Core Knowledge® SCIENCE

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Science in Action: Pearl, Dan, & Kendrick

Teacher Guide

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Teacher Guide

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Teacher Guide

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Introduction

About Science in Action

The goal of teaching students science from Kindergarten through high school graduation is not to turn every student into a scientist by profession. However, scientific advances occur at a faster rate year after year and this leads to a job market and society that needs people comfortable with science as part of their daily work lives. And while students traditionally receive an education in science, they may not be familiar how a path from learning about science leads to a career in the science. Students may have an imperfect understanding of how science will impact their future and future career. Students may be undecided about their futures and have no background or understanding about how science could inform their career as adults.

While STEM is now taught as a portion of classes in many grades, there are very few schools with dedicated engineering classes. Many industries have a focus on engineering which can change rapidly as a result of the faster evolution of technology. As a result, many students receive little exposure to this vital aspect of their future careers. Students are asked to learn about engineering and adapt to new engineering skills in a short time frame without developing the depth and breadth of how to put science in action.

With this in mind, Core Knowledge has developed the Science in Action readers. Each reader features two or more chapters. Students learn first about the early childhood of the subject and how their interest in the sciences and engineering was piqued. The second part features the subject in the present day and explores their academic and engineering experiences in college, their work experiences as they relate to their scientific and engineering experiences, and in some cases their careers post-college. Each account ends with an "Inspired by . . ." section which features one or more scientists or engineers who provided inspiration in their path. The goal is to help young students connect their own experiences at a younger age to their future endeavors and careers as part of the larger society outside the classroom.

Core Knowledge Foundation is committed to educating students in many disciplines. *Science in Action* is intended to show that a person, no matter what age, encounters science and engineering in their everyday experiences. Further, the program intends to help students connect their personal lives with the broader needs and interests of society so when they get to high school and beyond in their academic careers, they will more familiar with the paths they follow.

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 Readerss, 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 discrete ideas to be taught and learned. This omission makes the overarching concepts.

The lessons in Grade 4 Core Knowledge Science in Action 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. Additional cross-curriculum standards relevant to specific lessons will be listed at the lesson level.

Nature of Science

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.

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 DC.

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 that 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 backyard).
- 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.

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.

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.

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

Engineering and Design

ED.A. Defining and Delimiting Engineering Problems

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

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

ED.B. Developing Possible Solutions

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

- Develop solutions: Research and explore multiple possible solutions.

ED.C. Optimizing Design Solutions

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

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

Science, Technology, Society, and the Environment

STSE1. Interdependence of Science, Engineering, and Technology

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

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

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

Common Core State Standards for English and Language Arts

Reading Standards for Informational Text

Key Ideas and Details:

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

Craft and Structure:

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

Integration of Knowledge and Ideas:

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

Range of Reading and Level of Text Complexity:

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

What Teachers Need to Know

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

Know the Standards: These sections, found later in this Teacher Guide, explain what to teach and why, with reference to NGSS and Core Knowledge expectations.

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

Students come to elementary classrooms across the country with a wide range of prior experiences. Some have grown up in cities away from nature. Others have grown up in the country, intimately involved in nature.

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

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

Using the Reader

The *Science in Action Reader* includes 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 Reader is spiral bound to allow students to lay it flat when reading or following along.

The intent of the Grades 3–5 CK Science in Action lessons is to build students' understanding and knowledge of science concepts, as well as of associated practices and skills, using a teacher Read Aloud, accompanied by example images and diagrams. Cognitive science research has clearly documented the fact that students' listening comprehension far surpasses their reading comprehension well into the late elementary and early middle school grades. Said another way, students are able to understand and grasp far more complex ideas and 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

The *Science in Action* Teacher Guide is set up with lessons that parallel the chapters of the Reader. Additionally, there are experiences that follow some of the lessons. Experiences are class-length labs that support the science content in the Reader. Within the Teacher Guide is a list of the Nature of Science, SEPs, CCCs, and Literacy standards that students may encounter within the lessons and experiences.

Activity Pages

Activity Pages

Black line reproducible masters for activity pages, as well as an answer key, are included in Teacher Resources on pages 68–79. 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.

AP 1
AP 2
AP 3.1
AP 3.2
AP 4.1
AP 4.2
AP 5
AP 6
AP 7

Lesson 1—Character Traits Diagram (AP 1)

Lesson 2—Picture Yourself in a STEM Career (AP 2)

Experience A—Identifying Odors (AP 3.1)

Experience A—Design a Signature Scent (AP 3.2)

Experience B—Forecast It (AP 4.1)

Experience B—Weather Symbols (AP 4.2)

Experience C—Backyard Bingo (AP 5)

Experience D—Masters of Disguise (AP 6)

Experience E—Yellow Pan Trap (AP 7)

Online Resources

Online Resources

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

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

www.coreknowledge.org/cksci-online-resources

Materials and Equipment

These lessons suggest a moderate variety of materials to support activities that enhance the Science in Action 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

- reference books and other research materials
- stargazing app
- small unbreakable mirror
- flashlight or lamp

Lesson 4

- reference books and other research materials
- plastic cup
- water
- drinking straw

Experience A

- vinegar
- vanilla extract
- almond extract
- several jars of ground spices, such as cinnamon, curry, turmeric, cardamon, allspice, and nutmeg
- 3 oz or smaller paper cups
- cotton balls
- markers

Lesson 3

- reference books and other research materials

Lesson 4

- reference books and other research materials
- plastic cup
- water
- straw

Experience B

- reference books and other research materials
- large sheets of paper or poster board
- markers, crayons, or colored pencils
- tape or glue

Lesson 5

- reference books and other research materials

Experience C

- markers or dot stickers
- magnifying glasses, binoculars (optional)

Lesson 6

- reference books and other research materials

Experience D

- list of animals that use mimicry on index cards
- computers/tablets
- research materials or encyclopedias

Experience E

Day 1:

- yellow bowls or pans
- large jug of water
- disposable cups
- dish soap
- wooden craft stick
- permanent marker
- yellow paint (optional)
- paintbrush (optional)

Day 2:

- large tray
- fine mesh strainer
- clear collection jars or vials
- disposable cups
- isopropyl alcohol
- magnifying glass or microscope
- tweezers
- gloves
- goggles
- masking tape
- permanent marker

Pacing

The Core Knowledge Science in Action Reader consists of four chapters, each ten pages long. This accompanying Teacher Guide contains one lesson of instructional support per chapter. Each lesson offers prompts for the teacher to use in facilitation of class discussion. Many lessons offer brief hands-on activities, teacher demonstrations, or online enhancements in addition to the reading support.

The Science in Action 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 in Action chapter to help pair the chapters meaningfully with other units.

Science in Action Chapter/ Experience	Has content that ties to …	Core Knowledge Grade 4 Units
1. What About Pluto?	Earth science, STEM	• Making Sense of Science
2. Pearl Davis: Becoming a Scientist	Life science, STEM	• Structures and Functions of Living Things, • Making Sense of Science
Experience A: Signature Scents	Life science, habitats	• Structures and Functions of Living Things, • Making Sense of Science
3. Weather Watcher	Earth science, Physical science, STEM	• Energy Transfer and Transformation • Investigating Waves, • Making Sense of Science
4. Daniel Longhurst: Teaching Tomorrow's Scientists	Earth science, STEM	• Energy Transfer and Transformation • Investigating Waves, • Making Sense of Science
Experience B: Forecast It	Earth science, habitats	• Processes That Shape Earth, • Making Sense of Science
5. Wings and Wonders	Life science, STEM	• Structures and Functions of Living Things • Making Sense of Science
Experience C: Backyard Bingo	Life science	• Structures and Functions of Living Things • Making Sense of Science
6. Kendrick Fowler: Buzzing over Wasps	Life science, STEM	• Structures and Functions of Living Things • Making Sense of Science
Experience D: Masters of Disguise	Life science, STEM	• Structures and Functions of Living Things • Making Sense of Science
Experience E: Yellow Pan Trap	Life science	• Structures and Functions of Living Things • Making Sense of Science

Online Resources

Also, see the Online Resources Guide for recommendations about when to best enhance instruction to support these chapters.

www.coreknowledge.org/cksci-online-resources

LESSON 1

What About Pluto?

At a Glance

Learning Objectives

- ✓ Give one example of how a science explanation has changed.
- ✓ Explain how people's experiences can contribute to choosing science-related careers.

Instructional Activities

- teacher Read Aloud / Read Along
- class discussion
- vocabulary reinforcement
- demonstration
- develop a model

NGSS and CCSS References

NOS2. Scientific Knowledge Is Based on Empirical Evidence: Science findings are based on recognizing patterns.

NOS3. Scientific Knowledge Is Open to Revision in Light of New Evidence: Science explanations can change based on new evidence.

NOS7. Science Is a Human Endeavor: Men and women from all cultures and backgrounds choose careers as scientists and engineers.

PS4.B. Electromagnetic Radiation: An object can be seen when light reflected from its surface enters the eyes.

CCC2. Cause and Effect: Cause-and-effect relationships are routinely identified.

RL4.1. Key Ideas and Details: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.

RL4.3. Key Ideas and Details: Describe in depth a character . . . in a story . . ., drawing on specific details in the text (e.g., a character's thoughts, words, or actions).

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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dwarf planet **pattern** **planet** **solar 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.

force **horizon** **orbit**

Instructional Resources

Reader
Ch. 1

Reader, Chapter 1
"What About Pluto?"

Activity Page
AP 1

Activity Page
Character Traits Diagram (AP 1)

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
- stargazing app
- small unbreakable mirror
- flashlight or lamp

Advance Preparation:

If you do not already have an app showing the night sky, download one of several free ones available and try it out.

The Core Lesson

1. Focus attention on the lesson purpose.

Online Resources

Introduce students to the eight **planets** in our **solar system** by showing a music video that names the planets and gives some basic facts about their similarities and differences. Invite them to sing along as they read the captions.

2. Read and discuss: "What About Pluto?"

Reader

Ch. 1

Prepare to read together, or have students read independently, Chapter 1 "What About Pluto?" 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

- What can you infer Pearl's parents do for work? What clues in the story support your answer? (*They are teachers of some kind. I know that because they are talking about the work of their students.*)
- Explain to students that when Pearl thinks she smells stew cooking, she is recognizing **patterns**. She probably recalls what she smelled all the previous times her family cooked stew. Ask: What foods can you recognize from their odors? How do you use patterns to know what is cooking? (*Sample answer: I know when cookies are baking because I always smell brown sugar and vanilla.*)
- Point out the final question on the page. Have students brainstorm ideas about what Pluto is and what might have happened to it. Write their ideas down but do not correct them at this point.

Page 3

Online Resources

- What clues in the text make you think Pearl's dad is pleased with her questions? (*He grinned and he was willing to talk about a question of her choice.*)
- What word does Pearl use to describe herself as a person who asks many questions? (*curious*)
- As a class, visit the NASA website and type keywords (e.g., "Pluto," "dwarf planet") into the search box. Have students evaluate the search results and choose one that seems most likely to answer Pearl's question. Allow the class a few minutes to review the web page they chose.

Page 4

Online Resources

- Ask: What patterns in the motion of the smaller objects in our solar system can you infer from the picture? (*Those curved lines seem to show that the smaller objects move around the sun.*)
- Point out to students that they will learn about the sun, other stars, and some patterns of Earth's motion in greater depth in fifth grade.

  EXTEND—For students who have high interest in the solar system, allow them to access a video that has more details on the planets.

Page 5

- Have students discuss their answers to the text question, "Does it surprise you that scientists don't always agree on the answers to their questions?" Point out that it is common for scientists to change their explanations of things in nature. As an example, share with students that at one time scientists thought that Earth was at the center of the solar system and that the other planets and the sun moved around it. With more information, they realized that the sun is the center of the solar system and all the other space objects revolve around *it*.
- Invite students to answer the first text question: What questions do you have? (*Possible response: What are the names of other dwarf planets?*)

EXTEND—If students want to know if there are other dwarf planets in our solar system, have them search the NASA website for "dwarf planets" to learn about several others.

- Guide a discussion of the second text question: How would you find answers to them? (*Go to a library and get help from a librarian; search the NASA website and other science websites; ask an expert such as a middle school Earth science teacher.*)

Page 6

Online Resources

- Direct students' attention to point 1 in the list of three things a planet must do. Ask: What is an example of a space object that moves around a planet? (*a moon*)
- When students read point 3, explain that scientists have observed over one million objects in our solar system, including planets, **dwarf planets**, moons, asteroids, comets, and meteors.
- Explain that one other dwarf planet, named Ceres, is much closer to Earth than Pluto. It orbits the sun between Mars and Jupiter.

Page 7

Online Resources

- After reading Pearl's questions, allow students to ask their own questions to clarify what it means to "clear the neighborhood." If students want to know *how* a planet does this, explain that a planet has enough force of gravity to cause smaller objects to collide and combine with it.
- Ask: What force pulls the orange in the story downward? (*Earth's gravity*)

SUPPORT—If students struggle with the concept of gravitational force "clearing a neighborhood," show them a video that models this idea using magnets that differ in the amount of force and the resulting effects on nearby objects.

- Point out that objects in Pluto's neighborhood of space may cross over its path around the sun.

Page 8

- Ask: Why can't people on Earth see the stars on a cloudy night? (*because light from the stars cannot pass through the clouds to our eyes*)
- Ask: Why is it difficult to see most space objects in the daytime sky? (*Our eyes cannot see dim lights from distant stars and planets when the sky is lit up with very bright light from the sun.*)
- Show students an app that maps stars, planets, and other space objects for any location on Earth. Allow students to see what objects are in the sky as they face north, east, south, and west. Point out which are below and above the horizon. Change the date and time to show them a map of the sky later that evening or on another day.

Page 9

- Guide students to develop a model showing how a nonluminous space object can be visible. Take students with a flashlight and small mirror into a hallway that turns a corner. Have them try different positions for the planet, sun, and viewers on Earth. Suggest that if the student with the flashlight walks past the student with the mirror and turns the corner, they will be out of sight of the viewers on Earth, just as the sun is out of sight in the night sky.
- Ask: How does sunlight move for you to see a planet in the sky? (*It travels from the sun to the planet and then is reflected into our eyes.*)
- Ask: Why couldn't Pearl and her mom see Pluto when the app showed it in the sky above them? (*Pluto is too far away to see with just the eyes.*)

- Return to the list of brainstormed ideas about what Pluto is that students made when they read page 2. Have students evaluate the list and make changes as needed based on what they learned.

