

Grade 5 Science

Unit 3: Modeling Earth's Systems

13 lessons and a unit quiz. Use this pack with the **Modeling Earth's Systems 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: Earth's Spheres	—	AP 1.1
☐	Lesson 2: The Hydrosphere	PDF pages 7-14	AP 2.1, AP 2.2
☐	Lesson 3: Distribution of Earth's Water	—	AP 3.1, AP 3.2, AP 3.3, AP 3.4
☐	Lesson 4: The Geosphere	PDF pages 15-22	AP 4.1, AP 4.2
☐	Lesson 5: The Atmosphere	PDF pages 23-28	AP 5.1, AP 5.2
☐	Lesson 6: The Biosphere	PDF pages 29-34	AP 6.1, AP 6.2
☐	Lesson 7: Sphere Model Fair Preview	—	AP 7.1
☐	Lesson 8: Hydrosphere Interactions	PDF pages 35-40	AP 8.1, AP 8.2
☐	Lesson 9: Geosphere Interactions	PDF pages 41-48	AP 9.1, AP 9.2
☐	Lesson 10: Atmosphere Interactions	PDF pages 49-56	AP 10.1, AP 10.2
☐	Lesson 11: Biosphere Interactions	PDF pages 57-64	AP 11.1, AP 11.2
☐	Lesson 12: Modeling Interaction Between Two Spheres	—	AP 12.1, AP 12.2, AP 12.3
☐	Lesson 13: The Search for Earth II	PDF pages 65-70	—
☐	Unit review and assessment	—	AP UR.1, AP UR.2
☐	Words quiz	—	—

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

Lesson 1: Earth's Spheres

THE BIG QUESTION

What are Earth's spheres?

Words to know

- **hydrosphere** — the Earth system that contains all of the water on Earth
- **geosphere** — the Earth system that contains all the rocky layers of Earth
- **atmosphere** — the Earth system that is composed of all the gases that surround Earth
- **biosphere** — the Earth system that is composed of all the living things on Earth
- **dynamic** — constantly changing
- **sphere** — a system
- **system** — a set of parts that work together

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 29–33: the steps, materials and timing for this lesson.

Check for understanding

- Answer the Big Question in a sentence or two: What are Earth's spheres?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 1.1: Observe Locally, Think Globally — Teacher Guide PDF page 115

Lesson 2: The Hydrosphere

THE BIG QUESTION

What is the hydrosphere?

Words to know

- **salt water** — water that contains dissolved salt
- **fresh water** — naturally occurring water that contains little or no salt
- **groundwater** — water stored in the spaces between materials beneath Earth's surface
- **reservoir** — a place where water collects
- **water cycle** — the dynamic movement of water on, below, and above Earth's surface
- **dynamic** — constantly changing
- **sphere** — a system
- **system** — a set of parts that work together

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 34–41: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 1: "The Hydrosphere": PDF pages 7–14. Look at the pictures and maps together.

Talk it over

1. clear drinking glass or beaker Activity Pages Where Is Water in the Hydrosphere?
2. What parts of the hydrosphere did you observe when you went outdoors into the local environment?
3. to make some inferences about the closed system. Where did the water on the outside of the glass come from if the system is closed/sealed?
4. a volunteer to talk the rest of the class through the water cycle diagram. Ask: Why is this model called a cycle?
5. Collect the completed Where Is Water in the Hydrosphere?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What is the hydrosphere?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 2.1: Where Is Water in the Hydrosphere? — Teacher Guide PDF page 116

- Activity Page 2.2: Check — Teacher Guide PDF page 117

Lesson 3: Distribution of Earth's Water

THE BIG QUESTION

How is water distributed on Earth?

Words to know

- **hydrosphere** — the Earth system that contains all of the water on Earth
- **salt water** — water that contains dissolved salt
- **fresh water** — naturally occurring water that contains little or no salt
- **groundwater** — water stored in the spaces between materials beneath Earth's surface
- **reservoir** — a place where water collects
- **interact** — to affect and be affected by

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 42–46: the steps, materials and timing for this lesson.

Talk it over

1. Where is most of Earth's water located?
2. In what other places can water be found?
3. What is this a model of?
4. What does your model show about the hydrosphere?
5. How can you arrange the bottle and cups to best show relationships?
6. What doesn't your model show about the hydrosphere?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How is water distributed on Earth?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 3.1: Model Earth's Water Supply — Teacher Guide PDF page 118
- Activity Page 3.2: Graph Earth's Water Supply — Teacher Guide PDF pages 119–120
- Activity Page 3.3: Write a Letter About Water — Teacher Guide PDF page 121
- Activity Page 3.4: Evaluation Guide — Teacher Guide PDF page 122

Lesson 4: The Geosphere

THE BIG QUESTION

What is the geosphere?

