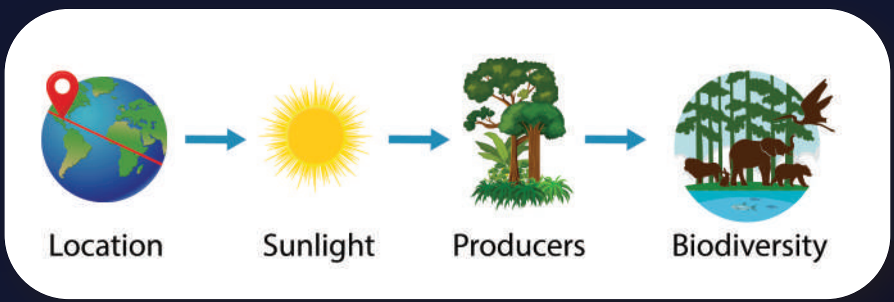
Core Knowledge® SCIENCE

Using Science Knowledge

Science Literacy Teacher Guide

Understanding and reasoning



Predictable phenomena

Working with information

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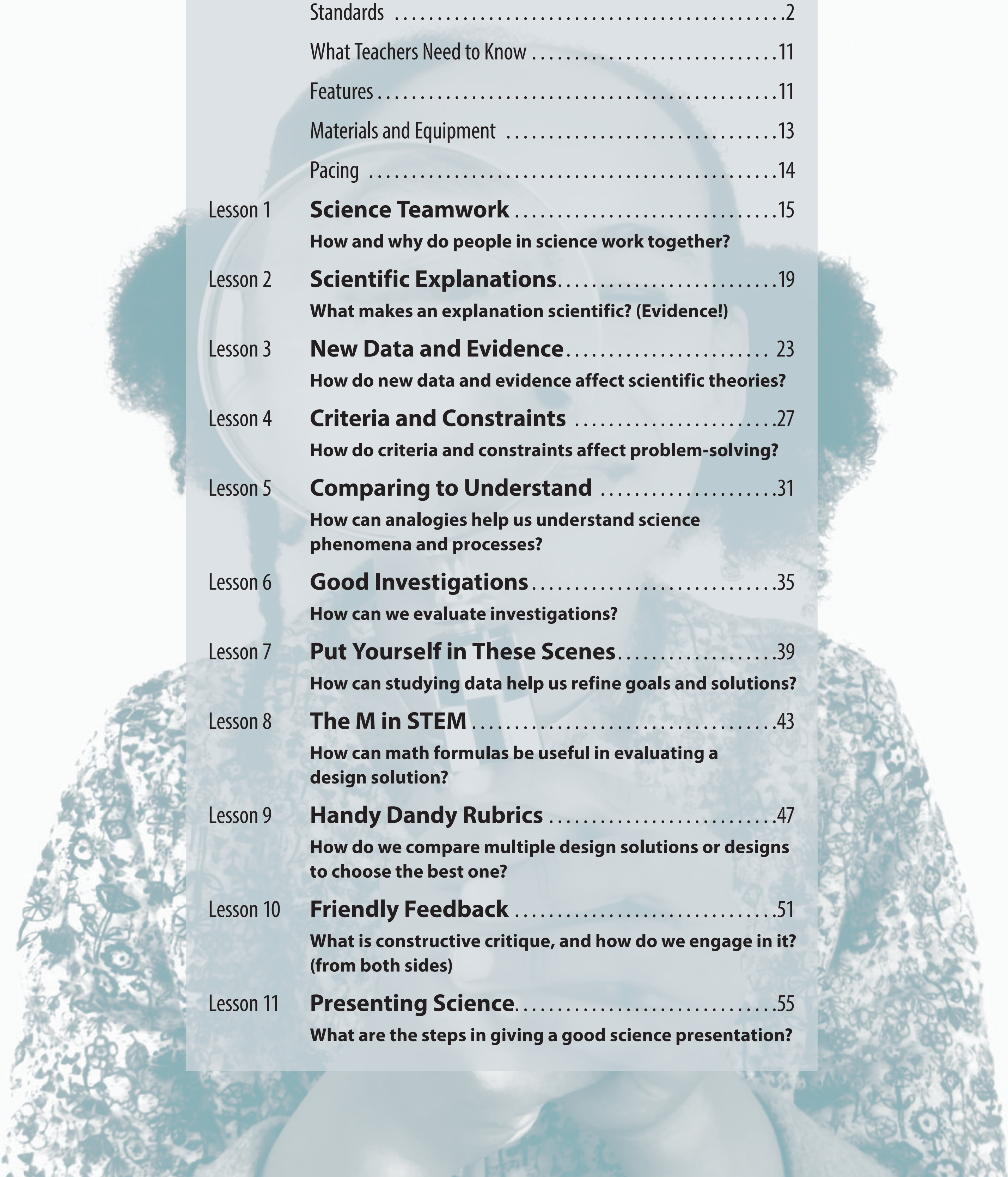

Using Science Knowledge

Science Literacy Teacher Guide

Core Knowledge Science™ 5

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.5.1:** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
- **CCSS.ELA-LITERACY.RI.5.2:** Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.
- **CCSS.ELA-LITERACY.RI.5.3:** 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.

Craft and Structure:

- **CCSS.ELA-LITERACY.RI.5.4:** Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *grade 5 topic or subject area*.
- **CCSS.ELA-LITERACY.RI.5.5:** Compare and contrast the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in two or more texts.
- **CCSS.ELA-LITERACY.RI.5.6:** Analyze multiple accounts of the same event or topic, noting important similarities and differences in the point of view they represent.

Integration of Knowledge and Ideas:

- **CCSS.ELA-LITERACY.RI.5.7:** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.
- **CCSS.ELA-LITERACY.RI.5.8:** Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).
- **CCSS.ELA-LITERACY.RI.5.9:** Integrate information from several 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.5.10:** By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.

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

The *Using Science Knowledge* 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.

Online Resources

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—Building a Team (AP 1)

Lesson 2—Bustin' Myths! (AP 2)

Lesson 3—Electrical Inventions over Time (AP 3)

Lesson 4—Criteria and Constraints (AP 4)

Lesson 5—Making Analogies (AP 5)

Lesson 6—Peer Review a Scientific Report (AP 6)

Lesson 7—Design and Refine (AP 7)

Lesson 8—Grazing Acreage (AP 8)

Lesson 9—Water Cycle Rubric (AP 9)

Lesson 10—Constructive Critique (AP 10)

Lesson 11—Presentation Plan (AP 11)

Lesson 12—Pattern Power (AP 12)

Lesson 13—Causal Relationships (AP 13)

Lesson 14—Units of Measurement (AP 14)

Lesson 15—Earth in the Universe Model (AP 15)

Lesson 16—Home Energy Efficiency (AP 16)

Lesson 17—Moon Unit (AP 17)

Lesson 18—Disorder and Order (AP 18)

Lesson 19—The Optimal Solution (AP 19)

Lesson 20—Apps for That (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 1

- materials for drawing, such as butcher paper, markers, crayons

Lesson 2

- reference books and other research materials

Lesson 3

- reference books and other research materials
- Timeline cards for AP 3

Lesson 5

- reference books and other research materials

Lesson 7

For each group:

- larger bucket/container
- smaller container
- blindfold
- fishing net or other implements, such as cups, mesh bags, or sandwich bags
- assortment of marbles, balls, and other materials (such as rocks) of different colors and sizes
- bowl
- water

Lesson 13

- reference books and other research materials

Lesson 15

- reference books and other research materials

Lesson 17

- various materials to test heat protection, such as different types of fabrics

Lesson 18

- reference books and other research materials

Lesson 19

- reference books 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. Science Teamwork	Physical, life, and earth science	**11.** Presenting Science	Physical and earth science, systems
2. Scientific Explanations	Physical, life, and earth science	**12.** Things That Happen Together	Life and earth science, natural resources
3. New Data and Evidence	Physical science, properties	**13.** Correlation	Life and earth science, protecting resources
4. Criteria and Constraints	Physical science, properties	**14.** Extreme Measurement	Life science, protecting resources
5. Comparing to Understand	Physical science, properties	**15.** Model It!	Life science, natural resources
6. Good Investigations	Life science, ecosystems	**16.** What Is Efficiency?	Earth and space sciece
7. Put Yourself in These Scenes	Life science, ecosystems	**17.** Choosing for Designs	Earth and space science
8. The M in STEM	Life science, ecosystems	**18.** Things Get Disorderly	Earth science, systems
9. Handy Dandy Rubrics	Physical and earth science, systems	**19.** Optimizing a Solution	Earth and space science
10. Friendly Feedback	Physical and earth science, systems	**20.** The Information Age	Life and earth science, protecting resources

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

Science Teamwork

At a Glance

Lesson Question

How and why do people in science work together?

Learning Objectives

✓ Describe different roles held by members of provided examples of science teams.

✓ Recognize that scientists and engineers come from all cultures and backgrounds.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- playground activity design

Main Science Idea

Great scientific accomplishments always involve teams of people working together.

NGSS and CCSS References

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.

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.

RI.5.3. 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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team **teamwork**

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.

goal **redundancy**

Instructional Resources

Student Reader

Ch. 1

Student Reader, Chapter 1
"Science Teamwork"

Activity Page

AP 1

Activity Page
Building a Team (AP 1)

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- materials for drawing, such as butcher paper, markers, and crayons

THE CORE LESSON

1. Focus attention on the Lesson Question.

Talk with students about any teams they are on or have been on previously. What were the team's goals? Why was it important to have team members? What does it mean to be on a team? What were their roles?

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 do people in science work together?

2. Read and discuss: "Science Teamwork."

Student Reader

Ch. 1

Prepare to read together, or have students read independently, Chapter 1 "Science Teamwork." 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

- List all the steps of Orion's journey. Do you think a four-person crew are the only people involved? *(No, there are many different steps where people do many different things.)*
- There are many different tasks and things to think about for the Artemis II program. Hold a discussion about how all pieces are both independent and interdependent. For example, one **team** must build the rocket, another team is on the Orion spacecraft, and another team is on the ground tracking Orion's progress.

Online Resources

EXTEND—Watch the video on Artemis I's launch and recovery. As students watch, encourage them to make a list of all the different ways people were working as a team with a common goal. Discuss if they think the fans are part of the team as well. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Page 3

- Think about the job titles of each astronaut. What do you think each person does? Do you think any of their tasks overlap? *(Sample answer: I think the commander is in charge of everyone. I think their tasks overlap a little bit, but they each have their main jobs.)*
- Think about their backgrounds and experience. What personality characteristics can you infer that each person has, and how is that helpful for the team? For example, Reid Wiseman was a fighter pilot. What characteristics might a fighter pilot have that help? *(A fighter pilot is probably used to going really fast and possibly being in stressful situations. He can help calm team members down. I think each person has something special to offer that others may not have. It helps balance the team.)*
- Look over the experiences and education. Why do you think they were chosen over others? *(I think Reid Wiseman might have been chosen because he had a stressful job as a fighter pilot, plus he has already been in space and knows how to do a lot of different research experiments.)*

Page 4

- Do you think the same four astronauts will be responsible for building the base camp? Why or why not? *(No, other people will be responsible for building. The astronauts don't know how to design and build a base camp, so other people who do know about doing that should be responsible.)*
- Review the different tasks in building the Artemis base camp, such as planning and building the structure, designing and building the orbiting station, training astronauts, learning how to transfer people to and from the surface, etc. Discuss how **teamwork** is essential to the goals of the Artemis base camp.
- The original Artemis II astronauts will probably be replaced with new astronauts by the time the base camp is built. What kinds of backgrounds might the new astronauts need? *(The replacement astronauts might need to know how to repair the buildings in the camp and how and what to mine from the moon.)*

Page 5

- Think of redundancy. How is this an example of team members supporting each other? *(Redundancy keeps the astronauts safe and makes sure that everything has a backup plan. This means that if something fails, there is a backup plan.)*
- Teams have a common goal or more than one goal. What are the overall goals for all of the Artemis II team members? *(Their goals are to build a base camp on the moon, help people get to the moon, and study the moon.)*

Know the Standards

NOS7. Science Is a Human Endeavor Contrary to what is often shown in movies or texts, scientists do not work in isolation. Instead, they work in teams and depend on the findings, insights, and supports of others.

Page 6

Online Resources

- Watch the video of a capsule returning to Earth. Talk about all the people involved and how they helped support the goals of the mission. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)
- Review the steps listed in the text. What different groups/teams do you think are within the Search and Rescue team? *(I think there is a group who made the parachute and a group who tracks the capsule. One group probably planned everything, and there are people on a ship or helicopter who help. There are probably doctors around to help, too.)*

Page 7

- How is the United States like a team? *(The entire country helped produce things that the mission needs.)*
- Focus on Georgia, Pennsylvania, and Washington. Talk about how specific states rely on these states to do their respective jobs.
- How are the four Artemis II astronauts relying on each state? (How are they working as a team?) *(These states all make things that are needed for the rockets and computers that will help keep the spacecraft safe.)*

Online Resources

EXTEND—If students show avid interest in the Artemis II mission, NASA has a variety of teaching resources available. (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 1

Online Resources

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Great scientific accomplishments always involve teams of people working together.

Watch the short video(s) on students designing playgrounds. Start the video at the 1:47 mark. As students watch, have them make a list of things that they feel are important in playgrounds. Talk about different playgrounds they have been to and different features they have liked or not liked. (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 2

Scientific Explanations

At a Glance

Lesson Question

What makes an explanation scientific? (Evidence!)

Learning Objectives

✓ Distinguish scientific conclusions that are supported by scientific evidence.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- *MythBusters* analysis

Main Science Idea

Evidence is what makes an explanation scientific.

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.5.1. Key Ideas and Details: Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from 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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evidence **explanation** **scientific**

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.

myth

Instructional Resources

Student Reader
Ch. 2

Student Reader, Chapter 2
"Scientific Explanations"

Activity Page
AP 2

Activity Page
Bustin' Myths! (AP 2)

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

Advance Preparation:

View and choose an episode of *MythBusters*.

The Core Lesson

1. Focus attention on the Lesson Question.

Online Resources

Download slides and choose a few images of constellations to project. Do not show students the myths yet. As you go through the constellations, ask students to come up with stories that describe how the person or thing ended up in the sky. Show students the myths. Ask them to think about if the myth was based on science or not. (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 makes an explanation scientific? (Evidence!)

2. Read and discuss: "Scientific Explanations."

Student Reader
Ch. 2

Prepare to read together, or have students read independently, Chapter 2 "Scientific Explanations." 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

- What do you think it means to be **scientific**? *(It means that it tries to answer questions about the world and uses observations as* ***evidence*** *to support their claims.)*
- Why were the **explanations** in mythology not considered to be scientific? *(I think they were more like made-up stories and maybe didn't use evidence.)*
- Maui is a deity, or god, recognized by the Polynesian people. What scientific phenomenon did the Polynesian people credit Maui with? Do you think they used scientific evidence to back their ideas up? *(They thought slowed the sun down. No, I don't think they used evidence.)*

Online Resources

SUPPORT—Situate students by showing them a map of Polynesia's location. Talk about what the environment looks like (oceans, islands, tropical) and how the Polynesian people might have wanted answers about how things happened. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Page 9

- Think about the Maui myth. What was it intended to explain? *(It was explaining why the sun takes a long time to cross the sky each day.)*

  ALERT—This myth may reinforce the misconception that the sun moves across the sky instead of Earth moving around the sun.

- What was Copernicus's explanation? How did it differ from the Polynesian myth? *(Copernicus claimed that Earth's rotation around the sun created the appearance of the sun arcing across the sky. In the Polynesian myth, the sun was the one that was moving.)*

  EXTEND—Many students will have seen the movie *Moana*. Explore other ways the movie described the demigod Maui and other ways he impacted Earth and its people.

- Why do you think the scientific explanation is more trusted than the Polynesian explanation? *(because it uses evidence that is based on observations that people can check and recheck.)*

Page 10

- Display the map image, pointing out the western United States from California up to British Columbia. Why might earthquakes and tsunamis be something these people were interested in understanding? *(Earthquakes happen a lot in California, and they are all along the coast where tsunamis happen.)* (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

  Online Resources

  SUPPORT—Students may be familiar with earthquakes but possibly not sure about tsunamis. Show them a short video describing these phenomena. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

- How does the myth explain tsunamis and earthquakes? *(The myth says that the whale and bird were fighting and caused the waves and the land to shake.)*

Page 11

- How does science explain tsunamis and earthquakes? (*Science says that parts of the planet are moving and cause the shaking.)*
- What do the myth and the scientific explanation have in common? *(They both suggest that earthquakes and tsunamis happen at the same time as each other.)*
- Science uses evidence that is very hard to see—it comes from far below the ocean and describes how the earth moves very slowly over time. Why didn't the Native American people use this evidence? *(They probably didn't have the science tools to find the evidence. The evidence probably took a long time to find, too.)*

Know the Standards

NOS8. Science Addresses Questions About the Natural and Material World Scientific claims rely on empirical evidence. Empirical evidence is the information obtained through quantitative and qualitative observations—any data gathered through the use of the senses.

