

Grade 4 Science

Unit 4: Processes That Shape Earth

13 lessons and a unit quiz. Use this pack with the **Processes That Shape Earth Student Reader** (print it, or download it once from the course) to teach the whole unit without the internet.

What is in this pack

- A lesson plan for each chapter: the Big Question, words to know, which pages to read, questions to talk over and the activity pages.
- The unit quiz, ready to print.
- Answers for the teacher at the back: every discussion question and the quiz key.

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Lesson schedule

Two or three lessons a week, about 30 minutes each. Tick each one off as you go.

	Lesson	Reader pages	Activity pages
☐	Lesson 1: Effects of Earth's Changing Surface	—	AP 1.1, AP 1.2, AP 1.3, AP 1.4, AP 1.5
☐	Lesson 2: Earth's Layers and Moving Crust	PDF pages 7–10	AP 2.1
☐	Lesson 3: Modeling Earth's Layers	—	AP 3.1, AP 3.2, AP 3.3
☐	Lesson 4: Evidence of Earth-Shaping Processes	PDF pages 11–18	AP 4.1
☐	Lesson 5: Earthquakes	PDF pages 19–24	AP 5.1, AP 5.2
☐	Lesson 6: Earthquake Problems and Solutions	—	AP 6.5, AP 6.6, AP 6.7, AP 6.8
☐	Lesson 7: Tsunamis	PDF pages 25–30	AP 7.1
☐	Lesson 8: Volcanoes	PDF pages 31–38	AP 8.1
☐	Lesson 9: Reading Maps of Volcanoes	—	AP 9.1, AP 9.2, AP 9.3, AP 9.4
☐	Lesson 10: Erosion	PDF pages 39–46	AP 10.1
☐	Lesson 11: Erosion Problems and Solutions	—	AP 11.1, AP 11.2, AP 11.3
☐	Lesson 12: Landslides	PDF pages 47–52	AP 12.1
☐	Lesson 13: Landslide Problems and Solutions	—	—
☐	Unit review and assessment	—	AP UC.1, AP UC.2, AP UC.3, AP UC.4
☐	Words quiz	—	—

Page numbers are the PDF page numbers of the Student Reader file, so they match what your PDF reader shows.

Lesson 1: Effects of Earth's Changing Surface

THE BIG QUESTION

How do changes in Earth's surface affect people, and what can be done about them? Problem-Based Learning Project: Examine and identify natural hazards, and consider their effects on people and property, to prepare for the unit capstone project.

Words to know

- **cause and effect** — a thing that brings about a result and its outcome
- **energy** — the ability to cause change
- **geologic** — related to the study of Earth's makeup and formation
- **geology** — the study of Earth's makeup and formation
- **natural hazard** — an extreme event in nature that can cause harm to living organisms and structures

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 28–34: the steps, materials and timing for this lesson.

Talk it over

1. What changes can you identify in the video?
2. What evidence was there that energy was transferred?
3. How could these changes affect objects or structures made by people?
4. What information will be on the presentation your team produces?
5. How should you behave when presenting to your audience?
6. How should you work with your team?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How do changes in Earth's surface affect people, and what can be done about them? Problem-Based Learning Project: Examine and identify natural hazards, and consider their effects on people and property, to prepare for the unit capstone project.
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 1.1: Natural Hazards Concept Map — Teacher Guide PDF page 137

- Activity Page 1.2: The Consequences of Natural Hazards — Teacher Guide PDF page 138
- Activity Page 1.3: Natural Hazards Presentation Evaluation Guide — Teacher Guide PDF page 139
- Activity Page 1.4: Natural Hazards Team Contract — Teacher Guide PDF page 140
- Activity Page 1.5: Take-Home Letter — Teacher Guide PDF page 141

Lesson 2: Earth's Layers and Moving Crust

THE BIG QUESTION

Why are some fossils of the same type found thousands of miles apart on different continents? Problem-Based Learning Project: Consider explanations about how we know that Earth's surface is made up of moving plates in anticipation of the unit capstone project.

Words to know

- **fossil** — the remains of an organism preserved in rock form
- **geologist** — a scientist who studies what Earth is made of and how it changes over time
- **plate** — in geology, a large fragment of Earth's crust and upper mantle
- **molten** — liquefied by heat

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 36–42: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 1: "Earth's Shifting Pieces": PDF pages 7–10. Look at the pictures and maps together.

