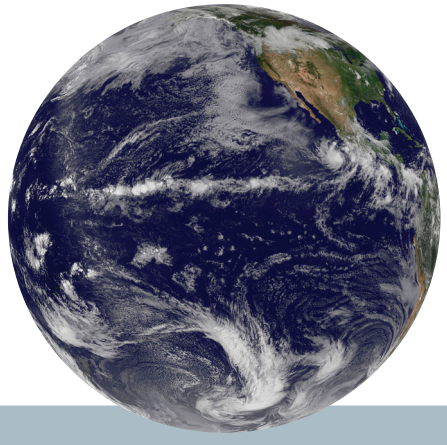
Core Knowledge® SCIENCE

# Modeling Earth's Systems

Hydrosphere



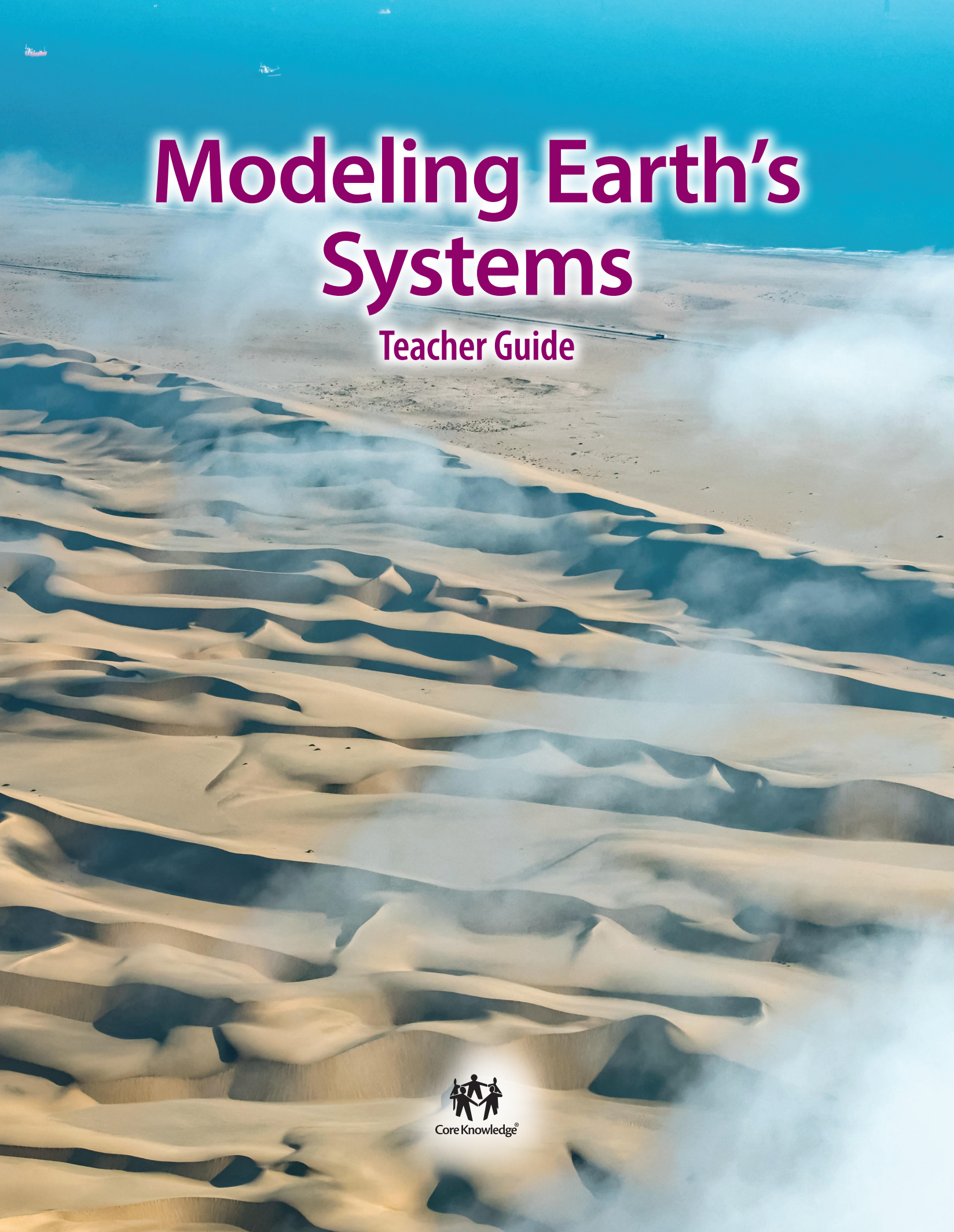
## Teacher Guide

Geosphere

Biosphere




Interaction of Earth's systems



# Modeling Earth's Systems

## Teacher Guide

Core Knowledge®

ISBN: 978-1-68380-543-4

# Modeling Earth's Systems

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# Modeling Earth's Systems

## Teacher Guide

Core Knowledge Science™ 5

UNIT 3

# Introduction

## About this Unit

### The Big Idea

This unit focuses on the scientific concept that Earth systems are dynamic and that they interact.

The natural world can sometimes seem like a complex array of independent issues and phenomena. We hear about air pollution, ocean currents, earthquakes, biodiversity, and much more. How does one issue or phenomenon relate to another? One way to understand the interrelationships is to think, as scientists do, in terms of the models or "spheres," specifically: the hydrosphere (all the water in the world in all its forms—underground, in the air, and in lakes, streams, estuaries, glaciers, and oceans), the atmosphere (the gases that surround us), the geosphere (all rocks, minerals, and landforms), and the biosphere (all living things).

These spheres constantly interact with each other. Liquid water falls from the atmosphere and helps living things in the biosphere to meet their needs for survival. Rocks crumble from a seaside cliff and dissolve in the ocean waters. Living things die and their molecules return to the soil. Understanding the Earth means to understand these interacting spheres in a way that can bring clarity to a complex natural world.

### Note to Teachers and Curriculum Planners

This unit introduces Grade 5 students to real-world examples and fundamental concepts that will be explored in greater depth in later grades. Students will apply their background knowledge to develop models of the different "spheres" of the Earth and use their models to discuss how different systems interact. The following are preliminary considerations for planning and instruction relative to this unit:

- Examples for students include: the influence of the ocean on ecosystems, landform shape, and our climate; the influence of the atmosphere on landforms and living things; and the influence of mountains on weather patterns such as winds and clouds in the atmosphere.
- While multiple systems are discussed in this unit, assessment of student learning is limited to explanations of how two "spheres" interact. Complex relationships between more than two systems are not assessed.
- As part of this unit, students are tasked to create a graphical representation of the amounts of fresh water versus salt water on the Earth, and indicate where these sources of water are typically found. Assessment excludes their understanding of water vapor (i.e., the amount of water found in the atmosphere).

This unit has been designed to build on prior knowledge, specifically knowledge gained through CKSci Grades 3 and 4. For more information about this, please read more on pages 4–8.

## Note to Core Knowledge Teachers

Thanks to ongoing research in the field, our understanding of how children learn continues to evolve. In the subject area of science, in particular, students benefit from not just reading about concepts and ideas, but from hands-on experiences. Following the release of the Next Generation Science Standards (NGSS), the Core Knowledge Foundation used this opportunity to update and enhance the science portion of the *2010 Core Knowledge Sequence*. The result of this effort is the revised *2019 Core Knowledge Science Sequence*.

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

**Online Resources**

To download the *2019 Core Knowledge Science Sequence,* use the links found in the Online Resources Guide.

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

This science unit, aligned to the *2019 Core Knowledge Science Sequence* and informed by NGSS, embodies Core Knowledge's vision of best practices in science instruction and knowledge-based schooling, such as the following:

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

To see how you can continue to use your current Core Knowledge materials with the 2019 CKSci™ curriculum, please see below an example of how this unit compares to the *2010 Core Knowledge Sequence*.

| **Examples of content retained from the *2010 Core Knowledge Sequence*** | **Examples of Core Knowledge content in this CKSci Unit** |
|---|---|
| **Ecology (Grade 3)**<br>• Habitats: interdependence of organisms and their environment<br>• The concept of a "balance of nature" (constantly changing, not a static condition)<br>**Geology (Grade 4)**<br>• Weathering and erosion<br>**Meteorology (Grade 4)**<br>• The atmosphere; weather and climate<br>**Chemistry of Food and Respiration (Grade 8)**<br>• Living cells get most of their energy through chemical reactions (i.e., …generally requiring water) | **Earth's Interacting Spheres**<br>• The spheres of Earth constantly interact and affect one another.<br>• Interactions of each sphere, including the hydrosphere, atmosphere, geosphere, and biosphere, including:<br>◦ Water shapes Earth's surface over time.<br>◦ Weather and climate affect the habitats of living things.<br>◦ Mountain ranges affect the formation of clouds and other weather events.<br>◦ Animal activity often alters the landscape over time. |
| For a complete look at how CKSci relates to the *2010 Sequence*, please refer to the full Correlation Charts available for download using the Online Resources Guide for this unit:<br>**www.coreknowledge.org/cksci-online-resources** | |

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

This unit, *Modeling Earth's Systems*, has been informed by the following Grade 5 Performance Expectations for the NGSS topic *Earth's Systems*. Students who demonstrate understanding can

**5-ESS2-1** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

**5-ESS2-2** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

**Online Resources**

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

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

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

**Sources:**

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

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

# Building Science Knowledge

## What Students Should Already Know

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

### PS1.A: Structure and Properties of Matter

**Grades K–2**

- Different kinds of matter exist (e.g., wood, metal, water), and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties (e.g., visual, aural, textural), by its uses, and by whether it occurs naturally or is manufactured. Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces (e.g., blocks, construction sets). Objects or samples of a substance can be weighed, and their sizes can be described and measured.

### PS1.B: Chemical Reactions

**Grades K–2**

- Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible (e.g., melting and freezing), and sometimes they are not (e.g., baking a cake, burning fuel).

### PS2.A: Forces and Motion

**Grades K–2**

- Objects pull or push each other when they collide or are connected. Pushes and pulls can have different strengths and directions. Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. An object sliding on a surface or sitting on a slope experiences a pull due to friction on the object due to the surface that opposes the object's motion.

## PS2.B: Types of Interactions

| | |
|---|---|
| **Grades K–2** | • When objects touch or collide, they push on one another and can change motion or shape. |
| **Grade 3** | • Objects in contact exert forces on each other. |

## PS3.A: Definitions of Energy

| | |
|---|---|
| **Grade 4** | • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. |

## PS3.B: Conservation of Energy and Energy Transfer

| | |
|---|---|
| **Grades K–2** | • Sunlight warms Earth's surface. |
| **Grade 4** | • Light also transfers energy from place to place. |

## PS3.C: Relationship Between Energy and Forces

| | |
|---|---|
| **Grades K–2** | • A bigger push or pull makes things go faster. Faster speeds during a collision can cause a bigger change in shape of the colliding objects. |
| **Grade 4** | • When objects collide, the contact forces transfer energy so as to change the objects' motions. |

## PS3.D: Energy in Chemical Processes and Everyday Life

| | |
|---|---|
| **Grades K–2** | • When two objects rub against each other, this interaction is called friction. Friction between two surfaces can warm of both of them (e.g., rubbing hands together). There are ways to reduce the friction between two objects. |
| **Grade 4** | • The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. |

## PS4.A: Wave Properties

| | |
|---|---|
| **Grade 4** | • Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; it does not move in the direction of the wave—observe, for example, a bobbing cork or seabird—except when the water meets the beach. |

## LS1.C: Organization for Matter and Energy Flow in Organisms

**Grades K–2**

- All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.

## LS2.A: Ecosystems: Interactions, Energy, and Dynamics

**Grades K–2**

- Animals depend on their surroundings to get what they need, including food, water, shelter, and a favorable temperature. Animals depend on plants or other animals for food. They use their senses to find food and water, and they use their body parts to gather, catch, eat, and chew the food. Plants depend on air, water, minerals (in the soil), and light to grow. Animals can move around, but plants cannot, and they often depend on animals for pollination or to move their seeds around. Different plants survive better in different settings because they have varied needs for water, minerals, and sunlight.

## LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

**Grades K–2**

- Organisms obtain the materials they need to grow and survive from the environment. Many of these materials come from organisms and are used again by other organisms.

## LS2.C: Ecosystem Dynamics, Functioning, and Resilience

**Grades K–2**

- The places where plants and animals live often change, sometimes slowly and sometimes rapidly. When animals and plants get too hot or too cold, they may die. If they cannot find enough food, water, or air, they may die.

**Grade 3**

- When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.

## LS4.C: Adaptation

**Grades K–2**

- Living things can survive only where their needs are met. If some places are too hot or too cold or have too little water or food, plants and animals may not be able to live there.

**Grade 3**

- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.

## LS4.D: Biodiversity and Humans

**Grades K–2**
- There are many different kinds of living things in any area, and they exist in different places on land and in water.

**Grade 3**
- Populations live in a variety of habitats, and change in those habitats affects the organisms living there.

## ESS1.C: The History of Planet Earth

**Grades K–2**
- Some events on Earth occur in cycles, like day and night, and others have a beginning and an end, like a volcanic eruption. Some events, like an earthquake, happen very quickly; others, such as the formation of the Grand Canyon, occur very slowly, over a time period much longer than one can observe.

**Grade 4**
- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed.

## ESS2.A: Earth Materials and Systems

**Grades K–2**
- Wind and water can change the shape of the land. The resulting landforms, together with the materials on the land, provide homes for living things.

**Grade 4**
- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

## ESS2.B: Plate Tectonics and Large-Scale System Interactions

**Grades K–2**
- Rocks, soils, and sand are present in most areas where plants and animals live. There may also be rivers, streams, lakes, and ponds. Maps show where things are located. One can map the shapes and kinds of land and water in any area.

**Grade 4**
- The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features of Earth.

## ESS2.C: The Roles of Water in Earth's Surface Processes

**Grades K–2**
- Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. It carries soil and rocks from one place to another and determines the variety of life forms that can live in a particular location.

## ESS2.D: Weather and Climate

**Grades K–2**

- Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.

**Grade 3**

- Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.
- Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.

## ESS2.E: Biogeology

**Grades K–2**

- Plants and animals (including humans) depend on the land, water, and air to live and grow. They in turn can change their environment (e.g., the shape of land, the flow of water).

**Grade 4**

- Living things affect the physical characteristics of their regions.

## ESS3.A: Natural Resources

**Grades K–2**

- Living things need water, air, and resources from the land, and they try to live in places that have the things they need. Humans use natural resources for everything they do: for example, they use soil and water to grow food, wood to burn to provide heat or to build shelters, and materials such as iron or copper extracted from Earth to make cooking pans.

**Grade 4**

- Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

## ESS3.B: Natural Hazards

**Grades K–2**

- Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that communities can prepare for and respond to these events.

**Grade 4**

- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts.

## ESS3.C: Human Impacts on Earth Systems

**Grades K–2**

- Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things—for example, by reducing trash through reuse and recycling.

## What Students Need to Learn

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

### A. Spheres of the Earth — Lessons 1–6

- Describe what makes up the hydrosphere.
- Describe what makes up the atmosphere.
- Describe what makes up the geosphere.
- Describe what makes up the biosphere.
- Describe the characteristics of a given ecosystem, including its relative size, habitats, and organisms that interact there.
- Create a single model that illustrates Earth's four spheres.
- Develop a graph to show the relative amounts of salt and fresh water in each of the following:
  - oceans
  - glaciers
  - polar ice caps
  - groundwater
  - lakes
  - rivers
  - all of Earth

### B. Modeling Earth's Systems — Lessons 7–12

- Describe how the hydrosphere interacts with other spheres.
- Describe how the geosphere interacts with other spheres.
- Describe how the atmosphere interacts with other spheres.
- Describe how the biosphere interacts with other spheres.
- Extend the model illustrating Earth's four spheres to represent their interactions.

## 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.

# Using the Student Reader

Student Reader

The *Modeling Earth's Systems* Student Reader has nine chapters and a student Glossary providing 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. In addition to Core Vocabulary, the Student Readers include a feature called Word to Know, which provides background information to help students understand key terms, and may sometimes include additional informational boxes, such as Think About.

**Explore, then read:** In the CKSci program, lessons are sequenced to provide active engagement before reading. First, students explore phenomena through hands-on investigations or teacher demonstrations, accompanied by active questioning and analysis; then, students study the informational text provided in the Student Readers. The icon shown at left will signal Core Lesson segments that focus on Student Reader chapters.

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

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

# Using the Teacher Guide

## Pacing

The *Modeling Earth's Systems* unit is one of five units in the Grade 5 CKSci series. To meet NGSS Performance Expectations we encourage teachers to complete all units during the school year. To be sure all NGSS Performance Expectations are met, each Core Lesson should be completed, and each requires thirty to forty-five minutes of instruction time. The time it takes to complete a lesson depends on class size and individual circumstances.

Within the Teacher Guide, the Core Lessons are divided into numbered segments, generally five or six, with approximate times listed per segment. The final segment is always a Check for Understanding, providing the teacher with an opportunity for formative assessment.

At the end of this Unit Introduction, you will find a Sample Pacing Guide on page 17 and a blank Pacing Guide on pages 18–19, which you may use to plan how you might pace the lessons, as well as when to use the various other resources in this unit. We strongly recommend that you preview this entire unit and create your pacing guide before teaching the first lesson. As a general rule, we recommend that you spend no more than twenty days teaching the *Modeling Earth's Systems* unit so that you have time to teach the other units in the Grade 5 CKSci series.

## The Core Lessons

- Lesson time: Each Core Lesson constitutes one classroom session of up to forty-five minutes. Understanding that teachers may have less instructional time, we show a time range of thirty to forty-five minutes per lesson. Teachers may choose to conduct all Core Lesson segments, totaling forty-five minutes; may choose to conduct a subset of the lesson segments; or may choose to spend less time per segment.
- Lesson order: The lessons are coherently sequenced to build from one lesson to the next, linking student engagement across lessons and helping students build new learning on prior knowledge.

| PART | LESSON | BIG QUESTION |
|---|---|---|
| **A. Spheres of the Earth** (5-ESS2-1, 5-ESS2-2) | **1.** Earth's Spheres | What are Earth's spheres? |
| | **2.** The Hydrosphere | What is the hydrosphere? |
| | **3.** Distribution of Earth's Water (two class sessions) | How is water distributed on Earth? |
| | **4.** The Geosphere | What is the geosphere? |
| | **5.** The Atmosphere (two class sessions) | What is the atmosphere? |
| | **6.** The Biosphere | What is the biosphere? |
| **B. Modeling Earth's Systems** (5-ESS2-1) | **7.** Sphere Model Fair Preview | How can we model interactions between Earth systems? |
| | **8.** Hydrosphere Interactions | How does the hydrosphere interact with Earth's other spheres? |
| | **9.** Geosphere Interactions | How does the geosphere interact with Earth's other spheres? |
| | **10.** Atmosphere Interactions | How does the atmosphere interact with Earth's other spheres? |
| | **11.** Biosphere Interactions | How does the biosphere interact with Earth's other spheres? |
| | **12.** Modeling Interaction Between Two Spheres (three class sessions) | How can I model interaction between Earth's spheres? |
| **Unit Review and Assessment** | Unit Review: The Search for Earth II | Is it possible that there is another planet somewhere that has the right combination of features to support life? |
| | Unit Assessment | What have I learned about Earth's spheres and the way they interact? |

## Activity Pages and Unit Assessment

Activity Pages

AP 1.1
AP 2.1
AP 2.2
AP 3.1
AP 3.2
AP 3.3
AP 3.4
AP 4.1
AP 4.2
AP 5.1
AP 5.2
AP 6.1
AP 6.2
AP 7.1
AP 8.1
AP 8.2
AP 9.1
AP 9.2
AP 10.1
AP 10.2
AP 11.1
AP 11.2
AP 12.1
AP 12.2
AP 12.3
AP UR.1
AP UR.2

Black line reproducible masters for Activity Pages and a Unit Assessment, as well as an Answer Key, are included in Teacher Resources on pages 109–157. The icon shown to the left appears throughout the Teacher Guide wherever Activity Pages (AP) are referenced.

Students' achievement of the NGSS Performance Expectations is marked by their completion of tasks throughout the unit. However, a combined Unit Assessment is provided as a summative close to the unit.

Lesson 1—Observe Locally, Think Globally (AP 1.1)

Lesson 2—Where Is Water in the Hydrosphere? (AP 2.1)

Lesson 2—Lesson 2 Check (AP 2.2)

Lesson 3—Model Earth's Water Supply (AP 3.1)

Lesson 3—Graph Earth's Water Supply (AP 3.2)

Lesson 3—Write a Letter About Water (AP 3.3)

Lesson 3—Evaluation Guide (AP 3.4)

Lesson 4—Fruit Model of the Geosphere (AP 4.1)

Lesson 4—Lesson 4 Check (AP 4.2)

Lesson 5—Modeling Air Particles in the Atmosphere (AP 5.1)

Lesson 5—Modeling Recording Pages (AP 5.2)

Lesson 6—Modeling the Location of the Biosphere (AP 6.1)

Lesson 6—Lesson 6 Check (AP 6.2)

Lesson 7—Types of Models (AP 7.1)

Lesson 8—Hydrosphere Interactions (AP 8.1)

Lesson 8—Lesson 8 Check (AP 8.2)

Lesson 9—Geosphere Interactions (AP 9.1)

Lesson 9—Lesson 9 Check (AP 9.2)

Lesson 10—Atmosphere Interactions (AP 10.1)

Lesson 10—Atmosphere Interactions Crossword Puzzle (AP 10.2)

Lesson 11—Biosphere Interactions (AP 11.1)

Lesson 11—Lesson 11 Check (AP 11.2)

Lesson 12—Model Planning (AP 12.1)

Lesson 12—Earth Interactions Take-Home Letter (AP 12.2)

Lesson 12—Model Analysis (AP 12.3)

Unit Review—Vocabulary Crossword Puzzle (AP UR.1)

Unit Review—Vocabulary Review (AP UR.2)

## Online Resources for Science

Online Resources

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

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

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

## Teaching Strategies

**Start with the familiar.**

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

**Ask the Big Question.**

At the beginning of each Teacher Guide lesson, you will find a Big Question and Core Lesson segment devoted to encouraging students to think about this question as they are introduced to new science content. Use this opportunity to engage students in conversation, to think about how their own real-world experiences relate to the topic, or to participate in a demonstration that relates to the Big Question.

**Encourage scientific thinking.**

Approach the lessons with students not as learning about science but as learning about the world with a scientific mind. Science learning models science practice.

Throughout the lessons, encourage students to ask questions about what they observe, do, and read. Record relevant questions in a prominent place in the classroom. Guide students back to these questions as opportunities to answer them emerge from readings, demonstrations, and activities.

**Use continuous Core Vocabulary instruction.**

As a continuous vocabulary-building strategy, have students develop a deck of vocabulary cards, adding a card for each Core Vocabulary term as it is introduced. Students can add illustrations and examples to the cards as their comprehension of terms expands. During instruction, emphasize Core Vocabulary terms and their meanings in context rather than relying on isolated drill for memorization of definitions. Students will be given the opportunity to preview Core Vocabulary words early in the lessons and to engage in Word Work activities toward the end of the lessons. Encourage students to come up with definitions in their own words and to use the words in their own sentences.

Core Vocabulary words for each lesson, as well as other key terms teachers are encouraged to use in discussing topics with students, are provided at the start of each lesson. You can find Core Vocabulary definitions in the Word Work lesson segments, as well as in the Glossary on pages 160–161.

**Emphasize observation and experience.**

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

**Use science practices.**

Give students opportunities to discover new content knowledge through investigation and to use their new knowledge both in problem-solving exercises and as evidence to support reasoning. Students learn what science and engineering practices are by engaging in those same practices as they learn.

Core Lesson segments are designed to reinforce the idea of science as an active practice, while helping students meet NGSS Performance Expectations. Each lesson segment is introduced by a sentence emphasizing active engagement with an activity.

**Make frequent connections.**

Use a combination of demonstrations and reading materials, rich with examples, to help students recognize how the science concepts they are learning apply in their everyday lives. Prompt students to relate lesson content to their own experiences, to relate the new and unfamiliar to the familiar, and to connect ideas and examples across disciplines. Refer to the Crosscutting Concepts cited in the lessons, often included in the NGSS References listed at the start of each lesson.

**Monitor student progress.**

Use verbal questioning, student work, the Check for Understanding assessments at the end of each lesson, and the Unit Assessment at the end of the unit (see pages 148–153) to monitor progress during each lesson and to measure understanding at the conclusion of the unit. Many lessons provide tips to help you support students who need further explanations or clarifications.

## Effective and Safe Classroom Activities

Conducting safe classroom demonstrations and activities is essential to successful elementary science education. The following resources provide Core Knowledge's recommendations for developing effective science classroom activities.

These resources, included at the back of the Teacher Guide on pages 162–166, consist of the following:

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

Online Resources

These resources may also be accessed within the CKSci Online Resources Guide for this unit, available at

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

# Materials and Equipment

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

## Part A: Spheres of the Earth

**Lesson 1**

- clipboards or other hard surfaces for students to write on (1 per student)
- pencils with erasers (1 per student)
- highlighters (1 per student)
- internet access and the means to project images/video for whole-class viewing

**Lesson 2**

- clear drinking glass or beaker
- water
- ice
- plastic wrap
- rubber band
- classroom globe
- index cards for student vocabulary deck (6 per student)
- internet access and the means to project images/video for whole-class viewing
- optional: table salt, cups, empty 1-liter bottle, water

**Lesson 3**

- water
- food dye
- clear 1-liter plastic bottle
- graduated cylinder to measure liquid volume
- eyedropper
- six small plastic cups (3-ounce bathroom size)
- salt (1 tablespoon for each bottle)
- permanent marker
- rulers
- colored pencils or markers

**Lesson 4**

- peach or photo of a cut peach
- knife
- construction paper (2 sheets per student)
- internet access and the means to project images/video for whole-class viewing
- index cards for student vocabulary deck (3 per student)

**Lesson 5**

- basketball
- pillowcase
- cellophane tape
- hole punch
- construction paper of one color (1 sheet per team)
- glue or paste
- index cards for student vocabulary deck (3 per student)

**Lesson 6**

- basketball
- thin plastic wrap
- colored pencils
- rulers
- internet access and the means to project images/video for whole-class viewing
- index cards for student vocabulary deck (4 per student)

## Part B: Modeling Earth's Systems

**Lesson 7**

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

**Lesson 8**

- beaker
- small desk fan
- water

**Lesson 8,** continued

- sediment (sand or flour)
- bowl
- cube of salt
- index cards for student vocabulary deck (2 per student)

**Lesson 9**

- bricks (2)
- shoeboxes  of equal size (2)
- thermometer
- plastic or glass container (1 quart)
- small stones
- sand or soil
- water
- organic material (leaves, grass clippings, worm castings, etc.)
- index cards for student vocabulary deck (4 per student)

**Lesson 10**

- index cards for student vocabulary deck (1 per student)

**Lesson 11**

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

**Lesson 12**

- internet access for research

**Unit Review**

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

# Sample Pacing Guide

The sample Pacing Guide suggests use of the unit's resources across an eighteen-day period. However, there are many ways that you may choose to individualize the unit for your students, based on their interests and needs. You may elect to use the blank Pacing Guide on pages 18–19 to reflect alternate activity choices and alternate pacing for your class. If you plan to create a customized pacing guide for your class, we strongly recommend that you preview this entire unit and create your pacing guide before teaching the first lesson.

**Online Resources**

For a yearlong pacing guide, please use the link found in the Online Resources Guide for this unit. This yearlong view of pacing also includes information about how this CKSci unit relates to the pacing of other programs, such as CKLA and CKHG in the *Core Knowledge Curriculum Series*™.

