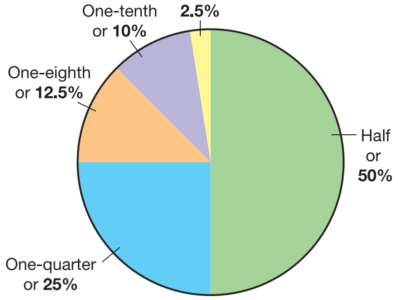
Core Knowledge® SCIENCE

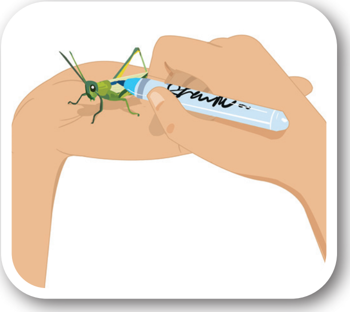
Making Sense of Science

Science Literacy Teacher Guide

Charts and graphs

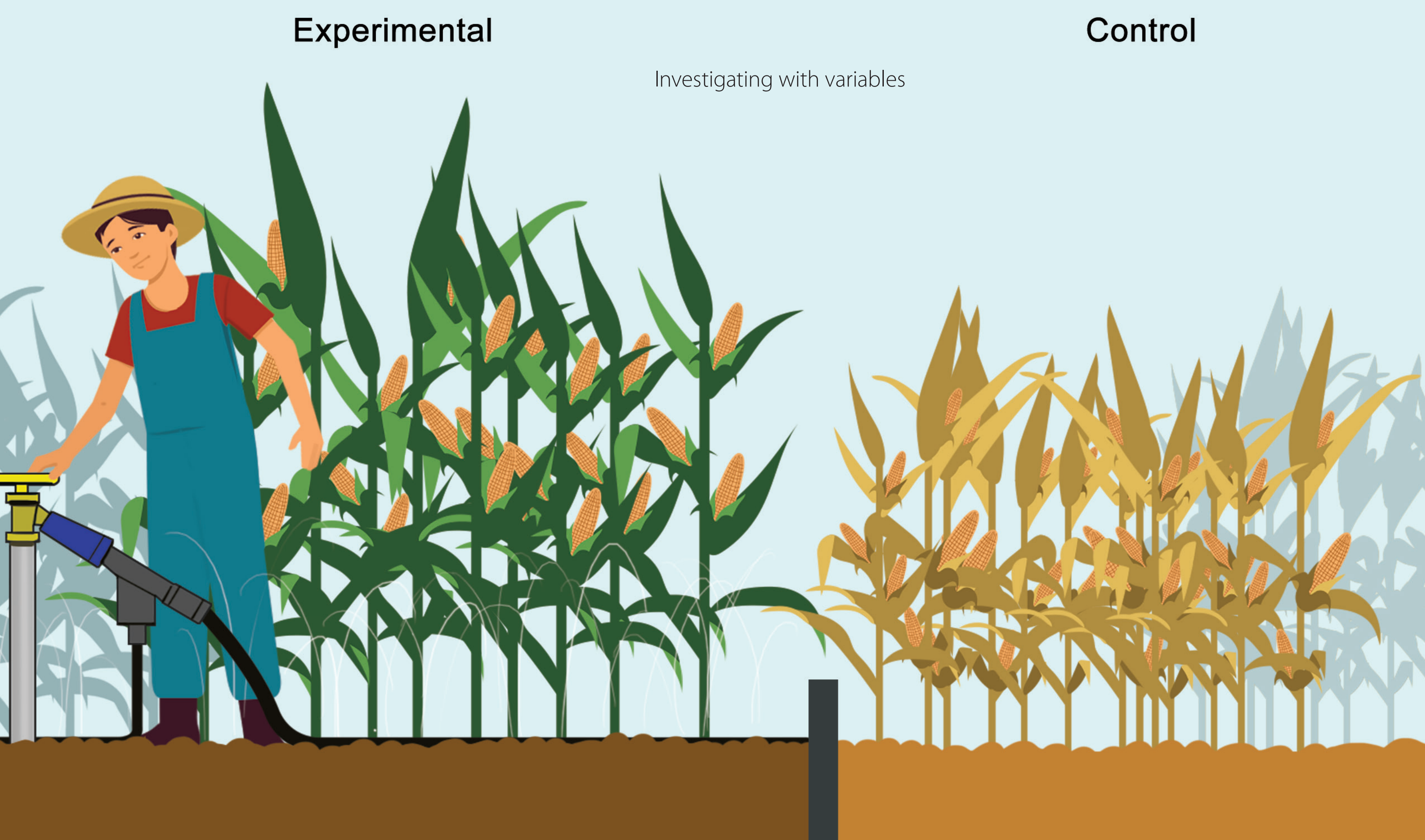


Collecting data



Structures and functions

Investigating with variables



Making Sense of Science

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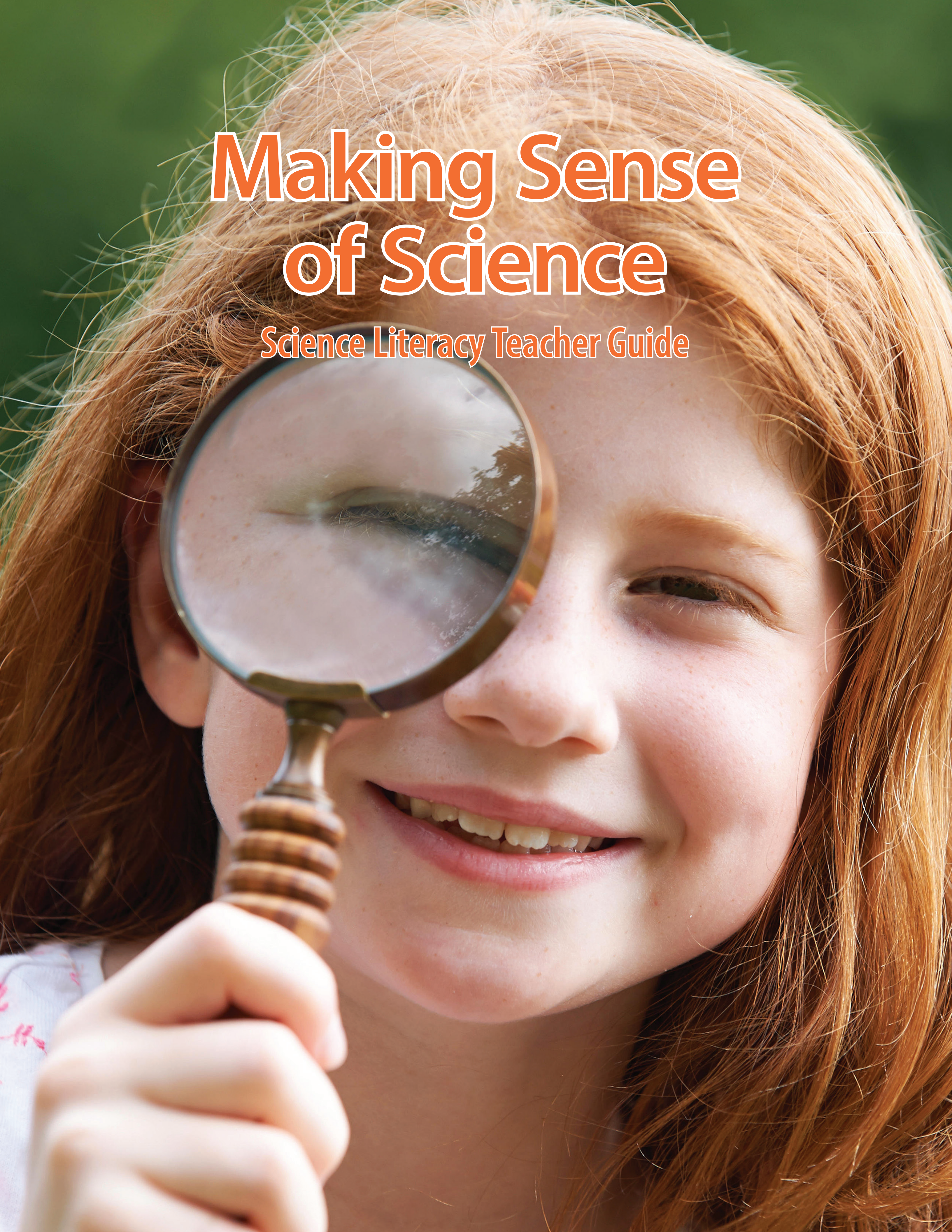

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Introduction

About Science Literacy

The goal of teaching students science from Kindergarten through high school graduation is not to turn every student into a scientist by profession, but rather it is to make scientifically literate citizens of them. At first glance, the term *science literacy* implies knowledge of the procedures and skills involved in scientific processes. A science-literate citizen does not necessarily commit to memory great volumes of content knowledge about the physical, life, or earth and space sciences. That person might know factual information, but science literacy is not limited to knowing facts. A science-literate person knows how to employ scientific thinking. Science literacy is a mindset that values the importance of observing, hypothesizing, and testing. Science literacy involves awareness of how scientists obtain and analyze data, what a conclusion is, how conclusions are shared, and what it means for an idea to be elevated to the status of a scientific theory or law. Furthermore, a person who is science-literate understands that science grows and that the science behind any subject may change as new facts become established. Certainly, science literacy must encompass all of these notions.

Expanding on this vision, a science-literate citizen understands the role of science in our society, acknowledging the importance of science knowledge in helping private and public groups make decisions based not on emotion, rumor, gossip, or hearsay but rather on the foundation of careful research and established scientific facts. One ethical commitment of a scientifically literate populace is a willingness to incorporate scientific thought into aspects of popular thought, emotion, and mood, and so scientific thinking helps balance discussions at all levels of government and all levels of private decision-making.

An even wider view of science literacy is that it can apply to all aspects of human learning, such as art, history, biography, mathematics, music, philosophy, and literature. To these areas of human endeavor, the scientifically literate person applies scientific thinking to make informed judgments about a novel or a painting to understand the artist's vision. A scientifically literate view of history, for example, focuses on how science and society interacted in the past, determines at what times science flourished, and examines when and why at other times it did not.

Core Knowledge Foundation is committed to a broad view of the term *science literacy* and to curricula that fosters science literacy in students incrementally over time. A person, no matter what age, can be conversant with grade-appropriate science processes. Young learners can consider science and its relationship to society. Relating a scientific mindset to other areas of human thought builds citizens capable of contributing, clarifying, and communicating worthy viewpoints to all aspects of societal life. Indeed, building a science-literate citizenry is an elevated goal.

Designed instructionally into the Core Knowledge curriculum, science literacy means students know the following:

- what science is,
- how to describe science and participate in it, and
- how to evaluate information as evidence and use data for decision-making.

With practice, students can grow into their own science literacy by knowing how to read about—and for emerging readers, listen to—scientific topics and discern validity. Science literacy is made more achievable for all learners with fortified background knowledge.

- In Grades K and 1, science literacy is focused on students learning science words.
- In Grades 2 and 3 science literacy expands to reading comprehension, to recognizing science concepts, and to students making connections from chapter contents
    - to processes in the day-to-day, and
    - to other content areas and disciplines.
- In Grades 4–5, science literacy expands to students understanding the uses of background knowledge and new information for decision-making and problem-solving.
- In Grades 6–8, science literacy increases in complexity with the evaluation of the quality of information and the legitimacy of claims and the evidence used to support them.

Vocabulary fluency is integral to background knowledge and literacy. By the end of the CK Science Literacy series for Kindergarten through Grade 5, students will have been repeatedly exposed to the meanings of dozens of science domain terms across multiple contexts.

Standards

Core Knowledge Science offers units that comprehensively address all of the Next Generation Science Standards (NGSS) in a three-dimensional approach that integrates Disciplinary Core Ideas (DCIs), Science and Engineering Practices (SEPs), and Crosscutting Concepts (CCCs). The program clusters the NGSS Performance Expectations into physical science, life science, and earth and space science units. Stemming from the commitment that background knowledge is essential, the units build around Student Books, which largely center on all of the NGSS DCI concepts. However, the pure NGSS approach de-emphasizes reading, and the standards do not treat the Science and Engineering Practices or the Crosscutting Concepts as *content*, or discreet ideas to be taught and learned. This omission makes the SEPs and CCCs logical concepts for focus of direct student attention. Core Knowledge maintains that it is favorable and valuable for students to read or hear stories that are specifically about practices and overarching concepts.

The lessons in Grade 3 Core Knowledge Science Literacy are constructed to cultivate student exposure to and understanding of the ideas present in the following NGSS dimensions. Lessons also cite relevant support of Common Core State Standards for English and Language Arts.

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.

National Governors Association Center for Best Practices, Council of Chief State School Officers. 2010. *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects*. National Governors Association Center for Best Practices, Council of Chief State School Officers, Washington D.C.

Nature of Science

NOS1. Scientific Investigations Use a Variety of Methods

- Science investigations begin with a question.
- Scientists use different ways to study the world.

NOS2. Scientific Knowledge is Based on Empirical Evidence

- Scientists look for patterns and order when making observations about the world.

NOS3: Scientific Knowledge is Open to Revision in Light of New Evidence

- Science knowledge can change when new information is found

NOS1. Scientific Investigations Use a Variety of Methods

- Science methods are determined by questions.
- Science investigations use a variety of methods, tools, and techniques.

NOS2. Scientific Knowledge Is Based on Empirical Evidence

- Science findings are based on recognizing patterns.
- Scientists use tools and technologies to make accurate measurements and observations.

NOS3. Scientific Knowledge Is Open to Revision in Light of New Evidence

- Science explanations can change based on new evidence.

NOS4. Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- Science theories are based on a body of evidence and many tests.
- Science explanations describe the mechanisms for natural events.

NOS5. Science Is a Way of Knowing

- Science is both a body of knowledge and processes that add new knowledge.
- Science is a way of knowing that is used by many people.

NOS6. Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes consistent patterns in natural systems.
- Basic laws of nature are the same everywhere in the universe.

NOS7. Science Is a Human Endeavor

- Men and women from all cultures and backgrounds choose careers as scientists and engineers.
- Most scientists and engineers work in teams.
- Science affects everyday life; Creativity and imagination are important to science.

NOS8. Science Addresses Questions About the Natural and Material World

- Science findings are limited to what can be answered with empirical evidence.

Science and Engineering Practices

SEP1. Asking Questions (for science) and Defining Problems (for engineering)

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas. Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.

- Ask questions about what would happen if a variable is changed.
- Identify scientific (testable) and non-scientific (non-testable) questions.
- Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
- Use prior knowledge to describe problems that can be solved.
- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

SEP2. Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs. Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Identify limitations of models.
- Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.
- Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.
- Develop and/or use models to describe and/or predict phenomena.
- Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.
- Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.

SEP3. Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions. Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
- Evaluate appropriate methods and/or tools for collecting data.
- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
- Make predictions about what would happen if a variable changes.
- Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.

SEP4. Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis. Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective. Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations.

- When possible and feasible, digital tools should be used.
- Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.
- Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.
- Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
- Analyze data to refine a problem statement or the design of a proposed object, tool, or process.
- Use data to evaluate and refine design solutions.

SEP5. Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.

- Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success.
- Organize simple data sets to reveal patterns that suggest relationships.
- Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems.
- Create and/or use graphs and/or charts generated from simple algorithms to compare alternative solutions to an engineering problem.

SEP6. Constructing Explanations (science) and Designing Solutions (engineering)

The end-products of science are explanations and the end-products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints. Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard).
- Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
- Identify the evidence that supports particular points in an explanation.
- Apply scientific ideas to solve design problems.
- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

SEP7. Engaging in Argument from Evidence

Argumentation is the process by which evidence-based conclusions and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims. Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).

- Compare and refine arguments based on an evaluation of the evidence presented.
- Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.
- Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.

- Construct and/or support an argument with evidence, data, and/or a model.
- Use data to evaluate claims about cause and effect.
- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

SEP8. Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to obtain information that is used to evaluate the merit and validity of claims, methods, and designs. Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.

- Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.
- Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.
- Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.
- Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.

Crosscutting Concepts

CCC1. Patterns

Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. In grades 3–5, students routinely identify and test causal relationships and use these relationships to explain change. They understand events that occur together with regularity might or might not signify a cause and effect relationship.

Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products. Patterns of change can be used to make predictions. Patterns can be used as evidence to support an explanation.

Patterns . . . are a pervasive aspect of all fields of science and engineering. When first exploring a new phenomenon, children will notice similarities and differences leading to ideas for how they might be classified. The existence of patterns naturally suggests an underlying cause for the pattern. For example, observing snowflakes are all versions of six-side symmetrical shapes suggests something about how molecules pack together when water freezes; or, when repairing a device a technician would look for a certain pattern of failures suggesting an underlying cause. Patterns are also helpful when interpreting data, which may supply valuable evidence in support of an explanation or a particular solution to a problem.

CCC2. Cause and Effect—Mechanism and Explanation

Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts. In grades 3–5, students identify similarities and differences in order to sort and classify natural objects and designed products. They identify patterns related to time, including simple rates of change and cycles, and to use these patterns to make predictions. Cause and effect relationships are routinely identified, tested, and used to explain change. Events that occur together with regularity might or might not be a cause-and=effect relationship.

Cause and effect lies at the heart of science. Often the objective of a scientific investigation is to find the cause that underlies a phenomenon, first identified by noticing a pattern. Later, the development of theories allows for predictions of new patterns, which then provides evidence in support of the theory. For example, Galileo's observation that a ball rolling down an incline gathers speed at a constant rate eventually led to Newton's Second Law of Motion, which in turn provided predictions about regular patterns of planetary motion, and a means to guide space probes to their destinations.

CCC3. Scale, Proportion and Quantity

In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance. In grades 3–5, students recognize natural objects and observable phenomena exist from the very small to the immensely large. They use standard units to measure and describe physical quantities such as weight, time, temperature, and volume. Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Scale, proportion, and quantity are essential considerations when deciding how to model a phenomenon. For example, when testing a scale model of a new airplane wing in a wind tunnel, it is essential to get the proportions right and measure accurately or the results will not be valid. When using a computer simulation of an ecosystem, it is important to use informed estimates of population sizes to make reasonably accurate predictions. Mathematics is essential in both science and engineering.

CCC4. Systems and System Models

Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

In grades 3–5, students understand that a system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. They can also describe a system in terms of its components and their interactions. A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. A system can be described in terms of its components and their interactions.

Systems and system models are used by scientists and engineers to investigate natural and designed systems. The purpose of an investigation might be to explore how the system functions, or what may be going wrong. Sometimes investigations are too dangerous or expensive to try out without first experimenting with a model.

CCC5. Energy and Matter—Flows, Cycles, and Conservation

Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations. In grades 3–5, students learn matter is made of particles and energy can be transferred in various ways and between objects. Students observe the conservation of matter by tracking matter flows and cycles before and after processes and recognizing the total weight of substances does not change. Matter is made of particles. Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems. Energy can be transferred in various ways and between objects.

Energy and matter are basic to any systems model, whether of a natural or a designed system. Systems are described in terms of matter and energy. Often the focus of an investigation is to determine how energy or matter flows through the system, or in the case of engineering to modify the system, so a given energy input results in a more useful energy output.

CCC6. Structure and Function

The way in which an object or living thing is shaped and its substructure determine many of its properties and functions. In grades 3–5, students learn different materials have different substructures, which can sometimes be observed; and substructures have shapes and parts that serve functions. Different materials have different substructures, which can sometimes be observed. Substructures have shapes and parts that serve functions.

Structure and function can be thought of as a special case of cause and effect. Whether the structures in question are living tissue or molecules in the atmosphere, understanding their structure is essential to making causal inferences. Engineers make such inferences when examining structures in nature as inspirations for designs to meet people's needs.

