GRADE 5

Building Blocks OF SCIENCE™ | 3D

Earth and Space Systems

Program Highlights and Lesson Sampler

Phenomenon-Based Investigations with Digital Support—in 30-Minute Lessons

Table of Contents

Inside this sampler, you will find:

Earth and Space Systems

Teacher's Guide

3rd Edition

Building Blocks OF SCIENCE™ | 3D

Kit Materials

Material	Quantity Needed From Kit	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
Blue modeling clay	16 oz			■		
Connector	15		■			
Flashlight with batteries	16		■	■		
Graduated cylinder, 100 mL	8				■	
Green modeling clay	16 oz			■		
Inflatable globe	1	■		■	■	
Literacy Reader: *Earth and Space Systems* (below grade level)*	1	■	■	■	■	
Literacy Reader: E*arth and Space Systems* (on grade level)*	1	■	■	■	■	
Magnetic compass	15		■			
Measuring tape, 150 cm	15		■			
Moon Phase Card Set	15			■		
Piece of chalk	15		■			
Plastic cup, 1.25 oz	24				■	
Plastic cup, 7 oz	8				■	
Red modeling clay	32 oz			■		
Rod	15		■			
Syringe, 1 mL	8				■	
Wheel	15		■			

* The below-grade literacy reader is distinguished from the on-grade literacy reader by a yellow dot near the bottom left corner of the back cover.

Needed But Not Supplied Materials

Material	Quantity Needed	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
Art supplies					■	■
Bucket	1			■		
Calculator	8			■		
Chart paper		■				
Chart paper or poster board	16				■	■
Chart paper or whiteboard		■	■			■
Colored pencils or markers		■	■	■	■	■
Computer or tablet with Internet access	1		■	■	■	■
Glue or tape						■
Hardcover book	1	■				
Hardcover book or clipboard	30		■			
Image of stars in space	1		■			
Large room, hallway, or other area that can be darkened	1		■			
Large, sunlit concrete area outdoors	1		■			
Marker		■	■			■
Newspapers				■		
Pair of scissors	1	■				■
Paper towels				■	■	
Projection system	1	■	■	■	■	■
Research materials (including science books and magazines, dictionaries, and computers with Internet access as available)		■			■	■
Ruler, 30 cm	8			■		
Satellite image of Earth from space	1				■	
Science notebook	30	■	■	■	■	■
Sheet of paper						■
Video equipment (optional)						■
Water				■	■	

NOTES

Unit Overview: *Earth and Space Systems*

Systems of matter and energy are present around Earth and across space. Interactions within and between these systems produce observable and predictable patterns—night and day, seasons, tides, weather and climate. Earth is composed of interconnected systems and is also part of a larger system in space. In the five lessons in *Earth and Space Systems*, students explore the interaction between Earth's systems and its role as part of larger systems. Students explore these concepts through investigation, discussion, and problem-solving. Students practice making observations and predictions, providing claims, evidence and reasoning, and evaluating problems and solutions.

Students begin by drawing upon previous knowledge to document what they know about systems in general and Earth and space systems in particular. Students go on to investigate the components that make up our solar system, and explore the apparent brightness of stars, including the Sun, as well as patterns in constellations in the sky. Students further explore Earth's role in larger systems by investigating the Sun-Earth-Moon system and Earth-Moon system. Students use models to observe the rotation and revolution of Earth and the Moon to explore patterns in day and night, shadows, seasons, and Moon phases. Students investigate the interconnected systems on Earth and describe how the systems depend on and affect one another. Students then model how water in the hydrosphere is distributed on Earth, and how humans benefit from and can influence Earth's systems.

In the final lesson, students use their research skills to find more about how communities that are using science and scientific ideas to help protect the environment and natural resources. Students are given the scenario that they have been hired by a community's city council to prepare a public service announcement about protecting Earth. Students combine their research findings with what they have learned throughout the unit about systems to create a public service announcement that conveys how the community they researched has used science to help the environment. Groups share their public service announcements with a wider audience.

Credit: Chanwit Ohm/Shutterstock.com

Next Generation Science Standards

The Building Blocks of Science unit *Earth and Space Systems* integrates process skills as defined by the Next Generation Science Standards (NGSS).

Performance Expectations

- **5-ESS1-1:** Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.
- **5-ESS1-2:** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.
- **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.
- **5-ESS3-1:** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- **5-PS2-1:** Support an argument that the gravitational force exerted by Earth on objects is directed down.
- **3-5-ETS1-2:** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Disciplinary Core Ideas

- **ESS1.A:** The Universe and Its Stars
- **ESS1.B:** Earth and the Solar System
- **ESS2.A:** Earth Materials and Systems
- **ESS2.C:** The Roles of Water in Earth's Surface Processes
- **ESS3.C:** Human Impacts on Earth Systems
- **PS2.B:** Types of Interactions
- **ETS1.B:** Developing Possible Solutions

Science and Engineering Practices

- Developing and Using Models
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information

Crosscutting Concepts

- Patterns
- Cause and Effect
- Scale, Proportion, and Quantity
- Systems and System Models

Important Terms Related to Science Instruction

Science and science instruction rely on specific terminology. Many scientific terms are likely to be new or unfamiliar to students. Below is a list of terms that are used throughout Building Blocks of Science units. Each is followed by a student-friendly definition to help students understand the meaning of the term in a scientific context. A brief description of how Building Blocks employs each of these scientific skills and tools is intended to help you help students model the behavior of scientists.

- **Analyze:** To examine. *Students are asked to examine (analyze) data they collect to help develop their understanding of core ideas and crosscutting concepts.*
- **Claim:** A statement. *To help students develop their understanding of concepts, they will make statements (claims) concerning various scenarios based on observations and data they have collected*.
- **Classify:** To arrange things in groups or categories. *As students investigate and collect data, they will arrange (classify) their data to look for patterns that may help to support claims that they make.*
- **Communicate:** To share information. *Students are continually asked to share experiences, questions, observations, data, and evidence (communicate) within their groups and with the class as a whole. Communication takes many forms, including discussions, the creation of models, designing solutions to problems, and formal presentations.*
- **Compare:** To note similarities and differences among things. *Like classifying, noting how things are alike and different (comparing) is another skill that students will use to analyze their data and look for patterns, cause and effect relationships, and other crosscutting concepts.*
- **Conclude:** To arrive at an opinion by reasoning. *The scientific practices of conducting investigations, collecting and analyzing evidence, and sharing and discussing information lead students to form opinions based on reasoning (to conclude). The conclusions that students develop during the unit will help you assess their understanding of the unit's core ideas.*
- **Evaluate:** To form an idea based on evidence. *Throughout each unit, students will look at (evaluate) the observations and data they collect and discuss their conclusions with classmates in order to form ideas about concepts based on evidence.*
- **Evidence:** Information to show whether something is true or valid. *Students will use the observations and data (evidence) they collect to support claims they make as being valid or true.*
- **Explain:** To describe in detail. *Throughout investigations, students will analyze the data they collect, make claims supported by evidence, and share their information with one another to make sense of (explain) core ideas and phenomena.*
- **Investigate:** To use a standard process to discover facts or information. *Students will carry out standard processes (investigate), sometimes developing those processes themselves, to discover facts or information related to scientific ideas.*
- **Model:** A representation of an object or idea. *Using a representation of an object or idea (a model) helps student scientists communicate and evaluate ideas regarding phenomena. Students will develop many types of models during a unit, including drawings, physical models, diagrams, graphs, and mathematical representations.*

- **Phenomena:** Occurrences or events that can be observed and cause one to wonder and ask questions. *Presenting occurrences or events (phenomena) related to the science concepts being studied engages students through real-world events and ensures common experiences for all students. Presenting phenomena also allows students to develop their own questions and take ownership of their learning.*

- **Predict:** To develop anticipated results of an event based on prior experience or knowledge. *Students are asked to anticipate (predict) the results of events based on experience and data from prior events.*

- **Reasoning:** Thinking about something in a logical way. *Students are asked to make claims, support them with evidence, and explain their claims in a logical fashion (with reasoning). Making claims supported with evidence and reasoning is scientific, or evidence-based, argumentation.*

- **Record:** To write down. *During investigations, students will keep track of their observations (record) by drawing or writing in their science notebooks or on student investigation sheets.*

- **Variable:** A factor that is able to be changed. *As students conduct investigations, they will consider which factors can be changed or manipulated (variables) to test something during the investigation.*

The 5E Instructional Model

Building Blocks of Science uses a constructivist approach to learning by encouraging students to build upon existing ideas using the 5Es. This instructional model cycles through five phases:

- **Engage:** Students draw upon prior knowledge to make connections to a new concept or topic.
- **Explore:** Students are provided with an activity related to a concept or topic and are encouraged to make claims and observations, collect evidence, and ask questions.
- **Explain:** Students use observations and discussion to construct an explanation for a concept or topic they are studying.
- **Elaborate:** Students must draw upon their experiences and apply their knowledge to a new situation in order to demonstrate understanding.
- **Evaluate:** Students assess their knowledge and review what they have learned.

In each Building Blocks of Science unit, students begin with an engaging pre-assessment activity, which allows the teacher to gauge levels of previous knowledge. The following lessons cycle through the explore, explain, and elaborate phases, and then in the final lesson, students are evaluated using project-based and summative assessments.

Incorporating Phenomena

Building Blocks of Science uses phenomena, or observable occurrences, to encourage students to develop questions that will lead to deeper understanding of the core ideas investigated in each unit and to support inquiry-based learning. Each unit includes both an anchoring phenomenon and lesson-specific investigative phenomena.

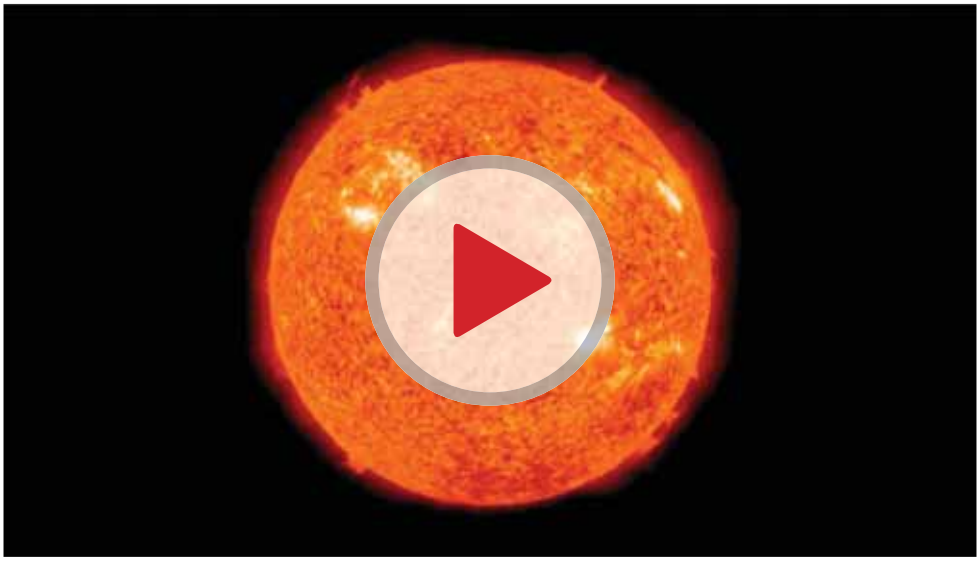
The unit's anchoring phenomenon, introduced to students in the first lesson, serves as the main focus of the unit. The anchoring phenomenon is introduced through a descriptive narrative in the Teacher's Guide and supported visually by a short online video. This visual teaser of the anchoring phenomenon piques students' interest and helps them to think more deeply and to develop questions. Viewing the video again at the end of the unit prompts students to make connections between the anchoring phenomenon and its applications beyond the scope of the unit's investigations.

An investigative phenomenon is presented to students at the beginning of each lesson to encourage them to develop additional questions. At the end of each lesson, the class revisits its questions and addresses them based on the evidence they collected during the lesson investigations, making connections to the lesson's investigative phenomenon.

As students begin to develop a deeper understanding of the unit's core ideas, they begin to make sense of the phenomena introduced throughout the unit. Students draw connections between what they have learned and how it applies to the world around them. In the last lesson, students engage in a performance task in which they are challenged to synthesize their knowledge to make connections to the unit's anchoring phenomenon. Students may be asked to build a model or design a solution to a problem. When communicating their designs and findings to their classmates, students explain their reasoning using evidence-based claims and answer questions during their presentation.

Each unit's literacy and digital components provide examples of connections between a concept and a phenomenon and ask students to make their own. Teachers are encouraged to support these connections by selecting related articles and videos or by engaging the class in discussion. Teacher Tips within the Teacher's Guide suggest other opportunities to identify related phenomena.

Anchoring phenomenon videos kick off each unit



The Engineering Cycle

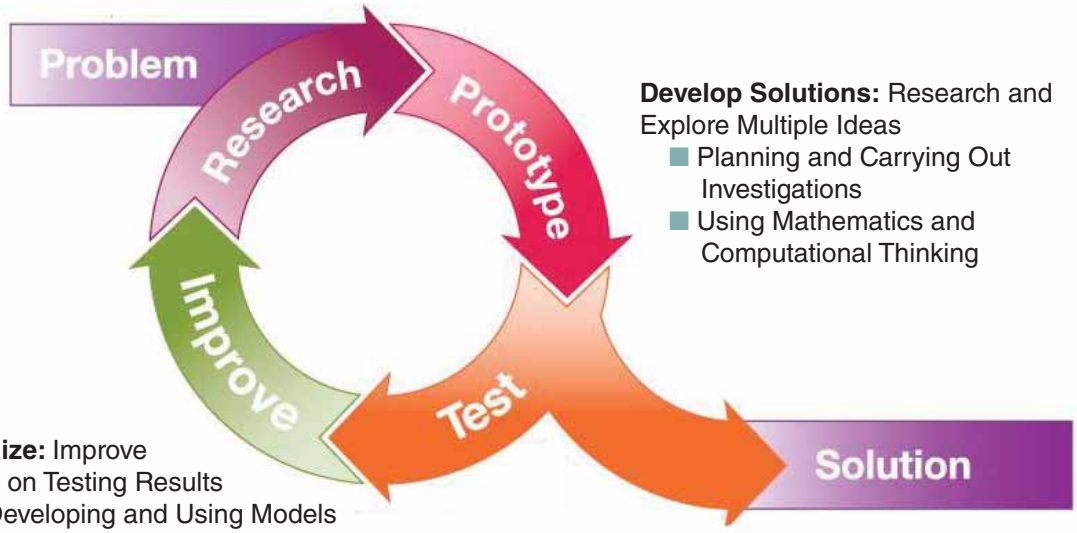
Building Blocks of Science incorporates an engineering design process to support the engineering, technology, and application of science (ETS) core idea outlined in the National Research Council's "A Framework for K–12 Science Education" (NRC, 2012, pp. 201–202). This ETS core idea has been brought into action through the NGSS ETS performance expectations, which allow students to practice systematic problem solving as they apply scientific knowledge they have acquired.

Through scientific engineering and design, students apply what they have learned to creatively solve real-world problems. This 21st-century skill encourages students to collaborate and exposes them to the idea that one problem can have multiple solutions.

An engineering design process can be thought of in three phases: defining a problem, developing solutions, and optimizing the design. Each phase can be correlated with NGSS Science and Engineering Practices as depicted in the graphic below.

Engineering Design Process

Define Problem: Identify Constraints and Criteria for Success
- Asking Questions and Defining Problems
- Obtaining and Evaluating Information



Develop Solutions: Research and Explore Multiple Ideas
- Planning and Carrying Out Investigations
- Using Mathematics and Computational Thinking

Optimize: Improve Based on Testing Results
- Developing and Using Models
- Analyzing and Interpreting Data

In each Building Blocks of Science unit, students employ this engineering cycle to assess their knowledge and build problem-solving skills. Depending on the activity, students may be creating a model, developing an experiment, or redesigning an existing product. To increase student engagement, relate the engineering process to a task, a phenomenon, or a career.

Sensemaking: Developing Claims Supported with Evidence and Reasoning

Scientific argumentation, or evidence-based argumentation, is defined as making scientific explanations (claims) using empirical data (evidence) to justify an argument (reasoning). Scientists use this type of argumentation to make sense of phenomena and refine their ideas, explanations, and experimental designs. In the classroom, students should be introduced to scientific argumentation to guide them in sensemaking, or building an understanding of phenomena based on evidence gained through observations, investigations, and data analysis. Through sensemaking, students refine and revise their understanding as new evidence is acquired and information is shared through class discussions.

Building Blocks of Science units offer multiple opportunities for students to make sense of scientific concepts by developing claims and supporting their claims with evidence and reasoning. At the start of an investigation, students are presented with a question related to a scientific concept. To make sense of a phenomenon or concept, students must draw upon their previous knowledge and experiences to develop a statement or conclusion that answers the question. To support that claim, students must provide relevant and specific data as evidence. This data may come from previous investigations, inference clues, texts, or class discussions. Students may even reference personal experience. Reasoning provides justification for why the selected evidence supports the claim. Relevant scientific principles should be incorporated into this reasoning. After the investigation, students should revisit their initial claims and determine if they are supported by newly gathered evidence. If the available evidence does not support students' initial claims, students should identify misunderstandings and present a claim that is supported.

To support students who struggle with scientific argumentation, ask them to use sentence frames such as "I think _____ because _____" to help with sensemaking. Explain that the first blank is the claim and the second blank is the evidence and reasoning.

Science Notebooks

Science notebooks are an integral part of the process of learning science because they provide a location for students to record their ideas, questions, predictions, observations, and data throughout the unit. The science notebook is used for notes, Tell Me More responses, diagrams, and outlines. Student investigation sheets can be glued, taped, or stapled into the science notebook as well.

Spiral notebooks are recommended and can be purchased inexpensively. If you choose to pre-assemble notebooks, consider including blank sheets of centimeter graph paper and plain paper for writing and drawing. It is recommended to create tabs for each lesson and to have students date each entry.

NOTE: Student investigation sheets use a specific numbering sequence to make it easier for students and teachers to identify them. The first number calls out the lesson, and the letter references the investigation. For example, Student Investigation Sheet 1A supports Investigation A of Lesson 1. If there are multiple student investigation sheets in one investigation, a second number will indicate the order of use (Student Investigation Sheet 2A.1, 2A.2, etc.).

Take-Home Science Activities

Take-Home Science activities are included in each unit and are called out within the related lesson. These activities reflect the science concepts and vocabulary that students are learning about and extend that learning to the home.