Page 10

- Where on this page are two science careers discussed? (*in the first two sentences when Pearl and her dad discuss her becoming a planetary scientist and when Pearl asks how perfumes are invented*)
- Elicit students' ideas about how a person's cologne can still be smelled after they leave a room. Encourage them to use cause-and-effect thinking in their explanations. (See **Know the Science**.)

  EXTEND—Explain to interested students that matter is made of tiny particles that are too small to be seen and move freely around in space. Have them use this idea to draw a model showing how the cologne particles spread throughout the air in a room.

- What adjective does Pearl use to describe herself on this page? (*"curious"*)

Page 11

- What adjective does Pearl use to describe herself on this page? (*"confident"*)
- Do you think Pearl had a good day on her first day of high school? Explain. (*Possible response: yes, because if she felt confident, people would probably think she was able to take care of herself and do well in school*)
- Have students identify Pearl's experiences that might have affected her decision to work as a scientist or an engineer. (*Experiences from the story include the discussion of Pluto in her grade four science lesson, using a star map app with her mom, and wondering about the perfume and colognes her parent enjoyed wearing.*)

3. Connect to lived experience.

Activity Page

AP 1

Invite students to share any details from the chapter that resemble someone or something familiar to them. Ask students to tell details about the chapter that interested them most. Invite students to ask questions about details that might not have been clear to them.

Use AP 1 to reinforce students' reflections on the chapter. Tell students they may re-read looking for adjectives that describe Pearl or use their own based on inferences they made.

See the Activity Pages Answer Key for a sample student response.

Display students' completed activity pages and have students take a gallery walk to compare their ideas.

Know the Science

In what state of matter is perfume when it is in the air? When liquid perfume is sprayed on the skin, some of it evaporates and becomes a part of the mixture of gases in the air around you. If perfume is sprayed into the air, tiny liquid droplets of perfume mix with the air and are held aloft by air currents. Later, these liquid droplets will change to a gas. Your nose can detect the scents of both the liquid and gas forms of perfumes.

LESSON 2

Pearl Davis: Becoming a Scientist

At a Glance

Learning Objectives

✓ Identify examples of STEM careers.

✓ Explain that people from many places and backgrounds can learn to be scientists and engineers.

Instructional Activities

- teacher Read Aloud / Read Along
- class discussion
- vocabulary reinforcement
- hands-on activity

NGSS and CCSS References

NOS7. Science Is a Human Endeavor: Men and women from all cultures and backgrounds choose careers as scientists and engineers.

NOS7. Science Is a Human Endeavor: Science affects everyday life.

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

RI.4.5. Craft and Structure: Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.

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engineer **scientist** **STEM**

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digital **pharmaceutical** **university**

Instructional Resources

Reader

Ch. 2

Reader, Chapter 2
"Pearl Davis: Becoming a Scientist"

Activity Page

AP 2

Activity Page
Picture Yourself in a STEM Career (AP 2)

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- drinking straws
- plastic or paper cups or jars
- tap water with food dye

Advance Preparation:

Add a few drops of food dye to a half gallon of tap water in preparation for the suggested activity supporting page 21.

The Core Lesson

1. Focus attention on the lesson purpose.

Ask students if they ever had the experience of thinking they couldn't do something and then found out they could. They may share experiences from when they were younger, such as learning to ride a bike or skateboard, or something more recent, such as reaching a certain level on a video game. As you read Chapter 2, have students listen for ways that Pearl changed her thinking about what she could do.

2. Read and discuss: "Pearl Davis: Becoming a Scientist."

Reader

Ch. 2

Prepare to read together, or have students read independently, Chapter 2 "Pearl Davis: Becoming a Scientist." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 12

- What were some of the questions Pearl asked in Chapter 1? (*Examples: Did you hear what happened to Pluto? Why did the scientists change their minds about Pluto? How do you know that you are seeing a planet and not a star? How are perfumes invented?*)
- What are some of the things Pearl did in the story in Chapter 1? (*Examples: She talked to her parents about planets; she learned about planets from the NASA website; she went out after dark with her mom to use a sky mapping app; she wore perfume on her first day of high school.*)
- Do you agree that asking questions is a good way to learn? Why? (*Sample answer: yes, because sometimes people can give you an answer right away*)

Pages 13

- Point out where in the text Pearl mentions STEM careers. Ask: What does "STEM" stand for? (*Accept all responses.*)
- Which headings on these two pages explain what STEM means? (*Science, Technology, Engineering, Mathematics*)

  EXTEND—Explain that "STEM" in all uppercase letters is an *acronym*, a word formed from the first letters of a series of words. Have students look back at Chapter 1 for another acronym (NASA) and research what each letter stands for. Then have them collect other examples of acronyms and maintain a class list.

Pages 14–15

- Show students how pages 14 and 15 are organized to support one main idea with four details.
- Have students use the question "Which of these jobs would you like to try?" as a purpose for reading each of the four examples on these two pages.
- How do digital designers affect people's everyday lives? (*Sample answer: They can make it easier or harder for people to use websites or apps.*)
- Which of these STEM careers interests you the most? Why? (*Sample answer: If I were a robotics engineer, I could design robots that can make my bed, clean up my bedroom, and walk my dog.*)
- Invite students to answer the text questions at the bottom of the page: "What other jobs are STEM careers? How could you find answers to this question?" (*ask a librarian, ask a science teacher, use online resources*)

Page 16

- Is being a medical doctor a STEM career? Explain your reasoning. (*yes, because medical doctors have to use their understanding of science and do investigations to help sick and injured people get better*)
- Explain to students that an *honor society* is something like a club that students have to be invited to join.
- What does the writer mean by "doing investigations"? (*Sample answer: asking questions, planning experiments, analyzing data, sharing results*)

Page 17

- Mention that many students feel the same way as Pearl did and want to attend college near their homes. Explain that living at home can save money, as colleges charge fees for room and board. Do a quick web search with students to identify colleges that are close to where your students live.
- Show students where RPI is on a map and have them estimate how far away it is from their homes. Ask: Would you be willing to attend a college that is far away from your home? Explain. (*Sample answer: I would do it if they asked me to play on their basketball team, if some of my friends were also going, or if they helped pay for my college education.*)
- Discuss how colleges and universities that draw students from all over the United States (and world) lead to people from all backgrounds having STEM careers.

Page 18

- What do you think students are missing when they feel homesick at college? (*Possible responses: their own beds, their favorite foods, their parents, siblings, and friends*)

- Explain to students that it usually takes four years to graduate from a university such as RPI.
- How do you think Pearl felt about her job helping first-year students? (*Sample answer: She probably felt proud that as a second-year student she could give them tips on getting comfortable at college.*)

Page 19

- Direct students to the image depicting college majors. Ask: What information can you get from this image? (*that there are many majors to choose among when you go to college*)

  SUPPORT—The graphic may have terms unfamiliar to some students. Have them look up words they are curious about in a dictionary or provide operational definitions, such as "The book called *The Little Prince* is a piece of *literature*."

- Point out that personalized medicines, designed for one person, are more likely to improve the health of a sick patient than ordinary medicines.

Page 20

- Where in the text does it say three ways people take their personalized medicines? (*in the caption—by inhaling, rubbing on the skin, or swallowing*)
- Point out that **scientists** and **engineers** are not the only jobs at pharmaceutical companies. There are many other jobs needed to run the companies, such as in sales, marketing, digital design, and accounting.

Page 21

- What about working in a lab might seem fun to Pearl? (*Sample answer: using a pipette, doing experiments, looking though a microscope, solving problems that help people*)
- Explain that a pipette is used to move small amounts of liquid from one container to another. Have students simulate using a pipette with a drinking straw, a cup of water containing food dye, and an empty cup. Demonstrate how to place one end of the straw into the cup of colored water, place a finger over the other end of the straw to seal it, transfer the straw to the empty cup, and release the water by lifting their finger. (See **Know the Science**.)

  CHALLENGE—Challenge interested students to figure out how to control the amount of water that they release from the pipette and share their ideas with the rest of the class.

Know the Science

How does a straw pipette work? When you place a straw open at both ends into a cup of water, the water will rise in the straw to the same level as in the cup. When you seal the top end of the straw with a finger and lift the straw out of the cup, the water stays in the straw due to a combination of two mechanisms. First, as the water inside the straw begins to be pulled down, a vacuum is created that holds the water in. Second, air pressure from the room is pressing upward on the water in the straw and has greater force than gravity, so the water stays in place.

Page 22

Online Resources

- Have students compare pages 22 and 23. Then ask: What is the same about how these two pages are set up? (*They have the same headings for the facts about each person.*)
- Ask: Which of these two people lived more recently? Which lived a longer time ago? How do you know? (*Dr. Bath lived recently, and van Leeuwenhoek lived a long time ago. I know by comparing the years they were born.*)
- What do Dr. Bath's words of wisdom mean to you? (*Sample answer: She meant that helping people was the best part of her work, even better than making money.*)

  EXTEND—Invite students to view a network television video interview with Dr. Patricia Bath that highlights her accomplishments as a Black women. Have students share their reactions by asking them what most impressed them about Dr. Bath.

Page 23

Online Resources

- If Antonie van Leeuwenhoek was indeed a patient and curious child, what do you think he liked to do as a child? Remind students that when he lived, there were no devices that used electricity, such as TVs and mobile phones. (*Sample answer: Maybe he liked to go outside and look at plants and bugs in nature.*)
- Share with students an online video showing the creatures Antonie van Leeuwenhoek might have seen using his microscope.
- Explain that van Leeuwenhoek did not go to college to learn to become a scientist or an engineer but still became an inventor and made many scientific discoveries.

  EXTEND—Ask a librarian to obtain for your students a copy of the award-winning children's nonfiction chapter book *All in a Drop: How Antony van Leeuwenhoek Discovered an Invisible World* written by Lori Alexander and illustrated by Vivien Mildenberger (Clarion Books, 2019).

3. Connect to lived experience.

Activity Page

AP 2

Invite students to share any details from the chapter that resemble someone or something familiar to them. Ask students to tell details about the chapter that interested them most. Invite students to ask questions about details that might not have been clear to them.

Use AP 2 to reinforce students' reflections on the chapter.

See the Activity Pages Answer Key for a correct list of the STEM careers discussed in this chapter and sample student responses.

After students have completed the sheet independently, have them turn and talk to share their three top choices and reasoning with another student.

EXPERIENCE A

Signature Scents

At a Glance

Learning Objectives

- ✓ Explain that the nose contains sense receptors that send information to the brain to interpret odors.
- ✓ Design a solution to an engineering design problem.

Instructional Activities

- hands-on engineering design task
- discussion
- drawing, labeling, and writing

NGSS and CCSS References

LS1.D. Information Processing: Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.

ETS1.A. Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.

SL.4.1.D. Comprehension and Collaboration: Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.

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brain **receptor**

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constraint **criteria** **signature**

Instructional Resources

Activity Pages

AP 3.1

AP 3.2

Activity Pages
Identifying Odors (AP 3.1)
Design a Signature Scent (AP 3.2)

Materials and Equipment

Collect or prepare the following items:

- internet access and the means to project images/video for whole-class viewing
- vinegar
- vanilla extract
- almond extract
- several jars of ground spices, such as cinnamon, curry, turmeric, cardamon, allspice, and nutmeg
- 3 oz or smaller paper cups
- cotton balls
- markers

Advance Preparation:

Preview the recommended video for appropriateness for your class.

The food scent materials are suggestions that can be adjusted as needed. Set up all the materials in a central location (a "materials table") from which students will pick up and return materials for their small groups.

The Core Lesson

1. Focus attention and preview the investigation.

- Remind students that they read a story about Pearl Davis, who loved perfumes, in Chapter 1.
- Lead a brief discussion of how humans and other animals use their sense of smell to gather information. Have students identify the nose as the external structure for sensing odors in humans and other mammals. Explain that parts

Online Resources

inside the nose, called ***receptors***, send information to the **brain**, where the odor is identified or interpreted as familiar, unfamiliar, pleasant, or unpleasant.

- Show students a video about the functions of the nose, including smelling odors. Afterward, discuss the main points.

2. Facilitate the investigation.

- Have students wash their hands before handling and sharing science materials.

Part 1: Identifying Odors

- Divide the class into small groups of no more than five students each.
- Have one student from each group go to the materials table and select one food scent material, place a small amount at the bottom of a cup, and cover it with a few cotton balls. Then have them return to the group and allow the other students to pass around the cup and sniff it. Guide the small groups to discuss what they think the source of the odor could be.
- Ask: Did you have memories of similar odors? Did remembering help you identify the odor? (*yes, I remembered the last time I smelled that odor and where I was and what I was doing*)

After discussion, the student who chose the scent can reveal what it is to the group.

Part 2: Design Your Signature Scent

- Explain that a "signature" scent is one that people associate with a person. Present the engineering design problem to students: What combination of materials would make a good "signature" scent for a new perfume or cologne?
- Tell students that they may use only three of the several materials available on the science table. Point out that limitations on solutions, such as this one, are called *constraints* by engineers.
- Tell students that a new signature scent should have a pleasing odor to the student who made it and, hopefully, to other students. Point out that requirements of solutions, such as this one, are called *criteria* by engineers.
- Assign each student in a group a letter from A through E. Distribute a cup to each student and have them use a marker to write their letter on their cup.
- Call the A students to the materials table with their labeled cups and give them a couple of minutes to design their signature scents. Guide them to make a mixture of three spices in their cup, cover it with cotton balls, and return to their groups. Tell students to remember what they used. If needed, provide scrap paper that they can use to jot down the names of the spices. Repeat the process for students B–E. This will ensure that students cannot observe the materials their group members used.

  ALERT—Warn students not to taste the materials and to clean up spills if they occur.

- When all students have returned to their groups with their signature scents, have them place the cups in the center of the table and take turns smelling the scents. Distribute AP 3.2 and have them record their ranking of the scents in the table, with 1 being their least preferred and 5 their most preferred.

