





LEVEL 2 MODULE 2 EARTH CHANGES



Great Minds® is the creator of *Eureka Math*®, *Eureka Math*²®, *Wit & Wisdom*®, *Arts & Letters*™, and *PhD Science*®.

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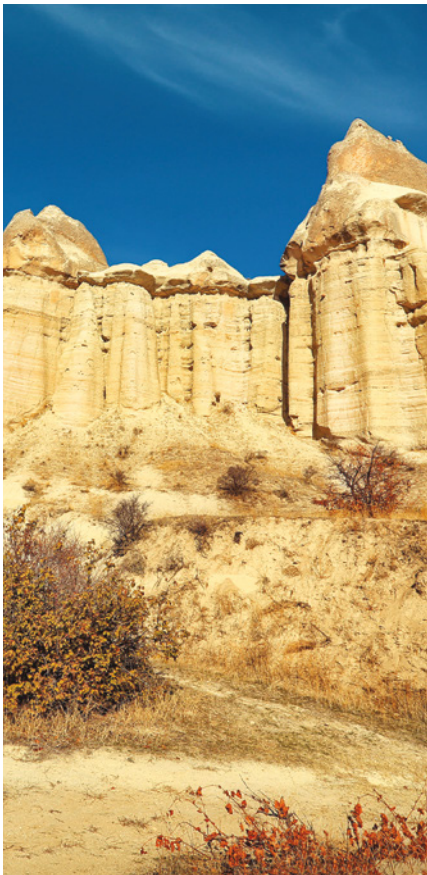
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MODULE OVERVIEW

DRIVING QUESTION

How can the island of Surtsey change shape over time?



INTRODUCTION

Background Information

Throughout the module, students study the anchor phenomenon—the transformation of Surtsey—to build an answer to the Driving Question: **How can the island of Surtsey change shape over time?** The module introduces students to Surtsey, a volcanic island near Iceland. Surtsey was formed quickly by an underwater volcanic eruption that began in 1963. In the years after the volcanic eruption, Surtsey's land changed size and shape as a result of wind and water. Wind and water continue to change Surtsey's land over time.

This rich, authentic phenomenon drives student learning as students seek to explain how and why Surtsey's land is changing. Students begin to make sense of this phenomenon by exploring Surtsey's land and its natural features. Students listen to excerpts from *Life on Surtsey: Iceland's Upstart Island* (Burns 2017) and *An Island Grows* (Schaefer and Felstead 2006) to learn about Surtsey and the island's formation from a volcanic eruption. Students then learn more about Surtsey's land by identifying and describing landforms and land components. Students observe photographs and measurements to identify changes to Surtsey's land, and they investigate physical models to determine that wind and water have caused the changes they observe.

Students apply their knowledge of how wind and water can change land to solve a problem as they complete an Engineering Challenge. They plan, create, and test a shoreline protection system to prevent the land near the Montauk Point Lighthouse from washing away.



Next, students build on their understanding of how land changes to explore how long it takes land to change. Students compare the time spans of Earth events that change Surtsey's land to better understand the timescale at which these events occur.

Finally, students summarize their understanding of how Earth events change the shape of land over time and apply their new knowledge to a new phenomenon.

Content Boundaries and Rationale

Why aren't the terms *weathering* and *erosion* introduced to students?

To align with the Next Generation Science Standards (NGSS), Level 2 Module 2 does not introduce students to the terms *weathering* and *erosion*. Students apply Disciplinary Core Idea ESS1.C: The History of Planet Earth and ESS2.A: Earth Materials and Systems, which focus on the ways Earth events shape land over time rather than on the mechanisms by which these changes occur. Students build on this understanding in Level 4 when they investigate weathering and erosion processes.



Why doesn't the anchor chart include clay and silt as components of land?

A Framework for K–12 Science Education (NRC 2012) describes rocks, soils, and sand as the components of land that students should be able to recognize by the end of Grade 2. Level 4 introduces students to sediment, and Level 5 has students compare the sizes and properties of sediments as part of the Disciplinary Core Idea progression for ESS2.A: Earth Materials and Systems. Level 2 Module 2 includes clay and silt to allow students to connect more authentically with the land materials they investigate in Concept 1, but the anchor chart does not list the terms. Until students develop their understanding of sediment in Levels 4 and 5, they categorize clay and silt as soil. This understanding appears on this module's anchor chart in the statement that land is made up of rocks, soil, and sand.

Why aren't students asked to memorize the names of landforms?

In Level 2 Module 2, students investigate shapes of land and how they can change. Rather than presenting individual landforms as discrete forms to memorize, the module describes landforms as part of specific land areas and provides their names to students in those contexts.



Additional Reading for Teachers

Many activities, investigations, and discussions throughout this module give students the opportunity to use their senses to explore phenomena. See the Supporting All Learners section of the Implementation Guide for information how to support students with sensory disabilities. In addition, use the following resource to learn more about the anchor phenomenon this module features.

Nomination of Surtsey for the UNESCO World Heritage List from the UNESCO World Heritage Centre website (<http://phdsci.link/1618>).



FOCUS STANDARDS

The Module Objectives describe what students should know and be able to do by the end of this module.

MODULE OBJECTIVE | Use an understanding of **relative scales (CC.3)** to **construct an argument (SEP.7)** about **events that occur over different periods of time (ESS1.C)**.

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.7: Engaging in Argument from Evidence • Construct an argument with evidence to support a claim.	ESS1.C: The History of Planet Earth • Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	CC.3: Scale, Proportion, and Quantity • Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).

MODULE OBJECTIVE | **Develop a model to represent (SEP.2)** how **wind and water can change the shape of land (ESS2.A)** **over time (CC.7)**.

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.2: Developing and Using Models • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	ESS2.A: Earth Materials and Systems • Wind and water can change the shape of the land.	CC.7: Stability and Change • Things may change slowly or rapidly.

MODULE OBJECTIVE | **Generate multiple solutions (SEP.6)** that are **made up of parts that work together (CC.4)** to reduce the impact of **water changing the shape of the land (ESS2.A)**, and **compare and test these solutions with peers (ETS1.C)**.

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.6: Constructing Explanations and Designing Solutions • Generate and/or compare multiple solutions to a problem.	ESS2.A: Earth Materials and Systems • Wind and water can change the shape of the land. ETS1.C: Optimizing the Design Solution • Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	CC.4: Systems and System Models • Systems in the natural and designed world have parts that work together.

NGSS Performance Expectations

Student learning in this module builds toward mastery of these Next Generation Science Standards (NGSS) Performance Expectations (NGSS Lead States 2013).

2-ESS1 EARTH'S PLACE IN THE UNIVERSE

2-ESS1-1 | Use information from several sources to provide evidence that Earth events can occur quickly or slowly.

2-ESS2 EARTH'S SYSTEMS

2-ESS2-1 | Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

K-2-ETS1 ENGINEERING DESIGN

K-2-ETS1-3 | Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

MODULE MAP

Anchor Phenomenon | Transformation of Surtsey

Driving Question | How can the island of Surtsey change shape over time?

Anchor Phenomenon Introduction

This lesson introduces students to the anchor phenomenon: the transformation of Surtsey.

LESSON	ANCHOR PHENOMENON	DRIVING QUESTION	LESSON OBJECTIVE
1	Transformation of Surtsey	How can the island of Surtsey change shape over time?	Use observations (SEP.6) to develop models that show the relative scale (SEP.2) of events (ESS1.C) that can cause landforms to change over time (CC.7). Part 1: Make observations to explain (SEP.6) that changes can occur (CC.7) as a result of volcanic events; specifically, volcanic events can cause landforms to form quickly (ESS1.C). Part 2: Develop a model that represents (SEP.2) the formation of Surtsey (ESS1.C) and that describes that the landform is changing over time (CC.7).

Concept 1: The Components and Shape of Land

Students discover that Surtsey's land is shaped by the actions of wind and water.

LESSON	LESSON PHENOMENON	PHENOMENON QUESTION	LESSON OBJECTIVE
2	Describing Surtsey's land	How can we describe Surtsey and the materials that make up its land?	Use observations (SEP.6) of landforms (ESS2.B) and properties of land materials (PS1.A) to explain how (SEP.6) land can change shape over time (CC.5). Part 1: Use observations (SEP.2) to show how maps (ESS2.B) can be used to compare the relative scales of landforms (CC.3). Part 2: Use observations of land materials (SEP.6) to describe the properties of landforms (PS1.A). Part 3: Use observations (SEP.6) of the properties of rocks (PS1.A) before and after they are shaken and scratched as evidence to explain (SEP.6) how rocks can change shape (CC.5).
3	Changes to the shape of Surtsey's land over time	What can cause Surtsey's land to change?	Use relative scales (CC.3) as evidence to develop an argument (SEP.7) that wind and water change land (ESS2.A). Part 1: Use observations of visuals (SEP.4) that compare Surtsey's land over time (CC.3) to describe how wind and water change land (ESS2.A). Part 2: Compare a model before air is blown and a model after air is blown (SEP.2) to describe the effects of wind (ESS2.A) on the size and shape (CC.3) of land (ESS2.A). Part 3: Develop and use models to represent (SEP.2) how water changes land (ESS2.A) by using relative scales to describe how land differs in shape (CC.3). Part 4: Develop an argument (SEP.7) to support a claim that wind or water changes land (ESS2.A) by using relative scales to describe changes to land (CC.3).

LESSON	LESSON PHENOMENON	PHENOMENON QUESTION	LESSON OBJECTIVE
4	How Cappadocia's fairy chimneys form and change	How do fairy chimneys form and change shape?	This lesson includes a Conceptual Checkpoint that provides students with the opportunity to demonstrate progress toward the Module Objectives.

Application of Concepts

Students use the engineering design process to solve a problem; they plan, create, and test a shoreline protection system to prevent the land of Montauk Point and the Montauk Point Lighthouse from washing away.

LESSON	TASK	PHENOMENON QUESTION	LESSON OBJECTIVE
5	Engineering Challenge	How can we slow changes to the land of Montauk Point to protect the Montauk Point Lighthouse?	Compare the effectiveness (SEP.6) of multiple (ETS1.C) systems (CC.4) that are solutions (ETS1.C) designed to reduce the impact of water on the shape of land (ESS2.A). Part 1: Compare multiple (SEP.6) systems (CC.4) designed to prevent water from changing the shape of land (ESS2.A). Part 2: Test the function of different materials (CC.6) to evaluate how well they slow water's changes to land (ESS2.A), and use comparisons of the testing data (SEP.5) to compare possible design solutions (SEP.6) and to determine which solutions (ETS1.C) would work well. Part 3: Compare multiple solutions (SEP.6) for a shoreline protection system (CC.4) to determine which solution (ETS1.C) works best to slow water's changes to land (ESS2.A). Part 4: Use evidence to explain (SEP.6) how the parts of a shoreline protection system work together (CC.4) to reduce the impact of water changing the shape of land (ESS2.A).

Concept 2: Time Spans of Changes to Land

Students discover that the Earth events that affect Surtsey have different time spans.

LESSON	LESSON PHENOMENON	PHENOMENON QUESTION	LESSON OBJECTIVE
6	Earth events on Surtsey	How can we compare the Earth events that change Surtsey's land?	Use relative scales (CC.3) as evidence to identify Earth events that happen quickly and Earth events that happen slowly (ESS1.C) and to develop an argument (SEP.7) about the time spans of Earth events (ESS1.C). Part 1: Use relative scales to compare Earth events (CC.3) that happen over different periods of time (ESS1.C). Part 2: Use observations to describe (SEP.6) the time spans of Earth events (ESS1.C) that change land over various amounts of time (CC.7). Part 3: Develop an argument (SEP.7) to describe the time spans of Earth events (ESS1.C) that cause land to change quickly or slowly (CC.7).
7	Earth events shaping landforms near Cappadocia	How can we describe the time spans of Earth events that change the land near Cappadocia?	This lesson includes a Conceptual Checkpoint that provides students with the opportunity to demonstrate progress toward the Module Objectives.

Application of Concepts

Students synthesize their learning from throughout the module and distill their knowledge of changes to land caused by Earth events as they complete an End-of-Module Assessment.

LESSON	TASK	PHENOMENON QUESTION	LESSON OBJECTIVE
8	Socratic Seminar and End-of-Module Assessment	How does a shoreline change to form a sea stack?	This lesson includes an End-of-Module Assessment that provides students with the opportunity to demonstrate progress toward the Module Objectives.

ASSESSMENT MAPS

Each *PhD Science*® module includes a system of assessments designed to provide students with multiple and varied opportunities to demonstrate proficiency with the elements identified in the Module Objectives. The assessment maps in this section identify the lessons in which the elements that make up each Module Objective are assessed. For more information on the *PhD Science* approach to formative and summative assessment, see the Implementation Guide.

MODULE OBJECTIVE | Use an understanding of **relative scales (CC.3)** to **construct an argument (SEP.7)** about **events that occur over different periods of time (ESS1.C)**.

ELEMENT	FORMATIVE ASSESSMENT	SUMMATIVE ASSESSMENT
SEP.7 Engaging in Argument from Evidence Construct an argument with evidence to support a claim.	Lesson 3 Lesson 6	Lesson 7 Lesson 8
ESS1.C The History of Planet Earth Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	Lesson 1 Lesson 6	Lesson 7 Lesson 8
CC.3 Scale, Proportion, and Quantity Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).	Lesson 2 Lesson 3 Lesson 6	Lesson 4 Lesson 8

MODULE OBJECTIVE | **Develop a model to represent (SEP.2)** how **wind and water can change the shape of land (ESS2.A)** over time **(CC.7)**.

ELEMENT	FORMATIVE ASSESSMENT	SUMMATIVE ASSESSMENT
SEP.2 Developing and Using Models • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	Lesson 1 Lesson 2 Lesson 3	Lesson 4 Lesson 7 Lesson 8
ESS2.A Earth Materials and Systems • Wind and water can change the shape of the land.	Lesson 3 Lesson 5	Lesson 4 Lesson 5 Lesson 7 Lesson 8
CC.7 Stability and Change • Things may change slowly or rapidly.	Lesson 6	Lesson 7 Lesson 8

MODULE OBJECTIVE | Generate multiple solutions (SEP.6) that are **made up of parts that work together (CC.4)** to reduce the impact of **water changing the shape of land (ESS2.A)**, and **compare and test these solutions with peers (ETS1.C)**.

ELEMENT	FORMATIVE ASSESSMENT	SUMMATIVE ASSESSMENT
SEP.6 Constructing Explanations and Designing Solutions Generate and/or compare multiple solutions to a problem.	Lesson 5	Lesson 5
ESS2.A Earth Materials and Systems Wind and water can change the shape of the land.	Lesson 3 Lesson 5	Lesson 4 Lesson 5 Lesson 7 Lesson 8
ETS1.C Optimizing the Design Solution Because there is always more than one possible solution to a problem it is useful to compare and test designs.	Lesson 5	Lesson 5
CC.4 Systems and System Models Systems in the natural and designed world have parts that work together.	Lesson 5	Lesson 5

BUILDING KNOWLEDGE AND SKILLS ACROSS LEVELS

Throughout Level 2, students build knowledge and skills associated with the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

Science and Engineering Practices

In this module, students develop and use models (**SEP.2**) in a variety of ways to represent how wind and water interact with land and how land can change size and shape over time. In Levels 3 through 5, students continue to develop and use models to show more abstract representations, cause and effect relationships, and interactions related to the functions of natural and designed systems.

As part of the Engineering Challenge, students learn how parts of a system work together by generating and comparing solutions (**SEP.6**) designed to slow shoreline changes caused by waves and to prevent a lighthouse from falling into the ocean. Students measure the success of their solutions by recording the number of waves they are able to create before a model lighthouse falls over. Students then select the best solution after improving and retesting their designs. In Levels 3 through 5, students analyze quantitative data to compare the solutions they generate and to determine how well each solution meets specific criteria and constraints.

This module provides multiple opportunities for students to engage in argumentation as they connect evidence to specific claims through reasoning (**SEP.7**). For example, students collect evidence to support the claims that rocks can change and that wind and water can change land. Students' proficiency with this skill is assessed during a Conceptual Checkpoint and the End-of-Module Assessment. In Levels 3 through 5, students expand their argumentation skills to construct or support arguments by using evidence, data, and models.

Disciplinary Core Ideas

Throughout this module, students are introduced to core ideas about Earth's materials, systems, and history. The first core idea that students come to understand is that Earth is continually changing. Students analyze the composition of land materials on or near Earth's surface to determine that the basic components of land are rocks, soil, and sand. Then, through a series of investigations, students explore how these land components come together to create different landforms and how these components can also break apart and change the shape of land. Students learn that interactions of water and wind with land can cause many of the changes to land that they observe (**ESS2.A**). In Levels 3 through 5, students build on these ideas as they learn about Earth's major interconnected systems: the geosphere, the atmosphere, the hydrosphere, and the biosphere.

Students also discover that the events that change land occur over varying time spans. Students are introduced to major Earth events and build the understanding that these events can be described as happening slowly or quickly. Students recognize that some Earth events have a beginning and an end, whereas others are continuous. Students explore slow Earth events, which helps lay the foundation for an understanding of geological time. Students realize that some events occur over time periods much longer than one person can observe (**ESS1.C**). In Levels 3 through 5, students build on their understanding of geologic time and how land changes as they study weathering and erosion, the formation of rock layers, and the fossil record.

During this module, students also complete an Engineering Challenge in which they are tasked with finding a solution to prevent land loss from Montauk Point to protect the Montauk Point Lighthouse. After investigating materials, students design and test shoreline protection systems. Students revise their designs and compare their results to identify the shoreline protection system that best protected the land **(ETS1.C)**. In Levels 3 through 5, students learn to plan and conduct fair test investigations, using quantitative data to evaluate whether their solutions meet previously identified criteria and constraints.

Crosscutting Concepts

In this module, students compare the time spans of Earth events and describe events as happening quickly or slowly to build the

understanding that events can be sequenced relative to one another **(CC.3)**. Students' observations and analyses of the different solutions people have developed to slow or prevent changes to land highlight that, in both the natural and designed worlds, a system's parts work together to carry out its function **(CC.4)**. Students draw on their prior knowledge of matter to describe the components of land as they categorize land materials and test rock samples. Students also learn that land components and land shapes can change as a result of Earth events and that these changes can occur slowly or quickly **(CC.7)**. In Levels 3 through 5, students expand the focus of these Crosscutting Concepts to include additional, more complex parameters related to size and scale, the interactions of systems, and differences in rates of change.

KEY TERMS

In this module, students learn the following terms through investigations, models, explanations, class discussions, and other experiences.

- | | | |
|-------------|-------------|-------------------|
| • Component | • Island | • Natural feature |
| • Elevation | • Land (n.) | • Time span |
| • Event | • Landform | • Volcano |

SAFETY CONSIDERATIONS

The safety and well-being of students are of utmost importance in all classrooms, and educators must act responsibly, prudently, and proactively to safeguard students. Science investigations frequently include activities, demonstrations, and experiments that require extra attention to safety measures. Students may perform these science investigations in the classroom or other areas of the school, including a playground, field, or gymnasium. Educators must do their best to ensure a safe environment for students.

The hands-on, minds-on activities of Module 2 focus on investigating how land changes shape. Students interact with various land materials and rock samples and work with models that require pouring water or blowing air on materials. Some of the more important safety measures to implement in Module 2 follow.

- Teachers must explain all safety considerations to students and review all safety expectations with them before each activity.**
- Students must carefully listen to and follow all teacher instructions.** Instructions may be oral, written on classroom charts, or communicated in the Science Logbook or other handouts.
- Students must demonstrate appropriate classroom behavior (e.g., no running, jumping, or pushing) during science investigations.** Students must handle all supplies and equipment carefully and respectfully. Additionally, students should do their best to avoid touching their face during investigations.
- Students and teachers must put away all food and drinks during science investigations.** Investigation materials can easily contaminate food and drinks. Also, spilled food or drinks can disrupt investigations.
- Students must never place materials in their mouth during a science investigation.**

6. **Students and teachers must wear personal protective equipment (e.g., safety goggles) throughout investigations that require this equipment.** Students and teachers must wear safety goggles whenever they work with glass objects, liquids other than pure water, sharp points (e.g., wires, toothpicks), materials made up of tiny pieces (e.g., sand), and projectiles. In this module, anyone working with land materials must wear goggles.
7. **Students must immediately inform teachers of any spills, breakages, or materials that have fallen to the floor. Students must then follow all teacher instructions for cleaning up, including allowing teachers to clean up spills, breakages, and other materials that may be dangerous.** During investigations, items can fall to the floor even when everyone is careful. Immediate removal of debris from the floor is essential to help prevent injury.
8. **Students must follow teacher instructions regarding cleanup at the end of each investigation.** Teachers may ask students to return materials to specific storage locations in the classroom or to clean the surfaces of their desks with provided materials (e.g., water and paper towels). After completion of the investigation and cleanup, students must thoroughly wash their hands.
9. **Teachers must monitor student activity on the internet.** If students must access the internet for science research purposes, teachers must monitor students' activity to ensure conformation with school and district policies.

More information on *PhD Science* safety appears in the Implementation Guide. Teachers should always follow the health and safety guidelines of their school or district. For additional information on safety in the science classroom, consult the National Science Teaching Association website (<http://www.nsta.org>) or other resources.



ANCHOR PHENOMENON INTRODUCTION



Introduction

LESSON 1 TRANSFORMATION OF SURTSEY

Anchor Phenomenon | Transformation of Surtsey

Driving Question | How can the island of Surtsey change shape over time?

OVERVIEW

In this lesson we begin to explore Earth events. We wonder about an aerial picture of an object that appears in the ocean. We learn that the object is an island called Surtsey, which we locate on a globe. We watch a video, read a book excerpt, and look at pictures to find out that a volcano erupted and formed Surtsey. When we observe another aerial picture and a 3D model that show Surtsey many years later, we notice that the island is changing shape. We then develop a model that explains our initial ideas about how Surtsey formed and transformed, and we compare our initial models to develop a class anchor model. We find that we have many questions about how the island of Surtsey can change shape over time, and we record our questions on a Driving Question board.

Later we will learn more about Surtsey's land and its components as we explore the island's changing natural features.

Lesson Objective

Use observations (SEP.6) to develop models that show the relative scale (SEP.2) of events (ESS1.C) that can cause landforms to change over time (CC.7).

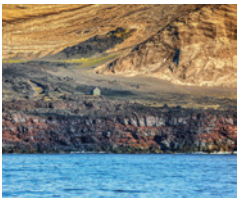
Performance Descriptors

Part 1: **Make observations to explain (SEP.6) that changes can occur (CC.7) as a result of volcanic events; specifically, volcanic events can cause landforms to form quickly (ESS1.C).**

Part 2: **Develop a model that represents (SEP.2) the formation of Surtsey (ESS1.C) and that describes that the landform is changing over time (CC.7).**

STANDARDS ADDRESSED

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.2: Developing and Using Models • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	ESS1.C: The History of Planet Earth • Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	CC.7: Stability and Change • Some things stay the same while other things change.



PART 1 of 2

PREPARE 10 minutes or less

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 1 Preparation Resource.

Video (5 minutes or less)

Inflatable globe (5 minutes or less)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 1.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	None	☐ Lesson 1 Resource A: Before and After Photographs ☐ Chart paper and marker for class chart	The list identifies disposable and prepared materials to save for reuse in the module. ☐ Class observations chart ☐ Sticky notes for Driving Question board
Learn: Locate Surtsey	None	☐ Prepared inflatable globe (1) ☐ Small stickers (2)	
Learn: Explore Island Formation	None	☐ <i>Life on Surtsey: Iceland's Upstart Island</i> (Burns 2017) (1) ☐ <i>An Island Grows</i> (Schaefer and Felstead 2006) (1)	
Learn: Model Surtsey's Formation	☐ Science Logbook (1 per student)	None	
Land	None	☐ Class observations chart (1, created in this lesson part) ☐ Sticky notes for Driving Question board	

LAUNCH 5 minutes or less

Students observe aerial photographs of Surtsey's location before and after a volcanic eruption to motivate their thinking about how Surtsey was formed.

1. Have students observe and compare photographs to identify that the island of Surtsey was formed in a location that was once open ocean.

LESSON 1 RESOURCE A

Display the photograph of open water showing what the area around Surtsey looked like before it formed and the photograph of Surtsey after it formed. Do not yet reveal what the photographs show. Inform students that these are aerial photographs, which means they were taken from high in the air.

Language Support

Students will encounter the terms *form* and *aerial* throughout the module. Providing the Spanish cognates *formar* and *aéreo* may be helpful. For the term *form*, consider sharing the following examples to illustrate the different meanings of the term that students will encounter ("make" and "made" or "happen"):

- The students form (make) a line by the door.
- I will see the line form (happen or get made).

Tell students the year in which each photograph was taken, and inform them that both photographs show the same location.

Performance Descriptor

Make observations to explain (SEP.6) that **changes can occur (CC.7)** as a result of volcanic events; specifically, **volcanic events can cause landforms to form quickly (ESS1.C)**.

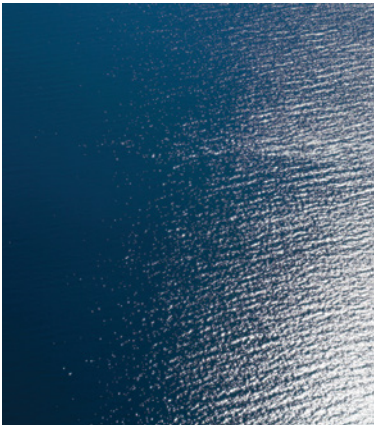
Agenda | 30 to 45 minutes

LAUNCH | 5 minutes or less

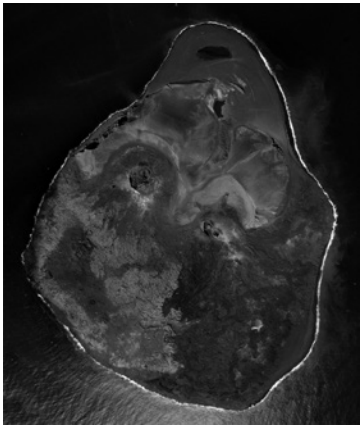
LEARN | 20 to 35 minutes

- Locate Surtsey (5 to 10 minutes)
- Explore Island Formation (10 to 15 minutes)
- Model Surtsey's Formation (5 to 10 minutes)

LAND | 5 minutes or less



1962



1967

Have students Think–Pair–Share to compare the two photographs. 🗉

Then invite students to share their observations with the class. As students share, record their observations on a class chart. As needed, clarify for students that color differences between the two photographs are simply because the photographs were taken with different kinds of equipment.

Invite students to discuss any questions they have about the photographs. Record students’ questions on the class observations chart. 🏠

Sample class observations chart:

What is the same?	What is different?
• <i>The pictures show the same location.</i> • <i>Both pictures were taken from high in the air.</i>	• <i>The pictures were taken in different years. One was taken in 1962, and one was taken in 1967.</i> • <i>There is a big object in the second picture.</i>
Our Questions	
• <i>What is the object in the second picture?</i> • <i>What happened in that place?</i> • <i>Where were the pictures taken?</i>	

Reveal that the object in the second photograph is a place called Surtsey. Tell students that in this lesson, they will learn more about Surtsey and find answers to some of their questions.

🗉 **Teacher Note**

Think–Pair–Share is a collaborative conversation routine in which students think about a question or prompt and then discuss their ideas with a partner before sharing a response with the class. This routine gives students time to consider their response before sharing. For more information, see the Instructional Routines section of the Implementation Guide.

🏠 **Content Area Connection: Mathematics**

In Grade 2, students develop the skill of representing and interpreting data; they explore how to compare data, how to group data, and how data changes over time. Consider providing students with a timeline of Surtsey’s transformation to support their understanding of timescales and of the time period between the two photographs.

LEARN 20 to 35 minutes

Locate Surtsey | 5 to 10 minutes

Students use a globe to identify the location of Surtsey relative to the location of their school. Students then make observations about land. Students determine that there is information about land on Earth that a globe cannot show.

2. Identify Surtsey on a globe, define the term *land*, and have students make observations about land.

Refer to students' questions on the class observations chart, and highlight any questions students have about the location of Surtsey in the photographs. 

Language Support

Students will encounter the term *location* throughout the module. Explain that *location* is another word for *place*. Students may benefit from identifying various locations at different scales and in relation to other places. For example, a gymnasium and a cafeteria have specific locations within a school, and a school has a specific location within a community.

How can we find out the location of Surtsey?

Listen for students to make suggestions such as looking at a map or globe, searching on the internet, or reading a book.

Hold up the prepared inflatable globe for students to observe. Explain that a globe is a ball-shaped model of Earth.  Point out the location of students' school on the globe, and place a sticker over the area. Then point out and place a sticker over the location of Surtsey.

Point out and identify the countries of Iceland and Greenland. Then identify the Atlantic Ocean, and show students the span of the globe that it covers. Invite students to pass the globe around the classroom by gently tossing it to one another. Instruct students who catch the globe to point to an area that they think shows land. After several tosses, have students share what they notice about the globe and the areas that they identified as land. 

Spotlight on Disciplinary Core Ideas

In this module, students build knowledge about mapping and the locations of water and land on Earth (ESS2.B). As students explore these ideas throughout Level 2, they look for specific physical features, such as islands and mountains, to develop their understanding of what maps can represent and how to use them.

Language Support

Students will encounter the term *globe* throughout the module. If more than one kind of globe is available, consider displaying these globes to show students that globes can look different.

Differentiation

If students are limited in their ability to toss or catch the inflatable globe, consider having them roll or hand the globe to one another.

 **How did you decide which parts of the globe are land?**

 **What do you think a globe can tell us about land? What do you think a globe cannot tell us about land?**

Explain that **land** is the solid material that covers some of Earth's surface. Confirm that a globe shows the locations and overall shapes of land on Earth but that it does not describe land areas in detail or identify how land formed. 

Language Support

Introduce the term *land* explicitly by using strategies such as these:

- Pronounce the word *land* and have students repeat it.
- Have students locate areas of land on the globe and compare them with areas of water.

After introducing *land* and other important terms, provide scaffolds for students who need additional support as they use the terms when speaking, writing, and investigating. For more information, see the Language Support section of the Implementation Guide.

Teacher Note

Use this opportunity to note students' general understanding of maps and geography. Depending on where students live and their background knowledge, they may notice that their home is far from or close to the ocean. Students may also notice that Surtsey is on a different continent, in a different country, and farther north than their home, and that both Surtsey and their home are locations in the Northern Hemisphere.

 **What do you notice about the area where Surtsey is?**

Listen for students to notice that Surtsey is near other areas of land and is surrounded by water.

Build on students' responses to establish that Surtsey is an island. Explain that an **island** is an area of land surrounded by water on all sides. 

Language Support

Introduce the term *island* explicitly. Providing the Spanish cognate *isla* may be helpful. Consider showing the photograph of Surtsey after its formation and drawing students' attention to the water that surrounds the land.

Extension

Consider using a two-dimensional world map as another means of representing Surtsey's location. Have students compare how a globe and a world map show land. Ask students whether either tool provides additional information about Surtsey's land or its location.

Teacher Note

Consider having students discuss whether Iceland and Greenland are also islands because they are surrounded by water. Establish that while Iceland and Greenland are considered countries, they are also islands.

Explore Island Formation | 10 to 15 minutes

Students watch a video that shows an underwater volcanic eruption. Students then listen to an excerpt from the book *Life on Surtsey: Iceland's Upstart Island* and view photographs in the book to begin learning about the volcanic eruption that formed Surtsey. Afterward, students listen to the story in the book *An Island Grows* and demonstrate their new learning by acting out what happens when a volcanic eruption forms an island.

3. Play a video that shows the formation of Surtsey.

Tell students that they will watch a video that shows the location where Surtsey formed in 1963. Instruct students to think about whether the video could help them understand what happened when Surtsey formed. Play the volcanic eruption video (<http://phdsci.link/3109>).

Then pose the following questions about the video.

 **What did you notice happening in the video?**

 **How might the video answer our questions about how Surtsey formed?**

Listen for students to mention that they observed a big explosion from under the water and that the explosion caused Surtsey to form.

Tell students that the video shows a kind of explosion called a volcanic eruption, which they will learn more about later in this lesson part. 

Teacher Note

During this lesson, students will build knowledge about the formation of Surtsey. To build this background, students will have multiple experiences with the phrase *volcanic eruption* and the term *volcano*. Students will develop a formal definition of the term *volcano* later in this lesson part. A volcano is both a landform and a vent in Earth's surface, but during this module students will focus on volcanoes as landforms.

4. Introduce *Life on Surtsey*, and read aloud an excerpt about the volcanic eruption that formed Surtsey.

Introduce the book *Life on Surtsey: Iceland's Upstart Island* (Burns 2017). Explain that the author, Loree Griffin Burns, wrote the book about her experiences on Surtsey after she spent several days with scientists on the island. Tell students that one of these scientists is named Erling Ólafsson and that Erling saw the volcanic eruption that formed Surtsey. 

Language Support

Students will encounter the term *eruption* throughout the module. Providing the Spanish cognate *erupción* may be helpful. Explain that an eruption is a forceful release of lava from a volcano.

Content Area Connection: English

In this part of the lesson, students use information and evidence from a text that is read aloud to them to build their understanding of land formation and to draw what the text describes (SEP.8). Consider having students use information and evidence from texts or media in other content areas to support them as they develop their reading, research, and reasoning skills.

Teacher Note

The rest of this module refers to *Life on Surtsey: Iceland's Upstart Island* as *Life on Surtsey*. Not all pages in *Life on Surtsey* are numbered. Consider writing small page numbers in the text or using sticky tabs to mark pages ahead of time.

 What do you think it was like to witness the volcanic eruption?

Turn to page 3 of *Life on Surtsey*, and read aloud the third and fourth paragraphs, which describe the volcanic eruption.

Language Support

After reading an important, unfamiliar word or phrase that students cannot define through context or morphological clues, pause to provide a familiar synonym or to define the word and use it in an example sentence. Then reread the sentence containing the word or phrase, and continue reading the text aloud. Important, unfamiliar words in this reading may include *ancient*, *eruption*, *cinder*, *plume*, *eventually*, and *Empire State Building*.

 What more did you learn about Surtsey from the book?

Show students the photographs on pages 3, 4, and 5. Read aloud the captions to describe the volcanic eruption in more detail. 

 We know the eruption that formed Surtsey took time. How much time passed before the island could be seen above the water? How much time passed before the island was fully formed?

Listen for students to mention the following ideas:

- It took one month for Surtsey's land to be visible above the surface of the ocean.
- Surtsey was created quickly and was fully formed in less than a year.

5. Read aloud from the book *An Island Grows*, and have students observe its illustrations to learn more about how volcanic eruptions can form islands.

Introduce the book *An Island Grows* (Schaefer and Felstead 2006). Inform students that the story in the book also provides information about how volcanic eruptions form islands.

 Teacher Note

The caption on page 3 indicates that the eruption that formed Surtsey occurred in November 1963, and the caption on page 5 states that Surtsey was fully formed by April 1964. Use this information to confirm that Surtsey formed in less than a year.

 Extension

To provide students with background about the origin and meaning of the name *Surtsey*, consider reading aloud the fourth paragraph on page 4.

Teacher Note

An Island Grows does not have page numbers. Consider writing small page numbers in the text or using sticky tabs to mark pages ahead of time where readings begin throughout the module. For example, the reading in this text starts on page 3, which begins, “Deep, deep beneath the sea ...”

Tell students that they will listen to the first few pages of the book. Ask that as students listen, they pay close attention to the verbs, or action words, the author uses to describe an island forming. Read aloud and display the illustrations on pages 3 through 9, beginning with “Deep, deep beneath the sea” and ending with the words “An island grows.”

Teacher Note

If you choose to read the remainder of the *An Island Grows*, explain that people eventually settled on the island the story depicts, as they do on many islands in the world. Tell students that Surtsey is different from most islands that form through volcanic eruptions because no people are allowed to live there long-term. Clarify that Surtsey is a protected area of land that people visit only to do scientific research.

6. Have students demonstrate and discuss their new learning about how volcanoes can form islands.

Have students demonstrate their understanding of the processes depicted in *An Island Grows* by participating in an Act It Out instructional routine. 

Arrange the class in a circle. Ask students to think about what they saw in the video and what happened at each stage of the volcanic eruption in *An Island Grows*. Tell students that they will listen to the first few pages of *An Island Grows* again and that this time, they should act out each sentence they hear. Reread and display the illustrations on the first nine pages of the book. Explain that a **volcano** is a hill or mountain that forms from the eruption of lava.  Specify that a volcanic eruption often leaves behind a large, bowl-shaped hole in the ground called a crater.

Language Support

Introduce the term *volcano* explicitly. Providing the Spanish cognate *volcán* might be helpful. Consider showing students photographs or additional videos of an erupting volcano.

Teacher Note

The Act It Out terminology learning routine provides students with an opportunity to connect movement with an unfamiliar term or concept. Students receive a term, individually or in pairs, and have a short time to imagine how they could represent it in movement. Students then take turns acting out their terms in groups.

Language Support

Students will encounter the terms *magma* and *lava* throughout the module. Providing the Spanish cognates *magma* and *lava* may be helpful. Explain that magma is hot liquid rock below Earth’s surface and lava is hot liquid rock above Earth’s surface. During the reading, consider pointing to an illustration that shows the locations of magma and lava. Emphasize that most of Earth’s surface is covered by water.

Then invite students to describe to the class how they demonstrated the volcanic eruption. Have students connect their understanding of volcanic eruptions and their actions during the Act It Out routine to explain how Surtsey formed.

Listen for students to mention the following ideas:

- That an underwater volcano erupted at the location where Surtsey formed
- That An Island Grows helped students understand how a volcano can form an island

- ✓ Ensure that students understand that underwater volcanic activity can cause islands to form and that it is what caused Surtsey to form. If students need support to develop this understanding, consider reviewing the text and images on the first five pages of Life on Surtsey.

Teacher Note

Consider displaying the aerial photograph of Surtsey in 1967 and pointing out craters. Connect students' observations about the craters to their new knowledge about volcanoes.

Model Surtsey's Formation | 5 to 10 minutes

Students develop a model that shows how Surtsey formed and record an explanation.

7. Instruct students to model and describe the events that led to the formation of Surtsey.

LESSON 1 ACTIVITY GUIDE A

Instruct students to turn to their Science Logbook. Tell students to create a detailed drawing with labels to show what they know about how Surtsey formed. Tell students to then use the additional prompts in their activity guide to record an explanation of how Surtsey formed and to support this explanation with evidence.

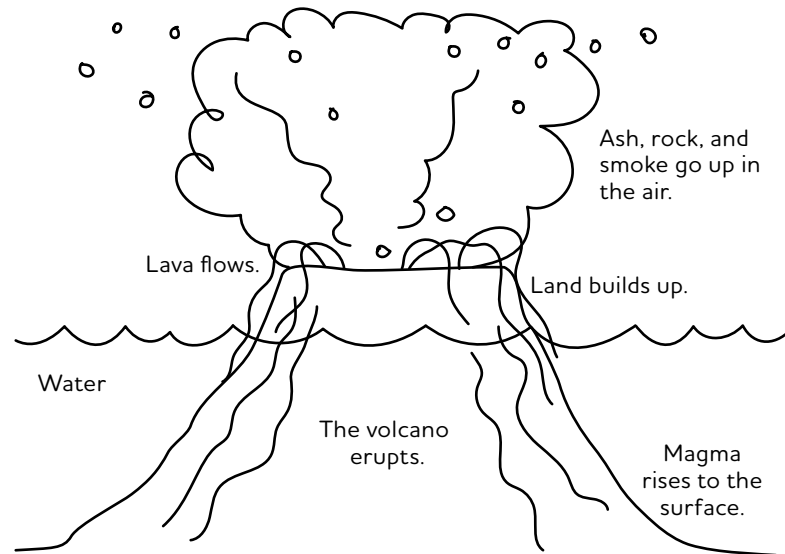
Encourage students to use evidence from the photographs and video they viewed, as well as from the text in the books they read. Circulate to support students as necessary. 

Teacher Note

Consider posing questions such as these:

- What was the area like before Surtsey formed?
- What happened next?
- How do you know what happened?

Sample student response:



Surtsey formed quickly/ slowly.

At first there was just the ocean, and there was no island. Then an underwater volcano suddenly erupted in the ocean. Ash, rock, and lava started to build up and form land. They kept building up until the island reached above the water.

I know this because I saw a video and pictures of the volcano erupting and the island forming.

**Pre-Assessment**

Make observations to explain (SEP.6) that **changes can occur (CC.7)** as a result of volcanic events; specifically, **volcanic events can cause landforms to form quickly (ESS1.C)**.

EVIDENCE	NEXT STEPS
Look for the following in each student's model and written explanation: - The model shows how a volcanic eruption quickly formed Surtsey (ESS1.C) and contains labels and an explanation that indicate the changes that occurred (CC.7). - The explanation is based upon observational evidence (SEP.6).	If students need support to create a model and explanation that show how Surtsey formed, first draw their attention to what the area around Surtsey looked like before the island formed. Then prompt students to orally explain the events that occur when a volcanic eruption in the ocean forms an island. If students need additional support to accurately explain how a volcanic eruption led to the formation of Surtsey, revisit the photographs, video, and books they explored in this lesson part.

LAND 5 minutes or less

Students reflect on their new learning about how Surtsey formed and use prior experiences to identify examples of related phenomena. These activities and others throughout the module help students connect rich, sometimes distant, phenomena to their own experiences. This practice is important to help students see their experiences as a tool to make sense of complex phenomena.

8. Guide students to review their new learning and to ask new questions.

Use the class observations chart from earlier in the lesson part to review students' new learning. Read aloud students' questions, and ask students to consider whether they can use their knowledge about how Surtsey formed to answer any of the questions. Then ask students the following question.

 What other questions do you have about the island of Surtsey?

Record students' new questions on the class observations chart.

9. Invite students to identify related phenomena and to share prior knowledge.

Tell students that they can use their own experiences as a tool to better understand the anchor phenomenon.  Invite students to share examples of their background knowledge about or experiences with land forming or changing over time. Record students' responses on sticky notes. Save these sticky notes to create a Related Phenomena section when developing the Driving Question board later in the lesson. 

 What information could help us learn more about Surtsey?

Tell students that in the next lesson part they will learn more about Surtsey.

HW Suggested Homework

Have students do additional research on volcanoes by visiting their school library, their local library, or a safe website. Then have students share what they learned with the class or with a trusted adult at home.

 Teacher Note

The related phenomena students share will also provide insight into their prior knowledge about the anchor phenomenon. The module includes several opportunities for students to revisit and reflect on these related phenomena. Additionally, refer to these phenomena at natural points when students need a familiar context to make sense of an unfamiliar phenomenon.

 Language Support

Use students' words when recording questions and related phenomena on the Driving Question board as well as labels and explanations on the anchor model. This text can include everyday language and students' home language. As students learn new terminology throughout the module, consider updating student language on anchor visuals to show the connection between the new terminology and the concepts students previously described.



PART 2 of 2

PREPARE 5 minutes or less

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 1 Preparation Resource.

Interactive model of Surtsey (5 minutes or less)

Preparation Notes

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper has a slight shadow on its right side, suggesting it's resting on a surface.

MATERIALS

The table lists materials needed for each section of Part 2.

SECTION	STUDENT MATERIALS	CLASS MATERIALS
Launch	None	☐ Lesson 1 Resource B: Surtsey Photographs over the Years ☐ Class observations chart (1, from Part 1)
Learn: Develop Initial Model	☐ Science Logbook (1 per student)	☐ Lesson 1 Resource B: Surtsey Photographs over the Years
Learn: Develop Anchor Model	☐ Science Logbook (1 per student)	☐ Chart paper and marker for class anchor model
Learn: Build Driving Question Board	☐ Science Logbook (1 per student)	☐ Chart paper, marker, and sticky notes for Driving Question board ☐ Class anchor model (1, created in this lesson part) ☐ Sticky notes for Driving Question board (from Part 1)
Land	None	☐ <i>Life on Surtsey</i> (Burns 2017) (1) ☐ Driving Question board (1, created in this lesson part)

MATERIALS REUSE

The list identifies disposable and prepared materials to save for reuse in the module.

- ☐ Class anchor model and marker (for all lessons)
- ☐ Driving Question board, marker, and sticky notes (for all lessons)

LAUNCH 5 minutes or less

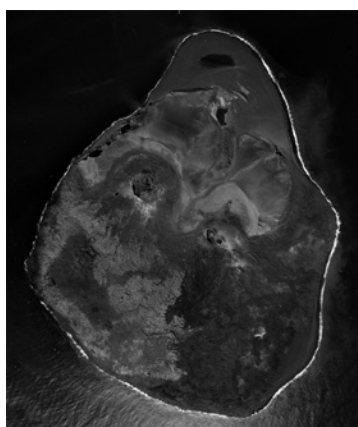
Students observe aerial photographs of Surtsey and wonder how and why Surtsey's land has changed shape.

1. Display aerial photographs of Surtsey to observe and discuss changes to its land over time.

 LESSON 1 RESOURCE B

Display the photographs of Surtsey from 1967 and 2004. 

Remind students that underwater volcanic eruptions formed Surtsey.



1967



2004

Have students Think–Pair–Share to discuss their observations of the photographs. Encourage students to compare the photographs to identify similarities and differences.

 **What do you notice about Surtsey's land in 1967 and 2004?**

Highlight responses that identify changes to the shape and size of Surtsey's land. Ask students to consider why the shape and size of the land look different in the two photographs.

 **How did Surtsey's land change between 1967 and 2004?**

Listen for students to mention that between 1967 and 2004, the size of Surtsey's land decreased and the shape of the land changed.

Performance Descriptor

Develop a model that represents (SEP.2) the formation of Surtsey (ESS1.C) and that describes that the landform is changing over time (CC.7).

Agenda | 30 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 35 minutes

- Develop Initial Model (5 to 10 minutes)
- Develop Anchor Model (10 to 15 minutes)
- Build Driving Question Board (5 to 10 minutes)

LAND | 5 minutes or less

Teacher Note

Color differences between the two photographs are due to different photographic processes and equipment.

 What do you think caused Surtsey to change?

Summarize students' responses to conclude that students need more information to determine what caused changes to Surtsey's land. Invite students to share new questions they have about Surtsey's land. Record students' new questions on the class observations chart from the previous lesson part.

Tell students that in this lesson part, they will look more closely at the changes to Surtsey's land.

LEARN 20 to 35 minutes

Develop Initial Model | 5 to 10 minutes

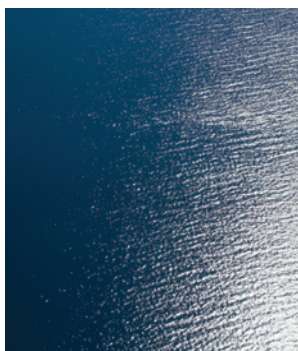
Students develop an initial model to show how they think the island of Surtsey has changed shape over time. Initial models of anchor phenomena allow students to communicate their initial ideas and identify gaps in their knowledge and also provide teachers insight into students' ideas.

2. Support students as they create an initial model of Surtsey to show how the island has changed shape over time.

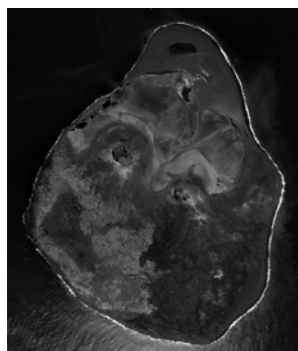
 LESSON 1 RESOURCE B  LESSON 1 ACTIVITY GUIDE B

Explain that developing models is one way to explore a phenomenon, such as changes to the shape of land. Tell students that they will develop an initial model in their Science Logbook to show the ways the shape of Surtsey has changed.

Display the aerial photographs from 1962, 1967, and 2004. Remind students that the photographs show Surtsey at three different times: before the eruption, a few years after the eruption, and many years after the eruption. Explain that students' model should show Surtsey at each of these times. Guide students to focus on Surtsey's shape in each photograph, changes to Surtsey's land, and their knowledge about how Surtsey formed.



1962



1967



2004

Inform students that their model should include drawings and words that identify both water and land, along with details such as labels and arrows. Tell students that their model should also include explanations of how Surtsey formed and descriptions of Surtsey's changes over time.

Allow students time to develop their model. As students work independently, circulate to ask probing questions, such as those that follow, that challenge students to consider more deeply their initial ideas about the anchor phenomenon.

 **What happened to Surtsey's land over time? How does your model show that?**

 **Which parts of the island look like they stayed the same? Which parts look like they changed? How does your model show that?**

3. Have students compare their models and discuss how they represented Surtsey's changes.

Have students share and compare their model with a partner. Prompt pairs with the following discussion questions:

 **How are your models similar? How are they different?**

 **How does your model show your learning about Surtsey?**

 **What questions do you still have about Surtsey?**

- ✓ *Students should be able to describe how Surtsey formed and identify the parts of the island that changed over time, but students are not yet expected to explain why or how some parts of the island changed. If students need additional support, ask them to review the photographs of Surtsey from 1967 and 2004. Have students point to areas on the photographs that show noticeable changes, and ask them to describe the differences they observe between the photographs.*

Develop Anchor Model | 10 to 15 minutes

Students use ideas from their comparisons of initial models to inform the development of the Driving Question and the class anchor model. Throughout the module, the Driving Question will guide students to connect their learning back to the anchor phenomenon. The anchor model will serve as an artifact of student understanding and will be used throughout the module as students reflect on and update their explanation of the anchor phenomenon.

4. Guide students to develop the Driving Question, and have students record it in the Knowledge Tracker in their Science Logbook. 📖

Explain that modeling the changes to the shape of Surtsey between 1967 and 2004 can help the class figure out how land can change over time. Encourage students to look at their initial model as they discuss why Surtsey's land changed. Use the following prompts.

- 💬 **How did Surtsey change after the volcanic eruption?**
- 💬 **After the eruption, what do you think caused Surtsey's land to change? Why do you think that?**

Then point out that students cannot yet explain how or why Surtsey changed shape. Identify this gap in students' understanding, and introduce the Driving Question: **How can the island of Surtsey change shape over time?** Ask students to record the Driving Question in the first section of their Knowledge Tracker.

5. Guide students to develop the class anchor model.

Explain that the first step in finding the answer to the Driving Question is to create a class anchor model. Point out that many students described changes to Surtsey's shape when discussing their initial model. Tell students that the anchor model will represent how those changes happened.

📖 Teacher Note

Students update their Knowledge Tracker in every lesson to record what they figure out in the lesson and how that new understanding may help them answer the Driving Question. This process makes visible for students how the activities they engage in allow them to better understand the anchor phenomenon.

Work as a class to develop an anchor model that explains the changes to Surtsey over time. Invite students to share information they think the anchor model should include. As students share, ask the rest of the class to use nonverbal signals to indicate whether they agree. 🗨️

Listen for students to indicate that the anchor model should show how Surtsey formed and how Surtsey has changed shape over time. If students are unsure or cannot agree about a piece of information, encourage them to review what they learned about Surtsey from the video, photographs, and texts to establish a common understanding.

Discuss with students the best way to represent Surtsey on the anchor model. Then display the 2023 3D model of Surtsey (<http://phdsci.link/1584>). Tell students that this is a much more recent model of Surtsey. Point out that the model shows Surtsey from above as well as from all sides. Slowly pan around the island.

💬 **We want to easily see Surtsey and show changes to its land. What side of Surtsey should our anchor model focus on?**

Guide students to conclude that a side-view perspective would best allow them to show the shape of Surtsey and changes to Surtsey's land. Draw the anchor model, including the components that students agreed on earlier.

Teacher Note

A side-view perspective is recommended as the main perspective for the class anchor model. A side view allows the class to depict changes in elevation more easily. Consider also adding to the model a panel that includes an aerial view if students would find this perspective helpful. Including separate sections for different perspectives, as well as for different points in time, allows the class to more clearly represent how Surtsey has changed over time. Additionally, consider leaving space for another panel where students can record a prediction of what Surtsey will look like in another 50 years. Students can make this prediction near the end of the module.

Anchor models will vary but should show the following:

- How Surtsey formed
- The initial shape of Surtsey
- The current shape of Surtsey

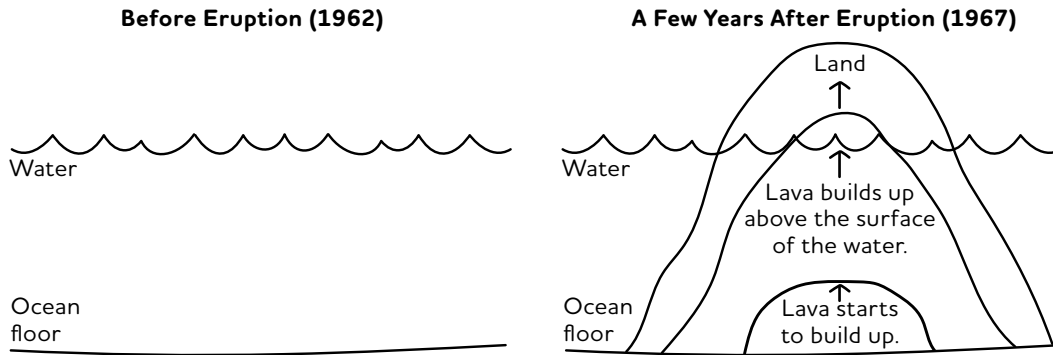
Remind students of the Driving Question, and record it at the top of the anchor model.

Teacher Note

Using nonverbal signals allows students to engage in a quick formative assessment. Students may use a signal such as a thumbs-up, a thumbs-down, or the American Sign Language signs for yes and no.

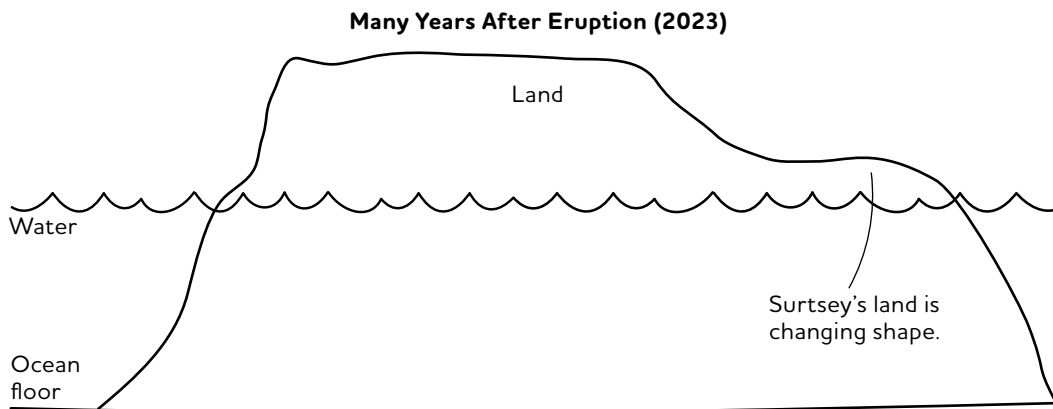
Sample anchor model:

How can the island of Surtsey change shape over time?



In 1962, there was no island.

A volcano erupted in the ocean. Lava from the eruption built up enough to reach above the water. The lava built up quickly, so the island of Surtsey formed quickly.



Surtsey's shape is changing over time, and some parts are changing more than others. We do not know why yet.

**Check for Understanding**

Develop a model that represents (SEP.2) the formation of Surtsey (ESS1.C) and that describes that the landform is changing over time (CC.7).

EVIDENCE	NEXT STEPS
Look for the following in the class anchor model: - The model shows Surtsey's formation, its initial shape after the eruption, and its present-day shape (SEP.2). - The model includes explanations of how Surtsey formed (SEP.2), how quickly the island formed, and how the island has changed shape (e.g., that it became smaller) (ESS1.C). - The drawings and explanations indicate that some parts of Surtsey have changed in shape and size more than other parts (CC.7).	If students need support to identify changes to Surtsey to show on the anchor model, encourage them to revisit and compare the 1967 and 2004 aerial photographs; pages 3, 7, and 39 in <i>Life on Surtsey</i>; and the 2023 3D model of Surtsey. Have students discuss the changes to Surtsey's shape over time, including whether parts of the island became smaller or bigger. Then ask students how they can include information about the changes in the class anchor model.

6. Ask students to reflect on the class anchor model.

On the class anchor model, point out the differences in the drawings of Surtsey in 1967 and 2023. Then use the following prompts to engage students in a discussion:

Which parts of Surtsey seem to be changing the most?

Why do you think Surtsey is changing?

What questions do you have about Surtsey?

Tell students that they will use these questions and other questions to develop a Driving Question board.

Build Driving Question Board | 5 to 10 minutes

Students identify gaps in their understanding of the anchor phenomenon and generate questions to add to the Driving Question board. The Driving Question board will serve as an artifact of student questions and will be used throughout the module to document new questions and motivate transitions between ideas.

7. Begin to develop the Driving Question board by identifying student questions related to the Driving Question.

Write the Driving Question at the top of the Driving Question board. Give students several minutes to review the class anchor model as well as their initial models in their Science Logbook and to discuss with a partner the questions they have. Invite pairs to share their questions with the class. Record at least one question from each pair on a sticky note. Create an Unanswered Questions section on the Driving Question board, and post the sticky notes under it. 

Teacher Note

Students may need guidance to develop and choose questions. To prepare for this activity, post the Driving Question so students can easily refer to it. As students share their questions, offer additional guidance to help students choose which questions to add to the Driving Question board.

8. Add student-generated related phenomena to the Driving Question board, and post the board in a visible location.

Review the sticky notes from the previous lesson part that list students' knowledge about and experiences with land forming or changing over time. Create a Related Phenomena section on the Driving Question board, and post the sticky notes under it. Tell students that they will update and revisit the Driving Question board throughout the module. Allow space to post sample student work along the way. 



Differentiation

If necessary, differentiate how students share their questions. In smaller classes, have students share more than one question to ensure that the class has enough questions. Consider providing prompts such as these for students who are working below grade level or who need additional language support:

- What do you wonder about Surtsey and its shape?
- What do you wonder about the changes to Surtsey?
- What do you wonder about how volcanoes form an island?