A reproducible letter explains how Take-Home Science activities work. Topic-specific activity sheets include directions for the parent, simple background information, and a space for the student to record observations or data. It is recommended that students share their findings and compare experiences as a class after completing the activity. Take-Home Science resources are found with the student investigation sheets at the end of the lesson in which they are assigned.

Assessment

Building Blocks of Science units provide assessment opportunities that correspond to specific lesson objectives, general science process skills, communication skills, and a student's ability to apply the concepts and ideas presented in the unit to new situations. The Teacher's Guide includes strategies for both formative and summative assessment. Each unit includes:

- **Pre-Unit Assessment and Post-Unit Assessment Opportunities:** The pre-unit assessment asks students to draw upon previous knowledge, allowing you to gauge their levels of understanding. The post-unit assessment touches upon the topics and concepts from the entire unit and evaluates students' learning. It is a beneficial practice to ask students to compare the pre-unit assessment and post-unit assessment activities to evaluate growth.

- **Formative Assessment Strategies:** At the end of each lesson, specific strategies are listed for each investigation. These include ways to utilize Student Investigation Sheets and Tell Me More questions as assessment tools. In lower grades, an Assessment Observation Sheet lists things to look for as you work with small groups of students.

- **Literacy and Digital Components:** These resources can be assigned to differentiate assignments and to assess student progress as needed.

- **General Rubric:** Appendix A includes a rubric that provides an expected progression of skills and understanding of science content. You can use these guidelines to assess students throughout the course of the unit.

- **Summative Assessment:** This unit-specific, cumulative assessment allows students to demonstrate their understanding of content presented by responding to questions in a variety of formats. Each question is aligned to performance expectations and provides insight on students' understanding of the concepts addressed. An answer key is provided, as well as a chart that indicates the performance expectation addressed by each question and lessons to revisit if remediation is required.

Additionally, there is a second end-of-unit assessment accessible only online. This digital summative assessment is **scenario-based** and touches upon all the standards from the unit. It includes both close-ended and open-ended questions.

Building Blocks of Science 3D—The Total Package

Phenomenon-Based Investigations with Digital Support—in 30-Minute Lessons

Hands-on materials are always included—not an extra purchase

Navigating the Teacher's Guide

Phenomenon

NGSS Standard and 5E Alignment

Investigation Overview with Time Considerations

Vocabulary

Tell Me More Formative Assessment Questions

Teacher Tips and Differentiation Strategies

LESSON 3

Push, Pull, Tumble

LESSON ESSENTIALS

Performance Expectations
- K-PS2-1: Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
- K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Disciplinary Core Ideas
- PS2.A: Forces and Motion
- PS2.B: Types of Interactions
- ETS1.B: Developing Possible Solutions

Science and Engineering Practice
- Planning and Carrying Out Investigations

Crosscutting Concept
- Cause and Effect

Literacy Components
- *Push, Pull, Go* Big Book pgs. 6, 11–14
- Literacy Article 3A: Falling Tree

Digital Component[1]
- Simulation: Dominoes

[1]Accessible at Carolina Science Online

PHENOMENON

Read the investigative phenomenon aloud to the class. Encourage students to generate questions about what they hear. Keep track of students' questions on a class chart, or have students record the questions in their science notebooks. Refer to these questions at the end of the lesson and throughout the unit to support the unit's anchoring phenomenon.

Investigative Phenomenon for Lesson 3: You wait to go down the slide. It's finally your turn. You slide down fast! Oh, no! Your friends are standing at the bottom of the slide. You can't stop sliding. You slide into one friend. He starts to fall. He falls into another friend. She falls over. It is important to look before you slide! What does this make you wonder?

Anticipated Questions:
- Why can't you stop sliding?
- Why does your friend fall over?
- Why does your friend knock another person over

LESSON OVERVIEW

In the previous lessons, students built their knowledge of fo
by rolling balls and observing swinging. They learned that c
applied to a system will change how the system moves. In t
begin to understand that the motion of an object is also affe
Students learn about systems and use what they learn to e
of falling dominoes. In the next lesson, students will extend
systems to explore the spinning motion of a toy top. They w
pulling force of gravity and its effect on motion.

INVESTIGATION OVERVIEW

Investigation A: How Can I Make Dominoes Tumble?
Using dominoes, students explore the motion of tumbling and further investigate forces.
- Teacher Preparation: 10 minutes
- Lesson: 30 minutes

Investigation
System?
Students further
manipulating the
dominoes.
- Teacher Prep
- Lesson: 30 m

Cred

64 PUSH, PULL, GO

LESSON 3

MATERIALS
- Student
1 Science notebook*
1 Student Investigation Sheet 3B: *How Do Dominoes Move After a Push?*
- Team of two students
8 Dominoes
- Teacher
1 Student Investigation Sheet 3B: *How Do Dominoes Move After a Push?* (Teacher's Version)
Assessment Observation Sheet: Lesson 3

NOTE: A materials list for each investigation precedes the procedure within the lesson.

*These materials are needed but not supplied.

OBJECTIVES
- Demonstrate that a force is any push or pull.
- Investigate and demonstrate that force causes an object to start moving, stop moving, or change direction.
- Predict and explore what happens if a component of a system in motion is missing or not working properly.
- Build on the understanding that position and motion can be changed by pushing and pulling objects.
- Gather evidence that it takes a push or pull to change the motion of objects.
- Build an understanding that objects move in different patterns (e.g., straight line, zigzag, curved line).

VOCABULARY
- Force
- Gravity
- Motion

TEACHER PREPARATION

Investigation A

1. Make a copy of Assessment Observation Sheet: Lesson 3 for yourself. During the investigations in this lesson, use the questions and prompts on this sheet to formatively assess students as they work.

2. Find an online video that shows large, complex domino setups. It will be helpful if the video uses dominoes similar to the ones students will use in the investigation.

3. Have eight dominoes from the kit available for each team of two students.

Investigation B

1. Have one copy of Student Investigation Sheet 3B: *How Do Dominoes Move After a Push?* for each student.

2. Have eight dominoes from the kit available for each team of two students.

3. Have your Assessment Observation Sheet handy to continue formatively assessing students.

Figure 3.1:

LESSON 3

Investigation B

WHAT IS A SYSTEM?

MATERIALS
- Student
1 Science notebook*
1 Student Investigation Sheet 3B: *How Do Dominoes Move After a Push?*
- Team of two students
8 Dominoes
- Teacher
1 Student Investigation Sheet 3B: *How Do Dominoes Move After a Push?* (Teacher's Version)
Assessment Observation Sheet: Lesson 3

*These materials are needed but not supplied.

1. Review the term "system" with students by referencing the swing or the ramp and ball. Ask students to make connections to the dominoes. Ask:
- What are the parts of this system? *(Eight dominoes)*
- What force causes changes in this system? *(A push)*
- What changes occur? *(A force causes the dominoes to tumble over.)*
- Do you think the system still work if you take away one part of it? Make a prediction.

2. Instruct students to use their dominoes to test their predictions. Allow time for pairs to set up their dominoes and then test what will happen if one domino is removed from the middle of the system. Assist students who appear to be struggling. When all students have tested their predictions, ask:
- What happens to the motion in the system when pieces are removed? How do you know?
- What do you think would happen if you removed two dominoes? Make a prediction and try it.
- How does changing a system affect the way it moves?

3. Provide each student with a copy of Student Investigation Sheet 3B: *How Do Dominoes Move After a Push?* Allow time for students to draw what happens to the line of dominoes and to complete the sentence prompts. Answer any questions students have as they work.

Disciplinary Core Ideas
- PS2.A: Forces and Motion
- PS2.B: Types of Interactions
- ETS1.B: Developing Possible Solutions

Science and Engineering Practice
- Planning and Carrying Out Investigations

Crosscutting Concept
- Cause and Effect

5Es
- Elaborate

Teaching Tip

Depending on the setup, some students' dominoes may continue to fall if they are very close together. If students appear to struggle with this concept, you may wish to lead a demonstration. Show what happens when you remove one of the middle dominoes, when you remove two dominoes that are side by side, and when you remove two dominoes from different locations.

? How can you change how fast something tumbles?

Tell Me More!

LESSON 3 ■ PUSH, PULL, TUMBLE 69

Extensions

Additional Features

- Lesson Overview Charts
- Guide to Instructional Scaffolding
- Teacher Preparation
- Background Information
- NGSS Standards by Lesson
- Literacy and Digital Components
- Summative Assessment

LESSON **3**

EXTENSIONS | ASSESSMENT STRATEGIES

Action Attraction
Challenge students to explore what might make the dominoes fall more slowly or more quickly. You might prompt students by asking:

- Does spacing make a difference in how a line of dominoes topples over?
- How might you test this question?
- Make a prediction and then try your ideas.

Domino Rally Events
Do a quick Internet search for videos that show domino challenges that people have set up. Share these videos with students, and encourage them to work together in small groups with all 96 dominoes to see how many dominoes they can set up to tumble with one push.

Credit: Africa Studio/Shutterstock.com

Counting and Setting Up Sets
Challenge pairs of students in a learning center to set up a line of dominoes that not only will fall down with one push but also is set up in sets of two or five. Have students offset the line of dominoes so that before the line is sent tumbling, they can identify and count the sets of two, three, or five.

1. Investigation A

- Use students' responses to the Tell Me More question to assess their understanding of domino motion. If students do not seem to understand this concept, you may wish to provide supplemental examples of motion and force.

2. Investigation B

- Use Student Investigation Sheet 3B: *How Do Dominoes Move After a Push?* to determine how well students understand force and motion using dominoes. Look for use of appropriate vocabulary and drawings that demonstrate motion.
- Use students' responses to the Tell Me More question to evaluate their understanding of forces. Students should recognize that adding force will increase the speed at which an object tumbles.

3. Refer to the Assessment Observation Sheet where you recorded observations during this lesson to formatively assess your class, and adjust instruction as needed.

4. Refer to the General Rubric in Appendix A to assess individual progress as needed.

Assessment Strategies

Literacy Articles

Literacy Article 3A

Name: _____ Date: _____

Falling Tree

You saw a tree in the forest. It was tall. It was wide. It was huge!

It rained hard. The wind blew.

The tree tumbled over! The tree fell onto smaller trees.

They had thin trunks. The smaller trees tumbled, too. The smaller trees fell on bushes. The bushes tumbled.

The rain stops. The Sun comes out. Birds start to sing.

Credit: Patrycja

Take-Home Science Activities

Student Investigation Sheet 3B: How Do Domino

Name: _____ Da

This is a line that moves.

Dominoes _____.

A push _____.

© Carolina Biological Supply Company Student Investigation Sheet 3B

Student Investigation Sheets

Take-Home Science

Dear Family,

Our class is beginning an inquiry science unit. Inquiry science is all about questions, active explorations, drawing, writing, and recording what you see and do to build an understanding of science. Young children are natural scientists. Scientists question everything. Once scientists answer one question, they move without blinking to the next question.

Take-Home Science is an exciting part of our program because it's one way we can better connect home and school. With everyone working together, we can reinforce the science concepts that your student is exploring in the classroom. Here's how Take-Home Science works.

Your student will bring home an investigation sheet that explains an activity related to the science unit the class is studying. The activity is designed so that everyone in the household—younger and older children alike—can work together to learn about science.

A section of the investigation sheet explains the science words and ideas that will be explored during the activity. These science words and ideas are not new to your student, because the activity follows a lesson in which those same concepts were explored.

The activities are simple and can be completed within 20 minutes using items normally found in the home. A section of the investigation sheet is for your student to complete and bring back to school. In class, your student will have the opportunity to share his or her experiences and results with other students.

The activities are intended to be quick, informal, and fun. Enjoy!

GO EXPLORING!

Credit: Cathy Keifer /Shutterstock

© Carolina Biological Supply Company Lesson 5 Take-Home Science Letter

Every unit anchored in phenomena

Earth and Space Systems

Unit Overview

Systems of matter and energy are present around Earth and across space. Interactions within and between these systems produce observable and predictable patterns—night and day, seasons, tides, weather and climate. Earth is composed of interconnected systems and is also part of a larger system in space. In the five lessons in *Earth and Space Systems*, students explore the interaction between Earth's systems and its role as part of larger systems. Students explore these concepts through investigation, discussion, and problem-solving. Students practice making observations and predictions, providing claims, evidence and reasoning, and evaluating problems and solutions.

Unit Anchoring Phenomenon

Systems of matter and energy are present around Earth and across space. Interactions within and between these systems produce observable and predictable patterns—night and day, seasons, tides, weather and climate. Earth is composed of interconnected systems and is also part of a larger system in space. The anchoring phenomenon for *Earth and Space Systems* is recognizing patterns that can explain the interconnectedness of the systems on Earth and in space.

	LESSON 1	LESSON 2
INVESTIGATIVE PHENOMENA	The Sun shines through your window early in the morning, and it wakes you up. You step outside and see the Moon high in the sky. You go through your day, and then you watch the Sun set on the horizon. The night sky with the Moon and stars begins to emerge. The next morning, the pattern repeats. What does this make you wonder?	If you go outside on a clear night, you can see stars, the Moon, airplanes, and satellites moving across the sky. At different times during the night, star patterns and the Moon are observed in different positions. What does this make you wonder?
OBJECTIVES	■ Begin building an age-appropriate understanding about Earth's roles in space systems. ■ Compare the sizes of the planets in our solar system and the distances of those planets from the Sun and from each other. ■ Explain how the pull of gravity impacts Earth's shape and path around the Sun. ■ Construct an argument to support concepts related to gravity.	■ Use a model to investigate the apparent brightness of stars. ■ Construct an argument to compare the apparent brightness of stars. ■ Investigate patterns in the nighttime sky to describe patterns in the rotation and revolution of Earth. ■ Describe the rotation and revolution of Earth by investigating patterns in the daytime and nighttime skies. ■ Collect and analyze data to provide evidence for the Sun's apparent movement across the sky.
SCAFFOLDING Students should know:	↓ A system is a group of parts that work together. ↓ Earth is a part of large space systems. ↓ The shapes and orbits of planets and their satellites are caused by the constant pull of gravity.	↓ Our Sun is a star, and it is the only star in our solar system. ↓ The apparent brightness of a star viewed from Earth can be affected by distance in the sky. ↓ Earth's rotation causes the pattern of daytime and nighttime and the patterns of change in the positions of stars in the sky. ↓ Shadows can be used to investigate the relationship between the Earth's rotation and the position of the Sun in the sky.

Concepts build from one lesson to the next

	LESSON 3	LESSON 4	LESSON 5
	The sky changes. In winter, it can get dark very early, almost as soon as you get home from school. In spring, the Sun stays out longer into the evening. Even the Moon looks different every week. What does this make you wonder?	You are out for a hike. You come to a clearing and observe your surroundings. You notice there is a stream running through the clearing. Trees and other plants are growing near the stream. You see birds wading in the water at one end of the stream, and you notice small insects on the water's surface. Some children are playing on the rocky outcrops at the other end of the stream. What does this make you wonder?	You know that Earth is a unique planet. It has a diversity of life that exists in a delicate balance with other aspects of our world, including water, mountains, air, and the cities we live in. Litter, pollution, fossil fuels, droughts, wildfires, endangered species, and climate change all threaten this delicate balance. What does this make you wonder?
	■ Construct models to demonstrate the connections in the Sun-Earth-Moon system. ■ Model how Earth's revolution contributes to seasons. ■ Graph and analyze data to provide evidence for seasonal changes in daylight. ■ Construct a model of the phases of the Moon based on the movement of the Moon around Earth and the location of the Sun. ■ Identify patterns, such as Moon phases and tides, to provide evidence for the interaction of the Earth-Moon system.	■ Identify Earth's major systems and the characteristics of each. ■ Create a model to describe how Earth's systems interact. ■ Use a model and create a graph to illustrate the distribution of water on Earth.	■ Describe how people affect Earth's systems and how people work to protect them. ■ Discuss ways that communities use science ideas and knowledge to help protect Earth's resources and environments. ■ Review unit content by developing questions to assess peers.
	↓ The Sun, Earth, and Moon are an interconnected system. ↓ Earth's tilt on its axis and its position in its orbit around the Sun influence seasonal patterns. ↓ Earth and the Moon are also an interconnected system. ↓ Patterns in the Moon's phases can be observed as the Moon orbits Earth. Repeating patterns can be predicted. ↓ Tides are the periodic rise and fall of the ocean. Tidal patterns are influenced primarily by the gravitational pull of the Moon.	↓ Earth itself has interconnected systems, the atmosphere, biosphere, geosphere, hydrosphere. ↓ The majority of water on Earth is salt water and is found in the oceans. ↓ Most of the water available as freshwater is stored in glaciers and ice caps.	↓ Local communities can use scientific ideas to protect natural resources. ↓ Local communities can use scientific understanding of interactions between systems to help protect their environment. ↓ Humans depend on and can influence Earth's systems.