  EXTEND—Guide students to add up the scores each scent received in their group. If some students are dissatisfied with their score (other students, reactions to the scent), allow them to return to the materials table to make adjustments to the materials they used.

3. Summarize and discuss.

Part 1: Identifying Odors

- Ask: What body structures are needed for a human to recognize an odor or to compare odors? (*the nose, receptors inside the nose that send messages to the brain, and the brain*)
- Explain that the brain stores memories of a human's experiences, including what they have smelled in the past. Have students give examples of how memories of odors can guide them in deciding what to do next. Ask: What if you smelled the odor of burnt toast? What would you do? (*Sample answer: I would tell my parent to check the electric toaster and maybe unplug it for safety.*)
- Point out that other kinds of animals also have brains that store memories of odors. Invite students to brainstorm a list of animals reacting to specific odors. (*Sample answers: dogs smelling meat cooking might come into the kitchen; a mouse may be attracted to cheese; honeybees may find the flowers they like to drink nectar from*) Then have students review the brainstormed list of examples and elaborate on them.

Part 2: Design Your Signature Scent

- Invite students to summarize the signature scent problem they solved. Ask: How did my talking about the problem first help you understand it better? (*You gave details that we needed to know to come up with a good solution, such as what materials we could use.*) (See **Know the Standards**.)
- How did you test how well you solved the problem? (*by letting other students sniff my cup and rank the odor against the others at my table*)
- Have students wash their hands after disposing of or putting away the science materials.

Know the Standards

ETS1.A: Defining and Delimiting Engineering Problems Defining problems is one part of the engineering design process, which also includes developing solutions and optimizing those solutions. In grades 3–5, students should be able to identify several criteria for a successful solution, though in this activity there is only one—that the mixture smell good. Constraints on solutions may include cost, the kinds or numbers of materials that can be used, or time limits.

4. Check for understanding.

Activity Pages

AP 3.1

AP 3.2

- Distribute AP 3.1, and have students follow the directions to draw and label.
- Have students answer AP 3.2 questions 1–4.
- See the Activity Pages Answer Key for correct answers and sample student responses.

LESSON 3

Weather Watcher

At a Glance

Learning Objectives

- ✓ Identify different ways of making scientific observations.
- ✓ Explain how people can act like scientists.
- ✓ Describe how science affects everyday life.

Instructional Activities

- video clip
- teacher Read Aloud / Read Along
- class discussion
- vocabulary reinforcement

NGSS and CCSS References

NOS1. Scientific Investigations Use a Variety of Methods: Science investigations use a variety of methods, tools, and techniques.

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

NOS5. Science Is a Way of Knowing: Science is a way of knowing that is used by many people.

NOS7. Science Is a Human Endeavor: Science affects everyday life.

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

L.4.4.a. Vocabulary Acquisition and Use: Use context . . . as a clue to the meaning of a word or phrase.

L.4.4.b. Vocabulary Acquisition and Use: Use common, grade-appropriate Greek and Latin affixes and roots as clues to the meaning of a word.

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pattern **sound** **weather**

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air pressure **forecast** **meteorologist** **vibration**

Instructional Resource

Reader

Ch. 3

Reader, Chapter 3
"Weather Watcher"

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 purpose.

Online Resources

Talk to students about the weather today. Ask if any students checked the weather before getting dressed and coming to school. Discuss how the weather forecast may have determined their clothing choices or activities, such as riding a bike to school versus taking the bus.

Watch a short video introducing different types of weather and how to check the weather outside. While they are watching, encourage students to think about why it is important that people know the weather in advance. (See the Online Resources Guide for a link to a recommended video.)

2. Read and discuss: "Weather Watcher."

Reader

Ch. 3

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

Page 24

- Pause after the first paragraph. Ask students if they can predict what is going to happen to the water in the straw. (*The water will come pouring out of the straw if Dan lifts his finger off the straw.*)
- Lead a discussion analyzing the experiment shown here with the straw. Explain that when you put a straw in a cup of water and cover the top of the straw with your finger, you trap the air inside the straw. This trapped air creates pressure that pushes down on the water inside the straw. When you lift the straw out of the cup, the outside **air pressure** is stronger and pushes up on the water, keeping it inside the straw until you remove your finger. This demonstrates how air pressure can hold water in the straw.

  EXTEND—Encourage students to try this experiment with the straw and water either in the classroom or at home on their own.

Page 25

- Focus on the term ***weather***. Ask students if they think Dan finds weather interesting or not, and why. (*Dan is probably interested in weather because being outside is his favorite part of the day.*)
- What are some tools that scientists use to measure the weather outside? (*thermometers, wind/weather vanes*)

  SUPPORT—If there are any misconceptions about what weather is, clarify that weather happens all the time. Even if it is not raining or snowing or windy outside, weather is still happening all around us. The absence or presence of clouds in the sky is part of weather. So is the temperature outside.

Page 26

- What does it mean to **forecast** something? (*It means to predict or tell what will happen in the future.*)
- What do you think a **meteorologist** does? Break down the parts of the word for students. The word *meteorological* comes from the Greek root word *meteorologia,* or a study of things up high. The suffix *-ologist* means someone who studies a topic. (*A meteorologist is a scientist that studies weather and tells what the weather will be like.*) What did the meteorologist forecast the weather to be like on this day? (*The meteorologist forecast that there was a high chance of rain.*)
- Ask students to share any times they have seen or heard a weather forecast. Some examples may include on a smartphone, television, tablet computer, radio, or other smart device. Encourage students to tell whether they found it helpful to see or hear those forecasts.

  EXTEND—Stream a local weather report or show students a weather forecast on a smart device. Discuss what the meteorologists believe the weather will be for the day. Keep track of the weather that day to decide whether the forecasts were right or not.

Page 27

- Scientists use lots of tools when studying nature. Tools can be highly complex, but they can also be very basic. Some basic tools can include things like paper and pencils. Using paper and pencils to record and document information is an important way scientists learn more about the natural environment. (See **Know the Standards**.)
- What do you think Dan is trying to observe by studying the sky? (*He is trying to see if the weather is going to change or if it is going to rain*.)
- Draw students' attention to the pictures of the three types of clouds. Ask them which cloud looks like it is going to bring a rainstorm. (*the dark, cumulonimbus cloud*.)

Page 28

- How is Dan acting like a scientist? (*He is making observations of nature/weather.*)
- What does Dan do after he hears the thunder and sees the lightning, and why? (*He moves inside the house to be safe*.)
- Some scientists work out in the field, and their jobs can be dangerous! They need to take proper precautions to keep themselves safe, just like Dan does. What are some dangerous or risky things scientists might do? (*They might study active volcanoes, study big animals in the wild, chase tornadoes, handle hazardous materials, etc*.)

Page 29

- What tools are Dan and Lily using to observe the storm? (*their ears*)
- Before reading the final paragraph, ask: Do you think the storm is moving closer to them or farther away when there are fewer seconds counted between the sounds of thunder and flashes of lightning? (*closer to them*)
- Dan is recognizing a **pattern** in the weather. A pattern is something you see over and over again. What pattern is Dan noticing that leads him to believe that the storm is moving closer to them? (*that the seconds between thunder and lightning are getting shorter and shorter*)

Page 30

- What is Dan imagining himself to be in the picture at the bottom of the page? (*a meteorologist*)
- Do you think wind is weather? Why or why not? (*Yes, wind is weather because it moves air around*.)

EXTEND—Professional Profile! Have students research what it takes to become a meteorologist. What do meteorologists study in school? Prompt students to find out what skills meteorologists need to be good at. Then invite students to share their findings with the class.

Know the Standards

NOS2. Scientific Knowledge Is Based on Empirical Evidence There are many tools that scientists use to make observations and take measurements. Some tools that students might use as they begin exploring the world include timers, rulers or metersticks, measuring tapes, graphs, charts, calculators, magnifying glasses, microscopes, and drawing paper and utensils.

Page 31

- What does Dan compare a thunderstorm to? (*battles in the sky*)
- Have students look at the diagram on the page. Ask them what happens to the warm air during a thunderstorm. (*It rises.*)

  SUPPORT—Interpreting diagrams is a skill that takes practice. If necessary, walk through the diagram with students to help them understand what is happening between the cold and warm air to create a thunderstorm.

Page 32

- How does sound travel? (*through* ***vibrations***)
- Go through the examples of instruments that produce sound vibrations.
  - How does a piano create sound vibrations? (*Little hammers hit the keys.*)
  - How is sound made from a clarinet? (*Air vibrates the reed.*)
  - How do drums make sound? (*Drumsticks strike the drum.*)

  EXTEND—All instruments produce sound that travels by vibration. Assign students an instrument to research, or let them choose an instrument they find interesting. Have them find out how that instrument produces sound.

Page 33

- What are some different ways Dan acts like a scientist? (*He reads about weather, he listens to weather reports, he makes observations, and he wonders about the world.*)
- Do you think Dan will continue watching the weather after today? Why or why not? (*Yes, he is very interested in the weather. The text indicates that he will have more weather-watching quests.*)
- What does Dan consider weather to be like? (*a language*)

3. Connect to lived experience.

Invite students to share any details from the chapter that resemble someone or something familiar to them. Perhaps they know someone who checks the weather every morning, or perhaps they watch the weather report before they go to school. Ask students to tell details about the chapter that interested them most. And invite students to ask questions about details that might not have been clear to them.

Remind the class that everyone has experience with weather; this is a universal thing that all people share. Ask students if they have ever watched the weather like Dan did in the story. Do they find any particular part of the weather interesting?

Relate the story about weather watching to any weather events that have happened in your area. Perhaps your area gets snowstorms, hurricanes, floods, or even droughts. Talk about how the weather affected everyday life.

LESSON 4

Daniel Longhurst: Teaching Tomorrow's Scientists

At a Glance

Learning Objectives

✓ Define *physics*.

✓ Describe the use of science in different professions.

✓ Explain how heat pumps work.

Instructional Activities

- teacher Read Aloud / Read Along
- class discussion
- vocabulary reinforcement
- class demonstration

NGSS and CCSS References

NOS5. Science Is a Way of Knowing: Science is a way of knowing that is used by many people.

NOS7. Science Is a Human Endeavor: Science affects everyday life.

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

L.4.4.a. Vocabulary Acquisition and Use: Use context . . . as a clue to the meaning of a word or phrase.

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physics **thermodynamics**

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.

efficient

Instructional Resource

Reader

Ch. 4

Reader, Chapter 4
"Daniel Longhurst: Teaching Tomorrow's Scientists"

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
- plastic cup
- water
- straw

Advance Preparation

Set up a table with the plastic cup, water, and straw. Pour the water into the plastic cup. Keep the straw next to the cup.

The Core Lesson

1. Focus attention on the lesson purpose.

Remind the class that they just read a chapter about a boy who liked to do a science experiment to hold water inside a straw. Explain that you are going to demonstrate how this experiment works.

Draw student attention to the station you have already prepared. Stick the straw inside the cup of water. With the straw still submerged, cover the top of the straw with your finger. Then, withdraw the straw from the cup. Hold the straw up in the air for students to be able to see. Now take your finger off the straw and let the water pour back into the cup from the straw. If time permits, allow students to give this experiment a try.

Explain that when you put a straw in a cup of water and cover the top of the straw with your finger, you trap the air inside the straw. This trapped air creates pressure that pushes down on the water inside the straw. When you lift the straw out of the cup, the outside air pressure is stronger and pushes up on the water, keeping it inside the straw until you remove your finger. This demonstrates how air pressure can hold water in the straw.

2. Read and discuss: "Daniel Longhurst: Teaching Tomorrow's Scientists."

Reader

Ch. 4

Prepare to read together, or have students read independently, Chapter 4 "Daniel Longhurst: Teaching Tomorrow's Scientists." When reading aloud together as a class, instruct students to follow along. Pause for discussion using prompts and questions such as the following:

Page 34

- What is Daniel's profession? (*high school teacher*)
- What does Daniel teach? (*physics, astronomy, and sometimes math*)

  SUPPORT—Make sure students understand what ***physics*** is. Physics is the science that helps us understand how things move and work in the world around us. It explains why the sky is blue, how a ball bounces, why we don't float off the ground, and how electricity lights up our homes. Physics teaches us about forces, energy, and matter. It helps us understand everything from tiny atoms to huge planets and stars.

- Do you think Daniel uses science for his job? Why or why not? (*Yes, he uses science. He has to know about science in order to teach science concepts to students.*)

Page 35

- What are some ways Daniel acted like a scientist when he was younger? (*asking questions, doing experiments, studying insects*)
- Do you think Daniel's interest in weather as a young kid relates to what he does today? Why or why not? (*yes, because studying weather inspired him to want to learn more about science and now he teaches science to others*)

  SUPPORT—Some students may not see the connection between Daniel's interests in weather as a young kid and his job today. Clarify that Daniel's profession as a teacher relates to science and weather because he teaches science. He may not be a meteorologist who studies only weather, but he gets to teach so much more than just weather to kids.

Page 36

- What or who inspired Daniel to become a teacher? (*his high school chemistry teacher*)
- Besides science, what were some of Daniel's other interests? (*foreign languages and architecture*)

  SUPPORT—Students may not yet know what architecture is. Architecture is the art and science of designing and building places where people live, work, and play. Architects create plans for houses, schools, skyscrapers, and parks. They think about how buildings will look, how they will be strong and safe, and how they will be comfortable and useful for people.

  CHALLENGE—After making sure students know what an architect is and does, challenge them to think about how architecture uses science. Architects need to use a lot of math and fundamental physics concepts to know how they can build things.

Page 37

- What does Daniel believe when it comes to learning math? (*It is a tool for figuring things out, not just memorizing steps.*)
- Think about what you know about math and what you know about space. Why do you think math is especially important for studying space? (*It can help scientists figure out distances between plants, speed of orbits, temperatures of stars, and other data required to study space.*)

  EXTEND—When astronauts get ready to go up into space, math becomes their best friend! Scientists use math to figure out exactly how much food and water each astronaut needs to stay healthy and strong. They calculate the exact amount of calories and nutrients based on how long the trip will be and how many people are going. Math helps make sure there's enough food and water to last the entire journey and that everything fits perfectly inside the spaceship. Thanks to math, astronauts can have safe and exciting adventures among the stars! Have students plan a trip to space for one astronaut. Give them a weight limit for the trip, and provide the weights of the astronaut and different foods. Then students can create a meal plan for the astronaut for one day and share their ideas with the class.

