

**FOURTH GRADE CURRICULUM
TABLE OF CONTENTS:**

Unit 1: Geology
How does a mountain turn into a grain of sand?

Fourth Grade Unit 1: Geology

OVERVIEW:

In this unit, students will be able to demonstrate an understanding that our earth is active and always changing. They will begin by closely observing a rock and exploring the varied processes that create different types of rocks. (Lesson 1) Then, they will build models to discover that natural processes change rocks and landscapes through weathering and erosion (Lesson 2 and 3). By the final lesson, they will look at a case study of the negative effects of erosion and problem-solve how to prevent erosion damage with models.

Lesson #	Guiding Question	Student Outcomes
1.	Are all rocks the same?	Students share the story of their rock based on their observations and research.
2.	Will a mountain last forever?	Students find a rock that has been affected by chemical or physical weathering.
3.	How did this rock get here?	Students present their model of a specific type of erosion to their classmates.
4.	Can humans keep a piece of land from washing away?	Students apply knowledge of erosion and prevention methods to their town.

Materials to Acquire in Advance:

- Lesson 1: samples of igneous, metamorphic, and sedimentary rocks

Images and some background content in the Grade 4 curriculum come from unknown sources. These lessons were created and adapted by Education Outside for use in garden classrooms.

NGSS Connections:

Disciplinary Core Ideas:

[ESS2.A] Earth Materials and Systems: Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

[ESS3.B] Natural Hazards: A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.)

[ESS1.C] The History of Planet Earth: Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)

For Reference:

Scientific & Engineering Practices:

<https://www.nap.edu/read/13165/chapter/7>

Cross-Cutting Concepts:

<https://www.nap.edu/read/13165/chapter/8>

TITLE | ARE ALL ROCKS THE SAME?

GRADE | Fourth Grade

UNIT | 1

LESSON | 1

Time: 45 - 60 minutes

Unit Essential Question: How does a mountain turn into a grain of sand?

Focus Question: Are all rocks the same?

Objectives: Students will be able to explain that not all rocks are the same and that they form through three different processes.

Summary: Students attempt to answer the question, “Are all rocks the same?” through the below table.

Engage	Students listen to a story that questions if rocks can change and engage their prior knowledge by observing a rock
Explore	Students explore the phenomenon of how different rocks change through simulated examples of sedimentary, metamorphic, and igneous processes.
Explain	Students will develop scientific explanations for observations from the “explore” stations. Students will test their understanding of each process with real life examples of different rocks.
Elaborate	Students will extend understanding of geologic processes through a student-planned investigation of rock samples.
Evaluate	Students will re-represent their understanding and reflect on their learning by sharing out the story of their rock based on their observations and research.

Materials:

- Image of basalt (Waldo)
- 30 x rock examples (a range of igneous, metamorphic, and sedimentary)
- if rocks aren't available, print images for students
- 30 x magnifying glasses
- Chart for each station labeled with the rock type/process that is represented
- Worksheets #1 & #2 (one per students in class)
- 30 x pencils (for each student)
- 30 x clipboards (for each student)
- Station materials
 - Sedimentary
 - Sand
 - Dirt

- Mulch
- Clear containers
- Optional: cardboard (to tamp down layers, could just use hands)
- 3 x spoons
- Metamorphic
 - 3 x play dough (different colors)
- Igneous (could also use glue and food coloring)
 - Chocolate chips
 - White chocolate chips/butterscotch chips
 - 2 x bowls
 - Spoon
- 3 x signs per station
- wax paper
- Images of rock types

Tips for Preparing the Lesson (High-Prep):

- Obtain rocks. Otherwise, print images of a variety of rocks (linked below)
- Set up two stations for Explore (decide if stations will be hands-on, as written, or demonstrated by Garden Educator--see tips in Background Section)
- Print worksheets page one and two separately (page one for Engage, page two for Elaborate)
- Make play dough week before and store in airtight containers (or just purchase)

Prior Knowledge: None.

Note: The images in this lesson were pulled from the internet and the source is unknown.

Grade 4, Lesson 1: Lesson Steps

Engage: Students listen to a story that questions if rocks can change, and they engage their prior knowledge by observing a rock.

Time: 10-15 mins

Materials:

- **Image of basalt**
- Rock for each student (a range of igneous, metamorphic, and sedimentary) if rocks aren't available, print images for each student
- **Worksheet #1 for each student**
- Pencils for each student
- Clipboards for each student

Teacher

1. **Say:** *“Good morning scientists! Today, we are not just scientists, but a special type of scientist called a geologist. Optional: Give a moment for students to brainstorm what a geologist studies. Geologists study what the earth is made of and the processes that shape it. Can anyone think of some things that the earth is made of?”*
2. **Have** students share with partners or the class what the Earth is made of...plants, water, etc.
3. **Say:** *Right! Today, I need YOUR help to solve a mystery about rocks, which help make up our Earth. Yesterday, [Teacher at school] introduced me to his pet rock, Waldo. [Teacher] loves Waldo so much that they gave me a picture of him (show picture). ‘Wow!’ I told [Teacher] ‘Your rock has holes in it, I’ve never seen that before!’ ‘Isn’t Waldo cool?!’ [Teacher] said. ‘It used to be made of MAGMA from a volcano!’ ‘WHAT?!’ I said ‘That’s impossible. Rocks are always just rocks. They don’t change. And besides, isn’t every rock the same?’*
4. **Say:** *“I’m really stumped. What do you think? Are all rocks the same?”* Instruct students to turn and share their answers with a partner.

5. **Say:** “To help solve this mystery, I have a rock for each of you to study.”

Instruct each student to observe their rock and write down their observations on their worksheet. (Worksheet #1 - linked below)

6. **Model** how to fill out the worksheet (students may be confused by what they should check)

7. **Pass** out rocks, worksheets, pencils, magnifying glasses, and clipboards to each student.

8. Allow 5 minutes for students to **observe** their rock and fill-out worksheets.

Explore: Students explore the phenomenon of how different rocks change through simulated examples of sedimentary, metamorphic, and igneous rocks.

Time: 15 mins

Materials:

- Sedimentary
 - sand
 - dirt
 - mulch
 - clear containers
 - 3 x spoons
 - optional: cardboard
- Metamorphic
 - 3 x play dough (different colors)
- Igneous
 - chocolate chips
 - white chocolate chips/butterscotch chips
 - 2 x bowls
 - spoon
 - wax paper
 - 3 x signs per station

Teacher

1. **Introduce** rock formation stations. This is where students will experience and try to figure out the processes that shape rocks. The first station will be done together.

2. **Demonstrate** Station A (Igneous) with the whole class.

- **Show** bowl of unmelted chocolate chips and butterscotch/white chocolate chips and another bowl with chips that have been slightly melted in a microwave beforehand. **Demo or ask a student volunteer** to mix chocolate chips with butterscotch/white chocolate chips with spoon. **Pour** a small amount onto wax paper (it should cool and harden) Option: **Ask** what would happen if we put the mix into a fridge?.

- **Ask** students *What could the materials represent in real life? (magma) What processes are happening? (heat, melting, cooling)*

3. **Introduce** the other two stations: B (Sedimentary), and C (Metamorphic). *Label stations by letter and reveal rock type later.*

- Students will rotate through the stations and follow the directions at station to experience rock processes themselves. (Option: Other two stations could also be demonstrated by Garden Educator and/or classroom teacher and students record observations/discuss)

4. **Encourage** them to wonder if their rock went through the changes shown at each station.