Lesson 4: Earth's Systems

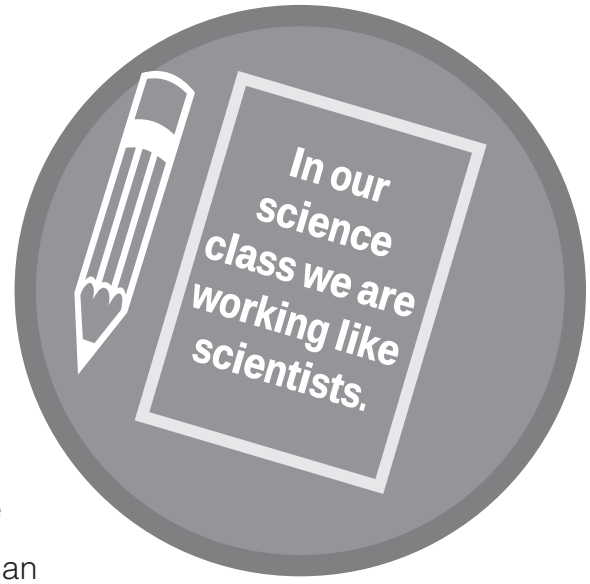
NGSS correlations by lesson

Investigation Overview	Standards	Resources
Investigation A: How Do Earth's Systems Interact? **5Es:** Explain, Elaborate Students investigate Earth's major systems and create a poster to model the interactions of these systems. ■ **Teacher Preparation:** 30 minutes ■ **Lesson:** 90 minutes **Tell Me More!** More than 750,000 square kilometers (289,000 square miles) of Amazon rain forest have been destroyed. Explain how deforestation in the Amazon influences two of the four systems you learned about in this investigation. **Investigation B: Can I Model and Graph the Distribution of Earth's Water?** **5Es:** Explain, Elaborate Students model the distribution of water on Earth by creating a graph and analyze the data to discuss patterns. ■ **Teacher Preparation:** 15 minutes ■ **Lesson:** 30 minutes **Tell Me More!** You modeled the distribution of water on Earth. Water is a vital resource. Explain how humans play a role in affecting the small amount of surface water that is available for humans to use.	**Next Generation Science Standards** **Performance Expectations** ■ **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. ■ **3-5-ETS1-2:** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. **Disciplinary Core Ideas** ■ **ESS2.A:** Earth Materials and Systems ■ **ESS2.C:** The Roles of Water in Earth's Surface Processes ■ **ETS1.B:** Developing Possible Solutions **Science and Engineering Practices** ■ Developing and Using Models ■ Analyzing and Interpreting Data ■ Using Mathematics and Computational Thinking **Crosscutting Concepts** ■ Scale, Proportion, and Quantity ■ Systems and System Models **Language Arts and Math Standards** **Language Arts** ■ **L.5.2:** Conventions of Standard English ■ **L.5.4:** Vocabulary Acquisition and Use ■ **L.5.6:** Vocabulary Acquisition and Use ■ **RF.5.3:** Phonics and Word Recognition ■ **RF.5.4:** Fluency ■ **RI.5.4:** Craft and Structure ■ **RI.5.7:** Integration of Knowledge and Ideas ■ **SL.5.1:** Comprehension and Collaboration ■ **SL.5.3:** Comprehension and Collaboration ■ **W.5.4:** Production and Distribution of Writing ■ **W.5.7:** Research to Build and Present Knowledge ■ **W.5.8:** Research to Build and Present Knowledge ■ **W.5.10:** Range of Writing **Math** ■ **5.G.A.2:** Graph points on the coordinate plane to solve real-world and mathematical problems. ■ **5.NBT.A.1:** Understand the place value system. ■ **5.NBT.A.3:** Understand the place value system.	**Student Investigation Sheets** ■ Student Investigation Sheet 4A: *How Do Earth's Systems Interact?* ■ Student Investigation Sheet 4B: *Can I Model and Graph the Distribution of Earth's Water?* **Literacy Components** ■ *Earth and Space Systems* Literacy Reader, pgs. 10–21, 23 ■ Literacy Article 4B: California's Water Shortage **Digital Components** ■ Interactive Whiteboard: Water Cycle ■ Simulation: Water Cycle **Vocabulary** ■ Atmosphere ■ Biosphere ■ Condensation ■ Evaporation ■ Geosphere ■ Glacier ■ Groundwater ■ Hydrosphere ■ Infiltration ■ Precipitation ■ Runoff ■ Water cycle

30-minute investigations fit into your busy day

Integrated ELA and math

Safety Contract



In science class, I will:

- Listen to directions
- Complete each step of the experiment
- Look, feel, smell, and listen but never taste
- Wait to begin until my teacher tells me
- Wear safety goggles when my teacher tells me
- Ask my teacher to approve any experiment I plan on my own or with classmates
- Keep my hands away from my mouth and eyes as I work
- Tie back long hair
- Tuck in loose clothing
- Keep my workstation neat
- Put away materials after use
- Follow all safety rules

I have read this contract and will follow these safety rules in science class.

Student's signature _____

Date _____

I have read this safety contract and understand what is expected of my child during science class.

Parent/Guardian's signature _____

Date _____

Note to Parent/Guardian:
Science materials and activities are chosen for safety and age appropriateness.

All lessons are anchored in phenomena

Earth's Systems

LESSON ESSENTIALS

Performance Expectations
- **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.
- **3-5-ETS1-2:** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Disciplinary Core Ideas
- **ESS2.A:** Earth Materials and Systems
- **ESS2.C:** The Roles of Water in Earth's Surface Processes
- **ETS1.B:** Developing Possible Solutions

Science and Engineering Practices
- Developing and Using Models
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking

Crosscutting Concepts
- Scale, Proportion, and Quantity
- Systems and System Models

Literacy Components
- *Earth and Space Systems* Literacy Reader, pgs. 10–21, 23
- **Literacy Article 4B:** California's Water Shortage

Digital Components‡
- **Interactive Whiteboard:** Water Cycle
- **Simulation:** Water Cycle

‡ Accessible at Carolina Science Online

PHENOMENON

Read the investigative phenomenon aloud to the class. Encourage students to generate questions about what they hear. Keep track of students' questions on a class chart, or have students record the questions in their science notebooks. Refer to these questions at the end of the lesson and throughout the unit to support the unit's anchoring phenomenon.

Investigative Phenomenon for Lesson 4: You are out for a hike. You come to a clearing and observe your surroundings. You notice there is a stream running through the clearing. Trees and other plants are growing near the stream. You see birds wading in the water at one end of the stream, and you notice small insects on the water's surface. Some children are playing on the rocky outcrops at the other end of the stream. What does this make you wonder?

Anticipated Questions:
- Are all the things you observe in the clearing part of one larger system?
- How are all of these things connected?
- What would happen if the stream dried up?

LESSON OVERVIEW

In previous lessons, students investigated the relationship between systems in space, the Sun-Earth-Moon system, and the Earth-Moon system. Students also explored patterns that describe evidence of the interconnectedness of these systems. In this lesson, students investigate Earth's major systems and create a poster to model how Earth's systems interact. Students then focus on one of Earth's systems, the hydrosphere, and graph the distribution of water on Earth. In the final lesson, students will research ways that individual communities can use science to help conserve Earth's resources, and they will communicate their findings to their classmates.

INVESTIGATION OVERVIEW

Investigation A: How Do Earth's Systems Interact?
Students investigate Earth's major systems and create a poster to model the interactions of these systems.
- **Teacher Preparation:** 30 minutes
- **Lesson:** 90 minutes

Investigation B: Can I Model and Graph the Distribution of Earth's Water?
Students model the distribution of water on Earth by creating a graph and analyze the data to discuss patterns.
- **Teacher Preparation:** 15 minutes
- **Lesson:** 30 minutes

Credit: Creative Travel Projects/Shutterstock.com

OBJECTIVES

- Identify Earth's major systems and the characteristics of each.
- Create a model to describe how Earth's systems interact.
- Use a model and create a graph to illustrate the distribution of water on Earth.

VOCABULARY

- Atmosphere
- Biosphere
- Condensation
- Evaporation
- Geosphere
- Glacier
- Groundwater
- Hydrosphere
- Infiltration
- Precipitation
- Runoff
- Water cycle

MATERIALS

Student

1 Science notebook*
1 Student Investigation Sheet 4A: *How Do Earth's Systems Interact?*
1 Student Investigation Sheet 4B: *Can I Model and Graph the Distribution of Earth's Water?*

Team of two students

Research materials (including science books, dictionaries, and computers as available)*

Team of four students

1 Graduated cylinder, 100 mL
1 Plastic cup, 7 oz
3 Plastic cups, 1.25 oz
1 Syringe, 1 mL

Class

Art supplies*
Chart paper or poster board*
Colored pencils or markers*
Paper towels*
Water*

Teacher

8 Teacher Sheet 4A: *Earth's Systems Poster Rubric*
1 Teacher Sheet 4B: *The Water Cycle*
1 Student Investigation Sheet 4A: *How Do Earth's Systems Interact?* (Teacher's Version)
1 Student Investigation Sheet 4B: *Can I Model and Graph the Distribution of Earth's Water?* (Teacher's Version)
1 Inflatable globe
Computer or tablet with internet access*
Projection system*
Satellite image of Earth from space*

NOTE: A materials list for each investigation precedes the procedure within the lesson.

*These materials are needed but not supplied.

TEACHER PREPARATION

Investigation A

1. Make one copy of Student Investigation Sheet 4A: *How Do Earth's Systems Interact?* for each student.

2. Make one copy of Teacher Sheet 4A: *Earth's Systems Poster Rubric* to use to evaluate each group's poster.

3. Decide how much class time you will allow for research. Arrange for students to use the school media center to access research materials online or in print, or gather printed reference materials for students to use in the classroom.

4. Have available chart paper or poster board, colored pencils and markers, and additional art supplies as desired for teams to use to create their posters.

5. Decide how much time groups will have to share their posters with the class, and determine a schedule. Be prepared to share both with the class.

Investigation B

1. Make a copy of Student Investigation Sheet 4B: *Can I Model and Graph the Distribution of Earth's Water?* for each student.

2. Each group of four students will need one graduated cylinder, one 7-oz plastic cup, three 1-oz plastic cups, and a 1 mL syringe from the kit. Groups will also need access to paper towels.

3. Have a distribution area set up where students can access water. Each group of four students will need 100 mL of water.

4. Have available the inflatable globe from the kit.

5. Choose a satellite image of Earth from space to share with the class. Use a projection system to share the image, or make a copy for pairs or small groups to share.

6. Prepare to share Teacher Sheet 4B: *The Water Cycle* with the class. You might display this using a document camera or similar projection system, or you might make a copy for each student. Alternatively, use Interactive Whiteboard: Water Cycle.

Just-in-time background information

BACKGROUND INFORMATION

Earth's Systems

A system is a group of parts that work together. Earth itself is a system made up of several major systems: the atmosphere, biosphere, geosphere, and hydrosphere. The **atmosphere** is the air, or the mixture of nitrogen, oxygen, and other gases that surrounds Earth. The **biosphere** is all the living things on Earth and their interactions in the places they live. The **geosphere** is all the solid parts of Earth, such as soils, sediments, and rocks. Another name for the geosphere is the lithosphere. Many different agents help shape the surface features of the geosphere, including gravity, water, and organisms. The **hydrosphere** is all the water on Earth, whether solid, liquid, or gas, including that in the atmosphere. (Note that some scientists consider Earth's frozen water to be a separate system called the cryosphere.)

Earth's systems interact with each other in multiple ways, affecting Earth's surface materials and processes. To give one example, the geosphere and hydrosphere interact with the atmosphere when land and ocean surfaces that absorb the Sun's energy radiate energy that warms the atmosphere. Warmed ocean water evaporates to become water vapor in the air.

Approximately 71 percent of Earth's surface is covered by water. The vast majority of this water—97 percent of Earth's water—is found in the ocean as salt water. In contrast, only about 3 percent of Earth's water is freshwater. Freshwater is found in lakes, in rivers, as groundwater, in the atmosphere, and frozen as snow and ice. The largest percentage of Earth's freshwater is frozen in ice caps and **glaciers**, huge sheets of ice that move slowly over land. Most of the remaining amount is found as **groundwater**, or water below Earth's surface. A very small amount of freshwater is present in surface water, like rivers and lakes, and other forms of freshwater including the atmosphere, organisms and soil moisture.

The **water cycle** is the continuous movement of water between Earth's surface (the geosphere) and the atmosphere. This cycle, powered by the Sun's energy, produces an exchange of water among the land, ocean, and atmosphere. The diagram below shows the major parts of the water cycle.

- **Evaporation:** Process in which a liquid changes to a gas.
- **Condensation:** Process in which a gas changes to a liquid.
- **Precipitation:** Water that falls from the sky to Earth's surface.
- **Infiltration:** Process in which water enters the soil and rock underneath Earth's surface. This process contributes to groundwater formation.
- **Runoff:** Water that flows over the land surface, pulled downhill by gravity, and makes its way into bodies of water such as rivers, lakes, and the ocean.

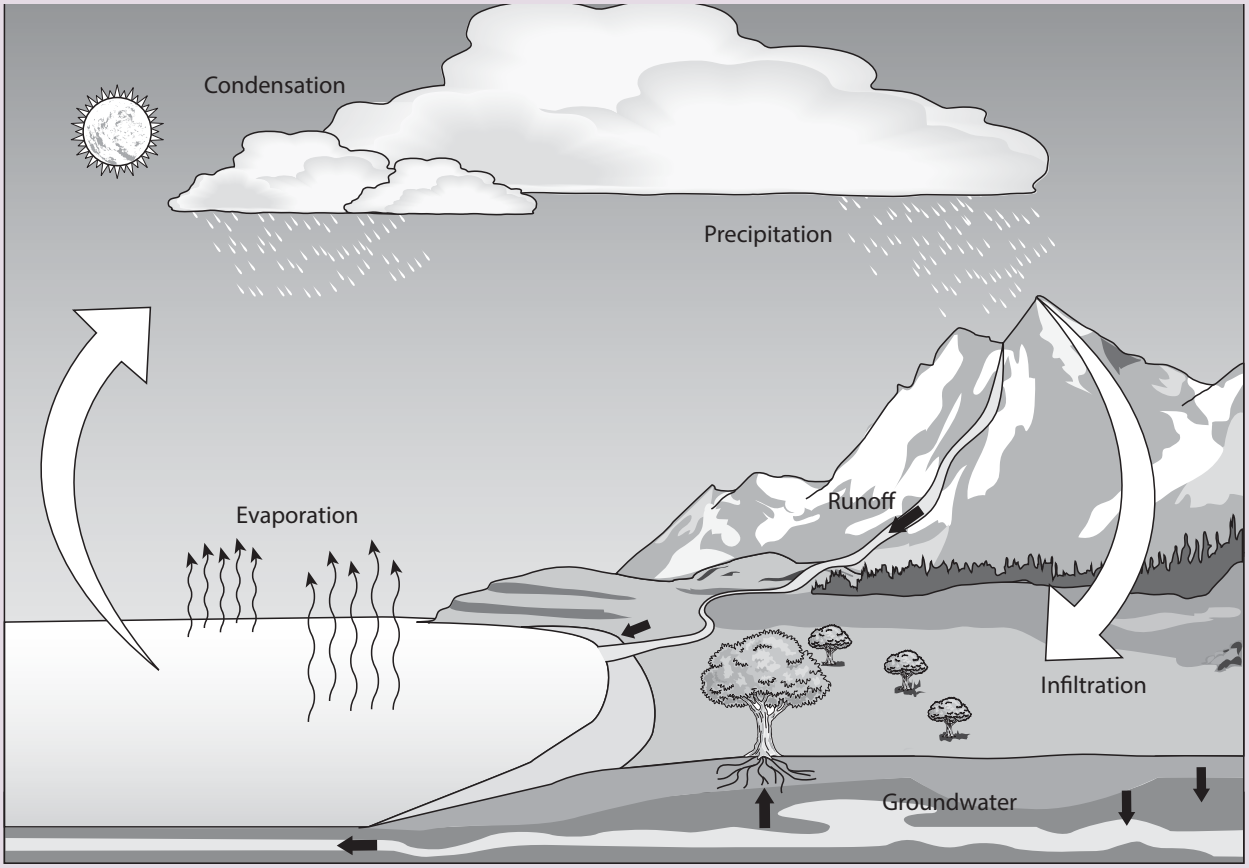


Figure 4.1: The water cycle

The water cycle affects Earth's environments and all living things in multiple ways. Moving water and ice shape Earth's land surface by carrying rocks from one area and depositing them in another. Water vapor in the atmosphere plays a key role in weather and climate. As wind moves around the planet, air carries moisture and energy. Moist air brings humidity, clouds, and precipitation, and it moderates temperatures. Evaporation of ocean water has an important cooling effect, moving heat away from the surface and keeping our planet habitable for living things. Precipitation and freshwater on the land surface and in the ground are essential for the survival of plants and animals, including humans.

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

Science and Engineering Practice
- Developing and Using Models

Crosscutting Concept
- Systems and System Models

5Es
- Explain
- Elaborate

Literacy Component
- *Earth and Space Systems* Literacy Reader, pgs. 10–15

Teaching Tip

If you need to teach this investigation over multiple class sessions, good places to stop are after Steps 5 and 8.

3-dimensional learning

Investigation A

HOW DO EARTH'S SYSTEMS INTERACT?

MATERIALS

Student
1 Science notebook*
1 Student Investigation Sheet 4A: *How Do Earth's Systems Interact?*

Team of two students
Research materials (including science books, dictionaries, and computers as available)*

Class
Art supplies*
Chart paper or poster board*
Colored pencils or markers*

Teacher
1 Teacher Sheet 4A: *Earth's Systems Poster Rubric*
1 Student Investigation Sheet 4A: *How Do Earth's Systems Interact?* (Teacher's Version)

*These materials are needed but not supplied.

ELA connection
L.5.2, L.5.4, L.5.6, SL.5.1, SL.5.3, RI.5.7, W.5.4, W.5.7, W.5.8

1. Review the meaning of "system" with the class, and ask students to share examples of systems they have learned about so far. Ask:

- Could you argue that Earth has its own systems? *(Answers will vary. Encourage students to provide reasoning to support their answers.)*

2. Write the following terms on the board: "atmosphere," "biosphere," "geosphere," and "hydrosphere." Instruct students to copy these terms into their science notebooks and work with a partner to develop a definition for each. After some time, ask students to share their definitions. As needed, clarify the meanings of the terms for the class.

- Atmosphere: The air, or the mixture of gases that surrounds Earth.
- Biosphere: All the living things on Earth and their interactions in the places they live.
- Geosphere: All the solid parts of Earth, such as soils, sediments, and rocks.
- Hydrosphere: All the water on Earth, whether solid, liquid or gas, including that in the atmosphere.

3. Identify the spheres as systems of Earth. Ask students to brainstorm how these systems work together and to record their ideas in their science notebooks. After some time for an initial brainstorm, ask students to discuss their ideas with a partner, and then invite volunteers to share their examples with the class. If students struggle to provide examples, offer the following:

- The biosphere relies on the hydrosphere for water to survive.
- The hydrosphere can change the shape of the geosphere through erosion.
- The atmosphere keeps the biosphere functioning by moderating global weather and climate.

4. Tell students that they will work in teams to research Earth's four major systems and create a poster to model how the systems interact. Divide the class into teams of four, and assign each student in the group one of Earth's systems to research.

5. Distribute a copy of Student Investigation Sheet 4A: *How Do Earth's Systems Interact?* Allow ample time for students to select appropriate sources from the available research materials and to complete Part A of their investigation sheet. As students conduct their research, circulate among them, offering guidance as needed.

6. Instruct students to summarize their research findings to share with their group members. Students should write the summary in Part B of Student Investigation Sheet 4A.

7. Explain that each group will use one feature of Earth to help them explain the interconnectedness of all four systems they researched. Assign each group one feature of Earth: mountain, ocean, soil, or air.

8. Instruct groups to work together to answer the questions and complete the chart in Part C of the investigation sheet to help plan their posters. Remind groups that their posters should describe the characteristics of each system and the interactions of the system with their specific feature. Tell groups how much time they have to share their posters with the class, and give them the schedule.