Words to know

- **geosphere** — the Earth system that contains all the rocky layers of Earth
- **rock cycle** — the process through which rock changes form through igneous, sedimentary, and metamorphic types
- **sediments** — small particles of rock
- **seismic wave** — a disturbance caused by energy traveling through Earth's crust
- **sphere** — a system

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 47–53: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 2: “The Geosphere”: PDF pages 15–22. Look at the pictures and maps together.

Talk it over

1. What parts of the geosphere did you observe in the video?
2. What other parts of the geosphere do you think exist?
3. What questions do you have about Earth's geosphere?
4. What melted rock did you see in the video?
5. Why do you think dynamic is a good adjective for the geosphere?
6. How is this cut piece of fruit a good model of parts of the geosphere?
7. What doesn't the model show?
8. Does this model of the layers of the geosphere show a small-scale phenomenon or large-scale phenomenon?
9. What are two ways igneous rocks form?
10. What is a way sedimentary rock forms?
11. How does the geosphere interact with the hydrosphere in creating sedimentary rock?
12. How do metamorphic rocks form?
13. What are the parts of this system?
14. What do the process arrows labeled “Breaking down” mean? Breaking down into what?

15. Where can people see melting rock?
16. Do you think sedimentary rock, like the rocks in the photo on page 13, can break down into sediments? How would you add to the diagram to show this process?
17. Why is this model called a cycle?
18. Would you say the rock cycle is a large- or small-scale system?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What is the geosphere?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 4.1: Fruit Model of the Geosphere — Teacher Guide PDF page 123
- Activity Page 4.2: Check — Teacher Guide PDF page 124

Lesson 5: The Atmosphere

THE BIG QUESTION

What is the atmosphere?

Words to know

- **atmosphere** — the Earth system that is composed of all the gases that surround Earth
- **air pressure** — the weight of air pressing on all things beneath and within it
- **air mass** — a large body of air with similar temperature, air pressure, and moisture throughout
- **altitude** — elevation above sea level

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 54–59: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 3: “The Atmosphere”: PDF pages 23–28. Look at the pictures and maps together.

Talk it over

1. In what states of matter does the hydrosphere exist?
2. In which of these states does most of the hydrosphere exist?
3. In what states of matter does the geosphere exist?
4. In which of these states does most of the geosphere exist?
5. In which state of matter do you predict the atmosphere exists?
6. What questions do you have about Earth's atmosphere?
7. What does the model in the form of a diagram show that the basketball and pillowcase did not show?
8. What does the basketball and pillowcase model show that the diagram does not show?
9. What causes air pressure?
10. What is the relationship between air pressure and altitude?
11. How do air masses produce weather?
12. Which two systems interact when air supports life?
13. In which part of the atmosphere is there enough air for living things to use?
14. How do living things depend on the atmosphere for protection?
15. Where is the atmosphere located in relationship to the geosphere?

16. What is the atmosphere made of?

17. Why can only the lowest layer of the atmosphere support life and produce weather?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What is the atmosphere?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 5.1: Modeling Air Particles in the Atmosphere — Teacher Guide PDF page 125
- Activity Page 5.2: Modeling Recording Pages — Teacher Guide PDF pages 126–132

Lesson 6: The Biosphere

THE BIG QUESTION

What is the biosphere?

Words to know

- **biosphere** — the Earth system that is composed of all the living things on Earth
- **species** — a group of organisms of the same type that are capable of reproducing together
- **biome** — a large region on Earth with a specific climate that contains certain species
- **extinct** — having no more living members old-faced words and phrases are del for students during instruction r terms do not have specific page ted drill or memorization
- **taxonomy** — the branch of science that names and groups organisms

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 60–66: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 4: “The Biosphere”: PDF pages 29–34. Look at the pictures and maps together.

Talk it over

1. Which part of Earth did the basketball represent in the model?
2. Which part of Earth did the pillowcase represent in the model?
3. How does the plastic wrap compare to the pillowcase used to model the atmosphere?
4. What does the model show about a comparison between the biosphere and atmosphere?
5. Are there more species discovered and named or yet to be discovered and named?
6. There are over 300,000,000 people living in the United States. How many species could each person discover and name?
7. Where on Earth are all of the six biomes named found?
8. In the desert shown in the photo, how does the biosphere interact with the hydrosphere?
9. In the tundra shown in the photo, how does the biosphere interact with the geosphere?
10. What are two ways described here in the chapter that the biosphere changes?
11. What are some of the changes that result in species becoming extinct?
12. Which of the changes discussed on this page are an example of an interaction within the parts of one Earth system?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: What is the biosphere?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 6.1: Modeling the Location of the Biosphere — Teacher Guide PDF page 133
- Activity Page 6.2: Check — Teacher Guide PDF page 134

Lesson 7: Sphere Model Fair Preview

THE BIG QUESTION

How can we model interactions between Earth systems?

Words to know

- **sphere** — a system
- **system** — a set of parts that work together

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 69–75: the steps, materials and timing for this lesson.

