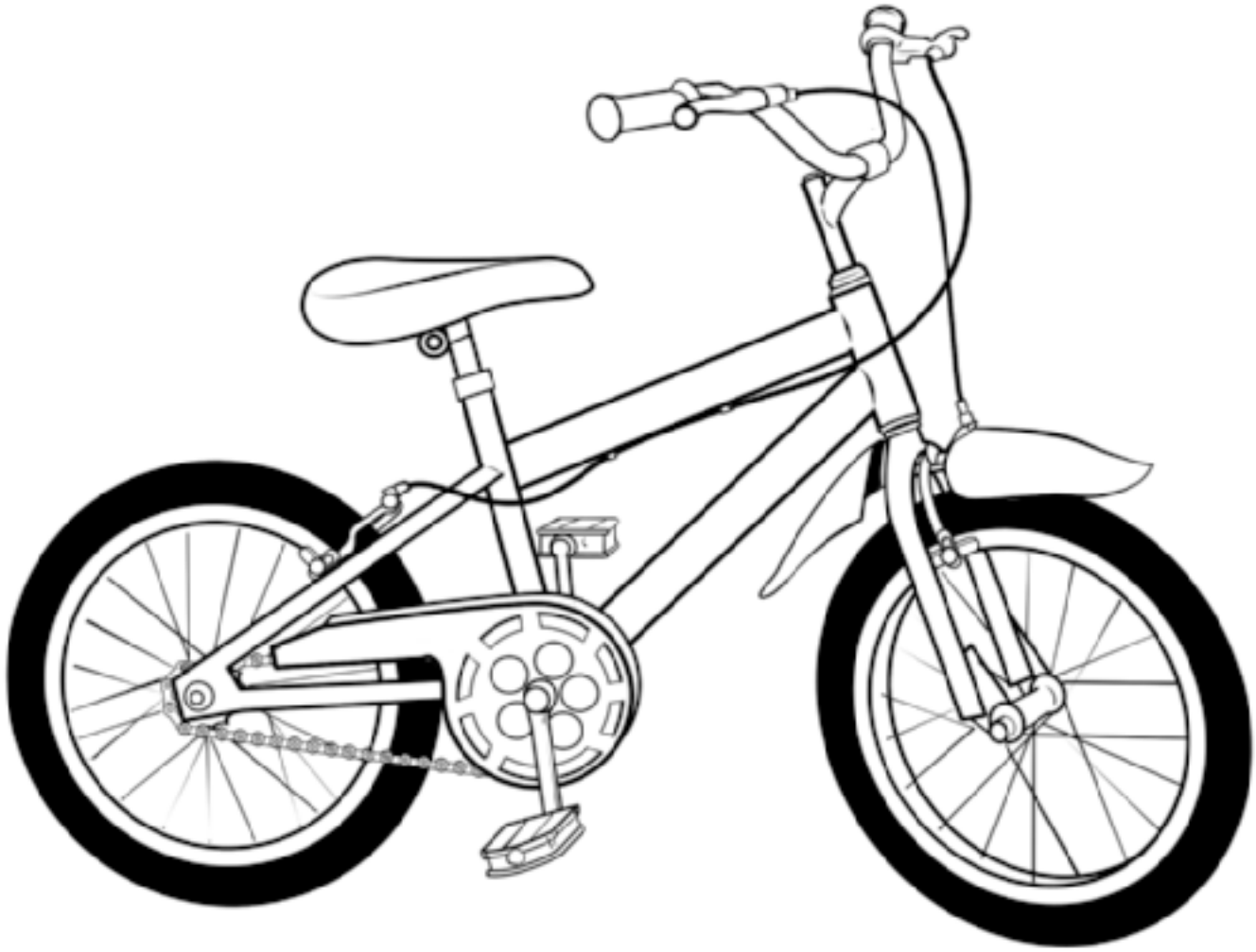
_____

Name _____ Date _____

Activity Page 9.1 Use with Lesson 9

## Parts of a Bike

**A bike is made of many simple machines. Fill in the chart to tell the part of the bike and what kind of simple machine it is.**



| Part of a Bicycle | Kind of Simple Machine |
|---|---|
| | |
| | |
| | |
| | |

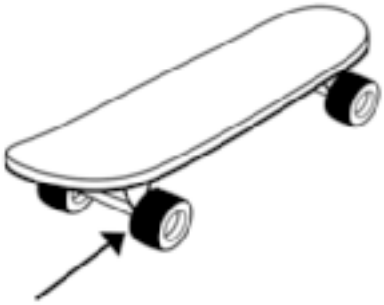
Name _____ Date _____

Activity Page 10.1 Use with Lesson 10

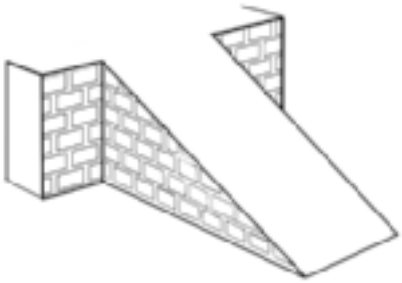
## Name That Machine!