9. Allow time for each group to share their poster. Instruct students to listen carefully and to take notes in Part D of the Student Investigation Sheet while other groups share their posters so they can gain a full understanding of all four of Earth's systems. Encourage students to ask clarifying questions. As each group presents, use Teacher Sheet 4A: *Earth's Systems Poster Rubric* to evaluate their poster and presentation.

Teaching Tip

If you need to teach this investigation over multiple class sessions, a good stopping point is after Step 5. Groups can create their poster in the next class session.

Tips for teaching in every lesson

Teaching Tip

Ask groups to use a feature of Earth from your area to create their posters

Teaching Tip

If you need to teach this investigation over multiple class sessions, a good stopping point is after Step 8. Students can share their posters in the next class session.

Teaching Tip

Assign each student in each group a role to help students stay on task.

10. Allow students time to complete Part E of the investigation sheet individually. As a class, review the main concepts related to Earth's major systems. Ask:

- Summarize each of the major Earth systems. *(The hydrosphere is all the water on Earth, including ice and water vapor. The biosphere is all the living things on Earth and their interactions in the places they live. The geosphere is all the solid parts of Earth. The atmosphere is the mix of gases surrounding Earth.)*
- Give an example of how the hydrosphere and biosphere interact. *(Students may suggest that animals and plants take in water. Organisms live in rivers, lakes, oceans, and other water environments.)*
- Provide an example of how the hydrosphere interacts with Earth's other systems. *(Student examples may include that water vapor in the air condenses to form rain that falls into lakes and oceans, or that ocean waves shape beaches as they erode and deposit sediment.)*

ELA connection L.5.6, W.5.10

Tell Me More!

More than 750,000 square kilometers (289,000 square miles) of Amazon rain forest have been destroyed. Explain how deforestation in the Amazon influences two of the four systems you learned about in this investigation.

NOTES

Investigation B

CAN I MODEL AND GRAPH THE DISTRIBUTION OF EARTH'S WATER?

MATERIALS

Student
1 Science notebook*
1 Student Investigation Sheet 4B: *Can I Model and Graph the Distribution of Earth's Water?*

Team of four students
1 Graduated cylinder, 100 mL
1 Plastic cup, 7 oz
3 Plastic cups, 1.25 oz
1 Syringe, 1 mL

Class
Paper towels*
Water*

Teacher
1 Teacher Sheet 4B: *The Water Cycle*
1 Student Investigation Sheet 4B: *Can I Model and Graph the Distribution of Earth's Water?* (Teacher's Version)
1 Inflatable globe
Computer or tablet with internet access*
Projection system*
Satellite image of Earth from space*

*These materials are needed but not supplied.

1. Facilitate a brief review of Earth's major systems. Ask:

- How would Earth be different without the hydrosphere? Construct an argument. *(Answers will vary. Encourage students to provide evidence and reasoning to support their arguments.)*

2. Display a satellite image of Earth from space. Ask:

- What do you observe about this satellite image? *(Students may suggest that it is a picture of Earth from space, or they may identify specific elements of the image, including clouds, water, land, or continents.)*
- Earth has been nicknamed the "Blue Marble." What do you think led to this name? *(Students should recognize that the name Blue Marble comes from the fact that the majority of Earth is covered in water.)*
- Based on the image, describe where most of Earth's water is found. *(Students should recognize that most of Earth's water is found in the oceans.)*

3. Distribute a copy of Student Investigation Sheet 4B: *Can I Model and Graph the Distribution of Earth's Water?* to each student. Direct students to complete Part A of the investigation sheet individually by identifying the phases of the water cycle. After allowing time for students to complete Part A, display Teacher Sheet 4B: *The Water Cycle* and point out the correct labels. Ask:

- How does water move into the atmosphere? *(Students should recognize that water will evaporate from bodies of water into the atmosphere. Some students may also recognize that plants release water into the atmosphere.)*

Disciplinary Core Ideas
- **ESS2.C:** The Roles of Water in Earth's Surface Processes
- **ETS1.B:** Developing Possible Solutions

Science and Engineering Practices
- Developing and Using Models
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking

Crosscutting Concept
- Scale, Proportion, and Quantity

5Es
- Explain
- Elaborate

Literacy Components
- *Earth and Space Systems* Literacy Reader, pgs. 16–21, 23
- **Literacy Article 4B:** California's Water Shortage

Digital Components
- **Interactive Whiteboard:** Water Cycle
- **Simulation:** Water Cycle

ELA connection
SL.5.1, SL.5.3

Digital simulations to enrich concepts

Digital Tip

For students who need extra review of the water cycle, use the Water Cycle simulation as a reinforcement.

- Describe how water moves from the condensation to precipitation stage? *(Students should explain that water vapor [a gas] cools to form water drops that make up clouds. Water falls as rain or snow from the sky.)*
- During infiltration, water enters the soil and rock beneath Earth's surface. Where does this water end up? *(Students might suggest that the water stays in the soil or that it might go into the roots of plants. If students do not mention groundwater, emphasize that infiltration is an important process for replenishing groundwater supply.)*
- In addition to needing water for drinking, in what ways do humans depend on the water cycle? Give an example. *(Students may suggest that humans depend on water for swimming and playing; watering plants; washing cars, dishes, or clothes; brushing teeth; or cooling off.)*

Teaching Tip

As groups work, monitor their cooperation, and check that each group member is able to obtain or move some of the water during the investigation. Each student should complete their own investigation sheet as they work.

4. Instruct students to individually record a prediction about Earth's distribution of water in Part B of the Investigation sheet.

5. Distribute a graduated cylinder, a large plastic cup, three small plastic cups, and a syringe to each team of four students. Ask students to read over the procedure in Part C, and answer any questions students may have. Allow ample time for groups to model distribution of water in the hydrosphere, observe, and record results in Part D of the investigation sheet.

6. When the investigation is complete, allow each group to work together to analyze their data in Part E. As students work, circulate around the room and help them as needed with their calculations and graphing. Check to make sure they have correctly graphed their data. Allow ample time for graphing and analysis.

Literacy integration

7. When all groups have completed the investigation sheet through Part E, invite teams to share their graphs with the class. During the discussion, point out different reservoirs on Earth using the inflatable globe from the kit.

Literacy Tip

Ask students to read Literacy Article 4B: California's Water Shortage to get a deeper understanding of water distribution and implications when fresh water is not available.

8. Instruct students to answer the questions in Part F of the investigation sheet, and then review students' responses as a class. Use the following questions to facilitate a discussion:

- Describe the path of a drop of water through the water cycle. (*Accept all reasonable responses.)*
- Explain how the water cycle can be multi-directional. *(Students should recognize that the water cycle has no one starting point, and water can enter and exit the cycle at different points of the cycle. For example, water may enter the atmosphere from a lake, form clouds that are moved across the globe, and then fall as precipitation.)*

- What can you conclude about the hydrosphere and the distribution of Earth's water? *(Students should recognize that the distribution of water on Earth is essential to the hydrosphere. The ocean is a huge storage area for water in the hydrosphere and is also a considerable influence on driving the evaporation of water into the atmosphere. Emphasize that much more water is in storage than is moving through the water cycle at any one time. In addition to oceans, glaciers and ice caps are primary reservoirs for water.)*

Formative assessment

ELA connection W.5.10

You modeled the distribution of water on Earth. Water is a vital resource. Explain how humans play a role in affecting the small amount of surface water that is available for humans to use.

Tell Me More!

Phenomenon

Review students' questions about the investigative phenomenon from the beginning of this lesson. Guide students in applying the concepts explored in this lesson and connecting them to the anchoring phenomenon: recognizing patterns that can explain the interconnectedness of the systems on Earth and in space. By the end of the lesson, students should be able to explain that:

- Earth is a system that is made up of four systems—the atmosphere, biosphere, geosphere, and hydrosphere—that interact with each other.
- Most of water on Earth is salt water. Freshwater makes up a very small percentage.
- Of the freshwater on Earth, most of it is stored in ice caps and glaciers and is therefore unavailable for use.

Connecting ideas about phenomena to evidence

ENVIRONMENTAL CONNECTIONS

Connecting investigations to environmental principles and concepts

This lesson incorporates several environmental principles and concepts that are important for students to recognize. In Investigation A, students research Earth's major systems and create a model to explain the interconnectedness of these systems. Students are also asked to think about the exchange of matter between natural systems, which have no permanent boundaries, and how humans depend on, benefit from, and influence natural systems. In Investigation B, students model the distribution of water on Earth. They think more deeply about the exchange of matter between natural systems and human societies, and the fact that that there are no permanent boundaries between these systems. The extensions at the end of this lesson offer additional opportunities for students to investigate the exchange of matter between natural systems, to explore how humans influence natural systems, and to understand how natural systems adjust to human-caused alterations.

Credit: NPeter/Shutterstock.com

EXTENSIONS

Terrarium

Challenge students to model the interaction of Earth's spheres by designing terrariums. Divide the class into small groups, and have each group research how to construct a terrarium. Provide groups the materials they need, making sure that each group uses the same type of plant, and allow students to build their terrariums. Have students monitor the terrariums and look for interactions between their model systems. Discuss how the plants in the terrarium are affected by the systems.

Credit: Brent Holmes/Shutterstock.com

Biomes

Have the class research Earth's biomes in small groups. As part of their research, have each group look for ways that each of Earth's systems interacts with their assigned biome. Encourage groups to create a visual showcasing their biome, the systems involved, and what environmental issues are facing their biome.

Ocean Issues

Engage students in the challenges facing our world ocean. You may wish to consider topics such as ocean acidification, coral reef bleaching, overfishing, marine debris, or ocean pollution. NOAA, 5Gyres Institute, Thank You Ocean, and USGS are good starting places to look for research, lesson plans, and activities for students.

Water Cycle Art and Storytelling

Encourage students to create art or literary works about the water cycle or its effects. Have students produce a collage, video, or creative literary work such as a poem, script or short story. Encourage students to use their creativity in illustrating concepts while keeping those concepts scientifically accurate. Then have students share their creative works with the class or display them for the school.

ASSESSMENT STRATEGIES

Formative assessment—how are they progressing?

1. Investigation A

- Review Student Investigation Sheet 4A: *How Do Earth's Systems Interact?* to confirm that students have recorded their group's research results. As students work in their research groups, observe to determine if they work cooperatively and complete their individual tasks. Guide them as needed to find appropriate resources and accurate information.
- As groups share their posters, assess them using Teacher Sheet 4A*: Earth System's Poster Rubric.* Ask questions of each team member to assess their understanding of key concepts.
- Use students' responses to the Tell Me More question to assess their knowledge of how changes in the biosphere can affect other Earth systems.

2. Investigation B

- Review students' responses to Student Investigation Sheet 4B: *Can I Model and Graph the Distribution of Earth's Water?* to assess their understanding of the distribution of water on Earth. Check students' graphs to make sure they have correctly represented their data and have appropriately labeled and titled their graphs. Correct any misunderstandings about Earth's water distribution that are present in students' summaries.
- Use students' responses to the Tell Me More question to gauge their understanding of how the small amount of surface water available for use can be affected by pollution, overuse, or infiltration of salt water in coastal areas.

4. Use the General Rubric included in Appendix A to assess individual progress as needed.

PLANNING AHEAD

Preparing for Lesson 5

Arrange for students to use the school media center or library to access research materials online or in print. Alternatively, gather science books and other reference materials about Earth's major systems for students to use in the classroom. Additionally, gather materials with which groups might prepare their public service announcement, such as markers, poster board, and video equipment for recording and viewing.

NOTES

Student Investigation Sheet 4A

How Do Earth's Systems Interact?

Name _____

Date _____

ELA connection
L.5.2, SL.5.1, SL.5.3, SL.5.5, RI.5.7, W.5.4, W.5.7, W.5.8

You will research one of Earth's major systems. Use approved resources from your teacher to conduct your research.

A. Research and Record

1. My Earth system is: _____

2. Conduct research to answer the following questions. Record your findings on the lines below.

- What does the prefix of your system's name mean?
- Describe the parts of the system. What are its features?
- How does the system interact with the other Earth systems?
- Differentiate between how the system affects organisms, including humans, and how organisms, including humans, affect the system.

3. Use at least four resources in your research, and list them below:

a. _____

b. _____

c. _____

d. _____

B. Summarize

Write a paragraph summarizing the answers to the questions in Part B to share with your group.

C. Prepare

1. Share with your group members what you learned from your research, and listen as they share their research findings with you. As each group member reports their findings, fill in the table below.

Atmosphere	Biosphere
Geosphere	Hydrosphere

2. You will be given a specific feature to help you describe ways in which Earth's systems interact.

a. Our feature: _____

3. With your group, create a poster that describes all four systems and the interactions that at least two of the systems have with the specific feature of Earth your group was assigned. You will share your poster with the class.

D. Learn and Ask Questions

Listen actively to other groups' presentations. Ask questions, and take notes below or in your science notebook. Make sure you describe or diagram the interactions between each of Earth's systems and the feature of Earth (air, mountain, ocean, soil) that each group describes.

E. Claim, Evidence, and Reasoning

Do Earth's systems depend on each other? Make a claim to answer the question. Provide evidence and reasoning to support your claim.

Claim (a statement or conclusion that answers the question you are testing)	
Evidence (data that supports your claim)	**Reasoning** (a justification explaining why your evidence supports your claim using scientific principles)

ELA connection
SL.5.3

Name _____

Date _____

ELA connection
L.5.6, RI.5.4, RI.5.7, RF.5.3, RF.5.4

California's Water Shortage

Did you know that Earth is sometimes called the water planet? Water doesn't stay in just one place, though. The water cycle is the constant movement of water among the land, ocean, and atmosphere. The key processes in the water cycle are evaporation, condensation, and precipitation. The ocean is the greatest source of water for evaporation. When ocean water evaporates, the salts in the water are left behind. As water vapor in the air cools, it condenses into liquid water. The water drops grow and form clouds. When the drops become large enough, they fall as precipitation, and the cycle continues.

Although water is continually cycling, not all areas of the planet receive the same amount of precipitation. Parts of California sometimes are at risk of experiencing water shortages. For some communities, that means mandatory water restrictions. These restrictions limit the consumption of water to certain days, times, and uses.

What causes water shortages? Like much of the western U.S., California greatly depends on melting snow to resupply rivers, lakes, and streams. Recently, winter storms have not dropped the usual amount of snow. Record temperatures have increased evaporation. The combination of these factors leaves the land parched. With surface resources low, some areas, especially those that are heavily farmed, have drilled for groundwater. This water is used for growing crops or watering livestock. Groundwater resources take many years to recharge. The shortage of water could have negative impacts on the agriculture industry.

Scientists and engineers are looking at ways to help California and other places on Earth that experience droughts. Some of the technology they are investigating includes turning salt water into freshwater, harvesting water with fog catchers, and recycling wastewater.

Questions:

1. You drop your water bottle on the sidewalk. Describe how the water cycle will change the spilled water.

2. Northern California has many forests. How might droughts affect these environments?

3. California produces almost half of all the fruits, nuts, and vegetables grown in the United States. How might a long-term drought in California affect all parts of the country?

Credit: muratart/Shutterstock.com

Student Investigation Sheet 4B

Name _____

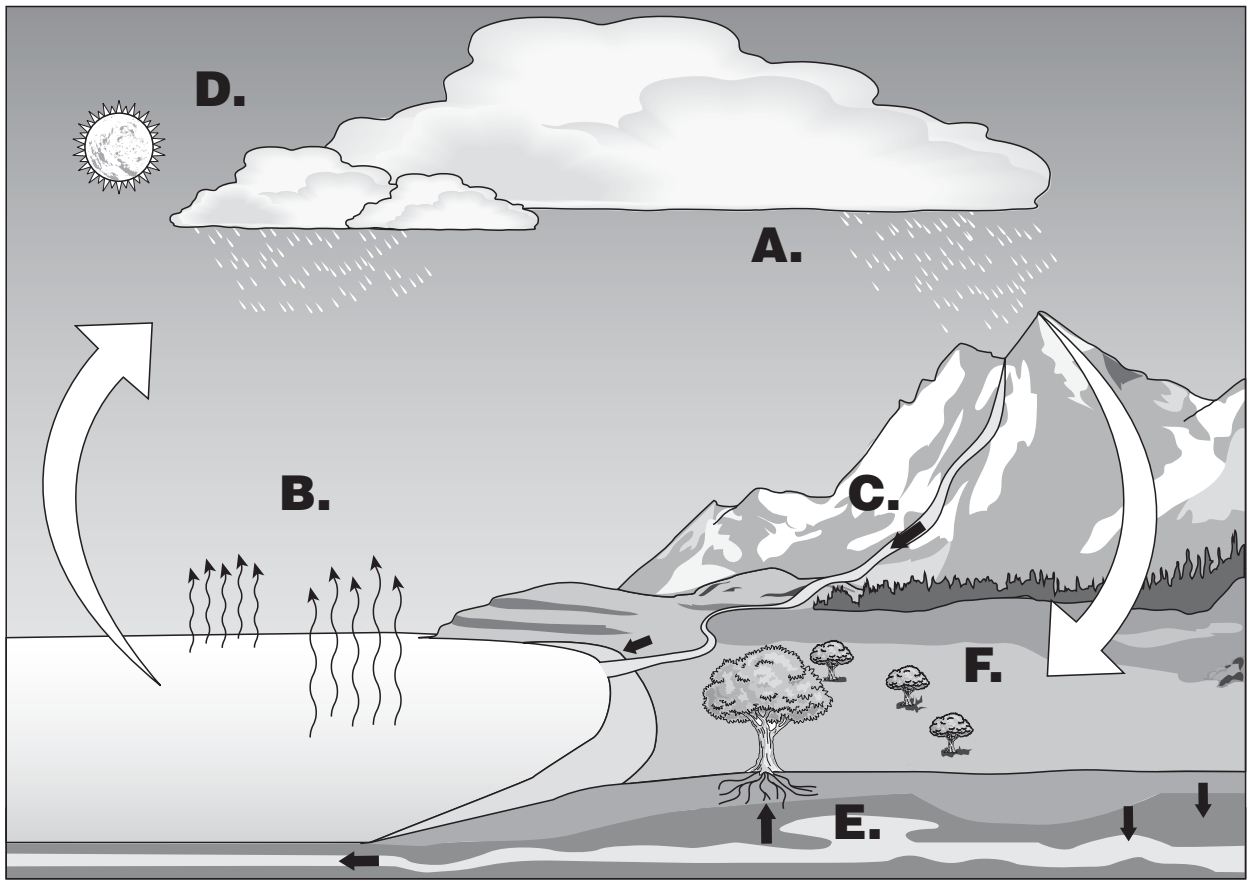
Date _____

ELA and math connections SL.5,1, SL.5.3, 5.G.A.2, 5.NBT.A.1, 5.NBT.A.3

Can I Model and Graph the Distribution of Earth's Water?