Page 12

- How are the characteristics of each wind personified in the wind god? *(Sample answer: Zephyrus is a gentle wind, so the figure kind-looking.)*
- What types of observations did the ancient Greeks and Romans use when describing the wind gods? *(They observed the temperatures, how strong the wind was, where it was coming from, and the direction it was blowing.)*
- Since they used observations to develop their explanation, does it count as a scientific explanation? *(No, the observations only describe the gods. Their explanation doesn't use observations of the gods themselves.)*

Page 13

- What is the scientific explanation for wind? *(Science says that the atmosphere is made of different air masses that move around as they warm and cool. Air near Earth's surface warms and rises, and cool air flows in. This air movement is wind.)*
- What evidence does the scientific explanation use? *(The evidence is temperature at different altitudes and masses.)*

  CHALLENGE—Watch the video explaining wind. Challenge students to write a myth explaining one of the phenomena described in the video (why airplanes fly faster, erosion, and clouds with rain in them) and then write the scientific explanation.

3. Check for understanding.

Activity Page

AP 2

Online Resources

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Evidence is what makes an explanation scientific.

Pick an episode of *MythBusters* for students to watch. Show them one or two of the myths that are being busted. As they watch, have students complete Activity Page 2. (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 3

New Data and Evidence

At a Glance

Lesson Question

How do new data and evidence affect scientific theories?

Learning Objectives

✓ Provide reasons that scientific conclusions change over time.

✓ Characterize the willingness to revise conclusions based on evidence as an attribute.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- changing ideas activity

Main Science Idea

Scientists are skeptical. They question things. New data and evidence require scientific ideas to be reevaluated and often changed. There's nothing wrong with that! It's an important part of the scientific process.

NGSS and CCSS References

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.

RI.5.3. 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.

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data **evidence** **method**

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claim **improbable** **skeptical** **theory**

Instructional Resources

Student Reader

Ch. 3

Student Reader, Chapter 3
"New Data and Evidence"

Activity Page

AP 3

Activity Page
Electrical Inventions over Time (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
- Timeline Cards for AP 3

Advance Preparation:

Print and laminate (optional) AP 3 Timeline Cards.

The Core Lesson

1. Focus attention on the Lesson Question.

Hold a discussion with the class, eliciting prior knowledge regarding scientific theories. Ask them if anyone can describe what a scientific theory is or if they know of any scientific theories. For example, they may have heard of the theory of plate tectonics, the theory of evolution, or the big bang theory. How do they think these theories came to be?

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How do new data and evidence affect scientific theories?

2. Read and discuss: "New Data and Evidence."

Student Reader

Ch. 3

Prepare to read together, or have students read independently, Chapter 3 "New Data and 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 14

- What was the original idea? *(They did not think that the great white shark could leap out of the water.)*
- Why did scientists initially dismiss the idea of leaping sharks? *(They dismissed the idea because they had not observed the behavior before and it didn't fit with prior observed behavior.)*
- What did the scientists need in order to accept the idea? *(They needed visual **evidence**.)*

Page 15

- What new evidence did the scientists gather? *(They captured photographs of the sharks jumping.)*
- What is their new idea? *(Their new idea is that juvenile white sharks are the leapers.)*
- Imagine you were one of the original scientists. How would you feel if someone had an idea different than yours? Would you be easily convinced? *(I would feel annoyed at first and not be convinced. After I saw evidence that showed I was wrong, I would feel glad that there is a new idea.)*

Page 16

- Write "scientific idea vs. idea" on the board. Guide a discussion with students, helping them understand that a scientific idea is a scientific explanation for why things work or how things happen and that they are developed after many observations. Talk to students about how a scientific idea is different from a general idea, which doesn't need evidence.

  ALERT—Students may be familiar with the terms *scientific theory* and *law*. A law is a statement that describes WHAT happens, while a theory describes WHY something happens. For example, the law of gravity says that an apple will fall when dropped from a tree; the theory explains why it falls (because of gravity).

- Point out the following description of science from the text: "it's also the way of acquiring and building that body of knowledge." How is scientific knowledge acquired and built? How was the knowledge of great white sharks built? *(Scientific ideas are built by gathering evidence and facts. Sometimes we find new evidence that helps us rethink and replace old ideas and theories.)*

Page 17

- What are science **methods**? *(Science methods are the ways you get information or gather observations, including the tools you use or the steps you take.)*
- Examine the methods used in the image. How do they contribute to learning more about sharks? What other tools might they have already been using? *(Other tools were probably measuring tapes, scales, and regular cameras.)*
- After examining the image, ask students to imagine other science topics that may also benefit from the tools and methods used to study sharks. (*I think scientists that study other animals would benefit, too, and maybe scientists that look at landscape—they can take pictures from drones or get into places that are hard for humans to reach on foot.)*

Know the Standards

NOS3. Scientific Knowledge Is Open to Revision in Light of New Evidence Science is based on empirical evidence, which is evidence that comes from observations. As new observations are made, ideas and theories may need to be revised or changed in order to accommodate our new understandings.

Page 18

- What does it mean to be skeptical? Share examples of when you have been skeptical before. *(I think skeptical means that you aren't sure if something is the truth because you need more evidence. I have been skeptical when someone told me my running shoes would make me run faster than ever.)*
- Why is it important to be skeptical? *(It's important because scientists need to make sure their explanations are based on accurate observations and facts.)*
- When can being skeptical NOT help science? *(It cannot help science if someone isn't using skepticism to learn more. They are being stubborn and ignoring new ideas and facts.)*

Page 19

- What was the scientific idea about orcas and great white sharks *before* this new evidence? *(The idea was that orcas didn't eat or attack great white sharks.)*
- Emphasize that scientific knowledge doesn't just change because of new evidence and methods; nature changes, too, so we have to adjust our understanding of nature.

Online Resources

- When nature changes, our observations help us answer WHAT is changing, but we should also be asking WHY it is changing. Project the news article about changes in animal behavior due to warming temperatures. Brainstorm ideas on what evidence scientists used to say there are changes in behavior and the methods they might have used. What methods and evidence might they use to explain *why* the changes are occurring? (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 3

Online Resources

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Scientists are skeptical and question things. New data and evidence require scientific ideas to be reevaluated and maybe changed. It's an important part of the scientific process.

This activity page includes two steps. First, follow the steps for the Ideas over Time: Electrical Inventions activity. Once complete, have students choose one of the electrical inventions to research and complete Activity Page 3. They are encouraged to use the student-friendly search engines listed in the Online Resources Guide. (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 4

Criteria and Constraints

At a Glance

Lesson Question

How do criteria and constraints affect problem-solving?

Learning Objectives

✓ Articulate the criteria for success in provided solution examples.

✓ Articulate constraints on solutions to provided design problems.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- criteria and constraints activity

Main Science Idea

Criteria are the conditions that the solution to a problem must meet (or what it has to do). Constraints are limitations or restrictions on a solution (or what it can't do).

NGSS and CCSS References

SEP1. Asking Questions and Defining Problems: Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world.

W.5.9: Draw evidence from literary or informational texts to support analysis, reflection, and research.

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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constraints **criteria**

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problem **solution**

Instructional Resources

Student Reader

Ch. 4

Student Reader, Chapter 4
"Criteria and Constraints"

Activity Page

AP 4

Activity Page
Criteria and Constraints (AP 4)

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.

Talk to students about playing on a sports team. Guide them through a discussion in which the students identify the goals for the team (to be a winning team and to improve), how they know they have reached the goals (for example, they won the majority of their games or, all players got better at certain skills), and things that may get in the way of them reaching those goals or make the goals hard to reach (injured or sick players, playing in different locations, etc). Scientists and engineers have similar things to think about! They have problems that they are trying to solve, they have things that make accomplishing this goal tricky, and they have to be able to tell when they are successful.

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How do criteria and constraints affect problem-solving?

2. Read and discuss: "Criteria and Constraints."

Student Reader

Ch. 4

Prepare to read together, or have students read independently, Chapter 4 "Criteria and Constraints." 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's the problem they are trying to solve? *(The problem is that they don't know what to do with cars that can't be used.)*
- Define the word **constraint**. Why is space the constraint in this story? *(A constraint is a limitation or restriction. Space is the constraint because it limits what they can do.)*
- Imagine a problem you might have, like building a house for your dog. What are some possible constraints? *(space, location, money, knowledge of how to build)*

Page 21

- List the additional constraints that James and Bahamians have. *(lack of resources to recycle or reuse car parts, no ways to easily dispose of parts, money)*
- Describe why these constraints may not exist for the same problem in different places, like the North American mainland. *(Other places have more space, more money, and ways to recycle or reuse old car parts.)*
- Why is it so important that James and others overcome the constraints and solve the problem? *(They don't want to give up because abandoned cars take away from the natural beauty of the island, and they want tourists to keep coming and bringing in money. Chemicals can also hurt the water supply and habitats there.)*

Page 22

- The main constraint for James is space. Describe how each solution helps overcome this constraint. *(They are trying to recycle and to export as much as possible. Leftover pieces will be reused in different ways, and money from tourism will be used to pay for these efforts.)*

  SUPPORT—Draw a circle on the board. For each solution, color in a slice of the pie chart. Point out how this reduces the amount of leftover parts that James has to deal with.

- Define **criteria**. How will James be using criteria in his problem? *(Criteria are standards by which something is judged. James will be using two criteria to see if his project was successful or not.)*
- What was the problem James was trying to solve? Why is he looking for "measurable amounts" in his criteria? *(He was trying to get rid of old cars on the island. He needs to be able to measure the amounts so he can confidently say if the efforts reduced the number of junk cars on the island. This is his evidence.)*

Know the Standards

SEP1. Asking Questions and Defining Problems This standard focuses student attention on defining problems, which involves asking questions about data, possible solutions, and designs. Identifying criteria and constraints helps engineers to better define the problems and their solutions.

Pages 22–23

- What is the problem Gabby and Phoebe are trying to solve? *(They are trying to clear plastic pollution from the beaches.)*
- What do you think some of their constraints might be? (*The waste cannot just be relocated. It probably takes a lot of time and effort to clean up the beaches—it doesn't seem very effective.)*
- What do you think Gabby and Phoebe should use as their criteria for success? *(A measurable amount of waste is recycled or reused; the beach is safe for both people and animals.)*
- What is Gabby and Phoebe's solution? *(reuse the waste to make kayaks)*
- What are some criteria for this solution? *(The manufacturer saves cost on the materials, buyers pay more for a kayak made of recycled plastic, and buyers will reduce their consumption of new plastic products.)*
- Now that Gabby and Phoebe have learned more from the president of the company, why do they think the constraints make the project unrealistic? Do you agree? Do you think they should give up? (*The plastic that they collect from the beaches is not necessarily the type of plastic needed by the manufacturer. It would cost a lot of money to collect enough HDPE. I agree because even if they collected the HDPE, there is still a lot of PET waste that they have to deal with. No, don't give up—there may be other solutions!*)

Pages 24–25

Online Resources

- Point out that Gabby and Phoebe started with just one problem. As they were designing and identifying constraints, they identified more problems. Show the image, and discuss how that is part of the engineering process. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)
- Again refer to the image of the engineering design process. Use it to walk through the steps that Gabby and Phoebe went through. Point out that the process is a cycle for a reason, because engineers are always refining and asking and identifying questions and making modifications.
- How were criteria and constraints important in Gabby and Phoebe's process? *(They helped Gabby and Phoebe to better define what the problems were, what their solution would look like, and what would work and what wouldn't.)*

3. Check for understanding.

Activity Page

AP 4

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Criteria are the conditions that the solution to a problem must meet (or what it has to do). Constraints are limitations or restrictions on a solution (or what it can't do).

Use Activity Page 4 to assess students' understanding of the Core Vocabulary for this chapter (*criteria, constraint).*

See the Answer Key for sample or correct answers.

LESSON 5

Comparing to Understand

At a Glance

Lesson Question

How can analogies help us understand science phenomena and processes?

Learning Objectives

✓ Define *analogy*.

✓ Summarize how provided analogies aid in the understanding of various science concepts.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- analogy description

Main Science Idea

Making a figurative comparison like an analogy to describe a similarity can help us understand how a thing is structured or how a process works.

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.

W.5.8. Research to Build and Present Knowledge: Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

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.

analogy **difference** **similarity**

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.

comparison **model**

Instructional Resources

Student Reader

Ch. 5

Student Reader, Chapter 5
"Comparing to Understand"

Activity Page

AP 5

Activity Page
Making Analogies (AP 5)

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

The Core Lesson

1. Focus attention on the Lesson Question.

Have students practice identifying similarities and differences by writing a few simple analogies on the board, such as "She is as light as a feather," "Time is like money," or "Finding that lost dog is like finding a needle in a haystack." Discuss how they help you understand the topic better.

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How can analogies help us understand science phenomena and processes?

2. Read and discuss: "Comparing to Understand."

Student Reader

Ch. 5

Prepare to read together, or have students read independently, Chapter 5 "Comparing to Understand." 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

- Describe what is meant by the term **analogy**. *(An analogy is a comparison between two things. It says one thing is like another.)*
- Why does the analogy about electric current and flowing water work? *(It works because electric current and flowing water both flow from one part to the other and the rate of flow determines how another part works.)*

- Why do you think scientists find analogies useful? *(I think it helps them explain things to other people—it's easier to picture what they mean.)*

Page 27

- Before reading the page, have students discuss their initial ideas on the relationship between tendons and bungee cords. What do they think the two might have in common?
- Point out the way analogies are written: Something (in this case, tendons) is like something else (in this case, bungee cords).
- What are the **similarities** and **differences** between tendons and bungee cords? *(They both stretch and then contract back to normal lengths. They both can only stretch to a certain point. They are made of different materials.)*

Page 28

- Again, before reading the page, elicit initial ideas on the possible similarities and differences between electrons and orbiting planets.

  SUPPORT—Start by asking students to list descriptors of orbiting planets. Focus on the word *orbiting*.

- Describe the similarities and differences between electrons and orbiting planets. *(They both orbit something else. Their sizes are different, and electrons don't stay in predictable tracks or orbits.)*
- How did this analogy help you understand electrons? *(It helped me picture how electrons orbit other things, like planets orbit the sun.)*

Online Resources

CHALLENGE—Watch a video to learn more about atoms, electrons, protons, and neutrons. Challenge students to come up with analogies for atoms, protons, and neutrons. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Page 29

- Before reading, ask students to talk about what they know about blood vessels. Write responses on the board. For each description, ask students to come up with a possible analogy.
- Before reading, have students think about what they know about roads. How do they think roads are similar to blood vessels? *(I think roads are meant to carry things, and blood vessels carry blood around.)*
- How did the analogy help you better understand the purpose of the circulatory system and blood vessels? *(It helped me understand that they are both meant to transport things from one place to other specific places.)*

Know the Standards

SEP2. Developing and Using Models Scientific models can be physical models and diagrams but can also be descriptive models such as analogies and metaphors.

Page 30

- What was Isaac Newton's spark? *(the apple falling from the tree)*
- The text says that a single spark can light a fire if conditions are right. Think about what will happen to the fire if conditions aren't right. How does this still follow the analogy about spark and inspiration? *(If conditions aren't right, the fire will go out. If conditions aren't right for inspiration, like there's no support or encouragement, inspiration might fade, too.)*
- Often people say that when they figure something out, a light bulb turns on in their head. How is this analogy similar to the spark and inspiration analogy? *(I think they are similar because they both make me think of something suddenly lighting up and turning on. Both inspiration and learning can continue to grow.)*

Page 31

- Before reading, have students guess why paleontologists are like detectives. What similarities do they have? What differences do they have that may not fit the analogy?
- Describe why a paleontologist is like a detective. *(They have to look for clues. They may have only small clues or only a few clues. They have to piece clues together to get the whole picture.)*
- Do you think the analogy that a different type of scientist, like a chemist, is like a detective would fit as well? Why or why not? *(I think it would fit because they still both have questions and have to take steps to get evidence and find the best answer.)*

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. An analogy is a type of comparison. It is figurative, not literal, but it can help us understand how a thing is structured or how a process works.

Use Activity Page 5 to help students practice describing how analogies help us better understand science topics.

In this activity page, students will first use what they know about the science topic to make guesses about a possible comparison. Then, they should conduct research to learn more about the topic. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Finally, students will develop a final comparison and describe why this comparison works. The purpose is not to get a "right" answer but instead to develop analogies and be able to support the reasoning behind their choice.

See the Answer Key for sample or correct answers.

LESSON 6

Good Investigations

At a Glance

Lesson Question

How can we evaluate investigations?

Learning Objectives

✓ Identify and describe characteristics of a sound scientific investigation.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- practice with positive feedback

Main Science Idea

All investigations are not equally effective. We should examine how an investigation is planned and carried out to help decide whether its results are trustworthy.

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. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

RI.5.8. Integration of Knowledge and Ideas: Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).

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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feedback **investigation**

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.

pattern **positive feedback**

Instructional Resources

Student Reader

Ch. 6

Student Reader, Chapter 6
"Good Investigations"

Activity Page

AP 6

Activity Page
Peer Review a Scientific Report (AP 6)

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.

Ask students to imagine that they have a problem to solve. Their pet animal cracker, Ryan the Rhinoceros, needs to cross to the other side of the river and must do this without getting wet! Ryan needs a raft to get to the other side. As a class, brainstorm ideas of things they need to think about when making and testing their raft.

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 investigations?