Spotlight on Science and Engineering Practices

The focus and relevance of students' questions should improve as students continue to practice asking questions that can be investigated (SEP.1). Continually guide students to understand which kinds of questions lead to a deeper understanding of a phenomenon and to review and revise existing questions on the Driving Question board.

Sample Driving Question board:

Driving Question: How can the island of Surtsey change shape over time?

Unanswered Questions

What is it like on Surtsey?

What is the land on Surtsey made of?

Do volcanoes create other islands?

Will the volcano that formed Surtsey erupt again?

What is causing Surtsey to change shape?

Does all land change shape?

How long is it taking for Surtsey to change shape?

Related Phenomena:

Sometimes bad weather can change the shape of land.

People can use tools and machines to change the land.

The shoreline at the beach keeps changing every year.

LAND 5 minutes or less

Students make connections between *Life on Surtsey* and the questions on the Driving Question board and brainstorm how they could investigate their questions.

9. Discuss as a class how students can begin to answer their questions.

Display the photograph on page 18 of *Life on Surtsey* (Burns 2017). Engage students in a discussion about how the photograph relates to their questions on the Driving Question board about how Surtsey is changing.

Invite students to share ideas about how the class could investigate these questions.

Listen for responses that mention students learning more about what Surtsey's land is made of and why areas of Surtsey look different. Students may mention reading other texts, observing models, or conducting investigations such as those they conducted in previous modules to help them answer their questions.

Inform students that in the next several lessons, they will begin to explore what caused changes to Surtsey's land.

Lesson 1

PREPARATION RESOURCE

PART 1 of 2

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- ☐ *An Island Grows* (Schaefer and Felstead 2006) (1)
- ☐ Chart paper and marker for class chart
- ☐ Inflatable globe (1)
- ☐ Lesson 1 Resource A: Before and After Photographs
- ☐ *Life on Surtsey: Iceland's Upstart Island* (Burns 2017) (1)
- ☐ Small stickers (2)
- ☐ Sticky notes for Driving Question board

PREPARATION

Complete the following tasks to prepare for this lesson part.

Video | 5 minutes or less

Instructions: Cue the volcanic eruption video (<http://phdsci.link/3109>) to play during the lesson part.

Inflatable Globe | 5 minutes or less

Materials

- ☐ Inflatable globe (1)

Instructions: Inflate the inflatable globe. Then identify the location of students' school and the location of Surtsey on the inflatable globe. (Note that Surtsey is located about 32 km from the south coast of Iceland.) You will place stickers on these locations during the lesson part.

PART 2 of 2

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- ☐ Chart paper and marker for class anchor model
- ☐ Chart paper, marker, and sticky notes for Driving Question Board
- ☐ Class observations chart (1, from Part 1)
- ☐ Lesson 1 Resource B: Surtsey Photographs over the Years
- ☐ *Life on Surtsey* (1)
- ☐ Sticky notes for Driving Question board (from Part 1)

PREPARATION

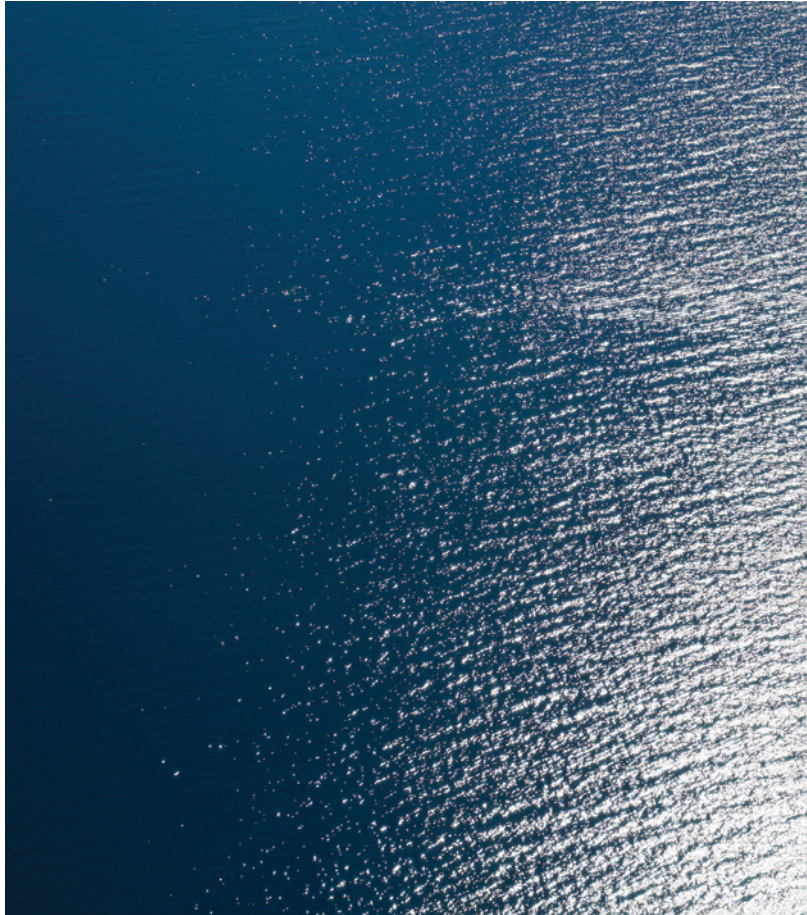
Complete the following task to prepare for this lesson part.

Interactive Model of Surtsey | 5 minutes or less

Instructions: Access the 2023 3D interactive model of Surtsey (<http://phdsci.link/1584>) from the Icelandic Institute of Natural History to use during the lesson part.

Lesson 1 Resource A

BEFORE AND AFTER PHOTOGRAPHS



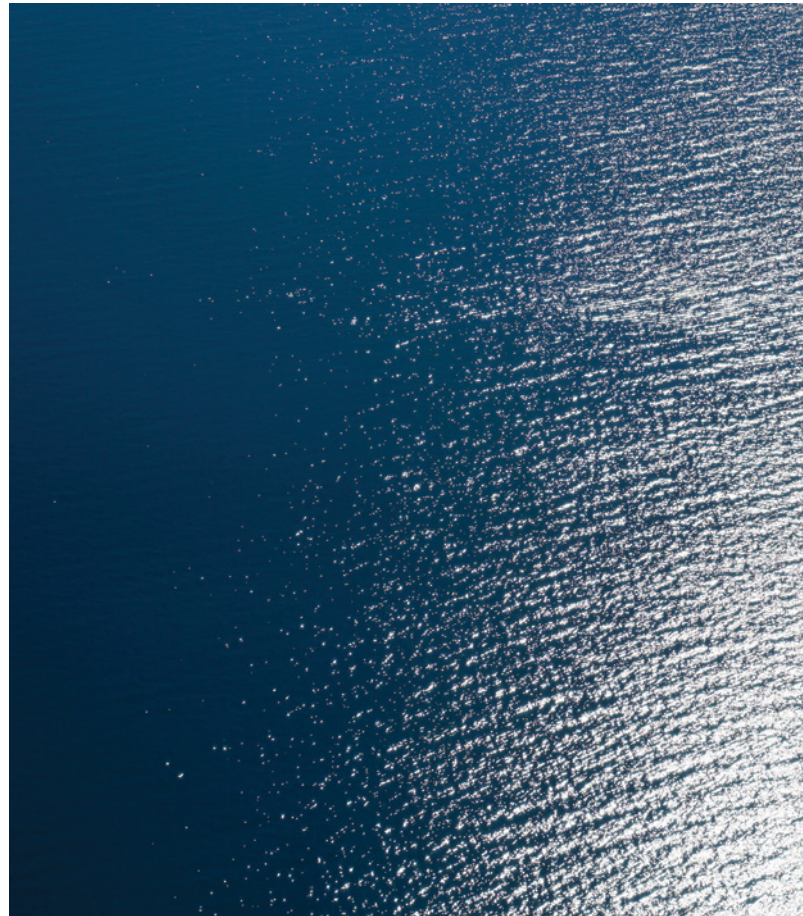
1962



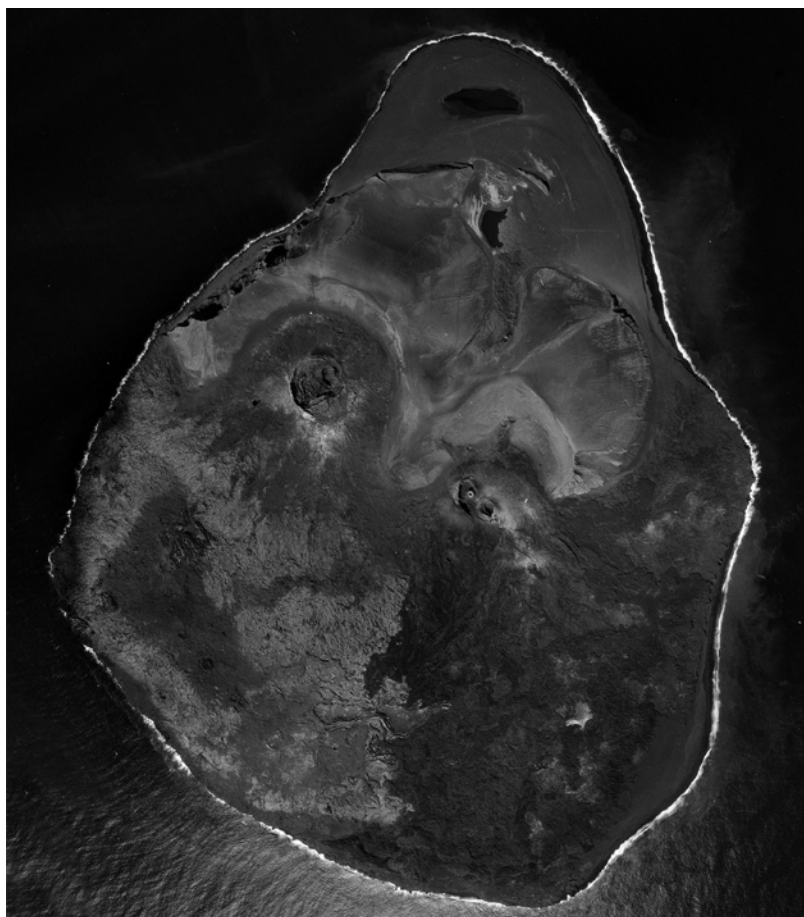
1967

Lesson 1 Resource B

SURTSEY PHOTOGRAPHS OVER THE YEARS



1962



1967



2004



CONCEPT 1 THE COMPONENTS AND SHAPE OF LAND



Concept 1 | The Components and Shape of Land

LESSON 2 THE COMPONENTS AND SHAPE OF LAND

Lesson Phenomenon | Describing Surtsey's land

Phenomenon Question | How can we describe Surtsey and the materials that make up its land?

OVERVIEW

Previously we determined that Surtsey formed from a volcanic eruption, and we began to build our knowledge of how Surtsey's land has changed size and shape.

In this lesson we use maps, photographs, and a 3D model to explore Surtsey's land. We examine samples of different land materials and determine that rocks, soil, and sand are components of land. We then investigate the components of Surtsey's land by observing rock samples similar to the rocks on the island. We identify properties of the rocks before and after shaking and scratching them, and we notice that the rocks' properties change. We agree that rocks with different properties can change in size and shape in different ways. We also conclude that the properties of Surtsey's landforms are determined by the properties of their components. Finally, we apply our new knowledge to update the class anchor model and anchor chart.

Later we will investigate how wind and water change the shape of land over time and will apply our new learning to explain how water and wind affect Surtsey.

Lesson Objective

Use observations (SEP.6) of **landforms (ESS2.B)** and **properties of land materials (PS1.A)** to **explain how (SEP.6) land can change shape over time (CC.5)**.

Performance Descriptors

Part 1: **Use observations (SEP.2)** to **show how maps (ESS2.B)** can be used to **compare the relative scales of landforms (CC.3)**.

Part 2: **Use observations of land materials (SEP.6)** to **describe the properties of landforms (PS1.A)**.

Part 3: **Use observations (SEP.6)** of **the properties of rocks (PS1.A)** before and after they are shaken and scratched as **evidence to explain (SEP.6) how rocks can change shape (CC.5)**.

STANDARDS ADDRESSED

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.2: Developing and Using Models - Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). SEP.6: Constructing Explanations and Designing Solutions Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	ESS2.B: Plate Tectonics and Large-Scale System Interactions Maps show where things are located. One can map the shapes and kinds of land and water in any area. PS1.A: Structure and Properties of Matter Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.	CC.3: Scale, Proportion, and Quantity Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower). CC.5: Energy and Matter Objects may break into smaller pieces, be put together into larger pieces, or change shapes.

MATERIALS

The table lists materials needed for each section of Part 1.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	None	None	The list identifies disposable and prepared materials to save for reuse in the module. ☐ Posters of Surtsey's landforms
Learn: Describe Surtsey's Land	☐ Science Logbook (1 per student)	☐ Lesson 2 Resource A: World Map ☐ Lesson 2 Resource B: Elevation Diagram ☐ Lesson 2 Resource C: Map of Surtsey's Landforms ☐ Prepared posters of Surtsey's landforms (1 set) ☐ Marker (1)	
Land	None	None	

LAUNCH 5 minutes or less

Students review their learning from Lesson 1 and discuss questions they have about the changing shape of Surtsey's land over time.

1. Identify gaps in students' explanation of the anchor phenomenon to develop the Phenomenon Question.

Display the class anchor model and Driving Question board. Review that students know that Surtsey's land is changing shape but that they do not yet know what is causing the changes. Use the following prompt to help students identify gaps in their learning.

 **What do we need to know to explain the changes to Surtsey's land?**

Suggest students learn more about Surtsey and the materials that make up its land.

 **What questions about Surtsey's land could we ask to understand the changes?**

Summarize students' questions to develop the Phenomenon Question **How can we describe Surtsey and the materials that make up its land?** Record some of students' questions on the Driving Question board.

Tell students that observing and describing Surtsey and the materials that make up its land can help them understand how and why the shape and size of Surtsey are changing.

Performance Descriptor

Use observations (SEP.2) to **show how maps (ESS2.B)** can be used to **compare the relative scales of landforms (CC.3)**.

Agenda | 35 to 40 minutes

LAUNCH | 5 minutes or less

LEARN | 25 to 30 minutes

- Describe Surtsey's Land (25 to 30 minutes)

LAND | 5 minutes or less

LEARN 25 to 30 minutes

Describe Surtsey's Land | 25 to 30 minutes

Students use a 3D model to identify and describe landforms on Surtsey. To explore Surtsey's landforms in more detail, students observe posters that show photographs of three landforms on the island. Students record their observations in their Science Logbook. Students then use their observations to compare the three land forms.

2. Have students use maps and models to explore and describe Surtsey's land.

 LESSON 2 RESOURCE A, LESSON 2 RESOURCE B

Remind students that in the previous lesson, they looked at a globe to locate areas of land and bodies of water, and point out that a globe is a ball-shaped model of Earth. Then display the world map. 



 **How is this map similar to the globe? How is it different from the globe?**

Listen for responses that mention the following ideas:

- Both the map and the globe show the locations of areas of land and bodies of water.
- The map is flat, while the globe is a sphere. 

Establish that globes and maps are both models that show where on Earth areas of land and bodies of water are located. Point out the location of Surtsey on the map.

Spotlight on Disciplinary Core Ideas

In this module, students use maps to locate, describe, and compare different landforms on Surtsey. Later in Level 2, students continue to explore maps and examine them in more detail (ESS2.B).

Teacher Note

Some students might also state that a globe is three-dimensional whereas a map is two-dimensional. A globe shows what Earth looks like from space.

 Does this map tell us everything there is to know about Surtsey's land?

Confirm that while the world map shows Surtsey, the map does not show detailed information about Surtsey's land or the materials that make up the land. Explain that a world map only shows general information about the shape and size of land in different parts of the world.

 How could we look more closely at Surtsey's land?

Listen for students to suggest using other kinds of maps, other photographs, or other tools.

Suggest that students revisit the 2023 3D model from Lesson 1 for a more recent, detailed view of Surtsey's land and shape. Display the 2023 3D model of Surtsey (<http://phdsci.link/1584>), and use the 3D tool to display features of the land. 

Allow students a few minutes to examine the 3D model of Surtsey. Then pose the following questions to guide a discussion about students' observations.

 How can we describe the shape of Surtsey's land in this model?

 Look at the land in different areas of Surtsey. How are these areas of the land similar to each other? How are they different?

Listen for students to mention the following ideas:

- Some areas of Surtsey are higher, while others are lower.
- Some areas are smoother, while others are rougher.
- Some areas are darker in color, while others are lighter.
- Plants are growing in some areas of Surtsey but are not growing in other areas.

Point out that students used terms such as *higher*, *lower*, *darker*, and *lighter* to compare some of the natural features of Surtsey. Explain that a **natural feature** is a part of an area that is not made by humans. Tell students that some natural features are called **landforms**. Explain that a natural feature is a landform if it is found on Earth's surface. Then tell students that some examples of landforms are hills, volcanoes, cliffs, and mountains. Tell students that some examples of natural features that are not landforms are living things and weather.  

Language Support

Introduce the terms *natural feature* and *landform* explicitly. Consider showing students photographs of landforms and natural features such as plateaus, mountains, or beaches.

 Teacher Note

While the 3D model of Surtsey can be used in conjunction with map models, it is not a map. The 3D model does not show cardinal directions or feature a legend, which are two essential components of a map.

 Teacher Note

If students need support to describe the shape of Surtsey's land, consider providing a word bank that includes words such as *taller*, *shorter*, *flatter*, *steeper*, *higher*, *lower*, *smoother*, *pointier*, *rougher*, and *more jagged*.

 Teacher Note

Consider displaying page 8 of *Life on Surtsey* (Burns 2017) and having students first identify all the natural features they observe in the photograph and then identify all the human-made objects they observe.

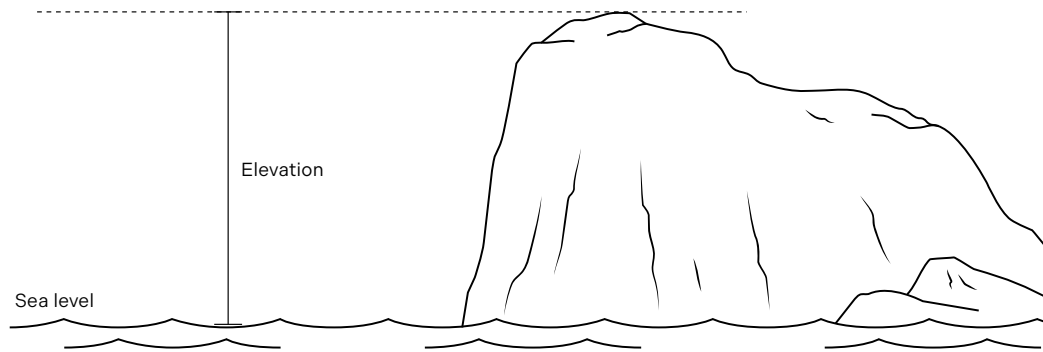
 Extension

Consider having students go outside to identify the natural features and human-made objects around their school. If students are unable to go outside, consider displaying a photograph of a local area that shows both natural features and human-made features.

Teacher Note

Other examples of landforms include valleys, beaches, and islands. Earth also has landforms that are not land features; bodies of water, such as rivers, oceans, and lakes, are natural features that also count as landforms. Non-landform natural features include the living things found in an area, as well as an area's climate, weather, and weather patterns.

Next, call attention to the differences students mentioned in the height of Surtsey's land. Explain that students were describing differences in **elevation**, a measure of height above sea level. To help students better understand the meaning of the term *elevation*, display the elevation diagram.



Explain that sea level is the level of the surface of the ocean. Point out that elevation is the height of a landform, such as a mountain, above sea level.

Language Support

Introduce the term *elevation* explicitly. Providing the Spanish cognate *elevación* may be helpful. Explain that elevation is a form of measurement people use to describe landforms.

Review that students have observed photographs, a video, a globe, and a map to learn about Surtsey's land. Suggest that next, students use another map to better observe and describe Surtsey's land.

3. Display a physical map of Surtsey and photographs of Surtsey's landforms, and have students describe and compare the landforms.

 LESSON 2 RESOURCE C  LESSON 2 ACTIVITY GUIDE A

Display the physical map of Surtsey. Point out the labels highlighting the locations of some of Surtsey's landforms.



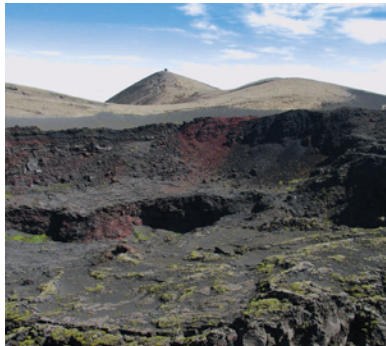
 **What information about Surtsey does this map show? How is this map different from the world map you observed earlier?**

Listen for responses that mention the following ideas:

- This map shows Surtsey's shape and some details about its landforms.
- This map shows details that could not be observed on the world map.

Inform students that this map is a physical map of Surtsey. Explain that a physical map is a map that shows the locations of the natural features in an area, such as the landforms found there. Suggest that students take a closer look at each of the landforms that are labeled on the map. Tell students that they will rotate through the room in groups to observe posters that show photographs of these landforms.

Landform A



Landform B



Landform C



Point out that on both the posters and the physical map, each landform is labeled A, B, or C. Tell students that they will each record in their Science Logbook their observations of each landform.

Divide the class into groups, and assign each group a poster to observe first. Instruct groups to move to their first poster and to record their observations. As groups observe the posters, circulate to answer any questions they may have.

Sample student response:

Landform A: Land with red, black, and green parts. A deep hole in the middle. A tall, pointy area in the back.

Landform B: A tall area. It is dark brown and bumpy on top and light gray on the side.

Landform C: A lot of smooth, round objects at the bottom. A tall, pointy area in the back.

After groups have recorded observations for all three posters, bring the class back together. Invite students to share their observations. As students share observations about a landform, record their observations on the poster for that landform. Allow students time to review the observations on the posters and to revise or add to the observations in their Science Logbook. 📝📝

📝 Teacher Note

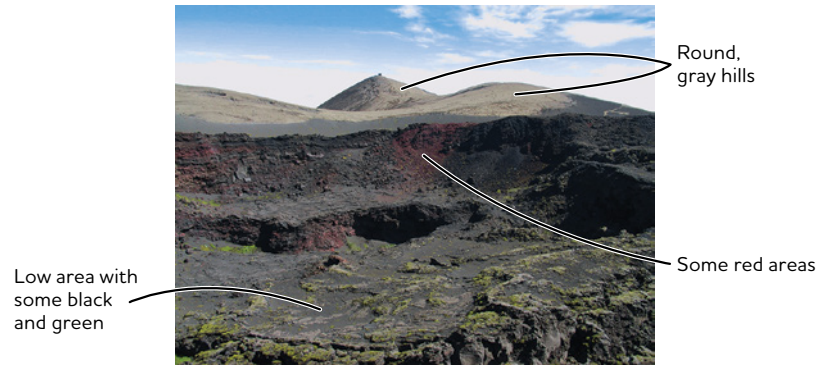
Students will likely recognize that the objects in Landform C are rocks and may wish to label them as such. They will discuss rocks in more detail in Part 2.

📝 Teacher Note

Because students' background knowledge and experiences with different landforms will vary, students may need support to identify the landforms in the photographs as hills. Consider allowing students to use their own vocabulary to identify the hills before informing the class that they are called hills. As necessary, explain that a hill is a raised area of land.

Sample class posters:

Landform A



Landform B



Landform C



Next, instruct students to use the physical map and the landform posters to respond to the prompt in their Science Logbook. Review that when students observed a 3D model to compare Surtsey's natural features, they used terms such as *higher*, *lower*, *darker*, and *lighter*. Encourage students to use comparative terms as they respond to the prompt.

 **Think about the posters and the map. What similarities did we observe between Landform A, Landform B, and Landform C? What differences did we observe?** 

Look for students to identify that all three landforms are on Surtsey but that there are differences in how the landforms look. Students may observe differences such as these:

- The landforms have different elevations.
- Landforms A and C both have tall hills, but Landform C is the only landform with a lot of round rocks.
- Landform B and Landform C are both near water, but they are different shades of gray, and Landform B looks much taller than Landform C.



Check for Understanding

Use observations (SEP.2) to **show how maps (ESS2.B)** can be used to **compare the relative scales of landforms (CC.3)**.

EVIDENCE	NEXT STEPS
Look for indications of the following in students' Science Logbook responses: • Students examine a physical map (ESS2.B) that models (SEP.2) Surtsey's landforms, review the corresponding posters to identify the landforms on the map, and record observations of the landforms. • Students use their observations of the physical map (ESS2.B) and posters to compare aspects of the landforms, including the relative scales of the landforms (CC.3).	If students need support to identify Surtsey's landforms on a physical map, consider modeling how to use the symbols on the map to find each landform and how to match each landform to the corresponding poster. If students need support to record and compare their observations of the landforms, consider providing a word bank. Include words such as <i>higher</i>, <i>lower</i>, <i>taller</i>, <i>shorter</i>, <i>flatter</i>, <i>steeper</i>, <i>rougher</i>, <i>pointier</i>, <i>more jagged</i>, <i>sharper</i>, <i>bumpier</i>, <i>rounder</i>, and <i>smoother</i>.



Differentiation

Consider using the following prompts to support students in identifying and comparing certain parts of the landform posters:

- Landforms A and C both have hills. Which landform has taller hills?
- Both Landforms B and C have gray coloring. Which landform is darker gray?

LAND 5 minutes or less

Students revisit the Phenomenon Question. Students consider how their learning about Surtsey's landforms can help them begin to answer the question, and they identify gaps in their learning.

4. Prompt students to review the Phenomenon Question and to identify gaps in their learning.

Return to the Phenomenon Question **How can we describe Surtsey and the materials that make up its land?** Ask students to consider how they can use their observations and comparisons of the landforms on Surtsey to begin to answer this question.

***Listen for** students to mention properties such as shape, color, and size to describe Surtsey and its landforms. Also listen for them to mention that they can use maps to locate and identify landforms on Surtsey.*

Point out that students have used properties such as shape, color, and size to describe and compare the three Surtsey landforms they observed. 

 **What do you think causes landforms to look different from each other?**

Highlight student responses that express uncertainty. Suggest that students continue exploring the Phenomenon Question by looking at materials similar to those that make up Surtsey and its landforms.

HW Suggested Homework

Briefly highlight that students have observed and compared landforms on Surtsey, and then wonder aloud about landforms on other areas of Earth.

Have students research the landforms of an unfamiliar location on Earth or of another planet, and then have them compare those landforms with the landforms of a local area. Have students record their findings and share them with a trusted adult or friend.

Teacher Note

Earlier in Level 2, students learn that matter can be described and classified by its observable properties. Consider reviewing this learning with students and creating a class properties list that students can refer to during this lesson.



PART 2 of 3

PREPARE 20 to 25 minutes

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 2 Preparation Resource.

Samples of land materials in bags and jars (20 to 25 minutes)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 2.

SECTION	STUDENT MATERIALS	CLASS MATERIALS
Launch	None	None
Learn: Observe Samples of Land Materials	☐ Safety goggles (1 per student) ☐ Handheld magnifiers (1 per student) ☐ Prepared samples of land materials in bags and jars (1 set per 2 groups) ☐ 10" paper plates (9 per group) ☐ Science Logbook (1 per student)	☐ Safety goggles (1 for teacher) ☐ Prepared samples of land materials in bags and jars (1 set, from prepared group materials) ☐ Handheld magnifier (1, from student materials) ☐ Lesson 2 Resource E: Components of Soil ☐ Chart paper and marker for class list
Learn: Describe Surtsey's Land	☐ Science Logbook (1 per student)	☐ Posters of Surtsey's landforms (1 set, from Part 1) ☐ Class land components list (1, created in this lesson part)
Land	☐ Science Logbook (1 per student)	☐ Posters of Surtsey's landforms (1 set, from Part 1) ☐ Marker (1)

MATERIALS REUSE

The list identifies disposable and prepared materials to save for reuse in the module.

- ☐ Basalt, sandstone, and pumice rock samples in jars

LAUNCH | 5 minutes or less

Students discuss how to explore Surtsey's land materials in the classroom to help them answer the Phenomenon Question.

1. Revisit the Phenomenon Question, and have students discuss how they could learn about Surtsey's land materials.

Encourage students to consider how they could learn more about Surtsey's land. Pose a discussion question such as the following.

 **We cannot go to Surtsey to observe the materials its land is made of. How could we learn more about those materials from our classroom?**

Build on responses that highlight students observing samples of land materials in the classroom. Tell students that they will investigate samples of land materials, including the kinds of materials that make up Surtsey's land.

Tell students that in this lesson part and the next, they will continue to explore the Phenomenon Question **How can we describe Surtsey and the materials that make up its land?** as they investigate land materials.

Performance Descriptor

Use observations of land materials (SEP.6) to describe the properties of landforms (PS1.A).

Agenda | 30 to 40 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 30 minutes

- Observe Samples of Land Materials (15 to 20 minutes)
- Describe Surtsey's Land (5 to 10 minutes)

LAND | 5 minutes or less

LEARN 20 to 30 minutes**Observe Samples of Land Materials | 15 to 20 minutes**

Students observe samples of land materials and record observations in their Science Logbook. Students then read an article to learn more about land materials. Together, students create a class chart to identify rocks, soil, and sand as components of land.

2. Have students observe samples of land materials to identify their components and describe their properties.



Tell students that color, texture, flexibility, hardness, shape, and size are examples of properties of materials that they can observe and describe. Briefly introduce a set of the prepared samples of land materials in bags and jars, and then hold up a handheld magnifier.

How might a magnifier help us observe the samples of land materials?

Listen for responses that mention students using the magnifier to observe small pieces within the samples.

Review how to use a handheld magnifier, and discuss safety expectations. Pass out a pair of safety goggles and a handheld magnifier to each student. Encourage students to ask questions and provide clarification, as needed.

Safety Note

This investigation poses potential hazards. To minimize the risks, review these safety guidelines with students:

- Wear safety goggles throughout the activity.
- Do not put any sample in or near your mouth.
- If a sample spills, tell an adult right away.
- Wash your hands after the activity.

Divide the class in half, and divide each half into groups. Give half the groups a set of prepared samples of land materials in jars and the other half of groups a set of prepared samples of land materials in bags. Also give each group a set of plates. Instruct groups with samples in jars to remove each sample from its jar and place it on a separate paper plate. Instruct groups with samples in bags to transfer just a few pinches of each sample to a separate plate. As necessary, demonstrate how to neatly move a sample to a plate.



Content Area Connection: Mathematics

In this lesson, students discern the structural features of different materials by observing and describing the materials' properties. Developing the skill of discerning materials' structures helps students become more mathematically proficient in analyzing other structures, such as geometric shapes with specific attributes.

Tell students that each sample is a different land material. 

Have students observe their samples and record the properties of each material on the land materials chart in their Science Logbook. 

After students record their observations, have them return each sample to its jar or bag. 

Then have groups who have jars swap samples with groups who have bags. Instruct groups to follow the same procedure with their new set of samples. Have students record the properties of each material in the land materials chart in their Science Logbook. As students work, circulate to provide support.

Sample student response:

Land Material	Properties
1. Clay	<i>Dusty, dark brown</i>
2. Silt	<i>Soft, has tiny lumps, light brown</i>
3. Sand	<i>Made up of small rocky pieces, heavy, white, brown, and tan</i>
4. Gravel	<i>Made up of small rocks, white, brown, and tan</i>
5. Topsoil	<i>Made up of small pieces, black</i>
6. Tuff	<i>Not heavy, light tan</i>
7. Basalt	<i>Has smooth, pointy edges, black</i>
8. Sandstone	<i>Looks like pieces of sand stuck together, rough, red</i>
9. Pumice	<i>Rough, has little holes, not heavy, gray</i>

After students finish observing and recording, bring the class back together and pose the following question.

 **What did you notice about the materials you observed?**

Listen for students to identify that some of the materials are made of tiny pieces, that all of the materials have properties (texture, shape, size, color), and that the materials have different properties from each other.

Explain that the materials that students observed represent some of the components found in land.

Tell students that a **component** is one part of a whole and that land can include many components. 

Teacher Note

During this investigation, students observing differences in properties within individual land materials (i.e., different colors within the sand or gravel) may think that a sample contains multiple materials. Clarify to students that each sample contains only one material.



Differentiation

To support multilingual learners and students working below grade level, consider having students record one observable property per sample, or have them describe their observations orally.



Teacher Note

For the samples in bags, have students work in pairs to return the loose materials to their bags, with one student holding the bag open as another student pours the sample from the plate back into the bag.



Extension

Consider having students investigate the components of local soil samples to identify the kinds of materials present in the land in their area. Potential sources for these samples include the area around students' school, a local park, or a local garden.

Language Support

Introduce the term *component* explicitly. Providing the Spanish cognate *componente* may be helpful. Consider asking students to observe a pencil and identify its components.

3. As a class, read about land components and create a list to identify land components. LESSON 2 RESOURCE E

Read aloud the first paragraph of the article about sand, silt, and clay (*CLICK® Magazine* 2009). 

 **Think about what we just read. How does it change your thinking about the components of land?**

Listen for students to mention the following ideas:

- Land can be made up of rocks, soil, and sand.
- Soil is a mixture of different components, such as clay, sand, silt, and other materials.

Establish that land is made up of many different components.  

As a class, use students' land materials charts and information from the reading to build a class list of land components. Revise the list until it reflects the understanding that land is made up of rock, soil, and sand components. Explain that although soil often contains sand, there are many places on Earth that are covered in large amounts of sand. Tell students that for this reason, the class will include sand as a separate land component on the class list. 

Language Support

Students will encounter the terms *rock*, *soil*, and *sand* throughout the module. Providing the Spanish cognate for *rock* (*roca*) may be helpful. After exploration, explain that soil is made up of clay, sand, and silt, as well as water, air, and dead plants. Further explain that sand is made up of little pieces of rock and that rock is the hard material that makes up Earth's surface.

Sample class list:

Land Components

-
- Rocks
 - Soil: Clay, silt, sand, water, air, plant parts
 - Sand
-

 Extension

If time allows, consider completing the activity described in the article to allow students to observe soil layers and different components of soil directly.

 Teacher Note

Consider displaying one of the land materials in a jar or bag and pointing out that the material is just one of the many components that can make up land.

 Teacher Note

If students continue to use the term *dirt*, explain that scientists use the more precise term *soil* to refer to the uppermost layer of land. *Dirt* is commonly used to describe soil in a place it is not found naturally, such as a building. Going forward, ask students to try to use the term *soil* instead of *dirt* when discussing the components of land.

 Teacher Note

In upcoming lessons, students will study land areas that are covered in sand, such as sand dunes and shorelines. If students express curiosity or hesitance about the inclusion of sand on the class list, consider pointing out a few land areas covered in sand on the inflatable globe from Lesson 1 Part 1.

 Which of the land materials you observed are kinds of rocks? How do you know?

Highlight student responses that identify tuff, basalt, pumice, gravel, and sandstone as rocks.

Describe Surtsey's Land | 5 to 10 minutes

Students revisit the landform posters from Part 1 and identify the materials that are components of each landform. Next, students make the connection that the kinds of materials that they observed are components of the landforms on Surtsey. Students then describe the properties of Surtsey's landforms.

4. Have students use their knowledge about land materials and components to identify components of Surtsey's landforms.

 LESSON 2 ACTIVITY GUIDE B

Direct students to their Science Logbook. Explain that students will again move around the classroom to observe the posters of Surtsey's landforms. Tell students that this time, they will use their understanding of land materials to describe Surtsey's landforms in more detail and to identify the kinds of materials that are components of each landform. Encourage students to refer to their land materials chart and to the class land components list to help them. Have students return to their group from Part 1. Assign each group a poster to observe first, and instruct groups to move to their first poster.

When all groups have observed each poster, direct students' attention to their Science Logbook. Explain that students will use their learning about land materials and components to identify a claim and answer a question. Instruct students to think about the land materials they observed and the landforms on Surtsey. Direct students to the two claims in their Science Logbook, and read both claims aloud. Instruct students to choose the correct claim. Then have students answer the prompt in their Science Logbook.  

 Think about how the materials you observed relate to the landforms on Surtsey. Circle the correct claim.

- **Rocks, soil, and sand are components of the landforms on Surtsey.**
- **Rocks, soil, and sand are not components of the landforms on Surtsey.**

 Teacher Note

As students choose a claim and answer the questions, monitor for any misconceptions that the land materials students observed are from Surtsey. Remind students that the samples are similar to materials found on Surtsey.

 Teacher Note

If students need support to answer the second prompt, remind them that properties include size, shape, color, and texture.

 Describe the properties of the landforms and their components.

Look for students to use size, shape, color, and texture to describe the properties of Surtsey's landforms relating to their rock, soil, and sand components. Students may mention that Landform A has dark soil with some green plants, Landform B looks like one big gray rock, and Landform C has lots of small, round rocks.

 Check for Understanding

Use observations of land materials (SEP.6) to describe the properties of landforms (PS1.A).

EVIDENCE	NEXT STEPS
Look for indications of the following in students' Science Logbook responses: - Students use their observations of the samples (SEP.6) to identify that rocks, sand, and soil are components of Surtsey's landforms. - Students refer to properties such as the size, shape, color, and texture of the land components to describe properties of Surtsey's different landforms (PS1.A).	If students need support to confirm the claim that rocks, soil, and sand are components of the landforms on Surtsey, work with them to examine the posters. Guide them to notice the rocks and dark soil with plants on Landform A, the rocks and soil or sand on Landform B, and the rocks on Landform C. If students need support to describe Surtsey's landforms, first have them revisit the posters and prompt them to describe properties (color, shape, size, and texture) of the rocks, soil, and sand in the photographs. As needed, ask guiding questions such as, "What color are the rocks on Landform C? What are they shaped like? How big are they?" If students need vocabulary support, more scaffolded questioning may also be helpful, such as, "Are the rocks big or small? Do they look smooth or rough?" Students may also benefit from revisiting the land material samples to help them generate descriptions.

-  *Summarize students' observations to confirm that landforms are made up of different components and to highlight comparisons between Surtsey's landforms. If students need additional support to identify the components of landforms, have them revisit the posters and guide them to notice the different components, or help them identify the components of landforms around the school grounds. Also ensure that students understand that natural features, such as landforms, can be described and compared by using relative scales (e.g., bigger and smaller). To support students with using relative scales for comparison, consider having them compare objects in the classroom that are clearly different in height or size.*

LAND 5 minutes or less

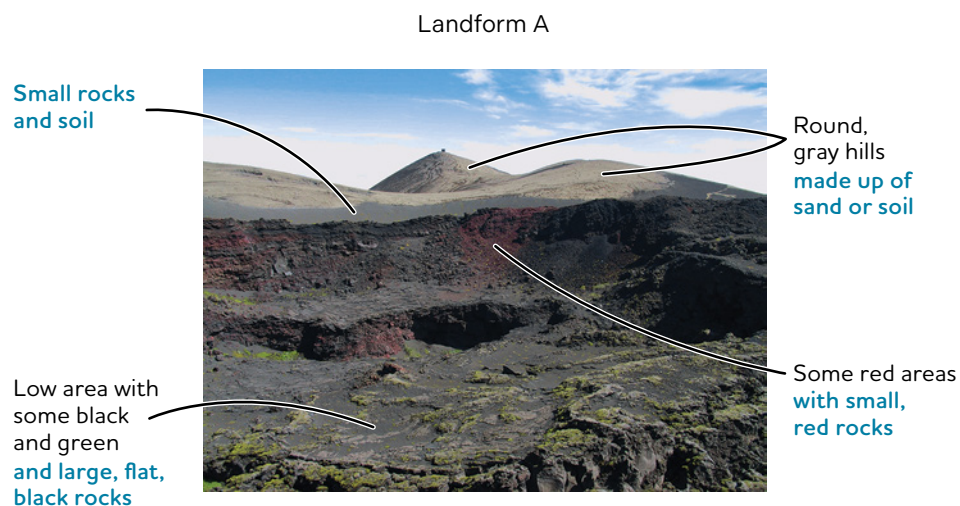
Students use their learning to update the posters of Surtsey's landforms. Students then ask other questions about Surtsey's landforms.

5. As a class, update the posters of Surtsey's landforms to show land components, and identify next steps to answer the Phenomenon Question.

 LESSON 2 ACTIVITY GUIDE B

Invite students to share their responses to the questions in their Science Logbook. Then ask students how they can use their learning to update the posters. Build on students' responses to update each poster so it includes observations and descriptions of land components. 

Sample class posters:



Teacher Note

Students may identify the dark areas in Landform A as either soil or rock.

Landform B



Landform C



Point out that all three landforms are made up of rocks and other components. Ask students to think about how the properties of rocks, soil, and sand may relate to Surtsey's changing shape.

... We observed the properties of some of the landforms on Surtsey and their components. What other questions do you have about Surtsey's land?

Build on students' responses to suggest that students explore differences in the kinds of components that make up each of Surtsey's landforms. Tell students that this exploration will help them continue to answer the Phenomenon Question **How can we describe Surtsey and the materials that make up its land?**



PART 3 of 3

PREPARE 10 to 20 minutes

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 2 Preparation Resource.

Sugar cube demonstration materials (5 to 10 minutes)

Rock test investigation materials (5 to 10 minutes)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 3.

SECTION	STUDENT MATERIALS	CLASS MATERIALS
Launch	None	☐ Lesson 2 Resource F: Photographs of Surtsey's Rocks ☐ Basalt, sandstone, and pumice rock samples in jars (1 set, from prepared group materials)
Learn: Investigate Surtsey's Rocks	☐ Prepared rock test investigation materials (1 set per group) ☐ Safety goggles (1 per student) ☐ Science Logbook (1 per student)	☐ Chart paper and marker for class chart ☐ Basalt, sandstone, and pumice rock samples in jars (1 set, from prepared group materials) ☐ Prepared sugar cube demonstration materials (1 set) ☐ Safety goggles (1 for teacher)
Learn: Support a Claim	☐ Science Logbook (1 per student)	☐ Class claim chart (1, created in this lesson part)
Land	☐ Science Logbook (1 per student)	☐ Lesson 2 Resource G: Diagram of Surtsey and Its Landforms ☐ Pocket chart, marker, and sentence strips for anchor chart

MATERIALS REUSE

The list identifies disposable and prepared materials to save for reuse in the module.

- ☐ Anchor chart, marker, and sentence strips (for all lessons)

LAUNCH 5 minutes or less

Students observe rocks similar to those that make up Surtsey's landforms. Students then consider whether rocks change and how rocks get their shape. Students identify that they need to look more closely at rocks similar to those that make up Surtsey's land to answer the Phenomenon Question.

1. Motivate students to look more closely at the components that make up Surtsey's land to determine whether those components can change over time.

 LESSON 2 RESOURCE F

Display the photographs that show different kinds of rocks that make up Surtsey's land in some areas. 



 **What do you notice about the rocks in these pictures?**

Highlight responses that mention that the rocks in the photographs differ in size, shape, color, and texture. Review that earlier, students learned that Surtsey's land is made up of many components, including rocks that have different properties. 

Performance Descriptor

Use **observations (SEP.6)** of **the properties of rocks (PS1.A)** before and after they are shaken and scratched as **evidence to explain (SEP.6) how rocks can change shape (CC.5)**.

Agenda | 30 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 30 minutes

- Investigate Surtsey's Rocks (15 to 20 minutes)
- Support a Claim (5 to 10 minutes)

LAND | 5 to 10 minutes

Teacher Note

Consider showing students additional photographs of Surtsey's rocks from *Life on Surtsey* (Burns 2017) on pages 11, 13, 36, 37, 42, and 45.

Teacher Note

Consider showing students the posters of Surtsey's landforms from the previous lesson part and highlighting the different kinds of rocks that make up Surtsey's landforms.

Display and pass around one set of the basalt, sandstone, and pumice rock samples in jars. Tell students not to open the jars. Encourage students to compare the properties of the rock samples with the properties of the rocks in the photographs.

 **Notice the properties of the rock samples. Do you think they are similar to or different from the properties of the rocks in the pictures? Why?**

Point out that the properties of the rock samples are similar to the properties of the rocks in the photographs. Tell students that some of the same kinds of rocks as the sample rocks may be present in the landforms in the photographs.

Next, have students consider the shapes of their rock samples and the shapes of the rocks in the photographs. Pose the following questions to help students think about how rocks may be shaped over time.

 **How do you think rocks get their shape?**

 **Do you think rocks can change over time?**

 **Do you think different kinds of rocks change in different ways?**

Build on this discussion to suggest that students explore how land components such as rocks are shaped to help them answer the Phenomenon Question **How can we describe Surtsey and the materials that make up its land?**

LEARN 20 to 30 minutes

Investigate Surtsey's Rocks | 15 to 20 minutes

Students observe rocks similar to those that make up Surtsey and question whether rocks change. Students investigate the properties of Surtsey's rocks by testing samples of three different rocks and recording observations of their results.

2. Introduce an investigation question and rock tests, and demonstrate how to perform the tests.

Tell students that they will further explore basalt, sandstone, and pumice rocks because they are similar to the kinds of rocks that make up Surtsey.

Inform students that they will make observations to gather evidence that helps them answer the following investigation question: Do rocks change?

Record the investigation question on a sheet of chart paper, and display the question for students to refer to throughout the lesson part.

Show students one set of the basalt, sandstone, and pumice rock samples in jars. Tell students that in groups, they will carry out two tests to investigate whether rocks can change: a shake test and a scratch test. Explain that the shake test will involve shaking each rock in its jar and that the scratch test will involve scratching each rock against sandpaper.

Show students the prepared sugar cube demonstration materials, and establish that each sugar cube represents a rock. 🧠

Demonstrate how to conduct the shake test by shaking the jar with the sugar cube inside for at least 30 seconds. Pass the closed jar around the class, and ask students to observe any changes to the sugar cube. Next, demonstrate how to conduct the scratch test by rubbing the edge of the second sugar cube back and forth along the sandpaper 20 times, allowing pieces of sugar that break off to fall onto a paper plate. Ask students to observe any changes to the sugar cube.

Briefly discuss with students the kinds of observations they should make when testing the rock samples.



Language Support

Students will encounter the term *represent* throughout the module. Providing the Spanish cognate *representar* may be helpful. Explain that scientists sometimes use different items to represent, or show, what they are studying. For example, the sugar cube in the current demonstration represents a rock.

 How might the two tests show what can happen to rocks in the natural world?

Listen for students to suggest that the tests could show how rocks change shape or size when they bump against other objects.

Divide the class into the same groups they worked in during the previous lesson part, and give each group a set of materials for the rock tests. Pass out safety goggles to each student. 

 Safety Note

This investigation poses potential hazards. To minimize the risks, review these safety guidelines:

- Wear safety goggles throughout the activity.
- Do not put any rocks or rock pieces in or near your mouth.
- Do not use the sandpaper to scratch people or objects other than the rock samples.
- Wash your hands after the activity.

3. Have groups carry out rock test investigations.

 LESSON 2 ACTIVITY GUIDE C

Direct students to the chart in their Science Logbook. Tell students to draw each rock sample in the first column on the chart.

Instruct groups to carry out the shake test by shaking each jar with the rock inside for 30 seconds and then pouring the jar's contents onto a paper plate for observation. 

Tell students to draw their observations of each rock and its properties after the shake test in the second column on the chart.

Next, instruct students to place the rock on a different paper plate and to use sandpaper to scratch the rock back and forth 20 times. Tell students that after they perform the scratch test, they should draw their observations of each rock and its properties in the third column on the chart in their Science Logbook. As students work, circulate to provide support as necessary.

 Teacher Note

The scratch test in this lesson demonstrates how rocks may break apart through abrasion or other physical processes. The test should not be confused with a mineral hardness test, in which a mineral is scratched against another substance of known hardness on the Mohs scale of mineral hardness to identify it.

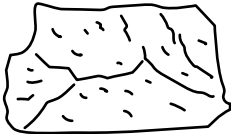
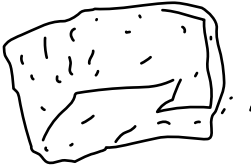
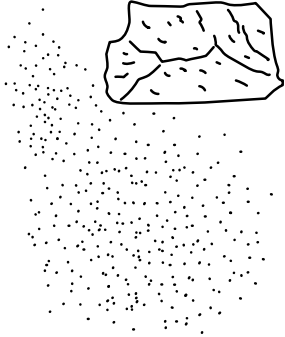
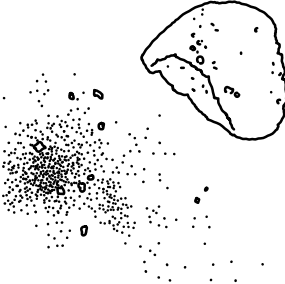
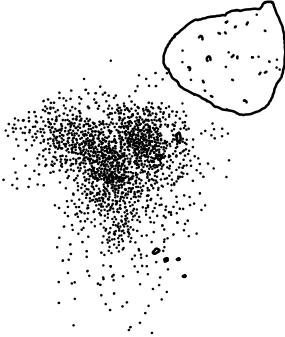
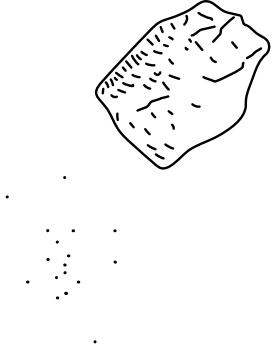
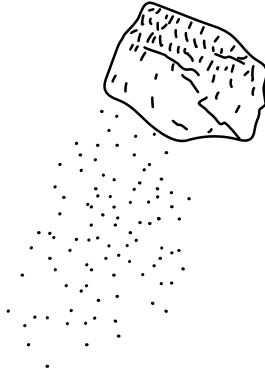
 Differentiation

Before groups begin their shake test, warn the class that shaking rocks can be loud. Some students may be sensitive to loud sounds. Consider providing these students with noise-reducing ear protection.

 Teacher Note

Consider providing a visual timer to help students keep track of how long they shake each rock.

Sample student response:

Rock Sample	Before Tests	After Shake Test	After Scratch Test
Basalt			
Pumice			
Sandstone			

After groups complete both tests, ask them to place each of their rock samples next to their paper plates from the shake and scratch tests. Have groups participate in a Gallery Walk to observe and compare their results. 📋

Support a Claim | 5 to 10 minutes

Students use their observations of rocks to respond to the investigation question. Students then consider the class claim that rocks can change. Students compare their observations of rocks before the shake and scratch tests and after the tests to identify differences in the rocks' properties. Finally, students use evidence from their observations of how the rocks' properties changed to support the class claim.

4. Have students use observations of their rocks before and after the rock tests to respond to the investigation question and to support a class claim that rocks can change.

LESSON 2 ACTIVITY GUIDE C

Bring the class back together, and remind students of the investigation question: Do rocks change?

Prompt students to share their response to the investigation question and to support their thinking with evidence from the rock tests.

Then pose the following discussion questions.

 **Think about the properties of the rocks before the shake test. Think about their properties after the shake test. What do you notice?**

 **Think about the properties of the rocks before the scratch test. Think about their properties after the scratch test. What do you notice?**

Listen for students to describe how the rocks' properties changed as a result of the shake and scratch tests. Students may list the following changes in properties:

- The rocks changed in texture from jagged to smooth or from smooth to jagged.
- The rocks changed in size from larger to smaller.
- Parts of the rocks broke into smaller pieces during each test.

Teacher Note

A Gallery Walk is a written response routine that deepens student engagement and understanding. Students display their work around the room or at workstations and then circulate to view, discuss, and record observations about one another's work.

Summarize students' findings by making the following class claim: Rocks can change. Write this claim on the sheet of chart paper, under the investigation question. Then have students discuss the following questions with a partner.

 **Did the shake test change all the rocks in the same way?**

 **Did the scratch test change all the rocks in the same way?**

Confirm that the rocks that students tested changed in different ways.

 **Why do you think the rocks changed in different ways?**

Listen for students to suggest that the rocks changed in different ways because they have different properties.

Next, tell students that they will use their observations of the rocks to support the class claim. Explain that to support the class claim, student pairs will choose two observations that provide evidence that the rocks' properties changed because of the tests. Instruct students to record their observations in their Science Logbook. Then have students record an explanation of how each observation provides evidence that supports the claim. Circulate to support students as they use their observations to develop explanations. 

After students finish recording, invite volunteers to share one observation and their explanation.

Look and listen for responses that mention one of the following ideas:

- After the tests, the rocks became smaller, their edges became smoother or more jagged, and pieces broke off.
- The observation supports the class claim because it shows that rocks can change from bigger to smaller, change from jagged to smooth or from smooth to jagged, or change in shape.

- ✓ As students share an observation and an explanation to support the class claim that rocks can change, ensure that students describe specific properties of their rocks before and after the shake and scratch tests. To provide additional support, ask students to focus on the property of shape as they describe the rocks before and after the tests, and point out the differences in shape that students describe.

Content Area Connection: **English**

If students need additional practice with Grade 2 writing standards, consider having them write an opinion piece about the class claim: Rocks can change. Students' use of explanations that include the linking word *because* will help them meet Grade 2 writing expectations. By crafting an introduction that states the claim and a conclusion that summarizes the information they gathered during the investigation, students will practice writing a well-supported opinion paragraph.

**Check for Understanding**

Use observations (SEP.6) of **the properties of rocks (PS1.A)** before and after they are shaken and scratched as **evidence to explain (SEP.6) how rocks can change shape (CC.5)**.

Evidence	Next Steps
Look and listen for indications of the following in students' observations and explanations: - Students use their observations from the shake and scratch rock tests as evidence to support the class claim (SEP. 6). - Students' explanations describe how the properties of the rocks changed as a result of the shake and scratch rock tests (PS1.A). - Students' cite evidence of rocks breaking into smaller pieces or changing size or shape to support the class claim that rocks can change (CC.5).	If students need support to identify and explain observations that support the class claim, consider reviewing the properties the class discussed earlier in the lesson. As necessary, pose questions such as these: - How did the rock tests change the rocks? - After the tests, what was different about the properties of the rocks? - Did you notice that not all the rocks changed in the same way? What differences did you notice?

LAND 5 to 10 minutes

Students observe a diagram of Surtsey and its landforms. Students share observations of the landforms and describe their properties and the properties of their components. Students use their knowledge about the properties of Surtsey's land and its components to answer the Phenomenon Question. Students then update the class anchor model, begin a class anchor chart, and update their Knowledge Tracker.

5. Have students observe the diagram of Surtsey and its landforms, and prompt students to answer the Phenomenon Question.

**LESSON 2 RESOURCE G**

Display the diagram of Surtsey and its landforms. Explain that the photographs on the diagram are the same photographs that students observed on the posters of Surtsey's landforms earlier in the lesson. Use a Whip Around routine to elicit responses about students' observations of the land in each photograph.

**Teacher Note**

A Whip Around is a collaborative conversation routine that gives each student an opportunity to respond to a question or prompt. Students share their responses one after another until they have all participated. Students with a response similar to another student's may show they agree by using a nonverbal signal, such as a thumbs-up, instead of repeating a response.

As students share, annotate the diagram by adding their observations to it. 📝

Then ask students to use their observations to respond to the following question.

💬 **How can we describe the components of each landform?**

Listen for students to identify properties of the components of the landforms in the photographs. Students may mention that some landforms have large, round rocks and tall hills, while other landforms have rocks of different colors or have soil and sand.

After students describe the landform components in each photograph, read aloud the caption below each photograph. Explain that the crater photograph shows one of the volcanic craters on Surtsey where eruptions happened. Point out that the large, round rocks on the spit are called boulders. 🗣️

Tell students that tuff rocks make up part of the sea cliff. 📝

Answer any questions students have about the landforms in the photographs and the captions. Then return to the Phenomenon Question **How can we describe Surtsey and the materials that make up its land?** Invite students to share their responses to this question.

Listen for student responses to identify that Surtsey can be described by its different landforms and by the shape and components of its land.

Use students' responses to distill the key learning that Surtsey's land is made up of rocks, soil, and sand and that the land's shape is determined by the properties of Surtsey's many landforms and of their components.

6. Work with students to update the class anchor model, and have students reflect on their new learning about Surtsey's land.

Tell students that they will update the class anchor model. Ask students to reflect on their learning about Surtsey's land and its components. Use students' suggestions to update the anchor model.

📝 Teacher Note

These annotations may be made in a variety of ways. For example, depending on your personal preference and the classroom technology available, you may opt to project or print Lesson 2 Resource G and then annotate by hand, or you may opt to add the annotations digitally.