A. Think

1. Look at the diagram below. Match the letters to the correct phase of the water cycle by filling in the chart beneath the diagram.



Letter	Phase of the Water Cycle
	Runoff
	Infiltration
	Groundwater
	Condensation
	Evaporation
	Precipitation

B. Predict

How do you think water is distributed among the different reservoirs (reserves) on Earth? Make a prediction by filling in the chart below. In the second column, record the percentage of Earth's water that makes up each reservoir listed in the first column. Explain the reasoning for each of your predictions in the third column.

Reservoir	% of Earth's Total Water	Reasoning
Oceans		
Glaciers/ice caps		
Groundwater		
Rivers, lakes, and other freshwater reserves		

C. Procedure

1. Go to the distribution center and measure 100 mL of water into the graduated cylinder and bring it back to your work station.

2. Pour the water from the graduated cylinder into the large plastic cup. This represents the total water on Earth. Write "total water on Earth" in the top circle of the diagram in Part D, and write the total amount of water on the line beneath the circle.

3. Use the syringe to remove 3 mL of water from the large cup and put it in one of the small cups. This represents the total amount of freshwater on Earth. Write "total freshwater" in the right circle in the second row of the diagram. Write the amount of water on the line beneath the circle.

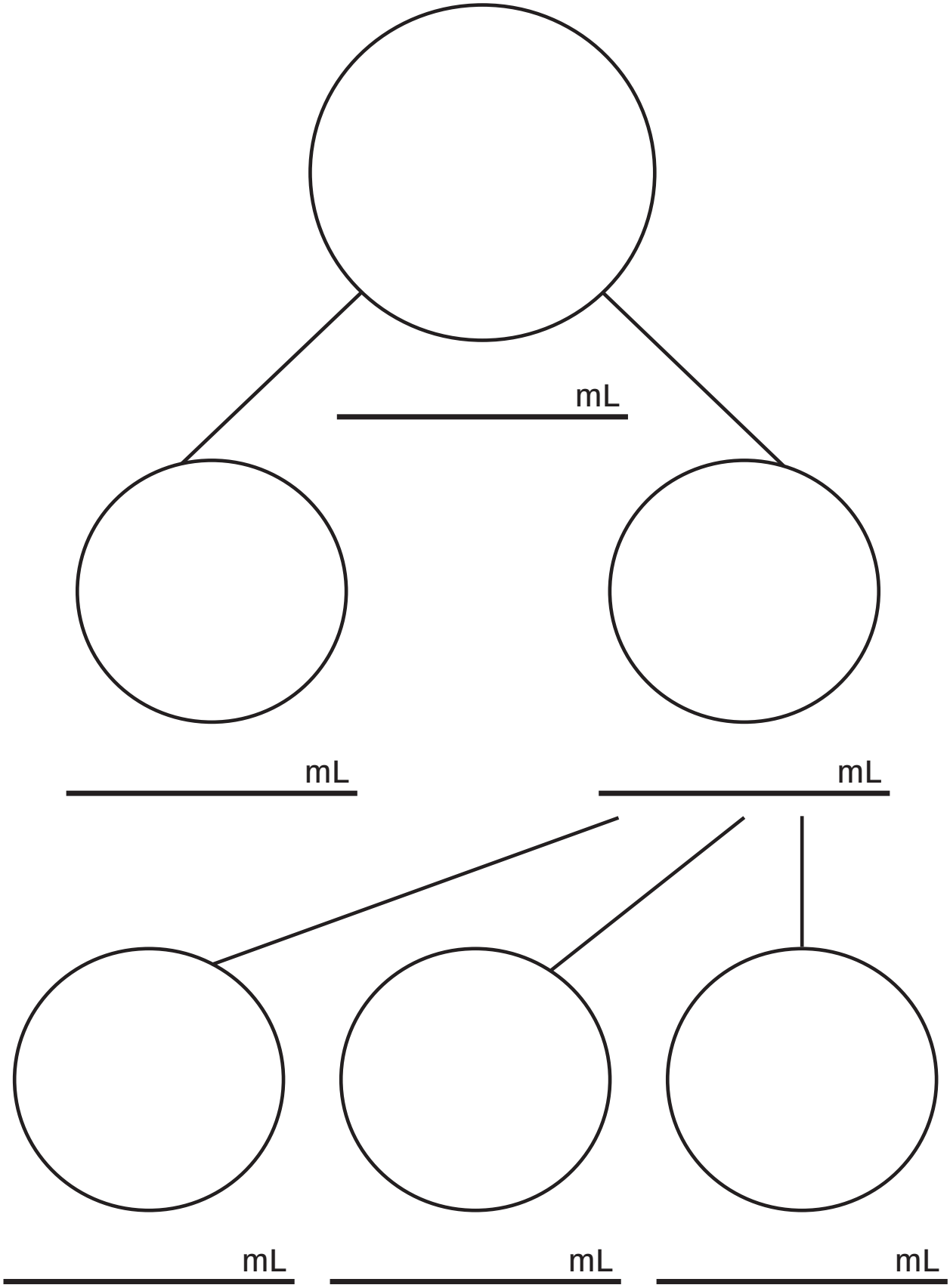
4. The water remaining in the large cup represents the total salt water on Earth. Write "total salt water" in the left circle in the second row of the diagram in Part D. Write the amount of water on the line beneath the circle

5. Use the syringe to remove 2 mL of water from the freshwater cup and put it in a second small cup. This represents the freshwater in glaciers/ice caps. Write "glaciers/ice caps" in one of the circles in the bottom row of the diagram in Part D. Write the amount of water on the line beneath the circle.

6. Use the syringe to remove 0.9 mL of water from the freshwater cup and put it in the third small cup. This represents the freshwater stored as groundwater. Write "groundwater" in one of the circles in the last row of the diagram in Part D. Write the amount of water on the line beneath the circle.

7. The remaining water in the freshwater cup, which should be 0.1 mL, represents surface water and other freshwater. Write "surface water/other freshwater" in the last circle in the diagram. On the line beneath this circle, record the amount of water.

D. Observe and Record



E. Graph

1. Create a bar graph showing the total amount of salt water and freshwater (in mL) that you modeled in this investigation. Make each bar a different color. Label the horizontal and vertical axes of the graph. Give the graph a title.

2. Using the data table below, create a second bar graph. Make each bar a different color. Label the horizontal and vertical axes of the graph. Give the graph a title.

Earth's Freshwater (About 3% of Total Water on Earth)	
Reservoir	Percentage of Total Freshwater
Glaciers/ice caps	68.7
Groundwater	30.1
Other (lakes, rivers, atmosphere)	1.2

F. Conclude

1. What are the limitations of your model?

2. Review your predictions from Part B of the investigation sheet. Use evidence from your observations in this investigation to support your predictions or explain how you would revise your predictions.

3. Describe how humans benefit from the hydrosphere, and give at least one positive and one negative example of how humans impact the hydrosphere.

4. The amount of available freshwater on Earth is very small, and accessing clean, usable drinking water is a major world concern. Explain some solutions that could be designed to tackle this problem.

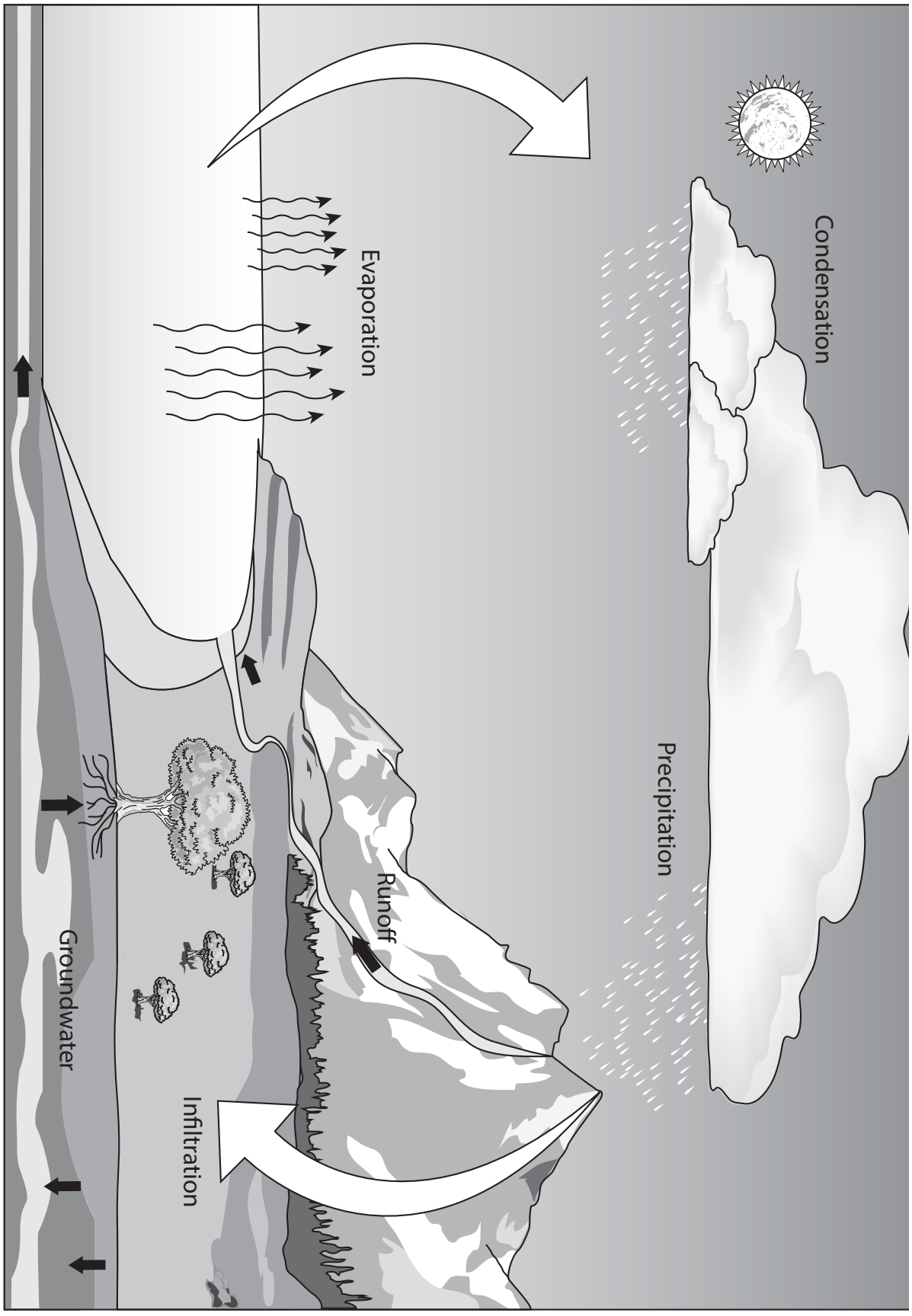
Teacher Sheet 4A

Earth's Systems Poster Rubric

	Content	Poster	Speaking	Participation
4	Numerous facts and details about Earth's systems are used to support the connection between the systems. Information on human benefit and impact on at least three of the systems are included.	Students come up with an original poster design. Poster is colorful and meaningful. Group shows much effort in creating poster.	Students speak clearly and distinctly, and volume is loud enough to be heard by all of the audience. Students frequently establish eye contact with audience.	Each member of the group takes a role in the presentation and shows a high level of engagement.
3	Some facts and details about Earth's systems are used to support the connection between the systems. Information on human benefit and impact on at least two of the systems are included.	Students show little creativity in poster design. Poster is meaningful. Shows some effort in creating poster.	Students speak clearly and distinctly, and volume is loud enough to be heard by most of the audience. Students establish some eye contact, but not as frequently.	Most members of the group take a role in the presentation and are somewhat engaged.
2	Few facts and details about Earth's systems are used to support the connection between the systems. Information on human benefit and impact on at least one of the systems is included.	Students show no creativity in poster design. Shows minimal effort in creating poster.	Students speak somewhat clearly, and volume is loud enough to be heard by most of the audience. Students establish little eye contact.	One or two members take control of the group, and others do not take a role. Group shows little engagement.
1	No attempt is made to provide facts and details about Earth's systems. No information on human benefit and impact is included.	No poster is created.	Students mumble, and volume too soft to be heard by audience. No effort to make eye contact.	Group is very unorganized. Members are not engaged or do not participate.

Teacher Sheet 4B

The Water Cycle



Student Investigation Sheet 4A: Teacher's Version

How Do Earth's Systems Interact?

A. Research and Record

1. My Earth system is: _____

2. Conduct research to answer the following questions. Record your findings on the lines below.

- What does the prefix of your system's name mean?
- Describe the parts of the system. What are its features?
- How does the system interact with the other Earth systems?
- Differentiate between how the system affects organisms, including humans, and how organisms, including humans, affect the system.

3. Use at least four resources in your research, and list them below:

a. _____

b. _____

c. _____

d. _____

B. Summarize

Write a paragraph summarizing the answers to the questions in Part B to share with your group. *(Summaries will vary based on the system each student researched.)*

C. Prepare

1. Share with your group members what you learned from your research, and listen as they share their research findings with you. As each group member reports their findings, fill in the table below.

Atmosphere	Biosphere
Geosphere	Hydrosphere

2. You will be given a specific feature to help you describe ways in which Earth's systems interact.

a. Our feature: _____

3. With your group, create a poster that describes all four systems and the interactions that at least two of the systems have with the specific feature of Earth your group was assigned. You will share your poster with the class.

E. Claim, Evidence, and Reasoning

Do Earth's systems depend on each other? Make a claim to answer the question. Provide evidence and reasoning to support your claim.

<table>
<tr><td colspan="2">Claim (a statement or conclusion that answers the question you are testing)
(Students should claim that Earth's systems do depend on each other.)</td></tr>
<tr><td>Evidence (data that supports your claim)
(Students should use examples from their research and what they learned from their classmates, and they should provide specific examples to support their claim.)</td><td>Reasoning (a justification explaining why your evidence supports your claim using scientific principles)
(Students' reasoning will vary. Students should use previous knowledge and what they have learned from this investigation as reasoning for their claim.)</td></tr>
</table>

California's Water Shortage

Did you know that Earth is sometimes called the water planet? Water doesn't stay in just one place, though. The water cycle is the constant movement of water among the land, ocean, and atmosphere. The key processes in the water cycle are evaporation, condensation, and precipitation. The ocean is the greatest source of water for evaporation. When ocean water evaporates, the salts in the water are left behind. As water vapor in the air cools, it condenses into liquid water. The water drops grow and form clouds. When the drops become large enough, they fall as precipitation, and the cycle continues.

Although water is continually cycling, not all areas of the planet receive the same amount of precipitation. Parts of California sometimes are at risk of experiencing water shortages. For some communities, that means mandatory water restrictions. These restrictions limit the consumption of water to certain days, times, and uses.

What causes water shortages? Like much of the western U.S., California greatly depends on melting snow to resupply rivers, lakes, and streams. Recently, winter storms have not dropped the usual amount of snow. Record temperatures have increased evaporation. The combination of these factors leaves the land parched. With surface resources low, some areas, especially those that are heavily farmed, have drilled for groundwater. This water is used for growing crops or watering livestock. Groundwater resources take many years to recharge. The shortage of water could have negative impacts on the agriculture industry.

Scientists and engineers are looking at ways to help California and other places on Earth that experience droughts. Some of the technology they are investigating includes turning salt water into freshwater, harvesting water with fog catchers, and recycling wastewater.

Questions:

1. You drop your water bottle on the sidewalk. Describe how the water cycle will change the spilled water. *(Students should understand that the water on the sidewalk will evaporate to form water vapor in the air. This vapor will eventually cool, condense, and fall to the ground as rain.)*

2. Northern California has many forests. How might droughts affect these environments? *(Answers will vary. Students may suggest that the lack of rainfall may affect plant growth; reduce the amount of water that is available for animals to drink; not replenish streams, which may then dry up, affecting aquatic ecosystems; or that dry conditions may lead to forest fires.)*

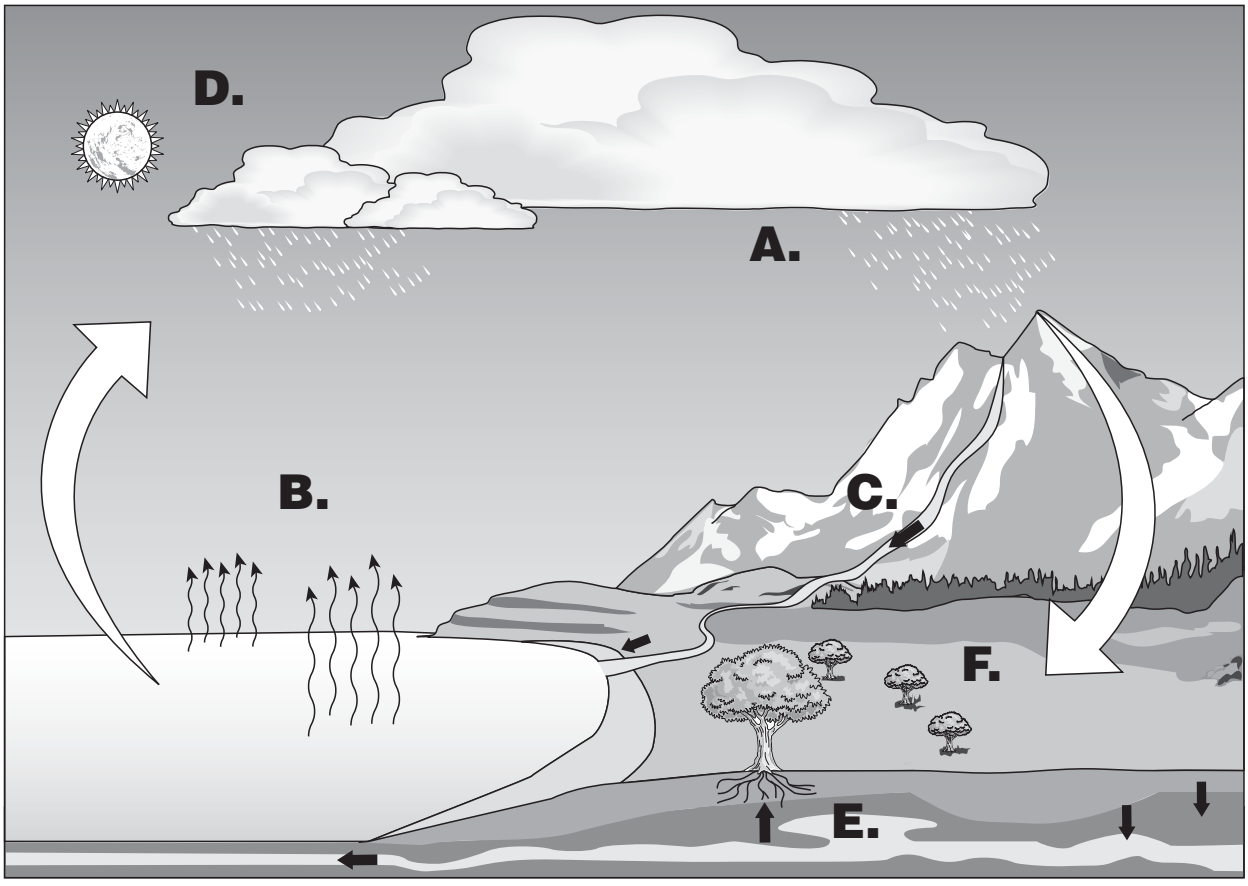
3. California produces almost half of all the fruits, nuts, and vegetables grown in the United States. How might a long-term drought in California affect all parts of the country? *(Students should infer that food shortages may result from a lack of water in California.)*

Student Investigation Sheet 4B: Teacher's Version

Can I Model and Graph the Distribution of Earth's Water?

