



# CK-12 Earth Science For High School Workbook



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# Contents

<b>1</b>	<b>HS What is Earth Science? Worksheets</b>	<b>1</b>
1.1	The Nature of Science . . . . .	2
1.2	Earth Science and Its Branches . . . . .	6
<b>2</b>	<b>HS Studying Earth's Surface Worksheets</b>	<b>10</b>
2.1	Earth's Surface . . . . .	11
2.2	Where in the World Are You? . . . . .	15
2.3	Modeling Earth's Surface . . . . .	19
2.4	Topographic Maps . . . . .	23
2.5	Using Satellites and Computers . . . . .	27
<b>3</b>	<b>HS Earth's Minerals Worksheets</b>	<b>30</b>
3.1	Matter Matters . . . . .	31
3.2	Minerals and Mineral Groups . . . . .	35
3.3	Mineral Identification . . . . .	39
3.4	Mineral Formation . . . . .	43
3.5	Mining and Mineral Use . . . . .	46
<b>4</b>	<b>HS Rocks Worksheets</b>	<b>50</b>
4.1	Types of Rocks . . . . .	51
4.2	Igneous Rocks . . . . .	55
4.3	Sedimentary Rocks . . . . .	59
4.4	Metamorphic Rocks . . . . .	63
<b>5</b>	<b>HS Earth's Energy Worksheets</b>	<b>66</b>
5.1	Energy Resources . . . . .	67
5.2	Non-renewable Energy Resources . . . . .	71
5.3	Renewable Energy Resources . . . . .	75
<b>6</b>	<b>HS Plate Tectonics Worksheets</b>	<b>79</b>
6.1	Inside Earth . . . . .	80
6.2	Continental Drift . . . . .	84
6.3	Seafloor Spreading . . . . .	88
6.4	Theory of Plate Tectonics . . . . .	92
<b>7</b>	<b>HS Earthquakes Worksheets</b>	<b>96</b>
7.1	Stress in Earth's Crust . . . . .	97
7.2	The Nature of Earthquakes . . . . .	101
7.3	Measuring and Predicting Earthquakes . . . . .	105
7.4	Staying Safe in Earthquakes . . . . .	109
<b>8</b>	<b>HS Volcanoes Worksheets</b>	<b>113</b>
8.1	Where Volcanoes Are Located . . . . .	114

8.2	Volcanic Eruptions . . . . .	118
8.3	Types of Volcanoes . . . . .	122
8.4	Volcanic Landforms and Geothermal Activity . . . . .	126
<b>9</b>	<b>HS Weathering and Formation of Soil Worksheets</b>	<b>130</b>
9.1	Weathering . . . . .	131
9.2	Soils . . . . .	135
<b>10</b>	<b>HS Erosion and Deposition Worksheets</b>	<b>139</b>
10.1	Water Erosion and Deposition . . . . .	140
10.2	Wave Erosion and Deposition . . . . .	144
10.3	Wind Erosion and Deposition . . . . .	148
10.4	Glacial Erosion and Deposition . . . . .	152
10.5	Erosion and Deposition by Gravity . . . . .	156
<b>11</b>	<b>HS Evidence About Earth's Past Worksheets</b>	<b>159</b>
11.1	Fossils . . . . .	160
11.2	Relative Ages of Rocks . . . . .	164
11.3	Absolute Ages of Rocks . . . . .	168
<b>12</b>	<b>HS Earth's History Worksheets</b>	<b>172</b>
12.1	Early Earth . . . . .	173
12.2	The Precambrian . . . . .	177
12.3	Phanerozoic Earth History . . . . .	181
12.4	History of Earth's Complex Life Forms . . . . .	185
<b>13</b>	<b>HS Earth's Fresh Water Worksheets</b>	<b>189</b>
13.1	Water on Earth . . . . .	190
13.2	Surface Water . . . . .	194
13.3	Groundwater . . . . .	198
<b>14</b>	<b>HS Earth's Oceans Worksheets</b>	<b>202</b>
14.1	Introduction to the Oceans . . . . .	203
14.2	Ocean Movements . . . . .	207
14.3	The Seafloor . . . . .	211
14.4	Ocean Life . . . . .	215
<b>15</b>	<b>HS Earth's Atmosphere Worksheets</b>	<b>219</b>
15.1	The Atmosphere . . . . .	220
15.2	Atmospheric Layers . . . . .	224
15.3	Energy in the Atmosphere . . . . .	228
15.4	Air Movement . . . . .	232
<b>16</b>	<b>HS Weather Worksheets</b>	<b>236</b>
16.1	Weather and Atmospheric Water . . . . .	237
16.2	Changing Weather . . . . .	241
16.3	Storms . . . . .	245
16.4	Weather Forecasting . . . . .	249
<b>17</b>	<b>HS Climate Worksheets</b>	<b>253</b>
17.1	Climate and Its Causes . . . . .	254
17.2	World Climates . . . . .	258
17.3	Climate Change . . . . .	262

<b>18</b>	<b>HS Ecosystems and Human Populations Worksheets</b>	<b>266</b>
18.1	Ecosystems . . . . .	267
18.2	The Carbon Cycle and the Nitrogen Cycle . . . . .	271
18.3	Human Populations . . . . .	275
<b>19</b>	<b>HS Human Actions and the Land Worksheets</b>	<b>279</b>
19.1	Loss of Soils . . . . .	280
19.2	Pollution of the Land . . . . .	284
<b>20</b>	<b>HS Human Actions and Earth's Resources Worksheets</b>	<b>288</b>
20.1	Use and Conservation of Resources . . . . .	289
20.2	Energy Conservation . . . . .	293
<b>21</b>	<b>HS Human Actions and Earth's Water Worksheets</b>	<b>296</b>
21.1	Humans and the Water Supply . . . . .	297
21.2	Problems with Water Distribution . . . . .	301
21.3	Water Pollution . . . . .	305
21.4	Protecting the Water Supply . . . . .	309
<b>22</b>	<b>HS Human Actions and the Atmosphere Worksheets</b>	<b>313</b>
22.1	Air Pollution . . . . .	314
22.2	Effects of Air Pollution . . . . .	318
22.3	Reducing Air Pollution . . . . .	322
<b>23</b>	<b>HS Observing and Exploring Space Worksheets</b>	<b>326</b>
23.1	Telescopes . . . . .	327
23.2	Early Space Exploration . . . . .	331
23.3	Recent Space Exploration . . . . .	335
<b>24</b>	<b>HS Earth, Moon, and Sun Worksheets</b>	<b>339</b>
24.1	Planet Earth . . . . .	340
24.2	Earth's Moon . . . . .	344
24.3	The Sun . . . . .	348
24.4	The Sun and the Earth-Moon System . . . . .	352
<b>25</b>	<b>HS The Solar System Worksheets</b>	<b>356</b>
25.1	Introduction to the Solar System . . . . .	357
25.2	Inner Planets . . . . .	361
25.3	Outer Planets . . . . .	365
25.4	Other Objects in the Solar System . . . . .	369
<b>26</b>	<b>HS Stars, Galaxies, and the Universe Worksheets</b>	<b>373</b>
26.1	Stars . . . . .	374
26.2	Galaxies . . . . .	378
26.3	The Universe . . . . .	382
<b>27</b>	<b>CK-12 Earth Science For High School Workbook Answers</b>	<b>386</b>
27.1	Chapter 1: What is Earth Science? . . . . .	387
27.2	Chapter 2: Studying Earth's Surface . . . . .	390
27.3	Chapter 3: Earth's Minerals . . . . .	398
27.4	Chapter 4: Rocks . . . . .	405
27.5	Chapter 5: Earth's Energy . . . . .	411
27.6	Chapter 6: Plate Tectonics . . . . .	416

27.7	Chapter 7: Earthquakes . . . . .	422
27.8	Chapter 8: Volcanoes . . . . .	428
27.9	Chapter 9: Weathering and Formation of Soil . . . . .	434
27.10	Chapter 10: Erosion and Deposition . . . . .	438
27.11	Chapter 11: Evidence About Earth's Past . . . . .	446
27.12	Chapter 12: Earth's History . . . . .	451
27.13	Chapter 13: Earth's Fresh Water . . . . .	457
27.14	Chapter 14: Earth's Oceans . . . . .	462
27.15	Chapter 15: Earth's Atmosphere . . . . .	469
27.16	Chapter 16: Weather . . . . .	475
27.17	Chapter 17: Climate . . . . .	481
27.18	Chapter 18: Ecosystems and Human Populations . . . . .	486
27.19	Chapter 19: Human Actions and the Land . . . . .	491
27.20	Chapter 20: Human Actions and Earth's Resources . . . . .	494
27.21	Chapter 21: Human Actions and Earth's Water . . . . .	497
27.22	Chapter 22: Human Actions and the Atmosphere . . . . .	503
27.23	Chapter 23: Observing and Exploring Space . . . . .	508
27.24	Chapter 24: Earth, Moon, and Sun . . . . .	513
27.25	Chapter 25: The Solar System . . . . .	520
27.26	Chapter 26: Stars, Galaxies, and the Universe Worksheets . . . . .	527

## CHAPTER

## 1

# HS What is Earth Science? Worksheets

## Chapter Outline

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1.1 THE NATURE OF SCIENCE

1.2 EARTH SCIENCE AND ITS BRANCHES

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- Lesson 1.1: The Nature of Science
- Lesson 1.2: Earth Science and Its Branches



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## 1.1 The Nature of Science

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### Lesson 1.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Science is both a way of gaining knowledge and a body of knowledge.
- \_\_\_\_\_ 2. There is no place for imagination and creativity in science.
- \_\_\_\_\_ 3. All science is based on evidence and logical thinking.
- \_\_\_\_\_ 4. Any idea can be investigated through scientific inquiry.
- \_\_\_\_\_ 5. Scientific investigations always follow the same sequence of steps.
- \_\_\_\_\_ 6. A good experiment must have one factor that can be manipulated.
- \_\_\_\_\_ 7. Data in the form of numbers is called qualitative data.
- \_\_\_\_\_ 8. Taking many measurements and averaging the results may correct random errors in data.
- \_\_\_\_\_ 9. If data from an experiment do not support a hypothesis, then the experiment is a failure.
- \_\_\_\_\_ 10. A scientific theory is just an educated guess about why something occurs.

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### Lesson 1.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **The Importance of Community in Science**

Although each scientist may perform experiments in her lab alone or with a few helpers, she will write up her results and present her work to the community of scientists in her field. Initially, she may present her data and conclusions at a scientific conference, where she can talk with other scientists and get feedback on her work. Using what she learns, she may go on to write a professional paper about her research and submit it to a scientific journal. Before the paper is accepted for publication, several scientists who are experts in the same field will review it. This is called peer review. These other scientists may suggest changes to the paper, and they will recommend whether or not the paper should be published. Once a paper is published, other scientists can learn about the work and may incorporate the results into their own research. Some scientists may try to replicate the experiment to see whether they get the same results. In this way, the knowledge base of science builds toward a greater understanding of nature.

The scientific community influences the quality and type of research that is done by scientists. For example, other scientists help determine which research projects receive funding. Most scientific research is expensive, so a scientist must write a research proposal to a funding agency, such as the National Science Foundation, requesting money to pay for equipment, supplies, and salaries. Scientific proposals are reviewed by other scientists in the field. In many fields, the funding rate is low and the money goes only to the most worthy research projects.

The scientific community monitors scientific integrity. During their scientific training, students learn how to conduct good scientific experiments. They learn not to fake, hide, or selectively report data. They also learn how to fairly evaluate data and the work of other scientists. Considering how much scientific research is done, there are very few incidents of scientific dishonesty. However, when such an incident occurs, it generally receives a lot of media attention. This may cause the public to mistrust scientists and scientific research in ways that are unfounded. Scientists who do not have scientific integrity are strongly condemned by the scientific community.

### Questions

1. What is peer review, and why is it important?
2. How does the scientific community influence the quality and type of scientific research that is done?
3. How does the scientific community promote scientific integrity?

---

## Lesson 1.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Which of the following is a valid science lab safety guideline?
  - a. Do not eat or drink anything while in the lab.
  - b. Wear a drawstring hoodie to protect yourself from chemicals.
  - c. Wait to clean up any spills until you complete the lab procedure.
  - d. Change the lab procedure if necessary to improve the experiment.
2. Which of the following is relevant to scientific inquiry?
  - a. moral judgments
  - b. personal opinions
  - c. assumptions about nature
  - d. none of the above
3. Which of the following ideas are basic to science?
  - a. Rules of nature may be different elsewhere in the universe.
  - b. Once accepted, scientific ideas are not subject to change.
  - c. Natural events and processes have natural causes.
  - d. all of the above
4. To be useful, a scientific hypothesis must
  - a. be true.
  - b. be testable.
  - c. be very specific.
  - d. apply in all situations.
5. Scientists may collect data by
  - a. doing experiments.
  - b. making observations.
  - c. taking measurements.
  - d. all of the above
6. In a good scientific experiment, the dependent variable depends on the
  - a. experimental controls.
  - b. independent variable.

- c. experimental error.
  - d. none of the above
7. Assume that a scientist is measuring mass in an experiment. The balance she is using is not set at zero, so it always measures mass a little too high. What type of error does this cause in her data?
- a. random error
  - b. observer error
  - c. systematic error
  - d. two of the above

---

## Lesson 1.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. testable, plausible explanation for a scientific question
- \_\_\_\_\_ 2. series of steps scientists use to investigate questions
- \_\_\_\_\_ 3. factor that must remain the same in an experiment so it does not affect the outcome
- \_\_\_\_\_ 4. factor in an experiment that the researcher changes
- \_\_\_\_\_ 5. scientific explanation that is supported by many observations
- \_\_\_\_\_ 6. factor measured as the outcome of an experiment
- \_\_\_\_\_ 7. useful representation of a real system that is simpler than reality

### Terms

- a. hypothesis
- b. theory
- c. control
- d. dependent variable
- e. independent variable
- f. model
- g. scientific method

---

## Lesson 1.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The scientific method typically begins with a(n) \_\_\_\_\_.
- 2. Before developing a hypothesis, a scientist typically undertakes \_\_\_\_\_.
- 3. A physical representation of a real object, such as a globe of the world, is a(n) \_\_\_\_\_ model.
- 4. If a hypothesis is tested and supported repeatedly, it may become a(n) \_\_\_\_\_.

5. A general idea about how something works is a(n) \_\_\_\_\_ model.
6. The scientific method typically ends with a(n) \_\_\_\_\_.
7. A set of equations that represents a real-world process is a(n) \_\_\_\_\_ model.

---

## Lesson 1.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain why models are used in science, and compare and contrast three different types of scientific models.

---

## 1.2 Earth Science and Its Branches

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### Lesson 1.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Earth science deals with Earth's lands, oceans, and atmosphere.
  - \_\_\_\_\_ 2. Most Earth scientists specialize in studying one aspect of the planet.
  - \_\_\_\_\_ 3. Seismologists forecast major storms to save lives and property.
  - \_\_\_\_\_ 4. Oceanography can be accurately defined as the hydrology of the oceans.
  - \_\_\_\_\_ 5. Meteorologists collect data using technologies such as radar and satellites.
  - \_\_\_\_\_ 6. All the branches of Earth science are connected.
  - \_\_\_\_\_ 7. A lunar geologist might study minerals and rocks under the oceans.
  - \_\_\_\_\_ 8. Climatologists are interested in long-term changes in the atmosphere.
  - \_\_\_\_\_ 9. Environmental science is the study of how the environment affects people.
  - \_\_\_\_\_ 10. Astronomy is defined as the study of the geology of other planets.
- 

### Lesson 1.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Introduction to Earth Science

Earth science consists of many branches of knowledge concerning planet Earth. It deals with any and all aspects of Earth: its lands, interior, atmosphere, and oceans. Earth is a very large and complex set of systems. Therefore, most Earth scientists focus on just one aspect of the planet.

The main branches of Earth science are geology, meteorology, climatology, oceanography, and environmental science. Each branch has a different focus. For example, geology focuses on Earth's solid materials and structures and the processes that create them. Geology, in turn, is divided into several branches, including mineralogy, planetary geology, marine geology, and seismology. Mineralogy, for example, is the study of the composition and structure of minerals. Seismology is the study of earthquakes and their causes. Because all of Earth's systems are interconnected, researchers in different branches of Earth science generally must work together to answer complex questions.

#### Questions

1. What is Earth science? Why does Earth science have many branches?
2. Identify the main branches of Earth science.
3. What is the focus of the branch of Earth science known as geology? How is geology divided into branches?

4. Why must scientists in different branches of Earth science generally work together to answer complex questions?

---

## Lesson 1.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The main branches of Earth science include
  - a. geology.
  - b. climatology.
  - c. meteorology.
  - d. all of the above
2. Which of the following questions would most likely be addressed by a geologist?
  - a. How do hurricanes form?
  - b. What causes ocean currents?
  - c. What is the composition of rocks?
  - d. How do human actions affect the climate?
3. A planetary geologist might study the
  - a. minerals found inside Earth.
  - b. composition of Earth's surface.
  - c. minerals and rocks on Mars.
  - d. all of the above
4. A marine geologist might study
  - a. organisms that live in the ocean.
  - b. movements of ocean water.
  - c. rocks on the ocean floor.
  - d. none of the above
5. If a student wants to learn more about tornadoes, she should take a class in
  - a. seismology.
  - b. climatology.
  - c. meteorology.
  - d. environmental science.
6. If an oil company wanted to hire a scientist to locate oil reserves in rocks under Earth's surface, the company would most likely hire a(n)
  - a. paleontologist.
  - b. hydrologist.
  - c. geologist.
  - d. ecologist.
7. Mineralogy is a branch of
  - a. oceanography.
  - b. astronomy.
  - c. seismology.
  - d. geology.

---

## Lesson 1.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. study of fossils
- \_\_\_\_\_ 2. study of Earth's solid materials and structures and the processes that create them
- \_\_\_\_\_ 3. study of Earth's atmosphere
- \_\_\_\_\_ 4. study of earthquakes and their causes
- \_\_\_\_\_ 5. study of weather and weather patterns
- \_\_\_\_\_ 6. broad science that deals with all aspects of planet Earth
- \_\_\_\_\_ 7. study of the effects of people on the environment

### Terms

- a. geology
- b. meteorology
- c. climatology
- d. paleontology
- e. environmental science
- f. Earth science
- g. seismology

---

## Lesson 1.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Scientists who study the composition and structure of minerals are called \_\_\_\_\_.
- 2. \_\_\_\_\_ are scientists you study the geology of other planets.
- 3. The study of water and its movements, distribution, and quality is \_\_\_\_\_.
- 4. The study of everything in the ocean environment is \_\_\_\_\_.
- 5. A(n) \_\_\_\_\_ studies ocean currents, waves, and tides.
- 6. A(n) \_\_\_\_\_ studies rocks and geologic processes of ocean basins.
- 7. A(n) \_\_\_\_\_ studies life in the oceans.

---

## Lesson 1.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

What is a question that might be investigated by an environmental scientist? Identify another branch of Earth science that might be called upon to help answer the question. Explain your choice.



---

**CHAPTER 2**

# HS Studying Earth's Surface Worksheets

## Chapter Outline

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- 2.1 EARTH'S SURFACE**
  - 2.2 WHERE IN THE WORLD ARE YOU?**
  - 2.3 MODELING EARTH'S SURFACE**
  - 2.4 TOPOGRAPHIC MAPS**
  - 2.5 USING SATELLITES AND COMPUTERS**
- 

- **Lesson 2.1: Earth's Surface**
- **Lesson 2.2: Where in the World are You?**
- **Lesson 2.3: Modeling Earth's Surface**
- **Lesson 2.4: Topographic Maps**
- **Lesson 2.5: Using Satellites and Computers**

---

## 2.1 Earth's Surface

---

### Lesson 2.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Constructive forces can change a high mountain to a flat plateau.
- \_\_\_\_\_ 2. A volcanic eruption can be a constructive or destructive force.
- \_\_\_\_\_ 3. The ocean floor is a flat, featureless surface.
- \_\_\_\_\_ 4. Mountains rise when continents collide.
- \_\_\_\_\_ 5. A stream flowing down a mountainside is a constructive force.
- \_\_\_\_\_ 6. Continental margins consist of oceanic crust.
- \_\_\_\_\_ 7. Many ocean trenches are located around the edge of the Pacific Ocean.
- \_\_\_\_\_ 8. Changes in Earth's surface always occur very slowly.
- \_\_\_\_\_ 9. Old seafloor is destroyed at oceanic trenches.
- \_\_\_\_\_ 10. The continental crust has been subject to destructive forces longer than the oceanic crust has.

---

### Lesson 2.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Building up and Wearing Down Earth's Continental Landforms**

Earth's continents are large land areas extending from high mountaintops to sea level. The oldest continental rocks are billions of years old, so the continents have had a lot of time for constructive and destructive forces to change them. Constructive forces cause physical features on Earth's surface, known as landforms, to build up. Destructive forces cause physical features to wear down.

Landforms often build up when Earth's crust deforms. This occurs when slabs of crust compress, pull apart, or slide past other slabs of crust. Crust deformation can result in the formation of hills, valleys, and other landforms. Mountains rise when continents collide and push up the crust. Volcanic mountains form when a slab of oceanic crust plunges beneath another slab of crust. This allows melted rock called magma to flow onto the surface, where it hardens to form solid rock. Over time, the hardened rock builds up to form a mountain. Landforms are also created when sediments are deposited. For example, a triangular deposit called a delta forms where a river or stream deposits sediments as it flows into a body of still water.

Volcanic eruptions are constructive forces when they cause mountains to form. However, explosive volcanic eruptions can be destructive forces if they blow apart mountains, leaving craters. Landforms are also worn down by the destructive forces of weathering and erosion. Water, wind, ice, and gravity are important agents of erosion. For

example, water in streams and rivers flowing down mountainsides wears away rocks and creates valleys. Landslides are also destructive forces that wear away steep slopes.

### Questions

1. What are continents and landforms?
2. Compare and contrast constructive and destructive forces.
3. How can volcanoes and rivers be both constructive and destructive forces?

---

## Lesson 2.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. How old are the oldest continental rocks?
  - a. about half a million years old
  - b. a few million years old
  - c. 100 million years old
  - d. billions of years old
2. Crustal deformation occurs when Earth's crust
  - a. pulls apart.
  - b. pushes together.
  - c. slides past other crust.
  - d. all of the above
3. Crustal deformation may result in the formation of
  - a. hills.
  - b. valleys.
  - c. mountains.
  - d. all of the above
4. Deltas form when
  - a. oceanic crust plunges beneath continental crust.
  - b. sediments are deposited.
  - c. continents collide.
  - d. volcanoes erupt.
5. The East African rift valley is forming where crust is
  - a. compressed.
  - b. pulled apart.
  - c. pushed together.
  - d. deposited by water.
6. The ocean basins are all younger than
  - a. 180 million years old.
  - b. 100 million years old.
  - c. 80 million years old.
  - d. 18 million years old.
7. New seafloor forms when

- a. sediments are deposited.
- b. volcanic activity occurs.
- c. crust is uplifted.
- d. none of the above

---

## Lesson 2.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. mountain range that runs through much of the ocean basin
- \_\_\_\_\_ 2. any force that wears down landforms
- \_\_\_\_\_ 3. deep valley on the ocean floor
- \_\_\_\_\_ 4. any force that causes landforms to grow
- \_\_\_\_\_ 5. continental crust that extends downward to the seafloor
- \_\_\_\_\_ 6. large land area that lies above sea level
- \_\_\_\_\_ 7. physical feature of Earth's surface

### Terms

- a. constructive force
- b. landform
- c. continent
- d. destructive force
- e. mid-ocean ridge
- f. ocean trench
- g. continental margin

---

## Lesson 2.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Earth's surface features result from constructive and \_\_\_\_\_ forces.
- 2. Weathering and erosion are examples of \_\_\_\_\_ forces.
- 3. If the eruption of a volcano creates a new mountain, it is an example of a(n) \_\_\_\_\_ force.
- 4. If the eruption of a volcano blows up a mountain and leaves a crater, it is an example of a(n) \_\_\_\_\_ force.
- 5. Water, wind, ice, and gravity are important agents of \_\_\_\_\_, which is a destructive force.
- 6. A landslide is a(n) \_\_\_\_\_ force because it wears down a steep slope.

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## Lesson 2.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

According to a well-known quote, “the only thing that does not change is change itself.” How does this apply to planet Earth?

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## 2.2 Where in the World Are You?

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### Lesson 2.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The direction called “northeast” is 90 degrees from north.
- \_\_\_\_\_ 2. Earth’s magnetic north pole is also called “true north.”
- \_\_\_\_\_ 3. Any location on Earth’s surface can be located by its latitude and longitude.
- \_\_\_\_\_ 4. The equator falls halfway between the north and south poles.
- \_\_\_\_\_ 5. The international dateline is located at 120 degrees east longitude.
- \_\_\_\_\_ 6. Another word that has the same meaning as relief is terrain.
- \_\_\_\_\_ 7. To find a stationary object on Earth’s surface, you must know its direction.
- \_\_\_\_\_ 8. Elevation on Earth is always measured relative to sea level.
- \_\_\_\_\_ 9. A compass needle always points toward 90 degrees north latitude.
- \_\_\_\_\_ 10. The line called the prime meridian is perpendicular to the equator.

---

### Lesson 2.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Describing Location**

Any location on Earth’s surface—or on a map of Earth’s surface—can be described by latitude and longitude. Latitude and longitude are expressed in degrees. Each degree is divided into 60 minutes, and each minute is divided into 60 seconds.

Latitude is a measure of the distance north or south of the equator. The equator is the imaginary line that circles Earth halfway between the north and south poles. All lines of latitude circle the planet parallel to the equator. The latitude of the equator is 0 degrees. The latitude of the north pole is 90 degrees north, and the latitude of the south pole is 90 degrees south.

Longitude is a measure of the distance east or west of the prime meridian. The prime meridian is an imaginary line that is perpendicular to the equator. It circles the planet and passes through the north and south poles. It also passes through Greenwich, England. All lines of longitude circle the planet perpendicular to the equator and pass through both poles. The longitude of the prime meridian is 0 degrees. On the opposite side of Earth, the longitude of the international dateline is 180 degrees.

Another aspect of location is elevation. Elevation is the height of a place above or below sea level. It is always measured relative to sea level, which is the average height of the ocean’s surface. It is also the midpoint between

high and low tides. Sea level is the same everywhere on Earth. The elevation of surface features, or landforms, is called topography. Relief, or terrain, is the topography of all the major features of a region.

### Questions

1. What is latitude? Describe the line of latitude that is 45 degrees north.
2. What is longitude? Describe the line of longitude that is 90 degrees east.
3. Define elevation, and explain how it is measured.

---

## Lesson 2.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Which method of determining location is used to find the location of an earthquake?
  - a. elevation
  - b. triangulation
  - c. street address
  - d. latitude and longitude
2. How far is Earth's magnetic north pole from its geographic north pole?
  - a. 11.5 degrees
  - b. 22.5 degrees
  - c. 45.0 degrees
  - d. 90.0 degrees
3. Each degree of latitude or longitude is divided into
  - a. 10 minutes.
  - b. 30 minutes.
  - c. 60 minutes.
  - d. 90 minutes.
4. The line that is 0 degrees latitude is known as the
  - a. international dateline.
  - b. prime meridian.
  - c. equator.
  - d. none of the above
5. Which of the following locations could be in the United States?
  - a. 120° east, 40° south
  - b. 120° east, 40° north
  - c. 120° west, 40° north
  - d. 120° west, 40° south
6. Which statement about sea level is true?
  - a. It varies throughout the day.
  - b. It differs from place to place.
  - c. It is the elevation of the ocean floor.
  - d. It is halfway between high and low tides.
7. Which of the following is the best definition of topography?

- a. elevation of landforms
- b. distance from the equator
- c. point of triangulation
- d. direction on a map

---

## Lesson 2.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. distance north or south of the equator
- \_\_\_\_\_ 2. distance east or west of the prime meridian
- \_\_\_\_\_ 3. height above or below sea level
- \_\_\_\_\_ 4. position on Earth's surface
- \_\_\_\_\_ 5. figure on a map that shows direction
- \_\_\_\_\_ 6. device with a magnetic needle that is used to find direction
- \_\_\_\_\_ 7. which way an object is moving

### Terms

- a. elevation
- b. longitude
- c. compass
- d. direction
- e. location
- f. compass rose
- g. latitude

---

## Lesson 2.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. \_\_\_\_\_ means finding a location based on its distance from three other locations.
- 2. A compass needle points to Earth's \_\_\_\_\_ north pole.
- 3. Earth's \_\_\_\_\_ north pole is the point where Earth's axis intersects the surface in the Northern Hemisphere.
- 4. The line representing 0 degrees longitude is called the \_\_\_\_\_.
- 5. Lines of \_\_\_\_\_ are parallel to the equator.
- 6. The average height of the ocean's surface is referred to as \_\_\_\_\_.
- 7. \_\_\_\_\_ refers to the elevations of all the landforms in a region.



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## Lesson 2.2: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast Earth's geographic and magnetic poles.

## 2.3 Modeling Earth's Surface

### Lesson 2.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Locations on a globe are determined using rectangular coordinates.
- \_\_\_\_\_ 2. A flat map is most accurate over a large area.
- \_\_\_\_\_ 3. All compass directions are curved lines on a Mercator projection.
- \_\_\_\_\_ 4. A conic projection best depicts the area where the cone touches the globe.
- \_\_\_\_\_ 5. Gnomonic projections are often used to map the poles.
- \_\_\_\_\_ 6. Mercator projections are no longer used.
- \_\_\_\_\_ 7. Robinson projections are still commonly used.
- \_\_\_\_\_ 8. Winkel Tripel projections are used by the National Geographic Society.
- \_\_\_\_\_ 9. Locations on a map are determined using polar coordinates.
- \_\_\_\_\_ 10. The oldest type of projection is a Mercator projection.

### Lesson 2.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Map Projections

Earth's surface is curved, whereas maps are flat. To represent a curved surface on a flat map requires the use of some type of projection. There are several commonly used types of projections.

The oldest type of projection is a Mercator projection. Mercator projections are still commonly used today. A Mercator projection is made by wrapping a flat piece of paper around a globe at the equator to make a cylinder. The paper touches the globe at the equator, but the distance between the globe and paper increases toward the poles. The features of Earth's surface are projected outward onto the cylinder. When the cylinder is unrolled, the result is a flat Mercator projection. A Mercator projection is most accurate near the equator. Here, the shapes and sizes of features are correct. However, the features get stretched out near the poles. For example, on a Mercator projection Greenland is stretched out to look almost as big the United States.

Other types of projections include conic, gnomonic, Robinson, and Winkel Tripel projections.

- A conic projection uses a cone rather than a cylinder to project Earth's curved surface onto a flat map. It best depicts the area where the cone touches the globe. This area depends on the choice of the map maker.
- A gnomonic projection projects Earth surface onto a flat map from a single point. The projection is most accurate for features near that point. The poles are often mapped this way.

- A Robinson projection creates an elliptical rather than rectangular map. Lines of latitude are represented by straight lines, whereas lines of longitude are represented by curved lines. This projection has less distortion near the poles than a Mercator project.
- A Winkel Tripel projection uses mathematical formulas to create a flat map of Earth's curved surface. This type of projection is distorted at the edges. The National Geographic Society uses Winkel Tripel projections.

### Questions

1. What are projections? Why are projections used to make maps of Earth's surface?
2. Describe how a Mercator projection is made. What is a disadvantage of Mercator projections?
3. List and briefly describe two other types of map projections.

---

## Lesson 2.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Using a globe to represent Earth's surface avoids distortions of the
  - a. sizes of continents.
  - b. shapes of land masses.
  - c. distances between places.
  - d. all of the above
2. To find the shortest distance between two points on a globe, you find the length of the
  - a. arc that connects them.
  - b. meridian closest to them.
  - c. straight line between them.
  - d. none of the above
3. A radar map may be used to show
  - a. topography.
  - b. weather.
  - c. climate.
  - d. two of the above
4. A Mercator projection is most accurate at
  - a. the poles.
  - b. the equator.
  - c. 45 degrees north.
  - d. 45 degrees south.
5. A gnomonic projection is always centered on
  - a. the equator.
  - b. a single point.
  - c. the north pole.
  - d. the south pole.
6. Which statement about a Robinson projection is true?
  - a. Scales along different lines of latitude are the same.
  - b. Distances along each line of latitude are true to scale.

- c. Distortion is greatest within 45 degrees of the equator.
  - d. There is more distortion near the poles than on a Mercator projection.
7. Which statement is true about all projections?
- a. They are the most accurate way to represent Earth's surface.
  - b. They project Earth's curved surface onto a cylinder or cone.
  - c. They distort sizes and shapes of features at the edges.
  - d. They are most accurate near the equator.

---

### Lesson 2.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. map that uses colors to show elevations of large areas
- \_\_\_\_\_ 2. map that is created by projecting Earth's surface on a cylinder
- \_\_\_\_\_ 3. map that shows terrain and vegetation
- \_\_\_\_\_ 4. map that is created by projecting Earth's surface on a cone
- \_\_\_\_\_ 5. map that shows elevations using contour lines
- \_\_\_\_\_ 6. map that has an elliptical shape because only latitude lines are projected while meridians are curved
- \_\_\_\_\_ 7. map that is created by projecting Earth's surface from a single point

#### Terms

- a. Mercator projection
- b. satellite-view map
- c. conic projection
- d. relief map
- e. gnomonic projection
- f. topographic map
- g. Robinson projection

---

### Lesson 2.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. A(n) \_\_\_\_\_ is the most accurate way to represent Earth's curved surface.
- 2. Any two-dimensional representation of Earth's surface is a(n) \_\_\_\_\_.
- 3. Any map that projects Earth's curved surface onto flat paper is a(n) \_\_\_\_\_.
- 4. A map that shows average temperatures and rainfall is a(n) \_\_\_\_\_ map.
- 5. A map that shows air masses, fronts, and storms is a(n) \_\_\_\_\_ map.

6. A map that shows the types and locations of rocks in an area is a(n) \_\_\_\_\_ map.
7. A(n) \_\_\_\_\_ projection uses mathematical formulas to represent Earth's curved surface in two dimensions.

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### Lesson 2.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain the pros and cons of using a globe to represent Earth's surface.

---

## 2.4 Topographic Maps

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### Lesson 2.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Each contour line on a topographic map represents a specific elevation.
- \_\_\_\_\_ 2. Every other contour line is labeled.
- \_\_\_\_\_ 3. The contour interval is a horizontal distance.
- \_\_\_\_\_ 4. If land is almost flat, contour lines will be close together.
- \_\_\_\_\_ 5. The innermost concentric hatched loop on a topographic map encloses the lowest point of a depression.
- \_\_\_\_\_ 6. Contour lines can be used to determine the direction that a stream is flowing.
- \_\_\_\_\_ 7. Contour lines on a bathymetric map represent distance from shore.
- \_\_\_\_\_ 8. Topographic maps show three dimensions of Earth's surface.
- \_\_\_\_\_ 9. The horizontal distance between adjacent contour lines is constant.
- \_\_\_\_\_ 10. On a bathymetric map, the lowest-numbered contour lines represent the deepest ocean floor.

---

### Lesson 2.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Reading Topographic Maps

A topographic map uses contour lines to show the three-dimensional shape of the land. Contour lines reveal the locations of hills, valleys, and other surface features. To read a topographic map, you should know that:

- Each contour line represents a specific elevation and connects all the points that have that elevation. Every fifth contour line is bolded and labeled with its elevation.
- Contour lines run next to each other but never intersect.
- Adjacent contour lines are separated by a constant difference in elevation, called the contour interval. The map legend gives the contour interval.
- Closely-spaced contour lines indicate a steep slope. They show that the elevation changes quickly over a short horizontal distance. Contour lines that seem to touch indicate a very steep rise, such as a cliff or canyon wall. Broadly spaced contour lines, in contrast, indicate a gentle slope.
- Contour lines that form concentric closed loops indicate hills. Smaller loops represent higher elevations.
- Hatched concentric loops indicate depressions. Hatch marks are short, perpendicular lines inside a loop. Smaller hatched loops represent lower elevations.

- A group of V-shaped contour lines indicates a stream valley. The narrow part of the Vs point uphill. Water always flows from higher to lower elevations, so the Vs also tell you the direction the water is flowing.

### Questions

1. What do contour lines represent?
2. What can you learn from the spacing of contour lines?
3. How can you identify hills and depressions on a topographic map?
4. Explain how contour lines show the location and direction of streams.

---

## Lesson 2.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The distance between adjacent contour lines indicates
  - a. slope.
  - b. rock depth.
  - c. horizontal distance.
  - d. none of the above
2. If you could walk along a contour line, you would be walking
  - a. up and down hill.
  - b. down a gentle slope.
  - c. continuously upward.
  - d. always at the same elevation.
3. Contour lines can be used to reveal the locations of
  - a. hills.
  - b. valleys.
  - c. level areas.
  - d. all of the above
4. V-shaped contour lines always point
  - a. north.
  - b. uphill.
  - c. downhill.
  - d. two of the above
5. On a contour map, a cliff is represented by contour lines that
  - a. seem to touch.
  - b. actually intersect.
  - c. are equally spaced.
  - d. are perpendicular.
6. The smallest closed contour line of a hill represents the
  - a. top of the hill.
  - b. lowest elevation.
  - c. bottom of the hill.
  - d. two of the above

7. What could you learn from a bathymetric map?
- depth of ocean water
  - types of rocks on the ocean floor
  - locations of mountains on the ocean floor
  - two of the above

---

## Lesson 2.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. landform represented by contour lines that form closed loops
- \_\_\_\_\_ 2. type of map that shows depths below sea level
- \_\_\_\_\_ 3. difference in elevation between adjacent contour lines
- \_\_\_\_\_ 4. type of map that shows rock units and other rock features
- \_\_\_\_\_ 5. line representing elevation
- \_\_\_\_\_ 6. type of map that shows terrain
- \_\_\_\_\_ 7. landform represented by hatched contour lines that form closed loops

### Terms

- bathymetric map
- contour interval
- contour line
- geologic map
- topographic map
- depression
- hill

---

## Lesson 2.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- A contour line connects points that have the same \_\_\_\_\_.
- Closely spaced contour lines represent a \_\_\_\_\_ slope.
- The scale of a topographic map represents \_\_\_\_\_ distance.
- A group of V-shaped contour lines represents a(n) \_\_\_\_\_.
- Higher-numbered contour lines on a bathymetric map represent greater \_\_\_\_\_.
- Structural features such as folds and faults are shown on a \_\_\_\_\_ map.
- A geologic map represents different rock units with different \_\_\_\_\_.



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## Lesson 2.4: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how a bathymetric map would show a ridge, a trench, and a flat plain on the ocean floor.

## 2.5 Using Satellites and Computers

### Lesson 2.5: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Satellites are useful for monitoring global changes.
- \_\_\_\_\_ 2. A geostationary satellite circles Earth from pole to pole.
- \_\_\_\_\_ 3. Communications satellites have polar orbits.
- \_\_\_\_\_ 4. A satellite in a polar orbit circles Earth at the same speed that Earth rotates.
- \_\_\_\_\_ 5. Satellites can be used to measure temperatures of the land and oceans.
- \_\_\_\_\_ 6. Satellites can be used to locate a person's exact location on Earth's surface.
- \_\_\_\_\_ 7. GPS was first developed for military purposes.
- \_\_\_\_\_ 8. A GPS receiver uses triangulation to determine its own location.
- \_\_\_\_\_ 9. A polar orbit is closer to Earth's surface than a geostationary orbit.
- \_\_\_\_\_ 10. Satellites can detect changes in sea level.

### Lesson 2.5: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### GPS and GIS

GPS, or Global Positioning System, is a system for locating exact positions on Earth's surface. It was originally developed by the U.S. military to help soldiers locate their positions on battlefields. The system is now widely used throughout the world. GPS is based on a network of more than two dozen satellites that constantly orbit Earth. A GPS receiver on the surface uses information from the satellites to determine its own position. The receiver detects radio signals from at least four nearby GPS satellites. There are precise clocks on each satellite and in the receiver. The receiver measures the time it takes for the radio signals from each satellite to reach it. It uses these times, together with the constant speed of radio waves, to calculate its distance from each satellite. Then the receiver uses the four distances to triangulate its exact location on Earth's surface.

A related technology is Geographic Information Systems, or GIS. GIS uses exact geographic locations from GPS receivers, along with any type of spatial information, to create maps and images. The spatial information might be numbers of people, types of plants or soils, presence of groundwater, or levels of rainfall. Geologists use GIS to make maps of natural resource distributions, among many other uses.

#### Questions

1. What is GPS?

2. How does a GPS receiver determine its exact location?
3. What is GIS? How does it use GPS?

---

## Lesson 2.5: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Satellites are used for
  - a. navigation.
  - b. communications.
  - c. storm tracking.
  - d. all of the above
2. Of the following uses, a satellite in a polar orbit is most likely to be used for
  - a. monitoring weather changes in a given area.
  - b. observing how weather is changing globally.
  - c. relaying communications signals.
  - d. two of the above
3. Which U.S. government agencies gather data with satellites?
  - a. National Aeronautics and Space Administration
  - b. National Oceanographic and Atmospheric Administration
  - c. United States Geological Survey
  - d. all of the above
4. Which type of signals does a GPS receiver receive from satellites?
  - a. microwave
  - b. radio
  - c. magnetic
  - d. light
5. Which information does a GPS receiver use to determine its distance from a satellite?
  - a. speed of radio waves
  - b. time to receive signals
  - c. strength of magnetic field
  - d. two of the above
6. A GPS receiver determines its own location based on its
  - a. location relative to the magnetic poles.
  - b. distance to four satellites.
  - c. latitude and longitude.
  - d. speed and distance.
7. GIS uses GPS and spatial information to
  - a. navigate satellites.
  - b. make maps and images.
  - c. gather weather data.
  - d. predict climate change.

---

## Lesson 2.5: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. system of satellites used to locate positions on Earth's surface
- \_\_\_\_\_ 2. type of satellite orbit that remains at an altitude of several hundred kilometers above Earth's surface
- \_\_\_\_\_ 3. system that links GPS data with any type of spatial information to create maps and images
- \_\_\_\_\_ 4. small object that orbits a larger object
- \_\_\_\_\_ 5. type of satellite orbit that remains at an altitude of 36,000 kilometers above Earth's surface

### Terms

- a. satellite
- b. GPS
- c. GIS
- d. geostationary orbit
- e. polar orbit

---

## Lesson 2.5: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The type of orbit that keeps a satellite over the same place on Earth's surface is a(n) \_\_\_\_\_ orbit.
- 2. A satellite with the type of orbit in question 1 revolves around Earth once every \_\_\_\_\_ hours.
- 3. The type of orbit that allows a satellite to see all of Earth's surface in less than a day is a(n) \_\_\_\_\_ orbit.
- 4. A satellite with the type of orbit in question 3 revolves around Earth once every \_\_\_\_\_ hours.
- 5. Using GPS to pinpoint a location requires signals from at least \_\_\_\_\_ GPS satellites.
- 6. Most maps are made today by \_\_\_\_\_.
- 7. Geologists use \_\_\_\_\_ Systems to make maps of natural resource distributions.

---

## Lesson 2.5: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast geostationary and polar satellite orbits and their uses.

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# CHAPTER 3

# HS Earth's Minerals Worksheets

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## Chapter Outline

- 3.1**     **MATTER MATTERS**
  - 3.2**     **MINERALS AND MINERAL GROUPS**
  - 3.3**     **MINERAL IDENTIFICATION**
  - 3.4**     **MINERAL FORMATION**
  - 3.5**     **MINING AND MINERAL USE**
- 

- **Lesson 3.1: Matter Matters**
- **Lesson 3.2: Minerals and Mineral Groups**
- **Lesson 3.3: Mineral Identification**
- **Lesson 3.4: Mineral Formation**
- **Lesson 3.5: Mining and Mineral Use**

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## 3.1 Matter Matters

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### Lesson 3.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Electrons orbit the nucleus of an atom.
- \_\_\_\_\_ 2. An electron cloud is a region where electrons are likely to be.
- \_\_\_\_\_ 3. All subatomic particles are about the same size.
- \_\_\_\_\_ 4. The mass of an atom is the combined masses of its protons and neutrons.
- \_\_\_\_\_ 5. Isotopes of a given element differ in their numbers of electrons.
- \_\_\_\_\_ 6. Carbon-13 is an ion of the element carbon.
- \_\_\_\_\_ 7. Hydrogen bonds are relatively weak bonds.
- \_\_\_\_\_ 8. The oxygen side of a water molecule has a slightly positive charge.
- \_\_\_\_\_ 9. In covalent bonds, atoms always share electrons equally.
- \_\_\_\_\_ 10. The non-metallic ion in an ionic bond is negatively charged.

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### Lesson 3.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Elements, Atoms, and Isotopes

A chemical element is a substance that cannot be made into simpler substances by ordinary chemical means. Examples of elements include hydrogen, oxygen, carbon, and iron. The smallest unit of a chemical element is an atom. An atom has all the properties of the element.

Atoms, in turn, consist of smaller particles, called subatomic particles. At the center of an atom is a nucleus (plural, nuclei). The nucleus consists of subatomic particles called protons and neutrons. Protons have a positive electrical charge. Neutrons are about the same size as protons but have no electrical charge. In other words, they are electrically neutral. Electrons are tiny subatomic particles that have a negative electrical charge. They are not found in the nucleus. They orbit the nucleus at various energy levels in a region known as the electron cloud.

Because electrons are minuscule compared with protons and neutrons, they contribute virtually nothing to the mass of an atom. Instead, the mass of an atom depends almost completely on the number of protons and neutrons in its nucleus. In fact, atomic mass is calculated as the number of protons plus the number of neutrons in an atom.

The number of protons in the nucleus of an atom determines what element the atom is. That's because each element has a unique number of protons in the nuclei of its atoms. However, atoms of a given element can differ in their numbers of neutrons. Atoms of an element with different numbers of neutrons are called isotopes. For example,

atoms of carbon always have 6 protons, but they may have 6, 7, or 8 neutrons. This means that there are three isotopes of carbon: carbon-12 (6 protons + 6 neutrons), carbon-13 (6 protons + 7 neutrons), and carbon-14 (6 protons + 8 neutrons).

### Questions

1. Relate atoms to elements.
2. Describe the structure of atoms.
3. What are isotopes? Give an example.

---

## Lesson 3.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Particles that make up atoms include
  - a. protons.
  - b. neutrons.
  - c. electrons.
  - d. all of the above
2. Which statement about neutrons is false?
  - a. Neutrons have no electrical charge.
  - b. Neutrons are about the same size as protons.
  - c. Neutrons are located in the nucleus of an atom.
  - d. The number of neutrons is the same in all atoms of an element.
3. An ion always has
  - a. a positive or negative electrical charge.
  - b. the same number of electrons as protons.
  - c. the same number of electrons as neutrons.
  - d. none of the above
4. A carbon atom with 8 neutrons is the isotope called
  - a. carbon-11.
  - b. carbon-12.
  - c. carbon-13.
  - d. carbon-14.
5. In ionic bonds, atoms of a metal
  - a. give up electrons.
  - b. receive electrons.
  - c. accept electrons.
  - d. share electrons.
6. Hydrogen bonds are
  - a. intermolecular.
  - b. covalent.
  - c. ionic.
  - d. polar.