- B (Metamorphic) Station: students take 3 different colors of playdough, roll it into a ball, and squish flat

- C (Sedimentary) Station: student’s layer sand, dirt, and mulch in a clear container and squish down

5. **Allow** 5 minutes at each station. **Use routine** for rotating through stations.

6. **Send** students to begin observing with 5-6 students per station.

Explain: Students will develop scientific explanations for observations from the “explore” stations. Students will test their understanding of each process with real examples of different rocks.

Time: 10 mins

Materials:

- **Images of each rock type with background info**

1. **Call** students back to seating circle with your class routine.
2. **Pair-Share:** Students predict with a partner which station their rock might be from.
3. **Review** each station. Ask: “*What did you do at station B/C? What do you think the materials might represent in real life? What process happened?*”
4. **Discuss** and reveal rock types (A-Igneous, B-Sedimentary, C-Metamorphic)
5. **Show** examples of each type of rock and explain how they formed.

Elaborate: Students will extend understanding of geologic processes through a student-planned investigation of rock samples.

Time: 5 mins

Materials:

- Rock for each student (a range of igneous, metamorphic, and sedimentary) if rocks aren’t available, print **images** for each student
- **Worksheet #1 for each student**
- **Worksheet #2 for each student**
- Pencils for each student
- Clipboards for each student

1. **Instruct** students to observe their rocks again, now that they’ve seen some changes that shape rocks.
2. **Pass** out Worksheet #2.
3. Students decide which type of rock they have.
4. Students fill out the back side of their worksheet from explore section.

Evaluate: Students will re-represent their understanding and reflect on their learning by sharing-out the story of their rock based on their observations and research.

Time: 5 mins

Materials:

- Rock for each student (a range of igneous, metamorphic, and sedimentary) *if rocks aren’t available, print **images** for each student*
- [Other materials are not needed, but garden educator can decide if students should hold onto or return materials]

1. **Pair-Share:** Students introduce their rock to a partner, explaining which type of rock they have and how they know.
2. **Ask** students to vote with a thumb up or down: “Are all rocks the same?”
3. **Ask** “*What type of rock is Waldo?*”
4. **Ask** “*How does studying rocks help geologists understand what Earth is made of and the processes that shape it?*”
5. [Optional discussion extension] **Say:** “*Rocks are as old as our Earth. How old is the Earth? If rocks are changing over time, do you think the Earth has stayed the same?*”

Lesson Extensions

Elaborate on this lesson by introducing that rocks change from one type to another and can teach us about Earth's processes through:

- 1. Rock Cycle Demo:** Use materials from this lesson to demonstrate how rocks could change from one type to another
 - Example: Melt together types of chocolate chips, cool them, crumble them apart again, layer them with other items and compact them (Igneous > Sedimentary)
- 2. Story of My Rock:** Students have a rock of their own and write stories (or draw a comic!) about how their rock was formed, making sure to include the type of rock and some keywords for each of the types (i.e. if it were igneous, they have to include the words "magma" and "cool", etc.)

Grade 4, Lesson 1: Lesson Background

Key Terms:

Geologist: what the earth is made of and the processes that shape it; "geo" = earth "ologist" = one who studies.

Sedimentary Rock: formed by weathering or erosion from water or wind.

Metamorphic Rock: formed by heat or pressure.

Igneous Rock: formed by lava or magma.

Mineral: materials rocks are made up of, they are pure chemical substances and have no organic substances (plants or animals).

Content Knowledge:

Explain Section: Igneous example is Basalt, Metamorphic example is Gneiss, Sedimentary is Conglomerate

Rock Formation: all rocks are made from minerals, but not the same minerals

- Sedimentary:

- formed from bits of rock and chemicals in water, sediments are a result of physical or chemical weathering (explained in the next lesson)
- sediments are transported by water, ice, or wind and deposited in a new location
- often form in layers
- (ex: sandstone, limestone)

- Metamorphic:

- formed from existing rocks changed by heat and pressure
- heat and pressure cause by plate tectonics shifting is often responsible for creating metamorphic rocks
- burial under thousands of meters of sediments can change sedimentary rocks into metamorphic rocks (limestone > marble, sandstone > quartzite)
- (ex: marble, quartzite)

- Igneous:

- formed by molten rock under the Earth's surface (magma) and when it surfaces (lava) it cools
- the time it takes to cool determines the type of rock it becomes
- crystal size is an indicator of cooling rate, the larger the crystal, the longer it took to cool
- (ex: granite, basalt)

- **Rock cycle:** the process through which rocks change from one type to another (image with pokemon below)

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Evaluate Section: Earth is 4.55 billion years old

NGSS Connections:

Disciplinary Core Ideas:

- **[ESS1.C] The History of Planet Earth: Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)**
 - Students will learn the different types of rocks and how they are informed.

Name: _____

Can my rock tell a story?

I notice my rock has... (check what you see your rock has)

- Layers (stripes)
 - Flat stripes
 - Wavy or swirled stripes
- Glossy, shiny texture like glass
- Crystals
- Grains/bits of rock
 - Bits are the same size
 - Bits have other material around it (like cement)
 - Bits are different sizes
 - Bits have no materials in-between them

I wonder... (write questions you have about your rock)

Name: _____

My rock has a story!

Look at the boxes you checked from the first worksheet to help you

Sedimentary	Metamorphic	Igneous
<input type="checkbox"/> Layers that are flat <input type="checkbox"/> Variety of colors <input type="checkbox"/> Visible bits of other rock <input type="checkbox"/> Material between grains	<input type="checkbox"/> Layers that are twisted or swirled <input type="checkbox"/> Layer of crystals	<input type="checkbox"/> Crystals <input type="checkbox"/> Grains/bits are all same size <input type="checkbox"/> No material around grains <input type="checkbox"/> Glossy sheen

Circle which one matches best.

1. My rock is a (sedimentary, metamorphic, igneous) rock!

2. My rock is like...
 - a. Station A
 - b. Station B
 - c. Station C

Photo of Waldo to be shown at the beginning of class (engage):