CCC7. Stability and Change (factors to always consider)

For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study. In grades 3–5, students measure change in terms of differences over time, and observe that change may occur at different rates. Students learn some systems appear stable, but over long periods of time they will eventually change. Change is measured in terms of differences over time and may occur at different rates. Some systems appear stable, but over long periods of time will eventually change.

Stability and change are ways of describing how a system functions. Whether studying ecosystems or engineered systems, the question is often to determine how the system is changing over time, and which factors are causing the system to become unstable.

Engineering and Design

ED.A. Defining and Delimiting Engineering Problems

Defining and delimiting engineering problems involves stating the problem to be solved as clearly as possible in terms of criteria for success, and constraints or limits.

- Define - Specify criteria and constraints that a possible solution to a simple problem must meet.

ED.B. Developing Possible Solutions

Designing solutions to engineering problems begins with generating a number of different possible solutions, then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem.

- Develop solutions - Research and explore multiple possible solutions.

ED.C. Optimizing Design Solutions

Optimizing the design solution involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important.

- Optimize - Improve a solution based on results of simple tests, including failure points.

Science, Technology, Society, and the Environment

STSE1. Interdependence of Science, Engineering, and Technology

- Science and technology support each other; Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.

STSE2. The Influence of Engineering, Technology, and Science on Society and the Natural World

- People's needs and wants change over time, as do their demands for new and improved technologies. Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. When new technologies become available, they can bring about changes in the way people live and interact with one another.

Common Core State Standards for English and Language Arts

Reading Standards for Informational Text

Key Ideas and Details:

- **CCSS.ELA-LITERACY.RI.4.1:** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
- **CCSS.ELA-LITERACY.RI.4.2:** Determine the main idea of a text and explain how it is supported by key details; summarize the text.
- **CCSS.ELA-LITERACY.RI.4.3:** Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

Craft and Structure:

- **CCSS.ELA-LITERACY.RI.4.4:** Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a *grade 4 topic or subject area*.
- **CCSS.ELA-LITERACY.RI.4.5:** Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.
- **CCSS.ELA-LITERACY.RI.4.6:** Compare and contrast a firsthand and secondhand account of the same event or topic; describe the differences in focus and the information provided.

Integration of Knowledge and Ideas:

- **CCSS.ELA-LITERACY.RI.4.7:** Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
- **CCSS.ELA-LITERACY.RI.4.8:** Explain how an author uses reasons and evidence to support particular points in a text.
- **CCSS.ELA-LITERACY.RI.4.9:** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.

Range of Reading and Level of Text Complexity:

- **CCSS.ELA-LITERACY.RI.4.10:** By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 4–5 text complexity band proficiently, with scaffolding as needed at the high end of the range.

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.

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

Features

Using the Student Book

Online Resources

The *Making Sense of Science* Student Reader includes twenty chapters and a student Glossary that provides definitions to Core Vocabulary words. Engaging text, photographs, and diagrams encourage students to draw upon their own experiences and the world around them to understand scientific concepts. The Student Reader is spiral bound to allow students to lay it flat when reading or following along. Core Knowledge offers a template for a bookmark. (See the Online Resources Guide for a link to the template. **www.coreknowledge.org/cksci-online-resources**) When starting any unit of study, you may wish to download the template, print one per student, and have each student create a personal bookmark.

Explore, then read: In the core units of the CKSci program, lessons are sequenced to provide active engagement before reading. First, students explore phenomena through hands-on investigations or teacher demonstrations, accompanied by active questioning and analysis; then, students study the informational text provided in the Student Readers, including the Science Literacy series.

CK Science Literacy Student Readers extend, clarify, and confirm what students have learned in their investigations. The text helps students develop a sense of the language of science while images, diagrams, charts, and graphs deepen conceptual understanding. Use of the CK Science Literacy Student Readers supports the Science and Engineering Practice "Obtaining, Evaluating, and Communicating Information" as described in *A Framework for K–12 Science Education*.

Independent reading or group read-aloud: While the text in the Student Readers is written for independent reading, we encourage group read-aloud and engagement with the text. The Teacher Guide provides Guided Reading Supports to prompt discussion, clarify misconceptions, and promote understanding in relation to the Lesson Questions.

The intent of the Grades 3–5 CK Science Literacy lessons is to build students' understanding and knowledge of science concepts, as well as of associated practices and skills, using text 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 texts 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.

Online Resources

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

Activity Pages

Activity Pages

AP 1–20

Black line reproducible masters for Activity Pages, as well as an Answer Key, are included in Teacher Resources on pages 96–118. 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.

Lesson 1—Design Your Own Experiment! (AP 1)

Lesson 2—Laws of Nature (AP 2)

Lesson 3—Target Practice (AP 3)

Lesson 4—Testable or Not Testable (AP 4)

Lesson 5—Modeling Weather (AP 5)

Lesson 6—How Much Data? (AP 6)

Lesson 7—What's Going on in This Graph? (AP 7)

Lesson 8—Eye Color and Vision (AP 8)

Lesson 9—Reading the News (AP 9)

Lesson 10—Science News (AP 10)

Lesson 11—Reporting the Science (AP 11)

Lesson 12—A Pattern in Writing (AP 12)

Lesson 13—Diagram of a Feedback Loop (AP 13)

Lesson 14—Practicing Informed Estimates (AP 14)

Lesson 15—Simple or Complex (AP 15)

Lesson 16—Conservation of Matter (AP 16)

Lesson 17—Structures and Functions (AP 17)

Lesson 18—Short and Long Changes (AP 18)

Lesson 19—Fair Test Questions (AP 19)

Lesson 20—Risky Business (AP 20)

Online Resources and Digital Engagements

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. In addition to resources supporting specific chapter activities, Core Knowledge also offers a collection of Digital Engagements designed for teacher-facilitated classroom use.

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

www.coreknowledge.org/cksci-online-resources

Materials and Equipment

These lessons suggest a moderate variety of materials to support activities that enhance the Science Literacy chapter readings. Prepare in advance by collecting the materials and equipment needed for all the demonstrations and hands-on investigations.

Internet access and the means to project images/videos for whole-class viewing are also required in many lessons but not repeated below.

Lesson 2

- reference books and other research materials

Lesson 3

- reference books and other research materials
- ball and hoop for each group
- large pieces of paper and drawing materials such as markers or crayons

Lesson 4

- gummy bears
- cup of water

Lesson 6

- information leaflets from medicines or printouts of medicine leaflets

Lesson 8

- modeling clay, toothpicks, ruler
- paper and pencil

Lesson 9

- reference book and other research materials
- tablets or computers for each student or pair

Lesson 10

- print articles for AP 10

Lesson 11

- tablets or computers for pairs or groups of three
- sticky notes
- drawing and poster materials such as poster board, butcher paper, markers, and crayons

Lesson 13

- pieces of paper and pencil

Lesson 14

- scissors
- small cups or containers (optional)
- handful of beans, small counters, or other small objects
- checkerboard

Lesson 20

- optional reference book and other research materials

Pacing

The Core Knowledge Science Literacy Student Reader consists of twenty chapters, each six pages long. This accompanying Teacher Guide contains one lesson of instructional support per chapter. Each lesson offers prompts for the teacher to use to facilitate class discussion. Many lessons offer brief hands-on activities, teacher demonstrations, or online enhancements in addition to the reading support. All lessons include an Activity Page reproducible master.

The Science Literacy lessons, requiring 30–45 minutes each, can be implemented in sequence, as a stand-alone unit across twenty consecutive class sessions. The unit can also serve as the basis of an enrichment program. Or, teachers may elect to use one lesson per week across the school year, layered in tandem with other physical, life, and earth/space science content units. To assist with the latter approach, the following table provides a key suggesting the science domain most prominently emphasized in each Science Literacy chapter to help pair the chapters meaningfully with other units.

Science Literacy Chapter	Has content that ties to . . .	Science Literacy Chapter	Has content that ties to . . .
1. Methods, Tools, and Techniques	Physical, life, and earth science	**11.** Science Reports	Physical and earth science, earth-shaping processes
2. Laws That Are Never Broken	Physical, life, and earth science	**12.** How to Decide	Physical and earth science, natural resources
3. Accurate and Precise	Physical science, waves	**13.** What's a Feedback Loop?	Physical and earth science, natural resources
4. Is It Testable?	Physical science, waves	**14.** Counting Populations	Life science, structures and functions
5. Concrete or Abstract	Physical science, waves	**15.** Simple Versus Complex	Physical science, collisions
6. Enough Data	Earth science, natural resources	**16.** It's Still There	Physical science, collisions
7. Charts and Graphs	Life science, structures and functions	**17.** Fantastic Functions	Life science, structures and functions
8. Columns and Rows	Life science, structures and functions	**18.** Was That Fast?	Life science, structures and functions
9. Strength of Evidence	Physical and earth science, earth-shaping processes	**19.** The Better Plan	Physical science, electricity
10. Think It Through!	Physical and earth science, earth-shaping processes	**20.** Risk	Physical science, electricity

Online Resources

Also, see the Online Resources Guide for recommendations about when to best enhance instruction through the use of the Core Knowledge Science Literacy Digital Engagements designed to support these chapters.

www.coreknowledge.org/cksci-online-resources

LESSON 1

Methods, Tools, and Techniques

At a Glance

Lesson Question

What are methods, tools, and techniques?

Learning Objectives

✓ Describe and classify tools used in investigations for observation, magnification, measurement, recording, and safety.

✓ Describe techniques and methods that most all scientific investigations have in common.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- experimental design exercise

Main Science Idea

Though they can be very different from one to the next, science investigations share common tools, techniques, and methods.

NGSS and CCSS References

NOS1. Scientific Investigations Use a Variety of Methods: Science investigations use a variety of methods, tools, and techniques to make measurements and observations. (Also **NOS5** and **NOS7**)

RI.4.7. Integration of Knowledge and Ideas: Interpret information presented visually, orally, or quantitatively and explain how the information contributes to an understanding of the text in which it appears.

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

www.coreknowledge.org/cksci-online-resources

Core Vocabulary and Language of Instruction

The Glossary at the end of this Teacher Guide lists definitions for Core Vocabulary and selected Language of Instruction.

Core Vocabulary terms are those that students should learn to use accurately in discussion. During instruction, expose students repeatedly to these terms but not through isolated drill or memorization.

method **technique** **tool**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

control **data** **pattern** **results** **variable**

Instructional Resources

Student Reader

Ch. 1

Student Reader, Chapter 1
"Methods, Tools, and Techniques"

Activity Page

AP 1

Activity Page
Design Your Own Experiment! (AP 1)

Materials and Equipment

Collect or prepare the following items:

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

The Core Lesson

1. Focus attention on the Lesson Question.

Online Resources

Talk to students about NASA's OSIRIS-REx mission. Watch a short video introducing the mission to students. While they are watching, encourage students to think about why this mission is important and what the goal(s) might be. What tools do they think scientists will use and develop throughout the mission? (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What are methods, tools, and techniques?

2. Read and discuss: "Methods, Tools, and Techniques."

Student Reader

Ch. 1

Prepare to read together, or have students read independently, Chapter 1 "Methods, Tools, and Techniques." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 2

- Scientists use different tools to make observations. What kinds of tools have you used to make quantitative observations? (*I have used measuring tape, rulers, beakers, counting, balances, and scales.*)
- The technique they are using is sampling. Why is this a technique and not a method or a tool? (*The tool is the thing they are using to collect the data—the measuring tape and nets. The method is that they are making quantitative observations by measuring. The technique is sampling because this is how they are doing the test.*)
- Lead a discussion analyzing the test depicted in the second image. (*Their question or problem is they want to understand stream chemistry (what's in the water). Their technique is to sample water. Their method is probably to gather quantitative measurements and probably some other observations like smell or color. Their tools may be microscopes, buckets, nets, and scales.*)

Page 3

- Focus on the term *specimen*. Clarify that specimens can be samples of living or nonliving things that are studied.
- What question was the scientist trying to answer? (*What kinds of insects live in the field?*)
- What tool, method, and technique did they use? (*They probably used nets, the method was probably naming the insects, and the technique was sampling by collecting specimens.*)

Page 4

- What question might the scientist be answering with these data? (*How big are the trout in the lake?*)
- Scientists took samples and collected specimens (the technique). What methods did they use to make observations of the specimens they collected? (*They took quantitative observations by measuring the mass and length.*)
- A pattern is something you see over and over again in the data. What is the pattern in these data? (*The pattern is the longer the fish, the heavier it is.*)

Know the Standards

NOS5. Science Is a Way of Knowing Science is often viewed as being only content. On the contrary, science includes knowing the content as well as doing practices, following processes, and using behavioral dispositions in the search for answers and explanations.

NOS7. Science Is a Human Endeavor Doing science means being creative, using critical thinking skills, and solving problems. Scientists rely on and use traits like these to conduct their work.

Page 5

- Describe why it is important to have a control in an experiment. (*It is important because a control is the only thing that remains unchanged. Everything else is changed, but the control gets nothing special. This lets the researcher know that whatever difference they see is caused by the thing that was changed.*)

Page 6

- Why are consistent results important? (*Consistent results are important because they tell you that the result didn't happen by accident or by chance. It will always happen.*)
- Lead a discussion focusing on consistency. What results are consistent, and how does that help you? (*Sample answers: When I study for a test, I always do better than if I didn't. This helps me know that studying helps me learn and remember. When I practice soccer more, I do better in my games. This helps me know that practicing helps me perform better in sports.*)
- Look at the list of similar experiments other farmers might conduct. Have students pair-share and think about how they would set up one of the experiments. Ask them to consider the question, variables, control, tools, and methods. (*Possible answer: Do pollinators help plants grow better? Variables are amount of water, same type of seed, and same weather. The control is the row of plants that doesn't have pollinators visiting them. Methods are quantitative observations, and tools are counting and measuring tape.*)

Page 7

- Ask students to share any times they have seen scientific findings reported. Some examples may include informational readings in school, magazines, newspapers, or news reports. Encourage students to share any graphics they may have seen.
- Stream a recent local weather report. Have students point out each time they see a graphic. How would the weather report be different without these graphics?

3. Check for understanding.

Activity Page

AP 1

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Reinforce that, though science investigations can be very different from one to the next, they share common tools, techniques, and methods.

Have students work together in pairs to design an experiment of their own. Use Activity Page 1 to informally assess students' understanding of the Core Vocabulary (*tool*, *method*, and *technique*).

See the Answer Key for sample or correct answers.

LESSON 2

Laws That Are Never Broken

At a Glance

Lesson Question

Where do the laws of nature apply? (Everywhere!)

Learning Objectives

- ✓ Articulate that gravity has the same effect everywhere on Earth.
- ✓ Describe how shadows always appear on the opposite side of objects from light sources.
- ✓ Describe how warmer and cooler objects always eventually reach room temperature.
- ✓ Recognize that freezing and melting of water always happen at the same temperature, no matter where the water is.
- ✓ Identify the concept of natural laws as the common thread among provided phenomena.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- card sort

Main Science Idea

The laws of nature apply everywhere.

NGSS and CCSS References

NOS4. Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena: Science theories are based on a body of evidence and many tests; Science explanations describe the mechanisms for natural events. (Also **NOS6** and **NOS8**)

RI.4.2. Key Ideas and Details: Determine the main idea of a text and explain how it is supported by key details; summarize the text.

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law **theory**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

gravity **observations** **shadows**

Instructional Resources

Student Reader

Ch. 2

Student Reader, Chapter 2
"Laws That Are Never Broken"

Activity Page

AP 2

Activity Page
Laws of Nature (AP 2)

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- reference books and other research materials

Advance Preparation:

- If conducting the climbing water demonstration, start the demonstration the day prior to this lesson.

The Core Lesson

1. Focus attention on the Lesson Question.

Online Resources

Watch a video on climbing water. Before the video, stop and ask students what they think might happen and why. Prompt students to talk about gravity—that most things move down instead of up. Once students see the video, ask them if this defies gravity. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: Where do the laws of nature apply? (Everywhere!)

Know the Standards

NOS6. Scientific Knowledge Assumes an Order and Consistency in Natural Systems: Scientific laws are based on many observations and pieces of evidence. The consistency allows scientists to develop laws that help support them in creating explanations and predictions.

2. Read and discuss: "Laws That Are Never Broken."

Student Reader

Ch. 2

Prepare to read together, or have students read independently, Chapter 2 "Laws That Are Never Broken." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 8

- The Law of Universal Gravitation says what will happen between two objects. Why is this a law and not a theory? What might the theory say? (*It describes what will happen, not why. The theory will explain why objects are attracted to each other.*)
- Focus on the word *phenomena* in the caption. Remind students that phenomena are things that we notice and wonder about and that can be explained by science. How do scientists use phenomena when developing laws and theories? (*They look at phenomena and gather lots of observations and data. They probably do tests to see if the phenomena act the same way every time.*)

Page 9

- Rephrase the law: a shadow is made when an object blocks the light. Encourage students to practice making a shadow, observing if it follows the law. Does it happen any other way? (*No, shadows are always made when there is something blocking the light source.*)
- Think about the difference in the scientific questions that laws and theories are trying to answer. (*Law: What happens when an object blocks a light source? Theory: How are shadows made?*)
- Remind students that lots and lots of observations go into making a scientific law. Scientists saw that the phenomenon happened the same way over and over again. This is why it is a law.

Page 10

- Reread the first sentence. Ask students if they can restate the law in their own words, and discuss if they have ever seen the law broken. (*Heat flows from warmer objects toward cooler objects until they are the same temperature.*)

  SUPPORT—Take a moment to unpack the law as stated in the Student Reader. Discuss other examples of the law, such as the following: holding your cold hand over a warm cup of hot chocolate, sitting on a cold couch but it's warm after you stand up, or feeling a counter after a hot plate has been sitting on it.

- Emphasize that this is a law because scientists saw this happening over and over again. There were never any observations that showed anything different. That is why it is a law—it is describing WHAT they saw. A theory would explain WHY it happens.

Page 11

- Look at the picture of the icicles. An icicle is frozen but slowly melting. Does this break the law? (*No, it doesn't break the law. The freezing and melting point is the same temperature, 32 degrees Fahrenheit. The water is both freezing and melting.*)

  CHALLENGE—Ocean water freezes at about 28 degrees Fahrenheit. Does this break the law? Why or why not? (*No, it doesn't break the law because ocean water is not pure water—it has salt in it.*)

Page 12

- How does the water cycle abide by this law? (*The water cycle has water changing states—liquid, gas, and solid. But only the appearance is changing, not what the water is made up of or how much of it* (*the mass*) *is there.*)
- Tell students you found the mass of popcorn kernels, then after popping them, the mass was different! Does this break the law? (*No, because the liquid water turns to gas—the steam—and it just moves into the air. It's still there, but it's not inside the popcorn anymore.*)

  SUPPORT—Show students a video of popcorn popping. Discuss the changes that they see, and then focus on the section on steam.

Page 13

- Imagine that an animal comes into this area, eats the leaves of the trees, and then leaves the area. The mass of materials that were once here has changed. Does this break the law? (*No, the food will eventually leave the body of the animal. The mass is still constant; it just changed how it looks and where it is.*)
- If someone observed and recorded a counterexample to any of these laws, what would happen? What would happen if there were a theory that used this evidence? (*It would no longer be a law. The theory would have to be revised.*)

3. Check for understanding.

Activity Page

AP 2

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Reinforce that the laws of nature apply everywhere. Remind students that scientists over generations have used lots of observations to develop these generalizations and never saw any counterexamples.

Use Activity Page 2, a card sort activity, to informally assess students' understanding of scientific laws, especially the Core Vocabulary for this lesson (*law, theory*). If students have not previously learned about some of the laws discussed in this chapter, allow them time to research.

See the Answer Key for sample or correct answers.

LESSON 3

Accurate and Precise

At a Glance

Lesson Question

What makes measurements accurate and precise?

Learning Objectives

✓ Differentiate accurate measurements from inaccurate measurements.