Talk it over

1. What are some changes on Earth's surface that result from movements of Earth's crust or movement of material through the crust?
2. How is a mountain range evidence of Earth's crust moving over time?
3. What is a geologist?
4. Why did it matter that the fossilized organisms were animals that were not strong swimmers?
5. Why are the fossils found on Antarctica of particular significance?
6. Do the shapes of the continents around the world suggest any patterns?
7. Are there any patterns when it comes to fossils?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: Why are some fossils of the same type found thousands of miles apart on different continents? Problem-Based Learning Project: Consider explanations about how we know that Earth's surface is made up of moving plates in anticipation of the unit capstone project.

- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 2.1: Check — Teacher Guide PDF page 142

Lesson 3: Modeling Earth's Layers

THE BIG QUESTION

How do scientists know that Earth is made up of layers?
Problem-Based Learning Project: Learn how to model Earth's layers and their interactions in anticipation of the unit capstone project.

Words to know

- **plate** — in geology, a large fragment of Earth's crust and upper mantle
- **core** — the innermost part of Earth
- **crust** — the outer part of Earth's surface
- **mantle** — the part of Earth's interior that is between the crust and the core
- **scale** — relative size, extent, or incremental measure

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 43–48: the steps, materials and timing for this lesson.

Talk it over

1. If we are going to make models of Earth, should the models be smaller or larger than the real thing?
2. Why should they be smaller?
3. Which two layers are the closest in thickness?
4. Which layer is the thickest?
5. Which layer is the thinnest?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How do scientists know that Earth is made up of layers? Problem-Based Learning Project: Learn how to model Earth's layers and their interactions in anticipation of the unit capstone project.
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 3.1: Planning a Model of Earth's Layers — Teacher Guide PDF page 143
- Activity Page 3.2: Developing a Model of Earth's Layers — Teacher Guide PDF page 144
- Activity Page 3.3: Lesson Reflection — Teacher Guide PDF page 145

Lesson 4: Evidence of Earth-Shaping Processes

THE BIG QUESTION

What evidence shows that Earth's surface has changed over time? Problem-Based Learning Project: Learn how Earth's surface changes over time because of natural events in anticipation of the unit capstone project.

Words to know

- **sedimentary rock** — rock made of sediment compacted together
- **igneous rock** — rock made of magma or lava that has cooled and hardened
- **metamorphic rock** — rock that forms when igneous or sedimentary rock is placed under tremendous heat or pressure
- **sediment** — small pieces of rock or other hard material that has broken down over time
- **boundary** — the edge or limit of something; in geology, the place where plates meet

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 49-56: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 2: "More Evidence of Earth-Shaping Processes": PDF pages 11-18. Look at the pictures and maps together.

Talk it over

1. What is an example of a process that helps shape Earth's surface?
2. What is an example of a piece of evidence that an Earth-shaping process has occurred?
3. Which type of rock do you think was the first to be made on Earth? Why?
4. Which rock type is made from other rocks that are put under tremendous pressure and heat?
5. Granite from a mountain is worn away by natural forces. It accumulates downhill as sand and gravel. Over time, substances carried by water and the weight of the material cement the particles together. What kind of rock has been made?
6. What is one way scientists might have been able to locate the crater?
7. How have scientists been able to come up with a date for when the asteroid struck Earth?
8. What might be some simple technologies that scientists use to help them when constructing an explanation for how and when the dinosaurs went extinct?

9. Why is it important for satellite images or images taken by drones or other aircraft to be recorded along with the locations of the satellites or aircraft?
10. Why do you think modern science and surveying favor the use of satellites and drones over hand-drawn maps?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What evidence shows that Earth's surface has changed over time? Problem-Based Learning Project: Learn how Earth's surface changes over time because of natural events in anticipation of the unit capstone project.
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 4.1: Check — Teacher Guide PDF page 146

Lesson 5: Earthquakes

THE BIG QUESTION

Why are some communities more likely to experience an earthquake than others? Problem-Based Learning Project: Learn why some communities are more prone to experience earthquakes than other communities in anticipation of the unit capstone project.

Words to know

- **earthquake** — shaking of the ground caused by a seismic wave
- **magnitude** — the size or extent of an earthquake
- **geologic** — related to the study of Earth's makeup and formation
- **seismic** — related to vibration of Earth

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 59–65: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 3: “Earthquakes”: PDF pages 19–24. Look at the pictures and maps together.