Waldo

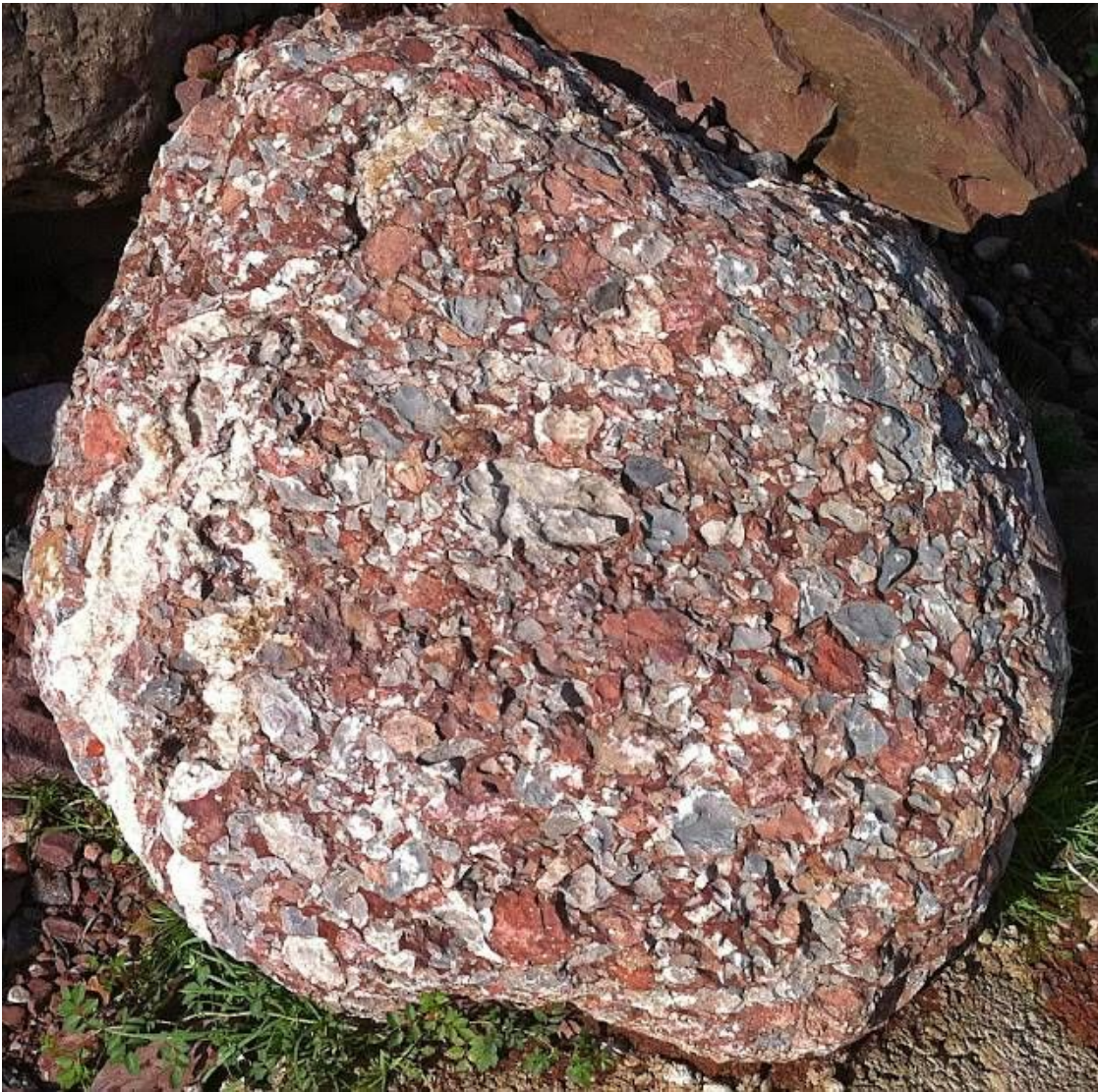
Igneous

- **Made from:** melted minerals and magma below Earth's surface
- **Formed:** when minerals and magma come up, they cool and harden
- **Often has:** crystals, grains/bits are all the same size, no material around grains, sometimes glossy sheen



Metamorphic

- **Made from:** bits of rock buried deep beneath the Earth's surface
- **Formed by:** Earth's heat and pressure over many years form new rocks from the bits
- **Often has:** layers/stripes that are twisted or swirled, layer of crystals, denser and harder than other rocks



Sedimentary

- **Made from:** tiny bits of rocks, minerals, sand, clay, seashells, or fossils!
- **Formed by:** water or wind moves sediments and layers them on top of other sediments over time
 - Earth's pressure compacts them to form rocks
- **Often has:** layers that are flat, variety of colors, visible bits of other rock, material between grains



[Sandstone - sedimentary]



[Limestone - sedimentary]



[Rock Phosphate - Sedimentary]



[Granite - Igneous]



[Pumice - Igneous]



[Basalt - Igneous]



[Obsidian - Igneous]



[Gneiss - Metamorphic]



[Slate - Metamorphic]



[Serpentine - Metamorphic]

Station B

Materials:

- 3 colors of playdough

Steps:

1. Tear off a piece of playdough the size of a dime from each color.
2. Roll the three colors together.
3. Squish them flat between the palms of your hands.

Questions:

- What do you notice?

- What type of rock do you think this would be?

Station C

Materials:

- Sand
- Mulch
- Dirt
- Clear container
- 3 spoons
- Extra materials bin

Steps:

1. Use a spoon to scoop a thin layer of sand into your clear container.
2. Use a spoon to scoop a thin layer of mulch into your clear container on top of the sand.
3. Use a spoon to scoop a thin layer of dirt into your container on top of the mulch.
4. Use your hand to squish down the layers in your container.
5. Pour materials from your container into the extra materials bin so someone else can use your container!

Questions:

- What do you notice?

- What type of rock do you think this would be? Why?

TITLE | WILL A MOUNTAIN LAST FOREVER?

GRADE | Fourth Grade

UNIT | 1

LESSON | 2

Time: 45 - 60 minutes

Unit Essential Question: How does a mountain turn into a grain of sand?

Focus Question: Will a mountain last forever?

Objectives: Students will understand how rocks change over time and be able to differentiate between physical and chemical changes in rocks.

Summary: Students attempt to answer the question, “Will a mountain last forever?” through the below table.

Engage	Students consider and discuss how mountains change using Mt. Whitney as an example.
Explore	Students use a sugar cube to explore 4 different rock weathering processes.
Explain	Students learn the difference between physical and chemical weathering through a picture sort and M&M activity.
Elaborate	Students will extend understanding by considering which rock types break down fastest and discussing human, animal and plant interactions with rocks and weathering.
Evaluate	Students will re-represent their understanding and reflect on learning by finding a rock and determining the type of weathering it went through.

Materials:

- 125 x Sugar cubes (4 per student)
- Station 1: (Rocks)
 - 5-10 x small rocks
 - Plastic jars with lids (two per group for station)
- Station 2: (Water/Acid Rain)
 - Water
 - Water pipette (1 per student at station)
 - 1 cup of Vinegar (optional)
 - Food dye (optional)
- Station 3: (Wind)
 - Straws (1 per student)
- Station 4: (Ice/Water)
 - Water

- Ice (2 - 4 cups)
- Spoons to dip ice cube (optional)
- Trays ~2 per station
- M&M's two per student
- Images (below):
 - Image #1: Mt. Whitney
 - Image #2: Rock Fall
 - Image #3: Physical 1
 - Image #4: Physical 2
 - Image #5: Chemical 1
 - Image #6: Chemical 2
- Weathering Worksheet (below)

Tips for Preparing the Lesson (High-Prep):

- Print out photos
- Cut straws in half to save materials, if needed

Prior Knowledge: Basic understanding of different types of rocks and how they are created.

Grade 4, Lesson 2: Lesson Steps

Engage: Students consider and discuss how mountains change using Mt. Whitney as an example.

Time: 5 mins

Materials:

- Printed picture of Mt. Whitney
- Printed picture of rock fall

Teacher

1. **Show** picture of Mt. Whitney. *This is Mt. Whitney. The tallest mountain in the contiguous United States. Mt. Whitney is so large that astronauts can see it from space. Mountains are made of solid rock all the way through. This mountain is bigger than you and bigger than me. But will this mountain always be there? Do mountains last forever?*
2. **Pair** students and have them discuss if mountains last forever.
3. **Ask** some students share some of their ideas.
4. **Record** students ideas on board.
5. **Show** picture of rock fall at Mt. Whitney. *This picture was taken one winter at Mt. Whitney. How did these rocks get there and why? What caused this?*
6. If students are having trouble thinking of ideas have them think of a rock in the garden and the different events/processes it goes through while sitting there. Connect that a mountain goes through similar events/processes.
7. Answers may include water, snow, ice, wind, rain, different temperatures.
8. Conclude that with different types of weathering, changes to rocks can occur.
9. **Say:** *We are going to explore this a bit deeper in our next activity.*

Explore: Students use a sugar cube to explore 4 different rock weathering processes.