Page 38

- What is the most important thing about Daniel's teaching philosophy? (*making connections*)
- What does Daniel hope students will be able to do with the scientific concepts they learn in his class? (*relate them to the world around them*) (See **Know the Standards**.)

  CHALLENGE—Challenge students to come up with examples of something they learn in science class that relates to the world around them.

Page 39

- What instruments did Daniel study throughout his life? (*piano, clarinet, saxophone*)
- How might Daniel's interest in music infuse his love for science? (*He could be curious about how music is made and how instruments make different sounds at different pitches and volumes. Studying sound is a part of science.*)

  SUPPORT—Explain to students that sound is everywhere and helps us connect with the world. Sound is an important part of science. Scientists study sound waves, or how sound travels. They also study how sound is used. For example, humans and animals use sound to communicate.

Page 40

- What scientific topic is Daniel really excited about? (*heat pumps*)
- Why are heat pumps getting a lot of attention lately? (*They are an efficient solution for heating and cooling homes.*)

Know the Standards

NOS5. Science Is a Way of Knowing Science is used by many people, even if they do not realize they are using science. Just the phenomenal fact that all things on Earth are bound to the planet by gravity—instead of floating away into space—is a way that science relates to our everyday life.

- Focus on the term ***efficient***. Explain to students that it means doing something in the best way possible without wasting time, effort, or resources.
- Lead a discussion about the idea of efficiency, or being efficient. Invite students to think about examples of something that is efficient. (*If you lay out your clothes and pack your backpack the night before, you're being efficient because it saves time in the morning*.) How can being efficient be helpful to you? (*It can help me do things quicker without wasting time, so I have more time for other things*.)

  EXTEND—Have students come up with one or two ways to make a task, process, or routine in their lives more efficient. Invite them to share their ideas with the class.

Page 41

- How does a heat pump work to heat up or cool your home? (*It moves heat from one place to another. A heat pump can bring heat up from below ground where there is no cold air.*)
- How does a heat pump work to cool your home? (*A heat pump can bring heat from inside the house to below ground*.)
- Draw student attention to the diagram on the page. Have students help interpret the diagram by asking them guiding questions. Do you think the blue pipes on the diagram indicate heating or cooling? (*cooling*) What do you think the red pipes on the diagram mean? (*heat*)
- What is the term for this process? (***thermodynamics***)

  EXTEND—In order for heat pumps to work efficiently, insulation is an important part of this technology. Insulation helps keep homes cooler or warmer. Have students conduct an investigation about insulation either in the class or at home on their own. First, they fill two identical containers with hot water. Then, they wrap each container with a different insulating material, such as a towel, foil, or bubble wrap. Students measure and record the temperature of the water in each container at regular intervals to see how quickly it cools down. The material that keeps the water warm the longest is the best insulator. This experiment demonstrates how insulation helps retain heat, similar to how a heat pump works to maintain temperatures in homes.

Page 42

- Who were the people in history that intrigued Daniel? (*Isaac Newton, Tycho Brahe, and Johannes Kepler*)
- How does Daniel use their scientific discoveries in his everyday job? (*Their discoveries form the foundation of the physics lessons that he teaches to students at school.*)
- What are some physics concepts or lessons that Daniel might teach to his students? If necessary, remind students that they just learned about what physics is and the kinds of things covered in physics. (*Daniel might teach his students about forces, energy, or matter*)

Page 43

- How does Daniel try to shape the future? (*by getting his students excited about science and encouraging them to think about how to solve problems*)
- In what way do teachers and engineers have similar roles? (*Being a teacher involves solving problems and helping others. This is a big part of engineering,*

too. Teachers design lessons to make learning fun and understandable, just like engineers design solutions to make things work better. Both use creativity, planning, and critical thinking to achieve their goals. Teachers build knowledge in students, while engineers build structures, machines, and systems.)

Page 44

- What kind of scientist was Tycho Brahe? (*astronomer*)
- How did Tycho Brahe contribute to the world of science? (*He built instruments for studying the sky, and he accurately measured the positions of stars and planets.*)

Page 45

- How did Johannes Kepler contribute to the world of science? (*He described the motion of planets around the sun, and he proposed that planets move in elliptical rather than circular orbits.*)
- What was Isaac Newton famous for? (*introducing the laws of motion and gravity*)
- What do Tycho Brahe, Johannes Kepler, and Isaac Newton all have in common? (*They were scientists, they studied physics, they made discoveries, and they needed to know math in order to do their jobs.*)

3. Connect to lived experience.

Invite students to share any details from the chapter that resemble someone or something familiar to them. Lead a discussion about the idea of inspiration. Ask students to share what inspires them. Some students may be inspired by their own dreams or goals. Others might be inspired by someone they know. Have they had someone in their life (e.g., a family member, teacher, friend, gym coach, etc.) that inspired them in some way?

Ask students to tell details about the chapter, or about Daniel's life, that interested them the most. Invite students to ask questions about details that might not have been clear to them.

Use Experience B to reinforce students' reflections of Chapters 3 and 4.

EXPERIENCE B

Forecast It

At a Glance

Learning Objectives

- ✓ Identify different things that make up the weather.
- ✓ Make a five-day forecast of the weather for a town.
- ✓ Prepare a weather presentation as a meteorologist.

Instructional Activities

- video clip
- hands-on activity
- presentation
- discussion
- vocabulary instruction

NGSS and CCSS References

NOS5. Science Is a Way of Knowing: Science is a way of knowing that is used by many people.

NOS7. Science Is a Human Endeavor: Science affects everyday life.

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forecast **weather**

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.

fictional **meteorologist**

Instructional Resources

Activity Pages

AP 4.1
AP 4.2

Activity Page
Forecast It (AP 4.1)
Weather Symbols (AP 4.2)

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
- large sheets of paper or poster board
- markers, crayons, or colored pencils
- tape or glue

Advance Preparation

Cut out the weather symbol cards from Weather Symbols (AP 1.2). You will need one set of cards for every student group.

THE CORE LESSON

1. Focus attention and preview the investigation.

Online Resources

Remind students that they read about a young boy who loved to watch the **weather** and then read about a science teacher named Daniel Longhurst.

Lead a short discussion on the weather today. Remind students that the weather changes all the time. There is always some kind of weather going on. Prompt students to think about if it is sunny, cloudy, rainy, snowy, windy, hot, or cold. Compare today's weather to yesterday's weather. **Ask:** Is today's weather the same as the weather from yesterday? Do you think today's weather will be the same as or different from the weather tomorrow?

Show students a national **forecast** map for the country. Briefly explain how a weather map is used to show different weather conditions in various regions. The map can be simple, like one that just shows the colors of temperatures ranging from purple to red. Lead a class discussion about what students notice on the map. What part of the country is having hotter temperatures? What part of the country is having cooler temperatures? Ask students how knowing this information can be helpful for the people who live in those areas. (See **Know the Standards**.)

Show students a video on a kid who wants to become a **meteorologist**. While they are watching, encourage students to think about what meteorologists do and why their jobs are important. (See the Online Resources Guide for a link to a recommended video.)

Tell students that in this experience, they will get to act like meteorologists and create weather forecasts for a local area.

2. Facilitate the investigation.

Activity Pages

AP 4.1

AP 4.2

Assign students into small groups, not larger than five students to a group. Distribute the following materials to each group: printed weather symbols from Weather Symbols (AP 4.2), large sheet of paper, markers/crayons/colored pencils, and tape/glue. Review with students the materials they have. Explain that each group will act like meteorologists. They will work together to come up with a five-day weather forecast for a **fictional** town.

Review the weather symbols. Make sure students understand the meaning of each weather symbol.

Distribute and review Forecast It (AP 4.1). Go over the directions for this hands-on activity and how to use the activity page. First, groups will work together to decide what the weather will be for each day of the week. Then students will individually complete the five-day weather table directly on their AP 4.1 sheet. Finally, students will use the information they record to design their posters using the weather symbols. Posters will be made using the large sheets of paper or poster board. At the end of class, students will act as meteorologists to give a presentation on their five-day forecast.

Circulate around the room as students work on their activities.

> **SUPPORT**—Remind students that forecasting something means telling what will very likely happen in the future. Forecasts aren't always 100 percent accurate. But they are based on information and data that help meteorologists figure out how the weather will continue or change.

Know the Standards

NOS7. Science Is a Human Endeavor Weather is an example of science that affects everyday life. Weather affects many different aspects of life, from figuring out how to dress to determining when to best plant vegetables for your garden. Weather can affect outdoor activities and sporting events. Extreme weather, like snowstorms, can even close down schools for the day!

As students complete the table with weather data, inform them that there is no right or wrong answer for the weather they choose to give their town. They are meant to come up with these data on their own. However, the weather needs to make scientific sense. For example, if the forecast on a given day is snowy, it does not make sense that the same day would also have hot temperatures. If it is snowing, the temperature needs to be cold.

For filling out the table on AP 4.1, students can put a checkmark or an X in the box if the weather applies to that day of the week. It is also acceptable for students to write the words "yes" or "no" in the table.

> **SUPPORT**—If necessary, help students complete the table for AP 4.1. Explain that the columns are separated by day of the week. Each day will have its own weather. The same weather can be repeated across multiple days if that's what students choose to do.
>
> **CHALLENGE**—To make this activity more challenging, assign each group a real town and have students research and study the typical weather in that town for this time of year. Groups will then make their five-day weather forecasts for their town that is based on real data and present their findings as meteorologists.
>
> **EXTEND**—In assigned groups, have students in the class track the weather for one week, Monday through Friday. Each group will record the weather for the day on a chart or table. At the end of the week, groups will use the data from the current week to help them predict what the weather will be like next week. Once they put together their five-day forecast for the following week, students present their findings to the class as meteorologists.

As students begin drawing the basic shapes of their towns on large sheets of paper, encourage them to be creative. Have them think about the shape of the state they live in compared to other states.

> **SUPPORT**—Remind students that towns, states, countries, and continents are all different shapes. There is no right or wrong way to draw this since students are coming up with fictional places. If necessary, show the class a map of the country and point out the various shapes of states.

As students begin to tape the weather symbols onto the posters of their towns, check that they are only putting on the weather symbols that apply to their weather report for Monday through Friday. Students do not need to use all of the weather symbols they were given.

Help students prepare for their forecast presentations. All posters will hang in the front of the class, and students will stand in front of their posters to give the forecast. Tell students that they will need to share the name of their town and what the weather will be on each given day. If there are five students in a group, each student can present the weather for one day. For smaller groups, students can forecast the weather for multiple days.

3. Summarize and discuss.

As each team presents its town and weather forecast for five days, hold a brief discussion at the end. Ask classmates to summarize the weather for that area based on the forecast.

> **CHALLENGE**—Challenge students to think about where in the country each team's fictional town could likely be located in real life. For example, if a team's town has a very snowy, cold forecast, their fictional town would likely be in the northern part of the country instead of in the southern states.

Ask guiding questions to help link details in the presentations back to the story they read about Dan the weather watcher. For example, how is forecasting the weather something that Dan may have enjoyed doing? (*Dan was really interested in weather and loved to watch weather reports and track storms. He would probably have enjoyed acting like a meteorologist because meteorologists track the weather for a living.*)

Have students make a connection back to what they read about Daniel Longhurst. For example, what do meteorologists and high school teachers have in common? (*They both present information to people. Meteorologists present information to viewers/listeners in the public. Teachers present information to students.*)

4. Check for understanding.

Activity Page

AP 4.1

- Have students summarize what they learned about forecasting the weather.
- Have students summarize what they learned about meteorologists.
- Review student tables on Forecast It (AP 4.1) and review their visual models to determine student understanding of the following concepts:
    - Weather always changes. It never stays exactly the same.
    - To forecast means to tell about something that will happen in the future.
    - Meteorologists forecast weather.

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

LESSON 5

Wings and Wonders

At a Glance

Learning Objectives

✓ Discuss tools that are used to watch birds in the wild.

✓ Identify techniques for watching animals in their habitat.

✓ Make a prediction about events in a story.

✓ Explain patterns that occur in nature.

Instructional Activities

- video clip
- teacher Read Aloud / Read Along
- class discussion
- vocabulary reinforcement

NGSS and CCSS References

NOS1. Scientific Investigations Use a Variety of Methods: 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.

NOS6. Scientific Knowledge Assumes an Order and Consistency in Natural Systems: Science assumes consistent patterns in natural systems.

NOS7. Science Is a Human Endeavor: Science affects everyday life.

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

L.4.4.a Vocabulary Acquisition and Use: Use sentence-level context as a clue to the meaning of a word or phrase.

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binoculars **habitat** **pattern** **scavenger**

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.

observe

Instructional Resource

Reader

Ch. 5

Reader, Chapter 5
"Wings and Wonders"

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 purpose.

Online Resources

Talk to students about what it's like to observe animals in their habitat. Ask whether students have ever observed animals in the wild, such as birds or squirrels in the trees, deer or raccoons on the ground, or even fish, jellyfish, or crabs in the ocean. Lead a brief discussion about how it takes careful observation and patience to watch animals in their habitat. Watch a short video introducing the idea of bird-watching to students. While they are watching, encourage them to think about the tools and techniques being used to watch birds in their habitat. What are some other kinds of tools scientists might use to study animals in the wild? (See the Online Resources Guide for a link to a recommended video: **www.coreknowledge.org/cksci-online-resources**)

2. Read and discuss: "Wings and Wonders."

Reader

Ch. 5

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

Page 46

- Talk about the setting of the story. Use clues from the text and the pictures. Where does it take place? Where is Kendrick? (*Kendrick is traveling in the United States with his parents.*)
- What did Kendrick discover on his trips? (*birds, insects, and mammals that he had never seen before in real life*)

Page 47

- What kind of bird did Kendrick discover in his travels? (*the scarlet tanager*)
- What is a distinctive feature of the scarlet tanager? (*The scarlet tanager is a bright-red bird.*)
- Lead a discussion about **habitats**. Remind students that a habitat is a natural home or environment where an animal or plant lives. Talk about some habitats of animals and give examples. (*A desert is a habitat for a cactus. The ocean is a habitat for a whale.*)

  EXTEND—Take students on a walk-and-talk outside the classroom. Walk around the school campus or playground. Have students look for and point out different plants and animals they see. As you walk, talk about what the students notice. Ask guiding questions like "What animals do you see?" "Where do you think this animal lives?" "What plants are growing here?" and "What do you think these plants need to grow?" Alternatively, you can assign students this extension activity to do on their own after school and have them write a summary of what they notice about animals, plants, and their habitats.

