

Exploring Light and Sound

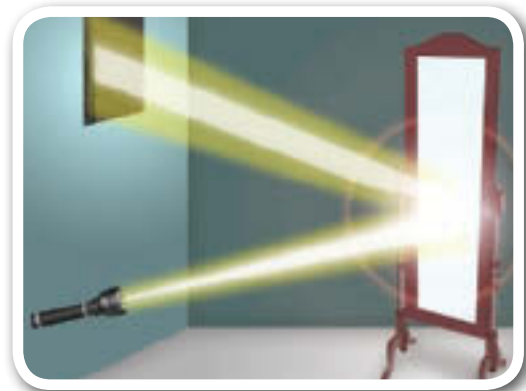
shadows



Teacher Guide



light and materials



reflecting light

light and sound in performances



Exploring Light and Sound

Teacher Guide



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Exploring Light and Sound

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Exploring Light and Sound Teacher Guide

Core Knowledge Science™ 1

Introduction

ABOUT THIS UNIT

The Big Idea

This unit focuses on the scientific concept of light and sound waves and how light and sound can be used to communicate information.

Students will be familiar with various types of waves in the form of sound and light which they experience everyday though they will likely not have the vocabulary to describe their experiences in scientific terms. They will have experienced that sound and light can be used to communicate over long distances. Students understand that they hear sound, but they may not know there is a relationship between sound and vibrations. Sound can cause matter to vibrate, and vibrating matter can cause sound. Students have recognized that certain objects give off light while other objects can only be seen when illuminated by objects that are light sources. Through experiences, students will learn that materials interact with light in different ways—some allow light to pass through, others block some or all light, and still others reflect clear images. Students will apply what they learn to use light and sound to solve a communication problem.

In this unit, students investigate with sound and light to see how sound and light can be used to communicate with an audience in a theater. Students will explore different light sources, mirrors, and shadows, but they will not discuss the speed of light. They will also not need to know technical details for how some communication devices work. They will further explore waves and their applications in technologies for information transfer in Grade 4 Unit 1 *Energy Transfer and Transformation* and Grade 4 Unit 2 *Investigating Waves*.

Students explore concepts that include the following:

- Sound can make matter vibrate, and vibrating matter can make us hear a sound.
- Objects can be seen if light is available to illuminate them or if they give off their own light.
- Some materials allow light to pass through them, others allow only some light through, and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam.
- People also use a variety of devices to communicate (send and receive information) over long distances.

Engineers and engineering designers use knowledge of the properties of matter as they use materials in design solutions and make things that are useful to people. This series of lessons incorporates learning goals that support the principles and practices of engineering design, such as defining problems, testing materials, and evaluating possible solutions.

Note to Teachers and Curriculum Planners

This unit introduces Grade 1 students to real-world examples and fundamental concepts of waves and their applications in technologies for information transfer. Students will explore how sound and light are associated with cause-and-effect relationships and how people depend on various technologies that use sound and light to communicate. The following are preliminary considerations for planning and instruction relative to this unit:

- While Grade 1 students will experience the idea that light travels from place to place with various light sources, they will not discuss the speed of light. Students are also not expected to explain how devices work using technological details at this grade level.

Students will investigate waves and their applications in technologies for information transfer in Grade 4.

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, 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 *Core Knowledge Sequence*.

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

Online Resources



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

www.coreknowledge.org/cksci-online-resources

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

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

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

This unit, *Exploring Light and Sound*, has been informed by the following Grade 1 Performance Expectations for the NGSS topic *Waves and Their Applications in Technologies for Information Transfer*. Students who demonstrate understanding can do the following:

1-PS4-1 Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

1-PS4-2 Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated.

1-PS4-3 Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.

1-PS4-4 Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

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

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:

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

Sources:

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

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

ETS1.A: Defining and Delimiting Engineering Problems

A situation that people want to change or create can be approached as a problem to be solved through engineering. Asking questions, making observations, and gathering information are helpful in thinking about problems. Before beginning to design a solution, it is important to clearly understand the problem.

ETS1.B: Developing Possible Solutions

Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

ETS1.C: Optimizing the Design Solution

Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

What Students Need to Learn

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

Lesson 1. Sound and Vibration

SEGMENTS 1–5

- Observe and compare sounds from the environment.
- Plan and carry out tests to collect evidence that vibrations cause sounds.
- Plan and carry out tests to collect evidence that sounds cause vibrations.
- Engage in argument about the relationship between flying aircraft and rattling windows.

Lesson 2. Light

SEGMENTS 1–5

- Discuss and ask questions related to a familiar light-related phenomenon.
- Compare luminous and nonluminous objects.
- Conduct simple tests to observe how differences in light intensity affect our ability to see things.
- Use evidence and reasoning to explain the lesson phenomenon.

Lesson 3. Light and Materials

SEGMENTS 1–5

- Identify and describe shadows.
- Investigate interactions of light with opaque materials.
- Investigate interactions of light with transparent and translucent materials.
- Investigate interactions of light with reflective materials.
- Use evidence from observations to describe ways that light can interact with materials.

- Identify examples of communication over long distances.
- Discuss and describe how to solve problems related to sound and light.
- Define and gather information about the problem (how to signal audience participation during a school play).
- Build and test a device, with guidance, that uses sound or light to communicate over a distance.
- Describe features of the design that qualify it as a solution to the problem (the need to communicate over a distance using light or sound).
- Collect and analyze data to compare solutions to determine which one is best suited to solve the problem (the need to communicate over a distance using light or sound).

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

As you will note when you examine the Student Book, minimal text is included on each page. Instead, colorful photos and engaging illustrations dominate the Student Book pages. The design of the Student Book in this way is intentional because students in Kindergarten through 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

To meet NGSS Performance Expectations we encourage teachers to complete all Grade 1 CKSci units during the school year. To be sure all NGSS standards and dimensions are addressed, each Core Lesson segment should be completed. Each lesson segment requires thirty to forty-five minutes of instruction time. The time it takes to complete a full lesson depends on class size and individual circumstances.

Within the Teacher Guide, each Core Lesson is composed of multiple numbered segments, generally four to six. Each segment concludes with a Check for Understanding, providing the teacher with an opportunity for formative assessment.

At the end of this unit introduction, you will find a blank Pacing Guide on pages 16–17, which you may use to plan how you might pace the lessons. We strongly recommend that you preview the unit in full before beginning and create your pacing guide before teaching the first lesson segment. As a general rule, we recommend that you spend a minimum of twenty-five days and a maximum of thirty-seven days teaching the *Exploring Light and Sound* unit so that you have time to teach the other units in the Grade 1 CKSci series.

The Core Lessons

- Lesson time: Most Core Lesson segments constitutes one classroom session of thirty to forty-five minutes. Some segments 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 lesson segments are coherently sequenced to build from one to the next, linking student engagement across lessons and helping students build new learning on prior knowledge.

Unit Opener: Introduction to the Unit Phenomenon and Problem	Unit Opener: Exploring Light and Sound	Big Question: What happens in a stage performance so that people can see and hear the show?
Lesson 1: Sound and Vibration (1-PS4-1)	1.1 Observing Sounds	Lesson 1 Guiding Question: What are sound and vibrations? 1.1 What are some patterns in sounds?
	1.2 Causing Sound	1.2 What can vibrations do?
	1.3 Causing Objects to Vibrate	1.3 What can sound do to objects and materials?
	1.4 Relationships Between Sound and Science	1.4 Why do windows rattle when a jet/helicopter passes overhead?
	1.5 Lesson 1 Roundup: Vibrations During a Performance	1.5 How do sound and vibrations work in a concert?
Lesson 2: Light (1-PS4-2)	2.1 Seeing in the Dark	Lesson 2 Guiding Question: Why is it hard to find a pencil in a dark room? 2.1 Why is it hard to find a pencil in a dark room?
	2.2 Observing Light Sources	2.2 What objects give off their own light, and what objects do not?
	2.3 Comparing Visibility	2.3 How does the amount of light affect how well we can see something?
	2.4 Reasoning About Light	2.4 How does light affect what you see?
	2.5 Lesson 2 Roundup: Investigating Light Sources	2.5 Why is it hard to find a pencil in a dark room?
Lesson 3: Light and Materials (1-PS4-3)	3.1 Seeing Shadows	Lesson 3 Guiding Question: What happens when light shines on different materials? 3.1 Where and when can you see shadows?
	3.2 Making Shadows	3.2 What materials make the darkest shadows?
	3.3 Comparing Materials That Let Light Pass Through	3.3 What materials allow some or all light to pass through?
	3.4 Changing the Direction of Light	3.4 What materials change the direction of a light beam?
	3.5 Lesson 3 Roundup: Using Light in a Stage Performance (two class sessions)	3.5 What happens when light shines on different materials?

Lesson 4: Solving Problems with Light or Sound (1-PS4-4)	4.1 Communicating over Long Distances	Lesson 4 Guiding Question: How can we communicate with an audience using light and sound?
		4.1 How do people communicate over long distances?
	4.2 Putting on a Play	4.2 How do students putting on a play communicate?
	4.3 Describing the Problem	4.3 How can you describe a problem about communicating during a play?
	4.4 Lesson 4 Roundup: Building and Testing a Device (two class sessions)	4.4 How do students use light and sound to communicate during a play?
Unit Supplement	Science in Action	Who are some people who work in this type of science, and what do they do?

Activity Pages

Activity Pages



AP UO.1

AP 1.1.1

AP 1.2.1

AP 1.3.1

AP 1.4.1

AP 1.5.1

AP 2.1.1

AP 2.2.1

AP 2.2.2

AP 2.3.1

AP 2.3.2

AP 2.4.1

AP 2.5.1

Black-line reproducible masters for Activity Pages, as well as an Answer Key, are included in Teacher Resources on pages 178–209. The icon shown to the left appears throughout the Teacher Guide wherever Activity Pages (AP) are referenced.

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

Unit Opener—What We Can See and Hear at a Concert (AP UO.1)

Lesson 1—Loud and Soft Sounds (AP 1.1.1)

Lesson 1—What Causes Sound? (AP 1.2.1)

Lesson 1—What Causes Objects to Vibrate? (AP 1.3.1)

Lesson 1—Show Causes and Effects (AP 1.4.1)

Lesson 1—What Do Sound and Vibrations Do? (AP 1.5.1)

Lesson 2—A Light Walk at Night (AP 2.1.1)

Lesson 2—How Bright Is That Light? (AP 2.2.1)

Lesson 2—Does It Give Off Light? (AP 2.2.2)

Lesson 2—Let the Light Shine In (AP 2.3.1)

Lesson 2—Testing Light Makers (AP 2.3.2)

Lesson 2—What's in the Closet? (AP 2.4.1)

Lesson 2—Draw a Funny Dark and Light Comic (AP 2.5.1)

Activity Pages



AP 3.1.1

AP 3.2.1

AP 3.2.2

AP 3.3.1

AP 3.4.1

AP 3.4.2

AP 3.5.1

AP 3.5.2

AP 4.1.1

AP 4.1.2

AP 4.2.1

AP 4.3.1

AP 4.4.1

AP 4.4.2

Lesson 3—Shadow Walk (AP 3.1.1)

Lesson 3—Shadow Makers (AP 3.2.1)

Lesson 3—Planning and Carrying Out Investigations (AP 3.2.2)

Lesson 3—What Happens to a Light Beam When Materials Are Placed in Its Path? (AP 3.3.1)

Lesson 3—How We Will Find Materials That Change the Direction of Light (AP 3.4.1)

Lesson 3—What Materials Can Change the Direction of Light? (AP 3.4.2)

Lesson 3—Our Investigation of Light and Materials (AP 3.5.1)

Lesson 3—Mapping Our Ideas (AP 3.5.2)

Lesson 4—Use Morse Code (AP 4.1.1)

Lesson 4—Tools for Communicating over Long Distances (AP 4.1.2)

Lesson 4—How to Solve a Problem (AP 4.2.1)

Lesson 4—Ask Questions About the Problem (AP 4.3.1)

Lesson 4—How We Solved the Problem (AP 4.4.1)

Lesson 4—Comparing Solutions (AP 4.4.2)

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

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

Teaching Strategies

Start with the familiar.

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

Ask driving questions.

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

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. 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.

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 210–211.

Emphasize observation and experience.

Lessons employ various ways for students to learn, including watching, listening, reading, doing, discussing, and writing. To meet the NGSS Performance Expectations, which are multidimensional standards, students must not only gain factual knowledge associated with Disciplinary Core Ideas, but also use the content knowledge they acquire.

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. Refer to the Crosscutting Concepts cited in the lessons, often included in the NGSS References listed at the start of each lesson.

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.

Instructional Design

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

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

DCI
SEP
CCC

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

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

www.coreknowledge.org/cksci-online-resources

Icon Key:

DCI PS4.A Wave properties

DCI PS4.B Electromagnetic radiation

DCI PS4.C Information technologies and instrumentation

SEP 1 Asking questions (for science) and defining problems (for engineering)

SEP 2 Developing and using models

SEP 3 Planning and carrying out investigations

SEP 4 Analyzing and interpreting data

SEP 5 Using mathematics and computational thinking

SEP 6 Constructing explanations (for science) and designing solutions (for engineering)

SEP 7 Engaging in argument from evidence

SEP 8 Obtaining, evaluating, and communicating information

CCC 1 Patterns

CCC 2 Cause and effect

CCC 3 Scale, proportion, and quantity

CCC 4 Systems and system models

CCC 5 Energy and matter: flows, cycles, and conservation

CCC 6 Structure and function

CCC 7 Stability and change

Student performance in a given task, related to making sense of a phenomenon or designing a solution, requires integrated elements of the SEPs, CCCs, and DCIs.

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 212–216, consist of the following:

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

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

www.coreknowledge.org/cksci-online-resources

MATERIALS AND EQUIPMENT

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

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

Unit Opener

- crayons
- pencils

Lesson 1 Sound and Vibration

Lesson 1.1

- recording device, such as a smartphone
- chart paper
- set of markers for writing on the chart (1 per class)
- pencils (1 per student)

Lesson 1.2

- tuning fork (1 per class)
- small cardboard boxes, such as crayon or tissue boxes, or paper cups (1 per pair)
- rubber bands large enough to fit around the boxes (1 per pair)
- pencils or crayons (2 per pair)
- safety goggles (1 per student)

Lesson 1.3

- safety goggles (1 per group)
- disposable beverage cups (1 per group)
- sheets of plastic wrap, about 4 in. wider than the cup openings (1 sheet per group)

Lesson 1.3, continued

- rubber bands, sized to hold the plastic wrap tightly to the cup (1 per group)
- fine table salt (one-eighth teaspoon per group)
- trays (1 per group)
- other assorted lightweight materials—such as larger salt crystals, cut-up squares of tissue paper, pencil shavings, or round sprinkles/nonpareils (about one-eighth teaspoon of a material per group)

Lesson 1.4

- access to musical instruments

Lesson 1.5

- cardboard paper tubes, about 6–12 in. in length (1 per student)
- waxed paper, 6x6-in. pieces (1 per student)
- rubber bands, sized to fit around the tubes (1 per student)
- pointed scissors or awl (teacher use)
- rubber bands, box of assorted sizes (1 per class)
- cardboard boxes, such as from shoes, tissues, or crayons (1 per group)
- disposable aluminum pie pans (2 per group)
- 12-inch. long pieces of string (1 per group)
- clean, empty plastic water bottles (1 per group)
- dried beans (1 tablespoon in a cup per group)

Lesson 2 Light

Lesson 2.2

- children's literature about fireflies
- smartphone
- cardboard shoeboxes with a small eyehole punched in one end (1 per group)
- small, common classroom objects (1 set per group)
- flashlight
- glow-in-the-dark objects, such as stars or glow sticks (1 pair per group)

Lesson 2.3

- cardboard shoeboxes, with a pinhole in one end (1 per group)
- small nonluminous classroom objects (1 per student)
- small luminous objects, such as glow sticks or flashlights (1 per group)

Lesson 2.4

- flashlight

Lesson 2.5

- flashlight
- copy of a theater ticket with seat numbers
- colored pencils

Lesson 3 Light and Materials

Lesson 3.1

- file folders (1 per student)
- markers or colored pencils (1 set per group)

Lesson 3.2

- flashlights (1 per group)
- clear plastic objects (1 per group)
- clear glass square, such as in a picture frame with no backing, or a water glass (1 per class)
- clouded plastic objects (1 per group)
- waxed paper squares (1 per group)
- cardboard squares (1 per group)
- poster board squares (1 per group)
- wood squares (1 per group)
- plastic mirrors (1 per group)
- aluminum foil squares (1 per group)

Lesson 3.3

- flashlights (1 per group)
- cardboard squares (1 per group)
- wood squares (1 per group)
- aluminum foil squares (1 per group)
- plastic mirrors (1 per group)

Lesson 3.3, continued

- tissue paper squares (1 per group)
- waxed paper squares (1 per group)
- clouded plastic objects (1 per group)
- clear plastic objects (1 per group)
- clear glass square, such as in an interior school door (1 per class)
- clear plastic cup filled with water (1 per class)
- black and gray crayons (1 set per group)

Lesson 3.4

- flashlights (1 per group)
- cardboard squares (1 per group)
- wood squares (1 per group)
- aluminum foil squares (1 per group)
- plastic mirrors (1 per group)
- tissue paper squares (1 per group)
- waxed paper squares (1 per group)
- clouded plastic objects (1 per group)
- clear plastic objects (1 per group)
- large sheets of white paper (1 per group)
- modeling clay (optional)

Lesson 3.5

- science folders (1 per student)
- stapler (1 per class)
- soft object, such as a ball (1 per class)

Lesson 4 Solving Problems with Light or Sound

Lesson 4.3

- meterstick or measuring tape (1 per class)

Lesson 4.4

- rubber bands, box of assorted sizes (1 per class)
- cardboard boxes, such as from shoes, tissues, or crayons (1 per group)
- disposable aluminum pie pans (2 per group)
- 12-inch. lengths of string (1 per group)
- clean, empty plastic water bottles (1 per group)
- dried beans (2 tablespoons or Tbsp. in a cup per group)
- flashlights (1 per group)
- cardboard squares (1 per group)
- wood squares (1 per group)
- aluminum foil squares (1 per group)
- plastic mirrors (1 per group)
- tissue paper squares (1 per group)
- waxed paper squares (1 per group)
- clouded plastic objects (1 per group)
- clear plastic objects (1 per group)
- large sheets of white paper (1 per group)
- scissors, stapler, tape, paper clips

Science in Action

- clear tape (1 roll per group)
- black construction paper (2–3 sheets per group)
- small flashlights (1 per group)
- aluminum foil (2–3 large sheets per group)
- scissors (1 per group)
- markers (1 per group)

EXPLORING LIGHT AND SOUND PACING

_____’s Class

Note to Teacher: *Exploring Light and Sound* is intended to be taught as the third unit of Grade 1 CKSci. As a general rule, we recommend that you spend a minimum of twenty-five days and a maximum of thirty-seven days teaching the *Exploring Light and Sound* unit so that you have time to teach the other units in the Grade 1 CKSci series.

Week 1

Day 1

Day 2

Day 3

Day 4

Day 5

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Week 2

Day 6

Day 7

Day 8

Day 9

Day 10

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Week 3

Day 11

Day 12

Day 13

Day 14

Day 15

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Week 4

Day 16

Day 17

Day 18

Day 19

Day 20

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Week 5

Day 21

Day 22

Day 23

Day 24

Day 25

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Week 6

Day 26

Day 27

Day 28

Day 29

Day 30

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Week 7

Day 31

Day 32

Day 33

Day 34

Day 35

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Week 8

Day 36

Day 37

Day 38

Day 39

Day 40

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UNIT 3

Exploring Light and Sound

OVERVIEW

Big Question: What happens in a stage performance so that people can see and hear the show?

Anchoring Phenomenon/Problem: Viewers in both the front and back of an audience can see and hear a musical concert. The driving question we explore in this unit is “What happens in a stage performance so that people can see and hear the show?” To answer this question in depth over the course of the unit, students will investigate the cause-and-effect relationships between vibrations and sound. They will recognize that sound causes vibrations and vibrations cause sound.

Students will also study light. Students will then classify objects as luminous or nonluminous. The goal is for students to explain that nonluminous objects can only be seen when there is enough light shining on them. Next, students will decide how to test the interactions between light and varied materials. They will discover that some materials block all light, some materials block some light, and other materials block little to no light.

Students then will explore how sound and light are used to communicate information using different tools. They will then design their own tool to solve a problem.

Student Book storyline: Mr. Ruiz’s class goes to the theater to see a concert. When they return to class, they will investigate light and sound.

Long-term project: Students will make observations and conduct tests to solving the problem of designing a tool that can be used to signal audience participation during a school play.

Introductory Class Session Exploring Light and Sound

Students explore and solve problems related to sound and light as they begin to think about how an audience interprets sound and light. Throughout the unit, they will use prior knowledge, observations, and hands-on experience to begin to understand how information conveyed through sound and light is received using different technologies. They will demonstrate this understanding as they solve an engineering problem focused on designing a tool that can be used to signal audience participation during a school play.

Unit Opener Objective

- ✓ Observe and ask questions about a video of a musical production.

Language of Instruction

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

observe

Instructional Activities

- class discussion
- question generation
- teacher Read Aloud

Instructional Resources

Student Book



Ch. 1

Activity Page



AP UO.1

Student Book, Chapter 1
“A Trip to a Musical Concert”

Activity Page

What We Can See and Hear at a Concert (AP UO.1)

NGSS References

Disciplinary Core Idea: PS4.C Information Technologies and Instrumentation

Science and Engineering Practices: 1 Asking Questions and Constructing Explanations; 6 Constructing Explanations and Designing Solutions

Connections to Engineering, Technology, and Applications of Science: Influence of Engineering, Technology, and Science on Society and the Natural World

Students will construct questions about their observations of a children’s theater production.

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

www.coreknowledge.org/cksci-online-resources

Materials and Equipment

Collect or prepare the following items:

- roll paper or a bulletin board prepared for cumulative use throughout the unit
- crayons
- pencils
- sticky notes
- internet access and the means to project images/video for whole-class viewing

1. Introduce the Anchoring Phenomenon.

Online Resources



Introduce the unit by writing the Big Question—**What happens in a stage performance so that people can see and hear the show?**—on the question board.

- Invite students to share their experiences at school and community theatrical shows.
- Play an online video of a musical concert. If students are unfamiliar with the music, provide them with a background.

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

www.coreknowledge.org/cksci-online-resources

NGSS Elements



SEP 1

CCC 2

DCI PS4.C

Tie to the Anchoring Phenomenon

Viewers in both the front and back of an audience can see and hear a concert. How is that possible?

- Elicit from students examples of where they have sat for shows in school auditoriums, theaters, libraries, parks, or houses of worship. (See **Know the Standards 1.**)
- Ask students if they sat near the stage in the front row, in the middle, or near the back in the last rows and if they could see and hear well.

Know the Standards

TEACHER DEVELOPMENT

1. Differentiation—Information Technologies and Instrumentation: The Anchoring Phenomenon refers to plays and other performances students may have seen in school, at the local library, or in the community—including puppet shows. While children share their experiences, invite examples that are culturally relevant to their families—for example, shadow puppets of Indonesia, water puppets of Vietnam, and marionettes of Mexico. Students may also wish to describe plays they have experienced in houses of worship. Also consider exploring the puppet shows that nearly all children have seen on television.

2. Read together: “A Trip to a Musical Concert.”

Student Book



Ch. 1

NGSS Elements



SEP 6

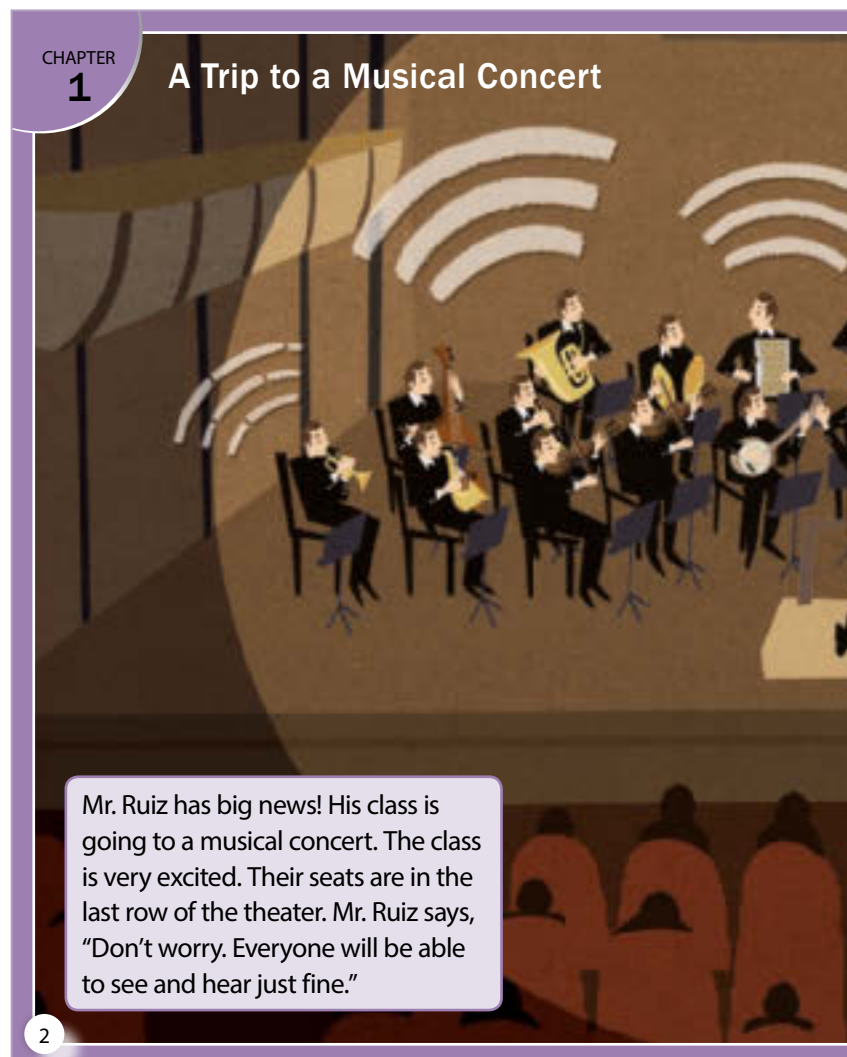
DCI PS4.C

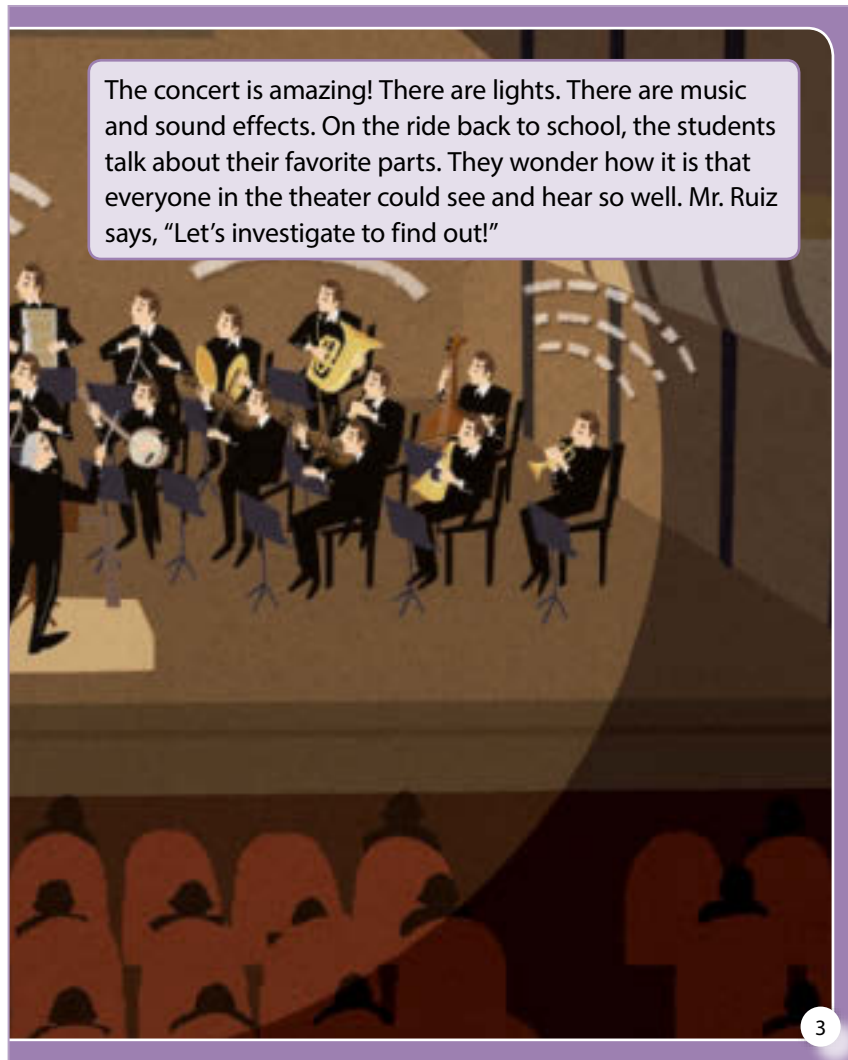
While some advanced students may be able to read words on a given page of the Student Book, as a general rule students should not be expected or asked to read aloud the text on the Student Book pages. The text in the Student Book is there so that teachers and parents can read it when sharing the Student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

Read Aloud Support

Pages 2–3

Ask students to turn to pages 2–3 of the Student Book and look at the picture as you read aloud. Remind them that the title of this unit is *Exploring Light and Sound*, and tell them to pay special attention to these ideas as they hear about Mr. Ruiz’s class trip to a theater.





LITERAL—What is going on in this theater?

» A musical concert is being performed.

INFERENTIAL—Are Mr. Ruiz's students pleased with their seats after all?

» Yes, they can see and hear very well, and they liked the show.

SUPPORT—Guide students to understand that Mr. Ruiz’s class will investigate light and sound when they get back to school. Make sure your students have some understanding of what light and sound are by explaining how the theater gets dark when the house lights go down and how the musical sounds can make people feel happy or scared. (See **Know the Science**.)

SUPPORT—For English language learners, point to the unit title words *light* and *sound*. Turn the classroom’s overhead lights on and off a few times, saying the word *light* when they are on. For sound, use a music player or smartphone music app to turn the sound on and off, each time saying the word *sound*.

3. Record questions on the question board.

NGSS Elements



3D Learning

Throughout the unit the question board will be used as a place for student questions to be posted. As students gain an understanding of the content, refer back to the questions to assess student understanding. Display the question board on a wall where all can see it. Read aloud the Anchoring Phenomenon: *Viewers in both the front and back of an audience can see and hear a musical concert. How is that possible?*

- Tell students that, over the next few weeks, they will be working on explaining how people see and hear a show in a theater and that their science time will include investigations.
- Have students brainstorm questions about sound and light they would like to investigate.
- Write each question on a sticky note, and attach it to the board.

4. Check for understanding.

Activity Page



AP UO.1

Review the questions recorded so far on the question board. Ask students to summarize what they understand about what can be seen and heard at a concert.

Give each student a copy of What We Can See and Hear at a Concert (AP UO.1) and crayons for students to complete the drawing. Save students’ work so it can be revisited at the end of the unit.

Monitor Progress

Students may need help completing the sentence at the top of the Activity Page. If they cannot think of another performance they have attended, suggest they write the name of the show they saw on the video (*Peter Pan*).

Know the Science

TEACHER DEVELOPMENT

How are light and sound similar? Light and sound are similar in that both are energy transferred from place to place by waves. Due to these similarities, light and sound exhibit related behaviors—they can both be transmitted or reflected by matter. One difference between them is that light waves (electromagnetic radiation) can travel in a vacuum (such as sunlight traveling through deep space to Earth) as well as through matter while sound waves are only propagated in matter when particles vibrate and bump into one another.

Formative Assessment

Review student responses in the discussion and to What We Can See and Hear at a Concert (AP U0.1) to determine student understanding of the following concepts:

- How a theater is set up?
- How might an audience experience light and sound during a performance?
(See **Know the Standards 2.**)

Tie to the Anchoring Phenomenon

In the next lessons, students will investigate the cause-and-effect relationships between vibrations and sounds. They will then go on to classify objects as luminous or nonluminous and test the interactions between light and varied materials. All their observations and tests will be applied to solving the problem of designing a tool that can be used to signal audience participation during a school play.

Know the Standards

TEACHER DEVELOPMENT

2. Disciplinary Core Idea LS1.D: The focus of this unit is observing behaviors of light and sound and understanding how this can be applied to solve human problems related to communication. The approach of the NGSS K–2 grade band is experiential rather than theoretical. For example, there is no attempt to use the terms *energy* or *wave* to discuss light or sound. Both these abstract concepts will be introduced in Grades 3–5. While not emphasized in this unit, students do learn in Kindergarten–Grade 2 that “animals sense and communicate information and respond to inputs.” This core idea helps students explain the unit phenomenon: how people in an audience can enjoy a show presented on a stage at a distance.

LESSON 1

Sound and Vibration

OVERVIEW

Guiding Question: What are sound and vibrations?

Lesson 1 Segments	Segment Questions	Advance Preparation
1.1 Observing Sounds Students engage with the lesson phenomenon, take a sound walk, and ask questions about the topic.	What are some patterns in sounds?	Download or bookmark an audio file of an aircraft passing low to the ground overhead. Set up the speaker system on which students can hear the aircraft sound. Plan a route for leading a sound walk around your school, either outdoors or indoors.
1.2 Causing Sound Students explore through investigation to support their ideas about how vibrations cause sound.	What can vibrations do?	Gather materials for the teacher demonstration and student investigation. See Materials and Equipment.
1.3 Causing Objects to Vibrate Students plan simple tests to explore through investigation and support their ideas about how sound can make objects vibrate.	What can sound do to objects and materials?	Gather materials for student investigation. See Materials and Equipment.
1.4 Relationships Between Sound and Science Students read along and use evidence from their investigations to explain the lesson phenomenon (that windows rattle when a jet or helicopter passes overhead.)	Why do windows rattle when a jet/helicopter passes overhead?	Read Chapter 2 in the Student Book.
1.5 Lesson 1 Roundup: Vibrations During a Performance Students finalize meeting the Performance Expectation related to the unit phenomenon.	How do sound and vibrations work in a concert?	Gather materials for student investigation, and make up bags of materials for each group. See Materials and Equipment.

What's the Story?

Summary: In Lesson 1 (Segments 1–5), students explore sound. They observe and explain sounds in their local community. They plan and carry out investigations to identify cause-and-effect relationships between sound and vibrations. Finally, they will use these understandings to begin to explain the unit phenomenon—how an audience in the back row of an auditorium can enjoy a show presented on the stage.

Learning Progression: Lesson 1 builds on student understandings about pushes and pulls and how objects are set in motion by forces that were explored in Kindergarten, in K-PS2-1: *Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.* In this lesson, students observe a back-and-forth motion, called *vibrations*, and further develop their ability to test cause-and-effect relationships in the context of forces and motion. Lesson 1 also builds toward the Grade 4 target of 4-PS3-2: *Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.*

Guiding Phenomenon: A noisy jet passes overhead, and the windows of buildings rattle. How can you explain this (1-PS4-1)?

Learning Objectives

By the end of Lesson 1, students will do the following:

- Observe and compare sounds from the environment.
- Plan and carry out tests to collect evidence that vibrations cause sounds.
- Plan and carry out tests to collect evidence that sounds cause vibrations.
- Engage in argument about the relationship between flying aircraft and rattling windows.

NGSS Standards and Dimensions

Performance Expectation: 1-PS4-1 Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.

Science and Engineering Practice 3 Planning and Carrying Out Investigations Plan and conduct investigations collaboratively to produce evidence to answer a question.	Disciplinary Core Idea PS4.A Wave Properties Sound can make matter vibrate and vibrating matter can make sound.
Crosscutting Concept 2 Cause and Effect Simple tests can be designed to gather evidence to support or refute student ideas about causes.	Connections to Nature of Science Scientific Investigations Use a Variety of Methods <ul style="list-style-type: none">• Science investigations begin with a question.• Scientists use different ways to study the world.