2. Read and discuss: "Good Investigations."

Student Reader

Ch. 6

Prepare to read together, or have students read independently, Chapter 6 "Good Investigations." 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

- Analyze the student introduction paragraph as a class. What components did it include? *(It started with background information. It included what they were going to study—population density of earthworms in playground soil. They wrote about how they were going to do it—set up a sample area to count earthworms.)*

- Point out that population density is defined as how many individuals live in an area. The methods the students are proposing match the definition—they will count *how many* earthworms there are *in an area,* the sample area.
- Focus on the second piece of **feedback**. Which do you think Sam and Freyda should use? Why? *(Some students might say that it is easier to use one sample area, and others may say that using various sample areas gives a better picture of the whole playground.)*

Page 33

- In this section, the students are giving more specific descriptions of how they will conduct the **investigation** and why they made these choices. Work with students to make a chart on the board that lists their choices and the reasons that support them.
- Notice the type of feedback that the instructor is giving. How would you describe it? *(It seems very positive. The instructor asks questions but also helps make the investigation better.)*
- Define the term *positive feedback* for students as feedback that focuses on strengths, contributions, and value to reinforce what people are doing well. Have students pair-share with a neighbor to come up with another piece of positive feedback, either for the students writing the report or general feedback for their neighbor

Page 34

- Walk through each sentence of the paragraph. Analyze it for its purpose. For example, the first four sentences are background information. The fifth sentence describes their proposed investigation This includes their study aim (tracking what the bird eats) and how they will achieve it (observe feeding behavior). They then discuss specifics of their methods and why they chose these methods. Last, they write what they will be looking for as a way of saying part of their hypothesis.
- How did the students use what they knew about Harry to form a hypothesis and develop their methods? *(They knew that Harry seemed to like to eat in the morning before school and in the evening. They used this knowledge to form their hypothesis and to decide when to gather data, which is part of their method.)*

Page 35

- Describe the parts of a hypothesis. Make sure to include the information from the teacher's feedback. *(They describe what their hypothesis is, explain why they think that, and use a null hypothesis.)*

  SUPPORT—Help students by explaining that the null hypothesis claims that there is going to be no difference, while the alternative hypothesis claims there will be a difference or effect.

  CHALLENGE—Give students a research question, and challenge them to come up with a hypothesis and null hypothesis. Here are some ideas for questions: Does tooth flossing affect the number of cavities? Does the amount of text highlighted in the textbook affect exam scores?

- Why do you think the teacher cautions and encourages the students to collect weather data? *(Weather data will give them more information on feeding patterns. But the effects of weather on feeding patterns is not the focus of the investigation.)*

Page 36

- This report is written by a fish biologist, not students. Who might be giving the feedback. Why does a biologist need feedback on their work? *(The feedback might be written by another scientist. Just like students, biologists need feedback to make sure their investigation includes necessary components and the results will be trustworthy.)*
- This investigation isn't testing a question like the other two reports. What is the purpose of this investigation? *(This is an engineering investigation. The biologist is testing a new hook that can be used to catch swordfish and tuna and not turtles.)*
- Analyze the paragraph. Describe the different components and how it is similar to or different from the science investigations. *(There is background information, but this one includes the criteria for the new hook, while the others didn't have to describe criteria.)*

Page 37

- What is the purpose of this paragraph? *(It describes the methods—how the author is going to test their idea (by using a prototype)—and what they will be looking for (the criteria), which is sort of like their hypothesis.)*
- Notice that each report states that they will be looking for patterns. Why are patterns important to look for in science and engineering investigations? *(Patterns tell you if a result is happening over and over again. This helps you develop your explanations or claims.)*
- Describe this investigation using the words *independent variable*, *dependent variable*, and *control*. *(The J hook is an element that is kept constant. It is the part of the experiment called the control. The independent variable is the new hook, and the dependent variables are number of fish and turtles caught.)*

  SUPPORT—Remind students that the independent variable is the variable the experimenter controls, the dependent variable is the outcome or result the experimenter is looking for, and the control is the variable that doesn't receive any special treatment—it stays the same.

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.

Encourage students to practice giving positive feedback for scientific reports by using Activity Page 6. Assign students to an article. (See the Online Resources Guide for a link to recommended articles. **www.coreknowledge.org/cksci-online-resources**) Students will use a checklist to support their analysis of a science article and then give written feedback. Note that these articles have already been peer-reviewed and published.

See the Answer Key for sample or correct answers. Answers to the activity page will vary based on the article. Ensure that students are completing the checklist and using positive feedback.

LESSON 7

Put Yourself in These Scenes

At a Glance

Lesson Question

How can studying data help us refine goals and solutions?

Learning Objectives

✓ Suggest refinements to a design solution based on provided data collected during a prototype test.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- designing and refining solutions activity

Main Science Idea

Studying data helps us refine goals and solutions.

NGSS and CCSS References

SEP4. Analyzing and Interpreting Data: Scientific investigations produce data that must be analyzed in order to derive meaning. This includes analyzing data to refine a problem statement or the design of a proposed object, tool, process, or design solution.

RI.5.1. Key Ideas and Details: Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from 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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data **goals** **solution**

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.

design **prototype** **refine**

Instructional Resources

Student Reader

Ch. 7

Student Reader, Chapter 7
"Put Yourself in These Scenes"

Activity Page

AP 7

Activity Page
Design and Refine (AP 7)

Materials and Equipment

Collect or prepare the following items:

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

For each group:

- larger bucket/container
- smaller container
- blindfold
- fishing net or other implements, such as cups, mesh bags, or sandwich bags
- assortment of marbles, balls, and other materials (such as rocks) of different colors and sizes (Example assortment:
  5 large red rubber balls (like the type for playing jacks), 10 glass marbles of color A,
  10 glass marbles of color B, 3 golf balls, 4 pairs of dice, 10 very small pebbles)
- bowl
- water

Advance Preparation:

Prepare marbles and balls for AP 7.

The Core Lesson

1. Focus attention on the Lesson Question.

On a computer, visit a search engine, and project your screen for students. Tell them you are hoping to visit the Grand Canyon as a field trip but that you need to learn more first. Put the words "Grand Canyon" into the search bar. Point out how many search results there are. Scan through the results, and tell students the search could help you reach your goal better. You just need to refine your search! Continue adding words to the search bar, such as Grand Canyon +field trip, then +.gov, then other refining terms such as +season, +activities, etc. Tell students that in this chapter, they will be thinking about how to refine based on results in similar ways.

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: How can studying data help us refine goals and solutions?

2. Read and discuss: "Put Yourself in These Scenes."

Student Reader

Ch. 7

Prepare to read together, or have students read independently, Chapter 7 "Put Yourself in These Scenes." 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

SUPPORT—Help students visualize the experimental design by making a simple drawing on the board. Emphasize that each feeder holds 8 ounces, for 24 ounces total a week.

- Analyze the chart. When was the most sugar water consumed? When was the least amount consumed? Are there any trends? *(The most sugar water was consumed in August, and the least amount was consumed in early July. Sugar consumption sharply increases from July to August, then sharply decreases in September.)*
- What questions do you have based on the graph? *(Why is there a consumption drop-off in the middle of August? Why does sugar-water consumption decrease in September?)*

Page 39

- How would a declining striped bass population impact other fish in the food web? *(Ospreys might have less food and eat more of the bluefish, making bluefish populations decline, too. There would probably be more menhaden, too, because there are fewer fish to eat them.)*
- How was the Rocky Coast Bay Association trying to achieve its **goal** (what was its **solution**)? *(The goal was to conserve the striped bass population, and its solution was to have fewer bass caught and more menhaden caught. This would let the bass population grow while keeping the menhaden population from growing too much.)*
- Do you think the association achieved its **goals**? Do you think it should do anything different? *(I don't think its goals were achieved because all the populations began to decline. I think it should lower the limits of all fishing because all the populations are lowering.)*

Page 40

- What was the big problem with this investigation? *(The problem wasn't the design but how it got carried out. All the bins got different treatment.)*
- What can you conclude by studying the graph? *(I see that the more often the compost bin was turned, the less time it took for the scraps to turn to soil. I also see that after three times per week, the change in time was less.)*
- What recommendations would you make to improve their **solution** so that their scraps turn to soil as quickly as possible? *(Based on the graph, I would tell them to make sure to turn every bin at least three to five times per week.)*

Know the Standards

SEP4. Analyzing and Interpreting Data Data analysis is important for more than just finding patterns and results. Analysis and interpretation can support scientists and engineers in refining their investigations and solutions, assisting them in developing quality explanations and solutions.

Page 41

- What is the problem? What is the proposed solution? *(The problem is how to identify infested trees quickly so they can be removed and the number of southern pine beetles can be reduced. The solution is to mark the infested trees with ribbons every month.)*
- Describe the results as shown in the graph. *(The line graph shows that the number of infested trees identified per scout was decreasing.)*
- Do you think their solution is helping them reach their goal? *(Either they are finding fewer trees because they have already marked all the infested trees and there are fewer trees, or they are not going to areas where there are infested trees anymore.)*

Page 42

- What are the new solutions for each case study? *(Case Study 1: Use more or larger feeders that hold more nectar and continue through September. Case Study 2: Lower the limit on the number of menhaden and striped bass that can be caught.)*
- What evidence supports these revised solutions? *(Case Study 1: The graph shows that hummingbirds consume more than 24 oz of nectar during some weeks and keep drinking nectar during September. Case Study 2: Other animals depend on menhaden for energy. More maidenhead were being fished, their population lowered, and less energy was available for others.)*

  SUPPORT—It may help to turn back to page 39 and review the food web. Alternately, it can be helpful to have students act out the food web by having volunteers stand in front of the class. Assign a few to be each animal. Then, act out the scenario of too many menhaden being fished. What will happen to the bluefish and osprey?

Page 43

- What are the new solutions for each case study? How were the solutions refined, if at all? *(Case Study 3: Turn the bins three times per week. It was refined because it was more specific about how many times per week. Case Study 4. Continue with the same solution, possibly encouraging others to do the same thing.)*
- What evidence supports these revised solutions? *(Case Study 3: Turning bins more than three times per week didn't speed up the process. Case Study 4: The average number of infested trees decreased while scouts were working to identify the trees.)*
- Why is it important to test prototypes in engineering solutions? *(You can't just simply design things. You have to test and see what will actually happen and see if you have to revise the prototype.)*

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. Studying data helps us refine goals and solutions.

Tell students they will be engineers trying to develop and refine their solution to a problem. The problem is that too many other animals are being caught as bycatch in the ocean. Their goal is to decrease the amount of bycatch.

Follow the activity sequence, Steps 1–9 from TeachEngineering All Caught Up: Acting Out Bycatching Points of View. In Step 9, encourage students to think about the results and ways they can refine their solutions. (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 8

The M in STEM

At a Glance

Lesson Question

How can math formulas be useful in evaluating a design solution?

Learning Objectives

✓ Use data generated by simple formulas to guide engineering choices.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- chart based on a formula

Main Science Idea

Mathematics and computational thinking are an integral part of making logical and practical decisions in engineering and science.

NGSS and CCSS References

SEP5. Using Mathematics and Computational Thinking: In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships.

RI.5.10: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.

5.MD.C.5 Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.

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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area **formula** **graph**

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acre **parcel** **revenue**

Instructional Resources

Student Reader

Ch. 8

Student Reader, Chapter 8
"The M in STEM"

Activity Page

AP 8

Activity Page
Grazing Acreage (AP 8)

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

Ask students about a time they used mathematics to make a decision. It may have been to figure out if they had enough money to buy something, if something would fit in a box, or how much of an ingredient to use in a recipe. Show a video about how mathematics and computational thinking are integral to daily life. (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 can math formulas be useful in evaluating a design solution?

Keep in mind as you read and discuss the chapter with students that they are not being asked to retain the illustrated math practices. Math calculations that are beyond the grade level are shown, along with correct answers, to demonstrate how math factors into design and decision-making in nearly every field.

2. Read and discuss: "The M in STEM."

Student Reader

Ch. 8

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

Pages 44–45

- How is the revenue for the elk farming created? *(The farmers sell elk antler velvet.)*
- What considerations do elk farmers have to consider? *(How is elk antler velvet collected? How much land is needed to raise an elk herd? What does an elk herd need to stay healthy?)*
- How can you figure out the questions on the page? *(Multiply 1,000 pounds by $50, and than multiply that number by 2.)*

  SUPPORT—Discuss the definition of the word **formula**, which is a mathematical relationship written using mathematical symbols. Make a class list of common formulas, such as 1 minute = 60 seconds or 1 pound (lb) = 16 ounces (oz). Make a simple calculation to figure out, for example, how many minutes are in a school day. Encourage students to recognize that they are constantly using mathematics.

Page 46

- If only the male elk produce velvet, does the farmer need female elk? *(yes, to maintain the herd and raise more elk)*
- How did you figure out the answers to the questions on the page? *(Divide 2,000 by 16 pounds of velvet from each bull. Then divide that number by 2 to find out how many bulls would be needed to make half the revenue.)*

Page 47

- What does the chart on the page show? *(It expresses the formula of a herd size of 40% bulls, 40% cows, and 20% young.)*
- How did you figure out the answers to the questions on the page? *(Look up 108 bulls on the chart, and add the number of cows and calves. Then divide 1,120 pounds by 16 pounds of velvet per bull. Then find 70 bulls on the chart, and add the cows and calves.)*

Page 48

- What other ways would math be used in elk farming? *(figure the cost of buying elk, the cost of feed, the cost of land and shelter, veterinary expenses, fencing)*
- What does the graph on the page show? *(It expresses the formula of the cost of buying a herd of a given size.)*

Know the Standards

SEP5. Using Mathematics and Computational Thinking In grades 3–5, students extend quantitative measurements to a variety of physical properties and use computation and mathematics to analyze data and compare alternative design solutions.

In this lesson, students explore how mathematics is used in business decision-making and design.

- How many cows and calves would you need to buy if you were to buy 100 bulls? *(100 cows and 50 calves)*

  SUPPORT—Discuss the definition of the word **graph** (a diagram showing the relation between quantities). Make a list of the types of graphs students have used—for example, bar graphs, line graphs, circle graphs—and how they can be used to visualize number relationships.

Page 49

- What are some advantages of raising a herd of wild animals like elk or deer? *(They graze and browse on grasses, shrubs, and trees in the environment. They don't eat meat, so feeding expenses are lower.)*
- What are some disadvantages of raising a herd of wild animals? *(They are used to roaming and would be hard to contain. They could overgraze the land and harm the environment.)*

Online Resources

CHALLENGE—Challenge students to learn more about elk and elk farming on the internet. Have them present what they learn about what elk need to survive and how they efficiently convert forage into protein so they can be easier to raise than other livestock. (See the Online Resources Guide for a link to recommended websites. **www.coreknowledge.org/cksci-online-resources**)

EXTEND—Extend the discussion about using mathematics and formulas in other areas of science, such as measuring and collecting weather data, tracking plant and animal growth, or calculating speed, distance, and time,

3. Check for understanding.

Activity Page

AP 8

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Math and computational thinking are crucial for making logical and practical decisions in engineering and science.

Use the activity page to informally assess students' understanding of the main idea of the chapter: using mathematics to make engineering and scientific decisions. Discuss student answers to the activity page. Discuss the implications of having too many cows grazing on areas that are too small.

See the Answer Key for sample or correct answers.

LESSON 9

Handy Dandy Rubrics

At a Glance

Lesson Question

How do we compare multiple design solutions or designs to choose the best one?

Learning Objectives

✓ Use provided rubrics of criteria and constraints to evaluate similar solutions.

✓ Justify the selection of a solution based on comparative evaluation.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- rubric activity

Main Science Idea

We should use organized methods to compare multiple design solutions or designs so that we choose the best one.

NGSS and CCSS References

SEP6. Constructing Explanations (for Science) and Designing Solutions (for Engineering): The goal of science is the construction of theories that provide explanatory accounts of the world. 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. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

RI.5.10: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.

RI.5.1. Key Ideas and Details: Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from 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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constraints **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.

assess **design** **evaluate** **grade**

Instructional Resources

Student Reader

Ch. 9

Student Reader, Chapter 9
"Handy Dandy Rubrics"

Activity Page

AP 9

Activity Page
Water Cycle Rubric (AP 9)

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.

Ask students about grading a science project or an open-ended writing assignment. When is grading fair?

Online Resources

Show a video about how to create and use rubrics for a science project. (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 compare multiple design solutions or designs to choose the best one?

2. Read and discuss: "Handy Dandy Rubrics."

Student Reader

Ch. 9

Prepare to read together, or have students read independently, Chapter 9 "Handy Dandy Rubrics." 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

- What is the goal of the science night project? *(to build a model to show what was learned)*
- What are the **constraints** of science night projects? *(size, shape, interactive, low cost, easy cleanup, teacher-approved)*
- What is one of the **criteria**? *(It must be informative.)*

  SUPPORT—Discuss the definition of the word **rubric**, which is a scoring guide used to evaluate or assess the quality of a design or project. Relate the experience to establishing constraints and criteria for a science experiment or project. Review that *constraints* include limitations and *criteria* are principles or standards by which something will be judged. Talk about examples of when students were graded with a rubric and worked with criteria and constraints. Emphasize how helpful it is to be able to understand what the project is and how it will be evaluated for the person working on the project and the one assessing the project.