- How is Kendrick acting like a scientist? (*He is making observations of nature. He is studying birds. He is being curious.*)
- Scientists use different tools to make observations. What tools is Kendrick using to explore the birds outside? (***binoculars**, field guide book*) (See **Know the Standards**.)
- Kendrick is observing birds in their habitat. Is making an observation a scientific tool, or is it a technique? (*It's a technique.*)

Know the Standards

NOS1. Scientific Investigations Use a Variety of Methods Science investigations use a variety of methods, tools, and techniques. In this text, Kendrick's method of investigating birds is to observe them up close. The tools he uses are binoculars. Students saw people use binoculars to watch birds in the short video. Make a connection between the text and the video. Explain that binoculars are a very useful tool for studying nature.

Page 48

- What activities did Kendrick enjoy as a child that may have led to him becoming a scientist? (*watching birds, exploring in nature*)
- Discuss how as a child Kendrick was interested in birds. What do these birds all have in common? (*They fly; they have wings.*)
- Lead a discussion about **patterns** in nature. Explain that patterns are things that repeat themselves. (See **Know the Standards**.) Animal behaviors can occur in patterns. For example, at night, the birds go back to their nests. This is a behavioral pattern because it happens over and over again. What is another behavioral pattern of birds? (*They wake up in the morning and look for food; they make nests for their homes; they sing songs to communicate with one another.*)

Page 49

- Why does the idea of joining the Boy Scouts interest Kendrick? (*He can do things outdoors, study wildlife, and make friends.*)
- Ask students if they ever felt excited about something that was new to them. How did it make them feel? Did they find themselves thinking about it a lot?

3. Connect to lived experience.

Invite students to share any details from the chapter that resemble someone or something familiar to them. Ask students to tell details about the chapter that interested them most. Was there anything about Kendrick that they could relate to?

Invite students to ask questions about details that might not have been clear to them.

Use Experience C to reinforce students' reflections on the chapter.

Know the Standards

NOS2. Scientific Knowledge Is Based on Empirical Evidence Science findings are based on recognizing patterns. Many patterns exist in nature. Students can start to see patterns of animal behaviors or even plants by making observations about them.

EXPERIENCE C

Backyard Bingo

At a Glance

Learning Objectives

- ✓ Observe living things in nature.
- ✓ Use scientific tools and methods to study plants and animals.

Instructional Activities

- hands-on activity
- discussion

NGSS and CCSS References

NOS1. Scientific Investigations Use a Variety of Methods: Science investigations use a variety of methods, tools, and techniques.

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

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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method **tool**

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observe

Instructional Resource

Activity Page

AP 5

Activity Page
Backyard Bingo (AP 5)

Materials and Equipment

Collect or prepare the following items:

- markers or dot stickers
- magnifying glasses, binoculars (optional)

Advance Preparation

Print Backyard Bingo (AP 5) so each student has their own copy. Give students markers or dot stickers to use for their bingo cards.

The Core Lesson

1. Focus attention and preview the investigation.

Online Resources

Remind students that they read about Kendrick who loved to watch birds in his backyard. Kendrick was using a simple science **method** called observation. To **observe** means to look closely at something. Ask students to recall what tools Kendrick used during his outdoor exploration. (*binoculars and a field guide to birds of North America*)

Lead a short discussion on the many different kinds of **tools** that scientists use. Explain that sometimes, you can be a scientist just by looking at something with your plain eyes! Ask students how they think tools help scientists study nature. (See **Know the Standards**.)

Talk about how anyone can be a scientist! Even kids can be scientists by just going outside and exploring things in nature. Tell students that in this experience, they will get to act like scientists by going outdoors and playing a game that requires them to look closely for wildlife.

Know the Standards

NOS1. Scientific Investigations Use a Variety of Methods Scientists use a variety of tools to help them explore and understand the world around us. They use microscopes to look at tiny things that our eyes can't see, like the details of a leaf or the parts of an insect. Telescopes help scientists study the stars and planets far away in space. Binoculars are great for watching birds and other wildlife up close without disturbing them. Scientists also use magnifying glasses, test tubes, and thermometers to examine things up close, mix chemicals safely, and measure temperatures. These tools help scientists make amazing discoveries every day!

2. Facilitate the investigation.

Activity Page

AP 5

Distribute the markers or dot stickers as well as Backyard Bingo (AP 5), one copy for each student. Go over the directions for this hands-on activity. Explain that the class will go outside into the schoolyard and try to find the items on the AP 5 card. The goal is to get a line of marked squares. It can be a straight line going up and down (vertical), side to side (horizontal), or corner to corner (diagonal). Remember: the free space can be part of their line!

> **SUPPORT**—Students may not be familiar with playing bingo. Talk about the free space in the middle of the card. This is a square that says "Free Space." This square is already marked for students! They don't have to find anything for this one. Explain that the free space helps them get a bingo faster because it's like a free gift! Since it's already marked, they only need to find and mark four other squares in that row, column, or diagonal line.

Lead a quick discussion about good strategies for observing things in the wild. Talk about how it's important to be quiet so as to not disturb or scare away the wildlife. If your class has magnifying glasses or binoculars to use, bring these tools with you and encourage students to share them so everyone gets a turn to use at least one tool.

> **ALERT**—Remind students to never eat anything they find outside. Mushrooms and other plants may look like edible food, but students should never put objects in their mouths that they find outside, as items can be poisonous or contain pesticides.

When students find the objects in nature, tell them to mark the box on their bingo card with the marker or a dot sticker.

Circulate around the schoolyard where students are making their observations. Encourage the students to look high and low. They may need to get up close to plants and trees or bend down low into the grass or rocks to find their items. Prompt students to listen for clues in nature, such as bird calls or buzzing.

> **EXTENSION**—Give students a drawing pad and pencil. Have them focus on one item in nature, observe it, and draw it. Then, have them write about what they noticed. How did the item look? If it was alive, how did it behave?

As students complete their bingo cards, encourage other students to keep working on finding as many things in nature as they can.

3. Summarize and discuss.

Bring the class back inside the classroom and talk about these discussion points:

- Which items on the card were the easiest to find?
- Which items on the card were the hardest to find?
- Which items on the card were most commonly found among the students?
- Were there any items that could not be found?

- Do students notice any patterns about the items they saw outside?
- Did using tools like a magnifying glass or binoculars help them make observations? Why or why not?

Ask guiding questions to help link details in the student experience back to the story they read about Kendrick. For example, how is what we did today similar to what Kendrick did? (*We made observations like Kendrick did. We used tools like Kendrick did. We had to be quiet and patient to see what we were looking for.)*

4. Check for understanding.

Activity Page

AP 5

- Have students summarize what they learned about making observations in nature.
- Have students summarize what they learned about the tools scientists use to make observations.
- Review student bingo cards for Backyard Bingo (AP 5) to determine student understanding of how to play the game making observations in nature.

See the Activity Pages Answer Key for sample student responses.

LESSON 6

Kendrick Fowler: Buzzing over Wasps

At a Glance

Learning Objectives

✓ Define what an entomologist does.

✓ Identify tools used by entomologists.

✓ Describe the characteristics of a parasitoid wasp.

✓ Explain the importance of conservation.

Instructional Activities

- video clip
- teacher Read Aloud / Read Along
- class discussion
- vocabulary reinforcement

NGSS and CCSS References

NOS1. Scientific Investigations Use a Variety of Methods: Science investigations use a variety of methods, tools, and techniques.

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

NOS6. Scientific Knowledge Assumes an Order and Consistency in Natural Systems: Science assumes consistent patterns in natural systems.

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

L.4.4.a Vocabulary Acquisition and Use: Use sentence-level context as a clue to the meaning of a word or phrase.

L.4.4.b. Vocabulary Acquisition and Use: Use common, grade-appropriate Greek and Latin affixes and roots as clues to the meaning of a word.

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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biodiversity crisis **biogeography** **conservation biology** **dark taxa**

entomologist **mimicry**

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.

biodiversity **conservation** **economics** **elusive**

politics **survive**

Instructional Resource

Reader

Ch. 6

Reader, Chapter 6
"Kendrick Fowler: Buzzing over Wasps"

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 purpose.

Online Resources

Talk to students about different ways that people study insects. Some people go outside and study insects in the wild. Others might trap insects and bring them back to a science lab to study. You can even study some insects safely in your home!

Introduce students to the idea of an ant farm. Explain that having an ant farm is one example of how some people study ants inside instead of outdoors. An ant farm lets you see how ants behave, interact with each other, and build their tunnels.

Ask whether students have ever had or seen an ant farm. Watch a short video on an ant farm. While they are watching, encourage them to think about the behaviors of the ants. Do students think the ants would behave the same way if they were in the wild? (See the Online Resources Guide for a link to a recommended video: **www.coreknowledge.org/cksci-online-resources**)

2. Read and discuss: "Kendrick Fowler: Buzzing over Wasps."

Reader

Ch. 6

Prepare to read together, or have students read independently, Chapter 6 "Kendrick Fowler: Buzzing over Wasps." 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

- Talk about the meaning of the word ***entomologist***. What do entomologists do? (*study insects in their natural habitat, learn about insect behaviors, figure out how insects are good or bad for the environment, learn what the insects eat and what eats them*)
- What kinds of tools do you think entomologists use? (*microscopes*) Talk about why entomologists might need to use microscopes. How can these types of tools help them study insects? (*They let scientists look at insects really close up to study what they look like.*)

Page 51

- What kind of insects does Kendrick study? (*parasitoid wasps*)
- Lead a discussion about the characteristics of parasitoid wasps based on the text and on the picture on the page. (*They are so small you can barely see them, they don't bother people, and the wasps have wings and legs and antennae.*)

  CHALLENGE—Have students turn and talk with a partner about how the reproductive behaviors of parasitoid wasps help balance the insect universe by acting as "pest control." If necessary, draw students' attention to the picture on the page of the wasp on top of the caterpillar. Ask students to tell what the wasp is doing with the caterpillar. How does this help control the population of other insects out there?

Page 52

- Read the whole page. Ask students how colors help wasps **survive** in their environment. (*Certain colors make the wasps look like stinging wasps, which scares away predators and keeps them safe. Other colors help them easily hide from predators.*)
- Talk about **mimicry**. Ask students to describe it in their own words. (*Mimicry is when an animal mimics another, more dangerous animal to scare away its predators.*)
- The type of mimicry shown is known as Batesian mimicry.

Page 53

- Read the first paragraph. How does an entomologist like Kendrick spend his days? (*He observes parasitoid wasps and does research.*)
- What is Kendrick trying to find out by studying parasitoid wasps? (*He's trying to find out what role these wasps play in nature. Even though they are very small creatures, they may have an important impact on the environment.*)
- Why is Kendrick's work related to wasps important to the scientific community as well as other areas? (*His data can help scientists and farmers learn about new ways to protect crops without using harmful chemicals.*)

  EXTENSION—Have students research some alternative ways that people can protect crops from pests without using harmful chemicals. (*Farmers can use predatory insects that feed on pests, they can use crop rotation, and they can use physical barriers like covers or netting to prevent pests from getting the crops.*)

Page 54

- Kendrick uses different tools to study parasitoid wasps. Which tools are described on this page? (*nets with super fine mesh, small cages, aspirators, vials, Malaise traps*) (See **Know the Standards**.)
- Lead a brief discussion about each type of tool mentioned on the page. (*The nets help catch the wasps. The small cages let scientists study the wasps as they buzz around. Aspirators help suck wasps into vials. Malaise traps snag insects and put them into bottles.*)

Page 55

- Where are the mandibles on the dobsonfly? (*in front of its head, opposite the wings*) Point out that for male dobsonflies, the mandibles are not used as weapons but as a way to intimidate other dobsonflies and to grasp things. Female dobsonflies have smaller, stronger mandibles which can also deliver a painful bite.
- What is one challenge to observing dobsonflies? (*They are most active at night so you probably have to watch them in the dark.*)

Page 56

- Focus on the term ***biodiversity crisis***. Clarify the importance of biodiversity in an ecosystem. Biodiversity helps maintain a balance of plants and animals within an ecosystem. Focus on the term ***biodiversity crisis***. The biodiversity crisis is the decline in the variety of life on Earth. The crisis includes the loss of species, loss of diversity of life, and damage to ecosystems.
- What did Kendrick hope to accomplish by becoming a scientist? (*He wanted to learn how to keep nature safe and protect species from vanishing.*)

Online Resources

EXTENSION—Assign students an animal from the endangered species list to research, such as the mountain gorilla, Asian elephant, monarch butterfly, or California condor. Prompt students to find out what efforts scientists and other groups are making to try to protect these species.

(See the Online Resources Guide for a link to a recommended video: **www.coreknowledge.org/cksci-online-resources**)

Page 57

- Read the first sentence on the page and pause. Focus on the term ***conservation biology***. Ask students what they think *conservation biology* means. (*It means to protect nature and wildlife.*) Then read the second sentence and see if students guessed correctly.

Know the Standards

NOS1. Scientific Investigations Use a Variety of Methods: One of the techniques that Kendrick uses as a scientist is that of observation. He has tools that he needs to use in order to make his observations. Students can act like scientists by making observations about how things work as well as living and nonliving things in nature.

NOS2. Scientific Knowledge Is Based on Empirical Evidence: Scientists use tools and technologies to make accurate measurements and observations. The tools that Kendrick and other entomologists use are designed to facilitate observations of insects in a safe way.