🗣️ Language Support

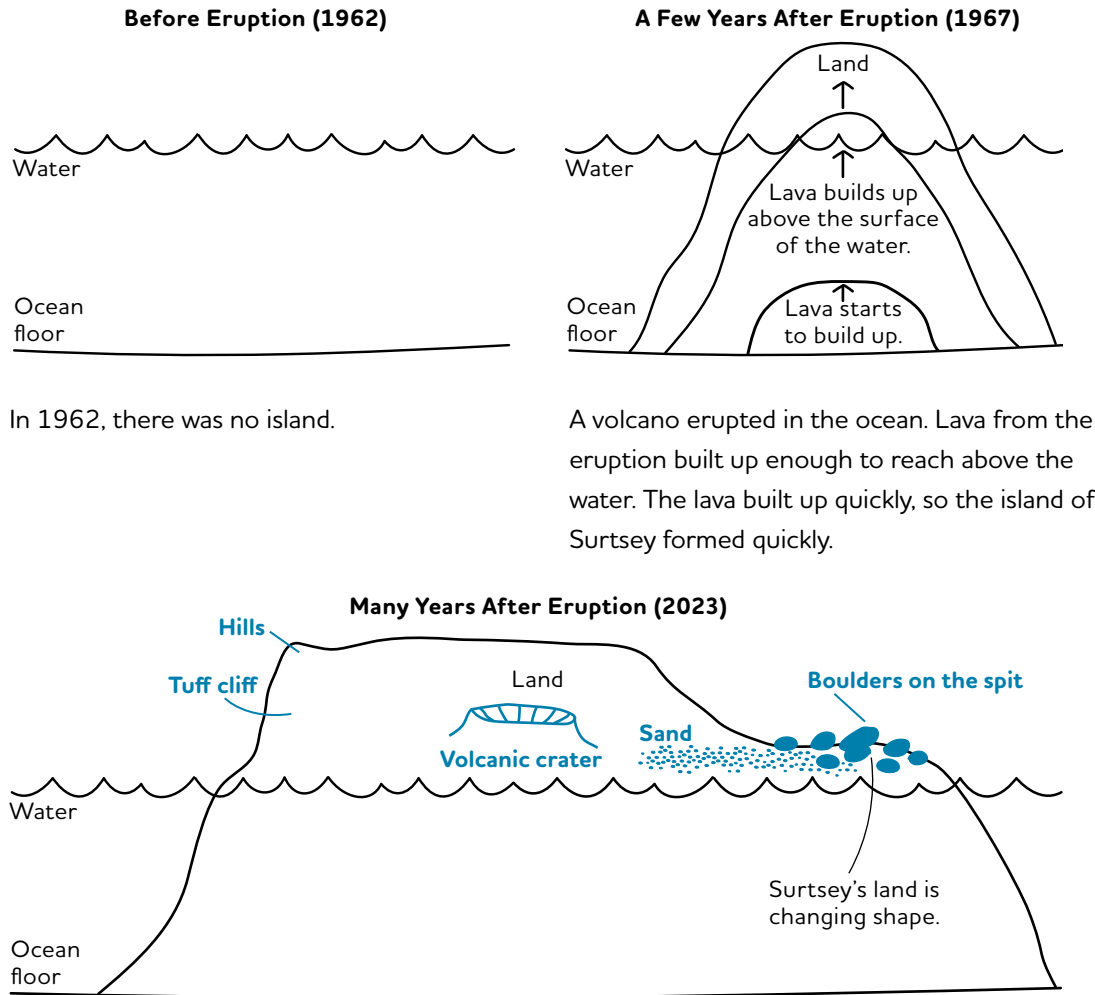
Students will encounter the term *spit* throughout the module. Explain that a spit is a small point or narrow band of land that is usually made up of sand or gravel. Explicitly show student the spit in the photographs of Surtsey.

📝 Teacher Note

Consider displaying the tuff rock sample from the previous lesson part and describing its relationship with the rock in the photograph of the sea cliff.

Sample anchor model:

How can the island of Surtsey change shape over time?



In 1962, there was no island.

A volcano erupted in the ocean. Lava from the eruption built up enough to reach above the water. The lava built up quickly, so the island of Surtsey formed quickly.

The natural features of Surtsey's land are hills, cliffs, craters, and a spit. Surtsey's land is made up of rocks, soil, and sand. Some landforms have different properties than others. Surtsey's shape is changing over time, and some parts are changing more than others. We do not know why yet.

7. Work with students to begin a class anchor chart.

Tell students that they will begin a class anchor chart that captures their learning throughout the module. Have students share what they have learned so far about the shape and components of land. Summarize students' responses on sentence strips, and place the sentence strips on the anchor chart.

Sample anchor chart:

Earth Changes

The Components and Shape of Land

- Land can have many different shapes.
- Rocks, soil, and sand are components of land.
- The shape and size of land can change.

8. Have students update the Knowledge Tracker in their Science Logbook to reflect on what they learned in this lesson.

Ask students to think about what they figured out during this lesson. Then tell students to consider how that new knowledge may help them answer the Driving Question: **How can the island of Surtsey change shape over time?** Have students record their ideas in the appropriate section of their Knowledge Tracker. 



Differentiation

As students connect what they have learned in this lesson back to the Driving Question, they may benefit from prompts such as the following:

- What new information did you learn in this lesson? How does that information remind you of the anchor phenomenon?
- How is the phenomenon we explored in this lesson similar to the anchor phenomenon?

HW Suggested Homework

Briefly review that students have performed both a shake test and a scratch test on rocks.

Have students find rocks near their home or school and place them in a plastic container with a lid. Ask students to conduct a shake test or scratch test with the rocks and observe what happens to the rocks' properties. Have students record their results and share them with a trusted adult or friend.

Lesson 2

PREPARATION RESOURCE

PART 1 of 3

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- ☐ Chart paper sheets (3)
- ☐ Lesson 2 Resource A: World Map
- ☐ Lesson 2 Resource B: Elevation Diagram
- ☐ Lesson 2 Resource C: Map of Surtsey's Landforms
- ☐ Lesson 2 Resource D: Posters of Surtsey's Landforms
- ☐ Marker (1)
- ☐ Printer access
- ☐ Scissors (1)
- ☐ Tape

PREPARATION

Complete the following tasks to prepare for this lesson part. Module resources needed for preparation follow this preparation resource.

Interactive Model of Surtsey | 5 minutes or less

Instructions: Access the 2023 3D interactive model of Surtsey from the Icelandic Institute of Natural History (<http://phdsci.link/1584>) to use during the lesson part.

Posters of Surtsey's Landforms | 5 to 10 minutes

Materials

- | | | |
|--|---|-------------------------------|
| ☐ Chart paper sheets (3) | ☐ Printer access | ☐ Tape |
| ☐ Lesson 2 Resource D: Posters of Surtsey's Landforms | ☐ Scissors (1) | |

Instructions

1. Print and cut out a copy of each labeled landform photograph in Lesson 2 Resource D.
2. Attach each labeled landform photograph to one sheet of chart paper. Leave enough room on the chart paper to record class observations during the lesson part.
3. Display each poster in a different area of the classroom.

Note: Keep the posters displayed in three different areas after the lesson part. The posters will be used again in Part 2.

PART 2 of 3

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available. This lesson part involves setting up samples of land materials. In Part 2, half the groups observe the prepared samples in jars while the other half observes the prepared samples in bags. After the first round of observations, groups who have jars will swap samples with groups who have bags. In Part 3, each group will need a set of 3 of the 4 rock samples observed in Part 2: basalt, sandstone, and pumice. All rock samples will be prepared before Part 2. Note that the class needs 3 jars for each group for the basalt, sandstone, and pumice rock samples as well as 1 jar for every 2 groups for the tuff rock samples.

- | | | |
|---|--|---|
| ☐ 1 tbsp measuring spoon (1) | ☐ Digital camera (1, optional) | ☐ Safety goggles (1 per student, plus 1 for teacher) |
| ☐ 1 qt resealable plastic bags (5 per 2 groups) | ☐ Disposable gloves (1 pair for teacher) | ☐ Sandstone rock sample (1 per group) |
| ☐ 4 oz clear plastic jars with lids (3 per group, plus 1 per 2 groups) | ☐ Gravel (1 tbsp per 2 groups) | ☐ Silt (1 tbsp per 2 groups) |
| ☐ 10" paper plates (9 per group) | ☐ Handheld magnifiers (1 per student) | ☐ Tape |
| ☐ Basalt rock sample (1 per group) | ☐ Lesson 2 Resource E: Components of Soil | ☐ Topsoil (1 tbsp per 2 groups) |
| ☐ Chart paper and marker for class list | ☐ Permanent marker (1) | ☐ Tuff rock sample (1 per 2 groups) |
| ☐ Clay (1 tbsp per 2 groups) | ☐ Posters of Surtsey's landforms (1 set, from Part 1) | ☐ Water access (optional) |
| ☐ Coarse sand (1 tbsp per 2 groups) | ☐ Pumice rock sample (1 per group) | |

PREPARATION

Complete the following tasks to prepare for this lesson part.

Samples of Land Materials in Bags and Jars | 20 to 25 minutes

Prepare 1 set of samples in bags for every 2 groups. Prepare 1 set of tuff rock samples in jars for every 2 groups. Prepare 1 set of basalt, sandstone, and pumice rock samples in jars for each group.

Teacher Safety Note: Work in a well-ventilated area and wear protective eyewear and disposable gloves while preparing materials for land materials in bags and jars.

Materials

- | | | |
|--|---|--|
| ☐ 1 tbsp measuring spoon (1) | ☐ Coarse sand (1 tbsp per 2 groups) | ☐ Safety goggles (1 for teacher) |
| ☐ 1 qt resealable plastic bags (5 per 2 groups) | ☐ Digital camera (1, optional) | ☐ Sandstone rock sample (1 per group) |
| ☐ 4 oz clear plastic jars with lids (3 per groups, plus 1 per 2 groups) | ☐ Disposable gloves (1 pair for teacher) | ☐ Silt (1 tbsp per 2 groups) |
| ☐ Basalt rock sample (1 per group) | ☐ Gravel (1 tbsp per 2 groups) | ☐ Tape |
| ☐ Clay (1 tbsp per 2 groups) | ☐ Permanent marker (1) | ☐ Topsoil (1 tbsp per 2 groups) |
| | ☐ Pumice rock sample (1 per group) | ☐ Tuff rock sample (1 per 2 groups) |

Instructions

1. For every 2 groups, measure 1 tbsp each of clay, sand, silt, gravel, and topsoil, and place each sample into a separate bag. Use a permanent marker to label each bag with the name and number of the sample it contains.
 - a. Sample 1: Clay
 - b. Sample 2: Silt
 - c. Sample 3: Sand
 - d. Sample 4: Gravel
 - e. Sample 5: Topsoil



2. Place each sample of tuff, basalt, sandstone, and pumice into a separate jar. Seal the jars, and then use tape and a permanent marker to label each jar with the name and number of the sample it contains.
 - a. Sample 6: Tuff
 - b. Sample 7: Basalt
 - c. Sample 8: Sandstone
 - d. Sample 9: Pumice

Note: that the appearance of rock samples from different suppliers may vary, even among samples of the same type of rock. If the variation is significant, consider taking photographs of the rock samples in groups before placing them in jars. Label each photograph with the name and number of the sample it shows, and display the photographs for students during Parts 2 and 3 of this lesson.



3. Gather the prepared samples of land materials in bags into 1 set per 2 groups. Gather the prepared tuff rock samples in jars and half the prepared basalt, sandstone, and pumice rock samples in jars into 1 set per 2 groups. Prepare to distribute the materials during the lesson part.

Note: Set aside the remaining half of the prepared basalt, sandstone, and pumice rock samples in jars for use in Part 3.

PART 3 of 3

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- | | | |
|---|---|--|
| ☐ 3" × 3" medium grit sandpaper (3 per group, plus 1) | ☐ Lesson 2 Resource G: Diagram of Surtsey and Its Landforms | ☐ Sandstone rock sample in jar (1 per group, from Part 2) |
| ☐ 4 oz clear plastic jar with lid (1) | ☐ 10" paper plates (6 per group, plus 1) | ☐ Safety goggles (1 per student, plus 1 for teacher) |
| ☐ Basalt rock sample in jar (1 per group, from Part 2) | ☐ Permanent marker (1) | ☐ Sugar cubes (2) |
| ☐ Chart paper and marker for class chart | ☐ Pocket chart, marker, and sentence strips for anchor chart | |
| ☐ Lesson 2 Resource F: Photographs of Surtsey's Rocks | ☐ Pumice rock sample in jar (1 per group, from Part 2) | |

PREPARATION

Complete the following tasks to prepare for this lesson part.

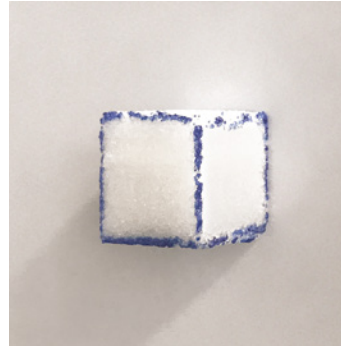
Sugar Cube Demonstration Materials | 5 to 10 minutes

Materials

-
- | | | |
|--|---|--|
| ☐ 3" × 3" medium grit sandpaper (1) | ☐ 10" paper plates (1) | ☐ Sugar cubes (2) |
| ☐ 4 oz clear plastic jar with lid (1) | ☐ Permanent marker (1) | |

Instructions

1. Use a permanent marker to color the edges of each sugar cube.
2. Place one sugar cube in a jar, and seal the jar.
3. Place the second sugar cube and the sandpaper on a paper plate.
4. Have the prepared materials ready to use for the demonstration during the lesson part.

**Rock Test Investigation Materials | 5 to 10 minutes****Materials**

-
- | | | |
|---|--|---|
| ☐ 3" × 3" medium grit sandpaper
(3 per group) | ☐ Basalt rock sample in jar
(1 per group, from Part 2) | ☐ Sandstone rock sample in jar
(1 per group, from Part 2) |
| ☐ 10" paper plates (6 per group) | ☐ Pumice rock sample in jar
(1 per group, from Part 2) | |

Instructions: Gather the materials into 1 set per group. Prepare to distribute a set of materials to each group during the lesson part.

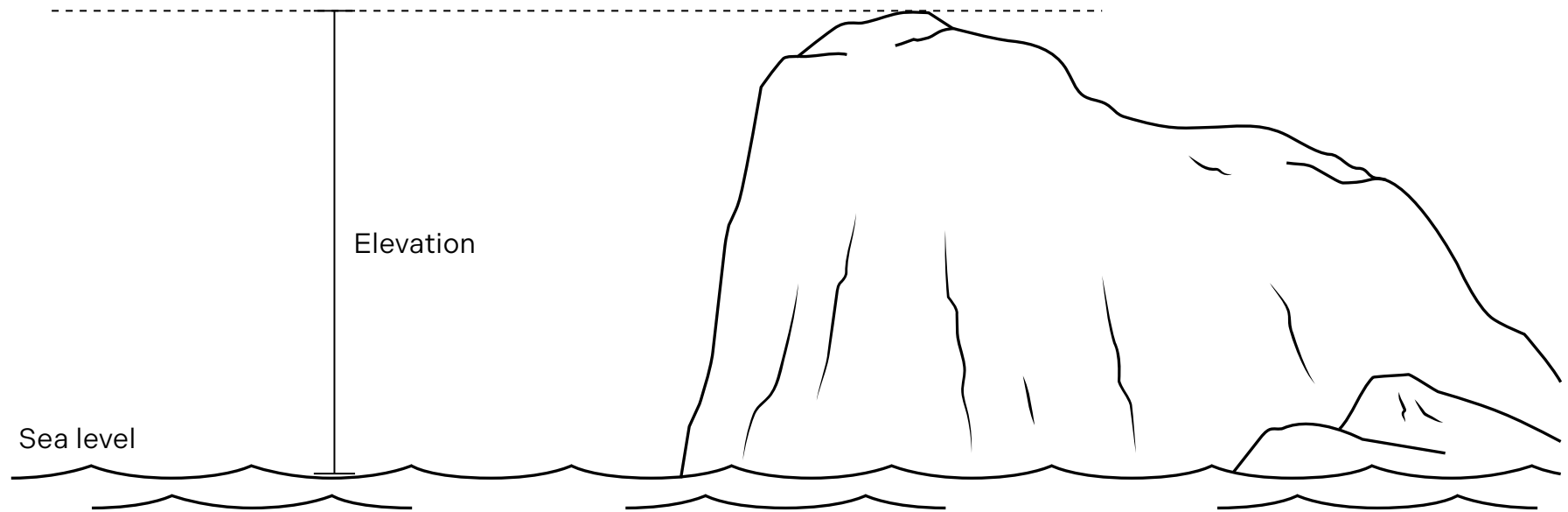
Lesson 2 Resource A

WORLD MAP



Lesson 2 Resource B

ELEVATION DIAGRAM



Lesson 2 Resource C

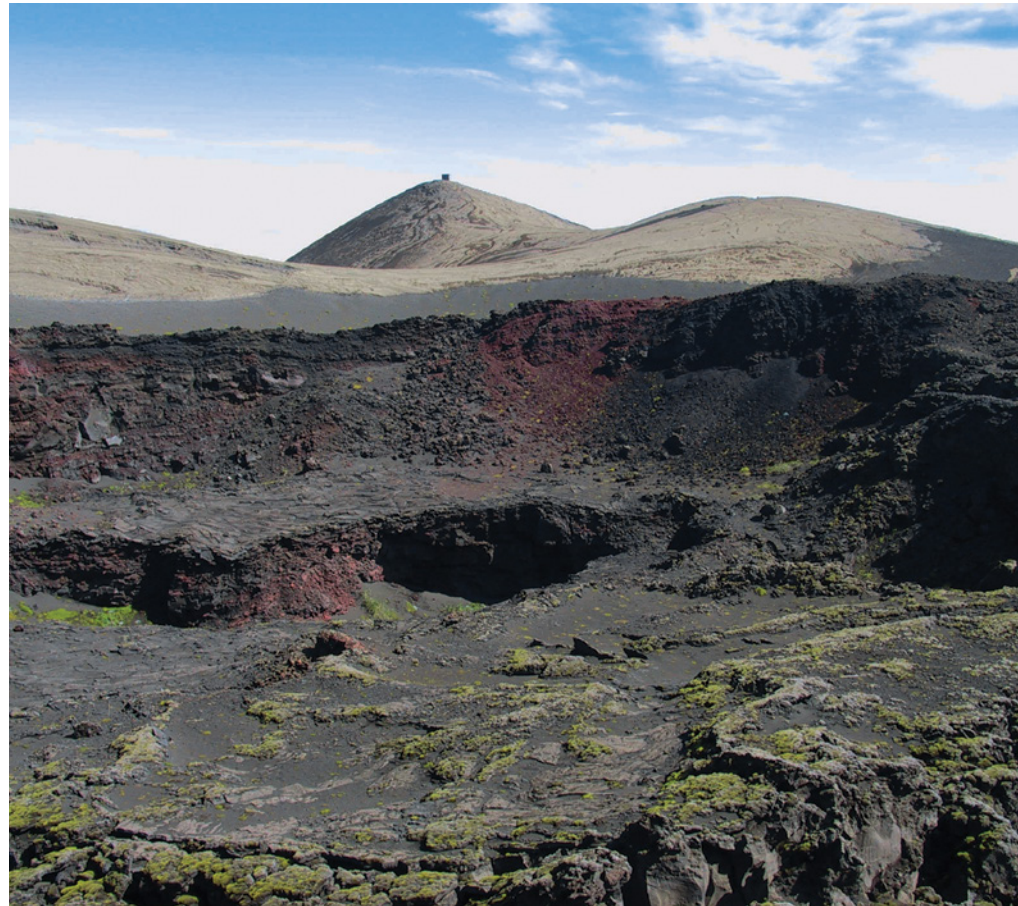
MAP OF SURTSEY'S LANDFORMS



Lesson 2 Resource D

POSTERS OF SURTSEY'S LANDFORMS

Landform A



Landform B



Landform C



Lesson 2 Resource E

COMPONENTS OF SOIL

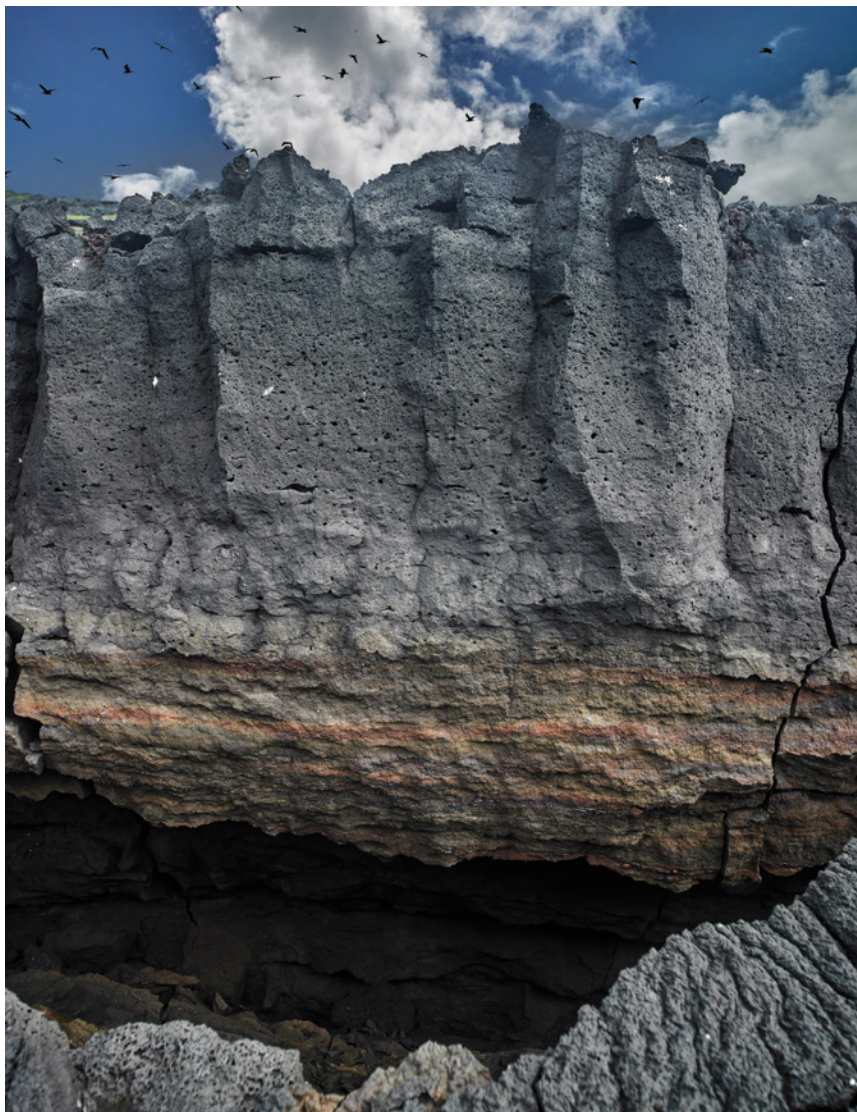
Adapted from "Sand, Silt, and Clay" (*CLICK® Magazine* 2009, 12–13)

Rocks and soil don't look or feel much alike. But soil is really just tiny pieces of rock mixed with bits of dead plants, water, and air. Those tiny rocks are called sand, silt, or clay, depending on their size. In soil, they're usually all mixed together, but you can separate them.

1. Get a large, clean, clear jar with a tight-fitting lid and fill it about halfway with soil. Take out any big twigs or stones, and break up the large lumps.
2. Fill the jar with water and add a teaspoon of dishwashing soap.
3. Screw the lid on, and shake the jar until everything is mixed.
4. Put the jar down, and wait a minute or two. What do you see?
5. Check the jar again in a few hours. Did anything change? The different sizes of rock should form layers in your jar.

Lesson 2 Resource F

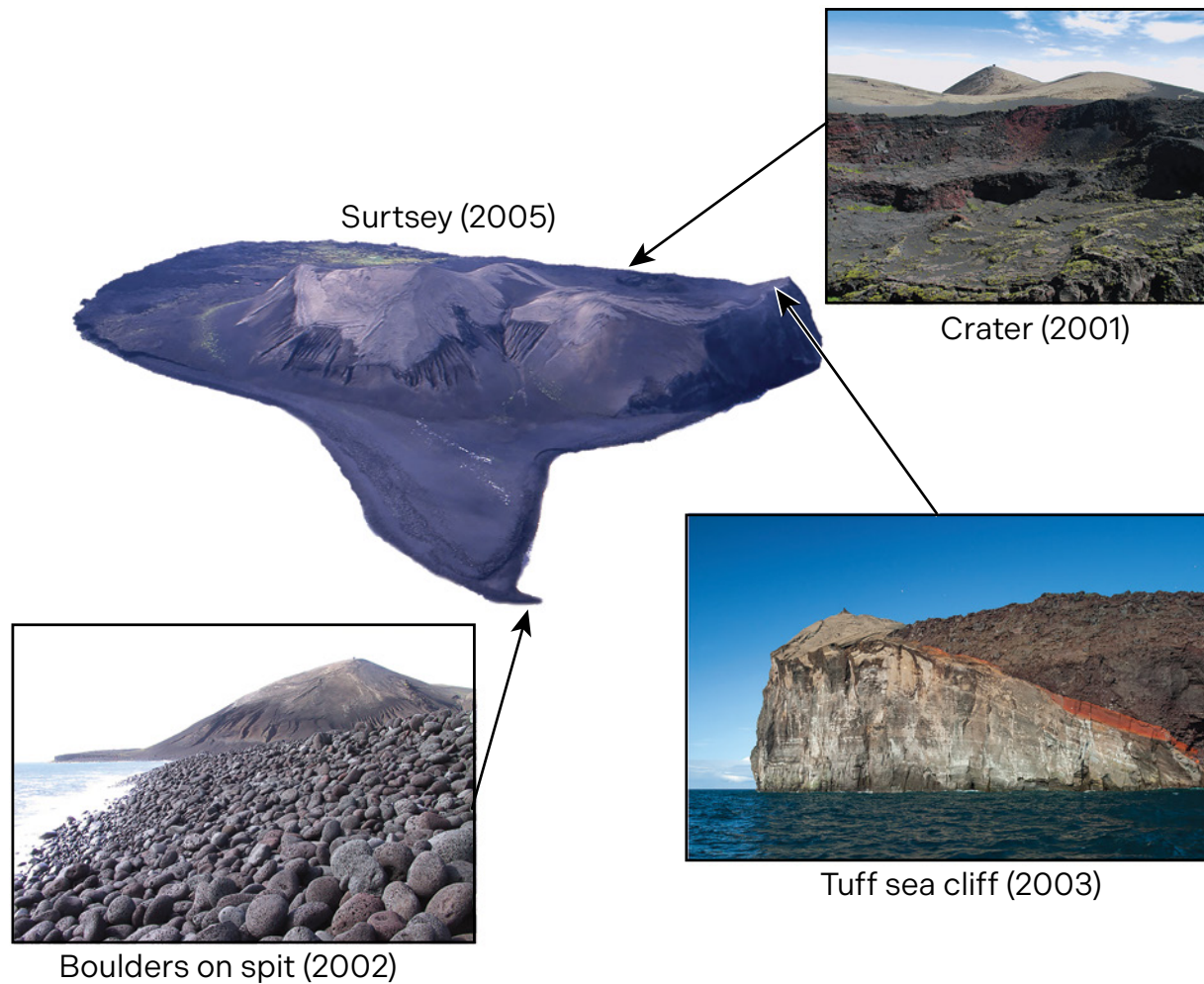
PHOTOGRAPHS OF SURTSEY'S ROCKS





Lesson 2 Resource G

DIAGRAM OF SURTSEY AND ITS LANDFORMS





Concept 1 | The Components and Shape of Land

LESSON 3 LAND CHANGES

Lesson Phenomenon | Changes to the shape of Surtsey's land over time

Phenomenon Question | What can cause Surtsey's land to change?

OVERVIEW

Previously we described Surtsey's land by identifying and labeling different landforms and their components. We investigated the properties of different land materials to figure out more about the components that make up Surtsey's land, and we shook and scratched rocks to explore the ways rocks can change. We identified that rocks and landforms on Surtsey can change size and shape.

In this lesson we use a data table with pictures and measurements to identify changes to Surtsey's land. We use these observations, as well as our observations of a video clip, as evidence to develop a claim that wind, water, or both wind and water can cause changes to Surtsey's land. Next, we use models to investigate that claim. We then use our investigation results as evidence to develop an argument that wind or water is causing Surtsey's land to change over time.

Later we will apply our learning to a new phenomenon as we complete a Conceptual Checkpoint.

Lesson Objective

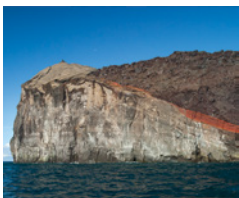
Use **relative scales (CC.3)** as evidence to **develop an argument (SEP.7)** that **wind and water change land (ESS2.A)**.

Performance Descriptors

- Part 1: **Use observations of visuals (SEP.4)** that **compare Surtsey's land over time (CC.3)** to describe how **wind and water change land (ESS2.A)**.
- Part 2: **Compare a model before air is blown and a model after air is blown (SEP.2)** to describe **the effects of wind (ESS2.A)** on **the size and shape (CC.3)** of **land (ESS2.A)**.
- Part 3: **Develop and use models to represent (SEP.2)** how **water changes land (ESS2.A)** by **using relative scales to describe how land differs in shape (CC.3)**.
- Part 4: **Develop an argument (SEP.7)** to support a claim that **wind or water changes land (ESS2.A)** by **using relative scales to describe changes to land (CC.3)**.

STANDARDS ADDRESSED

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.2: Developing and Using Models • Compare models to identify common features and differences. • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). SEP.4: Analyzing and Interpreting Data • Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. SEP.7: Engaging in Argument from Evidence • Construct an argument with evidence to support a claim.	ESS2.A: Earth Materials and Systems • Wind and water can change the shape of the land.	CC.3: Scale, Proportion, and Quantity • Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).



PART 1 of 4

PREPARE 5 minutes or less

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 3 Preparation Resource.

Video (5 minutes or less)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 1.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	None	☐ <i>Life on Surtsey</i> (Burns 2017) (1)	The list identifies disposable and prepared materials to save for reuse in the module. ☐ Class video observations chart
Learn: Observe Images of Surtsey and Examine Measurement Data	☐ Science Logbook (1 per student)	None	
Learn: Discuss Changes to Surtsey's Land	☐ Science Logbook (1 per student)	☐ Chart paper and marker for class chart	
Land	None	None	

LAUNCH **5 minutes or less**

Students observe an image that shows aerial views of Surtsey at two different points in time. Students begin to wonder about how Surtsey's land has changed.

1. Have students compare aerial views of Surtsey at two different points in time.

Display the image on page 7 of *Life on Surtsey* (Burns 2017). Tell students that the image shows one photograph of Surtsey on top of another photograph of Surtsey. Specify that the black-and-white photograph shows an aerial view of Surtsey in 1967 and that the red photograph shows an aerial view of Surtsey in 2014. Draw students' attention to Surtsey's size and shape in each aerial view.

 **What does this picture show us about Surtsey's land?**

Listen for students to mention the following ideas:

- The red part of the image is much smaller than the black-and-white part of the image.
- Surtsey has changed shape and has become smaller in size.

Confirm that the image shows that Surtsey's size and shape changed in the 47 years between 1967 and 2014. Remind students that Surtsey's land is made up of different kinds of rocks. Ask students to think about their previous investigations as they consider what might be causing Surtsey to change.

 **Something is happening that is causing Surtsey's land to change. What do you think is happening?**

Listen for students to suggest that something may be shaking the rocks or scratching against them to cause changes similar to the changes that students observed in the shake and scratch tests.

2. Work with students to develop the Phenomenon Question.

Ask students what questions they could explore to help them explain what is causing Surtsey's land to change. Highlight responses that mention examining different parts of Surtsey's land to determine what is causing changes to specific landforms.

Summarize students' questions to develop the Phenomenon Question **What can cause Surtsey's land to change?** Record relevant student questions on the Driving Question board.

Performance Descriptor

Use observations of visuals (SEP.4) that **compare Surtsey's land over time (CC.3)** to describe how **wind and water change land (ESS2.A)**.

Agenda | 30 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 35 minutes

- Observe Images of Surtsey and Examine Measurement Data (10 to 20 minutes)
- Discuss Changes to Surtsey's Land (10 to 15 minutes)

LAND | 5 minutes or less

LEARN 20 to 35 minutes

Observe Images of Surtsey and Examine Measurement Data | 10 to 20 minutes

Students look at data charts to observe images of Surtsey and its landforms and to examine measurement data. Students record observations about changes to Surtsey over time and share their observations with the class. They agree that they have evidence that Surtsey's land and landforms are changing.

3. Have students observe images and examine measurement data to look for evidence of changes to Surtsey.

 LESSON 3 ACTIVITY GUIDE A

Review that students observed several images and videos as they learned about Surtsey's land. Have students discuss other ways they could learn about Surtsey.

 **Think about the kinds of details we have learned about Surtsey. What other kinds of details could tell us more about Surtsey?**

 **What kinds of details about Surtsey might be important?**

 **What are details about Surtsey that we cannot learn from pictures and videos?**

Point out that using data could help students investigate what is causing Surtsey's land to change. Ask students to think about the ways in which they have observed and used data to help explain other phenomena. Encourage volunteers to share their experiences. 

 **What kinds of data could help us explore changes to Surtsey?**

Listen for *students to mention that they could use measurements of Surtsey and its landforms to learn more about how the island is changing over time.*

Direct students to the Surtsey data charts in their Science Logbook. Point out that the charts show information about Surtsey's shape, its size, its elevation, and the components that make up the land of its spit, such as sand and boulders (Baldursson and Ingadóttir 2007). Show students that each feature in the charts has descriptions or images from two points in time. Tell students that many years separate the points in time for each feature. 

Teacher Note

To remind students that data can contain numbers, consider reviewing examples of classroom activities in which students have collected or analyzed numerical data.

Extension

Consider having students work in pairs or independently to explore other areas of Surtsey by researching components of its land and finding measurement data, such as the elevation, size, and shape of its landforms.

How can measurement data give us evidence of changes to Surtsey?

Confirm that comparing measurements of a landform from different points in time can provide evidence of changes in its size or shape. Specify that if two measurements are very similar, that similarity indicates that the landform has not changed much.

Have students work with a partner to discuss the information in the data charts. Then ask students to record in their Science Logbook one observation about each feature.

Sample student response:

Shape: *The top part of the island got thinner and longer.*

Size: *The island was bigger in 1967 and smaller in 2004.* 

Elevation: *The elevation of Surtsey was higher in 1967 than in 2014.*

Components of the Spit: *The spit was mostly sand in 1990. But in 2016, it had smooth boulders and less sand.*

Ask students to reflect on the data in the charts and the observations they recorded. Invite volunteers to share their observations.

What did you observe about the data?

Does the data give us evidence that Surtsey's landforms are changing? What is that evidence?

Build on students' responses to establish that the shape, size, elevation, and components of Surtsey and its landforms are changing over time. Tell students that they will need to gather more information to determine what is causing Surtsey to change over time.

Differentiation

Consider providing measurements of Surtsey's area so students can use quantitative data to analyze the size of the island. In 1967, Surtsey's area was approximately 1 square mile (2.6 square kilometers). In 2004, its area was 0.5 square miles (1.3 square kilometers).

Discuss Changes to Surtsey's Land | 10 to 15 minutes

Students watch a video and observe wind and water on Surtsey. Students then use their observations from the video and from measurement data they examined earlier to develop an initial claim about what is causing Surtsey's landforms to change.

4. Play a video that shows wind and water on Surtsey, and have students develop and support a claim about what is causing Surtsey's land to change.

LESSON 3 ACTIVITY GUIDE B

Suggest that students look more closely at the natural features on and around Surtsey to figure out what is causing changes to the island. Inform students that they will watch a video to gather more information about the changes to Surtsey's land.

Tell students that the video shows a reporter and a group of researchers trying to land their boat on the shoreline of Surtsey's spit. Then explain that a shoreline is the place where land and a large body of water meet. Tell students to pay attention to what is happening near the shore as they watch the video. Play the "Surtsey, the Birth of an Island" video (<http://phdsci.link/1599>) from 1:03 to 3:05. 

Invite students to share what is happening near the shore in the video. Record students' observations on a class video observations chart.

Sample class chart:

What is happening near the shoreline?

- *There are big waves crashing into the island.*
- *Some wind is blowing onto Surtsey from the ocean.*
- *There is a lot of noise from the waves and boat.*
- *There are a lot of dark rocks and sand on the shore.*

Teacher Note

Pause the video as necessary to support students' comprehension.

Tell students that they will now make an initial claim to respond to the Phenomenon Question **What can cause Surtsey's land to change?** Remind students that a claim is a statement that answers a scientific question and describes a phenomenon. Have students work in pairs to develop and record an initial claim in their Science Logbook. Then invite volunteers to share their initial claim with the class.

Listen for initial claims that identify wind, water, or both wind and water as causes of changes to Surtsey's land.

Teacher Note

Allow students' claims to be broad. Because of the observable water interactions in the video, students may claim only that water causes changes to Surtsey's land. That is acceptable at this point.

In Part 2 of this lesson, students will encounter further evidence that wind is present on Surtsey. In Part 4, students will revisit their initial claim and make revisions if necessary.

Sample claims:

- *Wind can cause Surtsey's land to change.*
- *Water can cause Surtsey's land to change.*
- *Wind and water can cause Surtsey's land to change.*

What information do we need to support a claim?

Highlight responses that identify that students need evidence to support a claim. Remind students that in this lesson part, they observed Surtsey's land in an image showing aerial views, in data charts, and in the "Surtsey, the Birth of an Island" video. Have students work in pairs to identify examples from their observations that they could use as evidence to support their claim. Instruct students to record in their Science Logbook two pieces of evidence and to record how each piece of evidence supports their claim.

Look for students' responses to mention ideas such as the following:

- *The elevation of Surtsey was lower in 2014 than it was in 1967. Students may notice this change by observing the elevation data chart. In the video, students can hear wind. The landforms in the middle of the island are away from the water, so the lower elevation is likely due to wind.*

- The shoreline is the area where Surtsey’s land has changed the most. Students may notice this change by observing the aerial image. In the video, students can see and hear water near Surtsey’s shoreline.
- The components of the spit changed between 1990 and 2016. Students may notice this change by observing the data chart listing the components. In the video, students can hear wind and see big waves crashing against Surtsey’s spit. Wind and water could have caused the spit to become smaller and thinner.



Pre-Assessment

Use observations of visuals (SEP.4) that compare Surtsey’s land over time (CC.3) to describe how wind and water change land (ESS2.A).

EVIDENCE	NEXT STEPS
Look for the following in students’ responses: • Students use observations from images, measurement data, or a video as evidence to support their claim (SEP.4). • Students describe how wind and water can affect Surtsey’s land (ESS2.A). • Students use relative scales to provide evidence of changes to the size and shape of Surtsey’s land (CC.3).	If students need support to use their observations to make and support a claim about wind, water, or both wind and water causing changes to land, consider posing the following questions: • Think about the pictures we looked at. Which parts of Surtsey did you see change the most? • Think about what we saw in the video. What makes you think that wind and water can change Surtsey’s land? • Think about the measurement data in the charts. What data gives us evidence of Surtsey’s land changing the most?

LAND 5 minutes or less

Students review the Phenomenon Question. They decide to explore how wind and water affect land to help them answer the question.

5. Guide students to identify a gap in their learning.

Point out that students claimed that wind and water change Surtsey's land but that students need to gather more evidence to support their claims. Ask students to discuss how they can use their learning from this lesson part to begin answering the Phenomenon Question **What can cause Surtsey's land to change?** Use the following questions to guide students' discussion.

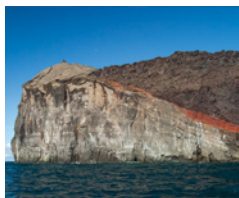
 **Have you ever seen something change because of wind or water?** 

 **How could we learn more about wind and water causing changes to Surtsey's land?**

Tell students that in the rest of this lesson, they will continue to explore the Phenomenon Question by planning an investigation to test how wind and water affect land.

Teacher Note

Consider recording students' responses to this question on sticky notes and posting the notes in the Related Phenomena section of the Driving Question board.



PART 2 of 4

PREPARE 30 to 40 minutes

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 3 Preparation Resource.

Video (5 minutes or less)

Wind model student procedure sheets (5 minutes or less)

Wind models (15 to 20 minutes)

Wind investigation materials (5 to 10 minutes)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 2.

SECTION	STUDENT MATERIALS	CLASS MATERIALS
Launch	None	☐ Lesson 3 Resource A: Photograph of Wind on Surtsey
Learn: Prepare for Wind Investigation	☐ Prepared wind model student procedure sheets (1 per group)	☐ Prepared wind models (sand, soil, and gravel) (1 of each, from prepared group materials) ☐ Handheld balloon pump (1, from prepared group materials) ☐ Medium paintbrush (1, from prepared group materials) ☐ Dry erase markers in 2 different colors (1 set, from prepared group materials) ☐ Prepared wind model student procedure sheet (1) ☐ Safety goggles (1 for teacher)
Learn: Investigate Wind and Land Interactions	☐ Prepared wind model student procedure sheets (1 per group) ☐ Prepared wind investigation materials (1 set per group) ☐ Safety goggles (1 per student) ☐ Science Logbook (1 per student)	☐ Safety goggles (1 for teacher)
Land	☐ Student wind models (1 per group, created in this lesson part)	None

MATERIALS REUSE

This list identifies disposable and prepared materials to save for reuse in the module.

- ☐ 6 qt plastic bins with holes

LAUNCH 5 minutes or less

Students view a video clip and photograph that show evidence of wind on Surtsey. Students discuss how they could investigate how wind can cause changes to Surtsey's land.

1. Have students view a video clip and photograph to identify evidence of wind on Surtsey, and wonder as a class how wind interacts with Surtsey's land.

 LESSON 3 RESOURCE A

Review the Phenomenon Question **What can cause Surtsey's land to change?** Remind students that they used their observations to claim that wind and water can change Surtsey's land.

 **How could we learn more about wind and water changing Surtsey's land?**

Suggest that students watch another clip from the "Surtsey, the Birth of an Island" video (<http://phdsci.link/1599>). Instruct students to pay attention to what the narrator says about the conditions that day. Play the video from 0:13 to 0:35. 

Then invite students to share what they learned.

Listen for students to mention that there is strong wind in the forecast and that the people may not be able to get back by boat.

Next, display the photograph of wind on Surtsey.



Performance Descriptor

Compare a model before air is blown and a model after air is blown (SEP.2) to describe **the effects of wind (ESS2.A)** on **the size and shape (CC.3)** of **land (ESS2.A)**.

Agenda | 30 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 35 minutes

- Prepare for Wind Investigation (5 to 10 minutes)
- Investigate Wind and Land Interactions (15 to 25 minutes)

LAND | 5 minutes or less

Teacher Note

Surtsey has a windy climate, with wind speeds exceeding 44 miles per hour an average of 30 days per year. Consider having students research the Beaufort wind scale to learn more about different wind speeds.

Review that in the previous lesson, students learned about some of the land components that make up Surtsey, including sand. Explain that the light tan area in the photograph shows sand on Surtsey.

Discuss connections students make between their video observations and the photograph.

 **Have you ever seen something move around like the sand in the picture?**

 **What do you think is causing the sand to move around?**

 **Think about what we learned from the video. What might explain what is happening to the sand?**

Listen for students to mention that wind is most likely causing the sand to move.

Tell students that a strong wind near one of Surtsey's craters is blowing the sand around. Point out that students also heard the narrator say there was a lot of wind and that they saw evidence of wind in the video. Summarize that students have evidence from both the video and the photograph that there are strong winds on Surtsey.

 **How can we find out more about the effects of strong wind on Surtsey's land?**

Tell students that in this lesson part, they will try to find out more about these effects.

 **We cannot travel to Surtsey to investigate how wind and land interact. How could we investigate that in our classroom?** 

Build on responses that suggest students observing other examples of wind and land interacting or students using a model. Tell students that they will use a model to investigate how wind and land interact.

Language Support

Students will encounter the term *interact* throughout the module. Providing the Spanish cognate *interactuar* may be useful. Consider having students think of examples of how they interact with their classmates.

LEARN 20 to 35 minutes

Prepare for Wind Investigation | 5 to 10 minutes

Students are introduced to the materials that they will use to investigate how wind and land interact and review the investigation procedure.

2. Introduce the materials and procedure students will use to investigate how wind and land interact.

Display one of each type of prepared wind model and a balloon pump. Identify the sand, soil, and gravel in the models. Explain that students will use the materials to model and investigate the effects of wind on land. Without placing the end of the balloon pump into a bin, demonstrate how to use the pump to produce a burst of air. 

What do you think each part of the model will represent?

Tell students that the sand, soil, and gravel each represent a different land component and that the moving air from the pump represents wind. Inform students that they will observe how the wind affects each of the land components. Remind students that in the previous lesson, they investigated materials that represented Surtsey's land components. 

Think about the components that make up Surtsey's land. How are Surtsey's land components similar to the land components we will investigate now?

Listen for students to mention that sand, soil, and rock (such as gravel) are also found in different parts of Surtsey's land.

Tell students that they will work in groups and that each group will receive sand, soil, or gravel. 

Show students a paintbrush and two dry erase markers of different colors. Explain that these are additional materials that students will use in their wind investigation. Have students think about how they could use all the investigation materials together to explore how wind and land interact.

Divide the class into groups, and give each group a prepared procedure sheet. Read the procedure aloud.

In your model, what might be evidence that wind can change land?

Listen for students to mention that they might observe wind causing the pile of sand, soil, or gravel in their model to change shape.



Differentiation

Some students may benefit from feeling the air from the balloon pump. Provide these students with a tactile experience by using the balloon pump to push air onto their palms. Then invite them to generate ideas about objects that they think the air from the pump could move or change.



Teacher Note

Consider having students review Lesson 2 Activity Guides B and C in their Science Logbook.



Teacher Note

In this investigation, students will use a single land material (sand, soil, or gravel) to investigate how wind can change land. Later in the lesson, students will use a mixture of materials (such as a mixture of sand and gravel) to represent land as they investigate the ways in which water can change land.

Confirm that students should look for evidence of the wind affecting the sand, soil, or gravel. Instruct students to observe whether the wind causes a change in the shape of the land.

Ensure that students understand that they will observe and describe the land in their model both before and after they use the pump to create wind. Students should also understand that they will then use the paintbrush to reshape the land before using the model a second time. Demonstrate how to reshape the land and how to use a dry erase marker to trace the outline of the land onto the side of the bin before and after using the pump. Tell students that they will later use the drawn lines to determine whether wind caused the land to change. 🌟

Investigate Wind and Land Interactions | 15 to 25 minutes

Students use a model to investigate how wind interacts with land. During the investigation, students follow their procedure sheet and record observations of their land before and after they blow air that represents wind. After the investigation, students discuss their observations as a class.

3. Have students complete the investigation and record and discuss their observations.

LESSON 3 ACTIVITY GUIDE C

Give each group a set of prepared wind investigation materials and each student a pair of safety goggles. Instruct students to circle their model's land component in their Science Logbook.

Safety Note

This activity poses potential hazards. To minimize the risks, review these safety guidelines with students:

- Wear safety goggles throughout the activity.
- Keep the bin covered while using the air pump.
- Do not point the air pump at others.
- If materials spill out of the bin, tell an adult right away.
- Do not use the paintbrush for anything other than moving the materials in the bin.
- Do not touch the land materials. If you touch them by accident, wash your hands after the activity.

Instruct students to begin working. Remind students to follow their procedure sheet and to record in their Science Logbook observations of the land in their model both before and after they blow wind. 📖

Spotlight on Three-Dimensional Integration

In Kindergarten, students learn that pushes and pulls can cause objects to move (PS2.A). Students may apply this learning as they consider how wind can change land (ESS2.A) by comparing the size and shape of land (CC.3) in their observations. If students need support to understand that wind can push on objects, hold up a sheet of printer paper and invite a student to use the pump to blow air against the paper.

Teacher Note

To help students keep track of their progress, consider having them draw a check mark next to each step in the procedure as they complete it.

As students work, circulate to help them read and complete the procedure and to ensure that they are using materials safely.

Teacher Note

Ensure that students do not disturb the bins after they have completed all the steps of the procedure. In the Land of this lesson part, students will participate in a Gallery Walk to observe other groups' results.

Support students by posing prompts such as these:

 **Describe your model before you blew air. Describe your model after you blew air.**

 **Do you notice any changes to the size or shape of the land?**

 **What changes did the wind cause?**

Wind model with sand sample student response:

Before Blowing Air	After Blowing Air
The sand is in a pile. It looks like a little hill.	- Some of the sand spread out and covered the bottom of the bin. - A shell is under the sand. - The sand pile is shorter.

Wind model with soil sample student response:

Before Blowing Air	After Blowing Air
There is a small hill of soil.	- Little pieces of soil blew into other parts of the bin. - The hill of soil is smaller. - A shell is under the soil.

Wind model with gravel sample student response:

Before Blowing Air	After Blowing Air
• <i>There is a pile of small rocks.</i>	• <i>A few pieces of gravel moved to the bottom of the bin.</i> • <i>The rocks spread out a bit, but the pile didn't get much smaller.</i> • <i>A shell is sticking out of the pile.</i>

Ask groups to discuss how their model before they blew air compares with their model after they blew air. Then have students work with their group to complete the summary responses in their Science Logbook. Encourage students to include evidence of changes to the size or shape of their land to support their responses. After students finish recording, invite volunteers to share their responses with the class.

 **Notice the shape of your land before you blew air. How is the shape different after you blew air?**

Listen for students to mention that their pile of land became shorter or more spread out.

 **What did the wind do to your land?**

Listen for students to mention that the wind moved some of their land to different areas and changed the shape of the land. Students may mention that the wind uncovered objects beneath the land.

**Check for Understanding**

Compare a model before air is blown and a model after air is blown (SEP.2) to describe **the effects of wind (ESS2.A)** on **the size and shape (CC.3)** of **land (ESS2.A)**.

EVIDENCE	NEXT STEPS
Look and listen for indications of the following in students' Science Logbook responses: - Students compare their model before they blew air with their model after they blew air to describe changes to land (SEP.2). - Students describe how wind affected the land in their model (ESS2.A). - Students describe changes to the size and shape of the land in their model by using relative scales (CC.3).	If students need support to identify changes to the land in their model, consider posing questions such as these: - Did your land materials change? - After you blew air, where did the land materials go? - Was anything under the land materials? - Think about the size and shape of your land before you blew air. Were they the same after you blew air?

LAND

5 minutes or less

Groups participate in a Gallery Walk to compare their observations from the wind investigation. Students reflect on their observations as a class and determine that they still need more information to understand how Surtsey's land is changing.

4. Facilitate a Gallery Walk for groups to compare their investigation observations, and have students reflect on their observations as a class.

Have groups participate in a Gallery Walk to observe other groups' results and to compare their results with other groups'. Then bring the class back together to discuss students' observations.

 **Think about the results that other groups had. How were changes to the sand, soil, and gravel similar? How were the changes different?**

Listen for students to mention ideas such as these:

- The land materials moved in all the bins.
- The land in all the models changed in size or shape.
- The size or shape of the land changed more in some models than in other models.

 **What changes to the land did you notice?**

 **What caused the changes that you observed?**

 **What happened when the wind blew over the land?**

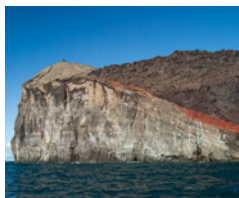
Listen for students to describe how the wind affected all the different types of land components and to mention that all groups noticed changes in the size or shape of the land in their model.

Summarize that students observed that wind can cause land to change in size and shape. Return again to students' claims that wind and water can cause land to change. Summarize that in this lesson part, students gathered evidence about the effects of wind on land. Tell students that in the next lesson part, they will gather evidence about the effects of water on land as they continue to explore the Phenomenon Question **What can cause Surtsey's land to change?**

HW Suggested Homework

Briefly review that students used models to observe how wind can change land.

As a class, brainstorm other examples of wind changing land that students may have observed. With adult supervision, have students participate in a scavenger hunt to look for examples of wind changing land in their local area. Have students draw their findings and then share their drawing with a trusted adult, a friend, or the class.



PART 3 of 4

PREPARE 45 to 60 minutes

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 3 Preparation Resource.

Video (5 minutes or less)

Wave model (10 to 15 minutes)

Wave model templates (5 minutes or less)

Wave model demonstration materials (5 minutes or less)

Rain and river model student procedure sheets (5 minutes or less)

Rain and river models (10 to 15 minutes)

Rain and river model investigation materials (5 to 10 minutes)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 3.

SECTION	STUDENT MATERIALS	CLASS MATERIALS
Launch	None	☐ Class video observations chart (1, from Part 1)
Learn: Investigate Water and Land Interactions	☐ Safety goggles (1 per student) ☐ Prepared rain and river model investigation materials (1 set per group) ☐ Science Logbook (1 per student)	☐ Prepared wave model demonstration materials (1 set) ☐ Safety goggles (1 for teacher) ☐ Prepared river model (1, from prepared group materials) ☐ Prepared rain model (1, from prepared group materials) ☐ Prepared rain and river model student procedure sheets (1 set)
Land	Science Logbook (1 per student)	None

MATERIALS REUSE

The list identifies disposable and prepared materials to save for reuse in the module.

- ☐ 6 qt plastic bins with holes

LAUNCH 5 minutes or less

Students review their learning and determine that they need to investigate interactions that happen between water and land.

1. Review students' prior learning, and help students identify the need to investigate water and land interactions.

Ask students to consider how they can use the results of their wind investigation to figure out what is causing Surtsey's land to change.

Listen for students to mention the following ideas:

- Students know that there is strong wind on Surtsey.
- Students know from their wind investigation that wind can change the shape of land.

What else do you think interacts with Surtsey's land?

Suggest that students revisit the "Surtsey, the Birth of an Island" video (<http://phdsci.link/1599>). Play the video from 1:34 to 1:50, and have students focus on the water and land in the video. Then have students use their observations of water to add to the class video observations chart.

How is the water interacting with Surtsey's land?

Listen for students to mention the waves crashing on Surtsey's cliffs and shoreline. Students may also mention that they think the movement of the water is causing changes to Surtsey's land.

How can we figure out if water is changing Surtsey's land?

Listen for students to suggest investigating water and land with models, just like they investigated wind and land.

Tell students that in this lesson part, they will investigate how water and land interact as they continue to explore the Phenomenon Question **What can cause Surtsey's land to change?**

Performance Descriptor

Develop and use models to represent (SEP.2) how **water changes land (ESS2.A)** by **using relative scales to describe how land differs in shape (CC.3)**.

Agenda | 35 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 25 to 35 minutes

- Investigate Water and Land Interactions (25 to 35 minutes)

LAND | 5 minutes or less

LEARN 25 to 35 minutes**Investigate Water and Land Interactions | 25 to 35 minutes**

Students observe a wave model demonstration to explore one interaction between water and land. Students then work in a group to conduct an investigation in which they use a rain or river model to explore a second interaction between water and land, and they record their observations and measurements. Next, students participate in an Inside–Outside Circles routine to share their observations and measurements and to learn about other groups’ observations and measurements. Finally, students consider the changes that the water in the three models caused and form a conclusion about how water affects land.

2. Use a wave model to model a water and land interaction, and have students discuss how the water in the model affects the land.

LESSON 3 RESOURCE D

Ask students to recall the materials they tested in earlier investigations, and review that each material represented land. Tell students that in the investigations in this lesson part, they will look at mixtures of materials and that each mixture will represent land.

Display the prepared wave model. Tell students that in this model, the mixture of sand and gravel at the end of the bin represents land. Point out that the mixture does not contain soil. Explain that the model represents the components of land that make up Surtsey’s shoreline. Inform students that the model will show what happens when waves interact with the land that makes up a shoreline. Reveal that water will be poured into the bin to represent the ocean and that the bin will tilt up and down, which will create waves in the water.

In the model, what might be evidence that water can change land?

Listen for students to suggest that when the waves in the model interact with the shoreline, students will be able to observe changes to the shape of the land.

What do you think the waves will do to the land?

Follow the procedure to carry out the wave model demonstration. Have students pay attention to whether they can observe evidence of water causing changes to the sand and gravel in the model. As necessary, repeat the demonstration to allow all students time to notice the effects of the waves on the land. Then invite volunteers to share their observations.

Display the completed wave model templates to show students what the land looked like at the beginning and at the end of the demonstration.

 **What do you notice about how the waves changed the land?**

 **What does this tell us about how water and land interact on a shoreline?**

Listen for students to describe how the water moved over the sand and gravel and to suggest that water can change the land on a shoreline by making it flatter and longer.

Ask students to reflect on their background knowledge and personal experiences of water and land interactions. 

 **How might water interact with land in other ways?**

Tell students that they will now investigate two other examples of water interacting with land by exploring a rain model and a river model. Display a prepared river model and a prepared rain model. Tell students that in both models, the land is a mixture of sand, soil, and gravel.

 **How might rain affect land?**

 **How might a river affect land?**

 **In our wave model, think about how the waves affected the land. Do you think rain affects land the same way? Do you think a river affects land the same way?**

Suggest that students collect more evidence to determine whether other interactions between water and land result in similar changes to land.

3. Introduce and have students conduct the rain and river water investigations.

 LESSON 3 RESOURCE E  LESSON 3 ACTIVITY GUIDE D

Inform students that they will work in groups to investigate how rain interacts with land and how a river interacts with land. Explain that half of the groups will work with a model that shows how rain and land interact and that the other half will work with a model that shows how a river and land interact.

Then divide the class into groups. Give each student a pair of safety goggles. Direct each group to a prepared rain model or a prepared river model, and prompt students to notice the procedure sheet next to their model. Read aloud a rain model procedure sheet and a river model procedure sheet, and answer any questions students have. 

Extension

As students consider their prior experiences with water and land interactions, encourage them to think about where these interactions take place on a large scale. Consider inviting students to locate on a map where water and land interact on Earth. For example, students could point out coasts, rivers, and lakes.

Teacher Note

Students may wonder why the land in the river and rain models looks different from the land in the wave model. Review that the land in the wave model represents a sandy shoreline, so it is made up of sand and gravel. Explain that the land in the rain and river models represents areas with more soil, so it is made up of soil, sand, and gravel.

Safety Note

This investigation poses potential hazards. To minimize the risks, review these safety guidelines with students:

- Wear safety goggles throughout the activity.
- Do not put water or other materials in or near your mouth.
- If water spills, tell an adult right away.
- Do not touch the soil. If you touch the soil by accident, wash your hands after the activity.

Before groups begin working, instruct students to circle their model in their Science Logbook. Prompt groups to discuss what they think will happen to the land in their model and to discuss how they can record the changes the water causes to the land.