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

www.coreknowledge.org/cksci-online-resources

LESSON 1.1

Observing Sounds

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: What are sound and vibrations?

Today's Question: What are some patterns in sounds?

Tie to the Anchoring Phenomenon: In a musical performance, many kinds of sounds are produced with each kind of instrument. Students should recognize that everyone in the audience can hear the sounds, whether they sit in the front or the back of the auditorium. Ask students about how they would hear the sounds made during a musical performance.

AT A GLANCE

Learning Objective

- ✓ Observe and describe sounds.

Instructional Activities

- class discussion
- question generation
- student investigation

NGSS References

Disciplinary Core Idea: PS4.A Wave Properties

Science and Engineering Practices: 3 Planning and Carrying Out Investigations; 1 Asking Questions and Defining Problems; 6 Constructing Explanations and Designing Solutions

Crosscutting Concept: 1 Patterns

Students will make observations, collect data, and ask questions about sound.

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

www.coreknowledge.org/cksci-online-resources

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.

hear loud quiet soft
sound

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.

hearing volume

Instructional Resources

Activity Page



AP 1.1.1

Activity Page

Loud and Soft Sounds
(AP 1.1.1)

Materials and Equipment

Collect or prepare the following items:

- question board
- recording device, such as a smartphone
- chart paper
- set of markers
- internet access and speakers for playing an audio file

THE CORE LESSON 1.1

1. Introduce students to Lesson 1.

NGSS Elements



SEP 1
SEP 6
CCC 1

Ask a volunteer to state the Big Question that you'll be answering in this unit—
What happens in a stage performance so that people can see and hear the show?

Invite students to recap a few of their experiences at a musical performance, such as at concerts, recitals, religious services, school, or in an auditorium.

Tell students that, before they can answer the unit's Big Question about how people in the back row can see and hear the show, they first need to understand what

sound is. In Lesson 1, they will learn what sound is and how sound is made to apply their understanding to the Big Question. Write the **Lesson 1 Guiding Question** where students can see it:

What are sound and vibrations?

Lesson Guiding Phenomenon: A noisy jet passes overhead, and the windows of the building rattle. Play an audio file for students of a low-flying aircraft. Discuss how they might hear windows rattling at the same time or soon afterward. Allow students to share their own experiences with this phenomenon. **Then ask students,** How can you explain this? Tell students to keep this in mind as the lesson develops. (See **Know the Standards.**)

Narrow student focus to Today's Question. **Ask students,** What are some patterns in sounds?

- » Sounds can be made by animals. Sounds can be made by machines. Sounds can be short, like a screech. Sounds can be long, like a desk being dragged on the floor.

Tie to the Anchoring Phenomenon

Students will encounter through investigations and reading many examples of sounds making objects vibrate and vibrating objects producing sound. Students will use what they learn about the properties of sound and sound generation to engineer a method for people to hear a performance throughout an auditorium.

Know the Standards

TEACHER DEVELOPMENT

SEP 3 Planning and Carrying Out Investigations; 1 Asking Questions and Defining Problems; 6 Constructing Explanations and Designing Solutions: Students will develop and use these three closely related Science and Engineering Practices in this lesson segment. On the listening walk in Step 2, they will make observations that can be used to make comparisons (Planning and Carrying Out Investigations). In Step 4, they will list their questions about sound (Asking Questions and Defining Problems). In Step 5, they will construct their evidence-based accounts by recording data on their T-charts (Constructing Explanations and Designing Solutions). Throughout the segment, they will be also be asking questions about patterns (Crosscutting Concept) in the natural world as they classify sounds as loud or soft and building toward DCI PS4.A: Wave Properties.

2. Take a listening walk.

NGSS Elements



SEP 3

Differentiation

- Take students on a listening walk around the school—indoors, outdoors, or both. Your route may include the school main office, a cafeteria kitchen, a gymnasium, a library, a playground, and under a large tree.
- Explain to students that they will have to be very quiet to hear some sounds. Work out a protocol for communicating on the walk. For example, tell students that if they hear a sound and want to share it, they should raise one finger. Tell them to remember the sounds so that they can help list them when you return to your classroom.

SUPPORT—To make sure hearing-impaired or other special needs students can observe and recall sounds from the listening walk, use an audio recording device (such as a mobile app) that will allow you to play back sounds in the classroom at higher volumes.

3. Record and analyze observations.

NGSS Elements



SEP 6

CCC 1

3D Learning

Monitor Progress

- On return to your classroom, have students recall the places they went in the walk and the sounds they heard in each place.
- Record their responses on a T-chart, like the one shown, on the board or large piece of paper.

Our Listening Walk

Place	Sounds

- Review the list of sounds, and ask students how they are the same and different. Point out that one way they are different is how loud or soft they are.
- Demonstrate on an electronic device, such as a computer or smartphone, how the loudness or softness of sounds can be changed. Use the word *volume*, explaining that it means the loudness or softness of a sound.
- Return students' attention to the T-chart, and guide them to add an *S* or *L* next to the names of the sounds, to classify them as soft or loud.

CHALLENGE—Challenge students to consider that soft sounds can become loud and loud sounds can become soft.

Ask students, Are there any sounds that are medium in volume?

- » Sounds that are neither loud nor soft might include people talking, water running from a sink faucet, or a bird chirping.

Have interested students list sound makers that can change volume from very soft to very loud and present their ideas to the class. (See **Know the Science.**)

4. List questions about sound.

NGSS Elements



DCI PS4.A
SEP 1
CCC 1

- Explain to students that this lesson is about sound and vibrations. Students are not likely to know what you mean by *vibrate* or *vibration*. Tell them that they can ask any questions they want, focusing on questions based on the observations they made in the listening walk.
- Draw a spider diagram on the board or chart paper. On the circle in the middle of the page, write “sound and vibrations.” On straight-line arms of the spider, write students’ questions.
- Explain that the class will try to answer some of these questions over the next few sessions in this lesson.

5. Check for understanding.

Activity Page



AP 1.1.1

- Return to Today’s Question. **Ask,** What are some patterns in sounds?
 - » Sounds can get loud and then soft. Sounds can start out soft and then get loud. Sounds can stay the same, such as the classroom bell. Sounds can change, like a train horn as it goes by.
- Tell students that the class will continue to investigate sound and the Guiding Question, **What are sound and vibrations?**

NGSS Elements



SEP 1

Monitor Progress

Formative Assessment

Distribute Loud and Soft Sounds (AP 1.1.1). Have students draw pictures or write words to identify loud sounds in the left column and soft sounds in the right column of the T-chart.

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

Know the Science

TEACHER DEVELOPMENT

How is loudness measured? “Turn up the volume. I can’t hear the TV.” The loudness of sounds is subjective. Some people may say the volume of a sound such as a television is just right. Others may say they can barely hear it. Much of the difference has to do with how human ears and the brain perceive sound. The distance a person is from the sound source—and even how they hold their head—will also affect the loudness of sounds. Scientists compare sounds objectively when they measure intensity using scientific instruments. Intensity is measured using the decibel scale, in which 0 represents absolute silence.

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

- Where have you heard that soft sound?
- Can that sound maker make a loud sound?
- On which side of the chart would you put a loaded dump truck passing by?

See the Activity Page Answer Key for sample student responses.

Tie to the Anchoring Phenomenon

Direct students' attention to the unit Big Question—**What happens in a stage performance so that people can see and hear the show?** Ask students to explain what they know about the answer after today's activities.

- » People at the play hear sounds with their ears. Some of the sounds are loud, and others are soft.

LESSON 1.2

Causing Sound

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: What are sound and vibrations?

Today's Question: What can vibrations do?

Tie to the Anchoring Phenomenon: In any performance on a stage, sounds are made when objects vibrate. Students encounter how vibrations generate sound that they can hear through planning their own investigations.

AT A GLANCE

Learning Objectives

- ✓ Observe and describe vibrations.
- ✓ Define *vibrate*.
- ✓ Investigate the cause-and-effect relationships between sound and vibrations. (Explain that vibrations cause sound.)

Instructional Activities

- student investigation
- student observation
- class discussion

NGSS References

Performance Expectation: 1-PS4-1

Disciplinary Core Idea: PS4.A Wave Properties

Science and Engineering Practice: 3 Planning and Carrying Out Investigations

Crosscutting Concept: 2 Cause and Effect

The Performance Expectation and Disciplinary Core Idea are fully addressed in this and the next segment of the lesson. In this segment of the lesson, students will explore how vibrating materials can make sound. In the third segment of the lesson, they will explore that sound can make materials vibrate.

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

www.coreknowledge.org/cksci-online-resources

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.

cause sound vibrate

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.

materials matter vibration

Instructional Resources

Activity Page



AP 1.2.1

Activity Page

What Causes Sound? (AP 1.2.1)

Materials and Equipment

Collect or prepare the following items:

- question board
- tuning fork (1 per class)
- small cardboard boxes, such as crayon or tissue boxes, or paper cups (1 per pair)
- rubber bands large enough to fit around the boxes (1 per pair)
- pencils or crayons (2 per pair)
- safety goggles (1 per student)

THE CORE LESSON 1.2

1. Focus student attention on Today's Question.

NGSS Elements



SEP 3

CCC 2

DCI PS4.A

3D Learning

Through discussion, students learn that questions about vibrations can be answered by devising simple tests.

What can vibrations do?

- Write today's question where all students can see it. Have students identify the unfamiliar science word in the question, *vibrations*. Allow volunteers to share what they think the word means, but do not correct them at this point.

- **Ask,** How can you find out what vibrations do?
 - » Watch a video, read a book, ask an expert, make our own vibrations. Accept all reasonable answers, and explain that there are many ways to answer science questions but that one of them is to do your own tests. (See **Know the Standards 1.**)

Tie to the Anchoring Phenomenon

Recall that the anchoring phenomenon for Unit 3 describes a performance in a space with many rows of seating for the audience. During the performance, people can see and hear well from all rows, including the last rows. In this lesson segment, students will produce evidence that the sounds people hear during the performance are made by objects, such as musical instruments, vibrating in a variety of ways. (See **Know the Science 1.**)

2. Build science vocabulary.

NGSS Elements



DCI PS4.A

Differentiation

Teach students about the word vibration by introducing them to a tuning fork. Explain that the tuning fork will vibrate and create sound.

- Lightly tap one tine of the fork against a firm (but not hard) object such as a book cover. Show the fork to a volunteer, and **ask**, What do you see now?
 - » The two points of the tuning fork are moving back and forth quickly.
- Repeat this demonstration a few times since many students will want a chance to observe the motion of the tuning fork.

Know the Standards

TEACHER DEVELOPMENT

1. CCC 2 Cause and Effect: In the context of the DCI for this lesson about sound and vibrations, cause and effect is closely integrated with the Science and Engineering Practice *Planning and Carrying Out Investigations*. Guide students to understand that manipulating materials and making observations is one way to carry out investigations. When students try out a procedure one way and then try another way, they are making progress toward “designing simple tests.” Using the results of these tests as evidence, students can begin to discuss cause-and-effect relationships.

Know the Science

TEACHER DEVELOPMENT

1. Sound or Sound Wave? At this grade level, it is not necessary for students to make the distinction between sound and sound waves, but keep in mind the difference between the two. *Sound* is used to describe the impression or sense of experiencing a sound wave, as in “The plane flying overhead made a deep sound.” Sound waves are a pattern of disturbances caused when energy moves through a medium such as air or water. When the jet flies overhead, the vibrations from the engines pushes air back and forth. This energy moves in waves and the vibrations reach the listener’s ears at which time the listeners experiences the sound produced by the sound waves.

SUPPORT—For students with visual or hearing impairments, hold the vibrating tuning fork against their arm so that they can feel the back-and-forth motion.

- Point out that the back-and-forth motion is called *vibration*.
- **Ask**, What else did you observe?
 - » There was a humming sound when the tuning fork was moving.

SUPPORT—To help all students, but especially English language learners, master their new vocabulary term, allow them to act out (model) the word. Have students stand up, tell them that they are tuning forks, and have them hold their arms straight over their heads. When you say, “Vibrate,” the students should wave their arms back and forth as fast as they can.

3. Design tests to observe cause and effect.

NGSS Elements



PE 1-PS4-1

SEP 3

CCC 2

DCI PS4.A

3D Learning

Monitor Progress

Differentiation

Facilitate students’ observations that vibrating objects cause sound.

- Have each student put on safety goggles. Explain that the goggles should stay on whenever students are using rubber bands.
- Give each pair of students a rubber band and a small box or cup.
- Challenge students to plan a way to use the objects to show vibrations and what vibrations can do.

SUPPORT—If some students struggle, ask guiding questions that will lead them to stretch the rubber band around the box or cup. If they are using cups or empty tissue boxes, ask them to find out what happens when the rubber band is stretched over the openings. (See **Know the Standards 2**.)

Ask the following questions:

- How can you make vibrations?
 - » by stretching the rubber band and then plucking it
- How can you know that motion is a vibration?
 - » because the rubber band moves back and forth very fast

Know the Standards

TEACHER DEVELOPMENT

2. Differentiation: In Kindergarten, students also used the Science and Engineering Practice *Planning and Carrying Out Investigations*. However, their work was more closely guided by their teachers. In Grade 1, students should have the opportunity to collaborate peer to peer, rather than just take teacher direction. However, you may find that some students will continue to need more guidance than others. If you guide students in this investigation, try asking clarifying questions, and avoid showing students what to do to make sounds.

Next, direct students to use their sense of hearing while plucking the rubber band. **Ask the following questions:**

- What do you observe?
 - » a sound
- What senses are you using to observe?
 - » I can hear the sound and feel the vibration.
- What is the cause of that sound?
 - » The vibration caused the sound.
- How do you know this?
 - » because when the rubber band stops vibrating, I no longer hear the sound (See **Know the Science 2.**)

EXTEND—Distribute two crayons or unsharpened pencils to students. Show them how to slide them under the rubber band to elevate the part of the band that they pluck. Then challenge students to explore loud and soft sounds, making up a little tune. Invite students to perform their loud/soft tune for the rest of the class.

4. Present evidence for a cause-and-effect relationship.

Activity Page



AP 1.2.1

NGSS Elements



PE 1-PS4-1

SEP 3

CCC 2

DCI PS4.A

3D Learning

- Give students a copy of What Causes Sound? (AP 1.2.1). Read aloud each sentence. Then allow students to work in their pairs to decide how to complete the sentences. Circulate among the pairs to help students spell the words they wish to write.
- At the bottom of the Activity Page, have students draw and label a diagram showing the cause-and-effect relationship between vibrations and sound. Encourage students to use color to make their diagrams clear.

Know the Science

TEACHER DEVELOPMENT

2. How do vibrations produce sound? When a rubber band vibrates, the air around it vibrates too. The air vibrates and causes air ahead of it to vibrate too. The result of the mechanical movement of consecutive air molecules vibrating is called a sound wave. When these waves reach the human ear, they cause a membrane inside the ear—the eardrum—to vibrate. Inside the ear, the vibrations are converted to nerve impulses that travel to the brain. The brain perceives those impulses as sound.

5. Check for understanding.

Activity Page



AP 1.2.1

NGSS Elements



PE 1-PS4-1

SEP 3

CCC 2

DCI PS4.A

Monitor Progress

- Call attention to the question board or poster developed in Lesson 1.1. Revisit the questions, and discuss if today's science work helped answer any of them. Encourage students to add more questions to the board, based on the work they did today.
- Have students stand and model tuning forks once more.
- **Ask**, What should we do to show what vibrations can do?
 - » make humming noises as we move

Formative Assessment

Review student responses to What Causes Sound? (AP 1.2.1) to determine student understanding of the following:

- Students can conduct their own investigations to answer questions.
- Vibrating matter can produce sound.
- Evidence from their investigation supports the concept of vibrations producing sound.

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

- In this segment of the lesson, students will develop an understanding that vibrating matter can make sound. In Lesson 1.3, students will develop understanding of the other part of this DCI, that sound can make objects vibrate.

Tie to the Anchoring Phenomenon

In the investigation using rubber bands and boxes, students inferred that vibrations can cause sound. Remind students that they are trying to understand what goes on at a performance in a large auditorium. In discussion, have students explain what objects or materials might be vibrating to make the sounds they would hear during a performance.

LESSON 1.3

Causing Objects to Vibrate

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: What are sound and vibrations?

Today's Question: What can sound do to objects and materials?

Tie to the Anchoring Phenomenon: Students infer through testing materials and objects that the sounds produced in a concert or play could cause other objects or materials to vibrate.

AT A GLANCE

Learning Objective

- ✓ Plan and carry out simple tests to gather evidence that sound makes matter vibrate.

Instructional Activities

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

NGSS References

Performance Expectation: 1-PS4-1

Disciplinary Core Idea: PS4.A Wave Properties

Science and Engineering Practices: 3 Planning and Carrying Out Investigations; 1 Asking Questions and Defining Problems

Crosscutting Concept: 2 Cause and Effect

Students continue their hands-on investigation to build evidence for how sound causes vibrations.

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

www.coreknowledge.org/cksci-online-resources

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.

cause sound vibrate

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.

materials matter vibration

Instructional Resources

Activity Page



AP 1.3.1

Activity Page

What Causes Objects to Vibrate? (AP 1.3.1)

Materials and Equipment

Collect or prepare the following items:

- question board
- disposable beverage cups (1 per group)
- sheets of plastic wrap, about 4 in. wider than the cup openings (1 sheet per group)
- rubber bands, sized to hold the plastic wrap tightly to the cup (1 per group)
- safety goggles (1 per group)
- fine table salt (one-eighth teaspoon per group)
- trays (1 per group)
- other assorted lightweight materials—such as larger salt crystals, cut-up squares of tissue paper, pencil shavings, or round sprinkles/nonpareils (about one-eighth teaspoon of a material per group)
- internet access and the means to project images/video for whole-class viewing

THE CORE LESSON 1.3

1. Focus student attention on Today's Question.

Online Resources



NGSS Elements



CCC 2
DCI PS4.A

What can sound do to objects and materials?

- Use online resources to play an audio file of a loud sound, such as firetruck sirens, for your class. See the Online Resources Guide for a link to the recommended audio file:
www.coreknowledge.org/cksci-online-resources
- **Ask students,** How do you feel/react when you hear a loud siren like this?
 - » It makes me want to cover my ears; it gets me excited; it makes me stop what I am doing and pay attention.
- **Ask,** Do loud sounds do anything to objects that are nearby?
 - » Accept all answers at this point.

Tie to the Anchoring Phenomenon

In this lesson segment, students will discover that sound causes observable vibrations in objects and materials. Encourage them to think about sitting in an auditorium and hearing a loud performance that their bodies can feel. That feeling is vibrations.

2. Use sound to make matter vibrate.

NGSS Elements



CCC 2
DCI PS4.A
3D Learning
Monitor Progress

- **SAFETY:** Have students wear safety goggles while using rubber bands. Also, remind students not to eat any science materials, even when they are foods.
- Give each small group of students a cup, a sheet of plastic wrap, and a rubber band. Model how students should set up their sound-sensing device by holding a piece of plastic wrap over the mouth of the cup and securing it with a rubber band. Show students a completed device with the plastic tightly stretched across the top. Students will get the best results with the plastic tightly stretched over the cup mouth.
- Have students work cooperatively to stretch the piece of wrap over the cup opening and hold it in place by stretching the rubber band around the edge of the cup.
- Have each team drop about one-eighth teaspoon of fine salt crystals on the plastic wrap.
- **Ask students,** What are the crystals of salt doing?
 - » just sitting there
- Next, have one student on each team hum right next to, but not touching, the lip of the cup. Students can try humming first softly and then loudly. Meanwhile, the rest of the team should be watching the salt closely.

SUPPORT—If students have difficulty getting sounds from humming to move the salt, consider playing some loud music. Place the cup next to the speaker, and invite the members of the team to observe how the salt seems to dance around (vibrate) with the music.

- **Ask students**, How can you explain what happened?
 - » The sound made the salt jump around.
- **Then ask**, Was there anything else that was moving?
 - » The plastic wrap moved up and down.
- Explain to students that up-and-down motion is like back-and-forth motion. Both are vibrations.

3. Design tests to observe cause and effect.

NGSS Elements



PE 1-PS4-1
SEP 3
CCC 2
DCI PS4.A
3D Learning
Differentiation

Facilitate students' observations that sound causes matter to vibrate.

- Invite each team to use the same cup covered in plastic wrap to plan other tests. Tell them to make the plastic wrap tight and without wrinkles before each test.
- Have the class brainstorm materials or objects they wish to test, and list their ideas on the board.
- Discuss the properties of objects that could be moved with sound.
 - » Small, lightweight objects could be moved with sound. For example, they may want to test paper confetti that they can make by cutting up tissue paper into tiny bits.
- Allow each team to choose a different material to test, guiding them to test materials that are safe and that you can make available, such as larger salt crystals, cut-up squares of tissue paper, pencil shavings, or tiny sprinkles/nonpareils.

EXTEND—For students who want to gather more evidence that sound causes matter to vibrate or may ask about how volume or pitch of sounds affects the particles, show online videos of similar investigations. Ask students to describe how the tests and results in the videos are similar to and different from their own.

4. Present evidence for a cause-and-effect relationship.

Activity Page



AP 1.3.1

- Have each team elect a speaker to report to the rest of the class.
- Invite the speakers to take turns speaking to the class about what material they tested and how sound affected it.
- **Ask students**, What evidence do you have that sound causes objects to vibrate?
 - » When we made sounds very close to the cup, the tiny objects moved up and down.

NGSS Elements



PE 1-PS4-1

SEP 3

CCC 2

DCI PS4.A

3D Learning

Monitor Progress

- Ask students to think about what other part of their setup was vibrating or moving up and down.
 - » the tight sheet of plastic wrap (See **Know the Science.**)
- Give students a copy of What Causes Objects to Vibrate? (AP 1.3.1). Read aloud each sentence. Then allow students to collaborate in their teams to decide how to complete the sentences. Circulate among the teams to help students spell the words they wish to write.
- At the bottom of the Activity Page, have students draw and label a diagram showing the cause-and-effect relationship between sound and vibrations. Encourage students to use color to make their diagrams clear.

5. Check for understanding.

Activity Page



AP 1.3.1

- Remind students that Today's Question is **What can sound do to objects and materials?** **Ask**, How do you answer this question based on your work as scientists today?

» Sound can make objects, such as salt crystals, vibrate.

- Return students' attention to the question board developed in Lesson 1.1. Ask if today's science work helped answer any of them. Encourage students to add more questions to the board, based on the work they did today.
- Have students stand and model sound causing matter to vibrate. Have a few students stand to one side of the room and hum loudly. **Ask**, If the rest of you are small bits of material, how should you act?

» move up and down or back and forth, as do vibrations

- In this segment of the lesson, students will have mastered the first phrase of the DCI, that sound can make matter vibrate. Along with their experiences in Lesson 1.2, students should have fully explored this DCI.

Formative Assessment

Review student responses to What Causes Objects to Vibrate? (AP 1.3.1) to determine student understanding of the following concepts.

- You can choose materials to use in simple tests to answer questions.

Know the Science

TEACHER DEVELOPMENT

How does sound cause the motion of solid objects? Sound we perceive with our ears and brain is caused by waves that move through matter from one place to another. Students have already learned that a vibrating object produces a sound they can hear. In today's test, they develop evidence that a sound can make matter vibrate. Student understanding will be that sound can make matter vibrate. In actuality it is the energy of sound waves that causes the vibrations. Because sound waves change, the motion of objects will also change. This is the reason why the salt and other small materials jump up and down.

- Sound can cause matter to vibrate.
- Evidence from your own investigation supports this idea.

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

Tie to the Anchoring Phenomenon

By testing various materials sitting on a tightly stretched membrane, students inferred that sound can cause vibrations. Remind students that they are trying to understand what goes on at a performance in a large auditorium. **Ask,** When have you listened to loud music or other sounds in a performance and covered your ears?

- » Accept all reasonable answers. Explain that inside their ears are parts that vibrate. When they cover their ears, they can stop some of the sound from making their ears vibrate.

LESSON 1.4

Relationships Between Sound and Science

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: What are sound and vibrations?

Today's Question: Why do windows rattle when a jet/helicopter passes overhead?

Tie to the Anchoring Phenomenon: Through reading, completing graphics, and discussion, students refine their explanations of how people in the rear of an auditorium can hear the show.

AT A GLANCE

Learning Objective

- ✓ Record cause-and-effect observations about sound and vibration.

Instructional Activities

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

NGSS References

Disciplinary Core Idea: PS4.A Wave Properties

Crosscutting Concept: 2 Cause and Effect

Students will make observations, collect data, and ask questions about cause-and-effect relationships about sound and vibration.

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

www.coreknowledge.org/cksci-online-resources

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.

cause hear sound vibrate

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.

materials matter vibration

Instructional Resources

Student Book



Ch. 2

Activity Page



AP 1.4.1

Student Book, Chapter 2
“Sound and Vibration”

Activity Page

Show Causes and Effects
(AP 1.4.1)

Materials and Equipment

Collect or prepare the following items:

- question board
- access to musical instruments

THE CORE LESSON 1.4

1. Focus student attention on Today’s Question.

NGSS Elements



CCC 2

DCI PS4.A

Why do windows rattle when a jet/helicopter passes overhead?

- Write Today’s Question where all students can see it.
- Invite students to share their experiences of very loud sounds associated with moving objects. If it is not an aircraft overhead, it may be a heavy vehicle on the ground, such as a passing dump truck or train, that made the sound. If they have not experienced windows rattling, they may have heard glassware rattling or felt pressure inside their ears. (See **Know the Science.**)

Tie to the Anchoring Phenomenon

Students will develop through reading and discussion a more formal definition of the term *vibrate* and use it to discuss what happens during a concert or play in relation to producing and hearing the show.

Know the Science

TEACHER DEVELOPMENT

What causes windows to rattle when a jet passes right overhead? Chances are, a jet airliner that is flying close to the ground may be either taking off or coming in for a landing. Both maneuvers require a lot of power from the engines. Those engines vibrate strongly, and the noise is very loud if the aircraft is nearby. Loud noises are produced by strong vibrations that move through the air. The vibrating air (the sound wave) pushes and pulls against buildings and windows, which causes them to vibrate. As your students have learned through investigation, vibrations produce sound, hence the sound of vibrating (rattling) windows!

2. Read together: “Sound and Vibration.”

Student Book



Ch. 2

NGSS Elements



CCC 2

DCI PS4.A

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 4

Ask students to turn to page 4 of the Student Book and look at the picture as you read aloud. Remind them that the title of this chapter is “Sound and Vibration,” and tell them to pay special attention to what causes sound.



While students look at the picture on page 4, remind them of your previous discussion of this situation.

LITERAL—Why do you think the people in the homes below hear the jet?

- » because the jet is flying very low to the ground
- » because I have heard low-flying jets when I am in my home

CORE VOCABULARY—**Ask students** to use the word **sound** to describe what happens when the jet goes by.

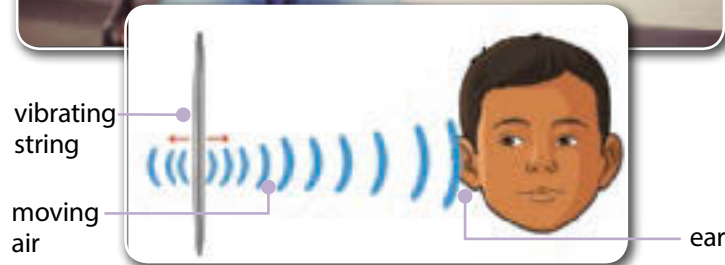
- » Sample answer: The jet makes a very, very big sound when it flies low to the ground.

INFERENTIAL—**Ask**, What other very big sounds have you heard near your home or our school?

- » Answers may include low-flying helicopters, trains, squealing bus brakes, or noise from a construction site.

Page 5

If you pluck a guitar string, it will vibrate. To vibrate means to move back and forth quickly. A moving string causes the air to vibrate. The moving air causes parts of your ears to vibrate. So, a vibrating string causes a sound you can hear with your ears.



Can you explain how the windows rattle? The jet engine vibrates. It makes air around the engine vibrate. The vibrating air causes the windows to rattle or vibrate.

5

SUPPORT—Ask, What does the drawing show about the photo of the boy strumming a guitar?

» It shows one string of the guitar vibrating. It shows the air vibrating next to it. It shows the vibrations going into the ear of the person.

Activity Page



AP 1.4.1

- Then give each student a copy of Show Causes and Effects (AP 1.4.1). Ask them to notice that the graphic organizer connects each cause with its effect by showing an arrow.
- Reread the text on page 5, and stop after each statement of a cause. Have the students find that cause on the graphic organizer and write to complete the sentence about the effect.

NGSS Elements



Differentiation

CHALLENGE—For each cause-and-effect relationship students record, **ask**, How could you use materials to test that this is true? Have students tell the class what simple tests they would design to provide evidence to support these relationships. (See **Know the Standards 1.**)

- **Ask**, How are the investigations you did earlier helpful in explaining what makes the windows rattle when a jet/helicopter passes nearby?
 - » The investigations showed that vibrations become sound and then sound can become vibration. The window rattles because of the vibration moving in the air.

SUPPORT—Discuss with students how the very loud sound of jet engines causes matter to vibrate and that the vibrations can travel through air and make windows rattle. Make sure they understand that the word *rattle* means parts of the window are moving back and forth quickly and hitting another part of the window.

Know the Standards

TEACHER DEVELOPMENT

1. Monitor Progress—CCC 2 Cause and Effect: There are two concepts associated with cause and effect in Kindergarten–Grade 2. The concept students learn in this lesson is “Simple tests can be designed to gather evidence to support or refute student ideas about causes.” The other is “Events have causes that generate observable patterns.” These two concepts are woven throughout the Kindergarten, Grade 1, and Grade 2 units. Notice that the first one is closely related to the Science and Engineering Practice of Planning and Carrying Out Investigations and the second is closely related to the Crosscutting Concept Patterns.



Have students look at the pictures on pages 6–7 as you read aloud.

Mr. Ruiz asks his class to think of things that vibrated at the concert. The instruments vibrated when played by the musicians. The microphones vibrated. The big speakers around the theater vibrated. The air around vibrated. Vibrations made the sounds that we heard.



6

SUPPORT—Ask, What do the curved lines around the drum and other instruments represent? If students are not sure, explain that they are symbols to show vibrations in the air. Tell students that vibrations in air are not visible but that the drawing reminds us that they are present.

EXTEND—Ask, What does the picture of the drum show about vibrations?

- » It shows that vibrations come off the drum in all directions and move through the air.

Make sure students understand that vibrations move away from their source in all directions.

There were many sounds during the concert. There was a cymbal clanging. There was a drum banging. There was a horn tooting. Each sound was made by something that vibrated. That made the air vibrate. How does this help you explain why people in the last row can hear the sounds?



7

CORE VOCABULARY—Ask students to use the word **vibrate** to identify the objects in the pictures that are making sound.

- » The trumpet vibrates.
- » The tuba vibrates.
- » The violins vibrate.
- » The banjo vibrates.
- » The drum vibrates.
- » The triangle vibrates.

EXTEND—Which instruments have parts made of stringlike materials that vibrate? (See **Know the Standards 2.**)

- » the violins
- » the banjo

Know the Standards

TEACHER DEVELOPMENT

2. Differentiation—PS4.A Wave Properties: Students may want to know how musical instruments vibrate to make sounds. Ask a music teacher to show your students a variety of instruments and point out the parts that vibrate. Examples: drums have thin, tight skins on them that are struck to make vibrations; blowing into the mouthpiece of a clarinet causes a reed (a thin strip of material) to vibrate, which then makes the air inside the tube of the clarinet vibrate, too.

Tie to the Anchoring Phenomenon

Remind students that they learned about Mr. Ruiz and his class going to a concert in Chapter 1. Discuss the final question on page 6 **by asking**, How did the sound get to the last row of the auditorium?

- » The sound caused vibrations in the air, and the vibrations moved throughout the auditorium in all directions.

5. Check for understanding.

Activity Page



AP 1.4.1

NGSS Elements



CCC 2

DCI PS4.A

Monitor Progress

- Call attention to the question board. Revisit the questions, and discuss if today's reading and discussion helped answer any of them.
- Group students in threes. Have one student act as a musical instrument and make a musical sound. Have another student act as the air and use their hands to show how vibrations move away from the sound maker. Have a third student act as a person who hears the sound by touching their ears and showing an expression on their faces. Have each group practice, working on the sequence of causes and effects, and then perform for the rest of the class.

Formative Assessment

Review student responses to Show Causes and Effects (AP 1.4.1) to determine student mastery of the following concepts:

- People make musical instruments vibrate.
- Vibrations from an instrument make the air around them vibrate.
- Vibrating air makes parts of your ears vibrate so that you can hear sound.

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

Tie to the Anchoring Phenomenon

Through reading, writing, and physical modeling, students should come to the inference that vibrations caused by sound travel through the air inside an auditorium and reach all seats, whether in the front, in the rear, on the sides, or in the center.

LESSON 1.5

Lesson 1 Roundup: Vibrations During a Performance

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: What are sound and vibrations?

Today's Question: How do sound and vibrations work in a concert?

Tie to the Anchoring Phenomenon: Students infer through testing materials and objects that the sounds produced in a concert or play could cause other objects or materials to vibrate.

AT A GLANCE

Learning Objective

- ✓ Investigate the relationship between sound and vibration.

Instructional Activities

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

NGSS References

Performance Expectation: 1-PS4-1

Disciplinary Core Idea: PS4.A Wave Properties

Science and Engineering Practices: 3 Planning and Carrying Out Investigations; 1 Asking Questions and Defining Problems

Crosscutting Concepts: 2 Cause and Effect; 1 Patterns

Students plan and then investigate how sound and vibration work together.

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

www.coreknowledge.org/cksci-online-resources

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.

cause

sound

vibrate

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.

materials

matter

vibration

Instructional Resources

Activity Page



AP 1.5.1

Activity Page

What Do Sound and Vibrations Do? (AP 1.5.1)

Materials and Equipment

Collect or prepare the following items:

- question board
- cardboard paper tubes, about 6–12 inches in length (1 per student)
- waxed paper, 6 × 6 in. pieces (1 per student)
- rubber bands, box of assorted sizes (1 per class)
- rubber bands, sized to fit around the tube (1 per student)
- pointed scissors or awl
- empty cardboard boxes, such as from shoes, tissues, or crayons (1 per group)
- disposable aluminum pie pans (2 per group)
- 12-inch long pieces of string (1 per group)
- clean, empty plastic water bottles (1 per group)
- dried beans (1 tablespoon in a cup in a per group)
- markers or colored pencils (whole class use)
- internet access and the means to project images/video for whole-class viewing

Advance Preparation

- Use the pointed scissors or awl to punch a small hole halfway down the side of each tube that students will use to make kazoos.
- You may wish to assemble a bag or bucket containing all the “per group” items for each group of students and a separate bag or bucket containing all the “per student” items for individual students.

THE CORE LESSON 1.5

1. Focus student attention on Today's Question.

Online Resources



How do sound and vibrations work in a concert? Show students an online video of a jug band with homemade instruments. See the Online Resources Guide for a link to the recommended video:

www.coreknowledge.org/cksci-online-resources

- Ask students to identify the materials and objects the instruments were made from.
- Have students explain how each instrument vibrated and produced sound.

Then explain that today the class will make their own instruments and use them to play along with the jug band video performers.

NGSS Elements



CCC 2

DCI PS4.A

Tie to the Anchoring Phenomenon

By designing their own musical instruments and performing with them, students apply previous learning about sound and vibrations to a scenario like the concert or play performance described in the anchoring phenomenon. (See **Know the Standards 1.**)

2. Investigate a specific example.

NGSS Elements



PE 1-PS4-1

SEP 3

CCC 2

DCI PS4.A

Monitor Progress

Facilitate an investigation using a kazoo.