✓ Differentiate precise measurements from imprecise measurements.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- ball shooting activity

Main Science Idea

Accurate means "on target." *Precise* means "within a narrow range."

NGSS and CCSS References

NOS2. Scientific Knowledge Is Based on Empirical Evidence: Scientists use tools and technologies to make accurate measurements and observations.

RI.4.7. Integration of Knowledge and Ideas: Use the illustrations and details in a text to describe its key ideas.

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

www.coreknowledge.org/cksci-online-resources

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accurate **precise**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

data **measurements**

Instructional Resources

Student Reader

Ch. 3

Student Reader, Chapter 3
"Accurate and Precise"

Activity Page

AP 3

Activity Page
Target Practice (AP 3)

Materials and Equipment

Collect or prepare the following items:

- reference books and other research materials
- internet access and the means to project images/video for whole-class viewing
- ball and hoop for each group
- large pieces of paper and drawing materials such as markers or crayons

Advance Preparation:

- Talk to the physical education teacher about possible materials (ball and hoop) or alternatives for Activity Page 3.

THE CORE LESSON

1. Focus attention on the Lesson Question.

Ask two or three students to come to the front of the classroom. Have students shoot a ball toward a target. Ask students which volunteer they think did "the best." Encourage students to explain why they think this. What does this have to do with science? Tell students that in this chapter, they will learn about things scientists think about when taking measurements.

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What makes measurements accurate and precise?

Know the Standards

NOS2. Scientific Knowledge Is Based on Empirical Evidence Empirical evidence is information that is acquired by observation or experimentation. Scientists record and analyze these data and use this analysis to make claims and explanations. An important part of gathering these data is making sure that they are both accurate and precise so the results and analyses are accurate as well.

2. Read and discuss: "Accurate and Precise."

Student Reader

Ch. 3

Prepare to read together, or have students read independently, Chapter 3 "Accurate and Precise." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 14

- Reread the last sentence. Encourage students to think about this as a scientific question. How would you restate it? How would they find out the answer? (*Who or what is the best basketball shooter? I would have each shoot a basketball ten times and measure how close to the target each shot was.*)
- Who do you think is going to be the most accurate and/or precise, robots or humans? Why? (*Possible answer: I think the robots will be the most accurate and precise because they can be programmed to shoot directly at the target.*)

Page 15

- Think of Mr. Roboto's shots. In your own words, what do *accurate* and *precise* mean? (Accurate *means to hit the target.* Precise *means to hit the same spot every time.*)
- What tools and measurements are being used to measure accuracy? What tools and measurements are used to measure precision? (*In order to measure accuracy, they are counting how many shots are made. In order to measure precision, they trace the arc that each shot makes.*)

Page 16

- Sarah is less accurate than Mr. Roboto. Why? (*She is less accurate because she does not make as many shots.*)
- Describe why Sarah is also less precise than Mr. Roboto. (*She is less precise than Mr. Roboto because there is more variation in her shots.*)
- Give students another example of accurate but less precise measurement, and have them discuss: An oceanographer needs to go out in a boat to collect data. She checks the weather forecast the night before her trip so she knows what to wear on the boat. The TV forecaster says it will be between 68 and 75 degrees Fahrenheit at noon the next day. The actual temperature on the boat at noon is 71 degrees Fahrenheit.

Page 17

- Why did Cy Borg get zero for accuracy? How could his accuracy be improved? (*He got a zero for accuracy because he didn't make any shots. This could be improved by changing the robot's aim so it is still precise but also accurate.*)
- In science, do you think it is better to be precise or accurate? Can you give an example? (*I think it might be better to be precise first, because you can change your aim if you are not accurate. If I am measuring the weight of a fish and the scale says the same thing but it is not accurate, I can improve the accuracy by checking that the scale is starting at zero.*)
- Think of another example of someone or something being precise but not accurate. Are data gathered from them helpful for science? (*An example is a soccer player who keeps hitting the goalpost on every shot but never makes the shot. It's not very helpful for science because the target is always off and never correct.*)

Page 18

- Talk to students about why it is important that we understand why Sihan is not accurate or precise. When scientists gather data, they must try to be as accurate and precise as possible. If they aren't, their results and conclusions could be wrong. So, they need to look at their instruments and how they are measuring things to understand why their accuracy and precision might be off.

Page 19

- Could we make any claims about the basketball shooters' accuracy or precision if they had taken only one shot? (*Not really; we need multiple data points to say if the person is accurate or precise.*)
- Compare the precision and accuracy of the four examples. (*Low accuracy and low precision is Sihan. High precision and low accuracy is probably Cy Borg. Sarah is has high accuracy but is not very precise, and high accuracy and high precision is Mr. Roboto because it is both accurate and precise.*)
- The best scientific observations and measurements are both accurate and precise. Why are both important in scientific investigations? (*Sample answer: When taking measurements, we need to make sure that we will have the same measurement every time and that it is accurate. If not, our results may not be correct.*)

3. Check for understanding.

Activity Page

AP 3

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Reiterate the definitions of *accurate* and *precise*. *Accurate* means "on target." *Precise* means "within a narrow range."

Use the activity to informally assess students' understanding of the Core Vocabulary words (*precise, accurate*). Students should work in groups of three or four to develop and carry out a test similar to the one they read about in Chapter 3.

Lead a discussion with the class on how they can see who was on target the most. (*counting who made the most baskets*) How can they see who was within the most narrow range? (*Possible ideas might be drawing a bull's-eye target under the hoop, marking where the ball fell each time, and measuring whose shots were closest to each other.*)

See the Answer Key for sample or correct answers.

LESSON 4

Is It Testable?

At a Glance

Lesson Question

What makes some questions testable and other questions not testable?

Learning Objectives

✓ Describe the scientific process of using testing to answer a question.

✓ Distinguish questions that can be tested from questions that cannot be tested.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement

Main Science Idea

Some questions are testable. Others are not.

NGSS and CCSS References

SEP1. Asking Questions: A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested.

RI.4.2. Key Ideas and Details: Determine the main idea of a text and explain how it is supported by key details; summarize the text.

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

www.coreknowledge.org/cksci-online-resources

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cause **effect** **testable question**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

control **dependent variable** **independent variable** **question** **variable**

Instructional Resources

Student Reader

Ch. 4

Student Reader, Chapter 4
"Is It Testable?"

Activity Page

AP 4

Activity Page
Testable or Not Testable (AP 4)

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- gummy bears
- cup of water

THE CORE LESSON

1. Focus attention on the Lesson Question.

Show students a handful of gummy bears or a picture of them. Ask students to brainstorm what kinds of questions scientists might ask about gummy bears. Focus their attention on the cup of water. What kinds of questions could they ask about gummy bears and water? Tell them that this chapter will help them understand how to write questions that can be tested.

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What makes some questions testable and other questions not testable?

2. Read and discuss: "Is It Testable?"

Student Reader

Ch. 4

Prepare to read together, or have students read independently, Chapter 4 "Is It Testable?" When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 20

- What does a testable question include? (*It includes a cause and an effect. The independent variable, which is the factor that is changed, is the possible cause. The dependent variable is the effect; it's the result.*)

Pages 21–22

- Spend time reviewing the ideas of independent and dependent variable with students. Ask for or provide examples of independent and dependent variables of a testable question. (*independent variable: type of soil; dependent variable: plant height. independent variable: amount of time spent studying; dependent variable: grades on tests. independent variable: steepness of ramp; dependent variable: speed a ball rolls*)

Pages 22–23

- How would you write a question using this information? (*Does the amount of light affect how tall a plant grows?*)
- Remind students that controls are something you think about *after* you have come up with a testable question. Controls are things you keep the same so you know the result is caused by the independent variable.
- Think back to the gummy bear conversation. Write a question that has an independent and dependent variable. What are some controls? (*How will water affect the size of the gummy bear? Controls are the same type of gummy bear, same size of gummy bear, same amount of water, and same amount of time in water.*)
- Add to the list as you ask the following question: What are some pieces of advice Taylor had about testable questions? (*They need an independent variable and a dependent variable—cause and effect. You need to be able to actually conduct the test. You should include "how" questions.*)
- Compare Trey's first attempt at a testable question to his final version. What changed? (*He didn't use a "why" question, it's something he can actually test and measure, and he has an independent and dependent variable.*)
- What are the controls (the things that will stay the same in his test)? (*The controls are the same size and type of pot, the same kind and amount of soil, the same amount of water on the same schedule, the same amount of space between seeds, and the same distance from the light.*)
- Reread Trey's testable question: How does changing the intensity of light affect the time it takes radish seeds to sprout? Identify the independent and dependent variables. (*The independent variable is the change in light intensity, and the dependent variable is the time it takes for the radish seeds to sprout.*)

Pages 24–25

- What are some things that the teacher might focus on in their feedback? In other words, what are the important parts of a testable question? (*It has a cause and an effect—independent and dependent variables. It can be tested and measured.*)
- For each of the questions and related feedback boxes, have students offer variations. Guide students by referencing the ongoing list on the board, emphasizing that things need to be measured and have to be testable.
- For the question "How would life on Earth be different if the sun's light were green?" spend time reviewing why this is not testable. (*We can't test it, because there is no planet like Earth with a green sun.*)

Know the Standards

SEP1 Asking Questions In fourth grade, students should focus on asking questions about what would happen if a variable changed and questions that focus on cause-and-effect relationships.

3. Check for understanding.

Activity Page

AP 4

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Use the activity page to informally assess students' understanding of testable questions.

Review the following points from the chapter about testable questions:

- They have two parts. One thing (the independent variable) is changed to see its effect on another thing (the dependent variable).
- They investigate something that we can observe and measure.
- They can be tested using experiments we can actually do.

See the Answer Key for sample or correct answers.

LESSON 5

Concrete or Abstract

At a Glance

Lesson Question

What do *concrete* and *abstract* mean when we refer to models?

Learning Objectives

✓ Classify provided examples of models as concrete or abstract.

✓ Describe the difference between things that are concrete and things that are abstract.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- weather forecasting

Main Science Idea

Something concrete can be directly observed. Something that is abstract is an idea or concept that can't really be physically represented.

NGSS and CCSS References

SEP2. Developing and Using Models: A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. Modeling tools are used to develop questions, predictions, and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations.

RI.4.4: Craft and Structure: Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a *grade 4 topic or subject area.*

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

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abstract **concrete** **model**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

analogy **diagram** **simulation**

Instructional Resources

Student Reader

Ch. 5

Student Reader, Chapter 5
"Concrete or Abstract"

Activity Page

AP 5

Activity Page
Modeling Weather (AP 5)

Materials and Equipment

Collect or prepare the following items:

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

Advance Preparation:

Find video of a local weather (optional).

The Core Lesson

1. Focus attention on the Lesson Question.

Online Resources

Is it possible to make miniature Earths? What would you do with them if you could? Engage students by watching two short videos on the Biosphere II experiment. After watching, ask students why scientists built Biosphere II, prompting them to think about how scientists are able to conduct experiments and make observations in Biosphere II that they couldn't do otherwise. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What do *concrete* and *abstract* mean when we refer to models?

2. Read and discuss: "Concrete or Abstract."

Student Reader

Ch. 5

Prepare to read together, or have students read independently, Chapter 5 "Concrete or Abstract." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 26

- Think about real concrete that we see outside. What are some similarities and differences in how science uses the word *concrete*? (*We can touch and feel both of them and use our senses to describe them. Scientists use the word to describe anything that is real and that we can use to make observations. Other people use* concrete *to describe the hard stuff we walk on or walls are built of.*)
- Review the image of concrete things. Discuss why these items are considered to be concrete. (*We can use our senses to observe them. They are real things, and we can describe them.*)
- Brainstorm other examples of things that are concrete. (*Possible answers: an image of the moon at night, an image of craters on Mars, a video of a lion hunting, a stream or river*)

Page 27

- Name some abstract things you might observe at school and what they represent. (*The school bell means that it is time to finish up or be somewhere. A crosswalk sign means that there is a crosswalk for us to walk on. In the library, there is a picture of someone with their finger over their mouth. It means to be quiet.*)

Online Resources

SUPPORT—Further explain the concept of abstract things with some common emojis. Ask students to describe what different emojis represent or mean. We can't touch or observe those things, so we use things like symbols to represent the emotion or idea. The emoji is concrete and helps us visualize the abstract idea of emotion. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

- Why are both concrete and abstract things important? (*Concrete things are the real thing. Abstract things like ideas or emotions are important but hard to observe. Concrete things help us make sense of abstract things.*)

Page 28

Online Resources

- List or show other concrete models. Are they physical or scale models? Why? (*Answers will vary depending on the models shown. For the images listed in the Online Resources Guide, only the facial muscles model is a true physical replica. The others are smaller than the real object.*) (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

CHALLENGE—Show students an image of a model lung. Ask them to discuss and decide if this is a physical replica or a scale model.

- How might scientists use these models? (*Scientists can do tests on models that they can't do on the real thing.*)
- Show a short video of astronauts training for weightlessness. What kind of model is this? (*This is a concrete model, probably a physical replica because it is a realistic model of weightlessness.*) (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Page 29

Online Resources

- Write a few scientific analogies on the board, such as the following: A plant cell is like a brick in a wall. Electricity is like flowing water. Based on these analogies, what can we say about the scientific topic? (*Answers will vary but should use the characteristics of the comparison item, e.g., a brick, to describe the scientific concept.*)
- Watch the simulation video from NASA, which is a compilation of many of their different visualizations and simulations. Hold a discussion on how people at NASA may have developed these models and why they did so. (*Simulations help scientists test, practice, describe the phenomenon, make predictions, and teach others.*) (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pages 30–31

- Discuss what a limitation is. Think of the solar system model. What is a limitation of this model? (*A limitation is a flaw or shortcoming, something that keeps the model from being totally accurate. In the solar system model, limitations are that it is not truly to scale and that it doesn't show the gas/solid nature of the planets.*)
- Have students pair-share their observations and form questions about the models shown on the pages. Discuss as a group if the models are concrete or abstract and the models' benefits and limitations. (*cell model: concrete, visualize the parts, not to scale; solar system model: concrete, see the order of the planets, size comparison, not to scale; diagram: abstract, helps see all the eras in order, not many differences are obvious*)

3. Check for understanding.

Activity Page

AP 5

Online Resources

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Something concrete can be directly observed. Something that is abstract is an idea or concept that can't really be physically represented.

Use this activity page to informally assess students' understanding of concrete and abstract models and the different types of models that are used. Show students a weather forecast from a local weather station or a video. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

See the Answer Key for sample or correct answers.

LESSON 6

Enough Data

At a Glance

Lesson Question

How much data should testing produce in an investigation?

Learning Objectives

✓ From provided options, select the better quantity of data for investigation scenarios.

✓ Explain the rationale for their judgments about recommended volumes of data in investigations.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- sample size recommendations

Main Science Idea

How much you can learn from and trust a test or investigation depends on how much data it produces.

NGSS and CCSS References

SEP3. Planning and Carrying Out Investigations:
Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. A main component is using fair tests in which variables are controlled and the number of trials considered.

RI.4.3. Key Ideas and Details: Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

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

www.coreknowledge.org/cksci-online-resources

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control **data**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

compare **investigation** **test**

Instructional Resources

Student Reader

Ch. 6

Student Reader, Chapter 6
"Enough Data"

Activity Page

AP 6

Activity Page
How Much Data? (AP 6)

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- information leaflets from medicines or printouts of medicine leaflets from an online source

The Core Lesson

1. Focus attention on the Lesson Question.

Ask students to imagine that their friend threw a dart at a dartboard for the first time. Amazingly, they hit the bull's-eye! Now, the friend is saying that they are an expert dart thrower. Do you agree with them? Why or why not? What if they threw a dart five more times and came close to the bull's-eye each time?

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How much data should testing produce in an investigation?

2. Read and discuss: "Enough Data."

Student Reader

Ch. 6

Prepare to read together, or have students read independently, Chapter 6 "Enough Data." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 32

- Why did Mel include black cloth in her test? (*This is the control. It's the variable that doesn't get any special treatment, so she can compare her results to it.*)
- Focus student attention on the question Mel is asking. Drawing from the ideas of Chapter 4, encourage students to state this as a testable question that has an independent and dependent variable (a cause and an effect). (*How does the type of material affect the ability of an adult to see at night?*)
- Think of Mel's goal to focus on the vision of the average adult. Why does Mel want to study more than just her uncle? (*Average is the middle value of many values. Mel needs to study more than just one person to get an average.*)

Page 33

- Think back to Lesson 1. What tools, techniques, and method is Mel going to use? (*She is going to sample adults, use quantitative observation methods, and use measurement tools.*)
- Why might sixty adults be better than six? Are six data points enough to say "average"? (*Six data points aren't enough to say "average" when there are billions of adults in the world. Sixty might be better because there is more variation in sixty people, so the average would reflect that better.*)

Page 34

- Think about Lorenzo's question. Which number of seeds would be the best to describe *all* plants? (*Twenty seeds would probably be best. Three isn't enough to know if it's by chance, but one hundred is too many to have to measure.*)
- Review the data chart with the students. What would happen if you remove the outliers (zero and didn't sprout)? (*The averages would change. These outliers make the results different than they should be.*)

Page 35

Online Resources

- Work with students to make a pros and cons list for using three seeds, twenty seeds, or one hundred seeds.
- Have students review the medicine leaflets, or project the image of the medicine leaflet from the Online Resources Guide. Look at the clinical trials portion. Ask students to think about the amount of data these scientists are collecting and why it is important to do so. (*Scientists in clinical trials have to gather lots of data from thousands of people to make sure that they know the*

Know the Standards

SEP3. Planning and Carrying Out Investigations In grade 4, students work toward developing investigations that are fair tests that include control variables and that consider the number of trials.

medicine is safe for all types of people and that they learn about possible side effects that can happen.) (See the Online Resources Guide for a link to data sheet. **www.coreknowledge.org/cksci-online-resources**)

- Scientists compare a group of people who take the medicine with a similar group of people who don't. Why do they do this? (*Good scientific tests have controls, which is when they don't get any special treatment, so the scientists are able to compare the results.*)

Page 36

- What is Noa's science question? (*How do different materials bend light?*)
- What will Noa test? (*prisms of different materials*)
- Lead a discussion focusing on the possible control and the amount of data that Noa should collect. (*The control might be not using a prism. Noa would probably need lots of different materials and possibly test each material multiple times.*)

Page 37

- Have students pair-share with a neighbor and then share out as a class. Analyze Noa's experimental design. Think about the control, the number of and different types of tests, and the independent and dependent variables.
- Again, have students pair-share and then discuss answers with the class. How many types of gelatin should Noa test in order to collect more data? (*Student answers will vary but should include explanations about their choice.*)

3. Check for understanding.

Activity Page

AP 6

Online Resources

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. How much one can learn from and trust a test or investigation depends on how much data it produces.

Have students work alone or work with a partner. They should create a simple storyboard that walks through the main points of their presentation. The storyboard should include the question that they are going to try to answer, make a suggestion on how many tests they should run, and explain the suggestion.

Find out more about simple storyboards. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

See the Answer Key for sample or correct answers.

LESSON 7

Charts and Graphs

At a Glance

Lesson Question

How can we use graphs and charts to make data easier to understand?

Learning Objectives

✓ Interpret data presented in grade-level-appropriate charts and graphs.

✓ Express how the presentation of data in charts and graphs makes the data easier to understand.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement

Main Science Idea

Charts and graphs can make data easier to understand and draw conclusions from.

NGSS and CCSS References

SEP4. Analyzing and Interpreting Data: Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools including graphs and charts to identify patterns and significant features.

RI.4.7. Integration of Knowledge and Ideas: Interpret information presented visually, orally, or quantitatively and explain how the information contributes to an understanding of the text in which it appears.