Page 58

SUPPORT—Students may not yet be familiar with the ideas of **politics** and **economics**. Help clarify the meaning of these terms to students before expecting them to answer the questions for this page. Explain to students that politics is about how people make decisions together about what rules we should have, how we should live, and how we can solve problems in our communities and countries. Then explain that economics is about how we make, buy, sell, and use things every day.

- How was a non-science college class like political economy related to Kendrick's studies? (*The political economy course looked about how decisions are made that can affect the environment.*)
- Why is Adirondack Park a good example of political economy and conservation biology? (*The government had to protect the park from dirtying the water supply, which in turn helped protect the environment. The government had to focus on what was important to the people in the community, their health.*)

Page 59

- What is **dark taxa**? (*groups of living things that scientists have not studied much yet*) Clarify for students that dark taxa can apply to many types of species, not just insects, such as plants, microorganisms, marine animals, and even fossils.
- Why does Kendrick think it is important to study dark taxa? (*It helps us better understand how ecosystems work.*)

CHALLENGE—Focus on marine species that are considered dark taxa. Many of these are deep-sea creatures. Challenge students to think about why scientists have not studied these species well. (*Scientists may not be able to get to these deep parts of the ocean to study them.*)

Page 60

- Who was Kendrick inspired by? (*Alexander von Humboldt*)
- What notable contributions did Alexander von Humboldt make to science? (*He helped develop the idea of biogeography.*) Talk about **biogeography** before reading the rest of the paragraph. Break the term into two parts "bio-" and "geography." See if students can guess what this word means in science. (See **Know the Standards.**)

Page 61

- What did Alexander von Humboldt discover? (*fossils and new species of living animals*)
- Can you still be a scientist even if you don't discover something new? (*Yes, being a scientist is about studying how things work in nature. You can learn things without making new discoveries.*)

Know the Standards

L.4.4.b. Vocabulary Acquisition and Use: Use common, grade-appropriate Greek and Latin affixes and roots as clues to the meaning of a word. Break the term *biogeography* into two parts. *Bio* means living things and *geography* is the study of places. So biogeography means to study where living things are located on the planet.

EXPERIENCE D

Masters of Disguise

At a Glance

Learning Objectives

✓ Describe how animals use mimicry to survive.

✓ Conduct research on animal behaviors.

Instructional Activities

- video clip
- hands-on activity
- discussion

NGSS and CCSS References

NOS1. Scientific Investigations Use a Variety of Methods: Science investigations use a variety of methods, tools, and techniques.

NOS1. Science Is a Way of Knowing: Science is a way of knowing that is used by many people.

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mimicry

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disguise **observe** **predator** **survive**

Instructional Resource

Activity Page

AP 6

Activity Page
Masters of Disguise (AP 6)

Materials and Equipment

Collect or prepare the following items:

- list of animals that use mimicry on index cards
- computers/tablets
- research materials or encyclopedias

Advance Preparation

Print Masters of Disguise (AP 6) so each student has their own copy. Prepare a list of animals that use mimicry to survive, such as owl butterflies, viceroy butterflies, hoverflies, ladybird spiders, and scarlet king snakes. Write the names of the animals on index cards, one animal per card. Make sure you have enough animals for the number of student groups.

If your classroom has computers or tablets, prepare them so student groups can conduct research on their assigned animals. If your classroom is not equipped with computers or tablets, schedule time for the students to work at the school computer lab or library.

The Core Lesson

1. Focus attention and preview the investigation.

Online Resources

Remind students that they read about Kendrick, an entomologist who studies parasitoid wasps. He likes to **observe** them in the wild and in science labs, which means he looks closely at them to learn more about their behaviors.

Talk about how parasitoid wasps are one animal of many that use **mimicry** to **survive** in their environments. Show a video of an octopus that uses mimicry to look like other animals in the ocean. As students watch, have them think about how this behavior helps the octopus survive. Ask students to name the different colors or shapes that the octopus can turn itself into. (See the Online Resources Guide for a link to a recommended video: **www.coreknowledge.org/cksci-online-resources**)

Explain that today students will work in groups to learn more about how other animals use mimicry to protect themselves from **predators** by tricking predators so they stay off their menu.

2. Facilitate the investigation.

Activity Page

AP 6

Assign students to work in small teams. Distribute Masters of Disguise (AP 6), one copy for each student. Then, pass out the name of the animal that students will research, one index card per animal for each team.

Go over the directions for this hands-on activity. Explain that teams will work together to research the animal they were assigned. They can use computers, tablets, or other research materials to learn more about their animals. The focus is on how the animal uses mimicry to survive in its environment.

Tell students to work through the activity page. Each student will need to complete their own worksheet.

> **SUPPORT**—Remind students of the difference between camouflage and mimicry. Some animals use camouflage and mimicry; others just use mimicry or just use camouflage.

Circulate around the room as teams conduct their research. Encourage equal participation from all team members.

> **EXTENSION**—Have students put together visual presentations of their animal. They can create posters with pictures that show how their animal uses mimicry to imitate other animals in order to stay safe from predators. Students who participate in this extension activity should still turn in their completed AP 6.

3. Summarize and discuss.

Have the teams break to reform a full class and talk about these discussion points:

- What animals use mimicry?
- What is each animal trying to mimic?
- Do the animals use mimicry to look like other animals or to look like plants? Or both?
- Do the animals use mimicry to hide from predators or to hunt prey?

Ask guiding questions to help link details in the student experience back to the story they read about Kendrick the wasp entomologist. For example, how is what we did today similar to what Kendrick does for work? (*We learned about animals that use mimicry, and Kendrick studies parasitoid wasps, which also use mimicry.*)

4. Check for understanding.

Activity Page

AP 6

- Have students summarize what they learned about mimicry.
- Review student worksheets for Masters of Disguise (AP 6) to determine student understanding of mimicry.

See the Activity Pages Answer Key for sample student responses.

EXPERIENCE E

Yellow Pan Trap

At a Glance

Learning Objectives

- ✓ Build a yellow pan trap.
- ✓ Investigate insects that are attracted to the yellow pan trap.
- ✓ Use tools for scientific investigations.
- ✓ Record observations of insects.

Instructional Activities

- hands-on activity
- observation
- discussion

NGSS and CCSS References

NOS1. Scientific Investigations Use a Variety of Methods: Science investigations use a variety of methods, tools, and techniques.

NOS5. Science Is a Way of Knowing: Science is a way of knowing that is used by many people.

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yellow pan trap

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tool

Instructional Resource

Activity Page

AP 7

Activity Page
Yellow Pan Trap (AP 7)

Materials and Equipment

Collect or prepare the following items:

Day 1:

- internet access and the means to project images/video for whole-class viewing
- yellow bowls or pans (1 per group)
- large jug of water
- disposable cups (1 per group)
- dish soap
- wooden craft stick (1 per group)
- permanent marker (1 per group)
- yellow paint (optional)
- paintbrush (optional)

Day 2:

- large tray
- fine mesh strainer (1 per group)
- clear collection jars or vials (1 per group)
- disposable cups (1 per group)
- isopropyl alcohol
- magnifying glass or microscope
- tweezers (1 per group)
- gloves (1 per student)
- goggles (1 per student)
- masking tape
- permanent marker (1 per group)

Advance Preparation

Prepare for this activity to span two class days.

Print Yellow Pan Trap (AP 7) so each student has their own copy.

Select a good location for students to place their yellow pan traps. They will need to leave the traps there for twenty-four hours. You may need to let your school maintenance or facilities manager know that you are leaving yellow bowls around the yard so that the bowls are not thrown out.

If you are unable to find yellow bowls or pans, you can paint white ones with yellow paint. Just make sure it's a bright, solid yellow color and give them enough time to dry before the investigation.

1. Focus attention and preview the investigation.

Online Resources

Remind students that they have been reading and talking about the idea of studying insects. One of the ways scientists study flying insects is by trapping them in what's called a **yellow pan trap**. This is a special **tool** entomologists use to learn more about insects like parasitoid wasps.

Show students a video on how a yellow pan trap is made and how it works. While they are watching, have them pay special attention to the steps for using a yellow pan trap. (See the Online Resources Guide for a link to a recommended video: **www.coreknowledge.org/cksci-online-resources**)

Explain that today students will work in groups to make their own yellow pan traps to see if they are able to catch any insects.

2. Facilitate the investigation.

Activity Page

AP 7

Day 1:

Assign students to work in small teams. Distribute Yellow Pan Trap (AP 7), one copy for each student.

Go over the directions for this hands-on activity. Explain that teams will work together to set out a yellow pan trap somewhere in the schoolyard. Then, they will wait twenty-four hours and check their pans to see if they collected any insects.

Tell students they will follow the steps on the activity page, starting with writing their names on the bottom or side of the bowl with the marker.

Pass out the following materials to each team:

- 1 wooden craft stick
- 1 bowl
- 1 disposable cup
- 1 permanent marker

Lead the class outside, with students carrying their materials and activity pages. Show students where they can set their pans. Encourage teams to spread out to cover different areas of the yard.

Circulate around the schoolyard as teams set up their yellow pan traps. Encourage equal participation from all team members. Make sure students are following the steps in order. When students are ready to add water to their bowls, they must pour the water from the water jug into their cups. Clarify that when it is time for them to add dish soap to the bowls, they will have to take turns sharing the bottle of dish soap so all teams can use it.

SUPPORT—Remind students that they should only use a little bit of dish soap and avoid mixing the soap too vigorously with the water because they don't want to make bubbles.

When the teams have finished setting their traps, remind them to take note of where their pan is located so they can come back to check it the following day.

Day 2:

Lead the class outside to check their yellow pan traps. Bring along a large tray so you can carry the traps back to the classroom without spilling them.

See whether any of the traps caught some insects! If any of the traps did not catch insects, dispose of the soapy water and trap, and assign the students from that team to another team that did catch insects so they can still participate in Day 2's activities.

Carefully carry the traps back to the classroom without spilling the water. Once students are back in the classroom, have them sit with their teams or new teams.

Distribute the following items to each team:

- 1 fine mesh strainer
- 1 clear container or vial
- 1 disposable cup
- gloves for each student
- goggles for each student

Tell students to review the Day 2 section of their activity page worksheets (AP 7). Explain that today they will take a closer look at the insects they caught in their yellow pan traps. Prompt students to follow the steps in the Day 2 section, and make sure they are aware that the second page is where they will record their observations.

ALERT—Ensure safety protocols by checking that all students are wearing their gloves and goggles. When dealing with insects and chemical solutions like alcohol, it is best to avoid getting this on students' skin or in their eyes. Remind students of safe behaviors when doing lab work, such as not running, pushing, or splashing solutions around. Remind students to report any incidents, such as broken glass, immediately if they occur.

Circulate around the room and ensure students are all getting a chance to participate. When students are ready to pour the alcohol into their containers/vials, go around the room and pour the alcohol into their cups. Students will then pour the alcohol from their cups into their specimen containers.

Student teams will then need the following materials:

- tweezers
- magnifying glass or microscope
- masking tape
- permanent marker

If you do not have enough tweezers and magnifying glasses/microscopes for each team, help the teams share these tools.

> **EXTENSION**—Have students try to find the scientific name of the insect they caught rather than just calling it an "ant" or a "fly." Encourage students to get as specific as they can. Students can use computers, tablets, or other research materials to look their insects up.

When teams are done inspecting their specimens, make sure they have labeled their containers/vials with tape so they know which one is theirs. Students can keep these vials in the classroom or science lab and return to them for future science projects if appropriate, or the containers or their contents can be discarded.

Prompt students to work on recording their observations as they inspect the insects rather than waiting until the very end of class to round up their observations.

3. Summarize and discuss.

Talk about these discussion points:

- What kinds of insects did students catch in their traps?
- What was the most common insect caught in the traps?
- What do the insects have in common?
- What can you learn about the insects by using this type of trap?

Ask guiding questions to help link details in the student experience back to the story they read about Kendrick, the wasp entomologist. For example, how is what we did today similar to what Kendrick does for work? (*We used yellow pan traps, which is a tool entomologists use to study insects.*)

4. Check for understanding.

Activity Page

AP 7

- Have students summarize what they learned about using entomology tools, like the yellow pan trap.
- Review student worksheets for Yellow Pan Trap (AP 7) to determine student understanding.

See the Activity Pages Answer Key for sample student responses.