Time: 20 mins

Materials:

- 125 x sugar cubes (4 per student)
- Trays (~2 trays per station)
- **Weathering Worksheet** (for each student)
- Station 1: (Rocks)
 - 5-10 x small rocks
 - Plastic jars with lids (two per group for station)
- Station 2: (Water/Acid Rain)
 - Water
 - Water pipette (3-5)
 - 1 cup of vinegar (optional)
 - Food dye (optional)
- Station 3: (Wind)
 - Straws (1 per student)
- Station 4: (Ice/Water)
 - Water
 - Ice (2 - 4 cups)
 - Spoons to dip ice cube (optional)

Teacher

1. **Say:** *So you mentioned that water, ice, wind, etc affect rocks. Today we are going to explore how this happens. Instead of using rocks we are using sugar cubes.*
2. Have students brainstorm why we may use a sugar cube instead of a rock. Have students list similarities of a sugar cube and a rock.
3. Each student will see how weathering affects their sugar cube by passing through 4 different stations. Every student should receive a new sugar cube at each station to see the different effects of weathering on their sugar cube. [Scaffold this with a “New Cubes” tray/bowl.]
4. **Clearly lay out stations and instructions** for students at each of the sugar cube weathering stations.
5. Depending on the site, students can pass through stations freely or have 3-4 minutes at each station.
6. **Instruct** students to observe the changes after each station and to see how weathering affects each of their sugar cubes. Record observations on the worksheet. **SAVE SUGAR CUBES** after each station so students can compare during discussion. [Scaffold with a “Used Cubes” tray at the station.]
7. Station options.
 - Station 1: Plastic jars with rocks. Put 1 sugar cube in jar with rocks and shake.
 - Station 2: Water pipette for dropping water onto cube. Could add vinegar & food coloring to water for a more dramatic change to cube.
 - Station 3: Blowing air through a straw onto cube.
 - Station 4: Dipping the sugar cube into a tray of ice water.
8. As students are passing through stations encourage them to figure out what weathering effect is modeled at each station.
9. Have students record the changes to their sugar cubes.

Explain: Students learn the difference between physical and chemical weathering through a picture sort and M&M activity.

Time: 6 mins

Materials:

- Photos of rocks
- Tray filled with used sugar cubes from each station
- M&M's 2 per student

1. **Ask** students *what station changed their rock the most?*
 - Hold up used sugar cubes from each station to prompt discussion.
2. Potential Guiding Questions include:
 - *What would happen if your sugar cube went through all 4 stations?*
 - *What weathering process is stimulated in each station?*
 - *Do rocks go through all 4 processes?*
 - *Which station would take the longest to weather each sugar cube? Guide discussion towards aspect of time.*
3. **Ask** *how rocks/mountains can change due to weathering?*
4. Teacher introduces terms *physical and chemical weathering*. Explaining the difference.
 - Physical weathering is caused by the effects of changing temperature on rocks, causing the rock to break apart.
 - Chemical weathering is the decomposition of rocks due to chemical reactions.
 - *Today we are going to do a quick representation of Physical and Chemical Weathering. Show an M&M. I want you to pretend that this M&M is a rock. We are going to break down this M&M two different ways. Your job is to figure out the way in which we are weathering this rock. Are we using physical weathering or chemical weathering?*
 - **Give** each student 1 M&M and **say** *eat this M&M using your teeth*. Next give each student 1 M&M and have them use their mouth (not teeth) to break down M&M. Have students guess which option was physical weathering and which was chemical. **Discuss** differences.
5. **Ask** students for examples of physical and chemical weathering they have seen in nature.
6. **Show** pictures and see if students can determine if the rock was changed by physical or chemical weathering. As image is shown, students will show sign language symbol (decided on prior) for which force they feel affected the rock. Have students give reasons for how the rock got to be that way. The information below is background for educators and is optional to tell students as they process.
 - **Image 3 - Physical 1** (Tree grew in between rock physically separating the rock)
 - **Image 4 - Physical 2** (Many rock surfaces have small crevices on them. Water can freeze in these crevices when it is cold, and then melt when the weather is warmer. This repeated freezing and thawing causes rocks to break apart.)
 - **Image 5 - Chemical 1** (The reaction between rocks and oxygen is known as oxidation. When elements or compounds in rocks react with oxygen and water, they form substances called oxides. One of the most common examples of oxidation is iron oxide, or rust.)
 - **Image 6 - Chemical 2** (Hydration occurs when a mineral absorbs water to form a new substance. Hydration causes the rock to expand its volume, which can put stress on the rock and make it more vulnerable to other types of weathering.)

Elaborate: Students will extend understanding by considering which rock types break down fastest and by discussing human, animal and plant interactions with rocks and weathering.

Time: 5 mins

Materials:

1. **Have** students brainstorm different types of rocks and what might break down the fastest.
2. **Ask:** Are any of these changes caused by humans, animals, or plants?

Evaluate: Students will re-represent their understanding and reflect on learning by finding a rock and determining the type of weathering it went through.

Time: 5 mins

Materials:

1. **Have** students think pair share to answer question *Do mountains last forever?*
2. **(Optional) Have** students explore garden and find a rock that has been weathered by physical or chemical weathering. Have them name what type of weathering has affected this rock.
3. Leave with the question *where do all of the smaller rocks go?* (This leads into the concept of erosion covered in Lesson 3)

Grade 4, Lesson 2: Lesson Background

Key Terms:

Physical weathering is caused by the effects of changing temperature on rocks, causing the rock to break apart.

Chemical weathering is the decomposition of rocks due to chemical reactions.

Biological weathering is the weakening and subsequent disintegration of rock by plants, animals, and microbes.

Common Misconceptions:

- Students may hold many misconceptions about erosion, including:
 - Rocks do not change.
 - Weathering and erosion are essentially the same thing. The two words can be used interchangeably.
 - Erosion happens quickly.
 - Erosion is always bad.
- Students tend to view the earth as static, stable, and unchanging. They often have difficulty believing that rocks can change or be worn down through the process of weathering. Students also tend to confuse weathering (the physical or chemical breakdown of rock) with erosion (the process of transporting sediments).
- Even once students understand the concepts of weathering and erosion, they tend to have difficulty conceptualizing the long time frames needed for these processes to occur. Some science lessons focus on the negative aspects of erosion (soil loss, ecosystem destruction, sediment buildup in water sources) and lead students to believe that erosion is always bad. However, teachers should stress that erosion does have positive aspects as well. Delta areas, like the Mississippi and the Nile, were created by the deposition of eroded sediments carried downriver. Without erosion, these rich, fertile farming areas would not exist.

NGSS Connections:

Disciplinary Core Ideas:

[ESS2.A] Earth Materials and Systems: Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

- Students are learning that rocks can be broken into smaller particles by water, ice, wind, and living organisms.
- Source: <https://www.nap.edu/read/13165/chapter/11#179>

Name _____

Date _____

Grade 4, Lesson 2

Does a mountain last forever?

- Draw each sugar cube before and after for each station.
- Write what changes occurred.

Before	After	What changed?

Image #1: Mount Whitney



Image 2: Rock Fall



Image # 3: Physical (1)



Image # 4: Physical (2)



Image # 5: Chemical (1)



Image #6: Chemical (2)



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TITLE | HOW DID THIS ROCK GET HERE?

GRADE | Fourth Grade

UNIT | 1

LESSON | 3

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Time: 45 - 60 minutes

Unit Essential Question: How does a mountain turn into a grain of sand?

Focus Question: How did this rock get here?

Objectives: Students will be able to build a model mountain and demonstrate a variety of factors that cause erosion.

Summary: Students attempt to answer the question, “How did this rock get here?” through the below table.