- Demonstrate for the class how to place the waxed paper over one end of the tube and hold it firmly in place with the rubber band. Sing loudly into the other end of the tube so that students can hear the interesting sound the kazoo makes.
- Place students in small groups. Have one student from each group get the same set of materials for all group members: a cardboard paper tube with a small hole cut into the side, a square of waxed paper, and a rubber band.
- Have each student make a kazoo, with teammates helping one another.
- Encourage students to try making kazoo music, talking with their team about sounds and vibrations.

Know the Standards

TEACHER DEVELOPMENT

1. Monitor Progress—Performance Expectation 1-PS4-1: In Lesson 1.2 and 1.3, students were guided to investigate how vibrating materials make sound and how sound can make materials vibrate. By the end of the unit, students will have addressed the entire Performance Expectation and create artifacts (musical instruments and labeled diagrams) that they use to support their ideas about cause-and-effect relationships between sound and vibrations.

- **Ask,** How does the sound of your voice affect the waxed paper?
» It makes the waxed paper vibrate. (See **Know the Science.**)

SUPPORT—Some students may still be unsure how to recognize vibrations. Hold up a piece of cardboard, and wave it back and forth as fast as you can. Let them know that this is an example of a kind of motion called *vibration*. Explain that when an object vibrates, it moves back and forth in place.

- Discuss how this is evidence to support the idea that sound makes materials vibrate. Remind students of what can happen to windows and other objects when a loud jet or helicopter passes nearby. **Ask,** How can you answer the question of why this happens now?
» It happens because sound can make objects vibrate!

EXTEND—Explain that very loud sounds can be harmful to people’s ears. This is because the sound makes parts inside the ear vibrate such that they can be damaged. Ask students to act out hearing a very loud sound and how they would react. When students cover their ears, explain that this stops some of the vibrations made by the loud noise. Point out that people who work in places where sound is loud often wear ear protectors.

3. Support the investigation.

NGSS Elements



PE 1-PS4-1

SEP 3

CCC 2

DCI PS4.A

Monitor Progress

Facilitate students’ investigation into how to make musical instruments using a variety of materials.

Invite one student from each group to get a set of materials containing the following:

- rubber bands, box of assorted sizes
- empty cardboard box, such as from shoes, tissues, or crayons (1 per group)
- disposable aluminum pie pans (2 per group)
- 12-inch long piece of string (1 per group)
- clean, empty plastic water bottle (1 per group)
- dried beans (1 tablespoon in a cup per group)

Know the Science

TEACHER DEVELOPMENT

How do sound and vibrations interact in a kazoo? A homemade kazoo is a traditional musical instrument consisting of a hollow tube with a hole in its side. One end of the tube has a tightly stretched membrane covering it. The membrane vibrates when students hum or sing into the other end. Students may think that only the moving air they expel as they sing is causing the membrane to vibrate. Actually it is the vibrations of air set up by a person’s vocal cords that cause the membrane to vibrate. Suggest that they blow into the tube silently to observe that air alone is not causing the vibration.

Discuss that the purpose of this investigation is to invent two or more musical instruments using these materials and using their understanding of how sound is made.

Ask, How will you know that the instruments you make are vibrating?

» They will make sound.

Have each team discuss and agree on the materials they will use and how they will work and then build their instruments and practice playing them.

When all teams are ready, have every student use one of these instruments or a kazoo to give a class performance of a familiar tune.

CHALLENGE—Students with high interest may enjoy classifying their instruments by which materials vibrate. For example, if they placed dried beans in a plastic bottle, the beans vibrate when they shake the bottle back and forth. Explain that in an orchestra, instrument groups are strings, percussion, wind, woodwind, and so on. The kazoo could be classified as a percussion because it relies on the vibration of the paper like a drum or a wind instrument because it relies on the movement of air to create sound. (See **Know the Standards 2.**)

4. Check for understanding.

Activity Page



AP 1.5.1

Give each student a copy of What Do Sound and Vibrations Do? (AP 1.5.1) and colored pencils or markers. Allow them to talk in their groups before drawing their diagrams.

Summative Assessment

NGSS Elements



PE 1-PS4-1

SEP 3

CCC 2

DCI PS4.A

3D Learning

Monitor Progress

Review student responses to What Do Sound and Vibrations Do? (AP 1.5.1) to determine student mastery of the following:

- For item 1, look for evidence that students understand that the sound of the human voice caused the waxed paper at the end of the kazoo to vibrate.
- For item 2, look for evidence that students understand how they caused the materials of their music maker to vibrate and how those vibrations moved through the air to people's ears to be heard as sound. Circulate among the teams, and encourage students to use labels to show causes and effects.
- For item 3, look for evidence that in planning and carrying out their investigations, students thought about how the materials could vibrate.

Know the Standards

TEACHER DEVELOPMENT

2. Differentiation—CCC 1 Patterns: When students classify, they look for patterns in the attributes of behaviors of materials and objects. In Kindergarten–Grade 2, students look for patterns in the natural and designed world and use these patterns to describe phenomena. This Crosscutting Concept is a focus of the two other Grade 1 topics—*Plant and Animal Survival* and *Sun, Moon, and Stars*.

SUPPORT—Provide students with a basic vocabulary list from which to choose for completing the Activity Page: *vibrate, vibration, sound, sing, ear, hear, materials*. Add other terms to the list your students may need.

Tie to the Anchoring Phenomenon

Through planning, constructing, and playing homemade music instruments—as well as writing about their thinking—students understand that musical instruments played on a stage vibrate and that the vibrations move throughout an auditorium to people’s ears.

LESSON 2

Light

OVERVIEW

Guiding Question: Why is it hard to find a pencil in a dark room?

Lesson 2 Segments	Segment Questions	Advance Preparation
2.1 Seeing in the Dark Students engage with the lesson phenomenon, watch a video, take a light walk, and ask questions about light to their unit question board.	Why is it hard to find a pencil in a dark room?	Preview the online video you will show the class. Make sure the Unit 3 question board is accessible.
2.2 Observing Light Sources Students watch a video about fireflies, identify luminous objects, and classify light sources as bright or dim.	What objects give off their own light, and what objects do not?	Preview the online videos you will show the class. Gather and prepare materials for the investigation in Step 4. See Materials and Equipment.
2.3 Comparing Visibility Students watch a video and work in teams to gather evidence to answer two questions.	How does the amount of light affect how well we can see something?	Preview the online video you will show the class. Gather materials for Steps 2 and 3. See Materials and Equipment.
2.4 Reasoning About Light Students read along and play a game to construct evidence-based explanations about the guiding question.	How does light affect what you see?	Read Chapter 3 in the Student Book. Gather materials for Steps 3 and 4. See Materials and Equipment.
2.5 Lesson 2 Roundup: Investigating Light Sources Students use a claim-evidence-reasoning structure to present their explanation of the lesson phenomenon.	Why is it hard to find a pencil in a dark room?	Gather materials for Steps 2 and 3. See Materials and Equipment.

What's the Story?

Summary: In Lesson 2, students explore luminous and nonluminous objects. They develop claims, identify evidence, and use reasoning to explain what makes nonluminous objects visible. They apply what they learn through investigation to answer this lesson's guiding question (Why is it hard to find a pencil in a dark room?) and add to their explanation of the unit phenomenon—how an audience in the back row of an auditorium can enjoy a concert presented on the stage.

Learning Progression: Lesson 2 builds on students’ understanding from Kindergarten of the Crosscutting Concept Cause and Effect, when, in their study of pushes and pulls, kindergarteners designed simple tests about causes related to forces. Also, the understanding students develop in this lesson about using their eyes to see light and objects relates to their investigation of animal senses in Unit 2 of Grade 1 (1-LS1-1). Later, in Grade 4, students will begin to explore the relationship between energy and light, learning that light transfers energy from place to place (4-PS3-2).

Guiding Phenomenon: When someone at home looks for a missing object at night, it is easier to find it in some places than in others (1-PS4-2).

Learning Objectives

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

- Discuss and ask questions related to a familiar light-related phenomenon.
- Compare luminous and nonluminous objects.
- Conduct simple tests to observe how differences in light intensity affect their ability to see things.
- Use evidence and reasoning to explain the lesson phenomenon.

NGSS Standards and Dimensions

Performance Expectation: 1-PS4-2 Make observations to construct an evidence-based account that objects can be seen only when illuminated.

Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concept
<p>6 Constructing Explanations and Designing Solutions</p> <p>Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.</p> <p>1 Asking Questions and Defining Problems</p> <p>Ask questions based on observations to find more information about the natural and/or designed world(s).</p> <p>2 Developing and Using Models</p> <p>Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).</p>	<p>PS4.B Electromagnetic Radiation</p> <p>Objects can be seen if light is available to illuminate them or if they give off their own light.</p>	<p>2 Cause and Effect</p> <ul style="list-style-type: none"> • Simple tests can be designed to gather evidence to support or refute student ideas about causes. • Events have causes that generate observable patterns.

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

www.coreknowledge.org/cksci-online-resources

LESSON 2.1

Seeing in the Dark

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: Why is it hard to find a pencil in a dark room?

Today's Question: Why is it hard to find a pencil in a dark room?

Tie to the Anchoring Phenomenon: When a play or musical performance is presented on a stage for an audience, light plays an important role in the audience's experience. Ask students to recall your discussions of this in the context of sound, but explain that now you want them to think about how light is used when they attend a performance.

AT A GLANCE

Learning Objectives

- ✓ Discuss an everyday phenomenon related to light and dark.
- ✓ Ask questions about light that are related to the anchoring phenomenon.

Instructional Activities

- class discussion
- question generation
- student observation

NGSS References

Disciplinary Core Idea: PS4.B Electromagnetic Radiation

Science and Engineering Practices:
6 Constructing Explanations and Designing Solutions; 1 Asking Questions and Defining Problems

Crosscutting Concept: 2 Cause and Effect

As students engage with the lesson phenomenon involving light, they can talk about causes and effects in related situations. They will ask questions based on the video watched and relate it to the unit phenomenon.

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

www.coreknowledge.org/cksci-online-resources

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.

dark

light

lit

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.

cause

darkness

effect

object

Instructional Resources

Activity Page



AP 2.1.1

Activity Page

A Light Walk at Night (AP 2.1.1)

Materials and Equipment

Collect or prepare the following items:

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

THE CORE LESSON 2.1

1. Introduce students to Lesson 2.

NGSS Elements



DCI PS4.B

Ask a volunteer to state the Big Question that you'll be answering in this unit, which is posted somewhere in the room—**What happens in a stage performance so that people can see and hear the show?**

Remind students that they learned about sound and vibrations in Lesson 1 and applied what they learned to thinking about the sounds made and heard in a concert.

Invite students to share their experiences attending shows in school or in the community and describe how light was involved. Draw out their observations related to the following:

- lighting over the audience and how it changed

- lighting shining on the musicians or performers
- lighting special effects (See **Know the Science.**)

Tell students that, before they can answer the unit’s Big Question about how people in the back row can see and hear a show on a stage, they first need to understand the role of light. In Lesson 2, they will learn about things that make light and things that do not make light to apply their understanding to the Big Question. In this lesson segment, the Lesson Guiding Question will also serve as the Lesson Segment Question. Write the Lesson 2 Guiding Question where students can see it:

Why is it hard to find a pencil in a dark room?

Lesson Guiding Phenomenon: You hear a sound in the middle of the night and get up to see what it is. You step on a pencil on the way out of the room. On the way back, you can see the pencil on the floor. Discuss how some objects can be seen better in the dark. Allow students to share their own experiences with this phenomenon. **Then ask students,** How can you explain this? Tell students to keep this in mind as the lesson develops. (See **Know the Standards 1.**)

Tie to the Anchoring Phenomenon

Students will encounter through investigations and reading examples of objects that give off light, contrast bright and dim lights, and explain what people see when light is present or absent. All these concepts can be applied to explain how light and vision are used to enjoy a stage performance.

Know the Science

TEACHER DEVELOPMENT

What are two types of stage lighting? The technologies used to create visual effects for all kinds of theatrical, dance, or musical performances are known collectively as *stage lighting*. Stage lighting tools include floodlights (that spread the light in a wash over the stage) and spotlights (that can place a pool of light within a defined space). Most stage lighting tools consist of a lamp (incandescent, LED, or fluorescent) housed in a boxlike container that has a reflector for directing the light. Spotlights also have a lens to focus the light, but floodlights do not generally have a lens. Stage lights are often mounted on pipes above the stage or audience, on yokes that allows them to rotate. They also have safety features such as cables and carabiners to prevent them from falling.

Know the Standards

TEACHER DEVELOPMENT

1. SEP 1 Asking Questions and Defining Problems; CCC 2 Cause and Effect: The three-dimensional learning supporting 1-PS4-2 is supported in this lesson segment by an additional Science and Engineering Practice and another aspect of the Crosscutting Concept. Students will *ask questions based on observations to find more information about the natural and/or designed world(s)* when they add questions about light to their question board. They will discuss how *events have causes that generate observable patterns* as they think about the anchoring phenomenon and discuss the video.

2. Show a video example.

Online Resources



As a class, watch a video about caves. Students make observations from media to identify recognizable patterns about light and dark.

Show students one or more online videos of cave exploration. See the Online Resources Guide for a link to the recommended video:

www.coreknowledge.org/cksci-online-resources

Ask:

- Why do the explorers put on a hard hat?
 - » to protect their heads from being bumped by the rock inside the cave
- What is it like inside the cave in the daytime?
 - » It's dark.
- How do the explorers see inside the cave?
 - » They wear headlamps that give off light.
- What would it be like in the cave if everyone turned off their headlamps at the same time?
 - » very dark

SUPPORT—After watching the video, have students join you in acting out the experience of going into a cave. Tell them to stand and slip on their jumpsuits and zip them up, strap on their hard hats, turn on their headlamps, and climb with you into the dark cave. Have them pantomime squeezing through some tight spots in the rock and climbing a rope to exit the cave. Encourage them to say what they might see along the way.

3. Take a light walk.

NGSS Elements



SEP 6

Differentiation

- Take students on a light walk around the school, explaining that the goal of the walk is to find as many sources of light as possible. Guide the walk to places where students may see light fixtures overhead, sunlight streaming through a window, and electronic devices such as computers and photocopiers.

CHALLENGE—For students who are able to write independently, allow them to take along pencils and paper to record the names of the light sources.

- If available, open a door to a dark room, such as a storage closet, and **ask students what they see inside.**
 - » not much because it is dark in there

Then switch on the light in the closet, and ask how they see now.

- » We see much better now.

4. Record and analyze observations.

NGSS Elements



SEP 6

CCC 2

DCI PS4.B

3D Learning

Monitor Progress

- Once back in your classroom, have students recall the places they went on the walk and the light sources they saw in each place.
- Record their responses on a T-chart, like the one shown, on the board or poster paper/board. (See **Know the Standards 2.**)

Our Light Walk	
Place	Light Source

5. Ask questions about light.

NGSS Elements



SEP 1

CCC 2

DCI PS4.B

3D Learning

- Explain to students that this lesson is about seeing and light. Invite them to ask any questions they want about the topic, reminding them that they are still working on explaining how people at a play or concert see the action on the stage from the last row.
- Add students' questions to the question board for this unit.
- Explain that the class will try to answer some of these questions over the next few sessions of this lesson.

Know the Standards

TEACHER DEVELOPMENT

2. Monitor Progress: Students who can contribute to the T-chart are demonstrating their ability to make firsthand observations of causes and effects (SEP 6), identify objects that give off their own light (DCI PS4.B), and look for causes and effects of the patterns in light sources that can be seen in the daytime (CCC 2).

6. Check for understanding.

Activity Page



AP 2.1.1

NGSS Elements



SEP 6

DCI PS4.B

Differentiation

- Return to the Lesson Segment Question. **Ask**, Why is it hard to find a pencil in a dark room?
 - » Because there is no light, you can't see the pencil. When light shines on a pencil, you can see the pencil.

- Tell students that the class will continue to investigate light and the Guiding Question, **Why is it hard to find a pencil in a dark room?**

Formative Assessment

- Point out to students that the light walk they took today was during the daytime. **Ask**, What would a light walk be like if it were nighttime?
 - » Accept all reasonable answers.
- Give each student a copy of A Light Walk at Night (AP 2.1.1), and read aloud the directions.
- Have students list the words for light sources they can see at night.

SUPPORT—Some students may not be ready to write words independently. If so, allow the students to tell you the light sources so that you can write them on the board and they can copy them onto their sheets.

EXTEND—Many students will enjoy expressing their understanding of light sources at night through art. Show students an image of Vincent Van Gogh's painting *Starry Night*. Then provide art supplies, and encourage students to express their feelings by creating their own "lights at night" artworks. (See **Know the Standards 3**.)

Tie to the Anchoring Phenomenon

Through direct observation and recall, students have developed an awareness that they encounter many sources of light during the day and night. Remind students that when they attend a concert or play, the lights in the auditorium are often bright while they get seated but turned off when the show begins. **Ask students to explain how the audience around them looks before and during the show.**

- » Before the show, people are easy to see because the overhead lights are on. When the show starts and the lights go down, people in the audience are harder to see, but it is easy to see the people on stage.

Know the Standards

TEACHER DEVELOPMENT

3. Differentiation: The Grade 1 Common Core Speaking & Listening standard CCSS.ELA-Literacy.SL.1.5 has students *add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings*. Students who struggled with writing on the Activity Page may succeed by expressing the same information as artwork. Give these students a chance to share their artworks with the class and talk about them.

LESSON 2.2

Observing Light Sources

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: Why is it hard to find a pencil in a dark room?

Today's Question: What objects give off their own light, and what objects do not?

Tie to the Anchoring Phenomenon: Students encounter luminous and nonluminous light objects through a video field trip and hands-on activities. These explorations can be used to explain how light contributes to the experience of attending a concert or play in a theater.

AT A GLANCE

Learning Objectives

- ✓ Differentiate between objects that give off light and objects that can only be seen when illuminated.
- ✓ Compare the brightness of light sources.

Instructional Activities

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

NGSS References

Disciplinary Core Idea: PS4.B Electromagnetic Radiation

Science and Engineering Practice:
6 Constructing Explanations and
Designing Solutions

Crosscutting Concept: 2 Cause and Effect

Students investigate the brightness of light sources and differentiate between objects that give off light and objects that do not.

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

www.coreknowledge.org/cksci-online-resources

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.

bright

dim

light

see

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

compare

contrast

darkness

observe

Instructional Resources

Activity Pages



AP 2.1.1
AP 2.2.1
AP 2.2.2

Activity Pages

A Light Walk at Night (AP 2.1.1)

How Bright Is That Light?
(AP 2.2.1)

Does It Give Off Light?
(AP 2.2.2)

Materials and Equipment

Collect or prepare the following items:

- question board
- children's literature about fireflies
- smartphone
- cardboard shoeboxes with a small eyehole punched in one end (1 per group)
- small, common classroom objects (1 set per group)
- flashlight
- glow-in-the-dark objects such as stars or glow sticks (1 pair per group)
- internet access and the means to project images/video for whole-class viewing

THE CORE LESSON 2.2

1. Focus student attention on Today's Question.

NGSS Elements



SEP 6
DCI PS4.B
CCC 2
Monitor Progress

What objects give off their own light, and what objects do not?

- Remind students that they took a light walk in Lesson 2.1. **Ask**, Where did we go, and what did we see?
 - » Sample answers: We went to the main office and saw lights on phones, copy machines, and computers. We went to the kitchen and saw lights in refrigerators and on stoves. We saw light bulbs on the ceilings of the hallways.
- **Ask students**, What objects on our walk did not give off light?
 - » sample answers: chairs, desks, pencils, people

- Explain that today the class will investigate differences between objects that give off their own light and how to test if an object gives off light or not. (See **Know the Standards 1.**)

Tie to the Anchoring Phenomenon

Students will explore bright and dim light sources and relate this to how lights in a theater are brightened or dimmed. Through experience, they will begin to build understanding that people in an audience and on a stage are visible only when a light source shines on them.

2. Show a video example.

Online Resources



Show students one or more online videos of fireflies. See the Online Resources Guide for a link to the recommended video:

www.coreknowledge.org/cksci-online-resources

NGSS Elements



SEP 6
DCI PS4.B

Ask students the following:

- What can fireflies do that many other animals cannot do?
 - » They give off their own light.
- When is the best time of day to see the light from fireflies?
 - » When it is just getting dark.
- Why do you think people travel from far away to see fireflies?
 - » Accept all reasonable answers, such as seeing insects give off light is unusual and pretty. (See **Know the Science.**)

Know the Standards

TEACHER DEVELOPMENT

1. Monitor Progress—SEP 6 Constructing Explanations and Designing Solutions: The focus of this lesson is on using explanations (evidence from observations) to understand science (that some objects can only be seen when they are illuminated). In the Grade 1 unit on plant and animal survival, students focused on the engineering part of this Science and Engineering Practice as they used materials to design a solution to a human problem that mimics how plants and other animals use their parts (1-LS1-1).

Know the Science

TEACHER DEVELOPMENT

How do living things produce light? There are different ways that an organism may produce light. Fireflies produce light by bioluminescence—a chemical reaction within the organism that releases energy as light. Certain ocean jellyfish, corals, and shrimp produce light by fluorescence—when light from an outside source is absorbed by the organism and some of it is immediately given off as a different color. Phosphorescence—such as in ocean glowworms—also requires absorption of an outside light source, but in this case, the glow lasts over an extended time.

EXTEND—Read aloud students’ related children’s literature, such as *Next Time You See a Firefly* by Emily Morgan. This nonfiction book has full-color photos that show the developmental stages in the life cycle of fireflies and explains how and why the fireflies light up.

3. Compare bright and dim lights.

Activity Pages



AP 2.2.1
AP 2.1.1

NGSS Elements



SEP 6
DCI PS4.B

Monitor Progress

Give each student a copy of *How Bright Is That Light?* (AP 2.2.1). Also display the T-chart from Lesson 2.1 called “Our Light Walk” and students’ completed *A Light Walk at Night* (AP 2.1.1), also from Lesson 2.1.

Allow students to work in small groups to discuss how to classify all the light sources they previously recorded. Assure them that some light sources may be hard to place in the chart because they seem neither dim nor bright.

SUPPORT—If students are struggling with the concept of dim versus bright light sources, show them how the screen light from a smartphone can be adjusted from low (dim) to very bright.

4. Identify objects that do not give off light.

Activity Page



AP 2.2.2

NGSS Elements



SEP 6
DCI PS4.B
CCC 2
3D Learning

Students make firsthand observations by testing objects to see if they give off their own light or not.

- Give each student a copy of *Does It Give Off Light?* (AP 2.2.2).
- Group students so that there is at least one strong reader on each team.
- **Ask students**, What objects from around our classroom do not give off light?
 - » sample answers: pencils, paper, erasers, staplers, people

SUPPORT—Clarify the differences between giving off light and reflecting light for students. Shine a flashlight with the class lights off, and explain that the flashlight gives off light. Then shine the light on a mirror or other shiny surface so students can see the light reflecting off the object.

- **Ask**, How can you test this?
 - » Put the object in a dark room or another dark space. If you cannot see it, it does not give off light.
- Provide a cardboard shoebox with a lid that can be lifted and opened and that also has a small eyehole punched into one end. Invite one student to place an object the class claims does not give off light into the box. Replace the lid tightly. Invite another student to look through the eyehole and report what they see to the rest of the class.
- Have the small groups test their ideas about other classroom objects.
- **Ask**, Was your claim supported by evidence from your test?
 - » sample answer: yes, because I could not see the object inside the dark space

SUPPORT—Some students may need you to review the language of claim-evidence-reasoning (CER) in the context of this science activity. Remind them that a claim is an answer to the question about objects that do not give off light. Reasoning is how they know their examples are correct. Evidence is the observations they have made, using the object and dark box, that support the claim.

- Allow other students to test claims about more objects using the same procedure.

CHALLENGE—Some young students are highly interested in the topic of space—well beyond what their learning standards require. Allow these students to research and create a poster showing objects in space that give off their own light (the sun and other stars) and objects that do not (planets, comets, and moons). If students are ready, discuss how objects such as the moon appear to give off a bright light but that this light is reflected light from the sun (like what a mirror does). (See **Know the Standards 2.**)

5. Check for understanding.

Activity Pages



AP 2.2.1
AP 2.2.2

- Return to Today's Question, and **ask students**, What objects give off their own light, and what objects do not? For each example students offer, ask for evidence to support their claims.
- Call attention to the question board. Revisit the questions recorded there so far, and ask students how today's investigations may help to answer some of them. Allow students to suggest revisions or additions to the questions on the board.

NGSS Elements



SEP 6
DCI PS4.B
CCC 2

Formative Assessment

Review student responses to both How Bright Is That Light? (AP 2.2.1) and Does It Give Off Light? (AP 2.2.2) to determine student understanding of the following concepts:

- Some objects give off their own light.
- Light sources can be described as dim or bright.

Tie to the Anchoring Phenomenon

Through direct observation and recall, students are developing understanding about objects that produce dim or bright lights and those that do not produce light. These concepts will help them construct explanations about how an audience experiences a concert or play in a theater or auditorium.

Know the Standards

TEACHER DEVELOPMENT

2. PS4.B Electromagnetic Radiation: The focus of this Disciplinary Core Idea at Kindergarten–Grade 2 is on recognizing luminous and nonluminous objects by whether they give off light or not. In Grades 3–5, students are introduced to the concept of reflected light and learn that they see nonluminous objects when they reflect light into their eyes.

LESSON 2.3

Comparing Visibility

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: Why is it hard to find a pencil in a dark room?

Today's Question: How does the amount of light affect how well we can see something?

Tie to the Anchoring Phenomenon: Students engage in writing and discussion and conduct tests using simple models for theaters in which there is little or no light to consider how the audience can see the show.

AT A GLANCE

Learning Objective

- ✓ Investigate nonluminous objects in various (diminishing) levels of light.

Instructional Activities

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

NGSS References

Performance Expectation: 1-PS4-2

Disciplinary Core Idea: PS4.B Electromagnetic Radiation

Science and Engineering Practice:
6 Constructing Explanations and
Designing Solutions

Crosscutting Concept: 2 Cause and Effect

Students will investigate nonluminous objects in various (diminishing) levels of light to explain how light affects what they can see.

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

www.coreknowledge.org/cksci-online-resources

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.

dark

light

see

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.

cause

darkness

effect

observe

Instructional Resources

Activity Pages



AP 2.3.1
AP 2.3.2

Activity Pages

Let the Light Shine In (AP 2.3.1)

Testing Light Makers (AP 2.3.2)

Materials and Equipment

Collect or prepare the following items:

- question board
- cardboard shoeboxes, with a pinhole in one end (1 per group)
- small nonluminous classroom objects (1 per student)
- small luminous objects, such as glow sticks or flashlights (1 per group)
- internet access and the means to project images/video for whole-class viewing

THE CORE LESSON 2.3

1. Focus student attention on Today's Question.

Online Resources



How does the amount of light affect how well we can see something? Show students a video of a child reading a book under the covers at night, and invite them to share their own experiences. See the Online Resources Guide for a link to the recommended video:

www.coreknowledge.org/cksci-online-resources

NGSS Elements



SEP 6

DCI PS4.B

Differentiation

Ask students the following:

- Why is it hard to see under the covers at night?
 - » because it is dark there
- If you want to read a book under the covers, what do you need?
 - » a light source such as a flashlight

- How does that help you?
 - » With a flashlight turned on, there is enough light to see the words and the pictures.

CHALLENGE—Invite interested students to test how well they can see using red light. Provide a flashlight with the lamp end covered in a piece of red cellophane held in place with a rubber band. Allow them to sit on the floor and cover themselves with a blanket. Provide a couple of books with different-sized text. Ask students to use evidence from their tests to explain how well they can see when only red light is present. (See **Know the Standards 1.**)

Tie to the Anchoring Phenomenon

Discuss with students how reading under the covers is like sitting in a theater watching a show. **Ask**, How can you see the people on the stage when the theater is dark?

- » Someone who works in the theater must turn on lights that make it easier to see.

2. Work in teams to gather evidence.

Activity Page



AP 2.3.1

- Give each student a copy of Let the Light Shine In (AP 2.3.1).
- Group students so that there is at least one strong reader on each team.
- Tell students to follow the procedure on their Activity Pages and write the answers to the questions.

NGSS Elements



SEP 6

CCC 2

DCI PS4.B

Differentiation

3D Learning

- SUPPORT**—Arrange students in cooperative teams with roles that will support English language learners and students reading below grade level. For this activity, consider assigning students the roles of materials getter, tester (places objects in the box), subject (looks through the peephole), and writer (writes down the answers to the questions on the Activity Page).
- Invite each team to report their results, and encourage cause/effect language.
 - **Ask**, What caused the object to be seen?
 - » letting light enter the box

Know the Standards

TEACHER DEVELOPMENT

1. Differentiation—PS4.B: Electromagnetic Radiation: Allow Grade 1 students to experience how well they see under red light without attempting to explain how red light differs from white light. While the nature of light and seeing is explored in Grades 1 and 4, it is not until middle school that students build their understanding that the color of light is related to the frequency (the number of waves passing a point during a specified time interval, such as one second) of light waves.

- **Ask,** What was the effect of letting light into the box?
» We could see the object.

EXTEND—Extend this investigation by asking students to design a way to measure how much light they allow to enter the box. For example, they can hold a ruler next to the box and lift the box lid one inch at a time.

3. Work in teams to gather evidence.

Activity Page



AP 2.3.2

NGSS Elements



SEP 6

CCC 2

DCI PS4.B

Monitor Progress

3D Learning

Students perform tests and make observations to construct explanations that objects that give off their own light can be seen in a space where there is no other light.

- Give each student a copy of Testing Light Makers (AP 2.3.2).
- Have students stay in their groups from Step 2, or regroup them depending on the number of light makers you have available.

SUPPORT—If you set up cooperative teams with roles in Step 2, consider having students switch roles for this step. Guide role selection to students' strengths.

- Tell students to follow the steps on their Activity Pages to plan their own test and answer the questions after talking about them with their teams.
- **Ask students,** What did you observe during your test?
» I observed that light makers can be seen when there is darkness around them.
- **Ask students,** What caused the light maker to be seen?
» I could see it because it makes its own light. (See **Know the Standards 2.**)

Know the Standards

TEACHER DEVELOPMENT

2. Monitor Progress—CCC 2 Cause and Effect: Students need ample opportunities to use the language of cause and effect. Throughout Kindergarten–Grade 2, focus on connecting events and causes (“What caused that screeching sound?”) and designing simple tests to support students’ ideas about causes (“Let’s hold the chalk in a certain way and see if it makes that sound again.”).

4. Check for understanding.

Activity Pages



AP 2.3.1

AP 2.3.2

NGSS Elements



SEP 6

CCC 2

DCI PS4.B

Call attention to Today's Question, and **ask**, How does the amount of light affect how well we can see something? Encourage students to use evidence from their tests with objects in the box to support their answers.

Formative Assessment

Review student responses to Let the Light Shine In (AP 2.3.1) and Testing Light Makers (AP 2.3.2) to determine student understanding of the following concepts:

- Objects that do not give off light cannot be seen in the dark.
- Objects become easier to see as the amount of light around them increases.
- Objects that are making light can be seen where there is no other light. (See **Know the Science**.)

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

Tie to the Anchoring Phenomenon

Have students consider again what happens in a theater during a concert or show. Drawing on their experiences with light and darkness, have them think about sitting in the back row of the theater after the lights are turned off. **Ask**, How do you know when the show is about to begin?

» Lights turn on over the stage, and we can now see the performers.

Know the Science

TEACHER DEVELOPMENT

In what ways do objects produce light? Light is produced by atoms when electrons fall from a higher energy level to a lower energy level. But first, energy must excite the electron to move up to the higher level. This may occur when matter is heated, when matter is exposed to electric current or sound, during chemical reactions, or when materials are ripped apart or rubbed (static electricity). When the electron returns from the higher energy level to a lower energy level, a photon is emitted.

LESSON 2.4

Reasoning About Light

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: Why is it hard to find a pencil in a dark room?

Today's Question: How does light affect what you see?

Tie to the Anchoring Phenomenon: Students will develop an understanding of what people can see when a space is dark or dimly lit and when a space is brightly lit. This will help them explain what an audience experiences in a theater before, during, and after a concert or play.

AT A GLANCE

Learning Objective

- ✓ Differentiate between objects that give off light from objects that can only be seen when illuminated.

Instructional Activities

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

NGSS References

Disciplinary Core Idea: PS4.B Electromagnetic Radiation

Science and Engineering Practice:
6 Constructing Explanations and
Designing Solutions

Crosscutting Concept: 2 Cause and Effect

Students will explore and explain the difference between objects that give off light and objects that can only be seen when illuminated.

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

www.coreknowledge.org/cksci-online-resources

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.

bright

dark

dim

light

see

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.

cause

compare

darkness

effect

object

Instructional Resources

Student Book



Ch. 3

Activity Page



AP 2.4.1

Student Book, Chapter 3
"Light"

Activity Page

What's in the Closet? (AP 2.4.1)

Materials and Equipment

Collect or prepare the following items:

- flashlight
- crayons or markers
- question board

THE CORE LESSON 2.4

1. Focus student attention on Today's Question.

NGSS Elements



DCI PS4.B

How does light affect what you see?

- Have students recall their prior investigations related to light, including putting objects in a dark box and looking for them through a peephole. (See **Know the Standards 1.**)

Know the Standards

TEACHER DEVELOPMENT

1. CCC 2 Cause and Effect: The central learning experiences of Lesson 2 are the investigations with materials that allow students to make direct observations that light is needed to see objects that do not give off their own light and that objects that give off their own light can be seen in the dark. While discussing the examples in the Student Book, refer to the tests students did earlier with cardboard boxes and so on. Discuss these tests using cause-and-effect language.

- Ask students how people use flashlights. Encourage them to use the vocabulary *darkness*, *light*, and *see* in their answers.
- Explain that, today, the class will read aloud about light and play a flashlight game.

Tie to the Anchoring Phenomenon

Through reading, discussion, and a flashlight game, students build understanding of what role light plays in a theatrical production—both on stage and in the audience.

2. Read together: “Light.”

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.



Ask students to turn to page 8 of the Student Book and look at the picture as you read aloud. Remind them that the title of this chapter is “Light,” and tell them to pay special attention to identifying objects that give off light and those that do not give off light as you read.

CHAPTER 3

Light

Mr. Ruiz tells his class a story about two brothers. One brother walks into the bedroom and sees his younger brother on his hands and knees under the lamp. The younger brother says he is looking for a pencil he lost. The older brother says, “Are you sure you lost it here by the lamp?” The younger brother says, “No, but the light is much better here.” What’s funny about this story?



8

Have students look at the picture on page 8. Explain that the picture illustrates the story told in text at the top of the page.

LITERAL—What is the younger brother looking for?

» his pencil

INFERENTIAL—When the older brother asks, “Are you sure you lost it here by the lamp?” what is he thinking about where the pencil might be?

» The pencil could be anywhere in the room, not just under the lamp.

CHALLENGE—Invite students to share their own stories about looking for a lost object in the darkness. Encourage them to use vocabulary such as *light*, *see*, *bright*, *dark*, and *dim*.

NGSS Elements



DCI PS4.B

Monitor Progress

Some objects around you give off light. The sun gives off light. Lamps give off light.



Nightlights give off light.



Lit candles give off light.



Mobile phones give off light. We can see light when it enters our eyes.

9

CORE VOCABULARY—Explain that **light** has to be present for them to see. (See **Know the Science.**)

Know the Science

TEACHER DEVELOPMENT

How do humans see? Vision results from the actions of the eye and brain working in coordination. Light enters the spherical-shaped eye through the clear covering (the cornea), passes through an opening (the pupil), and then passes through a clear structure called the lens. Both the cornea and lens focus the light before it strikes the lining of the back of the eyeball (the retina). The retina changes light into electrical signals, which move along the optic nerve to the brain. The brain interprets these signals as images that you “see.”

INFERENTIAL—What objects give off light?