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

TG–Teacher Guide; SR–Student Reader; AP–Activity Page

## Week 1

| Day 1 | Day 2 | Day 3 | Day 4 | Day 5 |
|---|---|---|---|---|
| *Earth's Spheres*<br>TG Lesson 1<br>AP 1.1 | *The Hydrosphere*<br>TG Lesson 2<br>SR Chapter 1<br>AP 2.1, 2.2 | *Distribution of Earth's Water* DAY 1<br>TG Lesson 3<br>AP 3.1, 3.3 | *Distribution of Earth's Water* DAY 2<br>TG Lesson 3<br>AP 3.2, 3.3, 3.4 | *The Geosphere*<br>TG Lesson 4<br>SR Chapter 2<br>AP 4.1, 4.2 |

## Week 2

| Day 6 | Day 7 | Day 8 | Day 9 | Day 10 |
|---|---|---|---|---|
| *The Atmosphere* DAY 1<br>TG Lesson 5<br>SR Chapter 3 | *The Atmosphere* DAY 2<br>TG Lesson 5<br>SR Chapter 3<br>AP 5.1, 5.2 | *The Biosphere*<br>TG Lesson 6<br>SR Chapter 4<br>AP 6.1, 6.2 | *Sphere Model Fair Preview*<br>TG Lesson 7<br>AP 7.1 | *Hydrosphere Interactions*<br>TG Lesson 8<br>SR Chapter 5<br>AP 8.1, 8.2 |

## Week 3

| Day 11 | Day 12 | Day 13 | Day 14 | Day 15 |
|---|---|---|---|---|
| *Geosphere Interactions*<br>TG Lesson 9<br>SR Chapter 6<br>AP 9.1, 9.2 | *Atmosphere Interactions*<br>TG Lesson 10<br>SR Chapter 7<br>AP 10.1, 10.2 | *Biosphere Interactions*<br>TG Lesson 11<br>SR Chapter 8<br>AP 11.1, 11.2 | *Modeling Interaction Between Two Spheres* DAY 1<br>TG Lesson 12<br>AP 12.1 | *Modeling Interaction Between Two Spheres* DAY 2<br>TG Lesson 12<br>AP 12.1, 12.2 |

## Week 4

| Day 16 | Day 17 | Day 18 | | |
|---|---|---|---|---|
| *Modeling Interaction Between Two Spheres* DAY 3<br>TG Lesson 12<br>AP 12.3 | *The Search for Earth II*<br>TG Unit Review<br>SR Chapter 9<br>AP UR.1, UR.2 | Unit Assessment<br>AP Unit Assessment | | |

# Pacing Guide

Eighteen days have been allocated to the *Modeling Earth's Systems* unit to complete all Grade 5 science units in the *Core Knowledge Curriculum Series*™. If you cannot complete the unit in eighteen consecutive days of science instruction, use the space that follows to plan lesson delivery on an alternate schedule.

**Week 1**

| Day 1 | Day 2 | Day 3 | Day 4 | Day 5 |
|---|---|---|---|---|
| | | | | |

**Week 2**

| Day 6 | Day 7 | Day 8 | Day 9 | Day 10 |
|---|---|---|---|---|
| | | | | |

**Week 3**

| Day 11 | Day 12 | Day 13 | Day 14 | Day 15 |
|---|---|---|---|---|
| | | | | |

**Week 4**

| Day 16 | Day 17 | Day 18 | Day 19 | Day 20 |
|---|---|---|---|---|
| | | | | |

## Week 5

| Day 21 | Day 22 | Day 23 | Day 24 | Day 25 |
|---|---|---|---|---|
| | | | | |

## Week 6

| Day 26 | Day 27 | Day 28 | Day 29 | Day 30 |
|---|---|---|---|---|
| | | | | |

## Week 7

| Day 31 | Day 32 | Day 33 | Day 34 | Day 35 |
|---|---|---|---|---|
| | | | | |

## Week 8

| Day 36 | Day 37 | Day 38 | Day 39 | Day 40 |
|---|---|---|---|---|
| | | | | |

# PART A

# Spheres of the Earth

## Overview

| Lesson | Big Question | Advance Preparation |
|---|---|---|
| **1.** Earth's Spheres | What are Earth's spheres? | Identify local environment and gather materials for student exploration.<br><br>(See Materials and Equipment, page 15.) |
| **2.** The Hydrosphere | What is the hydrosphere? | Read Student Reader, Chapter 1.<br><br>Gather materials for teacher demonstration. |
| **3.** Distribution of Earth's Water (2 days) | How is water distributed on Earth? | Gather materials for modeling activity. |
| **4.** The Geosphere | What is the geosphere? | Read Student Reader, Chapter 2.<br><br>Gather materials for teacher demonstration. |
| **5.** The Atmosphere (2 days) | What is the atmosphere? | Read Student Reader, Chapter 3.<br><br>Gather materials for teacher demonstration. (See Materials and Equipment, page 15.) |
| **6.** The Biosphere | What is the biosphere? | Read Student Reader, Chapter 4.<br><br>Gather materials for teacher demonstration. |

## Part A: What's the Story?

Earth is a planet characterized by several different spheres, or systems, that interact with each other and sustain life on Earth. The biosphere on the surface of Earth involves all life on Earth. The biosphere interacts with the atmosphere (the system of air), the geosphere (the system of land, including soil and rocks), and the hydrosphere (the system of water). This part, however, stresses basic knowledge of the four systems, and students will later begin to delve into interactions.

The complexity of the real world can make it difficult to apply a classification system because many factors can exist in two or more categories at the same time. For example, in most representations of the water cycle, the atmosphere is included because it is a vitally important mechanism for transporting water. However, in hydrosphere discussions in the Student Reader, the atmosphere is barely mentioned as part of the hydrosphere because students are going to consider the atmosphere as a discrete system.

As student comprehension increases, so should the emphasis that the classifications are not always rigid and that it is correct to think of Earth as one great, dynamic system.

**In Lesson 1**, students build on what they learned about ecosystems and habitats in Unit 2 *Habitats and Change* by exploring the water, land, air, and living things in a local environment. They recognize that Earth involves different systems, or spheres, that interact. They classify what they see around them into one of the Earth systems.

**In Lesson 2**, students read about the hydrosphere and its many dimensions and forms, including fresh and salt water, frozen water, rivers, reservoirs, lakes, streams, oceans, and different forms of waterways. Students learn about the different phases of water and learn about the water cycle.

**In Lesson 3**, students explore more about the hydrosphere. They identify where water can be found on Earth and recognize the prevalence of fresh and salt water.

**In Lesson 4**, students read about the layers of Earth, types of rocks, Earth's plates, and the rock cycle that make up the geosphere. They start to understand how the geosphere interacts with the hydrosphere in the creation of rocks.

**In Lesson 5**, to recognize how the atmosphere interacts with the geosphere and hydrosphere, on Day 1 students read about the layers and composition of Earth's atmosphere. On Day 2 they develop a model of the layers of Earth's atmosphere.

**In Lesson 6**, to reinforce how Earth's spheres interact, students read about life on Earth and recognize that life can be classified and that so can biomes.

So, to repeat, **Earth can be thought of in terms of spheres, or systems**. This part provides the scientific basis for understanding interrelationships, the subject of further lessons.

LESSON 1

# Earth's Spheres

**Big Question:** What are Earth's spheres?

## At a Glance

### Learning Objective

✓ Classify components of Earth's features as land, water, air, and living things.

### Lesson Activities

- vocabulary instruction
- outdoor student investigation
- discussion

### NGSS References

**Performance Expectation 5-ESS2-1:** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

**Disciplinary Core Idea ESS2.A:** Earth Materials and Systems

**Crosscutting Concept:** Systems and System Models

**Science and Engineering Practices:** Developing and Using Models

**Developing and Using Models** is important to this lesson, as students will be confronted with two types of models. During discussions, they will build mental models of what the words *sphere* and *dynamic* mean. As they make observations of the local environment, they will develop visual models by completing a graphic organizer. In Lesson 3, they will develop a model that includes measurements, and in later lessons in this unit, they will focus on developing models that show interactions among their parts.

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

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

## Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 160–161 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

| | | |
|---|---|---|
| **atmosphere** | **geosphere** | sphere |
| **biosphere** | **hydrosphere** | system |
| dynamic | | |

**Core Vocabulary Deck:** As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

## Instructional Resources

Activity Page

AP 1.1

**Activity Page**
Observe Locally, Think Globally (AP 1.1)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

- clipboards or other hard surfaces for students to write on (1 per student)
- pencils with erasers (1 per student)
- highlighters (1 per student)
- internet access and the means to project images/video for whole-class viewing

### Advance Preparation

Identify in advance a local environment where your students can safely make observations. Make sure there are enough natural features that students will be able to explore soil, rocks, and living things. Determine that there are no hazards, such as poison ivy, poison oak, or wasp nests. Also, determine whether any of your students with special needs will require accommodations to successfully participate.

## The Core Lesson 45 min

### 1. Focus student attention on the Big Question. 10 min

**What are Earth's spheres?**

#### Preview Core Vocabulary Terms

Display the following terms on the board or chart paper.

**atmosphere** **biosphere** **geosphere** **hydrosphere**

Underline *sphere* in each of the terms.

Point out that students are likely to recall from mathematics that a sphere is a solid figure in which all points on the surface are at equal distances from the center of the figure, the shape of a perfectly round ball. But if they were to check a dictionary, they would find that *sphere* also means the natural, normal place something is found. Explain that this is the meaning they will use to explore where Earth's air, land, water, and living things are located.

Remind students that they investigated weather and climate in Grade 3. Have them recall the science word for the layer of air that surrounds Earth's sphere. (*atmosphere*)

Explain that other parts of Earth have names that include the word part *sphere*, too. The geosphere is the solid rock parts of Earth. The hydrosphere is parts of Earth that are water. The biosphere is the parts of Earth that are living.

Point out that together these four spheres, or systems, make up a collective system—the Earth system. The Earth system is the whole Earth, and the spheres are parts of the system. Confirm student understanding of the meaning of *system*. Explain that a system consists of parts that act on each other, or interact. (See **Know the Standards** for support.)

## Know the Standards

**Systems and System Models:** Students in Grade 5 build their understanding from Grades K–2 that natural and human-designed objects can be described by their parts and that the parts work together. In this unit, students begin to recognize Earth as a system and identify and classify some of its parts. Later in the unit, students will focus on how these parts interact, or influence one another. Critical throughout the unit is the concept that the whole system (in this case, Earth) functions in ways (e.g., supporting life) that its individual parts cannot. In middle school, emphasis of this Crosscutting Concept will shift to teaching students how models can represent systems but that a particular model usually represents only some aspects of a system. In this lesson, students use a simple graphic model of the four Earth spheres to classify their outdoor observations.

Introduce the word *dynamic* to students as meaning experiencing continuous change. Show students a video of Earth from space, such as those NASA posts from the International Space Station.

Online Resources

Use this link to download the CKSci Online Resources Guide for this unit, where specific links to these resources may be found:

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

Ask: What evidence do the videos from space provide that Earth is a dynamic system? (*Answers will vary depending on what the video camera has captured but may include that swirling clouds are evidence of motion and that sunrises and sunsets are evidence for changing amounts of light reaching the ground.*)

## 2. Support student observations. 20 MIN

Activity Page

AP 1.1

Group students in pairs, both for safety and so that they can collaborate in making observations. Review your school's field trip safety rules with the class, making sure all students know how to behave and what to do in case of an emergency.

Distribute Observe Locally, Think Globally (AP 1.1), clipboards, and pencils with erasers to students. Have them read the directions on the Activity Page and look over the graphic organizer.

Explain that students will use the graphic organizer to classify things they observe in the natural environment. Make sure students understand that, for this activity, they can ignore human-made objects, such as sidewalks, cars, and buildings. Stress the importance of scientists being able to erase and revise their notes as they develop a model.

Lead the class to the natural site you have selected. Give students enough time to record ten or more observations. Circulate among students to help them identify parts of the environment in all four Earth spheres. (*Possible answers include geosphere: soil and rocks; hydrosphere: puddles, ice, snow, clouds, moist soil; atmosphere: air, clouds; biosphere: low-growing plants, trees, insects, birds, etc.*)

> **SUPPORT**—Some students may need hints about how they can observe the air/atmosphere. Use guiding questions that suggest that they use their sense of touch to feel the wind on their faces or their sense of sight to see the motion of plants that is caused by the wind. Then have them look for clouds in the sky, which, though they are made of water and are therefore part of the hydrosphere, are also part of the atmosphere.

## 3. Encourage discussion. 10 MIN

Activity Page

AP 1.1

When students return to class, distribute highlighters, and have them work in pairs. Each pair should discuss and highlight the parts of Earth that are dynamic, or always changing. At this point in the unit, accept all reasonable answers. Point out that as students complete more lessons in this unit, they will build understanding that all parts of the Earth system are dynamic but that the length of time it takes for each part to change varies greatly. (See **Know the Science** for support.)

**CHALLENGE**—Some scientists have suggested that the Earth systems model have five spheres instead of four. Challenge students to consider if the cryosphere (consisting of frozen water) should be considered a fifth sphere. If more than one student wishes to address this question, have students stage a debate and present their affirmative and negative positions.

## 4. Check for understanding. 5 MIN

Activity Page

AP 1.1 and Answer Key

**Formative Assessment Opportunity**

- Collect the completed Activity Page. Review the completed graphic organizers, looking for accuracy in students' classification of the observations they made.
- Choose one or two examples of dynamic systems to discuss with the class. Look for understanding of the general concept that systems are often in a state of constant change.
- Prompt students to ask questions they have about the four Earth spheres/systems. Use the discussion as an opportunity to reinforce main ideas and point out that they will be exploring each system in more depth in the next few lessons.

## Know the Science

**How are Earth's dynamic systems similar and different? Two answers involve energy and time.** Dynamic systems in the natural world are similar in that the changes involve energy. The wind, the evaporation of a puddle of water, the flight of a butterfly, or the wearing away of rock formations all are manifestations of energy, the ability to cause change. Two main sources of energy for these changes are the sun and Earth's internal heat. In the atmosphere, the sun directly powers the wind and evaporation. In the biosphere, the energy for animal flight comes from the foods they eat, which can be traced back to the sun as well. Weathering of rocks in the geosphere may be caused by the wind. One way dynamic systems differ is in the amount of time required for change. Some changes in the environment, such as animal movements, are readily observable because they occur quickly. Others, such as the weathering and erosion of mountains, are not as obvious because long periods of time are required for the change—often thousands to millions of years.

LESSON 2

# The Hydrosphere

**Big Question:** What is the hydrosphere?

## At a Glance

### Learning Objective

✓ Describe what makes up the hydrosphere.

### Lesson Activities

- teacher demonstration
- reading and discussion
- vocabulary instruction

### NGSS References

**Performance Expectation 5-ESS2-2:** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

**Disciplinary Core Idea ESS2.C:** The Roles of Water in Earth's Surface Processes

**Crosscutting Concepts:** Scale, Proportion, and Quantity; Systems and System Models

**Science and Engineering Practices:** Using Mathematics and Computational Thinking

**Systems and System Models** is an important Crosscutting Concept for Lessons 1–6 of this unit. In this lesson, emphasize that the hydrosphere is an Earth *system*. Look for opportunities to have students use the language of systems and system models to describe the interactions among the parts of the hydrosphere.

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

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

## Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 160–161 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

| | | | |
|---|---|---|---|
| dynamic | hydro- | **salt water** | system |
| **fresh water** | **hydrosphere** | sphere | **water cycle** |
| **groundwater** | **reservoir** | | |

**Core Vocabulary Deck:** As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

## Instructional Resources

Student Reader

Ch. 1

Activity Pages

AP 2.1

AP 2.2

**Student Reader, Chapter 1**
"The Hydrosphere"

**Activity Pages**
Where Is Water in the Hydrosphere? (AP 2.1)

Lesson 2 Check (AP 2.2)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

- clear drinking glass or beaker
- water
- ice
- plastic wrap
- rubber band
- classroom globe
- internet access and the means to project images/video for whole-class viewing
- index cards for student vocabulary deck (6 per student)
- optional: table salt, cups, empty 1-liter bottle, water

### Advance Preparation

Online Resources

Before class, visit Google Earth online to become familiar with its tools. Depending on your operating system, you may have to download a compatible browser to run this web application.

Use this link to download the CKSci Online Resources Guide for this unit, where specific links to these resources may be found:

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

## The Core Lesson 45 min

### 1. Focus student attention on the Big Question. 5 min

**What is the hydrosphere?** In the previous lesson, students learned that the Earth system can be broken down into four separate systems, or spheres (hydrosphere, biosphere, atmosphere, and geosphere). Explain that this lesson will take a deep dive into one system—the hydrosphere.

Remind students that Earth has four spheres to describe Earth's land and rocks, its water, the air, and living things. Ask the following:

» What parts of the hydrosphere did you observe when you went outdoors into the local environment? (*Students should recall the details they recorded on Activity Page 1.1*)

» Do you think you observed all parts of the hydrosphere? Explain your answer. (*Students should acknowledge that there are parts they could not observe. For example, they might not have seen the ocean, a lake, or a stream.*)

### 2. Demonstrate examples and guide discussion. 5 min

Show students a dry, clean, clear drinking glass or beaker. Have one student verify that the glass is dry inside and outside. Next, fill the glass with water and ice cubes. Seal the top with plastic wrap and a rubber band. Set the glass on a desk for a minute or two.

- Point out that you have set up a closed system inside the glass.
- Have one student observe the glass and report how it looks and feels on the outside. (*There are tiny drops of water on the glass, and the glass feels cool.*)
- Ask students to make some inferences about the closed system. Where did the water on the outside of the glass come from if the system is closed/sealed? (*Accept all plausible responses.*)
- If students know that the water came from the air in the room, ask them to explain how this models one process in the hydrosphere. (*It models what happens to water in the air when it is cooled.*)

## 3. Read and discuss: "The Hydrosphere." 25 MIN

Student Reader

Ch. 1

Prepare to read together, or have students read independently, "The Hydrosphere," Chapter 1 in the Student Reader. This chapter surveys the parts of the hydrosphere, classifying them as containing salt or fresh water, and explores the changes in state involved in the water cycle. (See **Know the Standards**.)

Activity Page

AP 2.1

Distribute Where Is Water in the Hydrosphere? (AP 2.1), and preview the directions with students.

### Preview Core Vocabulary Terms

Before students read, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read:

**fresh water** **hydrosphere** **salt water**
**groundwater** **reservoir** **water cycle**

### Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

**Page 1**

Show students a classroom globe or map. Allow them to take turns rotating the globe to the point where they can see almost entirely water and no land. Ask: Why do you think our planet is nicknamed "the water planet"? (*because there is more water than land on its surface*)

Online Resources

Take students online to use the Google Earth web application. Use this link to download the CKSci Online Resources Guide for this unit, where specific links to this resource may be found:

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

## Know the Standards

**ESS2.C: The Roles of Water in Earth's Surface Processes:** This Disciplinary Core Idea, which is addressed in all grade bands (K–2, 3–5, 6–8, and 9–12), has a very broad scope, addressing changes of state in the water cycle, weather patterns, how energy from the sun and gravity move water, density currents, and water's influence on weathering and erosion. In this lesson, the focus is on students knowing that most of Earth's water is in the ocean, that most fresh water is in glaciers and ice caps and underground, and that only a tiny fraction of fresh water is in streams, lakes, wetlands, and the atmosphere. These concepts are introduced in a mostly qualitative presentation in Lesson 2 and will be explored quantitatively in Lesson 3 with a graphing activity.

View the entire Earth from space, and use your mouse and cursor to rotate the globe left to right and then top to bottom. After each move, pause and have students estimate the fractions of the view that are water versus land.

**SUPPORT**—Some students may need support with fractions. Show them how each view of Earth can be visualized as a circle. Then have students draw a circle and mark off fractional parts. Guide students who decide to add up fractions with different denominators. For example, if students decide that the water covers one-half plus one-third of the view of Earth, show them how to find equivalent fractions as a strategy to find the total.

Elicit prior knowledge about states of matter by referring to Unit 1, *Investigating Matter*. Ask: What are some other examples of matter in the solid, liquid, or gas states? (*solids: rocks, wood; liquid: oil; gas: oxygen, helium*)

Point out that the words *system* and *interact* will be essential to understanding the rest of this unit. Ask: What are some other examples of systems in nature with parts that interact? (*the solar system, a food web, a hurricane, a volcano*)

**CHALLENGE**—Challenge interested students to create a running list of natural and designed systems. The systems may be related to science (the digestive system), engineering (computer operating system), or social systems (e.g., a school district). The lists can be individual or collaborative and maintained throughout this unit.

**Page 2**

Refer students to Where Is Water in the Hydrosphere? (AP 2.1). Have students use the chart to record reading notes.

Activity Page

AP 2.1

After reading page 2, challenge students to apply mathematical thinking to interpret the data presented about the Pacific Ocean. Guide them to convert measurement units within the metric system. For example, ask: How many kilometers deep is the Challenger Deep? (*eleven kilometers*)

**Page 3**

Use the classroom globe or Google Earth's zoom tool to find examples of each of the bodies of water described in the text: gulfs, seas, and straits.

If your students have not tasted ocean water, demonstrate the saltiness of the water by mixing thirty-five grams of table salt into a one-liter drinking bottle of warm water. Swirl until the salt is dissolved, and let the water cool. Then allow students to taste the salt water.

**Safety Note: Be sure to use a drinking container rather than laboratory equipment for this demonstration. Make sure students understand that it is dangerous to taste substances in a science lab.**

Based on their reading, have students add more information to their chart on Activity Page 2.1.

**SUPPORT**—Discuss why the ocean is salty. Students should understand that when a river flows into the ocean, it carries dissolved salts from rocks with it. As water evaporates from the ocean, the salt is left behind. Over millions of years, salt has accumulated in the ocean. In the water cycle, evaporated water falls back to Earth as rain or snow, which does not contain salt. The precipitation feeds creeks, streams, and rivers that dissolve more salts from rocks and carry them back to the oceans in a continuous cycle.

**Pages 4–5**

Identify with students local streams, rivers, ponds, lakes, and reservoirs. Discuss the differences among them.

- Use a globe to identify major rivers, such as the Mississippi, the Danube, the Nile, and the Chang (formerly Yangtze).
- Discuss wells and groundwater. Ask students if they know anyone who gets their water at home from a well. This is more common in rural areas than in urban and suburban areas, where water is delivered though a system of pipes from a more distant source. (See **Know the Science**.)

Based on their reading, have students add more information to their chart on Activity Page 2.1.

**Pages 6–7**

Remind students that they learned about physical properties of matter in Unit 1. They should also recall from Unit 1 that boiling, evaporation, and condensation are physical changes in matter.

Students may be confused that the four Earth spheres are not mutually exclusive. Explain that water vapor in the air is part of the hydrosphere as well as the atmosphere. Then, ask: Which sphere does water stored inside a cactus plant belong to? (*both the hydrosphere and the biosphere*)

Show students the classroom globe or Google Earth again. Point out how prevailing winds tend to go from west to east across the United States. Ask: How is it that rain falling on Ohio could come from the Pacific Ocean? (*because water evaporates from the Pacific Ocean and is carried by the wind toward the east*)

Remind students that in this unit there will be much more reading and discussion about how the spheres interact with one another.

Based on their reading, have students add the atmosphere to their chart on Activity Page 2.1.

## Know the Science

**What is groundwater, and how do people get at it to meet their needs? *By digging, driving, and drilling until they find the water!*** Water from precipitation gets deep into the ground because the force of gravity pulls everything with mass toward Earth's center. However, water doesn't reach Earth's center because, eventually, it encounters a layer of rocky material that does not let it go any farther. At any point on Earth, there is water below the surface. But sometimes this groundwater is not suited for human use because it is salty. Other times, the water is very deep in the ground and cannot be reached. In the past, wells were dug by hand. When the hole in the ground consistently filled with water, the digger stopped digging and lined the hole with stones or bricks. Today, some wells are made by driving a pipe into loose soil, sand, or gravel. But if water is not reached before hitting solid rock, a truck with a drill is needed. The drill can cut through rock until it reaches a depth where there is water between the grains in the rocks or in fractures and dissolution cavities. Sometimes, the drill has to go one thousand feet down or deeper to reach a steady supply of water. At that point, the drill is removed, and a pipe is left in place. Often, an electric-powered pump is needed to bring the water to the surface.

**Page 8**

Point out to students that the adjective *dynamic* can also be applied to people. Ask: What does it mean when we say someone has a dynamic personality? (*It means they are lively.*)

- Ask a volunteer to talk the rest of the class through the water cycle diagram. Ask: Why is this model called a *cycle*? (*because it has no beginning or end*)
- Discuss how the different bodies of water, both fresh and salt water, are part of the hydrosphere.

## 4. Teach Core Vocabulary. 5 MIN

### Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board or chart paper earlier in the lesson). Ask students to write each term in the upper left corner of an index card and underline it (one term per card):

**hydrosphere**
**fresh water**
**salt water**
**water cycle**
**reservoir**
**groundwater**

### Word Work

Summarize the reading by reviewing Core Vocabulary. Have students make notes on their cards as you discuss each term.

- **hydrosphere:** (n. the Earth system that contains all of the water on Earth) Refer back to page 1 of the Student Reader, and discuss the word parts in the word *hydrosphere*. Brainstorm other words with those word parts, such as *atmosphere, hemisphere, hydroplane,* and *hydropower*. Discuss the meanings of the word parts in each word.
- **fresh water:** (n. naturally occurring water that contains little or no salt)
- **salt water:** (n. water that contains dissolved salt)
- Compare fresh water and salt water and where they are found in bodies of water on Earth.
- **water cycle:** (n. the dynamic movement of water on, below, and above Earth's surface) Have students describe or draw the water cycle.
- **reservoir:** (n. a place where water collects) Some students may be more familiar with another definition of the term *reservoir*. Have students use a dictionary to look up the word. Point out that, in the Student Reader, this term refers to a place in nature where fluid collects, not a human-made lake used to store a community's water supply. However, both types of reservoirs store water.
- **groundwater:** (n. water stored in the spaces between materials beneath Earth's surface) Clarify that the groundwater collected in a region is considered to be a reservoir, though it is not an easily delineated body of water the way that a lake is.

## 5. Check for understanding. 5 MIN

Activity Pages

AP 2.1
AP 2.2
Answer Key

**Formative Assessment Opportunity**

See the Activity Pages 2.1 and 2.2 Answer Keys for correct answers and sample student responses.

- Collect the completed Where Is Water in the Hydrosphere? (AP 2.1). Scan students' tables and answers to the question for accuracy and completeness.
- Distribute Lesson 2 Check (AP 2.2). Have students work individually and without their Student Readers. Collect the completed sheets, and scan them for accuracy and completeness.
- Choose one or two examples that students struggled with to discuss with the class. Use the discussion to reinforce the main ideas and correct misconceptions.

LESSON 3

# Distribution of Earth's Water

**Big Question:** How is water distributed on Earth?

## At a Glance

### Learning Objective

✓ Develop a graph to show the relative amounts of salt and fresh water in each of the following: oceans, glaciers and polar ice caps, groundwater, lakes, rivers, wetlands, and the atmosphere.

### Lesson Activities (2 days)

- hands-on measurement
- graphing
- problem-solving writing
- self-evaluation

### NGSS References

**Performance Expectation 5-ESS2-2:** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

**Disciplinary Core Ideas ESS2.C:** The Roles of Water in Earth's Surface Processes

**Crosscutting Concept:** Scale, Proportion, and Quantity

**Science and Engineering Practices:** Using Mathematics and Computational Thinking; Developing and Using Models

**The Roles of Water in Earth's Surface Processes** are the focus of this lesson as students distinguish between fresh and salt water and identify the locations of water in and on Earth, including in the atmosphere. The lesson builds on Grade 2 content, where students identified water in the ocean, rivers, lakes, and ponds, distinguishing solid from liquid forms. When students reach middle school, this DCI becomes much broader, addressing changes of state in the water cycle, weather patterns, how energy from the sun and gravity move water, density currents, and water's influence on weathering and erosion.

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

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

## Core Vocabulary

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. No new Core Vocabulary terms are introduced in this lesson.

| | | | |
|---|---|---|---|
| fresh water | hydrosphere | reservoir | system |
| groundwater | interact | salt water | water cycle |

## Instructional Resources

Activity Pages

AP 3.1
AP 3.2
AP 3.3
AP 3.4

**Activity Pages**
Model Earth's Water Supply (AP 3.1)

Graph Earth's Water Supply (AP.3.2)

Write a Letter About Water (AP 3.3)

Evaluation Guide (AP 3.4)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

The following items are for each group of students.

- water
- food dye
- clear 1-liter plastic bottle
- graduated cylinder to measure liquid volume
- eyedropper
- six small plastic cups (3-ounce bathroom size)
- salt (one tablespoon for each bottle)
- permanent marker
- rulers
- colored pencils or markers

If there is a faucet in the classroom, allow students to fill their bottles there. You may wish to add the food dye to each bottle for students.

# The Core Lesson — Two Days, 45 min each

## 1. Day 1: Focus student attention on the Big Question. — 5 min

**How is water distributed on Earth?** Remind students that they read about all the places on Earth that are part of the hydrosphere in Student Reader Chapter 1. Ask the following:

» Where is most of Earth's water located? (*in the ocean*)

» In what other places can water be found? (*streams, rivers, ponds, lakes, cracks in rock, soil, underground, the pore spaces between mineral grains in rocks, and the atmosphere*)

Explain that in this lesson, students will have a chance to use numbers to compare the amount of water in each of these places.

## 2. Introduce the problem-solving scenario. 5 MIN

Activity Page

AP 3.3

Distribute Write a Letter About Water (AP 3.3), and read the directions with students. Make sure students understand that this is a real-world situation. Cities, counties, regions, and states really do have water commissions. Citizens may be members of the water board and make decisions about the location of water resources. The members of the board are often called upon to answer questions from the public, as well as the press.

Explain that students will write their letters after completing the modeling tasks. Activity Page 3.3 can be collected or put aside for now.

## 3. Develop a three-dimensional model. 30 MIN

Activity Page

AP 3.1

Group students in pairs or larger groups, depending on the amount of materials you have on hand. Distribute Model Earth's Water Supply (AP 3.1). Explain to students that they will make a three-dimensional model showing the proportion of water in the various reservoirs of the hydrosphere. (See **Know the Standards** for support.)