A. Think

1. Look at the diagram below. Match the letters to the correct phase of the water cycle by filling in the chart beneath the diagram.



Letter	Phase of the Water Cycle
C.	Runoff
F.	Infiltration
E.	Groundwater
D.	Condensation
B.	Evaporation
A.	Precipitation

B. Predict

How do you think water is distributed among the different reservoirs (reserves) on Earth? Make a prediction by filling in the chart below. In the second column, record the percentage of Earth's water that makes up each reservoir listed in the first column. Explain the reasoning for each of your predictions in the third column.

Reservoir	% of Earth's Total Water	Reasoning
Oceans	*(Predictions will vary.)*	*(Students' reasoning will vary. Accept all reasonable responses.)*
Glaciers/ice caps	*(Predictions will vary.)*	*(Students' reasoning will vary. Accept all reasonable responses.)*
Groundwater	*(Predictions will vary.)*	*(Students' reasoning will vary. Accept all reasonable responses.)*
Rivers, lakes and other freshwater reserves	*(Predictions will vary.)*	*(Students' reasoning will vary. Accept all reasonable responses.)*

C. Procedure

1. Go to the distribution center and measure 100 mL of water into the graduated cylinder and bring it back to your work station.

2. Pour the water from the graduated cylinder into the large plastic cup. This represents the total water on Earth. Write "total water on Earth" in the top circle of the diagram in Part D, and write the total amount of water on the line beneath the circle.

3. Use the syringe to remove 3 mL of water from the large cup and put it in one of the small cups. This represents the total amount of freshwater on Earth. Write "total freshwater" in the right circle in the second row of the diagram. Write the amount of water on the line beneath the circle.

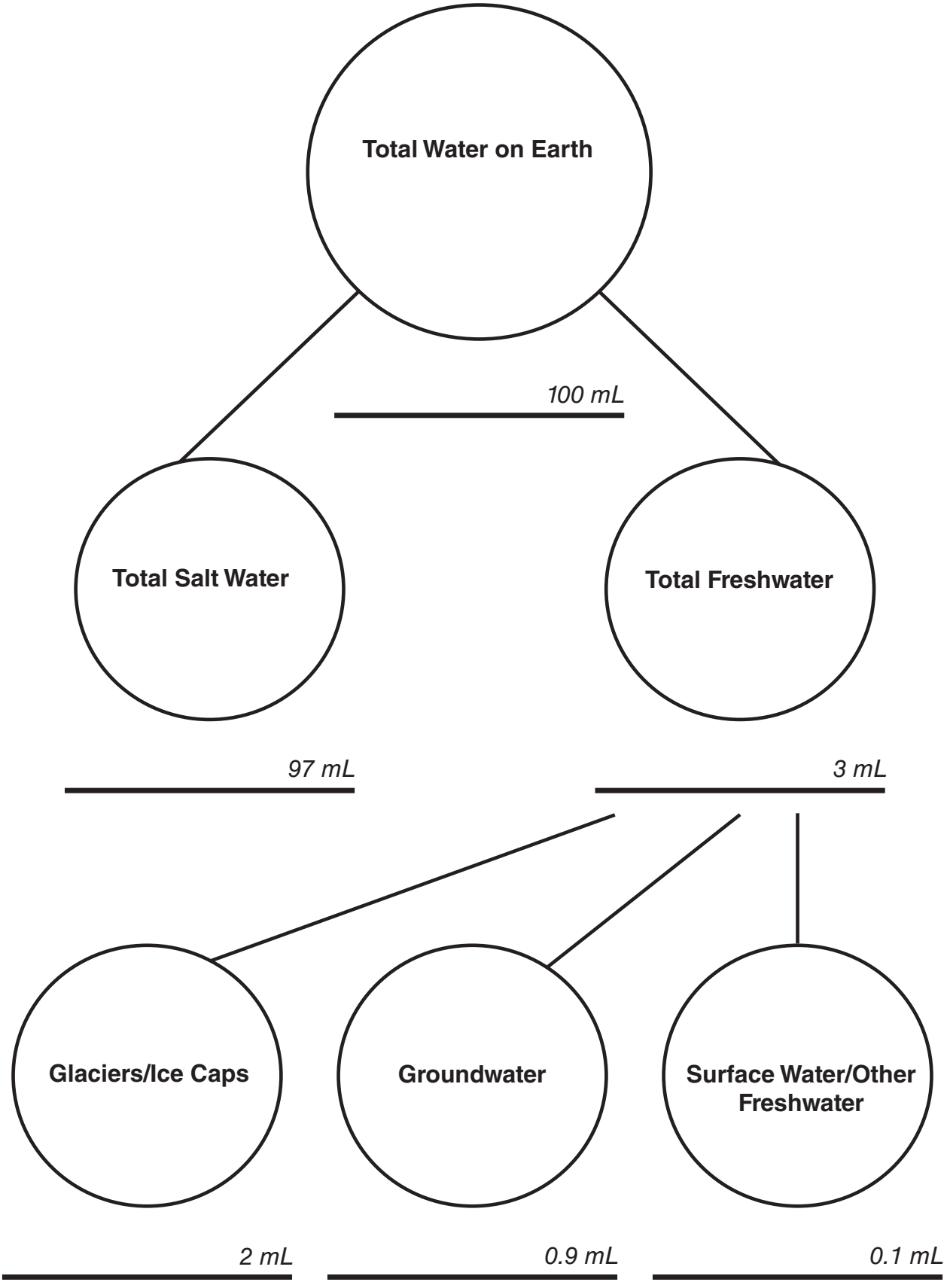
4. The water remaining in the large cup represents the total salt water on Earth. Write "total salt water" in the left circle in the second row of the diagram in Part D. Write the amount of water on the line beneath the circle

5. Use the syringe to remove 2 mL of water from the freshwater cup and put it in a second small cup. This represents the freshwater in glaciers/ice caps. Write "glaciers/ice caps" in one of the circles in the bottom row of the diagram in Part D. Write the amount of water on the line beneath the circle.

6. Use the syringe to remove 0.9 mL of water from the freshwater cup and put it in the third small cup. This represents the freshwater stored as groundwater. Write "groundwater" in one of the circles in the last row of the diagram in Part D. Write the amount of water on the line beneath the circle.

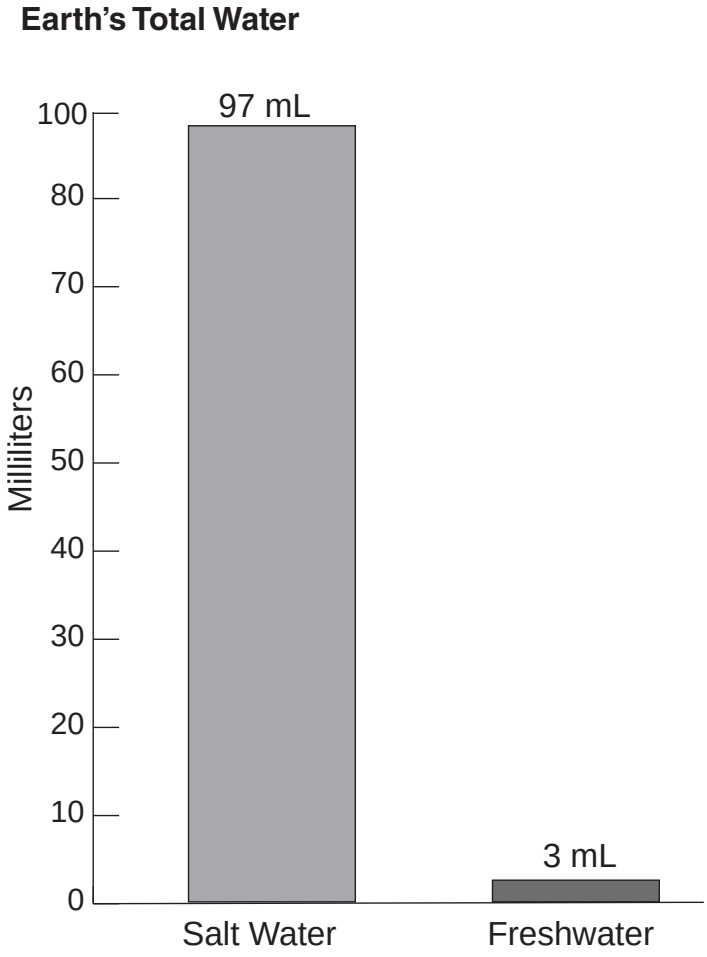
7. The remaining water in the freshwater cup, which should be 0.1 mL, represents surface water and other freshwater. Write "surface water/other freshwater" in the last circle in the diagram. On the line beneath this circle, record the amount of water.

D. Observe and Record



E. Graph

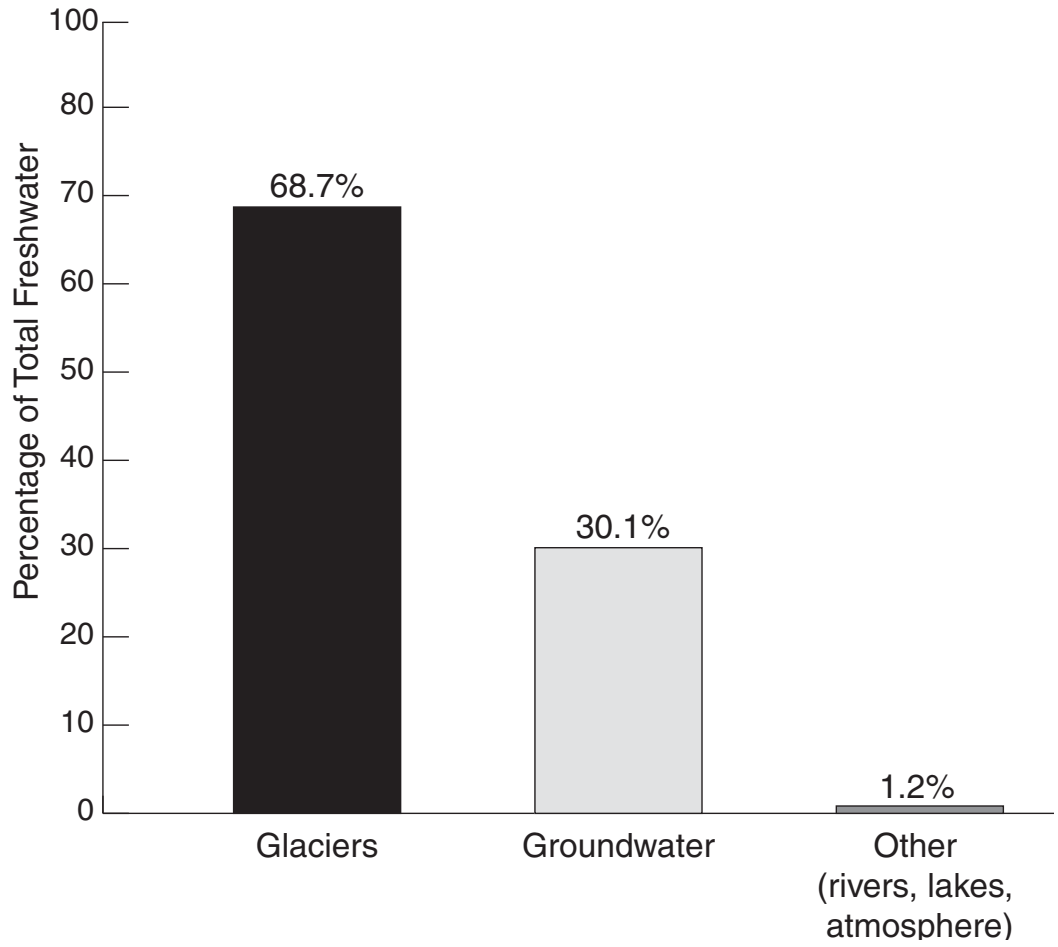
1. Create a bar graph showing the total amount of salt water and freshwater (in mL) that you modeled in this investigation. Make each bar a different color. Label the horizontal and vertical axes of the graph. Give the graph a title.



2. Using the data table below, create a second bar graph. Make each bar a different color. Label the horizontal and vertical axes of the graph. Give the graph a title.

Earth's Freshwater (About 3% of Total Water on Earth)	
Reservoir	**Percentage of Total Freshwater**
Glaciers/ice caps	68.7
Groundwater	30.1
Other (lakes, rivers, atmosphere)	1.2

Earth's Freshwater



F. Conclude

1. What are the limitations of your model? *(Answers will vary. Students may suggest that numbers are approximate, that they used freshwater to model both types of water, or that they model doesn't take into account water in the atmosphere.)*

2. Review your predictions from Part B of the investigation sheet. Use evidence from your observations in this investigation to support your predictions or explain how you would revise your predictions. (*Students' answers will vary based on their predictions from Part B, but all students should use evidence from the investigation to support the changes to their predictions that they describe.)*

3. Describe how humans benefit from the hydrosphere, and give at least one positive and one negative example of how humans impact the hydrosphere. *(Students may suggest that humans get the following benefits from the hydrosphere: water to drink, bathing, watering plants, and recreation. Students may suggest humans impact the hydrosphere in positive ways such as water conservation, using drought-tolerant plants, and reducing pollution in waterways. Negative examples may include pollution, draining wetlands, deforestation, wasting water, and reducing groundwater.)*

4. The amount of available freshwater on Earth is very small, and accessing clean, usable drinking water is a major world concern. Explain some solutions that could be designed to tackle this problem. *(Students' answers will vary. They may suggest rainwater catchers, filters, or purifying waste water.)*

Summative Assessment

Name _____

Date _____

What have they learned?

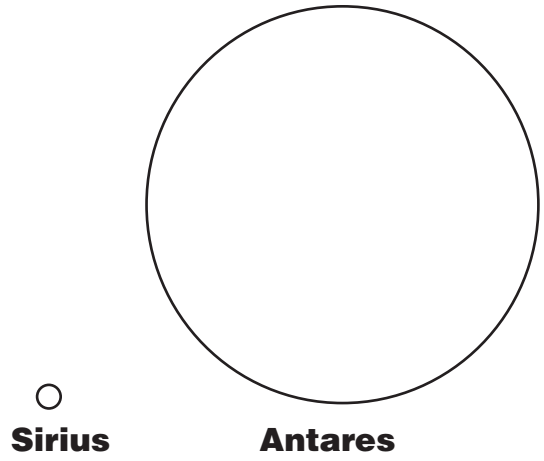
1. How many stars are in our solar system?

a. Two
b. FIve
c. One
d. Three

2. Many cities in the western U.S. rely on snowpack to supply their reservoirs. What system is snowpack a part of?

a. Hydrosphere
b. Biosphere
c. Geosphere
d. Atmosphere

3. The diagram below shows the relative sizes of two stars, Sirius and Antares.



Sirius is the second-brightest star in the night sky. Antares, though much larger than Sirius, is less bright. Explain how this is possible. _____

Building Blocks of Science Student Literacy

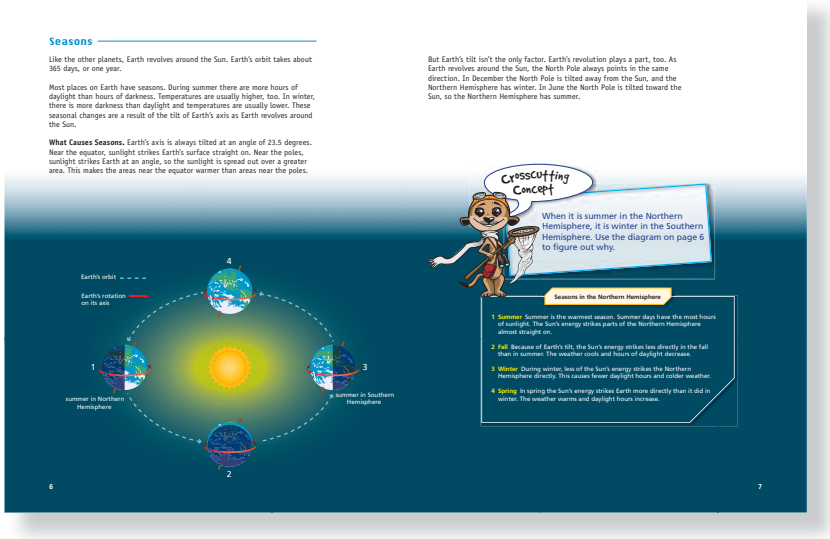
Build students' literacy skills with literacy components found within lessons and Literacy Readers.

Building Blocks of Science Literacy Components can be used to:

- Introduce a new lesson
- Support an investigation
- Incorporate science connections into your language arts sessions
- Differentiate instruction
- Review previously learned concepts

Literacy Readers—**on-level and below-level** readers in **English and Spanish** and available in **print or digital format**—provide informational text that:

- Incorporates English language arts and literacy standards
- Uses supporting text with graphs, vocabulary, charts, data, illustrations, and photographs to address **science concepts** related to lessons
- Provides opportunities to practice skills such as analysis and reasoning, and communication of ideas through **crosscutting concept** questions
- Challenges students to exercise and apply knowledge to a **science and engineering practice** activity
- Features a career that provides real-world insight into related science content



What else to look for?

Literacy Articles—These encourage students to elaborate upon unit topics, discuss real-world applications and phenomena, and ask students to connect this to concepts in the unit. Corresponding questions ask students to access high-level thinking and draw upon previous knowledge. (See page 33 of this sampler for an example.)