Engage	Students engage in the process of erosion by trying to move soil with water.
Explore	Students will explore the phenomenon of erosion by engineering ways to erode land.
Explain	Students will develop scientific explanations for observations by discussing large scale examples of erosion (ice, water, deforestation, wind).
Elaborate	Students will extend understanding by creating a model of erosion made by a specific cause.
Evaluate	Students will demonstrate their understanding and reflect on their learning by presenting their model of a specific type of erosion to their classmates.

Materials:

- Small cups of water (one per student or one per pair)
 - Engage Image 1 OR Engage Image 2 (below)
 - 4 marked off areas in the garden with soil
 - or 4 trays with soil
 - Items suggested for mountain:
 - Trowels
 - Gloves
 - Straws
 - Fan
 - Sticks
 - Rocks
 - Spray bottle with vinegar
 - Watering cans
 - Ice cubes
 - Images with erosion examples (below)
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Tips for Preparing the Lesson: (High-Prep)

- Prepare tray with soil and a cup of water (or 15-30 dixie cups of water if adapting Engage for teaching tip in background section)
- Mark 4-5 garden beds/areas of dirt for students to build model mountains or set up 4-5 trays of dirt.
- Set up a table or easily accessible spot for mountain-eroding materials (trowels, gloves, straws, etc.)

Prior Knowledge: Weathering

Grade 4, Lesson 3: Lesson Steps

Engage: Students engage in the process of erosion by trying to move soil with water.

Time: 7 mins

Materials:

- Tray with some soil
- Cup of water
- **Engage image 1** printed (or **Engage image 2**)

Teacher

1. **Say** *Good morning geologists! I have a special challenge for a brave volunteer. I challenge one student to make this soil move using only the water in this cup. **Emphasize** that the student can't use the cup itself or their hands.*
2. **Choose** a student volunteer and have them demonstrate so the class can see.
3. **Ask** *What did you notice happened when [student] poured the water? What do we call the process that happened here?* **Say** *The process that moves or transports the smaller particles of soil or sediment is called erosion.*
4. **Write or reveal** definition on board.
5. **Say:** *"Soil is just a small part of our Earth. Now that we know you can move soil with a cup of water, let's think about how larger parts of our Earth move. Like this rock. Engage image How do you think this rock got there?"* Students **share** their ideas.

Explore: Students will explore the phenomenon of erosion by engineering ways to erode land.

Time: 8 mins

Materials:

- 4 marked off areas in the garden with soil
- Items for testing erosion:
 - Straws
 - Fan
 - Sticks
 - Rocks
 - Spray bottle with vinegar
 - Watering cans
 - Ice cubes

Teacher

1. **Challenge** students to erode soil using the materials provided on a table.
2. **Emphasize** that students should use just the materials when they are trying to erode, not their hands or other items in the garden.
3. (Option: Instead of having materials available at the front of the class, educator could assign a material to a student/pair of students and then students can try one material and share with others to learn how the other materials worked).

Teacher

4. Materials:

- spray bottles, watering cans (rain, rivers)
- blow through straw, make cardboard fans (wind)
- use sticks to simulate growth of plant roots (plants)
- ice cubes (glacier)

5. **Send** students to designated spots in the garden where they won't disturb any plant growth.

Explain: Students will develop scientific explanations for observations by discussing large scale examples of erosion (ice, water, deforestation, wind).

Time: 5 mins

Materials:

1. **Ask:** Raise your hand if you were able to make the soil move. What strategies did you use? What did you notice happened to the soil?
2. **Hold** up each material and **ask** *What natural force does that model?*
3. **Record** on the board the forces of nature that could erode the land, circling the main forces of nature (water, wind, ice).

Elaborate: Students will extend understanding by creating a model of erosion made by a specific cause.

Time: 10 mins

Materials:

- **Images with erosion examples**
- 4 marked off areas in the garden with soil
 - or 4 trays with soil
- Items suggested for mountain:
 - Trowels
 - Gloves
 - Straws
 - Fan
 - Sticks
 - Rocks
 - Spray bottle with vinegar
 - Watering cans
 - Ice cubes

1. **Provide** a different image of erosion to each group.
2. **Challenge** students to build a mountain and then demonstrate the type of erosion that is on their card:
 - Ice
 - Water (rivers/oceans)
 - Wind
3. **Reiterate** that mountains are more than just dirt (they also have plants, rocks, etc.). If you do not have enough open space for groups to build mountains in the garden, provide each group with a tray/stream table and access to soil, rocks, etc.
4. **Divide** students into groups of 4-5.
5. **Send** groups back to their stations to begin creating a model mountain.

Evaluate: Students will demonstrate their understanding and reflect on their learning by presenting their model of a specific type of erosion to their classmates

Time: 5 mins

Materials:

1. **Gallery Walk:** **Instruct** students to present their model and explain the type of erosion shown to other groups
2. **Discuss** how erosion can have negative effects. *What would happen if there were houses at the bottom of the mountain? (leads into the next lesson on how to reduce the impact of erosion)*

Grade 4, Lesson 3: Lesson Background

Key Terms:

Erosion - happens when rocks and sediments are picked up and moved to another place by ice, water, wind or gravity

Weathering - the process where rock is dissolved, worn away, or broken down by physical, chemical, or organic processes

Physical weathering is caused by the effects of changing temperature on rocks, causing the rock to break apart

Chemical weathering is the decomposition of rocks due to chemical reactions

Glacier - a large, slowly moving mass of ice

Content Knowledge:

Erosion is the act in which earth is worn away, often by water, wind, or ice. A similar process, weathering, breaks down or dissolves rock, weakening it or turning it into tiny fragments.

The process of erosion moves bits of rock or soil from one place to another. Most erosion is performed by water, wind, or ice (usually in the form of a glacier). These forces carry the rocks and soil from the places where they were weathered. If water is muddy, it is a sign that erosion is taking place. The brown color indicates that bits of rock and soil are suspended in the water and being transported from one place to another. This transported material is called sediment.

When wind or water slows down, or ice melts, sediment is deposited in a new location. As the sediment builds up, it creates fertile land. River deltas are made almost entirely of sediment. Delta sediment is eroded from the banks and bed of the river.

Erosion and Global Warming:

Global warming, the increase in average temperature around the world, is speeding erosion. The change in climate has been linked to more frequent and more severe storms. Storm surges following hurricanes and typhoons threaten to erode miles of coastline and coastal habitat. These coastal areas have homes, businesses, and economically important industries, such as fisheries.

The rise in temperature is also quickly melting glaciers. This is causing the sea level to rise faster than organisms can adapt to it. The rising sea erodes beaches more quickly.

Teaching Tips:

- **Engage:** If demonstrating water moving soil so that the whole class can see is a challenge, the educator can prepare enough cups for every student to try to move soil somewhere in the garden as a 2-minute challenge and then discuss what happened as a class.

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- Model mountains can be built on trays with soil if there isn't enough garden space. Or the mountain could be done as a teacher demo and students could come up and try to erode the mountain with different materials.