Have students follow the procedure on the Activity Page. You may wish to provide plastic trays to place under the bottles and cups so that any spills can be contained. Depending on the material the cups are made from, students may need permanent markers to label them. Alternatively, they can write with a regular pen on a strip of masking tape.

Circulate among the groups to confirm that students are measuring accurately. If students have not used a graduated cylinder before, give a demonstration for the class. Remind students to keep the container on the table while they add water and to keep their eye at the level of the water to see when to stop pouring.

Give students clear directions for cleaning up, including where to pour the water and what to do with the cups and bottles. Make sure they wipe up any spills that have occurred.

## Know the Standards

**Developing and Using Models:** This Science and Engineering Practice is applied when a model is useful for representing ideas and explanations. In the primary grades (K–2), students compare models to the real thing and develop models that compare amounts, relationships, and patterns. In Grades 3–5, they identify the limitations of models, revise models, and use models to make predictions and test cause-and-effect relationships. When your students reach middle school, they will evaluate models, modify models based on evidence, and develop models of unobservable mechanisms.

## 4. Check for understanding. 5 MIN

**Formative Assessment Opportunity**

Review the student models. Ask the following questions:

- What is this a model of? (*the hydrosphere*)
- What does your model show about the hydrosphere? (*how much water is in the different reservoirs*)
- How can you arrange the bottle and cups to best show relationships? (*They could arrange the containers in a straight line, from largest to smallest volume.*)
- What doesn't your model show about the hydrosphere? (*It does not show how the hydrosphere is dynamic. All the water in the model is liquid, but in the real hydrosphere some of it is solid or gaseous.*)

## 1. Day 2: Refocus student attention on the Big Question. 5 MIN

**How is water distributed on Earth?** Review the models of the hydrosphere students created. Discuss which bodies of water contain the smallest and largest amounts of water.

## 2. Facilitate graphing. 20 MIN

Activity Page

AP 3.2

Distribute Graph Earth's Water Supply (AP 3.2), rulers, and colored pencils. Have students follow the directions. Point out that a graph is a two-dimensional model and that the measurements in the table are parts of one thousand—the same as in their three-dimensional models made with the bottle and cups of water.

You may wish to have students work in pairs to discuss how to divide up the circle. Encourage them to sketch with a pencil and eraser until they are satisfied with their representation. Measurements do not have to be precise, but they should generally reflect the proportions of the numbers in the data table.

Once students are satisfied, have them color the sections of the graph and label them.

Then, based on the data table, three-dimensional model, and two-dimensional model, have students answer the questions at the end of Activity Page 3.2.

## 3. Support student writing. 15 MIN

Activity Page

AP 3.3

Remind students about their roles as water commissioners. Return attention to Write a Letter About Water (AP 3.3). Have each student follow the directions and compose his or her own letter using the formal language of a public official.

**SUPPORT**—Some students made need additional writing instruction before composing their letters. Make sure students understand that the task requires writing informative/explanatory text. Plan with students the number of paragraphs they will write, and brainstorm topic sentences for each paragraph. Help students identify the concrete facts from their models that support their main ideas.

## 4. Check for understanding. 5 MIN

Activity Pages

AP 3.1
AP 3.2
AP 3.3
AP 3.4
Answer Key

**Summative Assessment Opportunity**

Distribute Evaluation Guide (AP 3.4). Read through the rubric together. Then have students review their Activity Pages and evaluate themselves.

Allow them to revisit their Activity Pages to revise their work as needed.

Collect all student Activity Pages. Review Activity Pages 3.2 and 3.3 Answer Keys for correct answers and sample student responses.

- Review the evaluation rubric with students. Explain that when learning new skills, everyone starts out as a beginner. Encourage students to work toward the expert level.
- Choose one or two letters to read to the class. Look for understanding of the general concept that the amount of water on Earth is finite and that only a small portion of it is suitable for use by humans.
- Prompt students to ask questions they may still have about the hydrosphere. Use the discussion as an opportunity to reinforce main ideas.
- Use Evaluation Guide (AP 3.4) as a basis for scoring student work in this performance task lesson. Provide feedback to students on their completed graphs and letters.

LESSON 4

# The Geosphere

**Big Question:** What is the geosphere?

## At a Glance

### Learning Objective

✓ Describe what makes up the geosphere.

### Lesson Activities

- video
- reading and discussion
- optional demonstration with diagramming activity
- modeling activity
- vocabulary instruction

### NGSS References

**Disciplinary Core Idea ESS2.A:** Earth Materials and Systems

**Crosscutting Concepts:** Systems and System Models; Scale, Proportion, and Quantity

**Science and Engineering Practices:** Developing and Using Models

**Systems and System Models** is the Crosscutting Concept for nearly all the lessons in this unit. In this lesson, students learn that systems can vary in scale and that there are interactions within a system as well as between different systems. For example, Earth's layers form a large-scale system, and the crustal plates form a system that is smaller in scale. Look for opportunities to have students use the language of systems to discuss earthquakes, volcanic eruptions, and the rock cycle.

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

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

## Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 160–161 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

| | | | |
|---|---|---|---|
| geo- | **geosphere** | sediments | sphere |
| **geologic** | **rock cycle** | seismic wave | |

**Core Vocabulary Deck:** As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple above.

## Instructional Resources

Student Reader

Ch. 2

Activity Pages

AP 4.1
AP 4.2

**Student Reader, Chapter 2**
"The Geosphere"

**Activity Pages**
Fruit Model of the Geosphere (AP 4.1)

Lesson 4 Check (AP 4.2)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

- peach or photo of a cut peach
- knife
- construction paper (2 sheets per student)
- internet access and the means to project images/video for whole-class viewing
- index cards for student vocabulary deck (3 per student)

Before class, preview the volcanic eruption video you plan to show to the class.

# The Core Lesson 45 min

## 1. Focus student attention on the Big Question. 10 min

**What is the geosphere?** Recall that in Lesson 1, students were introduced to the Earth system and its four separate subsystems, or spheres. In Lessons 2 and 3, they explored the hydrosphere in detail. Now, in Lesson 4, they will explore the geosphere.

Online Resources

Show students a video of an erupting volcano. (See the Online Resources for a link to suggested videos.) There are many available of Kīlauea in Hawaii. After viewing the video, ask the following:

» What parts of the geosphere did you observe in the video? (*Depending on the video they saw, students may have seen a mountain, lava, rocks, and so on.*)

» What other parts of the geosphere do you think exist? (*the parts under the surface of Earth, other mountains, and so on*)

» What questions do you have about Earth's geosphere? (*List the questions where students can see them during the rest of this lesson.*)

Use this link to download the CKSci Online Resources Guide for this unit, where specific links to these resources may be found:

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

## 2. Read and discuss: "The Geosphere." 20 MIN

**Student Reader**

**Ch. 2**

Prepare to read together, or have students read independently, "The Geosphere," Chapter 2 in the Student Reader. This chapter describes the parts of the geosphere at different scales, from its large-scale layers to the small-scale breaking down of rocks into tiny sediments in the rock cycle. (See **Know the Standards**.)

### Preview Core Vocabulary Terms

Before students read, write these terms on the board or chart paper. Encourage them to use the terms frequently as they discuss what they read.

**geologic** **geosphere** **rock cycle**

### Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

## Know the Standards

**Scale, Proportion, and Quantity:** This Crosscutting Concept encompasses three mathematical concepts, as indicated by its title, but this lesson will focus only on the concept of scale. The NGSS wording for Grades 3–5 is "Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods." Students' understanding of the geosphere will be enriched by applying this concept about scale to the various geologic processes surveyed. This will also build on the work K–2 students do to understand that "Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower)." It will also prepare students for middle school, where they will learn that "Phenomena that can be observed at one scale may not be observable at another scale."

**Page 9**

Explain to students that the word *rock* includes rock that is melted or molten, as well as solid. Ask the following:

- What melted rock did you see in the video? (*The lava was melted rock.*)
- Why do you think *dynamic* is a good adjective for the geosphere? (*This question will elicit prior knowledge or require predictions, but so far, students have seen that volcanic eruptions are quite dynamic.*)

**Pages 10–11**

Activity Page

AP 4.1

After reading pages 10–11, rotate a peach (or avocado) such that a cut with the knife will result in a round cut face. Make the slice, allowing the pit to remain on one half. Show students the half with the pit. Ask the following:

- How is this cut piece of fruit a good model of parts of the geosphere? (*It is round, and it has a core, a wide layer like Earth's mantle, and a thin skin like Earth's crust.*)
- What doesn't the model show? (*It does not show that the mantle has lower and upper layers. Nor does it show which layers are solid or molten rock.*)
- Does this model of the layers of the geosphere show a small-scale phenomenon or large-scale phenomenon? (*a large-scale phenomenon*)

  **SUPPORT**—Some students may not understand what you mean by *scale*. Explain that the word has many meanings but that in this case, it means a relative size of one thing when compared to another. As an explanation, have students visualize holding an insect in their hand. This is a small-scale living thing. Then compare the insect to an elephant or whale, which is a large-scale living thing.

Distribute Fruit Model of the Geosphere (AP 4.1). Have students read the directions, draw, and write labels to make their models and then answer the questions.

**Pages 12–13**

There are many details in this section of the chapter. Focus students on understanding the main idea—that rocks can be classified by how they form. Challenge students to summarize the details by asking the following:

- What are two ways igneous rocks form? (*from molten rock on or below Earth's surface*)
- What is a way sedimentary rock forms? (*from sediments that are pressed together over time*)
- How does the geosphere interact with the hydrosphere in creating sedimentary rock? (*Rock particles are carried by waterways.*)
- How do metamorphic rocks form? (*when a rock that already formed is changed by heat and pressure*)

Have students identify the layers in the sedimentary rock in the photo. Explain that the layers are made of different kinds of materials and were formed at different times in geologic history. Point out your use of the word *geologic*. Ask: If *geo* means "rock," what is geologic history? (*the history of Earth's rocks*) (See **Know the Science**.)

**Pages 14–15**

Distribute two sheets of construction paper to each student. Explain that the paper is a model for the thin plates of Earth's crust. As the class reads the first paragraph on page 14, have students use the paper to model the crustal motions described. Suggest that students place the two sheets of paper on a desk surface with the short ends and then put a hand on either sheet to move the "plates" in relation to one another.

After reading both pages, invite students to share what they know or have experienced about earthquakes and volcanoes. If students ask questions that require research, try searching the web by asking a specific question. It's likely that others have asked the same questions and answers can be readily found.

**Online Resources**

**CHALLENGE**—Allow students who are highly interested in volcanoes to spend time on the website from Oregon State University called *Volcano World*. Invite students to research answers to their own questions. Or give them questions to answer: Are there volcanic eruptions on planets other than Earth? How does a volcanic eruption sound? What is working on volcanoes like for scientists? Have students record their results in a science journal, on a poster, or in bulletin board display.

Use this link to download the CKSci Online Resources Guide for this unit, where specific links to this resource may be found:

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

Make sure students understand what seismic waves are. Review the general definition of *wave*—a disturbance in matter causing a regular pattern of motion. Remind students that in Grade 4 they investigated water waves. In a water wave, the water is the medium the energy of the wave travels through. Ask: What is the medium when seismic waves travel? (*rock, the ground*) Point out that seismic waves can also travel through water.

## Know the Science

**Why do mountains formed from sedimentary rock have layers? *Because sediments settle in water or air in horizontal layers over time***. Sedimentary rock forms in several ways, but much of it forms underwater. Fast-moving water in a river transports sediments across the land. When the river reaches a lake or the ocean, the water slows down and can no longer support the weight of the sediments. The sediments settle down, or are deposited, at the bottom of the lake or ocean. If you were to place a spoonful of mud in a jar of water, swirl it around, and then set the jar down, you could see that eventually the various-sized sediments settle to the bottom in horizontal layers. Layer upon layer form, and then if the whole area is lifted up by some geological force, a mountain may form. Most rocks visible on Earth's surface are sedimentary, and in these layers, or strata, one can find fossils and other clues to geologic history. You can also boil water beforehand, dissolve a lot of table salt in it, and then let it sit in the classroom uncovered to cool and evaporate until layers of salt form on the side of the container. This is another important way that sediments are deposited.

**Page 16**

Review the parts of the rock cycle diagram with students, focusing on interactions. Ask the following:

- What are the parts of this system? (*igneous rock, sedimentary rock, metamorphic rock, sediments*)
- What do the process arrows labeled "Breaking down" mean? Breaking down into what? (*Large rocks are breaking down into tiny pieces called sediments.*)
- Where can people see melting rock? (*when a volcano erupts and lava flows on Earth's surface*)
- Do you think sedimentary rock, like the rocks in the photo on page 13, can break down into sediments? How would you add to the diagram to show this process? (*Yes, sedimentary rocks are also subject to water and wind erosion and can break down into sediments. Adding an arrow labeled "Breaking down" that begins and curves back to end at "Sedimentary rock" would show this.*)
- Why is this model called a *cycle*? (*because it has no beginning or end*)
- Would you say the rock cycle is a large- or small-scale system? (*It is large-scale in that it takes place on all parts of Earth's surface at once.*)

## 3. Teach Core Vocabulary. 5 MIN

### Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board or chart paper earlier in the lesson). Ask students to write each term in the upper left corner of an index card and underline it (one term per card):

**geologic** **geosphere** **rock cycle**

### Word Work

Summarize the reading by reviewing Core Vocabulary and allowing students to add notes to their cards.

- Remind students of the discussion of the root word *sphere* from Lesson 1. In mathematics, a sphere is a solid figure in which all points on the surface are at equal distances from the center of the figure. But *sphere* also means the natural, normal place something is found. *Sphere* in this sense refers to a system.
- **geosphere:** (n. the Earth system that contains all the rocky layers of Earth) Compare the word *geosphere* to *hydrosphere*, and discuss the meanings of each word part. (Hydro *means "water," and* geo *means "earth."*)
- **geologic:** (adj. relating to Earth's rocky inner and outer features) Compare the words *geologic* and *geosphere,* and discuss the meanings of each word part. (Logic *refers to the study of something.*)

- **rock cycle:** (n. the process through which rock changes form through igneous, sedimentary, and metamorphic types) Have students explain the rock cycle in a simplified summary. (*Rock material from inside Earth gets broken down at the surface. The broken material forms different rock, which in turn is broken down again or changed to different types of rock by pressure and/or temperature.*)

## 4. Check for understanding. 10 MIN

Activity Pages

AP 4.1
AP 4.2
Answer Key

**Formative Assessment Opportunity**

See the Activity Pages 4.1 and 4.2 Answer Keys for correct answers and sample student responses.

- Collect the completed Fruit Model of the Geosphere (AP. 4.1). Scan students' labeled diagrams and answers to the questions for accuracy and completeness.
- Distribute Lesson 4 Check (AP 4.2). Have students work individually, with or without their Student Readers. Collect the completed sheets, and review them for accuracy and completeness.
- Choose one or two examples that students struggled with to discuss with the class. Use the discussion to reinforce the main ideas and correct misconceptions.
- Discuss any questions that remain unanswered.

LESSON 5

# The Atmosphere

**Big Question:** What is the atmosphere?

## At a Glance

### Learning Objective

✓ Describe what makes up the atmosphere.

### Lesson Activities

- reading and discussion
- teacher demonstration
- hands-on modeling activity

### NGSS References

**Disciplinary Core Idea ESS2.A:** Earth Materials and Systems

**Crosscutting Concepts:** Systems and System Models; Scale, Proportion, and Quantity

**Science and Engineering Practices:** Developing and Using Models

**Scale, Proportion, and Quantity:** In this lesson students will experience several models of the atmosphere, all at different scales. The first will be a three-dimensional model using a basketball and a pillowcase. The second will be a diagram presented in the Student Reader. The third model will be one students develop themselves to show the density of air particles in the atmosphere.

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

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

## Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 160–161 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

| | | | |
|---|---|---|---|
| **air mass** | altitude | **atmosphere** | troposphere |
| **air pressure** | atmos- | stratosphere | |

**Core Vocabulary Deck:** As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple on the previous page.

## Instructional Resources

Student Reader

Ch. 3

Activity Pages

AP 5.1
AP 5.2

**Student Reader, Chapter 3**
"The Atmosphere"

**Activity Pages**
Modeling Air Particles in the Atmosphere (AP 5.1)

Modeling Recording Pages (AP 5.2)

Before class, determine how many teams of students you will have for the modeling activity on Day 2. Then, make sufficient copies for your students prior to conducting the lesson. Each student will need one copy of AP 5.1, and each team will need one set of AP 5.2 pages.

## Materials and Equipment

**Collect or prepare the following items:**

- basketball
- pillowcase
- cellophane tape
- hole punch
- construction paper of one color (1 sheet per team)
- glue or paste
- index cards for student vocabulary deck (3 per student)

## The Core Lesson TWO DAYS, 45 MIN EACH

### 1. Day 1: Focus student attention on the Big Question. 10 MIN

**What is the atmosphere?** Review with students the Earth systems they have already explored in the context of states of matter. Have them draw on their prior knowledge from the first unit in Grade 5, *Investigating Matter*. Ask the following:

» In what states of matter does the hydrosphere exist? (*solid [glaciers and ice caps], liquid [oceans, ponds, rivers], gas [water vapor in the air]*)

» In which of these states does most of the hydrosphere exist? (*liquid*)

» In what states of matter does the geosphere exist? (*solid [rocks], liquid [molten rock]*)

» In which of these states does most of the geosphere exist? (*It is mostly solid.*)

» In which state of matter do you predict the atmosphere exists? (*mostly gases*)

» What questions do you have about Earth's atmosphere? (*List the questions where students can see them during the rest of this lesson.*)

## 2. Read and discuss: "The Atmosphere." 30 MIN

Student Reader

Ch. 3

Prepare to read together, or have students read independently, "The Atmosphere," Chapter 3 in the Student Reader. This chapter describes the layers of the atmosphere, the forces acting within it, and how living things depend on it.

### Preview Core Vocabulary Terms

Before students read, write these terms on the board or chart paper. Encourage them to use the terms frequently as they discuss what they read. Although *altitude* is a Word to Know and not Core Vocabulary, it is essential to understanding much of the lesson, including the modeling activity on Day 2.

**air mass** **air pressure** altitude **atmosphere**

### Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

**Page 17**

After reading this page, do a quick demonstration. Show students a basketball, and tell them it is a model of Earth. Then place the ball inside a pillowcase, and draw up the fabric so that it fits snugly over the ball. Explain that if Earth were the size of a basketball, the part of the atmosphere where most of the matter is located would be the thickness of the pillowcase covering it. Ask: Do you consider the atmosphere thick or thin? (*very thin*)

Draw on students' prior knowledge from Unit 1, and make sure they understand that, although the atmosphere seems to "float" above Earth and is mostly invisible, it is made of matter. The gases of the atmosphere are different substances with different properties. However, one property they have in common is that they are mostly colorless.

Have students briefly look outside at the sky. Make sure they understand that clouds are visible because they are made of solid ice crystals or liquid droplets of water, both of which interact with light differently than do the gases in the atmosphere. (See **Know the Science**.)

## Know the Science

**Why can we see clouds but not water vapor in the atmosphere? *The state of matter involved and the scale of the particle sizes are important factors.*** Water vapor is of molecular size. When water vapor condenses to liquid water, extremely small particles of water vapor collect to form round droplets of liquid water or faceted crystals of ice. The larger sizes and shapes of ice crystals and liquid drops make them much better at bending light than are particles of water vapor. As sunlight travels through a cloud, the light is scattered in many directions by the largish waterdrops or crystals. While visible light from the sun is made of all the colors of the spectrum, when *all* colors are scattered equally, you see clouds as white. When clouds look gray, it is often because of shadows cast by the same cloud or other clouds.

**Pages 18–19**

After reading pages 18–19, make sure students understand that most of the matter in the atmosphere is located in the lower part of the troposphere.

Also point out that although the diagrammatic model shows sharp lines between the layers, the layers vary somewhat in thickness depending on their location over Earth and with time. Ask the following:

- What does the model in the form of a diagram show that the basketball and pillowcase did not show? (*It shows the layers of the atmosphere and their thicknesses in miles/kilometers.*)
- What does the basketball and pillowcase model show that the diagram does not show? (*It shows the thickness of the lower parts of the atmosphere where the most air is in relationship to the diameter of Earth. It also shows that the atmosphere goes all around Earth.*)

Remind students that the atmosphere is a system. Ask: What are the components, or parts, of this system? (*troposphere, stratosphere, mesosphere, thermosphere, ionosphere, and exosphere*)

**Pages 20–21**

Have students identify the key ideas in this section of the chapter by asking the following:

- What causes air pressure? (*the weight of air particles*)
- What is the relationship between air pressure and altitude? (*As altitude increases, air pressure decreases.*)
- How do air masses produce weather? (*They move, they push one another, and they carry precipitation to new places.*)

Make sure students understand that all of the elements of weather take place in the thin layer of the atmosphere just above Earth's surface.

**SUPPORT**—Some students may struggle with distinguishing key ideas from details. Make copies of these two Student Reader pages. Allow students to use highlighters to identify key ideas and underline the related details.

**Page 22**

Point out that this page is about how two Earth systems interact, or affect each other. Ask the following:

- Which two systems interact when air supports life? (*the atmosphere and the biosphere*)
- In which part of the atmosphere is there enough air for living things to use? (*the layer right above Earth's surface [the troposphere]*)

## Know the Standards

**Systems and System Models:** Students' models of the atmosphere are an opportunity to discuss how "A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot." You can develop this idea by discussing how two parts of the atmosphere, the troposphere and the stratosphere, are needed to sustain life. Without either of these parts, the system does not function to allow survival of living things.

» How do living things depend on the atmosphere for protection? (*The ozone layer in the stratosphere blocks dangerous ultraviolet light from reaching living things on Earth's surface.*) (See **Know the Standards** on the previous page.)

## 3. Teach Core Vocabulary. 5 MIN

### Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board or chart paper earlier in the lesson). Ask students to write each term in the upper left corner of an index card and underline it (one term per card):

**atmosphere** **air pressure** **air mass**

### Word Work

Emphasize the Core Vocabulary from the chapter. Instruct students to add notes to their cards.

- **atmosphere:** (n. the Earth system that is composed of all the gases that surround Earth) Compare the words *geosphere, hydrosphere*, and *atmosphere*. If *sphere* means system, discuss the meanings of each word part. (Hydro *means "water";* geo *means "earth";* atmos *means "air."*)
- **air pressure:** (n. the weight of air pressing on all things beneath and within it) Underline *press* in *pressure*, and remind students that air presses in all directions.
- **air mass:** (n. a large body of air with similar temperature, air pressure, and moisture throughout) Reiterate to students that the differences in air masses are what cause them to move relative to each other, producing wind and weather.

## 1. Day 2: Refocus student attention on the Big Question. 5 MIN

**What is the atmosphere?** Invite students to recap some key ideas from their reading and discussion of Chapter 3 during Day 1. Ask the following:

» Where is the atmosphere located in relationship to the geosphere? (*It surrounds the geosphere.*)

» What is the atmosphere made of? (*a mixture of gases*)

» Why can only the lowest layer of the atmosphere support life and produce weather? (*because this is the layer where most of the air particles are located*)

## 2. Develop a model. 25 MIN

Activity Pages

AP 5.1
AP 5.2

Draw a picture of Earth on the board or chart paper. Explain that the diameter of Earth is about 12,750 kilometers, or 7,910 miles, so from the center to the surface of Earth is about 6,375 kilometers.

Distribute Modeling Air Particles in the Atmosphere (AP 5.1) to all students. Have students read the directions.

Divide the class into teams, and distribute one set of AP 5.2 to each team. Then have each team gather the other materials they will need (tape, hole punch, and construction paper). Consider allowing teams to either work on the floor or push tables and desks together. You may want to assign roles for each team member, such as reader, materials getter, taper, labeler, reporter, and so on.

Circulate among the teams, and ask guiding questions to help students develop their models and encourage discussion among team members. It is not important that students get the exact density of particles correct in each layer. However, their models should show that the vast majority of air particles are located near sea level and decrease as altitude increases.

**CHALLENGE**—If some groups finish quickly, challenge them to label their models with the names of the layers of the atmosphere. Make Student Reader Chapter 3 available to students so that they can use the diagram on page 19 as a reference.

## 3. Check for understanding. 15 MIN

Activity Page

AP 5.1 and
Answer Key

**Formative Assessment Opportunity**

- If possible, display students' models of the atmosphere on a wall.
- See the Activity Page 5.1 Answer Key for correct answers and sample student responses.
- Scan students' diagrams and answers to the questions for accuracy and completeness.
- Choose one or two models, and have a spokesperson from the team that made them speak to the class about what the model shows and how the team decided where to place the dots. Use the discussion to reinforce the main ideas and correct misconceptions.
- Review student questions recorded at the beginning of the lesson, and discuss any that remain unanswered.

LESSON 6

# The Biosphere

**Big Question:** What is the biosphere?

## At a Glance

### Learning Objective

✓ Describe what makes up the biosphere.

### Lesson Activities

- teacher demonstration
- reading and discussion
- modeling activity

### NGSS References

**Disciplinary Core Idea ESS2.A:** Earth Materials and Systems

**Crosscutting Concept:** Systems and System Models

**Science and Engineering Practices:** Developing and Using Models

**Developing and Using Models:** In this lesson, students continue to use models to conceptualize Earth systems. First, they return to the basketball model of Earth, this time covering it in plastic wrap to model the biosphere. Next, they consider how the classification system for living things is a model. Finally, an Activity Page guides them to develop their own models of the location of the biosphere in relation to the three other Earth systems.

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

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

## Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 160–161 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

| | | | |
|---|---|---|---|
| bio- | **biome** | extinct | taxonomy |
| **biodiversity** | **biosphere** | **species** | |

**Core Vocabulary Deck:** As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple on the previous page.

## Instructional Resources

Student Reader

Ch. 4

Activity Pages

AP 6.1

AP 6.2

**Student Reader, Chapter 4**
"The Biosphere"

**Activity Pages**
Modeling the Location of the Biosphere (AP 6.1)

Lesson 6 Check (AP 6.2)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

- basketball
- thin plastic wrap
- colored pencils
- rulers
- internet access and the means to project images/video for whole-class viewing
- index cards for student vocabulary deck (4 per student)

## The Core Lesson 45 min

### 1. Focus student attention on the Big Question. 5 min

**What is the biosphere?** Review with students the Earth systems they have already investigated. (*hydrosphere, geosphere, and atmosphere*) Point out that the biosphere is the fourth Earth system they will explore.

Ask students to recall the model from Lesson 5 using a basketball and pillowcase. Ask the following:

» Which part of Earth did the basketball represent in the model? (*the geosphere*)

» Which part of Earth did the pillowcase represent in the model? (*the two lower layers of the atmosphere, where most of the air particles are located*)

Show students the basketball again, reminding them that it is a model of Earth's geosphere. Hold up a sheet of plastic wrap, and have students notice its thickness. Have a volunteer help you wrap the ball tightly with the plastic.

Explain that if the geosphere were the size of a basketball, the biosphere would be the thickness of the plastic wrap. Ask the following:

» How does the plastic wrap compare to the pillowcase used to model the atmosphere? (*It is thinner.*)

» What does the model show about a comparison between the biosphere and atmosphere? (*It shows that the biosphere is an even thinner layer of Earth than the air in the atmosphere.*)

Tell students that scientists are always discovering new species. About 1,500,000 have already been described and named. In 2017, a group of scientists estimated that there might be as many as two billion unique kinds of organisms on land, in fresh water, and in the ocean. Invite students to think about these numbers. Ask the following:

» Are there more species discovered and named or yet to be discovered and named? (*many more yet to be discovered*)

» There are over 300,000,000 people living in the United States. How many species could each person discover and name? (*Guide students to solve the problem in two steps. Subtract the known species from the estimated total. Then divide that number by the number of U.S. residents. The answer should be 6.6 species.*)

## 2. Read and discuss: "The Biosphere." 20 MIN

Student Reader

Ch. 4

Prepare to read together, or have students read independently, "The Biosphere," Chapter 4 in the Student Reader. This chapter defines *biosphere*, explains classification of living things, surveys subsystems within the biosphere (biomes, ecosystems, habitats), and explains two ways species change.

### Preview Core Vocabulary Terms

Before students read, write these terms on the board or chart paper. Have students identify the prefix that three of the terms share. Point out that *bio* means "life." Encourage students to pay special attention to these terms as they read.

**biodiversity** **biome** **biosphere** **species**

### Guided Reading Supports

When reading aloud as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

**Page 23**

Point out to students that the word *biosphere* also refers to the layer of Earth where all living things are found. To prevent a misconception that living things only inhabit Earth's land surface, point out that the frilled shark lives as deep as one mile (1.6 kilometers) below the surface of the ocean. Other species of fish have been found in the Mariana Trench at a depth of five miles (eight kilometers).

Make sure students understand that an individual organism has a life span but that the type of organism (species) also has an average lifespan.