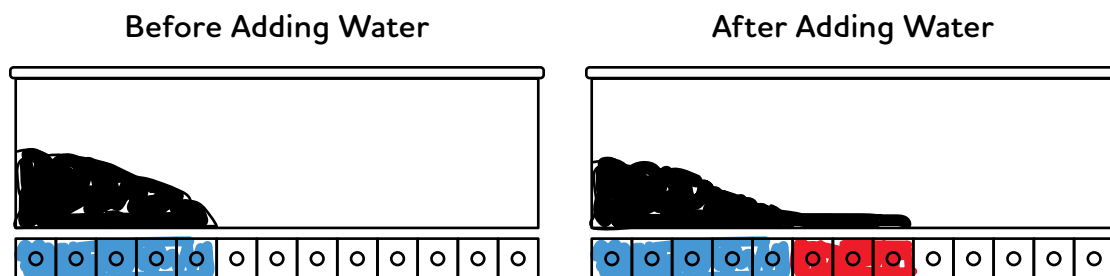
Then instruct groups to begin working. Remind groups to follow their procedure sheet closely.  Emphasize that students should record observations and measurements of their model before adding water, observe what happens after they add water, and record their observations and measurements after they add water. Point out that students should draw the land in the model from the side but should observe it both from the side and from above. As students work, circulate to help them read and complete their procedure sheet and to ensure that they are using materials safely.  

Support students by asking questions such as these:

 **What is happening to the land in your model?**

 **Do you notice any changes to the shape of the land? What caused those changes?**

Rain model sample student response:



Some land slid down. The land spread across the bottom of the bin and its shape became longer.

Teacher Note

Students' investigation results may vary depending on the type of soil used and its moisture content. The amount of water students use in the models may also require adjustment.

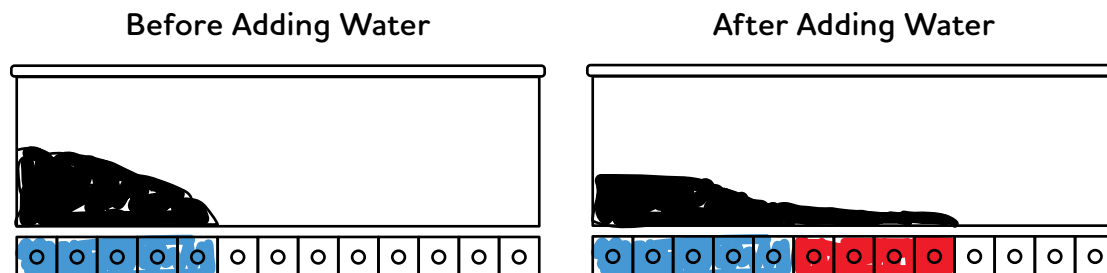
Differentiation

Consider allowing students who would benefit from graphomotor support to draw the land in their model on a larger sheet of paper rather than in their Science Logbook. Students may also benefit from dictating changes they observe in the shape of their land as a partner records the changes.

Teacher Note

To help students keep track of their progress, consider having them draw a check mark next to each step in the procedure as they complete it.

River model sample student response:



Some land slid down and made a pile in the middle of the bin.

4. Have students share and compare their observations and measurements.

LESSON 3 ACTIVITY GUIDE D

Bring the class back together. Have students participate in an Inside–Outside Circles routine to discuss their observations and measurements from the rain and river water investigations. Instruct students who worked with a river model to form the inside circle and students who worked with a rain model to form the outside circle. Tell partners to discuss the following questions.

When you added water, what happened to the land in your model?

Did your land get longer? How many cubes did you add?

After partners share their observations and measurements, have the inside circle rotate to allow students to discuss the same questions with a new partner. Repeat this rotation at least once more before facilitating a class discussion to summarize the investigations.

Think about the changes we saw to the wave model, the rain models, and the river models. How were the changes similar? How were they different?

Listen for students to mention the following ideas:

- The land in all three models became wet and changed shape.
- The shape of the land after water was added was different in the three models.

Teacher Note

Inside–Outside Circles is a collaborative conversation routine that allows students to respond to questions with a variety of classmates in a structured manner. The class divides in half, and students form two large concentric circles that face each other. A question is posed, and students discuss their response with the person they are facing in the other circle. After each question, one or both circles may rotate to provide students with a new talking partner for subsequent questions.

Content Area Connection: Mathematics

By using 1" cubes to measure the lengths of sand and soil distribution in the wave, rain, and river models, students develop the understanding that differences in length can be expressed in standard units.

Direct students to the summary response in their Science Logbook. Have students use evidence from their observations and measurements of their rain or river model to record a response to the question. After students finish recording, invite volunteers to share their response.

 **Notice the shape of your land before and after you added water. How is the shape different after you added water?**

Look and listen for students to mention that after they added water, the land became thinner or longer or that it moved to a different location in the bin.

Build on students’ responses to conclude that water can cause land to change in shape. 

 Check for Understanding

Develop and use models to represent (SEP.2) how **water changes land (ESS2.A)** by **using relative scales to describe how land differs in shape (CC.3).**

EVIDENCE	NEXT STEPS
Look and listen for indications of the following in students’ models and written explanations: - Models students develop (SEP.2) show the changes water causes to the land (ESS2.A). - Students use relative scales to describe changes water causes to the shape of land (CC.3). - Students use evidence from the models they developed (SEP.2) to describe the kinds of changes water causes to land (ESS2.A).	If students need support to use their rain or river model to describe changes water causes to land, consider posing questions such as these: - What happened when you added water to the bin? When you added water, did the land change shape? Where did the land go? - Before you added the water, how many cubes long was the land? After you added the water, how many cubes long was the land? What does that tell you about what happened to the land?



Extension

Consider having students continue to explore the river and rain models. Challenge students to predict what would happen to the land if they added another cup of water to each model. Prompt students to add the water to the models and then to compare their observations with their predictions. Ask students follow-up questions such as this: Imagine using rocks to represent the land. Do you think the water would interact with the land in the same way? Why do you think that?

LAND 5 minutes or less

Students summarize how water can affect Surtsey's land. Students then recall their learning about how wind interacts with land and compare the effects of wind and water on land. Finally, students revisit the Phenomenon Question and share the questions they still have about how Surtsey's land is changing.

5. Prompt students to discuss how water can affect Surtsey's land and to compare the effects of wind and water on land.

 LESSON 3 ACTIVITY GUIDE C

Bring the class back together. Have students Think–Pair–Share in response to the following questions:

 **What do you now know about how water and land interact?**

 **Think about how we saw water and land interact in the models. What might that tell us about how water can affect Surtsey's land?**

Remind students that in the previous lesson part, they investigated how wind and land interact. Encourage students to recall their observations from the “Surtsey, the Birth of an Island” video and to review their observations from the wind investigation in their Science Logbook. Facilitate a class discussion about how wind and water interact with land. Encourage students to provide evidence of wind and water changing land in their responses. 

To guide the discussion, pose a question such as this:

 **Think about how wind changes land and how water changes land. How are the changes similar?**

Listen for students to mention that both wind and water can change the size or shape of land.

-  Students should understand that both wind and water can cause changes to the size or shape of land. As necessary, refer to the results of the wind, wave, rain, and river investigations to help students understand this concept.

Teacher Note

During Part 4 of this lesson, students will use their evidence of wind and water changing land to develop an argument about Surtsey's changing land.

6. Have students revisit the Phenomenon Question and share outstanding questions about how Surtsey's land is changing.

Revisit the Phenomenon Question **What can cause changes to Surtsey's land?** Ask students to consider how their learning so far helps them respond to the question.

 **What questions do you still have about how Surtsey's land is changing?**

Tell students that in the next lesson part, they will consider new claims about how wind and water can change Surtsey's land.

HW Suggested Homework

Review that students used models to observe how water can change land. As a class, brainstorm other examples of water changing land that students may have observed. With adult supervision, have students participate in a scavenger hunt to look for examples of water changing land in their local area. Have students draw their findings and then share their drawing with a trusted adult, a friend, or the class.

MATERIALS

The table lists materials needed for each section of Part 4.

SECTION	STUDENT MATERIALS	CLASS MATERIALS
Launch	☐ Science Logbook (1 per student)	None
Learn: Develop an Argument	☐ Science Logbook (1 per student)	None
Land	☐ Science Logbook (1 per student)	None

MATERIALS REUSE

No disposable or prepared materials from Part 4 are reused in the module.

LAUNCH 5 minutes or less

Students review evidence from their observations of the Surtsey data charts from Part 1. Students also review their supporting evidence for the initial claim they recorded in response to the Phenomenon Question.

1. Have students review evidence from their observations of the Surtsey data charts and evidence supporting their initial claim about how land can change.

 LESSON 3 ACTIVITY GUIDE A, LESSON 3 ACTIVITY GUIDE B

Revisit the Phenomenon Question **What can cause Surtsey's land to change?** Have students return to their Surtsey data charts, and prompt them to review the observations they recorded in Part 1 (Lesson 3 Activity Guide A).

Reiterate that a claim is a statement that answers a scientific question and describes a phenomenon. Ask students to recall that earlier in the lesson, they recorded an initial claim in response to the Phenomenon Question. Have students return to their claim (Lesson 3 Activity Guide B), and prompt them to review the evidence they used to support it. Ask students to use a nonverbal signal to indicate whether their thinking has changed since they made their initial claim.

 **Think about what we learned in this lesson. What helped us understand what causes Surtsey's land to change?**

Listen for students to mention using observations and data from the data charts, videos, images, and investigations.

Tell students that in this lesson part, they will develop an argument to support a claim about changes to Surtsey's land.

Performance Descriptor

Develop an argument (SEP.7)

to support a claim that **wind or water changes land (ESS2.A)** by **using relative scales to describe changes to land (CC.3)**.

Agenda | 30 to 40 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 25 minutes

- Develop an Argument (20 to 25 minutes)

LAND | 5 to 10 minutes

LEARN 20 to 25 minutes**Develop an Argument** | 20 to 25 minutes

Students choose the claim that wind can cause changes to Surtsey's land or the claim that water can cause changes to Surtsey's land. Students identify a piece of evidence that supports their claim and develop an argument to explain how the evidence supports the claim. After discussing their arguments, students determine that both wind and water are causing changes to Surtsey's land.

2. Have students choose a claim about Surtsey's changing land and identify a piece of evidence that supports the claim.

LESSON 3 ACTIVITY GUIDE E

Direct students to the two claims in their Science Logbook. Read the claims aloud as students follow along. Clarify for students that both claims can be true.

Tell students that they will work with the partner with whom they developed their initial claim. Explain that pairs will choose one of the claims and will identify one piece of evidence that supports that claim. Further explain that pairs will analyze the observations and data that they recorded earlier in the lesson to identify the piece of evidence. Specify that pairs may choose evidence from their observations of video clips and images, their measurement data, and their data from investigations. 

Instruct students to find their partner and begin working. Tell students to record the piece of evidence they identify in the chart in their Science Logbook. Then have students record an explanation of how the piece of evidence supports their claim. 

Differentiation

If students need support to identify evidence, work with them individually or in small groups. Give students a piece of evidence that supports their claim and a piece of evidence that does not support their claim, and ask students to identify which is which.

Teacher Note

Replay the “Surtsey, the Birth of an Island” video from 1:03 to 3:05 or set up computers with the video for students to review. Encourage students to use the measurement data of Surtsey from their Science Logbook (Lesson 3 Activity Guide A).

Teacher Note

Consider posting a list of the items that students observed in this lesson and may draw evidence from:

- Image that shows aerial views of Surtsey in 1967 and 2014 (*Life on Surtsey*, page 7)
- Surtsey data charts (Lesson 3 Activity Guide A)
- “Surtsey, the Birth of an Island” video clips (<http://phdsci.link/1599>)
- Observations from the wind investigation (Lesson 3 Activity Guide C)
- Completed wave model templates from the wave investigation
- Observations from the rain and river investigations (Lesson 3 Activity Guide D)

Sample student response for Claim A:

Claim A: Wind changes the shape of Surtsey's land.

What evidence supports your claim?	How does this evidence support your claim?
<i>In our wind model, we saw the wind move the land in the bin. We also saw the wind change the shape of the land.</i>	<i>This evidence shows us that wind can change where land materials are. It also shows us that wind can change the shape of land. We think that means wind changes Surtsey's land in those ways.</i>

Sample student response for Claim B:

Claim B: Water changes the shape of Surtsey's land.

What evidence supports your claim?	How does this evidence support your claim?
<i>We saw in the data charts that Surtsey's shape changed. The spit got longer and thinner. The same thing happened to the land in our wave, rain, and river investigations.</i>	<i>This evidence makes us think that the waves crashing into Surtsey's shoreline changed Surtsey's shape.</i>

3. Have students develop arguments by determining whether or how evidence supports a claim.

 LESSON 3 ACTIVITY GUIDE A, LESSON 3 ACTIVITY GUIDE B, LESSON 3 ACTIVITY GUIDE E

Have students Think–Pair–Share with a different partner to describe how the piece of evidence they chose supports their claim. Allow time for pairs to discuss their reasoning. As necessary, circulate to help students communicate their reasoning. 

Then bring the class back together, and reveal that students used a claim and evidence to make an argument. Remind students that an argument is a description of whether or how evidence supports a claim. 

Have students find a different partner (not the same partner they worked with to develop their initial claim). After students have paired up, tell pairs that they will choose one partner's claim. Then explain



Differentiation

Students may need support when sharing their arguments and evidence. Consider posting the following sentence frames:

- I think that _____ because _____.
- My evidence is _____ and _____.



Teacher Note

If students need additional support, have them refer to their Science Logbook (Lesson 2 Activity Guide C) to review the evidence and explanations they used to support the claim they developed about rocks changing.



Spotlight on Science and Engineering Practices

Students have had previous experiences developing an argument and will continue to develop arguments throughout Level 2 (SEP.7).

that next, they will share with the class the evidence that supports the claim and the argument for how or why the evidence supports the claim. As needed, encourage students to refer to the left side of the chart in Lesson 3 Activity Guide E for the evidence and to the right side of the chart for the argument. Circulate to provide support if students need to adjust their evidence or argument before sharing.

Ask students to consider the following question as pairs share. 

 **Do I agree that the evidence supports the claim?**

After pairs finish sharing, focus students' attention on the data chart in their Science Logbook (Lesson 3 Activity Guide A) that shows Surtsey's shape over time.

 **What do you think is causing Surtsey's land to change shape?**

Listen for students to mention that both wind and water are changing the shape of Surtsey's land.

- ✓ Students should identify that both wind and water are causing Surtsey's land to change shape. If students need support to identify that both factors are involved, revisit the investigation results. If students need additional support to identify that wind is causing changes, encourage them to review their observations from the data charts. Point out the changes in elevation, and explain that wind caused them.

 Teacher Note

Keep in mind that although students' claims should focus on either wind or water changing Surtsey's land, the evidence and arguments may vary.



Check for Understanding

Develop an argument (SEP.7) to support a claim that **wind or water changes land (ESS2.A)** by **using relative scales to describe changes to land (CC.3)**.

EVIDENCE	NEXT STEPS
Look and listen for indications of the following in students’ responses: • Students identify evidence from observations and develop an argument to support the claim that water changes Surtsey’s land or the claim that wind changes Surtsey’s land (SEP.7, ESS2.A). • Students use relative scales to describe the changes that wind or water caused to Surtsey’s land (CC.3).	If students need support to analyze evidence and develop an argument, review the evidence that students explored throughout the lesson. Consider posing questions such as these: • Think about the two pictures of Surtsey in Lesson 3 Activity Guide A. What differences did you notice? What do wind and water have to do with those differences? • Think about what you observed in the video clips. What did you observe about wind and water? What does that have to do with Surtsey’s land? • Think about the wind, wave, rain, and river models. How did wind change the land in the models? How did water change the land in the models? If students need support to differentiate between evidence that is relevant to their claim and evidence that is not relevant to their claim, consider providing them with two different pieces of evidence—one that supports their claim and one that does not—and asking them to identify the piece of evidence that supports their claim. Then ask them why that piece of evidence supports their claim.

LAND 5 to 10 minutes

Students use their learning to answer the Phenomenon Question and to update the class anchor model, Knowledge Tracker, and class anchor chart.

4. Return to the Phenomenon Question, and work with students to update the class anchor model.

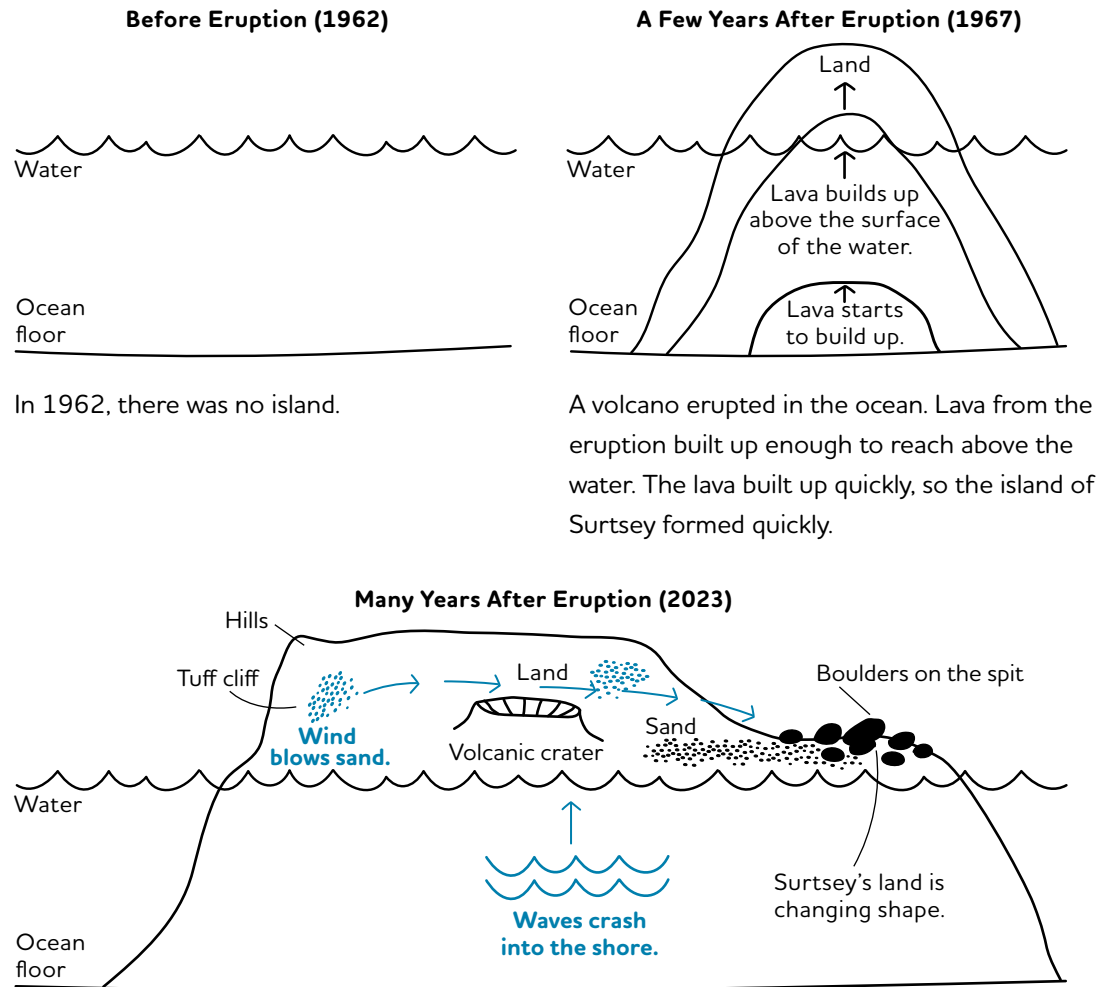
Review that students have used evidence to support the claim that wind and water can change the shape of land. Ask students to use their learning to answer the Phenomenon Question **What can cause Surtsey's land to change?**

***Listen for** students to provide evidence from their observations of video clips and images, their measurement data, and their data from investigations to support the idea that wind and water are causing the size and shape of Surtsey's land to change.*

Direct students' attention to the class anchor model. As a class, update the anchor model and explanation so they reflect students' new knowledge about how the size and shape of Surtsey's land have changed over time.

Sample anchor model:

How can the island of Surtsey change shape over time?



The natural features of Surtsey's land are hills, cliffs, craters, and a spit. Surtsey's land is made up of rocks, soil, and sand. Some landforms have different properties than others. **Surtsey is smaller now and has a lower elevation than when it formed. These changes to Surtsey's size and shape are caused by wind and water.**

5. Have students update the Knowledge Tracker in their Science Logbook to reflect on what they learned in this lesson.

Ask students to think about what they figured out during this lesson. Then tell students to consider how that new knowledge may help them answer the Driving Question. Have students record their ideas in the appropriate section of their Knowledge Tracker.

6. Work with students to update the class anchor chart.

Have students share what they have learned so far about wind and water causing changes to land. Work as a class to update the anchor chart so it reflects students' new knowledge.

Sample anchor chart:

Earth Changes

The Components and Shape of Land

- Land can have many different shapes.
 - Rocks, soil, and sand are components of land.
 - The shape and size of land can change.
 - **Wind and water can change the shape of land.**
-

Tell students that in the next lesson, they will apply their knowledge to a new phenomenon as they complete a Conceptual Checkpoint.

Lesson 3

PREPARATION RESOURCE

PART 1 of 4

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- Chart paper and marker for class chart
- *Life on Surtsey* (Burns 2017) (1)

PREPARATION

Complete the following task to prepare for this lesson part.

Video | 5 minutes or less

Instructions: Cue the “Surtsey, the Birth of an Island” video (<http://phdsci.link/1599>) to start at 1:03. Play the video during the lesson part.

PART 2 of 4

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available. Consider substituting bagged topsoil or local soil for potting soil to create a more authentic mixture of land materials. Note that model results may vary depending on the kind of soil and its moisture content.

- | | | |
|--|--|---|
| ☐ 1 cup measuring cup (1) | ☐ Gravel (1 cup per 3 groups) | ☐ Printer access |
| ☐ 6 qt clear plastic bin (1 per group) | ☐ Handheld balloon pump (1 per group) | ☐ Ruler (1) |
| ☐ Clear plastic shower cap (1 per group) | ☐ Lesson 3 Resource A: Photograph of Wind on Surtsey | ☐ Safety goggles (1 per student, plus 1 for teacher) |
| ☐ Disposable gloves (1 pair for teacher) | ☐ Lesson 3 Resource B: Wind Model Student Procedure Sheet | ☐ Scissors (1) |
| ☐ Drill with $\frac{3}{8}$ " drill bit (1) | ☐ Medium paintbrush (1 per group) | ☐ Small object (e.g., rock, shell) (1 per group) |
| ☐ Dry erase markers in 2 different colors (1 set per group) | ☐ Potting soil (1 cup per 3 groups) | |
| ☐ Fine sand (1 cup per 3 groups) | | |

PREPARATION

Complete the following tasks to prepare for this lesson part. Module resources needed for preparation follow this preparation resource.

Video | 5 minutes or less

Instructions: Cue the “Surtsey, the Birth of an Island” video (<http://phdsci.link/1599>) to start at 0:13. Play the video during the lesson part.

Wind Model Student Procedure Sheets | 5 minutes or less

Materials

-
- | | | |
|--|---|---------------------------------------|
| ☐ Lesson 3 Resource B: Wind Model Student Procedure Sheet | ☐ Printer access | ☐ Scissors (1) |
|--|---|---------------------------------------|

Instructions: Print and cut out a copy of the procedure sheet in Lesson 3 Resource B for each group and an additional copy for teacher reference. Consider using card stock and laminating for multiple uses.

Wind Models | 15 to 20 minutes

This lesson part involves setting up three kinds of wind models. Each group will receive a model containing sand, soil, or gravel. Each group will use only one model. Prepare 1 of each kind of model for every 3 groups.

Materials

-
- | | | |
|---|--|---|
| ☐ 1 cup measuring cup (1) | ☐ Fine sand (1 cup per 3 groups) | ☐ Potting soil (1 cup per 3 groups) |
| ☐ 6 qt clear plastic bin (1 per group) | ☐ Gravel (1 cup per 3 groups) | ☐ Ruler (1) |
| ☐ Clear plastic shower cap (1 per group) | ☐ Handheld balloon pump (1, from group materials) | ☐ Safety goggles (1) |
| ☐ Disposable gloves (1 pair) | ☐ Medium paintbrush (1, from group materials) | ☐ Small object (e.g., rock, shell) (1 per group) |
| ☐ Drill with $\frac{3}{8}$ " drill bit (1) | | |
| ☐ Dry erase marker (1, from group materials) | | |

Teacher Safety Note: Wear protective eyewear and disposable gloves while preparing materials for the wind models.

Instructions

1. Drill a hole into one of the narrow sides of each plastic bin. Each hole should be 2.5 cm from the bottom of the bin and should be centered horizontally. Ensure that the tip of the handheld balloon pump fits into each hole.

2. Use a dry erase marker to mark a spot on the outer bottom of the bin approximately 6 to 8 cm away from the drilled hole. Place a small rock, a small shell, or another small object on the mark in each bin.
3. Measure 1 cup of fine sand, and pour it onto the object in one of the bins.
4. Measure 1 cup of potting soil, and pour it onto the object in another bin.
5. Measure 1 cup of gravel, and pour it onto the object in a third bin.
6. Repeat steps 3 through 5 with the remaining bins.
7. Use a paintbrush to shape the pile of material in each bin as shown in the second photograph.



8. Cover each bin with a plastic shower cap. If the shower cap is bunched up, pull it apart before fitting it onto the bin.

Note: The plastic bins with holes will be reused to create the rain and river models that students use in Part 3. The gravel, sand, and soil can also be reused to create the rain and river models.

Wind Investigation Materials | 5 to 10 minutes

Materials

- | | | |
|---|--|---|
| ☐ Dry erase markers in 2 different colors
(1 set per group) | ☐ Handheld balloon pump (1 per group) | ☐ Prepared wind model (sand, soil, or
gravel) (1 per group) |
| | ☐ Medium paintbrush (1 per group) | |

Instructions: Assemble 1 set of materials per group. Prepare to give each group a set of materials during the lesson part.

PART 3 of 4

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available. If interlocking cubes are not available in blue and red, substitute interlocking cubes and crayons in two other colors.

- ☐ 1 cup measuring cup (1)
- ☐ 6 qt clear plastic bin with hole (1 per group, from Part 2)
- ☐ 8 oz paper cups (2 per group, plus 2 for demonstration)
- ☐ 10 qt plastic bucket (1)
- ☐ 41 qt clear plastic bin with lid (1, approx. 35" × 17" × 6")
- ☐ Blue interlocking cubes (6 per group, plus 7 to 10 for demonstration)
- ☐ Class video observations chart (1, from Part 1)
- ☐ Crayons in red and blue (1 of each per student, plus 1 of each for teacher)
- ☐ Disposable gloves (2 pairs for teacher)
- ☐ Fine sand ($\frac{3}{4}$ cup per group, plus 7 cups for demonstration)
- ☐ Gravel ($\frac{1}{3}$ cup per group, plus 1 cup for demonstration)
- ☐ Hook and loop fastener strip (1" per 2 groups)
- ☐ Lesson 3 Resource C: Wave Model Template
- ☐ Lesson 3 Resource D: Wave Model Demonstration Procedure
- ☐ Lesson 3 Resource E: Rain and River Model Student Procedure Sheets
- ☐ Newspaper sheet (1 per group)
- ☐ Potting soil (2 cups per group)
- ☐ Printer access
- ☐ Putty knife (1)
- ☐ Red interlocking cubes (6 per group, plus 3 to 10 for demonstration)
- ☐ Safety goggles (1 per student, plus 1 for teacher)
- ☐ Scissors (1)
- ☐ Sharpened pencil (1)
- ☐ Water access

PREPARATION

Complete the following tasks to prepare for this lesson part. Module resources needed for preparation follow this preparation resource.

Video | 5 minutes or less

Instructions: Cue the "Surtsey, the Birth of an Island" video (<http://phdsci.link/1599>) to start at 1:34. Play the video during the lesson part.

Wave Model | 10 to 15 minutes

Materials

- | | | |
|--|---|---|
| ☐ 1 cup measuring cup (1) | ☐ Disposable gloves (1 pair) | ☐ Putty knife (1) |
| ☐ 10 qt plastic bucket (1) | ☐ Fine sand (7 cups) | ☐ Safety goggles (1) |
| ☐ 41 qt clear plastic bin with lid
(1, approx. 35" × 17" × 6") | ☐ Gravel (1 cup) | ☐ Water ($\frac{1}{2}$ cup) |

Teacher Safety Note: Wear protective eyewear and disposable gloves while preparing materials for the wave model.

Instructions

1. Mix the gravel, the sand, and $\frac{1}{2}$ cup of water in the plastic bucket.
2. Pour the mixture into one end of the plastic bin.
3. Use the putty knife to shape the mixture into a wedge with a slope of about 45 degrees. Do not pack the mixture tightly; the materials should be loose.

Note: The mixture must be damp for the demonstration. To prevent the mixture from drying out, keep the bin covered before the demonstration.

Wave Model Templates | 5 minutes or less

Materials

- | | | |
|---|---|---------------------------------------|
| ☐ Lesson 3 Resource C: Wave Model Template | ☐ Printer access | ☐ Scissors (1) |
|---|---|---------------------------------------|

Instructions: Print and cut out two copies of the wave model template in Lesson 3 Resource C.

Wave Model Demonstration Materials | 5 minutes or less

Materials

- | | | |
|--|--|--|
| ☐ 8 oz paper cups (2) | ☐ Lesson 3 Resource D: Wave Model Demonstration Procedure | ☐ Prepared wave model templates (2) |
| ☐ Blue interlocking cubes (7 to 10) | ☐ Prepared wave model | ☐ Red interlocking cubes (3 to 10) |
| ☐ Crayons in red and blue (1 of each) | | ☐ Water access |

Instructions

1. Gather the wave model materials.
2. Fill both paper cups with water.

Rain and River Model Student Procedure Sheets | 5 minutes or less

In this lesson part, each group will use a rain model or a river model. Half of the groups in the class will use a rain model, and the other half will use a river model.

Materials

-
- | | | |
|---|---|---------------------------------------|
| ☐ Lesson 3 Resource E: Rain and River Model Student Procedure Sheets | ☐ Printer access | ☐ Scissors (1) |
|---|---|---------------------------------------|

Instructions: Print and cut out enough copies of the student procedure sheets in Lesson 3 Resource E for half of groups to receive a rain model procedure sheet and half of groups to receive a river model procedure sheet. Prepare an additional copy of each procedure sheet for teacher reference. Consider using card stock and laminating for multiple uses.

Rain and River Model Bins | 10 to 15 minutes

Follow the instructions in this section to prepare rain model bins for half of the groups in the class and river model bins for the other half of the groups. Both the rain model and the river model use a mixture of potting soil, gravel, and fine sand to represent land. Prepare a small batch of this mixture for each rain and river model, or adapt the instructions to prepare one large batch of the mixture for all the rain and river models and divide the mixture evenly between the models.

Consider substituting topsoil or local soil for potting soil to create a more authentic mixture of land materials.

Materials

-
- | | | |
|--|---|---|
| ☐ 1 cup measuring cup (1) | ☐ Disposable gloves (1 pair) | ☐ Putty knife (1) |
| ☐ 6 qt clear plastic bin with hole (1 per group, from Part 2) | ☐ Gravel ($\frac{1}{3}$ cup per group) | ☐ Safety goggles (1) |
| ☐ 10 qt plastic bucket (1) | ☐ Fine sand ($\frac{1}{4}$ cup per group) | ☐ Water access |
| | ☐ Potting soil (2 cups per group) | |

Teacher Safety Note: Wear protective eyewear and disposable gloves while preparing materials for the rain and river models.

Instructions

1. Mix 2 cups of soil, $\frac{1}{8}$ cup of gravel, and $\frac{1}{4}$ cup of sand in the plastic bucket.
2. Pour the mixture into one end of a plastic bin.
3. Use the putty knife to shape the mixture into a wedge with a slope of about 45 degrees. To prepare a **rain model** bin, do not pack the mixture tightly; the materials should be loose. To prepare a **river model** bin, pack down the edges of the mixture but leave the center loose.
4. Repeat steps 1 through 3 with the remaining bins.

Rain and River Model Investigation Materials | 5 to 10 minutes

Prepare rain model investigation materials for half of the groups in the class and river model investigation materials for the other half of the groups.

Materials

☐ 8 oz paper cups (2 per group)	☐ Newspaper sheet (1 per group)	☐ Red interlocking cubes (6 per group)
☐ Blue interlocking cubes (6 per group)	☐ Prepared rain or river model (1 per group)	☐ Sharpened pencil (1)
☐ Crayons in red and blue (1 of each per student)	☐ Prepared rain or river model student procedure sheet (1 per group)	☐ Water access
☐ Hook and loop fastener strip (1" per 2 groups)		

Note that students' investigation results may vary depending on the kind of soil and its moisture content. The amount of water students use in the models may also require adjustment.

Instructions

Rain model investigation materials

1. Fill a paper cup with water.
2. Use a sharpened pencil to poke 10 small holes in the bottom of a second paper cup.

3. Lay out a sheet of newspaper in a designated classroom area. On the sheet, place a prepared rain model bin, a set of crayons for each student in the group, a paper cup filled with water, a paper cup with holes, 6 blue interlocking cubes, 6 red interlocking cubes, and a prepared rain model procedure sheet.
4. Repeat steps 1 through 3 to prepare rain model investigation materials for the remaining rain model groups.

Note that students will use the interlocking cubes to measure the initial length of the wedge as part of the rain model procedure. (See the prepared rain model procedure sheets.)



River model investigation materials

1. Fill a paper cup with water.
2. Use a sharpened pencil to poke a hole near the edge of the bottom of a second paper cup.
3. Pull apart a hook and loop fastener strip. Affix the hook from the fastener to the side of a prepared river model bin that has the wedge of land. The hook should be about 1 inch from the top of the bin. Affix the loop from the fastener to the outside of the paper cup with the hole so the loop is opposite the hole.
4. Attach the cup to the bin by connecting the hook and the loop again. Press firmly to secure the cup, but avoid bending the cup.
5. Lay out a sheet of newspaper in a designated classroom area. On the sheet, place a prepared river model bin, a set of crayons for each student in the group, a paper cup filled with water, 6 blue interlocking cubes, 6 red interlocking cubes, and a prepared river model procedure sheet.
6. Repeat steps 1 through 5 to prepare river model investigation materials for the remaining river model groups.

Note that students will use the interlocking cubes to measure the initial length of the wedge as part of the river model procedure. (See the prepared river model procedure sheets.)



Note: The plastic bins with holes from the rain and river models will be reused for the Engineering Challenge in Lesson 5.

PART 4 of 4

MATERIALS

No materials are required for Part 4.

PREPARATION

No preparation tasks are required for Part 4.

Lesson 3 Resource A

PHOTOGRAPH OF WIND ON SURTSEY



Lesson 3 Resource B

WIND MODEL STUDENT PROCEDURE SHEET**Wind Model Procedure Sheet**

1. Observe the land from the side and from over the bin.
2. In your Science Logbook, write or draw what you see.
3. Have two group members hold the bin, one at each end.
4. Find the hole in the side of the bin. Place the tip of the balloon pump inside.
5. Pump air into the bin. Point the balloon pump to the left side of the bin, to the middle, and to the right side. Pump air 25 to 30 times. Take turns with your group members.
6. Observe the land from the side and from over the bin.
7. In your Science Logbook, write or draw what you see.
8. Take the shower cap off of the bin.
9. Use the paintbrush to shape the land into a hill.
10. Place the shower cap back onto the bin.
11. Use a marker to trace the shape of the land onto the side of the bin.
12. Repeat steps 3, 4, and 5. Then move on to step 13.
13. Use a marker of a different color to trace the shape of the land on to the side of the bin.
14. In your Science Logbook, describe how the land changed.

Lesson 3 Resource C

WAVE MODEL TEMPLATE

[illegible]

Lesson 3 Resource D**WAVE MODEL DEMONSTRATION PROCEDURE**

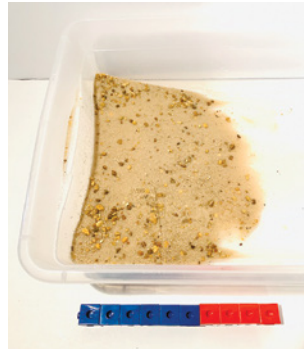
Use this procedure to carry out the wave model demonstration.

1. Connect the blue interlocking cubes into a column that is the length of the wedge of land when the mixture is viewed from the side. Lay the column next to the bin so it is alongside the wedge.



2. With the class, count aloud the number of blue cubes in the column.
3. Use a blue crayon to color the same number of boxes on each copy of the wave model template.
4. On the first copy of the template, draw a side view of the wedge.
5. Pour 2 cups of water into the bin at the end opposite the wedge.
6. Generate waves by gently lifting the end of the bin opposite the wedge by 10 to 12 inches and then gently lowering it. Repeat this motion 10 to 14 times.

7. Use the red interlocking cubes to measure the change in the length of the wedge. Add red interlocking cubes to the column of blue interlocking cubes so that the column represents the new length of the wedge.



8. With the class, count aloud the number of red cubes.
9. Use a red crayon to color the same number of boxes on the second copy of the wave model template.
10. On the second copy of the template, draw a side view of the wedge as it now appears.

Lesson 3 Resource E

RAIN AND RIVER MODEL STUDENT PROCEDURE SHEETS

Rain Model Procedure Sheet

1. Observe the land from the side and from over the bin.
2. In your Science Logbook, draw the land from the side.
3. Use cubes of one color to find out how long the land is.
4. In your Science Logbook, color the boxes to show how long the land is.
5. Hold the cup with holes above the land.
6. Slowly add your water to the cup with the holes.
7. Move the cup with holes over the land.
8. Observe the land, and look for changes.
9. In your Science Logbook, draw the land from the side.
10. Add cubes of a new color to find out how long the land is now.
11. In your Science Logbook, color the boxes to show how long the land is now.

River Model Procedure Sheet

1. Observe the land from the side and from over the bin.
2. In your Science Logbook, draw the land from the side.
3. Use cubes of one color to find out how long the land is.
4. In your Science Logbook, color the boxes to show how long the land is.
5. Slowly add your water to the cup on the side of the bin.
6. Observe the land, and look for changes.
7. In your Science Logbook, draw the land from the side.
8. Add cubes of a new color to find out how long the land is now.
9. In your Science Logbook, color the boxes to show how long the land is now.



Concept 1 | The Components and Shape of Land

LESSON 4 CONCEPTUAL CHECKPOINT

Lesson Phenomenon | How Cappadocia's fairy chimneys form and change

Phenomenon Question | How do fairy chimneys form and change shape?

OVERVIEW

Previously we determined that Surtsey is an island that was formed by a volcanic eruption. We observed pictures, videos, and models to identify that Surtsey's land is changing. Through investigations of land materials, we determined that the shape of rocks can change. We also discovered that wind and water are causing the changes to the shape of Surtsey's land.

In this lesson we apply our learning about how wind and water change land as we complete a Conceptual Checkpoint.

Later we will explore time spans of Earth events that cause changes to land.

STANDARDS ADDRESSED

This lesson provides students with the opportunity to demonstrate progress toward the Module Objectives. For detailed information on the alignment between Module Objectives and summative assessments, including this Conceptual Checkpoint, see the Assessment Maps section in the Module Overview. The table that follows lists NGSS elements summatively assessed in this lesson.

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.2: Developing and Using Models • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	ESS2.A: Earth Materials and Systems • Wind and water can change the shape of the land.	CC.3: Scale, Proportion, and Quantity • Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower). CC.7: Stability and Change • Some things stay the same while other things change.

MATERIALS

The table lists materials needed for each section of this lesson.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	☐ Science Logbook (1 per student)	None	No disposable or prepared materials from this lesson are reused in the module.
Conceptual Checkpoint	☐ Prepared fairy chimney formation chart (1 per student) ☐ Prepared Lesson 4 Conceptual Checkpoint (1 per student)	☐ Lesson 4 Resource A: Photographs of Fairy Chimneys	
Land	None	None	

LAUNCH 5 minutes or less

Students summarize how their learning from this concept helps them make sense of the anchor phenomenon.

1. Discuss how students have acquired new knowledge throughout the concept.

Display the anchor model, and ask students to review the Knowledge Tracker in their Science Logbook. Use prompts such as the following to facilitate a discussion about what students have learned so far.

 **How is Surtsey's land changing over time?**

 **How are wind and water changing Surtsey's land?**

 **How did we figure out that the size and shape of land can change?**

Listen for students to mention the following:

- That Surtsey was formed when a volcano erupted and has been getting smaller and changing shape over time
- That wind and water have changed the size and shape of Surtsey's land
- Investigations or activities that helped students develop their knowledge about how wind and water can cause changes to land

2. Transition the class to the Conceptual Checkpoint.

Explain that students can use what they know about changes to the size and shape of Surtsey's land to make sense of other, similar phenomena. Tell students that they will now apply their knowledge of how wind and water can change land to a new context as they complete a Conceptual Checkpoint.

Agenda | 30 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 30 minutes

- Conceptual Checkpoint (20 to 30 minutes)

LAND | 5 to 10 minutes

LEARN 20 to 30 minutes

Conceptual Checkpoint | 20 to 30 minutes

Students apply their learning about how wind and water change land to a new phenomenon, the formation and shaping of Cappadocia's fairy chimneys, as they complete a Conceptual Checkpoint.

3. Introduce the Lesson 4 Conceptual Checkpoint.

 LESSON 4 RESOURCE A, LESSON 4 RESOURCE B

Display the photographs of fairy chimneys in Cappadocia, Turkey. Tell students that a fairy chimney is a tall, narrow landform made of rock.  



Teacher Note

The landforms of Cappadocia and nearby Göreme National Park in Turkey have been listed as UNESCO World Heritage Sites since 1985 because of their unique cultural, historical, and natural features. The geology of the region is the result of millions of years of volcanic eruptions and earthquake events, and of human activity that dates back to the fourth century.

Teacher Note

Fairy chimneys are sometimes referred to as hoodoos. These landforms are natural features that are found throughout the world, primarily in hot, dry areas. Many of the fairy chimneys in the United States can be found in Bryce Canyon National Park, Badlands National Park, and the Colorado Plateau.

... **What do you notice about the fairy chimneys in the pictures?**

... **How do you think fairy chimneys form?**

Build on students' responses to explain that fairy chimneys form as wind and water change land.  Facilitate a discussion to elicit students' prior knowledge of other landforms created by wind and water interacting with land.

... **Do fairy chimneys remind you of other landforms you have seen?**

... **Think about the land and landforms on Surtsey. What are wind and water doing to Surtsey's elevation? How are wind and water changing Surtsey's landforms?**

Listen for students to mention the following ideas:

- Wind and water are changing Surtsey's elevation.
- Wind and water are changing the shape of Surtsey's landforms, such as the spit, the hills, the cliffs, and the craters.

Then direct students to consider how Cappadocia's land and its fairy chimneys are changing over time. Tell students that they will use what they know about how wind and water can cause changes to land to explore the Phenomenon Question **How do fairy chimneys form and change shape?**

Provide each student with a prepared Conceptual Checkpoint and a prepared fairy chimney formation chart.

4. Read aloud each assessment item, and give students time to complete the Conceptual Checkpoint.

Tell students that the fairy chimney formation chart provides information about how a fairy chimney forms. Instruct students to look at the images and the text in the chart. Then read aloud the information on the chart as students follow along. 

Next, direct students' attention to the Conceptual Checkpoint. Read aloud the first item. Tell students to refer to the fairy chimney formation chart as they complete this item. When students are ready, move to the next item. Continue to read aloud and to allow students time to complete the items until all students have completed the assessment.

Teacher Note

Fairy chimneys form slowly, over millions of years, as land is shaped by wind and water. Most fairy chimneys are made up of harder rock at the top and softer rock below. The harder rock shields the softer rock, slowing the effects of wind and water on the softer rock. The softer rock that remains forms the base of a fairy chimney, a tall vertical column that often resembles a capped mushroom or totem pole.

Teacher Note

Each column of the chart provides information about a stage in the fairy chimney formation process. Columns include an illustration and a description of events that occur to form a fairy chimney. Read the chart column by column to walk students through the process.



Conceptual Checkpoint

This Conceptual Checkpoint assesses students' understanding of the knowledge and skills they developed throughout Concept 1. Use the Lesson 4 Conceptual Checkpoint Scoring Guide to score each student's assessment. The scoring guide also lists the NGSS elements assessed by each item and identifies next steps for students who need additional support.

Teacher Note

Debriefing the Conceptual Checkpoint provides an opportunity to identify each student's strengths and growth areas and to respond flexibly to students' needs before moving to the next concept. This practice also helps students develop their metacognition skills as they identify the knowledge they applied to respond to assessment items and notice where they might have made mistakes.

To debrief the Conceptual Checkpoint, use the scoring guide to score each student's assessment. (See the scoring guide and sample responses in Appendix A: Summative Assessments and Scoring Guides.) Identify at least one assessment item to debrief with the class. Select an exemplar response to this item either from the Teacher Edition or from a student assessment. If selecting a response from a student assessment, remember to remove identifying information. Be sure to select responses from a variety of students over time.

When providing students with individual feedback on the assessment, guide them to focus on specific areas for improvement to deepen their understanding of the concept. Offer students who need additional support the opportunity to revisit portions of the module.

LAND 5 to 10 minutes

Students reflect on the related phenomena that they identified earlier in the module, which helps them make connections between their own experiences and rich, sometimes distant, phenomena. Students also identify remaining gaps in their understanding of the anchor phenomenon, which drives future learning.

5. Reflect as a class on related phenomena.

Remind students that they recorded related phenomena on the Driving Question board earlier in the module. Use the following prompts to engage students in a discussion about these related phenomena. 

 **How has your thinking about these related phenomena changed? How has your thinking about these phenomena stayed the same?**

 **Can you use what we have learned so far to explain these phenomena?**

 **Does what we have learned remind you of any other phenomena?**

Listen for students to share additional examples of phenomena related to land and landforms changing shape. As necessary, update the Driving Question board with students' new ideas.

6. Update the Driving Question board.

Display the Driving Question board, and direct students' attention to the unanswered questions they recorded. Read aloud the question on each sticky note, and have students use a nonverbal signal to show whether they can now answer the question. Then create a second column. Guide students to choose a column title such as Questions About Land. If students signal that they can answer a question, move the sticky note to the new column. Finally, invite students to share new questions or additional related phenomena. Add the questions to the column of unanswered questions, and add the phenomena to the Related Phenomena section.

 Teacher Note

This discussion will vary across classrooms depending on students' experiences and backgrounds. If students share related phenomena that can be explained by wind and water causing changes to land, take a moment to let students discuss those phenomena. For example, if students share the related phenomenon of the shoreline of a beach changing every year, engage students in a discussion about how water and wind can change the shoreline of a beach.

Sample Driving Question board:

Driving Question: How can the island of Surtsey change shape over time?

Questions About Land

What is it like on Surtsey?

What is the land on Surtsey made of?

Do volcanoes create other islands?

What is causing Surtsey to change shape?

Unanswered Questions

Will the volcano that formed Surtsey erupt again?

Does all land change shape?

How long is it taking for Surtsey to change shape?

What other kinds of landforms are there?

Are other islands changing shape like Surtsey?

Related Phenomena:

Sometimes bad weather can change the shape of land.

People can use tools and machines to change the land.

The shoreline at the beach keeps changing every year.

The land on our playground has soil and rocks in it.

Tell students that they will continue to investigate their unanswered questions in upcoming lessons.

Lesson 4

PREPARATION RESOURCE

PART 1 of 1

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- ☐ Lesson 4 Conceptual Checkpoint
- ☐ Lesson 4 Resource A: Photographs of Fairy Chimneys
- ☐ Lesson 4 Resource B: Chart Showing How Fairy Chimneys Form
- ☐ Printer access

PREPARATION

Complete the following tasks to prepare for this lesson part. Module resources needed for preparation follow this preparation resource.

Fairy Chimney Formation Chart | 5 minutes or less

Materials

- ☐ Lesson 4 Resource B: Chart Showing How Fairy Chimneys Form
- ☐ Printer access

Instructions: Print a copy of Lesson 4 Resource B for each student.

Lesson 4 Conceptual Checkpoint | 5 minutes or less

Materials

- ☐ Lesson 4 Conceptual Checkpoint
- ☐ Printer access

Instructions: Print a color copy of Lesson 4 Conceptual Checkpoint for each student.
(See Appendix A.)

Lesson 4 Resource A

PHOTOGRAPHS OF FAIRY CHIMNEYS

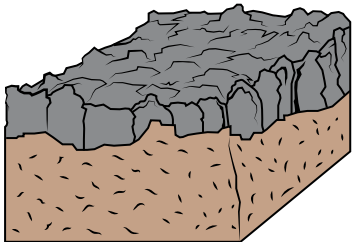
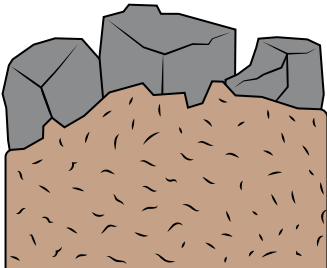
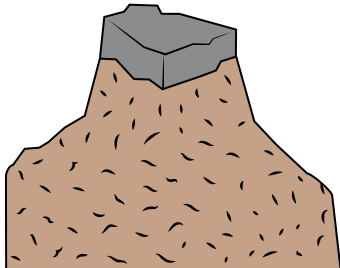
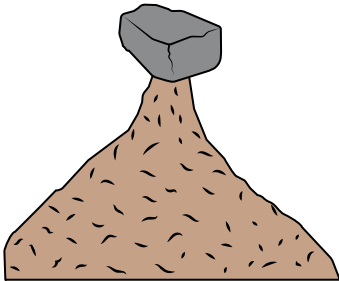






Lesson 4 Resource B

CHART SHOWING HOW FAIRY CHIMNEYS FORM

1	2	3	4
 There are layers of softer rock below the surface of the land. A thin layer of hard rock covers the softer rock.	 Water from rain and snow causes cracks in the rock. Pieces break off from the layer of hard rock.	 Water washes away some of the softer rock below. Wind blows away small pieces of softer rock and sand.	 Water and wind change the softer rock more quickly than they change the hard rock. A tower of rock forms. This tower is called a fairy chimney.



APPLICATION OF CONCEPTS ENGINEERING CHALLENGE



Application of Concepts

LESSON 5 ENGINEERING CHALLENGE

Task | Engineering Challenge

Phenomenon Question | How can we slow changes to the land of Montauk Point to protect the Montauk Point Lighthouse?

OVERVIEW

Previously we investigated how wind and water can cause the shape of Surtsey's land to change over time.

In this lesson we apply our knowledge of how water can change land to solve a problem during an Engineering Challenge. We follow the engineering design process to develop a shoreline protection system that could slow changes to the shoreline of Montauk Point and prevent the Montauk Point Lighthouse from falling into the ocean.

Later we will build on our understanding of how land changes as we explore how long it takes for land to change.

Lesson Objective

Compare the effectiveness (SEP.6) of multiple (ETS1.C) systems (CC.4) that are solutions (ETS1.C) designed to reduce the impact of water on the shape of land (ESS2.A).

Performance Descriptors

Part 1: **Compare multiple (SEP.6) systems (CC.4)** designed to prevent **water from changing the shape of land (ESS2.A)**.

Part 2: Test **the function of different materials (CC.6)** to evaluate how well they slow **water's changes to land (ESS2.A)**, and **use comparisons of the testing data (SEP.5) to compare possible design solutions (SEP.6)** and to determine which **solutions (ETS1.C)** would work well.

Part 3: **Compare multiple solutions (SEP.6) for a shoreline protection system (CC.4)** to determine which **solution (ETS1.C)** works best to slow **water's changes to land (ESS2.A)**.

Part 4: **Use evidence to explain (SEP.6)** how **the parts of a shoreline protection system work together (CC.4)** to reduce **the impact of water changing the shape of land (ESS2.A)**.

STANDARDS ADDRESSED

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.5: Using Mathematics and Computational Thinking • Use quantitative data to compare two alternative solutions to a problem. SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. • Generate and/or compare multiple solutions to a problem.	ESS2.A: Earth Materials and Systems • Wind and water can change the shape of the land. ETS1.C: Optimizing the Design Solution • Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	CC.4: Systems and System Models • Systems in the natural and designed world have parts that work together. CC.6: Structure and Function • The shape and stability of structures of natural and designed objects are related to their function(s).



PART 1 of 4

PREPARE 30 to 45 minutes

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 5 Preparation Resource.

Shoreline models (20 to 25 minutes)

Shoreline model with lighthouse (5 to 10 minutes)

Shoreline protection system cards (5 to 10 minutes)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 1.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	☐ Science Logbook (1 per student)	☐ Lesson 5 Resource A: Engineering Design Process Visual ☐ Lesson 5 Resource B: Montauk Point Lighthouse Photographs	The list identifies disposable and prepared materials to save for reuse in the module. ☐ Class problem and solution chart ☐ Shoreline models ☐ Shoreline model with lighthouse
Learn: Ask About an Engineering Problem	☐ Safety goggles (1 per student) ☐ Science Logbook (1 per student)	☐ Prepared shoreline model with lighthouse (1) ☐ Safety goggles (1 for teacher) ☐ Chart paper and marker for 2 class charts ☐ Lesson 5 Resource A: Engineering Design Process Visual	
Learn: Compare Possible Solutions	☐ Prepared shoreline protection system cards (1 set per student pair)	☐ Prepared shoreline protection system cards (1 set)	
Land	None	☐ Lesson 5 Resource D: Bulkhead Photograph	

LAUNCH 5 to 10 minutes

Students review the stages of the engineering design process to prepare for the Engineering Challenge. Students then observe photographs of the Montauk Point bluff and identify a problem facing the Montauk Point Lighthouse.

1. As a class, review the engineering design process.

 LESSON 5 RESOURCE A  LESSON 5 ACTIVITY GUIDE A

Have students reflect on their experience designing a solution to a problem during the previous module's Engineering Challenge. Display the engineering design process visual, and have students turn to the same visual in their Science Logbook. Review the stages of the process: Ask, Imagine, Plan, Create, Test, Improve, and Share. Tell students that during this lesson, they will use the stages of the engineering design process to solve a problem. Keep the engineering design process visual displayed for students to refer to.

Direct students' attention to the Ask stage on the engineering design process visual.

What happens in the Ask stage of the engineering design process?

Listen for students to recall the following actions that happen during the Ask stage:

- People define the problem and brainstorm possible solutions.
- People decide how they will know whether a solution solves the problem.

Explain that students will work to solve a problem related to land changing.

Performance Descriptor

Compare multiple (SEP.6) systems (CC.4) designed to prevent **water from changing the shape of land (ESS2.A)**.

Agenda | 30 to 45 minutes

LAUNCH | 5 to 10 minutes

LEARN | 20 to 30 minutes

- Ask About an Engineering Problem (10 to 15 minutes)
- Compare Possible Solutions (10 to 15 minutes)

LAND | 5 minutes or less

2. Have students compare photographs of the Montauk Point Lighthouse.

 LESSON 5 RESOURCE B

Display the two photographs of the Montauk Point Lighthouse. 



Tell students that both photographs show the Montauk Point Lighthouse, which stands on a landform called a bluff. Draw students' attention to the bluff in the photographs. Tell students that a bluff is a steep or rounded cliff that forms near a body of water or near where a body of water used to be. 

Language Support

Students will encounter the term *bluff* throughout the module. Multilingual learners may benefit from additional scaffolding in the form of sentence frames such as these:

- In the first picture, the bluff is _____. In the second picture, the bluff is _____.
- Some differences between the two pictures are _____.

Explain that the first photograph was taken a long time ago—many years before the second photograph, which was taken recently. Ask students to observe the photographs, and then invite students to share with the class their observations of how the land has changed. Have students use a nonverbal signal to indicate whether they agree with each of their classmates' ideas. Annotate the photographs by circling areas that students agree show change. 

Content Area Connection: Mathematics

Consider telling students that the historic Montauk Point Lighthouse was commissioned by George Washington in 1792. When the lighthouse was built, the edge of the bluff was about 300 feet from the lighthouse. By the mid-1960s, the edge of the bluff was about 60 feet from the lighthouse. Have students use their understanding of place value to figure out how much land had been lost by the mid-1960s.

Teacher Note

Students unfamiliar with Long Island, New York, may benefit from viewing maps of the United States and Long Island Sound to gain context for the water and land interactions along the shoreline at Montauk Point. Consider supplementing the lesson with maps or photographs as necessary.

Teacher Note

These annotations may be made in a variety of ways. For example, depending on your personal preference and the classroom technology available, you may opt to project or print Lesson 5 Resource B and then annotate by hand, or you may opt to add the annotations digitally.

Sample annotated photographs:



What differences do you notice between the pictures?

Listen for students to notice differences in the following:

- The shape and size of the bluff
- The rocks along the shoreline
- Where the buildings are relative to the water

Ask students to consider what they have learned about how land can change. Tell students to use their knowledge to better describe the problem with the Montauk Point Lighthouse. 📄

Remember what we know about how land can change. Can we use our knowledge to explain the differences in the pictures?

Listen for students to refer to their knowledge about how wind and water can move land from one place to another and to explain that wind and water could be changing the land of Montauk Point.

Imagine that the land of Montauk Point continues to change. What do you think will happen?

Listen for students to predict that if the land continues to change, the edge of the bluff will get closer to the buildings and the lighthouse could fall into the ocean.

Use students' responses to confirm that if the land continues to change, the lighthouse could fall into the ocean.

Teacher Note

Consider reviewing students' learning from the wind and water investigations and the wave model in Lesson 3. Ask students questions such as these: After we added wind to the wind model, what happened to the land? After we added water to the rain and river models, what happened to the land? Think about your observations of the wave model. Do you notice anything similar about the land around the lighthouse? Imagine that waves continue to wash away the land by the shoreline. What will happen to the lighthouse?

3. Introduce the Phenomenon Question.

Introduce the Phenomenon Question **How can we slow changes to the land of Montauk Point to protect the Montauk Point Lighthouse?** Tell students that they will further define the problem facing the lighthouse as they work through the engineering design process.