- » the sun
- » lamps
- » nightlights
- » smartphones
- » burning candles

How do we **see**?

- » Light enters our eyes.

SUPPORT—The content on this page should be familiar from Lesson 2.1 and can be used to determine how well students understood the results of their investigations earlier in this lesson. If students have trouble identifying light sources, go over the T-chart the class made in Lesson 2.1 showing places and light sources seen on their light walk around school.

EXTEND—Invite students to identify other objects that give off light. Remind them to think about the last few days of investigating for ideas.

- » sample answers: flashlights, glow sticks, computer screens, refrigerator lights, exit signs

Pages 10–11

NGSS Elements



SEP 6

DCI PS4.B

Differentiation

Ask students to look at the pictures on pages 10–11 as you read aloud.

Some objects give off very bright light. A fire gives off bright light. It lights the area nearby.



The sun's light is so bright that it can hurt your eyes. Never look directly at the sun.



10

Other objects give off dim light. A glow stick gives off a dim light.



A flashlight also gives off light. Sometimes the light is bright. Sometimes the light is dim. Why might someone want to read by a bright light?



11

CORE VOCABULARY—Make sure that students understand that **bright** means a lot of light (sometimes enough to squint their eyes) and that **dim** means there is only a little light.

LITERAL—What are the examples of bright light?

- » a fire
- » the sun

What are the examples of dim light?

- » a glow stick
- » a small flashlight

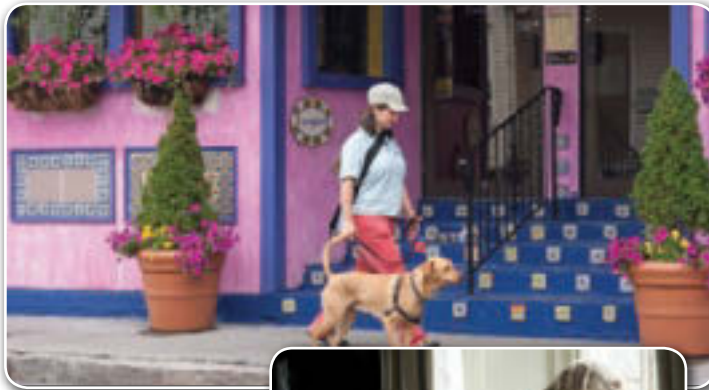
EXTEND—List on the board other examples of bright and dim lights, encouraging familiar examples from the local community.

CHALLENGE—Draw a long horizontal line on the board. Write the word *dim* on the left end and the word *bright* on the right end. Challenge students to compare all the examples of light they have read about and investigated in earlier lessons and place them on this scale. For example, students may decide that a glow stick is dimmer than a flashlight, so *glow stick* should be written to the left of *flashlight*. Write the names of objects that are difficult to classify as bright or dim in the middle of the scale. The brightest objects, such as the sun, should be placed closest to the word *bright*. Allow students to rearrange the words along the scale until they are satisfied with the results.

Page 12

Ask students to look at the pictures on page 12 as you read aloud.

Many things do not give off light. Flowers, buildings, and fences do not give off light. People and dogs do not give off light either! You see these things only when light shines on them. When you are outdoors in the daytime, sunlight shines on these objects.



When you are indoors in the daytime, sunlight shines through windows or from light from lamps. At night, light from lamps shines on objects.



12

LITERAL—Where does light come from that shines on people and dogs?

- » the sun
- » lamps

INFERENTIAL—What if the woman walks her dog in the nighttime? How will she see her dog and where she is going?

» She will see if there is light from streetlights, the moon, and car headlights.

Page 13

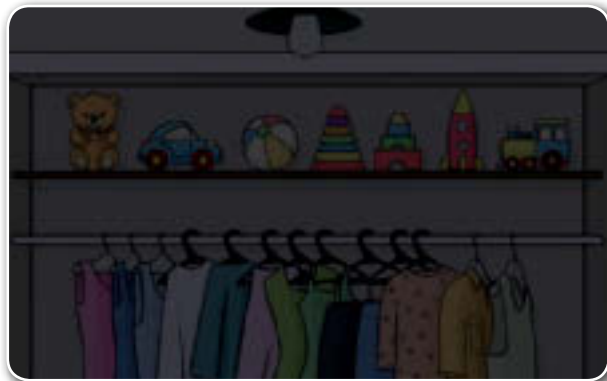
NGSS Elements



DCI PS4.B

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

Think about opening the door to a dark closet just a bit. Without light, you cannot see what is in there. That can be mysterious! But if you turn on a light, you can see inside the closet. It's just some shoes, some shirts, some dresses, and toys in there!



13

LITERAL—What can you see in the picture of the dark closet?

» a few hangers and maybe some clothes

Can you tell what kinds of clothes are hanging there? Explain.

» no, because it is too dark in the closet



Give each student crayons or markers and a copy of *What's in the Closet?* (AP 2.4.1). Suggest that they draw a closet in school, one at home, or one from their imaginations. Invite volunteers to show their drawings, compare what can be seen when it is dark and when light is available, and read their explanations. (See **Know the Standards 2.**)

Page 14

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



Some room lights have a dimmer switch. You can make the light dim, bright, or somewhere in between. It can be hard to read a book if the light is too dim or too bright. Using a dimmer switch can make the light perfect for reading.



14

LITERAL—What does a dimmer switch do?

» It makes a light dim or bright.

Know the Standards

TEACHER DEVELOPMENT

2. SEP 6 Constructing Explanations and Designing Solutions: This Science and Engineering Practice is one of two [the other is Asking Questions (for science) and Defining Problems (for engineering)] in which the approaches for science and engineering are significantly different. Constructing explanations takes place as a result of scientific observations and investigations; designing solutions is part of the engineering process that also includes identifying a problem, testing the solution, and making design improvements. This lesson focuses on the science aspect of this practice, but Grade 1 students have an opportunity to define problems in the unit on plant and animal survival.

EXTEND—Ask students to think of places where the lights have slowly changed from dim to bright or bright to dim. Where have you seen dimmer switches used?

» sample answers: at home, in a theater, in a store, in an office

SUPPORT—Some students may not have experienced the effects of dimmers. If so, use a smartphone screen brightness controller to slowly dim or brighten the screen's light so that students can see these effects.

Tie to the Anchoring Phenomenon

Explain to students that when a show at a theater is about to begin, the lights over the seats will slowly dim. Then, when the show is over, the same lights will slowly brighten. Explain that these theater lights are controlled by dimmer switches.

Page 15

Before you read aloud page 15, go back and reread the beginning of the story on page 8. Ask students to look at the illustrations on both pages as you read aloud.

Think again about the story of the brother looking for his pencil. Why was he under the light from the lamp? What could the older brother do to help find the pencil?



15

LITERAL—Where in the room is the younger brother looking for his lost pencil?

- » on the floor under a lamp

Why is he looking only under the lamp?

- » because that is the only place in the room with enough light for him to see the pencil

INFERENTIAL—How can his older brother help him find the pencil?

- » He can point the light from the flashlight all over the room so the younger brother can search the entire floor.

EVALUATIVE—What makes the story on page 8 funny or silly?

- » It is funny that the younger brother has only thought to look under the lamp when the pencil could be anywhere on the floor.

3. Play “I spy. . .” with a flashlight.

NGSS Elements



1-PS4-2
SEP 6
CCC 2
DCI PS4.B
3D Learning

Students play a game to construct explanations that objects that do not give off their own light can be seen better when light shines on them.

- Darken your classroom as much as possible.
- Say “I spy with my little eyes something that . . .” and give a hint about an object in the room without naming it.
- When a student thinks they know what object you are thinking of, hand them the flashlight, and say, “Help us see it more clearly.” The student should turn on the light and use the beam to illuminate the object.
- Allow students to continue playing the game, reinforcing the concept that light is needed to see objects that do not give off their own light.

4. Check for understanding.

NGSS Elements



SEP 6
CCC 2
DCI PS4.B
Differentiation

Call attention to Today’s Question and **ask**, How does light affect what you see? Have the students use examples from the Student Book to discuss each question:

- How does using only a nightlight at night affect what you see?
 - » Sample answer: When my room is dark at night, I can only see things clearly near the dim light from a nightlight.
- How does having the sunshine in the daytime affect what you see?
 - » Sample answer: Sunshine is very bright, so I can see everything very well.

- Was the younger brother smart to look for his pencil under the lamp?
 - » Sample answer: In one way he was smart—that was the only place in the darkness he would be able to see the pencil on the floor.
- SUPPORT**—For students who are struggling to understand the point of the anecdote at the beginning and end of the Student Book chapter, invite two students to act out the story for the class. Supply speaking lines to each actor. Then ask the actors to give reasoning for what they said.
- How did using a flashlight help show people objects in the “I spy” game?
 - » The bright light that lit up the object made it easier to see in the dark room.

Call attention to the question board. Revisit the questions recorded there so far, and ask students how reading the chapter and talking about the story of the two brothers might answer or relate to any of those questions.

Tie to the Anchoring Phenomenon

Now that the class has discussed using a flashlight in the dark, it is a good time to talk about how actors on stage in a play are illuminated with spotlights to make them easier for the audience to see.

Summative Assessment

Review student responses to What’s in the Closet? (AP 2.4.1) to determine student understanding of the following concepts:

- Objects that do not give off light cannot easily be seen in the darkness.
- A light source is needed to see objects that do not give off light.

Activity Page



AP 2.4.1

LESSON 2.5

Lesson 2 Roundup: Investigating Light Sources

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: Why is it hard to find a pencil in a dark room?

Today's Question: Why is it hard to find a pencil in a dark room?

Tie to the Anchoring Phenomenon: In this culminating lesson segment, students review all their accumulated evidence related to the Anchoring Phenomenon. The question about the pencil will be related to a question about how the usher finds your seats in a theater.

AT A GLANCE

Learning Objective

- ✓ Contrast visibility of luminous and nonluminous objects using evidence from observations.

Instructional Activities

- student investigation
- student observation
- class discussion

NGSS References

Performance Expectation: 1-PS4-2

Disciplinary Core Idea: PS4.B Electromagnetic Radiation

Science and Engineering Practices:
6 Constructing Explanations and Designing Solutions; 2 Developing and Using Models

Crosscutting Concept: 2 Cause and Effect

Students will observe and investigate the visibility of luminous and nonluminous objects.

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

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

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dark light see

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brightness cause compare darkness
effect

Instructional Resources

Activity Page



AP 2.5.1

Activity Page

Draw a Funny Dark and Light Comic (AP 2.5.1)

Materials and Equipment

Collect or prepare the following items:

- question board
- flashlight
- copy of a theater ticket with seat numbers
- colored pencils

THE CORE LESSON 2.5

1. Focus student attention on Today’s Question.

NGSS Elements



SEP 6

DCI PS4.B

Monitor Progress

Why is it hard to find a pencil in a dark room?

- Remind students of the story of the two brothers in Student Book Chapter 3.
Ask, Where on the floor of the dark room was the younger brother looking for the pencil?
 - » under a lamp
- Why was he looking there?
 - » because that was the only place in the room with enough light to see a pencil

- Explain that students will make up their own stories about looking for lost objects. (See **Know the Standards 1.**)

Tie to the Anchoring Phenomenon

Through discussion, role playing, and drawing comics, students will show fluency in their understanding of the roles darkness and light play in attending a stage performance.

2. Act out a theater usher's job.

NGSS Elements



SEP 6

CCC 2

DCI PS4.B

Differentiation

Explain that the ticket holders must sit in the assigned row and seat. Explain that the rows and seats have numbers on them that can be difficult to see in a darkened theater. **Ask students the following:**

- What is the job of an usher in a theater?
 - » showing people to their assigned seats
- Why might a person who comes late to the theater have trouble finding their seat?
 - » The theater may be dark, and this makes it hard to read the text on the ticket to know where to sit.
- What can the ushers do to read the numbers on the tickets and seats?
 - » They can use an object that gives off light and hold it so the light shines on the numbers.

Have students take turns acting as usher and ticket holder. Print out a sample of a ticket and allow the usher to use a flashlight to illuminate the text on the tickets, find the seat numbers, and point to the seats. (See **Know the Science.**)

Know the Standards

TEACHER DEVELOPMENT

1. Differentiation—SEP 6 Constructing Explanations and Designing Solutions: This practice is closely aligned with several Common Core ELA standards for Grade 1: *With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question (W.1.8); Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups (SL.1.1); and Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure (W.1.2).*

Know the Science

TEACHER DEVELOPMENT

Why can a flashlight be used as a pointer? This question anticipates Lesson 3, in which students will explore how light travels from place to place. Because light travels away from its source in straight lines, it is described as rays. Light rays from a flashlight create a “beam” of light as wide as the reflector inside the flashlight. A flashlight forms a straight beam that can be used as a pointer.

EXTEND—Read aloud children’s literature related to the theater, such as *Moses Sees a Play* by Isaac Millman. This picture book describes a performance by a deaf theater company for young hearing and hearing-impaired students. Follow up the reading with a discussion of the importance of light in a performance that cannot depend on sound to get its message across.

3. Draw a comic.

Activity Page



AP 2.5.1

NGSS Elements



SEP 2

DCI PS4.B

Monitor Progress

- Give each student a copy of Draw a Funny Dark and Light Comic (AP 2.5.1). Read the directions with the students, and make sure they understand that their story should be different from the one about looking for a lost pencil.
- Point out to students that a comic is one kind of model. Remind students that they use models when they use counters or graphs to solve a problem in math. Explain that they can also represent objects or events with all kinds of models in science. (See **Know the Standards 2.**)
- Distribute colored pencils, and have students plan and draw their comic.

SUPPORT—Some students may need extra copies of the Activity Page so that they can draft and refine their drawings and edit their writing.

4. Check for understanding.

Activity Page



AP 2.5.1

Return to Today’s Question, and **ask students**, Why is it hard to find a pencil in a dark room?

- Remind students that they have explored this situation in investigations and using the Student Book.
- Ask them to explain how evidence from these activities helps them answer the question.

Know the Standards

TEACHER DEVELOPMENT

2. SEP 2 Developing and Using Models: Kindergarten through Grade 2 students develop models in the form of diagrams, acting out situations, building replicas, and storyboarding. Developing their own comics is a form of storyboarding and gives student an opportunity to represent relationships and patterns they have observed in the world around them. As students move to Grades 3–5, their models will become more complex, they will identify their limitations, and they will use their models to make predictions. Using the word *model* when discussing students’ comics will make this practice more explicit for them.



Call attention to the question board. Revisit the questions recorded there so far, and ask students how their experiences in Lesson 2 helped to answer some of them. Allow students to suggest revisions or additions to the questions on the board.

Summative Assessment

Review student responses to Draw a Funny Dark and Light Comic (AP 2.5.1) to determine student understanding of the following concepts:

- Some objects cannot be seen unless there is a light from another object to illuminate them.
- Some objects produce their own light.
- You can see objects that give off their own light, even when they are in a dark space.

Tie to the Anchoring Phenomenon

At this point, students should be ready to explain how theatrical lighting can be used to draw the audience's attention to one character or object on the stage. Discuss how lighting engineers can darken the entire stage and then use a spotlight on one performer at a time.

LESSON 3

Light and Materials

OVERVIEW

Guiding Question: What happens when light shines on different materials?

Lesson 3 Segments	Segment Questions	Advance Preparation
3.1 Seeing Shadows Students engage with the lesson phenomenon, watch a video, take a shadow walk, and add questions about light and materials to their unit question board. They also begin a science folder to share at the conclusion of the lesson.	Where and when can you see shadows?	Preview the online video you will show the class. Plan a tentative route for the shadow walk. Make sure the Unit 3 question board is accessible.
3.2 Making Shadows Students collaborate to plan and conduct an investigation to determine which materials cast the darkest shadows.	What materials make the darkest shadows?	Gather and prepare materials for the investigation in Step 2. See Materials and Equipment.
3.3 Comparing Materials That Let Light Pass Through Students collaborate to plan and conduct an investigation to compare materials that let some light pass through.	What materials allow some or all light to pass through?	Gather materials for Steps 2 and 3. See Materials and Equipment.
3.4 Changing the Direction of Light Students collaborate to produce evidence to answer a question about how light is reflected.	What materials change the direction of a light beam?	Gather materials for Steps 2 and 3. See Materials and Equipment.
3.5 Lesson 3 Roundup: Using Light in a Stage Performance (2 days) Students read along and use their science notebooks to explain how certain materials affect light.	What happens when light shines on different materials?	Preview the online video you will show the class. Read Chapter 4 in the Student Book. Gather materials for Day 2. See Materials and Equipment.

What's the Story?

Summary: In Lesson 3, students collaborate to plan and carry out tests to compare how different materials interact with a light beam. Grade 1 is your students' first exposure to the core idea related to the interactions of light with various materials. They apply what they learn about the transmission and reflection of light to answer this lesson's guiding question (What happens when light shines on different materials?) and add to their explanation of the unit phenomenon, including how theatrical lighting and other materials can produce certain visual effects and allow all theatergoers to see what is happening onstage.

Learning Progression: Lesson 3 builds on students' understanding from Lessons 1 and 2 of the Crosscutting Concept Cause and Effect, as they continue to design simple tests about causes related to light. The understanding of reflection of light developed in this lesson will be applied in Grade 4 to the topic of vision (4-PS4-2) and further developed in middle school, when students explore how the frequency of light is related to its reflection and absorption (MS-PS4-2). In Kindergarten, the Science and Engineering Practice Planning and Carrying Out Investigations takes place only with teacher guidance. Consequently, Grade 1 is the first experience students will have working only with peers to plan their investigations.

Guiding Phenomenon: Performers and objects on a stage cast shadows the audience can see (1-PS4-3).

Learning Objectives

By the end of Lesson 3, students will do the following:

- Identify and describe shadows.
- Investigate interactions of light with opaque materials.
- Investigate interactions of light with transparent and translucent materials.
- Investigate interactions of light with reflective materials.
- Use evidence from observations to describe ways that light can interact with materials.

NGSS Standards and Dimensions

Performance Expectation: 1-PS4-3 Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.

Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
<p>3 Planning and Carrying Out Investigations</p> <p>Plan and conduct investigations collaboratively to produce evidence to answer a question.</p> <p>1 Asking Questions and Defining Problems</p> <p>Ask and/or identify questions that can be answered by an investigation.</p> <p>4 Analyzing and Interpreting Data</p> <p>Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.</p> <p>6 Constructing Explanations and Designing Solutions</p> <p>Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.</p>	<p>PS4.B Electromagnetic Radiation</p> <p>Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.)</p>	<p>2 Cause and Effect</p> <p>Simple tests can be designed to gather evidence to support or refute student ideas about causes.</p> <p>Events have causes that generate observable patterns.</p> <p>6 Structure and Function</p> <p>The shape and stability of structures of natural and designed objects are related to their function(s).</p>

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

www.coreknowledge.org/cksci-online-resources

LESSON 3.1

Seeing Shadows

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: What happens when light shines on different materials?

Today's Question: Where and when can you see shadows?

Tie to the Anchoring Phenomenon: Students will enjoy applying what they learn in this lesson about light, materials, and shadows to explain what people attending a play may see on the stage in a theater.

AT A GLANCE

Learning Objective

- ✓ Identify and describe shadows.

Instructional Activities

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

NGSS References

Disciplinary Core Idea: PS4.B Electromagnetic Radiation

Science and Engineering Practices: 3 Planning and Carrying Out Investigations; 1 Asking Questions and Defining Problems

Crosscutting Concept: 2 Cause and Effect

Students explore cause-and-effect relationships as they search around their school for examples of materials casting shadows.

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

www.coreknowledge.org/cksci-online-resources

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.

dark lit object shadow

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.

materials record

Instructional Resources

Activity Page



AP 3.1.1

Activity Page

Shadow Walk (AP 3.1.1)

Materials and Equipment

Collect or prepare the following items:

- question board
- file folders (1 per student)
- markers or colored pencils (1 set per group)
- internet access and the means to project images/video for whole-class viewing

THE CORE LESSON 3.1

1. Introduce students to Lesson 3.

NGSS Elements



DCI PS4.B

Ask a volunteer to state the Big Question that you'll be answering in this unit, which is posted somewhere in the room—**What happens in a stage performance so that people can see and hear the show?**

Remind students that in Lesson 1 they learned about sound and vibrations. In Lesson 2, they learned the difference between objects that make light and those that do not make light, and they used what they have learned to think about the sounds heard and objects seen at a concert or play.

Invite students to share their experiences attending shows in school or in the community, including describing how the lights interacted with objects and materials. Draw out their observations related to the following:

- how the stage curtain interacts with light
- how the musicians interact with light
- how people's eyeglasses interact with light (See **Know the Science.**)

Tell students that to fully answer the unit's Big Question they will continue their investigation of light, which will concentrate on the materials that light strikes in a theater. Write the Lesson 3 Guiding Question where students can see it:

What happens when light shines on different materials?

Tie to the Anchoring Phenomenon

Students will encounter through videos and when planning materials for investigations that light interacts in different ways. This concept can be applied to explain how objects and materials on a stage interact with theatrical lighting. (See **Know the Standards 1.**)

2. Watch a video about shadows.

Online Resources



Students plan where to make observations and identify recognizable patterns about shadows.

Show students a video in which children younger than Grade 1 students are baffled by their shadows. See the Online Resources Guide for a link to the recommended video:

www.coreknowledge.org/cksci-online-resources

Know the Science

TEACHER DEVELOPMENT

How does light interact with materials? When light interacts with matter, it may be transmitted, absorbed, or reflected. Light is transmitted when it passes through the material. When light is absorbed, some of the energy it carries is often converted to thermal energy, and the material warms. Materials that reflect light cause the light rays to change direction.

Know the Standards

TEACHER DEVELOPMENT

1. Differentiation—CCC 2 Cause and Effect: Students will identify and describe cause-and-effect relationships throughout their Kindergarten–Grade 12 science education. In the Kindergarten–Grade 2 years, they will learn that events (such as the appearance of a shadow) have causes that create patterns. For students who struggle with cause and effect, try using the language of patterns. Patterns are objects or events that repeat. Once students recognize certain patterns (such as where they can find shadows), they can begin to talk about causes and effects

Ask the following:

- What does the young child in the video discover?
 - » that a shadow doesn't have a smile/that they have a shadow
- How do young children react to seeing their shadows for the first time?
 - » They can be troubled or confused.
- What could you tell a younger child about shadows to make them feel better?
 - » Sample answer: I would say that a shadow is not a real object. It is only a place where there is much less light.

EXTEND—After watching the video, invite students to act out a scene in which they explain to a younger sibling why they should not be afraid of shadows.

3. Take a shadow walk.

NGSS Elements



SEP 3

DCI PS4.B

CCC 2

Monitor Progress

- **Pose a question to be investigated**, What causes shadows around our school? Invite students to suggest possible answers.
 - » Sample answer: Light shining from the sun on the school fence makes a shadow.
- Tell students you will take a walk around the school to find as many shadows as possible.
- Allow students to help plan their investigation by suggesting places to look for shadows.
- Guide the walk to places where students may see shadows of furniture, signs on posts, fences, and people.
- For each shadow students find, **ask**, What object made the shadow, and where can you see the shadow? Tell students to remember these details so that they can record them when you return to the classroom. (See **Know the Standards 2**.)

Know the Standards

TEACHER DEVELOPMENT

2. Monitor Progress—PS4.B Electromagnetic Radiation: While on the shadow walk, look for evidence that students are beginning to understand that shadows must have a solid or liquid surface on which they can be seen and that a shadow is an area on that surface where there is little light. Lesson 3.2 will formalize this concept, and the rest of the concepts in this Disciplinary Core Idea will be developed in Lessons 3.3–3.5.

SUPPORT—Consider using a digital camera to take pictures of the shadows students identify. When you return to class, allow students to review the images to help recall what they saw.

4. Record and analyze observations.

Activity Page



AP 3.1.1

NGSS Elements



SEP 3

DCI PS4.B

CCC 2

3D Learning
Differentiation

- On return to your classroom, give each student a copy of Shadow Walk (AP 3.1.1).
- Guide a class discussion in which student observations will be recorded on the T-chart.

EXTEND—Read aloud a picture book about shadows, such as *On a Dark, Dark Night* written by Jean Cochran and illustrated by Jennifer Morris. Invite students to respond by talking about the shadows they have seen at night. Reinforce the concept that shadows often have different sizes and shapes than the objects that blocked the light to make them.

Remind students that their shadow walk was a science investigation. Explain that scientists save records of their scientific work and that they will do the same.

CHALLENGE—For students who are interested, suggest that they use the blank back of their Activity Page to draw a diagram of how one of the shadows was made. Encourage them to use arrows to represent light and add labels to explain their thinking.

5. Make a science folder.

NGSS Elements



DCI PS4.B

Monitor Progress

- Tell students they will investigate their questions over the next few days and, like scientists, put all their work into a science folder.
- Give each student a blank file folder, and have them work in groups to share markers and colored pencils.
- Have students write a title for the folder and their names. Encourage them to decorate the folder with pictures about the topic.
- Explain that all completed Activity Pages will go into their folders.

SUPPORT—To help keep students organized, begin an anchor chart about the science folders. Describe the information you want on the cover and what to place inside the folder today. Leave room to list the names of each data sheet students produce as Lesson 3 progresses.

6. Ask questions about materials that light strikes.

NGSS Elements



SEP1
CCC 2

DCI PS4.B

- Explain to students that this lesson is about what happens to light when it meets different materials. Make sure students understand that a material is what an object is made of. Explain that wood, paper, metal, and glass are all materials.
- Encourage students to ask questions that can be answered by doing an investigation.
- Add students' questions to the question board for this unit.
- Explain that the class will try to answer some of these questions over the next few sessions of this lesson.

7. Check for understanding.

Activity Page



AP 3.1.1

NGSS Elements



SEP 6
DCI PS4.B

- Return to Today's Question, and **ask students**, Where and when can you see shadows? Guide students to understand that shadows can be seen in the daytime or nighttime, if there is a light source, an object to block the light, and a surface for the shadow to appear on.
- Call attention to the unit question board. Revisit the questions recorded there so far, and ask students if today's investigations may help to answer some of them. Allow students to suggest revisions or additions to the questions on the board.

Formative Assessment

Review student recorded observations on Shadow Walk (AP 3.1.1) to determine student understanding of the following concepts:

- Objects that block light cast shadows.
- A variety of light sources can be involved in making shadows.

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

Tie to the Anchoring Phenomenon

Through direct observation, students are beginning to develop awareness that light interacts with some materials to produce shadows. Invite students to share any experience with shadow puppets, and **ask**, What materials make the best shadow puppets?

- » Accept all reasonable answers, and return to this question after completing Lesson 3.2.

LESSON 3.2

Making Shadows

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: What happens when light shines on different materials?

Today's Question: What materials make the darkest shadows?

Tie to the Anchoring Phenomenon: As students plan and carry out their investigations, they should think about how shadows may be important parts of theatrical shows.

AT A GLANCE

Learning Objective

- ✓ Investigate interactions of light with opaque materials.

Instructional Activities

- student investigation
- class discussion

NGSS References

Performance Expectation: 1-PS4-3

Disciplinary Core Idea: PS4.B Electromagnetic Radiation

Science and Engineering Practices: 3 Planning and Carrying Out Investigations; 1 Asking Questions and Defining Problems

Crosscutting Concept: 2 Cause and Effect

Students will plan and carry out investigations of different interactions of light with opaque materials.

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

www.coreknowledge.org/cksci-online-resources

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.

block dark light materials
shadow surface

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.

evidence observe opaque record

Instructional Resources

Activity Pages



AP 3.2.1
AP 3.2.2

Activity Pages
Shadow Makers (AP 3.2.1)
Planning and Carrying Out
Investigations (AP 3.2.2)

Materials and Equipment

Collect or prepare the following items:

- question board
- flashlights (1 per group)
- clear plastic objects (1 per group)
- clear glass square, such as in a picture frame with no backing, or a water glass (1 per class)
- clouded plastic objects (1 per group)
- waxed paper squares (1 per group)
- cardboard squares (1 per group)
- poster board squares (1 per group)
- wood squares (1 per group)
- plastic mirrors (1 per group)
- aluminum foil squares (1 per group)

Advance Preparation

If you are using a clear glass square, cover the edges with tape and set the glass up in an area where you can monitor student behavior. Remind students to be careful around the glass as it can break if not handled carefully.

THE CORE LESSON 3.2

1. Focus student attention on Today's Question.

NGSS Elements



SEP 3
DCI PS4.B
CCC 2

What materials make the darkest shadows?

Show students a flashlight, and explain that they will use it today as a light source. Show them a material not on the materials list, such as a square of lightweight cloth.

- **Ask students**, How can you test this material to see if it makes a dark shadow?
 - » Sample answer: You can turn on the flashlight and shine the light beam right at the cloth. Then you can check the floor or wall to see if it made a shadow.
- Allow volunteers to demonstrate how they would do their test, and discuss the results.
- **Ask**, Could we use the same test on other materials?
 - » yes (See **Know the Science 1**.)

Tie to the Anchoring Phenomenon

Have students recall from Lesson 2 the discussion of ushers using a flashlight to read the seat numbers on a ticket. Discuss the material the ticket is made from (usually card stock), and ask if students predict the ticket would make a dark shadow. Accept all reasonable answers.

2. Conduct an investigation.

Activity Pages



AP 3.2.1
AP 3.2.2

Students ask and answer a question about materials that make dark shadows by devising a simple test.

- Give each student a copy of Shadow Makers (AP 3.2.1).
- Divide the class into small teams.

Know the Science

TEACHER DEVELOPMENT

1. What factors affect the darkness of a shadow? Opaque materials, those that do not let any light pass through them, cast the darkest shadows. Objects made of translucent or transparent materials may also cast shadows, but they will be lighter than those made by opaque materials. Transparent materials, such as sunglass lenses, can block some light and cast a faint shadow because the lenses don't let all the light through.



SUPPORT—Find ways to distinguish English language learners’ science content knowledge from their English reading and writing skills. Group these students with those that have strong ELA skills, and encourage them to discuss with their teams what to write on the Activity Page. Also, attach word cards to the sample materials that spell out their names. (See **Know the Standards.**)

- Have the class begin to plan their investigation by discussing the question they want to answer. Once there is agreement, have students write the question on their sheets.
- Give each team six sample materials (two opaque, two translucent, and two transparent) and a flashlight. The materials list includes many different types of opaque materials so groups can have different materials to test. Have each team discuss how they will test the materials and write their plan on their sheets.

SUPPORT—Some students may be confused by the term *material*. For example, point out that a pencil is mostly made of wood but has a paint covering and graphite inside it. Guide students to find objects that are made of only one material—a chair seat, a plastic notebook cover, a plastic cup, or a piece a chalk.

- Once you have approved each team’s plan, allow them to conduct their test, and record their observations in the table.
- Next, allow each team to choose two more materials from around the classroom to test and record their results in the table.

CHALLENGE—Challenge students to brainstorm more materials they can test. Make additional copies of Shadow Makers (AP 3.2.1) so that they can record their observations in a second chart.

3. Check for understanding.



The questions assess students’ understanding of all three dimensions.

- Return to Today’s Question, and **ask students**, What materials make the darkest shadows? Make sure students use evidence recorded on Shadow Makers (AP 3.2.1) as they answer the question.
 - » Among the answers should be cardboard, poster board, wood, a mirror, and aluminum foil.

Know the Standards

TEACHER DEVELOPMENT

Differentiation—SEP 3 Planning and Carrying Out Investigations: In every grade band, this Science and Engineering Practice has numerous substatements. In Kindergarten–Grade 2, there are six aspects to this practice. Make copies of Planning and Carrying Out Investigations (AP 3.2.2) for students, and as they do their investigation of material interaction with light, they can check off each phase of the investigation.

- **Ask,** If you hold these materials in front of your eyes, can you see through them?
» no
- **Ask,** What is a shadow?
» It is a place where light is blocked.
- **Ask,** Where did you see shadows?
» on surfaces such as the floor or a wall

EXTEND—Have students use the same materials to look for shadows on rough, curved, or angled surfaces, such as a sweater, a curved sheet of poster board, or on some stairs. Ask them to compare the shapes of the shadows to those on flat, smooth surfaces. (See **Know the Science 2.**)

- Call attention to the unit question board. Revisit the questions recorded there so far, and ask students if today's investigation may help to answer any of them. Allow students to suggest revisions or additions to the questions on the board.

Formative Assessment

Review student work on Shadow Makers (AP 3.2.1) to determine student understanding of the following concepts:

- People can work in teams to plan how to test materials.
- Some materials block light so they make dark shadows; others do not.
- People use evidence from testing materials to answer questions.

Know the Science

TEACHER DEVELOPMENT

2. How does surface texture affect reflections and shadows? An object with a very smooth surface, like a mirror, will reflect light well because most of the light bounces off the surface in one direction. But what about surfaces that have rougher textures? A surface like this does not reflect light as well because the light that strikes it bounces off the surface in more directions, spreading the light apart. Think about a new coin. It starts out very shiny, but over time it gets scuffed up and gets layers of grease and dirt on it. Both of these contribute to the coin losing its luster.

Have students add their Activity Pages to the science folders they made in Lesson 3.1.

If your students are successful in completing this lesson (Lesson 3.2), they will have demonstrated 3D learning. The emphasis on designing tests and collaborating to carry out an investigation will continue in Lessons 3.3 and 3.4. As they progress through this series of lessons, students will likely require less scaffolding of these concepts and skills.

Tie to the Anchoring Phenomenon

Through designing and carrying out tests on materials, students are developing greater understanding about the behavior of light. These concepts will help them construct explanations about theatrical lighting that can cause or can be used to make shadows on a stage.

LESSON 3.3

Comparing Materials That Let Light Pass Through

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: What happens when light shines on different materials?

Today's Question: What materials allow some or all light to pass through?

Tie to the Anchoring Phenomenon: Theater stages have curtains with different materials for different functions. During this lesson, students can begin to think about stage curtains and whether the audience can see through them or not. This widens the experience of light interacting with different materials.

AT A GLANCE

Learning Objective

- ✓ Investigate interactions of light with transparent and translucent materials.

Instructional Activities

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

NGSS References

Performance Expectation: 1-PS4-3

Disciplinary Core Idea: PS4.B Electromagnetic Radiation

Science and Engineering Practices: 3 Planning and Carrying Out Investigations; 4 Analyzing and Interpreting Data; 7 Constructing Explanations

Crosscutting Concept: 2 Cause and Effect

Students will investigate the effect of placing objects made with transparent and translucent materials in the path of a beam of light.

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

www.coreknowledge.org/cksci-online-resources

Core Vocabulary

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beam block dark light
materials shadow

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.

evidence observe opaque record
surface translucent transparent

Instructional Resources

Activity Page



AP 3.3.1

Activity Page

What Happens to a Light Beam When Materials Are Placed in Its Path? (AP 3.3.1)

Materials and Equipment

Collect or prepare the following items:

- question board
- flashlights (1 per group)
- cardboard squares (1 per group)
- wood squares (1 per group)
- aluminum foil squares (1 per group)
- plastic mirrors (1 per group)
- tissue paper squares (1 per group)
- waxed paper squares (1 per group)
- clouded plastic objects (1 per group)
- clear plastic objects (1 per group)
- clear glass square, such as in an interior school door (1 per class)
- clear plastic cup filled with water (1 per class)
- black and gray crayons (1 set per group)
- black sheets of paper (1 per group)

Advance Preparation

Most of these materials are the same as listed in Lesson 3.2. You may want to set up a station for the clear plastic cup filled with water near a sink or in a tray.

THE CORE LESSON 3.3

1. Focus student attention on Today's Question.

NGSS Elements



SEP 6

DCI PS4.B

CCC 2

Differentiation

What materials allow some or all light to pass through?

Remind students of how, in Lesson 3.2, they used a flashlight to test materials and find out which ones make the darkest shadows. **Ask the following:**

- What were some of the materials you tested that made dark shadows?
 - » cardboard, poster board, wood, a mirror, and aluminum foil
- What happened to the light from the flashlight that caused the dark shadows?
 - » The light was blocked by the materials we put in the path of the light beam.