Common Misconceptions:

- **Weathering and erosion** are the same thing: Weathering is the process that wears away at land/rocks, erosion is the process that moves little bits of rock and sediment after it has been weathered

NGSS Connections:

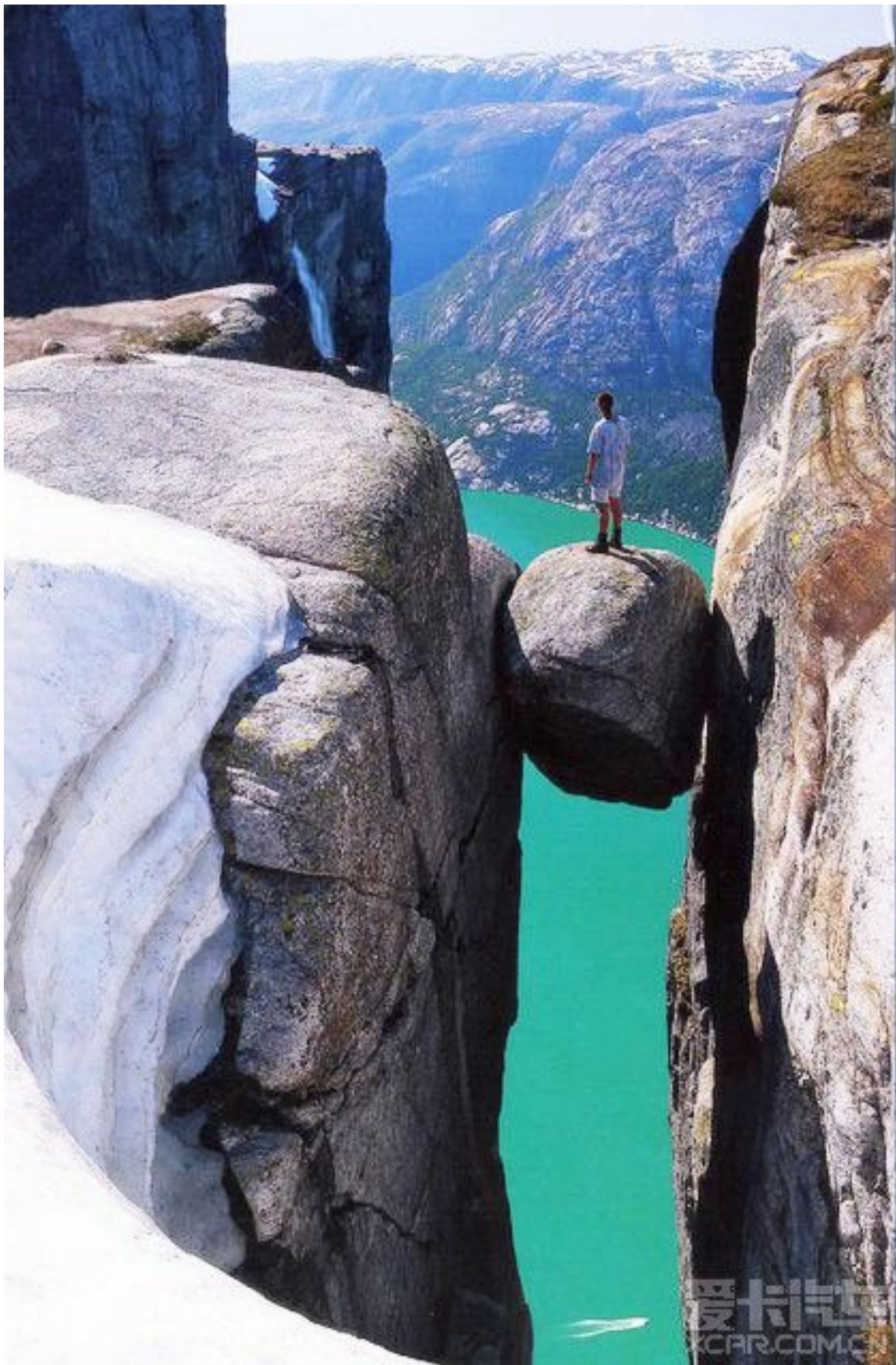
Disciplinary Core Ideas:

- **[ESS2.A] Earth Materials and Systems: Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.**

- Students will observe how forces of water, ice, wind, and living organisms move sediments and deposit them elsewhere.

- Source: <https://www.nap.edu/read/13165/chapter/11#179>

Engage Image #1:



Enage Image #2:



Erosion Images



Erosion by Deforestation

Erosion is a natural process, but human activity can make it happen more quickly. Trees and plants hold soil in place. When people cut down forests or plow up grasses for agriculture or development, the soil washes away or blows away more easily. Landslides become more common. Water also rushes over exposed soil rather than soaking into it, causing flooding.



Erosion by Ice

Ice can erode the land. In extremely cold areas and on some mountaintops, glaciers move slowly downhill and across the land. As they move, they pick up everything in their path, from tiny grains of sand to huge boulders.

The rocks carried by a glacier rub against the ground below, eroding both the ground and the rocks. Glaciers grind up rocks and scrape away the soil. Moving glaciers gouge out basins and form steep-sided mountain valleys. This is how Yosemite Valley was formed!



Erosion by Wind

Wind carries dust, sand, and volcanic ash from one place to another. Wind can sometimes blow sand into large mounds, called dunes.

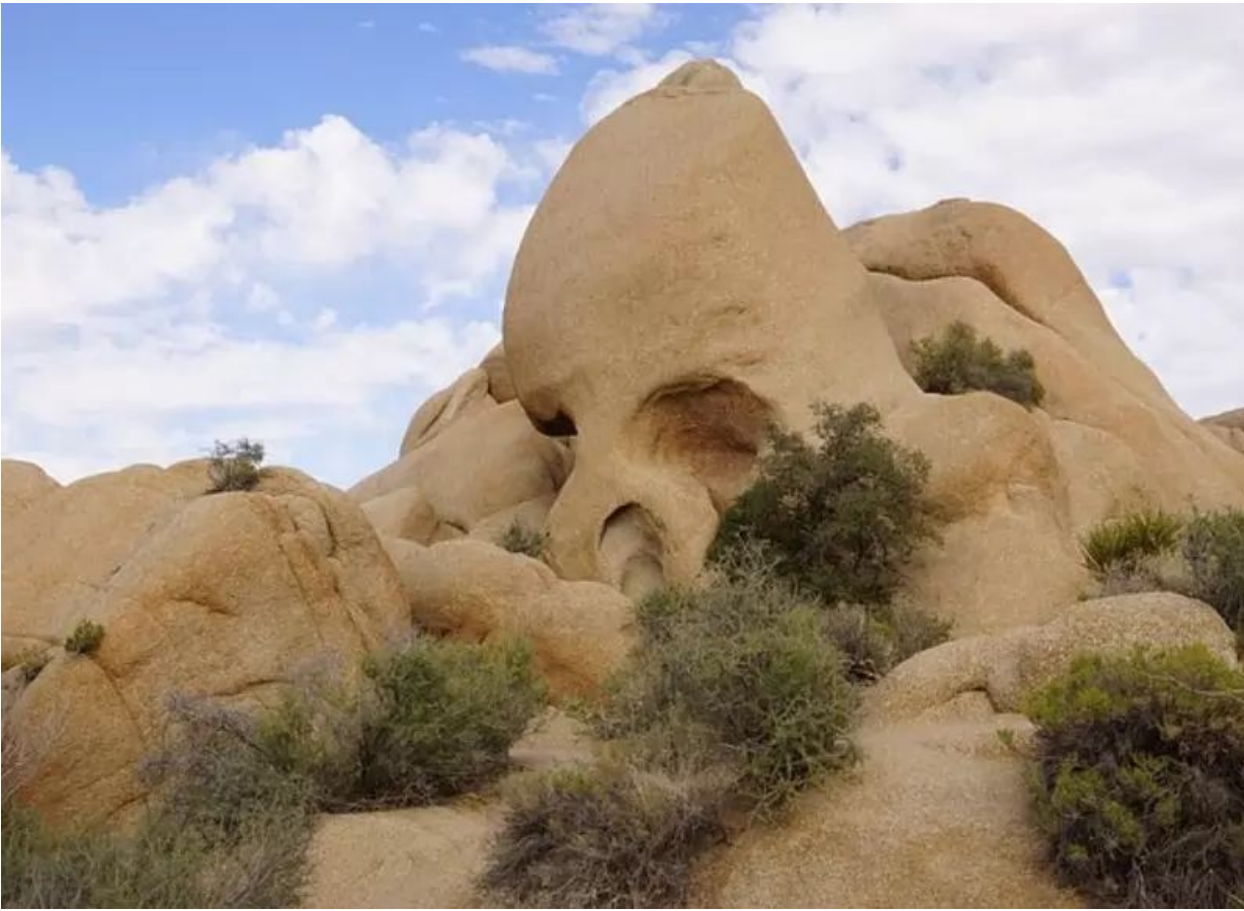
In dry areas, windblown sand blasts against rock with tremendous force, slowly wearing away the soft rock. It also polishes rocks and cliffs until they are smooth.