7. Molecules of water are
- covalent.
  - polar.
  - ionic.
  - two of the above

---

### Lesson 3.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. center of an atom
- \_\_\_\_\_ 2. chemical bond in which electrons are transferred between atoms
- \_\_\_\_\_ 3. atom of an element with a different number of neutrons
- \_\_\_\_\_ 4. chemical bond in which electrons are shared between atoms
- \_\_\_\_\_ 5. particle that results when an atoms gains or loses electron(s)
- \_\_\_\_\_ 6. bond between oppositely charged ends of two different molecules
- \_\_\_\_\_ 7. smallest particle of a compound that still has the properties of that compound

#### Terms

- covalent bond
- hydrogen bond
- ion
- ionic bond
- isotope
- molecule
- nucleus

---

### Lesson 3.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- A substance that cannot be broken down to simpler substances by ordinary chemical means is called a(n) \_\_\_\_\_.
- The smallest particle of an element that has the properties of that element is known as a(n) \_\_\_\_\_.
- A(n) \_\_\_\_\_ is a subatomic particle with a positive electrical charge.
- A(n) \_\_\_\_\_ is a subatomic particle with a negative electrical charge.
- A molecule that has slightly negative and positive ends is known as a(n) \_\_\_\_\_ molecule.
- The number of protons plus neutrons in an atom is its \_\_\_\_\_.
- The sum of the masses of all the atoms in a molecule is the \_\_\_\_\_.



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## Lesson 3.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast ionic and covalent bonds.

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## 3.2 Minerals and Mineral Groups

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### Lesson 3.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The mineral silver contains silver and carbon atoms.
- \_\_\_\_\_ 2. A mineral has a specific chemical composition.
- \_\_\_\_\_ 3. Minerals are identified on the basis of their physical properties.
- \_\_\_\_\_ 4. Silicate minerals make up over 90 percent of Earth's crust.
- \_\_\_\_\_ 5. Most minerals belong to the native elements group.
- \_\_\_\_\_ 6. Carbonates consist only of carbon and oxygen.
- \_\_\_\_\_ 7. Table salt is an example of a halide mineral.
- \_\_\_\_\_ 8. Phosphate minerals are similar in structure to silicate minerals.
- \_\_\_\_\_ 9. Gypsum is a common sulfide mineral.
- \_\_\_\_\_ 10. Pyrite, or "fool's gold," is a common sulfate mineral.

---

### Lesson 3.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### What Is a Mineral?

To be classified as a mineral, a substance must be a crystalline solid. It also must be inorganic and form through natural processes. In addition, it must have a definite chemical composition. Each of these properties is described next.

A crystalline solid is a substance that forms crystals. A crystal is a solid structure in which atoms or ions are arranged in a regular, repeating pattern. A given mineral always forms crystals with the same pattern of atoms or ions.

An inorganic substance is a substance that is not made by living things. (Organic substances, such as carbohydrates and proteins, are made by living things.) Both diamond and coal consist mainly of carbon. Diamond is a mineral, but coal is not. Coal looks like a mineral, but it is organic. It is a rock made of once-living things.

Minerals are made by natural processes that occur on or under Earth's surface. For example, diamond is created deep in Earth's crust when carbon is put under extreme pressure. Artificial "diamonds" can be made in a lab, by placing carbon under high pressure. However, artificial "diamonds" are not really minerals.

Some minerals, including gold and diamond, are made of single elements. But most minerals are chemical compounds that are made of two or more elements. Different minerals may contain many of the same elements. Elements

commonly found in minerals include oxygen, silicon, and calcium. However, each mineral has a specific chemical composition. For example, halite is made of equal numbers of sodium and chloride ions. Quartz is always made of one silicon atom for every two oxygen atoms.

### Questions

1. What is a mineral?
2. Describe a crystalline solid.
3. Contrast organic and inorganic substances.
4. Diamond and coal both consist of carbon. Why is diamond a mineral whereas coal is not?

---

## Lesson 3.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. All minerals
  - a. form crystals.
  - b. are inorganic.
  - c. form naturally.
  - d. all of the above
2. Minerals are divided into eight major groups based on their
  - a. physical properties.
  - b. chemical composition.
  - c. crystalline structure.
  - d. color and luster.
3. The basic building block of all silicate minerals is called a silica
  - a. tetrahedron.
  - b. pyramid.
  - c. sphere.
  - d. salt.
4. Which of the following minerals is a native element?
  - a. gold
  - b. fluorite
  - c. magnetite
  - d. muscovite
5. Which of the following minerals is an oxide?
  - a. turquoise
  - b. hematite
  - c. azurite
  - d. halite
6. The most common carbonate mineral is
  - a. coal.
  - b. silver.
  - c. calcite.
  - d. diamond.

7. Which statement about phosphate minerals is false?
- They are built of tetrahedra.
  - There are very few of them.
  - They contain phosphorus.
  - Most of them are rare.

---

## Lesson 3.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. minerals containing just one element
- \_\_\_\_\_ 2. solid in which the atoms are arranged in a regular repeating pattern
- \_\_\_\_\_ 3. way that light reflects off a mineral's surface
- \_\_\_\_\_ 4. mineral's tendency to break along flat planes
- \_\_\_\_\_ 5. color of a mineral's powder
- \_\_\_\_\_ 6. minerals that form salts
- \_\_\_\_\_ 7. largest mineral group

### Terms

- a. streak
- b. silicates
- c. crystal
- d. halides
- e. native elements
- f. cleavage
- g. luster

---

## Lesson 3.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- A unique substance with a definite chemical composition that is made up of two or more elements is a chemical \_\_\_\_\_.
- How heavy a substance is relative to the same volume of water is its \_\_\_\_\_.
- \_\_\_\_\_ is the pattern in which a mineral characteristically breaks.
- Hardness and color are \_\_\_\_\_ properties of minerals.
- Feldspar and quartz belong to the \_\_\_\_\_ group of minerals.
- All minerals in the \_\_\_\_\_ group have molecules that contain one carbon atom bonded to three oxygen atoms.

7. Oxides are minerals that contain one or two metal elements combined with \_\_\_\_\_.

---

### Lesson 3.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Identify and describe two mineral groups. How do the two groups differ?

## 3.3 Mineral Identification

### Lesson 3.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Minerals can be identified only by their chemical properties.
- \_\_\_\_\_ 2. Every mineral has its own unique color.
- \_\_\_\_\_ 3. All quartz is clear like glass.
- \_\_\_\_\_ 4. The streak of a given mineral does not vary.
- \_\_\_\_\_ 5. Some minerals do not have the property of streak.
- \_\_\_\_\_ 6. Sparkly luster is a type of metallic luster.
- \_\_\_\_\_ 7. The density of a mineral is calculated by multiplying its mass times its volume.
- \_\_\_\_\_ 8. On the Mohs hardness scale, diamond has a value of 1.
- \_\_\_\_\_ 9. A mineral breaks where its chemical bonds are weakest.
- \_\_\_\_\_ 10. If a mineral smells like rotten eggs, it is the mineral calcite.

### Lesson 3.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Color, Streak, and Luster**

Diamonds are popular gemstones because of the way they reflect light. Their luster makes them appear very sparkly. Turquoise is prized for its color. It is a striking greenish blue. The color of minerals and how they reflect light are two physical properties that may help to identify minerals.

Although the color of a mineral is easy to observe, color alone is rarely very useful for identifying minerals. One reason is that different samples of the same mineral may vary in color. For example, different samples of quartz may be colorless (clear) or purple. Purple quartz contains tiny amounts of iron that give it its color. Many minerals are colored by chemical impurities in this way. Another reason that color alone may not be very useful is that different minerals may be the same color. For example, both gold and pyrite (“fool’s gold”) are yellowish gold in color, but the two are different minerals.

A more useful property for identifying many minerals is streak. Streak is the color of a mineral’s powder. To check a mineral’s streak, scrape a piece of the mineral across an unglazed porcelain plate. Streak is a more reliable property than color for mineral identification because a given mineral’s streak does not vary. Even minerals that are the same color differ in the color of their streak. For example, gold has a golden yellow streak, whereas pyrite has a blackish streak. Streak cannot be used to identify all minerals because not all minerals leave a streak of powder when scraped

across unglazed porcelain. Quartz is an example of a mineral that does not have streak.

Luster describes how light reflects off a mineral's surface. Mineralogists have special terms to describe luster. First, they divide all minerals into those with metallic luster and those with non-metallic luster. Minerals with metallic luster are opaque and shiny. Pyrite is an example. All other minerals have non-metallic luster. There are six different types of non-metallic luster, including adamantine luster, which appears sparkly. Diamond has adamantine luster. Other types of non-metallic luster are earthy luster, which appears dull and clay-like; pearly luster, which appears pearl-like; resinous luster, which appears resin-like, as in tree resin; silky luster, which appears soft looking with long fibers; and vitreous luster, which appears glassy.

### Questions

1. Why is color alone rarely very useful for identifying minerals?
2. What is streak, and how can you check a mineral's streak? Why is streak more useful than color for identifying minerals?
3. What is luster? Outline how minerals are classified on the basis of luster.

---

## Lesson 3.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Physical properties of minerals include
  - a. chemical makeup.
  - b. bonding.
  - c. fracture.
  - d. all of the above
2. Which of the following properties may vary for different samples of a given mineral?
  - a. color
  - b. luster
  - c. streak
  - d. hardness
3. Which mineral has a resinous luster?
  - a. diamond
  - b. quartz
  - c. sulfur
  - d. none of the above
4. Minerals with higher specific gravity have greater
  - a. volume.
  - b. fracture.
  - c. density.
  - d. mass.
5. No other mineral can scratch the mineral
  - a. talc.
  - b. quartz.
  - c. diamond.
  - d. corundum.

6. If a mineral has cleavage it breaks
  - a. into pieces with jagged edges.
  - b. along smooth curved surfaces.
  - c. along smooth flat surfaces.
  - d. into splinters like wood.
7. If a mineral bubbles when exposed to a weak acid, it has the property of
  - a. radioactivity.
  - b. magnetism.
  - c. reactivity.
  - d. acidity.

---

### Lesson 3.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. sparkly non-metallic luster
- \_\_\_\_\_ 2. softest mineral
- \_\_\_\_\_ 3. amount of mass per unit volume
- \_\_\_\_\_ 4. hardest mineral
- \_\_\_\_\_ 5. glowing under ultraviolet light
- \_\_\_\_\_ 6. break in a mineral that is not along a cleavage plane
- \_\_\_\_\_ 7. glassy non-metallic luster

#### Terms

- a. density
- b. fluorescence
- c. talc
- d. fracture
- e. vitreous
- f. adamantine
- g. diamond

---

### Lesson 3.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. The physical property that is usually least useful for mineral identification is \_\_\_\_\_.
2. Scientists who study minerals are known as \_\_\_\_\_.



3. You can see the \_\_\_\_\_ of a mineral by scraping the mineral across an unglazed porcelain plate.
4. Minerals that are opaque and shiny have a(n) \_\_\_\_\_ luster.
5. Earthy, pearly, and silky are types of \_\_\_\_\_ luster.
6. \_\_\_\_\_ is a measure of whether a mineral will scratch, or be scratched by, other minerals.
7. The \_\_\_\_\_ hardness scale is a reference for mineral hardness.

---

### Lesson 3.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how the property of hardness can be used to help identify minerals. What role does the Mohs hardness scale play?

## 3.4 Mineral Formation

### Lesson 3.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Magma cools more quickly than lava.
- \_\_\_\_\_ 2. When melted rock cools quickly, large mineral crystals form.
- \_\_\_\_\_ 3. Dissolved minerals are left behind when water evaporates.
- \_\_\_\_\_ 4. Veins form when minerals are deposited in cracks in rocks by flowing water.
- \_\_\_\_\_ 5. Halite easily precipitates out of water.
- \_\_\_\_\_ 6. There are only three ways that minerals can form.
- \_\_\_\_\_ 7. Minerals can form only from liquids.
- \_\_\_\_\_ 8. Granite is a rock that forms when magma cools quickly.

### Lesson 3.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Formation of Minerals from Solutions

Water on Earth, such as water in the oceans, contains dissolved chemical elements mixed into a solution. Various processes can cause these dissolved elements to combine and form solid minerals.

One way minerals can form from solutions is by evaporation. When water evaporates, elements dissolved in the water are left behind as mineral crystals. Another way minerals can form from solutions is by precipitation. Water can hold only a certain amount of dissolved elements. When this limit is exceeded, particles come together to form mineral solids, which sink to the bottom of the water. Both halite and calcite easily precipitate out of water in this way.

A third way minerals can form from solutions is by deposition in rock underground. Magma heats nearby underground water, and the hot water dissolves elements from rock. Then, as the water flows through open spaces in rock, it cools. The cool water cannot hold as many dissolved elements as the hot water, so it deposits some of the elements as mineral crystals. When minerals are deposited in cracks in rock, they form long, narrow deposits called veins. When minerals are deposited in open spaces in rock, they form large mineral crystals called geodes.

#### Questions

1. List three ways minerals can form from solutions.
2. Compare and contrast mineral formation by evaporation and precipitation.

3. Explain how minerals are deposited in underground rock. Why do some deposits form veins whereas others form geodes?

---

### Lesson 3.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Minerals can form by
  - a. oxidation.
  - b. crystallization.
  - c. deposition.
  - d. all of the above
2. Mineral crystals do not grow very large when they form
  - a. from lava.
  - b. from magma.
  - c. slowly.
  - d. two of the above
3. Minerals in granite include
  - a. quartz.
  - b. geode.
  - c. silicon.
  - d. two of the above
4. Ocean water is a
  - a. mixture.
  - b. solution.
  - c. mineral.
  - d. two of the above
5. Assume that you dissolve some table salt in pure water and pour a small amount of the salt water onto a plate. If you let the water evaporate, what will be left on the plate?
  - a. nothing
  - b. halite
  - c. calcite
  - d. tufa
6. Heated underground water deposits minerals in rock when it
  - a. cools.
  - b. expands.
  - c. evaporates.
  - d. dries up.
7. Which statement about geodes is false?
  - a. They form in cracks in rocks.
  - b. They have large crystals.
  - c. They are rocks that form underground.
  - d. They are deposited by water.

---

## Lesson 3.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. melted rock on Earth's surface
- \_\_\_\_\_ 2. solid mixture of minerals
- \_\_\_\_\_ 3. mineral deposit in a crack in rock
- \_\_\_\_\_ 4. melted rock inside Earth
- \_\_\_\_\_ 5. mineral deposit in an open space in rock

### Terms

- a. magma
- b. lava
- c. rock
- d. vein
- e. geode

---

## Lesson 3.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The more quickly melted rock cools, the \_\_\_\_\_ the mineral crystals are.
- 2. Tufa towers in Mono Lake form by the process of \_\_\_\_\_.
- 3. Veins and geodes in rock form by the process of \_\_\_\_\_.
- 4. Granite forms underground so its mineral crystals are \_\_\_\_\_.
- 5. Minerals form when rocks become so hot that atoms or ions can move around and join into different \_\_\_\_\_ - \_\_\_\_\_.

---

## Lesson 3.4: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast the formation of minerals from magma and lava.

## 3.5 Mining and Mineral Use

### Lesson 3.5: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. It costs less to obtain new minerals than to recycle used minerals.
- \_\_\_\_\_ 2. There are only two ways to mine mineral ores.
- \_\_\_\_\_ 3. Surface mining uses blasting to remove overlying rock.
- \_\_\_\_\_ 4. Gold is the only mineral mined in California.
- \_\_\_\_\_ 5. Mining can have harmful effects on the environment.
- \_\_\_\_\_ 6. U.S. laws require the reclamation of land that has been mined.
- \_\_\_\_\_ 7. All land ever mined in the U.S. has been reclaimed.
- \_\_\_\_\_ 8. Sheetrock is made of the mineral gypsum.
- \_\_\_\_\_ 9. The main ingredient of window glass is the mineral halite.
- \_\_\_\_\_ 10. The metal copper is used for electric wires.

### Lesson 3.5: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Finding and Mining Minerals**

Geologic processes create and concentrate minerals that are valuable natural resources. Geologists study geological formations and then test the physical and chemical properties of soil and rocks to locate possible ore deposits. They also determine the size of the deposits and the concentration of mineral ores. These factors are important in deciding whether a mineral deposit is worth mining. A deposit will be mined only if it would be profitable to do so. A concentration of minerals is called an ore deposit only if it is profitable to mine.

Ore deposits that are close to the surface are mined by surface mining. In surface mining, any overlying rock is blasted away. The rock that contains the valuable minerals is placed in a truck and taken to a refinery. Specific methods of surface mining include open-pit mining, strip mining, mountain-top removal, and placer mining. In open-pit mining, minerals are extracted by digging a big hole in the ground. Strip mining is like open-pit mining except the material is removed in long strips. In mountain-top removal, a mountain top is completely removed to get to the level of the ore. Placer mining is the removal of ore that has been deposited in the gravel of a stream bed.

Ore deposits that are deep underground are mined by underground mining. Miners blast and tunnel into rock to gain access to the ore. The tunnels may be very deep under the ground. Underground mining is expensive and dangerous. Hazards in underground mines include toxic gases, lack of fresh air, total darkness, and the potential for accidents

such as explosions and mine collapses.

### Questions

1. What is an ore deposit? What factors determine whether a mineral deposit is profitable to mine?
2. Explain how ore deposits close to the surface are mined. Identify several specific methods.
3. Describe how ore deposits deep under the surface are mined. Why is this type of mining especially dangerous?

---

## Lesson 3.5: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Scientists who locate ore deposits are
  - a. geologists.
  - b. environmental scientists.
  - c. soil scientists.
  - d. paleontologists.
2. A mineral deposit will be mined only if it
  - a. is profitable to mine.
  - b. is located on the surface.
  - c. contains many different minerals.
  - d. is a renewable source of ores.
3. Methods of surface mining include
  - a. dredging.
  - b. mountain-top removal.
  - c. strip mining.
  - d. all of the above
4. Which statement about placer minerals is false?
  - a. They are found in stream gravels.
  - b. They end up in water because of weathering.
  - c. They were responsible for the 1848 California gold rush.
  - d. They are no longer being deposited in California.
5. Compared with surface mining, underground mining is
  - a. less expensive.
  - b. more dangerous.
  - c. always a better way to extract ore.
  - d. all of the above
6. Adding acid to rocks to remove ore is called
  - a. flotation.
  - b. leaching.
  - c. smelting.
  - d. crushing.
7. To extract metal from ore, the ore is
  - a. mixed with water.

- b. mixed with chemicals.
- c. heated to a high temperature.
- d. cooled to a sub-zero temperature.

---

## Lesson 3.5: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. extracting minerals close to the surface by digging a large hole
- \_\_\_\_\_ 2. restoring mined land to a natural state
- \_\_\_\_\_ 3. concentration of minerals that is profitable enough to mine
- \_\_\_\_\_ 4. extracting minerals from stream gravels
- \_\_\_\_\_ 5. rock that contains minerals with useful elements
- \_\_\_\_\_ 6. extracting minerals close to the surface by removing the surface in strips
- \_\_\_\_\_ 7. mineral that is cut and polished for jewelry

### Terms

- a. gemstone
- b. ore
- c. ore deposit
- d. placer mining
- e. reclamation
- f. strip mining
- g. open-pit mining

---

## Lesson 3.5: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The metal \_\_\_\_\_ is obtained from a mineral ore called bauxite.
- 2. Any method of extracting ores that are close to Earth's surface is called \_\_\_\_\_ mining.
- 3. After ores are mined, they are processed at a(n) \_\_\_\_\_.
- 4. Extracting ores that are deep under Earth's surface is called \_\_\_\_\_ mining.
- 5. The process of \_\_\_\_\_ heats ores to separate the minerals into layers.
- 6. The gemstone \_\_\_\_\_ is so hard that it is used to cut glass and metals.
- 7. The mineral \_\_\_\_\_ is mined for rock salt.

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## Lesson 3.5: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how mining can adversely affect the environment and how land that has been mined is reclaimed.



## CHAPTER

## 4

# HS Rocks Worksheets

## Chapter Outline

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- 4.1**    **TYPES OF ROCKS**
  - 4.2**    **IGNEOUS ROCKS**
  - 4.3**    **SEDIMENTARY ROCKS**
  - 4.4**    **METAMORPHIC ROCKS**
- 

- Lesson 4.1: Types of Rocks
- Lesson 4.2: Igneous Rocks
- Lesson 4.3: Sedimentary Rocks
- Lesson 4.4: Metamorphic Rocks

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## 4.1 Types of Rocks

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### Lesson 4.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Mineral grains in rocks are always visible to the unaided eye.
  - \_\_\_\_\_ 2. Each type of rock consists of a distinctive mineral or set of minerals.
  - \_\_\_\_\_ 3. Igneous rocks that cool slowly have smaller grains than those that cool quickly.
  - \_\_\_\_\_ 4. Sediments are never larger than grains of sand.
  - \_\_\_\_\_ 5. Some sedimentary rocks form from chemical precipitates.
  - \_\_\_\_\_ 6. Metamorphic rocks form only under Earth's surface.
  - \_\_\_\_\_ 7. Sandstone forms when quartzite is exposed to heat and pressure.
  - \_\_\_\_\_ 8. The concept of the rock cycle is attributed to geologist James Hutton.
  - \_\_\_\_\_ 9. The rock cycle always begins with igneous rock and ends with metamorphic rock.
  - \_\_\_\_\_ 10. Metamorphism can change the texture but not the mineral composition of rock.
- 

### Lesson 4.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### What Are Rocks?

Rocks are naturally formed, non-living Earth materials. Rocks are made of collections of mineral grains that are held together in a hard, solid mass. The mineral grains in rocks may be so tiny that you can see them only with a microscope, or they may be as big as your finger.

Rocks are identified primarily by the minerals they contain and by their texture. Each type of rock has distinctive minerals. A rock may be made of grains of all one mineral type. Much more commonly, a rock is made of a mixture of different minerals. Texture is a description of the size, shape, and arrangement of mineral grains. Two rocks may have the same chemical composition and contain mostly the same minerals, but they may have different textures. Their different textures indicate different histories. For example, a rock that formed from molten rock will have small grains and a fine texture if it cooled quickly on Earth's surface. A rock with the same composition that cooled slowly under Earth's surface will have larger grains and a coarser texture.

#### Questions

- 1. What are rocks, and what are they made of?
- 2. How are rocks identified?

3. Define rock texture. What determines the texture of rock? Give examples.

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## Lesson 4.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. All rocks
  - a. are naturally forming.
  - b. form beneath Earth's surface.
  - c. consist of sediments.
  - d. all of the above
2. Rocks are identified primarily by
  - a. the minerals they contain.
  - b. their texture.
  - c. their color.
  - d. two of the above
3. The classification of rocks into three major categories is based on
  - a. how the rocks form.
  - b. which chemicals the rocks contain.
  - c. how old the rocks are.
  - d. two of the above
4. Igneous rocks form by
  - a. cementation.
  - b. compaction.
  - c. crystallization.
  - d. precipitation.
5. Which of the following rocks is a sedimentary rock?
  - a. diorite
  - b. andesite
  - c. quartzite
  - d. sandstone
6. Processes that take place in the rock cycle include
  - a. erosion.
  - b. melting.
  - c. tectonic burial.
  - d. all of the above
7. Metamorphic rock can form from
  - a. igneous rock.
  - b. sedimentary rock.
  - c. other metamorphic rock.
  - d. all of the above

---

## Lesson 4.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. broken piece of rock
- \_\_\_\_\_ 2. exposed rock formation
- \_\_\_\_\_ 3. solid material left behind when a liquid evaporates
- \_\_\_\_\_ 4. rock that forms when molten rock solidifies
- \_\_\_\_\_ 5. transport of sediments from one place to another
- \_\_\_\_\_ 6. rock that forms from sediments
- \_\_\_\_\_ 7. rock that forms when existing rock is changed by heat or pressure

### Terms

- a. erosion
- b. igneous rock
- c. metamorphic rock
- d. sedimentary rock
- e. outcrop
- f. precipitate
- g. sediment

---

## Lesson 4.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. \_\_\_\_\_ is a description of the size, shape, and arrangement of mineral grains in a rock.
- 2. The process in which mineral crystals form as molten rock cools is called \_\_\_\_\_.
- 3. The process in which a rock changes due to heat or pressure inside Earth is \_\_\_\_\_.
- 4. The continuous series of processes by which rocks change from one type to another is called the \_\_\_\_\_.
- 5. \_\_\_\_\_ is the deposition of transported sediments.
- 6. The wearing away of rocks at Earth's surface is known as \_\_\_\_\_.
- 7. After molten rock flows onto Earth's surface, it is called \_\_\_\_\_.

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## Lesson 4.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast the three main categories of rocks.

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## 4.2 Igneous Rocks

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### Lesson 4.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. About 70 different types of igneous rocks are known.
- \_\_\_\_\_ 2. The most prevalent element in magma is oxygen.
- \_\_\_\_\_ 3. Most rocks on Earth are igneous rocks.
- \_\_\_\_\_ 4. Adding water to rock raises the rock's melting point.
- \_\_\_\_\_ 5. All minerals melt at about the same temperature.
- \_\_\_\_\_ 6. Minerals crystallize out of magma when it melts.
- \_\_\_\_\_ 7. A pluton is an extrusive igneous rock that cooled on the crust.
- \_\_\_\_\_ 8. Most igneous rocks lie below sedimentary rock or ocean water.
- \_\_\_\_\_ 9. Pumice is an example of volcanic rock.
- \_\_\_\_\_ 10. Obsidian is called natural glass.

---

### Lesson 4.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Magma**

The rock beneath Earth's surface is sometimes heated to high enough temperatures that it melts and forms magma. Different magmas have different compositions. They contain whatever elements were in the rock that melted. Magmas also contain gases. The main elements found in magma are the same as the elements that are found in crust. Oxygen and silicon are the most prevalent.

Whether a given rock melts and forms magma depends on several factors. Temperature is one factor. The temperature has to reach hundreds of degrees Celsius before any minerals melt. Minerals melt at different temperatures, so the mineral composition of rock is an important factor influencing whether it melts. Of common minerals, quartz melts at the lowest temperature (about 650 °C), whereas olivine melts at the highest temperature (about 1400 °C). Therefore, as the temperature of rock rises, the first mineral to melt is quartz (if present) and the last mineral to melt is olivine (if present). Partial melting occurs when the temperature rises high enough to melt only some of the minerals in rock. Temperature increases with depth below Earth's surface, so melting is more likely to occur at greater depths.

Pressure on rock also increases at greater depths. However, increased pressure raises the melting point of rock, so melting is less likely to occur at higher pressures. The addition of water to rock, on the other hand, lowers the melting point of rock, so melting is more likely to occur with added water.

**Questions**

1. How does magma form?
2. Describe the composition of magma.
3. Identify factors that influence the melting of rock. Explain the influence of each factor.

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**Lesson 4.2: Multiple Choice**

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. All igneous rocks form when
  - a. volcanoes erupt.
  - b. minerals precipitate.
  - c. molten rock hardens.
  - d. lava crystallizes.
2. Which statement about magma is false?
  - a. It contains gases.
  - b. It is melted rock.
  - c. It may form on Earth's surface.
  - d. It consists of elements in Earth's crust.
3. Whether a given rock inside Earth melts depends on
  - a. its temperature.
  - b. the pressure exerted on it.
  - c. its mineral composition.
  - d. all of the above
4. Fractional crystallization is the
  - a. breaking of crystals in magma.
  - b. opposite of partial melting.
  - c. formation of fractured rock.
  - d. two of the above
5. Which of the following minerals forms crystals at the lowest temperature?
  - a. quartz
  - b. feldspar
  - c. pyroxine
  - d. olivine
6. Why does basalt have no visible crystals?
  - a. It forms when lava cools quickly.
  - b. It forms beneath the ocean floor.
  - c. It consists of low-density minerals.
  - d. It consists of ultramafic minerals.
7. Which class of igneous rock contains the mineral quartz?
  - a. felsic
  - b. intermediate
  - c. mafic
  - d. ultramafic

---

## Lesson 4.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. most common intrusive igneous rock
- \_\_\_\_\_ 2. any igneous rock that forms on Earth's surface
- \_\_\_\_\_ 3. type of igneous rock that is light in color and low in density
- \_\_\_\_\_ 4. igneous rock that cools so rapidly it lacks crystals
- \_\_\_\_\_ 5. any igneous rock that forms beneath Earth's surface
- \_\_\_\_\_ 6. type of igneous rock that is dark in color and high in density
- \_\_\_\_\_ 7. most common extrusive igneous rock

### Terms

- a. intrusive rock
- b. felsic rock
- c. granite
- d. mafic rock
- e. extrusive rock
- f. basalt
- g. obsidian

---

## Lesson 4.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Bowen's reaction series shows the \_\_\_\_\_ at which minerals melt or crystallize.
- 2. \_\_\_\_\_ melting occurs when the temperature of rock is too low to melt all of the minerals.
- 3. The mineral that crystallizes at the highest temperature is \_\_\_\_\_.
- 4. Volcanic rock is another name for \_\_\_\_\_ igneous rock.
- 5. Igneous rock made only of the mineral olivine is classified as \_\_\_\_\_ in composition.
- 6. The stone in "stone-washed" is the igneous rock named \_\_\_\_\_.
- 7. Granite is an igneous rock with a(n) \_\_\_\_\_ composition.

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## Lesson 4.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*



California's Sierra Nevada Mountains consist mainly of granite. Based on what you know about granite, explain why the mountains could not have formed by volcanic activity. How did the mountains form?

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## 4.3 Sedimentary Rocks

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### Lesson 4.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The sediments in sedimentary rock may be precipitates.
- \_\_\_\_\_ 2. Weathering breaks up or dissolves rock.
- \_\_\_\_\_ 3. The more energy a stream has, the larger the sediments it can carry.
- \_\_\_\_\_ 4. Sediments settle out of water in vertical layers.
- \_\_\_\_\_ 5. Shale is a type of bioclastic sedimentary rock.
- \_\_\_\_\_ 6. Sedimentary rocks are softer than igneous or metamorphic rocks.
- \_\_\_\_\_ 7. Sedimentary rocks are too fragile to be used for construction.
- \_\_\_\_\_ 8. Rock salt forms from a chemical precipitate.
- \_\_\_\_\_ 9. Clastic rocks are sedimentary rocks that form only from sand-sized sediments.
- \_\_\_\_\_ 10. Lithification is the second step of cementation.

---

### Lesson 4.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Sedimentary Rock Formation**

Accumulated sediments harden into sedimentary rock by lithification. Two important steps are needed for sediments to lithify: compaction and cementation.

1. Compaction occurs when sediments are squeezed together by the weight of all the sediments on top of them.
2. Cementation occurs when spaces between sediments fill in with mineral crystals. The minerals crystallize out of water that seeps through the sediments.

Sedimentary rocks can form from sediments with a wide range of sizes. The type of sedimentary rock that forms depends on the size of the sediments.

- If sediments are large and rounded, they form rock called conglomerate.
- If sediments are large and angular, they form rock called breccia.
- Smaller, sand-sized sediments form sandstone.
- Still smaller, silt-sized sediments form siltstone.
- The smallest, clay-sized sediments form shale.

When sediments settle out of calm water, they form horizontal layers. One layer is deposited first; then another layer is deposited on top of the first layer. More and more layers are deposited on the layers below them. Therefore, any layer of sedimentary rock is always younger than the layer below it, as long as the layers have not been disturbed.

Biochemical sedimentary rocks form at the bottom of an ocean or salt lake. Living creatures remove ions—such as calcium, magnesium, and potassium—from the salt water to make shells and other tissues. When the organisms die, they sink to the ocean floor. Their shells become biochemical sediments, which may then become compacted and cemented into sedimentary rocks.

### Questions

1. What is lithification? What steps occur during lithification?
2. Relate sediment size to type of sedimentary rock.
3. Explain why any layer of sedimentary rock is younger than the layer below it, as long as the layers have not been disturbed.
4. What are biochemical sedimentary rocks? Where and how do they form?

---

## Lesson 4.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Which statement about sandstone is false?
  - a. It is very porous.
  - b. It is chemical sedimentary rock.
  - c. It forms from sand-sized sediments.
  - d. It is easily penetrated by rainwater.
2. In which sequence do the processes of weathering, deposition, and erosion occur to provide the basis of sedimentary rock?
  - a. weathering, erosion, deposition
  - b. erosion, weathering, deposition
  - c. deposition, erosion, weathering
  - d. erosion, deposition, weathering
3. When flowing water slows down it
  - a. drops sediments.
  - b. has less energy.
  - c. causes more erosion.
  - d. two of the above
4. Each layer of sedimentary rock
  - a. is older than the layer below it.
  - b. is younger than the layer above it.
  - c. was deposited after the layer below it.
  - d. was deposited after the layer above it.
5. Biochemical sedimentary rock
  - a. forms deep beneath Earth's surface.
  - b. forms at the bottom of salt water.
  - c. consists only of chemical precipitates.

- d. two of the above
- 6. Which of the following is a biochemical sedimentary rock?
  - a. sandstone
  - b. shale
  - c. limestone
  - d. siltstone
- 7. Uses of sedimentary rock include
  - a. building stone structures.
  - b. making concrete.
  - c. making asphalt
  - d. all of the above

---

### Lesson 4.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. sedimentary rock that forms from chemical precipitates
- \_\_\_\_\_ 2. process by which sediments harden into rock
- \_\_\_\_\_ 3. sedimentary rock containing only inorganic sediments
- \_\_\_\_\_ 4. breaking of rock into smaller pieces
- \_\_\_\_\_ 5. crystallization that fills in the spaces between loose sediments
- \_\_\_\_\_ 6. dissolving of minerals in rock
- \_\_\_\_\_ 7. sedimentary rock containing organic sediments

#### Terms

- a. physical weathering
- b. clastic rock
- c. chemical weathering
- d. bioclastic rock
- e. cementation
- f. lithification
- g. chemical rock

---

### Lesson 4.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The White House in Washington, D.C., is made of the sedimentary rock \_\_\_\_\_.

2. The transport of sediments by water, wind, ice, or gravity is called \_\_\_\_\_.
3. The two steps of lithification are compaction and \_\_\_\_\_.
4. Sedimentary rock that consists of large angular sediments is named \_\_\_\_\_.
5. Sedimentary rock that forms from clay is called \_\_\_\_\_.
6. Sedimentary rock that consists of large rounded sediments is named \_\_\_\_\_.
7. The squeezing together of sediments by the weight of overlying sediments is called \_\_\_\_\_.

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### Lesson 4.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast the sedimentary rocks sandstone and limestone.

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## 4.4 Metamorphic Rocks

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### Lesson 4.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. When rocks undergo metamorphism, they always change chemically.
- \_\_\_\_\_ 2. Extreme pressure during metamorphism always causes rocks to develop layers.
- \_\_\_\_\_ 3. Metamorphism can occur without extreme pressure being applied to rocks.
- \_\_\_\_\_ 4. The metamorphism of shale can result in the metamorphic rock schist.
- \_\_\_\_\_ 5. The metamorphic rock hornfels forms by regional metamorphism.
- \_\_\_\_\_ 6. The parent rock of the metamorphic rock quartzite is limestone.
- \_\_\_\_\_ 7. The metamorphic rock named schist may be used for landscaping.
- \_\_\_\_\_ 8. Some toothpastes contain the metamorphic rock marble.
- \_\_\_\_\_ 9. The metamorphic rock slate may be used as a building material.
- \_\_\_\_\_ 10. The metamorphic rock quartzite is very soft and crumbly.

---

### Lesson 4.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Metamorphism

Any type of rock—igneous, sedimentary, or metamorphic—can become a metamorphic rock. All that is needed is enough heat and/or pressure to alter the parent rock's physical or chemical makeup without melting the rock entirely. Rocks change during metamorphism because their minerals must be stable under the new temperature and pressure conditions. The need for stability may cause the structure of minerals to rearrange so new minerals form. Ions may move between minerals to create minerals with different chemical compositions.

Extreme pressure exerted from one direction only may cause foliation. During this process, layers form in rocks as they are squeezed by extreme pressure. Examples of foliated metamorphic rocks include slate and schist, both of which form from the sedimentary rock shale. Metamorphic rocks may also be non-foliated. Quartzite and marble are nonfoliated metamorphic rocks.

#### Questions

1. What causes rocks to undergo metamorphism?
2. Why do rocks change during metamorphism?
3. What is foliation? When does it occur?

---

## Lesson 4.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. What happens during metamorphism?
  - a. Rocks change physically or chemically.
  - b. Rocks form from magma.
  - c. Rocks melt completely.
  - d. any of the above
2. Foliation normally occurs when
  - a. rock temperature rises to the melting point.
  - b. pressure is exerted in just one direction on rock.
  - c. layers of rock are peeled away by extreme heat.
  - d. layers in rock disappear due to extreme pressure.
3. Regional metamorphism may be caused by
  - a. extreme pressure from overlying rock.
  - b. burial of rock deep below Earth's surface.
  - c. compression by geologic processes.
  - d. all of the above
4. Contact metamorphism occurs
  - a. over a wide area.
  - b. because of extreme heat.
  - c. when rock changes to magma.
  - d. because of weathering and erosion.
5. All of the following are non-foliated metamorphic rocks except
  - a. schist.
  - b. marble.
  - c. quartzite.
  - d. metaconglomerate.
6. When shale undergoes metamorphism, it may change to
  - a. phyllite.
  - b. marble.
  - c. quartzite.
  - d. none of the above

---

## Lesson 4.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

\_\_\_\_\_ 1. changes in enormous quantities of rock over a wide area

- \_\_\_\_\_ 2. example of foliated metamorphic rock
- \_\_\_\_\_ 3. formation of layers in rock due to pressure from one direction
- \_\_\_\_\_ 4. example of non-foliated metamorphic rock
- \_\_\_\_\_ 5. changes in rock due to heating by nearby magma

**Terms**

- a. gneiss
- b. foliation
- c. hornfels
- d. regional metamorphism
- e. contact metamorphism

---

**Lesson 4.4: Fill in the Blank**

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. \_\_\_\_\_ occurs when rock changes from one type to another due to extreme heat or pressure.
- 2. Slate forms when \_\_\_\_\_ undergoes metamorphism.
- 3. When sandstone undergoes metamorphism, it becomes \_\_\_\_\_.
- 4. Marble is a metamorphic rock that forms from \_\_\_\_\_.
- 5. Rocks change during metamorphism because the \_\_\_\_\_ must be stable under the higher temperature and pressure.
- 6. The rock from which a metamorphic rock forms is called the \_\_\_\_\_ rock.

---

**Lesson 4.4: Critical Writing**

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast regional and contact metamorphism.



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**CHAPTER 5**

# HS Earth's Energy Worksheets

## Chapter Outline

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- 5.1 ENERGY RESOURCES**
  - 5.2 NON-RENEWABLE ENERGY RESOURCES**
  - 5.3 RENEWABLE ENERGY RESOURCES**
- 

- **Lesson 5.1: Energy Resources**
- **Lesson 5.2: Non-renewable Energy Resources**
- **Lesson 5.3: Renewable Energy Resources**

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## 5.1 Energy Resources

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### Lesson 5.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. You need energy only when you move.
  - \_\_\_\_\_ 2. Energy can change from one form to another.
  - \_\_\_\_\_ 3. Energy can never be created or destroyed.
  - \_\_\_\_\_ 4. A ball rolling downhill has both potential and kinetic energy.
  - \_\_\_\_\_ 5. The heat released when a fuel burns is usually wasted energy.
  - \_\_\_\_\_ 6. Fossil fuels are nonrenewable energy resources because more fossil fuels can never be made.
  - \_\_\_\_\_ 7. The use of renewable energy resources has only pros and no cons.
  - \_\_\_\_\_ 8. Fossil fuels form from the decomposed remains of dead organisms.
  - \_\_\_\_\_ 9. The use of fossil fuels contributes to global warming.
  - \_\_\_\_\_ 10. Eventually, everyone will have to use renewable energy resources.
- 

### Lesson 5.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Types of Energy Resources

There are two basic types of energy resources. Like other natural resources, energy resources are either nonrenewable or renewable.

Nonrenewable resources are natural resources that either cannot be replaced at all or cannot be replaced as quickly as they are used. Fossil fuels—coal, oil, and natural gas—are the major nonrenewable energy resources used today. They form from the partially decomposed remains of once-living organisms. Fossil fuels take millions of years to form, far too long to be replaced as quickly as we use them. The use of fossil fuels also has adverse effects on the environment. When fossil fuels are burned, they release pollutants into the atmosphere that can harm human health and the health of ecosystems. The burning of fossil fuels also releases carbon dioxide and other greenhouse gases, which are causing global temperatures to rise.

Renewable resources are natural resources that either are virtually limitless or can be replaced as quickly as they are used. The sun will continue to provide us with solar energy for billions of years. Flowing water and wind will always be abundant. Sources of biomass energy, such as trees, can be replaced relatively quickly. Unlike the use of fossil fuels, the use of most renewable energy resources does not produce pollutants or carbon dioxide. However, some renewable energy resources can cause environmental problems. For example, damming streams to capture

energy from flowing water can harm ecosystems. Some renewable energy resources are currently expensive to use. Some are needed for other uses in addition to energy. For example, trees are needed for lumber in addition to fuel.

### Questions

1. Define nonrenewable and renewable resources.
2. Identify common nonrenewable energy resources. What problems are associated with their use?
3. What are some renewable energy resources? List at least one pro and one con of using renewable energy resources.

---

## Lesson 5.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. When plants make “food” by photosynthesis, they change the energy in sunlight to
  - a. heat energy.
  - b. light energy.
  - c. kinetic energy.
  - d. chemical energy.
2. What happens every time energy changes form?
  - a. New energy is created.
  - b. Some energy is destroyed.
  - c. The amount of energy stays the same.
  - d. Most of the energy is given off as heat.
3. When you kick a soccer ball, you are changing
  - a. kinetic energy to potential energy.
  - b. kinetic energy to chemical energy.
  - c. potential energy to chemical energy.
  - d. chemical energy to kinetic energy.
4. All of the following are commonly used for fuel except
  - a. food.
  - b. water.
  - c. sunlight.
  - d. gasoline.
5. For fuel to be useful, energy must be released
  - a. as heat or light.
  - b. in a controlled way.
  - c. continuously.
  - d. over a long period of time.
6. Which of the following is a nonrenewable energy resource?
  - a. geothermal
  - b. anthracite
  - c. sunlight
  - d. biomass
7. Which of the following statements about renewable energy resources is true?

- a. Using renewable energy resources never harms the environment.
- b. There are endless supplies of all renewable energy resources.
- c. All renewable energy resources are cheap to use.
- d. none of the above

---

## Lesson 5.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. energy stored in chemical bonds
- \_\_\_\_\_ 2. any material that can release energy in a chemical change
- \_\_\_\_\_ 3. energy that is stored
- \_\_\_\_\_ 4. ability to do work or produce change
- \_\_\_\_\_ 5. resource that is used more quickly than it can be replaced
- \_\_\_\_\_ 6. energy of anything in motion
- \_\_\_\_\_ 7. resource that is replaced as quickly as it is used

### Terms

- a. kinetic energy
- b. nonrenewable resource
- c. chemical energy
- d. renewable resource
- e. energy
- f. fuel
- g. potential energy

---

## Lesson 5.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. The law of \_\_\_\_\_ states that energy cannot be created or destroyed.
2. \_\_\_\_\_ energy has the potential to do work or be converted to other forms of energy.
3. Most of the energy released when fuel is burned is released as \_\_\_\_\_.
4. Coal, oil, and natural gas are called \_\_\_\_\_ fuels.
5. The fuels in question 4 are all \_\_\_\_\_ energy resources.
6. Sunlight, flowing water, and wind are all \_\_\_\_\_ energy resources.
7. Your body breaks down food and stores the energy as \_\_\_\_\_ energy.

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## Lesson 5.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Relate the concepts of energy, fuel, and heat.

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## 5.2 Non-renewable Energy Resources

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### Lesson 5.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Fossil fuels form because of intense heat and pressure on organic remains.
- \_\_\_\_\_ 2. Hydrocarbon compounds can be solids, liquids, or gases.
- \_\_\_\_\_ 3. The main reason coal is burned today is to heat homes and other buildings.
- \_\_\_\_\_ 4. About 90 percent of the energy used worldwide for transportation is provided by oil.
- \_\_\_\_\_ 5. Natural gas forms at a lower temperature than crude oil.
- \_\_\_\_\_ 6. Natural gas does not have to be processed before it can be used as a fuel.
- \_\_\_\_\_ 7. Worldwide fossil fuel use has been declining for several decades.
- \_\_\_\_\_ 8. At current rates of use, oil and natural gas will not run out for many centuries.
- \_\_\_\_\_ 9. Wastes from nuclear power plants remain dangerous for thousands of years.
- \_\_\_\_\_ 10. The U.S. no longer has any functioning nuclear power plants.

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### Lesson 5.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Oil

Oil, or petroleum, is a liquid fossil fuel. It is currently the single largest source of energy in the world. When oil first comes out of the ground, it is called crude oil. It is a thick, dark brown or black liquid. It forms from the remains of tiny organisms that live at the sea surface and then sink to the seafloor when they die, forming layers of deposits. As the layers pile up, heat and pressure increase. Over millions of years, the dead organisms turn into liquid oil.

Crude oil is a mixture of many different hydrocarbons. To separate the different hydrocarbons, crude oil must be broken down, or refined, in plants called refineries. Refining is possible because each hydrocarbon in crude oil boils at a different temperature. When the oil is boiled in a refinery, the different hydrocarbons boil off at different times and are collected separately. Most of the compounds that come out of the refining process are fuels, such as gasoline, diesel fuel, and jet fuel. Because these fuels are rich sources of energy and can be transported easily, they provide about 90 percent of the energy used for transportation around the world. The rest of the compounds from crude oil are used to make products such as waxes, plastics, and fertilizers.

The United States produces oil but only about one-quarter as much as the nation uses. The United States has only about 1.5% of the world's proven oil reserves, so most of the oil used by Americans must be imported from other nations. In the United States, the main oil-producing regions are the Gulf of Mexico, Texas, Alaska, and California.

Most offshore drilling occurs in the Gulf of Mexico. As in every type of mining, mining for oil has environmental consequences. Oil rigs are unsightly and spills are all too common. Oil spills can be disastrous to ecosystems.

### Questions

1. How does crude oil form?
2. Explain why and how crude oil is refined.
3. Why are fuels from crude oil so widely used for transportation?
4. Besides fuels, what products can be made from crude oil?
5. Describe oil production in the United States.

---

## Lesson 5.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. How long does it take fossil fuels to form?
  - a. about 500 thousand years
  - b. up to 5 million years
  - c. more than 100 million years
  - d. none of the above
2. Which fossil fuels formed from dead sea organisms?
  - a. coal and oil
  - b. oil and natural gas
  - c. coal and natural gas
  - d. coal, oil, and natural gas
3. The fossil fuel that is likely to last the longest before running out is
  - a. petroleum.
  - b. natural gas.
  - c. crude oil.
  - d. coal.
4. Which form of coal has the fewest impurities?
  - a. lignite
  - b. anthracite
  - c. bituminous
  - d. subbituminous
5. The different types of hydrocarbons in crude oil can be separated by
  - a. boiling.
  - b. fracking.
  - c. crushing.
  - d. dissolving.
6. Which statement about oil and the U.S. is false?
  - a. The U.S. has only about 1.5 % of the world's known oil reserves.
  - b. The U.S. produces only about one-quarter as much oil as it uses.
  - c. Most of the oil used in the U.S. is imported from other countries.
  - d. Most of the oil produced by the U.S. is produced in the Northeast.

7. Problems associated with the use of nuclear power include
- production of hazardous wastes.
  - dependence on a nonrenewable fuel.
  - release of carbon dioxide into the air.
  - two of the above

---

## Lesson 5.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. form of petroleum when it first comes out of the ground
- \_\_\_\_\_ 2. fossil fuel composed primarily of methane
- \_\_\_\_\_ 3. type of compound made of carbon and hydrogen atoms
- \_\_\_\_\_ 4. coal, oil, or natural gas
- \_\_\_\_\_ 5. remains or traces of an organism that have turned to rock
- \_\_\_\_\_ 6. single largest energy resource in the world today
- \_\_\_\_\_ 7. fossil fuel that formed from the remains of ancient swamp plants

### Terms

- fossil fuel
- petroleum
- coal
- crude oil
- fossil
- natural gas
- hydrocarbon

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## Lesson 5.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- Worldwide, more electricity is generated by burning \_\_\_\_\_ than any other fuel.
- Some compounds refined from \_\_\_\_\_ are used to make waxes, plastics, and fertilizers.
- The fossil fuel that releases the least amount of pollutants when it burns is \_\_\_\_\_.
- \_\_\_\_\_ is a method of drilling for natural gas that pumps fluids into underground rock.
- The energy released when the nucleus of an atom splits is called \_\_\_\_\_ energy.
- The element \_\_\_\_\_ is the fuel that is used in nuclear power plants.
- \_\_\_\_\_ energy is a nonrenewable energy resource that does not pollute the air.