Talk it over

1. What are some of the effects of earthquakes that you have heard of in the news, seen in a movie, or experienced yourself?
2. What do you think causes earthquakes?
3. Where do you think earthquakes most often occur?
4. Why is it easier to maintain your footing and balance when a surface is solid?
5. Why would soil that is wet with water be more vulnerable to an earthquake's vibrations than a thick slab of rock?
6. How much more energy would be released by a magnitude-9 earthquake than a magnitude-7 earthquake?
7. What is an earthquake?
8. What does seismic mean?
9. What can cause earthquakes?
10. Where do most large earthquakes occur?
11. How do landslides happen?
12. What is the tool called that measures earthquakes?

13. Geologists who study earthquakes measure their strength on a scale of what?
14. What can people do to live safely in areas that have earthquakes?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: Why are some communities more likely to experience an earthquake than others? Problem-Based Learning Project: Learn why some communities are more prone to experience earthquakes than other communities in anticipation of the unit capstone project.
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 5.1: Check — Teacher Guide PDF page 147
- Activity Page 5.2: Natural Hazard Solutions — Teacher Guide PDF page 148

Lesson 6: Earthquake Problems and Solutions

THE BIG QUESTION

How can engineers reduce earthquake damage to buildings?
Problem-Based Learning Project: Learn how engineers work to reduce earthquake damage to human-made structures in anticipation of the unit capstone project.

Words to know

- **criteria and constraints** — required factors and limitations
- **design solution** — an engineered remedy to a want or need

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 66–74: the steps, materials and timing for this lesson.

Talk it over

1. How do earthquakes affect Earth's surface?
2. How do earthquakes affect people?
3. What do people do to reduce the impacts of Earth's natural processes?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How can engineers reduce earthquake damage to buildings? Problem-Based Learning Project: Learn how engineers work to reduce earthquake damage to human-made structures in anticipation of the unit capstone project.
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 6.5: Making an Earthquake Shaker — Teacher Guide PDF page 153
- Activity Page 6.6: Making and Evaluating Design Solutions, Part 2 — Teacher Guide PDF page 154
- Activity Page 6.7: Engineering Design Showcase — Teacher Guide PDF page 155
- Activity Page 6.8: Letter to Parents or Community Members — Teacher Guide PDF page 156

Lesson 7: Tsunamis

THE BIG QUESTION

How can communities better protect themselves from tsunamis? Problem-Based Learning Project: Learn about the damage that tsunamis can cause and how communities deal with them in anticipation of the unit capstone project.

Words to know

- **tsunami** — a wave or series of waves caused by displaced water

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 75–82: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 4: “Tsunamis”: PDF pages 25–30. Look at the pictures and maps together.

Talk it over

1. Do earthquakes occur under the ocean?
2. Are there faults in the ocean?
3. What can earthquakes in the ocean cause?
4. What do you think a tsunami is?
5. What do you think the water represents?
6. What do you think the gravel represents?
7. Do you think tsunamis are different from regular waves?
8. Do you think tsunamis can be dangerous?
9. How did the large-scale movement of crustal plates near Japan trigger a series of disastrous events?
10. What are some ways to prevent one event or disaster from turning into many others?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How can communities better protect themselves from tsunamis? Problem-Based Learning Project: Learn about the damage that tsunamis can cause and how communities deal with them in anticipation of the unit capstone project.
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 7.1: Check — Teacher Guide PDF page 157

Lesson 8: Volcanoes

THE BIG QUESTION

Can scientists predict when a volcano is going to erupt?
Problem-Based Learning Project: Learn about the damage that volcanic eruptions can cause and how scientists can predict when they will occur in anticipation of the unit capstone project.

Words to know

- **volcano** — an opening in Earth’s crust through which lava erupts onto the surface
- **lava** — molten material from Earth’s mantle after it has reached Earth’s surface
- **magma** — molten material from Earth’s mantle below Earth’s surface
- **hot spot** — in geology, a plume of magma that causes eruptions through Earth’s crust without plates interacting
- **converging** — moving together
- **diverging** — moving apart
- **seamount** — a mountain emerging from the ocean floor that does not emerge above the surface of the water

Teacher’s lesson plan

Follow the Teacher Guide, PDF pages 83–89: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 5: “Volcanoes”: PDF pages 31–38. Look at the pictures and maps together.

Talk it over

1. What is a volcano?
2. What do you think causes a volcano to erupt?
3. Where do you tend to find most volcanoes?
4. In what ways do volcanoes help maintain Earth’s life cycle?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: Can scientists predict when a volcano is going to erupt? Problem-Based Learning Project: Learn about the damage that volcanic eruptions can cause and how scientists can predict when they will occur in anticipation of the unit capstone project.
- Use one of today’s words in a sentence of your own.