Have students quickly search online for the average life spans of plants and animals. Ask: What is the life span of an African elephant? (*up to fifty years*) What is the life span of a bristlecone pine tree? (*1,000–5,000 years*)

Many bacteria reproduce often by splitting in two, by binary fission. Is it even possible to say that a bacterium has a life span in the same sense that a lion does? Ask students to consider this issue.

**Pages 24–25**

After reading pages 24–25, make sure students understand that the word *biodiversity* can be used to describe small ecosystems, biomes, or the entire Earth.

Share with students that humans are a species called *Homo sapiens*. Point out that each species has a "first" and "last" name. The first name (capitalized) identifies the genus, and the second name (lowercase) is unique to the species. (See **Know the Science**.)

**CHALLENGE**—Invite students to make biodiversity cards. First, students should choose a species. Then, they should find a photo of it online. Next, students should research the following facts about the species: scientific name (genus and species), biome, important body structure, adult size, and life span. Finally, students should add all the facts and photo to a large card. Collect the cards in one place in the classroom. When students have made enough cards, use them to play a game such as twenty questions.

**Pages 26–27**

In life science lessons, students have learned about habitats, ecosystems, and environments. Discuss how habitats and ecosystems relate to biomes. Students should recognize that an ecosystem supports many different habitats and that a biome supports many different ecosystems. The key is the interaction between living things and their environments.

» Ask students to summarize a key idea of this section using the word *biomes*. (*Biomes are large regions of Earth's surface with similar climate and species.*)

» Ask: Where on Earth are all of the six biomes named found? *(on the land)* Point out that some scientists also identify fresh water and the ocean as two additional biomes.

## Know the Science

**Why do taxonomists use classification models? *It makes communication easier.*** The concept we now use for a system for naming and classifying living things was developed by Carolus Linnaeus in the 1700s. Different scientists use somewhat different levels of classification and are always striving to develop better models. Then and now, each new species described is given a two-part name, the first word identifying the genus and the second word identifying the species. These names are often derived from ancient Greek or Latin and follow specific written rules. The advantage of a system that is accepted and used by scientists around the world becomes clear when students consider the number of languages scientists speak and how the names nonscientists commonly use vary from region to region, even when people share a language. For example, a mountain lion of North and South America is also called a *puma, panther, catamount, cougar, el leon,* and *ghost cat*. However, the scientific name for this single species is *Puma concolor.*

Online Resources

**SUPPORT**—Use a social studies text or go online to show students a map of world biomes. Point out that the biomes are generally located at the same latitude, even if they are located on separate continents. Use this link to download the CKSci Online Resources Guide for this unit, where specific links to these resources may be found:

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

Explain to students that when an organism depends on its environment, students can identify interactions between Earth systems. Ask the following:

- In the desert shown in the photo, how does the biosphere interact with the hydrosphere? (*The plants need water to survive.*)
- In the tundra shown in the photo, how does the biosphere interact with the geosphere? (*The plants' roots take in minerals from the soil.*)

Point out that this discussion is just a preview of the interactions students will explore more fully in later lessons of this unit.

**Page 28**

Make sure students understand that biosphere changes involve nonliving factors, such as climate, as well as interactions among the living components. Ask the following:

- What are two ways described here in the chapter that the biosphere changes? (*Species can go extinct or evolve.*)
- What are some of the changes that result in species becoming extinct? (*changes in climate and human activities*)
- Which of the changes discussed on this page are an example of an interaction within the parts of one Earth system? (*humans affecting other species*) (See **Know the Standards**.)

## 3. Develop a model.

**10 MIN**

Activity Page

AP 6.1

Distribute Modeling the Location of the Biosphere (AP 6.1) to all students. Have students read the directions. Make sure they understand that a diagram is a type of model. Point out that a model can show certain aspects of the real thing but not all aspects. For this reason, students make decisions about what is important to show.

## Know the Standards

**LS4: Biological Evolution: Unity and Diversity:** In the context of this Earth science unit, students touch upon two of the major themes of life science—extinction and evolution. NGSS has four DCIs on these themes: LS4.A: Evidence of Common Ancestry and Diversity, LS4.B: Natural Selection, LS4.C: Adaptation, and LS4.D: Biodiversity and Humans. Relevant to defining *extinct* in this lesson is the Grades 3–5 Core Idea "Some kinds of plants and animals that once lived on Earth are no longer found anywhere." Relevant to defining *evolve* is the Grades 3–5 Core Idea "Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing." NGSS does not use the term *evolution* at this grade level.

Allow students to use Student Reader Chapters 1–3 as references.

Make available pencils, erasers, colored pencils, and rulers. Before students begin, suggest they work lightly in pencil to sketch their ideas. Chances are that students will want to try a couple of different approaches to presenting the model.

Circulate among your students, and ask guiding questions to help them develop their models. It is not important that students get the exact thickness of the biosphere, but it should be in the correct location (from just below to just above sea level). Ask: How does the biosphere overlap the other three spheres of Earth? (*It overlaps the ocean and freshwater parts of the hydrosphere. It overlaps the geosphere because living things are found in soil and plants grow there. It overlaps the atmosphere because flying animals are found in the air.*)

## 4. Teach Core Vocabulary. 5 MIN

### Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board or chart paper earlier in the lesson). Ask students to write each term in the upper left corner of an index card and underline it (one term per card):

**biosphere** **species** **biodiversity** **biome**

### Word Work

- **biosphere:** (n. the Earth system that is composed of all the living things on Earth) Compare the words *geosphere, hydrosphere, atmosphere,* and *biosphere*. If *sphere* means system, discuss the meanings of each word part. (Hydro *means "water,"* geo *means "earth,"* atmos *means "air," and* bio *means "life."*)
- **species:** (n. a group of organisms of the same type that are capable of reproducing together) Have students define the term in their own words.
- **biodiversity:** (n. the variety of species on Earth or in any one environment on Earth) Instruct students to write a sentence to define *biodiversity* that includes the word *species*. (*Biodiversity means a lot of different species living in the same place.*)
- **biome:** (n. a large region on Earth with a specific climate that contains certain species) Emphasize to students that the differences in biomes result from the different ways that Earth's other spheres interact. The amount of water, terrain, and weather conditions determine what forms of life can survive in a place. Have students identify two biomes that are dramatically different. (*ocean and desert, for example*)

## 5. Check for understanding. 5 MIN

Activity Pages

AP 6.1
AP 6.2
Answer Key

**Formative Assessment Opportunity**

Scan students' models, looking for recognition that the biosphere layers are very thin and located just above and below sea level.

Ask two or more volunteers to explain their models to the class. Use the discussion to reinforce the main ideas and correct misconceptions.

Distribute Lesson 6 Check (AP 6.2). Have students answer the questions individually or in pairs. After collecting the sheets, use the Answer Key for correct answers and sample student responses.

Prompt students to ask any new questions they may have. Discuss and answer questions as a class. Correct any misconceptions as needed.

# PART B

# Modeling Earth's Systems

## Overview

| Lesson | Big Question | Advance Preparation |
|---|---|---|
| **7.** Sphere Model Fair Preview | How can we model interactions between Earth systems? | Gather materials for a demonstration. (See Materials and Equipment, page 15.) |
| **8.** Hydrosphere Interactions | How does the hydrosphere interact with Earth's other spheres? | Read Student Reader, Chapter 5. Gather materials for a demonstration. |
| **9.** Geosphere Interactions | How does the geosphere interact with Earth's other spheres? | Read Student Reader, Chapter 6. Gather materials for a demonstration. |
| **10.** Atmosphere Interactions | How does the atmosphere interact with Earth's other spheres? | Read Student Reader, Chapter 7. |
| **11.** Biosphere Interactions | How does the biosphere interact with Earth's other spheres? | Read Student Reader, Chapter 8. |
| **12.** Modeling Interaction Between Two Spheres (3 days) | How can I model interactions between Earth's spheres? | Schedule time for research, in class and at home. (See Materials and Equipment, page 16.) |

## Part B: What's the Story?

By now in this unit, students have already learned that Earth has four major spheres: atmosphere, biosphere, geosphere, and hydrosphere. This next series of lessons leads students through readings, discussions, and presentations about the ways in which Earth's systems interact with one another. At the end of the series of lessons, students will model Earth's spheres and their interactions.

**Lesson 7** begins by engaging students in videos that show Earth's spheres interacting. Students will brainstorm—and see examples of—types of models that can be used in Lesson 12 to show how two Earth spheres interact.

This leads to a discussion that gives students an opportunity to think about the type of model that they might want to develop for Lesson 12.

**Lesson 8** extends the concept of the hydrosphere by discussing how the hydrosphere interacts with other Earth spheres through examples provided in a reading selection.

**In Lesson 9**, students build on their understanding of the geosphere by looking at how the geosphere interacts with other spheres on Earth. Students will delve more deeply into these interactions in a reading selection that highlights such phenomena as rain shadows and water tables.

**In Lesson 10**, students focus their attention on the atmosphere and the ways in which it interacts with other spheres to support life on Earth. Students engage in a reading selection that highlights desert dunes, gases, and polar ice volume as examples of atmospheric interactions.

**In Lesson 11**, students gain more exposure to the ways in which Earth's spheres interact by studying the biosphere. Here, students learn through a reading selection about gas exchange, decomposers and organic material, and other processes that support life on Earth.

**In Lesson 12**, students apply what they learned about how Earth's spheres interact to work on a modeling activity. Students will be assigned two-sphere interactions to focus on in this three-day lesson so that, as a whole, the class covers a wide variety of interactions that can be cross-connected. Students will research their assigned spheres and will make models at home that show how the spheres interact. Then students will display their models and circulate around the classroom to examine the models and complete a guided analysis that focuses on the ways the models relate to each other to represent a more complex system of interactions, thus satisfying NGSS Performance Expectation 5-ESS2-1.

So, to repeat, **the atmosphere, biosphere, geosphere, and hydrosphere are the major Earth spheres that interact to support processes that enable life on Earth**. The key concept for students to grasp is that two or more spheres can interact to support simple or complex processes.

LESSON 7

# Sphere Model Fair Preview

**Big Question:** How can we model interactions between Earth systems?

## At a Glance

### Learning Objective

✓ Preview modeling criteria related to the interaction of Earth's spheres.

### Lesson Activities

- student observation
- brainstorming activity

### NGSS References

**Disciplinary Core Idea ESS2.A:** Earth Materials and Systems

**Crosscutting Concepts:** Systems and System Models

**Science and Engineering Practices:** Developing and Using Models

**Developing and Using Models** is important to this lesson because students will begin to think about how models can represent Earth's major systems, or spheres, and how models can show the interactions. In this lesson, students will see examples of Earth's systems interacting and will preview the modeling activity they will complete in Lesson 12. Students will also discuss and brainstorm types of models that can be used to show interactions between the spheres.

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

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

## Core Vocabulary

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. No new Core Vocabulary terms are introduced in this lesson.

interaction system

## Instructional Resources

Activity Page

AP 7.1

**Activity Page**
Types of Models (AP 7.1)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

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

## The Core Lesson 45 MIN

### 1. Focus student attention on the Big Question. 5 MIN

**How can we model interactions between Earth systems?** Remind students that they learned about the hydrosphere, geosphere, biosphere, and atmosphere in previous lessons.

- Ask students to recall what they learned about the atmosphere. Prompt volunteers to share the important terms or concepts they learned about the atmosphere. (*The atmosphere is the air and some liquids and solids that surround our planet.*) Write down any Core Vocabulary words that students use to describe the system, such as *air pressure* and *air mass*.
- Ask students to recall what they learned about the biosphere. Prompt volunteers to share the important terms and concepts they learned about the biosphere. (*The biosphere involves living things.*) Write down any Core Vocabulary words that students use to describe the system, such as *biome*.
- Ask students to recall what they learned about the geosphere. Prompt volunteers to share the important terms and concepts they learned about the geosphere. (*The geosphere is made up of rocks and land structures.*) Write down any Core Vocabulary words that students use to describe the system, such as *rock cycle* and *geologic*.
- Ask students to recall what they learned about the hydrosphere. Prompt volunteers to share the important terms and concepts they learned about the hydrosphere. (*The hydrosphere is made up of all the planet's water, including oceans and glaciers.*) Write down any Core Vocabulary words that students use to describe the system, such as *water cycle* and *reservoir*.

Write the Big Question on the board or chart paper.

- Circle the word *interactions*, and ask students to give examples of an interaction based on what they know from the everyday use of this word. (*shaking hands with someone; giving someone a high-five; playing with someone during recess; working together on an assignment*)
- Circle the words *Earth systems*, and remind students that Earth has four major systems: the atmosphere, biosphere, geosphere, and hydrosphere.

Explain that in this and the following lessons, students will be looking at the ways in which the atmosphere, biosphere, geosphere, and hydrosphere interact with each other. Then they will talk about ways to model these interactions to show how the different spheres work together to support life on Earth.

- Make a class list of questions students can ask themselves as they work through this lesson, such as "How do I know an interaction between Earth's spheres took place?"
- Tell students that you will refer back to this list of questions and address them throughout the lesson.

## 2. Demonstrate examples and guide discussion. 10 MIN

Choose one of the following to stimulate discussion about the interaction of Earth spheres. If time permits, use both. Analyze the evidence that interactions are occurring.

Online Resource

Show a video of a landslide. Use this link to download the CKSci Online Resources Guide for this unit, where specific links to these resources may be found:

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

After watching the video, have students work with a neighbor to answer the following questions:

- Which Earth spheres can you identify as being involved in a landslide? (*hydrosphere, geosphere*)
- How does a landslide represent these spheres interacting? (*Sample answer: A landslide occurs when water from the hydrosphere loosens the rocks of the geosphere, causing it to fall.*)
- Does a landslide also involve an interaction with the biosphere? Why or why not? (*yes, because the changes to the land affect the things that live on the land, such as trees and animals*)
- Do you think a landslide is an example of an interaction that brings about a quick change or a slow change? (*a quick change*)

  **SUPPORT**—If necessary, start with more basic questioning techniques to help students arrive at the connection between the spheres that are interacting to cause a landslide. For example, you might ask students to name the things they saw in the video (*water, rocks*) and then ask questions that help students arrive at the correct understanding, such as the following:

  - Which sphere is responsible for water from the rain? (*hydrosphere*)
  - What happens when too much water mixes with the mountain? (*It loosens the rocks and makes the land change shape.*)
  - The rocks belong to which sphere? (*geosphere*)
  - Therefore, which spheres are interacting to make a landslide? (*hydrosphere and geosphere*)

Online Resources

Show a video of volcanic eruptions. Use this link to download the CKSci Online Resources Guide for this unit, where specific links to these resources may be found:

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

After watching the video, have students work with a neighbor to answer the following questions:

- Which Earth spheres can you identify as being involved in a volcanic eruption? (*geosphere, atmosphere*)
- How does a volcanic eruption represent these spheres interacting? (*An eruption changes the landscape and can blast out lava, which cools into new rock formations. Ash and smoke move into the air, or atmosphere.*)
- Does an eruption also involve an interaction with the biosphere? Why or why not? (*yes, because the things that live on the land, such as trees and animals, including humans, can die when they are in the way of lava and can also be choked by gas or smothered by ash*)
- Do you think an eruption is an example of an interaction that brings about a quick change or a slow change? (*a quick change*)

  **SUPPORT**—If necessary, start with more basic questioning techniques to help students arrive at the connection between the spheres that are interacting during an eruption. For example, you might ask students to name the things they saw in the video (*smoke, lava, rocks, clouds of ash*) and then ask questions that help students arrive at the correct understanding, such as the following:

  - If volcanoes are made up of rocks and are considered land structures, then to which sphere do they belong? (*geosphere*)
  - What happens when smoke and ash are released into the sky? Which sphere does this affect? (*atmosphere*)
  - Therefore, which spheres are interacting during an eruption? (*geosphere and atmosphere*)

  **CHALLENGE**—If time permits, have students come up with more examples of interactions between Earth spheres that cause quick changes, such as floods, earthquakes, or fires, and discuss these in their pairs.

## 3. Brainstorm types of models. 20 MIN

Activity Page

AP 7.1

Distribute Types of Models (AP 7.1). Review the Activity Page with students. Tell students they are looking at an example of a concept map. Explain that a concept map is a type of model that has one main topic in the middle and then moves outward into examples or subtopics. Tell students that they will use this Activity Page to brainstorm different types of models they can make in Lesson 12 when it is time for them to demonstrate how Earth's spheres interact. Let students know that they will fill out the Activity Page as a whole class. They will do this by doing the following:

- looking at pictures of different types of models (see **Know the Standards**)
- writing down notes about the different types of models on the Activity Page so they can choose the one they want to make

Show students a variety of models that they can choose to make in Lesson 12. As you show students each type of model, prompt them to write down the name of the model in one of the outer circles on their Activity Page concept maps. (It does not matter which of the outer circles they use for their notes.) Encourage them to write down notes on each type of model so they can remember what each is like. If necessary, students can also use their Activity Pages to draw quick sketches of the different types of models to help them remember what the models look like.

Use this link to download the CKSci Online Resources Guide for this unit, where specific links to these resources may be found:

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

Online Resources

**Dioramas:** Show students a picture of a diorama. (See the **Online Resources** for links to suggested images.)

Explain that a diorama is a three-dimensional model that students can make using things such as cardboard or poster board that is laid flat, shoeboxes, etc. This is the most common type of model used for science projects or science fairs. Often, dioramas have three-dimensional objects in the front while the back is painted or offers a scenic backdrop. Sometimes, dioramas are just for looking at. Other times, dioramas are made to be experiments in which a student will use the features of the diorama to demonstrate how something works. Offer some examples of how a diorama could be used to show interactions of Earth's spheres, such as a diorama of how canyons are formed.

## Know the Standards

**What is a model?** Models include diagrams, physical replicas, mathematical representations, drawings, graphs, concept maps, and computer simulations. Written narratives can also be regarded as conceptual modeling. Conceptual modeling relies on concepts—or ideas—that are used to help people better understand or learn about the subject being represented in the model. Although models do not correspond exactly to the real world, they bring certain features into focus for students to study more closely.

**Why use models?** Models can be used to represent a single thing (such as a flower) or entire systems (such as how a flower interacts with its environment). Models sometimes contain approximations and assumptions and are not to be confused with exact replications of phenomena or processes. Therefore, students and teachers should recognize limitations when working with models. In science, models are used to represent a system (or parts of a system) under study. Modeling activities encourage students to develop questions and explanations, as well as generate data that can be used to make arguments or communicate ideas to other people. Models are based on evidence. Therefore, they are often adjusted and refined when new evidence to support (or disprove) phenomena is uncovered.

**Diagrams:** Show students a picture of a diagram. (See the **Online Resources** for links to suggested images.)

Explain that a diagram is two-dimensional and can be made on poster board or another type of paper. Diagrams can be used to show how things work together as part of a process or system. Point out the use of arrows on the image to help students understand their importance for communicating how processes work in a particular order or how certain things in the diagram interact. Emphasize the importance of using colors, labels, numbers, and symbols (such as arrows) on diagrams to help viewers better understand them. Tell students that there are many types of diagrams. Some are elaborate and illustrative, such as the one in the example. Show students pictures of other types of diagrams, including:

- concept maps (refer to the one on their Activity Page)
- flowcharts
- trees
- Venn diagrams

Discuss that these are simpler examples of diagrams but that they still can be used to visually represent and model how Earth spheres interact. Offer some examples of how a diagram could be used to show interactions of Earth's spheres, such as how caves are formed.

**Graphs:** Show students a picture of a graph. (See the **Online Resources** for links to suggested images.)

Explain that a graph can be two-dimensional and made on poster board or another type of paper. Graphs can be used to show data and data relationships. Point out the data and data relationships used in the example by analyzing what is shown on the *x*- and *y*-axes. Compare how data is displayed in a line graph and circle graph. Tell students that data can take the form of dates (years), measurements, or amounts. Offer some examples of how a graph could be used to show interactions of Earth's spheres, such as the relationship between the amount of wind in a particular area and the formation of sand dunes.

**Written Narrative:** Tell students that a written narrative is considered a type of conceptual map because it presents a person's ideas about a scientific phenomenon. Let students know that they can write narratives as their "models" so long as their narratives contain the following elements:

- title
- objective
- main idea
- supporting ideas and evidence
- conclusion

Written narratives can contain pictures, diagrams, or illustrations that help support the content. Offer some examples of how a written narrative could be used to show interactions of Earth's spheres, such as a narrative about polar ice volume that includes data related to how the volume has changed over time.

## 4. Summarize and discuss. 5 MIN

Conclude the brainstorming session with a discussion about the types of models and which one each student thinks he or she might want to use and why. Draw attention to similarities between student responses.

Let students know that they do not have to make a firm decision on the type of model they will use right now. Rather, they can use the information they learned today to decide when it comes time to work on Lesson 12.

Tell students that you will not collect the Activity Pages for this lesson. Instead, students can keep them for future reference when they begin Lesson 12.

## 5. Check for understanding. 5 MIN

Activity Page

AP 7.1 and Answer Key

**Formative Assessment Opportunity**

Address any misunderstandings related to models, such as the idea that models are exact replicas of what they represent (models are often completed to scale, which means that each part of the model is approximately the correct size relative to each other part but that no part is the actual size of what the model represents).

LESSON 8

# Hydrosphere Interactions

**Big Question:** How does the hydrosphere interact with Earth's other spheres?

## At a Glance

### Learning Objective

✓ Describe how the hydrosphere interacts with other spheres.

### Lesson Activities

- reading and discussion
- vocabulary instruction
- teacher demonstration

### NGSS References

**Disciplinary Core Idea ESS2.A:** Earth Materials and Systems

**Crosscutting Concept:** Systems and System Models

**Science and Engineering Practices:** Developing and Using Models

**Developing and Using Models** is important because students consider models of how the hydrosphere interacts with other spheres. Throughout their performance tasks, they use models to learn more about specific ways that the hydrosphere interacts with the atmosphere, the geosphere, and the biosphere, building on what they learned about each of these spheres individually in previous lessons.

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

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

## Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 160–161 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

**erosion** **weathering**

**Core Vocabulary Deck:** As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary terms designated in purple on the previous page.

## Instructional Resources

Student Reader

Ch. 5

Activity Pages

AP 8.1

AP 8.2

**Student Reader, Chapter 5**
"Hydrosphere Interactions"

**Activity Pages**
Hydrosphere Interactions (AP 8.1)

Lesson 8 Check (AP 8.2)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

- beaker
- small desk fan
- water
- sediment (sand or flour)
- bowl
- cube of salt
- index cards for student vocabulary deck (2 per student)

## The Core Lesson 45 min

### 1. Focus student attention on the Big Question. 5 min

**How does the hydrosphere interact with Earth's other spheres?** Review what Earth's spheres are and how they are connected. Students should focus on interactions between two spheres at a time while understanding that some interactions involve multiple spheres.

Draw a circle on the board or chart paper to represent Earth. Draw a concentric circle that's just slightly wider than Earth, and label it "atmosphere." Draw rough outlines of Earth's oceans, seas, and lakes, and label them "hydrosphere." Label the land "geosphere." Finally, draw a small circle beside the larger picture, and label it "biosphere." Explain that the biosphere makes up a very small portion of Earth's mass and that most of the interactions among the spheres occur at Earth's surface. Leave the diagram in view as you proceed through Lessons 8 through 11 so that it can be referred to as you discuss examples of system interactions. (See **Know the Standards** for support.)

## Know the Standards

**Systems and System Models:** In this lesson, students must understand the components and interactions that define systems as well as interactions between systems. Explain to students that many different systems are nested within each other in the universe. Earth itself is a system nested within the solar system. And within Earth are the four spheres that are explored in Parts A and B. The purpose of describing and modeling systems is to identify and explore connections and cause-and-effect relationships. It may be helpful to relate this to other systems that students may already know about.

Help students identify components of Earth's four spheres so they will better be able to identify and classify system interactions. Ask the following:

- What sphere is represented by an iceberg? (*hydrosphere*)
- What sphere is represented by a colony of ants? (*biosphere*)
- What sphere is represented by the sandy soil in which the ants live? (*geosphere*)
- In what sphere do you find wind and air masses of different temperatures? (*atmosphere*)

Cycles of matter are involved in some of the examples of Earth system interactions that are described in the lesson and the Student Reader. It may be helpful to work as a class to sketch some of the cycles or provide complete diagrams for students to consult as they read. For this lesson, a figure of the water cycle from Part A could be projected or distributed as a diagram as students read.

## 2. Read and discuss: "Hydrosphere Interactions." 25 MIN

Student Reader

Ch. 5

Prepare to read together, or have students read independently, "Hydrosphere Interactions," Chapter 5 in the Student Reader, which provides examples of the hydrosphere interacting with Earth's other spheres.

### Preview Core Vocabulary Terms

Before students read, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read:

**erosion** **weathering**

### Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

**Page 29**

After reading the introductory paragraph that describes a brief rainstorm and its effects, discuss some of the specific events that occurred. Ask the following:

- Why did earthworms emerge from the soil during the rainstorm? (*The ground became saturated with water, and they can't survive fully underwater*)
- What evidence did you read of water moving back to the atmosphere? (*vapor rising from the wet land, evaporated water from skin*)
- What evidence was there of the hydrosphere affecting the geosphere? (*soil became saturated, pools and streams formed*)
- What evidence was there of the biosphere being helped by the hydrosphere? (*birds feeding on worms, mushrooms and flowers growing, plants being less wilted*)

**Pages 30–31** Emphasize that weathering involves rock breaking—solid pieces of rock permanently losing particles. The particles that break off can be large or small. Some human activities break down rock for industrial purposes, such as making gravel and concrete; explain that this is not an example of weathering. Weathering occurs when aspects of nature, such as the hydrosphere, break up rocks in the geosphere.

Explain that the difference between physical and chemical weathering is how they work to reduce the size or mass of rock. Chemical weathering involves a chemical reaction, with the rock reacting with acidic rain or some other chemical. For example, carbonate in limestone reacts with acid. Physical weathering does not involve chemical reactions. It is just particles of rock being knocked off or wedged apart by contact forces.

**Page 32** Clarify the distinction between erosion and weathering. Erosion is the carrying away of pieces of rock—products of weathering—from a given location. Sediments such as sand, silt, gravel, and dust are all movable by erosion. Wind, moving water, animals, human activities, landslides, and more are all agents of erosion. In some cases, an agent of erosion may also be an agent of weathering. For example, sedimentary rock can be fragile, so the movement of wind or water over it can both weather the rock—break particles off, thereby making the rock smaller—and carry away the pieces in the same action. The erosion phase is the one that actually moves the material to another location.

> **SUPPORT**—You can use sand or flour to demonstrate erosion. Pour a small amount of sand or flour into a bowl. Pour water onto it, and watch as the sand or flour is carried from one place to another. A fan can be used to produce wind. Ask students to identify the sediment and the agent of erosion.

Discuss real-world examples of erosion that students have observed. Again, ask them to identify the eroded material and the agent(s) of erosion. For this lesson, emphasize examples of water erosion, such as cyclical erosion of beaches, storm-surge erosion, and the erosion of the Grand Canyon.

**Page 33** After students have read the page, discuss the fact that water needs more energy than most other materials on Earth's surface to increase in temperature. It also takes much longer to cool than most other materials. As a result, bodies of water such as the Great Lakes often remain relatively warm well after the temperatures of the atmosphere and geosphere have dropped below freezing. This allows those bodies of water to provide heat and moisture to the atmosphere and fuel powerful storms. In spring and summer, those bodies of water will remain relatively cool much longer than the atmosphere and geosphere, which allows coastal areas to have more moderate climates. Have students identify any large bodies of water in their area, and ask whether they think those bodies have an effect on the weather in the area. If there's time, have students do additional research on the subject and share their findings with the class.

**Page 34** Explain that the hydrosphere and biosphere are tightly connected because organisms need water for processes at the cellular level and at higher levels. Water's role as a solvent, for example, allows life to exist in oceans and lakes because

oxygen and carbon dioxide are soluble—they can dissolve in liquid water and remain dissolved at a wide range of temperatures. (See **Know the Science** for further support with this analysis.) To demonstrate solvency, drop a cube of salt into a beaker of water. Display it for students to see. Ask the following:

» What happened to the salt? (*It dissolved.*)

» Does that mean the salt has gone away? (*No. It is still in the water.*)

» How do you think you could see the salt again? (*Let the water evaporate. The salt would be left behind.*)

## 3. Teach Core Vocabulary. 5 MIN

### Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board or chart paper earlier in the lesson). Ask students to write each term in the upper left corner of an index card and underline it (one term per card):

**erosion** **weathering**

### Word Work

- **erosion:** (n. the movement of sediment) Discuss examples of erosion. Have students identify the material that is being eroded and the location from which it is being carried. Have them identify the agents of erosion—water, wind, animal and human activity.
- **weathering:** (n. the process of breaking down rock into smaller pieces) Following the format of your discussion of erosion, discuss examples of weathering. What are the causes and effects? What makes them examples of weathering and not erosion? Are some of them examples of both? Have students write two examples on their Core Vocabulary card.