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## Lesson 5.2: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Weigh the pros and cons of using fossil fuels versus nuclear energy to produce electricity.

## 5.3 Renewable Energy Resources

### Lesson 5.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Most renewable energy resources do not cause much pollution.
- \_\_\_\_\_ 2. Solar energy has been used only in the past 100 years.
- \_\_\_\_\_ 3. The International Space Station is powered by wind turbines.
- \_\_\_\_\_ 4. Most of the streams in the U.S. that are suitable for hydroelectric power have not yet been dammed.
- \_\_\_\_\_ 5. A dam floods land upstream and may kill or displace living things.
- \_\_\_\_\_ 6. In many parts of the world, tide and wave power plants are very common.
- \_\_\_\_\_ 7. Winds blow because of unequal heating of Earth's surface by the sun.
- \_\_\_\_\_ 8. Wood and coal are both sources of biomass energy.
- \_\_\_\_\_ 9. Solar panels take up a lot of space.
- \_\_\_\_\_ 10. Dams can have adverse effects on downstream environments.

### Lesson 5.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Solar Energy

The sun is Earth's main source of energy, making the development of solar power a natural choice for an alternative energy resource. The sun's energy comes from the fusion of atoms of the lightest element, hydrogen. The results of fusion are atoms of the second lightest element, helium, and tremendous amounts of energy. Some of the sun's energy travels to Earth, mostly as visible light. The light carries the energy through empty space from the sun to Earth as radiation.

Solar energy has been used for power on a small scale for hundreds of years, and plants have used it for photosynthesis for billions of year. Unlike energy from fossil fuels, which almost always come from a central power plant or refinery, solar power can be harnessed locally because sunlight is everywhere. For example, a set of solar panels on a home's rooftop can be used to heat water for a swimming pool or provide electricity to the house. Solar energy can also be used in devices such as calculators and outdoor lights.

The use of solar energy on a larger scale is just starting to be developed. Scientists and engineers have very active, ongoing research into new ways to harness energy from the sun more efficiently. In the United States, solar power is being developed in areas that receive a lot of sun, including southeastern California, Nevada, and Arizona. Solar power plants turn sunlight into electricity using a large group of mirrors to focus sunlight on one place, called a

receiver. A liquid, such as oil or water, flows through the receiver and is heated to a high temperature by the focused sunlight. The heated liquid transfers its heat to a nearby object that has a lower temperature. This transfer occurs through a process called conduction. The energy conducted by the heated liquid is used to make electricity.

Solar energy has many advantages. It is extremely abundant and widespread, and it will never run out. But there are problems with the use of solar energy. For example, it is not available at night and not reliable in locations that are often cloudy. However, storage technology is being developed to overcome these problems. Other drawbacks include the expense of the technology needed to use solar energy and the relatively large amount of space required by solar panels.

### Questions

1. Where does solar energy come from, and how does it reach Earth?
2. What are some ways that solar energy can be used?
3. How do solar power plants collect, focus, and transfer solar energy?
4. What are pros and cons of using solar energy?

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## Lesson 5.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The sun gets its energy from
  - a. radiation.
  - b. conduction.
  - c. nuclear fusion.
  - d. geothermal power.
2. Which of the following is not a con of solar power?
  - a. It contributes to global warming.
  - b. It requires expensive technology.
  - c. It is not available at night.
  - d. It is not available when it is cloudy.
3. Potential sources of water power include
  - a. runoff.
  - b. waves.
  - c. ponds.
  - d. lakes.
4. Which of the following is a problem with using wind energy?
  - a. Wind turbines are expensive.
  - b. Wind turbines wear out quickly.
  - c. Wind turbines cause air pollution.
  - d. two of the above
5. Geothermal energy
  - a. is found in only a few places on Earth.
  - b. cannot be used to make electricity.
  - c. needs to be processed before use.
  - d. is clean and safe to use.

6. Compared with fossil fuels, biofuels

- a. burn less cleanly.
- b. create more pollution.
- c. release less carbon dioxide.
- d. two of the above

7. Possible sources of biomass include

- a. cow manure.
- b. food waste.
- c. algae.
- d. all of the above

---

### Lesson 5.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. transfer of heat directly between objects in contact
- \_\_\_\_\_ 2. organic material that is burned for energy or used to make fuel
- \_\_\_\_\_ 3. reaction in which two hydrogen atoms combine to create a helium atom
- \_\_\_\_\_ 4. transfer of energy through space
- \_\_\_\_\_ 5. electricity made with energy from flowing water
- \_\_\_\_\_ 6. energy from heat below Earth's surface
- \_\_\_\_\_ 7. fuel made from crops such as corn

#### Terms

- a. biofuel
- b. hydroelectric power
- c. conduction
- d. nuclear fusion
- e. radiation
- f. biomass
- g. geothermal

---

### Lesson 5.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Energy sources that will not run out are \_\_\_\_\_ energy sources.
- 2. Earth's main source of energy is the \_\_\_\_\_.

3. Solar power plants use mirrors to focus sunlight on one place called the \_\_\_\_\_.
4. The form of renewable energy that is most widely used by people worldwide is \_\_\_\_\_ power.
5. Water held behind a dam has \_\_\_\_\_ energy.
6. A(n) \_\_\_\_\_ is a device that turns wind into electricity.
7. Ethanol is a(n) \_\_\_\_\_ that is added to gasoline to reduce fossil fuel use.

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### Lesson 5.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast moving air and flowing water as alternative energy resources.

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# CHAPTER 6

# HS Plate Tectonics Worksheets

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## Chapter Outline

- 
- |     |                           |
|-----|---------------------------|
| 6.1 | INSIDE EARTH              |
| 6.2 | CONTINENTAL DRIFT         |
| 6.3 | SEAFLOOR SPREADING        |
| 6.4 | THEORY OF PLATE TECTONICS |
- 

- Lesson 6.1: Inside Earth
- Lesson 6.2: Continental Drift
- Lesson 6.3: Seafloor Spreading
- Lesson 6.4: Theory of Plate Tectonics

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## 6.1 Inside Earth

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### Lesson 6.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Earth is divided by composition into three layers.
- \_\_\_\_\_ 2. P-waves are the first seismic waves to reach a seismometer.
- \_\_\_\_\_ 3. S-waves travel more slowly through liquids than solids.
- \_\_\_\_\_ 4. The lithosphere is thinner than the crust.
- \_\_\_\_\_ 5. The mantle is heated mainly by heat conducted from the core.
- \_\_\_\_\_ 6. The outer core has a higher temperature than the inner core.
- \_\_\_\_\_ 7. S-waves cannot travel through the outer core.
- \_\_\_\_\_ 8. Radioactive elements break down in the inner core.
- \_\_\_\_\_ 9. Ancient meteorites are thought to be similar to Earth's crust.
- \_\_\_\_\_ 10. The core makes up about two-thirds of Earth by mass.

---

### Lesson 6.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Exploring Earth's Interior with Seismic Waves

How do scientists know what is inside Earth? They don't have much direct evidence. Rocks yield some clues but mainly just about the upper crust. Only in rare instances does a mineral, such as diamond, come to the surface from the lower crust or mantle. Scientists know about Earth's interior mainly from indirect evidence such as seismic waves.

Seismic waves are caused by the energy from earthquakes traveling through the ground. Seismic waves travel outward in all directions from the point where the ground breaks in an earthquake. The waves are detected by seismometers around the world. Two types of seismic waves are most useful for learning about Earth's interior: P-waves and S-waves.

- P-waves (primary waves) are the fastest seismic waves, so they are always the first waves to arrive at seismometers. P-waves travel more slowly through liquids than solids.
- S-waves (secondary waves) are only about half as fast as P-waves, so they always arrive later at seismometers. S-waves cannot travel through liquids at all.

By tracking seismic waves with seismometers all over Earth, scientists have learned important information about the

planet's interior. For example, P-waves slow down as they pass from the mantle to the outer core, so scientists know that the outer core is liquid whereas the mantle is solid. Another clue that the outer core is liquid is that S-waves stop at the mantle-core boundary.

### Questions

1. How do scientists know about Earth's interior?
2. Compare and contrast P-waves and S-waves.
3. Explain how scientists were able to learn from seismic waves that the mantle is solid and the outer core is liquid.

---

## Lesson 6.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Scientists know about Earth's interior by studying evidence from
  - a. meteorites.
  - b. seismic waves.
  - c. Earth's magnetic field.
  - d. all of the above
2. Which layer of Earth is the thinnest?
  - a. crust
  - b. mantle
  - c. inner core
  - d. outer core
3. The oceanic crust consists of rocks called
  - a. basalt.
  - b. granite.
  - c. gabbro.
  - d. two of the above
4. Relative to the oceanic crust, the continental crust
  - a. is thinner.
  - b. has greater denser.
  - c. has less variety of rocks.
  - d. rises higher on the mantle.
5. The lithosphere is
  - a. soft.
  - b. brittle.
  - c. bendable.
  - d. two of the above
6. Earth's mantle
  - a. consists of liquid rock.
  - b. is hotter than the crust.
  - c. is made of granite.
  - d. all of the above



7. Which statement about Earth's core is false?
- It is made of metal.
  - It is Earth's hottest layer.
  - It consists mostly of iron.
  - It gets its heat from the sun.

---

## Lesson 6.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. Earth's outermost layer
- \_\_\_\_\_ 2. rock from space that has struck Earth
- \_\_\_\_\_ 3. Earth's middle layer
- \_\_\_\_\_ 4. rigid part of Earth that consists of the crust and upper mantle
- \_\_\_\_\_ 5. how energy travels away from an earthquake
- \_\_\_\_\_ 6. part of the upper mantle that can flow
- \_\_\_\_\_ 7. Earth's innermost layer

### Terms

- crust
- lithosphere
- mantle
- meteorite
- asthenosphere
- core
- seismic wave

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## Lesson 6.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- The part of Earth's crust that consists of mafic rock is \_\_\_\_\_ crust.
- The part of Earth's crust that consists of felsic rock is \_\_\_\_\_ crust.
- The layer of Earth that consists of ultramafic rock is the \_\_\_\_\_.
- Heat is transferred throughout the mantle by the process of \_\_\_\_\_.
- The densest layer of Earth is the \_\_\_\_\_.
- Convection currents in Earth's \_\_\_\_\_ core give Earth a magnetic field.
- The part of Earth's core that is solid is the \_\_\_\_\_ core.

---

## Lesson 6.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Relate the lithosphere and asthenosphere to Earth's crust and mantle.

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## 6.2 Continental Drift

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### Lesson 6.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Wegener thought that the continents were still drifting together to form the supercontinent Pangaea.
- \_\_\_\_\_ 2. Wegener's hypothesis became widely accepted by other scientists only after he died.
- \_\_\_\_\_ 3. Wegener offered a detailed explanation for continental drift.
- \_\_\_\_\_ 4. The Rocky Mountains and mountains in eastern Greenland were once part of the same mountain range.
- \_\_\_\_\_ 5. Evidence for continental drift from magnetic polarity was discovered in the 1950s.
- \_\_\_\_\_ 6. Magnetite crystals in rocks always point to today's magnetic north pole.
- \_\_\_\_\_ 7. The present continents look as though they fit together like puzzle pieces.
- \_\_\_\_\_ 8. Evidence for ancient glaciers in currently tropical areas can be explained by continental drift.
- \_\_\_\_\_ 9. Wegener's hypothesis explains how continents can plough through solid oceanic crust.
- \_\_\_\_\_ 10. During the time of Pangaea, there were two magnetic north poles.

---

### Lesson 6.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Evidence for Continental Drift: Magnetic Polarity**

New evidence for magnetic drift was discovered in the 1950s from studies of Earth's magnetic history. Earth has a magnetic field like that of a bar magnet, with magnetic north and south poles. The magnetic poles are located near the geographic poles. In the 1950s, scientists studied the magnetic properties of rocks that formed at different times and in different places. They used magnetometers, which are devices that measure magnetic field direction and intensity. Why study rocks? Rocks containing the mineral magnetite have crystals that align with Earth's magnetic field. Magnetite crystals are like tiny magnets that point to the north magnetic pole as they crystallize from magma. Once the crystals form, their magnetic alignment, or polarity, is locked in place. Therefore, the alignment of crystals in rocks records the direction of Earth's magnetic field at the time the rocks formed. Scientists studying the magnetic polarity of rocks compared rocks that formed at different times and places. They made several important observations:

- Young rocks are aligned with Earth's current magnetic north pole regardless of the continent on which they formed.
- Old rocks of about the same age that formed on the same continent have the same magnetic field alignment, but it is different from Earth's current magnetic alignment.

- Old rocks of different ages, regardless of where they formed, are not aligned with each other or with Earth's current magnetic field.

How could these observations be explained? One possible explanation is that the locations of Earth's magnetic poles have changed their positions through time. However, to fit all the data, this explanation would require that Earth have had two magnetic north poles in the past. Another possible explanation—and one that is better supported by the data—is that the continents, and not the magnetic poles, have changed their positions through time. The magnetic polarity evidence supports the continental drift hypothesis. When the evidence was first discovered, it stimulated research to understand how continents can move over Earth's surface.

### Questions

1. Describe Earth's magnetic field.
2. Why are rocks useful for studying Earth's magnetic history?
3. What observations did scientists make in the 1950s about the magnetic polarity of rocks?
4. How did the observations in question 3 support the continental drift hypothesis?

---

## Lesson 6.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Evidence for continental drift includes
  - a. identical rocks located on both sides of the Atlantic Ocean.
  - b. similar mountain ranges found on both sides of North America.
  - c. fossils of different organisms discovered on the same continent.
  - d. ancient coal seams found in areas that are currently in the tropics.
2. Evidence of ancient glaciers supports Wegener's hypothesis because the evidence has been found on continents that are currently
  - a. much colder than they used to be.
  - b. located near the north pole.
  - c. very close to the equator.
  - d. covered by glaciers.
3. Earth is like a giant magnet with its north pole near the
  - a. geographic north pole.
  - b. center of Africa.
  - c. Grand Canyon.
  - d. equator.
4. Magnetite crystals always record the direction and strength of Earth's magnetic field at the
  - a. present time.
  - b. time of Pangaea.
  - c. time Earth formed.
  - d. time they crystallized.
5. When scientists first observed that differently aged rocks have different magnetic polarities, they proposed several possible explanations. Which of the following explanations did they propose?
  - a. The continents remained fixed in place and the north magnetic pole moved.

- b. The north magnetic pole remained fixed in place and the continents moved.
  - c. Both the continents and the north magnetic pole remained fixed in place.
  - d. two of the above
6. Why did other scientists not accept Wegener's hypothesis at first?
- a. There were no geologists at that time.
  - b. There was no evidence for the hypothesis.
  - c. There was no known explanation for the hypothesis.
  - d. two of the above
7. Which type of evidence convinced most scientists that the continents have drifted?
- a. magnetic polarity of ancient rocks containing magnetite.
  - b. ancient maps showing the shape and location of Pangaea.
  - c. current observations of the magnetic north pole wandering.
  - d. coral reefs located in areas that are very warm today.

---

## Lesson 6.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. mineral with crystals that are like tiny magnets
- \_\_\_\_\_ 2. direction of a magnetic field
- \_\_\_\_\_ 3. hypothesis that continents moved to their present positions over many millions of years
- \_\_\_\_\_ 4. area over which a magnet exerts force
- \_\_\_\_\_ 5. supercontinent that existed 250 million years ago
- \_\_\_\_\_ 6. how Earth's north magnetic pole seems to have moved but actually has not
- \_\_\_\_\_ 7. scientist who proposed that the continents have drifted

### Terms

- a. Pangaea
- b. continental drift
- c. magnetic polarity
- d. Wegener
- e. magnetic field
- f. magnetite
- g. apparent polar wander

---

## Lesson 6.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. A device that can measure magnetic field intensity is called a(n) \_\_\_\_\_.
2. As magnetite crystals form from magma, they align with Earth's \_\_\_\_\_.
3. The continental drift hypothesis was first proposed in the early \_\_\_\_\_ century.
4. Earth's current magnetic north pole is located in northern \_\_\_\_\_.
5. Eastern South America and western \_\_\_\_\_ were once joined together as part of Pangaea.
6. Scientists explain apparent polar wander by assuming that the continents have \_\_\_\_\_.
7. Most other scientists initially \_\_\_\_\_ the hypothesis of continental drift.

---

## Lesson 6.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Identify and explain evidence that Wegener collected to support the continental drift hypothesis.

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## 6.3 Seafloor Spreading

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### Lesson 6.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Seafloor spreading explains Wegener's hypothesis.
- \_\_\_\_\_ 2. An echo sounder with a single beam can create a 3-D map of the seafloor.
- \_\_\_\_\_ 3. A mid-ocean ridge runs mainly in a north-south orientation through the Atlantic Ocean.
- \_\_\_\_\_ 4. Abyssal plains are completely flat and lack any features.
- \_\_\_\_\_ 5. Stripes of normal and reversed polarity form mirror images on either side of mid-ocean ridges.
- \_\_\_\_\_ 6. Sedimentary rock on the seafloor is thickest at mid-ocean ridges.
- \_\_\_\_\_ 7. Seafloor changes to continental crust at the edges of continents.
- \_\_\_\_\_ 8. The seafloor-spreading hypothesis was proposed before World War II.
- \_\_\_\_\_ 9. At a deep-sea trench, oceanic crust sinks into the mantle.
- \_\_\_\_\_ 10. Seafloor spreading is caused by convection currents within the mantle.

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### Lesson 6.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Characteristics of the Seafloor

Although nobody really knows why, Earth's magnetic poles sometimes switch positions. The north magnetic pole becomes the south magnetic pole and vice-versa. This causes a reversal of Earth's polarity. When north and south magnetic poles are located where they are now, Earth's polarity is referred to as normal polarity. When the poles are in the opposite positions, Earth's polarity is referred to as reversed polarity.

During World War II, magnetometers were attached to battleships to help search for underwater submarines. The magnetometers discovered an astonishing feature: seafloor rocks show a pattern of normal and reversed magnetic polarity. Stripes of normal polarity and reversed polarity alternate across the ocean floor. The stripes form mirror images on either side of mid-ocean ridges. The stripes end abruptly at the edges of continents or at deep-sea trenches.

Other characteristics of the seafloor also change in a consistent way as distance from mid-ocean ridges increases. At the axis of a ridge, the rocks are youngest, thinnest, and hottest. They also have no sediments on top of them. With increasing distance from the axis of the ridge, the rocks become older, thicker, and cooler. They also have more sediments above them. Seafloor rocks are oldest near the edges of continents or deep-sea trenches. But even the oldest seafloor rocks are less than 180 million years old. This is much younger than the oldest rocks of continental crust. This means that seafloor is destroyed in a relatively short time after it is created.

**Questions**

1. Describe Earth's normal and reversed polarity.
2. How do reversals of Earth's polarity affect rocks on the seafloor?
3. What other characteristics of seafloor rocks change in a consistent way as distance from mid-ocean ridges increases?
4. Compare and contrast the ages of rocks in oceanic and continental crust.

---

**Lesson 6.3: Multiple Choice**

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Circle the letter of the correct choice.*

1. Bathymetric maps show
  - a. locations of ocean floor features.
  - b. elevations of mid-ocean ridges.
  - c. depths of deep-sea trenches.
  - d. all of the above
2. Before scientists had data from echo sounders, they thought that the seafloor was
  - a. broken up by trenches.
  - b. covered with ridges.
  - c. completely flat.
  - d. steeply sloping.
3. The magnetic polarity of the seafloor
  - a. is reversed at mid-ocean ridges.
  - b. is the same everywhere.
  - c. alternates in stripes.
  - d. two of the above
4. Compared with seafloor rocks at the center of mid-ocean ridges, seafloor rocks sampled at a distance from mid-ocean ridges are
  - a. older.
  - b. hotter.
  - c. thinner.
  - d. all of the above
5. Continents drift because they are pushed by
  - a. crashing ocean waves.
  - b. spreading seafloors.
  - c. erupting volcanoes.
  - d. sinking seafloors.
6. Changes in magnetic polarity occur because the
  - a. seafloor reverses its direction.
  - b. magnetic poles switch positions.
  - c. rocks on the seafloor form stripes.
  - d. seafloor sinks into deep-ocean trenches.
7. The oldest seafloor is



- a. more than 180 million years old.
- b. older than the oldest continental crust.
- c. found at the edges of continents.
- d. two of the above

---

### Lesson 6.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. situation in which Earth's north and south poles are aligned as they are now
- \_\_\_\_\_ 2. long chain of mountains that runs through the middle of an ocean
- \_\_\_\_\_ 3. mechanism by which continental drift occurs
- \_\_\_\_\_ 4. deepest reach of the ocean floor typically found at the edge of a continent
- \_\_\_\_\_ 5. device that uses sound waves to calculate the distance to the ocean floor
- \_\_\_\_\_ 6. situation in which Earth's north and south poles are aligned opposite to their present alignment
- \_\_\_\_\_ 7. flat area of the ocean floor

#### Terms

- a. abyssal plain
- b. reversed polarity
- c. echo sounder
- d. mid-ocean ridge
- e. seafloor spreading
- f. deep-sea trench
- g. normal polarity

---

### Lesson 6.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Oceanic crust forms when molten rock pours onto the surface at a(n) \_\_\_\_\_.
- 2. Seafloor is destroyed when it sinks below the crust at a(n) \_\_\_\_\_.
- 3. Distance to the ocean floor is calculated from the time it takes sound waves to travel there and back and the known \_\_\_\_\_ of sound waves in seawater.
- 4. After World War II, scientists pieced together ocean depths from many places to produce \_\_\_\_\_ maps of the seafloor.
- 5. Some deep-sea trenches are found far from continents near chains of active \_\_\_\_\_.
- 6. Newly formed rocks on the ocean floor at a mid-ocean ridge have \_\_\_\_\_ magnetic polarity.
- 7. Oceanic crust is constantly being pushed horizontally away from \_\_\_\_\_.

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## Lesson 6.3: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Relate the seafloor-spreading hypothesis to the continental drift hypothesis.

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## 6.4 Theory of Plate Tectonics

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### Lesson 6.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Earthquake epicenters outline the edges of tectonic plates.
- \_\_\_\_\_ 2. Convection cells in the mantle rise at deep-sea trenches.
- \_\_\_\_\_ 3. Mid-ocean ridges occur at convergent plate boundaries.
- \_\_\_\_\_ 4. Earthquakes occur only at transform plate boundaries.
- \_\_\_\_\_ 5. Volcanoes are unlikely where two continental plates converge.
- \_\_\_\_\_ 6. The Atlantic Ocean currently is shrinking because of plate tectonics.
- \_\_\_\_\_ 7. Supercontinents form and break up in a cycle.
- \_\_\_\_\_ 8. Hotspot volcanoes form in a line as crust moves over a mantle plume.
- \_\_\_\_\_ 9. Hotspot magma rarely penetrates oceanic crust.
- \_\_\_\_\_ 10. The Appalachian Mountains formed at a convergent plate boundary as Pangaea came together.

---

### Lesson 6.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Earth's Tectonic Plates

The lithosphere is divided into a dozen major and several minor plates. The edges of the plates can be identified from the distribution of earthquake epicenters. That's because most earthquakes occur at plate boundaries. A single plate may consist only of oceanic lithosphere or only of continental lithosphere, but nearly all plates are made of a combination of both types of lithosphere.

Plates are constantly moving over Earth's surface. Movement of the plates is termed plate tectonics. Plates move at a rate of a few centimeters a year. The reason they move is seafloor spreading, which occurs because of convection currents in the mantle. Hot material rises at a mid-ocean ridge; gradually moves horizontally away from the axis of the ridge, dragging seafloor with it; and eventually sinks back deep into the mantle at deep-sea trenches.

Plate boundaries are the edges where two plates meet. Most geologic activities—including earthquakes, volcanoes, and mountain building—take place at plate boundaries. Because plates are always moving, they move relative to one another at plate boundaries. Plates can move relative to one another in three different ways:

- They can diverge, or move away from each other. This occurs at a divergent plate boundary.
- They can converge, or move toward each other. This occurs at a convergent plate boundary.

- They can transform, or slide past each other. This occurs at a transform plate boundary.

The type of plate boundary and the type of crust (oceanic or continental) found on each side of the boundary determine the type of geologic activity that will occur there.

### Questions

1. Describe Earth's plates.
2. Explain what causes plates to move.
3. Define plate boundary, and identify types of plate boundaries.

---

## Lesson 6.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Nearly all tectonic plates consist of
  - a. only oceanic crust.
  - b. only continental crust.
  - c. both oceanic and continental crust.
  - d. neither oceanic nor continental crust.
2. Each year, tectonic plates move a few
  - a. millimeters.
  - b. centimeters.
  - c. kilometers.
  - d. none of the above
3. Seafloor spreading occurs because of
  - a. convection cells in the mantle.
  - b. earthquakes in the oceanic crust.
  - c. movement toward a ridge axis.
  - d. subduction at a mid-ocean ridge.
4. Most geologic activity takes place
  - a. within plates.
  - b. at plate boundaries.
  - c. where continents subduct.
  - d. two of the above
5. Which feature could form at a divergent plate boundary?
  - a. rift valley
  - b. transform fault
  - c. continental arc
  - d. subduction zone
6. At a convergent plate boundary between oceanic and continental crust, the oceanic crust always plunges beneath the continental crust because oceanic crust is
  - a. lighter.
  - b. denser.
  - c. colder.

- d. less viscous.
7. Some of the largest mountains in the world, including the Himalayas, occur where
- two oceanic plates diverge.
  - two continental plates converge.
  - an oceanic and a continental plate diverge.
  - an oceanic and a continental plate converge.

---

## Lesson 6.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. edge where two plates move toward each other
- \_\_\_\_\_ 2. large body of intrusive igneous rock at the edge of a subducting plate
- \_\_\_\_\_ 3. edge where two plates move away from each other
- \_\_\_\_\_ 4. result of divergent plate boundaries that occur within a continent
- \_\_\_\_\_ 5. point on the Earth's surface directly above the place where an earthquake occurs
- \_\_\_\_\_ 6. line of coastal volcanic islands at the edge of a subducting plate
- \_\_\_\_\_ 7. edge where two plates slip past each other

### Terms

- batholith
- continental arc
- continental rifting
- epicenter
- convergent plate boundary
- transform plate boundary
- divergent plate boundary

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## Lesson 6.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- A large chunk of lithosphere that can move over Earth's surface is called a(n) \_\_\_\_\_.
- The edge where two tectonic plates meet is called a(n) \_\_\_\_\_.
- \_\_\_\_\_ occurs when an oceanic plate plunges beneath a continental plate at a convergent plate boundary.
- A region where the phenomenon described in question 3 occurs often is called a(n) \_\_\_\_\_.
- The movement of plates over Earth's surface is called \_\_\_\_\_.
- A line of volcanoes that forms where two oceanic plates converge is called a(n) \_\_\_\_\_.

7. Geologic activity that takes place within a plate rather than at plate boundaries is known as \_\_\_\_\_-activity.

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### Lesson 6.4: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast geologic activity at a convergent plate boundary between oceanic and continental plates with that between two continental plates.

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# CHAPTER 7

# HS Earthquakes Worksheets

## Chapter Outline

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- 7.1 STRESS IN EARTH'S CRUST**
  - 7.2 THE NATURE OF EARTHQUAKES**
  - 7.3 MEASURING AND PREDICTING EARTHQUAKES**
  - 7.4 STAYING SAFE IN EARTHQUAKES**
- 

- **Lesson 7.1: Stress in Earth's Crust**
- **Lesson 7.2: The Nature of Earthquakes**
- **Lesson 7.3: Measuring and Predicting Earthquakes**
- **Lesson 7.4: Staying Safe in Earthquakes**

## 7.1 Stress in Earth's Crust

### Lesson 7.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. In geology, stress is the force per unit area that is placed on rock.
- \_\_\_\_\_ 2. Tension is the major type of stress at transform plate boundaries.
- \_\_\_\_\_ 3. Sedimentary rocks that do not have horizontal layers have been deformed.
- \_\_\_\_\_ 4. In an anticline, the youngest rocks are at the center.
- \_\_\_\_\_ 5. In a normal fault, the footwall drops down relative to the hanging wall.
- \_\_\_\_\_ 6. A rock's response to stress depends only on the type of stress.
- \_\_\_\_\_ 7. Basin-and-range landforms result from tension pulling crust apart.
- \_\_\_\_\_ 8. Confining stress always causes folds or faults.
- \_\_\_\_\_ 9. The oldest layers of sedimentary rock are on always the bottom unless rock layers have been disturbed.
- \_\_\_\_\_ 10. Left-lateral and right-lateral faults are two types of dip-slip faults.

### Lesson 7.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Stress and How It Changes Rock

Stress is force applied to an object. In geology, stress is the force per unit area that is applied to rock. A rock's response to stress depends on many factors. The factors include the type of rock, the surrounding temperature and pressure, the type of stress, and the length of time the rock is under stress. In response to stress, rocks may either deform (change shape) or fracture (break). If stress is removed from rocks that have deformed, they may or may not return to their original shape. If they do return to their original shape, the change in shape is called elastic deformation. If they do not return to their original shape, the change in shape is called plastic deformation.

Four types of stress that can act on rock are: confining stress, compression, tension, and shear.

- Confining stress is stress that is applied to a deeply buried rock by the weight of all the material above it. Because the rock cannot move, it cannot deform or fracture.
- Compression is stress that squeezes rocks together. It causes rocks to deform by folding or to fracture. Compression is the major type of stress at convergent plate boundaries.
- Tension is stress that pulls rocks apart. Rocks under tension lengthen or break apart. Tension is the major type of stress at divergent plate boundaries.



- Shear is stress that occurs when forces are parallel but applied in opposite directions. Shear stress is the major type of stress at transform plate boundaries.

## Questions

1. How is stress defined in geology?
2. What factors determine a rock's response to stress?
3. Compare and contrast elastic and plastic deformation of rock.
4. Identify and describe the four types of stresses that can act on rock.

---

## Lesson 7.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The most common stress on rocks at convergent plate boundaries is
  - a. shear.
  - b. tension.
  - c. compression.
  - d. confining stress.
2. A rock is more likely to fracture if
  - a. it is located on the surface.
  - b. it is deep within the crust.
  - c. stress is applied gradually.
  - d. two of the above
3. A simple bend in rock layers so they are no longer horizontal is called a
  - a. compression.
  - b. monocline.
  - c. strain.
  - d. fault.
4. In a syncline the
  - a. youngest rocks are on the outside.
  - b. folded rocks may form a dome.
  - c. folded rocks may form a basin.
  - d. two of the above
5. When rocks suddenly move along a fault, the energy released is a(n)
  - a. deformation.
  - b. earthquake.
  - c. anticline.
  - d. uplift.
6. Which of the following statements about dip-slip faults is false?
  - a. The faults' dip is inclined relative to the horizontal.
  - b. The faults may be normal faults or reverse faults.
  - c. The faults occur because of shear stress.
  - d. The faults may uplift mountain ranges.

7. A thrust fault
- is a type of reverse fault.
  - has a nearly vertical dip.
  - is a strike-slip fault.
  - two of the above

---

## Lesson 7.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. fracture in which there is no movement of rocks
- \_\_\_\_\_ 2. break in rock
- \_\_\_\_\_ 3. stress that pulls rocks apart
- \_\_\_\_\_ 4. bend in rock due to compression
- \_\_\_\_\_ 5. stress that squeezes rocks together
- \_\_\_\_\_ 6. change in the shape of rock due to stress
- \_\_\_\_\_ 7. fracture in which blocks of rock move

### Terms

- a. compression
- b. tension
- c. deformation
- d. fracture
- e. fold
- f. fault
- g. joint

---

## Lesson 7.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- Stress on a deeply buried rock that cannot deform is called \_\_\_\_\_ stress.
- \_\_\_\_\_ deformation occurs when rock returns to its original shape after stress is removed.
- \_\_\_\_\_ deformation occurs when rock does not return to its original shape after stress is removed.
- A fold in rock that bends upward is called a(n) \_\_\_\_\_.
- A fold in rock that bends downward is called a(n) \_\_\_\_\_.
- The distance rocks move along a fault is known as the fault's \_\_\_\_\_.
- The angle a fault makes with the horizontal surface of Earth is termed the fault's \_\_\_\_\_.

---

## Lesson 7.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast the two major types of faults and the conditions under which they occur.

## 7.2 The Nature of Earthquakes

### Lesson 7.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Each year, almost a million earthquakes are recorded by seismometers.
- \_\_\_\_\_ 2. In about three-quarters of earthquakes, the focus is less than 5 kilometers below Earth's surface.
- \_\_\_\_\_ 3. Earthquakes occur only at plate boundaries and never within plates.
- \_\_\_\_\_ 4. Most earthquakes with a high magnitude have a shallow focus.
- \_\_\_\_\_ 5. Divergent plate boundaries produce earthquakes all around the Pacific Ocean basin.
- \_\_\_\_\_ 6. Earthquakes at mid-ocean ridges are typically small and shallow.
- \_\_\_\_\_ 7. P-waves are seismic waves that can travel only through solids.
- \_\_\_\_\_ 8. Seismic waves that cause a rolling motion of the ground are body waves.
- \_\_\_\_\_ 9. The low point of a seismic wave is called a trough.
- \_\_\_\_\_ 10. Surface waves travel outward in all directions from an earthquake's focus.

### Lesson 7.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Seismic Waves

Energy is transmitted in waves. The energy from earthquakes is transmitted in waves called seismic waves. There are two basic types of seismic waves: body waves and surface waves.

Body waves are seismic waves that travel through the solid body of Earth. They originate at the focus of an earthquake and travel outward in all directions. Body waves include P-waves (primary waves) and S-waves (secondary waves). P-waves can travel through solids, liquids, and gases. They travel faster than any other type of seismic waves, so they are always the first waves to arrive at seismometers. P-waves move rocks forward and backward in the same direction that the waves are traveling. S-waves can travel only through solids. They travel more slowly than P-waves, so they reach seismometers after P-waves. S-waves move rocks up and down perpendicular to the direction that the waves are traveling.

Surface waves travel along the ground rather than through Earth. They travel outward from an earthquake's epicenter rather than its focus. They are the slowest of all seismic waves. Surface waves include Love waves and Rayleigh waves. Love waves cause the ground to move back and forth perpendicular to the direction that the waves are traveling. Rayleigh waves cause the ground to move in a circular motion. The combined ground movements of Love and Rayleigh waves give the surface of the ground a rolling motion. This motion causes most of the damage in an

earthquake.

### Questions

1. Distinguish between body waves and surface waves.
2. Describe the motions of rocks caused by P-waves and S-waves.
3. How do Love waves and Rayleigh waves move the ground?

---

## Lesson 7.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. About 80 percent of all earthquake strike around the
  - a. Indian Ocean.
  - b. Pacific Ocean.
  - c. Atlantic Ocean.
  - d. Mediterranean Sea.
2. Most earthquakes that occur at transform plate boundaries are
  - a. very weak earthquakes.
  - b. shallow focus earthquakes.
  - c. low magnitude earthquakes.
  - d. two of the above
3. Earthquakes caused by subduction of oceanic lithosphere occur at
  - a. convergent plate boundaries.
  - b. divergent plate boundaries.
  - c. transform plate boundaries.
  - d. all of the above
4. Massive earthquakes are the hallmark of thrust faulting and folding where two
  - a. continental plates converge.
  - b. continental plates diverge.
  - c. oceanic plates converge.
  - d. oceanic plates diverge.
5. All waves, including seismic waves, have a high point called a(n)
  - a. crest.
  - b. peak.
  - c. focus.
  - d. epicenter.
6. Surface waves generated by an earthquake include
  - a. P-waves.
  - b. S-waves.
  - c. Love waves.
  - d. two of the above
7. The greatest danger posed by earthquakes in the ocean floor is
  - a. Rayleigh waves.

- b. body waves.
- c. aftershocks.
- d. tsunamis.

---

## Lesson 7.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. type of seismic wave that can travel through solid Earth
- \_\_\_\_\_ 2. point on Earth's surface directly above the focus of an earthquake
- \_\_\_\_\_ 3. huge ocean wave generally caused by an earthquake beneath the seafloor
- \_\_\_\_\_ 4. height of a wave from the centerline to a crest
- \_\_\_\_\_ 5. place in the crust where rocks rupture, causing an earthquake
- \_\_\_\_\_ 6. distance between corresponding points on two adjacent waves
- \_\_\_\_\_ 7. type of seismic wave that travels most slowly

### Terms

- a. focus
- b. amplitude
- c. wavelength
- d. body wave
- e. epicenter
- f. surface wave
- g. tsunami

---

## Lesson 7.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. A(n) \_\_\_\_\_ is ground movement caused by the sudden release of energy stored in rocks.
- 2. Almost 95 percent of all earthquakes occur along \_\_\_\_\_.
- 3. Earthquakes with a shallow focus are \_\_\_\_\_ damaging than earthquakes with a deeper focus.
- 4. P-waves and S-waves are the type of seismic waves known as \_\_\_\_\_ waves.
- 5. The most damaging seismic waves are the type known as \_\_\_\_\_ waves.
- 6. The theory that explains how earthquakes occur is the \_\_\_\_\_ theory.
- 7. The study of seismic waves is known as \_\_\_\_\_.

---

## Lesson 7.2: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain why many earthquakes occur around the Pacific Ocean basin.

---

## 7.3 Measuring and Predicting Earthquakes

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### Lesson 7.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. One way of determining the intensity of an earthquake is by the damage it causes.
- \_\_\_\_\_ 2. The Richter magnitude scale is the earthquake intensity scale used by most scientists today.
- \_\_\_\_\_ 3. The Mercalli intensity scale uses seismograph data to measure earthquake intensity.
- \_\_\_\_\_ 4. The Richter magnitude and moment magnitude scales are logarithmic.
- \_\_\_\_\_ 5. On average, one earthquake per year occurs with a Richter magnitude between 8.0 and 8.9.
- \_\_\_\_\_ 6. Scientists are a long way from being able to predict earthquakes.
- \_\_\_\_\_ 7. Small earthquakes, called foreshocks, always occur a few days before a major earthquake.
- \_\_\_\_\_ 8. As stress builds up in rocks before an earthquake, the ground may start to tilt.
- \_\_\_\_\_ 9. Seismographs record only the surface waves generated by an earthquake.
- \_\_\_\_\_ 10. A seismometer must be very close to the epicenter of an earthquake to detect seismic waves.

---

### Lesson 7.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

---

### Earthquake Prediction

Scientists are a long way from being able to predict earthquakes. A good prediction must be accurate in terms of where an earthquake will occur, when it will occur, and what magnitude it will be. This information is need to decide whether and when people should be evacuated from an area. An unnecessary evacuation due to an inaccurate prediction would be expensive. It also might cause people to disregard future evacuation orders.

Where an earthquake will occur is the easiest factor to predict. Scientists know that earthquakes take place at plate boundaries and tend to occur where they have occurred before. Earthquake-prone communities should always be prepared for an earthquake. For example, they can implement building codes to make structures earthquake safe.

When an earthquake will occur is much more difficult to predict. The stress on rocks along a fault builds up at a constant rate, so earthquakes should occur at regular intervals. However, this is not always the case. For example, near Parkfield, California, an earthquake of magnitude 6.0 or higher occurs about once every 22 years on average.



Based on the dates of previous earthquakes, seismologists predicted that the next earthquake would strike the area in 1993, but it didn't occur until 2004.

Sometimes certain signs precede large earthquakes. Small earthquakes called foreshocks may occur as stress builds up before a major earthquake. Rocks around a fault may dilate and develop fractures as stress builds up in them. Water levels in wells may fluctuate as water moves into or out of rock fractures. The ground may start to tilt with building stress. Although these changes often precede large earthquakes, they don't always occur. There have been many reports of animals behaving erratically before earthquakes. Whether animals can actually sense imminent earthquakes is not clear. If they can, scientists do not know what it is they are sensing.

### Questions

1. If scientists could predict earthquakes, why would accurate predictions be important?
2. What is the easiest factor to predict about earthquakes? Why?
3. Identify signs that sometimes precede large earthquakes. Why are these signs not very useful for predicting earthquakes?

---

## Lesson 7.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Seismograms contain information that can be used to determine how
  - a. strong an earthquake was.
  - b. long an earthquake lasted.
  - c. far away an earthquake was.
  - d. all of the above
2. A seismogram shows the arrival times of P-waves and S-waves from an earthquake. The greater the difference in arrival times is, the greater is the
  - a. distance of the epicenter from the seismometer.
  - b. magnitude of the earthquake.
  - c. length of time the earthquake lasted.
  - d. destruction caused by the earthquake.
3. If a seismometer records P-waves and surface waves but not S-waves, you can infer that the earthquake occurred
  - a. on the other side of Earth.
  - b. at more than one epicenter.
  - c. very close to the seismograph.
  - d. very far below Earth's surface.
4. The situation in question 3 occurs because S-waves cannot travel
  - a. as far as P-waves.
  - b. deep underground.
  - c. as quickly as surface waves.
  - d. through Earth's liquid outer core.
5. On the moment magnitude scale, the earthquake with the greatest intensity
  - a. releases the most total energy.
  - b. is felt by the largest number of people.

- c. has a wave with the highest magnitude.
  - d. causes the greatest destruction to buildings.
6. How often do Richter magnitude 9 or higher earthquakes occur?
- a. at least once a month
  - b. about five times a year
  - c. about once a year
  - d. several times a century
7. Which of the following earthquake features is easiest to predict?
- a. when an earthquake will occur
  - b. where an earthquake will occur
  - c. how long an earthquake will last
  - d. what magnitude an earthquake will be

---

### Lesson 7.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. scale of earthquake intensity based on what people feel and what damage is done
- \_\_\_\_\_ 2. strength of an earthquake
- \_\_\_\_\_ 3. device that records ground motions detected by a seismometer
- \_\_\_\_\_ 4. scale of earthquake intensity based on the magnitude of the largest jolt of energy released by an earthquake
- \_\_\_\_\_ 5. device that senses ground motions caused by seismic waves
- \_\_\_\_\_ 6. scale of earthquake intensity based on the total energy released by an earthquake
- \_\_\_\_\_ 7. record of the ground motions created by a seismograph

#### Terms

- a. seismograph
- b. earthquake intensity
- c. Mercalli intensity scale
- d. seismogram
- e. Richter magnitude scale
- f. moment magnitude scale
- g. seismometer

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### Lesson 7.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. Scientists currently favor the \_\_\_\_\_ scale for measuring earthquake intensity.
2. The \_\_\_\_\_ of an earthquake's largest seismic wave is used to determine the Richter magnitude of the earthquake.
3. The distance from the \_\_\_\_\_ of an earthquake to a seismometer can be calculated from the difference in arrival times of P- and S-waves.
4. The epicenter of an earthquake can be found based on the distance from the epicenter to \_\_\_\_\_ different seismometers.
5. On the Richter scale, the intensity of a magnitude 5 earthquake is \_\_\_\_\_ times greater than the intensity of a magnitude 3 earthquake.
6. An increase in two integers on the \_\_\_\_\_ scale equals a 900-fold increase in energy released by an earthquake.
7. The last seismic waves to arrive at a seismometer are \_\_\_\_\_ waves.

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### Lesson 7.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how to find the epicenter of an earthquake using data from different seismometers.

## 7.4 Staying Safe in Earthquakes

### Lesson 7.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The ground shaking of earthquakes is almost never the direct cause of deaths.
- \_\_\_\_\_ 2. Damage done by an earthquake depends only on the earthquake's intensity.
- \_\_\_\_\_ 3. The key to earthquake-safe structures is flexibility.
- \_\_\_\_\_ 4. Buildings in earthquake zones should be constructed on soft sediments.
- \_\_\_\_\_ 5. Placing buildings on layers of steel and rubber helps absorb the shock of seismic waves.
- \_\_\_\_\_ 6. The safest place in a building during an earthquake is under a sturdy table.
- \_\_\_\_\_ 7. If you are in a car during an earthquake, you should flee from the car.
- \_\_\_\_\_ 8. Immediately after an earthquake, you should make sure that the electricity and gas in your home are turned on.
- \_\_\_\_\_ 9. Liquefaction of sediments occurs during earthquakes because of seismic waves.
- \_\_\_\_\_ 10. It may be difficult to fight fires after an earthquake because of breaks in water mains.

### Lesson 7.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Damage from Earthquakes

Earthquakes kill people and cause property damage. Collapsing structures are the major cause of destruction and death. The fires that follow most earthquakes also cause a lot of destruction and death. Several factors determine how destructive and deadly an earthquake is. One factor is earthquake intensity, but this factor may not be as important as you might think. A much more important factor is the quality of structures. Structures that are built to be earthquake proof are less likely to suffer damage and collapse than ordinary structures.

Other factors that influence how destructive and deadly an earthquake is include population density, whether the earthquake triggers a tsunami, and the type of ground upon which buildings are constructed. The following examples illustrate the influence of these factors.

- A magnitude 9.2 earthquake occurred near Anchorage, Alaska, in 1964. Despite the enormous intensity of the earthquake, it caused only 131 deaths. The main reason is that relatively few people lived in the hardest hit area.
- A magnitude 9.0 earthquake occurred in the Indian Ocean in 2004. About 230,000 people died in this earthquake. Most of them were killed by the huge tsunami that followed the earthquake.

- Soft sediments vibrate more during an earthquake than does solid bedrock, so structures built on sediments are more likely to be damaged and collapse. Sediments that are saturated with water also undergo liquefaction when the ground shakes, and they become like quicksand. Liquefied soil on a hillside may slide downhill in a landslide, burying homes and even entire village. Liquefied soil under buildings may cause them to collapse. For example, liquefied soil in the 1985 Mexico City earthquake caused a tremendous amount of damage to buildings and other structures.

### Questions

1. What are the main causes of damage and death during earthquakes?
2. What factors influence how destructive and deadly an earthquake is?
3. Use examples to illustrate the factors you identified in your answer to question 2.

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## Lesson 7.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Causes of deaths during earthquakes include
  - a. collapsing buildings.
  - b. landslides.
  - c. fires.
  - d. all of the above
2. Which of the following materials is best for building in an earthquake zone?
  - a. wood
  - b. brick
  - c. stone
  - d. adobe
3. To help structures move with the ground without breaking during earthquakes, they can be built on
  - a. rollers.
  - b. layers of sediment.
  - c. a deep bed of sand.
  - d. two of the above
4. The number of deaths that occur in an earthquake is influenced by
  - a. population density.
  - b. type of ground.
  - c. construction methods.
  - d. all of the above
5. If you are in a structurally unsound building during an earthquake, you should
  - a. go to the basement.
  - b. move to the top floor.
  - c. stand close to a window.
  - d. leave as quickly as possible.
6. If you are outside during an earthquake, you should
  - a. avoid open areas.

- b. stay away from power lines.
  - c. take shelter under an overpass.
  - d. go inside the nearest building.
7. To make sure your home is safe during earthquakes, you should do all of the following except
- a. bolt heavy furniture to walls.
  - b. attach brick chimneys to the roof.
  - c. check that gas lines are made of rigid material.
  - d. make sure heavy objects are not stored in high places.