Page 51

- Evaluate each design based on the rubric. *(size: both yes; shape: both yes; interactive: both yes; informative: both yes; low cost: both yes; easy cleanup: Design 1 no, Design 2 yes)*
- Discuss the rubric evaluation. Is it fair? *(Design 1 requires cleanup but is interactive and informative. Design 2 may be larger than the allowed size but is informative and has easy cleanup.)*
- Did both designs meet the criteria and constraints? *(Design 1 met the requirements, but Design 2 did not meet the constraint of easy cleanup.)*

Page 52

- What is the gardening club's goal? *(to plant a butterfly garden)*
- What are the criteria and constraints of the butterfly garden? *(full sun, hard surfaces, water, flower heights and colors, caterpillar plants, viewing)*

Know the Standards

SEP6. Constructing Explanations (for Science) and Designing Solutions (for Engineering) In grades 3–5, students use evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

In this lesson, students use rubrics to evaluate different projects.

Page 53

- Evaluate each butterfly garden based on the rubric. *(full sun: both yes; hard surfaces: both yes; water: both yes; flower heights: Plan A has some flowers of the same height; flower color: Plan A has more color variety than Plan B; caterpillar plants: both yes; viewing: both yes)*
- Discuss the rubric evaluation. Is it fair? *(Both would make nice gardens, but one plan has more color than the other, and the other has more variety in flower height, which helps to evaluate the best design.)*
- Did both designs meet the criteria and constraints? *(Plan A has flower color but not flower height variety, and Plan B has flower height variety but not flower color.)*

SUPPORT—To help students develop their understanding of criteria and constraints, as well as organize the discussion of criteria and constraints, create a T-chart and have students identify the criteria and constraints of the butterfly garden. To extend the discussion, ask students to identify any other possible criteria and constraints.

Page 54

- What are the constraints of the Earth's systems poster? *(must be a poster)*
- What are the criteria? *(The poster must include plants, animals, decomposers, the roles of oxygen and carbon dioxide, and interactions.)*

CHALLENGE—Challenge students to create their own ecosystem poster based on the rubric. Have them present it to the class and discuss how they met the criteria and constraints established in the rubric.

Page 55

- Evaluate each poster based on the rubric. *(plants: both yes; animals: forest floor no; decomposers: coral reef no; oxygen: both yes; carbon dioxide: both yes; interactions are stronger in the forest floor poster)*
- What grade did you give the posters? *(Answers will vary. Accept logical explanations.)*
- Discuss the rubric evaluation. What did you like? What did you dislike? *(It helps the poster creators to make sure they address all criteria, and they know when they don't. But it doesn't address all the creativity of the work, and deciding on the interactions was difficult.)*

EXTEND—Extend the discussion to using rubrics in all subjects, for example, in writing in language arts, social studies projects, math problem-solving, and art.

3. Check for understanding.

Activity Page

AP 9

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. We should use organized methods to compare multiple solutions to problems so that we choose the best one.

Use the activity page to informally assess students' understanding of the main idea of the chapter: using rubrics to evaluate designs. Discuss student answers to the activity page. Have students compare their criteria and constraints and support logical and reasonable responses.

See the Answer Key for sample or correct answers.

LESSON 10

Friendly Feedback

At a Glance

Lesson Question

What is constructive critique, and how do we engage in it? (from both sides)

Learning Objectives

- ✓ Identify a needed improvement in a design.
- ✓ Summarize evidence that indicates need for improvement to a design.
- ✓ Express proposed improvement in a design in a constructive manner and including a rationale.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- practice with constructive critique

Main Science Idea

A constructive critique is objective, specific, helpful, and kind.

NGSS and CCSS References

SEP7. Engaging in an 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.

RI.5.10: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (Also **RI.5.1**)

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constructive critique **objective** **subjective**

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.

criticism **positive** **specific**

Instructional Resources

Student Reader

Ch. 10

Student Reader, Chapter 10
"Friendly Feedback"

Activity Page

AP 10

Activity Page
Constructive Critique (AP 10)

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

Ask students about a time they got feedback that, for example, helped them be better at a sport or showed them how to improve a skill. Explain that getting feedback is one of the best ways to learn. But it is sometimes hard to give feedback and hard to accept it. Show a video about giving and getting constructive feedback. (See the Online Resources Guide for a link to the recommended videos. **www.coreknowledge.org/cksci-online-resources**) Talk about how hard it is to give someone feedback and how hard it is to take constructive feedback. Explain that this lesson is going to focus on good ways to give and take criticism to improve learning.

Pose a question for everyone to keep in the back of their minds as the class moves forward to read the chapter: What is constructive critique, and how do we engage in it? (from both sides)

2. Read and discuss: "Friendly Feedback."

Student Reader

Ch. 10

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

Page 56

- What changes can the creator of the atmosphere model make to improve the model based on the feedback he received? *(I'm not sure. Maybe use fewer labels?)*
- How is the model effective? *(It clearly lists all the layers of the atmosphere. It is colorful.)*
- What could make the model better? *(The model could show more about the different layers so you can understand how they are different.)*

  SUPPORT—Discuss the definition of the term **constructive critique**, which is feedback that helps the person receiving it. Explain that constructive criticism is objective, not subjective. Talk about the terms **objective**, which means based on facts and evidence, and **subjective**, which is an opinion with no specifics.

Page 57

- Discuss the qualities of each of the elements of constructive critique: objective, specific, helpful, and kind. *(objective: based on facts and evidence; specific: to give exact directions about what to change; helpful: makes something better; kind: to point out good things and ways to improve so it doesn't make anyone feel bad)*
- Discuss the reason to give praise before giving criticism. *(so you know what to change and what not to change)*
- Is the critique on the previous page constructive or subjective? *(subjective, because it doesn't say anything good and doesn't give any specifics)*

Page 58

- What are the positive statements in the criticism? *(It's bright. The arrows make it clear how the water is moving.)*
- What are the constructive criticisms? *(Changing the colors of the arrows would make it less confusing, and evaporation and condensation are mixed up.)*

Page 59

- Why can giving a constructive critique be difficult? *(You have to be able to think critically to identify what is good about something and how it can be improved. You can't just give your impression without having any evidence.)*
- Why is getting a constructive critique helpful? *(It tells you what is good and is objective and specific so you know what to change or not change.)*

Know the Standards

SEP7. Engaging in an Argument from Evidence In grades 3–5, students critique scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed worlds.

In this lesson, students explore giving and getting constructive criticism.

- What's the difference between how you feel if you get objective or subjective criticism? *(Subjective criticism makes you feel really good if someone likes what you did or really bad if they don't, but you don't know what you should change or not. You can learn from objective criticism, and you know what you should consider changing or not changing.)*

Page 60

- What are positive words you can use in a constructive critique? *(really like, very good, clear, interesting, informative, colorful, thorough)*
- What are ways to suggest changes in a constructive critique? *(It would be more clear if…, Adding more … would make it more informative.)*

CHALLENGE—Challenge students to write a constructive critique of the geosphere changes model design on the page. Have them say positive things about the model and then make suggestions that explain how the model could be improved. Have students read their constructive critiques to the class, and have the class critique the critiques.

Page 61

- How would you critique the Earth biomes project in a way that is objective, specific, helpful, and kind? *(The terrarium allows you to provide excellent examples of forest biome elements. It would be helpful if they were labeled with an explanation of how they interact.)*
- What makes it difficult to get criticism? *(Especially if you worked really hard on something, you feel that you did a bad job and feel bad about yourself.)*
- What can help you learn from criticism? *(understanding what you did well and getting really specific ideas about mistakes you made and how you can improve)*

EXTEND—Extend the discussion from providing and receiving feedback in school to other areas of life.

3. Check for understanding.

Activity Page

AP 10

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. A constructive critique is objective, specific, helpful, and kind. Considering others' feedback with an open mind is an important part of science.

Use the activity page to informally assess students' understanding of the main idea of the chapter: providing and receiving constructive critiques.

Discuss student answers to the activity page. Have students compare their praise and suggestions. Discuss how the critiques are not personal but focused on the task.

See the Answer Key for sample or correct answers.

LESSON 11

Presenting Science

At a Glance

Lesson Question

What are the steps in giving a good science presentation?

Learning Objectives

✓ Describe an effective process of fact-finding, organization of information, and presentation of ideas.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- presentation planning

Main Science Idea

Part of doing science investigations and learning about science is presenting what you know. You do a science presentation by finding information, organizing it, and preparing what you will show and say.

NGSS and CCSS References

SEP8. Obtaining, Evaluating, and Communicating Information: Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate

SL.5.4 Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace. (Also **W.5.7**)

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

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notes **outline** **presentation**

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 **research**

Instructional Resources

Student Reader

Ch. 11

Student Reader, Chapter 11
"Presenting Science"

Activity Page

AP 11

Activity Page
Presentation Plan (AP 11)

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

Ask students to describe what makes a good science presentation. They may say it is engaging and informative and has good visuals. Show a short video of a science presentation about Earth's systems. Talk about the aspects of the presentation that were engaging. (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 giving a good science presentation?

2. Read and discuss: "Presenting Science."

Student Reader

Ch. 11

Prepare to read together, or have students read independently, Chapter 11 "Presenting Science." 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

- Once you have decided on a topic, what is the first step in developing a science presentation? *(gathering information)*
- How can you gather information on your topic? *(look online, watch videos, find books, ask people who know)*
- Why are presentations difficult for some people to give? *(People may be afraid the audience will not like it or won't understand it. They are worried that they have nothing interesting to say.)*

SUPPORT—Discuss the definition of the word **presentation**, which is a speech or talk in which information is shown and explained to an audience. Talk about the roles of the presenter and the audience. Emphasize that it is the responsibility of the presenter to understand the audience and to present information that is relevant and interesting to the audience, which is often very difficult.

Page 63

- Why is taking **notes** important? *(You can record the information you find out so you can use it and refer to it later.)*
- Why is note-taking difficult? *(Sometimes you have nothing to record it with. You might not think something is important, but it is, and then you can't remember the source.)*

SUPPORT—Discuss the definition of the word *notes,* which are records of what you have learned or heard. Talk about a structure for taking notes, such as recording the date and time and source and then key points.

Page 64

- Discuss what an **outline** is. *(a plan for a presentation)*
- What comes first, taking notes or making an outline? *(These steps can be interwoven. You might start with an idea for an outline and then change it as you gather more information.)*
- What are the benefits of making an outline? *(It focuses your research and helps you make a point instead of just reading through your notes.)*

Page 65

- What are the benefits of having speaking notes? *(You can use them as topics that you will talk about rather than bore the audience by reading. You can stop and answer questions.)*
- How are visuals helpful in a presentation? *(Visuals give the audience something to look at and emphasize key points.)*
- What are some different ways to make an effective, informative science presentation? *(create a slide show, video, or dramatization, or use puppets to present information in an interesting way)*

Know the Standards

NGSS and CCSS References

SEP8. Obtaining, Evaluating, and Communicating Information In grades 3–5, students evaluate the merit and accuracy of ideas and methods. And they communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.

In this lesson, students explore the steps in developing a science presentation.

Page 66

- How is a presentation like a story, play, movie, or TV show? *(It has a beginning, middle, and end and is about an important idea.)*
- What are the benefits of practicing your presentation? *(You can figure out if the audience will understand and be engaged by it. You can make changes if you need to before the actual presentation.)*

CHALLENGE—Challenge students to create a presentation to model an Earth system, such as a hurricane, for first or second graders. Encourage them to create an outline and plan to incorporate age-appropriate visuals and objects.

Page 67

- What are the benefits of being very well prepared for a presentation? *(You can plan for interesting things to show and do. You can anticipate questions that the audience might have.)*
- How is making a presentation like acting in a play? *(You are trying to engage the audience and give them valuable information.)*
- What are some good strategies to avoid being too nervous? *(Practice in front of someone else. Be prepared. Know your information. Believe in yourself.)*

EXTEND—Extend the ideas of presentations in science to other subject areas. Discuss how science presentations with evidence that has been researched compare to presentations in social studies or language arts.

3. Check for understanding.

Activity Page

AP 11

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Part of doing science investigations and learning about science is presenting what you know. You do a science presentation by finding information, organizing it, and preparing what you will show and say.

Use the activity page to informally assess students' understanding of the main ideas of the chapter: the process for making a presentation. Discuss student answers to the activity page. Have students compare their ideas for each step of the process. Refer back to the science presentation video, and have students critique what is good and what could be improved.

See the Answer Key for sample or correct answers.

LESSON 12

Things That Happen Together

At a Glance

Lesson Question

How can we use patterns to make predictions?

Learning Objectives

✓ Explain how provided patterns of coinciding phenomena enable predictions.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- examples of causality and non-causative correlation

Main Science Idea

When two things happen together in a repeating pattern, the occurrence of one thing can often be used to predict the occurrence of the other.

NGSS and CCSS References

CCC1 Patterns: Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

RI.5.10 Range of Reading: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (Also **RI.5.1**)

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pattern **prediction**

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equator **latitude** **migrate** **tides**

Instructional Resources

Student Reader

Ch. 12

Student Reader, Chapter 12
"Things That Happen Together"

Activity Page

AP 12

Activity Page
Pattern Power (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.

Online Resources

Ask students to describe patterns in nature they have experienced. They may say day and night, seasons, life cycles of plants and animals, or the rock or water cycle. Show a short video about patterns in nature based on the rotation and revolution of Earth and the moon. Talk about the patterns they have observed based on these phenomena. (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 can we use patterns to make predictions?

2. Read and discuss: "Things That Happen Together."

Student Reader

Ch. 12

Prepare to read together, or have students read independently, Chapter 12 "Things That Happen Together." 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 yearly cycle of a lilac bush? *(Year after year, it gets leaves and blooms in the spring, loses its leaves in the fall, and stays leafless all winter.)*
- What can you predict based on this cycle? *(the best time to plant lilacs, the best time to cut flowers)*
- What could happen that would break this pattern? *(a disease, cutting the lilac bush down)*

- How is the pattern related to Earth's revolution around the sun? *(Lilacs bloom in spring when that part of Earth is tilting toward the sun.)*

  SUPPORT—Discuss the definition of the word **pattern**, which is a repeated sequence. Talk about examples of patterns, like a sewing pattern used to make copies, a musical phrase, or an artistic repetition. Explain that there are patterns all around us and that they help us make sense of the world. Emphasize that patterns, like weather **patterns**, help people make *predictions* or forecast what is going to happen.

Page 69

- What is the pattern of daily tides? *(Most coastal areas experience two high tides and two low tides every day.) (Science clarification: Some coastal areas do experience only one high tide and one low tide per day.)*
- What causes tides? *(Tides rise and fall in bodies of water as the moon moves around Earth.)*
- What can people predict based on tide patterns? *(when to hunt for shells, when to build a sandcastle, when to go swimming, when flooding is likely to occur)*

  SUPPORT—Model how tides occur, and explain that the moon is always there even though we don't see all of it every night. Because the moon in moving around Earth, it causes tides to come in and go out.

Page 70

- Explain the urban heat effect. *(Because buildings absorb heat, cities are a few degrees warmer than surrounding areas.)*
- What happens as a result of the urban heat effect? *(Surrounding areas may get snow when it just rains in the city. Plants leaf out and bloom earlier in the city than in surrounding areas.)*

Page 71

- Why would there be fewer living things farther away from the equator? *(There is more ice and frozen ground. Plants cannot survive extreme conditions. Animals cannot find shelter, food, or water in colder climates.)*
- How is the pattern of biodiversity in different latitudes related to Earth revolving around the sun? *(Because of Earth's tilt, the equator has a much more consistent warmer climate than Earth's poles. The warmer climate allows plants and animals to flourish.)*
- Why would the green jay and the artic tern share an ecosystem with different numbers of species? *(The arctic tern lives farther away from the equator than the green jay, so there is much less biodiversity there.)*

Know the Standards

NGSS and CCSS References

CCC1 Patterns 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.

In this lesson, students explore relationships among patterns that can and cannot be used to make predictions.

Page 72

- Why do animals migrate? *(When seasons change, they move to warmer or cooler climates to avoid harsh conditions.)*
- What is the relationship between the red knots' migration and the horseshoe crab annual cycle in New Jersey? *(At the time the red knots are migrating north, the horseshoe crabs are laying eggs, which the red knots eat.)*
- How could this pattern be disrupted? *(by disease, by changes in the climate)*

CHALLENGE—Challenge students to learn about the pattern of a migrating animal that travels through your location. Have them present their findings to the class.

Page 73

- What is the relationship between the red knots' migration and the insect annual life cycle in the Arctic? *(At the time the red knots are laying their eggs, the insects are hatching, so the birds have plenty to eat.)*
- How are the red knot migration and insect and horseshoe crab life cycles related to the revolution of Earth around the sun? *(These animals react to changes in the seasons caused by the tilt of Earth.)*
- How can understanding these patterns help people protect plant and animal species? *(People can look for changes in the patterns and investigate why things are changing and then come up with remedies.)*

EXTEND—Extend the study of patterns to weather patterns and how they are affected by Earth's movements around the sun. Then extend this study further to learn about how weather patterns affect other patterns, such as plant and animal behavior and even clothing and food sales.

3. Check for understanding.

Activity Page

AP 12

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. When two things happen together in a repeating pattern, the occurrence of one thing can often be used to predict the occurrence of the other.