## Know the Science

**What is one importance of solubility to living things?** ***The ability of a substance to dissolve in water affects organisms living in aquatic environments!*** In general, the solubility of gas in liquid decreases the warmer the solvent is. For example, if a pond gets very warm in the summer, oxygen does not dissolve as easily. This means less oxygen is available to the pond's inhabitants. Cold water can hold more oxygen. This is why the activity levels of some organisms seem much higher when the water is cool. For example, some fish are more likely to chase a fisherman's lure if the water is cool because the fish are getting more oxygen.

## 4. Refocus student attention on the Big Question. 5 MIN

Activity Page

AP 8.1

Distribute Hydrosphere Interactions (AP 8.1). Review the chapter, and have students compile examples of interactions in the chart using important details and key words. Once the examples are compiled, discuss commonalities across the interactions, and have students underline them in their charts.

- How does the biosphere pass water back to the atmosphere? (*Leaves release water vapor.*)
- What two forms of water can travel from the atmosphere to the geosphere during a storm? (*solid, liquid*)
- How can water weather and erode the geosphere? (*It can freeze in cracks of rock, prying the rock apart into smaller pieces; liquid water can pick up and carry sediment.*)

## 5. Check for understanding. 5 MIN

Activity Pages

AP 8.1
AP 8.2
Answer Key

**Formative Assessment Opportunity**

Distribute Lesson 8 Check (AP 8.2), and go over the directions with students. If there is time, have students complete the activity in class. If there is not time, allow students to take the activity home to complete there.

See the Activity Page Answer Key for correct answers and sample student responses. Collect the Activity Pages from students, and check their answers to identify concepts with which they are still struggling. Incorporate adjustments as you open the next lesson. Provide additional guidance for students who need more support.

LESSON 9

# Geosphere Interactions

**Big Question:** How does the geosphere interact with Earth's other spheres?

## At a Glance

### Learning Objective

✓ Describe how the geosphere interacts with other spheres.

### Lesson Activities

- reading and discussion
- vocabulary instruction
- demonstrations

### NGSS References

**Disciplinary Core Idea ESS2.A:** Earth Materials and Systems

**Crosscutting Concept:** Systems and System Models

**Science and Engineering Practices:** Developing and Using Models

**Developing and Using Models** is important because students consider models of how the geosphere interacts with the other spheres. Throughout their performance tasks, students use models to learn more about specific ways that the geosphere interacts with the atmosphere, the hydrosphere, and the biosphere, building on what they learned about each of these spheres individually in previous lessons.

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

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

## Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 160–161 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

| | | | |
|---|---|---|---|
| **aquifer** | leeward | **rain shadow** | topography |
| inorganic | organic | **soil** | **water table** |

**Core Vocabulary Deck** As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit. The deck will include the Core Vocabulary terms designated in purple on the previous page.

## Instructional Resources

Student Reader

Ch. 6

Activity Pages

AP 9.1

AP 9.2

**Student Reader, Chapter 6**
"Geosphere Interactions"

**Activity Pages**
Geosphere Interactions (AP 9.1)

Lesson 9 Check (AP 9.2)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

- bricks (2)
- shoeboxes of equal size (2)
- thermometer
- plastic or glass container (1 quart)
- small stones
- sand or soil
- water
- organic material (leaves, grass clippings, worm castings, etc.)
- index cards for student vocabulary deck (4 per student)

### Advance Preparation

Warm one brick in the sun and cool another in a freezer for a comparison demonstration during the reading support.

## The Core Lesson 45 min

## 1. Focus student attention on the Big Question. 5 min

**How does the geosphere interact with Earth's other spheres?** As in Lesson 8, students will focus on how one sphere interacts with and affects the others. Ask the following:

» What is the geosphere? (*the rock-based components of Earth, both solid and molten*)

If you drew a four-sphere diagram for Lesson 8, revisit it here. Point out that while the geosphere makes up the vast majority of Earth's volume and mass, only a small portion of it is available for interactions with the other three spheres. Much of the geosphere is below and separate from the atmosphere, hydrosphere, and biosphere, though the areas where it is below the hydrosphere, it does interact with that sphere.

Discuss in basic terms how the geosphere's solid surfaces and landforms could affect the atmosphere. Use simple analogies. Ask the following:

» What can the geosphere provide to other spheres if it is warm? (*heat, thermal energy*)

Ask students to picture a new volcano erupting and growing into a tall mountain in the middle of a rain forest. Ask:

» What might this volcano do to the forest? (*The eruption could kill some of the forest. But it could also provide new habitat where plants and other organisms can eventually grow, including habitats at higher elevations.*)

» What could the gases released by the volcano do to the atmosphere over the forest? (*They could change the atmosphere's composition and make it harder for light to penetrate and reach the forest.*)

The work of the geosphere can be very slow. It may be helpful to introduce the geologic time scale and discuss how geologists often study processes that are best measured by that scale instead of scales we use in our everyday lives or in analyzing other spheres. While parts of the hydrosphere's water cycle can be observed in a day or less, patterns in the geosphere can take hundreds, thousands, or millions of years to repeat.

## 2. Read and discuss: "Geosphere Interactions." 25 MIN

**Student Reader**

**Ch. 6**

Prepare to read together, or have students read independently, "Geosphere Interactions," Chapter 6 in the Student Reader, which provides examples of the geosphere interacting with Earth's other spheres.

### Preview Core Vocabulary Terms

Before students read, write these terms on the board or chart paper. Encourage students to pay special attention to these terms as they read:

**aquifer** **rain shadow** **soil** **water table**

## Know the Standards

Earth is a system nested within the solar system, which in turn is part of a galaxy, which is part of a universe. Within Earth are the four systems, or spheres, that are explored in Parts A and B. The Disciplinary Core Idea (DCI) aligned to Part B is **ESS2.A Earth's Materials and Systems:** Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.

Note that soil is considered part of the geosphere. Soil can consist of organic material and organisms as well, so it is not entirely rock-based. Soil can also be moist (hydrosphere) and aerated (atmosphere). But for the purpose of describing the spheres and their interactions, soil here is considered a component of the geosphere. Because so much of the geosphere is far away from the other spheres, in Earth's mantle and core, the crust and the upper mantle are the most interactive components of the geosphere with the other three spheres.

## Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

**Page 35**

Before or after reading the introductory paragraph that describes how a new island is formed, share media that depict some of the events.

Online Resources

- **Island Formation:** Show a time-lapse animation, made from satellite images, of the formation of Hunga Tonga-Hunga Ha'apai in the Kingdom of Tonga, which is in the South Pacific Ocean.

Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

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

Discuss with students how what they saw in the animation is similar to or different from what they read about in the Student Reader. Ask the following:

» What can happen when a volcano erupts underwater but close to the water's surface? (*An island can form.*)

» How is a volcanic island an interaction between the geosphere and both the hydrosphere and the biosphere? (*The volcano [geosphere] forms an island [geosphere] in water [hydrosphere]. It will also eventually have life [biosphere] on it.*)

**Pages 36–37**

Just as the sun's energy heats landmasses on Earth, landmasses on Earth can help heat the atmosphere. Demonstrate for students how this works.

Step 1: Take two standard bricks, and place one in the sun until it is warm to touch.

Step 2: Place the other brick in a freezer.

Step 3: Measure and record the air temperature in the room.

Step 4: Take two empty shoeboxes of equal size.

Step 5: Place the warm brick in one shoebox and the cool brick in the other. Put the lids back on the shoeboxes.

Step 6: After nine minutes, punch a hole in each shoebox's lid.

Step 7: Slip the bulb of the thermometer through the hole in one box, and record the temperature. Then do the same for the other box.

Discuss with students the results. The shoebox with the warm brick should contain warmer air. The shoebox with the cool brick should contain cooler air. Ask students why they think this is true based on what they have learned so far from the Student Reader.

Explain that the Sierra Nevada in California is a good example of a rain shadow. Show students the mountain chain on a map, and have them imagine moist air moving from the Pacific Ocean. Ask the following:

» What do you think will happen to the air as it moves toward the mountains, and how will that affect the land on the other side of the mountains? (*To the west of the mountains, precipitation falls as snow or rain, and the water flows downhill to the lower areas of the state. East of the mountains, it is much drier.*)

**Pages 38–39**

After students have read pages 38–39, ask the following:

» Which is more likely to get high precipitation, land at low elevation or land at high elevation? (*land at high elevation*)

» If North America continues to move mostly west and Asia continues to move mostly east, what will eventually happen? (*They will collide [though this will take hundreds of millions of years].*) What will happen to the water between them? (*It will be squeezed out into new bodies of water.*)

**CHALLENGE**—Have students research isostasy, or how ice, water, or other materials can affect the movement of Earth's crust up or down. (See **Know the Science** for further support with this challenging analysis.)

**Page 40**

Students who have never heard of water wells or aquifers may be surprised to learn that there is so much groundwater beneath their feet. To give them a sense of the scale of groundwater, tell them that there is ninety times as much water under the ground as there is in the world's lakes and rivers. You can also show them a map of a large aquifer, such as the Ogallala Aquifer under the Great Plains states of the United States. About thirty percent of the groundwater used to irrigate crops is pumped from this aquifer. It also supplies drinking water to several million people.

**SUPPORT**—An aquifer and rising water table can be demonstrated through a model using a clear plastic or glass container, some gravel or other small stones, sand or soil, and water. Place the stones in the bottom of the container, and then add a layer of soil or sand. Pour in some water, and let students watch as it settles in the empty spaces of the rock. Call this the aquifer. Explain that the surface of the settled water is the water table. Add some more water, and explain that this is an example of the water table rising as more groundwater is added. Explain that an aquifer can be replenished if it takes in as much water as it loses. If more water is pumped out than can be replaced by precipitation slowly seeping through the soil, the water table will sink.

## Know the Science

**What is isostasy?** ***The movement of Earth's crust up or down depending on materials, such as ice, that may be weighing it down!*** The buildup of snow and ice can form ice caps, ice sheets, and glaciers. The weight of frozen water and land can be so great that the underlying crust of Earth sinks deeper into the upper mantle. When the ice melts and drains away, the crust can rebound up and away from the mantle, elevating the island or continent. In this way, the pieces of Earth's crust are afloat atop the mantle, and the thicker, heavier pieces of crust (and their overlying material) sink lower into the mantle than thinner, lighter pieces.

**Page 41**

Online Resources

Consider taking a virtual tour of volcanic islands of the South Pacific to show students how heavily forested they can be after many years. Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

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

Fiji, Tonga, Niue, and Samoa are some islands or island chains that can be explored in an Earth browser. Ask students how they think these islands got this way.

You can adapt the aquifer setup from the Support on the previous page to show how accumulated organic material can change soil. Add bits of leaves, grass clippings, worm castings, or other organic material to the container, and mix it in with the soil. Ask students how organic materials benefit the soil. (*They add nutrients, which plants and other organisms use to live and grow.*) (This can also be set aside and used again in Lesson 11.)

**Page 42**

Discuss with students the fact that the geosphere provides physical spaces and habitats for organisms as well as for chemicals that organisms need for survival and growth.

> **SUPPORT**—Use the aquifer container once again. Discuss with students the different environments that are visible in the small container: organic material mixed with sand, a layer of porous rock below, even the water. Have students provide examples of how each of these can be its own space for organisms to grow in.

Discuss with students how a mineral in rock can end up in the human body. Draw a pathway on the board or chart paper that begins with rock, then groundwater, then plants, and on to humans or to animals that eat plants and are then eaten by humans. Tactfully explain that humans also release waste that contains minerals and cycles back through the system.

## 3. Teach Core Vocabulary. 5 MIN

### Prepare Core Vocabulary Cards

Direct student attention to the Core Vocabulary words (displayed on the board or chart paper earlier in the lesson). Have students write each term in the upper left corner of an index card and underline it (one term per card).

**soil** **aquifer** **water table** **rain shadow**

### Word Work

Have students write definitions in their own words for each of the following terms:

- **soil:** (n. the top layer of Earth's land that often has a mix of organic and inorganic material)
- **aquifer:** (n. an underground region of rocky material containing water that can be drawn out through a well)
- **water table:** (n. the upper surface or level of groundwater)

Have students draw a simple model of Earth's surface, including soil, an aquifer, and the water table, on the back of one of these cards. They should use leader lines or brackets to indicate where these features are relative to each other and should label them. Ask: What two spheres are interacting? (*geosphere and hydrosphere*)

- **rain shadow:** (n. a dry region on one side of a mountain that results from precipitation on the other side of the mountain removing moisture from clouds) Discuss why *shadow* is part of this term. How is the phenomenon like a shadow where there is little to no light? (*Something physically blocks the movement of moisture, just as an object physically blocks the transmission of light.*) Then have students write the term in a sentence on their card.

## 4. Refocus student attention on the Big Question. 5 MIN

Activity Page

AP 9.1

Distribute Geosphere Interactions (AP 9.1). Review the chapter, and compile examples of interactions in the chart using only important details and key words. Once the examples are compiled, discuss commonalities across the interactions. Ask the following:

- How does the geosphere play a role in storing the freshwater portion of the hydrosphere? (*Aquifers store groundwater below Earth's surface; cold landmasses can store water as ice caps and glaciers.*)
- How does topography affect the atmosphere? (*Elevated land features such as mountains can force air masses up, where they cool and condense, and precipitation falls.*)
- What does the geosphere provide to the biosphere in chemical terms? (*minerals*)
- What does the geosphere physically provide to the biosphere? (*space, habitat, shelter*)

## 5. Check for understanding. 5 MIN

Activity Pages

AP 9.1
AP 9.2
Answer Key

**Formative Assessment Opportunity**

Pass out Lesson 9 Check (AP 9.2) and go over the directions with students. If there is time, have them complete the activity in class. If there is not time, allow them to take the activity home to complete there.

See the Activity Page Answer Key for correct answers and sample student responses. Collect the Activity Pages from students and check their answers to identify concepts with which they are still struggling. Incorporate adjustments as you open the next lesson. Provide additional guidance for students who need more support.

LESSON 10

# Atmosphere Interactions

**Big Question:** How does the atmosphere interact with Earth's other spheres?

## At a Glance

### Learning Objective

✓ Describe how the atmosphere interacts with other spheres.

### Lesson Activities

- reading and discussion
- vocabulary instruction
- demonstrations

### NGSS References

**Disciplinary Core Idea ESS2.A:** Earth Materials and Systems

**Crosscutting Concept:** Systems and System Models

**Science and Engineering Practices:** Developing and Using Models

**Developing and Using Models** is important because students consider models of how the atmosphere interacts with the other spheres. Throughout their performance tasks, students use models to learn more about specific ways that the atmosphere interacts with the geosphere, the hydrosphere, and the biosphere, building on what they learned about each of these spheres individually in previous lessons.

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

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

## Core Vocabulary

Core Vocabulary words are shown in purple below. During instruction, expose students repeatedly to these terms, which are not intended for use in isolated drill or memorization.

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. A Glossary on pages 160–161 lists definitions for both Core Vocabulary and Language of Instruction terms and the page numbers where the Core Vocabulary words are introduced in the Student Reader.

cellular respiration  respiration  **deposition**

**Core Vocabulary Deck:** As a continuous vocabulary instruction strategy, have students develop a deck of vocabulary cards that will be used in various activities across this unit as a part of Word Work. The deck will include the Core Vocabulary term designated in purple on the previous page.

## Instructional Resources

Student Reader

Ch. 7

Activity Pages

AP 10.1
AP 10.2

**Student Reader, Chapter 7**
"Atmosphere Interactions"

**Activity Pages**
Atmosphere Interactions (AP 10.1)

Atmosphere Interactions Crossword Puzzle (AP 10.2)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

- index cards for student vocabulary deck (1 per student)

## The Core Lesson 45 MIN

### 1. Focus student attention on the Big Question. 5 MIN

**How does the atmosphere interact with Earth's other spheres?** This lesson is the third in a series of four lessons that provides specific examples of interactions between one of Earth's spheres and the other three. As in Lessons 8 and 9, students will focus on how one sphere interacts with and affects the others. Ask: What is the atmosphere? (*the blanket of air that surrounds Earth*)

Revisit the Activity Pages from Lessons 8 and 9 to discuss interactions of the hydrosphere and geosphere. Students may have the misconception that air does not have mass or weight. Explain that their bodies feel the weight of the atmosphere. At sea level, it is one atmosphere of pressure—equal to about fourteen pounds per square inch (psi). (You can make psi concrete for students by allowing them to balance a weight on a one-by-one-inch square stick on the palm of one hand.) At higher elevations, there is less atmospheric pressure, which can sometimes be experienced by a popping sensation in the ears.

## Know the Standards

Within Earth are the four systems, or spheres, that are explored in Parts A and B. The Disciplinary Core Idea aligned to Part B is **ESS 2.A Earth's Materials and Systems:**

Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.

Discuss some of the basic similarities between the atmosphere and other spheres. Ask the following:

- What kinds of energy transfers occur in the atmosphere, the geosphere, and the hydrosphere? (*thermal energy transfers, also known as heat*)
- What does heat do to the matter that makes up the different spheres? (*It usually causes it to expand and become more energetic.*)
- What is the main source of energy that causes the atmosphere to change? (*the sun*)

Discuss the relative position of the atmosphere and how it plays a role in shaping the other spheres. Ask the following:

- Where is the atmosphere compared to the other spheres? (*mostly outside or above them, between space and the others*)
- What do you think the atmosphere does in terms of allowing in or blocking solar energy to Earth's systems? (*It allows some energy in, but it also blocks some of it.*)

Focus on the atmosphere's composition and movement within it. Clouds (water vapor) are technically part of the hydrosphere, but they form and break down in the atmosphere. This is similar to how the hydrosphere contains much of the biosphere, particularly in the oceans, and that large bodies of water contain dissolved solutes as well as suspended particles of the geosphere. While the spheres are distinct, they are mingling and interacting in significant ways; the lines between them can be blurred. Focus the discussion on two spheres at a time, but remind students that the spheres are very much intertwined.

## 2. Read and discuss: "Atmosphere Interactions." 25 MIN

**Student Reader**

**Ch. 7**

Prepare to read together, or have students read independently, "Atmosphere Interactions," Chapter 7 in the Student Reader, which provides examples of the atmosphere interacting with Earth's other spheres.

### Preview Core Vocabulary Term

Before students read, write **deposition** on the board or chart paper. Encourage students to pay special attention to the term as they read.

### Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

**Page 43**

Explain to students that the air is made up of different types of gases. (See **Know the Science** for further support with this analysis.) It is these gases that react with energy from the sun. These gases can also react with Earth's other spheres. Ask the following:

» What is a medium? (*a substance through which something else can travel*)

» How is Earth's atmosphere a medium? (*Sunlight travels through it.*)

**Page 44**

After students have finished reading the page, compare the large-scale interaction between the atmosphere and the geosphere that results in a transfer of matter from one side of the Atlantic Ocean to the other to some dust or sand being blown across a dry sports field or sidewalk. Ask the following:

» What is the difference between the Sahara dust being blown from Africa to the Americas and a few grains of sand blown across a sidewalk? What's the same? (*Scale. The first example occurs on a very large scale. The second is on a small scale. The phenomenon is basically the same in each, but because the scale is so much larger in the first one, it can have a larger impact on the geosphere.*)

It may be helpful to pull out a globe (real or virtual) and discuss the unequal heating of Earth's surface. You can use a flashlight to model the sun and the way light is more concentrated at latitudes where sunlight strikes more directly. (In many virtual Earth browsers, there is an option to turn the sun on or off.) Demonstrate how sunlight strikes Earth, and ask students to explain what that means for which parts of the planet are the hottest and how this affects wind.

**Pages 45–46**

Discuss the passage that describes how wind erosion picks up sediment, which in turn knocks loose even more sediment. The analogy that can be made here is to sandblasting—mixing compressed air with sand to make a powerfully abrasive wind to remove paint from some surfaces. Ask the following:

» Why is wind carrying sand more abrasive and more likely to cause erosion of the geosphere than wind that is not carrying anything? (*There is more matter, more particles to collide with surfaces of the geosphere and knock the geosphere's particles loose.*)

Point to the image of the coastal sand dunes and draw attention to the ocean in the background. Ask the following:

» Why does the pattern and direction of the dunes' shapes look similar to ocean waves? (*Both are driven by the wind. The wind's direction is forming wavelike dunes just as it is forming water waves on the ocean's surface.*)

## Know the Science

**What is the composition of the atmosphere?** ***On average, 78% of Earth's atmosphere is nitrogen gas, 20% is oxygen, 1% is argon,*** **and** ***0.04% is carbon dioxide.*** There are trace amounts of other gases. Note that these shares do not include water vapor, which is abundant in the atmosphere but is not considered a component of air.

**Pages 47–48** After students have finished reading the pages, relate analogies of the atmosphere as a window and blanket or a greenhouse. Ask the following:

- How does the atmosphere help warm a body of water on Earth's surface? Name the two ways. (*It lets sunlight in from space, and it retains some of the heat that would otherwise go back out to space.*)
- What happens to the geosphere if more of the sea ice, ice caps, glaciers, and snow of Earth's polar regions melts? (*More of the geosphere will be exposed to the sun.*)
- How will a more exposed geosphere affect the rate of melting and heating in the hydrosphere and atmosphere? (*It could increase it, making things even warmer.*)

Discuss the role of the atmosphere as a medium for water. Ask the following:

- What are some surface features made of water that could not occur without the help of the atmosphere? (*Most lakes, rivers, and ponds would not occur. Glaciers, ice caps, and snow would not be possible.*)
- What about groundwater? (*Stores of groundwater might become very rare, as there would be no precipitation to fill or replenish aquifers.*)

**Page 49** Point out that even though carbon dioxide is relatively rare compared to oxygen, there is enough to support photosynthetic organisms, such as plants and algae.

Oxygen is used in the process of respiration. Some students may have the misconception that plants do not need oxygen. Explain that plants and algae need oxygen, too, but that plants also produce and release oxygen as a product of photosynthesis.

**Page 50** This is an opportunity to discuss examples of interactions between the biosphere and the atmosphere.

- How do plants and animals interact with oxygen and carbon dioxide in the atmosphere? (*Plants take in carbon dioxide and release oxygen. Animals take in oxygen and release carbon dioxide. The atmosphere provides these gases that sustain life.*)
- How could the biosphere counteract or make up for the amount of carbon that human activities are releasing into the atmosphere? (*Photosynthetic organisms could take in more carbon dioxide, convert it to food, grow larger or more abundant, and then feed more plant-eating organisms such as animals.*)
- What kind of evidence would you look for to determine whether the biosphere is in fact keeping up with the amount of carbon we are emitting into the atmosphere? (*We could measure how much of Earth's surface is covered with plants. We could try to estimate how much algae is in the oceans and lakes. We could try to measure how many animals there are.*)

Though carbon dioxide also dissolves in the oceans, rivers, and lakes and is also consumed during chemical weathering reactions, plants remove a great deal of carbon dioxide from the atmosphere. Explain that current science suggests that the biosphere is not able to keep up with the amount of carbon that's in the atmosphere. Have students describe the possible effects of climate change, such as drier areas and more forest fires, melting ice caps, rising sea levels, and more severe tropical storms.

## 3. Teach Core Vocabulary. 5 MIN

### Prepare Core Vocabulary Card

Direct student attention to the Core Vocabulary word **deposition** (displayed on the board or chart paper earlier in the lesson). Have students write the term in the upper left corner of an index card and underline it.

### Word Work

**deposition:** (n. the dropping of sediment in a new location) Have students locate their cards for the Core Vocabulary terms *weathering* and *erosion*. Emphasize that the process of deposition occurs in conjunction with these other two geologic processes. Have students write a definition of *deposition* in their own words.

## 4. Refocus student attention on the Big Question. 5 MIN

Activity Page

AP 10.1

Distribute Atmosphere Interactions (AP 10.1). Review the chapter, and compile examples of interactions in the chart using only important details and key words. Once the examples are compiled, discuss commonalities across the interactions. Ask questions to get at the interactions among the spheres:

- How does the atmosphere play a role in distributing the hydrosphere? (*Water vapor can enter the atmosphere, be carried great distances,* and *then fall to Earth's surface.*)
- What does the atmosphere provide to the biosphere? (*It's a medium through which sunlight travels, it traps some heat, it provides three important gases, and it distributes water.*)
- How does the atmosphere shape the geosphere in chemical terms? (*Iron in the geosphere reacts with oxygen in the atmosphere, causing rust. Sulfur in the air can dissolve in rain and chemically weather rocks.*)

## 5. Check for understanding. 5 MIN

Activity Pages

AP 10.1
AP 10.2
Answer Key

**Formative Assessment Opportunity**

Have students complete Atmosphere Interactions Crossword Puzzle (AP 10.2). Students can consult their Core Vocabulary cards as they do the puzzle.

See the Activity Page Answer Key for correct answers. Collect the puzzles and check students' answers, or provide answers to them and discuss as a class.

LESSON 11

# Biosphere Interactions

**Big Question:** How does the biosphere interact with Earth's other spheres?

## At a Glance

### Learning Objective

✓ Describe how the biosphere interacts with other spheres.

### Lesson Activities

- reading and discussion
- demonstrations

### NGSS References

**Disciplinary Core Idea ESS2.A:** Earth Materials and Systems

**Crosscutting Concept:** Systems and System Models

**Science and Engineering Practices:** Developing and Using Models

**Developing and Using Models** is important because students consider models of how the biosphere interacts with other spheres. Throughout their performance tasks, they use models to learn more about specific ways that the biosphere interacts with the atmosphere, the geosphere, and the hydrosphere, building on what they learned about each of these spheres individually in previous lessons.

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

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

## Core Vocabulary

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. No new Core Vocabulary terms are introduced in this lesson.

organic material toxin transpiration

## Instructional Resources

Student Reader

Ch. 8

Activity Pages

AP 11.1

AP 11.2

**Student Reader, Chapter 8**
"Biosphere Interactions"

**Activity Pages**
Biosphere Interactions (AP 11.1)

Lesson 11 Check (AP 11.2)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

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

## The Core Lesson 45 min

### 1. Focus student attention on the Big Question. 5 min

**How does the biosphere interact with Earth's other spheres?** This lesson is the last in a series of four lessons that provides examples of interactions between one of Earth's spheres and the other three. As in Lessons 8, 9, and 10, students will focus on how one sphere interacts with and affects the others. In this lesson, the biosphere is the focus. Ask: What is the biosphere? (*all the living things on Earth*)

Review the Activity Pages that students completed in Lessons 8, 9, and 10. As with the other spheres, the biosphere is defined, but its shape and dimensions are not easily defined. For example, a tree is an organism and contains a lot of organic material, but it also contains a lot of water (hydrosphere), some minerals (from the geosphere), and molecules of nitrogen, oxygen, and carbon dioxide that it exchanges with the atmosphere. Discuss the cycles of matter and energy that occur between the biosphere and the other spheres. Ask the following:

» What kinds of energy does the biosphere need? (*sunlight, thermal energy, chemical energy*)

## Know the Standards

Within Earth are the four systems, or spheres, that are explored in Parts A and B. The Disciplinary Core Idea aligned to Part B is **ESS 2.A Earth's Materials and Systems:**

Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.

» When a tree falls and breaks down, what kinds of matter are cycled back into the other spheres? (*Water cycles back into the hydrosphere; carbon, nitrogen, and oxygen cycle back into the geosphere and atmosphere.*)

In other lessons, you discussed the relative positions, or locations, of the other spheres. Do the same with the biosphere. Ask the following:

» Where is the biosphere compared to the other spheres? (*It can be found in all spheres, but it is mostly on the surface of the geosphere or in the hydrosphere. Some organisms spend a lot of time in the atmosphere, but they need to land on the other two.*)

Note that humans are part of the biosphere. This may be an opportunity to discuss whether everything humans do is considered an interaction between the biosphere and other spheres. For example, is the combustion of fossil fuels as natural as exhaling water vapor? There are no right or wrong answers in this kind of discussion, but it may help students comprehend that they are organisms—specifically, mammals and primates—and as such they are interacting with and depending on the other spheres just as mosquitoes, earthworms, bacteria, sharks, Komodo dragons, and other organisms do.

## 2. Read and discuss: "Biosphere Interactions." 30 MIN

**Student Reader**

**Ch. 8**

Prepare to read together, or have students read independently, "Biosphere Interactions," Chapter 8 in the Student Reader, which provides examples of the atmosphere interacting with Earth's other spheres.

### Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

**Page 51**

After students have read the page, point out the passage about "breath" that is visible outside on a cold day being water vapor that condenses on contact with cold air. The exhaled air also contains oxygen, nitrogen, and carbon dioxide, but the visible component is the condensed droplets of water vapor. This means the hydrosphere is involved as well.

> **SUPPORT**—The water vapor in exhaled air can also be made to condense and become visible by having students exhale against glass or another smooth object.

Discuss other interactions of the biosphere. Facilitate discussion by providing examples of organisms and asking what they do or digging deeper into some of the examples in the text. For example, you might explain that the seafloor has layers of material that are made of the remains of marine organisms and that some beaches are made of sand that is made of tiny fragments of coral.

**Page 52**

After students have read the page, ask: What are the two gases discussed here that are considered components of air? (*carbon dioxide, oxygen*) Emphasize that the carbon and oxygen cycles operate because there is a kind of balance among the things that take in and release these elements.