Activity pages

- Activity Page 8.1: Check — Teacher Guide PDF pages 158-159

Lesson 9: Reading Maps of Volcanoes

THE BIG QUESTION

How can you use maps to determine patterns of volcano formations? Problem-Based Learning Project: Learn about how maps can be used to determine where volcanoes will occur in anticipation of the unit capstone project.

Words to know

- **volcano** — an opening in Earth’s crust through which lava erupts onto the surface

Teacher’s lesson plan

Follow the Teacher Guide, PDF pages 90–96: the steps, materials and timing for this lesson.

Talk it over

1. What is a volcano?
2. What are the hazards of volcanic eruptions that travelers should know about?
3. How are volcanoes monitored?
4. How many unmonitored volcanoes does New Mexico have?
5. What is the total number of volcanoes in New Mexico?
6. What patterns do you see in the locations of volcanoes in the United States?
7. How did you use data from the map to explain this?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How can you use maps to determine patterns of volcano formations? Problem-Based Learning Project: Learn about how maps can be used to determine where volcanoes will occur in anticipation of the unit capstone project.
- Use one of today’s words in a sentence of your own.

Activity pages

- Activity Page 9.1: Volcanoes Evaluation Guide — Teacher Guide PDF page 160
- Activity Page 9.2: State-by-State Volcano Data — Teacher Guide PDF pages 161–162
- Activity Page 9.3: Volcanoes Infographic — Teacher Guide PDF page 163
- Activity Page 9.4: Volcanoes Map — Teacher Guide PDF page 164

Lesson 10: Erosion

THE BIG QUESTION

How do communities protect themselves from erosion?
Problem-Based Learning Project: Learn about the effects of slow erosion events and how communities protect themselves from the effects in anticipation of the unit capstone project.

Words to know

- **erosion** — movement of sediment from one location to another
- **sediment** — small pieces of rock or other hard material that has broken down over time
- **weathering** — the process of breaking rock into smaller pieces
- **sinkhole** — a hole in Earth’s surface that develops when the ground collapses into space beneath it
- **agent** — a thing that has a role in producing an effect
- **creep** — to move slowly, often escaping notice
- **survey** — to determine land boundaries

Teacher’s lesson plan

Follow the Teacher Guide, PDF pages 99–105: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 6: “Erosion”: PDF pages 39–46. Look at the pictures and maps together.

Talk it over

1. Where or when have you seen erosion in your own life?
2. What kinds of things do you think cause erosion?
3. How can the sun cause erosion?
4. How can gravity cause erosion?
5. How can the movement of Earth’s crust cause erosion?
6. How can animals cause erosion?
7. How can water cause erosion?
8. What is happening to the ground?
9. Is this an example of erosion or weathering?
10. What was causing this sinkhole?

11. Which model rock was weathered?

12. Why was that rock weathered?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How do communities protect themselves from erosion? Problem-Based Learning Project: Learn about the effects of slow erosion events and how communities protect themselves from the effects in anticipation of the unit capstone project.
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 10.1: Check — Teacher Guide PDF pages 165–166

Lesson 11: Erosion Problems and Solutions

THE BIG QUESTION

How does erosion affect Earth's surface, people, and communities? Problem-Based Learning Project: Learn about the effects of erosion events and how communities protect themselves from the effects in anticipation of the unit capstone project.

Words to know

- **erosion** — movement of sediment from one location to another
- **sediment** — small pieces of rock or other hard material that has broken down over time
- **downstream** — in the direction to which liquid flows
- **upstream** — in the direction from which liquid flows

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 106–112: the steps, materials and timing for this lesson.

Talk it over

1. What are some of the natural hazards your team has already explored?
2. What did you learn in the previous lesson about weathering?
3. What is erosion?
4. What are some examples of how erosion affects people and communities?
5. What was the cause of the erosion?
6. What part of the landscape was eroded?
7. How was this a risk to people?
8. How could the erosion affect wildlife?
9. How did the community solve the problem?
10. In what part of the notebook will you record the data you collect?
11. In what part of the notebook will you practice claim-evidence-reasoning thinking?
12. In what part of the notebook will you make decisions about how you will conduct the investigation?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How does erosion affect Earth's surface, people, and communities? Problem-Based Learning Project: Learn about the

effects of erosion events and how communities protect themselves from the effects in anticipation of the unit capstone project.

- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 11.1: Erosion Investigation Evaluation Guide — Teacher Guide PDF page 167
- Activity Page 11.2: Erosion Investigation Notebook — Teacher Guide PDF pages 168-169
- Activity Page 11.3: Testing Erosion Solutions — Teacher Guide PDF page 170

Lesson 12: Landslides

THE BIG QUESTION

How can communities prepare for landslide hazards?