SUPPORT—Explicitly reinforce new vocabulary by displaying a picture glossary to help English language learners and other students. Draw and label pictures to represent the terms *shadow*, *dark*, and *block*. Some of these words have multiple meanings, so the pictures you draw will focus on the meaning needed for this lesson. For the word *materials*, attach a few small samples of materials to the word card.

Tie to the Anchoring Phenomenon

Through investigations, students develop the concepts needed to infer that the function of a stage curtain is to block light, making it impossible for the audience to see behind the curtain before or after the show.

2. Designing the investigation.

NGSS Elements



SEP 3

DCI PS4.B

CCC 2

Explain to students that they will work with some of the same materials as in the last investigation. But now, they will think about what happens to a light beam when these materials are placed in its path. (See **Know the Science**.)

Darken the room, and turn on a flashlight to demonstrate a light beam. Point out how all the light seems to be moving in the same direction. Explain that this is what is meant by the term *light beam*. To make the light easier to see, sprinkle a little chalk dust or flour through the light beam.

Know the Science

TEACHER DEVELOPMENT

What is a light beam? A light source gives off light that travels in straight lines. These are often depicted in diagrams as thin-lined arrows pointing away from the source. When the light source is a bare light bulb, the diagrammed rays point in every direction. But when the source is a flashlight, with a reflector, the light rays move away from the flashlight in one general direction. All these light rays are collectively known as a *light beam*.

SUPPORT—Add the term *light beam* to the picture dictionary you created and displayed for students in Step 1.

Ask, How can we test what happens to the light beam when a material is placed in its path?

- » Sample answer: Turn on the flashlight. Hold the material in the path of the light beam. Then, see what happens on the other side of the material.

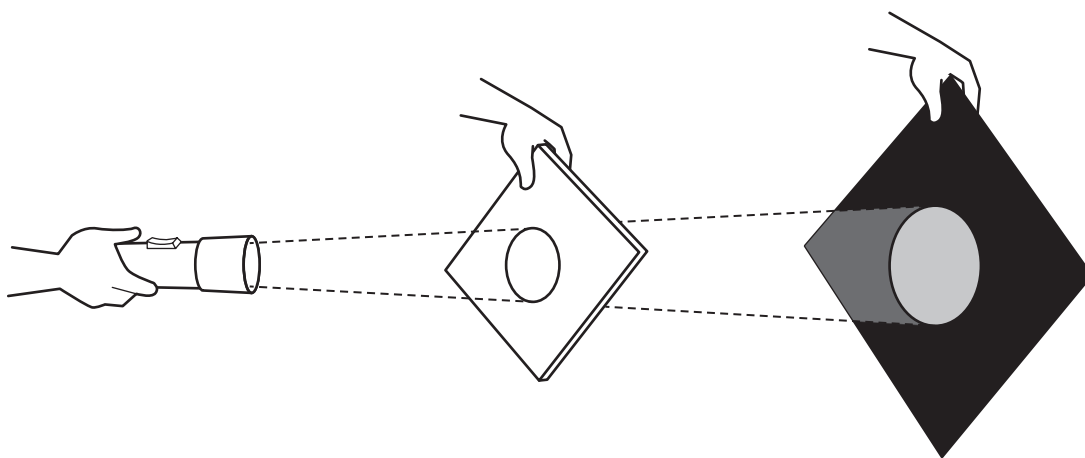
Invite two students to demonstrate their plan, **asking the following:**

- Where will you point the light beam?
- Where will you hold the sample material?
- Where will you look to see if light passed through?

Guide the class to standardize the plan by placing a black sheet of paper in the path of the beam and beyond the sample material. Allow students to try several orientations for their setup, but always keeping the flashlight at the same distance from the sample and the black paper.

Ask students, What will you be able to learn when you carry out this investigation?

- » which materials let the entire light beam pass through, which ones let part of the light beam pass through, and which ones do not let any part of the light beam pass through



3. Collecting data.

Activity Page



AP 3.3.1

Students answer a question about materials that make dark shadows by devising a simple test.

- Give each student a copy of What Happens to a Light Beam When Materials Are Placed in Its Path? (AP 3.3.1).
- Arrange students in teams of at least three so that one student holds the flashlight, one puts the sample material in the path of the light beam, and the third holds the black paper and makes observations. If there are more students on each team, assign roles such as materials gatherer and speaker.



- Provide each team with the ten sample materials to test. To safely test clear glass, take students to a clear glass window where they can stand on both sides (such as an interior door in the school).
- Have each student write the name of the material in the first column of the chart on their Activity Page.
- Then have each team predict how each material will affect a light beam from a flashlight. Make sure they understand the directions on the Activity Page to draw a “W” in the “I Predict” box if they think all light will pass through. If they think only some light will pass through, they should color the box gray. If they think no light should pass through, the box should be colored black.
- Next, have the teams carry out their test and record their results in the “My Test” column.
- Finally, allow the teams to choose two more sample materials that students can find in the classroom and repeat the procedure.

EXTEND—Have students consider which of the materials they tested would make the best shadow puppets (those that block light). Allow students to cut out animal shapes from either cardboard or aluminum foil and tape them to a pencil. Then invite students to show how their shadow puppets work.

4. Discussing the evidence.



Have students look at their Activity Page chart. **Ask the following:**

- Which of your tests agreed with your predictions? Which did not?
» Some may agree and others not. (See **Know the Standards.**)

SUPPORT—Explain to students that they should not feel upset if their predictions were found to be untrue. Explain that scientists make predictions all the time that end up being untrue. Learning that something is not true is an important part of science.

- Which materials blocked all the light beam?
» the cardboard, wood, aluminum foil, and mirror
- Which materials blocked most of the light beam?
» the tissue paper, waxed paper, and clouded plastic

Know the Standards

TEACHER DEVELOPMENT

Differentiation—SEP 4 Analyzing and Interpreting Data: For some kinds of data, such as numerical data, patterns and trends can be identified by making graphs. In this lesson, the data (how much light a material allows to pass through) are not numerical. Recording data as white, gray, or black has a visual impact and may help some students quickly answer questions about the properties of these materials.

- Which materials let all the light pass through?
 - » the clear plastic, clear glass, and clear cup of water

Have students also report their results testing the materials they chose from around the classroom.

CHALLENGE—Share with students the words scientists use when discussing the light-transmitting properties of materials. *Opaque* means that light is fully blocked. *Translucent* means that some light is blocked, and *transparent* means that all light passes through the material.

5. Check for understanding.

Activity Page



AP 3.3.1

Return to Today's Question, and **ask students**, What materials allow some or all light to pass through? Make sure students use evidence recorded on Activity Page 3.3.1 as they answer the question.

- » some light: the tissue paper, waxed paper, and clouded plastic; all light: the clear plastic, clear glass, and clear cup of water

NGSS Elements



1-PS4-3

SEP 3, 4, and 6

DCI PS4.B

CCC 2

Ask students the following questions:

- Which group of materials can you see clearly through?
 - » the ones that let all the light pass through
- Which group can you only see a little bit through?
 - » the ones that let some light pass through
- Which group can you not see through at all?
 - » the ones that do not let any light pass through

Call attention to the unit question board. Revisit the questions recorded there so far, and ask students if today's investigation may help to answer any of them. Allow students to suggest revisions or additions to the questions on the board.

Formative Assessment

Review student work on What Happens to a Light Beam When Materials Are Placed in Its Path? (AP 3.3.1) to determine student understanding of the following concepts:

- People can work in teams to plan how to test materials.
- Materials can either block the path of a light beam, let some light pass through, or let all the light pass through.
- People can record the results of tests and use them as evidence to answer questions.

At this point in the lesson, students should have a good understanding of the first two concepts highlighted in DCI PS4.B Electromagnetic Radiation: how shadows form and the properties of opaque, translucent, and transparent materials. In Lesson 3.4, students will explore mirrors and light. In Lesson 3.5, students will revisit all three concepts when they display their science folders.

Have students add their Activity Pages to the science folders they made in Lesson 3.1.

Tie to the Anchoring Phenomenon

Through designing and carrying out tests on materials and discussion of their results, students gain understanding they can apply to describing the function of a stage curtain or explaining how shadow puppets work.

LESSON 3.4

Changing the Direction of Light

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: What happens when light shines on different materials?

Today's Question: What materials change the direction of a light beam?

Tie to the Anchoring Phenomenon: Students encounter through investigation and discussion many applications of reflective materials, several of which are used in theatrical settings.

AT A GLANCE

Learning Objective

- ✓ Investigate interactions of light with reflective materials.

Instructional Activities

- student investigation
- question generation
- class discussion

NGSS References

Performance Expectation: 1-PS4-3

Disciplinary Core Idea: PS4.B Electromagnetic Radiation

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

Crosscutting Concepts: 2 Cause and Effect; 6 Structure and Function

Students will investigate the effects on light when objects made with reflective materials are placed in the path of that beam of light.

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

www.coreknowledge.org/cksci-online-resources

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.

change mirror direction shiny light beam surface materials

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.

evidence observe reflect

Instructional Resources

Activity Pages



AP 3.4.1
AP 3.4.2

Activity Pages

How We Will Find Materials That Change the Direction of Light (AP 3.4.1)

What Materials Can Change the Direction of Light? (AP 3.4.2)

Materials and Equipment

Collect or prepare the following items:

- question board
- flashlights (1 per group)
- cardboard squares (1 per group)
- wood squares (1 per group)
- aluminum foil squares (1 per group)
- plastic mirrors (1 per group)
- tissue paper squares (1 per group)
- waxed paper squares (1 per group)
- clouded plastic objects (1 per group)
- clear plastic objects (1 per group)
- large sheets of white paper (1 per group)
- modeling clay (optional)

Most of these materials are the same as listed in Lesson 3.2 and 3.3.

THE CORE LESSON 3.4

1. Focus student attention on Today's Question.

NGSS Elements



SEP 4

DCI PS4.B

Monitor Progress

What materials change the direction of a light beam?

Remind students that they have already investigated which materials block a light beam and which let all or some light pass through. Place the sample materials where everyone can see them.

- Ask volunteers to show a material that blocks light.
- Then ask for a volunteer to show a material that lets all light pass through.
- Then ask another student to show a material that lets only some light pass through.

SUPPORT—Some students may not recall the results of the investigations they completed. If so, allow them to open their science folders for this unit and use the Activity Pages to name materials of each type.

Tell students they will use the same materials today as they did in Lessons 3.2 and 3.3. **Ask**, Which of those materials, if any, might change the direction of the light beam from a flashlight? (See **Know the Science**.)

Tie to the Anchoring Phenomenon

As the reflector in a flashlight directs the light of the bulb in one general direction, so do reflectors in spotlights and floodlights over a stage. Talk with students about how a reflector directs light onto the musicians on the stage instead of lighting up the audience.

Know the Science

TEACHER DEVELOPMENT

What causes light beams to change direction? Students have observed that light beams travel in straight lines. One way to change the direction of a light beam is by placing a material that can reflect light in the path of the beam. The angle at which the beam reflects is equal to the angle at which it strikes the material relative to an imaginary line (formally called the normal) perpendicular to the surface. Materials that are good reflectors, such as many metals, have very smooth shiny surfaces. A mirror often has a coating of silver, a metal. Still water is also a good reflector. Though not addressed in Grade 1, light beams can also change direction when they pass through a refracting object. Refraction occurs when light moves from one transparent material into another (for example, from air into a glass lens and back into the air).

2. Design the investigation.

Activity Page



AP 3.4.1

NGSS Elements



SEP 3

DCI PS4.B

CCC 2

3D Learning

Differentiation

Students plan the tests they will carry out to identify materials that reflect light.

- Give each student a copy of How We Will Find Materials That Change the Direction of Light (AP 3.4.1). Lead a whole-class discussion of how to answer the questions.
- Have students place the flashlight on a white piece of paper so the light is pointed away from the paper. You may want to have modeling clay available so students can properly orient their flashlights.
- Darken the room, and invite volunteers to demonstrate where they would hold the sample materials to test them.
- **Ask students**, How will you know if the light beam changed direction?
 - » If I hold the materials in the path of the light and the light changes direction, it may light up the table or the white piece of paper.
- Guide students to diagram and label their plan on the Activity Page.

CHALLENGE—Some students may enjoy devising alternative setups for this test. Encourage them to try the flashlight, white paper, and materials in different orientations. If their plans work, allow them to diagram them on the Activity Page and complete the investigation using these plans.

3. Test the materials and collect data.

Activity Page



AP 3.4.2

NGSS Elements



SEP 3

DCI PS4.B

CCC 2

Differentiation

3D Learning

Students perform the tests to identify materials that reflect light.

- Give each student a copy of What Materials Can Change the Direction of Light? (AP 3.4.2).
- Arrange students in teams of three, so that one student holds the flashlight, one puts the sample material in the path of the light beam, and the third makes observations. If there are more students on each team, assign roles such as materials gatherer and speaker.
- Provide each team with eight sample materials to test, including a smooth piece of aluminum foil and an unbreakable mirror.
- Have each student write the name of a material in the first column of the Activity Page chart.
- Then have the teams test the material to determine if it can change the direction of light.

SUPPORT—Circulate among the teams to identify students struggling with the procedure. Show them how to hold the sample material parallel to the tabletop. In this orientation, the light will be redirected straight back and down on the white paper.

- Make sure that all students have completed the table on the Activity Page.

EXTEND—Have interested students also test a crumpled piece of aluminum foil and compare the results to the smooth foil. The light beam will be broken up and the light scattered in many directions. So, while the foil still changes the direction of light, there are now many small beams of light. (See **Know the Standards.**)

- Write the word *reflect* where everyone can see it. Invite students to use the word in a sentence about their investigation. Make sure they understand that one meaning of *reflect* is to make light change direction.

4. Check for understanding.

Activity Pages



AP 3.4.1
AP 3.4.2

NGSS Elements



SEP 3, 4, and 6
DCI PS4.B
CCC 2

Monitor Progress

Just as smoothness is a property of materials, so is shape. By crumpling the foil, the shape of the sample material was changed. A change in shape is a change in structure, which may result in a change in how the sample functions. The Crosscutting Concept of Structure and Function is featured in Grade 1, Unit 2, when students investigate animal and plant parts and their functions.

Ask students the following:

- How did using the first Activity Page help you do science?
 - » It gave us a place to show our plan for testing materials.
- Which materials caused a light beam to change direction?
 - » the plastic mirror and a piece of aluminum foil
- What is your evidence for this? (How do you know?)
 - » We did a test with a flashlight. The light beam changed direction when we put the mirror and foil in its path.
- How did using the second Activity Page help you?
 - » We wrote down what happened during the tests so we could look at it later and answer questions.

Know the Standards

TEACHER DEVELOPMENT

Differentiation—SEP 3 Planning and Carrying Out Investigations: This extension of the investigation will be interesting to all students, but explaining how the crumpled foil reflects light requires close observation of the foil and effort to think more deeply about Disciplinary Core Idea PS4.B. Prompt students look closely at the crumpled foil to observe that there are many small surfaces, all facing different directions. Each smaller surface reflects parts of the light beam in different directions. The result is diffused light. Diffused light may travel all over the room, not just toward the white piece of paper.

- What is it about these materials that makes them able to change the direction of light?
 - » They are smooth and shiny.

Point out that they have just identified a cause (smooth surface) and an effect (the light beam changing direction).

Call attention to the unit question board. Revisit the questions recorded there so far, and ask students if today's investigation may help to answer any of them. Allow students to suggest revisions or additions to the questions on the board.

Have students add their Activity Pages to the science folders they made in Lesson 3.1.

Formative Assessment

Review student work on How We Will Find Materials That Change the Direction of Light (AP 3.4.1) and What Materials Can Change the Direction of Light? (AP 3.4.2) to determine student understanding of the following concepts:

- People can work in teams to plan how to test materials.
- Smooth, shiny materials, such as those that make mirrors and aluminum foil, can change the direction of a light beam.
- Evidence from recorded results (data) can be used to identify cause-and-effect relationships.

Tie to the Anchoring Phenomenon

In the original staged version of *Peter Pan*, the tiny flying fairy, Tinkerbell, is portrayed by a darting light made by someone standing offstage with a handheld mirror. Try reenacting this effect with your students by using a strong flashlight and a small mirror.

LESSON 3.5

Lesson 3 Roundup: Using Light in a Stage Performance

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: What happens when light shines on different materials?

Today's Question: What happens when light shines on different materials?

Tie to the Anchoring Phenomenon: Students will develop through reading, discussion, and writing an understanding of how light may interact with materials on stage in a theatrical production or concert.

AT A GLANCE

Learning Objective

- ✓ Use evidence from observations to describe ways that light can interact with materials.

Instructional Activities (2 days)

- question generation
- teacher Read Aloud
- class discussion

NGSS References

Performance Expectation: 1-PS4-3

Disciplinary Core Idea: PS4.B Electromagnetic Radiation

Science and Engineering Practices: 3 Planning and Carrying Out Investigations; 6 Constructing Explanations and Designing Solutions

Crosscutting Concept: 2 Cause and Effect

Students will use evidence to explain the effects on light when objects made with different materials are placed in the path of that beam of light.

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

www.coreknowledge.org/cksci-online-resources

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.

dark

light beam

materials

mirror

reflect

shadow

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.

opaque

translucent

transparent

Instructional Resources

Student Book



Ch. 4

Activity Pages



AP 3.5.1
AP 3.5.2

Student Book, Chapter 4
“Light and Materials”

Activity Pages

Our Investigation of Light and Materials (AP 3.5.1)

Mapping Our Ideas (AP 3.5.2)

Materials and Equipment

Collect or prepare the following items:

- question board
- science folders (1 per student)
- stapler (1 per class)
- soft object such as a ball (1 per class)
- internet access and the means to project images/video for whole-class viewing

THE CORE LESSON 3.5

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

NGSS Elements



DCI PS4.B

CCC 2

Monitor Progress

What happens when light shines on different materials?

- Show a brief video about a game of flashlight tag. See the Online Resources Guide for a link to the recommended video:
www.coreknowledge.org/cksci-online-resources
- **Ask students**, What is it about the light from the flashlight that makes it possible to tag people?
 - » Light travels in a straight line and shines on the person it's pointed at. (See **Know the Standards 1**.)
- Make sure students understand that a light beam travels in a straight line and that this is what makes the game possible.

Tie to the Anchoring Phenomenon

Through reading, discussion, and ball toss speaking, students build an understanding of how light may interact with materials on stage. This is when they will solve the problem of communicating with a school play audience using sound or light.

2. Read together: "Light and Materials."

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.

Know the Standards

TEACHER DEVELOPMENT

1. Monitor Progress—CCC 2 Cause and Effect: All three Performance Expectations addressed so far in this unit have the same Crosscutting Concept. This gives students the opportunity to revisit it in the context of exploring sound, light and seeing, and the interaction of materials with light. Look for students' increasing ability to describe cause-and-effect relationships based on the tests they conducted.

Page 16

NGSS Elements

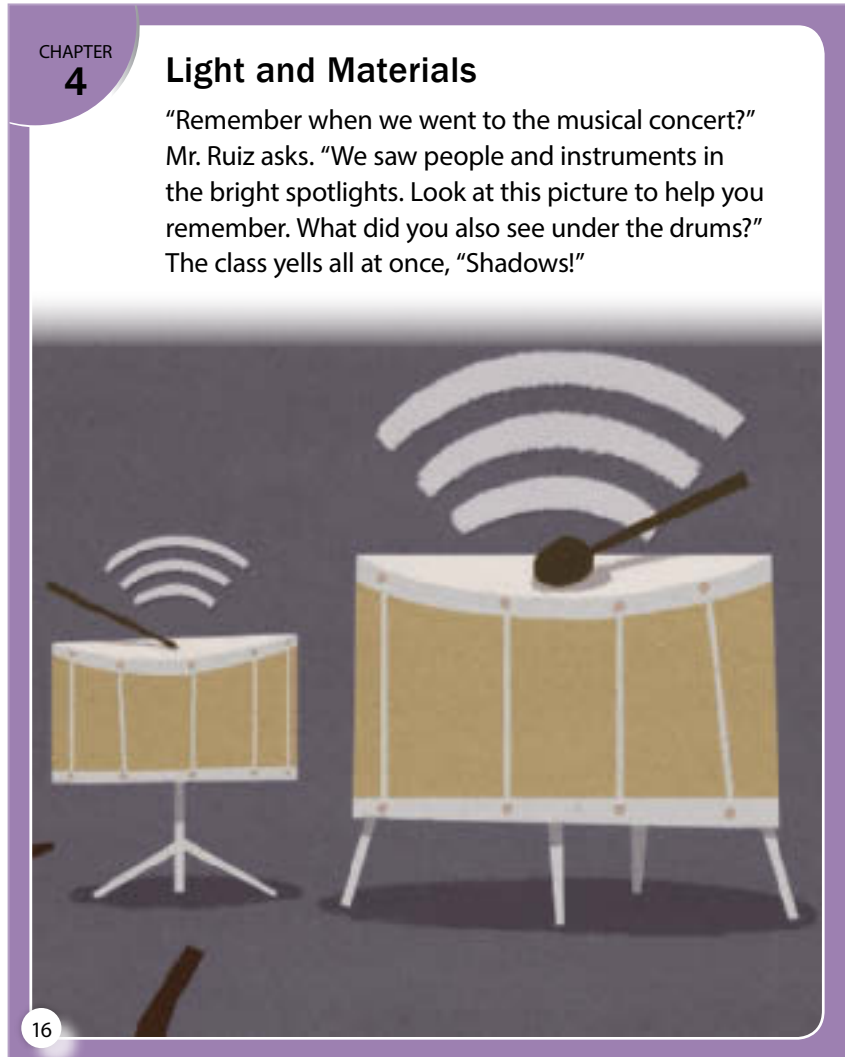


SEP 3

DCI PS4.B

Ask students to turn to page 16 of the Student Book and look at the picture as you read aloud. Remind them that the title of this chapter is “Light and Materials,” and tell them to pay special attention to noticing the different effects materials have on a beam of light as you read.

Have students look at the picture on page 16. Explain to students that the story of Mr. Ruiz and his class going to a concert has continued from Chapter 1.



LITERAL—What shape are the shadows under the drums?

» round

INFERENTIAL—Based on your investigations, where do you think the light is located? Explain how you know.

» The light is above the drums. Because light beams move in a straight line, the shadows are under the drums.

Have a student demonstrate the explanation with a flashlight and object.



How does the shadow in this picture happen? Light shines down on a person. Her body blocks the light. A darker shape appears behind her. That darker shape is called a shadow. Shadows are darker because there is less light there.



A shadow is not an object—like a ball, a bike, or a person. You need three things to make a shadow:

1. light shining
2. an object blocking the light
3. a surface on the other side of the object

Find the three things that make a shadow in this picture.

17

CORE VOCABULARY—Make sure students understand that a **shadow** is a dark area on a surface caused when light from a source is blocked and that shadows are not matter.

CORE VOCABULARY—Explain that **dark** means there is little light present compared to the rest of the surface.

LITERAL—What three things are needed to make a shadow?

- » a light source
- » an object that blocks light
- » a surface

Have students point to the three things needed to make a shadow in the picture.

CHALLENGE—Remind students that you have been talking about theaters and how the audience sees the show. **Ask**, Where would the audience sit in the theater shown in the picture? How do you know? (See **Know the Standards 2.**)

- » The audience would sit beyond the edge of the wood stage. I know because the shadow is behind the person, so the light is shining on the front of the person. People watching the show need the light to see the person in the dark theater.

Page 18

NGSS Elements



SEP 6

DCI PS4.B

Differentiation

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

Many kinds of materials block light. All these materials can be used to make shadows. They all can block light.



This ball is made from rubber bands. The ball blocks light.

This bat is made of wood, and wood blocks light. The ball is made of many materials. The ball blocks light, too.



The stones are objects, and they block light.

18

Know the Standards

TEACHER DEVELOPMENT

2. Differentiation—PS4.B Electromagnetic Radiation: Interested students can be challenged to think about the direction in which a shadow is oriented. Remind them that they know light beams move in straight lines. Through exploration with a flashlight and objects, students also can observe that the shadow appears to extend the imaginary line formed by the light beam. Try replicating the science in this picture, using a toy human figure to cast the shadow.

CORE VOCABULARY—Explain that **materials** are a kind of matter—what things are made of—such as air, water, wood, and glass. (See **Know the Science**.)

SUPPORT—Students may confuse *materials* and *objects*. Hold up an object from around the classroom, such as a rubber ball. Explain that the object is a ball but that the material is what it is made of—rubber. Do this as many times as needed for students to understand that materials are the “stuff” that objects are made of.

LITERAL—What are the examples of materials that block light?

- » rubber
- » wood
- » leather
- » rock

EXTEND—List on the board other examples of materials that block light from students’ investigations.

Know the Science

TEACHER DEVELOPMENT

What’s the difference between matter, materials, and materials science? Matter is anything that has mass and takes up space. Having mass usually means that something is made of atoms. The word *materials* means a substance or a mixture of substances. Substances can be composed of only one kind of atom or different kinds of atoms arranged in compounds or molecules. The field of study called *materials science* explores the properties of materials and how they can be used to solve human problems. How light interacts with various materials is one property explored by materials scientists.

NGSS Elements



SEP 6

DCI PS4.B

Differentiation

These students want to learn more about light and shadows. They are planning an investigation.

They have the three things needed to make a shadow:

1. a light
2. an object
3. a surface

What did the students do to make the shadow?



LITERAL—Where is the student holding the key?

- » in the path of the light

INFERENTIAL—Why did the key make a dark shadow?

- » because the key is made of metal and metal blocks light

CHALLENGE—What other objects are made of metal and should make dark shadows?

- » forks, knives, and spoons
- » coins
- » nails and screws
- » coins
- » paper clips
- » pots and pans

EXTEND—Point out that certain materials that block light and make dark shadows are called *opaque*.

Page 20

Ask students to look at the picture on page 20 as you read aloud.

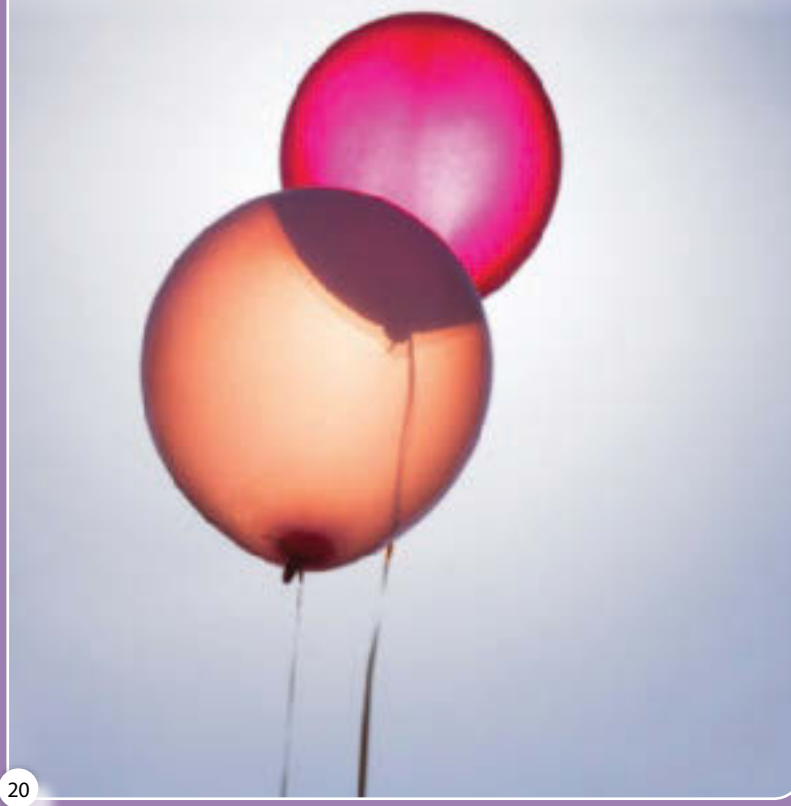
NGSS Elements



SEP 3
DCI PS4.B
CCC 2

Other materials block only some light. They let some light pass through to the surface behind them. There may be a shadow, but it will not be as dark.

Balloons can be made from different materials. These balloons let some light through.



LITERAL—Do the balloons completely block the light from the sun?

» No, some light passes through.

CHALLENGE—What materials tested in your investigations let some light pass through?

- » tissue paper
- » waxed paper
- » clouded plastic

EXTEND—Point out that certain materials that let only some light pass through are called *translucent*.

NGSS Elements

SEP 3
DCI PS4.B

Some materials do not block much light. They let light pass through to the surfaces behind them. You can see well through materials that let all light pass through.

Water and clear glass let light pass through.



Air lets the light pass through. You can see a long way into the sky.



21

LITERAL—How do you know that light can pass through the water and clear glass?

- » because you can see through both and because we tested those materials with a flashlight

INFERENTIAL—Think about the photographer who took the photo of the people with the kites. What could they see through the air?

- » the water, houses, trees, and blue sky

EXTEND—Point out that certain materials that let light pass through are called *transparent*.



Light beams move in straight lines. The sun is shining down in this canyon. The light shines in a straight path.



CORE VOCABULARY—Have students trace the path of the **light beam** with their fingers. Explain that light from all sources moves in straight lines but that you cannot always see a beam like this one.

INFERENTIAL—Where do you think the light source is in this photo?

» It is at the top of the photo where sunlight enters the canyon.

EXTEND—When did you work with light beams in your investigations?

» when we used a flashlight to see if any materials can change a light beam's direction of motion

NGSS Elements

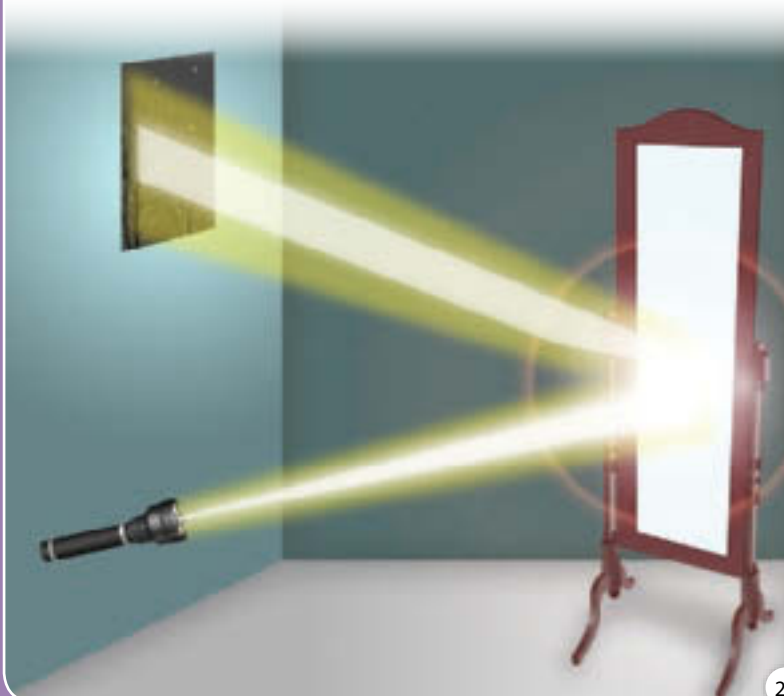


SEP 3
DCI PS4.B
CCC 2

Some objects can change the direction of a light beam, or reflect it. Materials that reflect light beams are often smooth and shiny.

Mirrors are good at reflecting light beams. Some mirrors are made of glass with a thin metal coating. Other mirrors are made of shiny metal.

When a mirror reflects a light beam, the light changes direction. It hits a surface in a different place.



CORE VOCABULARY—Explain that to **reflect** means to redirect a light beam.

CORE VOCABULARY—Explain that a **mirror** is an object that is very good at reflecting a light beam.

LITERAL—What can mirrors do to a light beam?

- » They can change its direction or reflect it.

What materials can mirrors be made from?

- » glass with a thin metal coating

INFERENTIAL—Have students recall their investigations. How do you know that the light has reflected?

- » We can see it light up a surface that is behind the light source.

1. Day 2: Write reports and assemble science folders.

Activity Pages



AP 3.5.1
AP 3.5.2

NGSS Elements



SEP 6
CCC 2
DCI PS4.B
3D Learning

Students use evidence from their tests to support their explanations about causes.

- Give each student copies of Our Investigation of Light and Materials (AP 3.5.1) and Mapping Our Ideas (AP 3.5.2).
- Give students the science folders they have been assembling throughout Lesson 3.
- Have students work in their teams to discuss and write answers to the questions on Activity Page 3.5.1, including examples from the Student Book. For question 6, encourage each student to reflect and respond individually about what surprised them.
- For Activity Page 3.5.2, have students write labels on the graphic organizer: light source (light bulb), light beam (three arrows), and in the rectangle write about the three ways materials interact with light (opaque, transparent, translucent).
- Have students add their Activity Pages to the science folders they made in Lesson 3.1 and look over and organize the pages.
- Help students affix all the Activity Pages to the folders with a stapler or other tools.

2. Ball toss speaking to share reflections.

NGSS Elements



SEP 6
CCC 2
DCI PS4.B

Hold a soft ball or other soft object, and tell the class one thing that surprised you about this lesson on light and materials. Toss the ball to a volunteer, and have them share another thing that surprised them. Have them toss it to another volunteer until all willing students have spoken.

3. Check for understanding.

Activity Pages



AP 3.5.1
AP 3.5.2

NGSS Elements



SEP 3 and 6
CCC 2
DCI PS4.B

Call attention to Today's Question, and **ask**, What happens when light shines on different materials? Have the students use examples from the Student Book to discuss each question:

- If you were in the canyon on page 22, how could you change the direction of that light beam?
 - » by holding a mirror in the path of the light
- If you tested them, which would make a darker shadow, a wood baseball bat or a glass aquarium filled with water?
 - » baseball bat

Call attention to the question board. Revisit the questions recorded there so far, and ask students how reading the chapter might answer or relate to any of those questions.

Summative Assessment

Review student responses to Our Investigation of Light and Materials (AP 3.5.1) and Mapping Our Ideas (AP 3.5.2) to determine student understanding of the following concepts:

- Some materials allow light to pass through them.
- Some materials allow only some light to pass through them and can cast very light shadows.
- Some materials block light and cast dark shadows.
- A light beam can be redirected by placing a smooth, shiny material in its path.
- Working in teams to carry out science investigations can be helpful.
- Doing tests with materials can change your ideas about light.

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

Tie to the Anchoring Phenomenon

In the reading and video, students encountered a variety of ways that materials interact with light beams. Now is a good time to discuss the application of these concepts to a stage performance. For example, ask students to describe what materials musical instruments in an orchestra are made from and what happens when light strikes them. For example, brass instruments are metal and reflect light well.

LESSON 4

Solving Problems with Light or Sound

OVERVIEW

Guiding Question: How can we communicate with an audience using light and sound?

Lesson 4 Segments	Segment Questions	Advance Preparation
4.1 Communicating over Long Distances Students engage with the lesson phenomenon, watch a video, and do research to identify ways people communicate over long distances.	How do people communicate over long distances?	Ask a school or community librarian to help you find reference books, nonfiction books, and online resources about long-distance communication inventions and inventors. Preview the websites and the video.
4.2 Putting on a Play Students read along, identify a school play for their class, and preview the problem they need to solve.	How do students putting on a play communicate?	Preview Chapter 5 in the Student Book. Locate a video or book for the story <i>The Little Red Hen</i> . See Materials and Equipment.
4.3 Describing the Problem Students describe the problem, identify science information they can apply, think about the materials, and tour the location in school where the play could take place.	How can you describe a problem about communicating during a play?	Visit the space in school where plays are presented. Gather materials for student investigation. See Materials and Equipment.
4.4 Lesson 4 Roundup: Building and Testing a Device (2 days) Students build, improve, and diagram their designs. They compare their solutions, identify strengths and weaknesses, and choose the solution best suited to solve the problem.	How do students use light and sound to communicate during a play?	Gather materials for student investigation. See Materials and Equipment.

What's the Story?