Use the activity page to informally assess students' understanding of the main idea of the chapter: correlation of events.

Discuss student answers to the activity page. Identify the natural patterns that are related to each pattern and discuss why some patterns are not related to natural patterns.

See the Answer Key for sample or correct answers.

LESSON 13

Correlation

At a Glance

Lesson Question

What's the difference between correlation and causality? (And how do people often confuse them?)

Learning Objectives

✓ Explain differences that distinguish examples of causality from examples of non-causative correlation.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- examples of causality correlation

Main Science Idea

Just because two things seemingly always happen together does not mean that one of the things causes the other.

NGSS and CCSS References

CCC2. Cause and Effect: 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. 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.

RI.5.10 Range of Reading: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (Also **RI.5.1**)

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causation **correlation** **indirect**

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causal relationship **direct** **effect**

Instructional Resources

Student Reader

Ch. 13

Student Reader, Chapter 13
"Correlation"

Activity Page

AP 13

Activity Page
Causal Relationships (AP 13)

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

Show a short video that introduces the concepts of correlation and causality. Talk about things that people believe that may or may not be related. For example, some believe that seeing a rainbow after a storm means good luck is coming your way. Discuss whether the rainbow causes good luck for everyone or not. (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's the difference between correlation and causality? (And how do people often confuse them?)

2. Read and discuss: "Correlation."

Student Reader

Ch. 13

Prepare to read together, or have students read independently, Chapter 13 "Correlation." 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 are the two events that show a correlation between lilac leaves and lilac flowers? *(Lilac leaves come out in early spring, and blooms increase soon after.)*
- Why are those two events correlated? *(They occur together predictably in a pattern.)*

- What causes the leaves to come out and flowers to bloom? *(the warmer weather in the spring)*

  SUPPORT—Discuss the definition of the word **correlation**, a relationship between two things. Talk about examples of correlations. For example, more people get the flu as the temperature falls in the winter. This correlation is real and can help make predictions about providing flu vaccines and medicine.

Page 75

- What causes tides? *(the gravitational pull of the moon)*
- What causes spring tides? *(the gravitational pull of the sun and moon)*

  SUPPORT—Discuss the definition of **causation** and **causal relationship**, when one thing is the cause of another. Explain that just because two things happen at the same time or are correlated, it doesn't mean that one causes the other, but sometimes it does. The moon phases are correlated to the tides, and the moon causes the tides. When the moon is full, the tides are highest because of the moon's gravitational pull on water.

Page 76

- What effect does the urban heat effect have on temperature in cities? *(It makes the temperature in cities higher than the surrounding areas.)*
- Why is the relationship between population and cities considered **indirect**, not *direct* like the relationship between the moon and tides? *(It's not the number of human bodies that creates the urban heat effect. It is what they do by building roads and buildings. Those structures absorb more heat than fields and trees in surrounding areas.)*

Page 77

- Why is the greater biodiversity near the equator an indirect relationship? *(More sunlight does not directly cause plants to grow and animals to flourish. It doesn't happen in deserts. More sunlight along with more rain allows plants to grow, which provide food for animals.)*
- What are some other indirect relationships in nature? Share these examples with students: Wildfires or cutting down trees causes animals and plants to relocate. The 17-year cicadas indirectly caused an overpopulation of moles who eat the larva. The mole population decreases when the cicadas disappear.

  CHALLENGE—Challenge students to research the indirect effects of wolves on ecosystems and how it affects the population of their prey and the abundance of vegetation. Have them present their findings to the class.

Know the Standards

NGSS and CCSS References

CCC2. Cause and Effect 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 use these patterns to make predictions.

In this lesson, students explore the differences between correlation and causation.

Page 78

- Why is the relationship between red knot migration patterns and insects hatching in the Arctic a correlation without causation? *(The arrival of the red knots does not directly or indirectly cause the insects to hatch.)*
- What might happen as global temperatures get warmer and insects hatch earlier in the Arctic? *(If red knots migrate at the same time, they will eat insects that are more fully developed or may find there is not enough food for them. This may cause them to migrate sooner.)*

  SUPPORT—Discuss the difference between a cause-and-effect relationship and a correlation. Emphasize that a correlation is when two things happen at the same time, but that may not be a cause-and-effect relationship, which is when one event directly or indirectly causes another to happen.

Page 79

- Why is the connection between ice cream sales and shark sightings a correlation without causation? *(Although they happen at the same time, one does not cause the other.)*
- Why do people claim there is a causal relationship when there is only a correlation without causation between two events? *(People want to make sense of the world and understand what is causing something to happen.)*
- How can people determine if a correlation is a causal relationship or not? *(through fair tests to see if one variable is the cause of another)*

  EXTEND—Extend the study of correlations and direct and indirect causal relationships by exploring how the increase in global temperature is affecting ecosystems around the world.

3. Check for understanding.

Activity Page

AP 13

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Just because two things seemingly always happen together does not mean that one of the things causes the other.

Use the activity page to informally assess students' understanding of the main idea of the chapter.

Discuss student answers to the activity page. Talk about evidence of the causal relationships.

See the Answer Key for sample or correct answers.

LESSON 14

Extreme Measurement

At a Glance

Lesson Question

How do we measure the very small and very large? (both spatially and temporally)

Learning Objectives

✓ Identify and describe phenomena and objects characterized by very small measurements (too small for unaided visual observation).

✓ Identify and describe phenomena and objects characterized by very large measurements (too large for unaided visual observation).

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- units of measurement activity

Main Science Idea

In science, people can measure things that are too small, too large, too fast, or too slow to directly observe.

NGSS and CCSS References

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. Scale, proportion, and quantity are essential considerations when deciding how to model a phenomenon.

RI.5.10 Range of Reading: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (Also **5.MD.A.1**)

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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astronomical unit **geologic timescale** **light-year**

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.

kilometer **micrometer** **millimeter** **nanometer**

Instructional Resources

Student Reader

Ch. 14

Student Reader, Chapter 14
"Extreme Measurement"

Activity Page

AP 14

Activity Page
Units of Measurement (AP 14)

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

Show a short video that reviews units and concepts of measurement. Following the video, talk about times when students measured something really big or really small. For example, think of ways to figure out how far it is from home to school. (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 measure the very small and very large? (both spatially and temporally)

2. Read and discuss: "Extreme Measurement."

Student Reader

Ch. 14

Prepare to read together, or have students read independently, Chapter 14 "Extreme Measurement." 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 the difference between a femtometer and a nanometer? *(A femtometer is one quadrillionth of a meter, and a nanometer is one billionth of a meter. A femtometer measures parts of atoms. A nanometer measures viruses and molecules, which are bigger than atoms.)*
- Why are units like femtometer and nanometer needed? *(They allow us to understand how small something is that we cannot see or measure with a ruler.)*

SUPPORT—Discuss the definition of the word *meter,* the basic unit of length in the metric system. Talk about familiar units of measurement that are based on the meter—kilometer, millimeter, centimeter—and what they measure. Relate femtometer and nanometer to the meter.

Page 81

- What is the difference between a micrometer and a nanometer? *(A micrometer is a millionth of a meter and measures cells and some microscopic organisms. A nanometer is a billionth of a meter and measures things like viruses that are smaller than a cell.)*
- What is the difference between a micrometer and a millimeter? *(A micrometer is a millionth of a meter and measures cells and some microscopic organisms. A millimeter is a thousandth of a meter and measures things like insects that are bigger than a cell.)*
- Why didn't people who lived hundreds of years ago need microscopic measurements? *(because people didn't know that microscopic matter even existed)*

CHALLENGE—Challenge students to learn about how and why camera lenses and film are measured in millimeters: 8 mm, 16 mm, 35 mm, and 70 mm. Have them explain to the class the difference between these gauges and how it affects camera and film quality.

Page 82

- What is the difference between a kilometer and a millimeter? *(A millimeter is a thousandth of a meter and measures things like insects that are bigger than a cell. A kilometer measures distances that are 1,000 meters long.)*
- What is an AU, or astronomical unit? *(It is 150 million kilometers long and measures objects in space.)*

Page 83

- How does a light-year compare to an astronomical unit? (*A light-year is much longer and based on the speed of light, which travels 300,000 kilometers per second. It is 63,241 times larger than an AU.*)
- How do people measure light-years? *(They use mathematics to calculate distance and the speed of light.)*

Online Resources

CHALLENGE—Explore the study of astronomical units and light-years by showing a video about how these distances are determined. Emphasize the integration of mathematics and physics in these measurements. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge .org/cksci-online-resources**)

Know the Standards

NGSS and CCSS References

CCC3. Scale, Proportion, and Quantity In grades 3–5, students recognize that natural objects and observable phenomena exist from the very small to the immensely large.

In this lesson, students explore units of measurement that are used to measure the very small and very large.

Page 84

- What is the difference between a timescale and a spatial scale that uses meters and light-years? *(A timescale measures time, and a spatial scale measures distance.)*
- What kinds of things are measured in epochs and eons? *(Earth's history and the age of rocks)*
- How old is Earth based on this geologic timescale? *(4.6 billion years old)*

Page 85

- What do scientists think was happening on Earth before human history? *(Earth formed, and life began and evolved through different periods.)*

Online Resources

SUPPORT—To help students contextualize Earth's timeline, consider showing them a geologic timescale displayed as a pie chart. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**) Relate our current epoch, the Holocene, to the length of other epochs in the timescale.

- How do scientists know that the entire history of humans fits into the Pleistocene and Holocene epochs? *(No human fossils have been found that date before this.)*

EXTEND—Explain that scientists use radioactive dating techniques to determine the ages of Earth's oldest known rocks and minerals. Talk about the oldest rocks found on Earth, fossils, and the preservation of living things in rocks. Discuss animals like the horseshoe crab and the gingko trees for which fossil evidence from earlier eras has been found.

3. Check for understanding.

Activity Page

AP 14

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. In science, people can measure things that are too small, too large, too fast, or too slow to directly observe.

Use the activity page to informally assess students' understanding of the main idea of the chapter: units of measurement for things that are too large or too small to observe.

Discuss student answers to the activity page. Have students refer back to the text or research these measurement scales to confirm their answers.

See the Answer Key for sample or correct answers.

LESSON 15

Model It!

At a Glance

Lesson Question

What kinds of systems can only be explored through models?

Learning Objectives

✓ Identify and describe examples of models that enable understanding of systems that cannot be directly observed.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- model drawing

Main Science Idea

Models can be physical objects. They can also be diagrams of systems, cycles, and predicted outcomes or events.

NGSS and CCSS References

CCC4. Systems and System Modeling: Systems and system models are used by scientists and engineers to investigate natural and designed systems. 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.

RI.5.10 Range of Reading: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (Also **RI.5.1**)

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model **scale** **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.

microscope **radiation** **telescope**

Instructional Resources

Student Reader

Ch. 15

Student Reader, Chapter 15
"Model It!"

Activity Page

AP 15

Activity Page
Earth in the Universe Model
(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 quick list of different types of familiar models, such as model cars, model airplanes, toy models of farms or neighborhoods, or computer simulation games. Show a short video that provides an overview of scientific modeling. Following the video, talk about what models can teach about systems or how system parts work. (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 systems can only be explored through models?

2. Read and discuss: "Model It!"

Student Reader

Ch. 15

Prepare to read together, or have students read independently, Chapter 15 "Model It!" 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

- What can a solar system model teach you about the solar system? *(the names, sizes, and positions of the planets in relation to the sun)*
- Why is a model more helpful than observing the real thing? *(You can't see all the planets with your own eyes and don't know how they are positioned.)*

- How can models be problematic? *(They may not show all the parts. They may not be to scale.)*

  SUPPORT—Discuss the definitions of the words **model**, which is a simple example of a particular thing showing how the parts work together, and **system**, which is a group of parts that act together to perform a function. Talk about familiar systems that can be modeled, such as a transportation system, a communication system, a heating system, or an ecosystem.

Page 87

- How did people figure out how to make an accurate model of the solar system? *(Over many years of observation and with the help of improving technology, people were able to identify the parts of the model.)*
- Why do models change over time? *(As technology improves and people learn more, they can add parts or change or challenge the conception of the model.)*

  CHALLENGE—Challenge students to learn about how different models of space have changed over time and how newer telescopes have added to our understanding of space.

Page 88

- How does improving microscope technology change people's models of small things we cannot see with the naked eye? *(Technology has revolutionized understanding of microscopic particles, which has led to great advances in understanding of the structure of living things and diseases.)*
- If the first electron microscope was invented about one hundred years ago, what can you imagine people will know about microscopic particles one hundred years from now? *(There will probably be models of the particles that make up all life on Earth and models of how to cure many more diseases.)*

Page 89

- Why are human body models helpful? *(People can understand how the body systems work and work together so they can fix things if something gets diseased or is broken.)*
- What kinds of human body models have you seen that have been developed? *(plastic models, diagrams, robots, animated simulations)*
- How do you think human body models were developed? *(using technology like X-rays and MRIs, doing autopsies)*

Know the Standards

NGSS and CCSS References

CCC4. Systems and System Modeling 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.

In this lesson, students explore models of systems that are too large or too small to observe with the naked eye.

Page 90

- How is a model of a food web helpful? *(People can see how energy transfers from one organism to another and can understand the effect on living things if one part of the web is damaged or diseased.)*
- How were food web models developed? *(People observed what different animals ate and created a model that included all the different parts of the system.)*

SUPPORT—As a class, create a very simple picture model of a familiar food web that includes, for example, a bird or squirrel. Show how the animal interacts with the local ecosystem. Then discuss what could happen if the ecosystem changed due to drought or construction.

Page 91

- Why are models of weather systems important? *(They help predict the weather so people are prepared for extreme weather or changes in the weather.)*
- How are weather models created? *(through observation, using technology like radar, satellites, and databases that help computers simulate weather patterns)*

EXTEND—Encourage students to use their imaginations to think of a model that would help them understand how different systems work or could work. Discuss each idea, and inspire students to find out if that model exists or what it would take to create it.

3. Check for understanding.

Activity Page

AP 15

Reiterate the main idea of the chapter in plain and simple terms. Reinforce the Main Science Idea of the chapter: Models can be physical objects. They can also be diagrams of systems, cycles, and predicted outcomes or events.

Use the activity page to informally assess students' understanding of the main idea of the chapter: modeling systems that cannot be observed with the naked eye.

Discuss student drawings on the activity page. Have them compare their drawings and conceptions of Earth's place in the universe. Discuss how models can help us understand systems that we cannot see.

See the Answer Key for sample or correct answers.

LESSON 16

What Is Efficiency?

At a Glance

Lesson Question

What roles does energy play in systems? (And what is energy efficiency?)

Learning Objectives

✓ Express that all systems involve energy.

✓ Identify the effects of energy in provided system examples.

✓ Explain the concept of energy efficiency in a provided scenario.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- energy-efficient practices

Main Science Idea

Efficiency means getting the best outcome out of a system or process in relation to the amounts of material and energy that go into the system.

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. 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.

RI.5.10 Range of Reading: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (Also **RI.5.1**)

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efficiency **energy**

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.

mass **photosynthesis** **system**

Instructional Resources

Student Reader

Ch. 16

Student Reader, Chapter 16
"What's Efficiency?"

Activity Page

AP 16

Activity Page
Home Energy Efficiency (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

Ask students what it means to be energy efficient and why energy efficiency may be a priority. Show a short video about energy efficiency. Following the video, talk about familiar examples of energy efficiency and wasted energy. Explain that you will explore these ideas in this lesson. (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 roles does energy play in systems? (And what is energy efficiency?)

2. Read and discuss: "What Is Efficiency"

Student Reader

Ch. 16

Prepare to read together, or have students read independently, Chapter 16 "What Is Efficiency?" 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

- What systems are involved in preparing a bowl of cereal? *(human body system, system of milk production, cereal production from agriculture, cereal packaging, bowl creation, spoon creation)*
- What do you save if you are more efficient in preparing a bowl of cereal? *(You save time. You save energy moving to and from the parts.)*

- How could you waste *more* **energy** in preparing a bowl of cereal? *(crawl or walk more slowly, wash the spoon and bowl again, spill everything and have to clean it up, not eat it and have to throw it out)*

  SUPPORT—Discuss the definition of the term *energy efficiency*, which is the use of less energy to perform the same task or produce the same result. Talk about why energy efficiency is important in many industries: because it can save money, reduce wasted time, and reduce pollution.

Page 93

- Why are space engineers interested in energy **efficiency**? *(Fuel and supplies are really heavy, and it takes a lot of energy to lift the weight into space.)*
- How can space engineers make space flights more energy efficient? *(Use lightweight materials for the spacecraft, minimize what people can take with them, use lighter fuels, and see what materials can be reused.)*

  CHALLENGE—Challenge students to create a plan for efficient packing for a seven-day trip. Have them present their plans to the class to determine who is the most efficient.