**Use the word bank to write the kind of simple machine shown in each picture.**

| | | |
|---|---|---|
| **ramp** | **wheel and axle** | **pulley** |
| **lever** | **wedge** | **screw** |



_____



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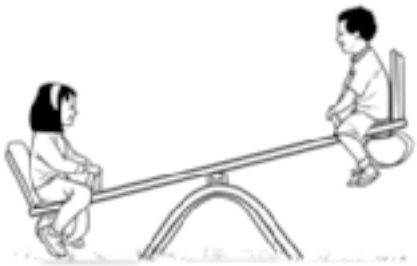

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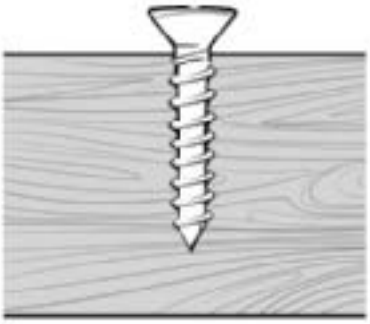

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# Activity Pages Answer Key: *Simple Machines*

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.

### Things That Make Work Easier (AP 1.1) (page 65)

Sample drawing answers: a wagon carrying a dog; a hammer hitting a nail; a shovel pushing snow; a broom sweeping debris

### Find the Ramp (AP 2.1) (page 66)

top left: The slide is a ramp. A child would slide down it.

top right: The board leading up to the back of the truck is a ramp. Furniture might go up the ramp.

bottom left: The slanted wood path is a ramp. Someone using a wheelchair might roll on the ramp.

bottom right: The triangle-shaped block is a ramp. A toy car rolls down the ramp.

### Find the Wheels and Axles (AP 3.1) (page 67)

Student responses should indicate wheels with labels and show via drawings the locations of unseen axles.

### Raise the Flag! (AP 4.1) (page 68)

Student responses should include labels correctly indicating the rope and pulley in the image. Arrows should indicate that when the rope is pulled down, the flag is raised up.

### Pom-pom Catapult (AP 5.1) (page 69)

Students should label the short arm of the catapult diagram "D" for *down* and the end holding the pom-pom "U" for *up*. Students should describe what they did to make the pom-pom go farther.

### Move That Rock! (AP 6.1) (page 70)

Student drawings and labels should show a long bar (or rod) for the arm of a lever with a rock or block of wood very close to the rocks as a fulcrum. Arrows should show the long arm is pushed down and the short arm lifts up a rock.

### Hold that Door! (AP 7.1) (page 71)

Student labels should correctly indicate the door, the floor, and the wedge. Directional arrows should point directly upward and downward from the narrow end of the wedge.

Sample answer: You put it on the floor and slide it under the door. You push on the thick end of the wedge.

### Turning Gears (AP 8.1) (page 72)

1. Drawing should indicate realistic approximation of the handle location.

2, 3. Arrows should indicate opposite directions for the movement of the two gears.

4. a wheel and axle (Note: Each gear tooth also works as a lever. This would be a very astute observation for students at this level!)

### Parts of a Bike (AP 9.1) (page 73)

Sample answers:

| Part of a Bicycle | Kind of Simple Machine |
|---|---|
| wheels | wheels and axles |
| pedals | levers |
| chain around gears | pulleys and gears |
| brake gripper | lever |

### Name That Machine! (AP 10.1) (page 74)

row 1 (L to R): wheel and axle, ramp, wedge

row 2 (L to R): pulley, lever, screw

# Appendix A

## Glossary

**Purple words and phrases** are Core Vocabulary for the unit. **Bold-faced words and phrases** are Language of Instruction, additional vocabulary terms related to the unit that you should model for students during instruction. Vocabulary words are not intended for use in isolated drill or memorization.