LEARN 20 to 30 minutes

Ask About an Engineering Problem | 10 to 15 minutes

Students observe a shoreline model demonstration that represents waves interacting with the shoreline of Montauk Point. Students then further define the engineering problem, focusing on the effects of waves on the shoreline. Students determine that they need to develop a solution that protects the shoreline, and they decide on criteria for the solution to succeed.

4. Introduce the shoreline model, and guide students to understand that it represents waves changing the land of Montauk Point.

Remind students that just as they cannot travel to Surtsey to observe its land changing shape, they cannot go to Montauk to observe changes to its land that affect the lighthouse.

 **We want to investigate what will happen to the lighthouse if the land keeps changing. How could we investigate that in our classroom?**

Build on students' responses to suggest that students use a model similar to the wave model they used in Lesson 3. Then gather the class around the prepared shoreline model with a lighthouse, and give each student a pair of safety goggles.



What does each part of the model represent?

Listen for students to identify that the sand represents the land of Montauk Point and that the straw represents the Montauk Point Lighthouse.

How can we use the model to discover what will happen if the land keeps changing?

Listen for students to suggest adding water to the model. Students may mention that the water interacting with the sand represents waves interacting with the land of Montauk Point.

In $\frac{1}{4}$ cup increments, add water to the part of the bin that is opposite the bluff until the water is approximately $\frac{1}{4}$ inch deep. Point out the location of the shoreline in the model. Remind students that a shoreline is the place where land and a large body of water meet.

Tell students that many different factors affect the Montauk Point shoreline. 📖

Inform students that because they cannot model all the wind and water interactions that affect Montauk, the shoreline model will demonstrate just the changes that waves make to the land of Montauk Point.

Create waves by gently lifting the end of the bin that is opposite the bluff by 3 inches and then gently lowering it. Explain that each up-and-down motion is one wave. Ask students to count each wave, and then continue the demonstration by lifting and lowering the bin until the bluff washes away and the lighthouse falls over. On a sheet of chart paper, record the total number of waves in the demonstration, and display this in the classroom for the remainder of the Engineering Challenge. 📖

Teacher Note

Sea level changes and storms are other factors that affect the Montauk Point shoreline. Consider explaining that big storms happen at Montauk Point. Tell students that these storms bring heavy rain and wind and can create strong waves along the shoreline. Add that sea levels are rising, which worsens the effects of storm waves. Conclude that both wind and water change the land of Montauk Point.

Teacher Note

The sample class problem and solution chart shown later in this Learn lists 24 as the total number of waves created in the demonstration. This is an approximate count, as the actual number of waves required for the lighthouse to fall may be higher or lower depending on the saturation of the materials and the compaction of the sand in the model. Students' models will show similar variability.

5. Have students further define the problem, identify the solution, and decide on criteria for success.

 LESSON 5 RESOURCE A  LESSON 5 ACTIVITY GUIDE B

Revisit the engineering design process visual. Remind students that during the Ask stage, people define the problem they need to solve, and review that students have only started to define the problem. Have students Think–Pair–Share to figure out the problem that waves cause for the Montauk Point Lighthouse. As students share, build on their responses to define the problem as a class.

Create a class problem and solution chart with three columns. Record the class problem in the first column. Have students record the class problem in the same column on the chart in the Ask section of their Science Logbook. 

Sample class problem and solution chart:

What is the problem?		
<i>Waves can wash away the land around the Montauk Point Lighthouse. Then the lighthouse will fall into the water.</i>		

 What do you think people could do to solve this problem?

Highlight responses related to people preventing water from changing the land around the lighthouse.

 How could we use the shoreline model to come up with a solution?

Listen for students to mention using the model to figure out a solution that protects the shoreline and lighthouse by slowing down water or preventing it from washing away land.

Record the solution on the class problem and solution chart, and have students record the solution in their Science Logbook.



Differentiation

To provide writing support for students, consider simplifying the information in the chart. Alternatively, after the class has filled out the chart, consider creating printed versions of the problem, solution, and criteria for success statements for students to paste into each column.

Sample class problem and solution chart:

What is the problem?	What is the solution?	
<i>Waves can wash away the land around the Montauk Point Lighthouse. Then the lighthouse will fall into the water.</i>	<i>We will create a solution that protects the shoreline. The solution will slow down water or prevent it from washing away the land.</i>	

How will we know if our solution works?

Listen for students to identify the following criteria for the solution:

- The shoreline protection system will make it harder for the waves to move the land.
- Less land will wash away.
- The lighthouse will not fall over. 

Prompt students to consider how they can measure how successful their solution is. If necessary, remind students of the number of waves recorded during the demonstration. Guide students to judge the success of their solution by whether their lighthouse is still standing after that number of waves or more. Add the criteria for a successful solution to the class chart, and have students do the same in their Science Logbook. 

Sample class problem and solution chart:

What is the problem?	What is the solution?	How will we know if the solution works?
<i>Waves can wash away the land around the Montauk Point Lighthouse. Then the lighthouse will fall into the water.</i>	<i>We will create a solution that protects the shoreline. The solution will slow down water or prevent it from washing away the land.</i>	<i>We will know the solution works if the lighthouse is still standing after at least 24 waves.</i>

Teacher Note

Human intervention cannot completely stop the ongoing processes that change the shape of land. If students suggest that a solution will stop land from washing away completely, briefly explain that Earth is constantly changing and that humans can only try to slow the natural processes that result in changing land.

Teacher Note

For an added challenge and to account for variation between students' shoreline models and the model used for the demonstration, consider guiding the class to agree on a number of waves slightly greater than the number recorded during the demonstration.

What questions do you have about how to design and build your solution?

Remind students that many of their questions will be answered during the Imagine stage of the engineering design process, when they brainstorm ideas for solutions.

Compare Possible Solutions | 10 to 15 minutes

Students compare the parts of different shoreline protection systems and discuss how the systems work together to hold land in place.

6. Distribute shoreline protection system cards, and have students consider the materials that make up the parts of the systems.

Tell students that when doing engineering, people look at solutions that already exist for problems similar to the one they need to solve. Explain that doing so can help people come up with new ideas.

Place students in pairs, and give each pair a set of prepared shoreline protection system cards. Use the cards to emphasize the term *system*, and explain that a system is made of parts that work together, or interact. Explain that each shoreline protection solution is a system because it is made of different parts that work together to protect the land. Tell students that the cards show examples of different shoreline protection systems and examples of the materials people use to build the systems. 

Read each card aloud. Explain that pairs will examine their cards to look for the parts that make up each system and will record their thinking on the cards. Write the following questions on the board, and read them aloud. Encourage pairs to consider the questions as they look at their cards and as they record notes. 

 How are the materials in the systems similar? How are the materials different?

 How are the systems similar? How are the systems different?

 How do the parts of each system work together?

Language Support

Students will encounter the term *system* throughout the module. Providing the Spanish cognate *sistema* may be helpful. Consider having students think of systems that they encounter in their lives, such as a lunch line.

Differentiation

Consider providing highlighters and colored pencils that students can use to label, circle, or underline important information. If students need support to answer the questions on the board, suggest that they use one color to identify materials and another color to draw lines that show how the materials interact to form a system.

Instruct pairs to begin working. After they finish, have them compare their answers to the questions with another pair’s answers. Then invite pairs to share with the class. As a class, discuss each shoreline protection system, how it works, and what materials it requires, as well as how the different systems and their materials compare. 🌟

Listen for students to identify the following:

- Similarities in the materials systems use (e.g., the edging and the bulkhead can both use wood, the bulkhead and the revetment can both use concrete)
- Differences in the materials systems use (e.g., only the edging uses plants or straw, only the revetment uses wire baskets filled with rocks, only the bulkhead uses steel)
- Similarities in the function of the systems (all the systems work to keep the land in place)



Check for Understanding

Compare multiple (SEP.6) systems (CC.4) designed to prevent **water from changing the shape of land (ESS2.A)**.

EVIDENCE	NEXT STEPS
Look for indications of the following in students’ notes on the shoreline protection system cards: • Students identify similarities and differences between the materials the shoreline protection systems use (SEP.6). Listen for the following in students’ responses during the class discussion: • Students explain that all the shoreline protection systems have materials that work together but that the materials may be different (SEP.6). • Students identify how the parts in each system work together (CC.4) to keep the land in place (ESS2.A).	If students need support to compare the shoreline protection systems, pose questions such as these to guide their thinking: • What different materials make up the parts in each system? • How are the systems similar? How are they different? • How does each system make it harder for water to change the land?



Spotlight on Disciplinary Core Ideas

Students build on their knowledge of the structure and properties of matter as they describe the materials by their observable properties and discuss how different properties may be suited to different purposes (PS1.A).

Summarize that each system that protects the shoreline uses a different combination of materials and that each system is designed to hold the land in place and prevent water from changing the land.

LAND 5 minutes or less

Students identify the parts of a bulkhead protection system and predict what might happen when parts are removed from the system.

7. Have students discuss how the parts of a bulkhead system work together.

LESSON 5 RESOURCE D

Display the bulkhead photograph, and tell students that it shows another system that protects the shoreline. Invite students to share their observations of the system.



What are the parts of this system?

Listen for students to notice plants, a wooden fence, and wooden posts.

Imagine we remove one of the parts from this system. What might happen?

Help students recognize that when one part of a system is removed, the system may not work properly. Draw students' attention to the flat wooden planks.



Imagine we replace the wood with a different material, such as cloth. What might happen?

Listen for students to suggest that water can move through cloth, so the cloth might not be able to hold the land in place.

Explain that for a system to be successful, its materials must have properties that allow the system's parts to work together. Tell students that in the next lesson part, they will enter the Imagine stage of the engineering design process. Inform students that during this stage, they will consider the best use of materials as they design a shoreline protection system for Montauk Point.



PART 2 of 4

PREPARE 30 to 40 minutes

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 5 Preparation Resource.

Shoreline protection system procedure sheets (5 minutes or less)

Shoreline protection system testing stations (20 to 25 minutes)

Engineering Challenge testing materials (5 to 10 minutes)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 2.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	None	☐ Lesson 5 Resource E: Bulkhead Diagram	The list identifies disposable and prepared materials to save for reuse in the module. ☐ 2" straw piece from shoreline model with lighthouse ☐ Engineering Challenge testing materials ☐ Shoreline protection system testing stations
Learn: Imagine a Shoreline Protection System	☐ Safety goggles (1 per student) ☐ Prepared shoreline protection system procedure sheet (1 per group) ☐ Prepared shoreline protection system testing stations (1 per group) ☐ Science Logbook (1 per student)	☐ Safety goggles (1 for teacher) ☐ Prepared Engineering Challenge testing materials (1 set) ☐ Chart paper and marker for class chart ☐ Prepared shoreline protection system procedure sheet (1)	
Learn: Plan a Shoreline Protection System	☐ Science Logbook (1 per student)	☐ 2" straw piece (1, from shoreline model with lighthouse from Part 1) ☐ Shoreline model (1, from prepared group materials) ☐ Lesson 5 Resource A: Engineering Design Process Visual	
Land	None	None	

LAUNCH 5 minutes or less

Students first describe a bulkhead system from memory and then try again to describe a bulkhead system while referring to a labeled diagram. This activity provides students with an opportunity to understand why people create sketches and diagrams of their engineering ideas.

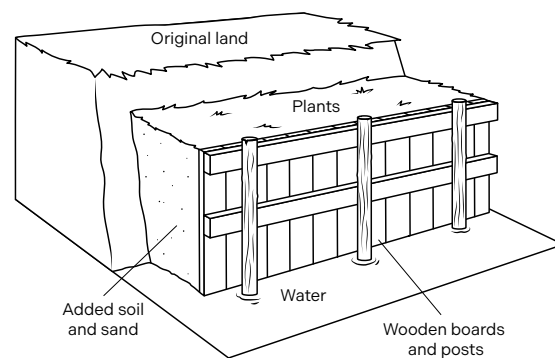
1. Have students describe the parts of a bulkhead system from their memory of a photograph and then again while viewing a diagram.

 LESSON 5 RESOURCE E

Use the Inside–Outside Circles routine to engage students in a discussion about the design of a bulkhead shoreline protection system. When students are in their circles, ask them to reflect on the photograph of the bulkhead system they examined in the previous lesson part and to try to recall the parts of the system. Then provide the following prompt for the routine.

 **Describe the parts of the bulkhead system to your partner.**

Next, display the bulkhead diagram.



Rotate the circles, and then provide the following prompt.

 **Look at the diagram of a bulkhead system. Describe the parts of the system to your partner.**

Bring the class back together, and ask students to compare the two ways they described the bulkhead shoreline protection system.

Performance Descriptor

Test **the function of different materials (CC.6)** to evaluate how well they slow **water's changes to land (ESS2.A)**, and **use comparisons of the testing data (SEP.5)** to **compare possible design solutions (SEP.6)** and to determine which **solutions (ETS1.C)** would work well.

Agenda | 35 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 25 to 35 minutes

- Imagine a Shoreline Protection System (15 to 20 minutes)
- Plan a Shoreline Protection System (10 to 15 minutes)

LAND | 5 minutes or less

 **First you described the system from memory. Then you described the system by looking at a diagram. Which way was easier? Why?**

Listen for students to mention that they found it easier to describe the system by looking at a diagram because they could see the system's parts.

Remind students that the Imagine stage of the engineering design process includes drawing sketches and creating diagrams like the one of the bulkhead system.

 **Why does it help to draw sketches and diagrams of designs?**

Listen for students to mention the following ideas:

- Drawing sketches and diagrams helps people remember their design ideas so they do not forget anything.
- Sketches and diagrams help other people understand what a solution could look like and what parts it could have.

Encourage students to use sketches as they test materials and brainstorm possible design solutions throughout the rest of the lesson.

LEARN 25 to 35 minutes

Imagine a Shoreline Protection System | 15 to 20 minutes

Students test materials for building their shoreline protection systems. Then they use the class data to determine the best materials to use.

2. Have students discuss which materials they should test, and explain the procedure for testing materials.

Remind students of the Phenomenon Question **How can we slow changes to the land of Montauk Point to protect the Montauk Point Lighthouse?** Tell students that they will use a shoreline model to test materials for their solution. Divide the class into groups for the Engineering Challenge. 

Give each group a prepared shoreline protection system procedure sheet, and give each student a pair of safety goggles.



Differentiation

Students should work in the same groups for the entire Engineering Challenge. When placing students in groups, consider students' ability levels and interests. For example, grouping students with different levels of English language proficiency can support the development of interpersonal and academic language skills.

 Safety Note

During this activity, students work with sand. Tell students to wear safety goggles when working with sand to minimize risk.

Draw students' attention to the prepared shoreline protection system testing stations. Then point out the designated area for the prepared Engineering Challenge testing materials, and display one of each material. Ask students to think about how they could use the materials to design a solution that slows changes to the land. Pose the following question, and take a class vote.

 **How should we choose which materials to test? Should we choose just one material to test? Or should we test all the materials?**

Tally students' responses on the board, and invite students to explain why they voted the way they did.

Look and listen for students to decide that they should test all the materials. Listen for students to mention that testing all the materials allows them to determine which material works best.

Explain that students will choose from the testing materials when they create their system that protects Montauk Point. Remind students of the shoreline protection cards they examined in the previous lesson part and the discussion they had about the materials those systems were made of.

 **We want to figure out which materials work best to protect the shoreline. What properties of materials should we test?**

Listen for students to suggest testing properties that relate to how well materials cover the land and hold it in place or how well materials block water and keep waves from washing away the land.

Explain that groups will use their shoreline model to test each material and find out how well it slows changes to land.

Next, read aloud the safety guidelines for the Engineering Challenge, and ensure that students understand each expectation.

 Safety Note

This Engineering Challenge poses potential hazards. To minimize the risks, review these safety guidelines with students, as well as other safety guidelines specific to the materials available:

- Wear safety goggles throughout the activity.
- Do not touch the tips of the toothpicks.

- Use the putty knife safely. Do not point it at others.
- Use scissors safely. Cut away from fingers, hands, arms, and legs.
- Do not put any material in or near your mouth.
- If water or another material spills, tell an adult right away.
- Wash your hands after the activity.

Tell students that they will follow the procedure sheet at their station to test the materials one at a time. Read the procedure aloud, and answer any questions students have. Then assign each group to a station. Instruct one student from each group to visit the designated area to gather the materials their group needs to begin building their shoreline protection system.

3. Provide time for students to test materials.

 LESSON 5 ACTIVITY GUIDE B

Reread each step of the procedure as groups follow along to test their first material. While groups work, circulate to provide guidance. After groups test their first material, instruct them to refer to the procedure sheet as they repeat the procedure for each remaining material. 

Teacher Note

Materials can be shaped and positioned in the model in various ways. If groups have trouble deciding how to arrange their materials, consider assigning groups specific ways to place the materials to ensure that students test different arrangements (such as placing the twigs either vertically in the sand or horizontally on top of the sand).

4. Have students share and compare their test results and decide which materials would make the best shoreline protection system.

 LESSON 5 ACTIVITY GUIDE B

On a class chart, record each material that students tested. Have groups share with the class their test results for each material. For each material, record the number of groups that colored a smiley face and the number of groups that colored a frowny face. Have students record the same tallies in the data table in the Imagine section of their Science Logbook.  Then have groups share the ways in which they shaped and positioned the materials to slow changes to the land. Record students' ideas on the class chart.

Teacher Note

If students wonder about the blanks next to the smiley and frowny faces on the chart in their Science Logbook, assure them that they do not need to fill out the blanks yet. They will do that in the next part of the activity, when the class compares testing data.

Content Area Connection: Mathematics

By recording and tallying the effectiveness of their trials with different materials, students build the skills of representing data and comparing information in a chart or graph.

Sample class chart: 

Material	Possible Designs	Test Results
Twigs	- Stand them up like a fence to block the water. - Lay them sideways across the sand.	 6  2
Chenille stems	- Stick them in the sand to try to keep it in place. - Cut or bend them into shapes that block water.	 1  7
Rocks	- Stack them to make a wall that blocks water. - Push them into the sand to hold the sand down.	 4  4
Toothpicks	- Stack them on top of each other to make a wall that blocks the water. - Stack them side by side like a fence.	 1  7
Cheesecloth	- Use it to cover the sand and keep it in place. - Roll it up like a log.	 3  5
Moss	Press it into the sand like grass to keep the sand in place.	 8  0

Tell students to examine the class chart and to decide which materials would make the best system to protect the shoreline. Have students record the materials they think are best by participating in a Stop and Jot routine. Direct students to the Material column in their Science Logbook, and instruct them to circle the materials that they think work best. Then ask students to record evidence for their decision. 

Invite volunteers to share their responses with the class.

Look and listen for students to identify the materials that will work best and to provide evidence from the test result tallies on the class chart.

Remind students that earlier, they voted to test all the materials in order to come up with the best solution.

Teacher Note

The sample results assume a total of 8 groups. Though these results indicate which materials are likely to be most effective, testing involves many variables (such as how hard the sand is packed in each model and how students place the materials). Actual classroom results may vary significantly.

Teacher Note

Stop and Jot is a written response routine that allows students to formulate individual responses related to texts or learning. Students receive a question or prompt, pause briefly before responding, and then write a response before discussing with a partner and/or the class.

 Do you think that testing and comparing all the materials helped us come up with a solution?

Listen for students to express that testing different materials allowed them to make comparisons and choose the best materials for a successful solution.

Ask students to circle a claim in their Science Logbook, using their experience with testing materials and the class discussion to help them.

Then return students' attention to the class chart, and summarize that the test results show that certain materials are better than others at slowing water's changes to land.

 Check for Understanding

Test **the function of different materials (CC.6)** to evaluate how well they slow **water's changes to land (ESS2.A)**, and **use comparisons of the testing data (SEP.5)** to **compare possible design solutions (SEP.6)** and to determine which **solutions (ETS1.C)** would work well.

EVIDENCE	NEXT STEPS
Look for the following in students' Science Logbook responses: • Students claim that it is helpful to test and compare different materials (SEP.6) to determine which materials could be part of a successful design solution (ETS1.C). • Students compare testing data the class gathered (SEP.5). • Students provide evidence that certain materials function better (CC.6) to slow water's changes to land (ESS2.A).	If students need support to use class data to identify the materials that will make the best shoreline protection system, consider reviewing the class chart with students individually or in small groups. Point out the number of groups that thought each material worked to slow water's changes to land. To help students understand how the material they choose affects the success of their solution, pose questions such as these: • What makes a material good at protecting land from water? Why do you think that? • Think about the materials we tested. Which materials had those properties? Which materials worked best? Look at our class test results. What is your evidence?

 Teacher Note

Consider posing the following questions to expand on the class discussion:

- Imagine you tested only one material. What would happen?
- Why did it help to compare different groups' results?

Plan a Shoreline Protection System | 10 to 15 minutes

Students draw a design for a shoreline protection system that shows the system's parts, and they communicate how the selected materials function to slow water's changes to land.

5. Have students draw an initial design of a shoreline protection model.

 LESSON 5 ACTIVITY GUIDE B

Gather the class at one of the testing stations. Remove the testing materials and use a putty knife to reshape the bluff. Add the 2-inch straw piece to a shoreline model to represent a lighthouse, and show the class this model. Point out to students that the straw piece represents a lighthouse. Tell groups that they will use a similar model to create a system that protects the shoreline. Have students work independently to draw a design in the Imagine section of their Science Logbook that could slow changes to the land of Montauk Point and protect the lighthouse. Tell students that when choosing materials for their design, they should consider the test results on the class chart. Specify that students' design should include no more than three materials (e.g., toothpicks, cheesecloth, and rocks). Instruct students to include the shoreline model with the lighthouse in their drawing and to label each material they include.

6. Have students compare design drawings, and ask groups to decide on a final design.

 LESSON 5 RESOURCE A  LESSON 5 ACTIVITY GUIDE B

Point out the Plan stage on the engineering design process visual. Remind students that during the Plan stage, people often propose design ideas and decide on a solution to build and test. Have students share the drawing of their design in their group. Then tell groups to decide on a design they think will work best to slow changes to land. Specify that students may either choose one group member's design or combine multiple ideas into a new design. Instruct students to draw their group's final design in the Plan section of their Science Logbook and to label the parts of the system and each material. 



Differentiation

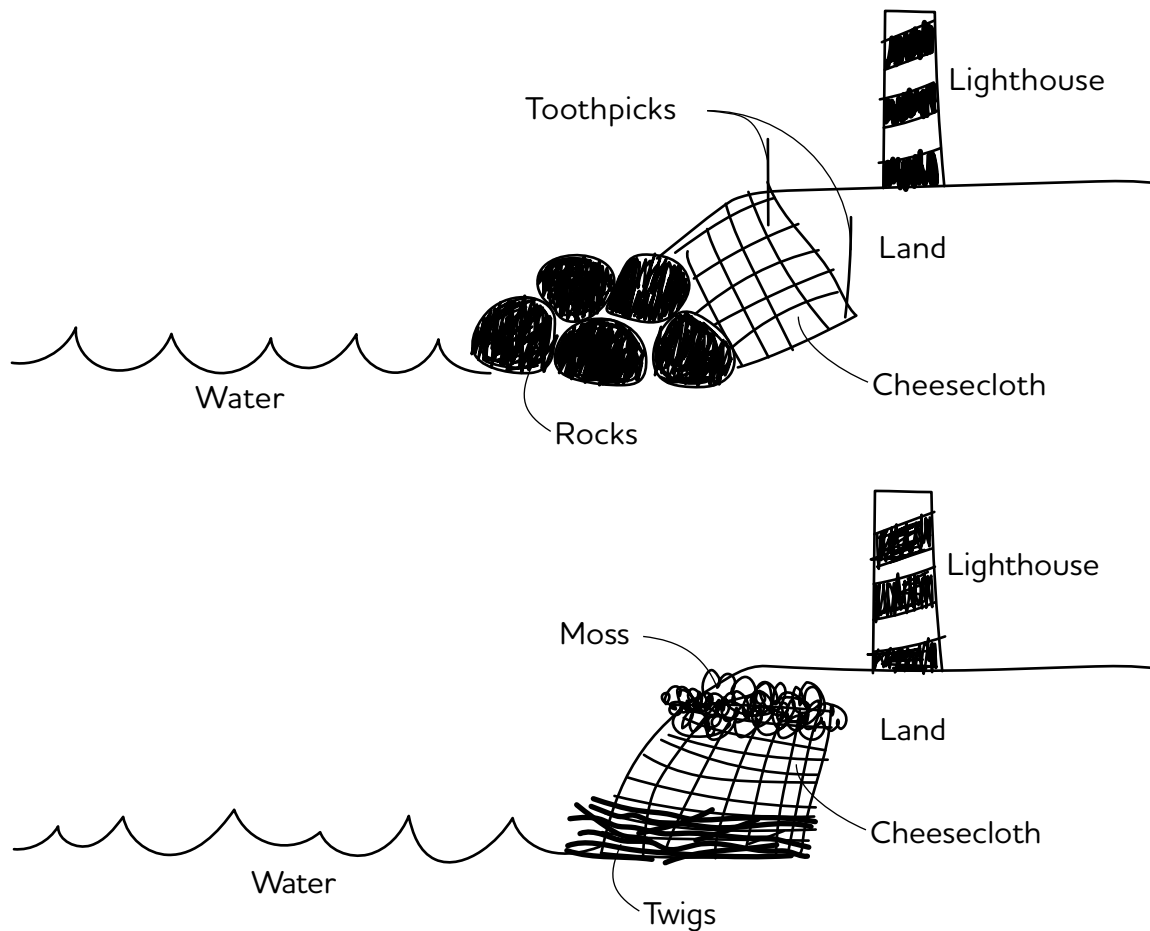
Students may need support to articulate their ideas and to agree on a final plan for their group's shoreline protection system. Consider posting the following sentence frames:

- I think we should _____ because _____.
- What if we try _____?
- I agree/disagree because _____.

Teacher Note

As students plan their design, remind them that classroom materials are limited. Let students know that the amounts of available materials are about the same as the amounts they used when they first tested the materials. If several engineering groups plan to use the same materials, consider posting a maximum amount of each material that each group can use.

Sample student designs:



LAND 5 minutes or less

Groups debrief the Plan stage by describing how their materials will work together to increase the effectiveness of their solution.

7. As a class, debrief the Plan stage.

Invite groups to describe how they expect their chosen materials to work together to create a system that successfully protects the shoreline.

After students listen to one another's ideas, encourage groups to continue thinking about different combinations of materials that might work well together in a shoreline protection system.

MATERIALS

The table lists materials needed for each section of Part 3.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	☐ Science Logbook (1 per student)	☐ Class problem and solution chart (1, from Part 1)	The list identifies disposable and prepared materials to save for reuse in the module. ☐ Student-made shoreline protection systems
Learn: Create and Test a Shoreline Protection System	☐ Safety goggles (1 per student) ☐ Prepared shoreline protection system testing stations (1 per group) ☐ Science Logbook (1 per student)	☐ Safety goggles (1 for teacher) ☐ Prepared shoreline protection system testing station (1, from prepared group materials) ☐ Engineering Challenge testing materials (1 set, from Part 2)	
Learn: Improve a Shoreline Protection System	☐ Safety goggles (1 per student) ☐ Shoreline protection system solutions at testing stations (1 per group, created in this lesson part) ☐ Prepared shoreline protection system testing stations (1 per group) ☐ Science Logbook (1 per student)	☐ Safety goggles (1 for teacher) ☐ Lesson 5 Resource A: Engineering Design Process Visual ☐ Engineering Challenge testing materials (1 set, from Part 2)	
Learn: Compare Shoreline Protection Systems	☐ Science Logbook (1 per student)	☐ Chart paper and marker for 2 class charts	
Land	☐ Science Logbook (1 per student)	None	

LAUNCH 5 minutes or less

Students review the class problem, solution, and the criteria for success. Students also review the design they recorded.

1. Review the problem and solution with students.

 LESSON 5 ACTIVITY GUIDE B

Remind students of the Phenomenon Question **How can we slow changes to the land of Montauk Point to protect the Montauk Point Lighthouse?** Direct students' attention to the class problem and solution chart from Part 1. Read aloud each column to remind students of the problem they are trying to solve, the kind of solution they identified, and how they will know whether their solution works.

Sample class problem and solution chart:

What is the problem?	What is the solution?	How will we know if the solution works?
<i>Waves can wash away the land around the Montauk Point Lighthouse. Then the lighthouse will fall into the water.</i>	<i>We will create a solution that protects the shoreline. The solution will slow down water or prevent it from washing away the land.</i>	<i>We will know the solution works if the lighthouse is still standing after at least 24 waves.</i>

Explain that groups will now build and test their design and evaluate their solution. Have students return to their engineering group, and ask them to briefly review the design they recorded in the Plan section of their Science Logbook. 

Performance Descriptor

Compare multiple solutions (SEP.6) for **a shoreline protection system (CC.4)** to determine which **solution (ETS1.C)** works best to slow **water's changes to land (ESS2.A)**.

Agenda | 30 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 35 minutes

- Create and Test a Shoreline Protection System (10 to 15 minutes)
- Improve a Shoreline Protection System (5 to 10 minutes)
- Compare Shoreline Protection Systems (5 to 10 minutes)

LAND | 5 minutes or less

Differentiation

Some students may find group work challenging. Consider assigning group members tasks such as these:

- Gathering and keeping track of materials
- Keeping the group on track
- Keeping track of time
- Counting the number of waves during testing
- Ensuring that all group members are heard and that everyone contributes

LEARN 20 to 35 minutes

Create and Test a Shoreline Protection System | 10 to 15 minutes

Students build and test their shoreline protection systems by applying their knowledge of the materials' properties and intended functions.

2. Provide time for students to build and test their design.

 LESSON 5 ACTIVITY GUIDE B

Give each student a pair of safety goggles.

Safety Note

During this activity, students work with sand. Tell students to wear safety goggles when working with sand to minimize risk.

Direct students' attention to one of the prepared shoreline protection system testing stations. Point out a prepared shoreline model with a straw and briefly review the parts of the model and what each part represents. Review how to create waves and reshape the bluff with a putty knife. Then show students how to reset the lighthouse by using the two interlocking cubes to determine its location on the bluff. Direct groups to their prepared shoreline protection system testing station.

Tell groups that they will have about 10 minutes to build and test their design. Explain that during the test, groups will count the number of waves they are able to create before the lighthouse falls and then record this number in the Create and Test section of their Science Logbook. 

Answer student questions, and then instruct one student from each group to gather the materials their group needs to begin building their shoreline protection system from the Engineering Challenge testing materials. After students collect their materials, allow groups to begin building and testing.

As groups work, circulate to listen to students' conversations and provide support if necessary.

Teacher Note

Some students may have difficulty keeping track of the number of waves in an active classroom setting. Consider telling students to nonverbally signal when they have finished building their system and are ready to test it. As necessary, help groups count the number of waves they create. Some solutions may prevent the lighthouse from falling even after a large number of waves. Consider setting a limit on the number of waves students should create (e.g., 50) before they stop.

Improve a Shoreline Protection System | 5 to 10 minutes

Students share their solutions with their peers in a Gallery Walk. Students analyze their initial solution to plan changes that could improve their system's stability and function. Students then compare their initial solution to their second solution to determine which was more successful.



Performance Checkpoint: Preparation

This activity includes a Performance Checkpoint. The Lesson 5 Part 3 Performance Checkpoint Scoring Guide provides guidance on how to score Lesson 5 Activity Guide B for each student.

3. Have students view other groups' solutions and then evaluate their own solution.



LESSON 5 RESOURCE A



LESSON 5 ACTIVITY GUIDE B

After groups test their solution and record their results, explain that students will participate in a Gallery Walk to view other groups' solutions. Specify that students will look at other groups' solutions and the test results that groups recorded. Review that during the Ask stage, students established how they would know that a solution to the problem was successful. Post the following questions for students to discuss as they view solutions.



How is this solution similar to your solution? How is this solution different from your solution?



Does this solution give you new ideas to improve your solution?

When students have completed the Gallery Walk, bring the class back together. Explain that each group will now improve, rebuild, and retest their solution. 

Display the engineering design process visual, and point out the Improve stage. Remind students that the Improve stage of the process involves changing a solution to make it better and then testing the solution again. Have students return to their groups. Consider posing the following questions, one at a time, for groups to discuss:



What about your solution worked well?



What about your solution did not work well?



Teacher Note

If a group's first solution successfully prevents the bluff from washing away after an agreed-upon maximum number of waves (e.g., 50), challenge that group to develop a different solution that achieves the same result (such as a solution that uses different materials or a solution that uses the same materials but in a different way).

 **What could you change about your solution to make it better?**

 **If you change your solution, what do you think will improve?**

Allow groups time to discuss possible solutions.

4. Introduce the Performance Checkpoint.

 LESSON 5 ACTIVITY GUIDE B

Before beginning the activity, tell students that the next several tasks they will complete are part of a Performance Checkpoint. Explain that the Performance Checkpoint will assess students' ability to compare their first solution with the second solution they will develop and to determine which solution works better. As a class, review the Improve section in students' Science Logbook. Point out the items that have an assessment icon. Tell students that these items will be scored.

5. Instruct groups to decide how they will improve their solution.

 LESSON 5 ACTIVITY GUIDE B

Ask groups to decide on one change that they think will improve their solution. Instruct students to record that change in the Improve section of their Science Logbook.

When all groups have an idea of what they would like to change, briefly discuss how students will measure the success of their updated solution.

 **How will you know if you improved your solution?**

Listen for *students to mention that the lighthouse will not fall over, will take longer to fall over, or will fall over after more waves.*

Direct groups to their testing stations, and instruct groups to make their proposed improvement. Before students test their updated solution, remind them to reshape the bluff with a putty knife and reset the straw by using the two interlocking cubes to determine its location on the bluff. After students finish testing, have them record in the Improve section of their Science Logbook the new number of waves they are able to create before the lighthouse falls.

6. Ask students to identify their more successful solution and to describe how the materials worked together to slow the water's changes to the land.

 LESSON 5 ACTIVITY GUIDE B

Ask students to compare the number of waves they recorded when they tested their first solution and the number of waves they recorded when they tested their second solution.

Then instruct students to work independently in the Improve section of their Science Logbook. Have students circle the sentence that accurately compares the two numbers of waves. Explain that students will use the sentence they choose to decide which of their solutions was more successful. Next, have students circle the solution that worked better. After students identify their more successful solution, instruct them to write two materials they used in that solution. Have students describe how the materials worked together to slow the water's changes to the land.

Compare Shoreline Protection Systems | 5 to 10 minutes

Students analyze class data from the Engineering Challenge to identify the solutions that were most successful at slowing water's changes to land. Then they discuss the features that the most successful solutions had in common.

7. In a class table, record the data from each more successful solution.

 LESSON 5 ACTIVITY GUIDE B

Have groups share the materials they used in their more successful solution and the number of waves it took for the lighthouse to fall. Assign a number to each engineering group, and record the data in a class table. In the first row, record the data from the shoreline model demonstration in Part 1.

Sample class data table:

Engineering Group	Number of Waves	Materials Used
<i>Model</i>	<i>24</i>	<i>None</i>
<i>1</i>	<i>19</i>	<i>Chenille stems and twigs</i>
<i>2</i>	<i>33</i>	<i>Rocks and cheesecloth</i>
<i>3</i>	<i>23</i>	<i>Chenille stems and cheesecloth</i>
<i>4</i>	<i>26</i>	<i>Rocks and twigs</i>
<i>5</i>	<i>47</i>	<i>Moss, cheesecloth, and toothpicks</i>
<i>6</i>	<i>38</i>	<i>Rocks, cheesecloth, and toothpicks</i>
<i>7</i>	<i>48</i>	<i>Moss, twigs, and cheesecloth</i>
<i>8</i>	<i>27</i>	<i>Moss and toothpicks</i>

8. Have students compare the results.

LESSON 5 ACTIVITY GUIDE B

When the class data table is complete, have students look closely at the Number of Waves column and the Materials Used column. Instruct students to use the information in the columns to determine which solutions were most successful and why.

Then bring the class back together, and have students participate in an Inside–Outside Circles routine to discuss the following questions:  

 **Which systems worked best?**

 **What is similar about the systems that worked best?**

 **Why do those systems work well?**

Teacher Note

A number of factors can contribute to reduced success in this Engineering Challenge. These factors include how groups place their materials (for example, groups may inadvertently weaken the bluff by forcing materials into it) and the force with which groups create waves. If groups express frustration with their results, remind students that people who design engineering solutions often improve their design many times before they are satisfied. If time allows, have students repeat testing with their chosen solution or try to replicate the success of another group's solution.

Content Area Connection: Mathematics

Collecting and comparing class results supports students' understanding of two-digit place values and of the idea that numbers can be compared as greater than, equal to, or less than one another.

Listen for students to notice similarities such as these between the most successful systems:

- *The systems used similar materials.*
- *The materials were shaped and positioned in similar ways, and they worked together in similar ways.*
- *The system parts worked together to successfully block the water and keep the land in place.*

Summarize students' responses, and record them on a class chart.

Tell students that they will work independently in the Improve section of their Science Logbook. Have students review the claim that it was helpful for groups to compare solutions with each other. Then ask students to record why this claim is true.



Performance Checkpoint: Scoring

This Performance Checkpoint assesses students' ability to **compare multiple solutions (SEP.6)** for **a shoreline protection system (CC.4)** to determine which **solution (ETS1.C)** works best to slow **water's changes to land (ESS2.A)**. Use the Lesson 5 Part 3 Performance Checkpoint Scoring Guide to score each student's assessment. The scoring guide also lists the NGSS elements this task assesses and identifies next steps for student who need additional support.

LAND 5 minutes or less

Students evaluate their designs and consider other improvements.

9. Ask students to evaluate their designs.

 LESSON 5 ACTIVITY GUIDE B

Ask students to evaluate their designs and to explain what worked well, what did not work well, and what they might change.

 **Think about the information you have now. If you could change your design, what else would you change?** 

Remind students that solutions rarely work exactly how they are supposed to the first time they are tested. Tell students that in the next lesson part, they will share their solution and tell the class about changes they would make to their system if they had the chance to improve their solution again.

Extension

If time allows and materials are available, consider presenting students with a different engineering problem related to water changing land, such as the need to stabilize the banks of a local river or other water source. Students can also build a solution to protect a different lighthouse. The Cape Hatteras website from the National Park Service (<http://phdsci.link/1619>) provides more information about the Cape Hatteras Lighthouse. To create a solution for this problem, students should repeat the engineering design process or make adjustments to their solution for Montauk Point to fit the new situation.



PART 4 of 4

PREPARE

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 5 Preparation Resource.

Gather materials shown in the Lesson 5 Preparation Resource. No preparation tasks are required for Part 4.

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 4.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	None	☐ Lesson 5 Resource A: Engineering Design Process Visual	No disposable or prepared materials from Part 4 are reused in the module.
Learn: Prepare for a Presentation	☐ Science Logbook (1 per student) ☐ Student-made shoreline protection system (1 per group, from Part 3) (optional) ☐ Safety goggles (1 per student) (optional; use if groups share a physical system)	☐ Safety goggles (1 for teacher) (optional; use if groups share a physical system) ☐ Science Logbook (1, from student materials)	
Learn: Share a Shoreline Protection System	☐ Science Logbook (1 per student) ☐ Student-made shoreline protection system (1 per group, from Part 3) (optional) ☐ Safety goggles (1 per student) (optional; use if groups share a physical system)	☐ Safety goggles (1 for teacher) (optional; use if groups share a physical system) ☐ Science Logbook (1, from student materials)	
Land	None	☐ Lesson 5 Resource G: Giorgina Reid Photograph ☐ Lesson 5 Resource H: Newspaper Article About Giorgina Reid ☐ Lesson 5 Resource I: Montauk Point Revetment Photographs ☐ Lesson 5 Resource J: Profile of Giorgina Reid (optional)	

LAUNCH 5 minutes or less

Students discuss ways to present their solution and learning to the class.

1. Have students discuss ways to present their solution and learning.

 LESSON 5 RESOURCE A

Return to the engineering design process visual. Tell students that they have reached the Share stage of the engineering design process. Remind students that during the Share stage, people present their work and learn from others. Invite students to brainstorm ways they can present their system that protects the shoreline and what they have learned.

 **How could your group share your solution with the class?**

Tell students that each group will prepare a presentation to share their solution with the class. 

LEARN 25 to 35 minutes

Prepare for a Presentation | 10 to 15 minutes

Students plan a presentation that will describe the parts of their shoreline protection system, their test results, and how the parts work together to contribute to the system's success.

2. Have groups plan their presentation and record presentation notes.

 LESSON 5 ACTIVITY GUIDE B

Have students return to their engineering group, and direct them to the Share section of their Science Logbook. Explain that groups will prepare a presentation in which they share the parts of their shoreline protection system, their test results from before and after they tried to improve the system, and any future improvements they would make to their design. Have students turn to the presentation checklist. Read the checklist aloud as students follow along. Tell students that they will use the chart and the space in their Science Logbook to record presentation notes and will use the checklist to make sure their presentation includes all necessary information.

Performance Descriptor

Use evidence to explain (SEP.6) how **the parts of a shoreline protection system work together (CC.4)** to reduce **the impact of water changing the shape of land (ESS2.A)**.

Agenda | 35 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 25 to 35 minutes

- Prepare for a Presentation (10 to 15 minutes)
- Share a Shoreline Protection System (15 to 20 minutes)

LAND | 5 minutes or less

Content Area Connection: English

As an extension to provide students with practice writing and delivering oral presentations, consider giving them time to prepare and provide a more formal presentation of their Engineering Challenge results. To meet Grade 2 writing expectations, students should include complete sentences, supporting evidence, and a concluding statement in their written Engineering Challenge summary. During their oral presentation, students should speak clearly, recount their findings with appropriate facts and applicable descriptive details, and use complete sentences.

Encourage groups to, optionally, fill out the chart and write a description of their shoreline protection system in the Share section of their Science Logbook to support their presentation. Remind groups that each group member needs to contribute to the presentation in some way. Allow groups to plan and practice their presentation, and circulate to provide support as needed. 

Share a Shoreline Protection System | 15 to 20 minutes

Students participate in a presentation to describe their shoreline protection system and to share the outcome before and after attempted improvements. Then they provide other groups with feedback about the comparative effectiveness of their solutions in slowing water's changes to land.

3. Provide time for students to share their solution and to discuss other groups' solutions.

 LESSON 5 ACTIVITY GUIDE B

Gather the class to listen to each group's presentation. Allow each group approximately 3 to 5 minutes to present. Tell students to listen for presentations to include the information on the presentation checklist.

After each group's presentation, ask the class to respond to each of the following questions.

-  **Think about the parts of the group's system. How do the parts work together to slow water's changes to land?**
-  **Think about how the group improved their system. Did that make the system work better?**
-  **How well did the group's system work? Explain how you know.**



Differentiation

Engineering groups may select the presentation format that suits their needs. Groups may consider a slideshow, a poster, an oral presentation, or a written presentation. Consult with each group to help students select a format and create a presentation in the time allowed.

**Check for Understanding**

Use evidence to explain (SEP.6) how **the parts of a shoreline protection system work together (CC.4)** to reduce **the impact of water changing the shape of land (ESS2.A)**.

EVIDENCE	NEXT STEPS
Use the presentation checklist to look and listen for the following in students' presentation: - Students present an evidence-based solution (SEP.6) that aims to slow water's changes to land (ESS2.A). - Students describe how the parts of their shoreline protection system worked together (CC.4).	If students need support before or during their group's presentation, review the items on the presentation checklist and provide the following prompts: - What materials did you choose for your system? Why did you choose them? - How did the parts work together? - Think about your first system. How many waves did it take for the lighthouse to fall? Think about your second system. How many waves did it take for the lighthouse to fall? - Why did you compare and test different materials? Why did you compare and test different solutions?

LAND 5 minutes or less

Students learn how the Montauk Point Lighthouse problem was solved and compare their own solutions and processes with those in the real world.

4. Introduce Giordina Reid and the shoreline protection system she developed to save the Montauk Point Lighthouse.

LESSON 5 RESOURCE G, LESSON 5 RESOURCE H

Revisit the Phenomenon Question **How can we slow changes to the land of Montauk Point to protect the Montauk Point Lighthouse?** Remind students of the problem: Water can change the land that the real Montauk Point Lighthouse sits on.

What questions do you have about the problem with the real Montauk Point Lighthouse?

Highlight questions about what happened to the lighthouse and whether it was saved.

Display the photograph of Giordina Reid, and read aloud the caption. 🌟



Giordina Reid stands by the shoreline protection system that she designed and helped build to save the Montauk Point Lighthouse.

Spotlight on Nature of Science

In this discussion, students develop an understanding of the following NGSS Nature of Science element:

Science Is a Human Endeavor

- Men and women of diverse backgrounds are scientists and engineers.

As students learn about Giordina Reid, encourage them to reflect on how men and women of diverse backgrounds can solve problems through engineering.

What do you wonder about how Giorgina Reid saved the lighthouse?

Listen for students to

- ask about who Giorgina Reid is and what she did and
- observe that she is standing on a bluff and has around her materials that look like plants and wooden boards.

Display the photograph of the newspaper article about Giorgina Reid. Then draw students' attention to the close-up diagram of the shoreline protection system in the article.



Point to the diagram of the shoreline protection system, and read aloud the labels. Prompt students to briefly discuss the system with a partner and to describe the materials Giorgina Reid used in her solution to slow changes to the land of Montauk Point.

In what ways was Giorgina Reid's system like your group's system?

Tell students that Giorgina Reid and volunteers spent 15 years installing wooden boards along the shoreline, putting sand between the boards, and planting grass and reeds in the sand. Explain that the boards, sand, and plants keep the bluff stable and protect the lighthouse. Inform students that over time, strong waves that crashed at the base of the bluff still created problems for the lighthouse.

Teacher Note

When the diagram heading is read aloud, students will hear the term *erosion*. Throughout this module, students have observed and investigated some examples of wind and water erosion but have not used the term. Students will encounter this term in Level 4, where they will be provided a scientifically accurate definition as they explore the topic in depth.

Extension

Consider reading aloud the profile of Giorgina Reid (Lesson 5 Resource J). Tell students that they will learn how Giorgina Reid worked to prevent water from washing away the land around the Montauk Point Lighthouse. Then ask the following questions:

- Giorgina Reid created a solution to protect the Montauk Point Lighthouse. How did she use the engineering design process to create the solution?
- Why did some people think Giorgina Reid was "nothing but a little old lady"? What was her reaction to that?

Language Support

If you opt to read aloud the profile of Giordina Reid (Lesson 5 Resource J), keep in mind that important, unfamiliar words in the profile may include *terrace* and *absorb*. As needed, provide students with synonyms, definitions, or example sentences.

5. Have students compare Montauk Point before and after the revetment project on Montauk Point's shoreline. LESSON 5 RESOURCE I

Display the photograph before the rock placement and the photograph after the rock placement.



Before people placed rocks (2019)



After people placed rocks (2021)

 What differences do you observe between the two pictures?

Listen for students to observe that there are more rocks around the bluff in 2021.

Reveal that people placed thousands of tons of rocks around Montauk Point's shoreline to further protect the shoreline and the lighthouse.

 When people placed the rocks, what stage of the engineering design process were they in?

Listen for students to recognize that the rock placement shows the *Improve* stage.



Imagine we could not create engineering design solutions that slow down water's changes to land. How would places where land and water interact be different?

Listen for students to mention ideas such as these:

- *Buildings near the ocean could fall into the water.*
- *People who live near water would have to move somewhere else.*

Emphasize that life would be very different if people did not create solutions to adjust to a changing Earth. Tell students that they will continue to learn about changes to land in the upcoming lessons as they explore how land changes over different amounts of time.

HW Suggested Homework

Briefly review that students have read about and designed different solutions to slow down the interactions between water and land.

Have students identify examples of solutions that people designed to change interactions between water and land. Alternatively, have students identify places where such solutions might be needed. Ask students to list their findings or draw the solutions and to prepare to share with the class.

Lesson 5

PREPARATION RESOURCE

PART 1 of 4

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- | | | |
|---|--|--|
| ☐ 1 cup measuring cup (1) | ☐ Interlocking cubes (2) | ☐ Printer access |
| ☐ 2" piece of 1 cm diameter straw (1) | ☐ Lesson 5 Resource A: Engineering Design Process Visual | ☐ Putty knife (1) |
| ☐ 4" string (1) | ☐ Lesson 5 Resource B: Montauk Point Lighthouse Photographs | ☐ Rubber stopper (1 per plastic bin with hole, from Lesson 3) |
| ☐ 6 qt clear plastic bin with lid (1 per group, including bins with holes from Lesson 3) | ☐ Lesson 5 Resource C: Shoreline Protection System Cards | ☐ Ruler (1) |
| ☐ Chart paper and marker for 2 class charts | ☐ Lesson 5 Resource D: Bulkhead Photograph | ☐ Safety goggles (1 per student, plus 1 for teacher) |
| ☐ Disposable gloves (3 pairs for teacher) | ☐ Paper towels | ☐ Scissors (1) |
| ☐ Dry erase marker (1) | ☐ Permanent marker (1) | ☐ Tape |
| ☐ Fine sand (2½ cups per group) | | ☐ Water access |

PREPARATION

Complete the following tasks to prepare for this lesson part. Module resources needed for preparation follow this preparation resource.

Shoreline Models | 20 to 25 minutes

Prepare this mixture in small batches for each group by following the instructions in step 2 for each shoreline model. Alternatively, adapt step 2 to prepare one large batch of sand for all shoreline models and then divide the mixture evenly per bin.

Materials

- | | | |
|---|--|---|
| ☐ 1 cup measuring cup (1) | ☐ Fine sand ($2\frac{1}{2}$ cups per group) | ☐ Ruler (1) |
| ☐ 6 qt clear plastic bin with lid (1 per group, including bins with holes from Lesson 3) | ☐ Paper towel sheets | ☐ Safety goggles (1 for teacher) |
| ☐ Disposable gloves (1 pair for teacher) | ☐ Putty knife (1) | ☐ Water access |
| ☐ Dry erase marker (1) | ☐ Rubber stopper (1 per plastic bin with hole, from Lesson 3) | |

Teacher Safety Note: Wear protective eyewear and disposable gloves while preparing materials for the shoreline models.

Instructions

- Place the rubber stoppers into the holes in the sides of the 6 qt clear plastic bins from Lesson 3. Use paper towel sheets to remove the dry erase markings on the plastic bins from Lesson 3.
- For each shoreline model, mix $2\frac{1}{2}$ cups of sand and 1 cup of water in a clear plastic bin.
The sand should be moist and hold together when packed; however, oversaturating the sand with water will drastically change the outcome of the demonstration and will reduce the success of the Engineering Challenge. If the sand is already damp, mix in water in $\frac{1}{4}$ cup increments to achieve the proper consistency.
- For each shoreline model, use the putty knife to sculpt the wet sand into a rectangular formation that is 3" high and extends $2\frac{1}{2}$ " into the bin from one end. This formation represents the bluff at Montauk Point. Use a dry erase marker to trace the shape of the bluff on one side of the bin.

Students will reshape the bluff by using this outline after each round of testing during the Engineering Challenge.

Notes

- Students will use the shoreline models during different parts of this lesson. Keep the lids on the bins when they are not in use to prevent the sand from drying out.
- One prepared shoreline model is needed for demonstration in Part 1, and each group will use one in Part 2 and Part 3.

Shoreline Model with Lighthouse | 5 to 10 minutes

Part 1 requires only one shoreline model with lighthouse for demonstration.

Materials

- | | | |
|---|---|---------------------------------------|
| ☐ 2" piece of 1 cm diameter straw (1) | ☐ Permanent marker (1) | ☐ Tape |
| ☐ 4" string (1) | ☐ Prepared shoreline model (1) | ☐ Water access |
| ☐ Disposable gloves (1 pair for teacher) | ☐ Ruler (1) | |
| ☐ Interlocking cubes (2) | ☐ Safety goggles (1 for teacher) | |

Teacher Safety Note: Wear protective eyewear and disposable gloves while preparing materials for the shoreline model with lighthouse.

Instructions

1. Measure $\frac{1}{4}$ " from one end of the straw piece, and draw a line with the permanent marker at this point to indicate how deep to push the straw into the sand.
2. Connect 2 interlocking cubes. Lay the cubes sideways in the middle of the bluff with one end touching the back side of the bin. Insert the straw piece into the sand at the other end of the cubes. Push the straw piece into the sand to the $\frac{1}{4}$ " mark. Remove the interlocking cubes.



3. Measure and mark on the string a point $\frac{1}{2}$ " inward from each end.

4. Place the model on a tabletop where students can easily see it. Use tape to secure the $\frac{1}{2}$ " measurement on one end of the string to the tabletop. Then use tape to secure the $\frac{1}{2}$ " measurement on the other end of the string to the bottom end of the bin. This will restrict the height to which the model can be lifted to generate waves to approximately 3".



Note: Students will use the shoreline model during different parts of this lesson. Keep the lid on the bin when not in use to prevent the sand from drying out.

Shoreline Protection System Cards | 5 to 10 minutes

Materials

-
- | | | |
|---|---|---------------------------------------|
| ☐ Lesson 5 Resource C: Shoreline Protection System Cards | ☐ Printer access | ☐ Scissors (1) |
|---|---|---------------------------------------|

Instructions: Print and cut out color copies of one set of three shoreline protection system cards in Lesson 5 Resource C for each student pair. Print and cut out an additional set of shoreline protection system cards for teacher reference. Consider using card stock and laminating for multiple uses.

PART 2 of 4

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- ☐ 1 cup measuring cup (1)
- ☐ 4" string (1 per group)
- ☐ 6" twigs (about 80)
- ☐ 12" × 12" cheesecloth (about 9)
- ☐ Blunt tip scissors (1 per group)
- ☐ Chart paper and marker for class chart
- ☐ Chenille stems (120)
- ☐ Disposable gloves (1 pair for teacher)
- ☐ Lesson 5 Resource A: Engineering Design Process Visual
- ☐ Lesson 5 Resource E: Bulkhead Diagram
- ☐ Lesson 5 Resource F: Shoreline Protection System Procedure Sheet
- ☐ Moss (about 4 cups)
- ☐ Permanent marker (1)
- ☐ Printer access
- ☐ Putty knife (1 per group)
- ☐ Rocks (about 160)
- ☐ Ruler (1)
- ☐ Safety goggles (1 per student, plus 1 for teacher)
- ☐ Scissors (1)
- ☐ Shoreline model (1 per group, including the shoreline model with lighthouse, from Part 1)
- ☐ Tape
- ☐ Toothpicks (about 400)
- ☐ Water access

PREPARATION

Complete the following tasks to prepare for this lesson part. Module resources needed for preparation follow this preparation resource.

Shoreline Protection System Procedure Sheets | 5 minutes or less

Materials

-
- ☐ Lesson 5 Resource F: Shoreline Protection System Procedure Sheet
 - ☐ Printer access
 - ☐ Scissors (1)

Instructions: Print and cut out a copy of the procedure sheet in Lesson 5 Resource F for each group and an additional copy for teacher reference. Consider using card stock and laminating for multiple uses.

Shoreline Protection System Testing Stations | 20 to 25 minutes

Materials

☐ 1 cup measuring cup (1)	☐ Putty knife (1 per group)	☐ Tape
☐ 4" string (1 per group)	☐ Ruler (1)	☐ Water access
☐ Blunt tip scissors (1 per group)	☐ Safety goggles (1 for teacher)	
☐ Disposable gloves (1 pair for teacher)	☐ Shoreline model (1 per group, including the shoreline model with lighthouse, from Part 1)	
☐ Permanent marker (1)		

Teacher Safety Note: Wear protective eyewear and disposable gloves while preparing materials for the shoreline models.

Instructions

1. Remove the 2" straw piece from the shoreline model with lighthouse from Part 1. Set aside the 2" straw piece to use during the lesson part.
2. Assess the bluffs in the shoreline models. The sand should be moist and hold together when packed; however, oversaturating the sand with water will drastically change the outcome of the demonstration. If necessary, mix in water in $\frac{1}{4}$ cup increments to achieve the proper consistency. If adjusting the consistency, use a putty knife to return each bluff to the dimensions specified in Part 1 of this preparation resource so that the bluff matches the shape traced on the bin.

Students will reshape the bluff by using this outline after each round of testing during the Engineering Challenge.

3. Measure and mark on each string a point $\frac{1}{2}$ " inward from each end.
4. Place each model on a flat surface in a designed testing station for each group. For each model, use tape to secure the $\frac{1}{2}$ " measurement on one end of the string to the flat surface. Then use tape to secure the $\frac{1}{2}$ " measurement on the other end of the string to the bottom end of the bin. This will restrict the height to which the model can be lifted to generate waves to approximately 3".



5. Add water to each bin in $\frac{1}{4}$ cup increments opposite the bluff until the water is approximately $\frac{1}{4}$ " deep.
6. At each designated testing station, place one blunt tip scissors and one putty knife.

Note: Students will use the shoreline models during different parts of this lesson. Keep the lids on the bins when they are not in use to prevent the sand from drying out. Should the sand become dry, mix in water in $\frac{1}{4}$ cup increments to achieve the proper consistency.

Engineering Challenge Testing Materials | 5 to 10 minutes

This Engineering Challenge requires a large quantity of materials. Designate a space in the classroom where materials are neatly arranged and students can collect the items they need. Alternatively, consider placing sets of materials in individual bins or on trays at groups' workstations for direct access.

Quantities for the listed materials depend on class size and group designs. Adjust quantities if needed.

Materials

-
- | | | |
|--|--|---|
| ☐ 6" twigs (about 80) | ☐ Moss (about 4 cups) | ☐ Scissors (1) |
| ☐ 12" × 12" cheesecloth (about 9) | ☐ Rocks (about 160) | ☐ Toothpicks (about 400) |
| ☐ Chenille stems (about 120) | | |

Instructions

1. If necessary, break or cut the twig garland into 6" pieces.
2. Gather the appropriate quantities of all materials. Place the materials in a central location for students to access during the lesson part.

Note: After students have finished testing the materials in the Learn: Imagine a Shoreline Protection System of Lesson 5 Part 2, replenish items that are difficult to reuse when wet, such as the cheesecloth.