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

www.coreknowledge.org/cksci-online-resources

Core Vocabulary and Language of Instruction

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chart **claim** **data** **graph**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

circle graph **line graph** **pie chart**

Instructional Resources

Student Reader

Ch. 7

Student Reader, Chapter 7
"Charts and Graphs"

Activity Page

AP 7

Activity Page
What's Going on in This Graph? (AP 7)

Materials and Equipment

Collect or prepare the following items:

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

THE CORE LESSON

1. Focus attention on the Lesson Question.

Online Resources

Project images of different types of graphs for students. (Note that these are the same images that will be used later in the activity page) Lead a discussion with students about the images. Why did scientists choose to display their data this way? How does it help us understand their ideas and findings? (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

2. Read and discuss: "Charts and Graphs."

Student Reader

Ch. 7

Prepare to read together, or have students read independently, Chapter 7 "Charts and Graphs." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 38

- Allow students time to read the circle graph and respond to the prompts on their own and then share out as a class.
- Spend time comparing a circle graph to a clock. Review what terms like *half past* or *quarter till* mean.
- Scientists often use charts to communicate their results and ideas. What claim can you make about electricity based on the chart? What's your evidence? (*My claim is that natural gas is the fuel that is most commonly used for electricity. My evidence is that it makes up the biggest slice in the pie chart.*)

Page 39

- What can you learn about energy sources by reading the circle graphs? (*Students will have various answers. Possible answers include that natural gas is the biggest source of electricity and that gasoline is the biggest energy source for transportation.*)
- Look at the graph Sources of Energy for Electricity, 2022. Focus on the Petroleum section. Then lead a discussion with students about the sources of energy for transportation that come from petroleum.
- What claims can you make about petroleum products by reading the circle graphs? What's your evidence? (*I learned that petroleum isn't used very much in electricity but is used a lot for transportation. My evidence is that it is used 1% for electricity but for 86% of all the transportation.*)

Page 40

- Have students think about the answers to the prompts individually and then share out as a class. (*The ways natural gas is used and volume of natural gas used are shown. The range is 0–15 MMcf. Homes used about 5 MMcf.*)
- What claims can you make about natural gas by reading this graph? What is your evidence? (*Natural gas is used mostly by electrical plants. My evidence is that electrical plants use over 12 MMcf of natural gas, which is more than any other use.*)
- How is this graph similar to and different from the pie graphs on the previous page? (*They both show how natural resources are being used. The bar graph lets us compare side by side, but the circle graph makes it easy to see how much of the whole each makes up.*)

Page 41

- How are bar graphs similar to and different from circle graphs? (*They both have titles and labels and legends. Circle graphs show parts of a whole, but bar graphs show how something changes over time or comparisons.*)
- What claims can you make about electricity from these graphs? What's your evidence? (*I learned that wind turbines are able to make more electricity each year. Delaware and Nevada used the most electricity from natural gas in 2017. My evidence is that each bar in the electricity capacity of wind turbines graph grew taller each year and that in 2017 Delaware and Nevada used more than any other state listed.*)

Page 42

- How are line graphs similar to bar graphs? (*They each have headers, labels, a y-axis, and an x-axis and can show two kinds of data.*)
- How are they different? (*Line graphs don't have categories.*)
- What claims can you make about wind turbine height from this graph? What's your evidence? (*Wind turbine height increased over time. My evidence is that the line started at just under 100 feet in 1990 but kept increasing to 2020.*)

Page 43

- Have students pair-share with a neighbor and then discuss the in-text prompts in the second paragraph as a class.
- What claim can you make based on the graph. What is your evidence? (*As the height of a wind turbine increases, so does its power. My evidence is that the line starts at nearly 0 when it is the lowest height. Then as height increases, the amount of power increases, too.*)
- Discuss the Main Science Idea. How do charts and graphs make data easier to understand? What would it be like if we didn't have charts and graphs? (*We would just have big lists of data, and we couldn't see trends or patterns.*)

3. Check for understanding.

Activity Page

AP 7

Online Resources

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Charts and graphs can make data easier to understand and draw conclusions from.

There are two options for this activity. Allow students to choose their own graphs to analyze, or choose the graphs for them. Websites with graphs are listed in the Online Resources Guide. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

It is recommended that you model this activity for students before allowing them to complete it on their own. If students finish early, encourage them to review another graph.

See the Answer Key for sample or correct answers.

LESSON 8

Columns and Rows

At a Glance

Lesson Question

How are sets of numerical data organized?

Learning Objectives

✓ Describe why data in various example tables appear in the columns and rows in which they do.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- class survey

Main Science Idea

Organizing data into columns and rows in a table makes relationships among data easier to see and understand.

NGSS and CCSS References

SEP5. Using Mathematics and Computational Thinking: Mathematics and computation are fundamental tools for representing physical variables and their relationships. Scientists are required to organize simple data sets to reveal patterns that suggest relationships.

RI.4.5. Craft and Structure: Describe the overall structure of events, ideas, concepts, or information in a text or part of a text.

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

www.coreknowledge.org/cksci-online-resources

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column **data table** **rows**

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data

Instructional Resources

Student Reader

Ch. 8

Student Reader, Chapter 8
"Columns and Rows"

Activity Page

AP 8

Activity Page
Eye Color and Vision (AP 8)

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- modeling clay, toothpicks, ruler
- paper and pencil

Advance Preparation:

Set up "probes" as shown on page 46 of the Student Reader.

THE CORE LESSON

1. Focus attention on the Lesson Question.

Tell students that you need to create a chart to record the number of students who brought lunch, who are getting hot lunch, and who are absent. Ask students to give ideas on ways to organize the information so it is easy for the front office and cafeteria workers to understand.

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How are sets of numerical data organized?

2. Read and discuss: "Columns and Rows."

Student Reader

Ch. 8

Prepare to read together, or have students read independently, Chapter 8 "Columns and Rows." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 44

- What do they think of when they hear the term *data table*? Refer to the table created at the beginning of the lesson. (*Students might think of a chart or graph. A data table has rows and columns. Each square or cell has information—data—about the investigation.*
- Discuss if the results are clear or not. Why might a **data table** be better? (*The results are hard to understand because it's hard to compare the data.*)
- What advice would you give Sasha? What would your suggested data table look like? Talk about what they think might go in the columns and what information goes in the rows. Allow students time to brainstorm and share ideas with a neighbor or as a class.

Page 45

- Have students think about the in-text prompt silently and then discuss it as a class. Which stimulus do touch-me-not plants stop responding to more quickly? How do you know? (*The touch-me-not plants stop responding to touch first. The average number of times until it stops responding decreases.*)
- Would you know this if there weren't any data tables? (*It would be hard to tell if there weren't data tables. The data tables made it clear.*)
- Describe how Sasha's data table changed and the things she was thinking about. Why did she add columns? (*She had to think about where she was going to put the independent and dependent variables—in the rows or columns. Then she had to think about how she would show data for each plant—in subcolumns. Finally she added another subcolumn for the averages.*)

Page 46

- How should Amy set up a table to record her data? What variables does she need to think about? What would be in the rows and the columns? Encourage students to create a blank data table with their ideas. (*The data table should list classmates' names and the smallest distance reported. The names should be in rows, and the data should be in the columns.*)
- Conduct the experiment along with Amy, either as a whole class or in small groups. Have students collect data and fill in their data table. Work together to reformat the data table to make it as clear as possible.

Page 47

- What kinds of things did Amy think about when considering how to set up her table? (*She thought about the space she would have and how to easily compare the data. She also considered how to show averages.*)
- Compare Amy's data table to your own. How are they similar or different? (*Sample answer: She thought about averages, and we didn't.*)
- How does this data table help Amy answer her question? (*It helps her to easily calculate and compare averages between fingertip and knee.*)

Page 48

- Analyze Marcus's test. What is the scientific question? What are the independent variables, dependent variable, and controls. (*The question is "How does the number of taste buds affect how well people can detect a very low concentration of sugar?" The independent variables are the number of taste buds and type of liquid, the dependent variable is if they correctly identify the sugar, and the control is plain water.*)
- Think back to Chapter 7 on having enough data. Do you think thirty people is enough data to answer their question? (*Yes, I think this is enough. Fewer people wouldn't be enough data, and more people would be hard to organize and keep track of.*)

Know the Standards

SEP5. Using Mathematics and Computational Thinking This practice is an excellent opportunity to showcase the connection between math and science. Students should practice setting up tables and graphs, analyzing these graphics, and making arguments about what the data say.

- Brainstorm initial ideas on how Marcus can set up the table to display his data.

  SUPPORT—On the board, list all of the data that Marcus has collected—names of tasters, correct/incorrect, number of taste buds. Review the independent variables and dependent variable. Discuss or draw a sample table as shown on the next page, and have students fill in the column and row headers.

Page 49

- Have students pair-share their ideas on how the data table on this page compares to the one on the previous page. Discuss as a class. (*The previous table made it easy to record data, but this table makes it easy to compare the groups and their responses.*)
- Again have students pair-share ideas for the next prompt on how they would have set up the table. (*I don't think I would have put the number incorrect because people can do the math themselves. Plus we are only focusing on number correct, so that's easy to compare.*)

3. Check for understanding.

Activity Page

AP 8

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Use Activity Page 8 to help students practice recording and displaying data so relationships and comparisons are easier to see. Lead students in conducting a class survey on eye color and the need for glasses or contacts.

See the Answer Key for sample or correct answers.

LESSON 9

Strength of Evidence

At a Glance

Lesson Question

How can we evaluate an explanation for weak evidence?

Learning Objectives

✓ Classify examples of supporting evidence in explanations as convincing or unconvincing.

✓ Describe what makes provided examples of evidence strong or weak.

✓ Describe healthy skepticism (that it is always reasonable to ask "why?").

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement

Main Science Idea

It is important to be concerned about whether information is reliable or not. Evidence to support a claim should be strong and from a trustworthy source. Opinions do not make strong evidence. Strong evidence can be verified by multiple sources.

NGSS and CCSS References

SEP6. Constructing Explanations and Designing Solutions: The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.

RI.4.2. Key Ideas and Details: Determine the main idea of a text and explain how it is supported by key details; summarize the text

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

www.coreknowledge.org/cksci-online-resources

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convincing evidence **evaluate** **skeptical**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

reliable **strong** **weak**

Instructional Resources

Student Reader

Ch. 9

Student Reader, Chapter 9
"Strength of Evidence"

Activity Page

AP 9

Activity Page
Reading the News (AP 9)

Materials and Equipment

Collect or prepare the following items:

- reference books and other research materials
- internet access and the means to project images/video for whole-class viewing
- tablets or computers for each student or pair

The Core Lesson

1. Focus attention on the Lesson Question.

Excitedly tell students that there is a new news story out today: You are the tallest teacher ever! Share evidence with the students: You are the tallest person in the classroom. You can see over everyone else's heads. Witnesses have said that you are very tall. Ask students if they believe this breaking news story and to describe why or why not. Tell them that they will be thinking more about how to evaluate science news.

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How can we evaluate an explanation for weak evidence?

2. Read and discuss: "Strength of Evidence."

Student Reader

Ch. 9

Prepare to read together, or have students read independently, Chapter 9 "Strength of Evidence." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 50

- Have students read the article portion first and then revisit while reading the analysis boxes. Ask students to describe their initial thoughts on the reading.
- What do you think weak evidence is? (*Weak evidence is a statement that doesn't seem very convincing or is an opinion.*)
- The analysis says you should be skeptical about the passage. What does it mean to be skeptical? Why might you be skeptical while reading the article? (Skeptical *means to question, to be unsure if it is accurate or evidence-based. I was skeptical because the article had statements that didn't have evidence to support them.*)

  EXTEND—Invite students who are interested to research the claim that Earth is flat and review the claims.

Page 51

- Lead a discussion about what healthy skepticism looks like and what kinds of questions you should ask. Write ideas on the board. (*Healthy skepticism asks questions like "How do we know this?"; "What evidence is there?"; "Is the explanation supported by the evidence?"; "Is the source trustworthy?"; "Do multiple sources make this claim?"*)
- Tell students that they will evaluate the articles and their explanations. What does it mean to evaluate something? (Evaluate *means to judge the quality of something, checking to see if it is done in the best way possible and that it is trustworthy and reliable.*)
- Use the list of healthy skepticism questions to evaluate the passage and its explanation. Use the provided analysis to support the evaluation.

Page 52

- Read the passage before reading the analysis boxes. Have students practice healthy skepticism and evaluate the explanation and evidence. What questions can you ask? Is the explanation supported by the evidence? (*We can ask if more than one source says this. Does the evidence come from tests and investigations? I think it is supported by the evidence.*)
- Focus on the ideas of strong and weak evidence. Why does the analysis box say the evidence is weak? (*It is weak evidence because it doesn't support the claim; different evidence would be helpful.*)
- What kind of evidence would be strong? (*Strong evidence would directly address the claim that Earth's climate everywhere was warmer, not just at the poles.*)

Page 53

- Read through the passage before reading the analysis boxes. Does the evidence convince you of the explanation? What questions do you have? (*Yes, I think I am convinced. There is strong evidence that supports the explanation. The evidence is stuff that we can actually test and see.*)
- Have students pair-share any strong or weak evidence they see. Then discuss *why* it is considered strong or weak as a class. (*I think it is all strong evidence. You can see iridium, and you can always see it and dinosaur fossils in the same location.*)

Page 54–55

- Before focusing on the analysis boxes, read the passage, and stop after each paragraph. Have students practice identifying any weak or strong evidence they see and discuss what they feel skeptical about. (*Answers are shown in-text, in the analysis boxes. Students may feel skeptical about the pieces of weak evidence or unclear about the idea that science uses many different pieces of evidence to support a claim.*)

  SUPPORT—Provide students with the analogy of evidence being pieces of a puzzle and the claim/explanation being the puzzle. Just one puzzle piece isn't enough to finish the puzzle, or see the entire picture, but once you gather enough of the pieces together, you can see the picture/finished product.

- Is the evidence convincing? What pieces of evidence support the explanation? (*Yes, I think the evidence is convincing. There is both strong and weak evidence. Once it is all together, it supports the explanation.*)
- If you take just one piece of evidence along, can it be convincing? What makes it (or could make it) convincing? (*One piece of evidence can be convincing, but it has to be very strong. It would be better to have lots of evidence that supports each other and the explanation, to make sure there are no opinions or assumptions, to look for patterns in the data, and to confirm they are based on observations.*)

3. Check for understanding.

Activity Page

AP 9

Online Resources

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Guide students to the articles listed in the Online Resources Guide. Allow students to choose a topic of their interest. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

As students evaluate the news articles, assess their ability to practice healthy skepticism by pointing out any weak or strong evidence and if the evidence has convinced them of the explanation.

See the Answer Key for sample or correct answers.

LESSON 10

Think It Through!

At a Glance

Lesson Question

What is reasoned judgment, and how do we spot it and practice it?

Learning Objectives

✓ Distinguish among facts, reasoned judgment based on research findings, and speculation in the provided explanations.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- analysis of a science article

Main Science Idea

Making a reasoned judgment means deciding what is probably true based on trustworthy facts and evidence.

NGSS and CCSS References

SEP7. Engaging in Argument from Evidence: Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

RI.4.3. Key Ideas and Details: Explain the relationships or interactions between two or more individuals, events, ideas or concepts in a historical, scientific, or technical text based on specific information in the text.

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

www.coreknowledge.org/cksci-online-resources

Core Vocabulary and Language of Instruction

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Core Vocabulary terms are those that students should learn to use accurately in discussion. During instruction, expose students repeatedly to these terms but not through isolated drill or memorization.

reasonable judgment **reasoning** **speculation**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

evidence **facts**

Instructional Resources

Student Reader

Ch. 10

Student Reader, Chapter 10
"Think It Through!"

Activity Page

AP 10

Activity Page
Science News (AP 10)

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- print articles for AP 10

The Core Lesson

1. Focus attention on the Lesson Question.

On the board, list the following sentences:

- Our school has __ grades. (Fill in the blank for the number of grades in the school).
- We need a new school building; there are so many people here!
- There are probably students of many different ages in our school.

Have students read the sentences and discuss them. Which ones ring true? Why? What's different about the sentences?

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What is reasoned judgment, and how do we spot it and practice it?

2. Read and discuss: "Think It Through!"

Student Reader

Ch. 10

Prepare to read together, or have students read independently, Chapter 10 "Think It Through!" When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Pages 56–57

- Reread the last two statements at the bottom of the cartoon. Do you agree that the volcano is going to erupt? What do you think *speculation* means? (*No, I don't agree. I think that* speculation *means that you have a little bit of information and then make guesses based on it.*)

- Come to a class consensus on the definition of *speculation*. Go through the statements with the students. Based on their definition of *speculation*, identify which are speculations. (*Answers will vary depending on their definition. However, statements should include "Let's get out of here! It's going to blow!!!!" and "Is it true what people are saying?"*)
- Which are reasonable statements? Why? (*Some of the reasonable statements should include "It's not safe to hike to the volcano today."; "Gases could be building up inside the volcano."; "The Park Service is probably detecting small tremors near the volcano."*)
- Emphasize the definition of *speculation*. Write the points on the board: There is no strong evidence. Good reasoning is missing. Did they pick out all the speculation statements in the cartoon?

Page 58

- Reread the first paragraph. You can use the available evidence along with good reasoning to make a claim. What do you think the author means by "good reasoning"? Can you find another example of good reasoning in the passage? (*I think good reasoning is something that makes sense based on what you know about the situation. You can find evidence to back it up. Another example is, "The Park Service is probably detecting small tremors near the volcano."*)
- What is reasonable judgment? (*Reasonable judgment is based on good reasoning and facts.*)
- Point to each word on the arrow diagram—facts, judgments, and speculation. Ask students to share examples of each. (*Sample answer: Fact—School starts at 7:30. Judgment—Students have to set alarms to wake up in time for school. Speculation—A lot of students must be tardy to school.*)
- Have students turn to a neighbor. Talk to each other about the difference between facts, judgments, and speculation. Why is it important to know the difference while doing science? (*It's important in science because you want to make sure that your claims and explanations are based on evidence and fact, not opinions and speculation.*)

Page 59

- Focus on the second paragraph. What separates judgments from facts? (*A reasonable judgment uses all the available evidence and good reasoning. Facts are not statements that use reasoning.*)
- Reread the statement in the third paragraph. Do you think the statement is speculation or reasonable judgment? Why? (*I think it is reasonable judgment because they probably had a lot of evidence and saw patterns that suggested it might be getting ready to erupt soon.*)

Know the Standards

SEP7. Engaging in Argument from Evidence Students should practice analyzing arguments, comparing the evidence and statements that are used to support these arguments.

Page 60

- Go through each statement alone, with a neighbor, or as a class. Have students identify the statements that they feel certain about and the ones that they do not feel very certain about. Why?

  SUPPORT—Display a word bank to help students identify the different statements. For facts, words to look for in texts are *demonstrates*, *confirms*, *established*, *determined*, *reported*, *concluded*. For speculation, look for words like *suspected*, *if correct*, *is unclear*, *apparently*, *assuming*, *supposedly*. For reasonable judgment, look for words such as *appears*, *posited*, *contends*, *indicated*, *reasoned*, *instructed*. Encourage students to add to the word bank.

Page 61

- Focus on the image in the text. Is this speculation, reasoned judgment, or fact? Why? (*I think this is fact because it is based on observations that people made.*)
- What is the main point or claim of this article? Is it well supported or not? Why? (*The main point is that coastline and shoreline conservation are important. I think it is well supported. There are a lot of facts and reasoned judgment with less speculation.*)
- Ask students to summarize their learning. What is reasoned judgment? How do we spot it and practice it? (*Reasoned judgment is a decision that is probably true and based on trustworthy facts and evidence. We can spot it by looking for facts, speculation, and reasoned judgments.*)

3. Check for understanding.

Activity Page

AP 10

Online Resources

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Assign groups of students to read and analyze two news articles, with one student identifying the facts, one student identifying the speculations, and one student identifying the reasonable judgments. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

After analyzing the articles, groups should decide which article is the most reliable source.