GRADE 4

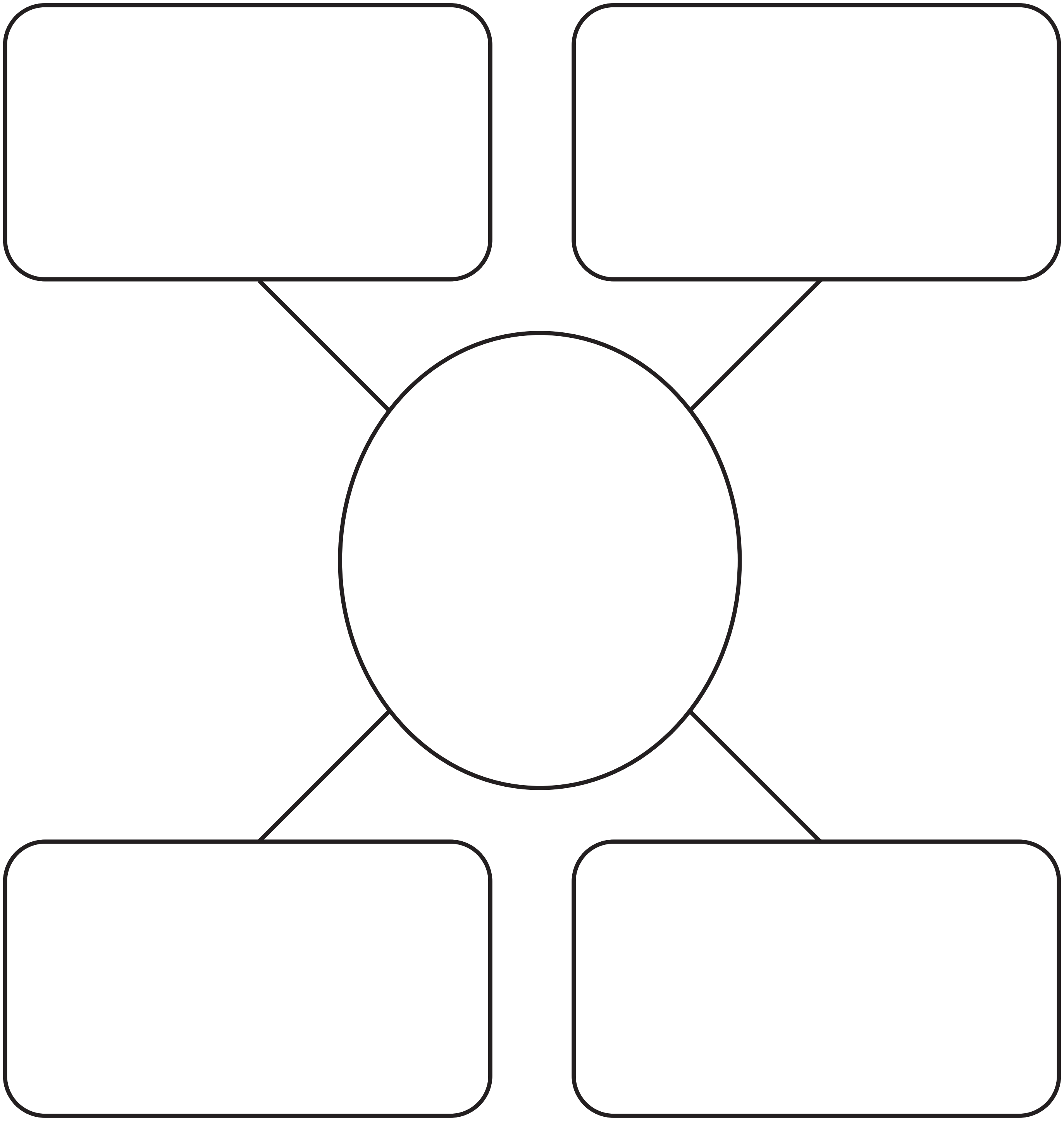
Teacher Resources

Name ______________________________ Date ____________________

Activity Page 1 Use with Lesson 1

Character Traits Diagram

Draw a picture of Pearl in the oval. In each of the rectangles, write an adjective that describes her personality and where in the story she showed it.



Name ______________________ Date ______________

Activity Page 2 Use with Lesson 2

Picture Yourself in a STEM Career

Of course, you don't have to choose now. But thinking about your future is always a good idea. Complete the table using details from the chapter.

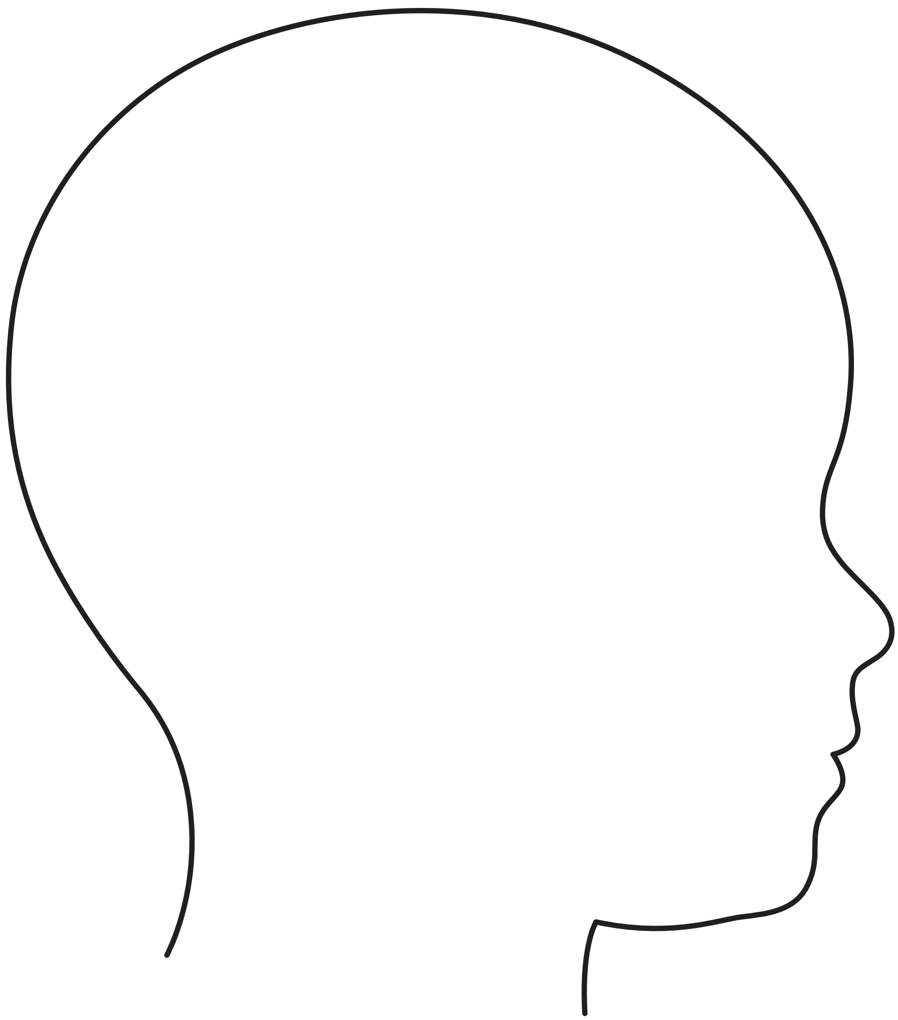
STEM careers discussed in this chapter	My favorite three (number 1, 2, or 3)	What I like about each of my three choices

Name ______________________________ Date ____________________

Activity Page 3.1 Use with Experience A Part 1

Identifying Odors

Draw details on the head and write labels to explain how humans identify odors.



Name ______________________________ Date ____________________

Design a Signature Scent

Most people who wear scents have a favorite. This is what is known as a "signature" scent. Rank the scents your group made from 1 to 5.

	Cup A	Cup B	Cup C	Cup D	Cup E
Rank: From 1 (low) to 5 (best)					

Answer the questions to explain how you solved the problem.

1. What problem were you trying to solve?

____

____

2. What factors limited (constraints) your possible solutions?

____

____

3. What were the requirements (criteria) for a good solution?

____

____

4. What three materials did you use for your signature scent?

____

____

Name ______________________________ Date ____________________

Activity Page 4.1 Use with Experience B

Forecast It

With your team, decide on a weather forecast for your town for Monday through Friday. Complete the chart below to record the weather for each day of the week. Place an X in the box for each day if the weather applies. Then follow the instructions below for making your weather map forecast.

	Monday	Tuesday	Wednesday	Thursday	Friday
Sunny					
Windy					
Rainy					
Snowy					
Hot temperatures					
Cold temperatures					

Name ______________________________ Date ____________________

Making Your Poster

Follow the instructions to make your weather poster.

1. On your large sheet of paper or poster board, draw a basic shape of what you want your fictional town to look like.

2. Give your town a name!

3. Now it's time to decorate your town. Draw any landmarks your town has or geographical features, like mountains, forests, lakes, or rivers. Be creative!

4. Use tape or glue to attach your weather symbols to the map you drew of your town. Use only the weather symbols that apply to your town's weather for the five-day week based on your table on the previous page.

5. Prepare a presentation. Each person on your team will get to act as a meteorologist and talk about the weather for a certain day. For your presentation, prepare to do the following:

    a. Introduce your town and tell the class its name.

    b. Tell the class what day of the week you are presenting on. Example, "For Monday, the weather will be . . ."

    c. Describe what the weather will be like for that day. Include any precipitation, sun, clouds, wind, and temperature.

    d. While talking, point to the map of your town and show classmates the weather symbols that go with your forecast.

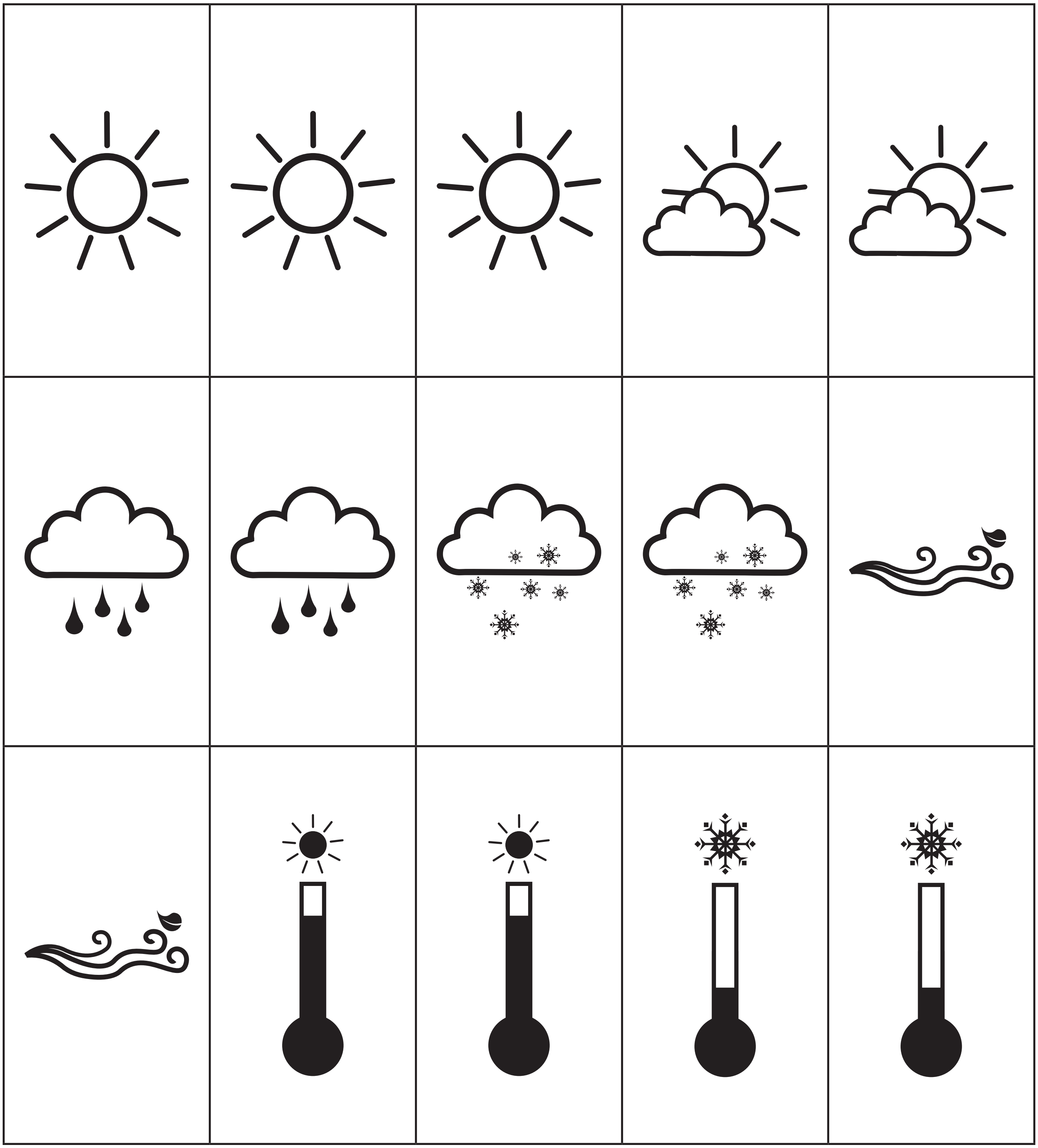
    e. Repeat this for all five days.

Name ______________________________ Date ________________

Activity Page 4.2 Use with Experience B

Weather Symbols

Print enough copies of this page so each team of students receives a set of weather symbol cards. Cut out the weather symbol cards.

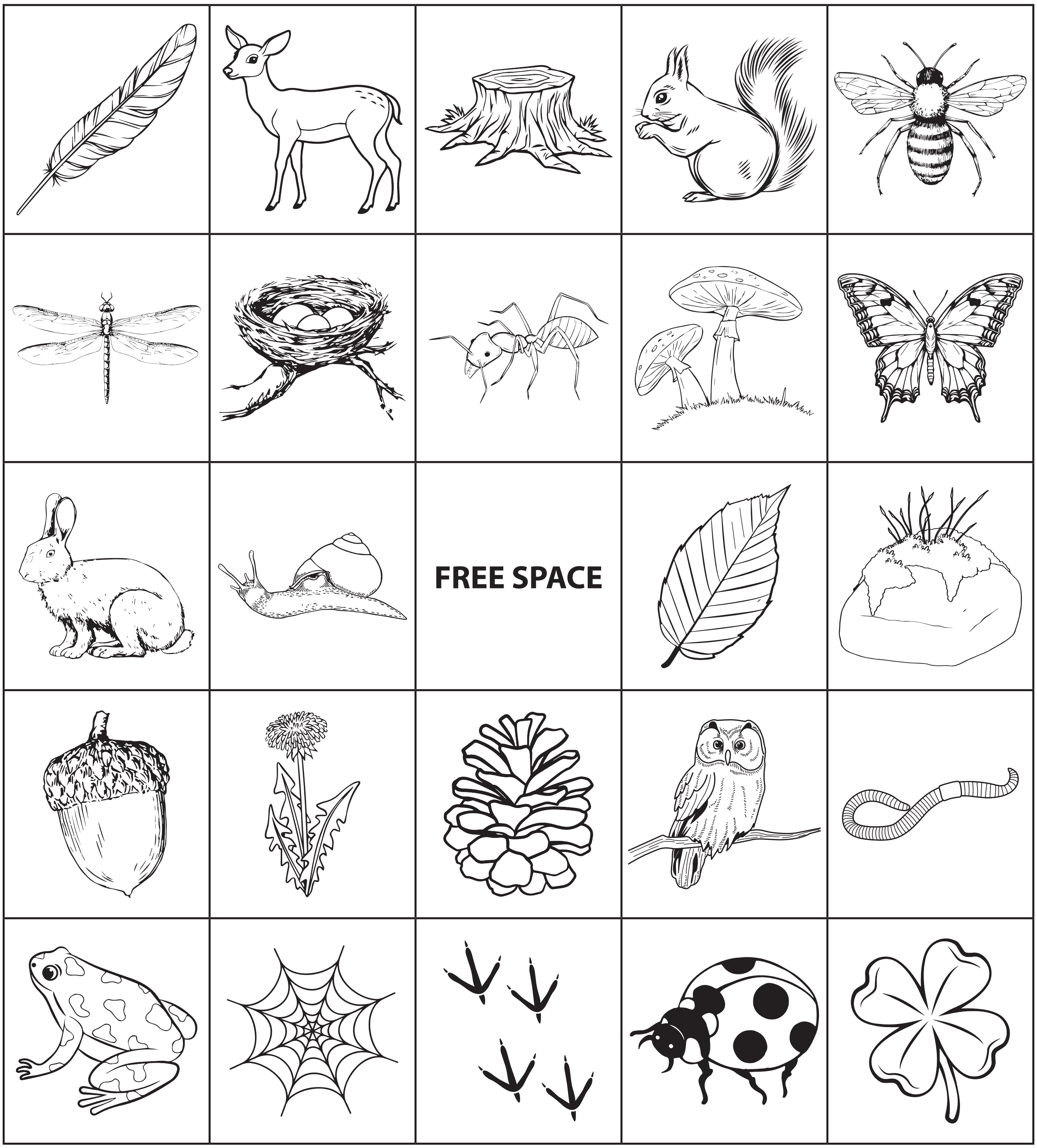


Name ____________________ Date ____________

Activity Page 5 Use with Experience C

Backyard Bingo

Find the objects in nature shown on the bingo card. Each time you find something outside, mark it on the card with a marker or dot sticker.