Summary: In Lesson 4 (Segments 1–4), students apply their learning from the previous three lessons to solve an engineering problem related to the unit's Anchoring Phenomenon: How can they signal when they want people in the audience to participate in the concert? To solve the problem, students explore methods of communicating over long distances using sound and light. They then will plan and build a model of their solution. Finally, they will evaluate how well each team's solution solves the problem that can be applied during a school play (1-PS4-4).

Learning Progression: Lesson 4 guides students to successfully meet Performance Expectation 1-PS4-4. As designed by NGSS, this performance expectation provides an opportunity to integrate engineering. It builds on student understandings of engineering design from Kindergarten, developed in the units called *Pushes and Pulls* (ETS1.A), *Weather Patterns* (ETS1.A), and *Changing Environments* (ETS1.B).

Guiding Phenomenon: People can communicate over distances using long and short pulses of sound or light, such as Morse code.

Learning Objectives

By the end of Lesson 4, students will do the following:

- Identify examples of communication over long distances.
- Discuss and describe how to solve problems related to sound and light.
- Define and gather information about the problem (how to signal audience participation during a school play).
- Build and test a device, with guidance, that uses sound or light to communicate over a distance.
- Describe features of the design that qualify it as a solution to the problem (the need to communicate over a distance).
- Collect and analyze data to compare solutions to determine which one is best suited to solve the problem (allows people to communicate over a distance using light or sound).

NGSS Standards and Dimensions

Performance Expectation: 1-PS4-4 Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.

Supports Engineering Design:

- 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 6 Constructing Explanations and Designing Solutions Use tools and materials provided to design a device that solves a specific problem.	Disciplinary Core Ideas PS4.A Wave Properties Sound can make matter vibrate, and vibrating matter can make sound.	Crosscutting Concepts 6 Structure and Function The shape and stability of structures of natural and designed objects are related to their function(s).
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<p>1 Asking Questions and Defining Problems</p> <p>Ask questions based on observations to find more information about the natural and/or designed world.</p> <p>Define a simple problem that can be solved through the development of a new or improved object or tool.</p> <p>2 Developing and Using Models</p> <p>Develop a simple model based on evidence to represent a proposed object or tool.</p> <p>8 Obtaining, Evaluating, and Communicating Information</p> <p>Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).</p> <p>4 Analyzing and Interpreting Data</p> <p>Analyze data from tests of an object or tool to determine if it works as intended.</p>	<p>PS4.B Electromagnetic Radiation</p> <p>Objects can be seen if light is available to illuminate them or if they give off their own light.</p> <p>Some materials allow light to pass through them, others allow only some light through, and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam.</p> <p>PS4.C Information Technologies and Instrumentation</p> <p>People also use a variety of devices to communicate (send and receive information) over long distances.</p> <p>ETS1.A Defining and Delimiting Engineering Problems</p> <p>A situation that people want to change or create can be approached as a problem to be solved through engineering.</p> <p>Asking questions, making observations, and gathering information are helpful in thinking about problems.</p> <p>Before beginning to design a solution, it is important to clearly understand the problem.</p> <p>ETS1.B Developing Possible Solutions</p> <p>Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.</p> <p>ETS1.C Optimizing the Design Solution</p> <p>Because there is always more than one possible solution to a problem, it is useful to compare and test designs.</p>	<p>Connection to Engineering, Technology, and Applications of Science: Influence of Engineering, Technology, and Science on Society and the Natural World</p> <p>People depend on various technologies in their lives; human life would be very different without technology.</p>
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For detailed information about the NGSS References, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

LESSON 4.1

Communicating over Long Distances

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: How can we communicate with an audience using light and sound?

Today's Question: How do people communicate over long distances?

Tie to the Anchoring Phenomenon: Students encounter, through discussion, video, and internet research, technologies that help explain how sound and light can reach all audience members at a performance, even those in the last row of an auditorium.

AT A GLANCE

Learning Objective

- ✓ Identify examples of communication over long distances.

Instructional Activities

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

NGSS References

Disciplinary Core Idea: PS4.C Information Technologies and Instrumentation

Science and Engineering Practice: 8 Obtaining, Evaluating, and Communicating Information

Connection to Engineering, Technology, and Applications of Science: Influence of Engineering, Technology, and Science on Society and the Natural World

Students explore examples of communication over long distances.

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

www.coreknowledge.org/cksci-online-resources

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.

code communicate message 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.

device engineer signal

Instructional Resources

Activity Pages



AP 4.1.1
AP 4.1.2

Activity Pages

Use Morse Code (AP 4.1.1)

Tools for Communicating over
Long Distances (AP 4.1.2)

Materials and Equipment

Collect or prepare the following items:

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

THE CORE LESSON 4.1

1. Introduce students to Lesson 4.

NGSS Elements



DCI PS4.A and
PS4.B

Monitor Progress

Ask a volunteer to state the Big Question that you'll be answering in this unit, which is posted somewhere in the room—**What happens in a stage performance so that people can see and hear the show?**

Remind students that they learned about sound and vibrations in Lesson 1 and light in Lessons 2 and 3. **Ask students the following:**

- How do people in the last row at a concert or play hear the music or players?
 - » The instruments or people make sounds, and the sounds make vibrations that people's ears can feel.
- What needs to happen for people in the last row at a concert to see the players?
 - » Light from a light source must shine on them.
- Why can't people in the audience see the players before the stage curtain goes up?
 - » because the material the curtain is made from does not let light pass through

SUPPORT—For students who struggle to recall the important core ideas from Lessons 1–3, make and display an anchor chart that includes the following concepts: Sound makes matter vibrate; vibrations make sound; objects can only

be seen if light shines on them or they make their own light; and materials either let all light pass through, let some light pass through, or block light and cast shadows. (See **Know the Standards 1.**)

Tell students that in this lesson they will plan a way to send signals to the audience during their school play. Before they do this, they first need to understand different tools people use to communicate and decide which form of communication will work best. In Lesson 4, students will learn how engineers solve problems in order to apply their understanding to their school play.

Write the Lesson 4 Guiding Question where students can see it:

How can we communicate with an audience using light and sound?

Tie to the Anchoring Phenomenon

Through discussion, students explain how sound, vibrations, light, and materials work in an auditorium and on a stage to enable the audience to see and hear the show.

2. Watch a video about the telegraph and Morse code.

Online Resources



Show students a video about the invention of the telegraph and Morse code. See the Online Resources Guide for a link to the recommended video:

www.coreknowledge.org/cksci-online-resources

The details about how the device worked are not important for Grade 1 students, so focus on understanding that this was a tool used to spell out messages with a code. Explain that this communication tool was invented about 150 years ago. **Ask the following:**

Activity Page



AP 4.1.1

- What was the problem Samuel Morse wanted to solve?
 - » how to send people urgent messages faster
- What did the device Samuel Morse built, called the telegraph, do?
 - » It could send messages over wires far away and produce written codes on a strip of paper.
- How did Alfred Vail help improve the design?
 - » He designed a new code system of dots and dashes to spell out letters.

Know the Standards

TEACHER DEVELOPMENT

1. Monitor Progress: This lesson addresses Performance Expectation 1-PS4-4. However, students will not be successful in demonstrating understanding unless they have already been successful with the Performance Expectations developed in the previous three lessons (1-PS4-1, 1-PS4-2, and 1-PS4-3). These standards require understanding of basic core ideas about sound, light, and how materials interact with light, which students will apply as they solve the problem posed in Lesson 4—How can we communicate with an audience using light and sound?



SEP 8

DCI PS4.C

Influence of
Engineering,
Technology,
and Science on
Society and the
Natural World
Differentiation

- How do some disabled people sometimes use Morse code today?
 - » They use their eyes to blink the code and send a message.
- Think about what happened when Samuel Morse was away from home and got a letter in the mail. How did the new telegraph make people's lives better than before?
 - » It allowed people to send urgent messages very fast. For example, if someone were very sick, people could get the message right away and go to be with the sick person.

CHALLENGE—Challenge interested students to draw what the telegraph would print in Morse code for their name or a simple word, such as *cat*. Give these students a copy of Use Morse Code (AP 4.1.1), which shows the dots and dashes next to each letter of the alphabet.

3. Research other ways to communicate over long distances.

Activity Page



AP 4.1.2

NGSS Elements



SEP 8

DCI PS4.C

Influence of
Engineering,
Technology,
and Science on
Society and the
Natural World
Differentiation
Monitor Progress

Give each student a copy of Tools for Communicating over Long Distances (AP 4.1.2). Allow them to use the first box on the chart to write or draw about the telegraph and Morse code and then use the remaining boxes to take notes during the class research.

Ask a school or community librarian to find children's reference books or nonfiction books about long-distance communication inventions and inventors.

Allow students to look through the books to find examples of tools for communicating and share them with the class.

Or take students online to research this question: What inventions help us communicate over long distances? (See **Know the Science.**)

Know the Science

TEACHER DEVELOPMENT

What are some devices used to communicate over long distances? The word *telecommunications* means communicating over long distances. In ancient times, people used smoke signals, drums, or flags to send messages over relatively short distances. Homing pigeons carrying written messages increased the distance, as did lighthouses and signal lamps on ships. Starting in the 1700s, many inventors worked on versions of devices that used electricity to communicate over wires. Morse and Vail's code made their device practical and was implemented widely. Later, radio and television were invented to communicate using radio waves. More recently, the invention of cable phones and television, wireless phones, the internet, smartphones, and satellites have made long-distance communication present everywhere.

SUPPORT—Students who are just beginning to read will need support to do online research. In advance, locate and bookmark internet resources appropriate for them. After using the bookmarked sites, try submitting the research question to a search engine. (See **Know the Standards 2.**)

As you and the class identify tools for long-distance communication, have students draw or write about them in the remaining boxes on their Activity Page. For each invention, **ask students**, How did this make people’s lives different?

» Answers will vary.

EXTEND—Print additional copies of Activity Page 4.1.2 if the class comes up with more than six devices for long-distance communicating.

4. Check for understanding.

Activity Page



AP 4.1.2

NGSS Elements



SEP 8

DCI PS4.C

Influence of
Engineering,
Technology,
and Science on
Society and the
Natural World

Return to Today’s Question, and **ask students**, How do people communicate over long distances? Guide students to understand that there are many devices that work in a variety of ways: smoke, drum sounds, Morse code, smartphones, etc.

Call attention to the unit question board. Revisit the questions recorded there so far, and ask students if today’s lesson may help to answer some of them. Allow students to suggest revisions or additions to the questions on the board.

Formative Assessment

Review student responses on Tools for Communicating over Long Distances (AP 4.1.2) to determine student understanding of the following concepts:

- People have invented many devices for communicating over long distances.
- People’s lives change when they begin to depend on each invention.

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

Tie to the Anchoring Phenomenon

Students have learned about varied devices that communicate over long distances and can use their understanding of some of these to explain how players on a stage communicate with the entire audience.

Know the Standards

TEACHER DEVELOPMENT

2. Differentiation: This research activity provides opportunities for you to address English Language Arts standards for Reading: Informational Text, Grade 1. There are relatively few high-quality science informational websites for beginning readers, so you may want to model finding information for your students. As you do, point out the various text features, such as menus, headings, and icons (CCSS.ELA-Literacy.RI.1.5); identify information that students can get from pictures instead of text (CCSS.ELA-Literacy.RI.1.6); and encourage them to ask questions about key details (CCSS.ELA-Literacy.RI.1.1).

LESSON 4.2

Putting on a Play

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: How can we communicate with an audience using light and sound?

Today's Question: How do students putting on a play communicate?

Tie to the Anchoring Phenomenon: Through reading, discussion, and writing, students begin to explore what it takes to put on a school play and what is involved in communicating with light and sound from the stage to people in the last row of the audience.

AT A GLANCE

Learning Objective

- ✓ Discuss and describe how to solve problems related to sound and light.

Instructional Activities

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

NGSS References

Disciplinary Core Ideas: PS4.A Wave Properties; PS4.B Electromagnetic Radiation; PS4.C Information Technologies and Instrumentation; ETS1.A Defining and Delimiting Engineering Problems; ETS1.B Developing Possible Solutions; ETS1.C Optimizing the Design Solution

Science and Engineering Practice: 1 Asking Questions and Defining Problems

Students will ask questions to determine how to solve problems related to sound and light.

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

www.coreknowledge.org/cksci-online-resources

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 signal solve spotlight

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.

communicate microphone opaque solution

Instructional Resources

Student Book



Ch. 5

Activity Page



AP 4.2.1

Student Book, Chapter 5
“Solving Problems with Light or Sound”

Activity Page

How to Solve a Problem
(AP 4.2.1)

Materials and Equipment

For optional support/challenge/extension:

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

THE CORE LESSON 4.2

1. Focus student attention on Today’s Question.

NGSS Elements



DCI PS4.A, PS4.B,
and PS4.C

Monitor Progress

How do students putting on a play communicate?

Remind students that in the last lesson segment they researched ways people communicate over long distances. What were they?

- » sample answers: smoke signals, drums, flags, signal lamps, traffic lights, smartphones

Ask students the following: (See **Know the Standards 1.**)

- What are some ways people on a stage communicate to their audience?
» with musical instruments

Know the Standards

TEACHER DEVELOPMENT

1. Monitor Progress: Lessons 1–3 in this unit developed three Disciplinary Core Ideas about sound and vibrations, how objects can be seen, and how light interacts with various materials (PS4.A, PS4.B, PS4.C). Lesson 4 requires students to apply these core scientific ideas to solving human problems. This is essential to reinforce these core ideas on an ongoing basis.

- » singing or speaking with their voices
- » with their body movements
- » with their costumes and masks
- Which of these examples you provided need vibrations to work?
 - » musical instruments
 - » singing or speaking with their voices
- Which of these examples you provided need light to work?
 - » body movements
 - » costumes and masks

Tie to the Anchoring Phenomenon

This question, although more specific to a school play, helps identify some of the forms of communication that any stage performance may use.

2. Read together: “Solving Problems with Light or Sound.”

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

Page 24

NGSS Elements



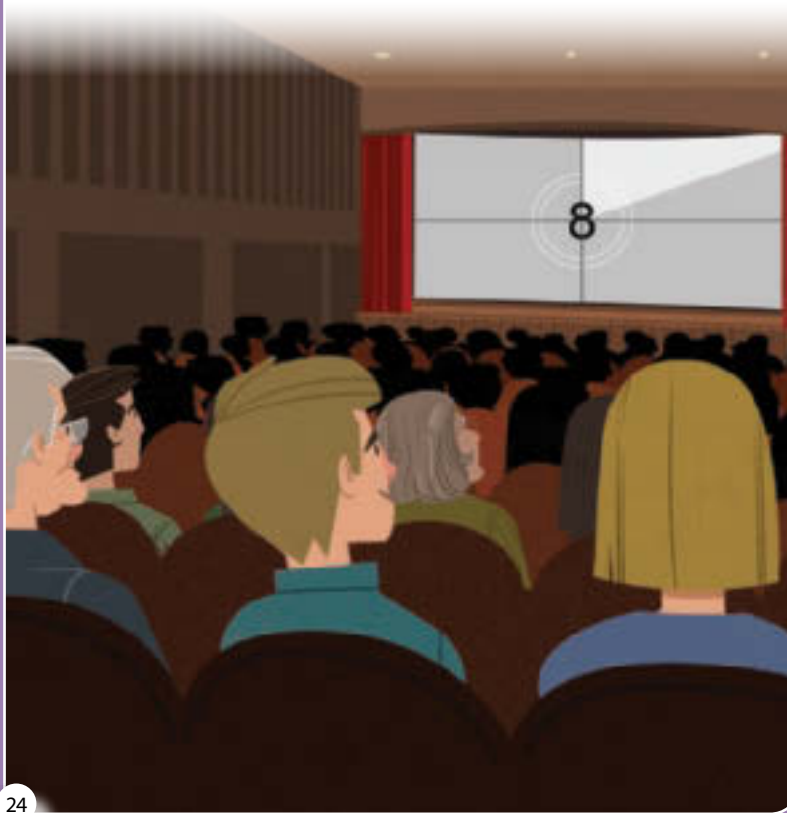
DCI PS4.A and
PS4.B

Ask students to turn to page 24 of the Student Book and look at the picture as you read aloud. Remind them that the title of this chapter is “Solving Problems with Light or Sound,” and tell them to pay special attention to how Mr. Ruiz’s class planned their school play as you read.

Have students look at the picture on page 24. Explain to students that the story of Mr. Ruiz and his class going to a concert has continued from Chapter 4.

Solving Problems with Light or Sound

Mr. Ruiz says to his students, “Do you remember that you were worried about sitting in the last row of the theater? How can people far away see and hear?”



24

INFERENTIAL—How many rows of seats might be in this theater?

- » Answers will vary, but students should infer that there are likely at least ten or more rows.

INFERENTIAL—Think about your investigations with sound and light. If you sat in the twentieth row, how could you hear and see the concert?

- » We could hear the show when instruments on stage vibrate and the vibrations make sounds. We can see the people and instruments on stage because there are lights above the stage that shine on them.

NGSS Elements



DCI PS4.A

Connections to
Engineering,
Technology,
and
Applications of
Science

The students have many ideas. They talk about a microphone placed near a musician. Maybe there are large speakers in the theater.

They also talk about lights that follow the action on stage. They are called spotlights.

How did these tools help the audience hear and see?



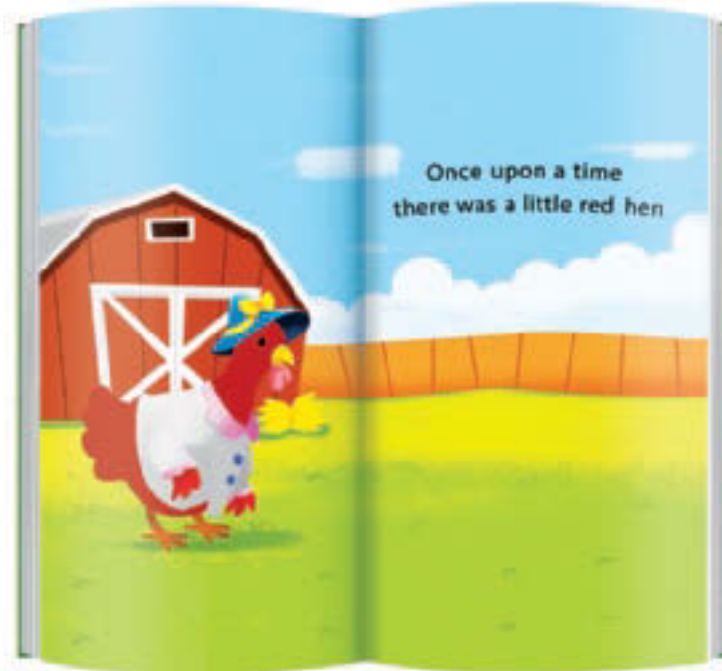
25

Have students look at the first picture. Point to the microphone above the musician's head. Explain that a microphone picks up the sounds of the music and sends signals through wires to large speakers around the auditorium. The speakers vibrate to make sounds that can be made very loud.

CORE VOCABULARY—Make sure students understand that a **spotlight** is a bright beam of light that can light up a single person on a stage.

Have students point to the light beams in the second picture.

Now Mr. Ruiz has big news for his class. They will put on a show for their school! The class votes to tell the story of *The Little Red Hen* with music. First, they read the story. Then they talk about their questions. Who wants to sing? Who wants to play an instrument? Will there be lights and shadows?



26

LITERAL—What show does Mr. Ruiz’s class want to put on for the rest of their school?

» *The Little Red Hen*

Online Resources



SUPPORT—Some students may not be familiar with the story of *The Little Red Hen*. Show an online video or picture book to share the story with students. See the Online Resources Guide for a link to the recommended video:

www.coreknowledge.org/cksci-online-resources

Discuss how the story can be turned into a school play.



Next they plan their show. They want costumes and masks.
They want spotlights. They want sound effects.



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LITERAL—Explain to students that the story of the Little Red Hen has been told with many different animals as characters. **Ask**, What characters do these masks show?

» *a dog, a cat, a chicken, and a duck*

INFERENTIAL—These masks are made of materials such as paper and cardboard. What will happen to a light beam from the spotlight when the mask is held up?

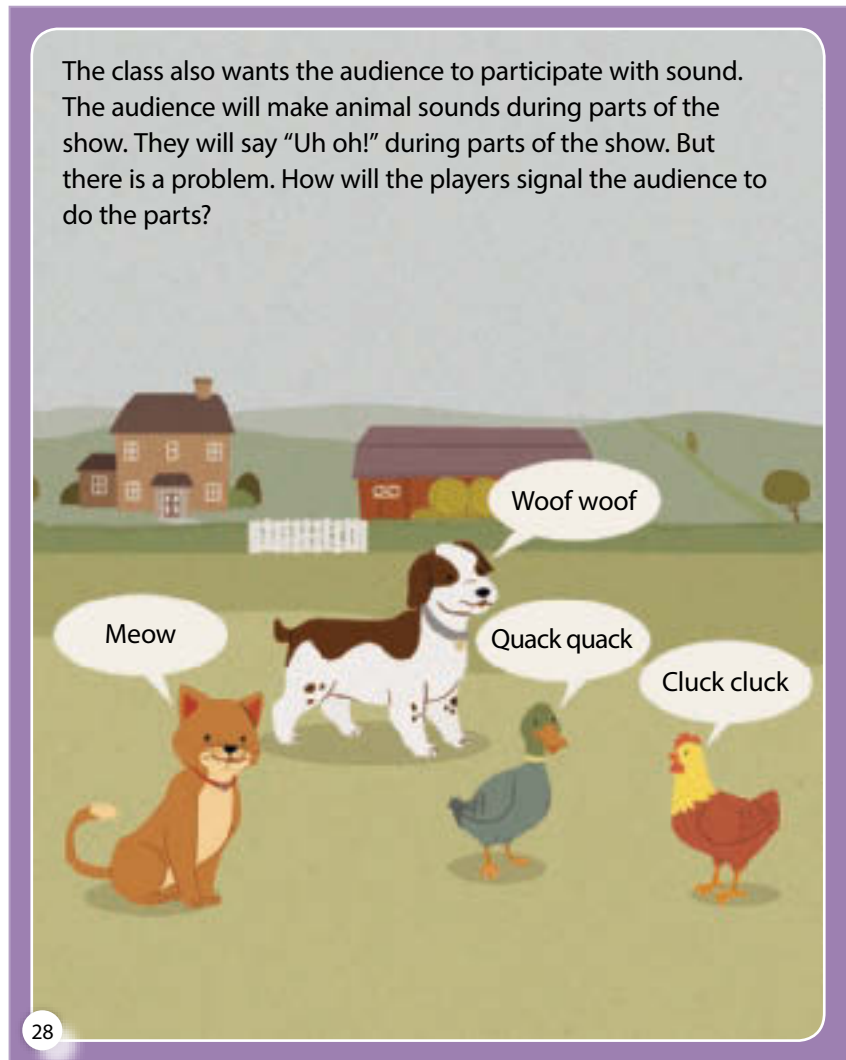
» The mask will block the light except where there are holes for the eyes.

EVALUATIVE—How could the class use a spotlight in their show?

» They could shine the spotlight on each character as they speak. Or they could shine the spotlight on the seeds, plants, wheat, sack of flour, and baked bread the Little Red Hen works with.

EXTEND—Remind students that materials that block light and make dark shadows are called *opaque*.

NGSS Elements

DCI PS4.C
ETS1.A

As you point to each animal in the picture, invite students to make the appropriate sounds.

LITERAL—What is the problem Mr. Ruiz’s class wants to solve?

» *how to signal the audience that it is time to participate in the show*

CHALLENGE—Replay the online video of *The Little Red Hen*, and **ask**, Where should I pause the video so that the audience can say “Uh oh!”?

» each time an animal says, “Not I”

» when the hen says, “This bread is for those who worked on it.”

NGSS Elements



DCI PS4.C,
ETS1.A, ETS1.B,
and ETS1.C

Students must solve the problem. They need to work together to figure out how to use light or sound to signal to the audience when to participate. The students use three main steps to solve the problem.

Now you know more about light and sound. How would you solve the problem?

How could you use light or sound to let audience members know when to make sound effects?

How could you let them know when to make a “meow” sound?

How could you let them know when to make a “woof” sound?

How could you let them know when to make a “cluck” sound?

How could you let them know when to make a “quack” sound?

- ☒ Talk about the problem.
- ☒ Come up with a plan.
- ☒ Test the plan.



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CORE VOCABULARY—Explain that a **problem** is a situation people want to change. For example, a broken toy is a problem if children want it to work.

CORE VOCABULARY—Explain that to **solve** the problem, someone has to make or do something to make the situation better. For example, putting fresh batteries in a broken toy might solve the problem.

LITERAL—What does the solution to our problem have to do?

- » signal the audience
- » use sound or light

EVALUATIVE—What are some ideas you would share to help Mr. Ruiz’s students with their show?

- » have signs to hold up when the audience is supposed to make sounds
- » give the performers flashlights to turn on when the audience is supposed to make that animal’s sound

LITERAL—What are three steps needed to solve the problem?

- » Talk about the problem.
- » Come up with a plan.
- » Test the plan.

INFERENTIAL—What are the children in the picture doing?

- » They are working with materials and tools to make something that can signal to the audience.

3. Completing a graphic organizer.

Activity Page



AP 4.2.1

NGSS Elements



DCI ETS1.A,
ETS1.B, and
ETS1.C

Differentiation

Give each student a copy of How to Solve a Problem (AP 4.2.1).

Divide the students into small problem-solving teams.

Have students discuss the storyline in Chapter 5 of Mr. Ruiz's class wanting to solve a problem and write their ideas about the problem in the three bubbles on their Activity Page. (See **Know the Science.**)

SUPPORT—Explicitly support ELA reading informational text by describing the headings in the three bubbles as key ideas and telling students that they will write supporting points. Emphasize that pictures and other graphics can often be just as helpful to convey information as text. (See **Know the Standards 2.**)

Know the Science

TEACHER DEVELOPMENT

What is engineering design? Engineering design is a process that guides engineers in solving problems that affect people's lives. A series of steps are common to every problem, but the steps are often repeated as needed to improve solutions. For Kindergarten–Grade 2 students, the process revolves around three activities. Students explore and talk about a problem they wish to solve, often gathering information about the situation. They represent and explain possible solutions with drawings and models. They also test how well their solutions work and compare them to other solutions.

Know the Standards

TEACHER DEVELOPMENT

2. Differentiation: Grade 1 reading standards require students to *Distinguish between information provided by pictures or other illustrations and information provided by the words in a text* (CCSS.ELA-Literacy.RI.1.6) and *Use the illustrations and details in a text to describe its key ideas* (CCSS.ELA-Literacy.RI.1.7). Having students at all levels complete graphic organizers, such as this one, is a good way to evaluate students' text comprehension.

4. Check for understanding.

Activity Page



AP 4.2.1

NGSS Elements



DCI PS4.A, PS4.B,
ETS1.A, ETS1.B,
and ETS1.C

Return to Today's Question, and **ask students**, How do students putting on a play communicate? Guide students to understand that sound (music, singing, spoken word, sound effects) and light (illuminating players and dancers, spotlights) are essential to plays.

Call attention to the unit question board. Revisit the questions recorded there so far, and ask students if today's lesson may help to answer some of them. Allow students to suggest revisions or additions to the questions on the board.

Formative Assessment

Review student responses on How to Solve a Problem (AP 4.2.1) to determine student understanding of the following concepts:

- Solving a problem requires talking about it.
- Solving a problem takes planning.
- Plans need to be tested.

Tie to the Anchoring Phenomenon

The reading and video gave students a context in which they could begin to explore how they will design a device that can send signals to people watching a class play and reach the last row in an auditorium.

LESSON 4.3

Describing the Problem

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: How can we communicate with an audience using light and sound?

Today's Question: How can you describe a problem about communicating during a play?

Tie to the Anchoring Phenomenon: Through discussion, writing, and touring a performance space, students are preparing to solve a problem directly related to the unit phenomenon that allows people in the back row of an audience to see and hear the show.

AT A GLANCE

Learning Objective

- ✓ Define and gather information about how to signal audience participation during a school play.

Instructional Activities

- question generation
- student investigation
- class discussion

NGSS References

Performance Expectation: K–2-ETS1-1

Disciplinary Core Idea: PS4.C Information Technologies and Instrumentation; ETS1.A Defining and Delimiting Engineering Problems

Science and Engineering Practice: 1 Asking Questions and Defining Problems

Students will investigate how to signal an audience to participate during a school play.

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

www.coreknowledge.org/cksci-online-resources

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

light source measure sound vibrate

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.

device reflection requirement useful

Instructional Resources

Activity Page



AP 4.3.1

Activity Page

Ask Questions About the Problem (AP 4.3.1)

Materials and Equipment

Collect or prepare the following items:

- question board
- meterstick or measuring tape (1 per class)

THE CORE LESSON 4.3

1. Focus student attention on Today's Question.

Activity Page



AP 4.3.1

How can you describe a problem about communicating during a play?

- **Ask students,** What was the problem Mr. Ruiz's class had in Student Book Chapter 5?
 - » They wanted to put on a school play of *The Little Red Hen* and signal the audience when to participate by saying "Uh oh!"
- Then have students think about performing a play for the rest of the students in your school. **Ask,** What story should we turn into a school play? List students' brainstorming ideas on the board, and hold a vote to choose one story for the play.
- Have the class discuss how they want the audience to participate. **Ask,** How and at what point in the play should your audience get involved?
 - » Sample answer: We want them to stand up and say "Watch out!" when the villain appears.

NGSS Elements



SEP 1

DCI PS4.C

ETS1.A

Differentiation

EXTEND—If your students are excited about the premise of actually performing a play, locate a script for the story they chose, allow them to pick parts to play, and rehearse. During rehearsals, discuss the points in the script where players will signal the audience to participate.

SUPPORT—If any students have trouble following an English language discussion, consider modeling the situation for the class. Tell students they will play the role of the audience at a play and you are the performer. Say a few lines from the story, and then stop and tell students you want them to snap their fingers three times. Then continue your performance. Explain that the problem is to make a device that will do the signaling to the audience. Allow students to ask questions to clear up any confusion. (See **Know the Standards**.)

- Further define the problem to solve. Explain that the players on the stage want to let the audience know when to participate and that they need to use what they know about sound or light to make something that will signal the audience.

Tie to the Anchoring Phenomenon

Students will apply the first step in solving a science problem about how to communicate with an audience in the last row of a performance space through guided discussion, research, and asking questions.

2. List students' questions and begin to clarify the problem.

Activity Page



AP 4.3.1

NGSS Elements



SEP 1

DCI PS4.C
and
ETS1.A

Give each student a copy of Ask Questions About the Problem (AP 4.3.1), and explain that every solution has requirements it has to meet. Have students work in pairs to discuss how to complete each question and add their own.

SUPPORT—For students who are not sure what you mean by *requirement*, provide an analogy: *Let's say you have to make your lunch to take to school the next day. Your lunch must be tasty. You must use foods that are already in your kitchen. You are not allowed to use the stove. Whatever you make must be eaten without heating it up, and it has to fit in your lunch bag.* Explain that these are requirements that must be obeyed to find a good solution.

Know the Standards

TEACHER DEVELOPMENT

Differentiation: Grade 1 students have many opportunities to develop their English speaking and listening skills in science. Encourage them to *build on others' talk in conversations by responding to the comments of others through multiple exchanges* (CCSS.ELA-Literacy.SL.1.1.b), *ask questions to clear up any confusion about the topics and texts under discussion* (CCSS.ELA-Literacy.SL.1.1.c), and *produce complete sentences when appropriate to task and situation* (CCSS.ELA-Literacy.SL.1.6).

Go over the completed Activity Pages with the class, and make sure everyone understands the limitations of the situation:

- Identify the location where the play would take place.
- Go over the ideas about sound and vibrations, light sources, and how light behaves when it strikes different materials, including reflection.
- Explain that students may use any of the materials they used to investigate sound and light plus any art supplies that are in class.
- Tell students how much time they will have—thirty minutes should be enough to build their device and practice using it.
- Explain that the class will be choosing the design that works best, so they will want to test it and demonstrate it for the rest of the class.
- Answer all additional questions students wrote down.

3. Tour the play location.

NGSS Elements



SEP 1
DCI PS4.C
and
ETS1.A

Take students to see where in your school their play could take place. Discuss where the chairs are placed and how far the last row will be from the stage. Remind students that their signal will have to reach students in the last row of seats as well as in the first row.

Discuss with students how much the room can be darkened, as this will affect the light sources they may want to use in their designs.

Have volunteers measure the distance from the stage to the last row of seating and record this distance as a whole number on the Activity Page. Explain that if the class cannot test their solution in this location, they can use a hallway and measure the same distance. (See **Know the Science**.)

CHALLENGE—Some students can be challenged to estimate the number of feet, yards, or meters before taking the actual measurement. Make sure students use the name of the unit as well as estimate a number. After they measure, have them compare their estimates to the actual distance.

Know the Science

TEACHER DEVELOPMENT

How is sound transmitted in an auditorium? Formal performance spaces are designed using the science of acoustics. If the space is well designed, people in any seat will hear the show well. Factors that affect how sound moves about the space include the size and shape of the room, how the floors, walls, and ceiling reflect or absorb sound, and the presence of background sounds such as from heating and cooling systems. Because every space interacts with sound differently, the best test of students' signaling devices that use sound will be in the space your school uses for performances.

4. Check for understanding.

Activity Page



AP 4.3.1

NGSS Elements



SEP 1

DCI PS4.C

ETS1.A

Monitor Progress

Ask students the following:

- What is the problem you will try to solve?
 - » how to make something to signal the audience when we want them to participate in our school play
- How will making something to signal the audience be useful?
 - » Sample answer: It will help the audience have a better time and make putting on the play more fun.
- How was it helpful to ask questions about the problem?
 - » It helped us understand what we could and could not do to solve it.
- Why was it important to measure the space where the play will be performed?
 - » If we know how far away the last row is, we can try out our solutions in a hallway and make sure they work.

Call attention to the unit question board. Revisit the questions recorded there so far, and ask students if today's investigation may help to answer any of them. Allow students to suggest revisions or additions to the questions on the board.

Formative Assessment

Review student work on Ask Questions About the Problem (AP 4.3.1) to determine student understanding of the following concepts about solving the problem of communicating over a long distance with an audience:

- People can use science ideas to solve problems.
- Thinking about what materials can be used is important.
- Knowing how much time you have available to get something done is important.
- When you make something, you need to test it to see how it works.

This lesson segment is building toward Performance Expectation 1-PS4-4 and fully addresses engineering design Performance Expectation K-2-ETS1-1. In the next lesson segment, students will build, test, explain, and evaluate their devices as they complete their performance for 1-PS4-4 and address K-2-ETS1-2 and K-2-ETS1-3.

Tie to the Anchoring Phenomenon

Through discussion, writing, and measuring, students have completed the first step in solving a problem related to communicating with sound or light from a stage to the last row in an auditorium.

LESSON 4.4

Lesson 4 Roundup: Building and Testing a Device

Big Question: What happens in a stage performance so that people can see and hear the show?

Lesson Guiding Question: How can we communicate with an audience using light and sound?

Today's Question: How do students use light and sound to communicate during a play?

Tie to the Anchoring Phenomenon: Through designing devices, representing them in diagrams, and testing them, students develop solutions to a problem directly related to the Anchoring Phenomenon: how to communicate using sound or light from the stage to all members of a theater audience.

AT A GLANCE

Learning Objectives

- ✓ Build and test a device that uses sound or light to communicate over a distance.
- ✓ Collect data to compare solutions to determine which one is best suited to solve the problem.

Instructional Activities (2 days)

- question generation
- student investigation
- class discussion

NGSS References

Performance Expectations: 1-PS4-4; K-2-ETS1-2; K-2-ETS1-3

Disciplinary Core Ideas:

PS4.C Information Technologies and Instrumentation; ETS1.B Developing Possible Solutions; ETS1.C Optimizing the Design Solution

Science and Engineering Practices:

6 Constructing Explanations and Designing Solutions; 2 Developing and Using Models; 4 Analyzing and Interpreting Data

Crosscutting Concept: 6 Structure and Function

Students will design and build a device that uses sound or light to communicate over a distance.