See the Answer Key for sample or correct answers.

LESSON 11

Science Reports

At a Glance

Lesson Question

What are the steps in doing a good science report?

Learning Objectives

✓ Describe what happens in provided steps for doing a science report.

✓ Articulate reasons for performing the provided steps in doing a science report.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- development of a science poster

Main Science Idea

Following a thoughtful process helps make a science report clear and understandable.

NGSS and CCSS References

SEP8. Obtaining, Evaluating, and Communicating Information: Being a critical consumer of information about science and engineering requires the ability to read or view reports of scientific or technological advances or applications and to recognize the salient ideas, identify sources of error and methodological flaws, distinguish observations from inferences, arguments from explanations, and claims from evidence.

RI.4.5. Craft and Structure: Describe the overall structure of events, ideas, concepts, or information in a text or part of a text.

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

www.coreknowledge.org/cksci-online-resources

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report

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conclusion **discussion** **introduction** **methods**

Instructional Resources

Student Reader

Ch. 11

Student Reader, Chapter 11
"Science Reports"

Activity Page

AP 11

Activity Page
Reporting the Science (AP 11)

Materials and Equipment

Collect or prepare the following items:

- tablets or computers for pairs or groups of three
- internet access and the means to project images/video for whole-class viewing
- sticky notes
- drawing and poster materials such as poster board, butcher paper, markers, and crayons

Advance Preparation:

- Place students in groups of two or three.
- Assign each group to a chosen article. Optionally print articles for groups.

THE CORE LESSON

1. Focus attention on the Lesson Question.

Online Resources

Project or hand out copies of the science news article. Allow students to skim the article. Ask them to describe things that jump out to them. Emphasize the headers and any visuals. What is included in each section? Have they ever seen anything like this before? (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What are the steps in doing a good science report?

2. Read and discuss: "Science Reports."

Student Reader

Ch. 11

Prepare to read together, or have students read independently, Chapter 11 "Science Reports." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 62

- Hold a discussion about science reports. What is a science report? What is its purpose? (*A science report explains a science investigation. It helps people understand why the investigation is important or what was learned from it.*)
- Look ahead to spot the topic of the report on pages 66 and 67. What is the question? What is the method? (*topic: craters on the moon; question: not stated; method: dropping a ball into cornmeal*)

- Refer again to the report on pages 66 and 67. The question isn't clearly stated. What might the question be? What are the independent and dependent variables? (*The question is "How does height affect crater size?" The independent variable is height, and dependent variable is crater size*).

Page 63

- Start a list on the board. Keep track of the different components of a science report as described in the reading.
- Look at the science report on pages 66 and 67. On a sheet of paper, ask students to create an outline that they think the author used to write the report. (*Title, Introduction and Background, Materials and Method, Results* [*Evidence*], *Explanation* [*Discussion and Conclusions, Sources*])

Online Resources

CHALLENGE—An abstract is a common part of a report that is a short summary of the entire report so readers know what to expect in the report. An example of a science report with an abstract can be found in the Online Resources Guide. Challenge students to write an abstract for the report on pages 66 and 67.

Page 64

- Read the Introduction and Background section on page 66. What information did the author discover? Do you have any additional questions? (*They found out about how craters are formed. I'd like to know about any interesting craters on Earth.*)
- How did the author of the report display their data? Why do you think they chose this style? (*They used line graphs. The line graphs show how two things changed together—height of the ball and size of crater.*)

  SUPPORT—It can be helpful for students to visualize the graphs and charts. Show students images of each type of chart, and talk about how each is used differently.

- What can you learn about the relationship between ball drop height and crater size by looking at the graphs? (*I learned that as the ball dropped from a higher distance, the crater width and depth increased as well.*)

Know the Standards

SEP8. Obtaining, Evaluating, and Communicating Information Fourth graders are learning to read, interpret, and produce scientific and technical texts, which are fundamental practices of science and engineering, as is the ability to communicate clearly and persuasively.

Page 65

- What was the author's conclusion? (*that the height of a dropped ball increases the speed*)
- Think closely about the author's testable question (especially the independent variable and the dependent variable), results, and conclusion. Do they match? (*The testable question and results focus on ball height and size of the crater, but the conclusion talks about ball height and ball speed. They don't match.*)

  SUPPORT—Call attention to the difference between a conclusion and a discussion. A conclusion ends the report and talks about things that could be different or are especially important. A discussion is meant to summarize and discuss the results and answer the testable question.

Page 66–67

- Place students into small groups. Use the suggestions in the boxes to analyze the passages. Does the writing in each section match the suggestions? (*Yes, we think the writing matches the suggestions.*)
- Compare the introduction to the Discussion and Conclusions section. Could you add or change anything? (*I think they match really well. I think that instead of saying, "My method can be used to model how impact craters form," it could say how different sizes of impact craters form. That would match the testable question better.*)

3. Check for understanding.

Activity Page

AP 11

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Students will use a science report and identify the salient parts as described in the chapter, using the sticky notes to organize their ideas and outline. If time allows, have students conduct research on the topic to add information. They will then create a poster summarizing the article, following the outline they produced with the sticky notes.

See the Answer Key for sample or correct answers.

LESSON 12

How to Decide

At a Glance

Lesson Question

How can patterns be used as evidence to support decisions?

Learning Objectives

✓ Define *decision*.

✓ Explain how looking at patterns in provided scenarios helps in identifying the cause of a problem with something needing to be repaired.

✓ Identify decisions that can be made more confidently when supported by observing a pattern.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement

Main Science Idea

Patterns in data can help us make decisions. Some devices are designed to use computers to do that "thinking" for us.

NGSS and CCSS References

CCC1. Patterns: Engineers often look for and analyze patterns, too. For example, they may diagnose patterns of failure of a designed system under test in order to improve the design

RI.4.7. Integration of Knowledge and Ideas: Interpret information presented visually, orally, or quantitatively and explain how the information contributes to an understanding of the text in which it appears.

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www.coreknowledge.org/cksci-online-resources

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decision **pattern** **troubleshoot**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

cause **effect**

Instructional Resources

Student Reader

Ch. 12

Student Reader, Chapter 12
"How to Decide"

Activity Page

AP 12

Activity Page
A Pattern in Writing (AP 12)

Materials and Equipment

Collect or prepare the following items:

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

The Core Lesson

1. Focus attention on the Lesson Question.

Engage students in a discussion about times they have had to make decisions. Start a list of decisions that they have made today and yesterday. Then, ask students how they went about making those decisions. What kinds of things were they thinking about? For example, they may have chosen what clothes to wear or helped someone else do so. How did they know which type of clothes to wear? Guide students to talk about how their decision was affected by the weather, what may have been clean or dirty, or even what they could find based on if they have cleaned their room lately!

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How can patterns be used as evidence to support decisions?

2. Read and discuss: "How to Decide."

Student Reader

Ch. 12

Prepare to read together, or have students read independently, Chapter 12 "How to Decide." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 68

- What is the problem in this scenario? (*The air-conditioning is broken.*)
- Why was the technician asking so many questions? (*He had to gather lots of information to decide what the cause may be.*)
- How is the AC technician like an engineer in this situation? (*Engineers identify problems, figure out causes, and eventually develop solutions to the problem.*)

Page 69

- What helped the technician make a good decision? How is this similar to or different from how you make decisions? (*The technician asked lots of questions and saw patterns in the answers. This is similar to how I solve a problem because I think about all the different things that may be causing a problem.*)
- List how patterns helped identify the problem. (*1) Patterns help narrow down possible causes; 2) different problems have different patterns; 3) certain causes and effects have certain patterns.*)
- Discuss how patterns work in cause-and-effect relationships. (*First, you see effects (the problem); then, you see patterns in the effects. Then you think about what could have caused the patterns.*)

Pages 70–71

- Tell students that the diagram is called a decision tree. Allow time to read through the decision tree and the different options listed. Students should focus on and describe how it helps in decision-making. (*It breaks things down to yes-or-no questions that help identify patterns in problems, and then the possible solutions are narrowed down.*)
- How is looking for patterns the same as troubleshooting? (*They both look for things that are happening over and over again or not happening over and over again! They can help you solve problems.*)
- How was the decision tree helpful? Have you ever done something like this? (*Possible answer: It was helpful because it listed all the things that could possibly be wrong with the TV. I've done something like this before when the computer program wouldn't turn on and I had to try a bunch of different things to try to figure out why.*)

Know the Standards

CCC1. Patterns This standard is closely related to another Crosscutting Concept, Cause and Effect. The discovery of patterns of events that occur regularly is often followed by identifying the cause of the phenomenon or problem.

Page 72

- What are the problems described in this passage? (*They have to move the dial every time and wait for the temperature to change. The temperature has to be adjusted if someone is there at a different time, and then energy is wasted.*)
- What patterns do you see described? (*Most rooms are at "room temperature." People usually lower the temperature before leaving or before going to bed. They like warmer air when in the house.*)
- What solution or decision can you think of that would solve these problems? (*Answers may vary, but some may suggest smart thermostats.*)

Page 73

- Can you think of any other devices that use patterns like a smart thermostat? What patterns do they use? (*Some devices are smart pet feeders that know when the animal usually eats. Lights can automatically adjust based on the daylight available. Some kitchen appliances like refrigerators also turn lights on and off based on how long the doors are usually open.*)
- Reread the Main Science Idea. Give students an example of how patterns can help us make decisions, such as clothes and weather or eating and time of day. Ask students to think of examples of patterns and decisions they make each day.

3. Check for understanding.

Activity Page

AP 12

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Use the activity page to informally assess students' understanding of the main idea of the chapter: finding patterns to support a decision.

See the Answer Key for sample or correct answers.

LESSON 13

What's a Feedback Loop?

At a Glance

Lesson Question

What is a feedback loop?

Learning Objectives

- ✓ Define *feedback*.
- ✓ In provided scenarios, describe how effects can become causes of future effects.
- ✓ Diagram a feedback loop from a described scenario.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- feeback loop diagram

Main Science Idea

In cause-and-effect relationships, the effects can become causes that affect later effects! That's called a feedback loop.

NGSS and CCSS References

CCC2. Cause and Effect: Any tentative answer, or hypothesis that A causes B requires a model or mechanism for the chain of interactions that connect A and B. A major activity of science is to uncover such causal connections, often with the hope that understanding the mechanisms will enable predictions.

RI.4.5. Craft and Structure: Describe the overall structure of events, ideas, concepts, or information in a text or part of a text.

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affect **effect** **feedback** **feedback loop**

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amplify **cause**

Instructional Resources

Student Reader

Ch. 13

Student Reader, Chapter 13
"What's a Feedback Loop?"

Activity Page

AP 13

Activity Page
Diagram of a Feedback Loop (AP 13)

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- pieces of paper and pencil

The Core Lesson

1. Focus attention on the Lesson Question.

Have each student draw a simple picture on a piece of paper, like a stick figure. Keep the picture hidden from others. Have students describe, or teach, another student how to draw the picture without showing the final version. Encourage students to give directions like, "Stop! Make that line longer." Hold a discussion about how their encouragement and further directions helped in creating the final product.

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What is a feedback loop?

2. Read and discuss: "What's a Feedback Loop?"

Student Reader

Ch. 13

Prepare to read together, or have students read independently, Chapter 13 "What's a Feedback Loop?" When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 74

- What is some feedback that you have received before? How did it change what happened the next time? (*Sample answer: I've received feedback when I was learning how to tie my shoes. The feedback helped because I changed the way I was doing a loop, and I was able to tie my shoes better.*)
- Draw a simple diagram on the board to describe how feedback works, such as *Cause → Effect 1 — Feedback/Cause → Effect 2*. Talk to students about what happened after the feedback step. (*The feedback made the response change, so it is different from the first effect.*)
- Review the image and explain how it illustrates the meanings of *affect* and *effect*. (*The water being poured affects the plant. The effect is the plant growing as a result of being watered.*)

Page 75

- Work through the feedback loop. Write it in simple cause-and-effect terms on the board. (*Cause: low temp; Effect: heater turns on; Effect: temp increases; Cause: temp too high; Effect: heat turns off; Effect: temp decreases; Cause: temp too low. Then return to the top.*)

  SUPPORT—It may be helpful to display a simple diagram of a feedback loop to support the written explanation and diagram in the text. Optionally write the descriptions, and have students identify if they are causes or effects.

- What is the purpose of the feedback loop for a thermostat? (*Its goal is to keep the temperature stable.*)

Page 76

- How are negative and positive feedback loops similar? How are they different? (*They both work to keep things stable. A negative feedback loop removes or reverses any change, and a positive feedback loop adds change to keep things the same.*)
- Apples and avocados are also ethylene producers. Look at the diagram, and imagine that an apple and avocado were near the bananas. Draw a simple feedback loop describing the changes.
- Why is fruit ripening a positive feedback loop and not a negative loop? (*It is positive because it is adding something, ethylene, and the system isn't stable; things are changing.*)

Page 77

- Review the diagrams of the body temperature feedback loop and the blood clotting feedback loop. Why is one a negative feedback loop and the other positive? (*The body temperature feedback loop is negative because nothing is being added and the purpose is to keep the body temperature stable. The blood clotting feedback loop is positive because a chemical is added to the system and the wound changes.*)

- Emphasize that positive feedback loops have beginnings and ends with small changes that increase and can be amplified. How is a squeal from loudspeakers an example of this? (*A microphone captures the output of the speaker it's already outputting to. The speaker will squeal, which will be captured by the microphone, and the squeal will continue to get louder and louder.*)

Page 78

- Have students practice using the words *cause* and *effect* to describe the feedback loop. (*Cause: gas increasing; Effect: atmosphere warms; Effect: ocean warms; Cause: more gas into atmosphere*)
- Is this a negative or positive feedback loop? How do you know? (*This is a positive loop because carbon dioxide gas keeps getting added to the system.*)
- Why is understanding feedback loops like this one important for us to know about? (*It helps us understand what is causing the atmosphere to warm and helps us think about what we can do to stop it; it helps us solve problems.*)

Page 79

- Describe how the carbon dioxide and atmosphere temperature feedback loop on page 78 and the air temperature and polar ice feedback loop are connected and what the result may be. (*They both are contributing to higher air temperatures, which may result in no more polar ice caps.*)
- Where are examples of when an effect becomes a cause? (*One example is that the temperature begins to warm more. It is an effect of ice melting and dark water absorbing the sun's energy. Then it becomes a cause because it causes more polar ice to melt.*)

3. Check for understanding.

Activity Page

AP 13

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

In this activity page, students will be provided with a short description of a feedback loop. Their task is to draw a diagram of the loop, determine if it is a positive or negative loop, and then describe why it is positive or negative.

See the Answer Key for sample or correct answers.

Know the Standards

CCC2. Cause and Effect Experiments are set up to test the sensitivity of the parameters involved, and this is accomplished by making a change (cause) to a single component of a system and examining, and often quantifying, the result (effect).

LESSON 14

Counting Populations

At a Glance

Lesson Question

How and why are populations of organisms determined? (counted versus estimated)

Learning Objectives

- ✓ Express benefits of knowing approximate population numbers for organisms.
- ✓ Define *population sample*.
- ✓ Define *informed estimate*.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- practice with informed estimates

Main Science Idea

Counting exact numbers of living things isn't always possible. Researchers can estimate populations using sampling methods.

NGSS and CCSS References

CCC3. Scale, Proportion, and Quantity: It is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

RI.4.1. Key Ideas and Details: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

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informed estimate **population sample**

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methods **population** **population size**

Instructional Resources

Student Reader

Ch. 14

Student Reader, Chapter 14
"Counting Populations"

Activity Page

AP 14

Activity Page
Practicing Informed Estimates (AP 14)

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- scissors
- small cups or containers (optional)
- handful of beans, small counters, or other small objects
- checkerboard

The Core Lesson

1. Focus attention on the Lesson Question.

Gently toss the counters on a desk or table so they are spread apart. Tell students that you really want to know how many counters there are but don't want to count each one. Brainstorm ideas on different ways they can estimate how many counters there are.

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How and why are populations of organisms determined? (counted versus estimated)

2. Read and discuss: "Counting Populations."

Student Reader

Ch. 14

Prepare to read together, or have students read independently, Chapter 14 "Counting Populations." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 80

- What is a population? What is population size? (*A population is a group of organisms in an area at the same time. Population size is the total number of individuals in that population.*)
- Brainstorm a list of different populations, such as cats in the local animal shelter, humans in a city, kids in a soccer league, or specific tree type in a nature reserve. What are some reasons you might want to know their population sizes? (*We might want to know their numbers so we can buy the right amount of food; determine how many houses to build or how much water and electricity is needed; make sure that everyone has enough soccer jerseys or enough coaches; or check that the trees are healthy and reproducing and not getting cut down by people.*)
- What might make finding the population size of these examples difficult or easy? (*Some might be difficult because you'd have to get reports from every household or go outside and count every single tree. That can take a lot of time.*)

Page 81

- What is an informed estimate? (*An informed estimate is an approximate population size that is calculated by counting the individuals in a small portion of an area and multiplying it by a factor that makes sense.*)
- What is a population sample? If the population is our school, what is a population sample for our school? (*A population sample is a small group of the population. It is the specific group you collect data from. Our classroom could be a population sample for the school.*)
- How are the two related? How is our classroom an informed estimate? (*You can use a population sample to come up with an informed estimate of a population size. It's an informed estimate because most classrooms are the same size.*)

Page 82

- Why do scientists rely on population samples and informed estimates when they are studying the ocean? (*The ocean is too big, and animals move too much.*)
- Why is it important that airplanes and boats move in straight lines when taking a population sample? (*They need to be careful so they don't overlap where they have gathered data. It makes it more organized.*)
- Can you think of a scientific question that oceanographers might need to use population samples for? Remember to think about independent and dependent variables! (*Sample answers: Does the temperature of water affect coral populations? How does the amount of plankton affect the number of animals in the area?*)

Page 83

- What are some possible issues with using trawls to sample a population? (*It can scrape the ocean floor or get wildlife that you don't intend to sample.*)

Online Resources

EXTEND—Watch the video on oceanographer research on sharks. Keep track of all the different ways informed estimates and population samples may have been used in their research and help these scientists make claims about the populations. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Page 84

- How is mark-recapture different from trawling if nets are used in both? (*It is different because after the organisms are counted, they're released, and then the scientists take another sample.*)

Online Resources

- Watch the video on using mark-recapture to study sharks. Why do you think they chose to use mark-recapture? Is this the same reason for using mark-recapture for grasshoppers? (*They are similar reasons: It's not easy to catch sharks in a net. This way, they can follow the shark over a long period of time.*) (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Page 85

- What would the population estimate of grasshoppers be if scientists had collected the following data? Mark phase: 50 collected; Recapture phase: 50 collected. Number of new, unmarked grasshoppers captured: 50. (*A total of 50 were caught in the first phase, and 50 new, unmarked grasshoppers were captured in the recapture phase, so the entire population is probably 100.*)
- Watch a video on using mark-recapture to estimate leopard populations. Compare it to the way sharks and grasshoppers were studied. What are some advantages and disadvantages? (*Advantage of using video to mark-recapture is that it just uses observations and doesn't harm the animals. You get lots of information about other things going on and not just about that animal. A disadvantage is that it looks like it takes a lot of time.*)

3. Check for understanding.

Activity Page

AP 14

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

This activity will allow students to practice a scientific method for making informed estimates. The sampling in Table 1 is set for a diagonal from one corner of the checkerboard to the other. You may wish to provide a more random sampling by utilizing a random number generator app or an eight-sided number cube to determine which grid squares are counted.

See the Answer Key for sample or correct answers.

LESSON 15

Simple Versus Complex

At a Glance

Lesson Question

What are some of the most simple and most complex systems?