Problem-Based Learning Project: Learn about the effects of quick-moving erosion events and how communities protect themselves from the effects in anticipation of the unit capstone project.

Words to know

- **landslide** — a form of mass movement in which a large section of a slope slides downhill all at once
- **mass movement** — downhill movement of a mass of earth surface material
- **debris** — the remains of something broken apart

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 113–119: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 7: “Landslides”: PDF pages 47–52. Look at the pictures and maps together.

Talk it over

1. What do you think a quick erosion event is?
2. What might be an example of a quick erosion event?
3. What do you think makes a landslide different from the slow downhill erosion of sediment on a mountainside?
4. Why would a landslide be dangerous both at the top and at the bottom of the slope where the landslide is occurring?
5. How do you think melting snow and ice may have contributed to this rockslide?
6. What is the overall effect of carving a slope into a steplike series of flat surfaces?
7. What is the problem with this approach?
8. Why can't the normal slope be as tall as the one with terraces?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How can communities prepare for landslide hazards? Problem-Based Learning Project: Learn about the effects of quick-moving erosion events and how communities protect themselves from the effects in anticipation of the unit capstone project.

- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 12.1: Check — Teacher Guide PDF pages 171-172

Lesson 13: Landslide Problems and Solutions

THE BIG QUESTION

How can people protect themselves from the hazards of landslides? Problem-Based Learning Project: Learn more about the effects of quick-moving erosion events and how communities protect themselves from the effects in anticipation of the unit capstone project.

Words to know

- **design solution** — an engineered remedy to a want or need

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 120–126: the steps, materials and timing for this lesson.

Talk it over

1. In what ways are landslides a problem for people?
2. Who might be most affected by the hazards of landslides?
3. How do engineers design solutions to problems such as landslides?
4. What are some ways that engineers try to prevent landslides?
5. What is one way engineers try to prevent landslides from destroying humanmade structures on slopes?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How can people protect themselves from the hazards of landslides? Problem-Based Learning Project: Learn more about the effects of quick-moving erosion events and how communities protect themselves from the effects in anticipation of the unit capstone project.
- Use one of today's words in a sentence of your own.

UNIT REVIEW

Unit review and assessment

- Activity page answer key (for the teacher): Teacher Guide PDF pages 185–189
- Activity Page UC.1 — Teacher Guide PDF page 180
- Activity Page UC.2 — Teacher Guide PDF page 181
- Activity Page UC.3 — Teacher Guide PDF page 182
- Activity Page UC.4 — Teacher Guide PDF page 184

WORDS QUIZ

Processes That Shape Earth

Name: _____ Date: _____

Circle the letter of the best answer.

1. Which word means “the remains of an organism preserved in rock form”?
 - a) metamorphic rock
 - b) fossil
 - c) tsunami
 - d) lava
2. Which word means “downhill movement of a mass of earth surface material”?
 - a) sinkhole
 - b) lava
 - c) weathering
 - d) mass movement
3. Which word means “molten material from Earth’s mantle below Earth’s surface”?
 - a) magma
 - b) igneous rock
 - c) plate
 - d) tsunami
4. Which word means “an opening in Earth’s crust through which lava erupts onto the surface”?
 - a) earthquake
 - b) sedimentary rock
 - c) igneous rock
 - d) volcano
5. Which word means “rock that forms when igneous or sedimentary rock is placed under tremendous heat or pressure”?
 - a) volcano
 - b) mass movement
 - c) metamorphic rock
 - d) igneous rock
6. Which word means “a wave or series of waves caused by displaced water”?
 - a) tsunami
 - b) earthquake
 - c) erosion
 - d) fossil

- 7.** Which word means “movement of sediment from one location to another”?
- a) erosion
 - b) weathering
 - c) hot spot
 - d) magnitude
- 8.** Which word means “rock made of sediment compacted together”?
- a) metamorphic rock
 - b) geologist
 - c) sedimentary rock
 - d) landslide
- 9.** Which word means “molten material from Earth’s mantle after it has reached Earth’s surface”?
- a) lava
 - b) landslide
 - c) mass movement
 - d) tsunami
- 10.** Which word means “the process of breaking rock into smaller pieces”?
- a) landslide
 - b) earthquake
 - c) sinkhole
 - d) weathering
- 11.** Which word means “small pieces of rock or other hard material that has broken down over time”?
- a) sinkhole
 - b) sediment
 - c) lava
 - d) geologist
- 12.** Which word means “the size or extent of an earthquake”?
- a) landslide
 - b) earthquake
 - c) magnitude
 - d) sedimentary rock

Answers

Lesson 1: Effects of Earth's Changing Surface

1. **What changes can you identify in the video?**

Answers will vary; however, each should include a description of what has changed and how. If students begin to discuss why these changes occur, acknowledge their ideas, and write their thoughts in a prominent place on the board or chart paper, saving these ideas for later lessons.