Talk it over

1. Which Earth spheres can you identify as being involved in a landslide?
2. How does a landslide represent these spheres interacting?
3. Does a landslide also involve an interaction with the biosphere? Why or why not?
4. Do you think a landslide is an example of an interaction that brings about a quick change or a slow change?
5. Which Earth spheres can you identify as being involved in a volcanic eruption?
6. How does a volcanic eruption represent these spheres interacting?
7. Does an eruption also involve an interaction with the biosphere? Why or why not?
8. Do you think an eruption is an example of an interaction that brings about a quick change or a slow change?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How can we model interactions between Earth systems?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 7.1: Types of Models — Teacher Guide PDF page 135

Lesson 8: Hydrosphere Interactions

THE BIG QUESTION

How does the hydrosphere interact with Earth's other spheres?

Words to know

- **weathering** — the process of breaking down rock into smaller pieces
- **erosion** — the movement of sediment

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 76–81: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 5: “Hydrosphere Interactions”: PDF pages 35–40. Look at the pictures and maps together.

Talk it over

1. What sphere is represented by an iceberg?
2. What sphere is represented by a colony of ants?
3. What sphere is represented by the sandy soil in which the ants live?
4. In what sphere do you find wind and air masses of different temperatures?
5. Why did earthworms emerge from the soil during the rainstorm?
6. What evidence did you read of water moving back to the atmosphere?
7. What evidence was there of the hydrosphere affecting the geosphere?
8. What evidence was there of the biosphere being helped by the hydrosphere?
9. What happened to the salt?
10. Does that mean the salt has gone away?
11. How do you think you could see the salt again?
12. How does the biosphere pass water back to the atmosphere?
13. What two forms of water can travel from the atmosphere to the geosphere during a storm?
14. How can water weather and erode the geosphere?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How does the hydrosphere interact with Earth's other spheres?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 8.1: Hydrosphere Interactions — Teacher Guide PDF page 136
- Activity Page 8.2: Check — Teacher Guide PDF page 137

Lesson 9: Geosphere Interactions

THE BIG QUESTION

How does the geosphere interact with Earth's other spheres?

Words to know

- **rain shadow** — a dry region on one side of a mountain that results from precipitation on the other side of the mountain removing moisture from clouds
- **aquifer** — an underground region of rocky material containing water that can be drawn out through a well
- **water table** — the upper surface or level of groundwater
- **soil** — the top layer of Earth's land that often has a mix of organic and inorganic material
- **inorganic** — describing material that does not come from living things
- **organic** — describing material that comes from living things

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 82–88: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 6: "Geosphere Interactions": PDF pages 41–48. Look at the pictures and maps together.

Talk it over

1. What is the geosphere?
2. What can the geosphere provide to other spheres if it is warm?
3. What might this volcano do to the forest?
4. What could the gases released by the volcano do to the atmosphere over the forest?
5. What can happen when a volcano erupts underwater but close to the water's surface?
6. How is a volcanic island an interaction between the geosphere and both the hydrosphere and the biosphere?
7. What do you think will happen to the air as it moves toward the mountains, and how will that affect the land on the other side of the mountains?
8. Which is more likely to get high precipitation, land at low elevation or land at high elevation?
9. If North America continues to move mostly west and Asia continues to move mostly east, what will eventually happen?
10. How does the geosphere play a role in storing the freshwater portion of the hydrosphere?

11. How does topography affect the atmosphere?
12. What does the geosphere provide to the biosphere in chemical terms?
13. What does the geosphere physically provide to the biosphere?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How does the geosphere interact with Earth's other spheres?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 9.1: Geosphere Interactions — Teacher Guide PDF page 138
- Activity Page 9.2: Check — Teacher Guide PDF page 139

Lesson 10: Atmosphere Interactions

THE BIG QUESTION

How does the atmosphere interact with Earth's other spheres?

Words to know

- **atmosphere** — the Earth system that is composed of all the gases that surround Earth
- **deposition** — the dropping of sediment in a new location
- **cellular respiration** — the chemical process inside cells that releases energy from food
- **respiration** — the exchange of gases with the environment

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 89–94: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 7: “Atmosphere Interactions”: PDF pages 49–56. Look at the pictures and maps together.

Talk it over

1. What kinds of energy transfers occur in the atmosphere, the geosphere, and the hydrosphere?
2. What does heat do to the matter that makes up the different spheres?
3. What is the main source of energy that causes the atmosphere to change?
4. Where is the atmosphere compared to the other spheres?
5. What do you think the atmosphere does in terms of allowing in or blocking solar energy to Earth's systems?
6. What is a medium?
7. How is Earth's atmosphere a medium?
8. What is the difference between the Sahara dust being blown from Africa to the Americas and a few grains of sand blown across a sidewalk? What's the same?
9. Why is wind carrying sand more abrasive and more likely to cause erosion of the geosphere than wind that is not carrying anything?
10. Why does the pattern and direction of the dunes' shapes look similar to ocean waves?
11. What happens to the geosphere if more of the sea ice, ice caps, glaciers, and snow of Earth's polar regions melts?