Explain that each small peak or spike in the graph represents a winter because that is when atmospheric carbon dioxide tends to be highest in a given year. (Leafy plants are removing more carbon dioxide from air during summer months.)

Finally, turn the class's attention to the overall trend in the NOAA graph. While the seasonal up-and-down pattern keeps going, the trend shows an increase in the concentration of carbon dioxide in the atmosphere, from about 310 parts per million (ppm) in 1960 to over 400 in 2018. Ask: What does "parts per million" mean? (*For every million parts or particles in the air, X many are the given gas.*) If students go online looking for information, they may run across the issue that sometimes ppm is recorded by weight and sometimes it is recorded by volume. Some tables of numbers will not seem to match up if they are reported in different units.

**Pages 53–54**

Students may wonder why plants take in water only to release it through transpiration. Explain that the process helps keep water and other fluids moving up the plant from the ground. As water molecules are released from plant leaves, new water molecules are drawn in from the roots and trunk. Transpiration keeps the flow going. Ask: What spheres does transpiration represent? (*biosphere, hydrosphere*)

In addition to water, nitrogen and methane also affect the biosphere. (See **Know the Science** for support with this analysis.)

**Page 55**

Help students formulate a summary of how the biosphere affects the hydrosphere in terms of its distribution of water and the nature of the water. Ask the following:

- What does the biosphere do that affects where the hydrosphere is? (*It absorbs liquid water, releases liquid water [waste], and releases water vapor. This results in movement of water, which alters its distribution within the hydrosphere.*)
- What does the biosphere do that affects what's in the hydrosphere? (*Some organisms live in water, so they are part of the system. They take in and release different things, such as oxygen and carbon dioxide. They can release other substances. In general, they change the amounts of things other than water molecules in the hydrosphere.*)

## Know the Science

**What is nitrogen fixation?** ***A process by which living organisms make nitrogen in a form that can be used by plants!*** Bacteria and other microbes can help fix nitrogen for plant roots. Nitrogen gas from the atmosphere has two atoms of nitrogen. However, plants need forms of nitrogen that are combined with hydrogen and/or oxygen. The microbes provide those forms.

**Pages 56–58**

It may be helpful to differentiate the meaning of *organic* in this context from the definition and criteria that are applied to certified organic products, such as organic dairy milk or organic grapes. Here, *organic* simply means carbon-based and made by a living thing. With organic certification, the term refers more to the way the products are raised or grown, the types of fertilizers and pesticides applied, and other specifics.

Online Resources

Show a video of the bumphead (aka humphead) parrotfish feeding as a herd on a coral reef and excreting sandy waste. Ask students to describe which spheres are shown by the video. (*biosphere, hydrosphere, and geosphere*) Use this link to download the CKSci Online Resources Guide for this unit, where a specific link to this resource may be found:

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

## 3. Refocus student attention on the Big Question. 5 MIN

Activity Page

AP 11.1

Distribute Biosphere Interactions (AP 11.1). Review the chapter, and compile examples of interactions in the chart using only important details and key words. Once the examples are compiled, discuss commonalities across the interactions. Ask questions about interactions among the biosphere and other spheres:

- How does the biosphere interact with the atmosphere? (*gas exchange, adding water vapor*)
- What are two different ways the biosphere affects the hydrosphere? (*It affects the distribution of water by taking in liquid water and releasing water vapor and liquid water that can travel to different locations, usually through the atmosphere. It also changes what's in the water both physically [things living in or suspended in water] and chemically [solutes].*)
- How does the biosphere shape the geosphere? (*It can weather and erode the geosphere and add organic material that helps produce soil.*)

## 4. Check for understanding. 5 MIN

Activity Pages

AP 11.1
AP 11.2
Answer Key

**Formative Assessment Opportunity**

Have students complete Lesson 11 Check (AP 11.2). See the Activity Page Answer Key for correct answers and sample student responses. Collect the assessment, and check students' answers to identify concepts with which students are still struggling. Incorporate adjustments as you open the next lesson. Provide additional guidance for students who need more support.

LESSON 12

# Modeling Interaction Between Two Spheres

**Big Question:** How can I model interactions between Earth's spheres?

## At a Glance

### Learning Objectives

- ✓ Create a single model that illustrates Earth's four spheres.
- ✓ Extend your model illustrating Earth's four spheres to represent their interactions.

### Lesson Activities (3 days)

- model planning and research
- model design and construction
- model presentation
- analysis and evaluation

### NGSS References

**Disciplinary Core Idea ESS2.A:** Earth Materials and Systems

**Crosscutting Concept:** Systems and System Models

**Science and Engineering Practices:** Developing and Using Models

**Developing and Using Models** is important to this lesson because students will be building models that represent how two Earth spheres interact. In this three-day lesson, students will start on Day 1 by planning and researching the interactions they will be representing in the models. On Day 2, students will plan out their designs but will build their models primarily at home. On Day 3, students will present their models and evaluate others to complete a guided analysis of how the interactions of the spheres work together to represent a more complex system of interactions, thus satisfying the Performance Expectation 5-ESS2-1.

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

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

## Core Vocabulary

**Language of Instruction:** The Language of Instruction consists of additional terms, not considered a part of Core Vocabulary, that you should use when talking about and explaining any concepts in this lesson. The intent is for you to model the use of these words without the expectation that students will use or explain the words themselves. No new Core Vocabulary terms are introduced in this lesson.

interaction sphere system

## Instructional Resources

Activity Pages

AP 12.1
AP 12.2
AP 12.3

**Activity Pages**
Model Planning (AP 12.1)

Earth Interactions Take-Home Letter (AP 12.2)

Model Analysis (AP 12.3)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

- internet access for research

Students will build their models at home using materials that they are able to access outside the classroom. If students have limited access to materials that are necessary to carry out this lesson successfully, check your school policy on lending out classroom materials—such as glue, markers, and craft wire—to students for use at home.

## Advance Preparation

**Day 1**

Have a list of sphere pairs ready to assign to students. Or you can assign students specific interactions to model in their presentations. Use the examples of spheres and interactions below or similar examples for the assignment.

- **Atmosphere/Biosphere Interactions**
  - gases used by living things; gas exchange
  - deposition of nutrients and metals to the plant or ground surface
- **Atmosphere/Geosphere Interactions**
  - volcanic eruption
  - weathering and erosion (e.g., desert dunes)
- **Atmosphere/Hydrosphere Interactions**
  - water cycle
  - acid rain
- **Biosphere/Geosphere Interactions**
  - earthquake
  - decomposers adding organic material to sediment to form soil

- **Biosphere/Hydrosphere Interactions**
  - rain forest biome
  - red tides
- **Geosphere/Hydrosphere Interactions**
  - canyon or cave formation
  - water table

Remember that some of these interactions may involve more than two spheres, but students only need to model how two spheres interact within the example being presented.

Schedule time for students to use the library for research, or have research materials and computers available to students in your classroom.

**Day 2**

Students will use time in class to design their models. At the end of class, the take-home Activity Page will be distributed to students to share with their family members. This Activity Page serves as support to tell family members and students what they will need to do in order to build their models at home.

Decide how many days to give students to build their models at home. Let students know ahead of time when they can plan to bring their completed models into class for the third and final day of this lesson. Use the prompt below to decide on a date for when to hold Day 3 of this lesson:

**Completed models must be brought back to class on** _____.

**Day 3**

Plan space in the classroom for all the models to be displayed. You may need to rearrange tables, desks, and chairs to make enough room for students to safely display their models as well as circulate around the room as they evaluate their peers' models.

***Because students will be working on their models at home over the course of several days, Day 3 of this lesson will not occur consecutively after Day 2.***

## The Core Lesson THREE DAYS, 45 MIN EACH

### 1. Day 1: Focus student attention on the Big Question. 10 MIN

**How can I model interactions between Earth's spheres?** Review the Activity Pages students completed in each of the previous lessons about the ways in which the hydrosphere, geosphere, biosphere, and atmosphere interact with each other.

With students, create a master chart of all the interactions they recorded.

Remind students that they also brainstormed the different types of models that can be used to show the interactions between Earth's spheres.

Tell students that this lesson will span several days and that students will be making models that represent how two Earth spheres interact. Break down the activity so that students understand what they will be doing during each day over the course of this lesson.

- Let students know that today you will be assigning them the spheres. You will then give students time to research in the library the ways in which those two spheres interact.
- Tell students that on the next day, they will work on planning and designing their models in class. Then, students will build their models at home and will have several days to complete them.
- On the third day of this lesson, students will bring their models to class and display them around the room. Students will complete a gallery walk to evaluate each other's models.

## 2. Preview the activity. 5 MIN

**Activity Page**

**AP 12.1**

Assign students their spheres. If you chose to also assign students their specific interactions to model, give these assignments out to students at this time.

Once students know which spheres they will be working with, distribute Model Planning (AP 12.1). Review the Activity Page together, and go over the directions.

If you already assigned students their specific interactions to model, tell them to write down the interaction in the second question. If you have not assigned the interaction to students, tell them that they will need to conduct research on the ways in which their two spheres interact and come up with an interaction to demonstrate in their model.

When reviewing the part of the Activity Page that asks, "Which type of model will you use to show how these two spheres interact?" have students recall the types of models they learned about: dioramas, diagrams, graphs, and written narratives.

> **SUPPORT**—If necessary, remind students of the different types of diagrams that were discussed in Lesson 7, including flowcharts, tree diagrams, and Venn diagrams.

Focus student attention on the drawing box on the second page of the Activity Page. Let students know that they will work on their designs and sketches during the second day of this lesson. They can only fill this drawing box out once they have all the information they need for their interactions.

On the final page of the Activity Page is a list of criteria for students' models. Review the criteria list with students carefully, and ensure understanding.

## 3. Support student research. 30 MIN

Allow time for students to start researching their spheres and interactions in the classroom or in the library. Circulate around the room as students conduct their research using their Activity Pages as a guide.

Online Resources

**SUPPORT**—If necessary, give students suggestions for online resources they can use to find information about their spheres and/or specific types of interactions. (See the Online Resources for links to suggested sources: **www.coreknowledge.org/cksci-online-resources**.)

As students work on their research, prompt them to start thinking about what kind of model they think would work best to represent the spheres and interactions they were assigned. Encourage students to take out Activity Page 7.1, where they took notes on the different types of models.

**SUPPORT**—If necessary, help students plan out their ideas for their models. Ask guiding questions, such as "How can you show the interaction between rain and soil in your model?" and "Think about the types of things that are involved in this interaction. What parts of the atmosphere are involved? What parts of the geosphere are involved?" Help students arrive at the answers themselves.

As you circulate throughout the room, make sure the interactions that students select properly support the two spheres they were assigned. If students do not correctly identify an interaction based on their spheres, then their models will not be accurate.

**SUPPORT**—Remind students that although many interactions involve more than two spheres, they only need to show the interactions of two spheres in their models.

Encourage students to not select the same interactions. If you notice that students with the same two spheres are selecting the same interactions to model, make recommendations for alternative interactions so that there is more variety when it comes time to do the gallery walk and evaluation on Day 3 of this lesson.

Give students enough time to complete their research and start answering some of the questions on the Activity Page. Let students know that they will be able to continue planning and designing their models in the next class.

## 1. Day 2: Refocus student attention on the Big Question. 5 MIN

**How can I model interactions between Earth's spheres?** Remind students that they started doing research on the spheres and interactions to show in their models. Let students know that today they will have time to plan and design their models in more detail.

## 2. Support the activity. 35 MIN

Activity Page

AP 12.1

Prompt students to take out Activity Page 12.1 and pick up where they left off in the last class. As students work on their design sketches, assure them that these are just sketches, or rough drafts, and that they will not be scored on artistic ability. Instead, the drawing box is there to help students plan out what they want to show in their models.

Circulate throughout the room, and inspect students' drawings. Offer guidance and support if you see ways for students to improve their models or if a particular type of model might not be the best for showing a particular interaction.

Give students enough time to complete pages 1 and 2 of the Activity Page in class.

## 3. Discuss next steps. 5 MIN

Activity Pages

AP 12.1
AP 12.2

Bring the class back together at the end to discuss the next steps for working on their models. Distribute Earth Interactions Take-Home Letter (AP 12.2). Tell students that they will take home Activity Page 12.1 as well as Activity Page 12.2. Make sure students understand that the take-home letter is for their family member and that the Activity Page is there to serve as a reference for students for their designs and drawings, as well as to use the criteria list for their models on the last page.

Emphasize that students will build their models at home. Tell students how many days they will have to make their models and on what day they should bring their completed models back to class. Make sure students bring their Activity Pages back to class with their completed models on the decided due date.

## 1. Day 3: Refocus student attention on the Big Question. 5 MIN

**How can I model interactions between Earth's spheres?** Remind students that they had several days to build their models at home and that today everyone has brought their completed models to class. Prompt students to place their models on display around the classroom.

Tell students that today they will have a chance to look at each other's models and will conduct a guided analysis and evaluation of the models.

## 2. Facilitate the gallery walk. 30 MIN

Activity Page

AP 12.3

Distribute Model Analysis (AP 12.3). Review the Activity Page with students. Tell them that they will fill out the questions at the top of the page as they walk around the room and review the various models. Then they will have a chance to complete the bottom two questions on the page after they complete the gallery walk and sit back down at their desks.

Initiate the gallery walk. Tell students to start at different models and work their way around the room, being sure that they see each model. Have students think about the following as they study each model:

- What spheres are being represented?
- What components of those spheres (e.g., rocks, water, trees, wind) are being shown?
- What interaction is being modeled?
- Does the model clearly and accurately depict the interaction?
- Is there any part of the model that is unclear or does not make sense?
- Does the model use colors, symbols, or other indicators to help the viewer understand the interaction between the spheres?

As students perform the gallery walk, circulate around the room, and prompt students to consider the above list of questions.

Guide students to keep moving through the models to be sure they have enough time to see each one.

> **SUPPORT**—If necessary, tell students to just spend only a couple of minutes at each model.

Make sure students have enough time to complete their Activity Pages after viewing the models.

## 3. Summarize and discuss. 5 MIN

Activity Page

AP 12.3

Once students have had time to conduct their gallery walk and complete their Activity Page, bring the class back together for a whole-class discussion to summarize what students observed and learned through the models. Students should be able to explain their observations and support them with what they have learned about Earth spheres and interactions.

Ask all students to share the one main thing they want other students to take away from their model. Ask students how the models relate to each other to represent more complex system interactions.

## 4. Check for understanding. 5 MIN

Activity Page

AP 12.3 and Answer Key

**Formative Assessment Opportunity**

Collect the completed Model Analysis (AP 12.3). Review the answers to the questions. Students should be able to accurately list the models that showed interactions between two different sets of spheres.

See the Activity Page Answer Key for sample student responses.

Conduct a review of the models. Models should meet all the criteria, including the following:

- showing an interaction of two spheres
- identifying relevant components and features of each sphere
- identifying and describing relationships (interactions) within and between the parts of the Earth spheres identified in the model
- describing a variety of ways in which the parts of two major Earth spheres interact to affect Earth's surface materials and processes in that context
- describing how parts of an individual Earth sphere do the following:
    - work together to affect the functioning of that Earth sphere
    - contribute to the functioning of the other relevant Earth sphere
- using color, symbols, illustrations, data, and other visual guides to inform viewers of key information on the model

Additionally, review models for the following:

- Creativity: Does the model show creative ability and originality?
- Scientific thought: Is the interaction between two spheres modeled in a way that makes sense?
- Thoroughness: Was the purpose of the model carried out to completion?
- Clarity: How clearly does the student model the interaction of the two spheres?

UNIT REVIEW

# The Search for Earth II

**Big Question:** Is it possible that there is another planet somewhere that has the right combination of features to support life?

## At a Glance

### Learning Objective

✓ Fluently discuss Earth's spheres and their interactions.

### Lesson Activities

- unit review
- reading and discussion
- vocabulary activity

### NGSS References

**5-ESS2-2:** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

**5-ESS2-1:** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

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

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

## The Big Idea

Earth is a complex, dynamic system of interrelated factors that, in concert, support an amazing diversity of life-forms. This lesson prompts students to consider whether or not Earth is unique in that regard by discussing the search for other similar worlds based on the criteria of what would make them habitable. This exploration revisits many of the Big Questions students have seen throughout the unit that focus on Earth's land, air, water, and organisms and how intricately they interact. The profoundly special nature of Earth's systems and their interrelationships becomes even more evident when contrasting Earth with every other known celestial body.

- The geosphere consists of solid land that, though undergoing a constant cycle of change, is stable enough for diverse life to take hold.
- The hydrosphere cycles water, a critical element for supporting life, globally.
- The blanket of gases in the atmosphere supports life, helps regulate Earth's surface temperature, and shields Earth's surface from solar radiation.
- As a result of the conditions stemming from the geosphere, hydrosphere, and atmosphere, the biosphere can exist. And the biosphere, in turn, affects Earth's other systems.

## Core Vocabulary

**Language of Instruction:** During instruction, remind students of their prior exposure to the following terms.

**air mass**
**air pressure**
**aquifer**
**atmosphere**
**biodiversity**
**biome**
**biosphere**
**deposition**
**erosion**
**fresh water**
**geologic**
**geosphere**
**groundwater**
**hydrosphere**
**rain shadow**
**reservoir**
**rock cycle**
**salt water**
**soil**
**species**
**water cycle**
**water table**
**weathering**

**Core Vocabulary Deck:** Students should refer to their full set of Core Vocabulary cards during the review discussion.

## Instructional Resources

Student Reader

Ch. 9

Activity Pages

AP UR.1
AP UR.2

**Student Reader, Chapter 9**
"The Search for Earth II"

**Activity Pages**
Vocabulary Crossword Puzzle (AP UR.1)

Vocabulary Review (AP UR.2)

Make sufficient copies for your students prior to conducting the lesson.

## Materials and Equipment

**Collect or prepare the following items:**

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

# The Core Lesson 45 min

## 1. Focus student attention on the Big Question. 5 min

**Is it possible that there is another planet somewhere that has the right combination of features to support life?**

Review with students what they have learned throughout this unit—the complex combination of factors that enables Earth to support life:

- atmosphere: altitude, air mass, and air pressure
- biosphere: biodiversity, species, and biomes
- geosphere: rock cycles, layers of the Earth
- hydrosphere: water cycles, reservoirs, groundwater, fresh water, and salt water
- interactions among Earth's spheres

Ask students what they think it would be like if Earth no longer had one of its main spheres. Use the following question as a guide: Are all four of Earth's spheres needed to support life on Earth? (*yes*)

Tell students that today they will read about the scientific search for a second planet Earth, a planet that contains the components needed to support life: atmosphere, biosphere, geosphere, and hydrosphere.

## 2. Read and discuss: "The Search for Earth II." 25 MIN

Student Reader

Ch. 9

Prepare to read together, or have students read independently, "The Search for Earth II," Chapter 9 in the Student Reader. This chapter introduces how scientists have been searching for and studying exoplanets to see whether any are suitable for life. It also describes the Biosphere 2 project in Arizona.

### Revisit Core Vocabulary Terms

Before students read, write these terms on the board or chart paper. Encourage them to use the terms frequently as they discuss what they read:

**atmosphere** **biosphere** **geosphere** **hydrosphere**

Ask students to recall the terms listed on the board or chart paper, and explain that, by now, they have had much exposure to the terms throughout the unit. Tell students to keep these terms and other terms that are associated with them, such as *water cycle*, *rock cycle*, and *biome*, in mind as they read through the Student Reader.

### Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

**Page 59**

Focus on developing student understanding of an exoplanet. Ask students to explain the difference between a planet and an exoplanet. (*An exoplanet is a planet that orbits a star that is outside of our own solar system.*)

**SUPPORT**—If necessary, help students understand that the planets within our solar system orbit the sun. On the other hand, exoplanets do not orbit our sun. Instead, they orbit other stars and are not part of our solar system.

**SUPPORT**—Show students a video of the telescope Kepler's findings. (See the Online Resources for a link to a suggested resource.)

**CHALLENGE**—If time permits, challenge students to develop a timeline of the findings from the Kepler mission over the years. As students work on their timelines, prompt them to think about why certain discoveries are important to human life. Students can research Kepler's timeline online. (See the Online Resources for a link to a suggested resource.)

Online Resources

Use this link to download the CKSci Online Resources Guide for this unit, where specific links to these resources may be found:

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

**Page 60**

After reading the page, have students turn to a neighbor and discuss the importance of having a geosphere on the next, future planet Earth. Students should be able to summarize the importance of the geosphere from what they read on the page.

**SUPPORT**—If necessary, point out to students that here on Earth, we have the resources available that we need to do things such as grow crops and construct buildings. On another planet, a geosphere is necessary so that we can continue to have the resources we need as a civilization. Explain that even if the next planet does not have all the same metals and resources (such as marble), it still must have enough that humans can properly establish a colony.

**Page 61**

After reading the page, ask: Why does the distance of the planet to its center star impact its hydrosphere? (*Stars are hot, and planets that are too close can be dry, whereas planets that are too far away can be frozen.*)

**CHALLENGE**—If time permits, challenge students to discuss with a neighbor why finding water on another planet that is suitable to sustain life can be tricky. Students should be able to explain that some water could be salty, some could be mixed with other gases, some might be frozen or evaporated as steam, and liquid water only occurs within a fairly small range of temperatures anyway.

**Page 62**

After reading the page, ask: Why wouldn't Mars's atmosphere work for humans? (*Students should be able to cite examples from the page.*)

**CHALLENGE**—Have students research the composition and size of other planets' atmospheres and discuss whether or not they would be good candidates for human life.

**Page 63**

After reading the page, call on volunteers to summarize why the biosphere is affected by the atmosphere, geosphere, and hydrosphere. Students should be able to explain that the biosphere depends on those other spheres to support life. Prompt students to give examples of how the spheres work together, which should be a good review of the modeling activity they did in the previous lesson.

**Page 64**

Direct student attention to the photograph on the page. Explain that this is a photograph of the actual Biosphere 2 in Arizona. Ask a student to explain why he or she thinks that Biosphere 2 is made out of see-through glass. (*so that the sun can provide light for the plants that grow inside of it*)

Have students work with a partner to discuss why Biosphere 2 was a good idea in theory. Then have them discuss what went wrong with the experiment and the outcome.

**SUPPORT**—In case students have a difficult time comprehending the concept of Biosphere 2, compare it to a human-made pond or terrarium, a controlled structure that contained the things needed to sustain life. Biosphere 2 had its own ecosystem that worked in harmony for a while, until gases became unbalanced.

## 3. Demonstrate more examples and guide discussion. 10 MIN

Choose one of the following, or a similar example, to stimulate further discussion. (If time permits, use all four.)

Use this link to download the CKSci Online Resources Guide for this unit, where specific links to these resources may be found:

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

**Option 1:** Show a video about the ocean biome in Biosphere 2. (See the Online Resources for a link to a suggested video.) Ask students the following questions after watching the video:

- Why do you think the ocean was the hardest biome for the people in Biosphere 2 to maintain?
- What is the connection between the ocean and the desert?

Online Resources

**Option 2:** Show a general video about Biosphere 2. (See the Online Resources for a link to a suggested video.) Ask students the following questions after watching the video:

- What are the different biomes in Biosphere 2?
- How can Biosphere 2 influence scientific exploration of other planets?

**Option 3:** Show a video about the Kepler mission. (See the Online Resources for a link to a suggested video.) Ask students the following questions after watching the video:

- What is the greatest takeaway from the Kepler mission?
- How do exoplanets differ from Earth?

**Option 4:** Have students form pairs and do online research of TESS, the Transiting Exoplanet Survey Satellite. (See the Online Resources for a link to a suggested resource.) As they do their research, have students collect information about the following:

- What is TESS?
- What is TESS's mission?
- How does TESS differ from Kepler?
- What can information learned from TESS help scientists understand about life on other planets?

## 4. Review take-home activities. 5 MIN

Activity Pages

UR.1
UR.2

For additional vocabulary reinforcement prior to administering the Unit Assessment, distribute Vocabulary Crossword Puzzle (AP UR.1) and Vocabulary Review (AP UR.2) as take-home assignments.

**See Teacher Resources pages 158–159 for guidance in administering the Unit Assessment to conclude the unit.**

UNIT 3

# Teacher Resources

**Activity Pages**

Name _____ Date _____

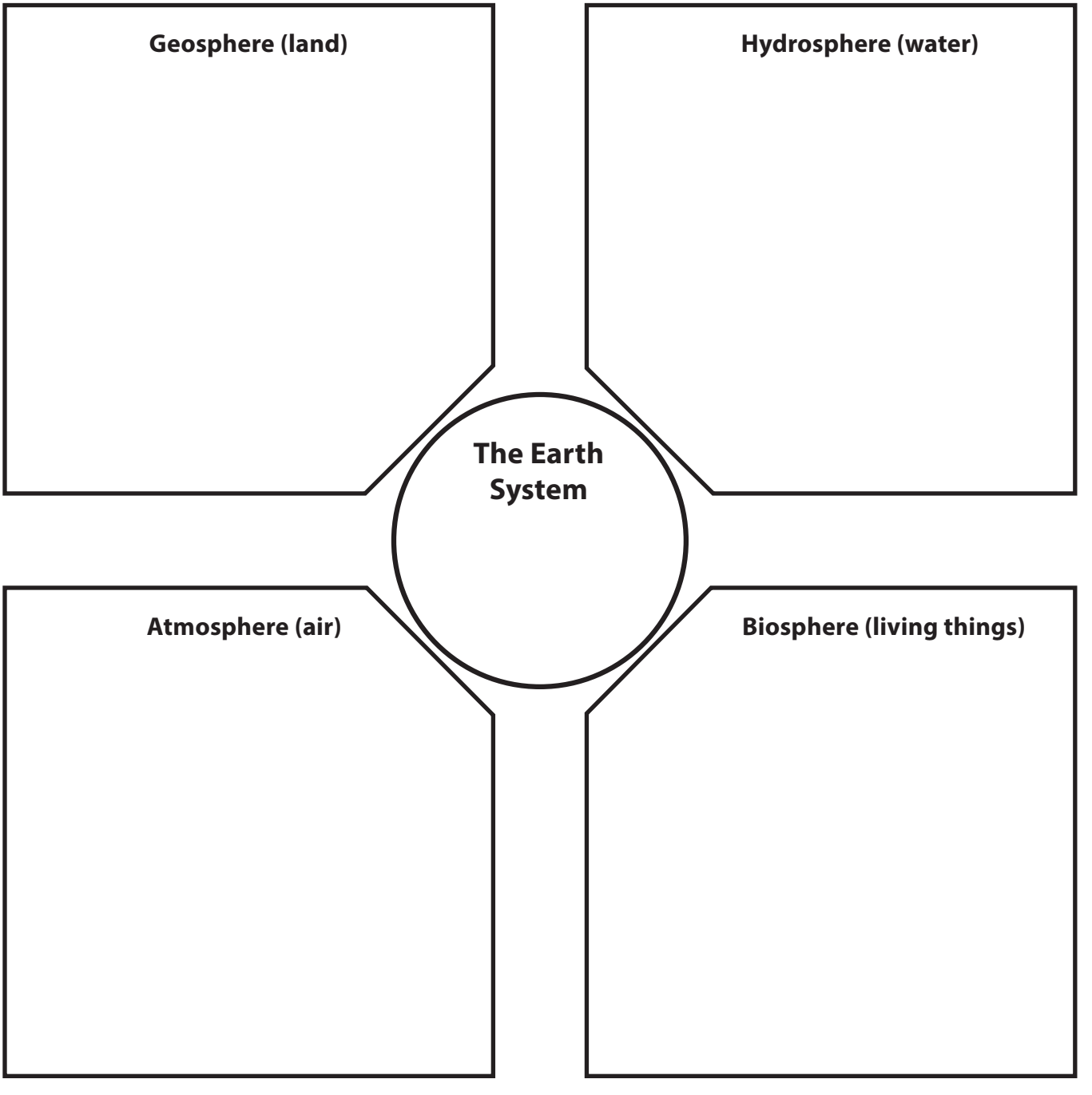
Activity Page 1.1 Use with Lesson 1.

# Observe Locally, Think Globally

What you see in your local environment can help you think about Earth as a whole.

Go outdoors. Observe a local environment. Use your senses of sight, hearing, and smell to identify parts of Earth.

**Classify each part, and write your ideas in the graphic organizer.** When you return to class, **highlight the parts that are dynamic, or always changing.**



Name _____ Date _____

Activity Page 2.1 Use with Lesson 2.

# Where Is Water in the Hydrosphere?

As you read Chapter 1, complete the chart below.

**Write the names of places on Earth where water is found in the first column.**

**Check the second or third column** depending on the type of water in each place. Then **answer the questions**.

| The Hydrosphere | | |
|---|---|---|
| **Reservoir** | **Salt Water** | **Fresh Water** |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Which reservoirs in the hydrosphere can have either salt water or fresh water?

Name _____ Date _____

Activity Page 2.2 Use with Lesson 2.