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

www.coreknowledge.org/cksci-online-resources

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.

materials **problem** **solution** **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.

engineer

Instructional Resources

Activity Pages



AP 4.4.1
AP 4.4.2

Activity Pages

How We Solved the Problem
(AP 4.4.1)

Comparing Solutions (AP 4.4.2)

Materials and Equipment

Collect or prepare the following items:

- question board
- rubber bands, box of assorted sizes (1 per class)
- cardboard boxes, such as from shoes, tissues, or crayons (1 per group)
- disposable aluminum pie pans (2 per group)
- 12-inch lengths of string (1 per group)
- clean, empty plastic water bottles (1 per group)
- dried beans (2 tablespoons in a cup per group)
- flashlights (1 per group)
- cardboard squares (1 per group)
- wood squares (1 per group)
- aluminum foil squares (1 per group)
- plastic mirrors (1 per group)
- tissue paper squares (1 per group)
- waxed paper squares (1 per group)
- clouded plastic objects (1 per group)
- clear plastic objects (1 per group)
- large sheets of white paper (1 per group)
- scissors, stapler, tape, paper clips (Remind students where to get these in your classroom.)

Advance Preparation

Consider placing all the materials in a central location and having one student from each team take materials as needed and return materials when they no longer need them.

THE CORE LESSON 4.4

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

NGSS Elements



DCI PS4.C

Differentiation

How do students use light and sound to communicate during a play?

- Remind students that they have been thinking about putting on a school play and want the audience to participate.
- Explain to students that today they will act like engineers and solve the problem that they defined in the last lesson segment. **Ask**, What problem are we trying to solve?
 - » how to make something to signal the audience when we want them to participate in our school play

SUPPORT—Students may know that a train engineer drives the train but may be unfamiliar with the word as it relates to this lesson. Explain that engineers are people who use what they know about science and math to solve problems and help other people. With students, develop a list of objects (smartphones, toasters, toys), structures (tall buildings, bridges, roads), and processes (how traffic lights are timed, how cars are put together in a factory) that engineers have designed.

- When you have been to a performance or seen one on television, how did the performer signal their audience that they wanted them to participate by singing along or asking a question?
 - » sample answers: by saying, “sing with me”; by pointing the microphone at the audience by showing the words to sing on the screen
- What science ideas do you have to use to signal your audience to participate?
 - » ideas about sound or light

Tie to the Anchoring Phenomenon

This problem-solving challenge is directly related to the idea that a stage performance has to reach all the rows of the audience with light and sound.

2. Guide device designing and building.

Activity Page



AP 4.4.1

NGSS Elements



SEP 2 and 6

DCI PS4.C, ETS1.B

CCC 6

Differentiation

Monitor Progress

3D Learning

Students use materials to design solutions about communicating at a distance and explain how they work.

- Divide the class into small teams. Have each team give itself a name.
 - Call teams one by one to view the materials available to build their tool.
 - **Ask each team**, Are you planning to use sound or light to signal the audience during our play?
 - » Answers will vary.
 - Allow teams to select materials to take back to their work areas to discuss. Make sure they understand that the device they design has to make a signal that reaches the last row in an auditorium.
 - As the teams work, circulate among them, and focus students on relating structure with function. **Ask**, How will each material you use help your solution work?
 - » Answers will vary.
 - Once teams have preliminary designs, they should test them in the classroom, discuss their effectiveness, and redesign them as needed.
- CHALLENGE**—For teams that finish quickly, challenge them to find a way to use their device to send more than one kind of signal to the audience, for example, to clap their hands at one time and snap their fingers at another time. To spark ideas, remind them that Morse code has two signals, short and long sounds. (See **Know the Science**.)
- Give each student a copy of How We Solved the Problem (AP 4.4.1). Have them follow the directions to write the name of their team and the materials they used. Encourage them to draw and revise their drawings as needed to depict the object they made and how they can use it to solve the problem.

Know the Science

TEACHER DEVELOPMENT

How can Morse code be generated? In Morse code, there are two signals that are used in various combinations to represent letters and numbers. Using a telegraph, the signals are transmitted by turning on and off an electric current. If the current is on for a brief amount of time, a dot is communicated. If the current is held on longer, a dash is communicated. Short and long signals can also be communicated by sounds, such as with a voice or instrument, or by turning on and off a light source.

SUPPORT—Circulate among the teams, and make sure students adhere to classroom rules for listening and speaking. Make sure students give peers enough time to think before having to speak. Encourage students who have good drawing skills to help their teammates and provide word lists needed for labels if you see students struggling with written English. (See **Know the Standards 1.**)

3. Facilitate testing the teams' solutions.

Activity Page



AP 4.4.2

NGSS Elements



SEP 4

DCI PS4.C and
ETS1.C

- Take students back to the location where their hypothetical play would take place. Place chairs or other seating at the distance from the stage that the last row would be. This should be the same measurement your class made in Lesson 4.3, Step 3.
- Seat all the teams in the last row, and make the room as dark as it would be during a school play.
- Give each student a copy of Comparing Solutions (AP 4.4.2) and pencils.
- Invite one team at a time to come to the stage area and demonstrate their device a few times.
- Have students record the team's name and write "light" or "sound," depending on which was used to communicate.
- As a class, reach consensus on what single score to give each device. Explain what *good*, *better*, and *best* mean. A *good* score means at least one test signal reached the last row. A *better* score means the signal reached the last row more than once. A *best* score means that the signal reached the last row during every test and was very clear to understand. (See **Know the Standards 2.**)

Know the Standards

TEACHER DEVELOPMENT

1. Differentiation: This team activity gives English language learners and students struggling with reading three other modalities to use in expressing themselves: writing, speaking, and drawing. For example, when they talk with teammates, they address CCSS.ELA-Literacy.SL.1.1 (*participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups*), and when they discuss their drawings, you can facilitate CCSS.ELA-Literacy.W.1.5 (*with guidance and support from adults, focus on a topic, respond to questions and suggestions from peers, and add details to strengthen writing as needed*).

2. Monitor Progress: This activity gives students practice meeting Grade 1 Measurement & Data standard CCSS.Math.Content.1.MD.C.4 (*organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another*).

1. Day 2: Guide data analysis.

NGSS Elements



SEP 4
DCI PS4.C and
ETS1.C

Have students use their data displays to answer the following questions:

- How many tools were tested?
 - » To answer, have students count the names of the teams.
- How many of the teams made tools that use light to communicate?
 - » To answer, have students count the number of teams for which they wrote “light.”
- How many of the teams made tools that use sound to communicate?
 - » To answer, have students count the number of teams for which they wrote “sound.”
- How many tools got a *good* score?
 - » To answer, have students count.
- How many tools got a *better* score?
 - » To answer, have students count.
- How many tools got a *best* score?
 - » To answer, have students count.

Have students take a close look at the devices that received a *best* score. Then ask about each device:

- How did this tool solve the problem?
 - » Sample answer: It made sounds by making beans inside a box vibrate.
- What about this tool worked well?
 - » Sample answer: It had a loud sound that reached everyone clearly; it is easy to use.
- What about this tool did not work as well?
 - » Sample answer: A few beans fell out on the stage, and that could be dangerous for the performers.

Hold a discussion to reach consensus on which tool is best suited to solve the problem of communicating to the back row during a school play.

2. Check for understanding.

Activity Page



AP 4.4.1

NGSS Elements



SEP 6

DCI PS4.C and
ETS1.B

CCC 6

Monitor Progress

Ask students the following:

- What is the problem you solved?
 - » how to make something to signal the audience when we want them to participate in our school play
- How did thinking about the materials you could use help?
 - » Knowing we could only use those materials helped us to stop thinking about plans that needed other materials.
- How did it help to think about the science you learned?
 - » Answers will vary but should mention concepts related to sound or light.
- Were you able to tell how each part worked? Give one example.
 - » Sample answer: The beans made noise when I shook the shaker.
- How was working as a team helpful?
 - » Sample answer: We shared ideas and talked about them. We took turns testing our solution to make sure it really works well.

EXTEND—Give students a chance to solve the same problem without restricting them to the materials listed in this lesson. Have them meet in their teams, come up with a different signaling system for their school play, and draw on poster paper a diagram to explain how it works.

- Why is it useful to test the tools in the place they will be used?
 - » Sample answer: We could sit far enough away from the tool to make sure its signal could reach the back row.
- How did a Good/Better/Best chart help you decide which tool should be used for our school play?
 - » Sample answer: We could compare the scores of all the tools and then choose one of those marked *best*.

Call attention to the unit question board. Revisit the questions recorded there so far, and ask students if today's investigation may help to answer any of them.

Formative Assessment

Review student work on How We Solved the Problem (AP 4.4.1) to determine student understanding of the following concepts:

- People can communicate over long distances using sound or light.
- Sometimes the materials you may use to solve a problem are limited.

- The shape of a device is related to how it functions.
- If a tested solution does not work the way you intended, you can make changes until it does work.

This lesson segment fully addresses Performance Expectation 1-PS4-4 and engineering design Performance Expectation K-2-ETS1-2.

Tie to the Anchoring Phenomenon

Through using an engineering design process, students engaged in solving a problem related to communicating with a theater audience over a distance.

Science in Action: Using Light as a Tool

Tie to the Anchoring Phenomenon: Students join Mr. Ruiz's class as they learn about how lasers were invented and how they are used today in different fields.

AT A GLANCE

Learning Objectives

- ✓ Read about everyday uses for light.
- ✓ Make a tool that makes light do something.

Instructional Activities (2 days)

- teacher Read Aloud
- student investigation

NGSS References

Science and Engineering Practice: 6 Constructing Explanations and Designing Solutions

Understandings About the Nature of Science: Scientific Investigations Use a Variety of Methods; Science Is a Human Endeavor; Science Addresses Questions About the Natural and Material World

Crosscutting Concept: 2 Cause and Effect

Connection to Engineering, Technology, and Applications of Science: Influence of Engineering, Technology, and Science on Society and the Natural World

Students read about the application of lasers and laser light to solve problems. They then brainstorm ways to use light to solve a problem.

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

www.coreknowledge.org/cksci-online-resources

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

bar code	cavity	dentist	energy
invent	laser	light	matter
scientific method	surgery		

Instructional Resources

Student Book



Ch. 6

Student Book, Chapter 6
"Science in Action: Using Light as a Tool"

Materials and Equipment

- clear tape (1 roll per group)
- black construction paper (2–3 sheets per group)
- small flashlights (1 per group)
- aluminum foil (2–3 large sheets per group)
- scissors (1 per group)
- markers (1 per group)

1. Day 1: Introduce the topic.

Remind students that they read about Mr. Ruiz’s class and learned about how light and sound can be used for a stage performance. Explain that today they will read more about how light is used.

2. Read together: "Science in Action: Using Light as a Tool."

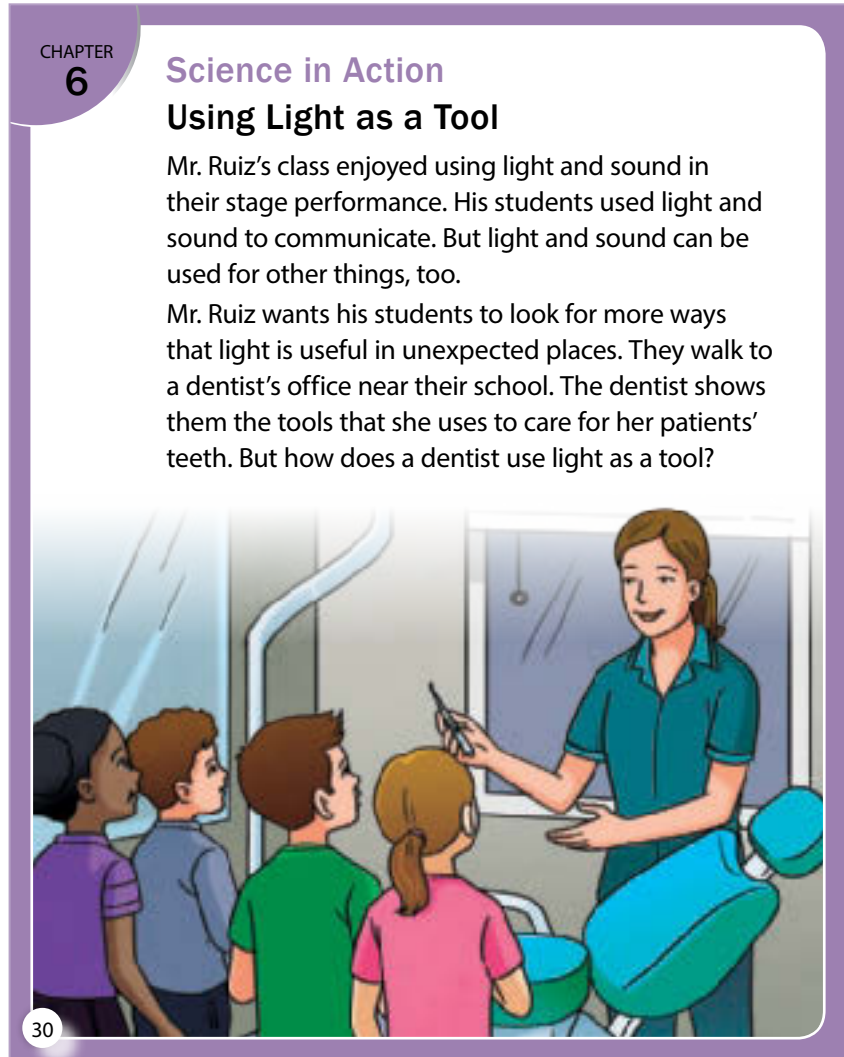
Student Book



Ch. 6

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

Ask students to turn to page 30 of the Student Book and look at the picture as you read aloud. Remind them that the title of this chapter is “Science in Action: Using Light as a Tool,” and tell them to pay special attention to the different ways that light is used in the pictures as you read.



NGSS Elements

Science Is a
Human Endeavor

Ask students to look at the picture on page 30. Explain that the picture shows a dentist.

CORE VOCABULARY—Explain that a **dentist** is a type of doctor who takes care of your teeth. (See **Know the Standards 1.**)

Know the Standards

TEACHER DEVELOPMENT

1. Science Is a Human Endeavor: Men and women of diverse backgrounds work as dentists, doctors, scientists, and engineers.

LITERAL—What does the dentist show the students?

» what she uses to care for patients' teeth

SUPPORT—Remind students that light is what makes things visible. Light can come from the sun, and it can also come from human-made things, like lamps and flashlights.

Page 31

Ask students to look at the two pictures on page 31. Explain that the pictures show tools that dentists use. Talk about what the tools on the page have in common: they both use light. (See **Know the Standards 2.**)

The students are surprised to see that some of the dentist's tools are tiny, bright lights! One of the tools shines a purple light inside a patient's mouth. The light causes changes. It can whiten teeth and harden the fillings in cavities.

Another tool of dentists is a laser. A laser is a strong, narrow beam of light. It's very powerful. A laser beam can cut through the hard surface of a tooth. The dentist uses the laser tool to repair a tooth. The dentist says the laser is an easier tool to use than a drill.



31

NGSS Elements



Influence of
Engineering,
Technology,
and Science on
Society and the
Natural World

Know the Standards

TEACHER DEVELOPMENT

2. Influence of Engineering, Technology, and Science on Society and the Natural World: Lasers are an example of tools that dentists use. Dentists need special tools in order to address problems related to fixing teeth. These tools are designed based on what scientists and engineers know about light and its properties. As a result, people in society benefit from the science that is applied to these instruments and tools.

SUPPORT—Explain that a **cavity** is a hole that forms in the teeth. It has to be filled with special materials to seal the hole.

SUPPORT—Explain that a **laser** is a strong, narrow beam of light. It can contain a lot of heat energy.

LITERAL—What can a laser do to your teeth?

» It can cut through teeth.

LITERAL—What do dentists use lasers for?

» They use them to reshape and repair teeth.

Page 32

Ask students to look at the pictures on page 32. Explain that the pictures show other uses for lasers besides at the dentist's office.

Back at school, Mr. Ruiz explains that lasers are used for other things, too. Strong lasers can be used to cut metal and other hard materials in factories that make things. Doctors performing surgery use lasers.

Mr. Ruiz says that a scientist named Gordon Gould invented the laser. Gould did what all scientists do—he started by asking a question. What would happen if a large amount of light energy was focused into one small beam? Asking a question is one of the first steps in the scientific method.





SUPPORT—Explain that a **bar code** is the set of lines and numbers that you see on the things you buy at the store. This is what you scan at the store so the machines know how much to charge you for an item.

SUPPORT—Explain that a **surgery** is a procedure when doctors have to fix part of your body.

LITERAL—What else can lasers do?

» They can be used to scan bar codes, perform surgery, and cut metal.

LITERAL—What did Gordon Gould want to know about light? (See **Know the Standards 3.**)

» He wanted to know what would happen if he directed all the light energy into one small beam.

SUPPORT—Explain that the **scientific method** is a system that scientists use where they carry out different steps in the same order to learn about something new.

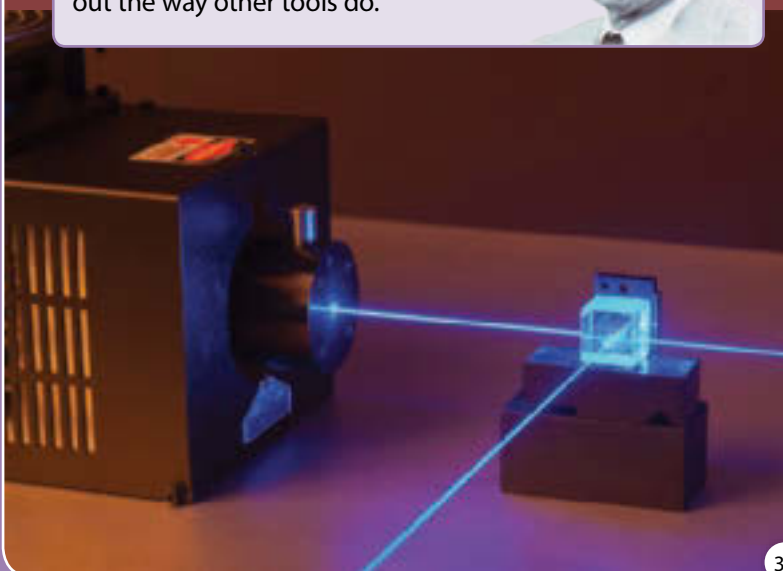
Know the Standards

TEACHER DEVELOPMENT

3. Scientific Investigations Use a Variety of Methods: Science investigations, discoveries, and inventions begin with a question. Gordon Gould wanted to know what would happen if a large amount of light energy were directed through a tiny opening. This prompted his invention of the laser.

Gordon Gould

Gordon Gould was a scientist who studied matter and energy. He was especially interested in how light behaves. The questions that Gordon Gould asked about light led to the invention of the laser. This was one of the most important inventions of the last century because lasers can be used in so many ways. Lasers have made many processes faster and easier. They perform tasks over and over again without wearing out the way other tools do.



33

NGSS Elements



Science
Addresses
Questions About
the Natural and
Material World

SUPPORT—Explain that **matter** is anything that takes up space. It can be a liquid, a solid, or a gas.

SUPPORT—Explain that **energy** is the ability to do work.

LITERAL—What did Gordon Gould study?

» matter and energy

LITERAL—What was Gould especially interested in?

» how light behaves

INFERENTIAL—What do you think would be different if a laser were never invented? (See **Know the Standards 4.**)

- » Some jobs could not be done. Some things would take longer to do. Some things would be harder to do.

1. Day 2: Facilitate the activity.

NGSS Elements



SEP 6

Scientific
Investigations
Use a Variety of
Methods

Influence of
Engineering,
Technology,
and Science on
Society and the
Natural World

- Remind students that they previously read about different ways that light is used in everyday life, particularly in the form of lasers. Tell them that today they will work on an activity where they get to act like a scientist! (See **Know the Standards 5.**)
- Have students form small groups, and distribute the materials. Explain that they will work together to come up with a way to get light to “do something.” They will use the materials in front of them to make the light from the flashlight shine in the shape of something, like a square, a heart, a star, a cloud, or another design.
- Encourage students to look at the materials in front of them, and tell them to come up with a question that will spark their inventions, such as “How can we get light from the flashlight to be in the shape of a heart?” Remind them that scientific investigations begin with a question about what a scientist wants to answer. (See **Know the Standards 6.**)
- Circulate around the room as students work. Suggest ways that students can use the materials. For instance, they can cut out a shape from the black construction paper or the aluminum foil and then tape the paper/foil over the flashlight.
- When the inventions are complete, invite groups to shine their flashlights onto an area of the wall while you turn off the lights. (See **Know the Standards 7.**)

Know the Standards

TEACHER DEVELOPMENT

4. Science Addresses Questions About the Natural and Material World: Designing a laser involves applying what is known about the natural world (light energy) and using that to figure out ways to concentrate the light through a small opening to control where the energy is focused. From here, Gould was able to figure out how to create an instrument that could use this type of energy.

5. SEP 6 Constructing Explanations and Designing Solutions: Students use materials to design and make a tool that gets light to do something/ behave in some way.

6. Scientific Investigations Use a Variety of Methods: Students come up with a question that will spark their ideas for an invention. The question should focus on getting light to do something, such as shine in a specific shape.

7. Influence of Engineering, Technology, and Science on Society and the Natural World: Students get an opportunity to act like scientists who are trying to invent something. They gain hands-on experience in applying what they have learned about light and how it behaves to make pretend tools that they can use.



SUPPORT—Limit the number of materials you give to students, and instruct them to try making the light in a shape that you preselect. This will eliminate the process of them trying to come up with something to make in groups.

CHALLENGE—Challenge students to use all of the materials when making their inventions.

EXTEND—Have students explore other tools and instruments that use light in different fields of science.

2. Check for understanding.

Review the tools that students make. Ensure they understand the concept of asking questions and coming up with creative ways to use materials, but do not score students on their crafting ability.

Teacher Resources

Activity Pages

• What We Can See and Hear at a Concert (AP UO.1)	179
• Loud and Soft Sounds (AP 1.1.1)	180
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Name _____

Date _____

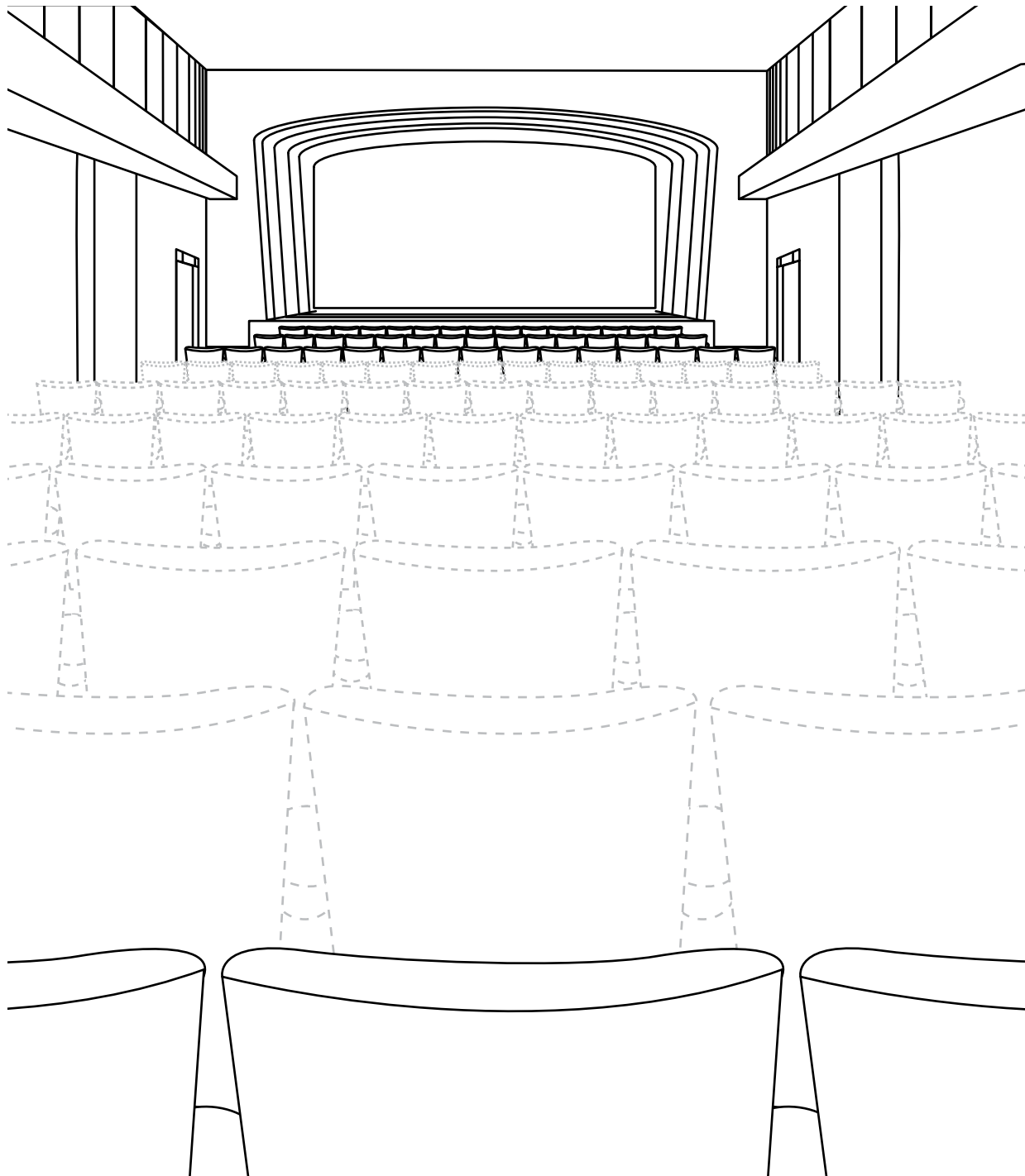
Activity Page UO.1

Use with Unit Opener

What We Can See and Hear at a Concert

I saw a play called _____.

Add to the drawing. Draw yourself in the back row. Draw other students in the front row. Draw players on the stage. Show how light is used. Show how sound is used.



Name _____

Date _____

Loud and Soft Sounds

Write loud sounds and soft sounds on the chart.

Sounds Around Us	
Loud Sounds	Soft Sounds

Name _____

Date _____

Activity Page 1.2.1

Use with Lesson 1.2

What Causes Sound?

Complete the sentences.

1. I stretched a _____ over a _____.
2. I made the _____ vibrate.
3. I know it vibrated because _____.
4. I heard a sound because _____.

Draw and label a picture to show how you made sounds.



Name _____

Date _____

Activity Page 1.3.1

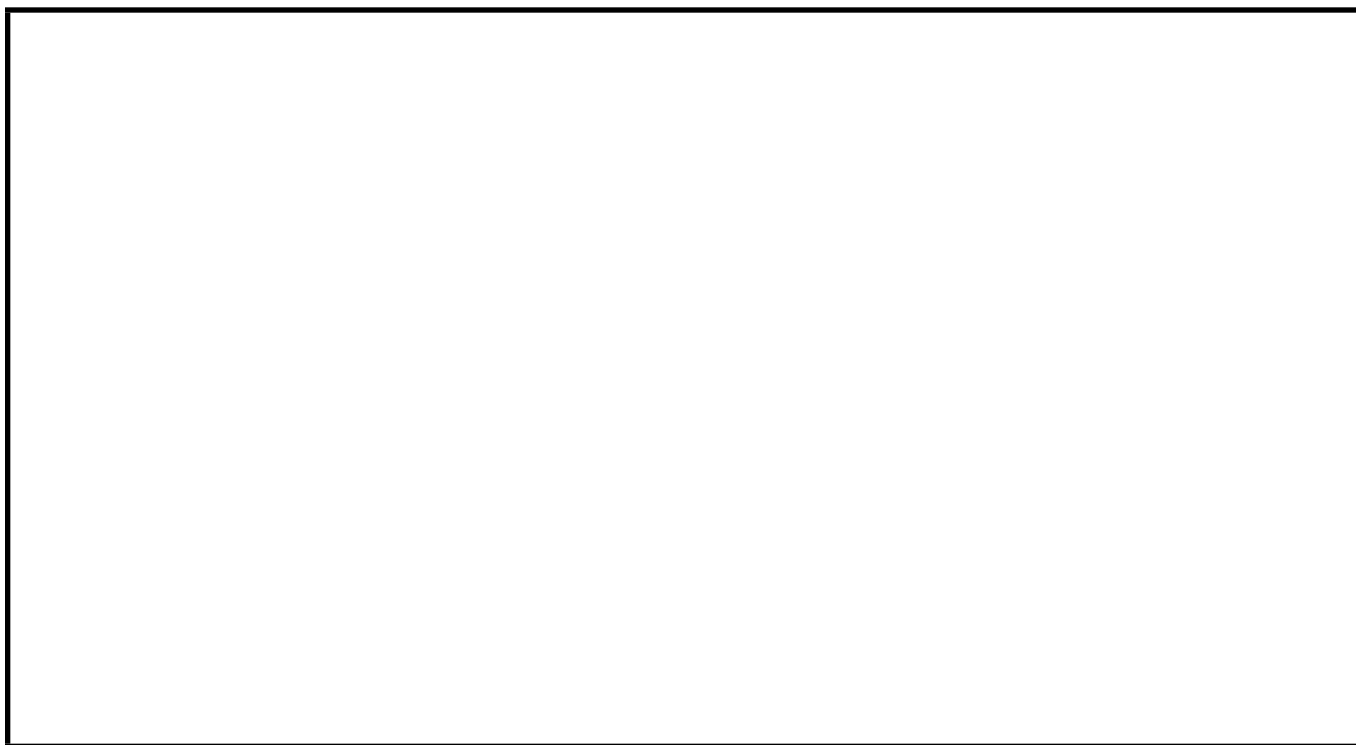
Use with Lesson 1.3

What Causes Objects to Vibrate?

Complete the sentences about your plan.

1. My team put _____ over a _____
and made it tight with a _____.
2. First, we put salt on the plastic and made a sound.
3. I saw the salt _____.
4. Then we made a plan to test _____.
5. In the test, we made a sound, and I saw _____.
6. I think the _____ caused the change.

Draw and label a picture to show how you made things vibrate.



Name _____

Date _____

Activity Page 1.4.1

Use with Lesson 1.4

Show Causes and Effects

Write to fill in what happens next.

Cause

Effect

You strum a guitar.



The strings move _____

The strings vibrate.



The air _____

The moving air vibrates.



Parts of your ears _____

Your ears vibrate.



You hear a _____

Name _____

Date _____

Activity Page 1.5.1

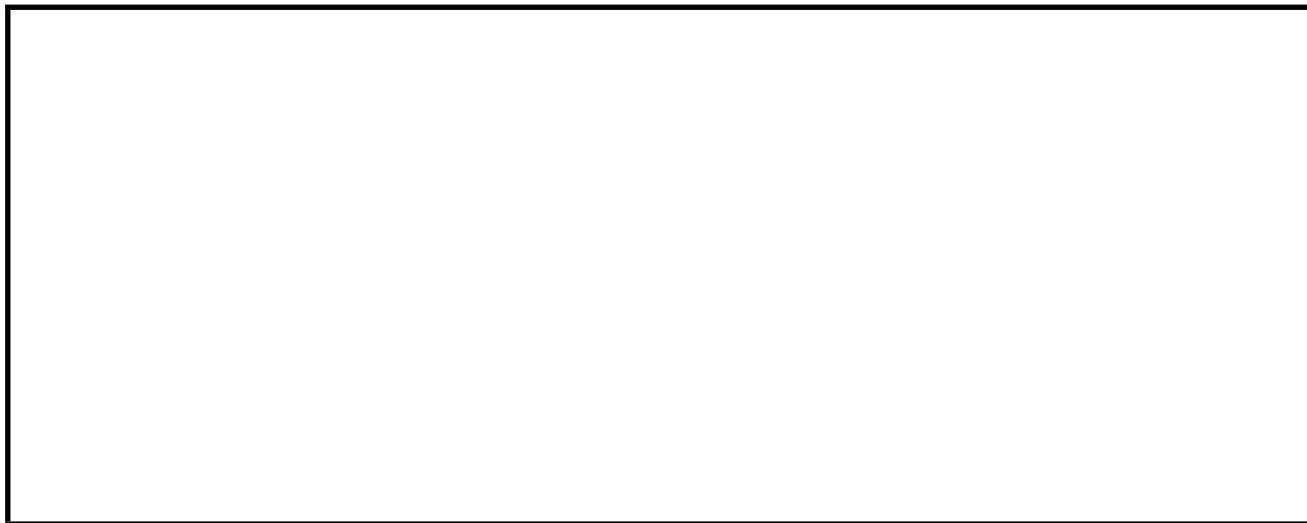
Use with Lesson 1.5

What Do Sound and Vibrations Do?

- 1. Draw your kazoo. Add labels to show how sound made something vibrate.**



- 2. Draw the other music maker you made. Label the parts that vibrate. Show how sound is heard.**



- 3. How did you choose the materials for the music maker you designed?**

Name _____

Date _____

Activity Page 2.1.1

Use with Lesson 2.1

A Light Walk at Night

List lights you can see at night.

1. Write lights you can see in your home at night.

_____	_____
_____	_____
_____	_____

2. Write lights you can see out a window at night.

_____	_____
_____	_____
_____	_____

3. Write lights you can see walking with your family at night.

_____	_____
_____	_____
_____	_____

Name _____

Date _____

How Bright Is That Light?

Think about the light sources you have seen. Group them as dim or bright lights on the T-chart.

Dim Lights	Bright Lights

Name _____

Date _____

Does It Give Off Light?

Draw the object or write its name in the column that tells if it gave off light or not.

Gives Off Light	Does Not Give Off Light

Name _____

Date _____

Activity Page 2.3.1

Use with Lesson 2.3

Let the Light Shine In

Work in a team. Do each step. Write answers to the questions.

1. Find small objects that do not give off light. What did your team find?

2. Close up a pinhole box. Put your eye to the pinhole. What does it look like in there?

3. Have your teammates close their eyes. Then choose a small object to put in the box. Close up the box. Have a teammate look through the hole. What do they see?

4. Tell your teammate to keep their eye at the pinhole. Slowly, lift the box top to let in light. What do they see now?

5. Talk with your team. What was needed to see the small objects and name them?

Name _____

Date _____

Activity Page 2.3.2

Use with Lesson 2.3

Testing Light Makers

Work in a team. Do each step. Write answers to the questions.

1. Ask your teacher for a small object that gives off light. What did your team get?

2. What can you do to test how the lighted object will look in the dark?

3. Talk with your team about the cause. What makes it possible to see the object inside the dark box?

Name _____

Date _____

Activity Page 2.4.1

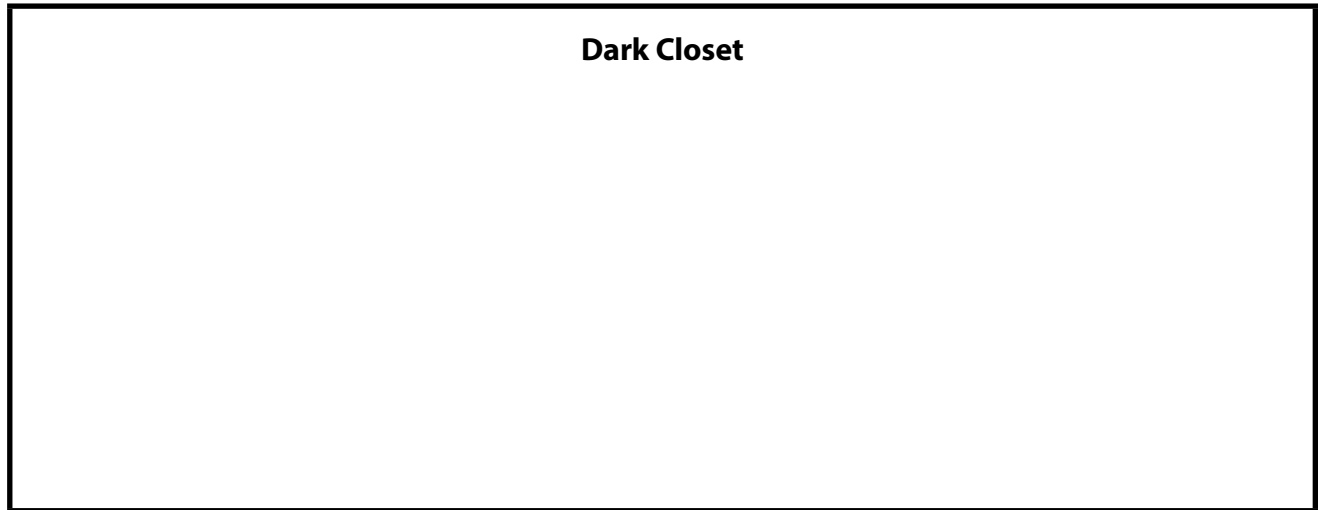
Use with Lesson 2.4

What's in the Closet?