Page 94

- What problems could astronauts encounter if the space system were not energy efficient? *(It might be too heavy to lift off or return to Earth. It could lose fuel or energy so there was not enough to return.)*
- Why would solar cells be better than batteries for the electric needs of a spacecraft? *(They are lighter and can be powered by the sun instead of heavy metallic batteries.)*

Page 95

- How can improving technology make things more energy efficient? *(As new technologies are developed, they can make renewable energy more affordable and reduce the amount of wasted energy.)*
- What makes one source of energy more efficient than another? *(the cost of extracting and storing the energy and distributing it for use)*
- At what point could renewable energy be more efficient than coal, oil, and natural gas? *(when it costs less to create, store, and distribute energy from solar, wind, or water sources than it does to extract, store, and distribute other forms of energy)*

Know the Standards

NGSS and CCSS References

CCC5. Energy and Matter In grades 3–5, students learn that matter is made of particles and that energy can be transferred in various ways and between objects. In this lesson, students explore energy transfer and efficiency in different systems.

Page 96

- How can a human body system be most efficient? *(when the amount of food eaten provides just the right amount of energy to function)*
- How does the human body waste energy? *(not getting enough sleep so you are too tired to do anything, eating more food than needed and not burning the energy provided)*

SUPPORT—Talk about plant system efficiency. Ask students what happens when a plant doesn't get enough water or nutrients or if it gets too much. Discuss how people have developed different varieties of plants that are more efficient because they are disease-resistant, have shorter growing seasons, or create bigger yields.

Page 97

- What is photosynthesis? *(It is the ability of plants to use energy from the sun to create their own food.)*
- How could energy from the sun be used by developing new technologies? *(It could be used to heat water and homes or to power cars or factories.)*

EXTEND—Extend the concept of energy transfer from the sun to Earth. The sun's energy not only provides heat energy that powers the weather system but also provides light that allows plants to photosynthesize and provide food energy for all other living things. Discuss ways to use the sun's energy at home for heat and light.

3. Check for understanding.

Activity Page

AP 16

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Efficiency means getting the best outcome out of a system or process in relation to the amounts of material and energy that go into the system.

Use the activity page to informally assess students' understanding of the main idea of the chapter: energy efficiency in systems.

Discuss student answers on the activity page. Have them compare their ideas and discuss which are the most energy efficient.

See the Answer Key for sample or correct answers.

LESSON 17

Choosing for Designs

At a Glance

Lesson Question

What makes different materials useful for different design purposes?

Learning Objectives

✓ Relate the structural properties of materials to their uses in provided examples of designed engineering solutions.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- choosing materials activity

Main Science Idea

Designing engineering solutions requires knowing how materials behave and choosing the right materials for each necessary 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.5.10 Range of Reading: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (Also **RI.5.1**)

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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.

engineering **insulating** **pressure**

Instructional Resources

Student Reader

Ch. 17

Student Reader, Chapter 17
"Choosing for Designs"

Activity Page

AP 17

Activity Page
Moon Unit (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

Ask what students know about NASA's Artemis program and the Orion crew module. Show a short video about Artemis I. Following the video, talk about the materials used to create the module. (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 makes different materials useful for different design purposes?

2. Read and discuss: "Choosing for Designs."

Student Reader

Ch. 17

Prepare to read together, or have students read independently, Chapter 17 "Choosing for Designs." 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 are the criteria for the Orion crew module? *(It must withstand tremendous forces, keep astronauts safe, and withstand turbulence and extreme heat and the choppy surface of the ocean.)*
- What are the criteria for your school building? *(It must be safe and solid and provide for many large classrooms to fit furniture and supplies for learning.)*
- Why are the materials used to build your school not good for building a space capsule? *(They are too heavy and bulky.)*

SUPPORT—Discuss the definitions of the words **structure**, the construction or arrangement of parts, and **function**, the intended purpose. Talk about how materials used to build one structure might not be good for building another.

Page 99

- What are the criteria used to build Orion's pressure vessel? *(It must be airtight and be able to maintain its shape. It must be able to withstand pressure but not be heavy.)*
- Why would wood be a good or bad material to use for the backshell? *(It would be a bad material because it is heavy and would burn up from the heat when the capsule reenters the atmosphere.)*

Page 100

- How did engineers determine what material to use for the heat shield? *(They had to figure out how hot the capsule could get and then find and test materials that could withstand that heat.)*
- In addition to the material used, how is the heat shield designed to protect the capsule? *(It is designed to burn and fly off to move the heat away from the capsule.)*

CHALLENGE—Challenge students to test materials that would protect hands from the heat of a wood fire, oven, or stove. Have them determine the criteria and constraints for the materials and present their results to the class.

Page 101

- Why is comfort an important criterion for the capsule? *(Astronauts will spend a lot of time there. If it's not comfortable, they will not be able to work effectively.)*
- What types of materials would not work for space suits? *(materials like wool that are thick or heavy or materials like cotton that absorb moisture or are breathable)*
- Would space suit materials and design also work for deep-sea diving? *(Although they control temperature and are airtight, they would be too bulky to move through water.)*

Page 102

- What are the criteria for the Orion parachutes? *(They must be extremely strong, lightweight, and flexible with a fine air-resistant texture.)*
- How important is the parachute to the success of the mission? *(If it doesn't work, the capsule could be destroyed, and the crew could die.)*

Online Resources

SUPPORT—Show a video about testing parachutes used for space travel. Talk about materials that have been used to make parachutes, including canvas, silk, and polyester. Discuss the advantages and disadvantage of different types of materials used for parachutes. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Page 103

- What considerations are made in developing materials for at-sea retrieval of the space capsule and astronauts? *(bright colors, ability for the capsule to turn upright and float, suits have life preservers)*
- How do engineers develop designs for products? *(They carefully define the function of a structure and brainstorm all the different things that could happen to make sure it will work and last. Then they test everything to make sure it works.)*

EXTEND—Extend the concept of choosing materials for different functions. Talk about materials that make the best athletic shoes, the warmest sweaters, the best mittens, and the safest cars.

3. Check for understanding.

Activity Page

AP 17

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Designing engineering solutions requires knowing how materials behave and choosing the right materials for each necessary function.

Use the activity page to informally assess students' understanding of the main idea of the chapter: choosing materials for structure and function.

Discuss student activity page design. Have them present their designs, describing the materials they would use to create their structures.

See the Answer Key for sample or correct answers.

LESSON 18

Things Get Disorderly

At a Glance

Lesson Question

What is entropy?

Learning Objectives

✓ Identify in provided examples ways in which systems naturally become less orderly and predictable.

✓ In provided scenarios, identify factors (work, effort) that are deliberately applied to slow change and delay instability.

✓ Describe the concept of entropy as the tendency of things to become less orderly.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- factors that delay instability

Main Science Idea

Entropy is the idea that matter and energy tend to become evenly distributed and inactive over time. Eventually, entropy changes all systems so they don't work in the same way.

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.5.10 Range of Reading: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (Also **RI.5.1**)

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entropy **stability**

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.

change **energy** **uniform**

Instructional Resources

Student Reader

Ch. 18

Student Reader, Chapter 18
"Things Get Disorderly"

Activity Page

AP 18

Activity Page
Disorder and Order (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

Ask students to describe a time when they dropped something like a box of marbles and they spilled all over. Discuss whether the things fell in an orderly way or whether they created a disorderly mess. Show a short video with examples of entropy. Following the video, talk about the tendency of things to become orderly or become disorderly over time. (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 is entropy?

2. Read and discuss: "Things Get Disorderly."

Student Reader

Ch. 18

Prepare to read together, or have students read independently, Chapter 18 "Things Get Disorderly." 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

- What is changing when you are standing outdoors in a wooded area? *(Plants are growing, water is evaporating, logs are rotting, and rocks are eroding.)*

- Does anything stay the same? *(No, some changes happen quickly, and some happen slowly, but everything changes.)*

  SUPPORT—Discuss the definitions of the words **stability** and *change*. Emphasize the idea that stability does not mean unchanging. It means predictable change. Discuss the idea of **entropy**, which is the tendency of everything in the universe to change and to become less ordered. Talk about the difference between things like a clothes drawer that is clean and organized and a drawer in which clothes are messy and mixed up. Entropy is a way in which things are most likely to change over time so that systems become unstable.

Page 105

- What can you expect if you leave a glass of hot tea or a glass of ice water sitting on a table for an hour? *(Both will become room temperature. The tea will cool, and the ice in the water will melt.)*
- What is more likely if you dump a bunch of puzzle pieces on a table: they will assemble into the finished puzzle or they will be a random, disorganized pile? *(It would be possible but so very unlikely that the assembled puzzle would appear.)*

Page 106

- What happens to the temperature in a building if the electricity goes off for many hours and the heat and air-conditioning do not work? *(The temperature becomes the temperature of the air outside.)*

  CHALLENGE—Challenge students to research designs people have made to control building temperatures to combat entropy.

Page 107

- Is entropy a good or bad thing? *(It is not good or bad; it is just the way things are, so you can predict how things will change over time.)*
- What are familiar examples of entropy in daily life? *(Roads develop potholes and cracks. Untended gardens become weedy and disordered. Cars rust, paint fades, and wood rots.)*

Online Resources

SUPPORT—Show a video that documents ocean waves destroying a sandcastle. Discuss the very remote possibility that the waves would create another sandcastle or leave the sandcastle unaffected. Explain that this type of predicable change is another example of entropy. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

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 that over long periods of time they will eventually change. Stability and change are ways of describing how a system functions. In this lesson, students explore the concept of entropy, the tendency of things to become less orderly.

Page 108

- How difficult would it be to separate the black and white sand by hand once it is mixed? *(It would be extremely difficult.)*
- Is it possible that over time, the black sand and white sand would never mix? *(It is possible but highly unlikely.)*
- In what ways do people depend on an understanding of entropy? *(Knowing that things will change, people prepare and budget for repairs, they plan on cleaning house, and they have equipment and supplies for repair of roads and bridges after a flood or storm.)*

Page 109

- What happens to a nature park that is left alone? *(Trees grow and fall. Paths are overgrown with weeds and grasses. Water erodes trails.)*
- What happens to abandoned buildings? *(Wood rots, windows break, wild animals move inside, paint peels, and eventually the buildings fall down and become part of the soil or are ruins.)*

EXTEND—Extend the concept of entropy to the effects of hurricanes, volcanic eruptions, and earthquakes. Discuss what people can predict about how Earth systems will change based on an understanding of entropy.

3. Check for understanding.

Activity Page

AP 18

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Entropy is the idea that matter and energy tend to become evenly distributed and inactive over time. Eventually, entropy changes all systems so they don't work in the same way.

Use the activity page to informally assess students' understanding of the main idea of the chapter: how, over time, entropy changes all things.

Discuss student activity page design. Have them compare and talk about their answers. Accept all logical comments.

See the Answer Key for sample or correct answers.

LESSON 19

Optimizing a Solution

AT A GLANCE

Lesson Question

How do we optimize a solution?

Learning Objectives

✓ Recognize that trial and error, with documentation, is a legitimate and valuable means of progress.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- design solution to an engineering problem

Main Science Idea

To optimize something means to revise and improve it so it can achieve its best possible performance.

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.5.10 Range of Reading: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (Also **RI.5.1**)

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optimize **solution**

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.

constraints **criteria** **failure** **performance**

Instructional Resources

Student Reader

Ch. 19

Student Reader, Chapter 19
"Optimizing a Solution"

Activity Page

AP 19

Activity Page
The Optimal Solution (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

With students, generate a very simple engineering problem for the class to solve, for example, how to arrange desks for optimal learning. Show a short video that reviews the engineering process. Following the video, talk about a possible solution to your problem. (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 optimize a solution?

2. Read and discuss: "Optimizing a Solution."

Student Reader

Ch. 19

Prepare to read together, or have students read independently, Chapter 19 "Optimizing a Solution." 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 was the problem SpaceX was trying to solve? *(create a rocket that would be partly reusable)*
- What were the criteria for the problem? *(1. Save money. 2. Reuse parts of the rocket.)*

SUPPORT—Discuss the definitions of the words *optimize,* make the best or most effective use of something, and *solution,* the means of solving a problem. Emphasize that optimizing a solution is figuring out the best possible solution given the constraints you have.

Page 111

- What were the constraints the engineers had? *(The rocket had to launch and return using the structure and design of the rocket already in production.)*
- How do you think the engineers optimized the solution? *(They brainstormed possible solutions that met the criteria and constraints. They developed prototypes of different solutions. They tested and retested solutions to see which was most effective.)*

Page 112

- What problem did the Perseverance engineers need to solve? *(They needed to make sense of the pictures the Perseverance rover took so data could be analyzed.)*
- How do you think the engineers optimized the solution? *(They developed criteria and constraints, brainstormed possible solutions, and then tested and retested to see which was most effective given the constraints of the technology.)*

Online Resources

SUPPORT—Show a video about the Perseverance mission to Mars. Discuss the criteria and constraints for the mission, including collecting data, photographs, sounds, and samples from Mars to determine if life exists on Mars as a stepping stone to human exploration of Mars. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Page 113

- How can technology that enables computers to search images help optimize solutions in space? *(Instead of sending random photos that will be identified by people on Earth, the camera could be programed to identify features that are found on Earth and those that are unique to the space location.)*
- Why are "what if" questions important when optimizing solutions to problems? *(Imagining potential problems and difficulties inspires engineers to design contingency plans in case something fails.)*

CHALLENGE—Challenge students to research an example of how a solution was optimized when new technology became available, such as distributing high-quality photographs using satellite technology. Have them report their findings to the class.

Know the Standards

NGSS and CCSS References

ED.A. Defining and Delimiting Engineering Problems In grades 3–5, students specify criteria and constraints that a possible solution to a simple problem must meet, research and explore multiple possible solutions, and improve a solution based on results of simple tests, including failure points.

In this lesson, students explore the engineering process of optimizing solutions to engineering problems.

Page 114

- Think about the history of flight and space flight. How has past experience helped to optimize solutions for each new flight? *(People have learned from the successes and failures of each flight and then used that knowledge to engineer the next flights.)*
- What role does failure have in optimizing solutions? *(You learn a lot when something doesn't work. Failure forces you to reconsider and try other solutions.)*
- How do people use trial and error? *(Anyone—a cook, a mechanic, a dentist—who is designing a new thing or learning a new skill tries and usually fails the first few times. Each time you fail, you try something a little different until you succeed.)*

Page 115

- What are some of the special challenges Ingenuity's engineers had to address in designing optimal solutions for Mars navigation? *(operating in Mars's thinner atmosphere, recharging batteries, and transmitting images to Earth)*
- What is an advantage of sending Ingenuity along with the rover to Mars? *(ability to view the planet from above and explore terrain that is hard for rovers to reach)*

EXTEND—Extend the concept of optimizing solutions to other engineering problems, such as building a bridge, improving transportation, addressing climate change, and fighting a new disease. Emphasize that problems are identified and then possible solutions are developed and then tested to find the optimized solution.

3. Check for understanding.

Activity Page

AP 19

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. To optimize something means to revise and improve it so it can achieve its best possible performance.

Use the activity page to informally assess students' understanding of the main idea of the chapter: the engineering process of optimizing solutions.

Discuss student activity page designs. Have students compare and talk about and test their solutions and determine the optimized solution.

See the Answer Key for sample or correct answers.

LESSON 20

The Information Age

At a Glance

Lesson Question

What are information technology and the "information age"?

Learning Objectives

✓ Generally characterize the progress of technology over human history.

✓ Identify and describe the influence of contemporary information technology in familiar scenarios.

Instructional Activities

- reading
- class discussion
- vocabulary reinforcement
- computer applications for everyday problems

Main Science Idea

Most current, modern technology is built to store and transfer digital information. This is an area of human activity that is developing fast.

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.5.10 Range of Reading: Read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently. (Also **RI.5.1**)

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age **information** **prehistory**

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.

Industrial Age **metal ages** **Renaissance**

Instructional Resources

Student Reader

Ch. 20

Student Reader, Chapter 20
"The Information Age"

Activity Page

AP 20

Activity Page
Apps for That (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

Show a short video that reviews prehistory and the age of metals. Following the video, talk about how students use rocks and metals in their lives. (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 information technology and the "information age"?

2. Read and discuss: "The Information Age."

Student Reader

Ch. 20

Prepare to read together, or have students read independently, Chapter 20 "The Information Age." 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 would it be like to live in the Stone Age? *(It would be very simple compared to today. Buildings and tools would made of stone, and people ate wild animals and plants)*
- How would living in the Bronze and Iron Ages be different from living in the Stone Age? *(There were more tools and weapons. People started farming and raising animals. They traveled around more. There were many more things made of metal, like jewelry and cookware.)*

  SUPPORT—Discuss the definitions of the words **prehistory**, the period of time before written history, and **age**, a period of time defined by a technology. Emphasize that these words are referring to a very long time ago in this chapter.

Page 117

- What characterized the Renaissance? *(People invented telescopes and eyeglasses and explored ideas, art, and architecture. The printing press enabled people to read, write, and distribute books. More and more people made and sold goods rather than just providing for their own families.)*
- How is the Industrial Age different from the Renaissance? *(Instead of making things by hand, more and more people worked in mines and factories where machines made goods that were traded around the world. More and more people moved to urban areas to find work.)*

Page 118

- What is the Information Age? *(Instead of just relying on books, newspapers, and personal writing, computers have allowed for **information** to be stored and shared around the world.)*
- What Information Age technology do you use? *(television, radio, smartphone, computer, internet)*

Online Resources

SUPPORT—Show a video about the history of the computer. Discuss how computers now have so many functions in addition to storing and communicating information, including running a dishwasher or car, monitoring your physical health, and developing weather forecasting. (See the Online Resources Guide for a link to a recommended video. **www.coreknowledge.org/cksci-online-resources**)

Know the Standards

NGSS and CCSS References

STSE1. Interdependence of Science, Engineering, and Technology In grades 3–5, students recognize that when new technologies become available, they can bring about changes in the way people live and interact with one another.