12. How will a more exposed geosphere affect the rate of melting and heating in the hydrosphere and atmosphere?
13. What are some surface features made of water that could not occur without the help of the atmosphere?
14. What about groundwater?
15. How do plants and animals interact with oxygen and carbon dioxide in the atmosphere?
16. How could the biosphere counteract or make up for the amount of carbon that human activities are releasing into the atmosphere?
17. What kind of evidence would you look for to determine whether the biosphere is in fact keeping up with the amount of carbon we are emitting into the atmosphere?
18. How does the atmosphere play a role in distributing the hydrosphere?
19. What does the atmosphere provide to the biosphere?
20. How does the atmosphere shape the geosphere in chemical terms?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How does the atmosphere interact with Earth's other spheres?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 10.1: Atmosphere Interactions — Teacher Guide PDF page 140
- Activity Page 10.2: Atmosphere Interactions Crossword Puzzle — Teacher Guide PDF page 141

Lesson 11: Biosphere Interactions

THE BIG QUESTION

How does the biosphere interact with Earth's other spheres?

Words to know

- **biosphere** — the Earth system that is composed of all the living things on Earth
- **organic** — describing material that comes from living things
- **toxin** — a substance that is harmful or fatal to an organism
- **transpiration** — the release of water vapor from the leaves of plants tropo-, prefix relating to the Greek word for change (Weather occurs in the troposphere and is constantly changing.)

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 95–99: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 8: “Biosphere Interactions”: PDF pages 57–64. Look at the pictures and maps together.

Talk it over

1. What kinds of energy does the biosphere need?
2. When a tree falls and breaks down, what kinds of matter are cycled back into the other spheres?
3. Where is the biosphere compared to the other spheres?
4. What does the biosphere do that affects where the hydrosphere is?
5. What does the biosphere do that affects what's in the hydrosphere?
6. How does the biosphere interact with the atmosphere?
7. What are two different ways the biosphere affects the hydrosphere?
8. How does the biosphere shape the geosphere?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: How does the biosphere interact with Earth's other spheres?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 11.1: Biosphere Interactions — Teacher Guide PDF page 143
- Activity Page 11.2: Check — Teacher Guide PDF page 144

Lesson 12: Modeling Interaction Between Two Spheres

THE BIG QUESTION

How can I model interactions between Earth's spheres?

Words to know

- **sphere** — a system
- **system** — a set of parts that work together

Teacher's lesson plan

Follow the Teacher Guide, PDF pages 100–107: the steps, materials and timing for this lesson.

Check for understanding

- Answer the Big Question in a sentence or two: How can I model interactions between Earth's spheres?
- Use one of today's words in a sentence of your own.

Activity pages

- Activity Page 12.1: Model Planning — Teacher Guide PDF pages 145–147
- Activity Page 12.2: Earth Interactions Take-Home Letter — Teacher Guide PDF pages 148–149
- Activity Page 12.3: Model Analysis — Teacher Guide PDF page 150

Lesson 13: The Search for Earth II

THE BIG QUESTION

Is it possible that there is another planet somewhere that has the right combination of features to support life?

Words to know

- **hydrosphere** — the Earth system that contains all of the water on Earth
- **salt water** — water that contains dissolved salt
- **fresh water** — naturally occurring water that contains little or no salt
- **groundwater** — water stored in the spaces between materials beneath Earth's surface
- **reservoir** — a place where water collects
- **water cycle** — the dynamic movement of water on, below, and above Earth's surface
- **geologic** — relating to Earth's rocky inner and outer features
- **geosphere** — the Earth system that contains all the rocky layers of Earth
- **rock cycle** — the process through which rock changes form through igneous, sedimentary, and metamorphic types
- **atmosphere** — the Earth system that is composed of all the gases that surround Earth
- **air pressure** — the weight of air pressing on all things beneath and within it
- **air mass** — a large body of air with similar temperature, air pressure, and moisture throughout
- **biosphere** — the Earth system that is composed of all the living things on Earth
- **biodiversity** — the variety of species on Earth or in any one environment on Earth
- **species** — a group of organisms of the same type that are capable of reproducing together
- **biome** — a large region on Earth with a specific climate that contains certain species
- **weathering** — the process of breaking down rock into smaller pieces
- **erosion** — the movement of sediment
- **rain shadow** — a dry region on one side of a mountain that results from precipitation on the other side of the mountain removing moisture from clouds
- **aquifer** — an underground region of rocky material containing water that can be drawn out through a well
- **water table** — the upper surface or level of groundwater
- **soil** — the top layer of Earth's land that often has a mix of organic and inorganic material

- **deposition** — the dropping of sediment in a new location

Teacher’s lesson plan

Follow the Teacher Guide, PDF pages 108–112: the steps, materials and timing for this lesson.