Learning Objectives

✓ Define *system*.

✓ Recognize and describe systems in provided scenarios.

✓ Classify provided system examples in order of complexity.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- classification of systems by level of complexity

Main Science Idea

A system with few parts might be called simple. A system that is complex has many structures that all interact.

NGSS and CCSS References

CCC5. Energy and Matter: Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

RI.4.3. Key Ideas and Details: Explain the relationships or interactions between two or more individuals, events, ideas or concepts in a historical, scientific, or technical text based on specific information in the text. (Also RI.4.7)

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

www.coreknowledge.org/cksci-online-resources

Core Vocabulary and Language of Instruction

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Core Vocabulary terms are those that students should learn to use accurately in discussion. During instruction, expose students repeatedly to these terms but not through isolated drill or memorization.

complex **simple** **system**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

circuit **interaction**

Instructional Resources

Student Reader

Ch. 15

Student Reader, Chapter 15
"Simple Versus Complex"

Activity Page

AP 15

Activity Page
Simple or Complex (AP 15)

Materials and Equipment

Collect or prepare the following items:

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

The Core Lesson

1. Focus attention on the Lesson Question.

Online Resources

Make a list of different familiar systems, such as a highway system, waterway system, system of weights and measures, system of government, solar system, and ecosystem. Discuss what all of these systems have in common: a set of things working together to do something. Show a video about a system, like the human body system. Discuss how different systems work together. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What are some of the most simple and most complex systems?

2. Read and discuss: "Simple Versus Complex."

Student Reader

Ch. 15

Prepare to read together, or have students read independently, Chapter 15 "Simple Versus Complex." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 86

- Why is a light switch a simple system? (*It has few parts and a simple on/off switch that opens or breaks the circuit.*)
- What other systems does a light switch interact with? (*electrical system, wiring system, lamp or light*)

  SUPPORT—Discuss the definition of *system*, which is a set of parts that work together to do something. Talk about the parts in the light switch (metal wires, wall attachment, screws, switch). Discuss how it interacts with other systems.

Page 87

- What are the parts in a tetherball system? (*ball, rope, pole, stand*)
- What does a tetherball system do? (*provides a competitive game*)
- What is the result of the collision caused by the interaction of the tetherball system with a human system? (*Energy transfers from the human to the ball and makes it move on the rope around the pole in different directions, at different speeds, and in different ways.*)

Page 88

- How is a dimmer switch system the same as a light switch system? (*It has similar parts and interacts with the electrical system and an appliance.*)
- What makes a dimmer switch a more complex system than a light switch? (*It doesn't have a simple on/off switch. It can provide different amounts of electricity to the light.*)

Page 89

- What are the main parts in an electric guitar system? (*strings, body, neck, wires*)
- What other systems does an electric guitar system interact with? (*electrical system, amplifier, human system*)
- What is the result of the collision caused by the interaction of the electric guitar system with a human system? (*It creates sound energy by interaction with the strings that is transferred to an amplifier.*)

  CHALLENGE—Challenge students to demonstrate or draw a picture of how energy is transferred from one system to another when a human interacts with an electric guitar, which sends energy to the guitar body, to an amplifier, and back to a human ear.

Know the Standards

CCC5. Energy and Matter In grades 3–5, students understand that a system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. They can also describe a system in terms of its components and their interactions. In this lesson, students explore a variety of simple and complex systems and the interactions in which energy is transferred.

Page 90

- What does a pinball system do? (*provides entertainment*)
- What is the result of the collision caused by the interaction of the pinball system with a human system? (*Energy from the human is passed to a metal ball, which bounces around the pinball machine, creating sound and light and recording a score. Humans operate the flippers to transfer energy to the ball.*)
- Why is a pinball system more complex than a dimmer switch? (*It has many more parts and many more possibilities for movement and energy transfer.*)

Page 91

- What are some of the systems in a human body? (*skeletal, respiratory, digestive, muscular, circulatory*)
- How do the systems in the body interact? (*The digestive system provides energy that allows the other systems to work so you can breathe and move and stay alive.*)
- What is the difference between a simple and a complex system? (*A simple system has few parts that have limited interactions. A complex system has many parts that interact with each other and many other systems.*)

CHALLENGE—Ensure that students know that to elaborate means to tell more about something. Invite a volunteer to elaborate on how a system can be tiny and complex at the same time. Invite students to think of example systems that might be very large yet simple at the same time.

EXTEND—Extend the concept of energy transfer between systems to the human body system. Emphasize that humans get energy from food, which comes from the sun. Discuss how all of the human body systems interact with each other and with other systems.

3. Check for understanding.

Activity Page

AP 15

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Use the activity page to informally assess students' understanding of the main ideas of the chapter: what a system is and the differences between simple and complex systems.

See the Answer Key for sample or correct answers.

LESSON 16

It’s Still There

At a Glance

Lesson Question

What does conservation of matter mean?

Learning Objectives

✓ Use details from provided examples to support an explanation of the concept of conservation of matter in their own words.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- simple math exercise

Main Science Idea

Conservation of matter is a law of chemistry and physics. The idea states that matter isn’t created or destroyed; instead, it is just rearranged into different forms when it is changed.

NGSS and CCSS References

CCC5. Energy and Matter: Flows, cycles, and conservation: Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems’ possibilities and limitations.

RI.4.1. Key Ideas and Details: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (Also **RI.4.4**)

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conservation **mass** **matter**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

created **destroyed** **particles**

Instructional Resources

Student Reader

Ch. 16

Student Reader, Chapter 16
"It's Still There"

Activity Page

AP 16

Activity Page
Conservation of Matter (AP 16)

Materials and Equipment

Collect or prepare the following items:

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

THE CORE LESSON

1. Focus attention on the Lesson Question.

Online Resources

Review what matter is, anything that has mass and takes up space. It can be solid, liquid, or gas. Show a video about matter. Introduce the idea that matter can change state from solid to liquid, for example. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What does conservation of matter mean?

2. Read and discuss: "It's Still There."

Student Reader

Ch. 16

Prepare to read together, or have students read independently, Chapter 16 "It's Still There." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 92

- How did the egg change when it collided with the floor? (*The shell broke in pieces, and the egg yolk and liquid spread out.*)
- If you scooped up the broken egg, would it weigh the same as the unbroken egg? Would it have the same mass? (*yes, unless the liquid started to evaporate*)

  SUPPORT—Discuss the definition of *conservation*, which means preservation. Talk about *conservation* of resources, which is the care and protection of natural resources. Connect the idea of resource preservation to the idea that matter is conserved, or preserved, even if it changes its state. Matter can never be created or destroyed. It just changes. The same amount of matter exists before and after the change.

Page 93

- What are the states of matter that water can take? (*liquid water, ice, and gas vapor*)
- If a block of ice collided with a hammer, would the broken pieces have the same mass as the block? (*yes, unless it started to evaporate*)

Page 94

- If you dissolve 2 g of salt and 1 g of sugar into 100 g of water, would you expect the water to have more or less mass? (*It would have 3 g more mass.*)
- How does matter change when you mix the pizza dough ingredients together? (*The flour becomes thick and sticky when the water and oil are added. It starts to get bigger when the sugar and yeast are added. It tastes salty when the salt is added.*)

Page 95

- How would the matter of the ingredients change when you make pizza sauce? (*All the ingredients are mixed together and spread through the sauce. The salt and sugar are dissolved, and the basil gets wet in the crushed tomatoes.*)
- What would happen to the mass of the matter if you blended all the ingredients in a food processor or blender? (*They would blend together with no lumps, but they would have the same mass.*)

Know the Standards

CCC5. Energy and Matter In grades 3–5, students learn matter is made of particles and energy can be transferred in various ways and between objects. Students observe the conservation of matter by tracking matter flows and cycles before and after processes and recognizing the total weight of substances does not change. In this lesson, students explore the concept of conservation of matter with food preparation.

- What happens to liquid when you cut a vegetable or piece of fruit? (*It can evaporate.*)

  CHALLENGE—Challenge students to explain how matter changes, but is not created or destroyed, when a plant grows from a seed, which is much smaller and weighs less than the plant.

Page 96

- Why would the mass of the original pizza ingredients be the same as a finished pizza? (*The matter is the same. It is just in a different form.*)
- How could the mass of the original ingredients be different from the finished pizza? (*if liquid evaporated or you cut out parts, like the stem of vegetables*)
- When a plant dries up and dies, how does the matter change? (*The liquid evaporates, and the plant matter changes into soil.*)

Page 97

- Why would the mass of a pizza change after it has been cooked? (*It would change when some of the liquid evaporated.*)
- How would the mass of a pizza change if it got burned to a crisp? (*It would be much less because all of the water would have evaporated, and the smoke would have carried matter into the air.*)
- What happens to the matter in the pizza when it collides with your teeth as you eat it? (*It would get chewed up in a paste so it can go into my stomach. There, it is broken down and supports my body.*)

  EXTEND—Extend the concept of conservation of matter to the water cycle. Have students imagine the same drop of water going through the entire water cycle.

3. Check for understanding.

Activity Page

AP 16

Online Resources

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Show a video about the conservation of matter. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

- How can you explain the idea of conservation of matter to a young child? (*Things can change if you shape them, freeze them, or cook them, but the stuff they are made of is just changed, not destroyed. And you make things by changing other things, so you can never create matter.*)

Use the activity page to informally assess students' understanding of the main idea of the chapter: What is conservation of matter?

See the Answer Key for sample or correct answers.

LESSON 17

Fantastic Functions

At a Glance

Lesson Question

How do materials and structures in living things perform amazing functions?

Learning Objectives

✓ Identify structures that perform given functions in a range of provided examples.

✓ Identify functions performed by given structures in a range of provided examples.

✓ Explain a cause-and-effect relationship in a provided structure-and-function pair example.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- structures and functions matching activity

Main Science Idea

What a structure is made of and how it is formed determine how it can function.

NGSS and CCSS References

CCC6. Structure and Function: The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

RI.4.1. Key Ideas and Details: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (Also **RI.4.4**)

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

www.coreknowledge.org/cksci-online-resources

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adapt **function** **structure**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

ecosystem **environment** **predator** **prey**

Instructional Resources

Student Reader

Ch. 17

Student Reader, Chapter 17
"Fantastic Functions"

Activity Page

AP 17

Activity Page
Structures and Functions
(AP 17)

Materials and Equipment

Collect or prepare the following items:

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

THE CORE LESSON

1. Focus attention on the Lesson Question.

Online Resources

Review what it means to adapt, or change, to a new circumstance, such as a new school or new neighborhood. Show a video about animal adaptations. Discuss how over time plants and animals have developed structures so they can survive in their environments. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How do materials and structures in living things perform amazing functions?

2. Read and discuss: "Fantastic Functions."

Student Reader

Ch. 17

Prepare to read together, or have students read independently, Chapter 17 "Fantastic Functions." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 98

- What structures do sailfish and anglerfish have to get food? (*The sailfish has a sharp bill to stab prey. The anglerfish has a fin that attracts prey, which it swallows with its huge mouth and daggerlike teeth.*)

  SUPPORT—Discuss plant structures like stems and leaves and body parts like arms and legs. There are internal structures like a heart and lungs and external structures like tails and claws. The structures have functions, or purposes. The function of a heart is to pump blood. The function of claws is to grab and hold on to things.

Page 99

- Describe the structure and function of the mouths of baleen whales. (*Feathery structures act like strainers to trap food and squeeze out water.*)
- What is the function of the tentacles? (*to capture food by stinging prey that are in the water*)
- How are sponges adapted to live underwater? (*They soak in water and strain the food out so they can stay in one place.*)

Page 100

- What is the function of the leaf structure or husk of the corn? (*It protects the kernels from being eaten or decayed while they are growing.*)
- What is the function of the corn silks? (*They are tubes that are pollinated by wind and insects and cause the kernels to grow. The kernels can be planted to grow more corn.*)

Page 101

- How do plant structures perform the function of making food for the plant and for other living things that eat plants? (*Plants have internal structures called chloroplasts that absorb sunlight and turn carbon dioxide and water into food.*)
- How is corn structured to perform the function of keeping the plant upright in windy environments? (*The stalks are woody and sturdy, so they don't bend or break in the wind.*)
- What is the function of plant roots? (*They absorb water and nutrients from the soil to allow the plant to grow.*)

Know the Standards

CCC6. Structure and Function In grades 3–5, students learn that different materials have different substructures, which can sometimes be observed, and that substructures have shapes and parts that serve functions. In this lesson, students explore the structures and functions of a variety of living things that are adapted to different ecosystems.

Page 102

- Describe a prairie environment. (*an open area of grassland with moderate temperatures, moderate rainfall, and few trees*)
- How have predators like hawks adapted to be able to find food in a prairie environment? (*Predators like birds have keen eyesight, the ability to fly over large areas, sharp talons to grab prey, and curved beaks to cut through fur and thick skin.*)
- How have predators like foxes, wolves, and coyotes adapted to be able to find food in a prairie environment? (*They can run fast, have sharp teeth, and have good hearing and smell to be able to hear and sniff out prey.*)

Page 103

- What external structures have animals like rabbits developed in order to survive in a prairie environment? (*They have keen hearing and eyesight to detect predators. Their colors blend in with their surroundings.*)
- How do animals like rabbits behave in order to survive in a prairie environment? (*They can run very fast and live underground.*)

  EXTEND—Extend the concept of adaptions of plants and animals to other ecosystems, such as a desert, forest, or rainforest. Compare how the structures of plants and animals in each environment are adapted for the functions of finding food and staying safe.

3. Check for understanding.

Activity Page

AP 17

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Use the activity page to informally assess students' understanding of the main idea of the chapter: the adaption of structures of living things to an environment for the functions of finding food and surviving.

Discuss student answers to the activity page. For each pair, discuss the cause-and-effect relationship of the structure to its function.

See the Answer Key for sample or correct answers.

LESSON 18

Was That Fast?

At a Glance

Lesson Question

What kinds of changes happen very fast, and what kinds happen very slow?

Learning Objectives

✓ Compare, contrast, and classify provided examples of changes from very fast to very slow.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- examples of observed changes

Main Science Idea

Some living things change, grow, and survive for a very short time. Other organisms have very long life spans. They change, grow, and survive over a long period of time.

NGSS and CCSS References

CCC7. Stability and Change: For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

RI.4.1. Key Ideas and Details: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.4.4. Craft and Structure: Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a *grade 4 topic or subject area*.

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

www.coreknowledge.org/cksci-online-resources

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life span **maturity**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

generation **organism**

Instructional Resources

Student Reader

Ch. 18

Student Reader, Chapter 18
"Was That Fast?"

Activity Page

AP 18

Activity Page
Short and Long Changes
(AP 18)

Materials and Equipment

Collect or prepare the following items:

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

The Core Lesson

1. Focus attention on the Lesson Question.

Online Resources

Discuss how long people can expect to live. Some students may have grand parents or great-grandparents who will live over one hundred years, but most can expect to live into their seventies in the United States. Humans can expect to live longer in places like Hong Kong, Japan, and European countries. Show a video about animal life expectancy. Discuss what students know about how long different animals live. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What kinds of changes happen very fast, and what kinds happen very slow?

2. Read and discuss: "Was That Fast?"

Student Reader

Ch. 18

Prepare to read together, or have students read independently, Chapter 18 "Was That Fast?" When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 104

- How long does the bacteria described on this page live? (*a few hours*)
- What quick changes occur during the life span of the bacteria? (*It creates lactic acid, which grows on raw dairy products and gives cheese and yogurt their taste.*)

Online Resources

SUPPORT—Show a video about how to make yogurt. Discuss how long it takes for the bacteria to reproduce to make yogurt from milk and existing yogurt, which is the life span of the bacteria. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Page 105

- Would you expect insects to have long or short life spans? (*short, because they are delicate and there are so many other animals that eat them*)
- What is the main change that an insect like the mayfly makes during its short life span? (*It sheds its skeleton to mate and reproduce.*)

Page 106

- Why do octopuses die after they mate and lay and care for their eggs? (*They have fulfilled the goal of reproducing.*)
- What other animals lay eggs but do not care for them? (*insects, snakes, spiders, frogs*)

SUPPORT—Discuss the definition of *life span*, which is the length of time a living thing lives or functions. Talk about how long different living things live. For example, a pet dog and cat typically lives thirteen or fourteen years. An oak tree can live hundreds of years.

Page 107

- How could Greenland sharks live 450 years? (*Because they live so deep in the ocean, they are protected from disease and have no predators to kill or eat them.*)
- Explain that most species of sharks live between twenty and thirty years and reach maturity at twelve to fifteen years of age. The age of maturity is the age when sharks are able to reproduce. How is it different from the mayfly? (*The mayfly reaches maturity and lives only a day or two.*)

CHALLENGE—Challenge students to begin to create an ongoing chart of the life spans of different organisms. Have them share their information with the class.

Know the Standards

CCC7. Stability and Change In grades 3–5, students measure change in terms of differences over time and observe that change may occur at different rates. Students learn that some systems appear stable, but over long periods of time, they will eventually change. In this lesson, students explore the short and long life spans of different living things.

Page 108

- What are the oldest trees you know? (*Possible answer: There may be old trees in a nearby park.*)
- How could a tree live to be over 3,000 years old? (*It got enough nutrients and water and was not diseased or a victim of a natural disaster like a fire.*)
- What slow changes would happen to a tree over its life span? (*It would grow taller and taller and wider and wider.*)

Page 109

- What are fossils? (*the remains or impressions of organisms that lived long ago*)
- What can fossils tell us about stability and change? (*They can tell us that plants and animals have existed on Earth a long time but that over time, some plants and animals have changed a great deal.*)

  EXTEND—Extend the concept of stability and change to a study of different periods of time, such as the Cretaceous, Jurassic, and Cambrian periods, and the living things from those periods that have been preserved in fossilized form, as well as living things such as hermit crabs and gingko trees that were found in previous time periods and still exist today.

3. Check for understanding.

Activity Page

AP 18

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Use the activity page to informally assess students' understanding of the main idea of the chapter: the fast and slow changes that different living things go through in their life span.

Discuss student answers to the activity page. As a class, research information about any differences in answers.

See the Answer Key for sample or correct answers.

LESSON 19

The Better Plan

At a Glance

Lesson Question

How do we test and evaluate a solution?

Learning Objectives

✓ Identify the more robust evaluation plan when differentiating among provided examples.

✓ Describe the favorable characteristics of the more robust plan and their reasoning for the selection.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- fair test questions

Main Science Idea

Planning ways to test and compare solutions can sometimes reveal which solution would be better, even without building the solutions or performing the tests. Planning the evaluation causes you to look carefully at what a design is supposed to do and how it is supposed to succeed.

NGSS and CCSS References

ED.A. Defining and Delimiting Engineering Problems: Defining and delimiting engineering problems involves stating the problem to be solved as clearly as possible in terms of criteria for success, and constraints or limits. (Also **ED.B.** and **ED.C**)

RI.4.1. Key Ideas and Details: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (Also **RI.4.4**)

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Core Vocabulary terms are those that students should learn to use accurately in discussion. During instruction, expose students repeatedly to these terms but not through isolated drill or memorization.

constraint **criteria** **rubric**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

fair test **variable**

Instructional Resources

Student Reader

Ch. 19

Student Reader, Chapter 19
"The Better Plan"

Activity Page

AP 19

Activity Page
Fair Test Questions (AP 19)

Materials and Equipment

Collect or prepare the following items:

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

The Core Lesson

1. Focus attention on the Lesson Question.

Online Resources

Discuss the process for solving a problem. First, identify the problem. Next, think of possible solutions, and finally, test the solutions to see if they work. Show a video about someone, such as Jack Andraka, who developed a solution for diagnosing pancreatic cancer, to provide an example of the problem-solving process. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How do we test and evaluate a solution?