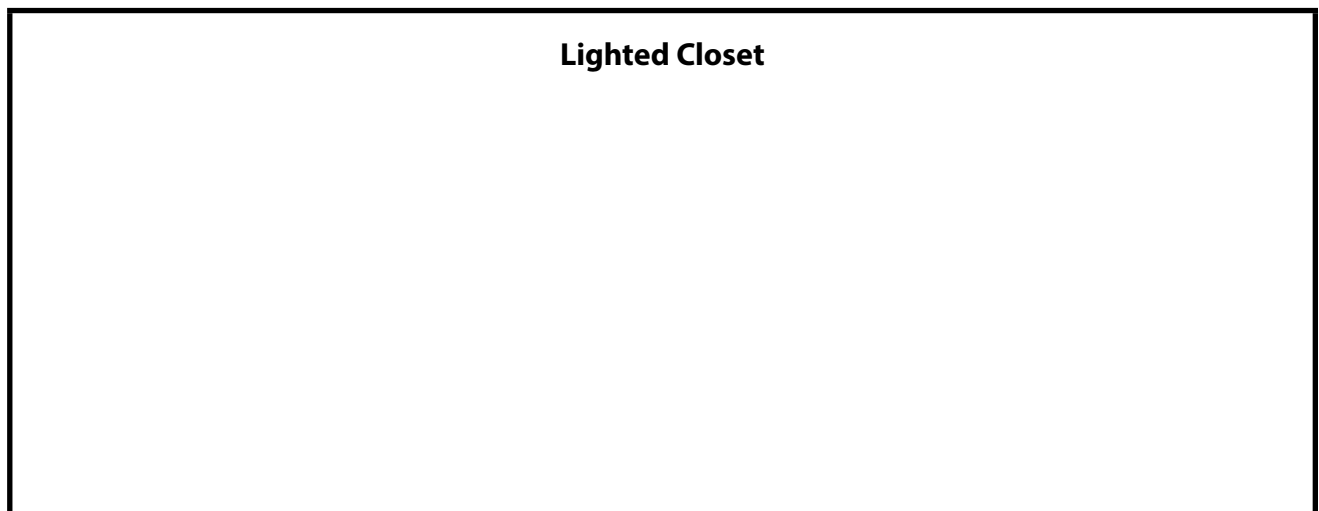
Follow steps 1 and 2.

1. Draw what you can see in a dark closet. Then draw what you can see in the same closet when a light is turned on.

Dark Closet



Lighted Closet



2. Write a sentence to explain the difference in your drawings.

Name _____

Date _____

Activity Page 2.5.1 (Page 1 of 2)

Use with Lesson 2.5

Draw a Funny Dark and Light Comic

Think of a funny story about looking for a lost object in the dark. Show how the object was found. Draw your story in four parts. Write the words people say in bubbles.

1. In panel 1, draw a place that is very dark.
Write what object is missing.
2. In panel 2, draw how the object looks in the darkness.
Write what a person might say.
3. In panel 3, draw an object that gives off light.
Write the name of the light source.
4. In panel 4, draw how the object looks when there is light.
Write what a person looking might say.

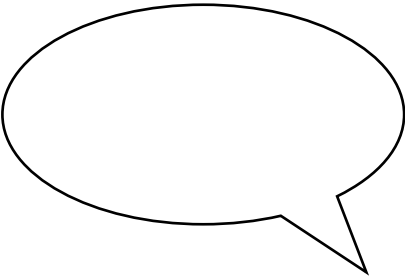
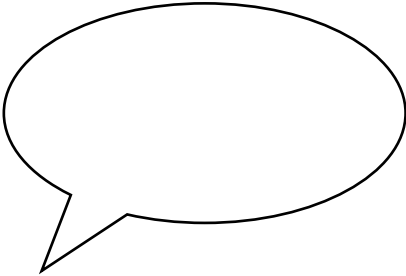
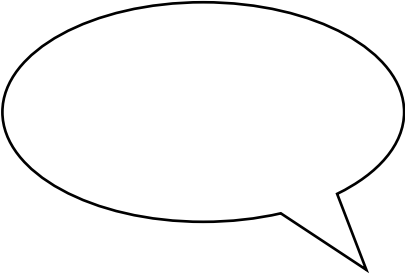
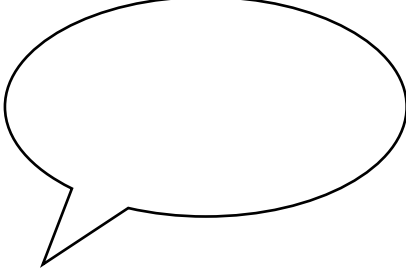
Name _____

Date _____

Activity Page 2.5.1 (Page 2 of 2)

Use with Lesson 2.5

Title: _____

<p>1</p> 	<p>2</p> 
<p>3</p> 	<p>4</p> 

Name _____

Date _____

Shadow Walk

Write about your shadow walk in the chart.

Object That Caused Light to Be Blocked	Light Source That Was Blocked

Shadow Makers

Answer each question. Then do your tests. Write what happens in the chart.

1. What is your question?

2. What test will you do?

Material We Tested	Dark Shadow or Light Shadow

Name _____

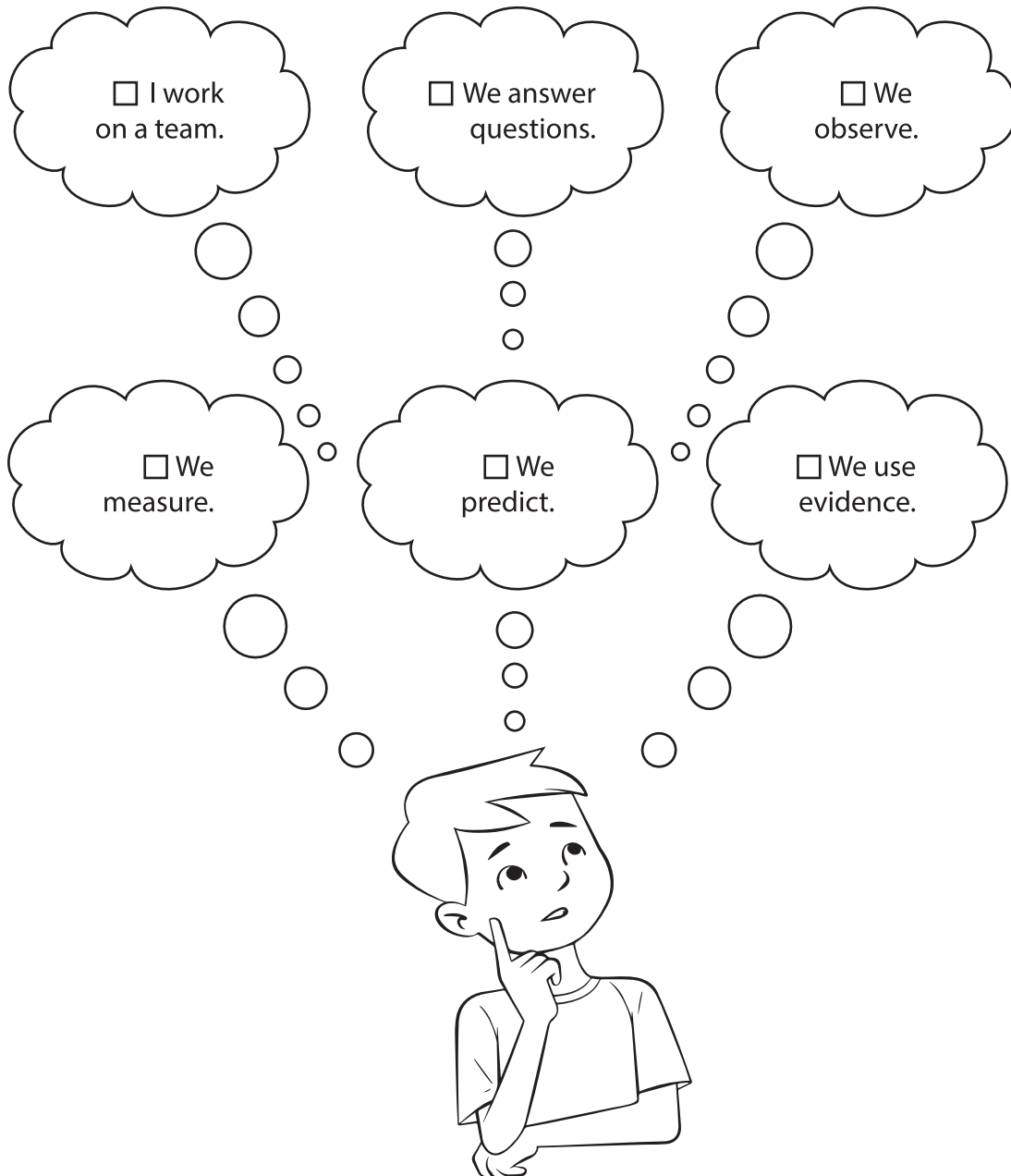
Date _____

Activity Page 3.2.2

Use with Lesson 3.2

Planning and Carrying Out Investigations

Add an X to each box as you complete that part of the investigation.



What Happens to a Light Beam When Materials Are Placed in Its Path?

- **List materials you will test in the chart.**
- **If you predict the black paper will light up a lot, draw a “W.”**
- **If you predict the black paper will light up a little, color the box gray.**
- **If you predict the black paper will not light up at all, color the box black.**
- **Then test each material, and use the same colors to show what you found.**



Material	I Predict	My Test

Name _____

Date _____

Activity Page 3.4.1

Use with Lesson 3.4

How We Will Find Materials That Change the Direction of Light

1. What test will your team do?

2. What materials do you need?

3. Draw and label a diagram of how you will do your test.

Our Test

Name _____

Date _____

Activity Page 3.4.2

Use with Lesson 3.4

What Materials Can Change the Direction of Light?

1. List materials you will test in the chart.
2. Test each material.
3. Circle *yes* or *no* to tell what you observed.

Material	Did it change the light's direction?	
	yes	no
	yes	no
	yes	no
	yes	no
	yes	no
	yes	no
	yes	no
	yes	no
	yes	no

Name _____

Date _____

Activity Page 3.5.1

Use with Lesson 3.5

Our Investigation of Light and Materials

Write what you learned.

1. What materials block light and make dark shadows?

2. What materials let some light through?

3. What materials let all light through?

4. What objects can change the direction of a light beam?

5. How was it helpful to work on a team?

6. What about light and materials surprised you?

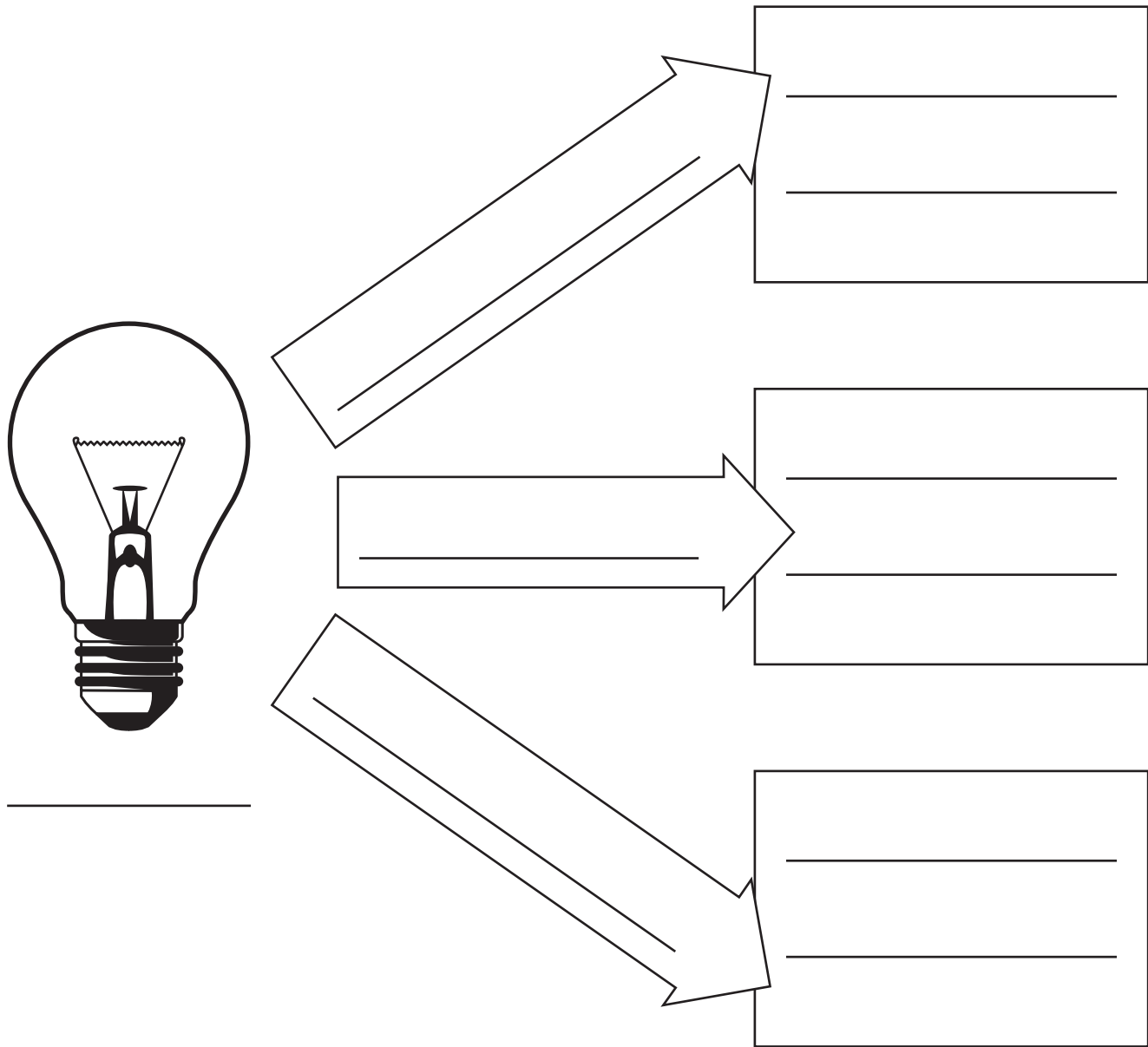
Mapping Our Ideas

Complete the graphic organizer.

Label the light source.

Label the light beams.

Write three ways materials affect light.



Name _____

Date _____

Activity Page 4.1.1

Use with Lesson 4.1

Use Morse Code

Think of a word to write in code. Find each letter on the chart. Draw the dots and dashes for each letter on the line.

Word: _____

Word in Morse code: _____

International Morse Code

A	■ ■ ■ ■ ■	N	■ ■ ■ ■ ■
B	■ ■ ■ ■ ■	O	■ ■ ■ ■ ■
C	■ ■ ■ ■ ■	P	■ ■ ■ ■ ■
D	■ ■ ■ ■ ■	Q	■ ■ ■ ■ ■
E	■	R	■ ■ ■ ■ ■
F	■ ■ ■ ■ ■	S	■ ■ ■ ■ ■
G	■ ■ ■ ■ ■	T	■ ■ ■ ■ ■
H	■ ■ ■ ■ ■	U	■ ■ ■ ■ ■
I	■ ■ ■ ■ ■	V	■ ■ ■ ■ ■
J	■ ■ ■ ■ ■	W	■ ■ ■ ■ ■
K	■ ■ ■ ■ ■	X	■ ■ ■ ■ ■
L	■ ■ ■ ■ ■	Y	■ ■ ■ ■ ■
M	■ ■ ■ ■ ■	Z	■ ■ ■ ■ ■

Name _____

Date _____

Tools for Communicating over Long Distances

Write or draw and label tools people use to send messages over long distances.

Name _____

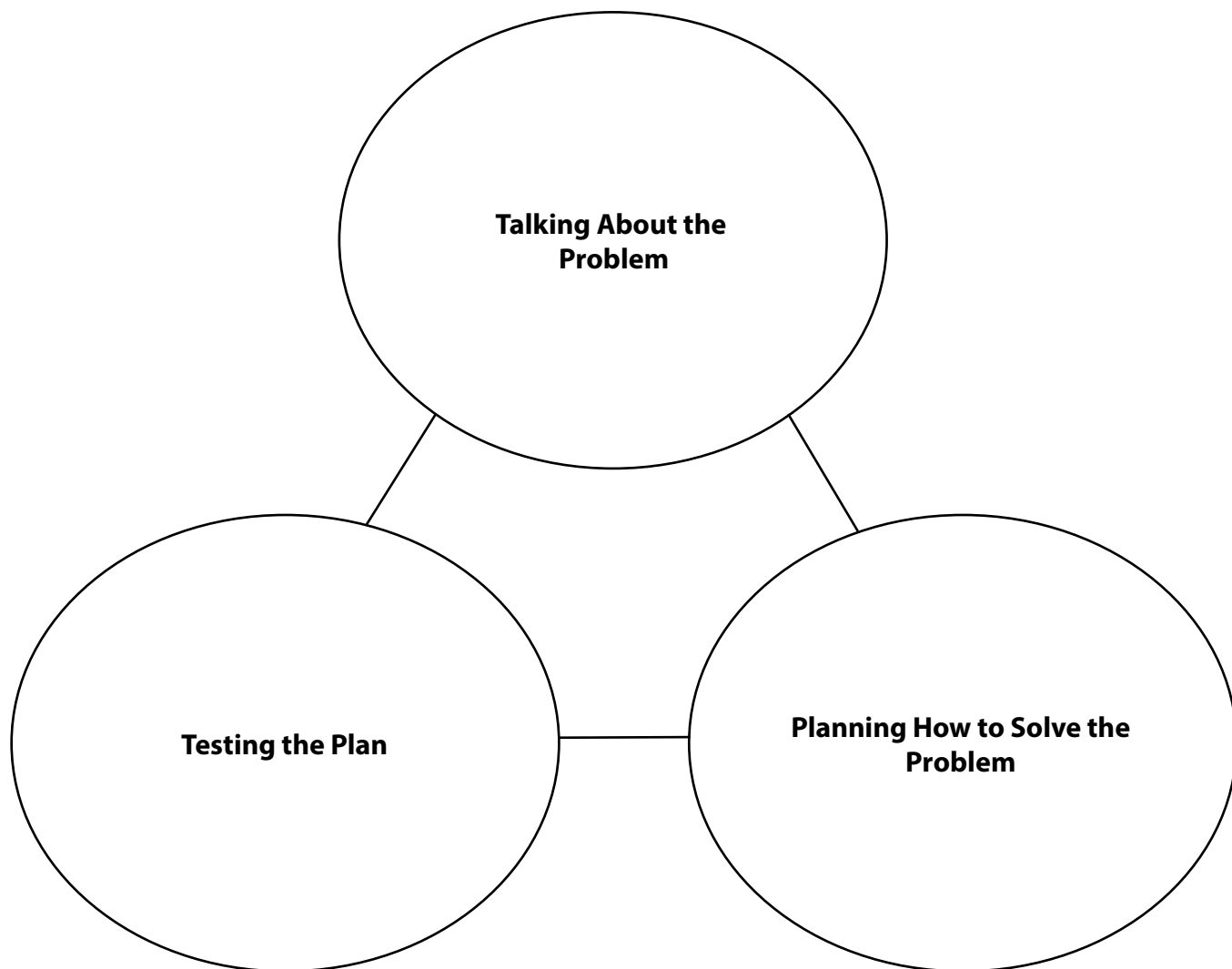
Date _____

Activity Page 4.2.1

Use with Lesson 4.2

How to Solve a Problem

Think about Mr. Ruiz's students. Write in the bubbles about their problem and how to solve it.



Name _____

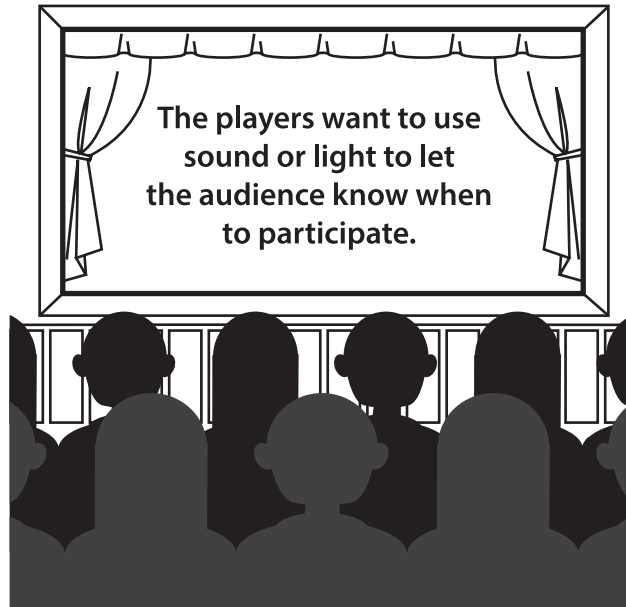
Date _____

Activity Page 4.3.1

Use with Lesson 4.3

Ask Questions About the Problem

Talk with your partner. Finish the question starters. Then add your own.



1. Where at school _____?
2. What science ideas _____?
3. What materials _____?
4. How much time do we have _____?
5. How will we communicate using _____?
6. How will we communicate using _____?
7. How will we know _____?
8. Distance to stage _____?
9. _____?

Name _____

Date _____

Activity Page 4.4.1

Use with Lesson 4.4

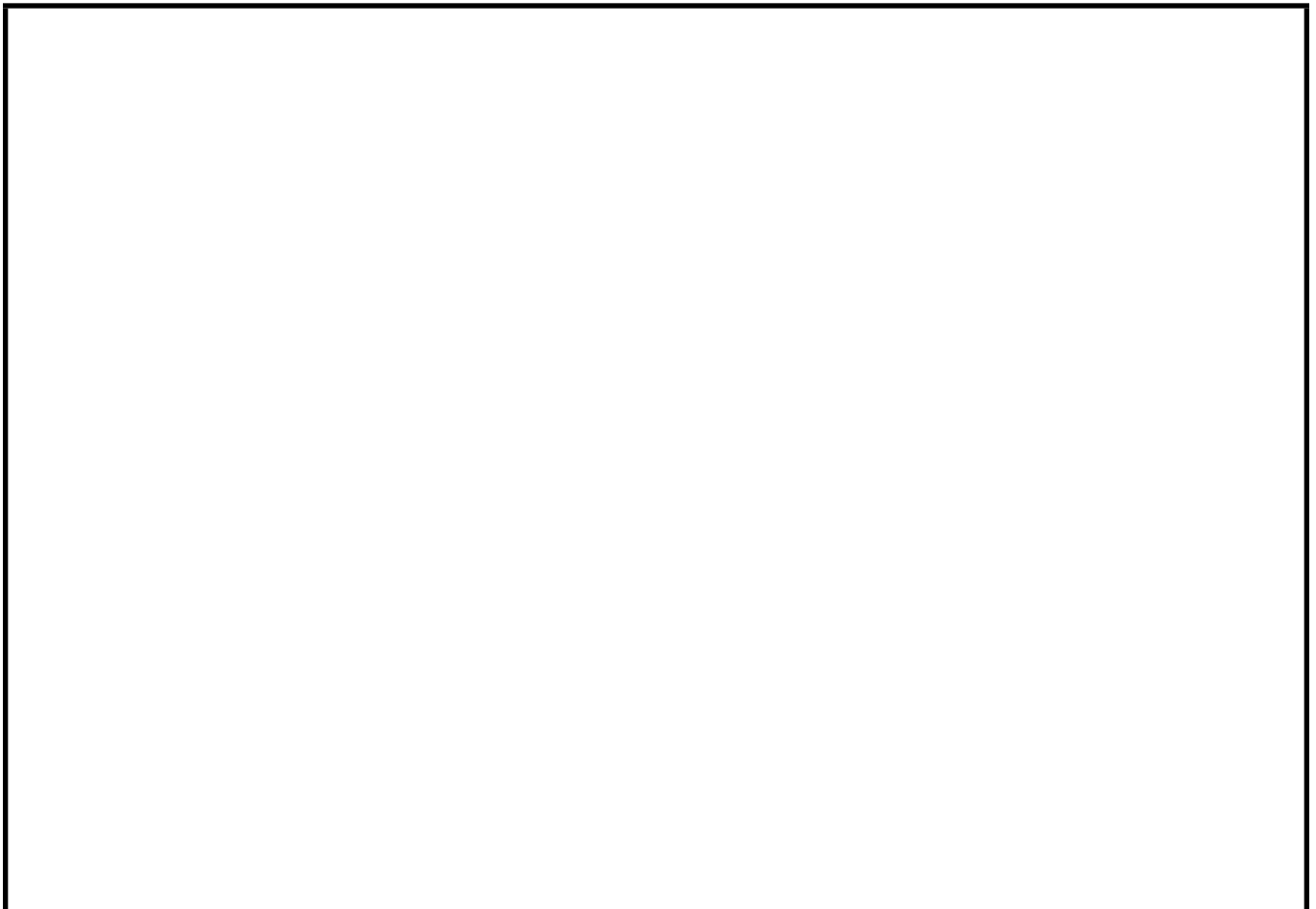
How We Solved the Problem

1. My team's name:

2. Materials we used:

Draw and label the parts of your tool.

Show how it works using sound or light.



Name _____

Date _____

Comparing Solutions

Write the name of each team.

Write if they used light or sound.

Score how well the solution worked.

Check Good, Better, or Best.

Team Name	Light or Sound?	Good	Better	Best

Activity Pages Answer Key: *Exploring Light and Sound*

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.

What We Can See and Hear at a Concert (AP UO.1) (page 179)

Students should draw themselves and others seated in the rows with actors on stage. Accept all drawings showing how light and sound are used.

Loud and Soft Sounds (AP 1.1.1) (page 180)

sample loud sounds: helicopter flying, loaded dump truck, car crashing, breaks squealing, lawn mower, blow-dryer, leaf blower, people sneezing

sample soft sounds: bird flying, bicycle wheels, car heater/air conditioner, combing hair, raking leaves, cat purring, person breathing

What Causes Sound? (AP 1.2.1) (page 181)

For sentence completion, students answers should note: that they stretched a rubber band over a box or whatever they used for the body; they made the rubber band vibrate; they know it vibrated because they could see it move back and forth; and that they heard a sound because vibrations cause sounds.

Student drawings should include a box with three rubber bands stretched over the opening in the box, a finger plucking the rubber band, and some way to indicate sounds.

What Causes Objects to Vibrate? (AP 1.3.1) (page 182)

For sentence completion, accept student responses that identify the materials they used. Students should also note that sound caused their materials to move in some way.

Student drawings should include a plastic cup/plastic wrap/rubber band setup, a child making a sound next to the lip of the cup, and some small pieces of matter sitting on the plastic wrap in motion.

Show Causes and Effects (AP 1.4.1) (page 183)

You strum a guitar. > The strings move back and forth.

The strings vibrate. > The air moves and vibrates.

The moving air vibrates. > Parts of your ears vibrate.

Your ears vibrate. > You hear a sound.

What Do Sound and Vibrations Do? (AP 1.5.1) (page 184)

1. Student drawings and labels should show a person singing into the open end of the kazoo and the waxed paper at the other end vibrating.
2. Student drawings and labels should show the instrument that the student designed and constructed with labels pointing to the parts that vibrate and vibrations moving through the air to a person's ear.
3. Accept all reasonable student explanations of material choices.

A Light Walk at Night (AP 2.1.1) (page 185)

Accept all student responses to lights they have seen.

How Bright Is That Light? (AP 2.2.1) (page 186)

sample dim light answers: computer power lights, smartphone screen lights, exit sign lights

sample bright light answers: computer screen lights, overhead lights in hallways, refrigerator lights

Does It Give Off Light? (AP 2.2.2) (page 187)

sample answers to gives off light: star, glow stick, flashlight

sample answers to does not give off light: eraser, pencil, block, ball

Let the Light Shine In (AP 2.3.1) (page 188)

Students should note that they cannot see the objects through the pinhole without the benefit of light.

Testing Light Makers (AP 2.3.2) (page 189)

Students should identify the light emitting object, how they can test it, and what makes it possible to see the object inside the box.

What's in the Closet? (AP 2.4.1) (page 190)

1. Dark Closet: Student drawings should show they cannot see in the dark closet.
Lighted Closet: Look for evidence in students' drawings that when a light is turned on in a closet, they can see objects clearly.
2. Student sentences should note that the difference in the two scenarios is the light source.

Draw a Funny Dark and Light Comic (AP 2.5.1) (pages 191–192)

Accept all reasonable student drawings. They should note that objects in light can be seen more clearly with more detail visible.

Shadow Walk (AP 3.1.1) (page 193)

Students should list objects that cast shadows, such as chairs, signs, fences, and people.

Students should identify the light source which was blocked by the object causing a shadow to be cast.

Shadow Makers (AP 3.2.1) (page 194)

Students should have a testable question and a plan to do the test. Accept all reasonable student responses for their testing.

Planning and Carrying Out Investigations (AP 3.2.2) (page 195)

Students should check off each part of the investigation as they complete it.

What Happens to a Light Beam When Materials Are Placed in Its Path? (AP 3.3.1) (page 196)

Accept all student predictions. Students should note that cardboard, wood, aluminum foil, and the mirror blocked all the light; tissue paper, waxed paper, and clouded plastic blocked most of the light; and clear plastic, clear glass, and the clear cup of water let all the light pass.

How We Will Find Materials That Change the Direction of Light (AP 3.4.1) (page 197)

Student plans and materials should match. Accept all reasonable student diagrams for their testing.

What Materials Can Change the Direction of Light? (AP 3.4.2) (page 198)

Students should list the materials they will test. Their results should be accurate for the material they tested.

Our Investigation of Light and Materials (AP 3.5.1) (page 199)

Accept student responses based on their science work and the reading passages.

Mapping Our Ideas (AP 3.5.2) (page 200)

Students should label their graphic organizers and have three real-world examples of how light and matter interact, such as blocks light, lets some light through, reflects light, and lets all the light through.

Use Morse Code (AP 4.1.1) (page 201)

Student words should match their Morse code .

Tools for Communicating over Long Distances (AP 4.1.2) (page 202)

Students should list the telegraph and Morse code. Remaining examples will depend on class research but may include examples such as smoke signals, drums, flags, signal lamps, traffic lights, and smartphones.

How to Solve a Problem (AP 4.2.1)
(page 203)

Student responses should include a problem such as, “How can the players signal the people in the audience using sound or light?” Their plan might include to try all kinds of sound and light makers. Their testing could include suggestions such as testing their ideas in the gym or lunchroom.

Ask Questions About the Problem (AP 4.3.1)
(page 204)

Students should complete all sentence stems and add an additional questions of their own.

How We Solved the Problem (AP 4.4.1)
(page 205)

Students should have a team name and a list of the materials used. A successful drawing should have labels and show how players can use a tool to communicate with the audience, including those in the last row.

Comparing Solutions (AP 4.4.2)
(page 206)

Students should evaluate every team’s solution and note if sound or light was used as part of the solution.

Student scoring should use the following criteria:

Good: None or one test signal reached the last row.

Better: The signal reached the last row more than once.

Best: The signal reached the last row during every test and was very clear to understand.

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.

B

bar code, n. an arrangement of two-dimensional graphic markings that contain coded data

beam, n. a ray or line of light (also *light beam*)

block, v. to get in the way of

bright, adj. giving off a lot of light

brightness, n. the quality of intensity of light

C

cause, v. to make something happen (n. the reason for an outcome)

cavity, n. an open space in something; a hole

change, v. to become different; to make something different (n. a difference from something's former condition)

code, n. a system of letters, symbols, patterns, or sounds used to communicate

communicate, v. to give information to someone

compare, v. to examine characteristics of two or more things, particularly looking for similarities

contrast, v. to look for differences between two things

D

dark, adj. with little or no light, not light

darkness, n. the condition of having little or no light

dentist, n. a doctor who cares for teeth

device, n. something planned or built for a specific purpose

dim, adj. giving off or illuminated by little light (v. to reduce an amount of light)

direction, n. the path along which something moves or the point toward which something is aimed

E

effect, n. a change that happens because of a cause

energy, n. the ability to cause change

engineer, n. a person who uses science to design solutions to problems, especially by constructing tools or devices (v. to design and build)

evidence, n. a detail that supports a claim or helps prove an idea is true

H

hear, v. to sense sound with your ears

hearing, n. the sense that enables the detection of sound

I

invent, v. to create something that did not exist before

L

laser, n. a device that produces an intense beam of light with specific properties

light, n. the type of energy that makes vision possible (v. to brighten)

light beam, n. a visible ray or straight shaft of light

light source, n. an object that gives off light

lit, adj. provided with light

loud, adj. describing intense sound at high volume

M

materials, n. matter that makes up different things

matter, n. anything that takes up space, even when you cannot see it

measure, v. to determine the amount of something

message, n. a communication

microphone, n. a device that picks up sound, for recording or to make it louder

mirror, n. a highly polished surface that reflects a clear image

O

object, n. a thing made of material

observe, v. to watch something and notice details about it (observation, n. the process of noticing details or a specific detail that is noticed)

opaque, adj. describing materials that do not allow light to pass through them

P

problem, n. a condition that falls short of satisfying a want or need

Q

quiet, adj. soundless or with little noise

R

record, v. to collect and keep information

reflect, v. to redirect or send back a light beam

reflection, n. a visible image bounced back by a shiny surface

requirement, n. something that is necessary or needed

S

scientific method, n. the series of steps in the investigation process that scientists use to make reliable discoveries

see, v. to detect images with eyes by sensing light

shadow, n. a dark area from which light is blocked by an object in front of the light source

shiny, adj. having a very smooth, glossy surface

signal, n. a piece of information sent to communicate

soft, adj. describing sound that is of low volume, the opposite of *loud*

solution, n. a process, action, or device that fixes a problem

solve, v. to fix a problem

sound, n. vibrations detected by the sense of hearing

spotlight, n. a bright beam of light that can be focused on something specific to call attention to it

surface, n. the outside part or uppermost layer of an object

surgery, n. a medical procedure that involves cutting into the body to repair it

T

tool, n. a device that helps in the performance of a task

translucent, adj. describing materials that allow some light to pass through them

transparent, adj. describing materials that allow light to freely pass through them and that can be seen through

U

useful, adj. helpful for a specific purpose

V

vibrate, v. to move back and forth quickly

vibration, n. rapid back-and-forth motion

volume, n. the loudness of a sound

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

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.

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.

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.



CKSci™
Core Knowledge **SCIENCE™**

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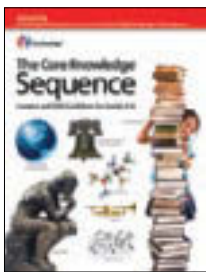
E.D. Hirsch Jr.

CKSci™

Core Knowledge **SCIENCE™**

Exploring Light and Sound

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
Core Knowledge SCIENCE series,
visit www.coreknowledge.org.

CKSci™
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