Read

Read Student Reader, Chapter 9: “The Search for Earth II”: PDF pages 65–70. Look at the pictures and maps together.

Talk it over

1. Why do you think the ocean was the hardest biome for the people in Biosphere 2 to maintain?
2. What are the different biomes in Biosphere 2?
3. What is the greatest takeaway from the Kepler mission?
4. What is TESS?
5. How does TESS differ from Kepler?

Answers are at the back of this pack.

Check for understanding

- Answer the Big Question in a sentence or two: Is it possible that there is another planet somewhere that has the right combination of features to support life?
- Use one of today’s words in a sentence of your own.

UNIT REVIEW

Unit review and assessment

- Unit Assessment (print for your student): Teacher Guide PDF pages 154–159
- How to mark it (for the teacher): Teacher Guide PDF pages 164–165
- Activity page answer key (for the teacher): Teacher Guide PDF pages 160–163
- Activity Page UR.1: Vocabulary Crossword Puzzle — Teacher Guide PDF page 151
- Activity Page UR.2: Vocabulary Review — Teacher Guide PDF page 153

WORDS QUIZ

Modeling Earth's Systems

Name: _____ Date: _____

Circle the letter of the best answer.

1. Which word means “an underground region of rocky material containing water that can be drawn out through a well”?
 - a) water table
 - b) atmosphere
 - c) geologic
 - d) aquifer
2. Which word means “the Earth system that contains all of the water on Earth”?
 - a) fresh water
 - b) air mass
 - c) biome
 - d) hydrosphere
3. Which word means “the Earth system that is composed of all the gases that surround Earth”?
 - a) water table
 - b) biome
 - c) atmosphere
 - d) geosphere
4. Which word means “water that contains dissolved salt”?
 - a) atmosphere
 - b) salt water
 - c) fresh water
 - d) biosphere
5. Which word means “the dropping of sediment in a new location”?
 - a) deposition
 - b) biosphere
 - c) fresh water
 - d) erosion
6. Which word means “the process through which rock changes form through igneous, sedimentary, and metamorphic types”?
 - a) water table
 - b) air mass
 - c) biome
 - d) rock cycle

- 7.** Which word means “relating to Earth’s rocky inner and outer features”?
- a) groundwater
 - b) fresh water
 - c) geologic
 - d) aquifer
- 8.** Which word means “the top layer of Earth’s land that often has a mix of organic and inorganic material”?
- a) aquifer
 - b) rain shadow
 - c) deposition
 - d) soil
- 9.** Which word means “the process of breaking down rock into smaller pieces”?
- a) weathering
 - b) reservoir
 - c) salt water
 - d) air mass
- 10.** Which word means “the dynamic movement of water on, below, and above Earth’s surface”?
- a) water cycle
 - b) hydrosphere
 - c) rain shadow
 - d) groundwater
- 11.** Which word means “a group of organisms of the same type that are capable of reproducing together”?
- a) aquifer
 - b) water cycle
 - c) species
 - d) biosphere
- 12.** Which word means “the Earth system that is composed of all the living things on Earth”?
- a) air mass
 - b) reservoir
 - c) geologic
 - d) biosphere

Answers

Lesson 2: The Hydrosphere

1. **clear drinking glass or beaker Activity Pages Where Is Water in the Hydrosphere?**
AP 2.1
2. **What parts of the hydrosphere did you observe when you went outdoors into the local environment?**
Students should recall the details they recorded on Activity Page 1.1
3. **to make some inferences about the closed system. Where did the water on the outside of the glass come from if the system is closed/sealed?**
Accept all plausible responses.
4. **a volunteer to talk the rest of the class through the water cycle diagram. Ask: Why is this model called a cycle?**
Because it has no beginning or end
5. **Collect the completed Where Is Water in the Hydrosphere?**
AP 2.1

Lesson 3: Distribution of Earth's Water

1. **Where is most of Earth's water located?**
In the ocean
2. **In what other places can water be found?**
Streams, rivers, ponds, lakes, cracks in rock, soil, underground, the pore spaces between mineral grains in rocks, and the atmosphere
3. **What is this a model of?**
The hydrosphere
4. **What does your model show about the hydrosphere?**
How much water is in the different reservoirs
5. **How can you arrange the bottle and cups to best show relationships?**
They could arrange the containers in a straight line, from largest to smallest volume.
6. **What doesn't your model show about the hydrosphere?**
It does not show how the hydrosphere is dynamic. All the water in the model is liquid, but in the real hydrosphere some of it is solid or gaseous.