---

### Lesson 7.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. second most damaging type of natural disaster after a hurricane
- \_\_\_\_\_ 2. small earthquake that follows a larger earthquake
- \_\_\_\_\_ 3. process in which saturated sediments become like quicksand during an earthquake
- \_\_\_\_\_ 4. number of people in a given area
- \_\_\_\_\_ 5. event in which soil and rocks suddenly fall downhill

#### Terms

- a. liquefaction
- b. earthquake
- c. population density
- d. landslide
- e. aftershock

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### Lesson 7.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The largest earthquake ever recorded occurred in the country of \_\_\_\_\_ in 1960.
- 2. Most of the fatalities following the 2004 Indian Ocean earthquake were caused by a(n) \_\_\_\_\_.
- 3. The least amount of earthquake damage is suffered by structures that are built on solid \_\_\_\_\_.
- 4. \_\_\_\_\_ start during earthquakes because the shaking ruptures gas and electric lines.
- 5. If you live in an earthquake-prone area, you should use \_\_\_\_\_ light bulbs to reduce the risk of fire.

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## Lesson 7.4: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain what people can do to protect themselves before, during, and after earthquakes.

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# CHAPTER 8 HS Volcanoes Worksheets

## Chapter Outline

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- 8.1 WHERE VOLCANOES ARE LOCATED**
  - 8.2 VOLCANIC ERUPTIONS**
  - 8.3 TYPES OF VOLCANOES**
  - 8.4 VOLCANIC LANDFORMS AND GEOTHERMAL ACTIVITY**
- 

- Lesson 8.1: Where Volcanoes Are Located
- Lesson 8.2: Volcanic Eruptions
- Lesson 8.3: Types of Volcanoes
- Lesson 8.4: Volcanic Landforms and Geothermal Activity



## 8.1 Where Volcanoes Are Located

### Lesson 8.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. When magma flows onto Earth's surface, it always forms volcanic mountains.
- \_\_\_\_\_ 2. Almost all volcanoes occur over hotspots within tectonic plates.
- \_\_\_\_\_ 3. Volcanoes erupt at mid-ocean ridges.
- \_\_\_\_\_ 4. Wherever mantle rock melts, volcanoes may result.
- \_\_\_\_\_ 5. Any water on a subducting plate raises the melting point of mantle material.
- \_\_\_\_\_ 6. The Cascade Mountains in Washington State occur along a transform plate boundary.
- \_\_\_\_\_ 7. Volcanoes are likely along the San Andreas fault in California because it is a convergent plate boundary.
- \_\_\_\_\_ 8. Volcanoes in an island arc are all about the same age.
- \_\_\_\_\_ 9. The most geologically active region in the world is the Pacific Ring of Fire.
- \_\_\_\_\_ 10. Volcanoes occur in the East African Rift Valley because the valley is over a hotspot.

### Lesson 8.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Volcanic Hotspots

Most volcanoes are found at convergent or divergent plate boundaries, but there are some intraplate volcanoes. The Hawaiian Islands are examples. The islands are the exposed peaks of a great chain of volcanoes that lie in the middle of the Pacific plate. The youngest of the Hawaiian Islands sits directly above a column of hot rock called a mantle plume. As the plume rises through the mantle, pressure is released and mantle melts to create a hotspot. All of the Hawaiian Islands are hotspot volcanoes.

Earth is home to about 50 known hotspots. Most of them are in the oceans because magma can more easily penetrate oceanic than continental lithosphere. The hotspots that are known beneath continents are extremely large. For example, a huge hotspot is located beneath the Yellowstone volcano on the North American continent.

As a plate drifts over a mantle plume, a hotspot volcano slowly moves away from the hotspot. Then a new hotspot volcano forms. This keeps repeating as the plate continues to drift, forming a chain of hotspot volcanoes. The youngest volcano in the chain is always at the start of the chain, directly over the mantle plume. Each volcano after that is older than the one before it, with the oldest volcano at the opposite end of the chain.

#### Questions

1. What is a hotspot volcano? Give examples.
2. How does a hotspot volcano form?
3. How many hotspots are there, and where are they found?
4. Describe and explain the relative ages of volcanoes in a chain of hotspot volcanoes.

---

## Lesson 8.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Mantle rocks may melt if
  - a. its temperature rises.
  - b. pressure on it decreases.
  - c. water is added to it.
  - d. any of the above
2. Volcanoes are common along
  - a. convergent plate boundaries.
  - b. divergent plate boundaries.
  - c. transform plate boundaries.
  - d. two of the above
3. About 75 percent of the world's volcanoes are found
  - a. around the Atlantic Ocean basin.
  - b. along the mid-Atlantic ridge.
  - c. around the Pacific Ocean basin.
  - d. throughout the American Northwest.
4. Melting occurs at divergent plate boundaries because hot mantle rock rises and this
  - a. increases the temperature of the mantle.
  - b. decreases the temperature of the mantle.
  - c. allows runoff to seep into the mantle.
  - d. releases pressure on the mantle.
5. Which of the following landforms result from volcanic activity?
  - a. continental arcs
  - b. hotspot islands
  - c. island arcs
  - d. all of the above
6. Volcanoes are common along oceanic trenches because this is where
  - a. most hotspots are found.
  - b. subduction occurs.
  - c. new seafloor forms.
  - d. none of the above
7. About how many known hotspots are there on Earth?
  - a. 5
  - b. 50
  - c. 500
  - d. 5000

---

## Lesson 8.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. column of hot rock in the mantle
- \_\_\_\_\_ 2. line of volcanic activity that surrounds the Pacific Ocean basin
- \_\_\_\_\_ 3. crack in the ground at a divergent plate boundary where magma erupts
- \_\_\_\_\_ 4. place above a mantle plume where melted rock can form a volcano
- \_\_\_\_\_ 5. eruption of magma from the mantle onto the surface
- \_\_\_\_\_ 6. example of islands that formed over a hotspot
- \_\_\_\_\_ 7. example of islands that formed over a convergent plate boundary

### Terms

- a. volcano
- b. fissure
- c. mantle plume
- d. hotspot
- e. Ring of Fire
- f. Aleutian Islands
- g. Hawaiian Islands

---

## Lesson 8.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The first step in the formation of a volcano is rock melting in the \_\_\_\_\_.
- 2. Subduction of a plate into the mantle occurs at \_\_\_\_\_ plate boundaries.
- 3. Subduction at the Middle American Trench creates volcanoes in \_\_\_\_\_ America.
- 4. Icelandic volcanoes occur over a(n) \_\_\_\_\_ along the mid-Atlantic ridge.
- 5. All intraplate volcanic activity occurs over \_\_\_\_\_.
- 6. In a chain of hotspot volcanoes, the volcano that sits directly above the mantle plume is \_\_\_\_\_.
- 7. Hotspots can penetrate oceanic lithosphere \_\_\_\_\_ easily than continental lithosphere.

---

## Lesson 8.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Volcanoes erupt when mantle rock melts. Explain why this occurs at convergent and divergent plate boundaries.

---

## 8.2 Volcanic Eruptions

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### Lesson 8.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Mount St. Helens is a dormant volcano.
- \_\_\_\_\_ 2. The 1980 Mount St. Helens eruption was an effusive eruption.
- \_\_\_\_\_ 3. Each volcanic eruption is unique.
- \_\_\_\_\_ 4. Mafic magma has higher viscosity than felsic magma.
- \_\_\_\_\_ 5. An explosive eruption occurs because of built-up pressure in the magma chamber.
- \_\_\_\_\_ 6. Mafic magma may cause a pyroclastic flow.
- \_\_\_\_\_ 7. Volcanic gases can form poisonous clouds in the atmosphere.
- \_\_\_\_\_ 8. In an effusive eruption, magma erupts through vents.
- \_\_\_\_\_ 9. Eruptions of mafic magma are generally less deadly than eruptions of felsic magma.
- \_\_\_\_\_ 10. Pillow lava forms when felsic magma cools very quickly under water.

---

### Lesson 8.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Predicting Volcanic Eruptions**

Volcanologists attempt to forecast volcanic eruptions, but this has proven to be nearly as difficult as predicting earthquakes. Many pieces of evidence can mean that a volcano is about to erupt, although the time and magnitude of the eruption are difficult to predict. Signs an eruption is likely may come from a history of previous volcanic activity, the occurrence of earthquakes, slope deformation, and gas emissions.

A volcano's history—how long since its last eruption and the time span between its previous eruptions—is a good first step in predicting eruptions. Currently erupting volcanoes (active volcanoes) and those that have erupted recently (dormant volcanoes) are heavily monitored because they may erupt again.

Moving magma shakes the ground, so the number and size of earthquakes may increase before an eruption. A volcano that is about to erupt may produce a sequence of earthquakes. Scientists use seismographs to record the length and strength of earthquakes to help them predict whether an eruption is imminent.

Magma and gas can push a volcano's slope upward, causing deformation in the ground. The changes may be subtle and only detectable by tiltmeters. These are instruments that measure the angle of a slope. In other cases, the changes may be very obvious. For example, Mount St. Helens grew a huge bulge on its north side before its 1980 eruption. Ground swelling may also cause rock falls and landslides.

Gases may escape from a volcano before magma reaches the surface. Scientists measure gas emissions in vents on or around volcanoes or from a distance using satellites. The gases measured may include sulfur dioxide, carbon dioxide, hydrochloric acid, and water vapor. The amounts of gases and their ratios are calculated to help predict eruptions.

### Questions

1. Identify signs that a volcano may be likely to erupt.
2. Why do earthquakes often precede volcanic eruptions?
3. A volcano about to erupt may deform the ground. How can this be detected?
4. Why do scientists measure gases released on or around a volcano to help predict eruptions?

---

## Lesson 8.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The costliest and deadliest volcanic eruption in U.S. history was
  - a. Mount Shasta.
  - b. Mount Redoubt.
  - c. Mount Mazama.
  - d. Mount St. Helens.
2. The chemical composition of magma determines
  - a. its eruption style.
  - b. the type of volcanic cone it creates.
  - c. the composition of rocks it forms.
  - d. all of the above
3. Mafic magmas
  - a. are low in silica.
  - b. are light in color.
  - c. contain minerals such as quartz.
  - d. all of the above
4. Felsic magmas
  - a. are not viscous.
  - b. erupt effusively.
  - c. do not flow easily.
  - d. cool to form extrusive rocks.
5. A pyroclastic flow may
  - a. knock down everything in its path.
  - b. have a maximum temperature of 700 °C.
  - c. travel at a speed of 1800 mph.
  - d. consist of mafic magma.
6. Types of lava in explosive eruptions may include
  - a. a'a.
  - b. pāhoehoe.
  - c. pillow lava.

- d. none of the above
- 7. Signs that a volcano may soon erupt include
  - a. earthquakes.
  - b. gas emissions.
  - c. ground deformation.
  - d. all of the above

---

## Lesson 8.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. potentially devastating eruption of rock, lava, ash, and gas from a volcano
- \_\_\_\_\_ 2. volcano that has not erupted recently and probably will not erupt again
- \_\_\_\_\_ 3. resistance of a liquid to flow
- \_\_\_\_\_ 4. hot ash, gas, and rock that race down a volcano's slopes during an explosive eruption
- \_\_\_\_\_ 5. relatively gentle, non-explosive volcanic eruption
- \_\_\_\_\_ 6. volcano that is not currently active but has erupted recently
- \_\_\_\_\_ 7. volcano that is erupting or shows signs that it will erupt soon

### Terms

- a. active volcano
- b. dormant volcano
- c. extinct volcano
- d. effusive eruption
- e. explosive eruption
- f. pyroclastic flow
- g. viscosity

---

## Lesson 8.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Smooth, ropy lava tubes that form from mafic magma are called \_\_\_\_\_.
- 2. A(n) \_\_\_\_\_ is a volcanic mudflow that occurs when a pyroclastic flow melts snow.
- 3. A region in the crust below a volcano where magma and gases collect is known as a(n) \_\_\_\_\_.
- 4. The material that erupts from a volcano in an explosive eruption is called \_\_\_\_\_.
- 5. \_\_\_\_\_ magmas contain dark-colored minerals such as olivine.
- 6. \_\_\_\_\_ magmas contain light-colored minerals such as quartz.

7. Scientists who study volcanoes are called \_\_\_\_\_.

---

## Lesson 8.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Relate type of magma (mafic or felsic) to style of volcanic eruption (effusive or explosive). Explain the relationship.



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## 8.3 Types of Volcanoes

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### Lesson 8.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. A volcano is a vent through which material escapes from a magma chamber.
  - \_\_\_\_\_ 2. Some volcanoes appear to be little more than cracks in the ground.
  - \_\_\_\_\_ 3. The shape of a volcano depends mainly on how much material erupts.
  - \_\_\_\_\_ 4. Composite volcanoes generally have effusive eruptions.
  - \_\_\_\_\_ 5. The layers of a shield volcano are usually very similar in composition.
  - \_\_\_\_\_ 6. A cinder cone is typically much larger than other types of volcanoes.
  - \_\_\_\_\_ 7. The idea of supervolcanoes dates back at least 1000 years.
  - \_\_\_\_\_ 8. Yellowstone sits atop a hotspot that has had three catastrophic eruptions.
  - \_\_\_\_\_ 9. Long Valley in California is the second largest supervolcano in North America.
  - \_\_\_\_\_ 10. Scientists have determined precisely when the next supervolcanic eruption will occur.
- 

### Lesson 8.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Composite and Shield Volcanoes

Composite volcanoes are created by felsic magma, which is viscous. The viscous lava cannot travel far down the sides of the volcano before it solidifies, forming the steeply sloping sides that are characteristic of composite volcanoes. Viscosity also causes some eruptions to explode as ash and small rocks. As a result, composite volcanoes consist of alternating layers of ash and lava that has solidified to form rock. The layers form the classic cone shape of composite volcanoes.

Shield volcanoes get their name from their shape. They are literally shaped like a shield. The sides of a shield volcano are not steep, but the volcano may cover a very large area. The lava that creates a shield volcano is mafic and not viscous, so it flows easily. The lava can flow over a wide area before it solidifies. This is what creates the broad shield shape. The low viscosity of the lava also means that shield volcano eruptions are effusive rather than explosive. As a result, the layers of shield volcanoes are usually very similar in composition.

#### Questions

1. Describe the shape of composite volcanoes. Why do composite volcanoes have this shape?
2. Describe the shape of shield volcanoes. Why do shield volcanoes have this shape?

3. Explain why composite volcanoes, but not shield volcanoes, consist of alternating layers of ash and rock.

---

### Lesson 8.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Composite volcanoes have steep sides because the lava
  - a. is not viscous.
  - b. solidifies quickly.
  - c. has a mafic composition.
  - d. two of the above
2. You would expect to find alternating layers of rock and ash in a cross section of a(n)
  - a. cinder cone.
  - b. shield volcano.
  - c. effusive volcano.
  - d. composite volcano.
3. Shield volcanoes are common at
  - a. convergent plate boundaries.
  - b. divergent plate boundaries.
  - c. intraplate hotspots.
  - d. two of the above
4. The largest shield volcano on Earth is
  - a. Mount St. Helens.
  - b. Mount Fuji.
  - c. Mauna Loa.
  - d. Parícutín.
5. Cinder cone volcanoes
  - a. are shaped like shield volcanoes.
  - b. typically become supervolcanoes.
  - c. grow slowly from many eruptions.
  - d. are often found near larger volcanoes.
6. Supervolcanoes
  - a. have frequent, explosive eruptions.
  - b. are classified as cinder cone volcanoes.
  - c. may have contributed to mass extinctions.
  - d. include Mount Pinatubo in the Philippines.
7. To be classified as a supervolcano, the volume of material in an eruption must be more than
  - a. 1000 km<sup>3</sup>.
  - b. 250 km<sup>3</sup>.
  - c. 120 km<sup>3</sup>.
  - d. 80 km<sup>3</sup>.

---

## Lesson 8.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. most common type of volcano
- \_\_\_\_\_ 2. huge hole in a volcano into which the surface collapses
- \_\_\_\_\_ 3. broad volcano with gently sloping sides
- \_\_\_\_\_ 4. example of a composite volcano
- \_\_\_\_\_ 5. most dangerous type of volcano
- \_\_\_\_\_ 6. example of a supervolcano
- \_\_\_\_\_ 7. large volcano with steeply sloping side

### Terms

- a. shield volcano
- b. supervolcano
- c. composite volcano
- d. caldera
- e. cinder cone
- f. Mount St. Helens
- g. Yellowstone

---

## Lesson 8.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Composite volcanoes are made of \_\_\_\_\_ rock.
- 2. The type of eruptions that produce shield volcanoes are \_\_\_\_\_ eruptions.
- 3. \_\_\_\_\_ are small volcanoes composed of fragments of rocks such as pumice.
- 4. Low-viscosity magma produces \_\_\_\_\_ volcanoes.
- 5. High-viscosity magma produces \_\_\_\_\_ volcanoes.
- 6. Cinder cones usually have a(n) \_\_\_\_\_ at the summit.
- 7. Scientists think that a(n) \_\_\_\_\_ forms when a very large magma chamber erupts all at once.

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## Lesson 8.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain the possible causes and consequences of supervolcano eruptions.

## 8.4 Volcanic Landforms and Geothermal Activity

### Lesson 8.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Hot springs are surface features associated with volcanic activity.
- \_\_\_\_\_ 2. The more viscous lava is, the more quickly it flows over the surface.
- \_\_\_\_\_ 3. A magma dome typically forms during an explosive volcanic eruption.
- \_\_\_\_\_ 4. Lava plateaus consist of sheets of lava that solidified below the surface.
- \_\_\_\_\_ 5. Lava creates new land as it flows into the ocean.
- \_\_\_\_\_ 6. Geysers are found in many places on Earth's surface.
- \_\_\_\_\_ 7. Underground water heated by magma may be hot enough to boil.
- \_\_\_\_\_ 8. Extreme pressure causes a geyser to erupt onto the surface.
- \_\_\_\_\_ 9. All geysers erupt as predictably as Old Faithful in Yellowstone National Park.
- \_\_\_\_\_ 10. Flowing lava created the Hawaiian Islands.

### Lesson 8.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Landforms from Lava

The most obvious landforms created by lava are volcanoes. These may be relatively small cinder cones or huge composite or shield volcano mountains. Sometimes lava erupts through a long crack, or fissure, instead through the vent of a volcano. The entire ocean floor is the result of fissure eruptions.

When lava is viscous, it flows slowly. Viscous lava typically causes explosive volcanic eruptions that form shield volcanoes. However, if there is not enough magma or enough pressure to cause an explosive eruption, the magma may form a lava dome instead. A lava dome is a large, rounded landform that forms when viscous lava cools and hardens before it can travel far from a vent. Lava domes often form in the middle of craters at the top of composite volcanoes. For example, there is a lava dome in the crater of Mount St. Helens.

When lava is not viscous, it flows quickly. It can flow over an extensive area before it cools and hardens. This type of lava flow may form a lava plateau. This is a wide, flat surface of igneous rock that forms when thin lava solidifies. The Columbia Plateau in the Pacific Northwest is a lava plateau. It covers more than 161,000 square kilometers (63,000 square miles) in Washington State, Oregon, and Idaho.

Lava may create new land by forming or expanding islands in the ocean. This occurs when lava solidifies on the coast or emerges from beneath the water. The Hawaiian Islands are formed from shield volcano eruptions and have

grown over the last 5 million years.

### Questions

1. List landforms created by lava.
2. How and why does a lava dome form?
3. What type of lava forms a lava plateau? Why?
4. Explain how the Hawaiian islands formed.

---

## Lesson 8.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Surface features related to volcanic activity include
  - a. geysers.
  - b. lava domes.
  - c. cinder cones.
  - d. all of the above
2. A lava dome may form if lava is
  - a. thin.
  - b. mafic.
  - c. viscous.
  - d. under great pressure.
3. Where is a lava dome most likely to form?
  - a. on the side of a shield volcano
  - b. in the middle of a crater
  - c. on the ocean floor
  - d. on a lava plateau
4. A lava plateau
  - a. forms from thin lava.
  - b. consists of sedimentary rock.
  - c. forms from the weathering of a volcanic mountain.
  - d. results when hot lava cools beneath ocean water.
5. An example of a landform created from a magma intrusion is
  - a. the Big Island of Hawaii.
  - b. Shiprock in New Mexico.
  - c. Mount St. Helens in Washington State.
  - d. none of the above
6. Conditions necessary for a geyser to occur include
  - a. water superheated by magma beneath Earth's surface.
  - b. buildup of pressure on underground water.
  - c. trapping of water in a narrow passageway underground.
  - d. all of the above
7. About how many geysers are there worldwide?

- a. 10
- b. 100
- c. 1000
- d. 10,000

---

## Lesson 8.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. large, flat surface of igneous rock that forms when lava flows over a wide area
- \_\_\_\_\_ 2. location of rock formed solely by fissure eruptions
- \_\_\_\_\_ 3. hot water that bubbles onto the surface
- \_\_\_\_\_ 4. large, rounded landform created by lava
- \_\_\_\_\_ 5. hot water that erupts onto the surface

### Terms

- a. lava dome
- b. hot spring
- c. lava plateau
- d. geyser
- e. seafloor

---

## Lesson 8.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Volcanic landforms vary with the \_\_\_\_\_ of the magma that created them.
- 2. Viscous lava flows \_\_\_\_\_ slowly than non-viscous lava.
- 3. The Columbia Plateau in the Pacific Northwest is a(n) \_\_\_\_\_.
- 4. The Hawaiian Islands are formed from the eruptions of \_\_\_\_\_ volcanoes.
- 5. Water in a hot spring or geyser is heated by \_\_\_\_\_.
- 6. About half of all the geysers in the world are found in the \_\_\_\_\_.
- 7. The most obvious landforms created by lava are \_\_\_\_\_.

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## Lesson 8.4: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast hot springs and geysers. Why do you think there are fewer geysers than hot springs in the world?



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CHAPTER

9

# HS Weathering and Formation of Soil Worksheets

## Chapter Outline

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9.1 WEATHERING

9.2 SOILS

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- Lesson 9.1: Weathering
- Lesson 9.2: Soils

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## 9.1 Weathering

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### Lesson 9.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Ice wedging is the transport of sediments by glaciers.
  - \_\_\_\_\_ 2. Agents of abrasion include wind and gravity.
  - \_\_\_\_\_ 3. Mechanical weathering increases the rate of chemical weathering.
  - \_\_\_\_\_ 4. Chemical weathering occurs because of chemical reactions.
  - \_\_\_\_\_ 5. Minerals that form deep under Earth's surface are unstable on the surface.
  - \_\_\_\_\_ 6. Clay is an example of a mineral that is unstable on Earth's surface.
  - \_\_\_\_\_ 7. Water can dissolve many minerals because water molecules are polar.
  - \_\_\_\_\_ 8. Acid rain accelerates the rate of chemical weathering.
  - \_\_\_\_\_ 9. Plants contribute to mechanical but not chemical weathering.
  - \_\_\_\_\_ 10. Cold, dry climates have the highest rates of weathering.
- 

### Lesson 9.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Chemical Weathering

Chemical weathering occurs when rocks undergo chemical reactions that change their mineral composition. Most minerals form under conditions of high pressure and temperature deep within the crust or even in the mantle. If the minerals reach Earth's surface where pressure and temperature are much lower, they become unstable. As a result, the minerals change chemically to other minerals, such as clay, that are more stable under conditions on the surface.

Water is the most important agent of chemical weathering. Water is a polar molecule, meaning that one side of the molecule is slightly positive and the other side is slightly negative. The positive side of each water molecule attracts negative ions and the negative side attracts positive ions. In this way, water molecules separate ions from their compounds and surround them. Water can completely dissolve some minerals, such as salt.

Two other important agents of chemical weathering are carbon dioxide and oxygen, both of which are gases in Earth's atmosphere.

- Carbon dioxide combines with water as raindrops fall through the atmosphere. This forms a weak acid, called carbonic acid, which can dissolve some types of rock.
- Oxygen is very reactive chemically. A common type of chemical reaction involving oxygen is oxidation. The

most familiar example of oxidation is the reaction of iron with oxygen to create iron oxide, or rust. Minerals rich in iron break down as the iron rusts. This is why some soils are red in color.

### Questions

1. What is chemical weathering? Why does it occur?
2. How does water cause chemical weathering?
3. Explain the roles of carbon dioxide and oxygen in chemical weathering.

---

## Lesson 9.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Weathering does not occur on the moon because the moon has no
  - a. atmosphere.
  - b. weather.
  - c. gravity.
  - d. two of the above
2. The general process that changes solid rock into sediments is called
  - a. erosion.
  - b. leaching.
  - c. hydrolysis.
  - d. weathering.
3. Mechanical weathering results in pieces of rock that are the same as the parent rock in
  - a. mineral content.
  - b. shape.
  - c. size.
  - d. two of the above
4. Abrasion may be caused by
  - a. freezing and thawing.
  - b. weak acids.
  - c. oxidation.
  - d. gravity.
5. Agents of mechanical weathering include
  - a. burrowing animals.
  - b. human beings.
  - c. plants.
  - d. all of the above
6. The rate of chemical weathering is higher when
  - a. temperatures are lower.
  - b. precipitation is higher.
  - c. rocks are intrusive.
  - d. all of the above
7. Which of the following can be an agent of both mechanical and chemical weathering?

- a. carbon dioxide
- b. oxygen
- c. gravity
- d. water

---

## Lesson 9.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. chemical reaction in which a mineral is changed by reacting with water
- \_\_\_\_\_ 2. major cause of mechanical weathering in climates with freeze-thaw cycles
- \_\_\_\_\_ 3. process of removing dissolved minerals as they are carried to lower layers of soil
- \_\_\_\_\_ 4. type of weathering in which rock breaks into smaller pieces
- \_\_\_\_\_ 5. chemical reaction in which oxygen reacts with another element to create a metal oxide
- \_\_\_\_\_ 6. form of mechanical weathering in which rocks scrape against each other
- \_\_\_\_\_ 7. type of weathering that changes the mineral composition of rock

### Terms

- a. mechanical weathering
- b. leaching
- c. chemical weathering
- d. ice wedging
- e. oxidation
- f. abrasion
- g. hydrolysis

---

## Lesson 9.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Cobbles from a streambed are smooth and rounded because of the type of weathering called \_\_\_\_\_.
- 2. The most important agent of chemical weathering is \_\_\_\_\_.
- 3. Hydrolysis and leaching are more common in climates with high levels of \_\_\_\_\_.
- 4. Carbon dioxide in the air combines with water in raindrops to form \_\_\_\_\_.
- 5. Iron-rich minerals change to rust in the type of chemical reaction known as \_\_\_\_\_.
- 6. Chemical weathering occurs \_\_\_\_\_ quickly when temperatures are warmer.
- 7. The average temperature and precipitation in a region is its \_\_\_\_\_.

---

## Lesson 9.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Identify and explain two ways that ice causes mechanical weathering.

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## 9.2 Soils

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### Lesson 9.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Peat is soil that is completely organic.
- \_\_\_\_\_ 2. The same type of rock always produces the same type of soil.
- \_\_\_\_\_ 3. Dry regions have thicker soils than wet regions.
- \_\_\_\_\_ 4. Inorganic material is the source of nutrients in soil.
- \_\_\_\_\_ 5. Fertile soils are rich in the element nitrogen.
- \_\_\_\_\_ 6. Some soils develop as many as six distinct layers.
- \_\_\_\_\_ 7. Soluble minerals and clays accumulate in subsoil.
- \_\_\_\_\_ 8. Pedalfer soils are usually the least fertile.
- \_\_\_\_\_ 9. Laterite soils are thick and rich in nutrients.
- \_\_\_\_\_ 10. Soil is a renewable resource only if it is carefully managed.

---

### Lesson 9.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Soil Horizons

Residual soil forms over many years as mechanical and chemical weathering slowly change solid rock into soil. Soil formation begins when bedrock cracks because of ice wedging or other processes of mechanical weathering. Water, oxygen, and carbon dioxide seep into the cracks and cause chemical weathering. Plants eventually start growing and cause biological weathering. As the weathered material collects, layers called soil horizons develop. The greatest degree of weathering is in the top layer, because this is where water and air first come into contact with rock. Each successive lower layer is less altered by weathering. Most soils have at least three distinct layers, called A, B, and C horizons. A cross-section of all the horizons is called a soil profile.

The A horizon is the top layer of soil. It is also called topsoil. This layer is usually darkest in color because it has the highest proportion of organic material. Topsoil is where most soil organisms live, including insects, worms, and other animals in addition to plants. Plant roots help to hold this layer of soil in place. Minerals in topsoil may dissolve in rainwater and soak into the next soil layer. Rainwater also transports tiny mineral particles such as clay deeper into the soil.

The B horizon is the next layer of soil. It is also called subsoil. This layer is lighter in color than topsoil because it contains less organic material. It is also where soluble minerals and clay particles from topsoil accumulate. Because

of the presence of clay and other minerals, subsoil holds more water than topsoil does.

The C horizon is the lowest layer of soil. It consists of partially altered bedrock. There is some evidence of weathering in this layer, but pieces of the original rock are still visible and identifiable.

### Questions

1. Describe how residual soil forms.
2. What is a soil profile?
3. Identify and distinguish among the three horizons found in most soils.

---

## Lesson 9.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. In most soils, inorganic materials make up about
  - a. 30 percent of soil.
  - b. 50 percent of soil.
  - c. 70 percent of soil.
  - d. 90 percent of soil.
2. Factors that lead to greater soil formation include
  - a. lower precipitation.
  - b. higher temperature.
  - c. slower plant growth.
  - d. all of the above
3. Humus in soil
  - a. binds together mineral grains.
  - b. increases the soil's fertility.
  - c. helps the soil hold water.
  - d. all of the above
4. The soil layer with the greatest degree of weathering is called the
  - a. A horizon.
  - b. B horizon.
  - c. C horizon.
  - d. D horizon.
5. Relative to other soil layers, topsoil has the
  - a. highest percentage of organic material.
  - b. least amount of biological activity.
  - c. lightest color.
  - d. two of the above
6. Which soil type is most permeable?
  - a. silt
  - b. clay
  - c. sand
  - d. loam

7. Under the best soil-forming conditions, soil forms at a rate of about
- 10 cm/year.
  - 1 cm/year.
  - 10 mm/year.
  - 1 mm/year.

---

## Lesson 9.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. subsoil layer of a soil profile
- \_\_\_\_\_ 2. type of soil that contains a mixture of mineral grain sizes
- \_\_\_\_\_ 3. type of soil that forms in grasslands
- \_\_\_\_\_ 4. component of soil that consists of decayed organic remains
- \_\_\_\_\_ 5. type of soil that forms in tropical rainforests
- \_\_\_\_\_ 6. type of soil that forms in deciduous forests
- \_\_\_\_\_ 7. topsoil layer of a soil profile

### Terms

- a. humus
- b. loam
- c. pedalfer
- d. A horizon
- e. pedocal
- f. laterite
- g. B horizon

---

## Lesson 9.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. The major factor that determines the type of soil in an area is \_\_\_\_\_.
2. Soils that form in the same place where they are found are called \_\_\_\_\_ soils.
3. Soils that formed somewhere else and were moved by erosion are called \_\_\_\_\_ soils.
4. Soils that are \_\_\_\_\_ allow water to flow easily through them.
5. A cross-section of soil showing its different layers is called a soil \_\_\_\_\_.
6. The layer of soil consisting only of partially altered bedrock is the \_\_\_\_\_.
7. Soil called pedalfer gets its name from the iron and \_\_\_\_\_ it contains.



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## Lesson 9.2: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast pedalfer and pedocal soils, and explain any differences.

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# CHAPTER 10 HS Erosion and Deposition Worksheets

## Chapter Outline

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- 10.1 WATER EROSION AND DEPOSITION**
  - 10.2 WAVE EROSION AND DEPOSITION**
  - 10.3 WIND EROSION AND DEPOSITION**
  - 10.4 GLACIAL EROSION AND DEPOSITION**
  - 10.5 EROSION AND DEPOSITION BY GRAVITY**
- 

- **Lesson 10.1: Water Erosion and Deposition**
- **Lesson 10.2: Wave Erosion and Deposition**
- **Lesson 10.3: Wind Erosion and Deposition**
- **Lesson 10.4: Glacial Erosion and Deposition**
- **Lesson 10.5: Erosion and Deposition by Gravity**

## 10.1 Water Erosion and Deposition

### Lesson 10.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Streams play a vital role in the water cycle.
- \_\_\_\_\_ 2. The dissolved load of a stream is composed of tiny sediments.
- \_\_\_\_\_ 3. The size of particles that a stream can carry depends on its velocity.
- \_\_\_\_\_ 4. Down cutting into the streambed is done mainly by a stream's suspended load.
- \_\_\_\_\_ 5. The highest elevation of a stream is at its headwaters.
- \_\_\_\_\_ 6. Floodplains have nutrient-rich soils.
- \_\_\_\_\_ 7. A decrease in gradient causes a stream to erode more sediment.
- \_\_\_\_\_ 8. Alluvial fans generally form in arid regions.
- \_\_\_\_\_ 9. Carbonic acid in groundwater comes from dissolved rocks.
- \_\_\_\_\_ 10. Base level is the elevation where a stream enters a body of standing water.

### Lesson 10.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Groundwater Erosion and Deposition

Rainwater absorbs carbon dioxide from the atmosphere as it falls through the air. The carbon dioxide combines with water to form carbonic acid. The slightly acidic water sinks into the ground and moves through spaces in soil called pores. The acidic water also travels downward through cracks in rock. Water that flows under the ground through soil or rock is called groundwater. Groundwater is a strong erosional force.

Working slowly over many years, groundwater moving through cracks in rocks dissolves and carries away rock minerals. This enlarges the cracks little by little. Eventually a cave may form. Dissolved minerals in groundwater may also be deposited in a cave, creating formations called stalactites and stalagmites. They form when calcium carbonate dissolved in groundwater comes out of solution. Stalactites form as water drips from the ceiling of a cave, creating icicle-like formations. Stalagmites form as water drips onto the floor of a cave, creating formations like upside-down icicles that grow from the floor of the cave upward. If a stalactite and stalagmite join together, they form a column. Sometimes the roof of a cave collapses. This forms a hole on the surface called a sinkhole. A sinkhole may be large enough to swallow a home or even several homes.

#### Questions

1. What is groundwater? Why is groundwater a strong erosional force?

2. Explain how groundwater erodes a cave.
3. Describe features created by groundwater deposition.
4. How does a sinkhole form?

---

## Lesson 10.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Sediments carried as solids in the water of a stream make up its
  - a. suspended load.
  - b. dissolved load.
  - c. transported load.
  - d. bed load.
2. A stream that can carry larger sediments has a
  - a. greater competence.
  - b. gentler gradient.
  - c. slower velocity.
  - d. two of the above
3. The suspended load of a stream is most likely to include
  - a. clay.
  - b. gravel.
  - c. pebbles.
  - d. dissolved ions.
4. A stream on a steep slope mainly erodes its
  - a. bed.
  - b. delta.
  - c. banks.
  - d. levees.
5. Flowing water does the work of
  - a. erosion.
  - b. deposition.
  - c. weathering.
  - d. all of the above
6. A meander slowly migrates when
  - a. sediments are deposited on the inside of the curve.
  - b. sediments are eroded on the outside of the curve.
  - c. sediments are deposited on the outside of the curve.
  - d. two of the above
7. The carbonic acid in groundwater is especially good at dissolving the rock
  - a. limestone.
  - b. sandstone.
  - c. granite.
  - d. basalt.

---

## Lesson 10.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. deposit of calcium carbonate on the floor of a cave
- \_\_\_\_\_ 2. deposit by a stream where it enters a body of still water
- \_\_\_\_\_ 3. curve in a stream channel caused by erosion and deposition along the banks
- \_\_\_\_\_ 4. deposit by a stream when it goes from a steep slope to a flat valley
- \_\_\_\_\_ 5. deposit of calcium carbonate on the ceiling of a cave
- \_\_\_\_\_ 6. intermittent movement of bed load
- \_\_\_\_\_ 7. ability of a stream to carry particles of sediment

### Terms

- a. meander
- b. stalactite
- c. saltation
- d. competence
- e. alluvial fan
- f. delta
- g. stalagmite

---

## Lesson 10.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Any body of running water is called a(n) \_\_\_\_\_.
- 2. Water that travels through the soil and rocks underground is known as \_\_\_\_\_.
- 3. The area a stream covers when it overflows its banks is its \_\_\_\_\_.
- 4. When a stream floods, it may deposit ridges called \_\_\_\_\_ at the edges of its channel.
- 5. A(n) \_\_\_\_\_ is an underground cavern eroded by groundwater.
- 6. If a stalactite and a stalagmite join together, they form a(n) \_\_\_\_\_.
- 7. If the roof of a cave collapses, it forms a(n) \_\_\_\_\_.

---

## Lesson 10.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.

Explain how a typical stream's work changes as it flows from its headwaters to its base level.

## 10.2 Wave Erosion and Deposition

### Lesson 10.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Ocean waves form from wind blowing over the water.
- \_\_\_\_\_ 2. The energy of waves is likely to be dispersed in a bay.
- \_\_\_\_\_ 3. Further erosion may create a wave-cut cliff from a wave-cut platform.
- \_\_\_\_\_ 4. All the sediment carried by waves comes from rivers that enter the ocean.
- \_\_\_\_\_ 5. Waves continually move sand along the shore.
- \_\_\_\_\_ 6. Sandbars are artificial barriers built to protect beaches from wave erosion.
- \_\_\_\_\_ 7. Most barrier islands are just a few kilometers wide.
- \_\_\_\_\_ 8. Dunes are natural features that protect inland areas from wave erosion.
- \_\_\_\_\_ 9. Sand is trapped on the up-current side of a groin.
- \_\_\_\_\_ 10. Sediments in waves erode cliffs by abrasion.

### Lesson 10.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Wave Deposition

Rivers carry sediments from the land to the sea. When a river flows into the ocean, the sudden loss of velocity typically results in the formation of a delta. However, if wave action is high, a delta will not form. Instead, waves will spread the sediments along the coastline and create a beach. Waves also erode sediments from cliffs and shorelines and transport them onto beaches. Beaches are most likely to form in quiet areas along a shoreline. For example, a beach may form where water comes ashore in a protected bay. Waves continually move sand on beaches down the shoreline. Waves also move sand back and forth from beaches on shore to bars of sand offshore as the seasons change. In the summer, waves have lower energy, so they deposit sand on beaches. In the winter, waves have higher energy, so they carry the sand back offshore to sandbars.

Besides beaches, several other features may be formed by wave-deposited sand. Barrier islands are islands of sand that are deposited by waves parallel to shore. They are usually just a few kilometers wide but tens of kilometers long. They tend to form along shores that are flat or gently sloping. In their natural state, barrier islands are the first defense against powerful wave erosion during hurricanes and other storms. They bear the brunt of the wave energy and help to protect shorelines from serious wave erosion. However, when barrier islands are built up with homes and other structures, they offer less protection to the shore, and the structures built on them may suffer serious wave damage.

Two other features deposited by waves are spits and tombolos. A spit is a sand deposit that is connected to land and extends out into the water. If a spit develops a curved, hook-like end, it is called a tombolo.

### Questions

1. Where and when are waves most likely to deposit sand and form beaches?
2. Explain how barrier islands form and how they protect shorelines from wave erosion.
3. Describe spits and tombolos.

---

## Lesson 10.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Factors that influence the size of ocean waves include how
  - a. strong the wind blows.
  - b. long the wind blows.
  - c. far the wind blows.
  - d. all of the above
2. Features that result directly from wave erosion include
  - a. cliffs.
  - b. breakwaters.
  - c. spits.
  - d. beaches.
3. Features that result from wave deposition include
  - a. groins.
  - b. barrier islands.
  - c. sea walls.
  - d. sea stacks.
4. Wave refraction may
  - a. concentrate wave energy.
  - b. destroy wave energy.
  - c. create wave energy.
  - d. all of the above
5. Which choice shows the correct sequence of features formed by continued wave erosion?
  - a. wave-cut cliff, sea arch, sea stacks
  - b. sea arch, wave-cut cliff, sea stacks
  - c. sea stacks, wave-cut cliff, sea arch
  - d. sea arch, sea stacks, wave-cut cliff
6. In addition to sand, sediments found on beaches may include
  - a. mineral grains.
  - b. rock fragments.
  - c. pieces of shell.
  - d. all of the above
7. Artificial structures that are built to protect shorelines from wave erosion include



- a. barrier islands.
- b. tombolos.
- c. groins.
- d. all of the above

---

## Lesson 10.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. sand deposited by waves in a quiet area along a shoreline
- \_\_\_\_\_ 2. long, narrow feature of sand deposited by waves parallel to a shoreline
- \_\_\_\_\_ 3. natural feature that forms when waves erode a cliff from two sides
- \_\_\_\_\_ 4. artificial structure built perpendicular to the shoreline to keep sand on a beach
- \_\_\_\_\_ 5. natural feature that forms when waves erode the top of a sea arch
- \_\_\_\_\_ 6. energy traveling through ocean water
- \_\_\_\_\_ 7. artificial barrier island built to protect the shore from incoming waves

### Terms

- a. sea arch
- b. sea stack
- c. beach
- d. barrier island
- e. breakwater
- f. ocean wave
- g. groin

---

## Lesson 10.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The “bending” of a wave when it strikes the shore at an angle is called \_\_\_\_\_.
- 2. A spit that develops a hook-like shape forms a feature called a(n) \_\_\_\_\_.
- 3. A(n) \_\_\_\_\_ is an onshore structure built parallel to the shoreline to protect it from wave erosion.
- 4. A level area formed by waves that undercut a wave-cut cliff is called a(n) \_\_\_\_\_.
- 5. With continued wave erosion, a sea arch may form two \_\_\_\_\_.
- 6. If wave action is high, waves may prevent the formation of a(n) \_\_\_\_\_ where a river enters the ocean.
- 7. During the \_\_\_\_\_, waves have less energy and tend to deposit sand on beaches.

---

## Lesson 10.2: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Identify two artificial structures that are built to protect shorelines from wave erosion. Explain how the structures do their job.

## 10.3 Wind Erosion and Deposition

### Lesson 10.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Wind is a more important erosional force in humid regions.
- \_\_\_\_\_ 2. Particles transported by saltation may stay in the air for days.
- \_\_\_\_\_ 3. The wind usually transports sand-sized particles by creep.
- \_\_\_\_\_ 4. Desert pavement is a surface covered by sand.
- \_\_\_\_\_ 5. Desert pavement forms as a result of deflation.
- \_\_\_\_\_ 6. Desert varnish forms because of wind-blown clay.
- \_\_\_\_\_ 7. Beach dune sand is usually made of a variety of minerals.
- \_\_\_\_\_ 8. Desert dune sand is usually composed only of quartz.
- \_\_\_\_\_ 9. Dune sand particles are rounded because rounded grains roll more easily than angular grains.
- \_\_\_\_\_ 10. Wind drops the sediments it is transporting when it slows down.

### Lesson 10.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Sand Dunes**

Deserts and seashores often have sand dunes. Sand dunes are small hills of sand deposited layer upon layer by the wind. For sand dunes to form there must be an abundant supply of sand and steady winds. A dune forms when a strong wind slows down—often when it blows over some type of obstacle, such as a rock or clump of grass—and drops its sand. As the wind moves up and over the obstacle, it increases in speed. It carries the sand grains up the upwind side of the dune by saltation. As the wind passes over the crest of the dune, its speed decreases. Sand cascades down the other side, forming the slip face of the dune. Sand dunes slope gently on the upwind side and steeply on the downwind slip face side. The slip face is steep because dry sand can form a relatively steep angle without falling downslope.

Sand in beach dunes may vary in composition depending on their location. Beach dune sand is usually composed of quartz because in humid areas other minerals weather into clays. In the tropics, they may be composed of calcium carbonate. Sand in desert dunes may be composed of a variety of minerals. There is little weathering in deserts, so less stable minerals are left behind. Although sand dunes may differ in the composition of their sand, the sand particles themselves are similar and usually very uniform in size and shape. The particles are sand-sized, because larger particles are generally too heavy for the wind to transport easily. The particles are rounded because rounded grains roll more easily than angular grains.

The type of sand dune that forms depends on the amount of sand available, the strength and direction of winds, and the type of ground over which the sand is moving. For example, crescent-shaped dunes form where a large amount of sand is available, winds blow consistently in one direction, and the ground is hard. Linear dunes form long straight lines parallel to the wind direction. They form in areas with less sand where winds come together from different directions.

### Questions

1. What are sand dunes?
2. Explain how a sand dune forms.
3. Describe similarities and differences among the sands of different dunes.
4. Identify factors that affect the type of sand dune that forms. Give examples.

---

## Lesson 10.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The ability of wind to erode sediments depends on
  - a. sediment size.
  - b. wind strength.
  - c. degree of aridity.
  - d. all of the above
2. Wind transports particles of silt and clay
  - a. by creep.
  - b. as bed load.
  - c. by saltation.
  - d. over great distances.
3. What is needed for a sand dune to form?
  - a. bare ground
  - b. plenty of sand
  - c. winds that never change direction
  - d. all of the above
4. Loess deposits form downwind of
  - a. glacial deposits.
  - b. deserts.
  - c. forests.
  - d. two of the above
5. Loess deposits
  - a. have gently sloping sides.
  - b. make very fertile soils.
  - c. form in vertical layers.
  - d. are mined for mineral ores.
6. The bed load of wind typically includes particles the size of
  - a. clay.
  - b. silt.

- c. sand.
  - d. two of the above.
7. Sand dunes form cross beds when the
- a. wind often changes direction.
  - b. slip face collapses.
  - c. particles vary in size.
  - d. obstacles keep moving.

---

### Lesson 10.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. stone that has been polished due to abrasion by wind-blown sand
- \_\_\_\_\_ 2. surface covered by gravel-sized particles that are not easily eroded by wind
- \_\_\_\_\_ 3. steep side of a sand dune
- \_\_\_\_\_ 4. lowering of the ground surface due to wind erosion of sediments
- \_\_\_\_\_ 5. small hill in a desert or on a beach formed by wind deposition of sand
- \_\_\_\_\_ 6. layers of very fine particles that have been deposited by the wind
- \_\_\_\_\_ 7. dark-colored coating that forms on exposed rocks in desert areas

#### Terms

- a. deflation
- b. desert pavement
- c. desert varnish
- d. loess
- e. sand dune
- f. slip face
- g. ventifact

---

### Lesson 10.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The way the wind transports silt-sized particles is called \_\_\_\_\_.
- 2. Particles moved by wind cause erosion through the process of \_\_\_\_\_.
- 3. Wind carries sand grains up a sand dune by \_\_\_\_\_.
- 4. The \_\_\_\_\_ load carried by the wind includes particles of clay.
- 5. \_\_\_\_\_ sands are usually rounded and very uniform in size and shape.

6. Mud on the ocean floor comes from silt and clay carried from the land by \_\_\_\_\_.
7. \_\_\_\_\_ deposits consist of layer upon layer of wind-deposited clay and silt.

---

### Lesson 10.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Relate sediment size to the way sediments are transported by wind.

## 10.4 Glacial Erosion and Deposition

### Lesson 10.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Glaciers currently cover about 30 percent of Earth's total surface.
- \_\_\_\_\_ 2. Glaciers cause erosion by abrasion and plucking.
- \_\_\_\_\_ 3. A varve is a high-altitude lake that forms in a cirque.
- \_\_\_\_\_ 4. Glaciers can carry sediments only if they are pebble-sized or smaller.
- \_\_\_\_\_ 5. Lateral moraines form from material plucked up by a glacier.
- \_\_\_\_\_ 6. A glacier advances when less ice melts than accumulates during a year.
- \_\_\_\_\_ 7. Alpine glaciers flow outward in all directions from the greatest accumulation of snow and ice.
- \_\_\_\_\_ 8. Continental glaciers erode features such as tarns and arêtes.
- \_\_\_\_\_ 9. Glaciers may carry sediments for many years.
- \_\_\_\_\_ 10. A broad area of stratified drift from meltwater is called an outwash plain.

### Lesson 10.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Depositional Features of Glaciers

Glaciers can carry rock particles of any size, from giant boulders to silt. The sediments can be carried for many kilometers over long durations of time. Melting glaciers deposit the sediments they are carrying in a jumble of particle sizes. The unsorted deposits are called glacial till. Many deposits of glacial till have a linear shape. Linear deposits are called moraines. Geologists study moraines to figure out how far glaciers advanced and how long it took them to recede. Moraines are named for their location relative to the glacier.