PART 3 of 4

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- | | | |
|---|---|--|
| ☐ 1 cup measuring cup (1) | ☐ Engineering Challenge testing materials (1 set, from Part 2) | ☐ Safety goggles (1 per student, plus 1 for teacher) |
| ☐ 2" piece of 1 cm diameter straw (1 per group, including the piece from Part 2) | ☐ Interlocking cubes (2 per group) | ☐ Shoreline protection system testing stations (1 per group, from Part 2) |
| ☐ Chart paper and marker for 2 class charts | ☐ Lesson 5 Resource A: Engineering Design Process Visual | ☐ Water access |
| ☐ Class problem and solution chart (1, from Part 1) | ☐ Permanent marker (1) | |
| ☐ Disposable gloves (1 pair for teacher) | ☐ Ruler (1) | |

PREPARATION

Complete the following task to prepare for this lesson part. Module resources needed for preparation follow this preparation resource.

Shoreline Protection System Testing Stations | 5 to 10 minutes

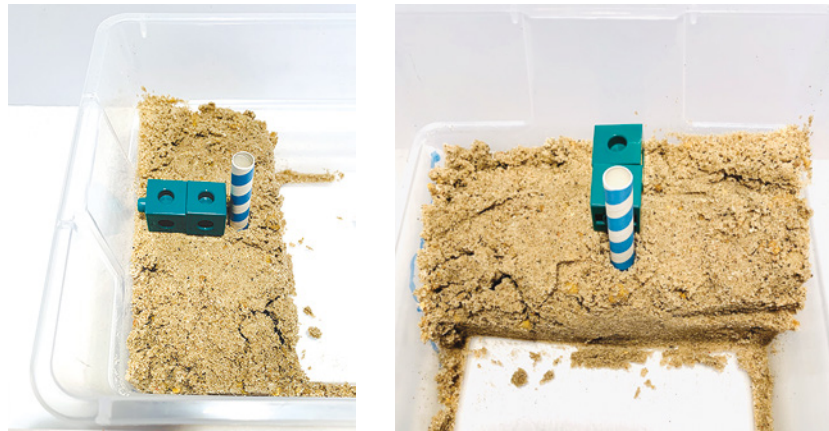
Materials

-
- | | | |
|---|---|--|
| ☐ 1 cup measuring cup (1) | ☐ Interlocking cubes (2 per group) | ☐ Shoreline protection system testing stations (1 per group, from Part 2) |
| ☐ 2" piece of 1 cm diameter straw (1 per group, including the piece from Part 2) | ☐ Permanent marker (1) | ☐ Water access |
| ☐ Disposable gloves (1 pair for teacher) | ☐ Ruler (1) | |
| | ☐ Safety goggles (1 for teacher) | |

Teacher Safety Note: Wear protective eyewear and disposable gloves while preparing materials for the shoreline models with lighthouse.

Instructions

1. Assess each shoreline model at the shoreline protection system testing stations. Return each shoreline model to its original conditions from Part 2.
2. Measure $\frac{1}{4}$ " from one end of each straw piece, and draw a line with the permanent marker at this point to indicate how deep to push the straws into the sand.
3. Connect 2 interlocking cubes. For each shoreline model, lay the cubes sideways in the middle of the bluff with one end touching the back side of the bin. Insert a straw piece into the sand at the other end of the cubes. Push each straw piece into the sand to the $\frac{1}{4}$ " mark.



4. Remove the interlocking cubes from the bin, and disconnect them. Place two interlocking cubes at each station.



5. If necessary, refresh water or add water to each bin in $\frac{1}{4}$ cup increments opposite the bluff until the water is approximately $\frac{1}{4}$ " deep to return the model to its condition at the beginning of Part 2.

Notes

- Ensure that each station still has blunt tip scissors and a putty knife.
- Students will use the shoreline models during different parts of this lesson. Keep the lids on the bins when they are not in use to prevent the sand from drying out. Should the sand become dry, mix in water in $\frac{1}{4}$ cup increments to achieve the proper consistency.

PART 4 of 4

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- ☐ Lesson 5 Resource A: Engineering Design Process Visual
- ☐ Lesson 5 Resource G: Giorgina Reid Photograph
- ☐ Lesson 5 Resource H: Newspaper Article About Giorgina Reid
- ☐ Lesson 5 Resource I: Montauk Point Revetment Photographs
- ☐ Lesson 5 Resource J: Profile of Giorgina Reid (optional)
- ☐ Safety goggles (1 per student, plus 1 for teacher) (optional; use if groups share a physical system)
- ☐ Student-made shoreline protection system (1 per group, from Part 3) (optional)

PREPARATION

No preparation tasks are required for Part 4.

Lesson 5 Resource A

ENGINEERING DESIGN PROCESS VISUAL



Lesson 5 Resource B

MONTAUK POINT LIGHTHOUSE PHOTOGRAPHS





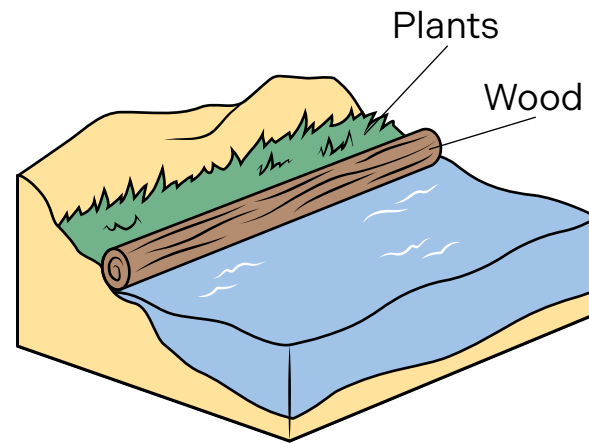
Lesson 5 Resource C

SHORELINE PROTECTION SYSTEM CARDS

Edging

Possible Materials

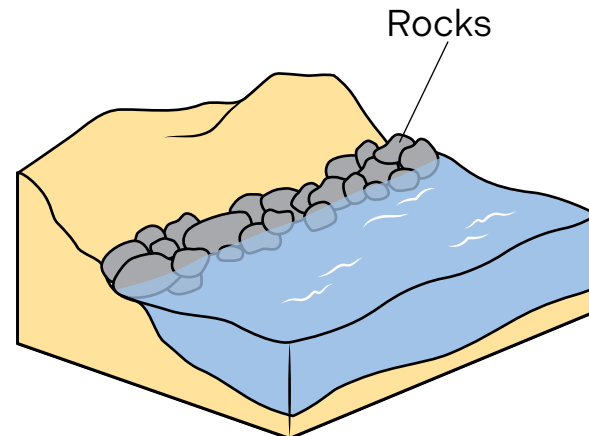
- Wood
- Blanket made of straw
- Plants



Revetment

Possible Materials

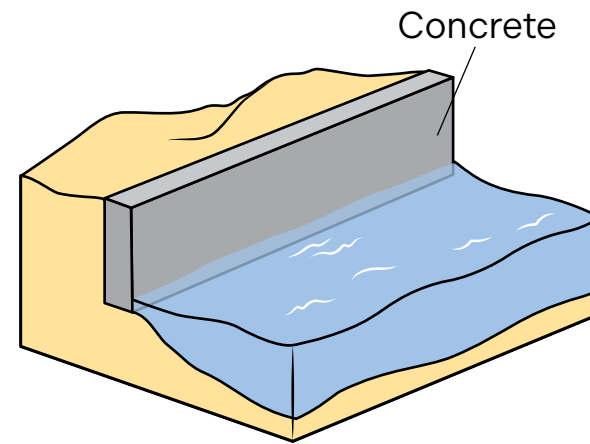
- Big rocks
- Concrete blocks
- Sand-filled bags
- Wire baskets filled with rocks



Bulkhead

Possible Materials

- Steel walls
- Wood
- Concrete



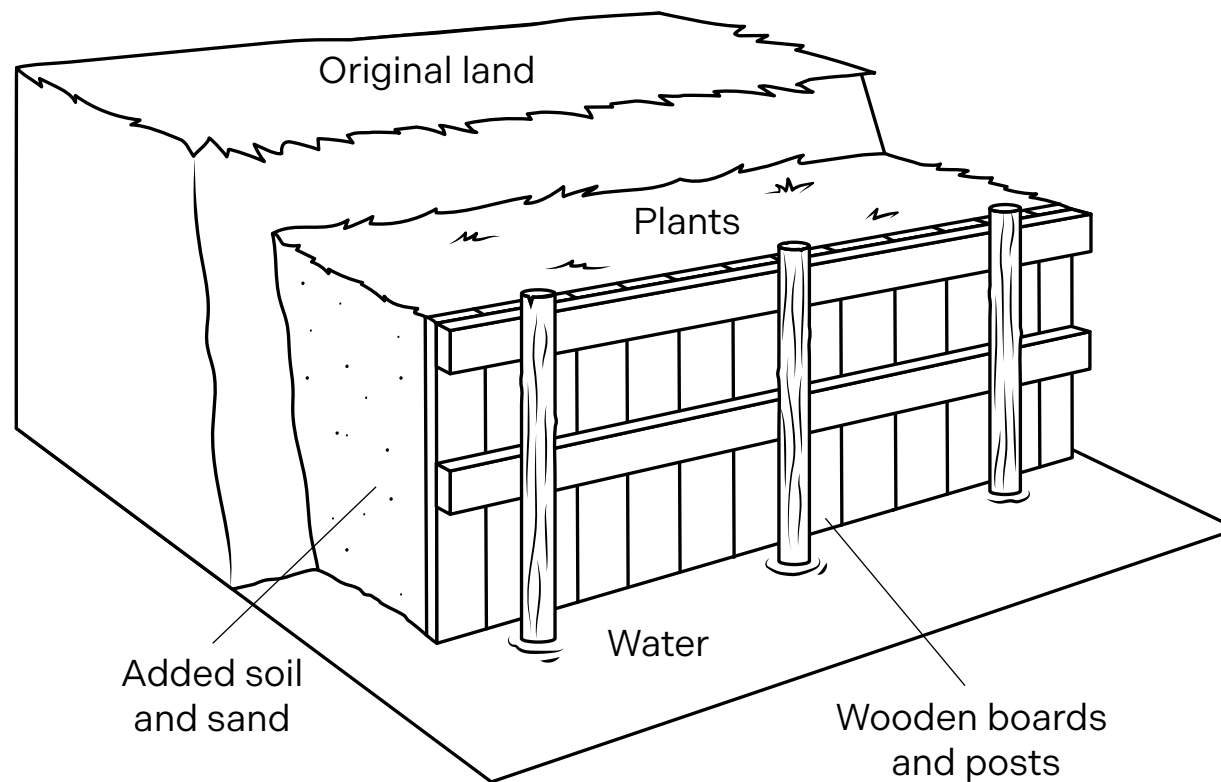
Lesson 5 Resource D

BULKHEAD PHOTOGRAPH



Lesson 5 Resource E

BULKHEAD DIAGRAM



Lesson 5 Resource F

SHORELINE PROTECTION SYSTEM PROCEDURE SHEET

Shoreline Protection System Procedure Sheet

1. Choose a material to test.
2. Put all of the material in the bin. Place the material in a way you think will keep water away from the sand.
3. Make a wave. Gently lift the end of the bin that does not have sand. When the string is straight, put down the end of the bin. Repeat this step to make 9 more waves.
4. In the Imagine section of your Science Logbook, write the material you tested.
5. Does the material work? Color the smiley face or the frowny face.
6. Remove the material from the bin.
7. Use the knife to reshape the sand. The sand should match the shape on the side of the bin.
8. Follow the same steps to test your next material.

Lesson 5 Resource G

GIORGINA REID PHOTOGRAPH



Giorgina Reid stands by the shoreline protection system that she designed and helped build to save the Montauk Point Lighthouse.

Lesson 5 Resource H

NEWSPAPER ARTICLE ABOUT GIORGINA REID

Her Light

How 'a little old lady' named Giordina Reid stopped the Montauk lighthouse from tumbling into the sea

BY BILL BLEYER
REPORT WRITER

WHEN GIORGINA REID died on June 16 at the age of 92, she had no relatives to mourn her passing. Only a handful of friends and neighbors attended the funeral before she was buried alongside her husband in Calverton National Cemetery, where her grave marker looks like a lighthouse.

The real memorial to Giordina Reid stands 50 miles to the east. It is one of the most famous and recognizable messages in that few

may know her name, but Reid's connection to the beacon is simple and incontrovertible. She saved the island's oldest lighthouse from destruction by the federal government, which until Reid showed up was planning to demolish it before nature did and replace it with a light on a soulless pole.

at Montauk Point have been tamped — the sea had been claiming more than a foot of the point a year.

Her work at Montauk spanned 17

Boards were placed along the bluff, supported by hollow pipes to create terraces. Sand was removed to create a trench behind the boards so a layer of reed stems could be placed, followed by a covering of sand that was planted with grass.

Reed stems
Cutaway view
Boards were driven into the sand to a depth of about two inches.

Terraces

WWII observation tower

Montauk Point Lighthouse

Grasses and shrubs currently cover most of the bluffs, including the terraces.

What the terraces looked like before they were overgrown with vegetation.

Erosion Control
A look at the method of building terraces used by Giordina Reid

NEWSDAY, SUNDAY, AUGUST 19, 2001

BR LI Life

G10

Newsday / Philip Dunisio

Lesson 5 Resource I

MONTAUK POINT REVETMENT PHOTOGRAPHS



Before people placed rocks (2019)



After people placed rocks (2021)

Lesson 5 Resource J

PROFILE OF GIORGINA REID

Giorgina Reid was an artist who lived on a bluff above the seashore on Long Island, New York. Yearly storms with heavy rains, strong winds, and large waves were washing away the land around many homes on Long Island, including Giorgina's (Rattiner 2014). Giorgina knew she had to do something to stop her home from falling into the sea.

Giorgina designed a terrace system. This means she created flat areas that looked like steps on the steep slope between the water's edge and the bluff where her house stood. She and her husband used wood to make the walls of these terrace steps and filled the wooden walls with reeds and sand to absorb rainwater. Then they planted beach grass on these flat terraces so the plants' roots would hold the sand and soil in place. Giorgina believed that her terrace system would stop the soil from washing away (Reid 1969; Bleyer 2001).

Giorgina's system solved the problem. When the next big storm came, none of the land around her home washed away. Her neighbors saw her success and built their own terrace systems to save their homes. Giorgina wrote a book about her system called *How to Hold Up a Bank* (Reid 1969).

In 1970, when Giorgina was 61 years old, she learned that the Montauk Point Lighthouse was also in danger of falling into the sea. Giorgina knew she could save the lighthouse. She took her terrace system idea to the Coast Guard, which was responsible for the lighthouse (Rattiner 2014).

"I knew what they were thinking," Giorgina wrote in the 1989 magazine article "To Save a Lighthouse." "Why she's nothing but a little old lady. ... But so what? A long time ago I found that being little didn't mean you couldn't do a job you set your mind to" (as quoted in Bleyer 2001, G12).

The Coast Guard let Giorgina go ahead with her plan. On April 22, 1970—the first Earth Day—Giorgina, her husband, and some volunteers began building her terrace system on the steep slopes around the lighthouse (Bleyer 2014). Giorgina's system worked there too. Giorgina, her husband, and the volunteers continued to work for fifteen years. Then the Coast Guard, which had been providing materials to support the system, took over the project.

The Coast Guard held ceremonies to honor Giorgina. President Ronald Reagan wrote a letter to praise her.

Giorgina Reid saved the Montauk Point Lighthouse from tumbling into the sea.



CONCEPT 2 TIME SPANS OF CHANGES TO LAND



Concept 2 | Time Spans of Changes to Land

LESSON 6 EARTH EVENTS AND TIME SPANS OF CHANGES TO LAND

Lesson Phenomenon | Earth events on Surtsey

Phenomenon Question | How can we compare the Earth events that change Surtsey's land?

OVERVIEW

Previously we applied our knowledge of how water changes land to solve a problem during an Engineering Challenge. We followed the engineering design process to develop a shoreline protection system that could slow changes to the shoreline of Montauk Point and prevent the Montauk Point Lighthouse from falling into the ocean.

In this lesson we build our understanding of how land changes by exploring Earth events that form landforms and change them. We revisit the events that formed and are changing Surtsey's land. Then we examine different Earth events, and we work as a class to sort them according to how long they took to happen. We also learn more about time spans by comparing the lengths of our own life events with the lengths of Earth events. Later in the lesson, we learn how the Sphinx and yardangs have changed as a result of wind events. We compare the time spans of these events to the time spans of the events that change Surtsey's land and notice that some events occur more slowly over time, while other events occur more quickly. Finally, we identify and use evidence to support a claim that fast and slow Earth events cause changes to land over time.

Later we will apply our learning to a new phenomenon in a Conceptual Checkpoint.

Lesson Objective

Use relative scales (CC.3) as evidence to identify **Earth events that happen quickly and Earth events that happen slowly (ESS1.C)** and to **develop an argument (SEP.7)** about **the time spans of Earth events (ESS1.C)**.

Performance Descriptors

Part 1: **Use relative scales to compare Earth events (CC.3)** that **happen over different periods of time (ESS1.C)**.

Part 2: **Use observations to describe (SEP.6) the time spans of Earth events (ESS1.C)** that **change land over various amounts of time (CC.7)**.

Part 3: **Develop an argument (SEP.7)** to describe **the time spans of Earth events (ESS1.C)** that cause **land to change quickly or slowly (CC.7)**.

STANDARDS ADDRESSED

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. SEP.7: Engaging in Argument from Evidence • Construct an argument with evidence to support a claim.	ESS1.C: The History of Planet Earth • Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	CC.3: Scale, Proportion, and Quantity • Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower). CC.7: Stability and Change • Things may change slowly or rapidly.



PART 1 of 3

PREPARE 15 to 20 minutes

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 6 Preparation Resource.

Earth event cards (5 to 10 minutes)

Earth event display (5 minutes or less)

Earth event photographs (5 minutes or less)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 1.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	None	☐ <i>Life on Surtsey</i> (Burns 2017) (1)	The list identifies disposable and prepared materials to save for reuse in the module. ☐ Earth event card order sheets ☐ Earth event display
Learn: Sort Earth Event Cards	☐ Prepared Earth event cards (6 sets) ☐ Sticky notes	☐ Prepared Earth event cards (1 set)	
Learn: Order Earth Event Cards	☐ Prepared Earth event cards (6 sets) ☐ Tape rolls (6) ☐ 11" × 17" paper (6) ☐ Prepared Earth event photographs (1 photograph per group) ☐ Clothespins (6)	☐ Chart paper and marker for class diagram ☐ Prepared Earth event display (1)	
Land	None	None	

LAUNCH 5 minutes or less

Students define *event*. They review the Earth events that have changed Surtsey's land. Then students consider how changes caused by wind and water compare with changes caused by a volcanic eruption.

1. Establish that waves crashing, rain falling, wind blowing, and volcanic eruptions are Earth events that change land.

Revisit the image on page 7 of *Life on Surtsey* (Burns 2017). Remind students that the image shows one photograph of Surtsey on top of another photograph of Surtsey. Review that the photographs show an aerial view of Surtsey. Remind students that the black-and-white photograph shows an aerial view of Surtsey in 1967 and that the red photograph shows an aerial view of Surtsey in 2014.

What caused changes to Surtsey's land?

Listen for students to mention that wind and water caused changes to Surtsey's land.

Explain that changes to Surtsey's land are caused by Earth events. Tell students that an **event** is something that happens. Further explain that an event either has a beginning and an end or repeats and is ongoing. Specify that waves crashing, rain falling, and wind blowing are examples of Earth events that can cause Surtsey's land to change.

Language Support

Introduce the term *event* explicitly. Providing the Spanish cognate *evento* may be helpful. Consider having students list kinds of events they have attended (such as a wedding, birthday party, or sporting event).

Display the class anchor model, and pose the following question.

What Earth event caused Surtsey to form?

Build on students' responses to confirm that a volcanic eruption is the Earth event that caused Surtsey to form. 

We know that a volcanic eruption caused changes that formed Surtsey. We also know that wind and water are causing changes to Surtsey's land. How can we compare the changes from wind and water with the changes from the volcanic eruption?

Performance Descriptor

Use relative scales to compare Earth events (CC.3) that happen over different periods of time (ESS1.C).

Agenda | 35 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 25 to 35 minutes

- Sort Earth Event Cards (10 to 15 minutes)
- Order Earth Event Cards (5 to 20 minutes)

LAND | 5 minutes or less

Teacher Note

It may be helpful to remind students how the eruption caused Surtsey to form: The eruption began underwater and the lava piled up high enough to create an island above water.

Students may wonder whether other volcanic eruptions have caused land to form. Some, but not all, islands form through volcanic eruptions. If students are curious about other volcanic islands, consider reading aloud pages 68 and 69 of *Life on Surtsey* (starting with the heading "Westman Islands"). Consider also explaining that volcanic eruptions above Earth's surface can cause changes to existing land. For example, they can create mountains or craters.

Build on students' responses to suggest that to better understand how Earth events change Surtsey's land, students will further explore Earth events that shape land.

Work with students to develop the Phenomenon Question **How can we compare the Earth events that change Surtsey's land?** Tell students that they will learn about other Earth events and then apply their knowledge to describe changes to Surtsey's land.

LEARN 25 to 35 minutes

Sort Earth Event Cards | 10 to 15 minutes

Groups observe cards that describe Earth events and decide on categories to sort their cards into. Then groups sort the cards into these categories and share their categories with one another.

2. Have students observe different Earth events and categorize these Earth events.

Divide the class into six groups, and give each group a set of prepared Earth event cards. Tell students that each card shows a different Earth event. Read aloud the title of each Earth event card. 

Instruct groups to observe the photographs on the cards and to create categories they can sort the cards into. Tell groups that the events on the cards may fit into more than one category and to choose the category they think is best. Have groups sort their cards into the categories they chose. 

After groups sort their cards, distribute sticky notes to each group. Give groups one sticky note for each category they created. Tell groups to record one category on each sticky note.

Have groups participate in a Whip Around routine to share with the class the categories on their sticky notes and their reasons for putting specific events in each category.

Sample student categories:

- *Rocks and Weather*
- *Big Changes and Small Changes*
- *Short Events and Long Events*

As needed, guide students to explain their reasoning with questions such as the following.

Teacher Note

Inform students that the Mount St. Helens Eruption card and the Loma Prieta Earthquake card show land after an event has ended and that the other cards show land as events are happening. Explain that Delicate Arch and Wave Rock are the result of ongoing events. Tell students that a rock arch or rock wall can occur naturally as wind and water change land over time. Throughout the lesson, help students connect their learning from Concept 1 with their learning about ongoing events that change Earth.

Pose the following questions to help guide students' thinking:

- How do you think land could end up looking like Wave Rock?
- Do you think Delicate Arch always looked this way? Why do you think that?

Content Area Connection: Mathematics

Sorting the event cards into numerous categories related to geology, time, or weather—and later re-sorting them—allows students to develop the analytical and reasoning skills to identify similarities.

💬 **How did you decide which categories to create?**

💬 **How did you choose cards for each category?**

Acknowledge that there are many ways to sort the Earth events on the cards. Facilitate a discussion to compare how groups categorized their cards.

Listen for students to mention similarities in how they sorted their cards. If any groups categorized their cards according to how long the events took to happen, highlight those card sorts.

Order Earth Event Cards | 15 to 20 minutes

Students share their ideas about the length of time it took for each Earth event to happen. Then students use their ideas to order the Earth event cards according to the length of time the events took to happen. Students compare card orders, agree on an order, and create a class display that shows the order of the Earth events from shortest length of time to longest length of time.

3. Have students order Earth event cards according to the length of time it took for the event to happen.

Ask the class questions such as these.

💬 **Think about the land on each Earth event card. What evidence do we have that the land has changed?**

💬 **How long do you think it took for these events to happen? Why?**

Listen for students to suggest that some events happened quickly and other events happened slowly. Students may refer to their background knowledge about some of the events, or they may use observations of the changes to the land as a clue. For example, they may suggest that it would take a long time for rock to become smooth enough to form Wave Rock.

Tell students that they will work in their group to place the Earth event cards in order according to how long they think each event took to happen. Explain that groups should arrange the events from shortest to longest. Draw the following diagram on a whiteboard or a sheet of chart paper.

Sample event order diagram:

Earth Events

Shortest Time

Longest Time



Distribute tape rolls and 11" × 17" paper to each group. Instruct groups to order their cards on the paper in a line, using the diagram as a guide. Specify that groups should wait to tape their cards onto the paper until instructed to do so.

As groups order their cards, circulate to provide support and to encourage students to explain their reasoning for the order they choose.

We know that some Earth events take less time to happen and some events take more time. How do your cards show that?

Listen for students to refer to relative timescales as they compare the Earth event cards. For example, students may mention that they put the eruption, earthquake, and tornado cards first on their sheet of paper because they think those events happen faster than the other three events.

Check for Understanding

Use relative scales to compare Earth events (CC.3) that **happen over different periods of time (ESS1.C)**.

EVIDENCE	NEXT STEPS
Look for students to do the following during the card sorting activity: - Students use relative timescales to compare Earth events and order them by time span (CC.3). - Students explain that they ordered the Earth events by how long the events take (ESS1.C).	Students may need support to order the Earth events on the cards from shortest length of time to longest length of time. Encourage students to consider their knowledge of Surtsey's Earth events and the amount of time each event took. Have students recall what they have learned about the timing of the volcanic eruption that formed Surtsey and the timing of the wind and water events that continue to shape Surtsey's land.



Differentiation

Consider asking students to draw an arrow similar to the arrow on the diagram across the top of their paper. Have students write an S on the left side of the arrow and an L on the right side of the arrow to represent the amount of time over which they think the events occurred.



Teacher Note

In this lesson part, students are not expected to correctly arrange the Earth event cards. In the next lesson part, students will work as a class to correctly arrange the cards from the event that happened over the shortest length of time to the event that happened over the longest length of time.

4. As a class, create a display that shows the order of Earth events from shortest length of time to longest length of time.

Invite the class to participate in a Gallery Walk to observe how each group ordered their Earth event cards. As students make observations, encourage them to consider how the card orders are similar and how they are different. Then bring the class back together for a discussion.

How did you decide on the order of the Earth events?

Listen for responses that mention the following reasoning:

- Some Earth events, such as *Delicate Arch Forming* and *Wave Rock forming*, probably take a very long time, because rocks take a long time to change shape. Students placed those cards near the end of the line.
- Some Earth events, such as the *Mount St. Helens Eruption* and the *Loma Prieta Earthquake*, probably happen quickly, so students placed those cards on the beginning of the line.

Reassure students that it is acceptable for groups to have different ideas about how to order the cards.

As a class, agree on an order in which to arrange the Earth event cards in an Earth event display. Begin by pointing out the hanging string with the prepared Earth event display. Explain that, like the diagram, the string represents a line on which students will place Earth events in order from the event that happened over the shortest length of time to the event that happened over the longest length of time.

Instruct students to return to their group. Give each group one prepared Earth event photograph and a clothespin. Ask groups to identify where they placed that event when they ordered their Earth event cards.

Invite one volunteer at a time from each group to share the name of their group's event and to use their clothespin to attach the photograph to the string. As each volunteer adds their event, have them consider the length of time over which the event happened and how its length compares with the length of the other events. Then encourage the volunteer to justify their placement of the event. 

As students listen, have them use a nonverbal signal to show whether they agree with an event's placement. Allow volunteers to use class feedback to rearrange events until the class agrees with the placement of all six Earth event photographs.

Allow groups to revisit the order of their cards and to make desired adjustments. Instruct groups to loosely tape their cards onto their paper in the order they chose and to write the names of their group members on the paper. Collect each group's Earth event card order sheet to use in the next lesson part. 

Teacher Note

To help students compare and order the events by relative duration, consider providing sentence frames such as these:

- ____ should go after _____. We think it took a longer amount of time.
- ____ should go before _____. We think it took a shorter amount of time.
- ____ should go between _____ and _____. We think it took less time than _____ and more time than _____.

Teacher Note

Students should use a single small piece of tape to affix each card to the paper in a way that allows them to easily remove the card. In the next lesson part, students will rearrange the cards after they read about the duration of each Earth event.

LAND 5 minutes or less

Students share their new questions about Earth events and update the Driving Question board.

5. Record students' new questions about Earth events.

Ask students to reflect on the class Earth event display.



Do you have any new questions about how long it takes for Earth events to happen?

Listen for students to ask questions such as these:

- *How long do tornadoes last?*
- *Does a volcanic eruption take longer to happen than an earthquake?*
- *Did Delicate Arch and Wave Rock take the same amount of time to form?*

Record students' questions on sticky notes, and add the notes to the Driving Question board. Tell students that they will return to their Earth event cards and the class Earth event display in the next lesson part.



PART 2 of 3

PREPARE 5 minutes or less

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 6 Preparation Resource.

Earth event texts (5 minutes or less)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 2.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	None	☐ Chart paper and marker for class list	The list identifies disposable and prepared materials to save for reuse in the module. ☐ Earth event display ☐ Earth event texts
Learn: Read About Time Spans of Earth Events	☐ Earth event card order sheets (6, from Part 1) ☐ Prepared Earth event texts (1 text per group) ☐ Science Logbook (1 per student)	☐ Earth event display (1, from Part 1)	
Learn: Compare Earth Events to Human Events	☐ Science Logbook (1 per student)	None	
Land	☐ Earth event card order sheets (6, from Part 1) ☐ Science Logbook (1 per student)	None	

LAUNCH 5 minutes or less

Students develop a class list of Earth events and identify events that have changed Surtsey's land. Students begin to consider how they might describe how long Earth events take.

1. As a class, develop a list of Earth events and identify Earth events that have shaped Surtsey's land.

Ask students to recall their learning from earlier in the module about how Surtsey was formed by a volcanic eruption. 

Remind students that a volcanic eruption is an Earth event. Have students share other kinds of Earth events. Record students' responses on chart paper to create a class list of Earth events.

Sample class list:

Earth Events

- Earthquakes
- Volcanic eruptions
- Tornadoes
- Floods
- Waves crashing
- Wind blowing

Facilitate a discussion about the Earth events that have changed Surtsey's land. Encourage students to use evidence from their texts, their observations of images and videos, and their observations during investigations to support their ideas. On the class list, circle the names of events that students identify as affecting Surtsey's land: volcanic eruptions, waves crashing, and wind blowing.

 **How long do you think each of these events take? Which event do you think takes the longest amount of time? Which event do you think takes the shortest amount of time?**

Highlight any uncertainty in the way students describe how long these Earth events take, and tell students that they will continue to explore Earth events and develop a better understanding of them as they work to answer the Phenomenon Question **How can we compare the Earth events that change Surtsey's land?**

Performance Descriptor

Use observations to describe (SEP.6) the time spans of Earth events (ESS1.C) that change land over various amounts of time (CC.7).

Agenda | 30 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 30 minutes

- Read About Time Spans of Earth Events (15 to 20 minutes)
- Compare Earth Events to Human Events (5 to 10 minutes)

LAND | 5 to 10 minutes

Teacher Note

To help students recall their learning, consider revisiting the text from *An Island Grows* (Schaefer and Felstead 2006), the text and photographs from *Life on Surtsey* (Burns 2017), and the video clip from "Surtsey, the Birth of an Island" (<http://phdsci.link/1599>).

LEARN 20 to 30 minutes

Read About Time Spans of Earth Events | 15 to 20 minutes

Groups return to their Earth event card order sheet. They then read more about the Earth event they were assigned in the previous lesson part. As a class, students use their new knowledge about the Earth events to reorder the photographs on the class Earth event display. Groups reorder their Earth event cards accordingly. Finally, students define the term *time span* and identify the time span of each Earth event.

2. Have students revisit their Earth event card order sheet and read about their Earth event from the previous lesson part.

Have students return to their group from the previous lesson part. Give each group their Earth event card order sheet.

 **To put the Earth event cards in the right order, what do we need to know?**

Listen for students to identify that they need to figure out how long each event took to happen.

Tell students that each group will now read information about the Earth event in the Earth event photograph they attached to the string during the previous lesson part. Give each group the prepared Earth event text that corresponds to their assigned Earth event photograph. Then instruct groups to read their text. 

After groups finish reading, invite each group to share what they learned about their Earth event and how long their event took to happen. Prompt groups to circle the information in the text that helped them determine their answer.

3. Work with students to reorder the Earth event photographs on the class Earth event display, and provide time for groups to reorder the cards on their Earth event card order sheet.

Explain that groups will use the information in their Earth event text to contribute to a class reordering of the six Earth event photographs. 

Remind students that they should place the events in order according to how long they took to happen. 



Differentiation

Some students may need support to read their Earth event text. As necessary, circulate and read aloud each text to help students understand challenging words.



Content Area Connection: English

Grade 2 reading standards require students to engage with information from a text and to demonstrate their comprehension of the text's main points. Students develop those skills during this activity as they practice obtaining information from a text, evaluating the information by questioning it and by making associations between science ideas, and communicating the information (SEP.8).



Content Area Connection: Mathematics

Students use their conceptual understanding of written amounts up to 1,000 as they discuss the time spans of slow Earth events. Students will use the concept of multiple thousands to comprehend extremely long time spans.



Teacher Note

Consider placing the event order diagram from Part 1 near the Earth event display for students to refer to as they reorder the events.

As in the previous lesson part, have a volunteer from each group adjust the placement of their photograph on the class Earth event display as necessary. Encourage groups to explain why they moved or did not move their photograph. Have the rest of the class use nonverbal signals to show whether they agree with an event's placement. Have volunteers continue until all six Earth event photographs are correctly placed:

1. Loma Prieta Earthquake
2. Moore Tornado
3. Mount St. Helens Eruption
4. Midland Flood
5. Delicate Arch Forming
6. Wave Rock Forming

Teacher Note

To make the abstract concept of time more accessible for students, this lesson refers to *many thousands* of years instead of *millions of years*. Delicate Arch formed faster than Wave Rock, but this fact is not crucial to students' overall understanding that events happen quickly or slowly.

Allow time for groups to revisit their Earth event card order sheet and to compare their initial order with the order in the updated class display. Allow groups to revise the order of their cards if necessary.

4. Define *time span*, and use units of time to describe the time spans of Earth events.

LESSON 6 ACTIVITY GUIDE A

Prompt students to reflect on their learning about the length of time different Earth events take by posing the following question.

What surprised you about how long the events lasted?

Build on students' responses to confirm that some events happened very quickly and some events took a very long time. Tell students that each Earth event happened over a different **time span**, or length of time.

Language Support

Introduce the term *time span* explicitly. Consider having students think of different time spans in their lives, such as how long they have been alive or the length of a school day.

Direct students' attention to the chart in their Science Logbook. Tell students to work in pairs within their group to complete the Earth Event column of the chart by matching Earth events with units of time. Have pairs discuss each Earth event and identify whether the event happened over seconds, minutes, hours, days, or years. Tell students to write each Earth event on the chart in the row that best describes the time span over which it happened. 

Sample student response:

Time	Earth Event	Life Event
Seconds	• <i>Loma Prieta earthquake</i>	
Minutes	• <i>Moore tornado</i>	
Hours	• <i>Mount St. Helens eruption</i>	
Days	• <i>Midland flood</i>	
Years	• <i>Delicate Arch forming</i> • <i>Wave Rock forming</i>	

After pairs complete this column of their chart, ask students to think about the units of time in the chart and how they relate to one another. Provide context for students by pointing out how many minutes they have been in science class.

 **How can we describe the difference between a minute and an hour?**

 **How can we describe the difference between a day and a year?**

If students use the same or similar terms (such as *fast*, *slow*, *short*, and *long*) to describe different units of time, acknowledge that time can be difficult to describe in words. Explain that it can be easier to understand complex ideas by comparing them with simpler, more familiar ideas. Tell students that they will now think about the time spans of events from their own lives to help them understand the time spans over which Earth events happen.



Differentiation: Support

Depending on students' needs, consider completing the time span activity as a class. Some students may benefit from hearing each text read aloud as the class fills out the chart.

Compare Earth Events to Human Events | 5 to 10 minutes

As a class, students complete a chart that compares the time spans of life events with the time spans of Earth events.

5. Guide students to identify examples of life events and to compare the time spans of life events with the time spans of Earth events.

 LESSON 6 ACTIVITY GUIDE A

Ask students to think about life events they routinely experience in their daily lives. Pose a question such as this:

 **What is an event that happens in your life that takes only seconds?**

After students provide several examples, ask each student to write their own life event that takes seconds in that row of their Science Logbook. Then have students fill out life events for the rest of the chart. 

Sample student response:

Time	Earth Event	Life Event
Seconds	• Loma Prieta earthquake	• Washing hands
Minutes	• Moore tornado	• Eating lunch
Hours	• Mount St. Helens eruption	• Sleeping at night
Days	• Midland flood	• Summer vacation
Years	• Delicate Arch forming • Wave Rock forming	• Growing up

 Content Area Connection: Mathematics

Throughout Grade 2, students acquire the skills of telling time, determining elapsed time, and associating clock time with activities. At this point, students are still developing an understanding of the passage of days, weeks, and months as they recount their experiences with recurring annual events.

 Compare the time spans of life events and the time spans of Earth events. What do you notice?

Listen for students to mention ideas such as these:

- Some life events take a similar amount of time to some Earth events.
- The two Earth events in the Years row took much longer than students' life events in the Years row, even though all of the events in this row happened over the span of years.

LAND 5 to 10 minutes

Students participate in an Inside–Outside Circles routine to compare the time spans of different Earth events. Students then record comparisons of the time spans in their Science Logbook.

6. Have students record comparisons of the time spans of different Earth events.

 LESSON 6 ACTIVITY GUIDE A

Direct groups to remove the cards from their Earth event card order sheet, and have each student take one card. Then bring the class back together to participate in an Inside–Outside Circles routine in which students compare the time spans of the Earth events on their cards. Instruct students holding the Loma Prieta Earthquake, Mount St. Helens Eruption, and Delicate Arch Forming cards to form the outside circle and students holding the remaining cards to form the inside circle. 

Ask partners to take turns comparing the time spans of their Earth events. Have students record their comparisons in their Science Logbook by using the provided sentence frames. Instruct students to write in their Science Logbook the two Earth events they are comparing and to indicate which event happened more quickly or more slowly. Then have students use their observations of the Earth event photographs and the information from the card text to explain their response.

Teacher Note

If there are fewer than 6 students per group, consider assigning each Earth event card to an equal number of students to promote a successful Inside–Outside Circles routine.

Look for ideas such as these in students' responses:

- *The Moore tornado happened more quickly than the Delicate Arch forming. I know this because the Moore tornado happened in minutes and the Delicate Arch formed over many years.*
- *The Midland flood happened more slowly than the Mount St. Helens eruption. I know this because the Midland flood happened over days and the Mount St. Helens eruption happened over hours.*



Check for Understanding

Use observations to describe (SEP.6) the time spans of Earth events (ESS1.C) that change land over various amounts of time (CC.7).

EVIDENCE	NEXT STEPS
Look for the following in students' written responses: • Students use observations (SEP.6) about Earth events from photographs and text to identify the length of time it takes for each Earth event to occur (ESS1.C). • Students describe that one Earth event has a longer or shorter time span than another Earth event (CC.7).	If students need support to identify the time spans of Earth events, prompt students to refer to the chart that compares the time spans of events in their Science Logbook. Have students circle in one color the Earth event that occurred over the shortest time span and circle in another color the Earth event that occurred over the longest time span. Then ask students to compare the events they circled. Consider posing questions such as these: • How long was the time span of each event? • Which event had a shorter time span? • Which event had a longer time span?

Bring the class back together, and ask the following question. Invite students to share their response.



How long do Earth events that change land take to happen?

- ✓ Ensure that students understand that Earth events that change land can happen quickly (over a short time span) or slowly (over a long time span). If students need support to develop the understanding that Earth events can happen over different time spans, briefly revisit the Earth event cards and guide students to compare the time spans of different Earth events.

Tell students that in the next lesson part, they will continue to explore time spans of Earth events.

HW Suggested Homework

Remind students that they have observed many different kinds of Earth events. Have students write a short story or poem about an Earth event, such as a weather event, earthquake, or volcanic eruption. Students' stories should specify the length of time it took for the event to happen.

MATERIALS

The table lists materials needed for each section of Part 3.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	None	☐ Lesson 6 Resource D: Great Sphinx of Giza Photograph ☐ <i>World Traveler: The Sphinx</i> (Schmidt and O'Halloran 2018) (1) ☐ Earth event display (1, from Part 2) ☐ Earth event texts (1 set, from Part 2) ☐ Lesson 6 Resource E: Great Sphinx of Giza Present-Day Photograph (optional)	No disposable or prepared materials from Part 3 are reused in the module.
Learn: Explore Yardangs	☐ Yardangs Knowledge Deck™ card (1 per student)	☐ Yardangs Knowledge Deck poster (1)	
Learn: Develop an Argument About Fast and Slow Earth Events	☐ Science Logbook (1 per student)	☐ Lesson 6 Resource F: Event and Landform Comparison Chart	
Land	☐ Science Logbook (1 per student)	None	

LAUNCH 5 minutes or less

Students observe a photograph of the Great Sphinx of Giza and read from the book *World Traveler: The Sphinx* (Schmidt and O'Halloran 2018) to gather more information about the Sphinx. Students establish that Earth events have changed the face of the Sphinx. Students then consider how wind changing the Sphinx compares with other Earth events that change landforms.

1. Have students observe and gather information about the Great Sphinx of Giza, and ask students to consider how wind changing the Sphinx compares with other Earth events that change landforms.

 LESSON 6 RESOURCE D

Display the prepared Great Sphinx of Giza photograph. Tell students that the photograph shows a giant statue called the Great Sphinx of Giza, which is located near Cairo, Egypt. 



Allow a few moments for students to observe the photograph, and then pose the following question.

 **What do you notice about the statue in this picture?**

Listen for students to mention that parts of the statue look cracked and broken and that there is sand all around the statue.

Tell students that they will read a book to gather more information about the Sphinx. Introduce the book *World Traveler: The Sphinx* (Schmidt and O'Halloran 2018). Read aloud pages 1 through 11.  

Performance Descriptor

Develop an argument (SEP.7) to describe **the time spans of Earth events (ESS1.C)** that cause **land to change quickly or slowly (CC.7)**.

Agenda | 30 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 30 minutes

- Explore Yardangs (5 to 10 minutes)
- Develop an Argument About Fast and Slow Earth Events (15 to 20 minutes)

LAND | 5 to 10 minutes

Teacher Note

Consider having students use a map or globe to compare their location and the location of Cairo, Egypt.

Language Support

Important, unfamiliar words in *World Traveler: The Sphinx* may include *complex*, *monument*, and *six-story*. As needed, provide students with synonyms, definitions, or example sentences.

Extension

If time allows, consider reading aloud the remainder of the book.

After the reading, display the photograph of the Sphinx's face on the cover of the book. Ask students to think about how the Sphinx may have changed over time as they consider the following questions.

 **Notice how the face of the Sphinx looks in the picture. Do you think it always looked that way? Why do you think that?**

 **What do you think caused the changes to the face of the Sphinx?** 

Listen for students to suggest that the face of the Sphinx was not always cracked and broken and that maybe Earth events such as wind blowing changed the statue and the land around it.

Next, read aloud page 12 of the book. Invite students to summarize for the class what has happened to cause the Sphinx to change over time.

Direct students' attention to the class Earth event display from the previous lesson part. 

 **The wind changing the Sphinx is an Earth event. How does that event compare with the Earth events in our display?**

Listen for students to mention ideas such as these:

- The book mentions that some people think the Sphinx is 4,500 years old. The wind changing the Sphinx could be like the events that formed Delicate Arch and Wave Rock.
- The wind changing the Sphinx is like the other Earth events that took a long time, but students are not sure whether the wind changing the Sphinx took more or less time than the other events.

Build on students' responses to establish that wind has been changing the Sphinx slowly, over a time span much longer than a person can observe in a lifetime of around 76 years. Explain that fast Earth events can be observed in a human lifetime and that slow Earth events cannot be observed in a human lifetime.

Teacher Note

This module defines a lifetime as 76 years to reflect the average life expectancy in the United States (Xu et al. 2022). Depending on their personal experiences, emotions, and level of curiosity, students may have additional questions about the length of a lifetime, and some students may struggle emotionally with this topic. If students wish to discuss this topic further, or if students need additional support, meet them where they are. Students who are anxious about their own mortality or the mortality of their loved ones

Teacher Note

If students suggest that the Sphinx's missing nose is the result of Earth events, reveal that most researchers believe that human activity caused this change. If possible, redirect the discussion to focus on Earth events that caused other changes to the Sphinx.

Teacher Note

Consider showing students a photograph of the present-day Sphinx (Lesson 6 Resource E) and adding it to the display. If using the present-day Sphinx photograph, specify that this photograph was taken much more recently than the photograph of the Sphinx in Lesson 6 Resource D, which was taken in 1857.

may be reassured to learn that many people live far beyond the age of 76. However, students who have experienced grief or loss may benefit from a different conversation. As needed, consider asking a school counselor to speak with students who have questions or concerns and to further support students who have experienced grief or loss.

Remind students that they used descriptions of Earth events to order the events and create their class display. Tell students that they will listen to the descriptions of the events again to review them. Read aloud each Earth event text. Ask students to use nonverbal signals to indicate whether they think each event is a fast Earth event or a slow Earth event.

Look for students to indicate that the *Loma Prieta earthquake*, *Moore tornado*, *eruption of Mount St. Helens*, and *Midland flood* are fast Earth events and that the *formation of Delicate Arch* and *Wave Rock* are slow Earth events.

Tell students that in this lesson part, they will focus on the length of time it takes for Earth events to form land or change land to better answer the Phenomenon Question **How can we compare the Earth events that change Surtsey's land?**

LEARN 20 to 30 minutes

Explore Yardangs | 5 to 10 minutes

Students examine the Yardangs Knowledge Deck poster and establish where yardangs are found. In pairs, students discuss how wind forms yardangs.

2. Have students learn about yardangs and discuss how wind forms them.

Display the back of the Yardangs Knowledge Deck poster, and read the text aloud. Ask students to use a nonverbal signal when they hear a familiar term that describes land or changes to land. Then draw students' attention to the photograph on the front of the poster. Instruct students to observe the photograph silently.

 **Where are yardangs found?**

 **What kinds of Earth events cause yardangs to form?**

Listen for students to identify that yardangs are found in the desert and that they form when strong winds blow sand at the rock, chipping it away.

Place students in pairs, and give each student a Yardangs Knowledge Deck card. Have pairs read the text on the back of the card. Then have pairs discuss questions such as these:

 **How does wind change land to form yardangs?**

 **How long does it take for yardangs to form?**

Circulate to support students' discussions. Then bring the class back together. Use students' responses to highlight that yardangs form as wind blows sand over a time span of thousands of years.

Develop an Argument About Fast and Slow Earth Events | 15 to 20 minutes

Students choose a claim about the time spans of Earth events. Next, students identify evidence that supports their claim. Then students record an argument in their Science Logbook that summarizes how the evidence supports the claim.

3. **Have students choose a claim about the time spans of Earth events, identify evidence that supports their claim, and record an argument that summarizes how the evidence supports the claim.**

 LESSON 6 RESOURCE F  LESSON 6 ACTIVITY GUIDE B

Display the event and landform comparison chart. Explain that the chart summarizes information students have learned about yardangs and about Surtsey. Highlight that wind blows sand to form yardangs. Then remind students that in Lesson 1, they learned from *Life on Surtsey* that Surtsey was formed by a near-constant volcanic eruption that took place over less than four years, between 1963 and 1967. Also remind students that in Lesson 3, they observed how water and wind change Surtsey over time: The wind blowing and the crashing waves change the shape of the land. 

Teacher Note

In Lesson 1, students learned that Surtsey was fully formed by April 1964. This date represents when the island reached its full size. However, the eruption that formed Surtsey continued to shape it until the eruption ended in June 1967.

Next, read aloud the information on the chart as students follow along.

Have students turn to the two claims in their Science Logbook. Remind students that a claim is a statement that answers a scientific question and describes a phenomenon. Then read the claims aloud as students follow along. Clarify for students that both claims can be true.

Place students in pairs, and instruct pairs to work together to choose a claim to support. Then ask pairs to identify a piece of evidence that supports their claim, and have students record that evidence in their Science Logbook. Encourage students to use their observations of the event and landform comparison chart and from previous activities to identify evidence. Allow time for students to discuss and record their evidence. Then prompt pairs to develop an argument that summarizes how their evidence supports their claim. Have students record their argument in their Science Logbook.  

Sample student response for Claim A:

Claim A: Earth events change land slowly.

One piece of evidence from the chart that supports my claim is *that wind blowing changes land slowly to form yardangs*.

Our evidence supports the claim because *the chart shows that wind forms yardangs over thousands of years and many lifetimes*.

Sample student response for Claim B:

Claim B: Earth events change land quickly.

One piece of evidence from the chart that supports my claim is *that a volcanic eruption formed Surtsey quickly*.

Our evidence supports the claim because *the chart shows that the eruption took less than 4 years. That is less than a lifetime*. 

Summarize students' responses to emphasize that the Earth events that form and shape yardangs happen over longer time spans and that the Earth events that formed and are shaping Surtsey happen over shorter time spans.

 Differentiation

Students may need support as they discuss evidence to develop an argument. Consider posting the following sentence frames:

- I think that ____ because ____.
- My evidence is ____ and ____.

 Teacher Note

Consider supporting students by prompting them to review how they developed an argument in Lesson 3 Part 4. Allow students to consult their Science Logbook (Lesson 3 Activity Guide E).

 Teacher Note

To provide evidence for Claim B, students may refer to either the volcanic eruption that formed Surtsey or to the blowing wind and crashing waves that are shaping Surtsey's land. Students only need to cite one Earth event as evidence, but they may choose to cite more than one kind of event. Either approach is acceptable.

**Check for Understanding**

Develop an argument (SEP.7) to describe **the time spans of Earth events (ESS1.C)** that cause **land to change quickly or slowly (CC.7)**.

EVIDENCE	NEXT STEPS
Look for the following in students' written responses: - Students use evidence from the event and landform comparison chart to develop an argument that supports a claim (SEP.7). - Students describe the time spans of Earth events (ESS1.C). - Students explain how Earth events cause land to change quickly or slowly (CC.7).	If students need support to identify evidence and develop an argument, have them circle relevant information on the event and landform comparison chart, and prompt them to orally explain their evidence before responding in writing. Ask questions and provide examples such as these: - Think about your claim, and then look at the chart. What part of the chart tells you about the time spans of Earth events? - Think about how we ordered Earth events earlier in this lesson. Which event on the chart changed land the fastest? Which event changed land the slowest?

- ✓ *Students should understand the following ideas: Some Earth events cause land to change quickly, or in a single human lifetime. Other Earth events cause land to change slowly, over the course of multiple lifetimes. If students need support to understand these ideas, revisit the event and landform comparison chart. Point to the number of years the chart lists for each Earth event and then point to the life span comparison for that event. Consider posing the following questions: Could someone observe this event in their lifetime? Does that mean the event happens slowly or quickly?*

Pose the following question.

 **What changes do you think will happen to Surtsey over the next 50 years, and what do you think will cause those changes?**

Listen for students to predict that Surtsey will get smaller and that wind and waves will cause this change.

Use students' responses to confirm that wind and waves will likely cause Surtsey to continue to get smaller over the course of students' lifetime. Highlight that although the wind blowing and waves crashing could be considered fast events because they change Surtsey over a single human lifetime, they still happen over a period of many years. As necessary, reiterate this clarification when students update the anchor model and anchor chart. 

LAND 5 to 10 minutes

Students revisit the Phenomenon Question and Driving Question. They use their new learning to update the class anchor model, their Knowledge Tracker, and the class anchor chart.

4. Update the class anchor model, have students update their Knowledge Tracker, and update the class anchor chart.

Review that in this lesson part, students used evidence to develop an argument that supports the claim that Earth events change land slowly or change land quickly. Ask students to use their learning to answer the Phenomenon Question **How can we compare the Earth events that change Surtsey's land?**

Remind students of the Driving Question: **How can the island of Surtsey change shape over time?** Then direct students' attention to the class anchor model. Ask students what they could add to the anchor model to answer the Driving Question and to reflect their new learning: that the Earth events that are shaping Surtsey's land happen over different time spans. As a class, update the anchor model and the explanations so they reflect students' learning.

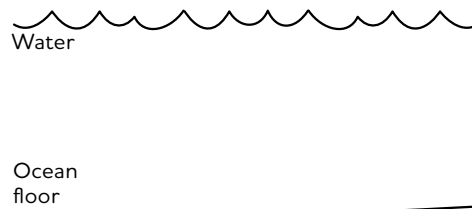
Teacher Note

If students need additional support to contextualize the length of time it takes for wind and waves to shape Surtsey, consider revisiting the event order diagram from Part 1. Place the eruption that formed Surtsey toward the left side of the arrow, and remind students that the eruption took less than 4 years. Then place wind blowing and waves crashing toward the middle of the arrow, and remind students that wind and waves have taken less than 50 years to change the shape of Surtsey. Lastly, place yardangs forming toward the right side of the arrow. Remind students that this event took thousands of years.

Sample anchor model:

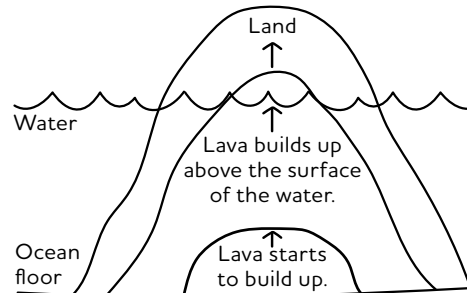
How can the island of Surtsey change shape over time?

Before Eruption (1962)



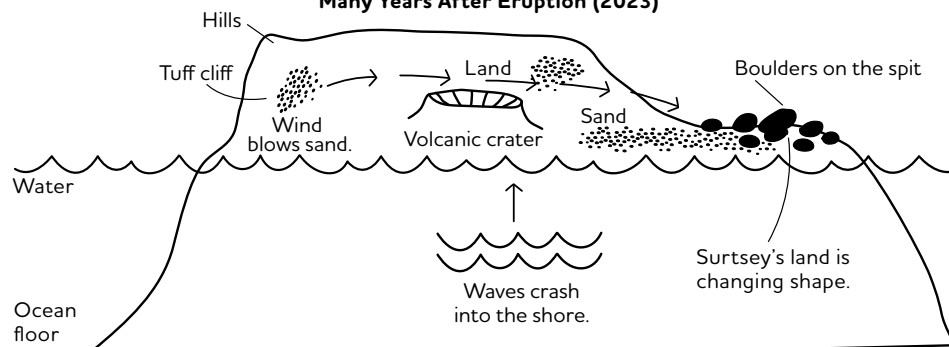
In 1962, there was no island.

A Few Years After Eruption (1967)



A volcano erupted in the ocean. Lava from the eruption built up enough to reach above the water. The lava built up quickly, so the island of Surtsey formed quickly.

Many Years After Eruption (2023)



The natural features of Surtsey's land are hills, cliffs, craters, and a spit. Surtsey's land is made up of rocks, soil, and sand. Some landforms have different properties than others. Surtsey is smaller now and has a lower elevation than when it formed. These changes to Surtsey's size and shape are caused by wind and water. **Some events, such as a volcanic eruption, have changed Surtsey very quickly. Other events, such as wind blowing and waves crashing, happen over longer time spans. Wind and water will continue to change the shape of Surtsey's land over time.**

5. Have students update the Knowledge Tracker in their Science Logbook to reflect on what they learned in this lesson.

Ask students to think about what they figured out during this lesson. Then tell students to consider how that new knowledge may help them answer the Driving Question. Have students record their ideas in the appropriate section of their Knowledge Tracker. 

6. Work with students to update the class anchor chart.

Have students summarize what they have learned so far about Earth events changing land. Work with students to update the class anchor chart so it reflects students' new knowledge.

Sample anchor chart:

Earth Changes

The Components and Shape of Land

- Land can have many different shapes.
 - Rocks, soil, and sand are components of land.
 - The shape and size of land can change.
 - Wind and water can change the shape of land.
-

Time Spans of Changes to Land

- **Some Earth events happen quickly. They change land over a short time.**
 - **Some Earth events happen slowly. They change land over a long time.**
-

Tell students that in the next lesson, they will apply their knowledge to a new phenomenon as they complete a Conceptual Checkpoint.



Differentiation: Support

As students connect what they learned in this lesson back to the Driving Question, they may benefit from prompts such as the following:

- What new information did you learn in this lesson? How does that information remind you of the anchor phenomenon?
- How is the phenomenon we explored in this lesson similar to the anchor phenomenon?

HW Suggested Homework

Briefly review that students observed examples of different Earth events that changed land in different places. Then wonder with students whether Earth events have changed land in their local area.

Have students look for evidence of an Earth event changing land or an object in their local area. Have students draw their findings. Ask students to examine the evidence they collect and to explain what could have caused the changes.

Lesson 6

PREPARATION RESOURCE

PART 1 of 3

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- | | | |
|---|---|---|
| ☐ 11" × 17" paper (6) | ☐ Lesson 6 Resource B: Earth Event Photographs | ☐ String (6 ft) |
| ☐ Chart paper and marker for class diagram | ☐ <i>Life on Surtsey</i> (Burns 2017) (1) | ☐ Sticky notes |
| ☐ Clothespins (6) | ☐ Printer access | ☐ Tape rolls (6) |
| ☐ Lesson 6 Resource A: Earth Event Cards | ☐ Scissors (1) | |

PREPARATION

Complete the following tasks to prepare for this lesson part. Module resources needed for preparation follow this preparation resource.

Earth Event Cards | 5 to 10 minutes

Materials

- | | | |
|---|---|---------------------------------------|
| ☐ Lesson 6 Resource A: Earth Event Cards | ☐ Printer access | ☐ Scissors (1) |
|---|---|---------------------------------------|

Instructions: Print and cut out seven color copies of the cards in Lesson 6 Resource A so that each group receives a full set and there is an additional set for teacher reference. Consider using card stock and laminating for multiple uses.