Lesson 4: The Geosphere

1. **What parts of the geosphere did you observe in the video?**
Depending on the video they saw, students may have seen a mountain, lava, rocks, and so on.
2. **What other parts of the geosphere do you think exist?**
The parts under the surface of Earth, other mountains, and so on

3. **What questions do you have about Earth's geosphere?**
List the questions where students can see them during the rest of this lesson.
4. **What melted rock did you see in the video?**
The lava was melted rock.
5. **Why do you think dynamic is a good adjective for the geosphere?**
This question will elicit prior knowledge or require predictions, but so far, students have seen that volcanic eruptions are quite dynamic.
6. **How is this cut piece of fruit a good model of parts of the geosphere?**
It is round, and it has a core, a wide layer like Earth's mantle, and a thin skin like Earth's crust.
7. **What doesn't the model show?**
It does not show that the mantle has lower and upper layers. Nor does it show which layers are solid or molten rock.
8. **Does this model of the layers of the geosphere show a small-scale phenomenon or large-scale phenomenon?**
A large-scale phenomenon
9. **What are two ways igneous rocks form?**
From molten rock on or below Earth's surface
10. **What is a way sedimentary rock forms?**
From sediments that are pressed together over time
11. **How does the geosphere interact with the hydrosphere in creating sedimentary rock?**
Rock particles are carried by waterways.
12. **How do metamorphic rocks form?**
When a rock that already formed is changed by heat and pressure
13. **What are the parts of this system?**
Igneous rock, sedimentary rock, metamorphic rock, sediments
14. **What do the process arrows labeled "Breaking down" mean? Breaking down into what?**
Large rocks are breaking down into tiny pieces called sediments.
15. **Where can people see melting rock?**
When a volcano erupts and lava flows on Earth's surface
16. **Do you think sedimentary rock, like the rocks in the photo on page 13, can break down into sediments? How would you add to the diagram to show this process?**
Yes, sedimentary rocks are also subject to water and wind erosion and can break down into sediments. Adding an arrow labeled "Breaking down" that begins and curves back to end at "Sedimentary rock" would show this.
17. **Why is this model called a cycle?**
Because it has no beginning or end

18. **Would you say the rock cycle is a large- or small-scale system?**
It is large-scale in that it takes place on all parts of Earth's surface at once.

Lesson 5: The Atmosphere

1. **In what states of matter does the hydrosphere exist?**
Solid [glaciers and ice caps], liquid [oceans, ponds, rivers], gas [water vapor in the air]
2. **In which of these states does most of the hydrosphere exist?**
Liquid
3. **In what states of matter does the geosphere exist?**
Solid [rocks], liquid [molten rock]
4. **In which of these states does most of the geosphere exist?**
It is mostly solid.
5. **In which state of matter do you predict the atmosphere exists?**
Mostly gases
6. **What questions do you have about Earth's atmosphere?**
List the questions where students can see them during the rest of this lesson.
7. **What does the model in the form of a diagram show that the basketball and pillowcase did not show?**
It shows the layers of the atmosphere and their thicknesses in miles/kilometers.
8. **What does the basketball and pillowcase model show that the diagram does not show?**
It shows the thickness of the lower parts of the atmosphere where the most air is in relationship to the diameter of Earth. It also shows that the atmosphere goes all around Earth.
9. **What causes air pressure?**
The weight of air particles
10. **What is the relationship between air pressure and altitude?**
As altitude increases, air pressure decreases.
11. **How do air masses produce weather?**
They move, they push one another, and they carry precipitation to new places.
12. **Which two systems interact when air supports life?**
The atmosphere and the biosphere
13. **In which part of the atmosphere is there enough air for living things to use?**
The layer right above Earth's surface [the troposphere]
14. **How do living things depend on the atmosphere for protection?**
The ozone layer in the stratosphere blocks dangerous ultraviolet light from reaching living things on Earth's surface.
15. **Where is the atmosphere located in relationship to the geosphere?**
It surrounds the geosphere.

16. **What is the atmosphere made of?**

A mixture of gases

17. **Why can only the lowest layer of the atmosphere support life and produce weather?**

Because this is the layer where most of the air particles are located

Lesson 6: The Biosphere

1. **Which part of Earth did the basketball represent in the model?**

The geosphere

2. **Which part of Earth did the pillowcase represent in the model?**

The two lower layers of the atmosphere, where most of the air particles are located

3. **How does the plastic wrap compare to the pillowcase used to model the atmosphere?**

It is thinner.

4. **What does the model show about a comparison between the biosphere and atmosphere?**

It shows that the biosphere is an even thinner layer of Earth than the air in the atmosphere.

5. **Are there more species discovered and named or yet to be discovered and named?**

Many more yet to be discovered

6. **There are over 300,000,000 people living in the United States. How many species could each person discover and name?**

Guide students to solve the problem in two steps. Subtract the known species from the estimated total. Then divide that number by the number of U.S. residents. The answer should be 6.6 species.

7. **Where on Earth are all of the six biomes named found?**

On the land

8. **In the desert shown in the photo, how does the biosphere interact with the hydrosphere?**

The plants need water to survive.

9. **In the tundra shown in the photo, how does the biosphere interact with the geosphere?**

The plants' roots take in minerals from the soil.

10. **What are two ways described here in the chapter that the biosphere changes?**

Species can go extinct or evolve.