# Lesson 2 Check

**Answer the questions to show what you know from this lesson.**

**1.** What is the **hydrosphere**, and where is it found?

**2.** What causes ocean water to be salty?

**3.** Why do you think people keep close track of the locations and amounts of **fresh water** on Earth?

**4.** How are condensation and evaporation opposites?

**5.** Draw and label a diagram of the **water cycle**. Use arrows to show where water changes state and position.

Name _____ Date _____

Activity Page 3.1 Use with Lesson 3.

# Model Earth's Water Supply

**STEP 1:** Fill a 1,000-mL bottle with water. Color it with food dye. This represents all the water in the hydrosphere.

**STEP 2:** Label a small cup "Glaciers and Polar Ice." Pour about 17 mL of water from the bottle into this cup.

**STEP 3:** Label another small cup "Fresh Groundwater." Pour about 8 mL of water from the bottle into it.

**STEP 4:** Label another small cup "Salty Groundwater." Pour about 9 mL of water from the bottle into it.

**STEP 5:** Label another small cup "Freshwater Lakes." Using a dropper, move about one drop of water from the bottle into this cup.

**STEP 6:** Label another small cup "Saltwater Lakes." Move about one drop of water from the bottle into this cup.

**STEP 7:** Label another small cup "Atmosphere." Using the dropper, move one drop of water from the bottle into this cup. *Note: The actual amount is less than the volume of the waterdrop.*

**STEP 8:** Label another small cup "Rivers." Using the dropper, move one drop of water from the bottle into this cup. *Note: The actual amount is less than the volume of the waterdrop.*

**STEP 9:** There are now about 965 mL of water left in the bottle. Add a spoonful of salt to the water. You can also add a bit of salt to the other cups labeled to indicate salt content.

Use your model to answer the questions on Activity Page 3.2.

Name _____ Date _____



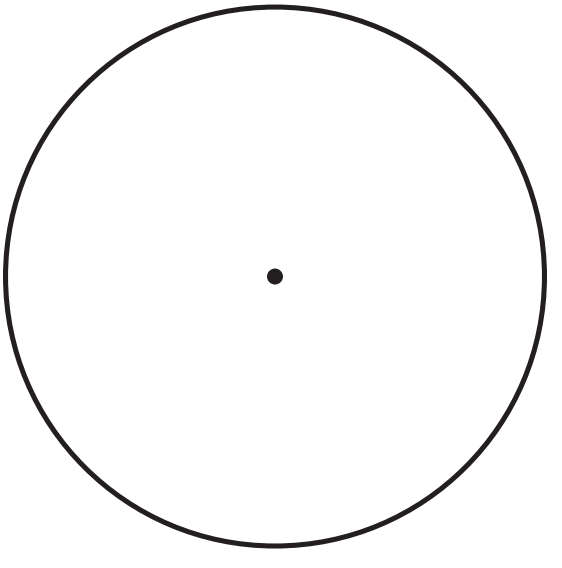
# Graph Earth's Water Supply

**Draw a circle graph using the data in the table. Estimate the size of each part of the graph. Color and label each section of the graph.**

| Locations of Earth's Water | Volume in Number of mL out of 1,000 mL |
|---|---|
| Oceans (salt) | 965 |
| Glaciers and Polar Ice Caps (fresh) | 17 |
| Groundwater (fresh) | 8 |
| Groundwater (salt) | 9 |
| Lakes (fresh) | 0.07 |
| Lakes (salt) | 0.06 |
| Atmosphere | 0.01 |
| Rivers (fresh) | 0.002 |

**Title:** _____

Note: Some of the volumes in the table are very small. Represent those tiny quantities with a single line in the graph instead of a wedge shape.



You made two models. The first was made by pouring water. The second was made by drawing a graph. **Answer these questions** based on your models.

**1.** Where is the most water on Earth located?

**2.** In which places is most of Earth's fresh water found?

**3.** Where is the remaining fresh water found?

**4.** People need fresh liquid water for drinking, washing, manufacturing, and irrigating crops. Which parts of the hydrosphere can provide this water?

Name _____ Date _____

Activity Page 3.3 Use with Lesson 3.

# Write a Letter About Water

You are the water commissioner for your region. Citizens call and write saying they need you to supply more water for farming, filling town pools, car washing, and other uses. **Write a letter to the public**. Explain reasons why you cannot supply them with more water.

**Introduce your topic clearly. Use facts and a definition of *hydrosphere* to support your answer. End your letter with a concluding statement.**

Name _____ Date _____

Activity Page 3.4 Use with Lesson 3.

# Evaluation Guide

Use this rubric to guide your work in this lesson. Using a pencil, check the level where you think you were at the start of the lesson. Circle your level at the end of the lesson.

| Skill | Expert | Intermediate | Beginner |
|---|---|---|---|
| **Modeling salt and fresh water on Earth** | Uses materials and measurement tools accurately to model the locations of water on Earth. Explains clearly what the model shows. | Uses materials and measurement tools with some errors when modeling the locations of water on Earth. Tries to explain what the model shows. | Needs help to use materials and measurement tools when modeling the locations of water on Earth. Does not attempt to explain what the model shows. |
| **Modeling water on Earth by drawing a graph** | Accurately transfers data from a table to a graph. Draws a complete graph, including a title and labels. | Partially transfers data from a table to a graph. Draws a graph, but one part may be missing. | Needs help to transfer data from a table to a graph. Draws a graph, but many parts are missing. |
| **Writing about water resources** | Writes a letter for the intended audience using correct style. Answers the question with facts. Uses science vocabulary accurately. | Writes a letter for the intended audience partially using correct style. Includes at least one fact. Uses at least one science vocabulary term accurately. | Needs help to write a letter for the intended audience using correct style. Does not attempt to include facts. Does not use science vocabulary accurately. |

Name _____ Date _____

Activity Page 4.1 Use with Lesson 4.

# Fruit Model of the Geosphere

**Draw lines and write labels to explain how a cut peach can model the layers of the geosphere. Then write answers to the question.**

**1.** How does the fruit model compare in scale to the real Earth?

_____

_____

**2.** What parts of Earth's layers doesn't the fruit model show well?

_____

_____

Name _____ Date _____

Activity Page 4.2 Use with Lesson 4.

# Lesson 4 Check

**Answer the questions to show what you know have learned.**

**1.** What is the geosphere?

**2.** You have seen how a peach can model the layers of Earth. Choose another fruit you could use as a model. Explain how it shows the layers of Earth.

**3.** What does the rock cycle model?

**4.** What are some ways that the geosphere is a dynamic system? Give three examples.

Name _____ Date _____

Activity Page 5.1 Use with Lesson 5.

# Modeling Air Particles in the Atmosphere

**A.** Work as a team. Get from your teacher a set of seven activity sheets, tape, a hole punch, and glue or paste.

**B.** Tape the seven sheets end to end into one long model. *Hint: The sheet that says "Sea level" should be on the bottom.* Make sure the number of kilometers go up in order to the top of your model. Lay your model on the floor.

**C.** Use the hole punch to make one hundred dots of one-color construction paper. Each dot represents a particle of air.

**D.** Arrange the dots on the model to show how the amount of air in the atmosphere decreases with altitude. Discuss with your team where to place the dots. Move them around until everyone agrees. *Hint: Three-fourths of air particles are located in the troposphere.*

**E.** Use glue or paste to attach the dots to the model.

**F.** Answer the questions below.

**1.** How did your team show the relationship between altitude and the amount of air particles?

_____

_____

**2.** Are air particles the same distance apart at the top of the troposphere as at the bottom of the troposphere? Explain.

_____

_____

**3.** How was your model limited? What part of the atmosphere could it not show?

_____

Name _____ Date _____

Activity Page 5.2 (Page 1 of 7) Use with Lesson 5.

90 km

80 km

70 km

60 km

50 km

40 km

30 km

20 km

10 km

Sea level

190 km

180 km

170 km

160 km

150 km

140 km

130 km

120 km

110 km

100 km

290 km

280 km

270 km

260 km

250 km

240 km

230 km

220 km

210 km

200 km

390 km

380 km

370 km

360 km

350 km

340 km

330 km

320 km

310 km

300 km

490 km

480 km

470 km

460 km

450 km

440 km

430 km

420 km

410 km

400 km

590 km

580 km

570 km

560 km

550 km

540 km

530 km

520 km

510 km

500 km

690 km

680 km

670 km

660 km

650 km

640 km

630 km

620 km

610 km

600 km

Name _____ Date _____

Activity Page 6.1 Use with Lesson 6.

# Modeling the Location of the Biosphere

The biosphere is made up of all living things on Earth. But it is also the layer of Earth where they live. Living things can be found up to 10 km above sea level and 8 km below the surface of the ocean. Soil is full of living things.

**Draw a model** showing where living things are found on Earth. Show where the biosphere layer overlaps with the geosphere, atmosphere, and hydrosphere layers. **Use colors or patterns** that blend to show the overlap. **Add a title and labels** to your model. *Hint:* First, **decide on the scale of your model**. Will it show the whole Earth or zoom in on a small part of Earth?

Name _____ Date _____

Activity Page 6.2 Use with Lesson 6.

# Lesson 6 Check

**Answer the questions to show you understand the key ideas in this lesson.**

**1.** What are some parts of the biosphere system?

_____

_____

**2.** How do scientists show the relationships between all the different species on Earth?

_____

_____

**3.** What is the relationship of a biome to the biosphere?

_____

_____

**4.** Species that cannot adapt to a changing environment can evolve or might go extinct. Think of an example, and explain what this means.

_____

_____

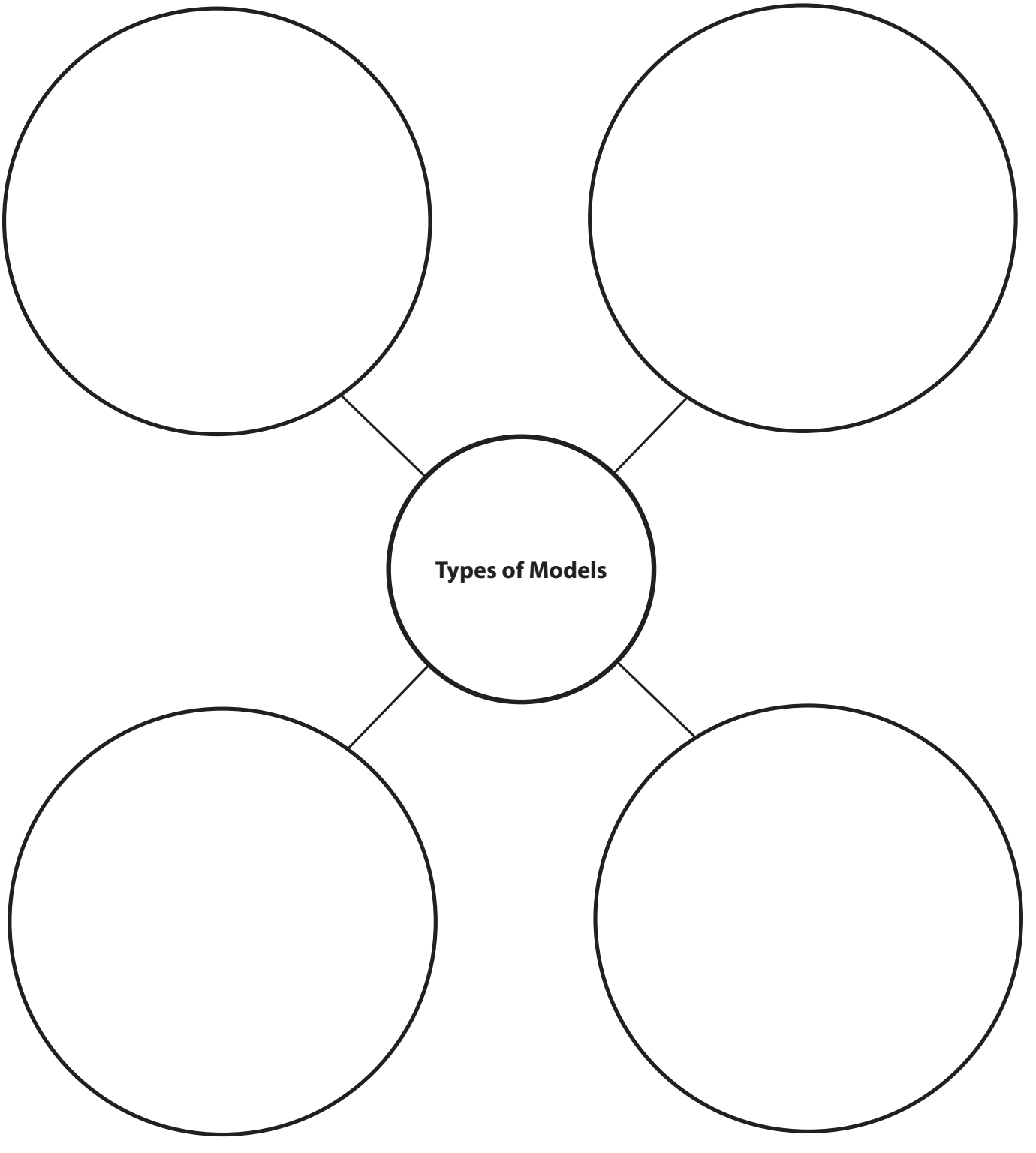
_____

Name _____ Date _____

Activity Page 7.1 Use with Lesson 7.

# Types of Models

**<u>Write</u> the types of models in the blank circles. Keep notes on each one.**



Name _____ Date _____

Activity Page 8.1 Use with Lesson 8.

# Hydrosphere Interactions

**<u>Write</u> examples of interactions from the Student Reader chapter for each of the spheres below.**

| Atmosphere | Geosphere | Biosphere |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

Name _____ Date _____

Activity Page 8.2 Use with Lesson 8.

# Lesson 8 Check

**Answer the questions to show what you know from this lesson.**

**1.** How does the hydrosphere shape the geosphere?

**2.** What are two types of weathering?

**3.** What is the difference between erosion and weathering?

**4.** What's a hydrosphere interaction that can result in both weathering and erosion? How?

**5.** Why does a lake-effect snowstorm occur? If the atmosphere and ground are below freezing, why isn't the lake?

Name _____ Date _____

Activity Page 9.1 Use with Lesson 9.

# Geosphere Interactions

**Write examples of interactions from the Student Reader chapter for each of the spheres below.**

| Atmosphere | Hydrosphere | Biosphere |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Name _____ Date _____

Activity Page 9.2 Use with Lesson 9.

# Lesson 9 Check

**Answer the questions to show what you know from this lesson.**

**1.** What is the relative position of the geosphere compared to the other spheres?

_____

**2.** How does the relative position of the geosphere affect how much of it can interact with the other spheres?

_____

_____

**3.** What are some components of soil?

_____

_____

**4.** What is the difference between an aquifer and a water table?

_____

_____

_____

**5.** On which side of a mountain would you find a rain shadow—the windward side or the leeward side? Explain.

_____

_____

_____

_____

**6.** What feature of a landmass would you look at to determine how the land and atmosphere might interact to produce rainfall or snowfall?

_____

Name _____ Date _____

Activity Page 10.1 Use with Lesson 10.

# Atmosphere Interactions

**Write examples of interactions from the Student Reader chapter for each of the spheres below.**

| Geosphere | Hydrosphere | Biosphere |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Name _____ Date _____

Activity Page 10.2 (Page 1 of 2) Use with Lesson 10.

# Atmosphere Interactions Crossword Puzzle

**Use the terms in the bank to complete the crossword puzzle.**

| | | | | | |
|---|---|---|---|---|---|
| carbon dioxide | cellular | composition | deposition | fossil fuel | medium |
| nitrogen | oxygen | respiration | vacuum | | |

*No spaces between words are included in the puzzle.

**Across**

**1.** a substance that something else travels through

**5.** a carbon-based energy source made of the remains of organisms

**6.** a space that has no matter or a relatively small amount of matter

**7.** a gas that is important to organisms but cannot be directly absorbed from the atmosphere

**8.** cellular process that uses food and oxygen to power other cellular processes

**9.** an important gas to plants and algae; takes up a very small portion of air

**10.** a key ingredient in cellular respiration; takes up about 20% of air

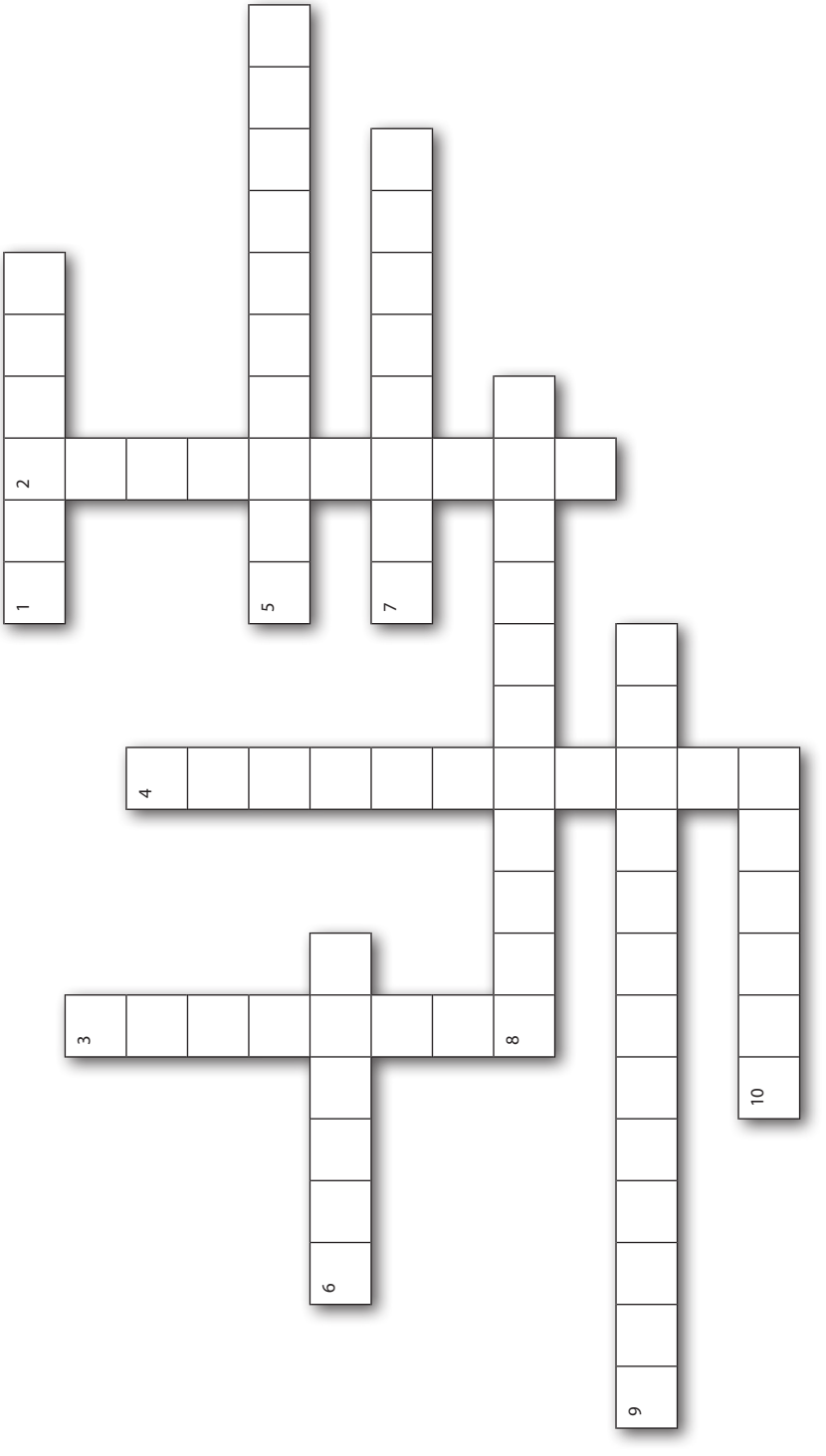
**Down**

**2.** sediment is dropped in a new location

**3.** of or relating to cells

**4.** what something is made of

# Atmosphere Interactions Crossword Puzzle



Name _____ Date _____

Activity Page 11.1 Use with Lesson 11.

# Biosphere Interactions

**<u>Write</u> examples of interactions from the Student Reader chapter for each of the spheres below.**

| Atmosphere | Hydrosphere | Geosphere |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Name _____ Date _____

Activity Page 11.2 Use with Lesson 11.

# Lesson 11 Check

**Answer the questions to show what you know from this lesson.**

**1.** Where is the biosphere relative to the other spheres?

**2.** Describe how gas exchange occurs between a plant and the atmosphere.

**3.** Why is the amount of carbon dioxide in the atmosphere increasing if carbon dioxide is absorbed and stored by so many types of organisms?

**4.** How does the biosphere contribute methane to the atmosphere?

**5.** How does a school of fish affect the hydrosphere in three different ways?

**6.** Describe an example of the biosphere changing the geosphere.

Name _____ Date _____

Activity Page 12.1 (Page 1 of 3) Use with Lesson 12.

# Model Planning

**Answer the questions below as you perform your research and plan to make your model.**

Which two spheres are you working on?

What kind of interaction will you show in your model?

What are some of the components or features of each sphere that you will show in your model?

Which type of model will you use to show how these two spheres interact?

Plan out the details of your model below. Describe how the model will show the interaction of the two spheres.

**Draw a design sketch of your model in the box below. Include labels, symbols, or notes that will help you make your design as accurate as possible.**

# Model Criteria

**Use the following criteria when making your model at home:**

- Show an interaction of two spheres.
- Identify relevant components and features of each sphere, such as the following:
  - geosphere (e.g., solid and molten rock, soil, sediment, continents, mountains)
  - hydrosphere (e.g., water and ice in the form of rivers, lakes, glaciers)
  - atmosphere (e.g., wind, oxygen)
  - biosphere (e.g., plants, animals [including humans])
- Identify and describe relationships (interactions) within and between the parts of the Earth spheres identified in the model.
- Describe a variety of ways in which the parts of two major Earth spheres interact to affect Earth's surface materials and processes in that context.
- Describe how parts of an individual Earth sphere do the following:
  - work together to affect the functioning of that Earth sphere
  - contribute to the functioning of the other relevant Earth sphere
- Use color, symbols, illustrations, data, and other visual guides to inform viewers of key information on the model.

Name _____ Date _____

Activity Page 12.2 (Page 1 of 2) Use with Lesson 12.

**Dear Family Members,**

Over the next several days, your child will be building a model at home that represents the relationship and interactions between two of Earth's major spheres that he or she has been assigned. He or she will learn that these spheres work together to create an interaction on Earth and contribute to important Earth processes.

Below are some suggestions for ways that you can support your child at home to reinforce what he or she is learning about Earth spheres and build a successful model.

**1. Materials and Supplies**

Your child will need materials and supplies to make his or her model. Common materials that may be used include the following:

- cardboard
- poster board
- shoeboxes
- crayons
- markers
- paint
- paintbrushes
- craft pom-poms
- craft wire
- felt
- scissors
- glue
- tape
- craft sticks
- straws
- play putty
- soft play clay
- cotton balls
- toothpicks
- sand or pebbles

Many materials can be found around the house or are available at craft/art stores. It is also possible to ask local stores for recycled cardboard boxes that can be used as displays or backgrounds for the models.

*If it is difficult to access certain materials necessary for the model, please contact the school so we can see whether materials can be borrowed from the school for student use at home.*

**2. Resources**

Your child may need to access pictures, illustrations, diagrams, data, or information to be used for building his or her model. Most of these resources are available at online websites. The library is another good resource to find this information. If your child will be doing research online, consider guiding him or her to these sites:

- National Geographic
- PBS Learning
- Encyclopedia Britannica
- National Science Foundation
- National Oceanic and Atmospheric Administration

- National Centers for Environmental Information
- Smithsonian Institution
- U.S. Geological Survey

**3. Earth Spheres and Interactions Model**

Your child has been assigned two specific Earth spheres to focus on for this model. The purpose of the model is to show how the two spheres interact. You may wish to reinforce this by working with your child to ensure that the interaction accurately depicts the two spheres working together.

Your child's model should do the following:

- Identify relevant components and features of each sphere.
- Identify and describe relationships (interactions) within and between the parts of the Earth spheres identified in the model.
- Describe a variety of ways in which the parts of two major Earth spheres interact to affect Earth's surface materials and processes in that context.
- Describe how parts of an individual Earth sphere do the following:
  - work together to affect the functioning of that Earth sphere
  - contribute to the functioning of the other relevant Earth sphere
- Use color, symbols, illustrations, data, and other visual guides to inform viewers of key information on the model.

Set aside time to review your child's progress on the model and provide support as needed.

Name _____ Date _____

Activity Page 12.3 Use with Lesson 12.

# Model Analysis

Which of the models represents an interaction between the

atmosphere and biosphere? _____

atmosphere and geosphere? _____

atmosphere and hydrosphere? _____

biosphere and geosphere? _____

biosphere and hydrosphere? _____

geosphere and hydrosphere? _____

Which type of model do you do think most effectively shows the interactive relationship between Earth's different spheres? Why?

_____

_____

_____

_____

Now that you have looked at several models, how might you revise your own model? Why (or why not)?

_____

_____

_____

_____

_____

_____

_____

Name _____ Date _____

Activity Page UR.1 (Page 1 of 2) Use with Unit Review.

# Vocabulary Crossword Puzzle

**Review the cards in your Core Vocabulary deck before you begin.**

**Use the terms in the word bank to complete the crossword puzzle. Not all terms will be used.**

| | | | | | |
|---|---|---|---|---|---|
| atmosphere | biosphere | hydrosphere | geosphere | reservoir | |
| seismic | sediment | water cycle | air mass | air pressure | evolve |
| extinct | weathering | erosion | deposition | biodiversity | biome |
| ecosystem | solar system | habitat | pollution | rock cycle | system |
| water table | species | | | | |

*No spaces between words are included in the puzzle.

**Across**

**3.** relating to energy moving through Earth's crust

**6.** to have no more living members in a species

**11.** adding new rock to an area of land

**12.** the sphere the rock cycle is part of

**14.** the sphere the water cycle is part of

**16.** a region with certain characteristics throughout, such as a forest or tundra

**17.** to develop gradually

**Down**

**1.** a large lake used as a source of water supply

**2.** a volume of air defined by its temperature and water vapor content

**4.** variety of life

**5.** the weight of the atmosphere pressing down onto Earth

**7.** the sphere that is made up of all living things

**8.** matter that is broken down and carried away through weathering and erosion

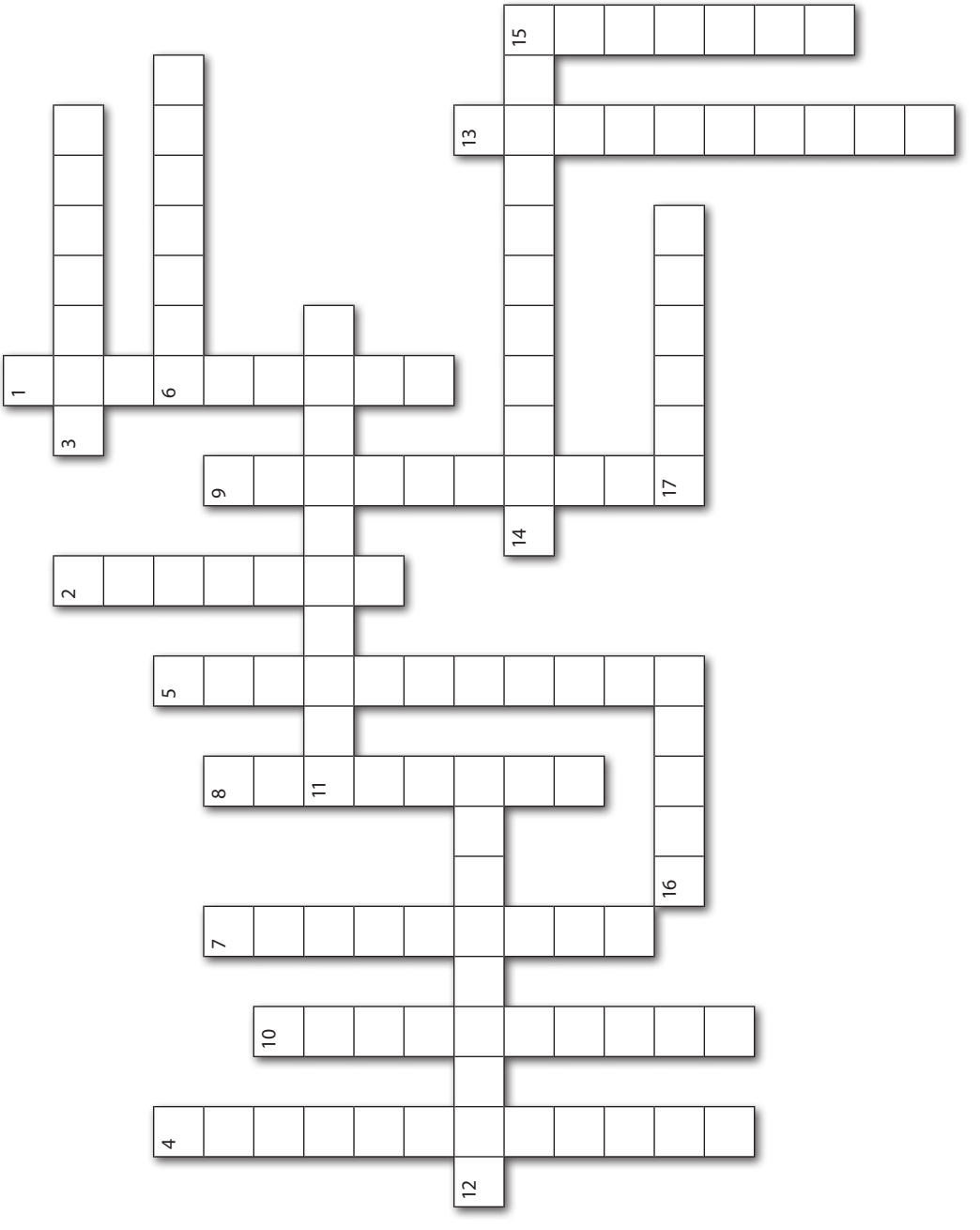
**9.** the cycle by which water circulates between the ocean, air, and land

**10.** the sphere that is made up of wind and air

**13.** breaking down of rock

**15.** carrying broken-down rock to a new location

# Vocabulary Crossword Puzzle



Name _____ Date _____

Activity Page UR.2 Use with Unit Review.