Science in the News Article Report—Students analyze a content-relevant reading or current event article, developing literacy skills as students identify important information, apply vocabulary, and draw connections to science content.

Building Blocks OF SCIENCE™ | 3D

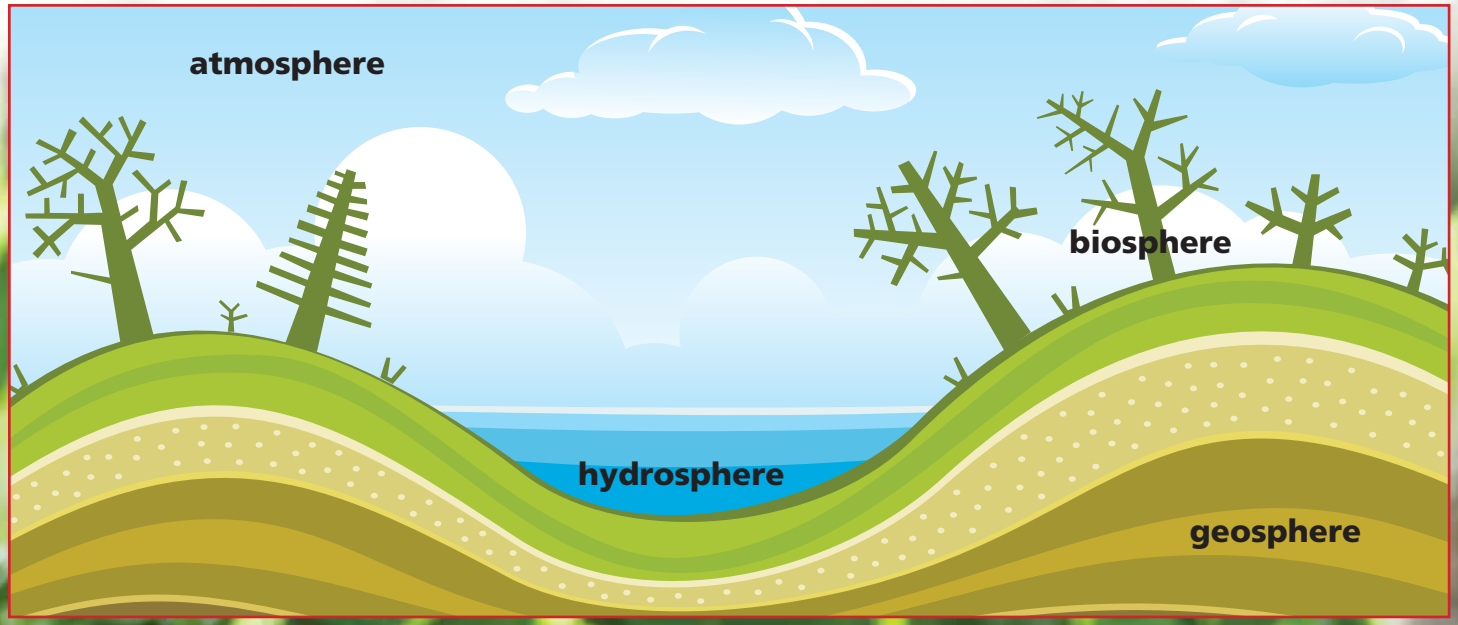
Earth and Space Systems

Student literacy–available in digital and print

Earth's Major Systems

Rock, water, air, and life all act together in Earth's major systems, or spheres. Each of these spheres is made up of many parts that work together.

- The **atmosphere** is the mixture of gases surrounding Earth. The air you breathe is part of the atmosphere.
- The **hydrosphere** includes all of Earth's liquid water and ice, water in soil and rock, and water vapor in the air. About three-fourths of Earth's surface is covered by water.
- The **geosphere** is made up of solid and liquid rock. Soil and sediment are also part of the geosphere.
- The **biosphere** is made up of all living things. The biosphere includes life in the atmosphere, the hydrosphere, and the geosphere. Humans are part of the biosphere.



The Biosphere

The biosphere is made up of all of the living things on Earth. It includes all of the plants, animals, fungi, and microbes. It also includes humans.

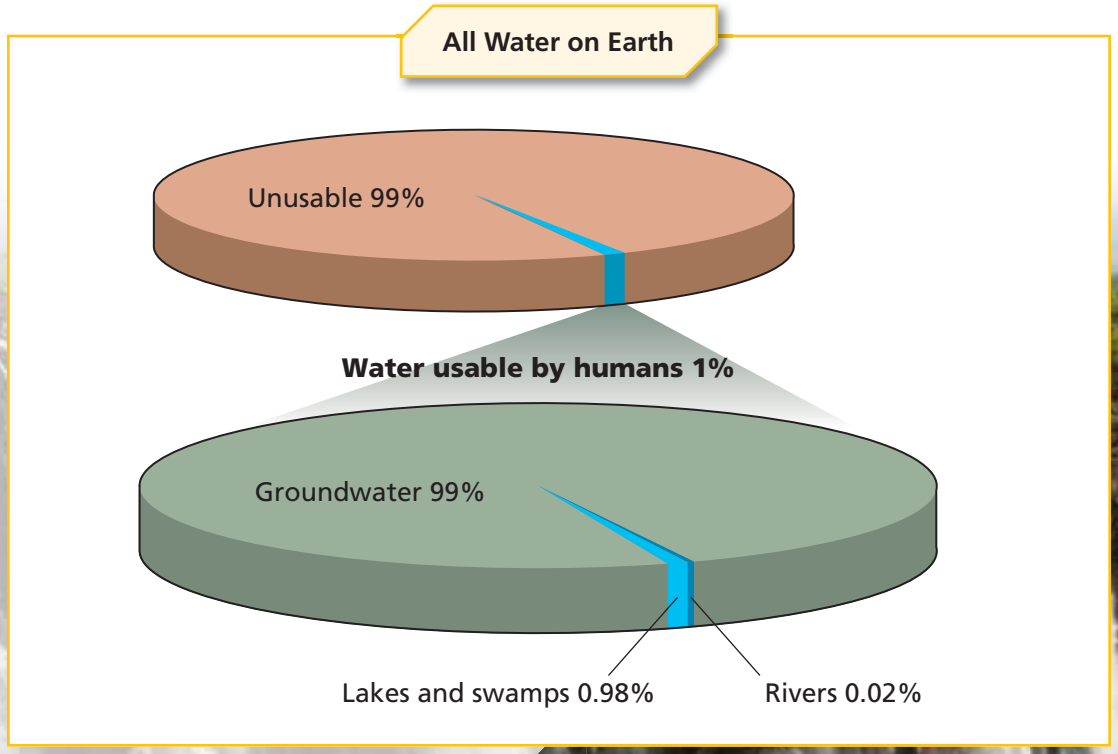
The organisms of the biosphere interact with the other systems. They get their water from the hydrosphere. Many get the air they need from the atmosphere. Plants get nutrients from the soil of the geosphere. People grow food in that same soil.

The living things in the biosphere interact with each other and with parts of the other spheres.

The Hydrosphere and Atmosphere

The hydrosphere is made up of all the liquid water on Earth. It also includes water frozen in ice and snow. The water droplets that make up the clouds and the invisible water vapor in the air are part of the hydrosphere. Water is also found in soil and in cracks in rock underground.

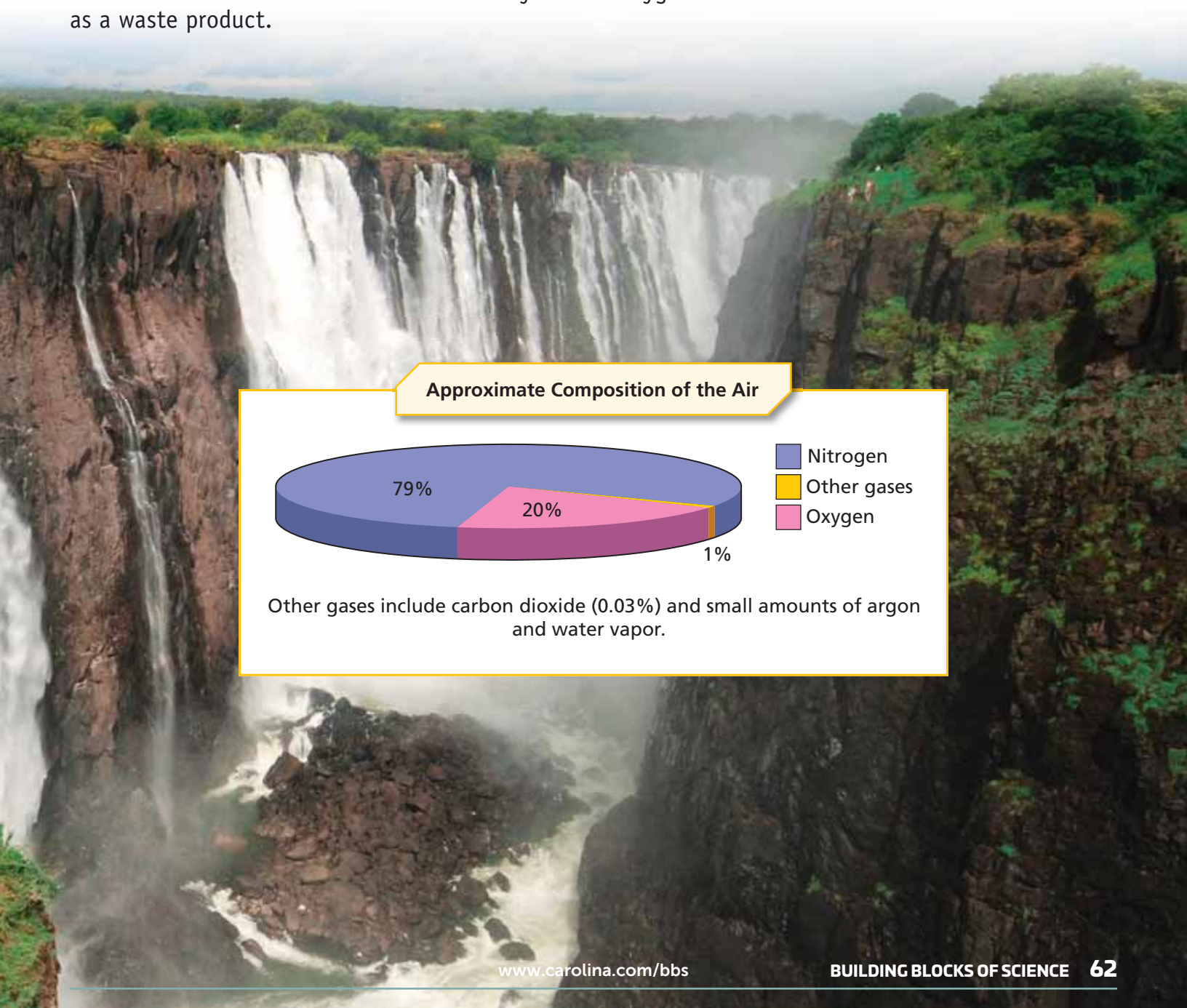
Most of Earth's water is not readily usable by humans unless it is specially treated. Ocean water, water frozen as ice, and water in the atmosphere all require a great deal of treatment to become drinkable. However, water that is found in rivers and lakes, in ponds, and underground does not require as much special treatment.



Most of the water humans can use is stored in the ground.

The atmosphere is the thin layer of gases that surrounds Earth. This mixture of gases is commonly known as air. Nitrogen gas makes up most of the air. The oxygen our bodies use for life processes makes up only about 20 percent of the air. The gases of the atmosphere help keep our planet warm. They capture some of the energy of sunlight and trap heat given off by Earth's surface. Ozone high in the atmosphere helps protect living things from the Sun's harmful rays.

The hydrosphere and atmosphere interact with each other and all other systems. Air contains water vapor, or water as an invisible gas. This water vapor condenses to form clouds. Water falls from clouds in the atmosphere as rain or snow. Organisms need water to live. Many organisms live in the water itself. Flowing water and moving air weather and erode rock. Humans and other animals release carbon dioxide into the air as they exhale. Plants use the carbon dioxide in air to make food. They release oxygen into the air as a waste product.



Approximate Composition of the Air

Other gases include carbon dioxide (0.03%) and small amounts of argon and water vapor.

The Geosphere

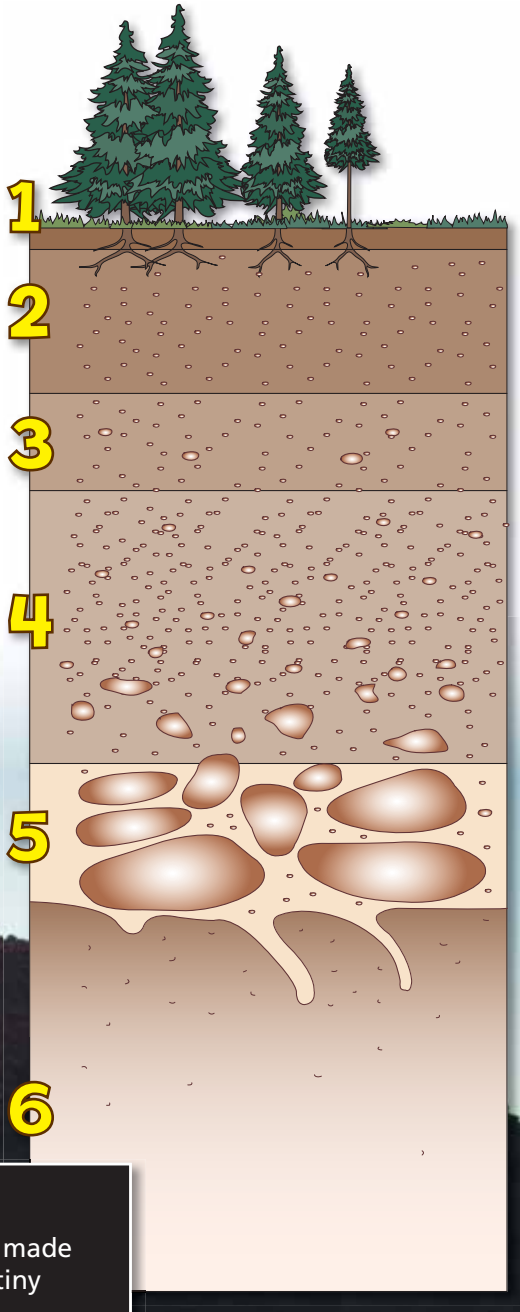
The geosphere is made up of all the rocks on Earth. It includes the soil and rocks in mountain ranges, canyons, and beaches. The solid rocks and **molten**, or liquid, materials under the surface are also part of the geosphere.

The geosphere is constantly changing. Forces within Earth crack and move the land. Ice freezes in cracks and causes rock to break. Water flowing over rock wears it away from one area and deposits it in another. Trees growing in cracks in rock also break it apart.

Molten rock flowing over the surface is called *lava*. Lava hardens to form the rock of the geosphere.

Living things of the biosphere also depend on the geosphere. Plants grow in soil, which is made up of broken rock. Other organisms live in soil. These organisms include worms, grubs, and insects. Also included are billions of microorganisms. These tiny living things are too small to see with the unaided eye.

Soil forms in layers called *horizons*. The top layers usually include living and once-living things. The middle and bottom layers have more minerals and rock pieces. The development of soil is an example of how all of Earth's systems work together.



Soil Layers

1. The top layer of soil is mostly plant material and humus. Humus is made up of dead plants and animals and decayed animal wastes. Many tiny organisms live in this layer and the one below it.
2. The next layer is known as topsoil. It is a mix of humus and weathered rock particles.
3. The layer below topsoil does not have a lot of nutrients. Water trickling down through this layer washes the nutrients deeper into the soil.
4. Subsoil collects dissolved minerals and clay from the layers above it.
5. Deeper in the soil, the rock particles are larger. This layer is mostly broken-up rock.
6. The lowest layer has no soil particles at all. It is made of bedrock. Bedrock is solid rock that is not broken or weathered.

Careers

Science in the world

Hydrologist

Hydrology is the study of water. You know that most of Earth's surface is covered with water. But the water is not always in the right place at the right time or of the right quality. Hydrologists solve water-related problems. They may help farmers find sources of water for irrigating crops. They may help cities plan for future water needs. Some help clean up polluted water. Others help site landfills by studying how water moves through the ground.

Would I like this career?	You might like this career if • you like to work with a team of people. • you enjoy working in the field. • you enjoy interpreting your findings for others.
What would I do?	• You would study how water moves across and through Earth's crust. • You would use what you learn to solve problems of water quality or availability. • You would communicate solutions with planners and people in government.
How can I prepare for this career?	• Study science and math. • Learn to communicate clearly both when speaking and writing.

Profesiones

Spanish literacy—available in digital and print

Hidrólogo

La hidrología es el estudio del agua. Aunque la mayor parte de la Tierra está cubierta de agua, no siempre tiene la calidad apropiada ni está disponible donde y cuando la necesitamos. Los hidrólogos resuelven problemas relacionados con el agua. Ayudan a granjeros a encontrar fuentes de agua para regar cultivos. Planifican las futuras necesidades de agua en las ciudades. Algunos ayudan a limpiar el agua contaminada. Otros ayudan en rellenos sanitarios estudiando cómo se mueve el agua a través del suelo.

¿Me gustaría esta profesión?	Te gustaría esta profesión si • te gusta trabajar en equipo. • te gusta trabajar en terreno. • te gusta interpretar tus hallazgos para otros.
¿Qué tendría que hacer?	• Estudiarías cómo se mueve el agua sobre y en la corteza terrestre. • Resolverías problemas de calidad y disponibilidad del agua. • Comunicarías soluciones a planificadores y personas en el gobierno.
¿Cómo puedo prepararme para esta profesión?	• Estudia ciencias y matemáticas. • Aprende a comunicarte claramente al hablar y escribir.

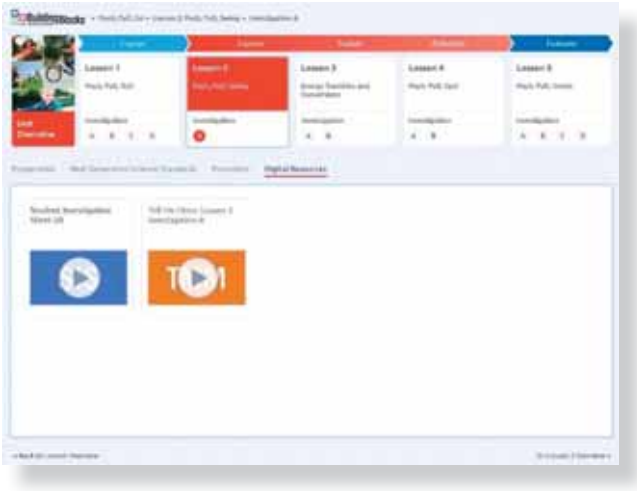
The Right Blend of Hands-On Investigation and Technology

Along with hands-on learning, Building Blocks of Science provides digital resources to enhance the classroom experience, offering an additional method of delivering content and support for teachers.