Erosion by Water (rivers/waves)

Rushing streams and rivers wear away their banks, creating larger and larger valleys. In a span of about 5 million years, the Colorado River cut deeper and deeper into the land in what is now the U.S. state of Arizona. It eventually formed the Grand Canyon, which is more than 1,600 meters (1 mile) deep and as much as 29 kilometers (18 miles) wide in some places.

Erosion by water changes the shape of coastlines. Waves constantly crash against shores. They pound rocks into pebbles and reduce pebbles to sand. Water sometimes takes sand away from beaches. This moves the coastline farther inland.



Erosion by Water (rain/acid rain)

Rain carries away bits of soil and slowly washes away rock fragments. Acid rain and freshwater rain formed one of the most notable rock formations in the world, in the shape of a skull at Joshua Tree National Park in California. Skull rock was formed by continuous action of rain drops (chemical weathering), and then the fragments that wore off got carried away by continual rainfall. The two eye sockets and nostrils formed from acid rain.

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TITLE | CAN HUMANS KEEP A PIECE OF LAND FROM WASHING AWAY?

GRADE | Fourth Grade

UNIT | 1

LESSON | 4

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Time: 45 - 60 minutes

Unit Essential Question: How does a mountain turn into a grain of sand?

Focus Question: Can humans keep a piece of land from washing away?

Objectives: Students will be able to model structures to reduce the impact of erosion and explain why that is helpful.

Summary: Students attempt to answer the question, “Can humans keep a piece of land from washing away?” through the table below.

Engage	Students discuss the negative effects of erosion.
Explore	Students build a model of an environment with supports to protect it from erosion.
Explain	Students will observe real-life examples of erosion prevention.
Elaborate	Students will extend understanding by brainstorming erosion control methods for other examples of erosion by water.
Evaluate	Students will re-represent their understanding by applying knowledge of types of erosion and prevention methods to their town.

Materials:

- Images #1 & #2: cliff erosion
- Sheets Images #3 descriptions/images of erosion scenario
- Erosion Control Materials
 - Designated areas in the garden for building (or trays with soil in them)
 - Trowels
 - Gloves
 - Sticks, leaves, rocks, other plant material
 - Aluminum foil
 - Cardboard
 - Strips of cloth
 - Sponges
- Photos of real-life examples of erosion control solutions
- Hose/watering can

Tips for Preparing the Lesson (High-Prep):

- Designate about 5 areas in the garden for building (*or prepare trays of soil*)
- Set out erosion control materials so that all students can access them while building (not all materials are required, but suggested)

Prior Knowledge:

- Weathering
- Erosion

Grade 4, Lesson 4: Lesson Steps

Engage: Students discuss the negative effects of erosion.

Time: 5 mins

Materials:

- **Image of coastal cliff erosion**

Teacher

1. **Show** image of cliff erosion with homes near coast.
2. **Ask:** *What happened here? (erosion) Who is affected by this? How could people prevent this damage (aside from moving somewhere else)?*
3. **Say:** *Today, we are going to be city planners. We need to prevent erosion so there is as little damage as possible to people's homes and buildings.*

Explore: Students will explore the phenomenon by building a model of an environment with supports that protect it from erosion.

Time: 15 mins

Materials:

- Explore Challenge: **Erosion by Deforestation image** with descriptions/images of erosion scenario
- Designated areas in the garden for building
 - *or trays with soil in them*
- Trowels
- Gloves
- Sticks, leaves, rocks, other plant material (good idea to provide a lot or designate areas students can pull from)
- Aluminum foil
- Cardboard
- Strips of cloth
- Sponges
- Hose/watering can

Teacher

1. **Challenge** students to build an environment in the garden that will withstand erosion by water with as little harm to living things as possible.
2. **Explain** that each group will be building a mountain with a town at the bottom.
3. **Show** image of mountain with deforestation. **Prompt** students to predict what will happen when rain falls on the exposed mountain side.
4. **Reiterate** that moving the community further away from the area facing erosion is not an option. (*Note: If you do not have enough open space for groups to build streams in the garden, provide each group with a tray/stream table and access to soil, rocks, etc.*)

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Teacher

6. **Tell** students they will have 12 minutes to build their mountain and erosion prevention before the storm comes (educator with hose/watering can)
6. **Divide** students into groups of 4-6 and **send** groups to designated building areas in the garden.
7. After 12 minutes, educator **pours** storm on models with hose/watering can.

Explain: Students will observe real-life examples of erosion prevention.

Time: 10 mins

Materials:

- **Photos of real-life examples of erosion control**

Teacher

1. **Students share** methods of prevention and how effective they were.
2. **Ask** students to predict what real-life methods might look like.
3. **Present** students with real-life examples of erosion control using photos as students predict them (ex: If students mention building a wall or support structure, show that image. Whatever methods students have not guessed, show at end.).

Elaborate: Students will extend understanding by brainstorming erosion control methods for other examples of erosion by water.

Time: 5 mins

Materials:

- Sheets with descriptions/**images of erosion scenario**

Teacher

1. **Discuss** that there are other scenarios that require erosion prevention.
2. **Show** the 3 other examples and explain what's happening.
3. For each photo, **ask the class** what solution they would use to prevent the problem.

Evaluate: Students will re-represent their understanding by applying knowledge of types of erosion and prevention methods to their town.

Time: 5-10 mins

Materials:

Teacher

1. **Discuss:** *Which of these scenarios might occur in our town? What could the town do to prevent those scenarios?*

Lesson Extensions:

None.

Grade 4, Lesson 4: Lesson Background

Key Terms:

Erosion - happens when rocks and sediments are picked up and moved to another place by ice, water, wind or gravity.

Weathering - the process where rock is dissolved, worn away, or broken down by physical, chemical, or organic processes.

Erosion Prevention and Control - the action of reducing the impact of erosion, particularly by water or wind.

Landslide - when a mass of rock or land slides down a hillside all at once.

Teaching Tips:

- Explore:
 - If there isn't enough space in your garden for groups of students to work in garden beds, you can provide large trays of soil for students or do a whole-class demo.
 - Not all materials are necessary for the explore section. Ideally, students will have access to materials to use plant materials, form a wall, compact soil, or add grit to soil.