- Lateral moraines form at the edges of an alpine glacier from material that drops onto the glacier from erosion of the valley walls.
- A medial moraine forms where the lateral moraines of two tributary glaciers join together in the middle of a larger glacier.
- Ground moraines form from sediment underneath a glacier that is deposited as the glacier melts. Deposits of ground moraine may improve soil fertility.
- Terminal moraine forms in a long ridge at the farthest point a glacier reaches.
- End (recessional) moraines form wherever a glacier stops long enough as it recedes to deposit a ridge of sediment.

After glaciers dump unsorted sediments, glacial meltwater can pick up, transport, and re-deposit the sediments. As meltwater moves through unsorted glacial till, it leaves behind the larger particles and takes away the smaller particles, especially silt and sand. The meltwater flowing beneath a glacier may deposit some of the sediments it is carrying in a winding ridge called an esker. As the sediments settle out of meltwater, the larger particles settle first, followed by layers of increasingly smaller sediments. These stratified layers are called stratified drift. A broad area of stratified drift from meltwater at the end of a receding glacier is called an outwash plain.

### Questions

1. What is glacial till? What is a moraine?
2. Identify five types of glacial moraines.
3. Explain why sediments deposited by glacial ice are unsorted whereas sediments deposited by glacial meltwater are sorted.
4. Identify two depositional features of glacial meltwater.

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## Lesson 10.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. A bowl-shaped depression carved into the side of a mountain by a glacier is called a(n)
  - a. arête.
  - b. cirque.
  - c. tarn.
  - d. horn.
2. Any linear rock deposit dropped by a melting glacier is known as a(n)
  - a. till.
  - b. erratic.
  - c. striation.
  - d. moraine.
3. Unsorted glacial till may be sorted into differently sized particles by
  - a. tributary glaciers.
  - b. meltwater.
  - c. plucking.
  - d. gravity.
4. Ground moraine is sediment from the
  - a. bottom of a glacier.
  - b. sides of two tributary glaciers.
  - c. terminal end of a glacier.
  - d. top of a valley glacier.
5. Scientists can determine the direction a glacier moved by examining
  - a. striations.
  - b. drumlins.
  - c. stratified drifts.
  - d. two of the above
6. When a block of ice in glacial till melts, it may form a(n)



- a. outwash plain.
- b. kettle lake.
- c. waterfall.
- d. varve.

7. Features formed by glacial deposition include

- a. glacial striations.
- b. hanging valleys.
- c. glacial erratics.
- d. two of the above

---

## Lesson 10.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. jumble of unsorted rock deposited by a melting glacier
- \_\_\_\_\_ 2. ridge deposited by a glacier where it paused while receding
- \_\_\_\_\_ 3. ridge deposited by a glacier at the farthest point it reached
- \_\_\_\_\_ 4. long, deep groove scratched in bedrock by glacial sediment
- \_\_\_\_\_ 5. linear deposit of till at the edge of an alpine glacier
- \_\_\_\_\_ 6. process of glacial erosion in which rock is picked up and carried away by a glacier
- \_\_\_\_\_ 7. large rock deposited by a glacier that is different from surrounding bedrock

### Terms

- a. glacial striation
- b. plucking
- c. glacial erratic
- d. glacial till
- e. lateral moraine
- f. terminal moraine
- g. end moraine

---

## Lesson 10.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. A large ice sheet that covers relatively flat ground is called a(n) \_\_\_\_\_ glacier.
- 2. A glacier that flows downhill through mountains is called a(n) \_\_\_\_\_ glacier.
- 3. A(n) \_\_\_\_\_ valley forms where an alpine glacier cuts off a tributary glacier and creates a cliff.

4. A peak called a(n) \_\_\_\_\_ forms when several glaciers flow in different directions from a mountaintop.
5. An alpine glacier erodes its valley into a \_\_\_\_\_ shape.
6. A winding ridge of sand deposited under a glacier by a stream of meltwater is a(n) \_\_\_\_\_.
7. A hill of sediments that points in the direction a glacier moved is a(n) \_\_\_\_\_.

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### Lesson 10.4: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast alpine and continental glaciers.

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## 10.5 Erosion and Deposition by Gravity

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### Lesson 10.5: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Gravity always moves material from a higher to a lower elevation.
- \_\_\_\_\_ 2. A landslide can move as quickly as 500 kilometers per hour.
- \_\_\_\_\_ 3. The California coastline is prone to landslides.
- \_\_\_\_\_ 4. Vegetation helps to prevent soil from sliding downhill.
- \_\_\_\_\_ 5. Creep occurs only when a slope is undercut.
- \_\_\_\_\_ 6. Slump occurs so slowly that you cannot actually watch it happening.
- \_\_\_\_\_ 7. A volcanic eruption might shake the ground and trigger a landslide.
- \_\_\_\_\_ 8. Landslides cause about a million dollars of damage in the U.S. each year.
- \_\_\_\_\_ 9. Installing good drainage on hillsides may help prevent landslides.
- \_\_\_\_\_ 10. Landslides are most likely to happen where they have occurred before.

---

### Lesson 10.5: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Types of Rapid Mass Movements

Mass movement is any movement of Earth materials by the force of gravity. Several types of mass movement occur suddenly and rapidly. They include landslides, avalanches, mudflows, and lahars.

Landslides and avalanches are the most dramatic, sudden, and dangerous types of mass movement. Landslides are sudden falls of rock, whereas avalanches are sudden falls of snow. When large amounts of rock suddenly break loose from a cliff or mountainside, they move quickly and with tremendous force. Landslides are exceptionally destructive. Homes may be destroyed as hillsides collapse. A landslide may bury entire villages. A landslide that dams a stream may create a lake. A landslide that flows into a lake or bay may trigger a tsunami. Landslides often occur on steep slopes in dry or semi-arid climates, especially following a heavy rain. The California coastline has steep cliffs and years of drought punctuated by seasons of abundant rainfall, so it is prone to landslides.

On hillsides with soils rich in clay, a period of heavy rain that thoroughly saturates the soil may create a mudflow. This is especially likely if there is not much vegetation to hold the wet soil in place. Mudflows follow river channels, and they may wash out any bridges, trees, and homes that are along their path. A lahar is a mudflow that flows down the side of a composite volcano. Ash from an eruption mixes with snow and ice. The snow and ice melt and contribute to the formation of hot, fast-moving mud.

**Questions**

1. Define mass movement, and list four types of rapid mass movement.
2. Describe landslides and their possible effects.
3. What conditions promote mudflows? What are possible consequences of mudflows?
4. What are lahars, and when do they occur?

---

**Lesson 10.5: Multiple Choice**

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Types of mass movement that involve snow include
  - a. slump.
  - b. lahar.
  - c. avalanches.
  - d. two of the above
2. Types of mass movement that involve mud include
  - a. landslides.
  - b. creep.
  - c. lahar.
  - d. two of the above
3. Sudden mass movements include all of the following except
  - a. landslides.
  - b. avalanches.
  - c. mudflows.
  - d. creep.
4. Factors that make landslides more likely include
  - a. dry climate.
  - b. steep slope.
  - c. recent heavy rain.
  - d. all of the above
5. Mudflows follow
  - a. mountain ridges.
  - b. river channels.
  - c. talus slopes.
  - d. none of the above
6. Evidence of creep includes
  - a. tilted electric poles.
  - b. trees with curved trunks.
  - c. crescent-shape scars on hills.
  - d. two of the above

---

## Lesson 10.5: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. deposit of rocks that fall and slowly accumulate at the base of a cliff
- \_\_\_\_\_ 2. movement of a large block of rock as a single unit down a slope
- \_\_\_\_\_ 3. sudden fall of rocks down a slope
- \_\_\_\_\_ 4. extremely gradual movement of soil down a slope
- \_\_\_\_\_ 5. mudflow of volcanic ash and melted snow down the side of a volcano
- \_\_\_\_\_ 6. sudden fall of snow down a slope
- \_\_\_\_\_ 7. sudden slipping of mud down a slope

### Terms

- a. creep
- b. landslide
- c. talus slope
- d. slump
- e. mudflow
- f. avalanche
- g. lahar

---

## Lesson 10.5: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Any transport of Earth materials by gravity is called \_\_\_\_\_.
- 2. If a landslide dams a stream, it may form a(n) \_\_\_\_\_.
- 3. If a landslide flows into a lake or bay, it may trigger a(n) \_\_\_\_\_.
- 4. Seismic waves from a(n) \_\_\_\_\_ may trigger landslides.
- 5. A crescent-shaped scar on the side of a hill is left behind when \_\_\_\_\_ occurs.
- 6. Mudflows are more likely when saturated soils contain a lot of \_\_\_\_\_.

---

## Lesson 10.5: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Identify factors that increase the chances of mass movement. Explain why each factor increases the risk.

## CHAPTER

**11****HS Evidence About Earth's  
Past Worksheets****Chapter Outline**

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- 11.1**    **FOSSILS**
  - 11.2**    **RELATIVE AGES OF ROCKS**
  - 11.3**    **ABSOLUTE AGES OF ROCKS**
- 

- **Lesson 11.1: Fossils**
- **Lesson 11.2: Relative Ages of Rocks**
- **Lesson 11.3: Absolute Ages of Rocks**

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## 11.1 Fossils

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### Lesson 11.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. People have been discovering fossils for thousands of years.
- \_\_\_\_\_ 2. In ancient times, fossils inspired legends of mythical creatures.
- \_\_\_\_\_ 3. Fossilization is a fairly common occurrence.
- \_\_\_\_\_ 4. There is virtually no fossil record of organisms that lacked hard parts such as bones or shells.
- \_\_\_\_\_ 5. A dead organism is less likely to become a fossil if it is buried by sediments.
- \_\_\_\_\_ 6. Because of difficulties of preservation, only a few thousand fossils have ever been discovered.
- \_\_\_\_\_ 7. The least common type of fossilization is the preservation of soft tissues.
- \_\_\_\_\_ 8. Some insects have been perfectly preserved in amber.
- \_\_\_\_\_ 9. Fossils of marine organisms found on land show that the land was once covered by a sea.
- \_\_\_\_\_ 10. Rocks containing the same index fossils are about the same age.

---

### Lesson 11.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **How Fossils Form**

A fossil is any preserved remains or traces of once-living organisms. Fossils include body fossils, which are fossilized remains of body parts, and trace fossils, which include burrows, tracks, feces, or other traces left by an organism. Collections of fossils that are found together are known as fossil assemblages.

The process of a once-living organism or its traces becoming a fossil is called fossilization. It most often occurs when the remains or traces are buried by sediments and then gradually change to rock. Fossilization is very rare. Only a tiny percentage of the organisms that have ever lived have become fossils. Usually, it is only the hard parts of organisms that are fossilized. The fossil record consists almost entirely of the shells, bones, or other hard parts of animals. Mammal teeth are much more resistant than bones, so a large portion of the mammal fossil record consists of teeth. The shells of marine organisms are also common. Organisms that lack hard parts, from bacteria to jellyfish, rarely become fossils.

Quick burial is almost always necessary for an organism to be fossilized because most decay and fragmentation occur when remains are exposed at the surface. Marine animals that die near a river delta may be buried rapidly by river sediments. A storm at sea may shift sediment on the ocean floor, covering a body and helping to preserve its skeletal remains. In general, quick burial is rare on land, so fossils of land organisms are less common than

fossils of marine organisms. However, land organisms are sometimes buried by mudslides, volcanic ash, or sand in a sandstorm. They may also be buried by mud in lakes, swamps, or bogs. Rarely, they may be buried by tar in tar pits or the ice of glaciers.

### Questions

1. What is a fossil? Distinguish between body fossils and trace fossils.
2. Why is fossilization rare?
3. What factors make fossilization more likely?

---

## Lesson 11.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. "Dragon bones" found in China 2000 years ago were probably
  - a. unusually shaped rocks.
  - b. dinosaur fossils.
  - c. bones of lizards.
  - d. pillow lava.
2. Coprolites are
  - a. fossilized feces.
  - b. extinct sea organisms.
  - c. minerals found in replacement fossils.
  - d. any fossilized traces of once-living organisms.
3. Which statement about fossils is false?
  - a. Only a tiny percentage of organisms becomes fossils.
  - b. Soft-bodied organisms are the least likely to become fossils.
  - c. Quick burial is almost always essential for remains to become fossils.
  - d. Land organisms are more likely to become fossils than marine organisms.
4. Complete preservation is possible if an organism is buried in
  - a. tar.
  - b. mud.
  - c. tree sap.
  - d. any of the above
5. Petrified wood forms because of
  - a. compression.
  - b. replacement.
  - c. permineralization.
  - d. none of the above
6. Compression is most common for fossils of
  - a. leaves.
  - b. teeth.
  - c. bones.
  - d. shells.
7. Fossils can provide clues about



- a. past climates.
- b. plate tectonics.
- c. extinct species.
- d. all of the above

---

## Lesson 11.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. most common method of fossilization
- \_\_\_\_\_ 2. space in rock left behind when an organism or part of an organism decays
- \_\_\_\_\_ 3. hardened ancient tree sap
- \_\_\_\_\_ 4. any preserved remains or traces of an ancient organism
- \_\_\_\_\_ 5. type of fossil that forms when a mold fills in with sediments
- \_\_\_\_\_ 6. common, widespread fossil that can be used to identify the ages of rocks
- \_\_\_\_\_ 7. any process by which fossils form

### Terms

- a. permineralization
- b. cast
- c. fossilization
- d. mold
- e. amber
- f. fossil
- g. index fossil

---

## Lesson 11.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The preserved remains of an organism's body parts is called a(n) \_\_\_\_\_ fossil.
- 2. A preserved burrow, track, or other evidence of an organism's life is called a(n) \_\_\_\_\_ fossil.
- 3. \_\_\_\_\_ is the process in which water deposits minerals within the remains of a buried organism.
- 4. A(n) \_\_\_\_\_ of organic remains forms when the remains are compressed by high pressure.
- 5. The best form of evidence about the history of life on Earth is \_\_\_\_\_.
- 6. Organisms that make good index fossils are widespread and existed for a(n) \_\_\_\_\_ period of time.
- 7. For a fossil that forms by \_\_\_\_\_, the original bone or shell dissolves and is replaced by different minerals.

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## Lesson 11.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast two different methods of fossilization.

## 11.2 Relative Ages of Rocks

### Lesson 11.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Natural laws never change.
- \_\_\_\_\_ 2. Steno correctly explained how marine fossils could end up on mountains far from an ocean
- \_\_\_\_\_ 3. Fossils in a rock layer represent the organisms that lived when the rock was formed.
- \_\_\_\_\_ 4. The oldest rock layers in the Grand Canyon are at the top.
- \_\_\_\_\_ 5. A fault is always older than the rock layers it cuts through.
- \_\_\_\_\_ 6. Nicholas Steno was the first scientist to question the Biblical age of Earth.
- \_\_\_\_\_ 7. William Smith is often called the father of modern geology.
- \_\_\_\_\_ 8. Rocks in different places that have the same index fossils are about the same age.
- \_\_\_\_\_ 9. Microfossils are useful index fossils because they are so widespread.
- \_\_\_\_\_ 10. The oldest ages are at the top of the geologic time scale.

### Lesson 11.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Matching Up Rock Layers

When rock layers are located in different places, laws such as superposition and cross-cutting cannot be used to match rocks that are the same age. Matching these rocks requires other evidence.

Sometimes distinctive rock formations may be recognizable in different locations. If so, rocks in the different locations are assumed to have formed under the same conditions at the same time. For example, the famous White Cliffs of Dover in southwest England consist of a soft rock called chalk. The rock formed from organisms that settled to the bottom of an ancient sea. Similar white chalk cliffs are also found in Denmark and Germany. They formed at the same time as the cliffs in Dover.

Index fossils can often be used to match rocks in different places. Rocks with the same index fossil(s) must be about the same age. To be useful as an index fossil, a fossil must represent an organism that was widespread but existed for only a short period of time. The well-known trilobite is often used as an index fossil.

Key beds can be used like index fossils to match rock layers in different locations. A key bed is a distinctive layer of rock that is found in many areas of the world or even worldwide. A famous key bed is a thin clay layer that formed all over the world at the boundary between the Cretaceous Period and the Tertiary Period. This is when the dinosaurs and many other organisms went extinct. The clay layer contains a high concentration of iridium, an

element that is rare on Earth but common in asteroids. The iridium makes this key bed easy to identify wherever it is found on the planet. Many scientists think that a huge asteroid struck Earth late in the Cretaceous Period, blanketing the planet with iridium-rich dust. The dust may have been a major reason for the mass extinction because it would have blocked sunlight from reaching Earth. When the dust settled, it formed a thin layer of iridium-rich sedimentary rock.

### Questions

1. Explain how distinctive rock formations can be used to match rocks in different places.
2. Why are index fossils useful for finding rock layers that are the same age? What makes a good index fossil?
3. What is a key bed? Describe the famous key bed that formed at the boundary between the Cretaceous and Tertiary Periods.

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## Lesson 11.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Steno's laws include the law of
  - a. lateral continuity.
  - b. faunal succession.
  - c. cross-cutting relationships.
  - d. all of the above
2. The Colorado River must be younger than all of the rock layers through which it has eroded, according to the principle of
  - a. cross-cutting relationships.
  - b. uniformitarianism.
  - c. superposition.
  - d. relative age.
3. If you know the relative ages of two rocks, you know
  - a. how old the rocks are in years.
  - b. which rock formed earlier.
  - c. which rock is younger.
  - d. two of the above
4. In the 1600s, most Europeans believed that Earth was about
  - a. 6 billion years old.
  - b. 6 million years old.
  - c. 6 thousand years old.
  - d. 6 hundred years old.
5. Eroded gaps in rock sequences are known as
  - a. key beds.
  - b. erosion zones.
  - c. unconformities.
  - d. lateral continuities.
6. The longest subdivisions of the geologic time scale are
  - a. eras.

- b. eons.
  - c. epochs.
  - d. periods.
7. The current epoch of the geologic time scale is the
- a. Cenozoic.
  - b. Quaternary.
  - c. Holocene.
  - d. Pleistocene.

---

## Lesson 11.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. law that younger layers of sedimentary rock are deposited on top of older layers
- \_\_\_\_\_ 2. principle that rock cutting across horizontal layers must be younger than all the layers
- \_\_\_\_\_ 3. scientist who developed the law of superposition
- \_\_\_\_\_ 4. scientist who developed the principle of cross-cutting relationships
- \_\_\_\_\_ 5. principle describing how changes in fossils represent changes in species through time
- \_\_\_\_\_ 6. scientist who developed the principle of faunal succession
- \_\_\_\_\_ 7. law that sediments are always deposited in flat, horizontal layers

### Terms

- a. original horizontality
- b. William Smith
- c. superposition
- d. James Hutton
- e. cross-cutting relationships
- f. faunal succession
- g. Nicholas Steno

---

## Lesson 11.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. According to the law of \_\_\_\_\_, sediments are deposited in continuous sheets that span the body of water where they are deposited.
- 2. The \_\_\_\_\_ age of a rock is its age in comparison with the ages of other rocks.
- 3. The idea that the same geologic processes occurring today also occurred in the past is called \_\_\_\_\_.

4. The scientist who introduced the idea stated in question 3 was \_\_\_\_\_.
5. Fossils of microscopic organisms are called \_\_\_\_\_.
6. A(n) \_\_\_\_\_ is a rock layer that is defined by a single index fossil or fossil assemblage.
7. A distinctive layer of rock that can be recognized across a large area is called a(n) \_\_\_\_\_.

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## Lesson 11.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

“The present is the key to the past” applies to the work of James Hutton. Explain how.

## 11.3 Absolute Ages of Rocks

### Lesson 11.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Radioactivity was discovered in the late 1800s.
- \_\_\_\_\_ 2. Each ring inside a tree trunk represents one decade of growth.
- \_\_\_\_\_ 3. During beta decay, a radioactive isotope emits two protons and two neutrons.
- \_\_\_\_\_ 4. Carbon-14 breaks down in the process of beta decay.
- \_\_\_\_\_ 5. All radioactive isotopes decay at the same rate.
- \_\_\_\_\_ 6. Potassium-argon dating has been used to date human fossils.
- \_\_\_\_\_ 7. The earliest geologic time scale included dates for each of the major subdivisions of time.
- \_\_\_\_\_ 8. Ice cores can reveal how concentrations of atmospheric gases changed over time.
- \_\_\_\_\_ 9. As time passes, the number of parent isotopes in a radioactive material increases.
- \_\_\_\_\_ 10. A radioactive isotope with a short half-life cannot be used to date very old rocks.

### Lesson 11.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Radiometric Dating

Radiometric dating is the process of using concentrations of radioactive isotopes and their daughter products to estimate the ages of materials. It is a very useful tool for dating fossils and rocks. Different isotopes are used to date materials of different ages because different isotopes have different rates of decay. Using more than one isotope also helps scientists check the accuracy of the ages they calculate.

Radiocarbon dating is used to find the age of once-living materials between 100 and 50,000 years old. This range is especially useful for determining the absolute ages of recent human fossils and living sites. Carbon-14 is the only radioactive isotope of carbon, and it has a half-life of 5,730 years. A tiny and constant percentage of carbon in the atmosphere is carbon-14. Plants take in carbon dioxide containing carbon-14—along with nonradioactive isotopes of carbon—during photosynthesis. Animals consume this carbon when they eat plants or other animals that have eaten plants. The carbon-14 in organisms constantly decays, but it is continuously replaced as long as an organism is alive. After an organism dies, the carbon-14 it contains continues to decay, but no new carbon-14 is taken in to replace it. Therefore, the carbon-14 content of the remains constantly declines. The remaining carbon-14 in organic materials can be measured and used to estimate the amount of time that has passed since the organism died.

Different radioactive isotopes are more useful for estimating the ages of older materials. For example, potassium-

40 decays to argon-40 with a half-life of 1.26 billion years. Potassium-argon dating can be used to date materials between 100,000 and over a billion years old. Two uranium isotopes are also used for radiometric dating. Uranium-238 decays to lead-206 with a half-life of 4.47 billion years. Uranium-235 decays to form lead-207 with a half-life of 704 million years. Uranium-lead dating can be used to date materials between 1 million and 4.6 billion years old.

### Questions

1. What is radiometric dating? Why are different isotopes used to date materials of different ages?
2. Explain how carbon-14 enters living things and how the carbon-14 content of organisms changes after they die. Why is radiocarbon dating useful only for relatively young specimens?
3. Identify other radioisotopes that are used for radiometric dating and the ages of the materials they can date.

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## Lesson 11.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Information on past climates can be obtained from
  - a. tree rings.
  - b. ice cores.
  - c. varves.
  - d. all of the above
2. If you start with a given amount of a radioactive isotope, what proportion of the original amount will remain after three half-lives?
  - a. [U+215B]
  - b.  $\frac{1}{4}$
  - c. [U+2153]
  - d.  $\frac{1}{2}$
3. Carbon-14 releases a beta particle when it decays to
  - a. carbon-13.
  - b. carbon-12.
  - c. nitrogen-13.
  - d. nitrogen-14.
4. Alpha decay of a parent isotope results in the formation of a(n)
  - a. daughter isotope.
  - b. large amount of energy.
  - c. alpha particle.
  - d. all of the above
5. Which of the following radioactive isotopes has the longest half-life?
  - a. carbon-14
  - b. potassium-40
  - c. uranium-238
  - d. uranium-235
6. Drawbacks of radiometric dating include which of the following?
  - a. It is not very useful for aging sedimentary rocks.
  - b. It cannot be used to estimate the ages of organic materials.



- c. It cannot be used to age rocks that are more than 1 billion years old.
  - d. all of the above
7. Earth's age is now generally considered to be about
- a. 4.6 million years.
  - b. 100 million years.
  - c. 2.6 billion years.
  - d. 4.6 billion years.

---

### Lesson 11.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. rate of decay of a radioactive isotope
- \_\_\_\_\_ 2. using concentrations of radioactive isotopes to estimate the age of a material
- \_\_\_\_\_ 3. two protons and two neutrons
- \_\_\_\_\_ 4. layered sediment at the bottom of a lake near a glacier
- \_\_\_\_\_ 5. form of an atom that is unstable and spontaneously gains or loses particles
- \_\_\_\_\_ 6. isotope formed during radioactive decay
- \_\_\_\_\_ 7. tendency of certain atoms to decay into other atoms and emit energy

#### Terms

- a. alpha particle
- b. daughter product
- c. radiometric dating
- d. radioactivity
- e. radioactive isotope
- f. half-life
- g. varve

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### Lesson 11.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The age of a rock or fossil in years is its \_\_\_\_\_ age.
- 2. A method of dating old wood based on tree growth is called \_\_\_\_\_ dating.
- 3. The time it takes for half of a given amount of radioactive isotope to decay is its \_\_\_\_\_.
- 4. Scientists drill into ice sheets to obtain cross-sections of ice called \_\_\_\_\_.
- 5. \_\_\_\_\_ of elements inside Earth's interior provides a steady source of heat.

6. The type of radiometric dating called \_\_\_\_\_ dating is used to date organic materials from 100 to 50,000 years old.
7. Of the three isotopes of carbon, only the isotope named \_\_\_\_\_ is radioactive.

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### Lesson 11.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

How did the discovery of radioactivity contribute to our knowledge of Earth's history?

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# CHAPTER 12

## HS Earth's History Worksheets

### Chapter Outline

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- 12.1**    **EARLY EARTH**
  - 12.2**    **THE PRECAMBRIAN**
  - 12.3**    **PHANEROZOIC EARTH HISTORY**
  - 12.4**    **HISTORY OF EARTH'S COMPLEX LIFE FORMS**
- 

- **Lesson 12.1: Early Earth**
- **Lesson 12.2: The Precambrian**
- **Lesson 12.3: Phanerozoic Earth History**
- **Lesson 12.4: History of Earth's Complex Life Forms**

## 12.1 Early Earth

### Lesson 12.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Earth formed about a billion years later than the sun.
- \_\_\_\_\_ 2. The oldest materials found on Earth are zircon crystals.
- \_\_\_\_\_ 3. Asteroid impacts helped to cool down early Earth.
- \_\_\_\_\_ 4. All of Earth's first crust was recycled into the mantle by convection.
- \_\_\_\_\_ 5. Earth has a slower spin than it should have for a planet of its size and distance from the sun.
- \_\_\_\_\_ 6. The moon formed from molten materials.
- \_\_\_\_\_ 7. The "Genesis Rock" is a chunk of Earth's original crust.
- \_\_\_\_\_ 8. Earth formed oceans before it formed an atmosphere.
- \_\_\_\_\_ 9. Earth has more volcanic activity now than at any time in the past.
- \_\_\_\_\_ 10. Most of the oxygen in Earth's atmosphere was produced by plants.

### Lesson 12.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### How the Moon Formed

One of the most unique features of planet Earth is its large moon. Unlike the only other inner planet moons—the moons of Mars—Earth's moon is not a captured asteroid. Understanding the moon's origin reveals a great deal about Earth's early history. To determine how the moon formed, scientists considered several lines of evidence:

- The moon is large. It is not much smaller than the smallest planet, Mercury.
- Earth and the moon are very similar in composition.
- The moon's surface is 4.5 billion years old, about the same age as the rest of the solar system.
- For a body of its size and distance from the sun, the moon has very little core, whereas Earth has a fairly large core.
- The oxygen isotope ratios of Earth and the moon indicate that they originated in the same part of the solar system.
- Earth has a faster spin than it should have for a planet of its size and distance from the sun.

Astronomers have carried out computer simulations that are consistent with these facts. From their analyses, they have detailed a "birth" story of the moon. According to the story, a little more than 4.5 billion years ago, Earth was

struck by a Mars-sized asteroid. The tremendous energy from the impact melted both Earth and the asteroid, and their molten materials mixed together. The dense metals remained on Earth but some of the molten materials were flung into orbit around Earth. These materials eventually accreted into a single body, the moon. Both planetary bodies were molten, so materials on both of them could differentiate into core, mantle, and crust. Earth's fast spin is due to energy imparted to it by the asteroid impact.

### Questions

1. What evidence did scientists consider when they tried to determine how the moon formed?
2. Summarize the "birth" story of the moon.
3. Why does Earth have such a fast spin?

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## Lesson 12.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Information scientists used to learn about early Earth came from
  - a. zircon crystals.
  - b. meteorites.
  - c. lunar rocks.
  - d. all of the above
2. Why was early Earth extremely hot?
  - a. Gravity put its interior under great pressure.
  - b. It was closer to the sun than it is now.
  - c. Its surface was covered with hot water.
  - d. all of the above
3. Earth's earliest crust formed by the process of
  - a. outgassing.
  - b. convection.
  - c. differentiation.
  - d. radioactive decay.
4. Which statement about Earth's moon is false?
  - a. It formed by accretion.
  - b. It is a captured asteroid.
  - c. It is similar in composition to Earth.
  - d. It is almost as old as Earth.
5. Earth's first atmosphere consisted of
  - a. hydrogen and helium.
  - b. water vapor and methane.
  - c. carbon dioxide and oxygen.
  - d. all of the above
6. Which of the following do scientists think formed first?
  - a. Earth's moon
  - b. Earth's oceans
  - c. Earth's atmosphere

- d. Earth's earliest organisms
7. Reasons oxygen is essential for most life on Earth include that it is needed for
- a. breathing.
  - b. the ozone layer.
  - c. the water cycle.
  - d. two of the above

---

## Lesson 12.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. cloud of gas and dust from which the solar system formed
- \_\_\_\_\_ 2. separation of Earth into layers based on density
- \_\_\_\_\_ 3. organism adapted to an extreme environment
- \_\_\_\_\_ 4. coming together of smaller particles to form a larger body such as a planet
- \_\_\_\_\_ 5. scientist who finds and studies fossils to learn about the history of life
- \_\_\_\_\_ 6. gas that blocks ultraviolet radiation from the sun
- \_\_\_\_\_ 7. release of gases from Earth's interior by volcanic eruptions

### Terms

- a. accretion
- b. paleontologist
- c. solar nebula
- d. ozone
- e. extremophile
- f. differentiation
- g. outgassing

---

## Lesson 12.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Earth formed when \_\_\_\_\_ caused small pieces of rock and metal to smash together and create the planet.
- 2. During differentiation, early Earth's densest materials moved to the planet's \_\_\_\_\_.
- 3. Scientists think that the moon formed from Earth when the planet was struck by a very large \_\_\_\_\_.
- 4. Earth's second atmosphere came from volcanic activity and impacts by \_\_\_\_\_.
- 5. Before there were plants on Earth, the planet's atmosphere contained very little \_\_\_\_\_.
- 6. Earth could not have oceans until the planet became \_\_\_\_\_ enough for water to condense.

7. Scientists think that Earth formed nearly \_\_\_\_\_ years ago.

---

## Lesson 12.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain the origins of Earth's atmosphere and oceans.

---

## 12.2 The Precambrian

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### Lesson 12.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The Precambrian Era ended about 2.5 billion years ago.
- \_\_\_\_\_ 2. Earth's first crust was made of felsic rock.
- \_\_\_\_\_ 3. Early in the Precambrian, Earth was cooler than it is today.
- \_\_\_\_\_ 4. About a billion years ago, North America was part of the continent of Laurentia.
- \_\_\_\_\_ 5. Scientists think it is likely that life evolved more than once on Earth.
- \_\_\_\_\_ 6. One way that scientists learn about early life is by studying extremophiles.
- \_\_\_\_\_ 7. Proteins are the least abundant class of organic molecules.
- \_\_\_\_\_ 8. RNA can encode genetic instructions and also build proteins.
- \_\_\_\_\_ 9. Cells evolved when organic molecules developed a nucleus.
- \_\_\_\_\_ 10. The earliest cells were probably prokaryotes similar to *E. coli*.

---

### Lesson 12.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Photosynthesis and Earth's Changing Atmosphere**

Without photosynthesis, the earliest cells most likely absorbed nutrients that floated in the organic soup that surrounded them. After hundreds of millions of years, these nutrients would have become less abundant. Sometime around 3 billion years ago, photosynthesis began. Photosynthesis allowed organisms to use sunlight and inorganic molecules to create chemical energy that they could use for food. They no longer needed to rely on nutrients floating in their environment. Photosynthesizing organisms could also become food for other organisms.

A byproduct of photosynthesis is the production of oxygen. After photosynthesis evolved, oxygen was soon present in the atmosphere in far greater concentrations than ever before. The addition of oxygen from photosynthesis created Earth's third atmosphere. This event is sometimes called the oxygen catastrophe because so many organisms died out. For organisms adapted to an oxygen-free environment, oxygen was toxic. The event is also called the great oxygenation event because it was a great opportunity for other organisms. The few organisms that survived developed a vital use for oxygen, cellular respiration. This is the process by which cells use oxygen to obtain energy from organic molecules. These organisms were able to flourish in the new atmosphere.

The addition of oxygen to the atmosphere was important to living things for another reason as well. With oxygen in the atmosphere, the ozone layer could develop. The ozone layer protected Earth's surface from harmful ultraviolet



light radiating from the sun. This allowed more complex life forms to evolve.

### Questions

1. What is photosynthesis? When did it evolve? How did organisms obtain nutrients before photosynthesis evolved?
2. How did photosynthesis change Earth's atmosphere?
3. Why was the addition of oxygen to the atmosphere both a catastrophe and a great opportunity for life on Earth?

---

## Lesson 12.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. To be considered alive, a molecule must
  - a. be organic.
  - b. have metabolism.
  - c. be able to reproduce.
  - d. all of the above
2. Miller and Urey's experiment showed that
  - a. organic molecules could form under conditions on early Earth.
  - b. amino acids arrived on Earth from meteorites.
  - c. proteins originated at hydrothermal vents.
  - d. DNA has a double helix structure.
3. An organism that consists of a cell without a nucleus is a(n)
  - a. prokaryote.
  - b. nucleic acid.
  - c. eukaryote.
  - d. stromatolite.
4. Photosynthesis evolved about
  - a. 5 billion years ago.
  - b. 3 billion years ago.
  - c. 5 million years ago.
  - d. 3 million years ago.
5. The earliest photosynthesizers were probably most like today's
  - a. plants.
  - b. grasses.
  - c. algae.
  - d. ferns.
6. Organelles in eukaryotic cells probably evolved from
  - a. smaller prokaryotic cells.
  - b. other eukaryotic cells.
  - c. proteins.
  - d. RNA.
7. Organisms that adapted to the oxygen in Earth's third atmosphere used oxygen for

- a. photosynthesis.
- b. cellular respiration.
- c. reproduction.
- d. replication.

---

## Lesson 12.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. ancient core of a continent
- \_\_\_\_\_ 2. supercontinent that existed about 1.1 billion years ago
- \_\_\_\_\_ 3. part of Rodinia
- \_\_\_\_\_ 4. place where a craton crops out at the surface
- \_\_\_\_\_ 5. type of rock found in oceanic trenches
- \_\_\_\_\_ 6. craton with a covering of younger rocks
- \_\_\_\_\_ 7. type of rock that makes up continents

### Terms

- a. platform
- b. Laurentia
- c. craton
- d. Rodinia
- e. shield
- f. felsic
- g. greenstone

---

## Lesson 12.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The \_\_\_\_\_ Era began when Earth formed.
- 2. Earth's early tectonic plates were \_\_\_\_\_ in size than modern plates.
- 3. \_\_\_\_\_ is the hypothesis that Earth was covered with ice at the end of the Precambrian.
- 4. About 2.5 billion years ago, small continents called \_\_\_\_\_ collided to create supercontinents.
- 5. Molecules that make up proteins are \_\_\_\_\_ acids.
- 6. Molecules that store and pass on genetic information are \_\_\_\_\_ acids.
- 7. The idea that RNA was the earliest organic molecule to evolve is the \_\_\_\_\_ hypothesis.

---

## Lesson 12.2: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain the hypothesis that eukaryotes evolved from prokaryotes.

## 12.3 Phanerozoic Earth History

### Lesson 12.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The Paleozoic Era began about 60 million years ago.
- \_\_\_\_\_ 2. The Paleozoic began and ended with a supercontinent.
- \_\_\_\_\_ 3. Six complete cycles of marine transgressions and regressions occurred during the Paleozoic.
- \_\_\_\_\_ 4. Scientists think that the Appalachian Mountains were once higher than the Himalayas are now.
- \_\_\_\_\_ 5. Pangaea existed about 2.5 million years ago.
- \_\_\_\_\_ 6. In the past, heat built up beneath supercontinents.
- \_\_\_\_\_ 7. The Atlantic Ocean basin is currently growing smaller.
- \_\_\_\_\_ 8. The Sierra Nevada Mountains in California are uplifted igneous intrusions.
- \_\_\_\_\_ 9. The Cenozoic Era began about 65.5 million years ago.
- \_\_\_\_\_ 10. The paleogeography of the Cenozoic was very much like it is today.

### Lesson 12.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Mesozoic Era

The Mesozoic Era began about 240 million years ago and ended about 66 million years ago. The era is best known as the age of the dinosaurs. It was an active geological era as well.

At the beginning of the Mesozoic, there was one continent, Pangaea, and one ocean, Panthalassa. By about 180 million years ago, Pangaea began to break apart. At the same time, the Panthalassa Ocean began to separate into the individual but interconnected oceans that we see on Earth today. Why would a supercontinent break up after being together for tens of millions of years? A supercontinent is like a giant insulating blanket that does not allow mantle heat to escape very effectively. As heat builds up beneath a supercontinent, continental rifting begins. Basaltic lavas fill in the rifts and eventually lead to seafloor spreading and the formation of new ocean basins. The Atlantic Ocean basin formed as Pangaea split apart and seafloor spreading pushed Africa and South America apart.

As the continents making up Pangaea moved apart, there was an intense period of plate tectonic activity. Seafloor spreading was so vigorous that the mid-ocean ridge buoyed upward and displaced so much water that there was a marine transgression. Much of the North American continent was covered with water. Later in the Mesozoic, those seas regressed and then transgressed again. The moving continents also collided with island arcs and microcontinents so that mountain ranges accreted onto the continents' edges. For example, the subduction of the oceanic Farallon

plate beneath western North America during the late Jurassic and early Cretaceous produced igneous intrusions and other structures. The intrusions have since been uplifted to form the Sierra Nevada Mountains.

### Questions

1. Describe Earth's continents and oceans at the beginning of the Mesozoic Era.
2. Why do supercontinents break up?
3. What caused the Atlantic Ocean basin to form? Why is it still growing larger?
4. Why was much of North America under water as Pangaea broke apart early in the Mesozoic?
5. Describe how California's Sierra Nevada Mountains formed in the Mesozoic.

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## Lesson 12.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The longest era of the Phanerozoic is the
  - a. Cenozoic.
  - b. Mesozoic.
  - c. Paleozoic.
  - d. Precambrian.
2. Geologists know about marine transgressions and regressions from
  - a. sedimentary rock.
  - b. glacial advances.
  - c. continental collisions.
  - d. all of the above
3. Orogeny occurs
  - a. over many millions of years.
  - b. when continents smash into microcontinents.
  - c. as continents collide with island arcs.
  - d. all of the above
4. When Laurentia and Gondwana collided, the collision created the
  - a. Appalachian Mountains.
  - b. Alps Mountains.
  - c. Himalaya Mountains.
  - d. Rocky Mountains.
5. During the Mesozoic, the climate was predominantly
  - a. tropical.
  - b. polar.
  - c. temperate.
  - d. subpolar.
6. What occurs as a supercontinent begins to break up?
  - a. seafloor spreading
  - b. continental rifting
  - c. formation of new ocean basin
  - d. all of the above

7. Toward the end of the Mesozoic Era
- much of North America was covered with water.
  - glaciers advanced as far south as Chicago.
  - a marine transgression occurred.
  - two of the above

---

### Lesson 12.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. characteristic sedimentary rock layers from marine transgressions and regressions
- \_\_\_\_\_ 2. retreating of sea level from land
- \_\_\_\_\_ 3. mountain-building event
- \_\_\_\_\_ 4. rising of sea level over the land
- \_\_\_\_\_ 5. most recent supercontinent
- \_\_\_\_\_ 6. oldest era of the Phanerozoic Eon
- \_\_\_\_\_ 7. age of dinosaurs

#### Terms

- Paleozoic
- facies
- marine transgression
- orogeny
- marine regression
- Mesozoic
- Pangaea

---

### Lesson 12.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- The eon in which we currently live is the \_\_\_\_\_ Eon.
- Scientists think that Paleozoic marine transgressions and regressions occurred because of changes in the size of \_\_\_\_\_.
- During the time of Pangaea, most of Earth's water formed a huge ocean called the \_\_\_\_\_ Ocean.
- The most recent era of the Phanerozoic Eon is the \_\_\_\_\_ Era.
- Ice ages occurred during the \_\_\_\_\_ Epoch of the Cenozoic Era.
- During the Paleozoic, the southern continents merged to form \_\_\_\_\_.
- When Laurentia and Gondwana collided, they created the supercontinent \_\_\_\_\_.

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## Lesson 12.3: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain factors that may have led to the Pleistocene ages.

## 12.4 History of Earth's Complex Life Forms

### Lesson 12.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The main mechanism for biological evolution is natural selection.
- \_\_\_\_\_ 2. The first multicellular organisms evolved during the Paleozoic Era.
- \_\_\_\_\_ 3. The Phanerozoic Eon extends from about 540 million years ago to the present.
- \_\_\_\_\_ 4. The first humans appeared during the Mesozoic Era.
- \_\_\_\_\_ 5. Plants colonized the land before animals did.
- \_\_\_\_\_ 6. Mass extinctions are generally preceded by adaptive radiations.
- \_\_\_\_\_ 7. The Cambrian Period had a tremendous diversification of life forms.
- \_\_\_\_\_ 8. Large extinction events separate the periods of the Paleozoic Era.
- \_\_\_\_\_ 9. The first mammals evolved after the dinosaurs went extinct.
- \_\_\_\_\_ 10. All dinosaurs were exothermic (cold-blooded).

### Lesson 12.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Paleozoic Life**

The Paleozoic Era follows the Precambrian and is the first era of the Phanerozoic Eon. The Paleozoic lasted from about 540 to 240 million years ago. It is divided into several periods, beginning with the Cambrian and ending with the Permian. Large extinction events separate the periods. After each extinction event, many new life forms evolved.

During the Cambrian Period, there was a tremendous diversification of marine life forms, commonly called the "Cambrian Explosion." At the start of the period, shallow seas covered most of the land, and every major type of marine organism evolved during this time. Animals also evolved shells and other hard parts in the Cambrian, so from the Cambrian forward, fossils are much more abundant and better preserved. For example, the Burgess Shale formation in the Rocky Mountains of British Columbia, Canada, contains an amazing diversity of Cambrian life forms.

During the remainder of the Paleozoic Era, several major evolutionary events occurred, beginning with the first fish about 500 million years ago. By about 425 million years ago, the first land plants and fungi had evolved. This was followed by the first insects (400 million years ago), first amphibians (360 million years ago), and first reptiles (300 million years ago).

As the Paleozoic was reaching its end about 250 million years ago, the largest mass extinction in Earth's history



occurred. It is called the Permian mass extinction. More than 95 percent of marine species and 70 percent of land species went extinct. This was also the only known mass extinction of insects species. The Permian mass extinction appears to have taken place in three pulses with separate causes. Gradual environmental change, an asteroid impact, intense volcanism, and changes in the composition of the atmosphere may each have played a role.

### Questions

1. What was the “Cambrian explosion”?
2. Why are there more and better-preserved fossils from the Cambrian forward?
3. List major evolutionary events that occurred during the Paleozoic Era.
4. Describe the Permian mass extinction, and identify possible causes.

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## Lesson 12.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. For a trait to increase in a population by natural selection, it must
  - a. be controlled by genes.
  - b. result from a new mutation.
  - c. help organisms adapt to their environment.
  - d. two of the above
2. Which of the following “firsts” occurred during the Mesozoic Era?
  - a. first birds
  - b. first fishes
  - c. first reptiles
  - d. two of the above
3. The Burgess shale formation in British Columbia, Canada, contains an amazing diversity of fossils from the
  - a. Jurassic Period.
  - b. Permian Period.
  - c. Cambrian Period.
  - d. Devonian Period.
4. The first plants to colonize the land lived during the
  - a. Precambrian.
  - b. Paleozoic.
  - c. Mesozoic.
  - d. Cenozoic.
5. Which of the following is a possible cause of the Cretaceous mass extinction?
  - a. impact of a giant meteorite
  - b. cold temperatures of the ice ages
  - c. flooding of marine transgressions
  - d. breakup of the supercontinent Pangaea
6. The genus Homo, to which modern humans belong, evolved about
  - a. 200,000 years ago.
  - b. 2 million years ago.
  - c. 20 million years ago.

- d. 200 million years ago.
7. During the Pleistocene ice ages, the Bering land bridge allowed humans to migrate for the first time to
- North America.
  - Europe.
  - Africa.
  - Asia.

---

## Lesson 12.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. difference in a genetically controlled trait in a population
- \_\_\_\_\_ 2. adaptation that allowed early reptiles to reproduce on land
- \_\_\_\_\_ 3. random change in a gene
- \_\_\_\_\_ 4. change in the frequency of a trait because it affects survival or reproduction
- \_\_\_\_\_ 5. characteristic of an organism that helps it survive in a given environment
- \_\_\_\_\_ 6. process in which many new species quickly evolve to fill available niches
- \_\_\_\_\_ 7. change in the genetic makeup of a species over time

### Terms

- adaptation
- adaptive radiation
- natural selection
- variation
- evolution
- amniotic egg
- mutation

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## Lesson 12.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- \_\_\_\_\_ were a group of extremely diverse multicellular organisms that flourished toward the end of the Precambrian.
- The era of the Phanerozoic in which the first insects evolved is the \_\_\_\_\_ Era.
- The first mammals evolved in the \_\_\_\_\_ Era of the Phanerozoic.
- A(n) \_\_\_\_\_ is an event in which large numbers of species go extinct within a short period of time.
- Archaeopteryx, which lived during the late Jurassic, was the earliest known \_\_\_\_\_.

6. The largest mass extinction in Earth's history occurred at the end of the \_\_\_\_\_ Period.
7. The Cenozoic Era is referred to as the age of \_\_\_\_\_.

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### Lesson 12.4: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how a population could evolve a new trait that helps its members adapt to a change in the environment. Describe an example.

## CHAPTER

## 13

# HS Earth's Fresh Water Worksheets

## Chapter Outline

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**13.1**    **WATER ON EARTH**

**13.2**    **SURFACE WATER**

**13.3**    **GROUNDWATER**

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- **Lesson 13.1: Water on Earth**
- **Lesson 13.2: Surface Earth**
- **Lesson 13.3: Groundwater**

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## 13.1 Water on Earth

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### Lesson 13.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Most of Earth's liquid fresh water is stored in the atmosphere.
- \_\_\_\_\_ 2. Water is the only substance on Earth that naturally exists in all three states of matter.
- \_\_\_\_\_ 3. Groundwater discharge is a process by which groundwater reaches the surface.
- \_\_\_\_\_ 4. Water vapor enters the atmosphere only by the process of evaporation.
- \_\_\_\_\_ 5. Water droplets in clouds always fall to the ground as precipitation.
- \_\_\_\_\_ 6. Areas in the U.S. with the highest concentrations of soil moisture cluster in the geographic center of the country.
- \_\_\_\_\_ 7. In the U.S., less water is used for agriculture than for industry.
- \_\_\_\_\_ 8. When climate cools, there is less liquid water in the oceans so sea level falls.
- \_\_\_\_\_ 9. Even fresh water contains some dissolved salts.
- \_\_\_\_\_ 10. Some water molecules on Earth may be billions of years old.

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### Lesson 13.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### The Hydrologic Cycle

Water moves continuously around Earth's surface in the hydrologic (water) cycle. The sun provides the energy that drives the cycle. It supplies the energy needed for evaporation, in which liquid water changes to water vapor. The sun's energy evaporates water from the oceans and from bodies of water on land. When water evaporates, only the water molecules evaporate; any salts in the water stay behind.