Support for Teachers

Everything you need to teach the lesson

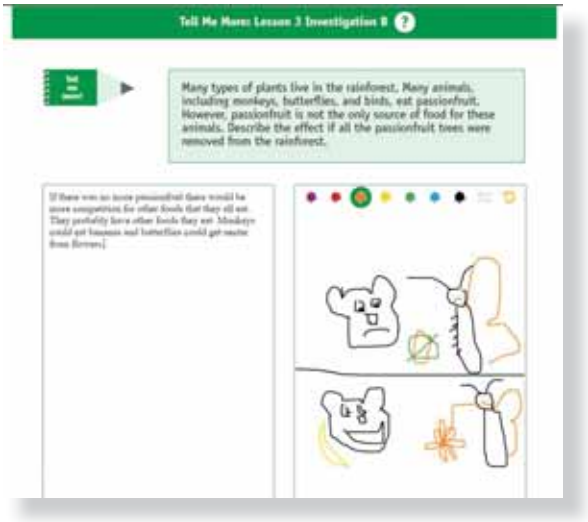
- Identification of where a lesson falls within the **5E Learning Cycle**
- Preparation—Includes investigation overview, materials list, and step-by-step teacher preparation instructions
- **NGSS Standards**—Includes the PEs, DCIs, SEPs, and CCCs that will be addressed within the investigation
- **Lesson Procedure**—Step-by-step instruction for each investigation within a lesson
- **Digital Resources**—All the digital resources available in one place, by lesson and by individual investigations within each lesson



Digital resources by lesson

Everything you need to teach ALL your students

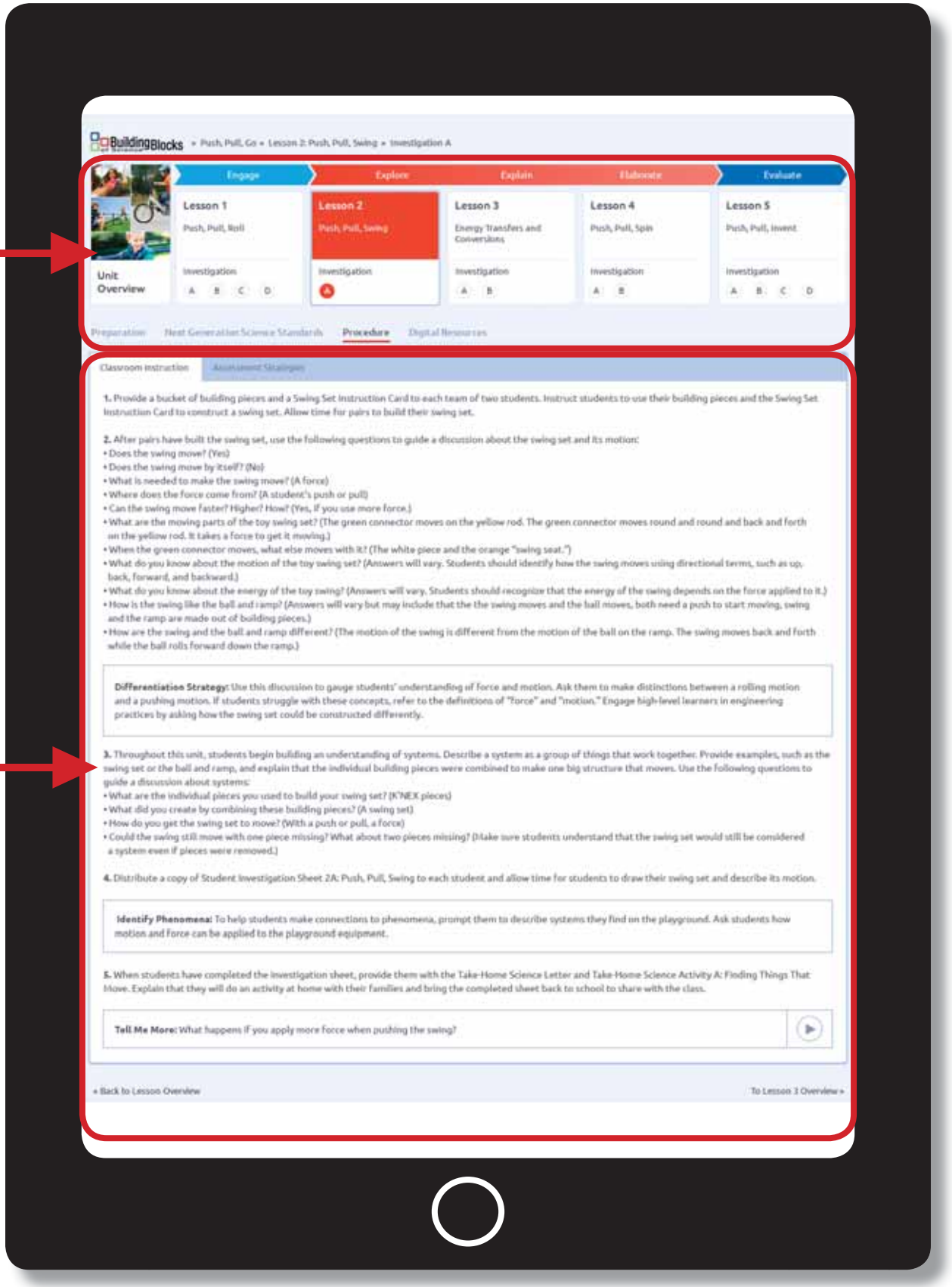
- Step-by-step instruction including guiding questions and anticipated responses
- Differentiation strategies at point of use within each investigation
- **Identify Phenomena** provides teachers with prompts to help students make connections to phenomena addressed within an investigation
- Assessment Strategies including **Tell Me More** formative assessment to help gauge student understanding



Tell Me More, a formative assessment strategy

For a closer look, visit:

www.carolina.com/bbs3dreview


BuildingBlocks » Push, Pull, Go » Lesson 2: Push, Pull, Swing » Investigation A
Engage
Explore
Explain
Elaborate
Evaluate
Lesson 1
Push, Pull, Roll
Lesson 2
Push, Pull, Swing
Lesson 3
Energy Transfers and Conversions
Lesson 4
Push, Pull, Spin
Lesson 5
Push, Pull, Invent
Unit Overview
Investigation
A B C D
Preparation
Next Generation Science Standards
Procedure
Digital Resources
Classroom Instruction
1. Provide a bucket of building pieces and a Swing Set Instruction Card to each team of two students. Instruct students to use their building pieces and the Swing Set Instruction Card to construct a swing set. Allow time for pairs to build their swing set.
2. After pairs have built the swing set, use the following questions to guide a discussion about the swing set and its motion:
• Does the swing move? (Yes)
• Does the swing move by itself? (No)
• What is needed to make the swing move? (A force)
• Where does the force come from? (A student's push or pull)
• Can the swing move faster? Higher? How? (Yes, if you use more force.)
• What are the moving parts of the toy swing set? (The green connector moves on the yellow rod. The green connector moves round and round and back and forth on the yellow rod. It takes a force to get it moving.)
• When the green connector moves, what else moves with it? (The white piece and the orange "swing seat.")
• What do you know about the motion of the toy swing set? (Answers will vary. Students should identify how the swing moves using directional terms, such as up, back, forward, and backward.)
• What do you know about the energy of the toy swing? (Answers will vary. Students should recognize that the energy of the swing depends on the force applied to it.)
• How is the swing like the ball and ramp? (Answers will vary but may include that the the swing moves and the ball moves, both need a push to start moving, swing and the ramp are made out of building pieces.)
• How are the swing and the ball and ramp different? (The motion of the swing is different from the motion of the ball on the ramp. The swing moves back and forth while the ball rolls forward down the ramp.)
Differentiation Strategy: Use this discussion to gauge students' understanding of force and motion. Ask them to make distinctions between a rolling motion and a pushing motion. If students struggle with these concepts, refer to the definitions of "force" and "motion." Engage high-level learners in engineering practices by asking how the swing set could be constructed differently.
3. Throughout this unit, students begin building an understanding of systems. Describe a system as a group of things that work together. Provide examples, such as the swing set or the ball and ramp, and explain that the individual building pieces were combined to make one big structure that moves. Use the following questions to guide a discussion about systems:
• What are the individual pieces you used to build your swing set? (K'NEX pieces)
• What did you create by combining these building pieces? (A swing set)
• How do you get the swing set to move? (With a push or pull, a force)
• Could the swing still move with one piece missing? What about two pieces missing? (Make sure students understand that the swing set would still be considered a system even if pieces were removed.)
4. Distribute a copy of Student Investigation Sheet 2A: Push, Pull, Swing to each student and allow time for students to draw their swing set and describe its motion.
Identify Phenomena: To help students make connections to phenomena, prompt them to describe systems they find on the playground. Ask students how motion and force can be applied to the playground equipment.
5. When students have completed the investigation sheet, provide them with the Take-Home Science Letter and Take-Home Science Activity A: Finding Things That Move. Explain that they will do an activity at home with their families and bring the completed sheet back to school to share with the class.
Tell Me More: What happens if you apply more force when pushing the swing?
« Back to Lesson Overview
To Lesson 3 Overview »

Digital Components to Support Instruction and Assessment

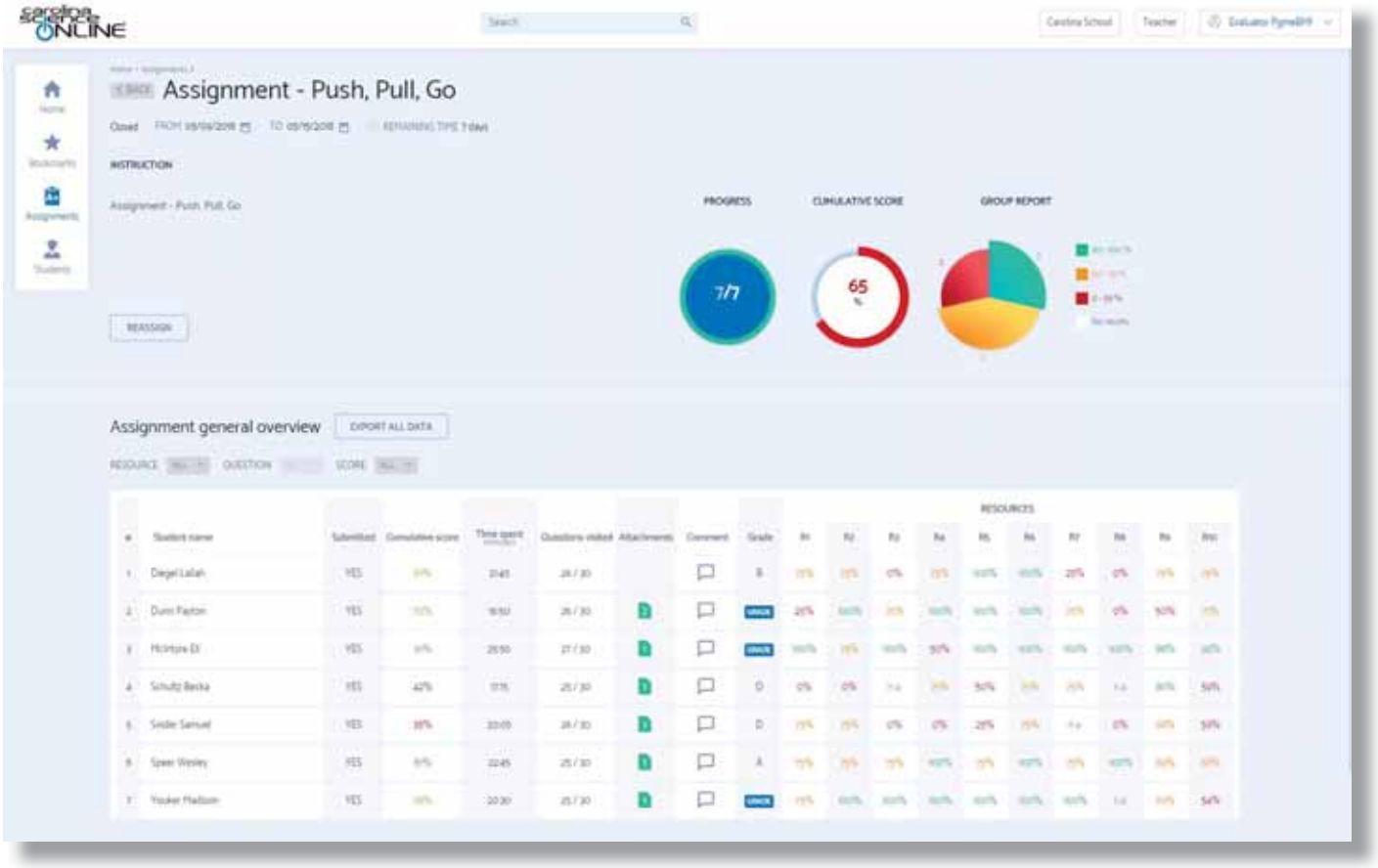
For the Teacher—Customizable Digital Planning at Your Fingertips

Building Blocks of Science 3D goes beyond just providing you access to your content. You can also:

- Use the assignment management system to create and grade custom assignments for classes and individual students to help differentiate instruction
- Create customizable bookmarks that include your student and instruction resources as well as URL links, PDF files, PowerPoint® presentations, and video files

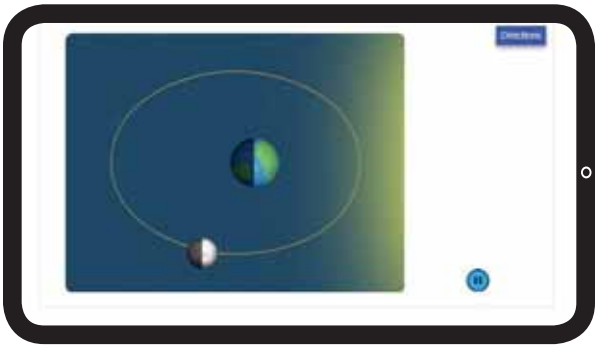
The assignment management system dashboard allows you to:

- Track the progress of your classes and individual students
- See student assignment results for the class at a glance and by individual student in detail
- Automatically grade close-ended questions (e.g., multiple choice, matching, fill-in-the-blank)
- Adjust student grades based on individual student performance and open-ended responses
- Assign remediation to student groups that need additional support or enrichment to groups that need a challenge



Digital components for students enhance and deepen student understanding, differentiate learning, and provide multiple modalities for delivering information.

"Digital Tips" take the guesswork out of integrating the following digital resources with hands-on investigations:



Simulations: Flexible enough to be used to introduce, support, or review a topic or concepts. Simulations are manipulative and provide a visual for differentiation.

Interactive Whiteboard Activities: With typing and drawing capabilities, IWB activities bring investigation-aligned classroom charts to life and are perfect for individual student review.

Student Investigation Sheets:
Students record their observations and data digitally when completing investigations.

Interactive Literacy Readers:
These enhanced versions of the printed student readers include check-for-understanding questions and animations to support the concepts covered in the text, enforce literacy skills, and provide additional practice.

Building Blocks OF SCIENCE™ | 3D

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Learning Framework

Kindergarten	**Push, Pull, Go** *K-PS2-1; K-PS2-2; K-2-ETS1-1;K-2-ETS1-2*	**Living Things and Their Needs** *K-LS1-1; K-ESS2-2;K-ESS3-1;K-ESS3-3; K-2-ETS1-2*	**Weather and Sky** *K-PS3-1;K-PS3-2;K-ESS2-1; K-ESS3-2; K-2-ETS1-1; K-2-ETS1-2*
1st Grade	**Light and Sound Waves** *1-PS4-1; 1-PS4-2; 1-PS4-3; 1-PS4-4; K-2-ETS1-1; K-2-ETS1-2*	**Exploring Organisms** *1-LS1-1; 1-LS1-2; 1-LS3-1; K-2-ETS1-2*	**Sky Watchers** *1-ESS1-1; 1-ESS1-2*
2nd Grade	**Matter** *2-PS1-1; 2-PS1-2; 2-PS1-3; 2-PS1-4; K-2-ETS1-1; K-2-ETS1-2*	**Ecosystem Diversity** *2-LS2-1; 2-LS2-2; 2-LS4-1; K-2-ETS1-2; K-2-ETS1-3*	**Earth Materials** *2-PS1-1; 2-ESS1-1; 2-ESS2-1; 2-ESS2-2; 2-ESS2-3; K-2-ETS1-1; K-2-ETS1-2*
3rd Grade	**Forces and Interactions** *3-PS2-1; 3-PS2-2; 3-PS2-3; 3-PS2-4; 3-5-ETS1-1; 3-5 ETS1-2*	**Life in Ecosystems** *3-LS1-1; 3-LS2-1; 3-LS3-1; 3-LS3-2; 3-LS4-1; 3-LS4-2; 3-LS4-3; 3-LS4-4; 3-5-ETS1-2*	**Weather and Climate Patterns** *3-ESS2-1; 3-ESS2-2;3-ESS3-1; 3-5-ETS1-2*
4th Grade	**Energy Works** *4-PS3-1; 4-PS3-2; 4-PS3-3; 4-PS3-4; 4-PS4-1; 4-PS4-3; 4-ESS3-1; 3-5 ETS1-2; 3-5-ETS1-3*	**Plant and Animal Structures** *4-LS1-1; 4-LS1-2; 4-PS4-2; 3-5-ETS1-2*	**Changing Earth** *4-ESS1-1; 4-ESS2-1; 4-ESS2-2; 4-ESS3-2; 3-5-ETS1-2*
5th Grade	**Structure and Properties of Matter** *5-PS1-1; 5-PS1-2; 5-PS1-3; 5-PS1-4; 3-5-ETS1-2*	**Matter and Energy in Ecosystems** *5-PS3-1; 5-LS1-1; 5-LS2-1; 5-ESS2-1; 5-ESS3-1; 3-5-ETS1-3*	**Earth and Space Systems** *5-PS2-1; 5-ESS1-1; 5-ESS1-2; 5-ESS2-1; 5-ESS2-2; 5-ESS3-1; 3-5-ETS1-2*

Phenomenon-based investigations with digital support in 30-minute lessons!

For more information, visit www.carolina.com/bbs