In this lesson, students explore information technology.

Page 119

- How do advances in one age affect the next age? *(The advances are not discarded; they are developed further. Inventing electric appliances enabled all kinds of inventions, including early computers. In addition to writing new books, millions of books that were written over hundreds of years are available in digital form to anyone.)*
- How has data storage changed since the Renaissance? *(All data were stored in books in libraries or in bookstores that only a few people had access to. Now they are stored in the cloud, and everyone has access.)*
- How does having data stored in the "cloud" make information accessible? *(Movies, music, websites, TV shows, pictures, books, and videos can be accessed by anyone with a computer. You don't have to buy a videotape, vinyl record, CD, or DVD or store any data on your personal devices.)*

Page 120

- How has the Information Age changed businesses? *(People can go to a website to buy things instead of going to a store. People can work from home instead of going to an office. Drones can deliver packages to specific addresses.)*
- Are there negative things about having so much information available? *(It is sometimes hard to tell if something is real or true or not. It is worrisome that computer-controlled robots could be smarter than people. People don't have as much privacy as they did.)*
- What will the next "age" be? *(the virtual age, in which people do not have to interact in the real world.)*

CHALLENGE—Challenge students to imagine how the Information Age will be different in another twenty years.

Page 121

- How might improved technology affect advances in medicine? *(Information about rare diseases and treatments and cures can be communicated and shared widely to improve heath. Computer databases can keep medical records and help diagnose diseases.)*

EXTEND—Extend the concept of the Information Age to advances in science, including weather forecasting, monitoring air quality and sea rise, and predicting earthquakes and volcanic eruptions.

3. Check for understanding.

Activity Page

AP 20

Main Science Idea: Reiterate the main idea of the chapter in plain and simple terms. Most current, modern technology is built to store and transfer digital information. This is an area of human activity that is developing fast.

Use the activity page to informally assess students' understanding of the main idea of the chapter: understanding what characterizes the Information Age.

Discuss student activity page ideas. Have students compare and talk about their app ideas to see if they already exist.

See the Answer Key for sample or correct answers.

GRADE 5

Teacher Resources

Activity Pages

Name ______________________________ Date ____________________

Activity Page 1 Use with Lesson 1

Building a Team

Fill in responses to complete the scenario.

Help! Imagine your school needs a new playground! Teams are challenged to come up with plans.

The roles for each team are:

Artist: the person who is responsible for drawing the design of the playground

Reporter: the person who presents the final product to the class and should be able to describe all decisions that were made

Team Manager: the person who

____

____

Feedback Manager: the person who

____

____

The group's tasks:

- Decide on location in the school grounds
- Decide what playground equipment should be in the new playground
- Brainstorm and think about issues like:
  - Making sure it is accessible to all students
  - Weather and climate—Do you need lots of shade? Protection from the rain?
  - Keeps everyone safe from harm

The group's final product:

A drawing or blueprint of your proposed playground

In presenting your team's plan to an audience, how would you complete this statement?

Working as a team for a project like this is important because

____

____

____

____

Name ______________________________ Date ____________________

Activity Page 2 Use with Lesson 2

Bustin' Myths!

Complete the worksheet while watching the clip(s) shown by your teacher.

1. What myth or legend are they investigating? Pick one if there are more than one in the clip you are viewing.

2. What information do the MythBusters already know before the investigation?

3. What did they do to investigate the myth/legend? (Make a list of the steps the MythBusters used during their investigation.)

4. What evidence did they gather?

5. What is their final claim/explanation? Why?

6. How does the myth differ from the scientific explanation?

Name ______________________________ Date ____________________

Activity Page 3 | Use with Lesson 3

Electrical Inventions over Time

Research one of the electrical inventions you just found out about. Complete the activity page with your findings. Remember to cite your sources!

My chosen invention:

Question: When was your invention first made?
Answer:
Source:

Question: Who developed the invention?
Answer:
Source:

Question: What was used before this invention?
Answer:
Source:

Question: How did this invention help? Why was it important?
Answer:
Source:

Question: What happened that helped inventors come up with this new invention (what new information or observations)?
Answer:
Source:

Question: Has this invention changed since it was first made?
Answer:
Source:

Name ________________________________ Date ____________________

Activity Page 4 Use with Lesson 4

Criteria and Constraints

Let's practice identifying criteria and constraints!

What are criteria? ____

What is a constraint? ____

You are designing a doghouse for your new puppy, Avocado. Indicate whether each statement is a criterion or constraint for your solution. If it is a constraint, describe the constraint in the box.

	CRITERIA	CONSTRAINT
"I have less than 50 dollars to build the doghouse."		
"It may rain or snow. The solution must work when it is wet."		
"Sometimes we get a lot of rain. The doghouse can't float. The solution must allow it to stay on the ground."		
"I don't have a lot of time to build. The doghouse can't take a lot of time to build."		
"I want to decorate the house with plants, but there is a drought."		
"I can't afford oak because it is too expensive."		
"We may move someday. The solution must be lightweight."		
"In order for Avocado to stay cool inside, the solution must allow air to flow through."		

Name ______________________ Date ______________

Making Analogies

Start by writing some ideas for a comparison. To do this, think about what you know about the science topic. Then, research to learn more about the topic, and fill out the column on the right to complete the analogy. The first one is done for you.

Science topic	My guesses	Final comparison	Because…
Blood vessels are like…	*roots* *buckets* *stop signs*	highways	They both transport and connect things.
Eyes			
A cell			
DNA			
The immune system			
Layers of Earth			
A hypothesis			
Tides			

Name ______________________________ Date ____________________

Activity Page 6 Use with Lesson 6

Peer Review a Scientific Report

You have to peer review a scientific report and make sure the report includes the parts of a good investigation. First, check off things in the checklist that are present in the report. Then, give feedback to the author on their article—think about the strengths of the report and the stretches (things that can be improved).

<table>
<tr><td colspan="2">Name of the article:

Author:</td></tr>
<tr><td colspan="2">Background information</td></tr>
<tr><td>• Includes background information
• Is easy to understand
• Helps you understand the investigation</td><td>Positive feedback: (Things to think about: Is there anything else you would like to know?)</td></tr>
<tr><td colspan="2">Question and Hypothesis</td></tr>
<tr><td>• States the question or purpose
• States the hypothesis
• Has a null hypothesis
• Has an independent, a dependent, a control variable</td><td>Positive feedback: (Things to think about: What is the question or purpose? What is the hypothesis or null hypothesis? Can you list the variables? Do you have any other suggestions?)</td></tr>
<tr><td colspan="2">Methods (Complete the checklist and give comments.)</td></tr>
<tr><td>• Explains what type of data will be collected
• Says how the data will be collected
• Explains why the data are going to be collected in this way</td><td>Positive feedback: (Things to think about: Does the data collection make sense? Is it safe and harmless?)</td></tr>
<tr><td colspan="2">Results and Conclusion</td></tr>
<tr><td>• Describes patterns
• Includes a conclusion
• Answers original question
• Has graphs or images for support
• Has trustworthy results and conclusion</td><td>Positive feedback: (Things to think about: Are the results trustworthy? Why)</td></tr>
<tr><td colspan="2">Your overall feedback:

What are some strengths?

What are some stretches?</td></tr>
</table>

Name ______________________________ Date ____________________

Activity Page 7 Use with Lesson 7

Design and Refine

You and your fellow engineers have been given the important goal of designing a net that reduces the bycatch of ocean animals. Your job is to design and test your net (your prototype/solution). Make sure to gather your data! After analyzing your results, you will be given a chance to refine your solution.

Before testing your prototype, collect the following data:	
Total number of balls in the bucket	

In the table below, describe each type of ball you have. Below that header, tally the number of that type of ball removed during fishing. For example: Ball 1: Big Purple			
Ball 1: ________	Ball 2: ________	Ball 3: ________	Ball 4: ________

After analyzing class results, answer the following questions with your group:
1. Were your fishing techniques 100% foolproof? Explain.
2. How could you improve the efficiency of the nets and reduce bycatch?
3. Which prototype worked best, and why?
4. Think of some ways you could improve the design of your net. Are there any materials you would like to try? Are there any other methods that might be more successful?
5. Draw your new design on a separate sheet of paper. Gather feedback.
6. Based on feedback, how would you further refine your solution/prototype?

Name ______________________________ Date ____________________

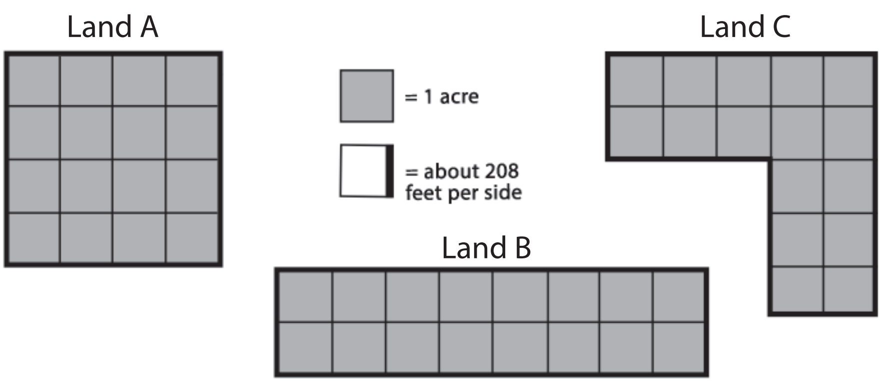
Grazing Acreage

The land where elk are kept must be surrounded by fencing. Fencing is a big part of the cost of elk farming. Fencing that is tall and strong enough to keep the elk in costs $2 per foot. The total cost of fencing to enclose an elk herd can be calculated using the formula below.

Total cost of fencing ($) = Length (feet) × $2.00

Three parcels of land are available for the elk farmer to rent. All of the parcels have the same area, 16 acres. They must be surrounded by fencing all along their perimeters. The elk farmer wants to minimize the cost of fencing.

Use the formula to help the elk farmer choose which parcel of land to rent. Which one is best? Why? Did you use any other formulas to help you decide?



Name ______________________________ Date ____________________

A farmer has a farm with grazing land. She finds that she needs 150 acres for 50 cows to graze productively. If she wants to increase the size of her herd, how many more acres will she need?

Calculate how many acres are necessary for each additional cow.

Then, complete the chart by using a formula to avoid overgrazing. Calculate how many acres of pasture would be needed for different numbers of additional cows.

Number of Additional Cows	Acres
10	
20	
30	
50	
60	
80	
100	
200	
500	
1,000	

Name ______________________________ Date ____________________

Activity Page 9 Use with Lesson 9

Water Cycle Rubric

Create a rubric for creating and evaluating a project that explains the water cycle.

Rubric
Criteria:
Constraints:

Name ______________________________ Date ____________________

Activity Page 10 Use with Lesson 10

Constructive Critique

Read the plan for a model of an Earth biome. Then use the sentence frames to write a constructive critique of the plan. Make sure your critique is objective, specific, helpful, and kind.

I will create a shoebox diorama of a desert biome. It will have sand on the bottom and a plastic cactus.

Praise

1. One good thing about this idea is

____

____

2. Another good thing is

____

____

Specific Objective Suggestions

1. Maybe it would be better if

____

____

Why is this helpful?

____

____

2. You might want to

____

____

Why is this helpful?

____

____

Name ______________________________ Date ____________________

Activity Page 11 Use with Lesson 11

Presentation Plan

Use the steps below to create a science presentation plan about some topic related to Earth's spheres.

Describe the topic:	**Sources to research:**
Main points to outline:	**Beginning:** **Middle:** **End:**
Format of the presentation:	
Attention-grabbing ideas:	
Ways to practice:	

Name ______________________________ Date ____________________

Activity Page 12 Use with Lesson 12

Pattern Power

1. Make a check mark beside those patterns that are the direct result of a natural pattern.

	Birthday celebrations
	Sleep cycles
	Sewing patterns
	Tides
	School schedules
	Holidays like Fourth of July and Thanksgiving
	Planting seasons
	Musical patterns
	Rainbows
	Animal hibernation

2. Identify two natural patterns.

____

____

____

____

3. Identify two patterns that are NOT natural.

____

____

____

____

Name ______________________________ Date ____________________

Activity Page 13 Use with Lesson 13

Causal Relationships

Draw lines from effects to their likely direct or indirect causes.

Effect	**Cause**
1. tides	**a.** warmer temperatures in spring
2. animal hibernation	**b.** disease of bees
3. riverbank erosion	**c.** deer overpopulation
4. increased biodiversity	**d.** moon's gravitational pull
5. insect overpopulation	**e.** flooding
6. plants shriveling	**f.** wildfire
7. leaves and flowers blooming	**g.** cold temperatures in winter
8. overgrazing	**h.** warm and wet climates
9. lack of pollination	**i.** bird disease
10. dangerous air quality	**j.** drought

Now describe three more examples of effects and their causes.

1. ____

____

____

2. ____

____

____

3. ____

____

____

Name ______________________________ Date ____________________

Activity Page 14 Use with Lesson 14

Units of Measurement

Rank the units of measurement 1–10 from smallest to largest. (Use the Student Reader chapter to help you. You don't need to memorize these now!)

Units of Time		Units of Distance Measurement	
	eon		astronomical unit
	nanosecond		centimeter
	day		femtometer
	microsecond		kilometer
	minute		light-year
	hour		meter
	epoch		micrometer
	year		mile
	era		millimeter
	millisecond		nanometer

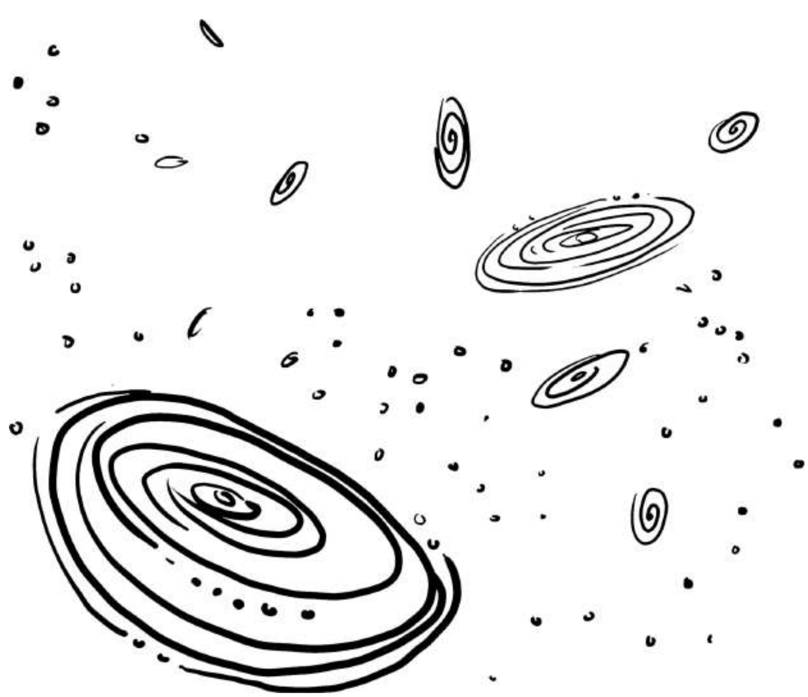
Name ______________________________ Date ____________________

Activity Page 15

Use with Lesson 15

Earth in the Universe Model

Label the picture to make it function as a model of a way to think about Earth in the universe.



Name ______________________ Date ______________

Activity Page 16 Use with Lesson 16

Home Energy Efficiency

Make a list of ten ways to increase energy efficiency in a home system.