Water vapor remains in the atmosphere until it undergoes condensation to become tiny droplets of liquid water. If the droplets gather in clouds and collide with other water droplets, they may grow large enough to fall from the clouds as precipitation. Precipitation may be liquid or frozen water. Types of precipitation include rain, snow, sleet, and hail. Most precipitation falls into the oceans; the rest falls on land.

Precipitation that falls on land as rain may runoff into streams, lakes, or the ocean; or it may infiltrate the ground and become soil moisture or groundwater. Water in soil is needed by plants to grow. Water that seeps more deeply into the ground may enter aquifers that store fresh water for centuries. Alternatively, groundwater may travel back to the surface through springs or find its way to the oceans. Precipitation that falls as snow may soon melt and follow one of the paths of liquid precipitation. When snow melts slowly, it provides a steady flow of fresh water to streams and

lakes. Alternatively, snow may sit on a mountain for several months, or it may become part of the ice in a glacier, where it may remain for hundreds or even thousands of years. A small amount of snow may change directly to water vapor by sublimation and re-enter the atmosphere.

Plants and animals depend on water to live, and they also play roles in the water cycle. Animals take in liquid water in food and drink. They may release gaseous water when they exhale or liquid water when they sweat or urinate. Plants take up liquid water from the soil and release large amounts of water vapor into the air through their leaves. The process in which this occurs is called transpiration.

### Questions

1. What role does the sun play in the water cycle?
2. How does water vapor in the air return to land as liquid or frozen water?
3. Trace possible paths of rainwater back to the atmosphere.
4. Identify ways that solid precipitation may re-enter the water cycle.
5. What roles do living organisms play in the water cycle?

---

## Lesson 13.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Properties of water include
  - a. polarity.
  - b. low surface tension.
  - c. contraction upon freezing.
  - d. two of the above
2. Most fresh water on Earth occurs in
  - a. lakes and ponds.
  - b. rivers and streams.
  - c. glaciers and ice sheets.
  - d. soil and underground rocks.
3. The process in which water on the surface becomes groundwater is called
  - a. infiltration.
  - b. sublimation.
  - c. precipitation.
  - d. evapotranspiration.
4. The main source of energy that drives the hydrologic cycle is
  - a. heat from Earth's interior.
  - b. storms and other weather.
  - c. the force of gravity.
  - d. solar radiation.
5. Clouds form when water
  - a. sublimates.
  - b. evaporates.
  - c. condenses.
  - d. two of the above

6. Artificial sources of water include
  - a. aquifers.
  - b. aqueducts.
  - c. springs.
  - d. all of the above
7. In the U.S., the single biggest use of water is for
  - a. drinking.
  - b. bathing.
  - c. farming.
  - d. cooling.

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### Lesson 13.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. process in which a solid changes directly to a gas
- \_\_\_\_\_ 2. process in which plants release water vapor into the air through their leaves
- \_\_\_\_\_ 3. process in which a liquid changes to a gas
- \_\_\_\_\_ 4. form in which 3 percent of water exists on Earth
- \_\_\_\_\_ 5. water that falls from clouds toward the ground
- \_\_\_\_\_ 6. storage location for a substance such as water
- \_\_\_\_\_ 7. process in which a gas changes to a liquid

#### Terms

- a. reservoir
- b. fresh water
- c. condensation
- d. sublimation
- e. evaporation
- f. transpiration
- g. precipitation

---

### Lesson 13.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. Most fresh water on Earth exists in the \_\_\_\_\_ state.
2. The amount of time a molecule such as water stays in a reservoir is its \_\_\_\_\_ time.

3. Water in the gaseous state is known as \_\_\_\_\_.
4. The continuous movement of water around Earth is called the \_\_\_\_\_.
5. The single greatest use of water globally is \_\_\_\_\_.
6. Water stored in rocks beneath Earth's surface is called \_\_\_\_\_.
7. The greatest reservoir of water on Earth is the \_\_\_\_\_.

---

### Lesson 13.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Relate the hydrologic cycle to water's ability to exist in all three states of matter under normal Earth temperatures.



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## 13.2 Surface Water

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### Lesson 13.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The largest types of streams are rivers.
- \_\_\_\_\_ 2. The river with the greatest flow in the world is the Mississippi.
- \_\_\_\_\_ 3. Every continent has just one continental divide.
- \_\_\_\_\_ 4. Water usually drains out of a lake through a stream.
- \_\_\_\_\_ 5. Organisms that live in the aphotic zone of a lake include plants.
- \_\_\_\_\_ 6. Only certain specialized plants are able to live in wetlands.
- \_\_\_\_\_ 7. Wetlands generally have very little biological diversity.
- \_\_\_\_\_ 8. Wetlands naturally purify water by filtering out pollutants.
- \_\_\_\_\_ 9. Floods are not a natural part of the water cycle.
- \_\_\_\_\_ 10. Lands with heavy vegetation are less likely to experience flooding.

---

### Lesson 13.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Lakes

Lakes are relatively large bodies of still water. They are usually fed by streams and drained by streams as well. They also lose water by evaporation. Most lakes contain fresh water, but a few have salty water, including the Great Salt Lake in Utah. Large lakes have tides and currents, and they can affect local weather patterns. Lakes form in a variety of different ways. For example, they may form in a depression carved by a glacier or in a caldera at the top of a volcano.

The ecosystem of lakes is divided into several distinct zones, including surface, open-water, and deep-water zones.

- The surface (or littoral) zone is the relatively shallow region close to shore. In this zone, there is plenty of sunlight for photosynthesis by plants and algae. Animals in this zone include snails, insects, and small fish.
- The open-water zone (also called the photic or limnetic zone) is the top part of the water away from shore. It has abundant sunlight for photosynthesis by algae and plants. Many fish, such as bass and trout, live in this zone.
- The deep-water zone (also known as the aphotic or profundal zone) is the deep part of the water away from shore. It has little or no sunlight, so it has no photosynthesis. Most deep-water organisms are scavengers, such

as crabs and catfish, or decomposers, such as fungi or bacteria. They feed on dead organisms and other debris that fall to the bottom of the lake.

Lakes are not permanent features of the landscape. Some come and go with the seasons, as water levels rise and fall. Others disappear over longer time spans. They may fill with sediments, the springs or streams that feed them may diminish, or their outlets may expand due to erosion. When the climate of an area changes, lakes can either expand or shrink. For example, lakes may expand if precipitation increases, and they may shrink or even disappear if precipitation decreases.

### Questions

1. Briefly describe bodies of surface water called lakes.
2. State two ways that lakes can form.
3. Identify three ecological zones found in lakes.
4. Explain why lakes are not permanent features of the landscape.

---

## Lesson 13.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Types of streams include all of the following except
  - a. brooks.
  - b. bayous.
  - c. rivers.
  - d. estuaries.
2. Where the water in a stream slows and deepens, it forms a
  - a. pond.
  - b. pool.
  - c. lake.
  - d. wetland.
3. Where a river enters an ocean, it forms a(n)
  - a. estuary.
  - b. confluence.
  - c. tributary.
  - d. basin.
4. A small body of still, fresh water that has no outlet and is fed by an underground spring is most likely a
  - a. lake.
  - b. pond.
  - c. wetland.
  - d. swamp.
5. Which of the following statements about lakes is (are) false?
  - a. Lakes always have fresh water.
  - b. Lakes may be large enough to have tides.
  - c. Lakes are not permanent features of the landscape.
  - d. two of the above

6. More than half of the world's lakes are in Canada, and most of them were formed by
  - a. faults.
  - b. volcanoes.
  - c. glaciers.
  - d. rifts.
7. Zones of a lake in which photosynthesis can take place include the
  - a. littoral zone.
  - b. limnetic zone.
  - c. profundal zone.
  - d. two of the above

---

## Lesson 13.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. any area that is wet for most or all of the year
- \_\_\_\_\_ 2. wetland that contains brackish water
- \_\_\_\_\_ 3. any body of water that is constantly flowing downhill
- \_\_\_\_\_ 4. wetland where grasses and reeds are common but trees are not
- \_\_\_\_\_ 5. place where two streams come together
- \_\_\_\_\_ 6. wetland where trees and vines are common
- \_\_\_\_\_ 7. point where a stream enters a body of still water

### Terms

- a. mouth
- b. estuary
- c. confluence
- d. wetland
- e. marsh
- f. swamp
- g. stream

---

## Lesson 13.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. When two streams come together, the smaller stream is called a(n) \_\_\_\_\_.
2. A topographically high area that separates two different water basins is a(n) \_\_\_\_\_.

3. The study of bodies of fresh water and their organisms is known as \_\_\_\_\_.
4. An overflow of water in one place is called a(n) \_\_\_\_\_.
5. The lake zone that is closest to shore is the \_\_\_\_\_ zone.
6. The next largest bodies of still water after oceans are \_\_\_\_\_.
7. A wall built on a riverbank to prevent the river from overflowing is known as a(n) \_\_\_\_\_

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### Lesson 13.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Wetlands are protected by law in the U.S. Make an argument in support of protecting them.

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## 13.3 Groundwater

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### Lesson 13.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Water moves from wet soil to dry soil by capillary action.
- \_\_\_\_\_ 2. A region can have only one aquifer beneath it.
- \_\_\_\_\_ 3. The residence time of water in an aquifer is always thousands of years.
- \_\_\_\_\_ 4. Surface water reaches an aquifer through the process of infiltration.
- \_\_\_\_\_ 5. The only way water ever leaves an aquifer is through wells.
- \_\_\_\_\_ 6. Groundwater is a nonrenewable natural resource.
- \_\_\_\_\_ 7. Much more water is taken from the Ogallala aquifer each year than is replenished.
- \_\_\_\_\_ 8. A spring always has a constant flow of water.
- \_\_\_\_\_ 9. Water is attracted to soil particles.
- \_\_\_\_\_ 10. The water table forms the base of an aquifer.

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### Lesson 13.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Groundwater

Groundwater is the largest reservoir of liquid fresh water on Earth. Most groundwater is located in aquifers. An aquifer is a layer of permeable rock, sand, or gravel that holds large amounts of groundwater. Aquifers are found at different depths. Some are located just below the surface, and others are found much deeper underground. Most regions have aquifers beneath them, and some regions have more than one. Even deserts are likely to have aquifers beneath them. However, the source of water for an aquifer beneath a desert is likely to be far from where the aquifer is located; for example, it may be in a distant mountainous area.

The amount of water that is available to enter groundwater in a region is influenced by many factors. They include the local climate, slope of land, type of surface rock, vegetation cover, land use in the area, and water retention. For example, more water goes into the ground where there is a lot of rain, the land is flat, surface rock is porous, the soil is devoid of vegetation, and water does not already fill the soil and the rock beneath the surface.

The residence time of groundwater in an aquifer is the length of time water remains there. It can range from just a few minutes to hundreds of thousands of years. In fact, groundwater is often called “fossil water” because it may have remained in the ground for so long, often since the end of the Pleistocene ice ages.

#### Questions

1. What is the significance of groundwater. Where is most groundwater located?
2. What is an aquifer? Where are aquifers located?
3. Identify factors that influence the amount of water that is available to enter groundwater in a region.
4. What is the residence time of groundwater in an aquifer?

---

### Lesson 13.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Factors that influence the amount of water that is available to enter groundwater include
  - a. local climate.
  - b. slope of land.
  - c. type of surface rock.
  - d. all of the above
2. To be a good aquifer, the rock in an aquifer must be
  - a. porous.
  - b. permeable.
  - c. impermeable.
  - d. two of the above
3. More water goes into the ground where the
  - a. soil is covered with plants.
  - b. soil is already saturated.
  - c. land is flat.
  - d. two of the above
4. The water table
  - a. is a layer of impermeable rock.
  - b. always remains at the same level.
  - c. falls when there is a lot of rainfall.
  - d. may feed streams in a wet region.
5. If groundwater discharge from an aquifer is greater than recharge
  - a. the water table will rise.
  - b. subsidence may occur.
  - c. wells may go dry.
  - d. two of the above
6. Which statement about aquifers is false?
  - a. They may lie beneath deserts.
  - b. Their source regions may be far away.
  - c. They are always deep below the surface.
  - d. They may become contaminated by ocean water.
7. The Ogallala aquifer
  - a. supplies almost all irrigation water used in the U.S.
  - b. contains water that is mostly from the last ice age.
  - c. lies beneath the Northeastern United States.
  - d. all of the above

---

## Lesson 13.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. largest reservoir of liquid fresh water on Earth
- \_\_\_\_\_ 2. interconnectedness of pores within rock or sediment
- \_\_\_\_\_ 3. layer of porous underground rock and sediment that stores groundwater
- \_\_\_\_\_ 4. top of an aquifer
- \_\_\_\_\_ 5. place where ground water bubbles to the surface
- \_\_\_\_\_ 6. way in which water moves through a porous substance
- \_\_\_\_\_ 7. sinking of the ground surface

### Terms

- a. aquifer
- b. spring
- c. capillary action
- d. subsidence
- e. water table
- f. permeability
- g. groundwater

---

## Lesson 13.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Rock that forms the base of an aquifer is \_\_\_\_\_.
- 2. Water that enters an aquifer is called \_\_\_\_\_.
- 3. Water that leaves an aquifer is called \_\_\_\_\_.
- 4. \_\_\_\_\_ are small spaces between grains of rock.
- 5. The study of groundwater is known as \_\_\_\_\_.
- 6. A(n) \_\_\_\_\_ is created by digging or drilling into the ground to reach groundwater.
- 7. Groundwater is often called \_\_\_\_\_ water because it has remained in the ground for so long.

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## Lesson 13.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how people obtain and use groundwater and why this source of fresh water may be at risk.



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# CHAPTER 14

## HS Earth's Oceans Worksheets

### Chapter Outline

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- 14.1 INTRODUCTION TO THE OCEANS
  - 14.2 OCEAN MOVEMENTS
  - 14.3 THE SEAFLOOR
  - 14.4 OCEAN LIFE
- 

- Lesson 14.1: Introduction to the Oceans
- Lesson 14.2: Ocean Movements
- Lesson 14.3: The Seafloor
- Lesson 14.4: Ocean Life

## 14.1 Introduction to the Oceans

### Lesson 14.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. About 50 percent of Earth's surface is covered with water.
- \_\_\_\_\_ 2. All of Earth's oceans are interconnected.
- \_\_\_\_\_ 3. Ocean water heats up and cools down more quickly than land.
- \_\_\_\_\_ 4. Earth's tallest mountain rises from the Pacific Ocean floor.
- \_\_\_\_\_ 5. People have not yet visited the deepest place in Earth's oceans.
- \_\_\_\_\_ 6. All phytoplankton in the ocean live in the photic zone.
- \_\_\_\_\_ 7. The photic zone makes up the greatest volume of ocean water.
- \_\_\_\_\_ 8. The neritic zone is the ocean zone that lies above the continental shelf.
- \_\_\_\_\_ 9. Ocean water has greater salinity where evaporation is higher.
- \_\_\_\_\_ 10. Land near an ocean has a wider range of temperatures because of the water.

### Lesson 14.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Ocean Zones**

To better understand regions of the ocean, scientists define ocean zones based on depth of water or distance from shore. By depth of water, the entire ocean is divided into two major zones: the photic zone and the aphotic zone.

- The photic zone consists of the top 200 meters of ocean water. This is the depth to which sunlight can penetrate ocean water. Organisms that photosynthesize depend on sunlight for food, so they are restricted to the photic zone. Tiny photosynthetic organisms known as phytoplankton supply nearly all of the energy and nutrients to the rest of the marine food web. Therefore, most other marine organisms live in, or at least visit, the photic zone.
- The aphotic zone includes all ocean water below the top 200 meters. In the aphotic zone, there is not enough sunlight for photosynthesis. The aphotic zone makes up the majority of the ocean. However, it contains a relatively small proportion of its organisms, both in diversity and in numbers.

By distance from shore, the ocean is divided into three major zones: the littoral, neritic, and oceanic zones.

- The littoral, or intertidal, zone is closest to shore. It comprises the region between high and low tide marks.

This zone is characterized by constant change, as the tides rise and fall and ocean waves crash on shore. By depth of water, the entire littoral zone is in the photic zone.

- The neritic zone extends from the low tide mark to the edge of the seaward side of the continental shelf. By depth, some of this zone is in the photic zone, and some of it is in the aphotic zone.
- The oceanic zone is the rest of the ocean beyond the continental shelf. The top part of the oceanic zone is in the photic zone, but the vast majority of it is not.

### Questions

1. List ocean zones based on depth and ocean zones based on distance from shore.
2. How do the photic and aphotic zones differ?
3. Compare and contrast the littoral, neritic, and oceanic zones.

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## Lesson 14.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. About what percentage of ocean water mass is made up of salts?
  - a. 0.35 percent
  - b. 3.5 percent
  - c. 35
  - d. 55 percent
2. The density of ocean water increases as
  - a. salinity increases.
  - b. temperature increases.
  - c. pressure decreases.
  - d. all of the above
3. The average depth of ocean water is about
  - a. 380 meters.
  - b. 3800 meters.
  - c. 38,000 meters.
  - d. none of the above
4. Reasons that the deep ocean is a difficult environment for organisms include the
  - a. extremely high salinity.
  - b. complete absence of light.
  - c. constantly changing temperatures.
  - d. all of the above
5. Horizontal ocean zones include all of the following except the
  - a. neritic zone.
  - b. littoral zone.
  - c. aphotic zone.
  - d. oceanic zone.
6. Why would Earth be a very different planet without its oceans?
  - a. Oceans help to keep temperatures fairly constant worldwide.

- b. Oceans are an essential part of the hydrologic cycle.
  - c. Oceans contain the majority of Earth's biomass.
  - d. all of the above
7. Most of the salts in ocean water come from
- a. deep-sea vents.
  - b. rocks and soil on land.
  - c. underwater volcanic eruptions.
  - d. decomposition of marine organisms.

---

## Lesson 14.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. vertical arrangement of ocean zones by depth
- \_\_\_\_\_ 2. ocean zone closest to shore
- \_\_\_\_\_ 3. ocean zone farther from shore than the continental shelf
- \_\_\_\_\_ 4. ocean zone where there is enough sunlight for photosynthesis
- \_\_\_\_\_ 5. part of the ocean basin that lies between continental and oceanic crust
- \_\_\_\_\_ 6. ocean zone between the low tide mark and the edge of the continental shelf
- \_\_\_\_\_ 7. ocean zone where there is not enough sunlight for photosynthesis

### Terms

- a. continental margin
- b. water column
- c. aphotic zone
- d. oceanic zone
- e. neritic zone
- f. photic zone
- g. littoral zone

---

## Lesson 14.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The total mass of living organisms in a given area is the area's \_\_\_\_\_.
- 2. The main salt in ocean water is \_\_\_\_\_.
- 3. The continental \_\_\_\_\_ is divided into the continental shelf, slope, and rise.
- 4. The salt content of ocean water is referred to as its \_\_\_\_\_.

5. The deepest place in the ocean is named the \_\_\_\_\_.
6. The photic zone of the ocean extends to about \_\_\_\_\_ meters below the surface.
7. The \_\_\_\_\_ zone of the ocean is the region between the high and low tide marks.

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### Lesson 14.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

How might Earth be different without its oceans?

## 14.2 Ocean Movements

### Lesson 14.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Thermohaline circulation refers to the movement of ocean water in surface currents.
- \_\_\_\_\_ 2. Waves break when they become too tall to be supported by their base.
- \_\_\_\_\_ 3. Tsunami are caused only by earthquakes.
- \_\_\_\_\_ 4. Rip currents are deep currents that pass close to shore.
- \_\_\_\_\_ 5. Earth's rotation is responsible for the Coriolis effect.
- \_\_\_\_\_ 6. The direction of surface currents is influenced by the shape of ocean basins.
- \_\_\_\_\_ 7. The Gulf Stream raises London's average air temperature.
- \_\_\_\_\_ 8. Changes in temperature and salinity of ocean water take place on the ocean floor.
- \_\_\_\_\_ 9. Adding salt to water makes it less dense.
- \_\_\_\_\_ 10. Upwelling causes a decrease in marine organisms where it occurs.

### Lesson 14.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Tides

Tides are the repeated rise and fall of sea level at any given place. The pull of the moon's gravity on Earth is the primary cause of tides. The pull of the sun's gravity is a secondary cause. Although the moon has much less mass than the sun, its effect on Earth's tides is greater because it is so much closer to Earth.

As the moon revolves around Earth, its gravity pulls Earth toward it. The lithosphere is unable to move much but ocean water can, and it bulges outward toward the moon. This creates a high tide on the side of Earth facing the moon. The moon's gravity pulling Earth toward it leaves behind water on the opposite side of the planet. This creates another high tide bulge on the opposite side of Earth from the moon. Because so much water is pulled into the two high tide bulges low tides occur at places in between. Earth rotates beneath the moon once each day, so any given place on the coast will experience two high tides and two low tides every day.

The difference in water levels between high and low tides is called the tidal range. This range is greatest during spring tides and least during neap tides.

- Spring tides occur when the gravitational pull of both the moon and the sun are in the same direction. This happens when the moon is in its new or full moon phase, so spring tides occur about twice a month. The high tides are higher and the low tides are lower than at other times of the month.

- Neap tides occur when the gravitational pull of the moon and the sun are at right angles to each other. This happens during the first and third quarter phases of the moon, so spring tides also occur about twice a month. The high tides are lower and the low tides are higher than at other times of the month.

### Questions

1. Explain how the moon causes high and low tides.
2. Why are there two high tides and two low tides in a given place each day?
3. Why does the sun have only a secondary effect on Earth's tides?
4. Compare and contrast spring and neap tides.

---

## Lesson 14.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The largest wind waves in the ocean form when the wind
  - a. is very strong.
  - b. blows steadily for a long time.
  - c. blows over a very long distance.
  - d. all of the above
2. Waves cause individual water particles to
  - a. travel toward shore.
  - b. move in tiny circles.
  - c. sink to the bottom.
  - d. move in currents.
3. In most locations along the shore, a high tide occurs twice each
  - a. year.
  - b. month.
  - c. week.
  - d. day.
4. Which of the following factors has the greatest effect on surface currents?
  - a. global winds
  - b. Earth's revolution
  - c. differences in water salinity
  - d. differences in water temperature
5. The ocean water motions that most affect local climates on land are
  - a. tides.
  - b. waves.
  - c. deep currents.
  - d. surface currents.
6. Near the poles, ocean water is very dense because of its
  - a. low temperature.
  - b. low salinity.
  - c. large volume.

- d. two of the above
7. Which of the following statements about upwelling is false?
- It brings nutrients to the surface.
  - It typically takes place along coasts.
  - It causes cold, dense water to rise.
  - It occurs when winds push water toward shore.

---

## Lesson 14.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. type of ocean current caused by global winds
- \_\_\_\_\_ 2. transfer of wind energy across the surface of ocean water
- \_\_\_\_\_ 3. tide with the greatest difference between high and low tides
- \_\_\_\_\_ 4. type of ocean current caused by differences in density
- \_\_\_\_\_ 5. tide with the least difference between high and low tides
- \_\_\_\_\_ 6. daily rise and fall of sea level at a given place along the shore
- \_\_\_\_\_ 7. rise of cold water from the deep ocean to the surface

### Terms

- wave
- tide
- surface current
- upwelling
- spring tide
- deep current
- neap tide

---

## Lesson 14.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- High water pushed ashore by storm winds is called \_\_\_\_\_.
- A damaging wave caused by a sharp jolt to ocean water is a(n) \_\_\_\_\_.
- Tides are caused primarily by the \_\_\_\_\_ gravity.
- The difference between the ocean levels at high and low tides is the \_\_\_\_\_.
- \_\_\_\_\_ tides occur at new moon and full moon phases.
- The effect of Earth's rotation on the direction of surface currents is called the \_\_\_\_\_.



7. \_\_\_\_\_ is the event in which very cold, very saline water sinks to the bottom of the ocean.

---

### Lesson 14.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how and why thermohaline circulation occurs.

---

## 14.3 The Seafloor

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### Lesson 14.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Samples of seawater from different depths are needed to understand ocean water chemistry.
- \_\_\_\_\_ 2. A dredge is used to drill and gather samples from the solid seafloor.
- \_\_\_\_\_ 3. Submersibles have arms for collecting samples of seawater and rocks.
- \_\_\_\_\_ 4. The submersible named Alvin can dive up to 6500 meters beneath the ocean surface.
- \_\_\_\_\_ 5. Alvin allows four people to stay deep underwater for up to 12 hours.
- \_\_\_\_\_ 6. Fish are renewable natural resources only if they are not overharvested.
- \_\_\_\_\_ 7. Bottom trawling is a fishing method that may severely disturb ecosystems.
- \_\_\_\_\_ 8. Our only use of ocean organisms is for food.
- \_\_\_\_\_ 9. Minerals in manganese nodules include iron, nickel, and copper.
- \_\_\_\_\_ 10. Manganese nodules are currently being mined for their valuable minerals.

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### Lesson 14.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Studying the Seafloor

Scuba divers can dive only to about 40 meters beneath the surface, and they cannot stay at that depth for very long. Although this is a good way to research the ocean floor near a coast where the water is relatively shallow, researching most of the ocean floor requires accessing much greater depths. There are several other ways of studying the seafloor. For example, echo sounders and lasers can reveal the depth of the ocean and provide data to create bathymetric maps showing the three-dimensional shape of the seafloor.

Samples of seawater from different depths in the water column can be collected remotely. To do this, bottles are placed along a cable at regular depths and closed as a weight is dropped down the cable. The water trapped in the bottles can be analyzed later in a laboratory. Rock and sediment samples from the seafloor can be collected remotely with dredges or other equipment. A dredge is a giant rectangular bucket that is dragged along behind a ship to collect loose rocks from the seafloor. Gravity corers are metal tubes that fall to the seafloor and slice into the sediments to collect samples. The research vessel, the Joides Resolution, drills deep into the seafloor to collect samples of sediment and oceanic crust. Scientists analyze the samples for chemistry and paleomagnetism.

Another way samples of seawater and rocks can be collected is directly by scientists in a submersible. A submersible is a special underwater vehicle that can travel deep below the ocean surface to collect samples, make measurements,

take photographs, or allow scientists to make direct observations. The submersible named Alvin is an HOV, or human-operated vehicle. Alvin can dive up to 4500 meters beneath the surface and has made more than 4000 dives since 1964. Some other submersibles can dive even deeper than Alvin.

To avoid the expense, dangers, and limitations of human deep-sea missions, remotely operated vehicles, or ROVs, can be used. ROVs are small vehicles carrying cameras and scientific instruments that scientists can operate remotely with sophisticated electronic operating systems. ROVs were used to study the famous sunken ship the Titanic, which would have been far too dangerous for a human-operated vehicle to enter.

### Questions

1. Describe three ways that samples of water, sediments, or rocks can be gathered remotely from the ocean or seafloor.
2. What is a submersible? What has been achieved with the submersible HOV named Alvin?
3. What are ROVs? What are advantages of using ROVs instead of HOVs in researching deep-sea environment?

---

## Lesson 14.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Which statement about seafloor exploration is true?
  - a. Scientists have directly visited most of the seafloor.
  - b. Scientists have explored most of the seafloor remotely.
  - c. About half of the seafloor has been explored by ROVs.
  - d. Vast regions of the seafloor have not yet been explored.
2. Scuba divers can research the ocean directly. However, they can only
  - a. dive to about 140 meters below the surface.
  - b. research the seafloor at mid-ocean ridges.
  - c. stay down for short periods of time.
  - d. all of the above
3. Scientists can study the ocean floor from the surface with
  - a. echo sounders.
  - b. lasers.
  - c. ROVs.
  - d. all of the above
4. The research vessel the Joides Resolution collects samples from the seafloor by
  - a. dredging.
  - b. trawling.
  - c. drilling.
  - d. coring.
5. Submersibles that can dive the deepest can reach
  - a. more than 4500 meters beneath the surface.
  - b. up to 3500 meters beneath the surface.
  - c. a maximum of 3000 meters beneath the surface.
  - d. none of the above
6. Compared with studying the seafloor with an HOV, using an ROV is more

- a. expensive.
  - b. dangerous.
  - c. economical.
  - d. two of the above
7. The sunken ship named the Titanic was explored by
- a. Alvin.
  - b. HOVs.
  - c. ROVs.
  - d. scuba divers.

---

### Lesson 14.3: Matching

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. metal tube that slices into, and collects sediments from, the seafloor
- \_\_\_\_\_ 2. bucket dragged behind a ship to collect loose rock samples from the seafloor
- \_\_\_\_\_ 3. lump of valuable minerals found on the seafloor
- \_\_\_\_\_ 4. underwater vehicle that carries scientists deep beneath the ocean's surface
- \_\_\_\_\_ 5. device used to map the ocean floor
- \_\_\_\_\_ 6. method of fishing with a large net towed across the seafloor
- \_\_\_\_\_ 7. remotely operated vehicle that can study the deep seafloor

#### Terms

- a. echo sounder
- b. gravity corer
- c. bottom trawling
- d. dredge
- e. manganese nodule
- f. ROV
- g. HOV

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### Lesson 14.3: Fill in the Blank

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. A bottle attached to a cable is used to collect samples of \_\_\_\_\_ from different depths in the water column.
- 2. The submersible named \_\_\_\_\_ is an HOV that has made more than 4000 dives since 1964.

3. The acronym HOV in question 3 stands for \_\_\_\_\_ vehicle.
4. The most valuable nonliving resources taken from the ocean are oil and \_\_\_\_\_.
5. Oil \_\_\_\_\_ are structures on the surface of the ocean from which oil wells are drilled into the ocean floor.
6. When fish are overharvested, their rate of \_\_\_\_\_ cannot keep up with the rate at which they are consumed.

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### Lesson 14.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Based on your knowledge of the seafloor, explain potential problems of obtaining nonliving natural resources from the seafloor.

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## 14.4 Ocean Life

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### Lesson 14.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The world's smallest and largest animals live in the oceans.
- \_\_\_\_\_ 2. Most plankton are about the size of small fish.
- \_\_\_\_\_ 3. Zooplankton are responsible for about half of Earth's total primary productivity.
- \_\_\_\_\_ 4. Many fish can create their own light through chemical reactions.
- \_\_\_\_\_ 5. Most species of marine reptiles live in cold water.
- \_\_\_\_\_ 6. Marine mammals have adaptations such as kidneys able to excrete salt.
- \_\_\_\_\_ 7. Many animals that live in the intertidal zone have some means of anchoring to rocks.
- \_\_\_\_\_ 8. The only photosynthesizers in the open ocean are phytoplankton.
- \_\_\_\_\_ 9. There are no primary producers in the aphotic zone.
- \_\_\_\_\_ 10. Fish adaptations in the deepest ocean include a slow metabolism.

---

### Lesson 14.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Marine Ecosystems

A great abundance of life is found in the intertidal zone despite the very difficult conditions there. Intertidal organisms must adapt to high-energy, crashing waves. They also must be able to withstand repeated exposure to air during low tides. Hard shells protect many intertidal organisms from waves as well as drying out. The moving water also requires many of the organisms to have a means of attaching themselves to rocks or other stationary surfaces.

Corals are tiny animals that deposit calcium carbonate to create rock reefs near the shore. Many other organisms live in or around coral reefs. In fact, they are among the most densely inhabited and diverse ecosystems on Earth. Because coral reefs are close to shore, they are subject to pollution from land. Corals are also very sensitive to temperature and are stressed by rising ocean temperatures due to global warming.

Almost all of the food in the vast oceanic zone is created by phytoplankton that live near the water surface. Zooplankton and larger animals feed on the phytoplankton and on each other. The relatively few species that live at greater depths in the oceanic zone are very specialized. Food is relatively scarce, so they have adaptations that allow them to get by on less. These may include small body size, very low metabolic rate, and minimal bone structure. To maximize the chances of catching prey, some species have jaws that unhinge to accept a larger fish or backward-

folding teeth to keep prey from escaping. Many fish that live in the absolute darkness of the deep ocean have the ability to produce light with chemical reactions. An example is the angler fish, which has a glowing “lure” to attract prey.

Hot, chemical-rich water pours out of hydrothermal vents at mid-ocean ridges. Unique ecosystems form around these vents. There is no sunlight for photosynthesis this far below the surface, so producers make food by chemosynthesis. They are bacteria that use chemicals in the hot water for energy to make food. Consumers in the vent ecosystem giant tube worms and certain species of shrimp, clams, and fish. The chemosynthetic bacteria live inside the tubeworms in a symbiotic relationship. The bacteria get a safe place to live, and the tubeworms get a reliable source of food.

### Questions

1. What adaptations are needed by organisms in the intertidal zone?
2. Describe coral reef ecosystems. What threats do these ecosystems face?
3. Explain how fish in the oceanic zone adapt to conditions far below the surface.
4. Why are hydrothermal vent ecosystems unique?

---

## Lesson 14.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Zooplankton may be
  - a. tiny invertebrates.
  - b. juvenile forms of vertebrates.
  - c. tiny plants and algae.
  - d. two of the above
2. Marine plants and seaweeds live mainly in the
  - a. neritic zone.
  - b. aphotic zone.
  - c. oceanic zone.
  - d. intertidal zone.
3. Marine invertebrates include
  - a. starfish.
  - b. jellyfish.
  - c. lobsters.
  - d. all of the above
4. Which of the following adaptations do most fish have?
  - a. swim bladder
  - b. high metabolic rate
  - c. warm-bloodedness
  - d. two of the above
5. Marine reptiles that return to land to lay eggs include all of the following except
  - a. sea turtles.
  - b. sea snakes.
  - c. marine iguanas.
  - d. saltwater crocodiles.

6. Seabirds that live on land and go to sea only to fish include all of the following except
- gulls.
  - pelicans.
  - albatrosses.
  - frigate birds.
7. The world's coral reefs are threatened by
- pollution from land.
  - rising ocean temperatures.
  - extreme pressure in the deep ocean.
  - two of the above

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### Lesson 14.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. tiny marine animals that eat phytoplankton
- \_\_\_\_\_ 2. creation of food energy
- \_\_\_\_\_ 3. any animal that lacks a backbone
- \_\_\_\_\_ 4. tiny marine organisms that cannot swim and hang suspended in the water
- \_\_\_\_\_ 5. fissure at a mid-ocean ridge where hot water pours out
- \_\_\_\_\_ 6. tiny marine organisms that make food by photosynthesis
- \_\_\_\_\_ 7. any animal that has a backbone

#### Terms

- plankton
- vertebrate
- phytoplankton
- hydrothermal vent
- zooplankton
- invertebrate
- primary productivity

---

### Lesson 14.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- Because they photosynthesize, phytoplankton live in the \_\_\_\_\_ zone of the water column.
- The ability of organisms to produce light is called \_\_\_\_\_.



3. Marine vertebrates with fins, scales, and gill are classified as \_\_\_\_\_.
4. Because of their tremendous species diversity, \_\_\_\_\_ are called the “rainforests of the oceans.”
5. An island called a(n) \_\_\_\_\_ forms when a coral reef grows around a volcano, which eventually erodes away.
6. Bacteria at hydrothermal vents make food by the process of \_\_\_\_\_.
7. Phytoplankton release \_\_\_\_\_ as a waste produce of photosynthesis.

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### Lesson 14.4: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Identify a class of marine vertebrates, examples of organisms in that class, and adaptations that help them live in their marine environment.

## CHAPTER

## 15

# HS Earth's Atmosphere Worksheets

## Chapter Outline

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- 15.1 THE ATMOSPHERE**
  - 15.2 ATMOSPHERIC LAYERS**
  - 15.3 ENERGY IN THE ATMOSPHERE**
  - 15.4 AIR MOVEMENT**
- 

- Lesson 15.1: The Atmosphere
- Lesson 15.2: Atmospheric Layers
- Lesson 15.3: Energy in the Atmosphere
- Lesson 15.4: Air Movement

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## 15.1 The Atmosphere

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### Lesson 15.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Respiration is more-or-less the reverse of photosynthesis.
  - \_\_\_\_\_ 2. The atmosphere is a crucial part of the hydrologic cycle.
  - \_\_\_\_\_ 3. The ozone layer in the atmosphere allows complex life forms to live on Earth.
  - \_\_\_\_\_ 4. Without the atmosphere, Earth would always have the same temperature.
  - \_\_\_\_\_ 5. Warm air can hold less moisture than cooler air.
  - \_\_\_\_\_ 6. Particles in the atmosphere include metals and fecal matter.
  - \_\_\_\_\_ 7. Particles in the atmosphere are needed for clouds to form.
  - \_\_\_\_\_ 8. Gravity has no effect on the gases in Earth's atmosphere.
  - \_\_\_\_\_ 9. Virtually all weather takes place in the lower atmosphere.
  - \_\_\_\_\_ 10. Carbon dioxide is the only important greenhouse gas.
- 

### Lesson 15.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Significance of the Atmosphere

Earth's atmosphere, along with the abundant liquid water at Earth's surface, are the keys to our planet's unique place in the solar system. Much of what makes Earth exceptional depends on the atmosphere. Let's consider some of the reasons we are lucky to have an atmosphere.

Atmospheric gases, especially oxygen and carbon dioxide, are extremely important for living organisms. Plants use carbon dioxide to make food (sugar) by photosynthesis and they release oxygen as a waste product of photosynthesis. Photosynthesis is responsible for nearly all of the oxygen currently found in the atmosphere. By producing oxygen and food, plants have made an environment that is favorable for other organisms, including animals. Most organisms use respiration to break down food for energy. This process uses oxygen from the atmosphere and releases carbon dioxide as a waste product.

There are three other reasons we are lucky to have the atmosphere.

- A layer of ozone gas in the stratosphere absorbs high-energy ultraviolet (UV) radiation from the sun. This protects living things on Earth's surface from these harmful rays. Without ozone for protection, only the simplest life forms would be able to live on Earth.

- The atmosphere moderates Earth's climate and makes it more hospitable to living things. Greenhouse gases, such as carbon dioxide and water vapor, trap heat in the atmosphere. Without these gases, Earth's temperatures would be frigid at night and scorching during the day.
- Gas molecules in the atmosphere transmit sound waves to our ears and allow us to hear. Without the atmosphere, Earth would be a virtually silent place.

## Questions

1. Explain how carbon dioxide and oxygen are used by living organisms.
2. Why is the ozone layer important to life on Earth?
3. How does the atmosphere moderate Earth's temperatures?
4. How does the atmosphere allow us to hear?

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## Lesson 15.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The atmosphere is needed for people to
  - a. fly planes.
  - b. sail boats.
  - c. hear birds sing.
  - d. all of the above
2. How does the atmosphere change as altitude increases?
  - a. The density of air decreases.
  - b. The pressure of air increases.
  - c. The percent of oxygen in air decreases.
  - d. all of the above
3. Without the atmosphere, Earth would have no
  - a. life.
  - b. weather.
  - c. soil.
  - d. all of the above
4. The gas that organisms need for respiration is
  - a. carbon dioxide.
  - b. water vapor.
  - c. oxygen.
  - d. ozone.
5. Greenhouse gases include
  - a. oxygen.
  - b. nitrogen.
  - c. ozone.
  - d. two of the above
6. The amount of water vapor in the air
  - a. is always constant.

- b. varies by location.
- c. varies by season.
- d. two of the above

---

## Lesson 15.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. important greenhouse gas
- \_\_\_\_\_ 2. elevation above sea level
- \_\_\_\_\_ 3. process in which organisms convert sugar into energy
- \_\_\_\_\_ 4. long-term average weather at a specific place
- \_\_\_\_\_ 5. amount of water vapor in the air
- \_\_\_\_\_ 6. description of the atmosphere at a specific time and place
- \_\_\_\_\_ 7. gas in the atmosphere that absorbs UV radiation

### Terms

- a. humidity
- b. climate
- c. altitude
- d. respiration
- e. carbon dioxide
- f. weather
- g. ozone

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## Lesson 15.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The thin blanket of gases and tiny particles that surrounds Earth is the \_\_\_\_\_.
- 2. The process of \_\_\_\_\_ is responsible for nearly all the oxygen in the atmosphere.
- 3. The molecule that consists of three oxygen molecules is called \_\_\_\_\_.
- 4. \_\_\_\_\_ gases trap heat in the atmosphere and help to moderate global temperatures.
- 5. The two gases that make up 99 percent of the atmosphere are nitrogen and \_\_\_\_\_.
- 6. Air density \_\_\_\_\_ as altitude increases.
- 7. The force of air pushing against a unit of area is called \_\_\_\_\_.

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## Lesson 15.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Relate air density and pressure to altitude.

## 15.2 Atmospheric Layers

### Lesson 15.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. When gas molecules lose energy, their density decreases.
- \_\_\_\_\_ 2. The stratopause occurs between the stratosphere and troposphere.
- \_\_\_\_\_ 3. The air in the stratosphere does a lot of mixing because it is unstable.
- \_\_\_\_\_ 4. Temperature inversions often trap pollutants close to Earth's surface.
- \_\_\_\_\_ 5. Ultraviolet radiation harms living things by damaging the DNA in their cells.
- \_\_\_\_\_ 6. About 99.9 percent of the atmosphere's mass lies below the stratosphere.
- \_\_\_\_\_ 7. The troposphere rises to an altitude of about 10 kilometers above sea level.
- \_\_\_\_\_ 8. The cause of ionization in the thermosphere is solar radiation.
- \_\_\_\_\_ 9. The Van Allen radiation belts are located in the ionosphere.
- \_\_\_\_\_ 10. There is no real outer limit to the exosphere.

### Lesson 15.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Troposphere**

The troposphere is the lowest layer of Earth's atmosphere. In this layer, the temperature of the air is generally highest near Earth's surface and decreases with altitude. Throughout the troposphere, the temperature falls by an average of 6.5 °C per 1000 meters of increase in altitude. Earth's surface is the major direct source of heat for the troposphere, but nearly all of that heat comes originally from the sun. Earth's surface absorbs sunlight and radiates it back into the atmosphere as heat. The temperature is also higher near the surface because of the greater density of gases there.

Because of the temperature gradient in the troposphere, warmer air is located below cooler air. This condition is unstable. Warmer air near the surface rises because it is less dense, and cooler air higher in the troposphere sinks because it is denser. As a result, air in the troposphere does a lot of mixing, which causes the temperature gradient to vary with time and place. The rising and sinking of air in the troposphere also causes weather, all of which takes place in the troposphere.

Under certain conditions, a temperature inversion may occur in the troposphere. This happens when warmer air sits over colder air, which is at the surface. Temperature inversions often occur during the winter when the ground is very cold at night. The cold ground cools the air directly above it, making this layer of air denser than the air above it. Temperature inversions may also occur near a coast where cold seawater cools the air above it. The cooler, denser

air moves inland and slides beneath warmer air over the land. A temperature inversion is very stable, so it may last for several days or even weeks.

At the top of the troposphere is a thin layer of air in which the temperature does not change with altitude. This layer, called the tropopause, traps the cooler, denser air of the troposphere beneath the warmer, less dense air of the stratosphere. This prevents air in the troposphere and stratosphere from mixing.

### Questions

1. Describe the temperature gradient in the troposphere. What is the major direct source of heat in the troposphere?
2. Explain why air in the troposphere does a lot of mixing.
3. What is a temperature inversion? Why does it occur, and why is it stable?
4. What prevents air in the troposphere and stratosphere from mixing?

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## Lesson 15.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. A change in temperature with distance is called a temperature
  - a. gradient.
  - b. inversion.
  - c. reversal.
  - d. none of the above
2. How temperature changes within each layer of the atmosphere is determined primarily by the
  - a. heat source of the layer.
  - b. ozone content of the layer.
  - c. air density in the layer.
  - d. air currents in the layer.
3. The major direct source of heat in the troposphere is
  - a. the greenhouse effect.
  - b. Earth's surface.
  - c. the solar wind.
  - d. UV rays.
4. In a temperature inversion, warmer air
  - a. sits over cooler air.
  - b. rises into the stratosphere.
  - c. is less stable than cooler air.
  - d. sinks to Earth's surface.
5. The thickness of the ozone layer in the atmosphere varies by
  - a. season.
  - b. latitude.
  - c. longitude.
  - d. two of the above
6. Most meteors burn up in the



- a. mesosphere.
  - b. troposphere.
  - c. stratosphere.
  - d. thermosphere.
7. Temperatures increase with increasing altitude in the
- a. troposphere.
  - b. mesosphere.
  - c. stratosphere.
  - d. two of the above

---

## Lesson 15.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. layer of the atmosphere where the International Space Station orbits
- \_\_\_\_\_ 2. lowest layer of the atmosphere
- \_\_\_\_\_ 3. outermost layer of the atmosphere
- \_\_\_\_\_ 4. layer of the atmosphere that contains the ozone layer
- \_\_\_\_\_ 5. part of the thermosphere where electrons flow in electric currents
- \_\_\_\_\_ 6. layer of the atmosphere with the coldest temperatures
- \_\_\_\_\_ 7. zone of charged solar particles that cause the aurora

### Terms

- a. exosphere
- b. ionosphere
- c. magnetosphere
- d. mesosphere
- e. stratosphere
- f. thermosphere
- g. troposphere

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## Lesson 15.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The atmosphere is divided into layers based on the way that \_\_\_\_\_ changes with altitude.
- 2. Density and pressure of air are higher when air temperature is \_\_\_\_\_.
- 3. Temperatures in the troposphere \_\_\_\_\_ with higher altitude.

4. The direct source of heat for the stratosphere is the \_\_\_\_\_.
5. Temperatures in the mesosphere \_\_\_\_\_ with higher altitude.
6. At night, AM radio waves bounce off particles in the \_\_\_\_\_.
7. High-speed particles traveling outward from the sun make up solar \_\_\_\_\_.

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## Lesson 15.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Describe and explain the temperature gradient in the mesosphere.

## 15.3 Energy in the Atmosphere

### Lesson 15.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Less solar energy reaches lower latitudes than higher latitudes.
- \_\_\_\_\_ 2. Differences in solar radiation by latitude cause winds and ocean currents.
- \_\_\_\_\_ 3. Electromagnetic waves can travel through gases but not through solids.
- \_\_\_\_\_ 4. The longest wavelengths of visible light appear red in color.
- \_\_\_\_\_ 5. A candle flame contains more heat than a bathtub full of hot water.
- \_\_\_\_\_ 6. If you continue heating a pot of boiling water, the temperature of the water keeps rising.
- \_\_\_\_\_ 7. The angle of tilt of Earth's axis keeps changing as the planet revolves around the sun.
- \_\_\_\_\_ 8. In the atmosphere, conduction is more effective at lower altitudes.
- \_\_\_\_\_ 9. A molecule of carbon dioxide traps more heat in the atmosphere than a molecule of any other greenhouse gas.
- \_\_\_\_\_ 10. Sources of methane gas include the decomposition of plant materials.

### Lesson 15.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **How Solar Radiation Heats Earth's Surface and Atmosphere**

Energy from the sun travels to Earth and heats the surface. Different parts of the surface receive different amounts of solar energy. Generally, the equator receives the most energy because the sun's rays strike the surface most directly at the equator. The amount of solar radiation received at higher latitudes depends on the season. The seasons are caused by the direction Earth's axis of rotation is pointing relative to the sun. The axis is always tilted 23.5 degrees relative to Earth's plane of orbit around the sun, but the north and south poles may tilt toward or away from the sun.

When it is summer in the Northern Hemisphere, the north pole tilts toward the sun. As a result, the sun's rays strike the Northern Hemisphere more directly at this time of year. Light from the sun is more concentrated where the rays are more direct, so the Northern Hemisphere is heated more during the summer than at other times of year. The opposite is true when it is winter in the Northern Hemisphere. The north pole tilts away from the sun, so the sun's rays strike the Northern Hemisphere less directly. Sunlight is less concentrated where the rays are less direct. As a result, Northern Hemisphere is heated less in the winter than at other times of year. The Southern Hemisphere has seasons for the same reasons, but the seasons are reversed relative to the Northern Hemisphere.