2. **What evidence was there that energy was transferred?**

Answers will vary, depending on the video. For example, in the sandstorm video, each moving grain of sand carried energy, as indicated by each grain changing position.

3. **How could these changes affect objects or structures made by people?**

Examples: The moving sand could wear the paint off a car or house; earthquakes can cause even large buildings to collapse; etc.

4. **What information will be on the presentation your team produces?**

The causes and effects of the natural hazard for my community

5. **How should you behave when presenting to your audience?**

Speak loudly and clearly, using formal language, and look at my audience

6. **How should you work with your team?**

Work well, with all members getting to participate equally

Lesson 2: Earth's Layers and Moving Crust

1. **What are some changes on Earth's surface that result from movements of Earth's crust or movement of material through the crust?**

Earthquakes, tsunamis, volcanic eruptions, landslides

2. **How is a mountain range evidence of Earth's crust moving over time?**

Some mountain ranges are formed when the crust crumples.

3. **What is a geologist?**

A scientist who studies what Earth is made of and how it changes over time

4. **Why did it matter that the fossilized organisms were animals that were not strong swimmers?**

It suggests these organisms could not have traveled between continents that are now far apart. Either the continents were close together, or something else carried the organisms around the planet.

5. **Why are the fossils found on Antarctica of particular significance?**

Antarctica has a frigid climate that does not support plants or many animals. The fact that it had plants and animals like the other continents in the diagram suggests all of the continents were together in a more tropical region of Earth.

6. **Do the shapes of the continents around the world suggest any patterns?**

Yes, it looks like they could fit together like puzzle pieces.

7. **Are there any patterns when it comes to fossils?**

Yes, some fossils are found in certain parts of the world, even if they don't naturally belong there.

Lesson 3: Modeling Earth's Layers

1. **If we are going to make models of Earth, should the models be smaller or larger than the real thing?**

Smaller

2. **Why should they be smaller?**

Because Earth is too big to see all at once, so the only way to look at all its parts is to make it smaller

3. **Which two layers are the closest in thickness?**

Inner core and outer core

4. **Which layer is the thickest?**

Mantle

5. **Which layer is the thinnest?**

Crust

Lesson 4: Evidence of Earth-Shaping Processes

1. **What is an example of a process that helps shape Earth's surface?**

Erosion, earthquake effects, plate movements

2. **What is an example of a piece of evidence that an Earth-shaping process has occurred?**

A new landform is present; a landform is a different size or shape.

3. **Which type of rock do you think was the first to be made on Earth? Why?**

Igneous. Both metamorphic and sedimentary rock form from other rocks. Igneous is made directly from cooled material from Earth's interior, so it must have been the first type of rock.

4. **Which rock type is made from other rocks that are put under tremendous pressure and heat?**

Metamorphic

5. **Granite from a mountain is worn away by natural forces. It accumulates downhill as sand and gravel. Over time, substances carried by water and the weight of the material cement the particles together. What kind of rock has been made?**

Sedimentary

6. **What is one way scientists might have been able to locate the crater?**

Sonar, satellite imaging

7. **How have scientists been able to come up with a date for when the asteroid struck Earth?**

They use techniques that determine how many of certain types of particles are in the material. This can be used to determine age [radiometric dating].

8. **What might be some simple technologies that scientists use to help them when constructing an explanation for how and when the dinosaurs went extinct?**

Writing utensils, computers, and recording devices are just a few examples.

9. **Why is it important for satellite images or images taken by drones or other aircraft to be recorded along with the locations of the satellites or aircraft?**

Without knowing where the image was taken, it's just an image. It only has meaning if it can be aligned with the correct, actual location on Earth.

10. **Why do you think modern science and surveying favor the use of satellites and drones over hand-drawn maps?**

Real images such as photographs are more accurate than drawings. Satellites and drones can record thousands of images without having anyone up in the air or moving around Earth's surface in the time it would take to measure and record things using hand tools.