Common Misconceptions:

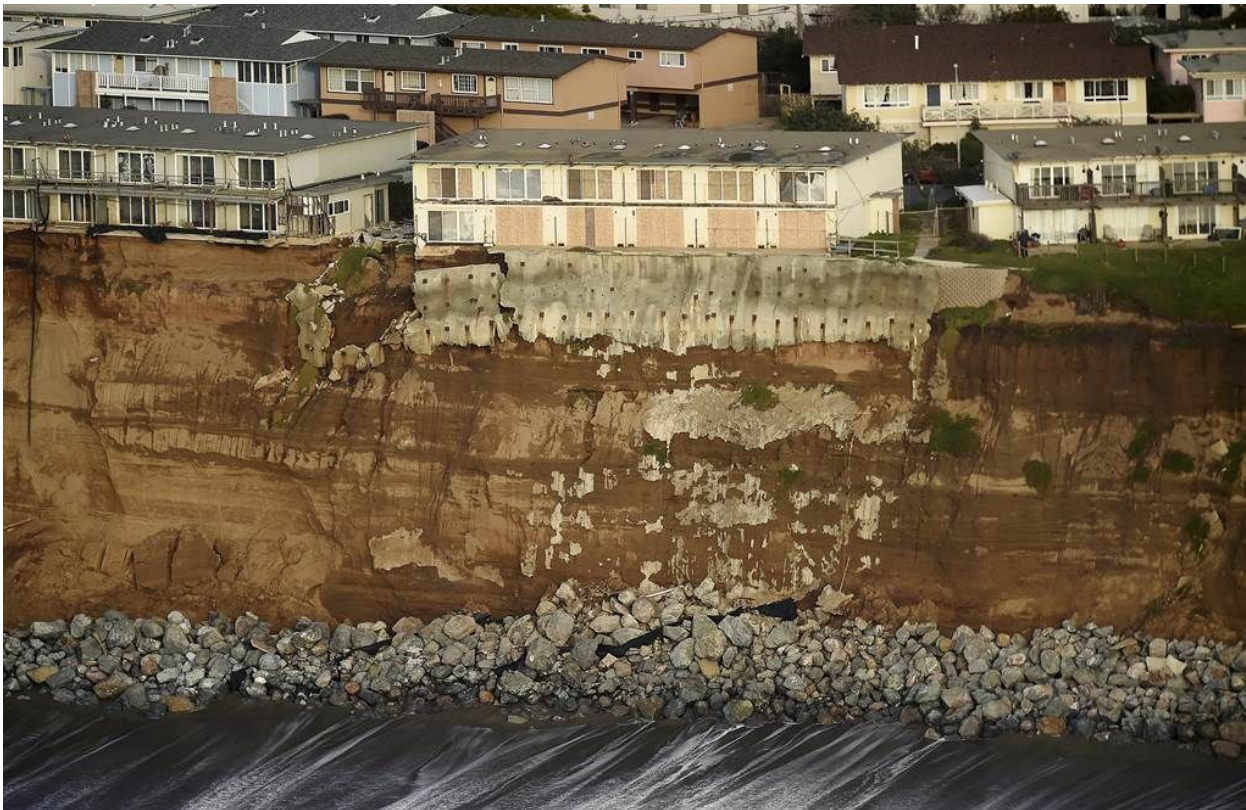
- People living near eroding areas should just move: Moving is hard, especially when your family is invested in a place. Many people in San Francisco would have to move due to powerful, eroding waves, earthquakes, and storms.
- Erosion control is most often used to prevent erosion by water: Erosion control is also used for wind erosion, but water causes damage in a greater variety of ways (rivers, waves, rainfall).

NGSS Connections:

Disciplinary Core Ideas:

- **[ESS2.A] Earth Materials and Systems: Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.**
 - Students will consider a variety of ways that water erodes land through a model and a discussion.
 - Source: <https://www.nap.edu/read/13165/chapter/11#179>
- **[ESS3.B] Natural Hazards: A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.)**
 - Students will design and discuss solutions to the natural process of erosion to reduce its impact.
 - Source: <https://www.nap.edu/read/13165/chapter/11#192>

Images # 1 & 2: Cliff Erosion



Explore Challenge



A town chopped down a nearby forest for lumber. Rainfall on the cleared forest lands carries lots of soil and rocks down to the town below (these are called landslides). **How can you prevent erosion from damaging the town?**

Scenario 1



This lighthouse was built on an island. At the time, the lighthouse was nearly 1,000 meters (3,300 feet) from the ocean. But after 80 years, the ocean eroded most of the beach near the lighthouse. Look how close the water comes to the lighthouse! During strong storms, the waves now come close enough to wear away the foundation of the lighthouse.

How can you control erosion from destroying this lighthouse?

Scenario 2



A large, rushing river erodes away the soil on the sides and bottom of the river. Over time, the river carves out wider and deeper valleys. This pushes back homes of animals and people nearby.

How can you control this river from eroding the river banks so quickly?

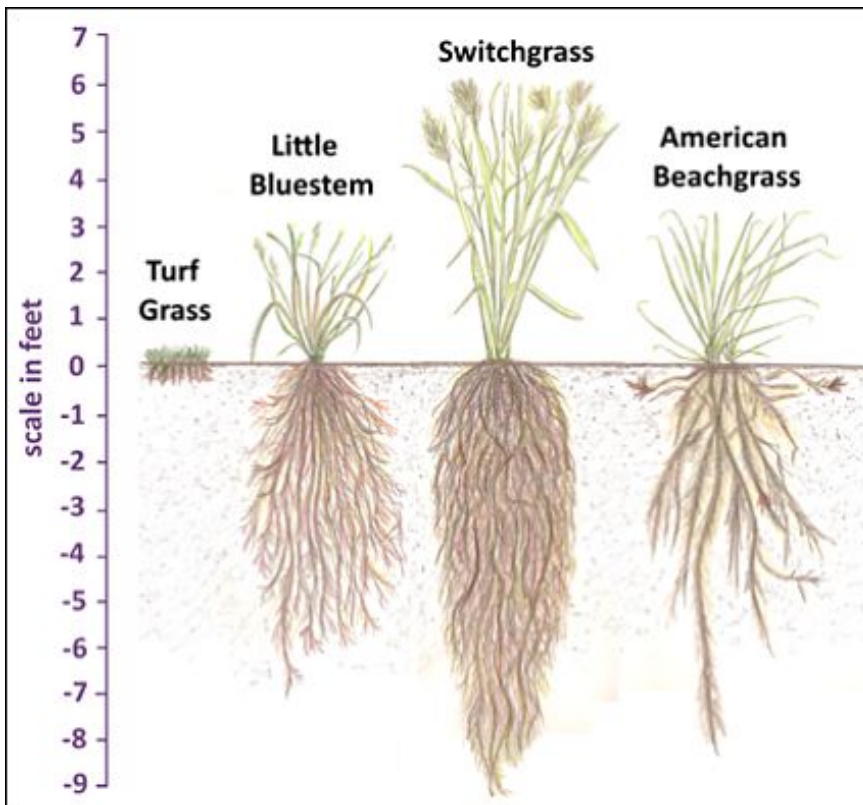
Scenario 3



When a farmer ploughed their land and removed all plants at once, the exposed soil on the surface washed away with heavy rainfall, carrying away healthy, nutrient-rich soil.

How can you help this farmer control the erosion of healthy soil?

Solution 1



The most helpful solution is adding plants (even just grass!). Plants, stone, and sand help anchor the soil to the area, preventing soil from wearing away. This helps land along shorelines from widening rivers or pushing back coastlines, and it helps other areas from rainfall erosion.

Solution 2



Retaining Walls: Sometimes, engineers simply install walls to physically prevent soil from being moved. Retaining walls can be built around the area of erosion to prevent water run off. Runoff water leads to further erosion. Walls are often placed near cliffs. When erosion by water or wind threatens to tumble the boulders toward buildings and cars, walls protect landowners and drivers by holding the rocks in place.

Solution 3



Mulch made of wood chips or straw or fabrics are laid out over exposed soil to help hold soil in place and to protect the nutrient-rich soil on the surface. This is a common tool for farmers and gardeners!