11. **What are some of the changes that result in species becoming extinct?**

Changes in climate and human activities

12. **Which of the changes discussed on this page are an example of an interaction within the parts of one Earth system?**

Humans affecting other species

Lesson 7: Sphere Model Fair Preview

1. **Which Earth spheres can you identify as being involved in a landslide?**
Hydrosphere, geosphere
2. **How does a landslide represent these spheres interacting?**
Sample answer: A landslide occurs when water from the hydrosphere loosens the rocks of the geosphere, causing it to fall.
3. **Does a landslide also involve an interaction with the biosphere? Why or why not?**
Yes, because the changes to the land affect the things that live on the land, such as trees and animals
4. **Do you think a landslide is an example of an interaction that brings about a quick change or a slow change?**
A quick change
5. **Which Earth spheres can you identify as being involved in a volcanic eruption?**
Geosphere, atmosphere
6. **How does a volcanic eruption represent these spheres interacting?**
An eruption changes the landscape and can blast out lava, which cools into new rock formations. Ash and smoke move into the air, or atmosphere.
7. **Does an eruption also involve an interaction with the biosphere? Why or why not?**
Yes, because the things that live on the land, such as trees and animals, including humans, can die when they are in the way of lava and can also be choked by gas or smothered by ash
8. **Do you think an eruption is an example of an interaction that brings about a quick change or a slow change?**
A quick change

Lesson 8: Hydrosphere Interactions

1. **What sphere is represented by an iceberg?**
Hydrosphere
2. **What sphere is represented by a colony of ants?**
Biosphere
3. **What sphere is represented by the sandy soil in which the ants live?**
Geosphere
4. **In what sphere do you find wind and air masses of different temperatures?**
Atmosphere
5. **Why did earthworms emerge from the soil during the rainstorm?**
The ground became saturated with water, and they can't survive fully underwater

6. **What evidence did you read of water moving back to the atmosphere?**
Vapor rising from the wet land, evaporated water from skin
7. **What evidence was there of the hydrosphere affecting the geosphere?**
Soil became saturated, pools and streams formed
8. **What evidence was there of the biosphere being helped by the hydrosphere?**
Birds feeding on worms, mushrooms and flowers growing, plants being less wilted
9. **What happened to the salt?**
It dissolved.
10. **Does that mean the salt has gone away?**
No. It is still in the water.
11. **How do you think you could see the salt again?**
Let the water evaporate. The salt would be left behind.
12. **How does the biosphere pass water back to the atmosphere?**
Leaves release water vapor.
13. **What two forms of water can travel from the atmosphere to the geosphere during a storm?**
Solid, liquid
14. **How can water weather and erode the geosphere?**
It can freeze in cracks of rock, prying the rock apart into smaller pieces; liquid water can pick up and carry sediment.

Lesson 9: Geosphere Interactions

1. **What is the geosphere?**
The rock-based components of Earth, both solid and molten
2. **What can the geosphere provide to other spheres if it is warm?**
Heat, thermal energy
3. **What might this volcano do to the forest?**
The eruption could kill some of the forest. But it could also provide new habitat where plants and other organisms can eventually grow, including habitats at higher elevations.
4. **What could the gases released by the volcano do to the atmosphere over the forest?**
They could change the atmosphere's composition and make it harder for light to penetrate and reach the forest.
5. **What can happen when a volcano erupts underwater but close to the water's surface?**
An island can form.
6. **How is a volcanic island an interaction between the geosphere and both the hydrosphere and the biosphere?**
The volcano [geosphere] forms an island [geosphere] in water [hydrosphere]. It will

also eventually have life [biosphere] on it.

7. **What do you think will happen to the air as it moves toward the mountains, and how will that affect the land on the other side of the mountains?**

To the west of the mountains, precipitation falls as snow or rain, and the water flows downhill to the lower areas of the state. East of the mountains, it is much drier.

8. **Which is more likely to get high precipitation, land at low elevation or land at high elevation?**

Land at high elevation

9. **If North America continues to move mostly west and Asia continues to move mostly east, what will eventually happen?**

They will collide [though this will take hundreds of millions of years].

10. **How does the geosphere play a role in storing the freshwater portion of the hydrosphere?**

Aquifers store groundwater below Earth's surface; cold landmasses can store water as ice caps and glaciers.

11. **How does topography affect the atmosphere?**

Elevated land features such as mountains can force air masses up, where they cool and condense, and precipitation falls.

12. **What does the geosphere provide to the biosphere in chemical terms?**

Minerals

13. **What does the geosphere physically provide to the biosphere?**

Space, habitat, shelter

Lesson 10: Atmosphere Interactions

1. **What kinds of energy transfers occur in the atmosphere, the geosphere, and the hydrosphere?**

Thermal energy transfers, also known as heat

2. **What does heat do to the matter that makes up the different spheres?**

It usually causes it to expand and become more energetic.