### A

**arm, n.** the narrow, movable part of a lever on either side of a fulcrum

**axle, n.** a rod or spindle that passes through the center of a wheel

### C

**catapult, n.** a device that uses an arm to hurl or launch something

**chore, n.** a routine task associated with taking care of a place

**clockwise, adv./adj.** in a curved path in the direction of the typical forward motion of the hands of a clock; from left to right along the top arc of a circle and right to left along the bottom arc of a circle

**combine, v.** to mix together

**compound machine, n.** a device constructed of two or more simple machines

**counterclockwise, adv./adj.** in a curved path in the direction opposite of the typical forward motion of the hands of a clock; from right to left along the top arc of a circle and left to right along the bottom arc of a circle

### D

**design, n.** a plan or drawing of an invention or solution to a problem (v. to generate ideas for a planned solution)

**direction, n.** the course along which something moves

**distance, n.** the amount of space between two points

### E

**easier, adj.** requiring less effort; performed with less difficulty

**effort, n.** exertion required in an attempt to achieve something

### F

**forward, adj./adv.** in the direction that one is facing

**fulcrum, n.** the point on which a lever pivots

### G

**gear, n.** a toothed wheel that interacts with another toothed wheel to rotate it

**groove, n.** a long, narrow dip in a surface

### I

**interact, v.** for two or more factors to affect each other

### L

**launch, v.** to set into motion, especially aloft

**lever, n.** a rigid bar resting on a pivot point (fulcrum)

**lift, v.** to raise to a higher position

**lower, v.** to move to a less high position

### M

**machine, n.** a device used to modify motion and force to perform work

### P

**pattern, n.** a repeating or predictable characteristic or occurrence

**problem, n.** a want or circumstance in need of correction or improvement

**pry, v.** to raise or pull apart with a lever

**pulley, n.** a wheel with a rope pulled along its grooved edge to reverse the direction of effort needed to raise or lower an object

### R

**raise, v.** to lift up

**ramp, n.** a sloping plane

**rotate, v.** to turn about a central axis

## S

**screw, n.** a long wedge spiraled around a central rod, the rotation of which pulls the device into a solid material

**showcase, n.** an occasion during which multiple people share their ideas, abilities, or offerings on a particular subject

**simple machine, n.** a device with no or few moving parts used to modify motion and force to perform work

**solution, n.** the remedy for a problem

**spiral, v.** to wind around a central axis while moving away from the point of origin

**split, v.** to forcibly push or pull to divide into parts

## T

**task, n.** an action that has to be performed

**tool, n.** a handheld instrument that aids in completing a task

## W

**wedge, n.** a solid piece of material that tapers to a thin edge, used to split a material apart or tightly hold against a surface or material

**wheel, n.** a circular frame capable of turning on an axle

**work, n.** the process of a using a push or a pull to cause an object to move

# Appendix B

## Classroom Safety for Activities and Demonstrations

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:

- Be aware of students who have food allergies, and adjust related activities or make materials substitutions as necessary. Check the ingredients of all food to make sure known allergies are not listed. Students with food allergies can still be affected even if they do not ingest the food item. Some common food allergies are peanuts, tree nuts (e.g., almonds, walnuts, hazelnuts, etc.), and cow's milk (rice milk is a good nut-free alternative).
- 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**

## Student Safety Contract

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

_____

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

# Appendix C

## 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**

### 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.

# Appendix D

## Advance Preparation for Activities and Demonstrations

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, such as food allergies, 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.

# Appendix E

## What to Do When Activities Don't Give Expected Results

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 segment's guiding 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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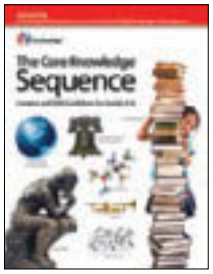
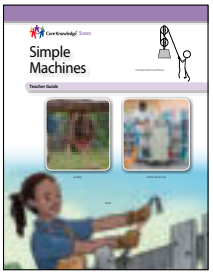
## Simple Machines

**Core Knowledge Science 1**




**What is the Core Knowledge Sequence?**

The *Core Knowledge Sequence* is a detailed guide to specific content and skills to be taught in Grades K–8 in language arts, history, geography, mathematics, science, and the fine arts. In the domains of science, including Earth and space, physical, and life sciences, the *Core Knowledge Sequence* outlines topics that build systematically grade by grade to support student learning progressions coherently and comprehensively over time.




**For which grade levels is this book intended?**

In general, the content and presentation are appropriate for students in the early elementary grades. For teachers and schools following the *Core Knowledge Sequence*, this book is intended for Grade 1 and is part of a series of **Core Knowledge SCIENCE** units of study.

For a complete listing of resources in the
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