# Vocabulary Review

**Complete each sentence with the correct term. Not every term in the word bank will be used. Review the cards in your Core Vocabulary deck before you begin.**

| | | | | | |
|---|---|---|---|---|---|
| species | deposited | hydrosphere | air pressure | reservoir | biodiversity |
| sediment | water cycle | air mass | geosphere | extinct | weather |
| water table | biosphere | seismic | biomes | ecosystem | solar system |
| habitat | pollution | rock cycle | system | erosion | atmosphere |

**1.** Water is part of the Earth sphere called the _____.

**2.** Rocks, mountains, and other landforms are parts of the _____.

**3.** When there is a lot of weight from the atmosphere pressing down onto Earth, there is high _____.

**4.** Interactions of the biosphere, hydrosphere, and atmosphere with the geosphere can cause _____.

**5.** When scientists look for variety of life in certain habitats, they are searching for _____.

**6.** Wind can _____ rocks, which then get carried away by _____ and _____ in new locations.

**7.** The _____ is responsible for air and wind.

**8.** All living things on Earth are part of the _____.

**9.** Rain forests, grasslands, and deserts are examples of _____.

**10.** When an entire species no longer exists, it is considered _____.

**11.** A _____ is used to keep water as a supply or when it is needed by people.

**12.** When scientists study earthquakes, they refer to the earthquakes as _____ activity.

Name _____ Date _____

# Unit Assessment: What Have I Learned About Earth's Systems?

**Answer the items below to show what you have learned.**

**1.** Write the word from the word bank that **best** describes each thing. You may use each word more than once.

| geosphere | atmosphere | biosphere | hydrosphere |
|---|---|---|---|

rain _____

mountain _____

ice _____

oxygen _____

human _____

tree _____

volcano _____

grass _____

snow _____

carbon dioxide _____

**2.** Write *yes* or *no* to indicate whether each item makes up part of the hydrosphere.

_____ glaciers

_____ rivers

_____ mountains

_____ oxygen

_____ plants

_____ fish

_____ lakes

_____ hydrogen

_____ volcanoes

_____ forests

**3.** Place each word in the correct part of the table.

| | | | | | | |
|---|---|---|---|---|---|---|
| **oceans** | **rivers** | **lakes** | **streams** | **rain** | **ice** | **seas** |

| Salt Water | Fresh Water |
|---|---|
| | |

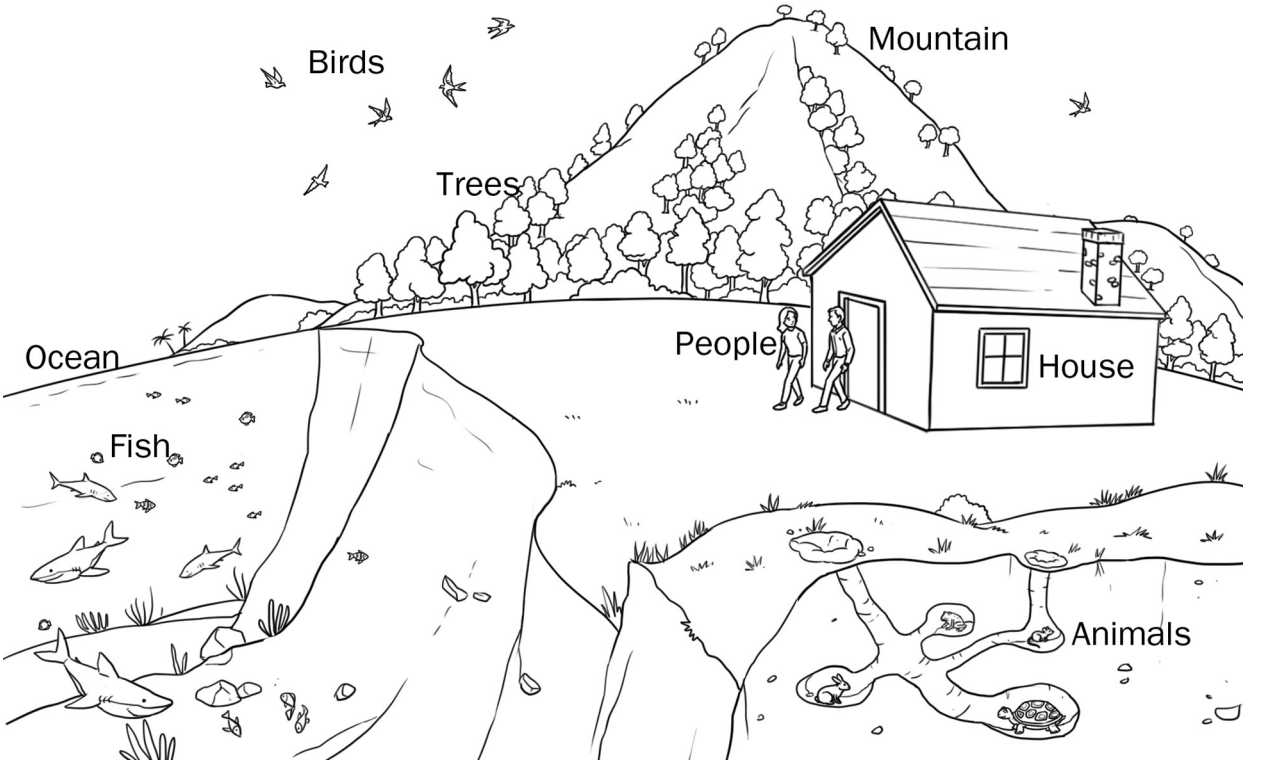
**4.** Complete the paragraph.

The _____ is all of Earth's land combined. One of the processes that has helped shape Earth's surface over a long period of time is the _____ _____. Because of this process, _____ is constantly being recycled. _____ means relating to our planet's rocky inner and outer features. Scientists study geology to learn more about _____ itself.

Be sure to use the Core Vocabulary that you have learned in this unit in your answer.

**5.** Which of the following are gases that make up part of the atmosphere? Choose all correct answers:

**a)** nitrogen
**b)** raindrops
**c)** spores
**d)** oxygen
**e)** argon
**f)** dust
**g)** carbon dioxide
**h)** water vapor
**i)** ice




**6.** On the lines below, write the name of each part of the biosphere you can see in the picture.

**7.** On the lines below, describe one way in which the hydrosphere interacts with each of the other three spheres.

geosphere _____

atmosphere _____

biosphere _____

**8.** On the line in front of each description, tell which spheres are interacting.

_____ Volcanoes blast ash into the air.

_____ Earthquakes below the ocean's surface cause tsunamis to form.

_____ People use metals from Earth to build structures.

**9.** Complete the table by naming the spheres that are interacting with the atmosphere. Write your answer in the last row of each column.

| atmosphere | atmosphere | atmosphere |
|---|---|---|
| Wind blows over a desert, creating a dust storm. | People and animals take in oxygen to breathe and survive. | Wind blows over warm ocean waters and becomes warmer itself. |
| | | |

**10.** On the lines below, describe one way in which the biosphere interacts with the other three spheres. Do not use examples that have already been used in this assessment.

hydrosphere _____

geosphere _____

atmosphere _____

**11.** In the box below, create a model that shows Earth's four spheres.

**12.** Add ways in which the spheres interact to your model above. Use arrows to show the direction in which the interactions occur.

# Activity Pages Answer Key: *Modeling Earth's Systems*

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.

### Observe Locally, Think Globally (AP 1.1) (page 109)

Students should classify the parts of the local environment they observe as being part of the atmosphere, biosphere, geosphere, and hydrosphere.

### Where Is Water in the Hydrosphere? (AP 2.1) (page 110)

**Reservoir:** Students should identify the hydrosphere as having the following reservoirs: the ocean, lakes, streams, rivers, gulfs, seas, groundwater, and the atmosphere. Ponds, straits, wetlands, glaciers, and ice caps are also suitable answers.

**Salt Water:** Students should add check marks to the following rows under the Salt Water column: the ocean, lakes, gulfs, seas, and groundwater.

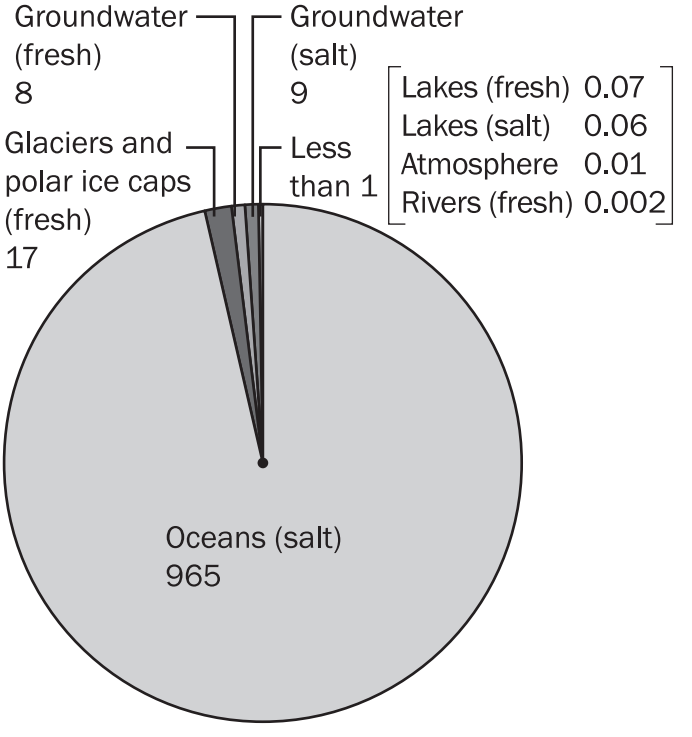
**Fresh Water:** Students should add check marks to the following rows under the Fresh Water column: lakes, streams, rivers, groundwater, and the atmosphere.

- lakes and groundwater

### Lesson 2 Check (AP 2.2) (page 111)

1. The hydrosphere is all the water on Earth and is found in the ocean, in lakes, rivers, and streams, underground, and in the atmosphere.
2. The salt comes from rocks on the land and is carried to the ocean by rivers and streams. When water evaporates from the ocean, the salt is left behind and accumulates.
3. because people need fresh water for drinking and there is not as much fresh water on Earth as there is salt water
4. Condensation changes a gas into a liquid and evaporation changes a liquid into a gas.
5. Drawing should be similar to the one on Student Reader page 8.

### Graph Earth's Water Supply (AP 3.2) (pages 113–114)




1. in the ocean
2. in glaciers, polar ice, and in the ground
3. in lakes, rivers, groundwater, and the atmosphere
4. groundwater, lakes, and rivers

### Write a Letter About Water (AP 3.3) (page 115)

Student letters should have a definition of the hydrosphere, support for their argument using facts, and a closing statement.

### Fruit Model of the Geosphere (AP 4.1) (page 117)

Lines and labels should indicate the following: The hard pit is the inner core. The darker material around the pit is the outer core. The pale part of the fruit next to the darker part is the lower mantle. The pale part under the skin is the upper mantle. The skin is like the crust.

1. The model is a small-scale version of the very large-scale Earth.
2. Answer will vary, depending on the fruit you used. Students may say that the outer core is not very clear and it is hard to see a difference between the lower and upper mantle layers.

### Lesson 4 Check (AP 4.2) (page 118)

1. an Earth system made up of the rocky parts of Earth
2. Sample answer: A cut apple could show the thin crust (apple skin), the thick mantle (most of the fruit), and the Earth's core (apple core).
3. It models how the three types of rocks form.
4. Sample answer: Earthquakes change the crust, lava flows out of volcanoes and builds mountains, rock is worn away, and sediments are carried to oceans and lakes.

### Modeling Air Particles in the Atmosphere (AP 5.1) (page 119)

1. We made the dots close together near sea level and spread them out as they got higher above Earth's surface.
2. No, they are not the same. Air particles are closer together near sea level than at the top of the troposphere. One way to know is that people who climb Mount Everest need extra oxygen to breathe.
3. the outermost part of the exosphere

### Modeling the Location of the Biosphere (AP 6.1) (page 127)

Student models should primarily show the biosphere, with areas highlighted where the biosphere overlaps with the geosphere, atmosphere, and hydrosphere.

### Lesson 6 Check (AP 6.2) (page 128)

1. plants, animals, single-celled organisms, biomes
2. They use a classification system with levels.
3. The six land biomes describe large parts of the biosphere on Earth's solid surface.
4. Sample example: If the African elephant species cannot adapt to drought, climate change, or hunting by humans, it could become extinct.

### Types of Models (AP 7.1) (page 129)

Students should note that their model could be a diagram, diorama, graph, or written narrative. Students might include notes on advantages and disadvantages of each type of model.

### Hydrosphere Interactions (AP 8.1) (page 130)

**Atmosphere:** acid rain, cooling and heating of large bodies of water, evaporation, lake-effect snow

**Geosphere:** erosion, evaporation, weathering

**Biosphere:** precipitation, water distributes nutrients, water for plants to grow, water that animals live in, water to drink

### Lesson 8 Check (AP 8.2) (page 131)

1. The hydrosphere can weather and erode the geosphere. These processes can break down rock and move sediments around, which reshapes land features.
2. chemical and physical
3. Erosion is the carrying away of sediment (pieces of rock) from a given location. Weathering is the breaking down of rock into smaller pieces.
4. The flow of water can both weather and erode the land. The moving water can break off particles or chemically weather the rock and carry away the weathered particles.
5. A lake can remain above freezing because it takes more energy to heat up water than the air or the ground, and it takes longer for water to cool down. The relatively warm lake can provide much water vapor to the cold, dry air moving over it. The vapor builds up and condenses into clouds that can release rain or snow.

## Geosphere Interactions (AP 9.1) (page 132)

**Atmosphere:** amount of precipitation creates different biomes, movement of hot and cold air masses affect the landscape, topography affects amount of precipitation

**Hydrosphere:** aquifers created from precipitation; ice and snow on mountaintops; landmasses affect the shape of the hydrosphere; precipitation creates rivers, lakes, and streams

**Biosphere:** minerals needed by living things, shelter, space for organisms to live, water distributes nutrients, water that animals live in

## Lesson 9 Check (AP 9.2) (page 133)

1. The geosphere is mostly below the others.
2. Because so much of the geosphere is far below the other spheres, only a small portion of the geosphere can interact with the others.
3. Soil consists of inorganic materials such as sand, clay, and particles of rock. It can also contain organic material such as the remains of organisms.
4. An aquifer is an underground store of groundwater in empty spaces of porous rock. The water table is the level of the groundwater.
5. The leeward side. A moving air mass will lose its moisture as precipitation on the first side of a mountain it encounters. When it reaches the other, leeward side, it will have already lost most of its moisture, so that leeward side is in the rain shadow.
6. its topography

## Atmosphere Interactions (AP 10.1) (page 134)

**Geosphere:** chemicals in air affect landforms, erosion, wind caused by heating and cooling shapes landscapes

**Hydrosphere:** distributes water through the water cycle; sunlight affects heating and cooling of water, which affects weather; sunlight filters in the atmosphere affect precipitation

**Biosphere:** distributes water essential for life, oxygen and carbon dioxide provide essentials for life, ozone blocks sun rays that are harmful to living organisms

## Atmosphere Interactions Crossword Puzzle (AP 10.2) (pages 135–136)

**ACROSS:**

**1.** medium

**5.** fossil fuel

**6.** vacuum

**7.** nitrogen

**8.** respiration

**9.** carbon dioxide

**10.** oxygen

**DOWN:**

**2.** deposition

**3.** cellular

**4.** composition

## Biosphere Interactions (AP 11.1) (page 137)

**Atmosphere:** exchange of nitrogen and methane, exchanging oxygen and carbon dioxide, human activity affecting amounts of carbon dioxide, transpiration

**Hydrosphere:** distributes water through the water cycle; exchange of water in the water cycle; sunlight filtered through the atmosphere affects plant growth, which can affect toxins

**Geosphere:** animal and plant waste and remains create soil, animals can physically weather and erode the landscape, decomposers, plants can change the landscape

## Lesson 11 Check (AP 11.2) (page 138)

1. The biosphere is found mainly on the surface of the geosphere and in the liquid parts of the hydrosphere.
2. Plants take in carbon dioxide and oxygen directly from the atmosphere. They release some oxygen and water vapor from their stomata. They take in forms of nitrogen from their roots. The nitrogen is originally from the atmosphere.
3. The rate that carbon dioxide is added to the atmosphere by human activity is greater than the rate that the biosphere can absorb, store, and use it.
4. Some methane comes from cows and other animals. When plants and animals die, their decomposing remains release methane.
5. The fish are themselves in the hydrosphere, so they change what the water consists of. The fish will also take in oxygen and release carbon dioxide, which is dissolved in water. The fish can also release waste products that affect the water's chemistry.
6. Tree roots grow into cracks in the rock below the soil. The roots expand and break up the rock. This is physical weathering.

## Model Planning (AP 12.1) (pages 139–141)

- Students should choose two of the following: atmosphere, biosphere, geosphere, and hydrosphere.
- Students should provide a description of the interaction between the two spheres.
- Accept all reasonable examples of components or features of each sphere.
- Accept all reasonable examples of model types.
- Accept all student plans. Student descriptions should include some interactions between the two spheres.
- Sketch should include labels, symbols, or notes to help direct model design considerations.

## Model Analysis (AP 12.3) (page 144)

- Students should note which models match to the appropriate pairs of spheres.
- Accept reasonable student responses.
- Accept all reasonable student revision suggestions.

## Vocabulary Crossword Puzzle (AP UR.1) (pages 145–146)

**ACROSS:**

**3.** seismic

**6.** extinct

**11.** deposition

**12.** geosphere

**14.** hydrosphere

**16.** biome

**17.** evolve

**DOWN:**

**1.** reservoir

**2.** air mass

**4.** biodiversity

**5.** air pressure

**7.** biosphere

**8.** sediment

**9.** water cycle

**10.** atmosphere

**13.** weathering

**15.** erosion

## Vocabulary Review (AP UR.2) (page 147)

1. hydrosphere
2. geosphere
3. air pressure
4. erosion
5. biodiversity
6. weather; erosion, deposited
7. atmosphere
8. biosphere
9. biomes
10. extinct
11. reservoir
12. seismic

## Unit Assessment: Teacher Evaluation Guide

The Unit Assessment on pages 148–153 is designed as a fifty-point test. Through this assessment, students demonstrate their overall learning of the unit's Learning Objectives. CKSci Unit Assessments typically range from ten to fifteen questions in the upper elementary grades, which can be answered in a longer, single classroom session or administered in two sittings.

Items with simpler answers that assess knowledge but not the deeper understandings of the content, such as multiple choice or short answers, are weighted differently and are worth fewer points. Assessment items that require more complex thinking and a deeper understanding of the content, such as writing explanations or identifying multiple relationships, are worth more points. Items that require synthesis of content and other student knowledge are weighted with more points as well. Some test items encourage students to use their Core Vocabulary decks as a reference source for terminology and concepts related to the test item.

## Expected Answers and Model Responses

**1.** Several of these components are part of multiple spheres. Accept reasonable interpretations. (5 points)

rain: hydrosphere
mountain: geosphere
ice: hydrosphere
oxygen: atmosphere
human: biosphere
tree: biosphere
volcano: geosphere
grass: biosphere
snow: hydrosphere
carbon dioxide: atmosphere

**2.** yes: glaciers, rivers, lakes (3 points)
Accept additional responses if students can correctly defend their choices.

**3.** **Salt Water:** oceans, seas (and occasionally lakes and parts of rivers) (3 points)
**Fresh Water:** rivers, lakes, streams, rain, ice

**4.** geosphere; rock cycle; rock; geologic; Earth (3 points)

**5.** a, d, e, g, h (3 points)

**6.** birds; trees and other plants; people; fish; burrowing animals (5 points)

**7.** Accept all reasonable responses. Sample answers: The hydrosphere interacts with the geosphere where groundwater is stored in underground reservoirs. The hydrosphere interacts with the atmosphere when water evaporates as water vapor and condenses to form clouds. The hydrosphere interacts with the biosphere as organisms take in water to enable their bodies to function. (6 points)

**8.** geosphere and atmosphere (3 points)
geosphere and hydrosphere
biosphere and geosphere

**9.** (left) geosphere (3 points)
(center) biosphere
(right) hydrosphere

**10.** Accept all reasonable responses. Sample answers: The biosphere interacts with the hydrosphere as fish exchange gases with the water in which they live. The biosphere interacts with the geosphere as plant roots grow into cracks and weather rock. The biosphere interacts with the atmosphere as land animals are exposed to changing weather. (6 points)

**11.** Students should generate a simple drawing or diagram that represents in some way the geosphere, atmosphere, hydrosphere, and biosphere. (5 points)

**12.** Evaluate labels and arrows on the diagram for accurate representations of interactions. (5 points)

# Appendix A

## Glossary

**Purple words and phrases** are Core Vocabulary terms for the unit. **Bold-faced words and phrases** are additional vocabulary terms related to the unit that you should model for students during instruction and that are often used within the Student Reader, and these latter terms do not have specific page numbers listed. Vocabulary words are not intended for use in isolated drill or memorization.

### A

**air mass, n**. a large body of air with similar temperature, air pressure, and moisture throughout (21)

**air pressure, n**. the weight of air pressing on all things beneath and within it (20)

**altitude, n**. elevation above sea level

**aquifer, n**. an underground region of rocky material containing water that can be drawn out through a well (40)

**atmos-, prefix** relating to air

**atmosphere, n**. the Earth system that is composed of all the gases that surround Earth (17)

### B

**bio-, prefix** relating to life

**biodiversity, n**. the variety of species on Earth or in any one environment on Earth (24)

**biome, n**. a large region on Earth with a specific climate that contains certain species (26)

**biosphere, n**. the Earth system that is composed of all the living things on Earth (23)

### C

**cellular respiration, n**. the chemical process inside cells that releases energy from food

### D

**deposition, n**. the dropping of sediment in a new location (45)

**dynamic, adj**. constantly changing

### E

**erosion, n**. the movement of sediment (32)

**extinct, adj**. having no more living members

### F

**fresh water, n**. naturally occurring water that contains little or no salt (4)

### G

**geo-, prefix** relating to rock

**geologic, adj**. relating to Earth's rocky inner and outer features (9)

**geosphere, n**. the Earth system that contains all the rocky layers of Earth (9)

**groundwater, n**. water stored in the spaces between materials beneath Earth's surface (4)

### H

**hydro-, prefix** relating to water

**hydrosphere, n**. the Earth system that contains all of the water on Earth (1)

### I

**inorganic, adj**. describing material that does not come from living things

**interact, v**. to affect and be affected by

### M

**minerals, n**. solid inorganic substances that occur naturally

### O

**organic, adj**. describing material that comes from living things

### R

**rain shadow, n**. a dry region on one side of a mountain that results from precipitation on the other side of the mountain removing moisture from clouds (37)

**reservoir, n**. a place where water collects (4)

**respiration, n**. the exchange of gases with the environment

**rock cycle, n**. the process through which rock changes form through igneous, sedimentary, and metamorphic types **(16)**

## S

**salt water, n**. water that contains dissolved salt **(3)**

**sediments, n**. small particles of rock

**seismic wave, n**. a disturbance caused by energy traveling through Earth's crust

**soil, n**. the top layer of Earth's land that often has a mix of organic and inorganic material **(41)**

**species, n**. a group of organisms of the same type that are capable of reproducing together **(24)**

**sphere, n**. a system

**system, n**. a set of parts that work together

## T

**taxonomy, n**. the branch of science that names and groups organisms

**toxin, n**. a substance that is harmful or fatal to an organism

**transpiration, n**. the release of water vapor from the leaves of plants

**tropo-, prefix** relating to the Greek word for change (Weather occurs in the troposphere and is constantly changing.)

## W

**water cycle, n**. the dynamic movement of water on, below, and above Earth's surface **(8)**

**water table, n**. the upper surface or level of groundwater **(40)**

**weathering, n**. the process of breaking down rock into smaller pieces **(30)**

# Appendix B

## Classroom Safety for Activities and Demonstrations

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

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

- 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, for students to read and agree to prior to the start of the first unit so students are aware of the expectations when engaged in science activities.

**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 daughter or son and sign this contract. If you have any questions, please feel free to contact me.

_____ _____/_____/_____/

Parent or guardian signature and date

# Appendix C

## Strategies for Acquiring Materials

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

Online Resources

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

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

## Ways to Engage with Your Community

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

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

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

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

# Appendix D

## Advance Preparation for Activities and Demonstrations

Being properly prepared for classroom activities and demonstrations is the first step to having a successful and enriching science program. Advance preparation is critical to effectively support student learning and understanding of the content in a lesson.

**Before doing demonstrations and activities with the class:**

- Familiarize yourself with the activity by performing the activity yourself or with a team, and identify any issues or talking points that could be brought up.
- Gather the necessary materials for class usage. Consider if students will gather their materials at stations or if you will preassemble the materials to be distributed to the students and/or groups.
- Identify safety issues that could occur during an activity or demonstration, and plan and prepare how to address them.
- Review the Teacher Guide before teaching, and identify opportunities for instructional support during activities and demonstrations. Consider other Support and/or Challenge opportunities that may arise as you work to keep students engaged with the content.
- Prepare a plan for postactivity collection and disposal of materials/equipment.

**While engaged in the activity or demonstration:**

- Address any emergencies immediately.
- Check that students are observing proper science safety practices as well as wearing any necessary safety gear, such as goggles, aprons, or gloves.
- When possible, circulate around the room, and provide support for the activity. Return to the Teacher Guide as students work, to utilize any Support and Challenge opportunities that will make the learning experience most meaningful for your students.

**After the activity or demonstration:**

- Use your plan for students to set aside or dispose of their materials as necessary.
- Have students wash their hands after any activity in which they could come in contact with any potentially harmful substances.

When engaging students in activities and demonstrations, model good science practices, such as wearing proper safety equipment, never eating during an investigation, etc. Good science practices at a young age will lead to students observing good science practices themselves and being better prepared as they move into upper-level science classes.

# Appendix E

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

Science activities and experiments do not always go according to plan. Microwave ovens, super glue, and X-rays are just some of the discoveries made when people were practicing science and something did NOT go according to plan. In your classroom, however, you should be prepared for what to do when activities don't give the expected results or when an activity doesn't work.

**When going over an activity with an unexpected result, consider these points in discussion with your students:**

- Was there an error in following the steps in order? You or the student may have skipped a step. To help control for this, have students review the steps to an investigation in advance and make a check mark next to each step as they complete it.
- Did students design their own investigation? Perhaps their steps are out of sequence, or they missed a step when performing the activity. Review and provide feedback on students' investigation plan to ensure the work is done in proper sequence and that it supports the lesson's Big Question.
- When measurements were taken, were they done correctly? It is possible a number was written down incorrectly, a measurement was made in error, such as a wrong unit of measure or quantity, or the starting or ending point of a measurement was not accurate.
- Did the equipment or materials contribute to the situation? For example, chemicals that have lost their potency or a scale that is not measuring accurately can contribute to the success or failure of an activity.

One of the greatest gifts a student can learn when engaged in science is to develop a curiosity for *why something happened*. Students may find it challenging or frustrating to work through a problem during an activity, but guiding them through the problem and figuring out *why* something happened will help them to develop a better sense of how to do science.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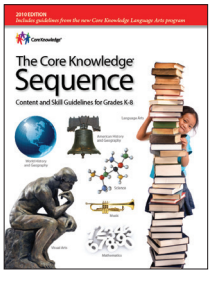


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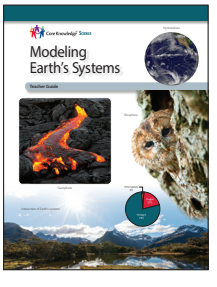


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ISBN: 978-1-68380-543-4