Much of the heat that Earth's surface receives by radiation from the sun is radiated back into the atmosphere where

it heats the troposphere. Radiation is the transfer of energy between two objects by electromagnetic waves. Heat from Earth's surface also travels to the troposphere by conduction. In conduction, heat is transferred between two objects that are in direct contact. Molecules of the warmer object vibrate rapidly and collide with nearby molecules, transferring their energy. In the atmosphere, conduction is more effective at lower altitudes where air density is higher and gas molecules are closer together.

Heat is transferred throughout the troposphere by convection. Convection occurs when molecules of a substance—in this case, gases in the atmosphere—move in currents because of differences in density. Air near the surface warms because of heat transferred from the surface. The warm air is low in density, so it rises. The rising warm air cools, becomes denser, and sinks to the surface again. These air movements form convection currents that mix air throughout the troposphere.

### Questions

1. Explain why the Northern Hemisphere is warmer in the summer than in the winter.
2. Describe how heat from Earth's surface is transferred to the atmosphere.
3. How is heat transferred throughout the troposphere?

---

### Lesson 15.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Water in a lake stays cooler than nearby land on a hot sunny day because water has a higher
  - a. albedo.
  - b. insolation.
  - c. latent heat.
  - d. specific heat.
2. The UV waves that are completely absorbed by the ozone layer are called
  - a. UVA.
  - b. UVB.
  - c. UVC.
  - d. UVD.
3. Earth's seasons occur because of changes in the
  - a. direction Earth is tilting.
  - b. speed of Earth's revolution.
  - c. distance of Earth from the sun.
  - d. solar radiation produced by the sun.
4. Heat transfer by the movement of molecules in currents is called
  - a. radiation.
  - b. conduction.
  - c. reflection.
  - d. convection.
5. Only about half of the solar radiation that strikes the top of the atmosphere reaches the ground because of
  - a. absorption.
  - b. reflection.
  - c. scattering.

- d. all of the above
6. Which of the following is the best analogy for how greenhouse gases affect Earth's climate?
- wool blanket
  - heating pad
  - radiator
  - candle flame
7. All of the following greenhouse gases are naturally occurring in the atmosphere except
- CO<sub>2</sub>.
  - H<sub>2</sub>O.
  - NO<sub>2</sub>.
  - CFCs.

---

### Lesson 15.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. heat that is taken in or released when matter changes state
- \_\_\_\_\_ 2. amount of solar radiation that reaches a given area in a given time
- \_\_\_\_\_ 3. measure of how fast atoms of a material are vibrating
- \_\_\_\_\_ 4. transfer of energy by electromagnetic waves
- \_\_\_\_\_ 5. measure of the total energy of a substance
- \_\_\_\_\_ 6. measure of how well a surface reflects light
- \_\_\_\_\_ 7. amount of energy needed to raise the temperature of 1 gram of a substance by 1 °C

#### Terms

- albedo
- heat
- latent heat
- specific heat
- insolation
- temperature
- radiation

---

### Lesson 15.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. Most objects radiate infrared energy, which we feel as \_\_\_\_\_.

2. The moon appears to glow in the night sky because it \_\_\_\_\_ sunlight.
3. About 44 percent of solar radiation falls in the range of wavelengths called \_\_\_\_\_ light.
4. Of the solar energy that reaches the outer atmosphere, \_\_\_\_\_ radiation has the greatest energy.
5. During the \_\_\_\_\_ solstice in the Northern Hemisphere, the sun's rays are most direct on the Tropic of Cancer.
6. During the equinoxes, the sun's rays shine most directly on the \_\_\_\_\_.
7. In the process of \_\_\_\_\_, heat moves by direct contact from a warmer to a cooler object.

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### Lesson 15.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain the relationship between temperature and heat.

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## 15.4 Air Movement

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### Lesson 15.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Convection in the atmosphere creates Earth's weather.
- \_\_\_\_\_ 2. Water vapor condenses out of air when it is heated.
- \_\_\_\_\_ 3. Water heats up and cools down more slowly than land.
- \_\_\_\_\_ 4. Water has a very low specific heat.
- \_\_\_\_\_ 5. A seasonal land breeze blows during the summer.
- \_\_\_\_\_ 6. Katabatic winds form over high plateaus.
- \_\_\_\_\_ 7. Chinook winds bring moisture to the leeward side of a mountain range.
- \_\_\_\_\_ 8. Santa Ana winds often spread wildfires in Southern California.
- \_\_\_\_\_ 9. You might see dust devils in an haboob.
- \_\_\_\_\_ 10. A Hadley cell forms between 30 and 60 degrees north latitude.

---

### Lesson 15.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Atmospheric Circulation and Global Winds

Because more solar energy strikes the equator, the air over the equator is warmer than elsewhere on the planet. Warm air has low density, so it rises and forms a low pressure zone. At the top of the troposphere, half of the warm air moves toward the north pole and half toward the south pole along the top of the troposphere. At about 30 degrees north latitude, the air from the equator meets air flowing toward the equator from higher latitudes and descends to the ground, creating a high pressure zone. Once on the ground, the air returns to the equator. These air movements form a convection cell, called a Hadley cell, which is found between 0 and 30 degrees north latitude. A similar Hadley cell is also found between 0 and 30 degrees south latitude, except the air flows in the opposite directions.

In addition to Hadley cells, there are two other major convection cells in each hemisphere. A Ferrell cell is located between 30 and about 60 degrees north or south latitude. In the Northern Hemisphere, air in this cell moves from north to south; it moves in the opposite direction in the Southern Hemisphere. A polar cell is located between about 60 and 90 degrees north or south latitude. In the Northern Hemisphere, the air in this cell moves from south to north and descends at the north pole. It moves in the opposite direction in the Southern Hemisphere and descends at the south pole.

Global circulation cells cause global wind belts. Global wind belts are enormous. They occur because of the flowing

air at the bottom of the major circulation cells. In both hemispheres, the global wind belts are the trade winds, westerlies, and polar easterlies. In the Northern Hemisphere, the trade winds flow from northeast to southwest at the bottom of the Hadley cell; the westerlies blow from southwest to northeast at the bottom of the Ferrell cell; and the polar easterlies blow from northeast to southwest at the bottom of the polar cell. The winds blow in the opposite directions in the Southern Hemisphere. The winds do not blow due north or south because of the Coriolis effect. It deflects winds to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

### Questions

1. Identify and briefly describe the three major convection cells in the Northern Hemisphere.
2. Identify and describe the three global wind belts in the Northern Hemisphere.
3. Relate the wind belts in question 2 to the convection cells in question 1.

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## Lesson 15.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Where cool air descends to the ground there is a
  - a. high-pressure zone.
  - b. Foehn wind.
  - c. valley breeze.
  - d. polar front.
2. Winds blow when air flows from areas of higher to lower
  - a. elevation.
  - b. pressure.
  - c. temperature.
  - d. altitude.
3. When warm air cools it
  - a. becomes less dense.
  - b. becomes denser.
  - c. can hold more moisture.
  - d. two of the above
4. Land and sea breezes
  - a. may occur daily and seasonally.
  - b. are types of local winds.
  - c. occur because of differences in specific heat.
  - d. all of the above
5. India is well known for its local winds called
  - a. katabatic winds.
  - b. monsoon winds.
  - c. Chinook winds.
  - d. Santa Ana winds.
6. A rainshadow occurs
  - a. on the leeward side of a mountain.
  - b. where moist air sinks to the ground.



- c. in a low-pressure zone.
  - d. all of the above
7. In global atmospheric circulation
- a. warm air sinks at the equator.
  - b. warm air flows north from the equator.
  - c. warm air flows south from the equator.
  - d. two of the above

---

## Lesson 15.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. wind that blows from a mountain to a valley during the night
- \_\_\_\_\_ 2. wind that blows from land to sea
- \_\_\_\_\_ 3. Hot, dry wind that blows from the interior of California to the Pacific Ocean
- \_\_\_\_\_ 4. wind that is a larger scale version of a land or sea breeze
- \_\_\_\_\_ 5. wind that blows from sea to land
- \_\_\_\_\_ 6. wind that blows where air is forced up over a mountain range
- \_\_\_\_\_ 7. wind that blows from a valley to a mountain during the day

### Terms

- a. land breeze
- b. Santa Ana
- c. valley breeze
- d. Chinook
- e. sea breeze
- f. mountain breeze
- g. monsoon

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## Lesson 15.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Warm air rising creates a(n) \_\_\_\_\_ pressure zone on the ground.
- 2. The horizontal flow of air through the troposphere is called \_\_\_\_\_.
- 3. A wind called a(n) \_\_\_\_\_ forms in the downdrafts at the front of a thunderstorm.
- 4. Global winds deflect to the east or west because of the \_\_\_\_\_ effect.
- 5. The global winds that blow across most of the continental U.S. are called \_\_\_\_\_.

6. Rain is common in a(n) \_\_\_\_\_ pressure region.
7. A(n) \_\_\_\_\_ is a fast-flowing river of air at the boundary between the troposphere and stratosphere.

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### Lesson 15.4: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast land and sea breezes.

## CHAPTER

**16****HS Weather Worksheets****Chapter Outline**

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**16.1 WEATHER AND ATMOSPHERIC WATER**

**16.2 CHANGING WEATHER**

**16.3 STORMS**

**16.4 WEATHER FORECASTING**

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- **Lesson 16.1: Weather and Atmospheric Water**
- **Lesson 16.2: Changing Weather**
- **Lesson 16.3: Storms**
- **Lesson 16.4: Weather Forecasting**

## 16.1 Weather and Atmospheric Water

### Lesson 16.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. When air temperature falls, the air can hold more water vapor.
- \_\_\_\_\_ 2. Cloudy days tend to have a greater range of temperatures than clear days.
- \_\_\_\_\_ 3. Water vapor condenses when air temperature reaches the dew point.
- \_\_\_\_\_ 4. A cloud consists of billions of individual water droplets.
- \_\_\_\_\_ 5. Dust or other particles are needed for clouds to form.
- \_\_\_\_\_ 6. Only high clouds consist of ice crystals.
- \_\_\_\_\_ 7. Stratocumulus clouds rarely bring precipitation.
- \_\_\_\_\_ 8. Advection fog forms when warm humid air travels up a hillside and cools.
- \_\_\_\_\_ 9. All precipitation falls from clouds.
- \_\_\_\_\_ 10. Hail forms in cumulonimbus clouds with strong updrafts.

### Lesson 16.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Clouds

Clouds have a big influence on weather. They are a necessary precursor of precipitation, although not all of them produce precipitation. Clouds also prevent some solar radiation from reaching the ground and absorb some of the heat that is re-radiated from the surface. As a result, cloudy days are likely to be cooler and cloudy nights warmer than clear days and nights.

Water vapor condenses out of the air when the temperature reaches the dew point. Air may reach its dew point when humidity increases or air temperature decreases. The latter commonly happens when warm, moist air rises. For clouds to form, water vapor must condense around tiny particles called nuclei (singular, nucleus). A nucleus might be a speck of dust or smoke, or it might be a salt crystal. The condensation of many water molecules around a nucleus forms a tiny droplet of liquid water. If billions of these water droplets come together, they make a cloud.

Clouds are classified in several ways. The most common classification used today divides clouds into groups based on altitude.

- High clouds form at high altitudes and consist of ice crystals. Examples of high clouds include cirrus, cirrostratus, and cirrocumulus clouds.

- Middle clouds form at middle altitudes and consist of ice crystals, water droplets, or both. Examples of middle clouds include altocumulus and altostratus clouds.
- Low clouds form at low altitudes and consist entirely or mainly of water droplets. Examples of low clouds include stratus, stratocumulus, and nimbostratus clouds.
- Vertical clouds grow upward and have their bases at low altitude and their tops at middle or high altitude. They form when strong air currents carry warm air upward. Examples of vertical clouds include cumulus and nimbostratus clouds.

### Questions

1. How do clouds influence weather?
2. Explain how clouds form.
3. Outline how clouds are classified by altitude.

---

## Lesson 16.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Weather factors include
  - a. average air temperature.
  - b. annual precipitation.
  - c. humidity.
  - d. two of the above
2. The dew point is the temperature at which
  - a. dew forms on surfaces.
  - b. water vapor starts to condense.
  - c. relative humidity is 100 percent.
  - d. all of the above
3. Relative humidity may decrease if
  - a. water vapor condenses out of the air.
  - b. water evaporates into the air.
  - c. air temperature decreases.
  - d. two of the above
4. Which type of cloud forms at high altitudes?
  - a. cirrocumulus
  - b. altocumulus
  - c. stratocumulus
  - d. nimbostratus
5. Which type of cloud forms when strong air currents carry warm air upward?
  - a. cirrus
  - b. stratus
  - c. cumulus
  - d. cirrostratus
6. The type of fog that forms when cool air moves over a warm lake is called

- a. radiation fog.
  - b. advection fog.
  - c. steam fog.
  - d. upslope fog.
7. Rain that passes through a layer of freezing air near the ground becomes
- a. glaze.
  - b. hail.
  - c. sleet.
  - d. snow.

---

## Lesson 16.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. amount of water vapor in the air in a particular place
- \_\_\_\_\_ 2. percentage of water vapor in a given volume of air relative to the maximum amount the air can hold
- \_\_\_\_\_ 3. type of middle-altitude cloud
- \_\_\_\_\_ 4. temperature at which air becomes saturated with water vapor
- \_\_\_\_\_ 5. type of low-altitude cloud
- \_\_\_\_\_ 6. type of cloud that grows vertically
- \_\_\_\_\_ 7. type of high-altitude cloud

### Terms

- a. dew point
- b. humidity
- c. cirrostratus cloud
- d. relative humidity
- e. altostratus cloud
- f. stratus cloud
- g. cumulus cloud

---

## Lesson 16.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. \_\_\_\_\_ is the condition of the atmosphere at a particular place and time.
- 2. Weather depends on the amount and location of \_\_\_\_\_ in the atmosphere.
- 3. The average weather of a region over a long period of time is the region's \_\_\_\_\_.

4. Basic cloud types are defined on the basis of their \_\_\_\_\_.
5. A cloud located at ground level is called \_\_\_\_\_.
6. \_\_\_\_\_ is a type of precipitation that forms when moist air cools on contact with a cold surface.
7. \_\_\_\_\_ is dew that forms when the air temperature is below freezing.

---

### Lesson 16.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain why relative humidity depends on air temperature.

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## 16.2 Changing Weather

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### Lesson 16.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. An air mass acquires the temperature and humidity of its source region.
- \_\_\_\_\_ 2. Temperate zones are ordinarily too stable for air masses to form.
- \_\_\_\_\_ 3. Storms may arise if an air mass and the region it moves over have different characteristics.
- \_\_\_\_\_ 4. A temperature inversion forms when a cold air mass travels over warmer ground.
- \_\_\_\_\_ 5. You would expect an air mass that forms near the north pole to flow south.
- \_\_\_\_\_ 6. Fronts between air masses are the main cause of stormy weather.
- \_\_\_\_\_ 7. At a stationary front, winds usually blow parallel to the front.
- \_\_\_\_\_ 8. A squall line forms along an occluded front.
- \_\_\_\_\_ 9. The weather along a front varies with the season.
- \_\_\_\_\_ 10. The stormiest weather usually occurs along a warm front.

---

### Lesson 16.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Air Masses**

An air mass is a very large batch of air that has nearly the same temperature and humidity throughout. An air mass acquires its characteristics from the region over which it forms, called its source region. When the air mass sits over the source region for several days, it picks up the temperature and humidity of that region. Air masses form in high pressure zones. They may form over continents, in which case they are dry, or over oceans, in which case they are moist. They most commonly form over polar or tropical regions. Polar air masses have cold temperatures, and tropical air masses have warm temperatures. Temperate zones are typically too unstable for air masses to form.

After air masses form, they are slowly pushed along by high-level winds. Cold air masses tend to flow toward the equator, and warm air masses tend to flow toward the poles. This movement of air masses brings heat to cold areas and cools down warm areas. Movement of air masses is one several processes that help balance out the planet's temperatures.

When an air mass moves over a region, it shares its temperature and humidity with that region. Storms may arise if an air mass moves over a region with different characteristics. For example, when a cold air mass moves over warmer ground, the bottom layer of air is heated. The heated air rises, forming clouds, rain, and sometimes thunderstorms. When a warm air mass travels over colder ground, the bottom layer of air cools. The cool air is dense, so it stays



near the ground below the warm air above it. This forms a temperature inversion.

### Questions

1. What is an air mass?
2. What gives an air mass its characteristics? Where might a warm, moist air mass form?
3. Why do air masses move? How do they influence weather in the regions over which they move?

---

## Lesson 16.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. An air mass gets its characteristics from the
  - a. regions over which it passes.
  - b. atmospheric layers above it.
  - c. other air masses it meets.
  - d. area where it forms.
2. An air mass that forms over a polar land mass is likely to have
  - a. low temperature and high humidity.
  - b. low temperature and low humidity.
  - c. moderate temperature and high humidity.
  - d. moderate temperature and low humidity.
3. Air masses are slowly pushed along by
  - a. Earth's rotation.
  - b. the Coriolis effect.
  - c. high-level winds.
  - d. Earth's gravity.
4. What generally happens at any front?
  - a. An air mass rises.
  - b. The temperature falls.
  - c. A high-pressure zone forms.
  - d. two of the above
5. After a cold front passes, the weather is likely to be
  - a. drier.
  - b. cooler.
  - c. warmer.
  - d. two of the above
6. One air mass is lifted above two others at a(n)
  - a. stationary front.
  - b. occluded front.
  - c. warm front.
  - d. cold front.
7. The source region of an air mass labeled mP might be
  - a. the northern Atlantic Ocean.

- b. northern Canada.
- c. the Caribbean Sea.
- d. northern Africa.

---

## Lesson 16.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. line where two air masses meet
- \_\_\_\_\_ 2. front in which air masses do not move for several days
- \_\_\_\_\_ 3. line of thunderstorms along a front
- \_\_\_\_\_ 4. front that involves three air masses
- \_\_\_\_\_ 5. large batch of air that all has about the same temperature and humidity
- \_\_\_\_\_ 6. front in which a cold air mass overtakes a warm air mass
- \_\_\_\_\_ 7. front in which a warm air mass slides over a cold air mass

### Terms

- a. air mass
- b. front
- c. cold front
- d. stationary front
- e. warm front
- f. squall line
- g. occluded front

---

## Lesson 16.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Air masses typically form in \_\_\_\_\_ pressure zones.
- 2. Cold air masses tend to flow toward the \_\_\_\_\_.
- 3. Warm air masses tend to flow toward the \_\_\_\_\_.
- 4. Air masses do not mix at a front because they have different \_\_\_\_\_.
- 5. At a front, one air mass rises above another, causing a \_\_\_\_\_ pressure zone.
- 6. A cold air mass has greater \_\_\_\_\_ than a warm air mass.
- 7. An air mass that forms over the ocean will have \_\_\_\_\_ humidity.

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## Lesson 16.2: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast warm and cold fronts.

## 16.3 Storms

### Lesson 16.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Anticyclones are cyclones that occur in the Southern Hemisphere.
- \_\_\_\_\_ 2. Cyclones can be the most intense storms on Earth.
- \_\_\_\_\_ 3. Hurricanes can produce higher winds than tornadoes.
- \_\_\_\_\_ 4. It is easier to predict the path of a hurricane than a tornado.
- \_\_\_\_\_ 5. Tornado activity in the U.S. is greatest along the East Coast.
- \_\_\_\_\_ 6. A category 5 hurricane is described as “strong” on the Saffir-Simpson scale.
- \_\_\_\_\_ 7. There are about 40,000 hurricanes around the world each year.
- \_\_\_\_\_ 8. Blizzards can produce sleet or freezing rain.
- \_\_\_\_\_ 9. Heat waves are the deadliest weather phenomena.
- \_\_\_\_\_ 10. Heat waves have increased in frequency and duration in recent years.

### Lesson 16.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Cyclones and Anticyclones

A cyclone is a large system of winds that are rotating around a low-pressure center. The winds rotate because of the Coriolis effect. They rotate counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere. Low pressure occurs because the swirling air rises. The rising air cools, creating clouds and precipitation. Stormy weather is likely. There are two types of cyclones: mid-latitude cyclones and tropical cyclones.

- Mid-latitude cyclones are the main cause of mid-latitude winter storms, such as blizzards and nor-easters.
- Tropical cyclones are very large storms that are also known as hurricanes, typhoons, or other local names.

The opposite of a cyclone is an anticyclone. An anticyclone is a large system of winds that are rotating around a high-pressure center. The winds rotate in the opposite direction to a cyclone, and the air sinks to the ground instead of rising. Anticyclones generally bring fair weather rather than storms.

#### Questions

1. Describe a Northern Hemisphere cyclone. How would a cyclone in the Southern Hemisphere be different?
2. Identify storms caused by mid-latitude cyclones and tropical cyclones.

3. Compare and contrast cyclones and anticyclones.

---

## Lesson 16.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Which type of storm is most common worldwide?
  - a. blizzard
  - b. tornado
  - c. hurricane
  - d. thunderstorm
2. Lightning may move
  - a. from a cloud to the ground.
  - b. from one cloud to another.
  - c. within a cloud.
  - d. all of the above
3. Characteristics of a Southern Hemisphere anticyclone include
  - a. winds rotating clockwise.
  - b. a high-pressure center.
  - c. rising air.
  - d. all of the above
4. The Fujika scale measures storm intensity by
  - a. wind speed.
  - b. duration of storm.
  - c. damage done by storm.
  - d. two of the above
5. Tropical cyclones may be called
  - a. nor-easters.
  - b. typhoons.
  - c. tornadoes.
  - d. thunderstorms.
6. Storm surge caused by a hurricane occurs when the
  - a. low-pressure center of the storm comes on land.
  - b. leading edge of the storm reaches the coast.
  - c. trailing edge of the storm goes ashore.
  - d. none of the above
7. To be a blizzard, a storm must have
  - a. temperatures below  $-7^{\circ}\text{C}$ .
  - b. winds faster than 56 km per hour.
  - c. visibility of 2/5 km or less for at least 3 hours.
  - d. all of the above

---

## Lesson 16.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. storm that develops from a tropical depression
- \_\_\_\_\_ 2. huge release of electricity from a cumulonimbus cloud
- \_\_\_\_\_ 3. mid-latitude cyclone in the mid-Atlantic and New England states
- \_\_\_\_\_ 4. large system of rotating winds around a low pressure center
- \_\_\_\_\_ 5. storm with low temperatures, high winds, and reduced visibility
- \_\_\_\_\_ 6. twirling whirling funnel cloud with high-speed winds
- \_\_\_\_\_ 7. large system of rotating winds around a high pressure center

### Terms

- a. anticyclone
- b. tornado
- c. blizzard
- d. cyclone
- e. lightning
- f. hurricane
- g. nor'easter

---

## Lesson 16.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Tornadoes form at the front of severe \_\_\_\_\_.
- 2. Cyclones rotate \_\_\_\_\_ in the Northern Hemisphere.
- 3. Most winter storms in New England are caused by \_\_\_\_\_ cyclones.
- 4. The low-pressure zone of a tropical cyclone is known as a tropical \_\_\_\_\_.
- 5. \_\_\_\_\_ are measured on the Fujita scale.
- 6. \_\_\_\_\_ are measured on the Saffir-Simpson scale.
- 7. Heavy snow that falls on the leeward side of the Great Lakes is called \_\_\_\_\_ snow.

---

## Lesson 16.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Both tornadoes and hurricanes cause death and destruction, but the two types of storms have many differences. Explain how they differ and how the differences relate to their potential destructiveness.

## 16.4 Weather Forecasting

### Lesson 16.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Weather forecasts are more accurate than ever before.
- \_\_\_\_\_ 2. A change in barometric pressure indicates that a change in weather is coming.
- \_\_\_\_\_ 3. Weather stations are located only on land.
- \_\_\_\_\_ 4. Weather radar detects water in the atmosphere when it reflects radio waves.
- \_\_\_\_\_ 5. Weather satellites detect only visible and infrared light.
- \_\_\_\_\_ 6. Numerical weather prediction uses complex mathematical models to forecast weather.
- \_\_\_\_\_ 7. Numerical weather prediction is not as accurate as prediction by experienced meteorologists.
- \_\_\_\_\_ 8. Closed isobars on a weather map represent high and low pressure cells.
- \_\_\_\_\_ 9. Weather map symbols include symbols for cloud type and wind speed.
- \_\_\_\_\_ 10. The first weather satellite was launched in 1992.

### Lesson 16.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Collecting Weather Data

A great deal of weather data must be collected in order to forecast the weather. Examples of devices used to measure specific weather factors include thermometers and barometers. Thermometers measure temperature, and barometers measure air pressure. Measurements of barometric pressure are especially important for weather forecasting. A change in barometric pressure indicates that a change in weather is coming. If air pressure rises, clear weather can be expected. If air pressure falls, storms are likely. Barometric pressure data from a large area can be used to identify pressure systems, fronts, and other weather systems.

Thermometers and barometers are found in weather stations. These are small collections of weather instruments, which may also include devices for measuring wind speed, wind direction, humidity, and precipitation. About 10,000 weather stations are located on land all over the world. In addition, weather stations are located on about 15 satellites, 700 buoys, 3000 aircraft, and 7300 ships. All of these weather stations constantly collect data on the condition of the atmosphere where they are located.

Other devices that measure atmospheric conditions include radiosondes, weather radar, and weather satellites.

- Radiosondes measure atmospheric characteristics such as temperature and air pressure as they travel through



the atmosphere after being launched by a balloon or airplane. Radiosondes use radios to communicate the data they collect to a computer.

- Weather radar sends out radio waves that bounce off precipitation in the atmosphere and then return to the radar device. Weather radar can sense many characteristics of precipitation, such as its location, intensity, and movement.
- Weather satellites observe all wavelengths of electromagnetic radiation. They can create visible light images of features such as storms, clouds, fires, and smog. They can create infrared images of characteristics such as water and land temperatures.

### Questions

1. Identify two weather instruments and the weather factors they measure.
2. What are weather stations? Where are they located?
3. Explain how radiosondes, weather radar, and weather satellites add to our knowledge of atmospheric conditions.

---

## Lesson 16.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. A thermometer may detect changes in temperature with
  - a. a coil of metal.
  - b. infrared radiation.
  - c. electrical resistance.
  - d. any of the above
2. Weather instruments that may contain a column of mercury include
  - a. barometers.
  - b. radar devices.
  - c. thermometers.
  - d. two of the above
3. Weather maps always show
  - a. weather for a particular area.
  - b. multiple weather factors.
  - c. data from computer models.
  - d. two of the above
4. Barometric pressure can be used to
  - a. identify pressure systems.
  - b. locate fronts.
  - c. predict weather.
  - d. all of the above
5. All of the weather stations around the world number in the
  - a. tens.
  - b. hundreds.
  - c. thousands.
  - d. millions.

6. Tracking the movement of a radiosonde in flight produces data on
  - a. air pressure.
  - b. air temperature.
  - c. wind direction.
  - d. precipitation.
7. Weather satellites take infrared images to record
  - a. smog.
  - b. clouds.
  - c. storms.
  - d. temperatures.

---

### Lesson 16.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. device that measures atmospheric conditions as it moves through the air
- \_\_\_\_\_ 2. line connecting places with the same air pressure
- \_\_\_\_\_ 3. device containing a temperature-sensitive indicator such as mercury
- \_\_\_\_\_ 4. line connecting places with the same wind speed
- \_\_\_\_\_ 5. device used to measure air pressure
- \_\_\_\_\_ 6. visual depiction of one or more weather factors for a particular area
- \_\_\_\_\_ 7. radio detection and ranging device

#### Terms

- a. weather map
- b. barometer
- c. isotach
- d. radar
- e. thermometer
- f. isobar
- g. radiosonde

---

### Lesson 16.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. If air pressure \_\_\_\_\_, stormy weather is on its way.
2. Weather \_\_\_\_\_ uses radio waves to detect water in the atmosphere.

3. Weather \_\_\_\_\_ are the best way to monitor large-scale weather systems such as cyclones.
4. Numerical weather prediction is carried out using \_\_\_\_\_.
5. Lines of equal temperature on a weather map are called \_\_\_\_\_.
6. A rising barometric reading suggest that \_\_\_\_\_ weather is coming.
7. A weather \_\_\_\_\_ may be used to launch a radiosonde into the atmosphere.

---

### Lesson 16.4: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

How has the accuracy of weather forecasting changed? What role do you think technology has played in this change?

## CHAPTER

## 17

# HS Climate Worksheets

## Chapter Outline

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**17.1 CLIMATE AND ITS CAUSES**

**17.2 WORLD CLIMATES**

**17.3 CLIMATE CHANGE**

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- **Lesson 17.1: Climate and Its Causes**
- **Lesson 17.2: World Climates**
- **Lesson 17.3: Climate Change**

## 17.1 Climate and Its Causes

### Lesson 17.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Weather is more predictable than climate.
- \_\_\_\_\_ 2. The main determinant of a location's climate is the amount of solar radiation it receives.
- \_\_\_\_\_ 3. Early sailors called the ITCZ the doldrums because of the lack of steady wind.
- \_\_\_\_\_ 4. The ITCZ migrates slightly with the seasons.
- \_\_\_\_\_ 5. Sinking air warms and causes condensation.
- \_\_\_\_\_ 6. The jet stream is always located at exactly 60 degrees north latitude.
- \_\_\_\_\_ 7. Climate is based on the weather of a place for at least 30 years.
- \_\_\_\_\_ 8. Climate includes only the average temperature and humidity of a region.
- \_\_\_\_\_ 9. The horse latitudes commonly have windy, stormy weather.
- \_\_\_\_\_ 10. Local winds have no influence on the climate of a place.

### Lesson 17.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Influences on Climate

The climate of a location is influenced mainly by its latitude, but several other factors may also be important. These include the location's position relative to an ocean or mountain range.

When a location is near an ocean or even a large lake, the body of water is likely to have a major impact on the climate.

- A place near an ocean has a maritime climate if winds usually blow in off the ocean. This type of climate is moderate, with relatively little variation in temperatures seasonally or daily. Surface currents and upwelling may contribute to the influence of the water on a coastal climate. For example, the cold waters of the California current bring cool temperatures to the California coast, whereas the warm waters of the Gulf Stream bring warm temperatures to the coast of England.
- A place too far inland to be influenced by an ocean has a continental climate. This type of climate is more extreme, with greater variation in temperatures seasonally and daily.

Mountain ranges may also have a big impact on climate. Places with higher altitudes have lower temperatures because density of air decreases with altitude. When the air is less dense, air molecules are less likely to collide and

generate heat. Mountain ranges may also create a rainshadow effect. This causes the leeward side of the range to have a warm, dry climate. If a mountain range separates a coastal region from the rest of the continent, maritime air masses may have trouble rising over the mountain range. As a result, the coastal area will have a maritime climate but the inland area on the leeward side of the range will have a continental climate.

### Questions

1. Compare and contrast maritime and continental climates.
2. How can surface currents influence a coastal climate?
3. Explain two ways that a mountain range may influence climate.

---

## Lesson 17.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The climate of a region depends on its position relative to
  - a. an ocean.
  - b. the equator.
  - c. a mountain range.
  - d. all of the above
2. Beneath a Hadley cell, the prevailing winds generally blow toward the
  - a. horse latitudes.
  - b. polar front.
  - c. equator.
  - d. none of the above
3. In an area where the air is mostly rising or sinking, there is not much
  - a. wind.
  - b. humidity.
  - c. precipitation.
  - d. stormy weather.
4. Air is mostly sinking over the
  - a. equator.
  - b. ITCZ.
  - c. horse latitudes.
  - d. polar fronts.
5. Ocean motions that influence coastal climates include
  - a. upwellings.
  - b. surface currents.
  - c. waves and tides.
  - d. two of the above
6. The climate along the ITCZ is
  - a. rainy.
  - b. cool.
  - c. dry.
  - d. two of the above

7. At about 30 degrees north and south latitude, the climate is generally
- humid.
  - frigid.
  - windy.
  - arid.

---

## Lesson 17.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. low-pressure area between two Hadley cells
- \_\_\_\_\_ 2. boundary between Ferrell and polar cells
- \_\_\_\_\_ 3. climate with extreme temperature differences
- \_\_\_\_\_ 4. high-pressure area between Hadley and Ferrell cells
- \_\_\_\_\_ 5. base of an atmospheric circulation cell
- \_\_\_\_\_ 6. long-term average weather for a given location
- \_\_\_\_\_ 7. moderate climate influenced by the ocean

### Terms

- climate
- polar front
- continental climate
- prevailing wind
- maritime climate
- horse latitude
- ITCZ

---

## Lesson 17.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- The major factor determining an area's climate is its \_\_\_\_\_.
- The meeting of two different air masses along the polar front causes the polar \_\_\_\_\_.
- Directly beneath the jet stream, the weather is often \_\_\_\_\_.
- When molecules of air collide, the collisions give off \_\_\_\_\_.
- The rainshadow effect results in a dry climate on the \_\_\_\_\_ side of a mountain range.
- A circulation cell called a(n) \_\_\_\_\_ cell lies between the ITCZ and horse latitudes.
- The global wind belt between the horse latitudes and polar front are called the \_\_\_\_\_.

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## Lesson 17.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Most of Earth's major deserts are located at about 30 degrees north or south latitude. Explain why.



## 17.2 World Climates

### Lesson 17.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Vegetation can be used as an indicator of climate type.
- \_\_\_\_\_ 2. Tropical climates occur only at the equator (0 degrees latitude).
- \_\_\_\_\_ 3. All tropical climates are wet year round.
- \_\_\_\_\_ 4. Dry climate zones cover about one-quarter of the world's land area.
- \_\_\_\_\_ 5. Moist subtropical mid-latitude climates are continental climates.
- \_\_\_\_\_ 6. Mediterranean climates are found on the western sides of continents.
- \_\_\_\_\_ 7. Polar climates are found along the polar front in North America.
- \_\_\_\_\_ 8. Most tundra biomes are found in the area surrounding the Arctic Ocean.
- \_\_\_\_\_ 9. The north- and south-facing sides of a hill are likely to have different microclimates.
- \_\_\_\_\_ 10. A marine west coast climate has cold temperatures and light precipitation.

### Lesson 17.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Climate Zones

Climate zones are classified by the Köppen classification system. This system is based on the temperature, amount of precipitation, and times of year when precipitation falls. The Köppen classification system recognizes five major climate groups, represented by the letters A through E.

A. Tropical moist climates. These climates are found between the equator and about 25 degrees north and south latitude. They have intense sunshine, high year-round temperatures, and abundant rainfall. Rain may fall year-round or seasonally.

B. Dry climates. These climates are found at about 30 degrees north and south latitude. They are also found at higher latitudes in rainshadows and within continents. They have plenty of sunshine, with hot summers and cool winters. Rainfall is irregular and infrequent, and there is less precipitation than evaporation.

C. Moist subtropical mid-latitude climates. These climates are found in mid-latitude coastal areas, such as the southeastern United States and western Europe. They have distinct seasons with cool to cold winters and mild summers. Rainfall is plentiful.

D. Continental climates. These climates are found within continents in the Northern Hemisphere, between about 40

and 70 degrees north latitude. They are not found in the Southern Hemisphere because the southern continents are too narrow. Continental climates have extreme temperatures, with very cold winters and relatively warm summers. They are relatively dry climates with stormy winters.

E. Polar climates. These climates are found in areas around the Arctic Ocean and to a lesser extent in Greenland and Antarctica. Winters are long, dark, and bitterly cold. Summers are short and cool. The climates are dry, with most of the limited precipitation falling in the summer.

### Questions

1. What is the Köppen classification system? What are the major climate groups in this system?
2. Which of the major climate groups are moist? Why are they moist?
3. Where are group B dry climates found? What other climate groups are dry? Why?

---

## Lesson 17.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Continental climates are found in
  - a. North America.
  - b. South America.
  - c. South Africa.
  - d. all of the above
2. The Köppen classification system classifies climates based on
  - a. amount of precipitation.
  - b. timing of precipitation.
  - c. temperature.
  - d. all of the above
3. The five major climate groups in the Köppen system include all of the following except
  - a. moist subtropical mid-latitude climates.
  - b. Mediterranean climates.
  - c. tropical moist climates.
  - d. dry climates.
4. Which type of vegetation would you expect to be dominant in a tropical wet and dry climate?
  - a. grasses
  - b. cacti
  - c. evergreen trees
  - d. mosses
5. The southeastern United States has a
  - a. humid subtropical climate.
  - b. Mediterranean climate.
  - c. dry-summer subtropical climate.
  - d. humid continental climate.
6. Boreal forests are found in
  - a. polar climates.

- b. subpolar climates.
  - c. tundra climates.
  - d. marine west coast climates.
7. Climate zones change with changes in latitude. This may be mimicked by changes in
- a. biome.
  - b. altitude.
  - c. longitude.
  - d. precipitation.

---

## Lesson 17.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. coniferous forest found in a subpolar continental climate
- \_\_\_\_\_ 2. tropical grassland
- \_\_\_\_\_ 3. climate type and its plants and animals
- \_\_\_\_\_ 4. type of biome in a mid-latitude semi-arid desert
- \_\_\_\_\_ 5. main type of biome found in wet tropical regions
- \_\_\_\_\_ 6. measure of the number of different species in a region
- \_\_\_\_\_ 7. scrubby, woody vegetation that grows in a dry-summer subtropical climate

### Terms

- a. steppe
- b. tropical rainforest
- c. chaparral
- d. biodiversity
- e. taiga
- f. savanna
- g. biome

---

## Lesson 17.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Dry climates include semi-arid climates and \_\_\_\_\_.
- 2. The biome with the highest biodiversity is the \_\_\_\_\_.
- 3. The Köppen classification system recognizes a total of \_\_\_\_\_ major climate groups.
- 4. \_\_\_\_\_ is a sub-surface layer of permanently frozen ground in an area with a polar climate.

5. A biome with a polar climate and small plants such as mosses is called \_\_\_\_\_.
6. A thick layer of ice found mostly on Greenland and Antarctica is called a(n) \_\_\_\_\_.
7. The climate of a small area that differs from the surrounding climate is called a(n) \_\_\_\_\_.

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## Lesson 17.2: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain why the natural vegetation in an area can be used to identify the area's climate zone.

## 17.3 Climate Change

### Lesson 17.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Earth's climate has been relatively stable for most of the past 2000 years.
- \_\_\_\_\_ 2. Earth's temperature has risen about 14 °C since the end of the Pleistocene ice ages.
- \_\_\_\_\_ 3. Short-term climate changes such as the ENSO have only local effects on climate.
- \_\_\_\_\_ 4. Sunspots reduce the amount of solar radiation given off by the sun.
- \_\_\_\_\_ 5. Plate tectonics may change the way that heat is distributed around the planet.
- \_\_\_\_\_ 6. Milankovitch cycles produce a climate pattern that repeats every 100,000 years.
- \_\_\_\_\_ 7. Carbon dioxide levels in the atmosphere have been rising only since the end of World War II.
- \_\_\_\_\_ 8. Current carbon dioxide levels are the highest they have been in more than half a million years.
- \_\_\_\_\_ 9. China now releases more carbon dioxide per person than any other nation in the world.
- \_\_\_\_\_ 10. In Arctic climates, permafrost is melting and its extent is decreasing.

### Lesson 17.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### El Niño and La Niña

The largest and most important short-term climate changes are the oscillations between an El Niño and a La Niña. This cycle is called the El Niño southern oscillation, or ENSO, and it repeats every 2 to 7 years. To understand the ENSO, it is important to know what happens during a normal year. Normally, the trade winds blow across the Pacific Ocean near the equator from east to west. This causes warm water to pile up in the western Pacific. In the eastern Pacific, along the west coast of South America, the water is cold, and upwelling occurs offshore.

During an El Niño, surface water temperature in the Pacific is warmer than usual, and the trade winds weaken or reverse direction. The winds blow east instead of west, so warm water piles up off the west coast of South America. With warm, low-density water at the surface, upwelling does not occur. By altering atmospheric and oceanic circulation, an El Niño changes global climate patterns. Some regions receive more rainfall than normal, including the west coasts of North and South America. Other regions receive less rainfall than normal, including parts of South America, Australia, and Indonesia. An El Niño typically lasts for one or two years.

Following an El Niño, the normal circulation pattern may resume. Often, however, an El Niño is followed by an exaggeration of the normal pattern. When the reaction is extreme, this is a La Niña. During a La Niña, trade winds blow from east to west and warm water piles up in the western Pacific, the same as occurs during a normal year.

However, ocean temperatures along coastal South America are colder than normal, and cold water reaches farther into the western Pacific than usual. These events change global climate patterns as well. In many locations, a La Niña produces the opposite climate variations from an El Niño. For instance, parts of Australia and Indonesia that are drier than normal during an El Niño are typically wetter than normal during a La Niña.

### Questions

1. What is the ENSO? How often does it repeat?
2. Explain how an El Niño differs from what happens during a normal year.
3. How does an El Niño affect global climates?
4. What is a La Niña? Compare its effects on global climates with the effects of an El Niño.

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## Lesson 17.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Which statement about Earth's climate is false?
  - a. Climate has changed throughout Earth's history.
  - b. Earth has never been as warm as it is today.
  - c. Short-term climate changes are common.
  - d. Plate tectonics can alter climate.
2. Scientists think that the Pleistocene ice ages were caused by
  - a. sunspots.
  - b. human activities.
  - c. greenhouse gases.
  - d. Milankovitch cycles.
3. Processes that add greenhouse gases to the atmosphere include
  - a. volcanic eruptions.
  - b. rice production.
  - c. organic decay.
  - d. all of the above
4. Volcanic eruptions may affect Earth's climate by
  - a. adding carbon dioxide to the atmosphere.
  - b. releasing dust that blocks solar radiation.
  - c. causing Earth to wobble on its axis.
  - d. two of the above
5. Greenhouse gases raise Earth's temperature by
  - a. absorbing heat that reaches the atmosphere from the sun.
  - b. trapping heat that radiates off Earth's surface.
  - c. reducing circulation in the atmosphere.
  - d. all of the above
6. All of the following are greenhouse gases except
  - a. chlorofluorocarbons.
  - b. methane.
  - c. oxygen.

- d. ozone.
- 7. Other changes that are likely to occur as Earth gets warmer include
  - a. worse droughts.
  - b. less biodiversity.
  - c. more severe hurricanes.
  - d. all of the above

---

## Lesson 17.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. variations in Earth's position relative to the sun that may cause ice ages
- \_\_\_\_\_ 2. warm period from the 10th to 14th centuries A.D.
- \_\_\_\_\_ 3. period with normal but exaggerated trade winds
- \_\_\_\_\_ 4. cold period from the 14th to 19th centuries A.D.
- \_\_\_\_\_ 5. short-term climate cycle between El Niño and La Niña
- \_\_\_\_\_ 6. period in which trade winds weaken or reverse direction
- \_\_\_\_\_ 7. magnetic storm on the sun's surface

### Terms

- a. medieval warm period
- b. little ice age
- c. El Niño
- d. ENSO
- e. Milankovitch cycle
- f. La Niña
- g. sunspot

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## Lesson 17.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Most of the recent global warming is caused by human activities that release \_\_\_\_\_ gases into the atmosphere.
- 2. Warmer global temperatures cause sea level to \_\_\_\_\_.
- 3. An El Niño occurs when the temperature of the Pacific Ocean is \_\_\_\_\_ than normal.
- 4. The major reason for the recent increase in atmospheric carbon dioxide is the burning of \_\_\_\_\_.
- 5. In \_\_\_\_\_ agriculture, trees are cut and burned to clear land for agriculture.

6. Forests \_\_\_\_\_ the level of carbon dioxide in the atmosphere.
7. As greenhouse gases increase in the atmosphere, the acidity of the ocean \_\_\_\_\_.

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### Lesson 17.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Make an argument to support the claim that human actions are causing the current period of global warming.



## CHAPTER

**18****HS Ecosystems and Human Populations Worksheets****Chapter Outline**

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**18.1 ECOSYSTEMS****18.2 THE CARBON CYCLE AND THE NITROGEN CYCLE****18.3 HUMAN POPULATIONS**

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- Lesson 18.1: Ecosystems
- Lesson 18.2: The Carbon Cycle and the Nitrogen Cycle
- Lesson 18.3: Human Populations

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## 18.1 Ecosystems

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### Lesson 18.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. All ecosystems that have a similar climate and similar organisms belong to the same biome.
  - \_\_\_\_\_ 2. All ecosystems have the same general roles that living things fill.
  - \_\_\_\_\_ 3. Scavengers are animals that kill and eat other animals.
  - \_\_\_\_\_ 4. Energy flows through an ecosystem in just one direction.
  - \_\_\_\_\_ 5. Food chains generally have a maximum of four or five trophic levels.
  - \_\_\_\_\_ 6. Nutrients are food molecules such as carbohydrates and proteins.
  - \_\_\_\_\_ 7. Each niche in an ecosystem can be inhabited by only one species.
  - \_\_\_\_\_ 8. Species that are parasites usually kill their host species.
  - \_\_\_\_\_ 9. Without decomposers, life on Earth would have died out long ago.
  - \_\_\_\_\_ 10. Matter flows through an ecosystem in exactly the same way as energy.
- 

### Lesson 18.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Roles and Feeding Relationships in Ecosystems**

There are many different types of ecosystems. Climate factors determine which type of ecosystem is found in any given location. Different organisms live in different types of ecosystems, but every ecosystem has the same general roles and feeding relationships.

Two basic roles that are found in all ecosystems are the roles of producer and consumer. Every ecosystem has producers, which are organisms that produce food in the form of chemical energy. The major producers are algae in the oceans, plants on land, and bacteria at hydrothermal vents. Plants and algae use the energy in sunlight to produce food by photosynthesis. Bacteria at hydrothermal vents use the energy in chemicals to produce food by chemosynthesis.

All other organisms in an ecosystem are consumers. Consumers are organisms that obtain food energy by consuming other organisms. There are many different types of consumers. Herbivores are organisms that eat plants or other producers. These organisms break down plants or other producers to get the matter and energy they need. Deer are herbivores. Carnivores are organisms that eat other animals. They may eat herbivores or other carnivores. Lions are carnivores. Omnivores may eat plants and animals as well as fungi, bacteria, and organisms from other kingdoms. Raccoons are omnivores.

The various ways in which organisms obtain food from other living things are called feeding relationships. There are a variety of different feeding relationships. For example, predators such as lions kill and eat prey organisms, such as antelope and zebra. Scavengers eat organisms that are already dead. For example, a hyena might eat the remains of an animal that was killed but not completely consumed by a lion. Decomposers break down dead organisms or the waste products of living organisms. In the process, they return nutrients to the ecosystem. Bacteria and fungi are examples of decomposers.

### Questions

1. Describe the role of producer, and identify major types of producers.
2. What are consumers? List and define three different types of consumers.
3. Compare and contrast predation and scavenging, and give examples of organisms in each type of feeding relationship.
4. How do decomposers obtain food energy? List two examples of decomposers

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## Lesson 18.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Organisms that are producers include
  - a. plants.
  - b. bacteria.
  - c. phytoplankton.
  - d. all of the above
2. Consumers that eat only producers are called
  - a. omnivores.
  - b. carnivores.
  - c. herbivores.
  - d. predators.
3. The first trophic level in an ecosystem is made up only of
  - a. primary consumers.
  - b. producers.
  - c. herbivores.
  - d. two of the above
4. Organisms that can interbreed and produce fertile offspring belong to the same
  - a. species.
  - b. population.
  - c. community.
  - d. ecosystem.
5. Abiotic factors in a forest ecosystem include
  - a. trees.
  - b. nutrients.
  - c. sunlight.
  - d. two of the above
6. Organisms that break down dead organisms and return the nutrients to the ecosystem are classified as

- a. prey.
  - b. predators.
  - c. scavengers.
  - d. decomposers.
7. What percentage of energy at one trophic level is available to the next higher trophic level?
- a. 10 percent
  - b. 25 percent
  - c. 50 percent
  - d. 90 percent

---

## Lesson 18.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. relationship between species that try to use the same resources
- \_\_\_\_\_ 2. way a species makes a living
- \_\_\_\_\_ 3. relationship between species in which one species benefits and the other species is not harmed
- \_\_\_\_\_ 4. place where an organism lives
- \_\_\_\_\_ 5. relationship between species in which both species benefit
- \_\_\_\_\_ 6. any relationship between species in which at least one species benefits
- \_\_\_\_\_ 7. relationship between species in which one species benefits and the other species is harmed

### Terms

- a. commensalism
- b. competition
- c. habitat
- d. mutualism
- e. niche
- f. parasitism
- g. symbiosis

---

## Lesson 18.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. A(n) \_\_\_\_\_ consists of all the living things in an area together with the nonliving things that they need.
- 2. All the individuals of a single species that live together at a given place and time make up a(n) \_\_\_\_\_.
- 3. All the populations living together in the same area make up a(n) \_\_\_\_\_.