1. ______________________

____

2. ______________________

____

3. ______________________

____

4. ______________________

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5. ______________________

____

6. ______________________

____

7. ______________________

____

8. ______________________

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9. ______________________

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10. ______________________

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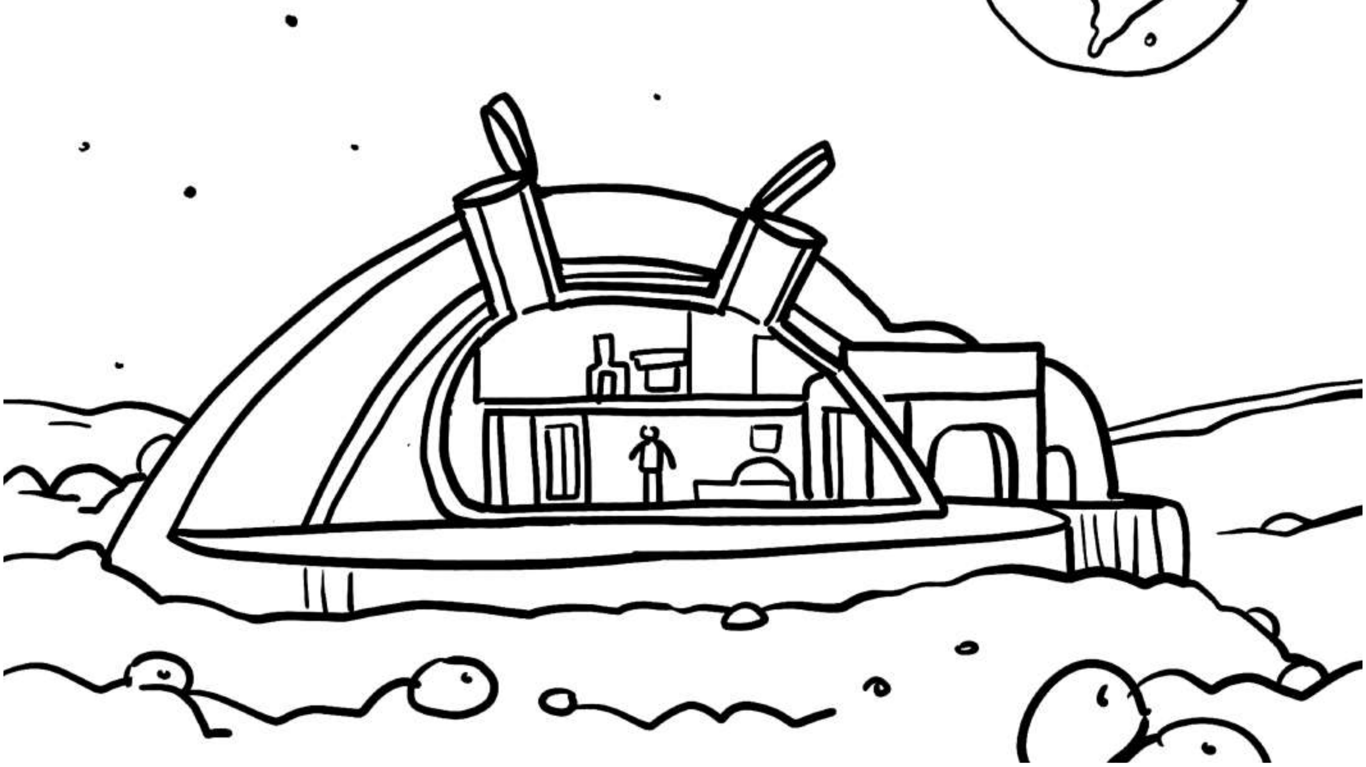
Name ______________________________ Date ____________________

Activity Page 17 Use with Lesson 17

Moon Unit

Describe a structure for living on the moon.

Tell how the different materials help meet criteria for living on the moon.



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Name ______________________________ Date ________________

Activity Page 18 Use with Lesson 18

Disorder and Order

Draw lines to match each example of things getting disorderly (entropy) to a way to try to preserve or restore order.

Disorder	**Order**
erosion of riverbank	patch holes to make watertight
rust on bridge support	cut up and use for fuel or construction
abandoned car	dredge waterway to control water flow
farm field	replace or fortify
moldy bread	repurpose parts
cracks in pavement	prepare for next growing season
fallen tree	compost
leaky roof	fill holes or repave

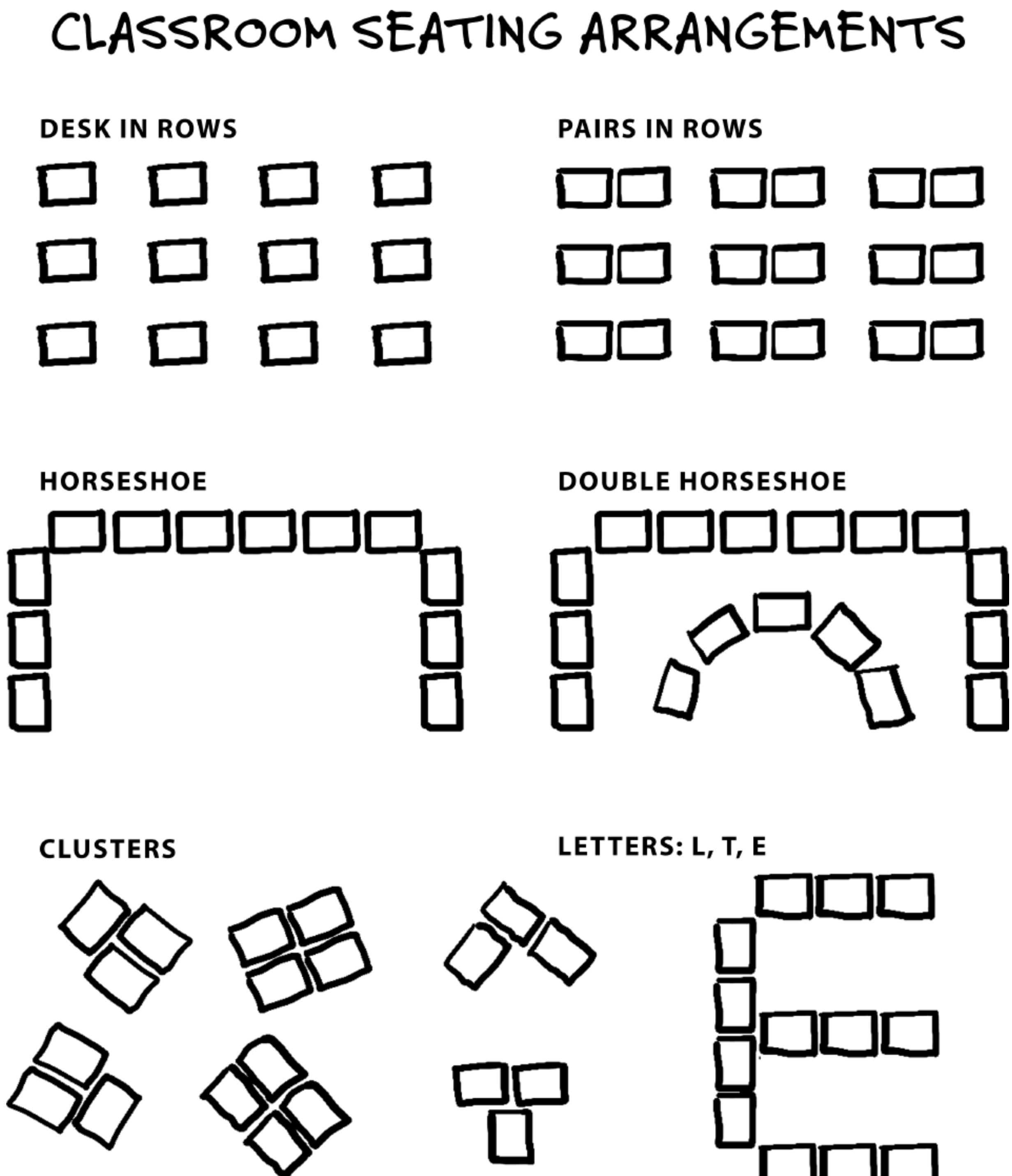
Write about another example of something that you have observed naturally changing and becoming disorderly.

Name ______________________________ Date ____________________

Activity Page 19 Use with Lesson 19

The Optimal Solution

Design a solution for the problem the class identified at the beginning of the lesson. Include a drawing of the solution as well as steps or materials needed.



Name ______________________________ Date ____________________

Activity Page 20 Use with Lesson 20

Apps for That

Describe a computer application for each of the problems below. You can describe an app that exists in the real world, or you can invent your own idea using your imagination.

Modern Problem	Computer Application
How long will it take to get to school?	
What is that bug?	
What should I eat?	
What should I wear today?	
What can I do while I'm waiting?	
What does that word mean?	
I'm locked out of my house.	
What are the words to that song?	

Answer Key: *Using Science Knowledge*

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.

**Building a Team (AP 1)
(page 96)**

Look for final projects that include each required element. Responses to prompts should discuss elements such as teamwork, redundancy, goals, and backgrounds.

**Bustin' Myths! (AP 2)
(page 97)**

1–3, Answers will vary. Make sure students identify the information known before the investigation and the procedural steps for the investigation; 4, Look for a list of evidence; 5, Answers will vary based on the evidence. Make sure students include the claim and the evidence; 6, Myths don't use evidence, but scientific explanations do.

**Electrical Inventions over Time (AP 3)
(page 98)**

Answers will vary. Ensure that students have described any new information that helped in the invention's development, and how it has changed over time.

**Criteria and Constraints (AP 4)
(page 99)**

Criteria are the standards used to judge whether a project is successful; Constraints are limitations for a solution; In order, from top to bottom: Constraint (money), Criteria, Criteria, Constraint (time), Constraint (limited resource), Constraint (money), Criteria, Criteria

**Making Analogies (AP 5)
(page 100)**

Guesses: Accept all answers; Final comparisons: Look for answers that relate to the Because column. Because (in order): they both have lenses to look at images; they have many parts that work together to do a job; they spiral; stop bad things; have layers; the answer isn't known yet; they both go back and forth.

**Peer Review a Scientific Report (AP 6)
(page 101)**

Answers will vary. Make sure students respond to the checklist and give positive feedback relevant to the prompts.

**Design and Refine (AP 7)
(page 102)**

Data gathered will vary. Sample answers: 1, No, it was not foolproof. There was bycatch; 2, We could use a new net with smaller holes; 3, Answer depends on class data; 4, A net with two layers might work. I could use flexible materials so big animals can get through; 5, Answers will vary; 6, Answers will vary.

**Grazing Acreage (AP 8)
(pages 103–104)**

Each additional cow needs 30 acres. Use the following formula to complete the chart: Total acres = Number of cows × 30 acres.

**Water Cycle Rubric (AP 9)
(page 105)**

Look for rubrics that list criteria (goals/things that must be included); for example, the project should show evaporation, condensation, and precipitation. Some constraints are size, cost, and materials.

**Constructive Critique (AP 10)
(page 106)**

Look for critiques that are kind and that explain how the suggestions are helpful.

**Presentation Plan (AP 11)
(page 107)**

Ensure that students are completing all parts of the outline and that their plans are relevant to the topic.

**Pattern Power (AP 12)
(page 108)**

Check marks should be placed by sleep cycles, tides, planting seasons, rainbows, animal hibernation. Examples of natural patterns: seasons, sunrise/sunset, tides. Examples of patterns that are not natural: musical patterns, holidays.

**Causal Relationships (AP 13)
(page 109)**

1, d; 2, g; 3, e; 4, i; 5, h; 6, j; 7, a; 8, c; 9, b; 10, f; Look for causes and effects that explicitly describe things changing together.

Units of Measurement (AP 14)
(page 110)

Units of Time: 10, 1, 6, 2, 4, 5, 8, 7, 9, 3; Units of Distance Measurement: 9, 5, 1, 7, 10, 6, 3, 8, 4, 2.

Earth in the Universe Model (AP 15)
(page 111)

Image labels should indicate that the Earth is not in the center of the solar system and is the third planet from the sun.

Home Energy Efficiency (AP 16)
(page 112)

Accept all ideas that get the best outcome in relation to amount of energy or material use.

Moon Unit (AP 17)
(page 113)

Look for designs that list materials used and how they meet criteria for living on the moon.

Disorder and Order (AP 18)
(page 114)

Erosion of riverbank – dredge waterway to control water flow; rust on bridge support – replace or fortify; abandoned car – repurpose parts; farm field – prepare for next growing season; moldy bread – compost; cracks in pavement – fill holes or repave; fallen tree – cut up and use for fuel or construction; leaky roof – patch holes to make watertight. Accept any examples that accurately describe something becoming disorderly.

The Optimal Solution (AP 19)
(page 115)

Accept all solutions. Make sure students describe the steps in logical sequence and list any materials needed.

Apps for That (AP 20)
(page 116)

Possible answers, in order: map or navigation app; animal or wildlife identifier; recipe finder; outfit developer; what to do when you're bored suggestions; dictionary; important phone numbers to have; lyrics finder.

Appendix A

Glossary

Colored 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

acre, n. a unit of land measurement equal to 43,560 square feet

age, n. a period of time defined by a technology

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

area, n. amount of space within a certain space

assess, v. to judge something based on its significance or worth

astronomical unit, n. unit of length equal to the average distance between Earth and the sun

C

causal relationship, n. a connection between two things where one is the result of the other

causation, n. an event that causes another event to occur

change, v. to become different, to make something different

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

comparison, n. an observation of shared characteristics

constraints, n. limits on the designed solution to a problem

constructive critique, n. feedback that aims to help people improve their behavior or performance

correlation, n. a description of the relationship between two or more variables

criteria, n. the conditions that a solution must meet to be judged as successful

criticism, n. an evaluation of what is good or bad about something

D

data, n. information that is observed or measured and recorded

design, n. a plan to show how something is made or how a process should work

difference, n. an instance of something being unlike or distinguishable from another

direct, adj. a type of relationship in which no other factor interacts between two variables that influence one another

E

effect, n. the outcome produced by a cause

efficiency, n. the degree of producing desired results

energy, n. the capacity to do work or cause change

engineering, n. a process used to develop a solution to a problem

entropy, n. the idea that matter and energy tend to become evenly distributed and inactive over time

equator, n. an imaginary line that divides Earth into two hemispheres

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

evidence, n. a detail that supports a claim or helps prove an idea is true

explanation, n. the stated reason for something or about how something happens

F

failure, n. results that aren't as expected or desired

feedback, n. reactions to a product or a performance used as a basis for improvement

formula, n. a mathematical rule that uses letters or names to represent amounts that can be changed

function, n. the action or purpose for which a thing works

G

geologic timescale, n. a timeline that divides Earth's history into time units

goals, n. the result or end that a person wants to happen

grade, n. an indicator of accomplishment in school

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

I

improbable, adj. unlikely to be true or to happen

indirect, adj. a type of relationship in which two variables affect each other through a third variable

Industrial Age, n. a period of change that began around 1760 when more people began working in mines and factories where machines made goods

information, n. knowledge or facts that is given or received

insulating, v. adding material to something in order to protect from electricity, heat loss, or sound

investigation, n. an instance of investigating

K

kilometer, n. a metric unit of length equal to 1,000 meters

L

latitude, n. measurement of the distance north or south of the equator, which is 0 degrees at the equator and increases to 90 degrees toward the North and South Poles

light-year, n. the distance that light travels in one Earth year

M

mass, n. the amount of matter in an object

metal ages, n. a period of time when people made more things out of metal, like tools and weapons

method, n. the way scientists gather information and observations, and the tools and steps used

micrometer, n. a millionth of a meter, used to measure microscopic organsims

microscope, n. a tool used to view small objects, such as cells and microbes

migrate, v. to move from one place to another in different seasons

millimeter, n. a thousandth of a meter, used to measure things that are bigger than a cell

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

myth, n. a traditional story that explains the world and human experience

N

nanometer, n. a billionth of a meter, used to measure things like viruses

notes, n. records of what you have learned or heard

O

objective, adj. based on facts and evidence

optimize, v. to revise and improve something so it can achieve its best possible performance

outline, n. a plan for a presentation or paper

P

parcel, n. a part of something

pattern, n. a reliable system of traits or a set of repeating details

performance, n. the execution or accomplishment of work, an action, or a task

photosynthesis, n. the process used by producers to make glucose and oxygen from sunlight, water, and carbon dioxide

positive, adj. good, the opposite of negative

positive feedback, n. feedback that focuses on strengths, contributions, and value to reinforce what people are doing well

prediction, n. a declaration in advance of what one thinks will happen

prehistory, n. the period of time before written history

presentation, n. a way for a speaker to convey information to an audience

pressure, n. a pushing force applied on something

problem, n. a condition that falls short of satisfying a want or a need

prototype, n. a preliminary version of a design from which other forms are developed

R

radiation, n. the emission of energy as electromagnetic waves

redundancy, n. backup plans; additional versions of a component that accomplish the same tasks

refine, v. to improve

Renaissance, n. a period of time when people made and sold goods rather than just providing for their families, and inventions were made to support the exploration of ideas, art, and architecture

research, n. a careful study and investigation to discover and explain new knowledge

revenue, n. all the money a business earns

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

S

scale, n. the size of a picture, plan, map, or model compared to the real thing

scientific, adj. describes the study of the natural world through observation and experimentation

similarity, n. shared or similar characteristic between two things

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

solution, n. a process, action, or device that fixes a problem

specific, adj. restricted to a particular individual, situation, relation, or effect

stability, n. the tendency of something to remain undisrupted

structure, n. the way in which something is made and the parts it is made of

subjective, adj. based on personal feelings, tastes, or opinions

system, n. a set of parts that work together and affect each other

T

team, n. a group of people who work together to achieve a common goal

teamwork, n. work done together as a group

telescope, n. a magnification device for viewing objects that are too far away to see well with the unaided eye

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

tides, n. the alternating rising and lowering of the sea level along a coastline

U

uniform, adj. even and regular throughout

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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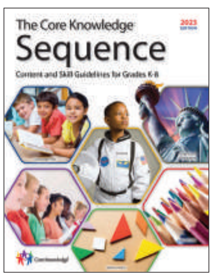
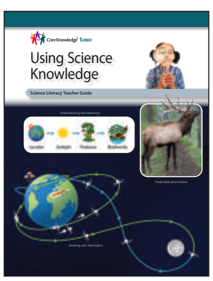


What is the Core Knowledge Sequence?
The *Core Knowledge Sequence* is a detailed guide to specific content and skills to be taught in Grades K–8 in language arts, history, geography, mathematics, science, computer science, and the fine arts. In the domain of computer science, the *Core Knowledge Sequence* 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 5 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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