Lesson 5: Earthquakes

1. **What are some of the effects of earthquakes that you have heard of in the news, seen in a movie, or experienced yourself?**

The ground shakes a lot, buildings are damaged, gas lines rupture, fires break out, injuries and deaths occur.

2. **What do you think causes earthquakes?**

Movement of Earth's plates, volcanic eruptions

3. **Where do you think earthquakes most often occur?**

Near volcanoes, where plates meet

4. **Why is it easier to maintain your footing and balance when a surface is solid?**

Hard surfaces are easier to grip.

5. **Why would soil that is wet with water be more vulnerable to an earthquake's vibrations than a thick slab of rock?**

The particles aren't packed as tightly. The water is mixed with the particles of soil, and everything is looser and able to vibrate and move more easily.

6. **How much more energy would be released by a magnitude-9 earthquake than a magnitude-7 earthquake?**

About one thousand times more energy

7. **What is an earthquake?**

An event that makes the ground shake or move

8. **What does seismic mean?**

The type of waves related to earthquakes or vibrations in Earth's crust

9. **What can cause earthquakes?**

The movement of Earth's plates against each other

10. **Where do most large earthquakes occur?**

Near volcanoes or by where plates meet

11. How do landslides happen?

Landslides can be caused when the soil becomes full of water or when earthquakes shake the ground loose.

12. What is the tool called that measures earthquakes?

Seismograph

13. Geologists who study earthquakes measure their strength on a scale of what?

Magnitude

14. What can people do to live safely in areas that have earthquakes?

Have alarm systems to warn of earthquakes, build in areas where earthquake damage is less likely, design buildings to withstand earthquake damage

Lesson 6: Earthquake Problems and Solutions

1. How do earthquakes affect Earth's surface?

The soil can shift or slide. Solid rocks move up and down or side to side and can fracture. Landslides can form. Large water waves can occur from the shaking of rocks or landslides falling into the ocean. This displaces water, which can cause large water waves that can destroy structures when they reach land elsewhere.

2. How do earthquakes affect people?

Roadways and buildings can be damaged and even collapse. People can be injured or killed by falling building materials, landslides, or tsunamis.

3. What do people do to reduce the impacts of Earth's natural processes?

They design buildings that resist the motion of earthquakes so that the buildings do not fall down.

Lesson 7: Tsunamis

1. Do earthquakes occur under the ocean?

Yes

2. Are there faults in the ocean?

Yes

3. What can earthquakes in the ocean cause?

Large waves/tsunamis

4. What do you think a tsunami is?

A large wave

5. What do you think the water represents?

The ocean

6. What do you think the gravel represents?

The land, shore, beach

7. Do you think tsunamis are different from regular waves?

Yes

8. Do you think tsunamis can be dangerous?

Yes

9. **How did the large-scale movement of crustal plates near Japan trigger a series of disastrous events?**

It caused an earthquake that did some damage by itself, but it also triggered a tsunami that flooded the coast, destroyed property, killed people, and disabled a nuclear power plant to the point that its reactors melted down.

10. **What are some ways to prevent one event or disaster from turning into many others?**

There should be backup systems in place for things such as nuclear power plants or even backups for the backups. When it takes just one thing to go wrong and create a new disaster, that's a problem.

Lesson 8: Volcanoes

1. **What is a volcano?**

A formation that erupts; a formation that spews lava

2. **What do you think causes a volcano to erupt?**

Earthquakes, plates moving, buildup and pressure of magma

3. **Where do you tend to find most volcanoes?**

In the ocean as islands, near the edges of continents

4. **In what ways do volcanoes help maintain Earth's life cycle?**

They create a cyclical process that helps form new structures to support life in new places.

Lesson 9: Reading Maps of Volcanoes

1. **What is a volcano?**

An opening in Earth's crust through which lava erupts onto the surface

2. **What are the hazards of volcanic eruptions that travelers should know about?**

People can be injured or killed by explosions, hot flowing lava, falling debris, or tsunamis.

3. **How are volcanoes monitored?**

With devices that can sense the ground tilting, analyze gases coming from the ground, or detect earthquakes

4. **How many unmonitored volcanoes does New Mexico have?**

Three

5. **What is the total number of volcanoes in New Mexico?**

Three

6. **What patterns do you see in the locations of volcanoes in the United States?**

Most volcanoes are in states touching the Pacific Ocean.

7. **How did you use data from the map to explain this?**

We checked every state on the map and wrote down the number of volcanoes in each category. Then we added up the number to find a total for each state.