3. **What is the main source of energy that causes the atmosphere to change?**

The sun

4. **Where is the atmosphere compared to the other spheres?**

Mostly outside or above them, between space and the others

5. **What do you think the atmosphere does in terms of allowing in or blocking solar energy to Earth's systems?**

It allows some energy in, but it also blocks some of it.

6. **What is a medium?**

A substance through which something else can travel

7. **How is Earth's atmosphere a medium?**

Sunlight travels through it.

8. **What is the difference between the Sahara dust being blown from Africa to the Americas and a few grains of sand blown across a sidewalk? What's the same?**

Scale. The first example occurs on a very large scale. The second is on a small scale. The phenomenon is basically the same in each, but because the scale is so much larger in the first one, it can have a larger impact on the geosphere.

9. **Why is wind carrying sand more abrasive and more likely to cause erosion of the geosphere than wind that is not carrying anything?**

There is more matter, more particles to collide with surfaces of the geosphere and knock the geosphere's particles loose.

10. **Why does the pattern and direction of the dunes' shapes look similar to ocean waves?**

Both are driven by the wind. The wind's direction is forming wavelike dunes just as it is forming water waves on the ocean's surface.

11. **What happens to the geosphere if more of the sea ice, ice caps, glaciers, and snow of Earth's polar regions melts?**

More of the geosphere will be exposed to the sun.

12. **How will a more exposed geosphere affect the rate of melting and heating in the hydrosphere and atmosphere?**

It could increase it, making things even warmer.

13. **What are some surface features made of water that could not occur without the help of the atmosphere?**

Most lakes, rivers, and ponds would not occur. Glaciers, ice caps, and snow would not be possible.

14. **What about groundwater?**

Stores of groundwater might become very rare, as there would be no precipitation to fill or replenish aquifers.

15. **How do plants and animals interact with oxygen and carbon dioxide in the atmosphere?**

Plants take in carbon dioxide and release oxygen. Animals take in oxygen and release carbon dioxide. The atmosphere provides these gases that sustain life.

16. **How could the biosphere counteract or make up for the amount of carbon that human activities are releasing into the atmosphere?**

Photosynthetic organisms could take in more carbon dioxide, convert it to food, grow larger or more abundant, and then feed more plant-eating organisms such as animals.

17. **What kind of evidence would you look for to determine whether the biosphere is in fact keeping up with the amount of carbon we are emitting into the atmosphere?**

We could measure how much of Earth's surface is covered with plants. We could try to estimate how much algae is in the oceans and lakes. We could try to measure how many animals there are.

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

Lesson 11: Biosphere Interactions

1. **What kinds of energy does the biosphere need?**
Sunlight, thermal energy, chemical energy
2. **When a tree falls and breaks down, what kinds of matter are cycled back into the other spheres?**
Water cycles back into the hydrosphere; carbon, nitrogen, and oxygen cycle back into the geosphere and atmosphere.
3. **Where is the biosphere compared to the other spheres?**
It can be found in all spheres, but it is mostly on the surface of the geosphere or in the hydrosphere. Some organisms spend a lot of time in the atmosphere, but they need to land on the other two.
4. **What does the biosphere do that affects where the hydrosphere is?**
It absorbs liquid water, releases liquid water [waste], and releases water vapor. This results in movement of water, which alters its distribution within the hydrosphere.
5. **What does the biosphere do that affects what's in the hydrosphere?**
Some organisms live in water, so they are part of the system. They take in and release different things, such as oxygen and carbon dioxide. They can release other substances. In general, they change the amounts of things other than water molecules in the hydrosphere.
6. **How does the biosphere interact with the atmosphere?**
Gas exchange, adding water vapor
7. **What are two different ways the biosphere affects the hydrosphere?**
It affects the distribution of water by taking in liquid water and releasing water vapor and liquid water that can travel to different locations, usually through the atmosphere. It also changes what's in the water both physically [things living in or suspended in water] and chemically [solutes].
8. **How does the biosphere shape the geosphere?**
It can weather and erode the geosphere and add organic material that helps produce soil.

Lesson 13: The Search for Earth II

1. **Why do you think the ocean was the hardest biome for the people in Biosphere 2 to maintain?**

What is the connection between the ocean and the desert?

2. **What are the different biomes in Biosphere 2?**

How can Biosphere 2 influence scientific exploration of other planets? Option 3: Show a video about the Kepler mission. (See the Online Resources for a link to a suggested video.) Ask students the following questions after watching the video:

3. **What is the greatest takeaway from the Kepler mission?**

How do exoplanets differ from Earth? Option 4: Have students form pairs and do online research of TESS, the Transiting Exoplanet Survey Satellite. (See the Online Resources for a link to a suggested resource.) As they do their research, have students collect information about the following:

4. **What is TESS?**

What is TESS's mission?

5. **How does TESS differ from Kepler?**

What can information learned from TESS help scientists understand about life on other planets?

Unit quiz key

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