Earth Event Display | 5 minutes or less

Materials

- ☐ String (6 ft)
- ☐ Tape roll (1, from group materials)

Instructions: Use the tape to hang the string horizontally across an area of the classroom at a height students can reach.

Earth Event Photographs | 5 minutes or less

Materials

- ☐ Lesson 6 Resource B: Earth Event Photographs
- ☐ Printer access
- ☐ Scissors (1)

Instructions: Print and cut out one color copy of each Earth event photograph in Lesson 6 Resource B so that each group receives one photograph. Consider using card stock and laminating for multiple uses.

PART 2 of 3

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- | | | |
|---|---|---|
| ☐ Chart paper and marker for class list | ☐ Earth event display (1, from Part 1) | ☐ Printer access |
| ☐ Earth event card order sheets (6, from Part 1) | ☐ Lesson 6 Resource C: Earth Event Texts | ☐ Scissors (1) |

PREPARATION

Complete the following task to prepare for this lesson part. Module resources needed for preparation follow this preparation resource.

Earth Event Texts | 5 minutes or less

Materials

-
- | | | |
|---|---|---------------------------------------|
| ☐ Lesson 6 Resource C: Earth Event Texts | ☐ Printer access | ☐ Scissors (1) |
|---|---|---------------------------------------|

Instructions: Print and cut out one copy of each Earth event text in Lesson 6 Resource C so that each group receives the text for their assigned Earth event photograph from Part 1.

PART 3 of 3

MATERIALS

To prepare for and implement this lesson part, ensure that the following materials are available.

- ☐ Earth event display (1, from Part 2)
- ☐ Earth event texts (1 set, from Part 2)
- ☐ Lesson 6 Resource D: Great Sphinx of Giza Photograph
- ☐ Lesson 6 Resource F: Event and Landform Comparison Chart
- ☐ Lesson 6 Resource E: Great Sphinx of Giza Present-Day Photograph (optional)
- ☐ *World Traveler: The Sphinx* (Schmidt and O'Halloran 2018) (1)
- ☐ Yardangs Knowledge Deck™ card (1 per student)
- ☐ Yardangs Knowledge Deck poster (1)

PREPARATION

Complete the following task to prepare for this lesson part. Module resources needed for preparation follow this preparation resource.

Great Sphinx of Giza Present-Day Photograph | optional | 5 minutes or less

Materials

-
- ☐ Lesson 6 Resource E: Great Sphinx of Giza Present-Day Photograph
 - ☐ Printer access
 - ☐ Scissors (1)

Instructions: Print and cut out one color copy of the Great Sphinx of Giza present-day photograph in Lesson 6 Resource E. Consider using card stock and laminating for multiple uses.

Lesson 6 Resource A

EARTH EVENT CARDS

**Mount St. Helens
Eruption**



**Midland
Flood**



**Moore
Tornado**



**Loma Prieta
Earthquake**



**Delicate Arch
Forming**



**Wave Rock
Forming**



Lesson 6 Resource B

EARTH EVENT PHOTOGRAPHS

Mount St. Helens Eruption



Midland Flood



Loma Prieta Earthquake



Delicate Arch Forming



Moore Tornado



Wave Rock Forming



Lesson 6 Resource C

EARTH EVENT TEXTS

Mount St. Helens Eruption



Mount St. Helens is a volcano.

The volcano erupted and sent rocks flying.

The eruption lasted for almost 9 hours.

Midland Flood



Rain began to fall in Midland, Michigan.

Rain fell for 2 more days.

When the rain stopped, water covered the land.

Loma Prieta Earthquake



Earthquakes shake the ground.

This earthquake caused the land to crack.

The earthquake lasted less than 15 seconds.

Delicate Arch Forming



This is a rock arch.

The rock arch is made of sandstone.

Water shaped the rock over many thousands of years.

Moore Tornado



Tornado winds are very strong.

Tornadoes spin as they move.

This tornado lasted for about 40 minutes.

Wave Rock Forming



This curved cliff is in Australia.

The cliff is made of granite.

Water shaped the cliff over many thousands of years.

Lesson 6 Resource D

GREAT SPHINX OF GIZA PHOTOGRAPH



Lesson 6 Resource E

GREAT SPHINX OF GIZA PRESENT-DAY PHOTOGRAPH

Great Sphinx of Giza



Lesson 6 Resource F

EVENT AND LANDFORM COMPARISON CHART

Landform Forming or Changing Shape	Earth Event	Time Span	Lifetimes to Observe	Picture
Yardang	Wind blowing	Thousands of years	More than 200 	
Surtsey	Volcanic eruption	Less than 4 years	1 	
Surtsey	Wind blowing and waves crashing	Less than 50 years	1 	



Concept 2 | Time Spans of Changes to Land

LESSON 7 CONCEPTUAL CHECKPOINT

Lesson Phenomenon | Earth events shaping landforms near Cappadocia

Phenomenon Question | How can we describe the time spans of Earth events that change the land near Cappadocia?

OVERVIEW

Previously we discovered that Earth events that change land occur over different time spans. We identified that some Earth events, such as earthquakes, can happen in only seconds. Other events take hours, days, or years, and some take many thousands of years. We compared the time spans of different events and concluded that the volcanic eruption changed Surtsey faster than the wind blowing and the waves crashing; wind and water are continuing to shape Surtsey over the years.

In this lesson we apply our learning about time spans and changes to land caused by Earth events as we complete a Conceptual Checkpoint.

Later we will apply our learning to a new context in an End-of-Module Assessment.

STANDARDS ADDRESSED

This lesson provides students with the opportunity to demonstrate progress toward the Module Objectives. For detailed information on the alignment between Module Objectives and summative assessments, including this Conceptual Checkpoint, see the Assessment Maps section in the Module Overview. The table that follows lists NGSS elements summatively assessed in this lesson.

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.2: Developing and Using Models - Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). SEP.6: Constructing Explanations and Designing Solutions Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. SEP.7: Engaging in Argument from Evidence Construct an argument with evidence to support a claim.	ESS2.A: Earth Materials and Systems Wind and water can change the shape of the land. ESS1.C: The History of Planet Earth Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	CC.7: Stability and Change Things may change slowly or rapidly.



PART 1 of 1

PREPARE 10 minutes or less

Complete the following preparation before the lesson. Find the full materials list and preparation instructions in the Lesson 7 Preparation Resource.

Event and landform comparison chart (5 minutes or less)

Lesson 7 Conceptual Checkpoint (5 minutes or less)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 1.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	☐ Science Logbook (1 per student)	None	No disposable or prepared materials from Part 1 are reused in the module.
Learn: Conceptual Checkpoint	☐ Prepared event and landform comparison chart (1 per student) ☐ Prepared Lesson 7 Conceptual Checkpoint (1 per student)	☐ Lesson 7 Resource A: Photographs of Landforms Near Cappadocia	
Land	☐ Science Logbook (1 per student)	None	

LAUNCH 5 minutes or less

Students summarize how their learning from this concept helps them make sense of the anchor phenomenon.

1. Discuss how students have acquired new knowledge throughout the concept.

Display the anchor model, and ask students to review the Knowledge Tracker in their Science Logbook. Use prompts such as the following to facilitate a discussion about what students have learned so far.

 **How do wind and water change Surtsey's land?**

 **Think about the time spans of Earth events that have changed Surtsey's land. How do the time spans compare?**

 **Earth events with different time spans have changed Surtsey's land. How did we figure out how to describe those events?**

Listen for students to mention the following:

- Wind blowing and crashing waves have caused some parts of Surtsey's land to get smaller or change in shape.
- The changes to Surtsey's land caused by the volcanic eruption happened more quickly than the changes to Surtsey's land caused by wind and water. The Earth events that formed Surtsey and changed its shape have different time spans.
- Investigations or activities that helped students develop their knowledge about the time spans of different Earth events.

2. Transition the class to the Conceptual Checkpoint.

Explain that students can use what they know about Earth events and changes Earth events cause to land to make sense of other, similar phenomena. Tell students that they will now apply their knowledge of Earth events to a new context as they complete a Conceptual Checkpoint.

Agenda | 30 to 45 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 30 minutes

- Conceptual Checkpoint (20 to 30 minutes)

LAND | 5 to 10 minutes

LEARN 20 to 30 minutes

Conceptual Checkpoint | 20 to 30 minutes

Students apply their learning about Earth events changing land to the phenomenon of Earth events changing landforms near Cappadocia as they complete a Conceptual Checkpoint.

3. Introduce the Lesson 7 Conceptual Checkpoint.

📄 LESSON 7 RESOURCE A, LESSON 7 RESOURCE B

Remind students that in an earlier lesson, they learned about one of Cappadocia's landforms: fairy chimneys. 📄 Display the photographs of landforms near Cappadocia, Turkey. Read the labels aloud, and allow students a few moments to observe the photographs.



Crack in the land



Ihlara Valley

💬 What do you notice about the landforms in the pictures?

Establish that the landforms near Cappadocia have different components and shapes. Remind students that the fairy chimneys in Cappadocia formed as Cappadocia's land changed. Point out that land near Cappadocia has tall hills and mountains that surround much lower areas of land. Tell students that these lower areas are called valleys. Explain that a valley is a landform that is found between hills or mountains and that has a lower elevation. 📄

💬 Earth events shape landforms near Cappadocia. How do you think those events are similar to the Earth events that shape Surtsey's land? How do you think they are different? 📄

📄 Teacher Note

Review that in the Lesson 4 Conceptual Checkpoint, students explored how wind and water form and shape fairy chimneys.

📄 Teacher Note

Land near Cappadocia consists of layers of volcanic and sedimentary rock. Together, these rock layers make up many different landforms, including fairy chimneys, caves, canyons, volcanoes, plateaus, and valleys.

📄 Teacher Note

The country of Turkey is one of the most geologically active parts of the world. Turkey experiences thousands of earthquakes each year and has a long history of volcanic activity.

Teacher Note

Until this point, students may have only encountered the term *shape* as a noun. Point out to students that *shape* can also be a verb. As necessary, explain that to shape something is to give it a certain shape or to change its shape.

Suggest that to better answer this question, students will gather more information about the Earth events that shape the land near Cappadocia. Tell students that they will use what they know about Earth events that change land and their time spans to explore the Phenomenon Question **How can we describe the time spans of Earth events that change the land near Cappadocia?**

Provide each student with a prepared Conceptual Checkpoint and a prepared event and landform comparison chart.

4. Read aloud each assessment item, and give students time to complete the Conceptual Checkpoint.

LESSON 7 RESOURCE B

Tell students that the event and landform chart provides information about the Earth events that affect the landforms near Cappadocia. Allow students a few moments to look at the photographs and text in the chart. Then read aloud the information in the chart as students follow along. 

Next, direct students' attention to the Conceptual Checkpoint. Read aloud the first item. Tell students to refer to the event and landform comparison chart as they complete this item. When students are ready, move to the next item. Continue to read aloud and allow students time to complete the items until all students have completed the assessment.

Conceptual Checkpoint

This Conceptual Checkpoint assesses students' understanding of the knowledge and skills they developed throughout Concept 2. Use the Lesson 7 Conceptual Checkpoint Scoring Guide to score each student's assessment. The scoring guide also lists the NGSS elements assessed by each item and identifies next steps for students who need additional support.

Teacher Note

Each row of the chart provides information about how an Earth event forms or shapes a different landform near Cappadocia, including the time span over which the event occurs. Read one row of the chart at a time.

Teacher Note

Debriefing the Conceptual Checkpoint provides an opportunity to identify each student's strengths and growth areas and to respond flexibly to students' needs before moving to the next concept. This practice also helps students develop their metacognition skills as they identify the knowledge they applied to respond to assessment items and notice where they might have made mistakes.

To debrief the Conceptual Checkpoint, use the scoring guide to score each student's assessment. (See the scoring guide and sample responses in Appendix A: Summative Assessments and Scoring Guides.) Identify at least one assessment item to debrief with the class. Select an exemplar response to this item either from the Teacher Edition or from a student assessment. If selecting a response from a student assessment, remember to remove identifying information. Be sure to select responses from a variety of students over time.

When providing students with individual feedback on the assessment, guide them to focus on specific areas for improvement to deepen their understanding of the concept. Offer students who need additional support the opportunity to revisit portions of the module.

LAND 5 to 10 minutes

Students create a new model to reflect what they have figured out about the anchor phenomenon throughout the module. Students also reflect on the related phenomena they identified earlier in the module, which helps them make connections between their own experiences and rich, sometimes distant, phenomena.

5. As a class, discuss students' progress toward making sense of the anchor phenomenon.

 LESSON 1 ACTIVITY GUIDE B, LESSON 7 ACTIVITY GUIDE

Ask students to return to the initial model they developed in their Science Logbook at the beginning of the module. Have students Think–Pair–Share to respond to the following prompts.

 **How has your thinking about the anchor phenomenon changed since you made your initial model?**

 Are there questions about the anchor phenomenon that we have not answered?

Have students develop a new model in their Science Logbook to reflect their new knowledge.  Then use input from students to update the class anchor model.

Next, direct students' attention to the Driving Question board. Ask students to think about the related phenomena they shared earlier in the module.

 How has your thinking about these related phenomena changed? How has your thinking stayed the same?

 Can you use what we have learned to explain these phenomena?

 How was it useful to think about related phenomena throughout the module?

Listen for students to apply knowledge from the module to explain related phenomena and to explain how discussing related phenomena helped them better understand phenomena from the module.

6. Update the Driving Question board.

Focus students' attention on the Other Question column of the Driving Question board. Have students use a nonverbal signal to indicate whether they can now answer each question. Then work together to update the Other Questions header to Questions About Changes Caused by Earth Events, and re-sort questions as needed. 

Teacher Note

As students develop their new model, consider displaying Lesson 1 Resource B to remind students how Surtsey looked at each time represented by their model: before the eruption, a few years after the eruption, and many years after the eruption.

Teacher Note

Students may have unanswered questions or questions that do not fit into one of the identified categories. Consider discussing ways in which students can find answers or creating a class parking lot to store the questions for later discussion.

Sample Driving Question board:

Driving Question: How can the island of Surtsey change shape over time?

Questions About Land

What is it like on Surtsey?

What is the land on Surtsey made of?

What other kinds of landforms are there?

Questions About Changes Caused by Earth Events

Does all land change shape?

How long is it taking for Surtsey to change shape?

Are other islands changing shape like Surtsey?

Do volcanoes create other islands?

What is causing Surtsey to change shape?

Related Phenomena:

Sometimes bad weather can change the shape of land.

People can use tools and machines to change the land.

The shoreline at the beach keeps changing every year.

The land on our playground has soil and rocks in it.

We had to add more mulch in our garden after a big rainstorm quickly washed it away.

Lesson 7

PREPARATION RESOURCE

PART 1 of 1

MATERIALS

To prepare for and implement this part of the lesson, ensure that the following materials are available.

- ☐ Lesson 7 Conceptual Checkpoint
- ☐ Lesson 7 Resource A: Photographs of Landforms Near Cappadocia
- ☐ Lesson 7 Resource B: Event and Landform Comparison Chart of Landforms Near Cappadocia
- ☐ Printer access

PREPARATION

Complete the following tasks to prepare for this part of the lesson. Module resources needed for preparation follow this preparation resource.

Event and Landform Comparison Chart | 5 minutes or less

Materials

- ☐ Lesson 7 Resource B: Event and Landform Comparison Chart of Landforms Near Cappadocia
- ☐ Printer access

Instructions: Print a color copy of Lesson 7 Resource B for each student.

Lesson 7 Conceptual Checkpoint | 5 minutes or less

Materials

- ☐ Lesson 7 Conceptual Checkpoint
- ☐ Printer access

Instructions: Print a color copy of Lesson 7 Conceptual Checkpoint for each student.
(See Appendix A.)

Lesson 7 Resource A

PHOTOGRAPHS OF LANDFORMS NEAR CAPPADOCIA

Crack in the Land



Ihlara Valley



Lesson 7 Resource B

EVENT AND LANDFORM COMPARISON CHART
OF LANDFORMS NEAR CAPPADOCIA

Landform Forming or Changing Shape	Earth Event	Time Span	Lifetimes to Observe	Picture
Crack in the land	Earthquake	Seconds	1 	
Ihlara Valley	Water flowing in a river	Many thousands of years	More than 50 	



APPLICATION OF CONCEPTS SOCRATIC SEMINAR AND END-OF-MODULE ASSESSMENT



Application of Concepts

LESSON 8 TRANSFORMATION OF SURTSEY

Tasks | Socratic Seminar and End-of-Module Assessment

Driving Question | How can the island of Surtsey change shape over time?

Phenomenon Question | How does a shoreline change to form a sea stack?

OVERVIEW

Previously we learned what has caused Surtsey's land to change over time.

In this lesson we participate in a Socratic Seminar to synthesize our learning from throughout the module and express our understanding of how land changes over time. We also complete an End-of-Module Assessment in which we apply our knowledge to a new phenomenon, the formation of the Twelve Apostles sea stacks.

STANDARDS ADDRESSED

This lesson provides students with the opportunity to demonstrate progress toward the Module Objectives. For detailed information on the alignment between Module Objectives and summative assessments, including the End-of-Module Assessment in this lesson, see the Assessment Maps section in the Module Overview. The table that follows lists NGSS elements summatively assessed in this lesson.

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
SEP.2: Developing and Using Models • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	ESS1.C: The History of Planet Earth • Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	CC.3: Scale, Proportion, and Quantity • Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).
SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	ESS2.A: Earth Materials and Systems • Wind and water can change the shape of the land.	CC.7: Stability and Change • Things may change slowly or rapidly.
SEP.7: Engaging in Argument from Evidence • Construct an argument with evidence to support a claim.		



PART 1 of 3

PREPARE 5 to 10 minutes

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 8 Preparation Resource.

Key term cards (5 to 10 minutes)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 1.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	☐ Prepared key term cards (1 card per student)	☐ Lesson 8 Resource A: Key Term Cards	No disposable or prepared materials from Part 1 are reused in the module.
Learn: Engage in Socratic Seminar	☐ Science Logbook (1 per student)	☐ Lesson 1 Resource B: Surtsey Photographs over the Years	
Land	☐ Science Logbook (1 per student)	None	

LAUNCH 5 to 10 minutes

Students discuss relationships between key terms to review module concepts in preparation for a Socratic Seminar.

1. Reinforce connections between key terms.

Tell students that they will participate in a Link Up instructional routine to identify relationships, or connections, between key terms they learned throughout the module.  Ask for a few volunteers to model the routine. Give each volunteer a different prepared key term card, and read aloud each term. Describe the routine to the class, explaining each step while guiding the volunteers through one round. Then have volunteers complete additional rounds as necessary. Point out that terms can relate to each other in different ways. 

Next, distribute prepared key term cards to the rest of the class so each student has a card. While handing out the cards, make sure to read aloud each term. Prompt students to circulate and find a partner with a different, but related, key term. Ask students to discuss how their words relate.

Continue the routine until students have had the opportunity to discuss their key terms with a few other students. After the routine, invite pairs from the final round to explain to the class how their terms are related.

LEARN 20 to 25 minutes**Engage in Socratic Seminar | 20 to 25 minutes**

Students participate in a collaborative conversation to express and deepen their knowledge related to the Driving Question.

2. Prepare for the Socratic Seminar.

 LESSON 1 RESOURCE B

Display the photographs of Surtsey over the years from the beginning of the module, and ask students to review the Knowledge Tracker in their Science Logbook.

Agenda | 30 to 45 minutes**LAUNCH | 5 to 10 minutes****LEARN | 20 to 25 minutes**

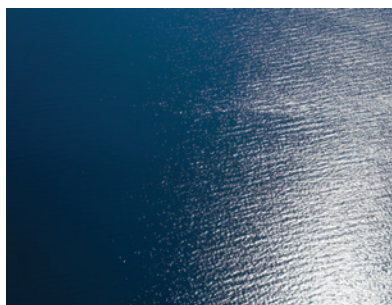
- Engage in Socratic Seminar (20 to 25 minutes)

LAND | 5 to 10 minutes **Teacher Note**

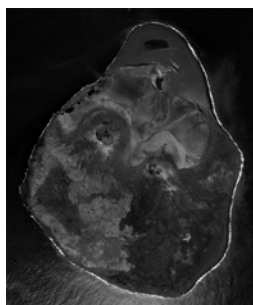
Link Up is a terminology learning routine that helps students understand relationships between scientific terms. Each student receives a key term card. Then students circulate to find a student with a term that they think relates to theirs. When they find someone with a related term, the two students discuss the relationship between their terms.

 Differentiation

Before using the Link Up routine with key terms, consider having students practice with familiar words such as *water*, *wind*, *rock*, and *map*. Highlight connections between these familiar words to help students understand the different ways terms can be related.



1962



1967



2004

As students review the Knowledge Tracker, ask them to think about what they have learned since they first observed the photographs. Tell students that they will share this knowledge with one another as they discuss the Driving Question in a Socratic Seminar. 🏠

3. Initiate the Socratic Seminar, and support students as necessary.

Review the routines and expectations for participating in a Socratic Seminar, including classroom guidelines and resources for speaking and listening. Explain that students can refer to the anchor model, the anchor chart, and other classroom resources to support their discussion. Then display and read aloud the Driving Question: **How can the island of Surtsey change shape over time?** Ask students to prepare for the Socratic Seminar by briefly discussing the question with a partner.

Instruct students to sit in a circle. Read aloud the Driving Question again to begin the Socratic Seminar. Allow students to respond to one another directly, with minimal teacher facilitation. Students should remind one another of conversation norms, ask for evidence, and pose questions to extend the conversation. 📖 As necessary, step in briefly to reinforce norms for collaborative conversations. If students' conversation wanes or wanders, consider asking one of the following questions to stimulate additional discussion:

- 💬 How can we describe what land is made of?
- 💬 How can wind and water affect land?
- 💬 How can we describe the time spans of Earth events?
- 💬 How has Surtsey's land changed over time?

🏠 Content Area Connection: English

This Socratic Seminar allows students to use their speaking and listening skills to express and deepen their science content knowledge. In a Socratic Seminar, students prepare for and participate in a collaborative, evidence-based academic conversation. In this discussion, students should work toward grade-level expectations for speaking and listening.

For more information about Socratic Seminars, see the Implementation Guide.

📖 Teacher Note

Depending on students' familiarity with Socratic Seminars, consider modifying the routine with one or more of these suggestions.

- Students hold seminars in groups rather than participating in the seminar as a class.
- Students use sentence frames to help them build on one another's remarks.
- Students use talking chips. Each student receives a chip. After a student shares, the student places the chip in the middle of the circle. After every student shares and all chips are in the circle, students retrieve the chips and start the process again.

LAND 5 to 10 minutes

Students compare module artifacts to reflect on how Science and Engineering Practices have helped them build knowledge.

4. Reflect on Science and Engineering Practices.

Restate a few responses from the Socratic Seminar that show evidence of students' learning. Ask students to think about how their knowledge has grown since the beginning of the module. 

 **You have learned a lot about how land changes over time. What did you do to build your knowledge?**

Model how to find a student work product (e.g., a page from a Science Logbook or a class chart) that shows evidence of how students built their knowledge during the module. Point out the difference between the knowledge students built and what students did to build that knowledge. Then instruct students to find another work product in their Science Logbook or elsewhere in the classroom that shows evidence of how they built knowledge. Have students discuss the following questions with a partner who chose a different work product. 

 **What did you do in this work?**

 **What is the same about what you did? What is different?**

Listen for responses that include the following. Responses may vary widely depending on students' selected work.

- Evidence of student learning and the process of acquiring that knowledge (e.g., *We used models to learn how wind and water change the shape of land. We read about the time spans of different Earth events and compared them.*)
- Similarities and differences between how students acquired that knowledge (e.g., *We made many different kinds of observations to understand how Surtsey's land has changed over time; for example, we observed data, videos, and pictures, and we carried out investigations with models.*)

 Teacher Note

Display the Driving Question board, anchor chart, and anchor model to help students reflect on how their knowledge has grown.

 Differentiation

To provide additional support, assign student pairs specific work products that demonstrate clear evidence of similarities in the learning process, such as products in which students applied the same Science and Engineering Practice. For example, consider pairing these work products:

- Lesson 3 Activity Guide B and Lesson 6 Activity Guide B
- Lesson 3 Activity Guides C and D
- Lesson 1 Activity Guide A and Yardangs Knowledge Deck card

Restate several responses that relate to the Science and Engineering Practices.  Remind students that science practices are actions they can take to learn about the world and to gather evidence for scientific ideas. Select a student response and explain how it relates to one of the practices. Ask students to share other experiences they have had when using this practice, such as in other modules or outside of school. Help students identify how they used the practice to build knowledge of phenomena or to develop scientific ideas. Tell students that they can continue to use science practices to understand the world around them. 

Teacher Note

Depending on student responses, this discussion may focus broadly on one or more of the eight Science and Engineering Practices (e.g., SEP.3: Planning and Carrying Out Investigations) or may focus on actions related to specific elements of the Science and Engineering Practice (e.g., measuring, which relates to SEP.3 and SEP.5).

Spotlight on Three-Dimensional Integration

Throughout *PhD Science*, students apply all three dimensions of the NGSS in concert to make sense of phenomena. This activity highlights the role of Science and Engineering Practices in students' three-dimensional learning throughout the module. This discussion should not isolate Science and Engineering Practices; rather, it should help students reflect metacognitively on links between phenomena, ideas, concepts, and practices in science and engineering.



PART 2 of 3

PREPARE 10 to 20 minutes

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 8 Preparation Resource.

Sea stack formation chart (5 to 10 minutes)

Level 2 Module 2 End-of-Module Assessment (5 to 10 minutes)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 2.

SECTION	STUDENT MATERIALS	CLASS MATERIALS	MATERIALS REUSE
Launch	☐ Twelve Apostles Knowledge Deck™ Card (1 per student)	☐ Twelve Apostles Knowledge Deck™ Poster (1) ☐ Marker and sticky notes	The list identifies disposable and prepared materials to save for reuse in the module. ☐ End-of-Module Assessments
Learn: Complete End-of-Module Assessment	☐ Prepared sea stack formation chart (1 per student) ☐ Prepared Level 2 Module 2 End-of-Module Assessment (1 per student)	None	
Land	None	None	

LAUNCH | 5 to 10 minutes

Students learn about sea stacks called the Twelve Apostles to prepare for an End-of-Module Assessment.

1. Introduce the assessment phenomenon.

Tell students that in this lesson they will apply their understanding of how land changes over time by completing an End-of-Module Assessment. Explain that the assessment is a way for students to show the knowledge they have developed throughout the module.

Tell students that they will first learn about a new landform. Display the photograph on the front of the Twelve Apostles Knowledge Deck poster. Then display the back of the poster, and read the text aloud. Have students use a nonverbal signal to indicate when they hear the name of the kind of landform the poster shows. Engage students in a conversation about the landforms on the poster.

 **What are the landforms called?**

 **Where are the landforms found?**

 **Why do you think the landforms have this shape?**

Draw on students' observations to arrive at the following key ideas.

- The landforms are sea stacks. These sea stacks are called the Twelve Apostles.
- Sea stacks are pieces of land that stand in the water along a shoreline.
- Sea stacks are made of rock called limestone.

Next, give each student a Twelve Apostles Knowledge Deck card. Ask students to observe the photograph on the front of the card and to work with a partner to identify at least one headland and one sea stack. Invite students to share their observations with the class. Confirm students' findings by using sticky notes to label a headland and a sea stack on the Knowledge Deck poster. Display the poster for students to refer to throughout the lesson.

Read aloud each sentence on the back of the Twelve Apostles Knowledge Deck card as students follow along. Tell students that they may use the Knowledge Deck card as a resource during the End-of-Module Assessment as they work to answer the Phenomenon Question **How does a shoreline change to form a sea stack?**

Agenda | 30 to 40 minutes

LAUNCH | 5 to 10 minutes

LEARN | 20 to 25 minutes

- Complete End-of-Module Assessment
(20 to 25 minutes)

LAND | 5 minutes or less

LEARN 20 to 25 minutes

Complete End-of-Module Assessment | 20 to 25 minutes

Students complete an End-of-Module Assessment to demonstrate their understanding of how land changes over time.

2. Administer the End-of-Module Assessment.

Give each student a prepared End-of-Module Assessment and a prepared sea stack formation chart. Tell students that the sea stack formation chart provides information about how changes to a shoreline cause sea stacks to form. Allow students a few moments to look at the images and the text in the chart. Then read aloud the information in the chart as students follow along. 

Next, direct students' attention to the End-of-Module Assessment. Read aloud the first item. Tell students to refer to the sea stack formation chart as they complete this item. When students are ready, move to the next item. Continue to read aloud the assessment items, one at a time, so every student responds to each item before proceeding to the next item. As students work, remind them to refer to the sea stack formation chart where specified in the assessment and to use the resources posted in the room. Encourage students to provide complete responses.

Teacher Note

To prepare for the next lesson part, use the End-of-Module Assessment Scoring Guide to score each student's assessment. (See the scoring guide and sample responses in Appendix A: Summative Assessments and Scoring Guides.) Identify at least one assessment item to debrief with the class in the next lesson part. Select an exemplar response to this item either from the Teacher Edition or from a student assessment. If selecting a response from a student assessment, remember to remove identifying information. Be sure to select responses from a variety of students over time.

When providing students with individual feedback on the assessment, guide them to focus on specific areas for improvement to deepen their understanding of module concepts. Offer students who need additional support the opportunity to revisit portions of the module.

Teacher Note

The hole that the chart refers to in column 3 is shaped like an arch. As needed, point out the hole for students.

LAND 5 minutes or less

Students learn that they will debrief the End-of-Module Assessment in the next lesson part.

3. Preview the next lesson part.

Tell students that Part 3 of this lesson will give them the opportunity to share their thinking about the End-of-Module Assessment.



PART 3 of 3

PREPARE 45 to 70 minutes

Complete the following preparation before this lesson part. Find the full materials list and preparation instructions in the Lesson 8 Preparation Resource.

End-of-Module Assessment feedback (20 to 30 minutes)

Sample assessment responses (10 to 15 minutes)

Crosscutting Concept Cards (5 to 10 minutes)

Student work products (10 to 15 minutes)

Preparation Notes

[illegible]

MATERIALS

The table lists materials needed for each section of Part 3.

SECTION	STUDENT MATERIALS	CLASS MATERIALS
Launch	None	☐ Twelve Apostles Knowledge Deck Poster (1)
Learn: Debrief End-of-Module Assessment	None	☐ Level 2 Module 2 End-of-Module Assessment ☐ Prepared sample assessment responses
Learn: Reflect on Crosscutting Concepts	None	☐ Prepared stability and change crosscutting concept card ☐ Prepared student work products
Land	None	None

LAUNCH | 5 minutes or less

Students ask questions about the assessment phenomenon to prepare for a class discussion.

1. Review the assessment phenomenon.

Explain that in this lesson part, students will review part of the End-of-Module Assessment and discuss their responses.

Revisit the Twelve Apostles Knowledge Deck poster. Read the text aloud again to remind students of the assessment phenomenon. Ask students to share questions they have about the phenomenon.

LEARN | 20 to 30 minutes

Debrief End-of-Module Assessment | 10 to 15 minutes

Students discuss a teacher-selected assessment item to deepen their understanding of key knowledge and skills.

2. Discuss part of the End-of-Module Assessment.

Display each prepared assessment item alongside its sample assessment response prepared in Part 2 of this lesson. Use a routine such as Inside–Outside Circles to facilitate a discussion about the item. Revisit relevant student questions from the Launch, and pose general questions such as the following:

-  What do you notice about this response?
-  What do you wonder about this response?
-  How does this response change your thinking?

Agenda | 30 to 40 minutes

LAUNCH | 5 minutes or less

LEARN | 20 to 30 minutes

- Debrief End-of-Module Assessment (10 to 15 minutes)
- Reflect on Crosscutting Concepts (10 to 15 minutes)

LAND | 5 minutes or less

Provide sentence frames such as the following to support students during the discussion:

- I notice _____. That makes me wonder _____.
- I notice _____. That makes me think _____.
- I used to think _____. Now I think _____.

If students' End-of-Module Assessment responses indicate the need, repeat this process with additional assessment items.

Teacher Note

Depending on students' familiarity with reflection and revision, consider these additional strategies for debriefing the assessment.

- Display a student-friendly version of the scoring guidance for the assessment item. Have students share evidence that the sample response meets the criteria described in the guidance as well as any questions they have.
- Display a sample response that does not meet expectations alongside the previously displayed sample response that does meet expectations. Have students compare the responses.
- Have students offer feedback on peers' responses or on their own response to the assessment item.
- Have students revise their response to the assessment item, applying new ideas from the debrief conversation to show deeper understanding through their response.

Reflect on Crosscutting Concepts | 10 to 15 minutes

Students reflect on the role of Crosscutting Concepts in making sense of module phenomena.

3. Review examples of Stability and Change from throughout the module.

Remind students that they can work to answer questions they have about the natural world, which is how scientific ideas are developed. Then introduce the Stability and Change card, and share the following ideas with students:

- Students can use Crosscutting Concepts as lenses to help them figure out answers to their questions. 

Teacher Note

Consider using a prop such as a large magnifying glass to help students understand the analogy of physically looking through a lens. In this lesson and future lessons, use this prop when students apply the lens of a Crosscutting Concept to understand a phenomenon or connect scientific ideas.

- The Stability and Change card represents the idea that things can change—sometimes quickly and sometimes slowly—or they can stay the same. Sometimes land changes quickly, and sometimes it changes slowly.
- Students have done a great deal to build their knowledge of how land changes, and they often used the lens of Stability and Change to deepen their science understanding. 🌟

Ask students to review examples of Stability and Change that they encountered during the module.

 **What have we learned about stability and change that helps us explain how Earth events cause changes to land?**

Listen for student responses that mention that wind events, water events, and other Earth events can change land and that these changes can happen slowly or quickly.

Select a prepared student work product related to students' responses to this question, and model how to discuss the work product by using the lens of Stability and Change. 🧠 Then ask students to circulate to review the prepared student work products displayed in the classroom. As students circulate, have them consider individually how the lens of Stability and Change helped them understand the phenomena the work products depict. After a few minutes, have half the class stand next to a work product. Have the rest of the class find a partner who is standing next to a work product, and instruct pairs to discuss the following question.

 **How did the lens of Stability and Change help you understand this phenomenon?**

Ask students to switch roles, choose different prepared work products, and repeat this process.

4. Discuss how using the lens of Stability and Change has helped students make sense of different phenomena.

Point out that students used the lens of Stability and Change throughout the module to understand different phenomena. Ask students to share phenomena that the lens of Stability and Change helps them understand, such as phenomena from this module, from other modules, or from outside of school. Tell students they can continue to apply Crosscutting Concepts to answer their questions and find links between scientific ideas as they explore new situations.

Spotlight on Three-Dimensional Integration

Throughout *PhD Science*, students apply all three dimensions of the NGSS in concert to make sense of phenomena. This activity highlights the role of Crosscutting Concepts in students' three-dimensional learning throughout the module. This discussion should not isolate Crosscutting Concepts; rather, it should help students reflect metacognitively on links between phenomena, ideas, concepts, and practices in science and engineering.

This lesson highlights Stability and Change because this concept plays an especially important role in students' making sense of phenomena throughout this module. Highlight connections to other Crosscutting Concepts, Disciplinary Core Ideas, and Science and Engineering Practices in the discussion as they appear.

Language Support

To help students explain how they applied the lens of Stability and Change, consider providing a sentence frame such as the following:

A _____ (event) can change _____ (landform) over time.
This change happens _____ (quickly/slowly).

Teacher Note

Consider saving the Stability and Change card as well as cards representing Crosscutting Concepts that students are familiar with from prior modules. Refer to relevant cards as students apply Crosscutting Concepts to make sense of phenomena in future modules.

LAND 5 minutes or less

Students discuss the Driving Question board to reflect on new knowledge and open questions.

5. Update the Driving Question board.

Draw students' attention to the Driving Question board, and invite them to reflect on their new knowledge and what else they would like to learn. Begin by asking students to think about questions they answered during the module. Pose questions such as these to facilitate the discussion:

... **What did you do to answer these questions?**

... **Which answers surprised you? Why?**

... **Which questions relate to each other? How?**

Then ask students to share new questions they have. Ask students to reflect on these new questions and any unanswered questions they still have from earlier in the module. Pose questions such as these to facilitate the discussion: 

... **What do we need to know to answer this question?**

... **What can we do to learn information that helps us answer this question?**

... **Does this question raise other questions?**

HW Suggested Homework

Have students draw a landform that is present in their community and label the properties of the landform. Have students share their drawing with a classmate or trusted adult and describe how they think the landform has changed over time.

**Extension**

Offer opportunities for students to explore these questions, such as through shared research, collaborative investigation, or optional homework.

Lesson 8

PREPARATION RESOURCE

PART 1 of 3

MATERIALS

To prepare for and implement this part of the lesson, ensure that the following materials are available.

- ☐ Lesson 8 Resource A: Key Term Cards
- ☐ Printer access
- ☐ Scissors (1)
- ☐ Lesson 1 Resource B: Surtsey Photographs over the Years

PREPARATION

Complete the following tasks to prepare for this part of the lesson. Module resources needed for preparation follow this preparation resource.

Key Term Cards | 5 to 10 minutes

Materials

- ☐ Lesson 8 Resource A: Key Term Cards
- ☐ Printer access
- ☐ Scissors (1)

Instructions: Print and cut out enough copies of the Key Terms Cards in Lesson 8 Resource A so that each student receives one card. Consider using card stock and laminating for multiple uses. Distribute the cards during the Lesson 8 Part 1 Launch, making sure to pass out each term to at least one student.

PART 2 of 3

MATERIALS

To prepare for and implement this part of the lesson, ensure that the following materials are available.

- ☐ Level 2 Module 2 End-of-Module Assessment
- ☐ Lesson 8 Resource B: Sea Stack Formation Chart
- ☐ Marker and sticky notes
- ☐ Printer access
- ☐ Twelve Apostles Knowledge Deck Card (1 per student)
- ☐ Twelve Apostles Knowledge Deck Poster (1)

PREPARATION

Complete the following tasks to prepare for this part of the lesson. Module resources needed for preparation follow this preparation resource.

Sea Stack Formation Chart | 5 to 10 minutes

Materials

- ☐ Lesson 8 Resource B: Sea Stack Formation Chart
- ☐ Printer access

Instructions: Print a color copy of Lesson 8 Resource B for each student.

Level 2 Module 2 End-of-Module Assessment | 5 to 10 minutes

Materials

- ☐ Level 2 Module 2 End-of-Module Assessment
- ☐ Printer access

Instructions: Print a color copy of Level 2 Module 2 End-of-Module Assessment for each student. (See Appendix A.)

PART 3 of 3

MATERIALS

To prepare for and implement this part of the lesson, ensure that the following materials are available.

- ☐ End-of-Module Assessment (1 per student, from Part 2)
- ☐ Lesson 8 Resource C: Crosscutting Concepts Cards
- ☐ Scissors (1)
- ☐ End-of-Module Assessment Scoring Guide
- ☐ Printer access
- ☐ Twelve Apostles Knowledge Deck Poster (1)

PREPARATION

Complete the following tasks to prepare for this part of the lesson. Module resources needed for preparation follow this preparation resource.

End-of-Module Assessment Feedback | 20 to 30 minutes

Materials

-
- ☐ End-of-Module Assessment (1 per student, from Part 2)
 - ☐ End-of-Module Assessment Scoring Guide

Instructions: Score End-of-Module Assessment and write individual feedback using the End-of-Module Assessment Scoring Guide. (See Appendix A.)

Sample Assessment Responses | 10 to 15 minutes

Instructions: Select at least one End-of-Module Assessment item for the class to debrief, and prepare a sample response for that item to share with students.

Crosscutting Concept Cards | 5 to 10 minutes

Materials

- ☐ Lesson 8 Resource C: Crosscutting Concept Cards
- ☐ Printer access
- ☐ Scissors (1)

Instructions: Print and cut out one copy of the Stability and Change card. Consider also printing and cutting out cards for other Crosscutting Concepts that students are familiar with. Refer to these cards during relevant moments in future lessons.

Student Work Products | 10 to 15 minutes

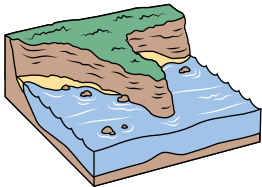
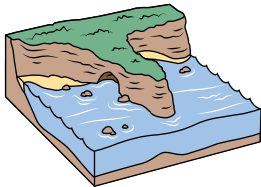
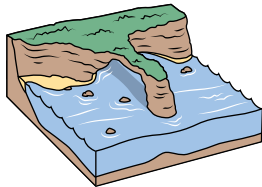
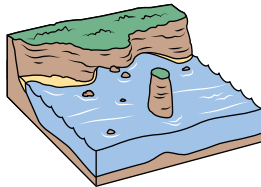
Instructions: Select student work products that show evidence of three-dimensional learning, and display them in different areas of the classroom. Student work products may include the anchor model, other class charts, and selected Student Logbook pages.

Lesson 8 Resource A**KEY TERM CARDS**

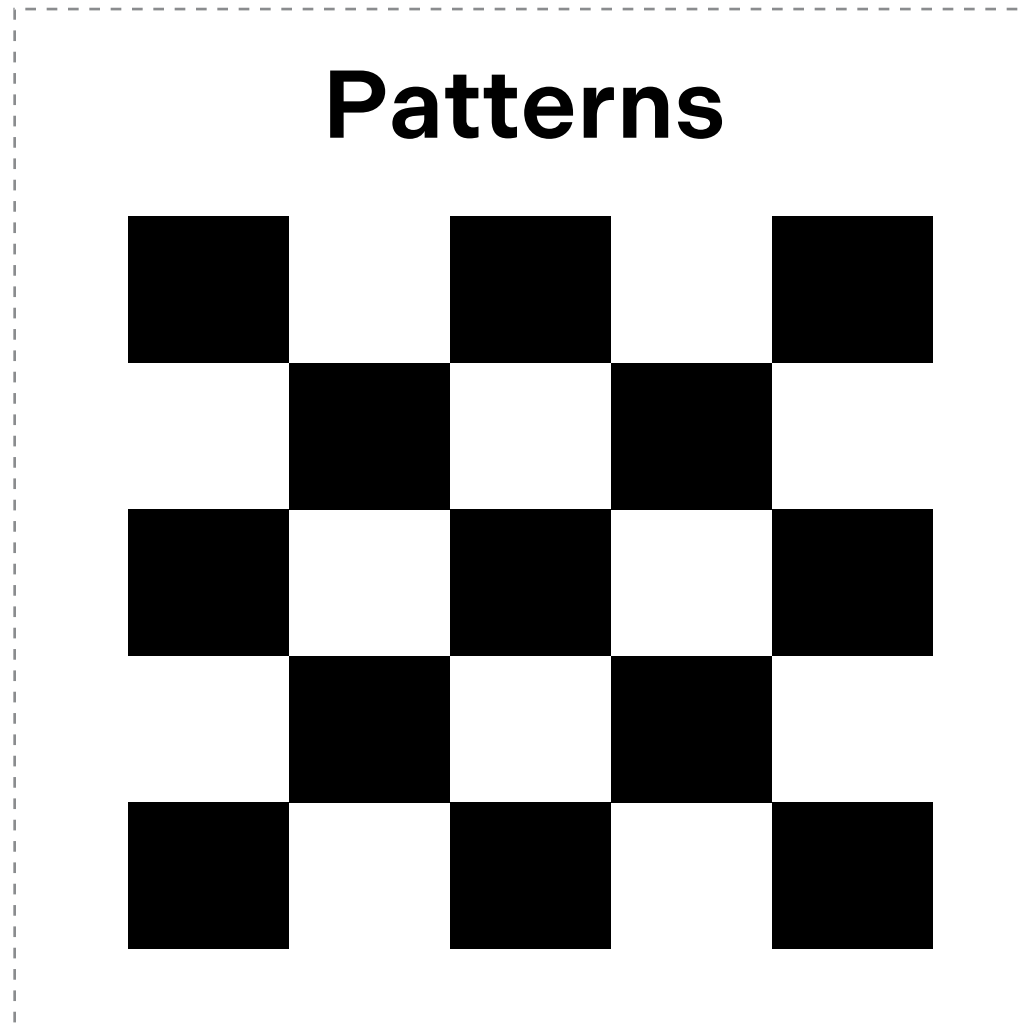
Component	Elevation	Event
Island	Land	Landform
Natural feature	Time span	Volcano

Lesson 8 Resource B

SEA STACK FORMATION CHART

1	2	3	4
 Part of a rocky shoreline sticks out into the ocean.	 Water from waves makes small cracks in the shoreline rock. Pieces of rock break off.	 Waves wash away the pieces of rock. Wind also blows away some of the pieces. The waves and wind make a hole at the bottom of the shoreline rock.	 The hole gets bigger. Then the shoreline rock over the hole falls into the ocean. A tower of rock is left in the water. The tower is called a sea stack.

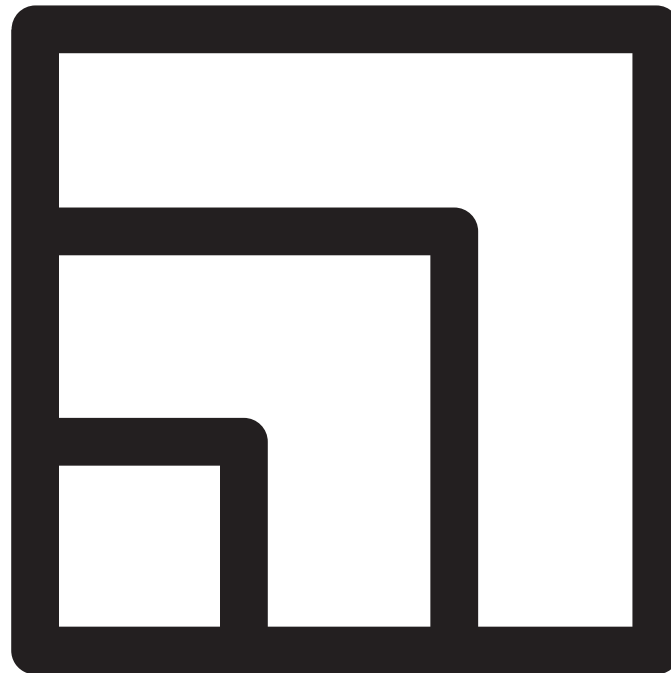
Lesson 8 Resource C

CROSSCUTTING CONCEPT CARDS

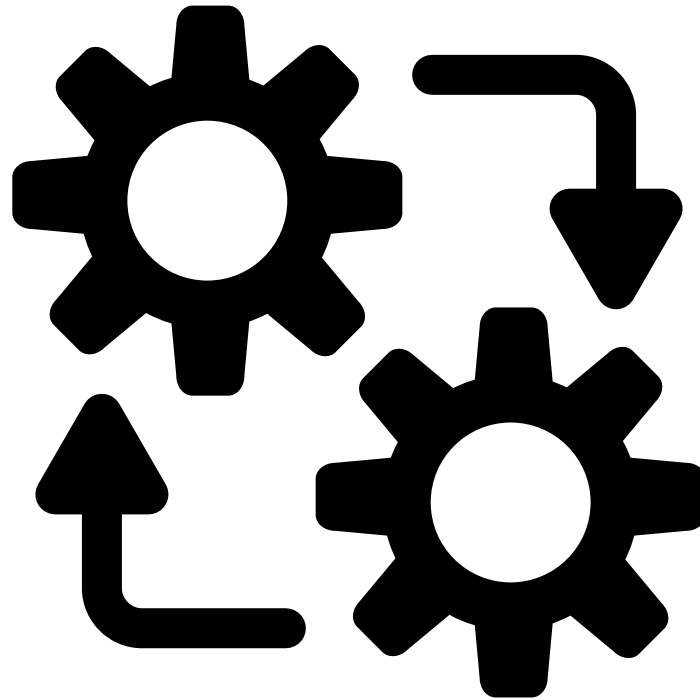
Cause and Effect



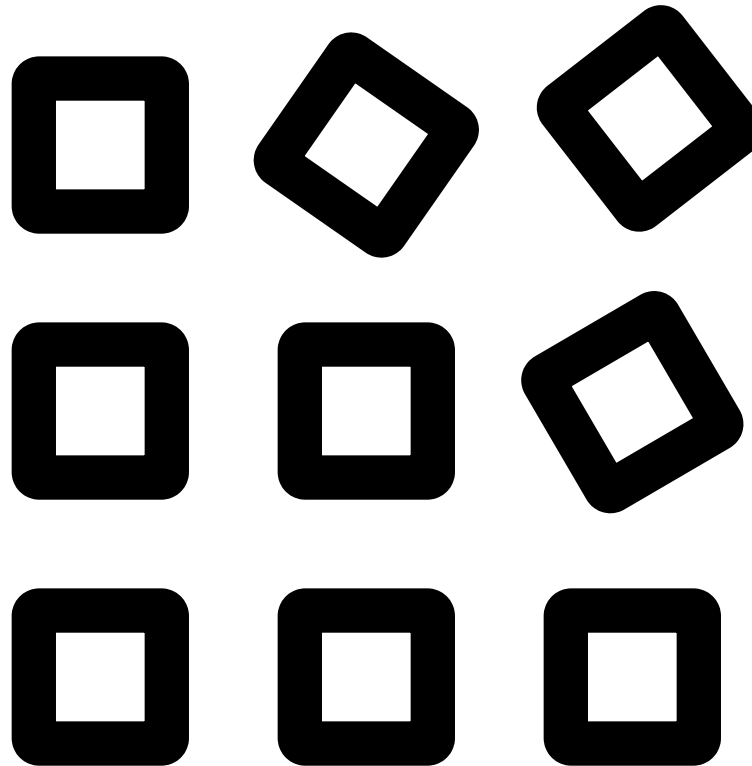
Scale, Proportion, and Quantity



Systems and System Models



Energy and Matter



Structure and Function



Stability and Change



APPENDIX A

SUMMATIVE ASSESSMENTS AND SCORING GUIDES

CONTENTS

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End-of-Module Assessment Scoring Guide	391

Name: _____

Level 2 Module 2

LESSON 4 CONCEPTUAL CHECKPOINT

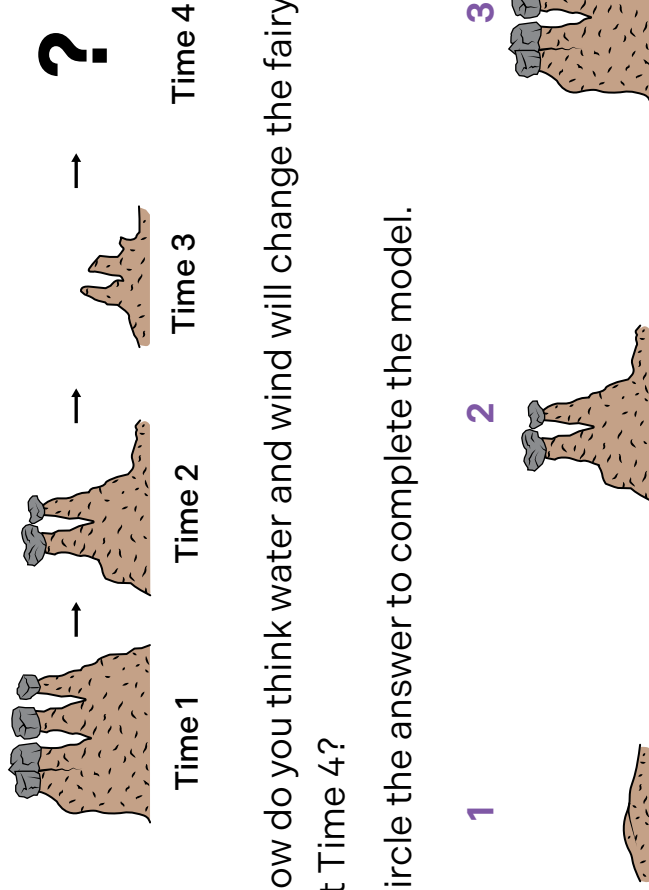
1. How do water and wind change land to form fairy chimneys?

Circle the answer to complete each sentence.

- Water from rain and snow causes cracks
in the rock to get **bigger** / **smaller**.
- Wind causes small pieces to break off from a large rock.
That causes the rock to get **bigger** / **smaller**.

2. Water and wind have changed a group of fairy chimneys over time. Observe the incomplete model.

Fairy Chimneys over Time



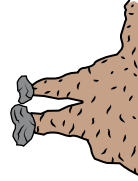
- a. How do you think water and wind will change the fairy chimneys at Time 4?

Circle the answer to complete the model.

1



2



3



- b. Explain how water and wind change the shape or size of fairy chimneys over time.

Name: **Sample**

Level 2 Module 2

LESSON 4 CONCEPTUAL CHECKPOINT

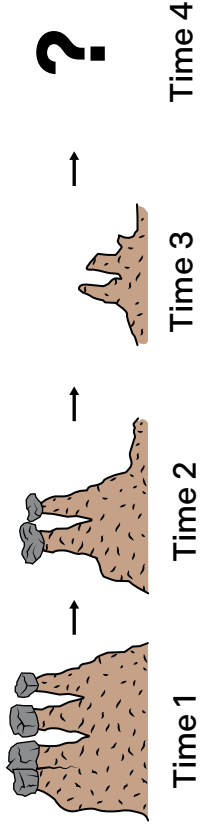
1. How do water and wind change the land to form fairy chimneys?

Circle the answer to complete each sentence.

- Water from rain and snow causes cracks
in the rock to get **bigger** / **smaller**.
- Wind causes small pieces to break off from a large rock.
That causes the rock to get **bigger** / **smaller**.

2. Water and wind have changed a group of fairy chimneys over time. Observe the incomplete model.

Fairy Chimneys over Time



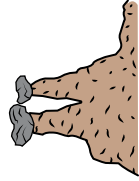
- a. How do you think water and wind will change the fairy chimneys at Time 4?

Circle the answer to complete the model.

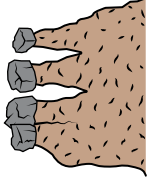
1



2



3



- b. Explain how water and wind change the shape or size of fairy chimneys over time.

The model shows the fairy chimneys getting shorter over

time. I think if water and wind keep changing the fairy

chimneys, the fairy chimneys will disappear.

Level 2 Module 2

LESSON 4 CONCEPTUAL CHECKPOINT SCORING GUIDE

Score each student's Conceptual Checkpoint. The Scoring Guidance column identifies the correct response for each item and includes information about how to determine a student's score. The Points Available column indicates the total number of points available for each item. Use the Score column to record a student's points for each item.

Name: _____ Date: _____

ITEM	SCORING GUIDANCE	POINTS AVAILABLE	SCORE
1	Line 1: bigger Line 2: smaller A correct response is worth 0.5 points.	1	
2	Choice 1 is correct. Choice 2 is incorrect. The model shows the pattern that fairy chimneys get shorter (not bigger) over time. Choice 3 is incorrect. The model shows the pattern that fairy chimneys get shorter (not bigger) over time. A correct response is worth 1 point.	1	
2b	1 point: The student uses the model to explain how wind and water change the shape or size of fairy chimneys. (For example, wind and water make fairy chimneys smaller, shorter, or narrower.)	1	

Total Points Available: 3 Student Score: _____

ALIGNMENT MAP

For teacher reference, this alignment map lists the NGSS elements assessed by each item in the Conceptual Checkpoint. In the alignment map, an asterisk (*) indicates an element that is part of a Module Objective.

ITEM	SEP ELEMENT	DCI ELEMENT	CC ELEMENT
1	SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	CC.7: Stability and Change • Some things stay the same while other things change.
2a	SEP.2: Developing and Using Models* • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	CC.3: Scale, Proportion, and Quantity* • Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).
2b	SEP.2: Developing and Using Models* • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	CC.3: Scale, Proportion, and Quantity* • Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).

NEXT STEPS

This section identifies next steps for students who need additional support with one or more Conceptual Checkpoint items. Implement these next steps only after scoring students' Conceptual Checkpoint.

ITEM	NEXT STEPS
1	Students may need support to use their observations of the fairy chimney formation chart to describe how water and wind cause fairy chimneys to form. Encourage students to review their observations from the wind, river, and rain investigations in Lesson 3 Parts 2 and 3. Then consider posing questions such as these about the Lesson 4 Resource B fairy chimney formation chart: Look at each part of the chart. Which parts describe what water did? Which parts describe what wind did? What do you notice about the land from one picture to the next?
2a	If students need support to develop a model that shows how wind and water change fairy chimneys over time, encourage students to revisit their observations of the Surtsey data charts in Lesson 3 Part 1. Prompt students to review the changes they noticed to Surtsey's shape, size, and elevation and to look for patterns in their observations. Then consider posing questions such as these about the model: Look at Time 1 and Time 2 on the model. What changes do you notice? Think about how Surtsey's landforms are changing over time. How are the changes to the fairy chimneys similar? We know how water and wind can change Surtsey's landforms. How do you think water and wind can change fairy chimneys?
2b	If students need support to use their model to describe how water and wind change the shape or size of fairy chimneys, encourage them to examine how the size changes from one point in time to the next. Consider posing questions such as these: Look at Time 2 and Time 3 on the model. What happened to the height of the fairy chimney? From the beginning of the model to the end of the model, does the fairy chimney get bigger, or does it get smaller?

Level 2 Module 2

LESSON 5 PART 3 PERFORMANCE CHECKPOINT SCORING GUIDE

Score each student's Performance Checkpoint. The Scoring Guidance column identifies the correct response for each item and includes information about how to determine a student's score. The Points Available column indicates the total number of points available for each item. Use the Score column to record a student's points for each task.