Lesson 10: Erosion

1. **Where or when have you seen erosion in your own life?**
Sand moved at beach, soil washed away during rain
2. **What kinds of things do you think cause erosion?**
Wind, water, things that dig/ burrow, earthquakes
3. **How can the sun cause erosion?**
Sunlight leads to wind, which can blow dirt around.
4. **How can gravity cause erosion?**
Earth materials will be pulled down by gravity.
5. **How can the movement of Earth's crust cause erosion?**
The movement will cause rocks to move around like in landslides.
6. **How can animals cause erosion?**
They can move dirt and rocks around when they make their homes.
7. **How can water cause erosion?**
It will move dirt downhill.
8. **What is happening to the ground?**
It is falling apart; it is sinking.
9. **Is this an example of erosion or weathering?**
Erosion
10. **What was causing this sinkhole?**
Water
11. **Which model rock was weathered?**
The one with the water balloon
12. **Why was that rock weathered?**
Water expands when it freezes, and the expansion forced apart the "rock" around it.

Lesson 11: Erosion Problems and Solutions

1. **What are some of the natural hazards your team has already explored?**
Earthquakes, tsunamis, and volcanic eruptions
2. **What did you learn in the previous lesson about weathering?**
Weathering is the breaking of rock into smaller pieces. Weathering is caused by various agents.
3. **What is erosion?**
The transport of weathered sediments away from a location
4. **What are some examples of how erosion affects people and communities?**
Highways can be buried so that people cannot travel on them. Houses can be destroyed when they fall into sinkholes. Topsoil can be carried away from farms, making it impossible to grow crops. Buildings along beaches can collapse.
5. **What was the cause of the erosion?**
Moving water; a windstorm followed by very heavy rainfall and flooding
6. **What part of the landscape was eroded?**
The banks of a stream/creek

7. **How was this a risk to people?**

The stream bank lost soil, and a sewer line was exposed. If more soil were lost, the pipe could break. Then, sewer waste would pollute the stream. If the stream overflowed, the sewage could come near people's homes and a children's playground.

8. **How could the erosion affect wildlife?**

A break in the sewer pipe could harm salmon and other fish living in the stream.

9. **How did the community solve the problem?**

Money was found to repair the stream bank by placing pieces of dead trees, rocks, and plantings along the stream bank.

10. **In what part of the notebook will you record the data you collect?**

In the Observation/Measurements section in the middle

11. **In what part of the notebook will you practice claim-evidence-reasoning thinking?**

In the Explanation section at the end

12. **In what part of the notebook will you make decisions about how you will conduct the investigation?**

In the Planning section at the beginning

Lesson 12: Landslides

1. **What do you think a quick erosion event is?**

When a piece of land breaks apart from other land very quickly

2. **What might be an example of a quick erosion event?**

Possible answers: landslide, mudslide

3. **What do you think makes a landslide different from the slow downhill erosion of sediment on a mountainside?**

It happens faster, and a lot of material moves all at once.

4. **Why would a landslide be dangerous both at the top and at the bottom of the slope where the landslide is occurring?**

At the top, the material you're on can slip out from under you and cause you to fall with it. At the bottom, you can be buried or knocked over by the falling material.

5. **How do you think melting snow and ice may have contributed to this rockslide?**

It weathered and eroded the area, making the steep slope that was then vulnerable to further weathering and erosion.

6. **What is the overall effect of carving a slope into a steplike series of flat surfaces?**

More of the surface area of the slope is flat.

7. **What is the problem with this approach?**

For every flat surface, there is a vertical wall that needs to support it.

8. **Why can't the normal slope be as tall as the one with terraces?**

There isn't enough support. The terraced slope has flat surfaces whose sediment is

not being pulled downhill like it would be on the other hill, and the supporting walls keep those flat levels in place.

Lesson 13: Landslide Problems and Solutions

1. **In what ways are landslides a problem for people?**
They damage roadways and buildings and can injure people.
2. **Who might be most affected by the hazards of landslides?**
Anyone who lives or travels at the base of a slope that is prone to landslides
3. **How do engineers design solutions to problems such as landslides?**
They learn about the causes of landslides. They come up with possible ideas to prevent them. They do investigations to test their ideas.
4. **What are some ways that engineers try to prevent landslides?**
Planting certain types of vegetation on slopes; building retaining walls
5. **What is one way engineers try to prevent landslides from destroying humanmade structures on slopes?**
Attaching the structures' foundations to the rock beneath the dirt on a slope

Unit quiz key

1. b 2. d 3. a 4. d 5. c 6. a 7. a 8. c 9. a 10. d 11. b 12. c