2. Read and discuss: "The Better Plan."

Student Reader

Ch. 19

Prepare to read together, or have students read independently, Chapter 19 "The Better Plan." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 110

- What problem needs to be solved with solar arrays on a tropical island? (*which solar panels will be best at providing energy in a sunny place where fossil fuels are expensive*)
- What are the constraints? (*The panels must be lightweight so they don't damage the roof, and they must be arranged to sit on a small roof.*)

  SUPPORT—Discuss the definition of the word *constraint*, which is the limits to a plan. Talk about the constraints of the solar panel solution.

Page 111

- What are the criteria for the project? (*The solar panels must fit in a certain number of square feet of space without damaging the roof and generate a certain amount of electricity.*)
- What would happen if the criteria were not met for this project? (*The solar panels would damage the roof and would not provide enough electricity. People would be unhappy.*)

  SUPPORT—Discuss the definition of the word *criteria*, which are the standard by which something will be judged or things that need to be included. Talk about the criteria for the solar array project and the importance of establishing criteria to judge a solution.

Page 112

- What is a fair test? (*a true test that controls variables to answer a scientific question*)
- What were the variables in the solar panel test? (*materials: glass and metal in Option A and flexible panels that produce less electricity in Option B; the way the panels are arrayed on the roof*)
- What were the controlled variables? (*the location of the houses, similar roofs*)

Page 113

- What benefits and drawbacks of the Option A solution did the test show? (*Option A produces more electricity but is heavier and could be damaged during a storm.*)

Know the Standards

ED.A. Defining and Delimiting Engineering Problems

ED.B. Developing Possible Solutions

ED.C. Optimizing Design Solutions In grades 3–5, students specify criteria and constraints that a possible solution to a simple problem must meet. In this lesson, students explore a problem and its criteria and constraints and evaluate possible solutions.

- What benefits and drawbacks of the Option B solution did the test show? (*Option B produces less electricity but is flexible and may not be damaged in severe weather.*)

Page 114

- What kind of rubric was used? (*a scoring guide that addressed the criteria and constraints*)
- Was the test scored fairly? (*yes, because the score was based on the results, not what anyone thought*)
- What kinds of issues can occur when fair tests are not conducted? (*Someone who has power or influence can change the results, and decisions could be made based on preference rather than test results.*)

CHALLENGE—Challenge students to conduct a fair test of different kinds of light bulbs. Have them establish criteria such as the cost, the quality of the light, and the amount of light. Then have them conduct tests using controlled variables. Ask them to report their results to the class.

Page 115

- How does the test help homeowners make a decision about which type of solar panel to install? (*If they want more electricity, they can go with Option A, but if they don't need so much electricity and want to avoid damage, they can go with Option B.*)
- What other concerns might homeowners need to consider when installing solar panels? (*how long the panels will last, the cost, maintenance*)

EXTEND—Extend the concept of testing to consumer product testing. Discuss the criteria that are established to test appliances, cars, toys, and things such as sports equipment.

3. Check for understanding.

Activity Page

AP 19

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Use the activity page to informally assess students' understanding of the main idea of the chapter: how to establish criteria and identify constraints in conducting fair tests.

Discuss student answers to the activity page. Accept logical explanations for any discrepancies. Discuss other questions that should or should not be considered in fair tests.

See the Answer Key for sample or correct answers.

LESSON 20

Risk

At a Glance

Lesson Question

Why does science need to be concerned with risk?

Learning Objectives

- ✓ Describe the improvement mindset at the core of engineering.
- ✓ Define *risk*.
- ✓ Describe risks detailed in provided examples.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- risk evaluation of light sources

Main Science Idea

Many things studied in science and designed by engineers can do harm. They can unintentionally hurt people, other organisms, and environments. It's important to pay attention to the risk of negative outcomes.

NGSS and CCSS References

STSE1. Interdependence of Science, Engineering, and Technology: Science and technology support each other; Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies. (Also **STSE2)**

RI.4.1. Key Ideas and Details: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (Also **RI.4.4**)

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

www.coreknowledge.org/cksci-online-resources

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Core Vocabulary terms are those that students should learn to use accurately in discussion. During instruction, expose students repeatedly to these terms but not through isolated drill or memorization.

risk

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students themselves will use or explain the words.

fluorescent **incandescent** **LED**

Instructional Resources

Student Reader

Ch. 20

Student Reader, Chapter 20
"Risk"

Activity Page

AP 20

Activity Page
Risky Business (AP 20)

Materials and Equipment

Collect or prepare the following items:

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

The Core Lesson

1. Focus attention on the Lesson Question.

Online Resources

Discuss the importance of artificial light. Have students think about how they see at night and in dark rooms. Talk about what their family does when the electricity goes out. Show a simple video of the history of artificial light. Have students identify the inventions they recognize and discuss how life would be different if we relied only on sunlight to see. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: Why does science need to be concerned with risk?

2. Read and discuss: "Risk."

Student Reader

Ch. 20

Prepare to read together, or have students read independently, Chapter 20 "Risk." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 116

- What problem do artificial light sources solve? (*the ability to see at night, to see in a dark room, or to see details*)
- What types of artificial light do you use or know of? (*Sample answers: flashlights, night-lights, car lights, lamplight, glow sticks, TV or computer screen light, emergency lights, power light, warning light*)
- What are some risks and limitations of artificial light? (*It only lights up a small area at night. It can burn out or lose power. It can cause a fire or get overheated.*)

  SUPPORT—Discuss the definition of the word *risk*, which is something that involves danger. Talk about danger risks involving light, such as getting burned, starting a fire, not being able to see, and falling or tripping.

- Call attention to the image and caption. Let students know that "Hg" is a chemical nickname for mercury, which is a toxic metal. Ask for a volunteer to tell what *toxic* means.

Page 117

- What types of light sources use fire? (*open campfires, torches, candles, oil lamps*)
- What are the advantages of using fire to light areas? (*It allows people to see at night, and it can be controlled.*)
- What are the disadvantages of using fire as a light source? (*It can go out if you don't feed the fire. It can spread. It is not steady.*)

Page 118

- Why did people invent candles? (*to provide a steady source of light that could be controlled*)
- How are candles an improvement over torches? (*They are smaller and can be controlled, so there is less risk of starting a fire.*)
- What are the disadvantages of using candles for light? (*The light is not very bright, so you can't see much beyond the candle. The candle can burn out. If you don't pay attention, a candle can start a fire. You need matches.*)

Know the Standards

STSE1. Interdependence of Science, Engineering, and Technology

STSE2. The Influence of Engineering, Technology, and Science on Society and the Natural World
New technologies developed by engineers advance science and allow people to make progress.

In this lesson, students consider the risks involved in developing new technologies.

Page 119

- How are lamps an improvement over candles? (*They can be powered by oil and the fire is enclosed in glass, so they are less risky. They also provide more light and are more portable than candles.*)
- What risks were involved in the use of oil lamps? (*They depended on oil, which caused the killing of many whales, and then petroleum, which could be difficult to find. They could also start fires.*)

Page 120

- How is electric light an improvement over oil lamps? (*It is much less risky and can be turned on and off to light an entire building.*)
- What are the risks involved with electric light? (*Light bulbs can get hot, or electricity can short out and cause a fire. The glass bulbs can break and cut people. You can also get shocked by electricity.*)

CHALLENGE—Challenge students to research different types of electric light bulbs and report to the class how they work, the different wattages, and how much they cost.

Page 121

- Why did engineers invent new sources of electric light? (*to make them last longer, use less electricity, provide more light, and cost less*)
- How do new sources of light minimize risk? (*They don't get as hot and do not involve glass or flames.*)

Online Resources

EXTEND—Extend the discussion about light to the physical science of light. Show a video about light. Relate how the invention of light bulbs depended on an understanding of light. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

3. Check for understanding.

Activity Page

AP 20

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms.

Use the activity page to informally assess students' understanding of the main idea of the chapter: how to assess risk in new inventions.

Discuss student answers to the activity page. Accept logical explanations for any discrepancies. Discuss what does and does not make something risky.

See the Answer Key for sample or correct answers.

GRADE 4

Teacher Resources

Activity Pages

Name ________________________ Date ________________

Activity Page 1 Use with Lesson 1

Design Your Own Experiment!

Work with a partner to design your own experiment. Pick one of the questions below to get you started! Then complete the worksheet to outline your experiment.

- Does bread always land butter side down?
- Which color of candy-coated chocolate melts faster?
- Which is the best way of keeping a peeled apple from turning brown?
- Does adding salt to ice and water slow down, speed up, or not change how fast the ice melts in the water?
- Which will fizz out more after ten shakes, cold soda or room-temperature soda?

Question:		
Technique:		
Experimental design: List your variables	**Control**	**Experiment**
Methods:		
Tools:		

Name ______________________________ Date ____________________

Activity Page 2 Use with Lesson 2

Laws of Nature

Think of something that is always true. Describe it in one sentence.

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Now write a short story with a scene where you imagine the natural or scientific law gets broken. What happens? What are the consequences? Make it fun!

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Name ______________________________ Date ____________________

Activity Page 3 Use with Lesson 3

Target Practice

Working as a group, your job is to make a plan that answers the following question: Who is the most accurate and precise ball shooter in our group? Complete the table, and carry out a test to answer the question.

Question:	Who is the most accurate and precise ball shooter in our group?
Your hypothesis: **(I think . . . because . . .)**	
Describe how you will measure accuracy. (What tools will you use? How will you know the shots are accurate?)	
Describe how you will measure precision. (What tools will you use? How will you know the shots are precise?)	
Record your data:	
Your conclusion: **(Make sure you say *who* is the most precise and accurate and describe *why*.)**	

Name ______________________________ Date ____________________

Activity Page 4 Use with Lesson 4

Testable or Not Testable

A testable question

- involves a cause and effect;
- has two variables—one thing (the independent variable) is changed to see its effect on another thing (the dependent variable); and
- investigates something that we can observe or measure.

Make an X to indicate whether each question is testable or not testable. Then comment about why you think so.

	Testable	Not Testable	Why?
Does the amount of water affect the growth of a basil plant?			
Do people like peanut butter more than jelly?			
How does changing the shape of a kite affect its ability to fly?			
How do kites work?			
What is the effect of time spent studying on test grades?			
What causes a volcano to erupt?			
Does the power level of a microwave change the rate at which popcorn pops?			

Name ______________________ Date ______________

Activity Page 5 Use with Lesson 5

Modeling Weather

Watch the weather report shown by your teacher. Pay attention to the use of models you see in the forecast. Then respond to the following questions based on what you saw.

Are the models in the forecast concrete or abstract? Why do you think so?	
Describe a concrete model you saw. Why was this concrete model helpful?	
Make up an analogy to help describe something in the weather forecast. Explain the analogy.	
Describe or draw a diagram you saw. Why is this diagram useful?	
Describe a simulation you saw. Why is this simulation useful?	

Name ______________________________ Date ____________________

Activity Page 6 Use with Lesson 6

How Much Data?

A dog food company wants to know if their new food, Tasty Tidbits, improves dog breath. The company want you to test the dog food but isn't sure how many dogs you need to test the new food. Your job is to help the company decide. Circle the number of dogs you think need to be tested. Then, use the storyboard to describe how you would present your ideas and persuade the company to use your suggestion.

1 dog	**5 dogs**	**20 dogs**	**500 dogs**

Drawing:	Drawing:
Caption:	Caption:
Drawing:	Drawing:
Caption:	Caption:

Name ______________________________ Date ____________________

Activity Page 7 Use with Lesson 7

What's Going on in This Graph?

Your teacher will provide a graph or give you options to choose from. Look closely at the graph. Then, respond to the questions that follow.

What is the graph's title? (If the graph doesn't already have a title, give it one.)
What do you notice about the graph?
What do you wonder about the graph? (*What are you curious about that comes from what you notice in the graph?*)
How does this relate to you and your community?
What might be going on in this graph? (*Write a catchy headline that captures the graph's main idea. If your headline makes a claim, tell us what you noticed that supports your claim.*)

Name ______________________________ Date ____________________

Activity Page 8

Use with Lesson 8

Eye Color and Vision

Let's see if eye color determines if you will need glasses or contacts. On a separate sheet of lined paper, make a table like the one below. Survey the class using these two questions:

1. What is your eye color? (brown, green, blue, or other)
2. Do you wear contacts or glasses? (yes or no)

Name	Eye Color	Glasses or Contacts?
Include enough rows for all the students in your class.		

Next, complete the following:

1) What is your scientific question?

____

____

2) What is the independent variable? Dependent variable?

____

____

3) Make a data table displaying your results. Use separate paper.

4) Answer the investigation question: Does there seem to be a connection between eye color and the need for glasses/contacts in this class? Why?

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Name ______________________________ Date ____________________

Activity Page 9 Use with Lesson 9

Reading the News

Let's practice healthy skepticism in science! From the resources provided, choose a science topic and the related articles to evaluate. Read through the articles once, and jot down your initial thoughts below. Then, reread the articles, and write observations to complete the sections below.

Name of the articles:
Authors:
Initial thoughts. Are you skeptical of this article? Describe why or why not.
Explanation or claim the author is making:
Weak evidence:
Strong evidence:
List any convincing evidence:
Does the evidence support the explanation/claim? Why?

Name ______________________________ Date ____________________

Activity Page 10 Use with Lesson 10

Science News

Read the provided science news articles. Complete the sections below.

Person: ____________________ **Claim:** ____________________
Person: ____________________ **Claim:** ____________________
Person: ____________________ **Claim:** ____________________
Person: ____________________ **Claim:** ____________________
Article 1: Is this a reliable source? Why or why not?
Article 2: Is this a reliable source? Why or why not?
Summary Question: Which article is the most reliable? Why? (Explain why you think this. What evidence and sources did they use or not use? What would have made the article more trustworthy?)

Name ______________________________ Date ____________________

Activity Page 11 Use with Lesson 11

Reporting the Science

Use the provided report and this table to determine and explain the information that should be on a science poster. Use the sticky notes to keep track of the outline the author used while writing the report. Then, make a poster!

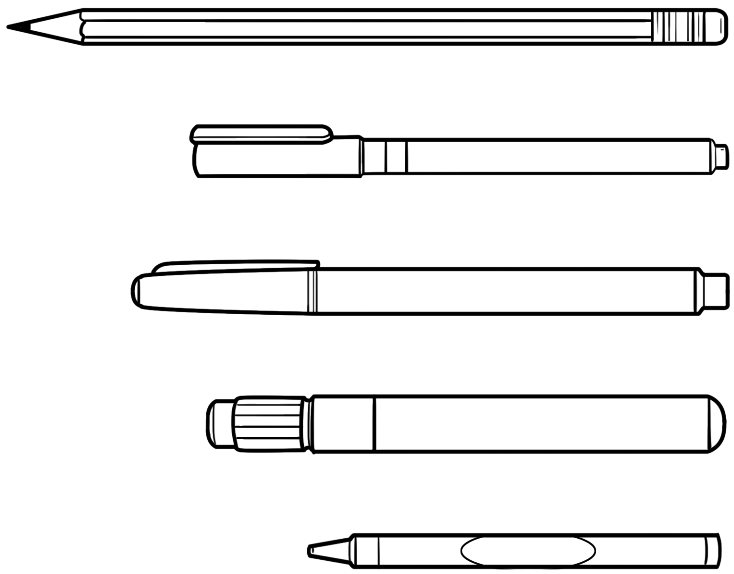
Title	
Topic	
Their question (Use the word *affect*.)	
Independent variable	
Dependent variable	
Introduction summary (Include any stated hypothesis or prediction.)	
Research I could add	
Title of sources, if any	
Method(s)	
Data and results	
Explanation (conclusion)	
Explanation (discussion)	

Name ______________________________ Date ____________________

Activity Page 12 Use with Lesson 12

A Pattern in Writing

An engineer is someone who tries to solve problems by using science. Today, you are going to be an engineer who thinks about patterns to solve a problem! You need to find a writing implement that you can easily carry and will work best for a science notebook where data are collected. Below are your options. Jot notes in the space around the pictures. Use the chart to list the patterns you see. Then, make a recommendation for the best writing implement for your needs.



Pattern of Similarities	Differences

Based on these observations, I have decided to recommend: ______________________

I think this because:

____

____

Name ______________________________ Date ____________________

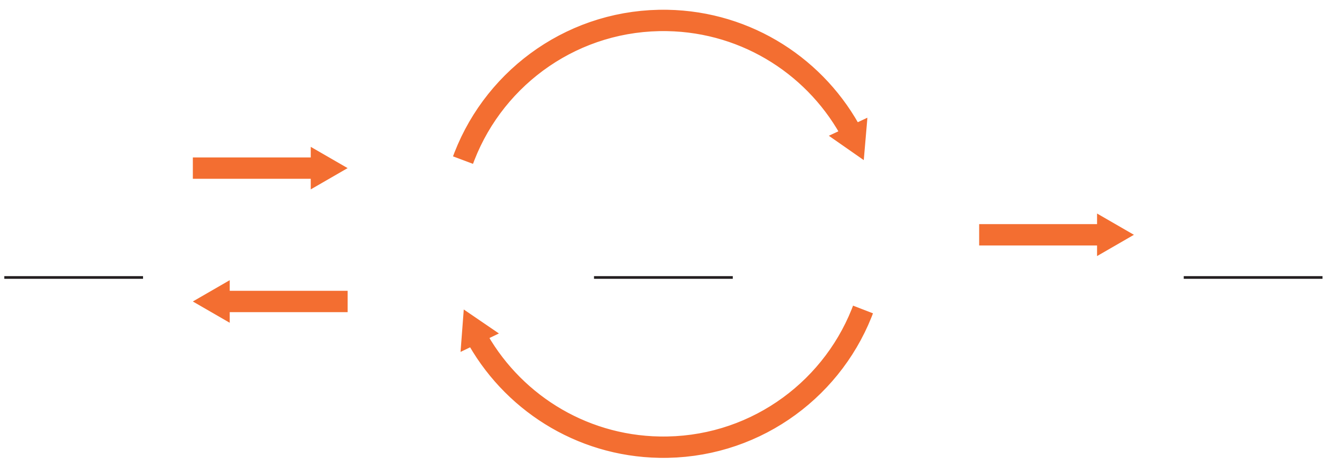
Activity Page 13 Use with Lesson 13

Diagram of a Feedback Loop

Read the description of the feedback loop. Then, use the information to create a diagram of the loop. Finally, write if it is a positive or negative loop, and why.

Description	A driver in traffic gets cut off in traffic. Their mood gets worse. Then they get honked at and they get a little more upset. They then start driving a little fast and get honked at again. Their mood gets worse until they are too upset to drive safely..

Diagram what happens, the causes and effects.



Describe the feedback loop.

Name ______________________________ Date ____________________

Activity Page 14 Use with Lesson 14

Practicing Informed Estimates

In this activity, you will look at how data obtained from random sampling of a population compare with data obtained by an actual count.

1. Open up the checkerboard.
2. Have your teacher or a partner spread the beans (or seeds) out on the checkerboard.
3. Count the number of sunflowers seeds in the Sample #1 box. Write the answer in the table.

TABLE 1 – Estimating Population Size with Random Sampling Data Sheet

Sample #	Grid Segment	# of Sunflowers
1	A1	
2	B2	
3	C3	
4	D4	
5	E5	
6	F6	
7	G7	
8	H8	

4. Repeat Step 3 until you have data for eight different sample boxes. These eight boxes are your sample.
5. Calculate the AVERAGE number of sunflower seeds per grid box. Record in Table 2.
6. Multiply the average by 64 (the total number of grid boxes) to find an estimate of the total number of plants in the field based on your sample. Record in Table 2.