Name ________________________ Date ______________

Activity Page 6 Use with Experience D

Masters of Disguise

Research information about the animal your team is assigned. Complete the questions on this worksheet.

1. What animal are you researching?

____

2. Does the animal use mimicry to look like another animal, a plant, or both?

____

3. What animal (or plant) is your animal trying to look like?

____

4. What specific behavior does your animal do to mimic that animal (or plant)?

____

5. Does the animal use mimicry to hide from predators, hunt prey, or both?

____

6. Do you think mimicry helps your animal survive? Why or why not?

____

Draw a picture of the animal your team researched.

Name ______________________________ Date ____________________

Activity Page 7 Use with Experience E

Yellow Pan Trap

Day 1: Follow the steps below to set up a yellow pan trap.

1. With your team, find a good location for your trap.
2. Place the yellow bowl or tray on the ground. Make sure the surface is flat. You may need to move away rubble, pebbles, or some grass to make it level.
3. Pour water from the water jug into your disposable cup. Then pour the water from your cup into the trap.
4. Drizzle a small amount of dish soap into the water in your trap.
5. Use a wooden craft stick to *gently* stir the soap into the water. Avoid making too many bubbles.
6. Leave the trap for twenty-four hours.

Day 2: Follow the steps below to collect the specimens from the trap. Make sure to protect yourself and follow safety guidelines by wearing gloves and goggles!

1. Find and collect your pan trap. Visually inspect it to see if you caught any insects!
2. Place your trap on the teacher's tray. Once back in the classroom, bring your trap to your workstation.
3. Write your names on a piece of masking tape with the marker, and place the tape on the container or vial.
4. Use a fine mesh strainer to scoop up the insects from your trap.
5. Carefully pour the insects into a container or vial.
6. Pour the alcohol from your disposable cup into the container or vial.
7. Use tweezers to gently pick insects out of the container or vial. Inspect them under a magnifying glass or microscope.
8. Record your observations of the insects on the next page.

Name ______________________________ Date ____________________

Activity Page 7 *(continued)* Use with Experience E

Yellow Pan Trap

Record your observations of the insects below.

What insects did you trap and observe?

____

Describe one or more of the insects. Include details about its physical appearance, such as size, color, shape, and body features.

____

Draw a picture of one insect you observed.

Activity Pages Answer Key

This answer key offers guidance to help you assess your students' learning progress. Here you will find descriptions of the expectations and correct answers for each activity page of this unit.

Character Traits Diagram (AP 1)
(page 68)

Students should draw Pearl in the center oval and use the rectangle to note a character trait and an example of how that trait is expressed.

Picture Yourself in a STEM Career (AP 2)
(page 69)

Students should list careers from the chapter such as science teacher, plant scientist, robotics engineer, digital designer, statistician, medical doctor, researcher, eye surgeon, and inventor. Students should rank their top three and note what they like about each profession.

Identifying Odors (AP 3.1)
(page 70)

Students should note that particles enter the brain, receptors inside the nose connect to the brain, and the brain remembers what the odor is.

Design a Signature Scent (AP 3.2)
(page 71)

Students should note that the problem they are trying to solve is to develop a signature scent. Constraints include the limited number of materials and people's different experiences with scents. The criteria is having a pleasant odor. Students should list the three materials they used.

Forecast It (AP 4.1)
(page 72)

Students should complete the weather forecast table as well as the town map. During their presentations, students should meet each criterion found in the Making Your Poster section of the activity.

Backyard Bingo (AP 5)
(page 75)

Students should mark any items on the bingo sheet they find. In the event that no one completes a line, have students count up the number of items they found.

Masters of Disguise (AP 6)
(page 76)

Students should identify the animal they are researching, describe the organism it is mimicking, and describe any behaviors that help with mimicry. Students should also note if the mimicry helps them hide, hunt, or perform both behaviors.

Yellow Pan Trap (AP 7)
(page 77)

Students follow the directions for setting up the yellow pan trap. Students should observe the insect after trapping and record what the insect was and what it looked like.

Glossary

Orange words and phrases are Core Vocabulary for the unit. **Boldface words and phrases** are additional vocabulary terms related to the unit that you should model for students during instruction. Many of these also appear in the Reader. Vocabulary words are not intended for use in isolated drill or memorization.

A

air pressure, n. the force of air pushing down on a surface

B

binoculars, n. handheld tool for viewing objects at a distance with both eyes

biodiversity, n. variety of life in an ecosystem or habitat

biodiversity crisis, b. the crisis brought about by the loss of species, loss of genetic diversity, and loss of ecosystems

biogeography, n. branch of biology that deals with the geographical distribution of living organisms

brain, n. a body part located inside the skull and that is the control center for the entire body

C

conservation, n. preservation and careful management of the environment

conservation biology, b. the discipline focused on protecting the biodiversity of Earth's species and natural resources

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

criteria, n. requirements against which a design or performance is judged

D

dark taxa, n. groups of insects that scientists have not studied much

deductive reasoning, n. process of reaching a valid conclusion from the evidence

digital, adj. describing information within electronic devices that is composed of binary data

disguise, n. means to give something a different appearance

diverse, adj. having a great deal of variety

dwarf planet, n. an object in space which moves around the sun but not other planets, has a round shape, and produces enough force to clear away other objects around it

E

economics, n. study of the production, use, and transfer of wealth

efficient, adj. being productive with little waste of effort or materials

elusive, adj. hard to find, catch, or achieve

engineer, n. a person who uses science to design solutions to problems, especially by constructing tools or devices (v. to design and build)

entomologist, n. person who studies insects

F

fictional, adj. related to things that happen in fiction

force, n. a push or pull that can change the motion of an object

forecast, n. prediction or estimate of a future event

forecast, v. to predict or estimate a future event

H

habitat, n. home or environment where a living organism normally lives

horizon, n. the farthest visible place on land, where the outline of the land meets the sky

host, n. animal or plant on or in which another animal or plant lives

M

meteorologist, n. person who studies the weather

method, n. the way that data are gathered

mimicry, n. imitating another thing

O

observe, v. to notice or watch something

orbit, n. the path of an object around a star, planet, or moon

P

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

pharmaceutical, adj. related to medicinal drugs

physics, n. branch of science that studies the nature and properties of matter and energy

planet, n. a large body that revolves around the sun in the solar system, or a similar object orbiting a different star

politics, n. activities related to the governing of people and places

predator, n. an animal that naturally preys on others

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

R

receptor, n. an organ or cell which responds to stimuli and sends a signal to the brain

S

scavenger, n. animal that feeds on dead plants, dead animals, and refuse

scientist, n. a person who investigates using scientific methodology

signature, adj. something related closely with a person or thing

solar system, n. a system of objects in space that includes at least one star, planets, their moons, asteroids, comets, and other space debris

sound, n. form of energy that comes from an object vibrating

STEM, adj. an interdisciplinary approach to education and learning which encompasses the disciplines of Science, Technology, Engineering, and Math

survive, v. to continue to live or exist

T

thermodynamics, n. branch of science that studies the relationship between heat and other forms of energy

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

U

university, n. an institute of higher learning after high school

V

vibration, n. back-and-forth movement of particles

W

weather, n. state of the atmosphere in an area at a specific time

Y

yellow pan trap, n. shallow bowl filled with water and soap to catch, kill, and preserve insects

Classroom Safety for Activities and Demonstrations

In the Core Knowledge Science program (CKSci), activities and demonstrations are a vital part of the curriculum and provide students with active engagement related to the lesson content. The activities and demonstrations in this unit have been selected and designed to engage students in a safe manner. The activities and demonstrations make use of materials and equipment that are typically deemed classroom safe and readily available.

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

- Report and treat any injuries immediately.
- Check equipment prior to usage, and make sure everything is clean and ready for use.
- Clean up spills or broken equipment immediately using the appropriate tools.
- Monitor student behavior to ensure they are following proper classroom and activity procedures.
- Do not touch your eyes, ears, face, or mouth while engaging in an activity or demonstration.
- Review each step of the lesson to determine if there are any safety measures or materials necessary in advance.
- Wear personal protective equipment (e.g., safety goggles, aprons, etc.) as appropriate.
- Check for allergies to latex and other materials that students may have, and take appropriate measures.
- Secure loose clothing, hair, or jewelry.
- Establish storage and disposal procedures for chemicals as per their Safety Data Sheet (SDS), including household substances such as vinegar and baking soda.

Copy and distribute the Student Safety Contract, found on the next page. Have a read-along, and have students agree to the expectations for students when engaged in science activities prior to the start of the first unit.

Online Resources

For additional support for safety in the science classroom, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Student Safety Contract

When doing science activities, I will do the following:

- Report spills, breakages, or injuries to the teacher right away.
- Listen to the teacher for special instructions and safety directions. If I have questions, I will ask the teacher.
- Avoid eating or drinking anything during the activity unless told to by my teacher.
- Review the steps of the activity before I begin. If I have questions, I will ask the teacher.
- Wear safety goggles when working with liquids or things that can fly into my eyes.
- Be careful around electric appliances and unplug them, just by pulling on the plug, when a teacher is supervising.
- Keep my hands dry when using tools and devices that use electricity.
- Be careful to use safety equipment like gloves or tongs when handling materials that may be hot.
- Know when a hot plate is on or off and let it cool before touching it.
- Roll or push up long sleeves, keep my hair tied back, and secure any jewelry I am wearing.
- Return unused materials to the teacher.
- Clean up my area after the activity and wash my hands.
- Treat all living things and the environment with respect.

I have read and agree to the safety rules in this contract.

____ ________/________/________/

Student signature and date

____

Print name

Dear Parent or Guardian,

During science class, we want to create and maintain a safe classroom. With this in mind, we are making sure students are aware of the expectations for their behavior while engaged in science activities. We are asking you to review the safety rules with your student and sign this contract. If you have any questions, please feel free to contact me.

____ ________/________/________/

Parent or guardian signature and date

Appendix C

Strategies for Acquiring Materials

The materials used in the Core Knowledge Science program (CKSci) are readily available and can be acquired through both retail and online stores. Some of the materials will be reusable and are meant to be used repeatedly. This includes equipment such as scales, beakers, and safety goggles, but also items such as plastic cups that can be safely used again. Often these materials are durable, can be cleaned, and will last for more than one activity or even one school year. Other materials are classified as consumable and are not able to be used more than once, such as glue, baking soda, and aluminum foil.

Online Resources

The Material Supply List for this unit's activities can be found online. Follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Ways to Engage with Your Community

The total cost of materials can add up for an entire unit, even when the materials required for activities and demonstrations have been selected to be individually affordable. And the time needed to acquire the materials adds up too. Reaching out to your community to help support STEM education is a great way to engage parents, guardians, and others with the teaching of science, as well as to reduce the cost and time of collecting the materials. With that in mind, the materials list can be distributed or used as a reference for the materials teachers will need to acquire to teach the unit.

Consider some of the following as methods for acquiring the science materials:

- School Supply Drive—If your school has a supply drive at any point in the year, consider distributing materials lists as wish lists for the science department.
- Open Houses—Have materials lists available during open houses. Consider having teams of volunteers perform an activity to show attendees how the materials will be used throughout the year.
- Parent-Teacher Organizations—Reach out to the local PTO for assistance with acquiring materials.
- Science Fair Drive—Consider adding a table to your science fair as part of a science materials drive for future units.
- College or University Service Project—Ask service organizations affiliated with your local higher education institutions to sponsor your program by providing materials.
- Local Businesses—Some businesses have discounts for teachers to purchase school supplies. Others may want to advertise as sponsors for your school/programs. Usually you will be asked for verifiable proof that you are a teacher and/or for examples of how their sponsorship will benefit students.

Remember: If your school is public, it will be tax exempt, so make sure to have a Tax Identification Number (TIN) when purchasing materials. If your school is private, you may need proof of 501(c)(3) status to gain tax exemption. Check with your school for any required documentation.

Core Knowledge®

CKSci™

Core Knowledge SCIENCE™

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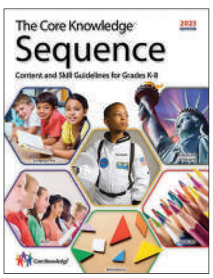
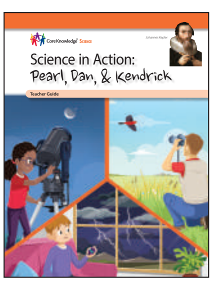


What is the Core Knowledge Sequence?

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, and the fine arts. In the domains of science, including Earth and space, physical, and life sciences, the *Core Knowledge Sequence* outlines topics that build systematically grade by grade to support student learning progressions coherently and comprehensively over time.



For which grade levels is this book intended?

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

For a complete listing of resources in the **Core Knowledge SCIENCE** series, visit **www.coreknowledge.org**.

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