Name: _____ Date: _____

ITEM	SCORING GUIDANCE	POINTS AVAILABLE	SCORE
1	1 point: The student describes one way in which their group will improve the solution so it successfully slows water's changes to the land.	1	
2	1 point: The student compares two solutions designed to slow water's changes to land and determines which solution withstood more waves before the lighthouse fell.	1	
3	1 point: The student uses evidence from testing to compare two solutions and determine which solution worked better to slow water's changes to land.	1	
4	1 point: The student describes how two materials they used to create their solution worked together to slow water's changes to land.	1	
5	1 point: The student explains why they agree with the claim that it was helpful for groups to compare solutions with each other. In their answer, they cite evidence such as the following: Groups were able to see other ways of solving the problem, they were able to use other groups' ideas to help improve their own solutions, or they were able to look at data to determine which kinds of solutions were most effective.	1	

Total Points Available: 5 Student Score: _____

ALIGNMENT MAP

For teacher reference, this alignment map lists the NGSS elements assessed by each task in the Performance Checkpoint. In the alignment map, an asterisk (*) indicates an element that is part of a Module Objective.

ITEM	SEP ELEMENT	DCI ELEMENT	CC ELEMENT
1	SEP.6: Constructing Explanations and Designing Solutions* • Generate and/or compare multiple solutions to a problem.	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	N/A
2	SEP.6: Constructing Explanations and Designing Solutions* • Generate and/or compare multiple solutions to a problem.	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	N/A
3	SEP.6: Constructing Explanations and Designing Solutions* • Generate and/or compare multiple solutions to a problem.	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	N/A
4	N/A	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	CC.4: Systems and System Models* • Systems in the natural and designed world have parts that work together.
5	SEP.6: Constructing Explanations and Designing Solutions* • Generate and/or compare multiple solutions to a problem.	ETS1.C: Optimizing the Design Solution* • Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	N/A

NEXT STEPS

This section identifies next steps for students who need additional support with one or more Performance Checkpoint tasks. Implement these next steps only after scoring students' Performance Checkpoint.

ITEM	NEXT STEPS
1	If students need support to identify an improvement to their solution, have students revisit the class problem and solution chart and review the criteria for success. Guide students to generate ideas for improvement by comparing their design and the designs of groups that were able to create more waves before their lighthouse fell.
2	If students need support to compare the number of waves the two solutions withstood before the lighthouse fell, have students record the number of waves their first solution withstood and the number of waves their second solution withstood. Then consider posing questions such as these: Look at the number of waves you were able to create before the lighthouse fell in your first solution. Then look at the number of waves you were able to create before the lighthouse fell in your second solution. Which number is bigger? Which sentence says that?
3	If students need support to identify their more successful solution, encourage them to review their data from when they tested the two systems. Consider posing questions such as these: Which solution kept the lighthouse standing longer? Which solution worked better to slow down water's changes to land? How do you know?
4	If students need support to describe how the parts of their shoreline protection system worked together to slow water's changes to land, have students look at each material they used individually. Consider posing a question such as this: How did each material block the water or hold the land in place? Then pose questions such as these: How did one part of the system work together with other parts? What happened when the waves reached each part?
5	If students need support to explain why it was helpful for groups to compare solutions, have them revisit the class data table that shows all the groups' solutions. Consider posing questions such as these: Are there many possible solutions to the problem? We looked at the solutions other groups created and compared them with our solutions. Did that help groups create a solution that worked? We saw how other groups used materials in different ways than we did. How did that help everyone come up with new and better ideas?

Name: _____

Level 2 Module 2

LESSON 7 CONCEPTUAL CHECKPOINT

1. Observe the chart about the landforms near Cappadocia.

Compare the time span of the events.

a. Does the Earth event change land slowly or quickly?

Draw a check mark (✓) in each row.

Earth Event	Changes Land Slowly	Changes Land Quickly
Earthquake		
Water flowing in a river		

b. Compare the landforms in the chart.

Circle the answer to complete each sentence.

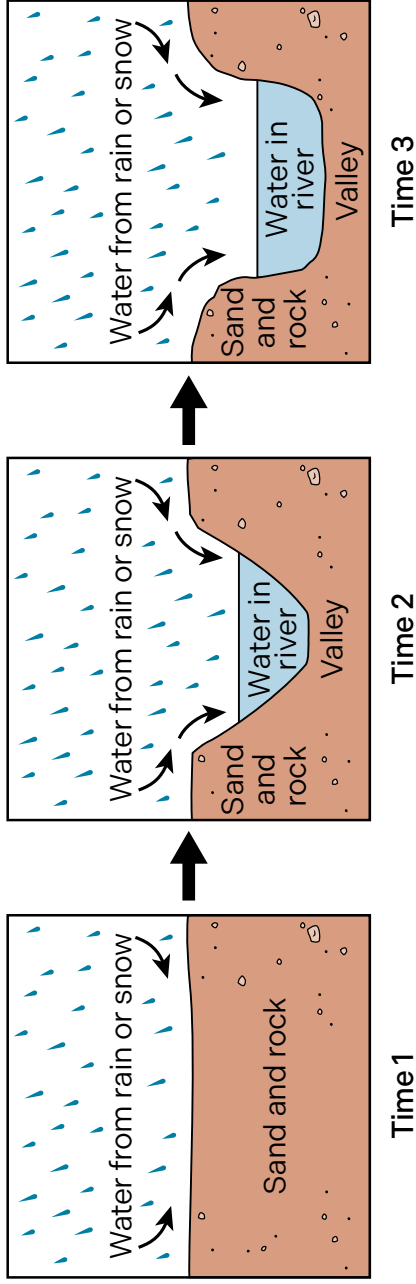
- In one lifetime, a person can observe a **valley** / **crack in the land** forming.
- The time span for Ihlara Valley to form was

longer / **shorter** than the time span for the crack in the land to form.

2. Water can form and shape valleys over many thousands of years.

Observe the model.

How Valleys Are Formed and Shaped by Water



How are valleys formed and shaped by water?

Circle **two** answers.

- **Water from rain and snow forms a river.**
- **Water from sand and rock forms rain and snow.**
- **Water in a river changes the shape of land.**
- **Water in a river changes the kinds of components that make up land.**
- **Water in a river causes a valley to get smaller over time.**

3. Near Ihlara Valley, there are cliffs made of rock. Earth events shape the cliffs.

Observe the pictures and read the chart.



Broken rock



Smooth rock

Ihlara Valley Landform Information

Landform Changing Shape	Earth Event	Time Span	Lifetimes to Observe
Cliff with broken rock	Falling rocks	Seconds	1 
Cliff with smooth rock	Wind blowing sand	Thousands of years	More than 50 

a. Circle **one** claim that is supported by evidence from the chart.

- **Falling rocks can change land quickly.**
- **Wind can change land slowly.**

b. What evidence from the chart supports the claim you chose?

[illegible]

Name: **Sample**

Level 2 Module 2

LESSON 7 CONCEPTUAL CHECKPOINT

1. Observe the chart about the landforms near Cappadocia.

Compare the time span of the events.

a. Does the Earth event change land slowly or quickly?

Draw a check mark (✓) in each row.

Earth Event	Changes Land Slowly	Changes Land Quickly
Earthquake		✓
Water flowing in a river	✓	

b. Compare the landforms in the chart.

Circle the answer to complete each sentence.

- In one lifetime, a person can observe a

valley / **crack in the land** forming.

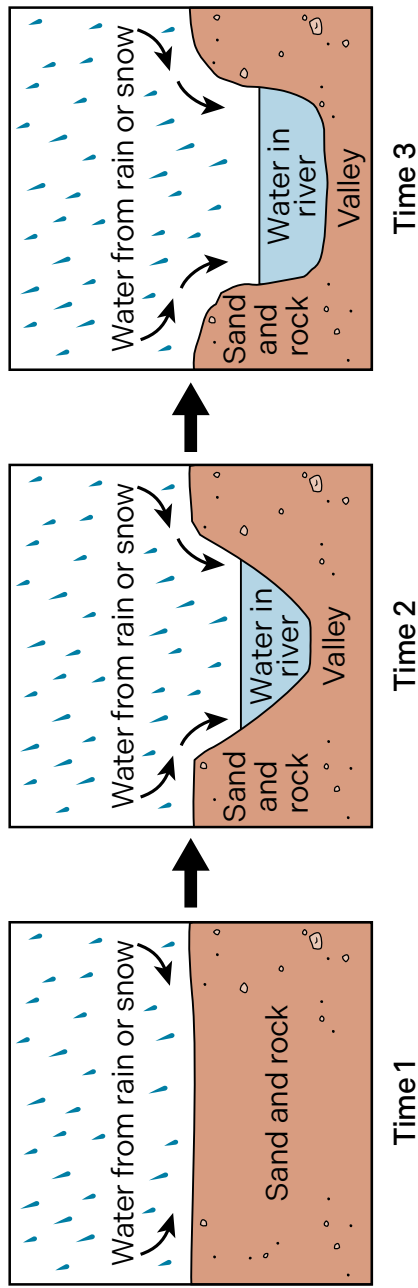
- The time span for Ihlara Valley to form was

longer / **shorter** than the time span for the crack in the land to form.

2. Water can form and shape valleys over many thousands of years.

Observe the model.

How Valleys Are Formed and Shaped by Water



How are valleys formed and shaped by water?

Circle **two** answers.

- **Water from rain and snow forms a river.**
- **Water from sand and rock forms rain and snow.**
- **Water in a river changes the shape of land.**
- **Water in a river changes the kinds of components that make up land.**
- **Water in a river causes a valley to get smaller over time.**

3. Near Ihlara Valley, there are cliffs made of rock. Earth events shape the cliffs.

Observe the pictures and read the chart.



Broken rock



Smooth rock

Ihlara Valley Landform Information

Landform Changing Shape	Earth Event	Time Span	Lifetimes to Observe
Cliff with broken rock	Falling rocks	Seconds	1 
Cliff with smooth rock	Wind blowing sand	Thousands of years	More than 50 

a. Circle **one** claim supported by evidence from the chart.

- **Falling rocks can change land quickly.**
- **Wind can change land slowly.**

b. What evidence from the chart supports the claim you chose?

The chart shows that wind blowing sand is an event that

shapes a cliff to make the rock smooth. The chart says the

wind blowing sand takes thousands of years and more than

50 lifetimes. That means the wind changes land slowly.

Level 2 Module 2

LESSON 7 CONCEPTUAL CHECKPOINT SCORING GUIDE

Score each student's Conceptual Checkpoint. The Scoring Guidance column identifies the correct response for each item and includes information about how to determine a student's score. The Points Available column indicates the total number of points available for each item. Use the Score column to record a student's points for each item.

Name: _____ Date: _____

ITEM	SCORING GUIDANCE	POINTS AVAILABLE	SCORE
1a	Line 1: Changes Land Quickly Line 2: Changes Land Slowly A correct response is worth 0.5 points.	1	
1b	Line 1: crack in the land Line 2: longer A correct response is worth 0.5 points.	1	
2	Choice 1 is correct. Choice 2 is incorrect. Sand and rock do not contain water that forms rain and snow. The water in a river comes from rain and snow. Choice 3 is correct. Choice 4 is incorrect. The water in a river does not affect the kinds of components that make up land. Choice 5 is incorrect. The water in a river causes a valley to grow larger (wider or deeper), not smaller. A correct response is worth 1 point.	2	

ITEM	SCORING GUIDANCE	POINTS AVAILABLE	SCORE
3a 3b	3a is unscored. Students may choose either claim. In 3b, students provide evidence to support their claim. Scoring guidance is for 3b. 1 point: The student uses evidence from the chart to identify that falling rocks shape the cliff with broken rock over a time span of seconds. OR 1 point: The student uses evidence from the chart to identify that wind blowing sand shapes the cliff with smooth rock over a time span of thousands of years.	1	

Total Points Available: 5 Student Score: _____

ALIGNMENT MAP

For teacher reference, this alignment map lists the NGSS elements assessed by each item in the Conceptual Checkpoint. In the alignment map, an asterisk (*) indicates an element that is part of a Module Objective.

ITEM	SEP ELEMENT	DCI ELEMENT	CC ELEMENT
1a	SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	ESS1.C: The History of Planet Earth* • Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	CC.7: Stability and Change* • Things may change slowly or rapidly.
1b	SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	ESS1.C: The History of Planet Earth* • Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	CC.7: Stability and Change* • Things may change slowly or rapidly.
2	SEP.2: Developing and Using Models* • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	N/A
3a 3b	SEP.7: Engaging in Argument from Evidence* • Construct an argument with evidence to support a claim.	ESS1.C: The History of Planet Earth* • Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	CC.7: Stability and Change* • Things may change slowly or rapidly.

NEXT STEPS

This section identifies next steps for students who need additional support with one or more Conceptual Checkpoint items. Implement these next steps only after scoring students' Conceptual Checkpoint.

ITEM	NEXT STEPS
1a	If students need support to use the event and landform comparison chart to identify whether Earth events change land quickly or slowly, have students reflect on the kinds of Earth events they observed in Lesson 6. Guide students to recall that they compared and ordered the Earth events and that they developed an argument to support a claim about the time spans of Earth events. Consider posing questions such as these: How can we tell if an event changes land slowly or quickly? Which part of the chart can help us figure out how fast an Earth event occurs?
1b	If students need support to compare the formation of a crack in the land and the formation of a valley, ask students to consider what they learned in Lesson 6 about how water changes land. Point to the time span and lifetime columns of the event and landform comparison chart. Encourage students to reflect on how the Earth events on the chart compare with a human life span. Consider posing questions such as these: Can a person observe a crack forming in land? Why do you think that? Can a person observe a valley forming? Why do you think that? How does that help us compare the time spans of these two Earth events?
2	If students need support to use the model to identify how water changes land to form a valley, encourage students to recall how water changes Surtsey's land. Ask students to think about the wave, rain, and river models from Lesson 3 and about how they saw the water in the models affect the land materials. Consider posing questions such as these: How does water change Surtsey's land? How can water in rivers change land? What does that tell us about how water flowing in a river forms a valley?
3a 3b	If students need support to develop an argument that uses evidence to support a claim, encourage students to recall how they developed arguments in Lessons 3 and 6. Prompt students to recall that they first identified evidence to support the claim they chose and then explained how that evidence supported the claim. Consider posing questions such as these: What evidence supports the claim you chose? How does the evidence support the claim?

Name: _____

Level 2 Module 2

END-OF-MODULE ASSESSMENT

1. Read the sea stack formation chart.

How do waves and wind change the rocky shoreline?

Circle **two** sentences.

- Wind makes cracks in rock.
- Waves make cracks in rock.
- Wind blows away pieces of broken rock.
- Wind makes the shoreline bigger.
- Waves make the shoreline bigger.

2. A rockfall happens when rock pieces break off from bigger rocks and fall on land or in the water.

The chart shows information about a rockfall and other events that form a sea stack.

Earth Events That Form a Sea Stack

Earth Event	Time Span	Lifetimes to Observe
Rockfall	Seconds	1 
Wind blowing	Thousands of years	More than 50 
Waves crashing	Thousands of years	More than 50 

a. Circle **two** answers that describe the events that form a sea stack.

- **A rockfall changes the land slowly.**
- **A rockfall changes the land quickly.**
- **Wind and waves change the land slowly.**
- **Wind and waves change the land quickly.**
- **A rockfall, wind, and waves have the same time span.**

b. Describe the time span of the events that form a sea stack.

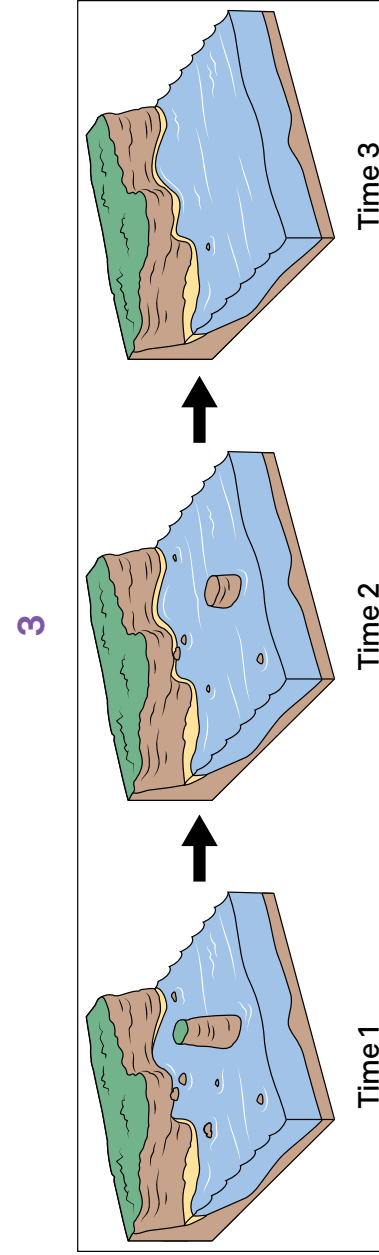
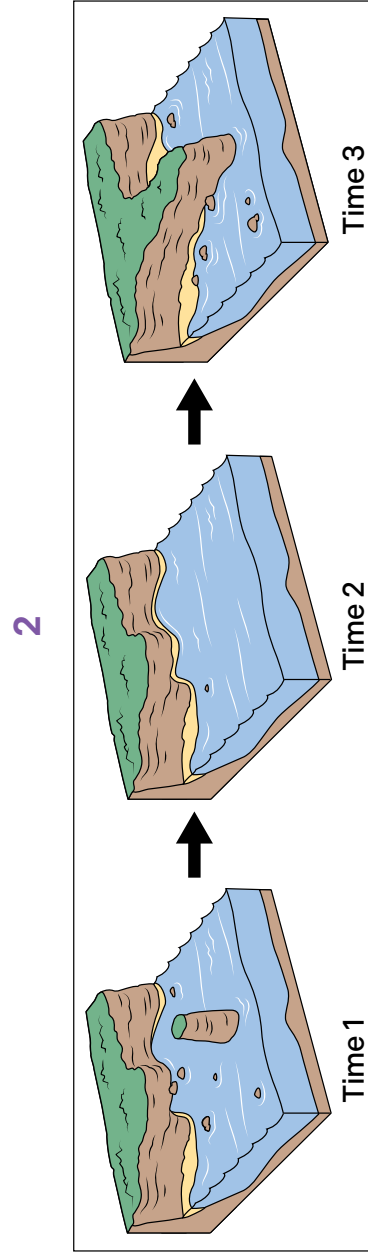
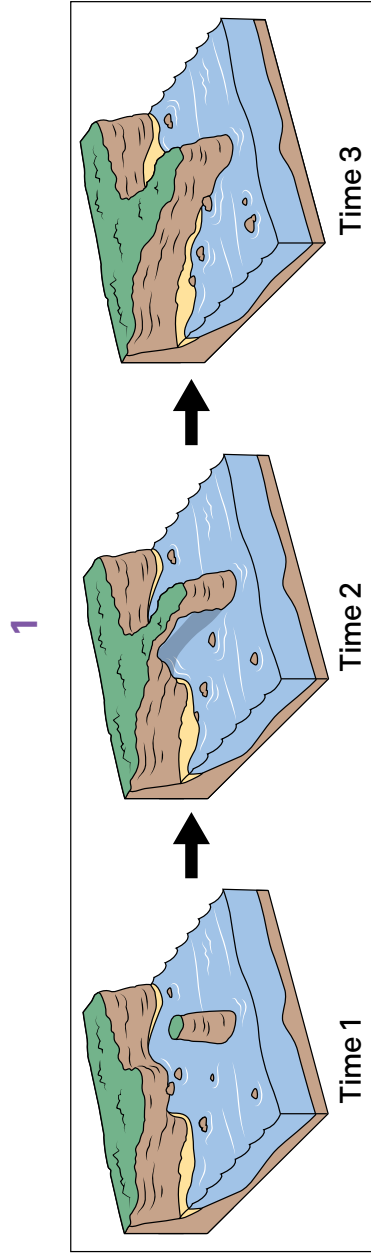
Circle the answer to complete the sentence.

- In one lifetime, a person can observe

a rockfall event / wind and wave events
forming a sea stack.

3. After a sea stack forms, wind and waves continue to change the land.

Circle the model that shows what happens to a sea stack over thousands of years.



4. Think about what happens to sea stacks after they form.

a. Circle **one** claim about how wind and waves will change a sea stack after it forms.

- Wind and waves will change the size of a sea stack over time.
- Wind and waves will change the shape of a sea stack over time.

b. What evidence supports the claim you chose?

Name: **Sample**

Level 2 Module 2

END-OF-MODULE ASSESSMENT

1. Read the sea stack formation chart.

How do waves and wind change the rocky shoreline?

Circle **two** sentences.

- Wind makes cracks in rock.
- Waves make cracks in rock.
- Wind blows away pieces of broken rock.
- Wind makes the shoreline bigger.
- Waves make the shoreline bigger.

2. A rockfall happens when rock pieces break off from bigger rocks and fall on land or in the water.

The chart shows information about a rockfall and other events that form a sea stack.

Earth Events That Form a Sea Stack

Earth Event	Time Span	Lifetimes to Observe
Rockfall	Seconds	1 
Wind blowing	Thousands of years	More than 50 
Waves crashing	Thousands of years	More than 50 

- a. Circle **two** answers that describe the events that form a sea stack.

- A rockfall changes the land slowly.
- A rockfall changes the land quickly.
- Wind and waves change the land slowly.
- Wind and waves change the land quickly.
- A rockfall, wind, and waves have the same time span.

- b. Describe the time span of the events that form a sea stack.

Circle the answer to complete the sentence.

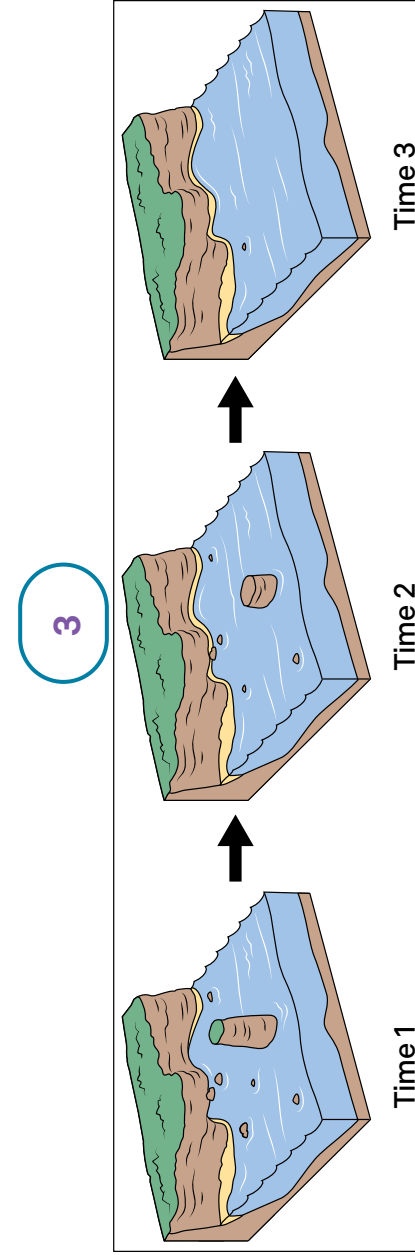
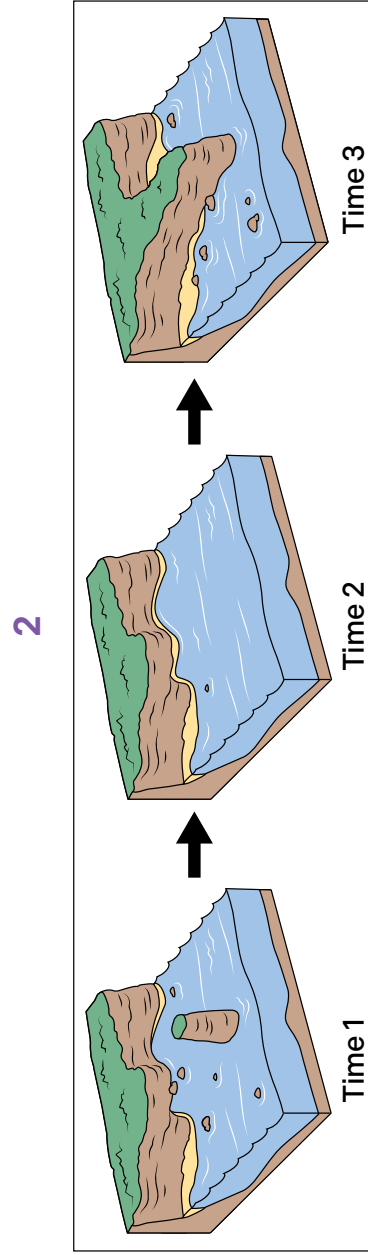
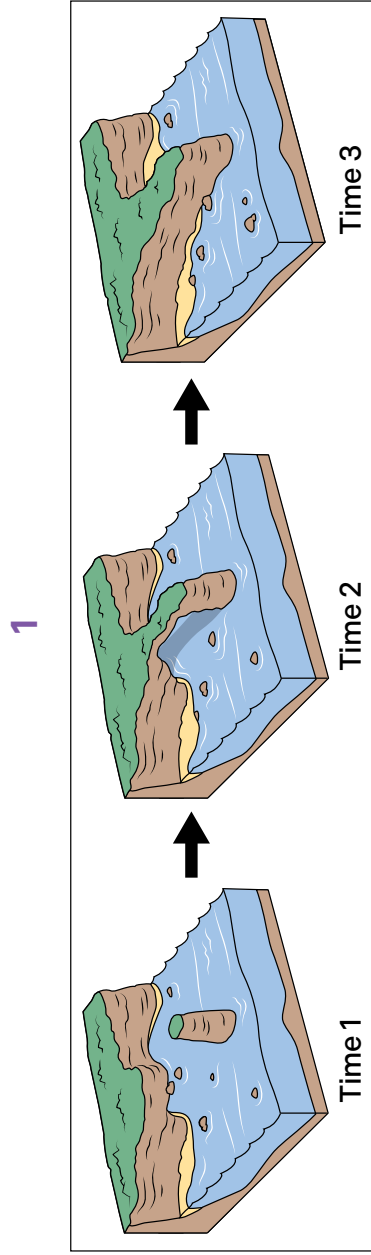
- In one lifetime, a person can observe

a rockfall event / **wind and wave events**

forming a sea stack.

3. After a sea stack forms, wind and waves continue to change the land.

Circle the model that shows what happens to a sea stack over thousands of years.



4. Think about what happens to sea stacks after they form.

a. Circle **one** claim about how wind and waves will change a sea stack after it forms.

- Wind and waves will change the size of a sea stack over time.
- Wind and waves will change the shape of a sea stack over time.

b. What evidence supports the claim you chose?

Wind blows away pieces of rock, and waves wash away pieces

of rock. That will make the sea stack smaller over time.

Level 2 Module 2

END-OF-MODULE ASSESSMENT SCORING GUIDE

Score each student's End-of-Module Assessment. The Scoring Guidance column identifies the correct response for each item and includes information about how to determine a student's score. The Points Available column indicates the total number of points available for each item. Use the Score column to record a student's points for each item.

Name: _____ Date: _____

ITEM	SCORING GUIDANCE	POINTS AVAILABLE	SCORE
1	Choice 1 is incorrect. The chart does not include information about wind causing cracks to form in rock. The chart shows that water from waves causes cracks to form in rock and that wind blows away pieces of broken rock. Choice 2 is correct. Choice 3 is correct. Choice 4 is incorrect. Wind does not make the shoreline bigger. Choice 5 is incorrect. Waves do not make the shoreline bigger. A correct response is worth 0.5 points.	1	

ITEM	SCORING GUIDANCE	POINTS AVAILABLE	SCORE
2a	Choice 1 is incorrect. A rockfall event has a time span of seconds, and changes to the land can be observed in less than one lifetime. This means that a rockfall changes the land quickly, not slowly. Choice 2 is correct. Choice 3 is correct. Choice 4 is incorrect. These wind and wave events have a time span of thousands of years, and the changes to the land take more than 50 lifetimes to observe. This means that wind and waves change the land slowly, not quickly. Choice 5 is incorrect. The wind and wave events have the same time span (thousands of years), but rockfall events have a much shorter time span (seconds). The time spans are different. A correct response is worth 1 point.	2	
2b	Correct response: a rockfall event A correct response is worth 0.5 points.	0.5	
3	Choice 1 is incorrect. Model 1 shows a sea stack connecting back to the land, but that does not happen. Wind and waves cause a sea stack to disappear over time. Choice 2 is incorrect. Model 2 shows a sea stack disappearing and later, land reappearing. Wind and waves can cause a sea stack to disappear over time, but they cannot cause the land to reappear. Choice 3 is correct. A correct response is worth 1 point.	1	
4a 4b	4a is unscored. Students may choose either claim to support with evidence in 4b. Scoring guidance is for 4b. 1 point: The student supports the claim that wind and waves will change the size of a sea stack over time by explaining that wind blows away rock and waves wash away rock. OR 1 point: The student supports the claim that wind and waves will change the shape of a sea stack over time by explaining that wind blows away rock and waves wash away rock.	1	

Total Points Available: 5.5 Student Score: _____

ALIGNMENT MAP

For teacher reference, this alignment map lists the NGSS elements assessed by each item in the End-of-Module Assessment. In the alignment map, an asterisk (*) indicates an element that is part of a Module Objective.

ITEM	SEP ELEMENT	DCI ELEMENT	CC ELEMENT
1	SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	N/A
2a	SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	ESS1.C: The History of Planet Earth* • Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	CC.7: Stability and Change* • Things may change slowly or rapidly.
2b	SEP.6: Constructing Explanations and Designing Solutions • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	ESS1.C: The History of Planet Earth* • Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	CC.7: Stability and Change* • Things may change slowly or rapidly.

ITEM	SEP ELEMENT	DCI ELEMENT	CC ELEMENT
3	SEP.2: Developing and Using Models* • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	CC.3: Scale, Proportion, and Quantity* • Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).
4a 4b	SEP.7: Engaging in Argument from Evidence* • Construct an argument with evidence to support a claim.	ESS2.A: Earth Materials and Systems* • Wind and water can change the shape of the land.	CC.3: Scale, Proportion, and Quantity* • Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).

APPENDIX B MODULE STORYLINE

ANCHOR PHENOMENON INTRODUCTION

LESSON 1

Where we are

Anchor Phenomenon | Transformation of Surtsey

Driving Question | How can the island of Surtsey change shape over time?

Lesson Objective | Use observations (SEP.6) to develop models that show the relative scale (SEP.2) of events (ESS1.C) that can cause landforms to change over time (CC.7).

What we do

Wonder: We observe two aerial pictures of the same location at different times. We notice an object in one of the pictures. We learn that the object is a place called Surtsey.

Organize: We use a globe to identify the location of Surtsey. We make observations about land and determine that a globe cannot show all the information about land on Earth. We also learn that Surtsey is an island.

Reveal: We watch a video of a volcano erupting in the ocean. Our teacher reads aloud from *Life on Surtsey* (Burns 2017), and we learn that Surtsey formed from a volcanic eruption. We then listen as our teacher reads aloud from *An Island Grows* (Schaefer and Felstead 2006) to gather information about how volcanic eruptions can form islands.

Organize and Distill: We act out how a volcanic eruption forms an island. Next, we use our learning and create a model that shows how a volcano quickly formed Surtsey. We also share examples of our own experiences with land forming or changing over time.

Wonder: We observe more aerial pictures of Surtsey from different years and learn that Surtsey's land has changed shape. We wonder how and why Surtsey is changing.

Organize: We develop initial models to show how Surtsey has changed. We then use our initial model and new learning to create a class anchor model.

Wonder: We think of questions we have about Surtsey's land and add them to a Driving Question board.

Organize: We generate ideas about how we could investigate our questions.

What we figure out

The island of Surtsey formed from a volcanic eruption. The island's shape and size are changing over time.

Volcanic eruption events can form land quickly.

By the end of Lesson 1, we learn how Surtsey's land formed and that it has changed shape and size over time, and we identify that many questions remain about how and why Surtsey's land is changing. **In Lesson 2,** we will begin to answer our questions by describing Surtsey's land and land materials.

CONCEPT 1 THE COMPONENTS AND SHAPE OF LAND

LESSON 2

Where we are

Lesson Phenomenon | Describing Surtsey's land

Phenomenon Question | How can we describe Surtsey and the materials that make up its land?

Lesson Objective | Use observations (SEP.6) of landforms (ESS2.B) and properties of land materials (PS1.A) to explain how (SEP.6) land can change shape over time (CC.5).

What we do

Wonder and Organize: We reflect on the anchor model and Driving Question board. We develop questions about changes to Surtsey's size and shape and decide to learn more about its land.

Reveal: We observe Surtsey's land by using a 3D model. We gather information about land as we learn about natural features called landforms. We describe the properties of different kinds of land as we compare Surtsey's landforms.

Wonder: We reflect on the Phenomenon Question and wonder about the materials that make up Surtsey's land and its landforms.

Organize: We observe some of the materials that make up land. We then read an article to learn more about land materials, and we identify rock, soil, and sand as land components.

Reveal: We use our new knowledge of land components to identify that Surtsey's landforms are made of rocks, soil, and sand.

Organize: We investigate the properties of rocks as we test three different rock samples that are similar to rocks found on Surtsey. We record our observations to support a class claim that rocks can change.

Distill: We answer the Phenomenon Question and update the anchor model and Knowledge Tracker. We then record what we learned about Surtsey's land on a class anchor chart. We post the anchor chart for the length of the module so we can make changes to it as we discover more information.

What we figure out

Land can have many different shapes.

Rocks, soil, and sand are components of land.

The shape and size of land can change.

Surtsey has many different landforms, and some of these landforms have different properties than others.

By the end of Lesson 2, we conclude that the properties of Surtsey's landforms are determined by the properties of their components. **In Lesson 3,** we will investigate how wind and water change the shape of land and apply this understanding to explain changes to Surtsey's land.

LESSON 3

Where we are

Lesson Phenomenon | Changes to the shape of Surtsey's land over time

Phenomenon Question | What can cause Surtsey's land to change?

Lesson Objective | Use relative scales (CC.3) as evidence to develop an argument (SEP.7) that wind and water change land (ESS2.A).

What we do

Wonder: We view pictures and videos and wonder what is causing Surtsey to change.

Organize: We record observations of Surtsey's changes over time. We then create a claim and determine we need more evidence to support our claim. We decide to use models to investigate how wind and water affect land. We start by modeling how wind and land interact.

Reveal: We compare our investigation results to reveal that wind can cause land to change shape.

Organize: Next, we model how water and land interact. We observe a wave model, a rain model, and a river model.

Reveal: We compare the observations and measurements we record to determine that water can also change the size and shape of land.

Organize: We revisit and evaluate our claims from earlier in the lesson. Then we choose a new claim, and we identify evidence that supports our chosen claim.

Distill: We explain how our evidence supports our claim. We learn that we developed an argument. We discuss our arguments as a class and determine that both wind and water are causing Surtsey's land to change shape. Then we answer the Phenomenon Question and update the anchor model and our Knowledge Tracker. We also begin an anchor chart.

What we figure out

Wind and water interact with land materials.

Wind and water can change the shape and size of land.

Wind and water are causing Surtsey's land to change shape and size.

By the end of Lesson 3, we learn that wind and water are changing the shape of Surtsey's land. **In Lesson 4,** we will apply our learning to a new context in a Conceptual Checkpoint.

LESSON 4

Where we are

Lesson Phenomenon | How Cappadocia's fairy chimneys form and change

Phenomenon Question | How do fairy chimneys form and change shape?

This lesson includes a Conceptual Checkpoint that provides students with the opportunity to demonstrate progress toward the Module Objectives.

What we do

Distill: We summarize how our learning from this concept helps us make sense of the anchor phenomenon.

Know: We apply our learning about how wind and water change the shape of land to a new phenomenon, fairy chimneys in Cappadocia, Turkey, as we complete a Conceptual Checkpoint.

Distill and Know: We reflect on the related phenomena that we identified earlier in the module. This reflection helps us make connections between our own experiences and rich, sometimes distant, phenomena. We also identify remaining gaps in our understanding of the anchor phenomenon, which will drive our future learning experiences.

What we figure out

Water from rain and snow can cause cracks in rock and can wash away softer rock.

Wind can blow away small pieces of softer rock and sand.

These interactions can cause softer rock to change more quickly than harder rock, forming fairy chimneys.

By the end of Lesson 4, we complete a Conceptual Checkpoint, applying our understanding of how wind and water can change the shape of land to explore the phenomenon of fairy chimneys forming and changing. **In Lesson 5,** we will use our knowledge of how water changes land to solve a problem in an Engineering Challenge.

APPLICATION OF CONCEPTS ENGINEERING CHALLENGE

LESSON 5

Where we are

Task | Engineering Challenge

Phenomenon Question | How can we slow changes to the land of Montauk Point to protect the Montauk Point Lighthouse?

Lesson Objective | **Compare the effectiveness (SEP.6)** of **multiple (ETS1.C) systems (CC.4)** that are **solutions (ETS1.C)** designed to reduce **the impact of water on the shape of land (ESS2.A)**.

What we do

Organize: We review the stages of the engineering design process. Then we observe pictures of the Montauk Point Lighthouse and describe how the land in this area has changed over time.

Wonder and Organize: During the Ask stage, we identify a problem: Waves are washing away the land near the lighthouse. We decide to create a solution that protects the shoreline. We explore how different materials work together in different shoreline protection systems to slow changes to land. During the Imagine stage, we test materials as we think about possible designs.

Organize: During the Plan stage, we create a diagram of our chosen design and describe how our chosen materials will work together.

Reveal: During the Create and Test stages, we build and test our shoreline protection system.

Distill: During the Improve stage, we discuss what we learned during testing. We brainstorm and test improvements. After testing our revised systems, we compare how well each system protected the land.

Know: During the Share stage, we prepare a presentation to share our design with the class. Then we learn how the Montauk Point Lighthouse was saved by Giorgina Reid's terracing system and a rock revetment project.

What we figure out

People can apply knowledge of the natural world to protect land.

People can solve problems by designing systems with parts and materials that work together.

By the end of Lesson 5, we apply our knowledge of how water changes land to develop a shoreline protection system that slows changes to the shoreline of Montauk Point and prevents the lighthouse from falling into the ocean. **In Lesson 6,** we will explore Earth events that shape land to investigate how long it takes for land to change.

CONCEPT 2 TIME SPANS OF CHANGES TO LAND

LESSON 6

Where we are

Lesson Phenomenon | Earth events on Surtsey

Phenomenon Question | How can we compare the Earth events that change Surtsey's land?

Lesson Objective | Use **relative scales (CC.3)** as evidence to identify **Earth events that happen quickly and Earth events that happen slowly (ESS1.C)** and to **develop an argument (SEP.7)** about **the time spans of Earth events (ESS1.C)**.

What we do

Wonder: We revisit *Life on Surtsey* and decide to explore Earth events that affect Surtsey.

Organize and Reveal: We sort Earth event cards into categories and notice that Earth events occur over different lengths of time. We organize the cards to create a diagram that shows the relative timing of the events. We then read about the events to revise our diagram, and we identify the time spans of each event.

Reveal: We compare time spans of Earth events with time spans of life events to make sense of the differences between fast and slow events.

Distill: We use our observations to compare the time spans of the Earth events on our class display.

Wonder and Organize: We use a Knowledge Deck poster to gather information about yardangs. We learn that yardangs form when strong winds blow sand at the rock, chipping it away.

Reveal and Distill: We view information about the time span of Earth events that form and shape yardangs and Surtsey. We evaluate a claim about these events and conclude that the events that form and shape yardangs happen over longer time spans than the Earth events that formed and are shaping Surtsey. We answer the Phenomenon Question and update the anchor model, our Knowledge Tracker, and the anchor chart.

What we figure out

Some Earth events happen quickly and change land over a short time span.

Some Earth events happen slowly and change land over a long time span.

Some events, such as a volcanic eruption, have changed Surtsey very quickly. Other events, such as wind blowing and waves crashing, happen over longer time spans.

Wind and water will continue to change the shape of Surtsey's land over time.

By the end of Lesson 6, we build our understanding of Earth events that change land slowly and quickly and develop an argument about the time spans of Earth events. **In Lesson 7**, we will apply our learning to a new context in a Conceptual Checkpoint.

LESSON 7

Where we are

Lesson Phenomenon | Earth events shaping landforms near Cappadocia

Phenomenon Question | How can we describe the time spans of Earth events that change the land near Cappadocia?

This lesson includes a Conceptual Checkpoint that provides students with the opportunity to demonstrate progress toward the Module Objectives.

What we do

Distill: We summarize how our learning from this concept helps us make sense of the anchor phenomenon.

Know: We apply our learning about the time span of Earth events to a new phenomenon, Earth events that change land near Cappadocia, as we complete a Conceptual Checkpoint.

Distill and Know: We create a new model to reflect what we have figured out about the anchor phenomenon throughout the module. We also reflect on the related phenomena we identified earlier in the module, which helps us make connections between our own experiences and rich, sometimes distant, phenomena. Finally, we update our Driving Question board.

What we figure out

The Earth events that change the land near Cappadocia happen over different time spans.

Earthquakes change land quickly.

Water flowing in a river to form a valley changes land slowly.

By the end of Lesson 7, we complete a Conceptual Checkpoint, applying our understanding of the time span of Earth events to explore the Earth events that change the land near Cappadocia. **In Lesson 8**, we will summarize our understanding of the Driving Question and apply our new knowledge in an End-of-Module Assessment.

APPLICATION OF CONCEPTS SOCRATIC SEMINAR AND END-OF-MODULE ASSESSMENT

LESSON 8

Where we are

Tasks | Socratic Seminar and End-of-Module Assessment

Driving Question | How can the island of Surtsey change shape over time?

Phenomenon Question | How does a shoreline change to form a sea stack?

This lesson includes an End-of-Module Assessment that provides students with the opportunity to demonstrate progress toward the Module Objectives.

What we do

Organize: We discuss relationships between key terms to review module concepts in preparation for a Socratic Seminar.

Distill: We then participate in a collaborative conversation to express and deepen our knowledge related to the Driving Question: How can the island of Surtsey change shape over time?

Organize and Reveal: We compare module artifacts to reflect on how Science and Engineering Practices have helped us build knowledge.

Know: We learn about a new landform, sea stacks called the Twelve Apostles, to prepare for an End-of-Module Assessment. Next, we complete an End-of-Module Assessment to demonstrate our understanding of how land changes over time.

Distill and Know: We discuss an End-of-Module Assessment item our teacher has chosen to review as a class.

Know: We reflect on the role of Crosscutting Concepts in making sense of module phenomena. We review examples of Stability and Change from throughout the module. We discuss the Driving Question board to reflect on our new knowledge and pose new questions that we have.

What we figure out

The Earth events that form sea stacks happen over different time spans.

Wind and wave events that form sea stacks change land slowly.

Rockfall events that form sea stacks change land quickly.

Wind and waves will continue to change sea stacks over time.

ANCHOR CHART PROGRESSION

Earth Changes

The Components and Shape of Land

- Land can have many different shapes. (Lesson 2 Part 3)
 - Rocks, soil, and sand are components of land. (Lesson 2 Part 3)
 - The shape and size of land can change. (Lesson 2 Part 3)
 - Wind and water can change the shape of land. (Lesson 3 Part 4)
-

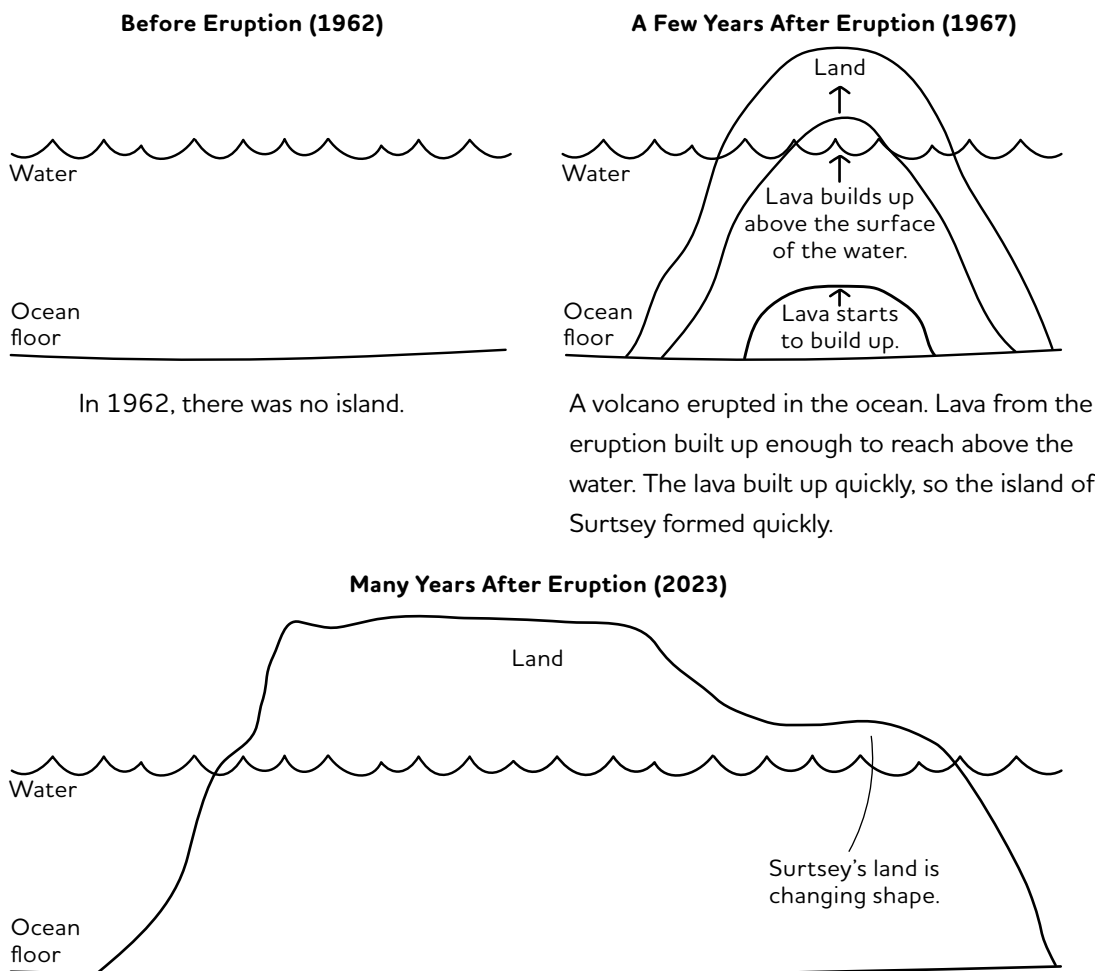
Time Spans of Changes to Land

- Some Earth events happen quickly. They change land over a short time. (Lesson 6 Part 3)
 - Some Earth events happen slowly. They change land over a long time. (Lesson 6 Part 3)
-

ANCHOR MODEL PROGRESSION

Lesson 1 Part 2

How can the island of Surtsey change shape over time?

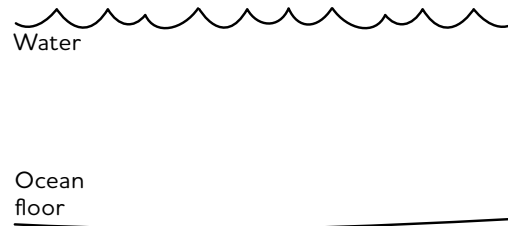


Surtsey's shape is changing over time, and some parts are changing more than others. We do not know why yet.

Lesson 2 Part 3

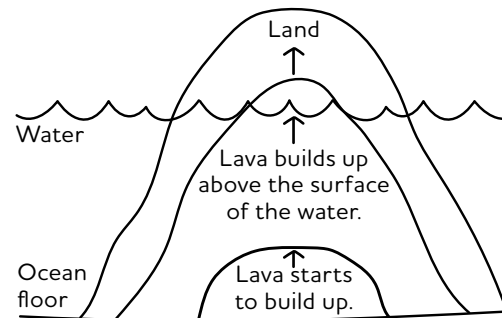
How can the island of Surtsey change shape over time?

Before Eruption (1962)



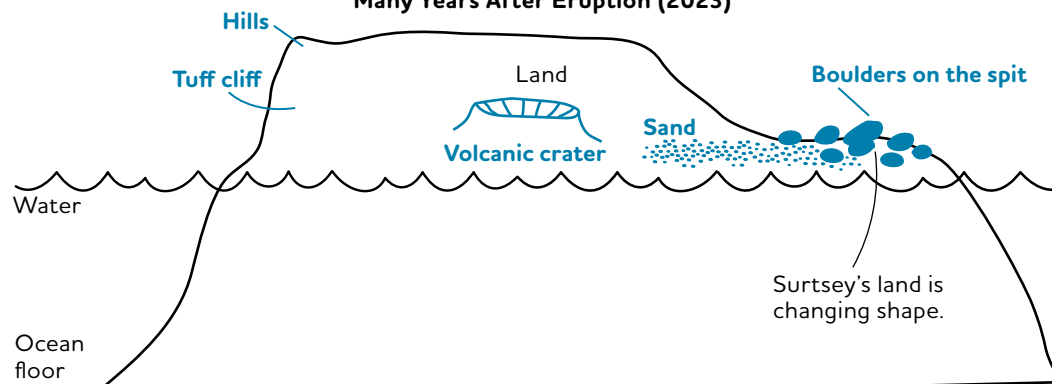
In 1962, there was no island.

A Few Years After Eruption (1967)



A volcano erupted in the ocean. Lava from the eruption built up enough to reach above the water. The lava built up quickly, so the island of Surtsey formed quickly.

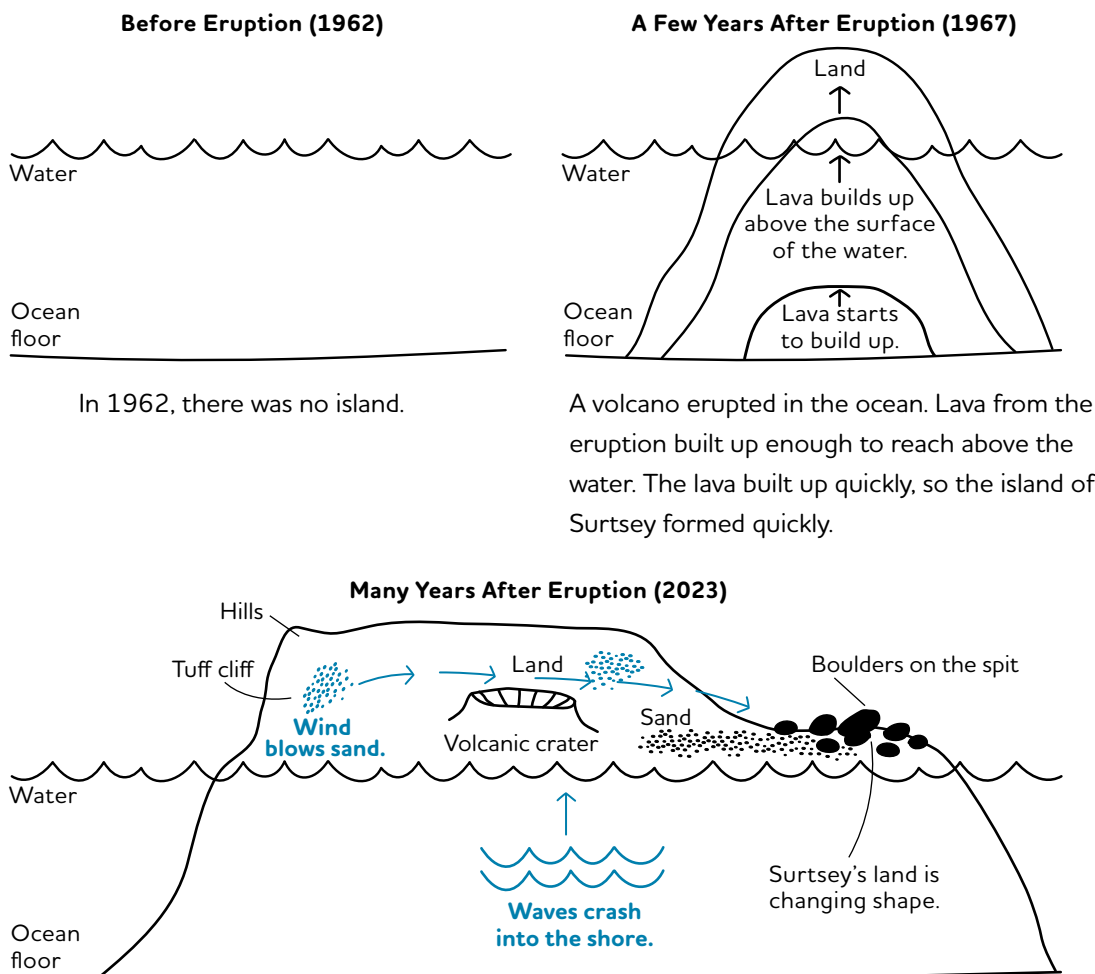
Many Years After Eruption (2023)



The natural features of Surtsey's land are hills, cliffs, craters, and a spit. Surtsey's land is made up of rocks, soil, and sand. Some landforms have different properties than others. Surtsey's shape is changing over time, and some parts are changing more than others. We do not know why yet.

Lesson 3 Part 4

How can the island of Surtsey change shape over time?

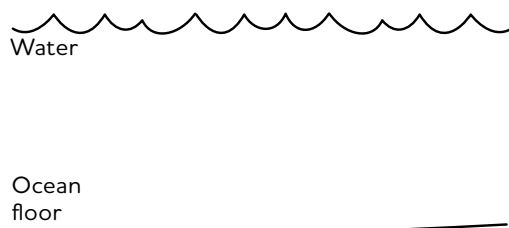


The natural features of Surtsey's land are hills, cliffs, craters, and a spit. Surtsey's land is made up of rocks, soil, and sand. Some landforms have different properties than others. **Surtsey is smaller now and has a lower elevation than when it formed. These changes to Surtsey's size and shape are caused by wind and water.**

Lesson 6 Part 3

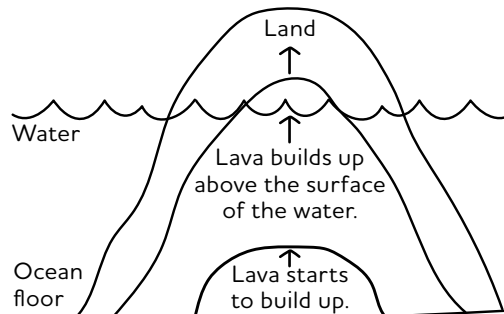
How can the island of Surtsey change shape over time?

Before Eruption (1962)



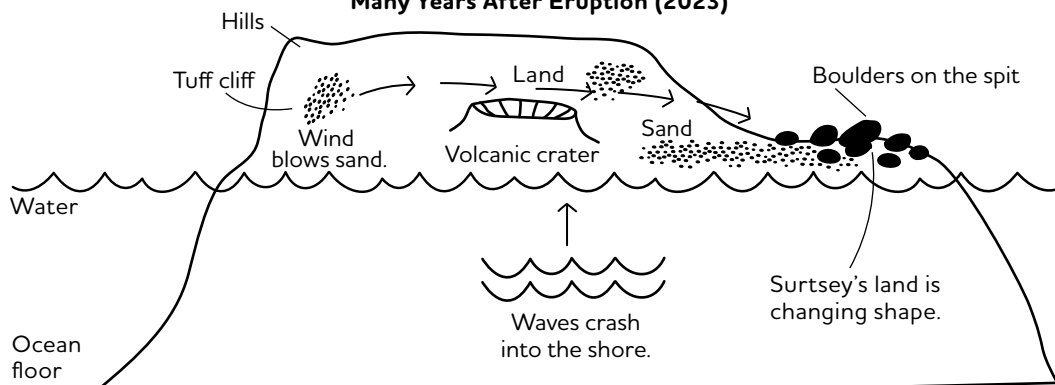
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A volcano erupted in the ocean. Lava from the eruption built up enough to reach above the water. The lava built up quickly, so the island of Surtsey formed quickly.

Many Years After Eruption (2023)



The natural features of Surtsey's land are hills, cliffs, craters, and a spit. Surtsey's land is made up of rocks, soil, and sand. Some landforms have different properties than others. Surtsey is smaller now and has a lower elevation than when it formed. These changes to Surtsey's size and shape are caused by wind and water. **Some events, such as a volcanic eruption, have changed Surtsey very quickly. Other events, such as wind blowing and waves crashing, happen over longer time spans. Wind and water will continue to change the shape of Surtsey's land over time.**

APPENDIX C MODULE TERMINOLOGY

MODULE GLOSSARY

These are Level 2–appropriate descriptions of the module terminology and are not intended to be complete definitions.

TERM	DESCRIPTION	LESSON PART
Component	One part of a whole	Lesson 2 Part 2
Elevation	A measure of height above sea level	Lesson 2 Part 1
Event	Something that happens and that either has a beginning and an end or repeats and is ongoing	Lesson 6 Part 1
Island	An area of land surrounded by water on all sides	Lesson 1 Part 1
Land (n.)	The solid material that covers part of Earth's surface	Lesson 1 Part 1
Landform	A natural feature found on Earth's surface	Lesson 2 Part 2
Natural feature	A part of an area that is not made by humans	Lesson 2 Part 1
Time span	A length of time	Lesson 6 Part 2
Volcano	A hill or mountain that forms from the eruption of lava	Lesson 1 Part 1

DOMAIN-SPECIFIC WORDS, GENERAL ACADEMIC WORDS, AND SPANISH COGNATES

Module Key Terms (Tier Two or Three)

WORD(S)	SPANISH COGNATE
Component	Componente
Elevation	Elevación
Event	Evento
Island	Isla
Land (n.)	None
Landform	None
Natural feature	None
Time span	None
Volcano	Volcán

Domain-Specific Words (Tier Three)

WORD(S)	SPANISH COGNATE
Bluff (n.)	None
Eruption	Erupción
Globe	None

WORD(S)	SPANISH COGNATE
Lava	Lava
Magma	Magma
Rock (n.)	Roca
Sand (n.)	None
Soil (n.)	None
Spit (n.)	None

General Academic Words (Tier Two)

WORD(S)	SPANISH COGNATE
Aerial	Aéreo
Form (v.)	Formar
Interact	Interactuar
Represent	Representar
Surface (n.)	None
System	Sistema

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is capable of
greatness