Name ________________________________ Date ____________________

Activity Page 14 (*continued*) Use with Lesson 14

7. Now count and record all the sunflower plants actually shown in the field.

TABLE 2 – Data Calculations

Average Number of Sunflower Seeds Per Grid Box	
Estimated Total Number of Sunflower Seeds	
Actual Number of Sunflower Seeds	

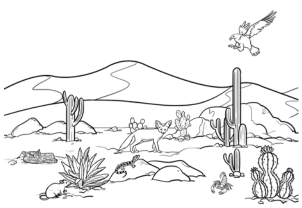
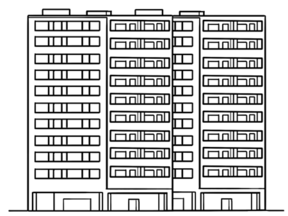
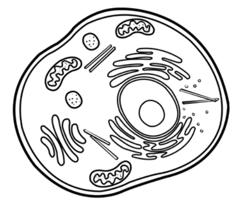
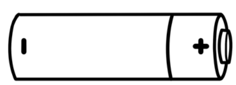
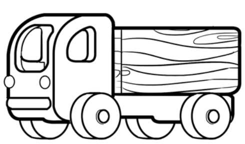
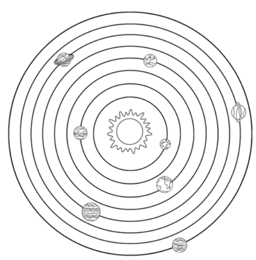
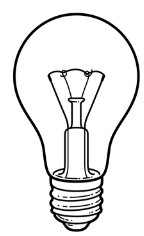
Compare the total number you got from SAMPLING to the ACTUAL count. How close are they?

Name ______________________________ Date ________________

Activity Page 15 | Use with Lesson 15

Simple or Complex

Circle the system that you think is the most complex. Draw a square around the system that you think is the most simple. Explain your thinking at the bottom of the page.

Desert ecosystem 	Apartment building 	Human cell 
Cell phone 	Battery 	House 
Toy truck 	Solar system 	Light bulb 

Which of these systems is the simplest system? Explain your thinking.

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Which of these systems is the most complex? Explain your thinking.

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Name ________________________________ Date ____________________

Activity Page 16 Use with Lesson 16

Conservation of Matter

Read each scene, and then write a response.

1. Rakim takes a bowl and adds 50 grams of oatmeal, 20 grams of raisins, 1 gram of sugar, and 50 grams of milk. He then heats it up in a microwave. According to the law of conservation of matter, what is the mass of everything in the bowl after cooking? Show the math to explain your answer.

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   If the oatmeal were so hot that steam rose from it, how would that affect the total mass in the bowl?

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2. Lana leaves a candle with a mass of 150 grams in the sun. The next day, the candle has melted. She weighs the wick at the center of the candle. It has a mass of 5 grams. According to the law of conservation of matter, what is the mass of the wax in the candle? Show the math to explain your answer.

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3. Erik puts a fizzy tablet with a mass of 10 grams in a cup containing 100 grams of water. Once the tablet is done fizzing, there is a little white powder in the water at the bottom of the cup. The water with the powder has a mass of 108 grams. What happened to the other 2 grams according to the law of conservation of matter? Explain your answer.

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Name ______________________________ Date ____________________

Activity Page 17 Use with Lesson 17

Structures and Functions

Draw lines to match structures of living things to their functions.

sharp teeth	spot movement of prey
superior eyesight	provide warmth
thick fur	hear predators coming
deep roots	stay upright in different weather conditions
superior hearing	sniff out sources of food
superior sense of smell	tear thick skin
strong trunk	protection from being eaten
thorns	absorb water in dry areas

Think about nonliving structures that function in similar ways to the structures of living things. For example, the lens of a magnifying glass focuses light. It is similar to the way the lens of an eyeball focuses light. An insulated coat traps warm air and keeps cold air away from the body. An animal's fur functions the same way. Think of two more examples, and explain them here.

Name ______________________ Date ______________

Activity Page 18 Use with Lesson 18

Short and Long Changes

There are things you see every day that change quickly. There are also things that change slowly.

1. Name something you see that changes over the course of a school day.

   ____

   Explain what it's like at the start and how it is different at the end of a school day.

   ____

   ____

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2. Name something you see that changes over the course of a month.

   ____

   Explain what it's like at the start and how it is different at the end of a month.

   ____

   ____

   ____

   ____

3. Name something you see that changes over the course of a school year.

   ____

   Explain what it's like at the start and how it is different at the end of a school year.

   ____

   ____

   ____

   ____

Name ______________________________ Date ________________

Activity Page 19 Use with Lesson 19

Fair Test Questions

Place a check mark by the five questions that you think are best for a fair test comparing two different things.

	Does it look good?
	How much does it cost?
	How big or small is it?
	What does the person in charge want?
	What do the experts say about it?
	How long does it last?
	How good is the advertising?
	How reliable is it?
	What extra features come with it?
	Does it solve a problem?

Choose two questions you think are not good for a fair test investigation. Explain why you think they are not good questions for such an investigation.

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Name ________________________ Date ________________

Activity Page 20 | Use with Lesson 20

Risky Business

Rank the light sources from what you think are the most risky to least risky. Use 1 for the most risky, 2 for the second most risky, and so on.

	incandescent light bulb		open campfire
	torch		glow stick
	hand-crank flashlight		hurricane lamp
	candle		fluorescent light bulb
	gas streetlight		electric streetlight
	laser light		LED light

Explain the risks of the three riskiest light sources according to your ranking.

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Identify another designed device that poses a risk to people using it. Explain the risk. Make suggestions about how to make it less risky.

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Answer Key: *Making Sense of Science*

This answer key offers guidance to help you assess your students' understanding. Here, you will find descriptions of expectations, reasonable sample responses for open-ended items, and, where called for, singularly correct answers for each activity page of this grade level.

Design Your Own Experiment! (AP 1) (page 96)

Make sure questions are from the options listed. Technique describes how they are doing the test. Look for control variables that will not change and one experimental variable. Methods should describe quantitative or qualitative observations. Tools should relate to their techniques.

Laws of Nature (AP 2) (page 97)

Accept all answers for the first prompt. Make sure students describe how the law is broken and its consequences.

Target Practice (AP 3) (page 98)

Make sure the hypothesis is written in the "I think . . . because . . ." format. Tools are listed. Students should describe how they will define accuracy and precision. Conclusions should be based on data and should identify the most accurate and precise shooter.

Testable or Not Testable (AP 4) (page 99)

Q1, Testable. Has all characteristics; Q2, Not testable. Is not cause and effect, can't measure "like"; Q3, Testable. Has all characteristics; Q4, Not testable. Has no cause and effect or variables; Q5, Testable. Has all characteristics; Q6, Not testable. Has no characteristics; Q7, Testable. Has all characteristics.

Modeling Weather (AP 5) (page 100)

Student responses should accurately describe concrete or abstract models. Analogies, diagrams, and simulations should be accurately identified and described.

How Much Data? (AP 6) (page 101)

20 dogs; Look for drawings that describe an investigation that results in dependable findings. Answers should include a question, the number of dogs used, and why other numbers of dogs would not work.

What's Going on in This Graph? (AP 7) (page 102)

Student responses should include what they notice or wonder about the graph. Make sure students connect the graph to their own lives. The headline should correctly identify the major result shown in the graph.

Eye Color and Vision (AP 8) (page 103)

Sample answers: 1, Does eye color impact vision?; 2, The independent variable is eye color. The dependent variable is glasses or contacts; 3, Look for a data table that lists variables being tested and observed; 4, Based on my data, if you have brown eyes, you need contacts or glasses more than other eye colors.

Reading the News (AP 9) (page 104)

Look for initial thoughts that accurately use the word *skeptical*. Students should distinguish between weak, strong, and convincing evidence. Make sure students use listed evidence to determine if the claim is supported.

Science News (AP 10) (page 105)

Make sure students are identifying people from the articles and their claims. When determining reliable sources, students should identify trustworthy facts, speculation, and reasoned judgments.

Reporting the Science (AP 11) (page 106)

Answers should be based on the report. The identified independent variable should be the thing that changes, and the dependent variable should be what is being measured. Methods, data and results, and explanation are included.

A Pattern in Writing (AP 12) (page 107)

Similarities: purpose, shape, length; Differences: blue or black; some permanent, some not; some can be sharpened. Recommendation: a pencil, because it is a good length, doesn't need to be a certain color, and can be erased and sharpened.

Diagram of a Feedback Loop (AP 13) (page 108)

Honked at, Bad mood, Road rage; Positive; More traffic incidents are being added and mood keeps getting worse.

Practicing Informed Estimates (AP 14) (pages 109–110)

Focus on the response to the reflection question. Make sure they are comparing the sample to the actual count.

Simple or Complex (AP 15) (page 111)

Answers will vary. The simplest system should have only a few parts. The most complex system should have many structures that all interact.

Conservation of Matter (AP 16) (page 112)

1, 50 + 20 + 1 + 50 = 121. The mass is 121 grams before and after cooking. If steam is present, the mass in the bowl would decrease; 2, 150 – 5 = 145. The mass of the wax is 145 grams; 3, There was originally 110 grams. After the change, the water and powder are 108 grams, so the other 2 grams escaped as gas bubbles.

Structures and Functions (AP 17) (page 113)

sharp teeth – tear thick skin; superior eyesight – spot movement of prey; thick fur – provide warmth; deep roots – absorb water in dry areas; superior hearing – hear predators coming; superior sense of smell – sniff out sources of food; strong trunk – stay upright in different weather conditions; thorns – protection from being eaten. Accept all responses that accurately relate to the function of a living thing.

Short and Long Changes (AP 18) (page 114)

1, Accept all responses that identify and describe a change that occurs over a day. Example: daylight; 2, Accept all responses that include accurate descriptions of changes that occur over a month. Example: moon phases; 3, Accept all responses that describe things that change over a year. Example: seasons.

Fair Test Questions (AP 19) (page 115)

Check marks should be placed next to the following items: How big or small is it? How long does it last? How reliable is it? What extra features come with it? Does it solve a problem?; Look for responses that critique the lack of controlled variables for comparison.

Risky Business (AP 20) (page 116)

Accept all orders. Look for responses that discuss possible negative outcomes. Accept all additional devices. Look for discussion of negative outcomes and ways to negate risk.

Glossary

Orange words and phrases are Core Vocabulary in the lessons, though the terms are not called out with color or bold treatment on the Student Reader pages. **Boldface words and phrases** are additional vocabulary terms related to the lessons that you should model for students during instruction. Many of these also appear in the Student Reader. Vocabulary words are not intended for use in isolated drill or memorization.

A

abstract, adj. can't be physically represented

accurate, adj. on target

adapt, v. to change to a new circumstance

affect, v. to create a change in something

amplify, v. to make larger or greater

analogy, n. a model that explains one idea by comparing it to something else

C

cause, n. the reason something happens

chart, n. a graphical representation of information

circle graph, n. a chart used for showing portions of a total that is shaped like a circle divided into sections, also called a pie chart

circuit, n. the complete path that electricity flows in

claim, n. a statement that answers a question or poses a solution to a problem

column, n. a vertical arrangement of related items or data

compare, v. to examine characteristics of two or more things, particularly looking for similarities

complex, adj. describes a system with many parts that interact with each other and many other systems

conclusion, n. the section at the end of a scientific report that talks about things that are important or could have been different in the investigation

concrete, adj. can be directly observed

conservation, n. the preservation and careful management of the environment

constraint, n. a limitation on the designed solution to a problem

control, n. the unchanged thing or group used as a comparison to the results of an experiment

convincing evidence, n. evidence that is more likely to be true than untrue

created, v. produced something original

criteria, n. conditions that a solution to a problem must meet for the solution to be considered successful

D

data, n. information collected by observation or measurement

data table, n. a grid that organizes data into rows and columns

decision, n. a choice made after thinking about several possibilities

dependent variable, n. the variable that is being tested in an experiment and depends on another variable

destroyed, adj. reduced, ruined, or made useless

diagram, n. a picture that relates how something functions

discussion, n. a conversation or debate with the goal of understanding a topic or subject

E

ecosystem, n. all the living and nonliving things that interact in a given area

effect, n. a change that happens because of a cause

environment, n. the living and nonliving elements in an area that affect the things that live there

evaluate, v. to examine the details of something and determine the value or effectiveness of it

evidence, n. information that helps answer a question, support a claim, or solve a problem

F

facts, n. information that is proved to be true

fair test, n. a controlled investigation in which only one variable changes while all other factors remain constant

feedback, n. response to something that happens that provides information or input into what happens next time

feedback loop, n. a cause-and-effect relationship in which the effects become causes that affect later effects

fluorescent, adj. energy efficient yet containing mercury

function, n. the way something works to achieve a task or serve a purpose

G

generation, n. a group that exhibits similar characteristics and are contemporaries

graph, n. a diagram that organizes and displays data in a way that reveals patterns and makes the data easier to understand

gravity, n. the invisible force that pulls objects down toward the surface of the Earth

I

incandescent, adj. glowing, white, or luminous with intense heat

independent variable, n. the variable that is changed in an experiment and is the possible cause

informed estimate, n. a count of individuals in a small portion of an area, multiplied by a factor that makes sense

interaction, n. a relationship in a system through which factors affect each other

introduction, n. the beginning of a report that explains what will follow and the purpose of the report

investigation, n. an instance of investigating

L

law, n. a statement based on many observations and pieces of evidence

LED, n. small light-emitting diodes used as a light bulb

lifespan, n. the length of time a living thing lives or functions

line graph, n. a graph that uses points and lines to show change over time

M

mass, n. the amount of matter in an object

matter, n. anything that has mass and takes up space

maturity, n. the age at which an organism can reproduce

measurements, n. the amounts determined by measuring

method, n. the way that data is gathered

model, n. a representation of something that can help people learn about the real thing

O

observations, n. noted details

organism, n. a living thing that can reproduce, grow, adapt, and respond to its environment

P

particles, n. tiny pieces of matter that are too small to be seen

pattern, n. a recognizable or recurring design or sequence of events

pie chart, a chart used for showing portions of a total that is shaped like a circle divided into sections, also called a circle graph

population, n. a group of a single type of organism living in the same place at the same time

population sample, n. the specific group data is collected from

population size, n. the total number of individuals in a population

precise, adj. within a narrow range

predator, n. an animal that naturally preys on others

prey, n. an animal that is hunted or killed by another animal for food

Q

question, n. an expression for the purpose of inquiring or looking for a reason or explanation

R

reasonable judgment, n. judgment based on good reasoning and facts

reasoning, n. a scientific mindset that connects claims and evidence

reliable, adj. able to be trusted

report, n. explanation of a science investigation

results, n. the outcomes of something

risk, n. something that involves danger

rows, n. a part of a data chart that displays related data horizontally

rubric, n. a scoring guide that addresses the criteria and constraints

S

shadows, n. the darker area behind an object relative to a light source

simple, adj. describes a system with few parts

simulation, n. a program or system that imitates another system or problem

skeptical, adj. questioning nature, unsure if a statement is accurate or based on evidence

speculation, n. an opinion about something without necessary or sufficient evidence or information

strong, adj. describes evidence that can be verified by multiple sources

structure, n. the arrangement of parts that make up something

system, n. a set of parts that work together to complete a task

T

technique, n. how scientists conduct a test

test, v. to systematically observe outcomes from the manipulation of variables

testable question, n. a scientific question that includes a cause and effect, independent variable, and dependent variable

theory, n. a set of ideas used to explain something

tool, n. a device that helps in the performance of a task

troubleshoot, v. to identify and correct the problem in a system

V

variable, n. a factor in a test that is changed so the outcome of the change can be observed

W

weak, adj. describes evidence that is not convincing or is an opinion

Appendix B

Safety

Classroom Safety: 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 the Science Literacy lessons make comparatively modest use of materials and hands-on science experiences. Some activities and demonstrations do make use of materials and equipment that are typically deemed classroom safe and readily available.

Safety should be a priority when engaged in science activities. With that in mind, observe the following safety procedures when the class is engaged in activities and demonstrations:

- Report and treat any injuries immediately.
- Check equipment prior to usage, and make sure everything is clean and ready for use.
- Clean up spills or broken equipment immediately using the appropriate tools.
- Monitor student behavior to ensure they are following proper classroom and activity procedures.
- Do not touch your eyes, ears, face, or mouth while engaging in an activity or demonstration.
- Review each step of the lesson to determine if there are any safety measures or materials necessary in advance.
- Wear personal protective equipment (e.g., safety goggles, aprons, etc.) as appropriate.
- Check for allergies to foods, 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.

Internet Safety: Though online resources present many rich opportunities for student learning, unsupervised online activity for children is not advised. The U.S. Department of Justice provides the following guidelines, Keeping Children Safe Online:

- Discuss internet safety and develop an online safety plan.
- Supervise young children's use of the internet.
- Review games, apps, and social media sites.
- Adjust privacy settings and use parental controls. for online games, apps, social medial sites, and electronic devices.
- Tell children to avoid sharing personal information, photos, and videos online.
- Teach children about body safety and boundaries.
- Be alert to potential signs of abuse.
- Encourage children to tell a parent, guardian, or other trusted adult if anyone asks them to engage in sexual activity or other inappropriate behavior.

Copy and distribute the Student Online Safety Contract, found on the next page. Prior to the start of the first lesson, do a read-along, and have students agree to the expectations for when they engage in computer and online activities.

Online Resources

For additional support concerning internet safety and online instruction, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Student Safety Contract

Dear Parent or Guardian,

During science class, we want to create and maintain a safe classroom. With this in mind, we want students to be aware of the behavior expectations for engaging in online science activities. Please review the safety rules below with your student and sign this contract. If you have any questions, please feel free to contact me.

For important safety information about children, computers, and the internet, consider resources at these sites:

https://protectyoungeyes.com/

https://sharedhope.org/

https://www.justice.gov/coronavirus/keeping-children-safe-online

____

Teacher signature and date

______________________________ ____/____/____/

Parent or guardian signature and date

______________________________ ____/____/____/

When doing online activities, I will do the following:

- Only do online activities with the supervision of an adult.
- Only visit websites and use apps that I am guided to by my teacher, parent, or trusted adult guardian.
- Never use my real name or reveal personal information if I communicate with others online.
- Tell a trusted adult right away if anyone online asks questions about my name, where I live, or where I go to school.
- Be careful around electronic devices and only plug them in or unplug them when an adult is supervising.

I understand and agree to the safety rules in this contract.

____

Student signature and date

______________________________ ____/____/____/

Print name

____

Appendix C

Strategies for Acquiring Materials

The materials used in the Core Knowledge Science Literacy program are readily available and can be acquired through both retail and online stores. Some of the materials are reusable and are meant to be used repeatedly. This includes items such as plastic cups that can be safely used again. Often, these materials are durable and will last for more than one activity or even one school year. Other materials are classified as consumable and cannot be used more than once.

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 and technology can add up for an entire science program, even when the materials required for activities and demonstrations have been selected to be individually affordable. 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 in the teaching of science, as well as 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.

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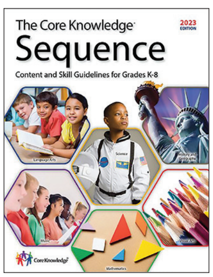
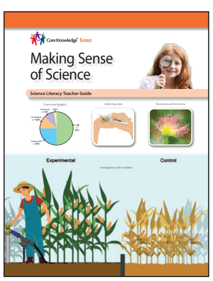


What is the Core Knowledge Sequence?
The *Core Knowledge Sequence* is a detailed guide to specific content and skills to be taught in Grades K–8 in language arts, history, geography, mathematics, science, computer science, and the fine arts. In the domain of computer science, the *Core Knowledge Sequence* outlines topics that build systematically grade by grade to support student learning progressions coherently over time.



For which grade levels is this book intended?
In general, the content and presentation are appropriate for students in the upper elementary grades. For teachers and schools following the *Core Knowledge Sequence*, this book is intended for Grade 4 and is part of a series of **Core Knowledge SCIENCE** units of study.

For a complete listing of resources in the
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