4. \_\_\_\_\_ factors are all the living organisms in an ecosystem.
5. \_\_\_\_\_ factors are all the nonliving components of an ecosystem.
6. Any organism that makes its own food is called a(n) \_\_\_\_\_.
7. Any organism that obtains its food from other organisms is called a(n) \_\_\_\_\_.

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### Lesson 18.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

A food chain is a very simple model. What does a food chain represent, and why is it much simpler than reality?

## 18.2 The Carbon Cycle and the Nitrogen Cycle

### Lesson 18.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Carbon is constantly recycled through ecosystems.
- \_\_\_\_\_ 2. Plants take in nitrogen gas in the process of respiration.
- \_\_\_\_\_ 3. Soil is a major reservoir of carbon.
- \_\_\_\_\_ 4. A living forest is a carbon sink.
- \_\_\_\_\_ 5. The carbon dioxide concentration in the atmosphere has leveled off since the year 2000.
- \_\_\_\_\_ 6. Greenhouse gases are like the glass walls and roof of a greenhouse.
- \_\_\_\_\_ 7. Nitrogen is the second most abundant gas in the atmosphere after oxygen.
- \_\_\_\_\_ 8. When organic remains decompose, their nitrogen is released into the atmosphere as nitrogen gas.
- \_\_\_\_\_ 9. Nitrogen from fertilizers prevents bacteria from growing in pond or lake water.
- \_\_\_\_\_ 10. Plants can use nitrogen in the form of nitrates in the soil.

### Lesson 18.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### The Nitrogen Cycle

Nitrogen is vital for life on Earth as an essential component of organic compounds such as amino acids, nucleic acids, and chlorophyll. Nitrogen gas is plentiful in the atmosphere, but plants cannot use nitrogen in the gaseous form. To be useful to plants, nitrogen must be “fixed,” or converted into certain nitrogen compounds. Some nitrogen is fixed by lightning or blue-green algae, but most is fixed by bacteria in soil. Soil bacteria combine nitrogen gas with oxygen or hydrogen and create nitrogen-containing compounds such as ammonia. Nitrogen-fixing bacteria live either freely in the soil or in a symbiotic relationship with leguminous plants (peas, beans, peanuts). The symbiotic bacteria use carbohydrates from the plants to produce ammonia that the plants can use as a source of nitrogen. When the leguminous plants die, their nitrogen compounds are returned to the soil, where other plants can use them.

Animals obtain nitrogen by eating plants. They use the nitrogen to grow animal tissues. After a plant or animal dies or produces wastes, bacteria and fungi in the soil fix the organic nitrogen in the remains or wastes and return it to the soil as ammonia. Nitrifying bacteria oxidize the ammonia to nitrites and nitrates, which can be used by the next generation of plants.

When there are few usable nitrogen compounds in soil, this can curtail plant growth. Modern agricultural practices increase plant productivity by adding nitrogen fertilizers to soil. This can have unintended consequences:

- Nitrogen from fertilizers may return to the atmosphere as nitrous oxide or ammonia, both of which may have deleterious effects. Nitrous oxide contributes to the breakdown of the ozone layer, and ammonia contributes to smog and acid rain.
- Excess fertilizers run off the land and end up in ponds, lakes, and coastal areas of the ocean. The nitrogen causes enormous numbers of bacteria and algae to grow. When these organisms die, their decomposition uses up all the available oxygen. Without oxygen, fish and most other organisms cannot survive. On a large scale, this creates an area called a dead zone.

### Questions

1. How is nitrogen fixed, and why is fixing nitrogen important?
2. Explain how the nitrogen in a deceased organism is recycled.
3. Describe two adverse environmental consequences of using nitrogen fertilizers.

---

## Lesson 18.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Compounds that contain carbon include
  - a. calcium carbonate.
  - b. carbon dioxide.
  - c. glucose.
  - d. all of the above
2. The chemical reaction for cellular respiration is represented by the equation
  - a.  $6 \text{ CO}_2 + 6 \text{ H}_2\text{O} + \text{energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{ O}_2$ .
  - b.  $6 \text{ O}_2 + 6 \text{ H}_2\text{O} + \text{energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{ CO}_2$ .
  - c.  $\text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{ O}_2 \rightarrow 6 \text{ CO}_2 + 6 \text{ H}_2\text{O} + \text{energy}$ .
  - d.  $\text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{ H}_2\text{O} \rightarrow 6 \text{ CO}_2 + 6 \text{ O}_2 + \text{energy}$ .
3. Carbon reservoirs include
  - a. forests.
  - b. fossil fuels.
  - c. oceans.
  - d. all of the above
4. Nitrogen may be fixed by
  - a. lightning.
  - b. plants called legumes.
  - c. animals that eat plants.
  - d. all of the above
5. Carbon dioxide is released into the atmosphere in all of the following processes except
  - a. decomposition.
  - b. volcanic eruption.
  - c. cellular respiration.
  - d. photosynthesis.
6. Anywhere carbon is stored is a carbon

- a. sink.
  - b. source.
  - c. reservoir.
  - d. compound.
7. Processes involved in the long-term cycling of carbon include
- a. photosynthesis.
  - b. respiration.
  - c. carbon fixing.
  - d. sedimentation.

---

## Lesson 18.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. element that is the basis of all life
- \_\_\_\_\_ 2. changing nitrogen gas to a form that plants can use
- \_\_\_\_\_ 3. reservoir where more carbon is stored than released
- \_\_\_\_\_ 4. type of organic compound that includes sugar
- \_\_\_\_\_ 5. changing ammonia to nitrites or nitrates
- \_\_\_\_\_ 6. most abundant gas in the atmosphere
- \_\_\_\_\_ 7. reservoir where more carbon is released than stored

### Terms

- a. carbohydrate
- b. carbon sink
- c. carbon
- d. nitrification
- e. nitrogen
- f. carbon source
- g. nitrogen fixing

---

## Lesson 18.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The process of \_\_\_\_\_ changes inorganic carbon in carbon dioxide to organic carbon in food using energy in sunlight.
- 2. The removal of forests from the landscape is called \_\_\_\_\_.



3. Nitrogen is fixed in the soil by \_\_\_\_\_.
4. The process in question 3 occurs when nitrogen is combined with oxygen or \_\_\_\_\_.
5. By the process of oxidation, nitrites can be changed to \_\_\_\_\_.
6. Nitrous oxides released from fertilizers contribute to the breakdown of the \_\_\_\_\_ layer in the atmosphere.
7. A \_\_\_\_\_ zone results when fish and other larger water organisms die because of lack of oxygen.

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## Lesson 18.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

How do human actions change carbon sinks to carbon sources? How does this affect the environment?

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## 18.3 Human Populations

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### Lesson 18.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. A population has exceeded its carrying capacity if it uses up resources faster than they can be replenished.
  - \_\_\_\_\_ 2. The same factors limit human population growth all over the world.
  - \_\_\_\_\_ 3. The rate at which the human population is growing is still increasing.
  - \_\_\_\_\_ 4. The development of agriculture allowed people to settle down in one place for the first time.
  - \_\_\_\_\_ 5. Subsistence farmers grow only enough food to support their own families.
  - \_\_\_\_\_ 6. Every major advance in agriculture has allowed the global human population to increase.
  - \_\_\_\_\_ 7. Experts agree that the worldwide human population has not yet reached its carrying capacity.
  - \_\_\_\_\_ 8. Modern agricultural practices allow people to produce more food without harming the environment.
  - \_\_\_\_\_ 9. Human actions have increased the rate of species extinctions to at least 100 times the normal rate.
  - \_\_\_\_\_ 10. An important step in achieving sustainable development is to reduce human population growth.
- 

### Lesson 18.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Sustainable Development**

A topic generating a great deal of discussion these days is sustainable development. Sustainable development is any economic development that allows people to escape a life of poverty while conserving resources and protecting the environment. Many different approaches must be adopted to achieve these goals.

One of the most important steps to achieving sustainable development is reducing the rate of human population growth. If there were a smaller number of people, fewer resources would be needed and smaller amounts of pollution and greenhouse gases would be released. One way to slow human population growth is to provide education for girls and women in countries where they typically go without education. Studies have shown that as women become educated, they tend to have fewer children.

Advances in science and technology are likely to be an important part of sustainable development. If scientists had a better understanding of how Earth's natural systems work, they would also have a better understanding of how people are affecting them. Technologies could also be developed to help solve problems created by overpopulation and overuse of resources. An example of a technology that could aid sustainable development is fish farming, as long as it is done in environmentally sound ways. Raising fish on farms rather than relying solely on wild fish could reduce the risk of overharvesting wild fish populations. Another example is the development of cleaner energy

sources that would reduce pollution and greenhouse gas emissions.

Individuals can also play a role in achieving sustainable development. This applies primarily to people in the developed nations. They could change their behavior to reduce the impact they have on the planet. They could consume only what they need and avoid wasting resources. They could also try to limit their purchases to products that are produced sustainably. For example, they could choose to purchase wood products only from companies that plant new trees to replace those that are cut down.

### Questions

1. What is sustainable development?
2. How would reducing the rate of human population growth help achieve sustainable development? Why does education play a role in slowing population growth?
3. Give examples of technologies could help reduce resource depletion or harm to the environment.
4. What can individuals do to promote sustainable development?

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## Lesson 18.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Generally, when a population reaches its carrying capacity, the population
  - a. stops growing.
  - b. expands its habitat.
  - c. quickly goes extinct.
  - d. no longer has limiting factors.
2. Over the past 50 years, the size of the human population
  - a. stayed about the same.
  - b. increased by 1 billion.
  - c. more than doubled.
  - d. none of the above
3. Human beings developed the ability to grow their own food about
  - a. 200 years ago.
  - b. 2000 years ago.
  - c. 10,000 years ago.
  - d. 2 million years ago.
4. The Green Revolution increased agricultural productivity by
  - a. improving crops.
  - b. increasing access to water.
  - c. expanding use of chemical pesticides.
  - d. all of the above
5. What percentage of Earth's ice-free lands have been converted to human uses?
  - a. 90 percent
  - b. 50 percent
  - c. 30 percent
  - d. 20 percent
6. Goals of sustainable development include

- a. protecting the environment.
  - b. helping people get out of poverty.
  - c. using resources only as quickly as they are replaced.
  - d. all of the above
7. Which of the following statements about carrying capacity is (are) true?
- a. The carrying capacity of a population never changes.
  - b. The carrying capacity is the same for all populations in a habitat.
  - c. The carrying capacity depends on biotic and abiotic factors.
  - d. all of the above

---

### Lesson 18.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. factor that determines the carrying capacity for a species
- \_\_\_\_\_ 2. chemical used to kill organisms that harm plants
- \_\_\_\_\_ 3. use of more resources than needed or than can be sustained in the long term
- \_\_\_\_\_ 4. use of resources in ways that do not deplete them or harm the environment
- \_\_\_\_\_ 5. maximum population size of a species that a habitat can support
- \_\_\_\_\_ 6. organism that moves into a new environment where it may harm native species
- \_\_\_\_\_ 7. situation in which a population exceeds its carrying capacity

#### Terms

- a. carrying capacity
- b. limiting factor
- c. invasive species
- d. overpopulation
- e. over-consumption
- f. sustainable development
- g. pesticide

---

### Lesson 18.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. During the \_\_\_\_\_ Revolution, products were first mass produced and fossil fuels were first widely used for power.

2. The \_\_\_\_\_ Revolution was a dramatic increase in agricultural productivity that occurred in the 20th century.
3. A population grows when the number of births is \_\_\_\_\_ than the number of deaths.
4. Factors that may limit population growth include \_\_\_\_\_ factors such as water.
5. A population generally stops growing when it reaches the size called the \_\_\_\_\_.
6. The current global human population size is about \_\_\_\_\_ billion people.
7. Species ordinarily produce \_\_\_\_\_ offspring than their habitat can support.

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### Lesson 18.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Do you think that the global human population has reached its carrying capacity? Why or why not?

## CHAPTER

**19****HS Human Actions and the  
Land Worksheets****Chapter Outline**

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**19.1 LOSS OF SOILS****19.2 POLLUTION OF THE LAND**

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- Lesson 19.1: Loss of Soils
- Lesson 19.2: Pollution of the Land

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## 19.1 Loss of Soils

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### Lesson 19.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Soil loss can permanently degrade farmland.
- \_\_\_\_\_ 2. The natural vegetation of prairies is deciduous forests.
- \_\_\_\_\_ 3. The “black blizzards” of the Dust Bowl were mid-latitude snowstorms.
- \_\_\_\_\_ 4. Human activities can greatly increase the rate of soil erosion.
- \_\_\_\_\_ 5. The agents of soil erosion are different from the agents of other erosion.
- \_\_\_\_\_ 6. Most of the best land for farming has not yet been cultivated.
- \_\_\_\_\_ 7. The rate of topsoil loss is currently greater in developing than developed nations.
- \_\_\_\_\_ 8. Hills are especially prone to erosion.
- \_\_\_\_\_ 9. Parking lots with special permeable pavement can reduce runoff and erosion.
- \_\_\_\_\_ 10. Soil erosion is a natural process.

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### Lesson 19.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Causes of Soil Erosion

The agents of soil erosion, like other types of erosion, include water, wind, ice, and gravity. Running water is the leading cause of soil erosion, because water is abundant and has a lot of power. Wind is another important cause, because wind can pick up fine particles of soil and carry them long distances. Soil erosion is as natural as any other type of erosion, but human activities have greatly accelerated soil erosion. Any activities that remove vegetation, disturb the soil, or allow the soil to dry out are likely to increase the rate of soil erosion. Such activities include farming, livestock grazing, logging, mining, construction, and recreation.

- Farming is the most significant activity that accelerates soil erosion because of the amount of land that is farmed and how greatly farming disturbs the soil. If farmers use traditional farming methods, they remove native vegetation and plow the soil before planting. Because most crops grow only in spring and summer, the soil is left bare and exposed during the rest of the year.
- Grazing animals expose soil by eating the plant cover. They also disturb the ground with their sharp hooves. If too many animals graze the same area, it becomes overgrazed and subject to serious erosion.
- Logging removes trees that protect the ground from soil erosion. Tree roots hold soil, tree canopy protects soil from hard rain, and dead leaves cover the forest floor and protect the soil. Heavy logging equipment

contributes to soil erosion by wearing down vegetation and disturbing the soil.

- Surface mining removes ground cover and disturbs the soil, leaving it vulnerable to erosion.
- Construction of buildings and roads churns up the ground and exposes soil to erosion. Paved areas such as parking lots also contribute to erosion by not allowing rain to soak into the ground, thereby increasing runoff.
- Recreational activities may accelerate soil erosion. Off-road vehicles kill plants and make ruts in soil. In some delicate habitats, even hikers' boots can leave the ground bare and exposed to agents of erosion.

## Questions

1. What are natural agents of soil erosion?
2. Identify human activities that are likely to increase the rate of soil erosion.
3. Why is farming the most significant activity that accelerates soil erosion?

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## Lesson 19.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Causes of the Dust Bowl include
  - a. farming practices.
  - b. mining activities.
  - c. overgrazing.
  - d. logging.
2. Some of the topsoil from the Dust Bowl was carried to
  - a. southern California.
  - b. Washington State.
  - c. the East Coast.
  - d. all of the above
3. Human actions that increase soil erosion are those that
  - a. remove vegetation.
  - b. disturb the soil.
  - c. allow the soil to dry out.
  - d. all of the above
4. Which percentage of topsoil has been lost in the U.S. since Europeans first arrived?
  - a. 99 percent
  - b. 66 percent
  - c. 33 percent
  - d. 1 percent
5. Which statement about soil is true?
  - a. Soil sustains natural habitats.
  - b. Soil is a nonrenewable resource.
  - c. Soil is needed only for agriculture.
  - d. Soil loss is due solely to human actions.
6. How do trees help protect soil from erosion?
  - a. Their roots hold soil in place.



- b. Their canopy shields soil from hard rain.
  - c. Their fallen leaves cover soil.
  - d. all of the above
7. Soil erosion could be reduced on a construction site by
- a. building on a steep hill.
  - b. landscaping with plants.
  - c. paving all the bare ground.
  - d. two of the above

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## Lesson 19.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. primary agent of Dust Bowl erosion
- \_\_\_\_\_ 2. leading agent of soil erosion
- \_\_\_\_\_ 3. plants grown in the winter to hold the soil in place
- \_\_\_\_\_ 4. major human activity that accelerates soil erosion
- \_\_\_\_\_ 5. area of severe soil erosion in the U.S. in the 1930s
- \_\_\_\_\_ 6. layer of soil most likely to be eroded
- \_\_\_\_\_ 7. layer of organic debris on the forest floor

### Terms

- a. Dust Bowl
- b. leaf litter
- c. agriculture
- d. wind
- e. running water
- f. cover crop
- g. topsoil

---

## Lesson 19.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Prior to World War I, the soil of the Great Plains was naturally held in place by \_\_\_\_\_.
- 2. Agents of soil erosion include water, wind, ice, and \_\_\_\_\_.
- 3. In \_\_\_\_\_ agriculture, forests are cut and burned to make way for agriculture.
- 4. \_\_\_\_\_ exposes soil to erosion when too many livestock are kept in a given area.

5. Paved parking lots generally speed up soil erosion from nearby land by increasing \_\_\_\_\_.
6. The rate of topsoil loss in the U.S. has \_\_\_\_\_ recently.
7. To reduce soil erosion, you should use \_\_\_\_\_ irrigation instead of sprinklers.

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### Lesson 19.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Describe the Dust Bowl, and explain what it taught us about protecting the soil.

## 19.2 Pollution of the Land

### Lesson 19.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Hazardous chemicals in Love Canal were cleaned up before they made people sick.
- \_\_\_\_\_ 2. Hazardous wastes include medical wastes and agricultural chemicals.
- \_\_\_\_\_ 3. The effects of contamination at Love Canal included higher-than-normal rates of miscarriages.
- \_\_\_\_\_ 4. Every case of cancer should be investigated for possible toxic waste contamination.
- \_\_\_\_\_ 5. Lead is no longer considered to be toxic to human beings.
- \_\_\_\_\_ 6. Nations that have more industry produce more hazardous waste.
- \_\_\_\_\_ 7. Love Canal was designated as a Superfund site in the 1960s.
- \_\_\_\_\_ 8. The greatest concentration of Superfund sites is in the northeastern U.S.
- \_\_\_\_\_ 9. By law, companies now must keep records showing how they have disposed of any hazardous wastes.
- \_\_\_\_\_ 10. The safest way to dispose of household hazardous wastes is down the toilet.

### Lesson 19.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **Hazardous Waste and Its Effects**

Hazardous waste is any waste material that is dangerous to human health or that degrades the environment. Hazardous wastes include substances that are toxic, chemically active, corrosive, or flammable. Many different types of materials are hazardous, and there are many possible sources of hazardous wastes. Most households, for example, have substances that could become hazardous wastes if not stored and disposed of properly. These include cleaning chemicals such as drain cleaners and lawn chemicals such as herbicides. Other common sources of hazardous wastes include automotive chemicals such as motor oil and brake fluid, batteries, medical wastes, paints, dry cleaning chemicals, and agricultural chemicals such as fertilizers and pesticides.

Exposure to hazardous wastes may cause illness or even death in people or other organisms. The chemical wastes at Love Canal, for example, caused high rates of cancer in children and higher-than-normal numbers of miscarriages and birth defects. Fetuses, infants, and young children are more susceptible to damage by hazardous wastes because they are growing rapidly. Therefore, for their size, they tend to take in more of the toxic chemicals. However, it is important to realize that just one person with cancer is not enough to suspect contamination by hazardous wastes. Cancer occurs fairly often and has many possible causes. Contamination is suggested by more than the normal number of cancers in a particular area. This is called a cancer cluster. The presence of a cancer cluster was how groundwater contamination was discovered in Woburn, Massachusetts. High rates of childhood leukemia and

certain other illnesses were diagnosed in children in this community. As a result of concern by parents, well water was analyzed and shown to have high levels of a toxic chemical called trichloroethylene.

Two other chemicals that are especially toxic to humans are lead and mercury. Lead was once a common ingredient in gasoline and paint, but it was banned for these uses after it was shown to damage the human nervous system, especially in young children. Mercury is produced naturally in volcanic eruptions. Other sources of mercury are batteries, electronics, and the burning of coal. Like exposure to lead, exposure to mercury damages the human nervous system.

### Questions

1. What is hazardous waste? What are some examples?
2. Identify health problems commonly associated with exposure to hazardous wastes.
3. Why is a single cancer case not enough to suspect contamination by hazardous wastes?

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## Lesson 19.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Hazardous wastes include substances that are
  - a. toxic.
  - b. corrosive.
  - c. flammable.
  - d. any of the above
2. The hazardous waste problem discovered in Woburn, Massachusetts, involved contamination of
  - a. air.
  - b. soil.
  - c. streams.
  - d. groundwater.
3. Which age group is generally most susceptible to the ill effects of hazardous chemicals?
  - a. infants
  - b. adolescents
  - c. young adults
  - d. middle-aged adults
4. The Superfund Act established a trust fund to clean up hazardous waste sites for which a responsible company could not be identified. Money for the trust fund comes from
  - a. taxpayers.
  - b. fines paid by polluters.
  - c. city and state governments.
  - d. petroleum and chemical industries.
5. At Love Canal, a school and many homes were built on soil that covered
  - a. an old petroleum refinery.
  - b. an abandoned chemical mine.
  - c. barrels full of used car batteries.
  - d. steel drums of hazardous chemicals.
6. The problem of Love Canal was finally addressed when

- a. government surveys discovered high cancer rates in residents.
  - b. local residents organized and demanded government action.
  - c. the responsible company volunteered to clean up the area.
  - d. the Resource Conservation and Recovery Act was passed.
7. Hazardous items commonly found in households include
- a. batteries.
  - b. herbicides.
  - c. paints.
  - d. all of the above

---

## Lesson 19.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. any waste material that is dangerous to human health or that degrades the environment
- \_\_\_\_\_ 2. U.S. law requiring companies to keep track and properly dispose of any hazardous materials they produce
- \_\_\_\_\_ 3. hazardous element that was previously added to paints and gasoline
- \_\_\_\_\_ 4. having the ability to destroy other things by chemical reactions
- \_\_\_\_\_ 5. U.S. law requiring companies to pay to clean up sites they have polluted with hazardous wastes
- \_\_\_\_\_ 6. hazardous element that is released in volcanic eruptions and the burning of coal
- \_\_\_\_\_ 7. having the ability to easily catch fire

### Terms

- a. Superfund Act
- b. flammable
- c. Resource Conservation and Recovery Act
- d. corrosive
- e. lead
- f. hazardous waste
- g. mercury

---

## Lesson 19.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. \_\_\_\_\_ is an abandoned waterway in Niagara Falls, New York, that was contaminated in the 1950s by toxic chemicals.
2. The site described in question 1 was instrumental in the passage of the \_\_\_\_\_ Act in 1980.

3. Toxic chemicals called \_\_\_\_\_ are used to kill organisms that attack plants.
4. A \_\_\_\_\_ is a group of higher-than-average cancer rates in a particular area.
5. Both lead and mercury can cause damage to the human \_\_\_\_\_ system.
6. Currently, the nation that is the world's largest producer of hazardous wastes is the \_\_\_\_\_.
7. Contaminated sites that must be cleaned up per the Superfund Act are designated as \_\_\_\_\_ sites.

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### Lesson 19.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Summarize the story of Love Canal and how it led to passage of the Superfund Act of 1980.

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CHAPTER

**20**

# HS Human Actions and Earth's Resources Worksheets

## Chapter Outline

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**20.1**    **USE AND CONSERVATION OF RESOURCES**

**20.2**    **ENERGY CONSERVATION**

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- Lesson 20.1: Use and Conservation of Resources
- Lesson 20.2: Energy Conservation

## 20.1 Use and Conservation of Resources

### Lesson 20.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. All renewable natural resources are living things.
- \_\_\_\_\_ 2. Plant nutrients may be lost from soil because of air pollution.
- \_\_\_\_\_ 3. Forests may be either renewable or non-renewable resources.
- \_\_\_\_\_ 4. Fossil fuels can be renewable resources if we conserve them.
- \_\_\_\_\_ 5. Electricity can be generated only from non-renewable resources.
- \_\_\_\_\_ 6. Non-renewable resources may be very abundant or very rare.
- \_\_\_\_\_ 7. Nearly 80 percent of the world's oil is found in Japan, China, and the U.S.
- \_\_\_\_\_ 8. Much of the electronic waste from the U.S. ends up in developing countries.
- \_\_\_\_\_ 9. More natural resources are wasted in developing than developed countries.
- \_\_\_\_\_ 10. Recycling is the only way to conserve non-renewable natural resources.

### Lesson 20.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Resource Availability

Many of the resources we depend on are non-renewable. Non-renewable resources vary in their availability. Some are very abundant, whereas others are very rare. Resources such as gravel and sand are technically non-renewable but are so abundant that running out is not an issue. Other resources are truly limited in quantity, including many minerals. When they are gone, they are gone, and something must be found to replace them. Some non-renewable resources, such as diamonds and rubies, are costly in part because they are very rare.

Besides abundance, the cost of a resource is determined by how easy it is to locate and extract. If a resource is difficult to find or obtain, it may go unused unless there are no other cheaper alternatives. For example, the oceans are filled with an abundant supply of water, but removing salt from ocean water (desalination) is very costly, so this source of water mainly goes unused. However, if the cost of desalination were to decrease, more ocean water would likely be used.

Politics may also affect resource availability and cost. Nations that have a desired resource in abundance will often export that resource to other countries. Countries that need the resource must import it from one of the countries that produces it. This situation is a potential source of political conflict. Oil is a good example of this. Only 11 countries have nearly 80 percent of all of the world's oil. They are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya,



Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela. However, the biggest users of oil are the United States, China, and Japan. This leads to a situation in which the availability and price of oil is determined largely by oil-producing countries, which have their own interests to look out for. They may raise the price of oil for reasons that have nothing to do with the cost of obtaining it. Wars may even be fought over oil or other resources that are not evenly distributed.

### Questions

1. Describe variability in the abundance of non-renewable resources.
2. Besides abundance, what factors determine the cost of natural resources?
3. Which countries have the most oil reserves, and which countries use the most oil? Why is this situation a potential source of political conflict?

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## Lesson 20.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Forests are natural resources that may be used for
  - a. timber.
  - b. habitat.
  - c. recreation.
  - d. all of the above
2. Examples of potentially renewable resources include all of the following except
  - a. soil.
  - b. water.
  - c. wildlife.
  - d. fossil fuels.
3. Which of the following items is made only from renewable resources?
  - a. cotton tee shirt
  - b. bottled water
  - c. wood house
  - d. cell phone
4. The cost of non-renewable resources depends on how
  - a. abundant they are.
  - b. easy it is to find them.
  - c. difficult it is to extract them.
  - d. all of the above
5. The biggest users of oil in the world include
  - a. the United Arab Emirates.
  - b. the United States.
  - c. Saudi Arabia.
  - d. all of the above
6. Electronic wastes such as old computers
  - a. are hazardous wastes.
  - b. contain only harmless materials.

- c. can be disposed of safely in landfills.
  - d. two of the above
7. Which of the following non-renewable resources is least likely to run out?
- a. coal
  - b. gravel
  - c. diamond
  - d. petroleum

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## Lesson 20.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. any natural resource that is limitless or can be regenerated as quickly as it is used
- \_\_\_\_\_ 2. to obtain a resource or other product from another country
- \_\_\_\_\_ 3. trees that are cut for wood to use for building or other purposes
- \_\_\_\_\_ 4. anything useful to people that comes from the natural environment
- \_\_\_\_\_ 5. to reduce the use of a natural resource so it will last longer
- \_\_\_\_\_ 6. any natural resource that cannot be regenerated at all or not as quickly as it is used
- \_\_\_\_\_ 7. to send a resource or other product to another country

### Terms

- a. timber
- b. conserve
- c. renewable resource
- d. non-renewable resource
- e. export
- f. natural resource
- g. import

---

## Lesson 20.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. When we practice \_\_\_\_\_, we make sure that natural resources will be available in the future.
- 2. Natural resources are usually classified as either renewable or \_\_\_\_\_.
- 3. A forest is an example of a(n) \_\_\_\_\_ resource if it is used wisely.
- 4. Minerals are examples of \_\_\_\_\_ resources.
- 5. \_\_\_\_\_ is the use of more resources than people actually need.

6. Discarded materials produce \_\_\_\_\_ that degrades the environment.
7. \_\_\_\_\_ is the process of collecting and processing of used materials and turning them into new products.

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## Lesson 20.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

For many natural resources, the categories of renewable and non-renewable are not completely separate. Instead, they are more like two ends of a continuum. Explain why, and illustrate your answer with examples.

## 20.2 Energy Conservation

### Lesson 20.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. We must use energy to get energy from fossil fuels.
- \_\_\_\_\_ 2. Drilling for oil far from shore is more expensive than drilling close to shore.
- \_\_\_\_\_ 3. If the net-energy ratio is less than one, it takes less energy to get an energy resource than the resource provides.
- \_\_\_\_\_ 4. No energy is used to obtain solar energy.
- \_\_\_\_\_ 5. The net-energy ratio of coal varies depending on the cost of transporting it.
- \_\_\_\_\_ 6. Boats are a less energy-efficient means of transportation than airplanes.
- \_\_\_\_\_ 7. A light bulb that gives off less heat is more energy efficient than one that gives off more heat.
- \_\_\_\_\_ 8. Less than half the energy used in the United States is used for transportation and residential uses.
- \_\_\_\_\_ 9. You generally can conserve energy by driving a smaller car.
- \_\_\_\_\_ 10. Using fans rather than air conditioners saves energy.

### Lesson 20.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Obtaining Energy

Net energy is the amount of useable energy available from a resource after subtracting the amount of energy needed to make it available. For example, for every five barrels of oil that are made available for use, it requires one barrel for extracting and refining the petroleum. Therefore, the net energy available is only four barrels. The energy needed to obtain an energy resource increases when the easy deposits of that resource have already been consumed. For example, if all the near-shore petroleum in a region has been extracted, more costly drilling must take place farther offshore. If the energy cost of obtaining energy increases, the resource will be used even faster because a larger share of the energy obtained is used to obtain it.

The ratio of energy obtained to the energy needed to obtain it is called the net-energy ratio. For example, if it takes 2 units of energy to make available 10 units of energy, then the net-energy ratio is  $10/2$  or 5.0. A net-energy ratio larger than 1 means that there is a net gain in usable energy. A net-energy ratio smaller than one means there is an overall energy loss. Solar energy has a relatively high net-energy ratio of 5.8. For natural gas, the net-energy ratio is 4.9, and for petroleum it is 4.5. Coal has a range of net-energy values, from 2.5 to 5.1, because of differing costs of transporting coal. Solar energy yields more net energy than fossil fuel sources because sunshine is abundant and does not need to be located, extracted, or transported very far.

**Questions**

1. What is net energy? How is it calculated?
2. Define net-energy ratio, and give an example.
3. Why does solar energy have a higher net-energy ratio than fossil fuels do?

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**Lesson 20.2: Multiple Choice**

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. To obtain useable energy, energy is generally needed to
  - a. find an energy source.
  - b. extract the energy.
  - c. transport the energy.
  - d. all of the above
2. For every five barrels of oil that are obtained, about how many barrels of oil are needed to obtain them?
  - a. one
  - b. two
  - c. three
  - d. four
3. If it takes 10 units of energy to make available 12 units of energy, what is the net-energy ratio?
  - a. 0.83
  - b. 1.00
  - c. 1.20
  - d. 1.33
4. Which use of energy in the United States accounts for 17 percent of the total energy used?
  - a. transportation
  - b. residential
  - c. commercial
  - d. industrial
5. Outcomes of energy conservation include
  - a. higher energy costs.
  - b. longer lasting resources.
  - c. greater environmental impacts.
  - d. all of the above
6. If all the near-shore petroleum in a region has been extracted, drilling must take place further offshore. How does this affect the energy resource?
  - a. Its net-energy ratio will increase.
  - b. It will be more costly to obtain.
  - c. It will be used more quickly.
  - d. two of the above

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## Lesson 20.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. amount of useful work done by a unit of energy
- \_\_\_\_\_ 2. saving energy by using less of it or using it more efficiently
- \_\_\_\_\_ 3. amount of useable energy available from an energy resource
- \_\_\_\_\_ 4. less energy-efficient type of light bulb
- \_\_\_\_\_ 5. amount of useable energy in a resource divided by the amount of energy needed to obtain it
- \_\_\_\_\_ 6. more energy-efficient type of light bulb

### Terms

- a. energy efficiency
- b. net-energy ratio
- c. energy conservation
- d. net energy
- e. compact fluorescent light bulb
- f. incandescent light bulb

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## Lesson 20.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. There is a net gain in useable energy if the net-energy ratio is greater than \_\_\_\_\_.
- 2. Solar energy has net-energy ratio that is \_\_\_\_\_ than the net-energy ratio of natural gas.
- 3. In any energy transfer, some energy is nearly always lost as \_\_\_\_\_.
- 4. Transportation by car is \_\_\_\_\_ energy efficient than transportation by train.
- 5. Halogen light bulbs are \_\_\_\_\_ energy efficient than incandescent light bulbs.
- 6. The single greatest use of energy in the United States is for \_\_\_\_\_.

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## Lesson 20.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain what energy efficiency means and how using energy-efficient devices conserves energy.

## CHAPTER

## 21

# HS Human Actions and Earth's Water Worksheets

## Chapter Outline

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- 21.1 HUMANS AND THE WATER SUPPLY
  - 21.2 PROBLEMS WITH WATER DISTRIBUTION
  - 21.3 WATER POLLUTION
  - 21.4 PROTECTING THE WATER SUPPLY
- 

- Lesson 21.1: Humans and the Water Supply
- Lesson 21.2: Problems with Water Distribution
- Lesson 21.3: Water Pollution
- Lesson 21.4: Protecting the Water Supply

## 21.1 Humans and the Water Supply

### Lesson 21.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. All forms of life on Earth depend on water for survival.
- \_\_\_\_\_ 2. You can live longer without water than you can without food.
- \_\_\_\_\_ 3. Everywhere in the world, people use more water for irrigation than for any other single purpose.
- \_\_\_\_\_ 4. Water that goes down the drain in most homes is lost from the ecosystem.
- \_\_\_\_\_ 5. There is so much water on Earth that there is no need to recycle it.
- \_\_\_\_\_ 6. Using overhead sprinklers for irrigation is a consumptive use of water.
- \_\_\_\_\_ 7. Some of the world's farmers still grow crops without irrigation.
- \_\_\_\_\_ 8. A drip irrigation system is less expensive to install than an overhead sprinkler system.
- \_\_\_\_\_ 9. Raising some species by aquaculture can cause environmental problems.
- \_\_\_\_\_ 10. Most environmental uses of water are consumptive uses.

### Lesson 21.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Using Water for Irrigation

Agriculture is the single greatest use of water worldwide, and most of the water used in agriculture is used to irrigate fields of crops. Common irrigation methods include:

- sprinkler irrigation, in which water is sprayed onto the fields from overhead.
- trench irrigation, in which canals carry water from a water source to the fields and through the fields along rows of crops.
- flood irrigation, in which water is allowed to flow over the fields, like flood water of a river overflowing its floodplain.

All three of these irrigation methods waste water. More than a third of the water may never reach the crops because it evaporates or runs off the fields. Water that runs off a field often carries valuable soil with it.

A much more efficient way to water crops is by drip irrigation. With drip irrigation, pipes and tubes deliver small amounts of water directly to the soil at the roots of each plant. The water is not sprayed into the air or allowed to run over the ground so nearly all of it goes directly into the soil near plant roots. Very little water is lost to evaporation or runoff. However, drip irrigation systems are relatively expensive to install and maintain, so they are



not used as widely as they could be. Where farmers do not have to pay the full cost of their water use, they may lack financial incentives to use less water. In these situations, farmers may not be motivated to install more expensive drip irrigation systems.

### Questions

1. Identify three common irrigation methods that waste water. Why do these methods waste water?
2. What is drip irrigation? What are its pros and cons relative to the irrigation methods you identified in answer 1?
3. What might be ways to motivate farmers to use more water-efficient irrigation systems?

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## Lesson 21.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. What percentage of water use is environmental use?
  - a. 1 percent
  - b. 15 percent
  - c. 28 percent
  - d. 50 percent
2. Which use of water is greatest in the Americas?
  - a. agricultural use
  - b. municipal use
  - c. industrial use
  - d. personal use
3. Municipal uses of water include
  - a. drinking.
  - b. lawn watering.
  - c. clothes washing.
  - d. all of the above
4. Non-consumptive uses of water include
  - a. swimming.
  - b. flood irrigation.
  - c. trench irrigation.
  - d. two of the above
5. Power plants use water for
  - a. cooling.
  - b. making steam.
  - c. dissolving wastes.
  - d. processing chemicals.
6. Flushing a toilet is a
  - a. non-consumptive use of water.
  - b. consumptive use of water.
  - c. municipal use of water.
  - d. two of the above

7. Industrial water use makes up the greatest percentage of water use in
- Asia.
  - Africa.
  - Oceania.
  - Europe.

---

## Lesson 21.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. irrigation method in which water is sprayed on the fields from overhead
- \_\_\_\_\_ 2. use of water for power plants, oil refineries, and manufacturing
- \_\_\_\_\_ 3. irrigation method in which water flows over the fields
- \_\_\_\_\_ 4. use of water in a way that keeps it in the ecosystem
- \_\_\_\_\_ 5. farming to raise fish or other water organisms
- \_\_\_\_\_ 6. use of water in a way that removes it from the ecosystem
- \_\_\_\_\_ 7. irrigation method in which drops of water are applied directly to the soil

### Terms

- aquaculture
- consumptive use
- drip irrigation
- non-consumptive use
- sprinkler irrigation
- flood irrigation
- industrial use

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## Lesson 21.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- The single largest use of water worldwide is for \_\_\_\_\_.
- The least wasteful method of irrigation is \_\_\_\_\_ irrigation.
- A greater percentage of water is used for agriculture in \_\_\_\_\_ than any other continent.
- \_\_\_\_\_ use of water includes water that is recycled and reused.
- In \_\_\_\_\_ irrigation, canals carry water from the source to the fields.
- Raising algae in ponds is an example of a type of farming called \_\_\_\_\_.
- Less than \_\_\_\_\_ percent of all the water we use is used for recreation.

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## Lesson 21.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast consumptive and non-consumptive uses of water, and give an example of each type of water use.

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## 21.2 Problems with Water Distribution

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### Lesson 21.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. All people have access to enough water but not necessarily to clean water.
- \_\_\_\_\_ 2. People in more developed countries use a smaller proportion of the world's water than people in less developed countries.
- \_\_\_\_\_ 3. Water scarcity is likely to become a less important problem in the near future.
- \_\_\_\_\_ 4. Much of northern Africa receives too little rain to supply the population with enough water.
- \_\_\_\_\_ 5. People in some other countries use less water in a year than people in the U.S. use in a day.
- \_\_\_\_\_ 6. Many people in the world have no choice but to drink polluted water.
- \_\_\_\_\_ 7. Disease-causing agents in water may include bacteria, toxic chemicals, and parasites.
- \_\_\_\_\_ 8. Millions of people use the Ganges River for both drinking and bathing.
- \_\_\_\_\_ 9. Only people under age five ever die from drinking unsafe water.
- \_\_\_\_\_ 10. Water resources are not yet scarce enough to causes international disputes.

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### Lesson 21.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### **World Water Distribution and Supply**

Fresh water that people can use is distributed unevenly around the world. Large portions of the world receive very little water from rainfall or rivers. This includes much of northern Africa and central Asia. Even areas that normally receive enough rain may periodically receive too little. If an area receives lower-than-normal levels of rain for several months or a year, a drought may occur. During a drought, there is not enough water to meet all the needs of the people. Human activities can contribute to the frequency and duration of droughts. For example, deforestation keeps trees from returning water to the atmosphere by transpiration. This decreases the amount of water vapor in the air and the potential for clouds to form and precipitation to fall.

Global warming is changing worldwide patterns of rainfall and water distribution. As the planet warms, regions that currently receive an adequate supply of rain may receive less. Regions that rely on snowmelt for water may find that there is less snow and that it melts earlier and faster in the spring. Water from the melted snow may run off and not be available through the dry summers.

Over time, as global temperatures increase and human populations grow, there will be less water per person. Scientists predict that by the year 2025, nearly half of the world's people will not have enough water to meet their

daily needs. Nearly one-quarter of the world's people will have less than 500 m<sup>3</sup> of water to use in an entire year. That's less water than some people in the United States currently use in a single day! As water supplies become scarcer, more conflicts will arise between nations that have enough clean water and those that do not. As with energy resources today, wars are likely to erupt in the future over limited water resources.

### Questions

1. How is water distributed around the world?
2. What are droughts? How can human actions make droughts more likely?
3. Relate global warming to the world water supply.
4. Why are future conflicts over water likely to occur?

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## Lesson 21.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Compared with the amount of water humans used 100 years ago, today humans use about
  - a. two times as much.
  - b. three times as much.
  - c. six times as much.
  - d. ten times as much.
2. Reasons why water scarcity will become a bigger problem in the future include
  - a. continued global warming.
  - b. larger human population.
  - c. greater pollution of water sources.
  - d. all of the above
3. Which statement(s) about the worldwide distribution of water is (are) true?
  - a. Useable water resources are very evenly distributed around the planet.
  - b. Large areas of the world receive very little water from rainfall or rivers.
  - c. Water resources are well matched to human population size worldwide.
  - d. all of the above
4. How many people worldwide currently lack access to safe drinking water?
  - a. approximately 1.1 million
  - b. fewer than 0.5 million
  - c. more than 1.1 billion
  - d. about 0.5 billion
5. Of all cases of disease, about what percentage are caused by drinking unsafe water?
  - a. 28 percent
  - b. 48 percent
  - c. 68 percent
  - d. 88 percent
6. Possible consequences of water scarcity include
  - a. livestock dying.
  - b. development halting.
  - c. human hunger increasing.

- d. all of the above
7. According to the United Nations, water scarcity
- is a problem for only a few populations worldwide.
  - is a problem that is improving worldwide.
  - is a worldwide crisis.
  - none of the above

---

## Lesson 21.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. disease-causing organism
- \_\_\_\_\_ 2. example of a waterborne disease
- \_\_\_\_\_ 3. period of lower-than-normal rainfall that creates or worsens water scarcity
- \_\_\_\_\_ 4. periodic or chronic shortage of water
- \_\_\_\_\_ 5. any disease caused by unsafe drinking water
- \_\_\_\_\_ 6. general cause of changing patterns of rainfall and water distribution
- \_\_\_\_\_ 7. human action that decreases the amount of water entering the atmosphere

### Terms

- drought
- water scarcity
- waterborne disease
- pathogen
- global warming
- deforestation
- cholera

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## Lesson 21.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- By 2025, scientists predict that nearly \_\_\_\_\_ percent of the world's people will not have enough water.
- Deforestation has a major impact on the \_\_\_\_\_ cycle.
- \_\_\_\_\_ diseases, which are caused by unsafe drinking water, are the leading causes of death of young children in many nations.
- Dracunculiasis is a disease caused by drinking water containing \_\_\_\_\_ of the guinea worm.
- One way to avoid contaminated surface waters is to drill \_\_\_\_\_.

6. The Helsinki Rules are international laws regarding rights to \_\_\_\_\_.
7. As safe water becomes scarcer in the future, \_\_\_\_\_ may erupt over water resources just as with energy resources today.

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## Lesson 21.2: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain why water distribution problems include problems with both the quantity and the quality of water.

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## 21.3 Water Pollution

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### Lesson 21.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Diseases caused by polluted water kill millions of people every year.
- \_\_\_\_\_ 2. Water pollution contributes to water shortages by making some water sources unsafe to use.
- \_\_\_\_\_ 3. Water pollution affects human and environmental health only in less developed countries.
- \_\_\_\_\_ 4. Municipal water pollution comes only from households and businesses.
- \_\_\_\_\_ 5. Industrial water pollutants include heavy metals and organic toxins.
- \_\_\_\_\_ 6. All industrial water pollutants come from factories and power plants.
- \_\_\_\_\_ 7. Fertilizers that run off lawns and farm fields are extremely harmful to the environment.
- \_\_\_\_\_ 8. The Mississippi is the only river that causes a dead zone.
- \_\_\_\_\_ 9. Ships at sea empty their wastes directly into ocean water.
- \_\_\_\_\_ 10. The most polluted areas of the ocean are coastal waters.

---

### Lesson 21.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Sources of Water Pollution

Water pollution is any contaminant that gets into lakes, streams, or oceans. Water pollution is a worldwide problem. In less developed countries, the main source of water pollution is raw sewage that is dumped into water that people must use for drinking and bathing. In more developed countries, sources of water pollution include municipal, industrial, and agricultural sources.

- Municipal sources of water pollution come from the wastewater of cities and towns. The wastewater contains many different contaminants from homes and businesses. The contaminants come from inadequately treated sewage, storm drains, septic tanks, boat sewage, and yard runoff, among other sources.
- Industrial pollution comes from factories, power plants, and even hospitals. Some of the most hazardous industrial pollutants include radioactive substances, heavy metals, organic toxins, chemicals, oil and other petroleum products, and heated water.
- Agricultural pollution comes mainly from runoff water. Water running over farm fields and animal pens picks up fertilizers, pesticides, and animal wastes and carries them to bodies of water such as streams, lakes, and oceans.



Fertilizers deserve special mention as sources of water pollution. They are found in runoff from lawns, golf courses, and farm fields. Nutrients such as nitrates in fertilizers promote the growth of algae, so bodies of water polluted with fertilizers become clogged with algae. When the algae die, they decompose, and decomposition uses up all the dissolved oxygen in the water. Without oxygen, the water can no longer support aquatic organisms, including plants and fish. This creates dead zones, or areas of water in lakes and oceans that lack fish and most other aquatic organisms.

### Questions

1. What is water pollution?
2. Identify the main cause of polluted water in less developed countries.
3. List the three major sources of water pollution in more developed countries.
4. Explain how fertilizers can negatively affect bodies of water such as lakes and oceans.

---

## Lesson 21.3: Multiple Choice

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Circle the letter of the correct choice.*

1. Contaminants in municipal wastewater may come from
  - a. boats that dump sewage.
  - b. storm drains.
  - c. yard runoff.
  - d. all of the above
2. Industrial pollutants may include all of the following except
  - a. radioactive substances from hospitals.
  - b. chemicals from burning fossil fuels.
  - c. heated water from power plants.
  - d. sewage from home septic tanks.
3. Most ocean pollution comes from
  - a. natural processes.
  - b. floating oil rigs.
  - c. large ships.
  - d. land.
4. Which statement is false about the April, 2010 explosion of the Deepwater Horizon drilling rig?
  - a. It caused the largest oil spill to date.
  - b. It happened in the Gulf of Mexico.
  - c. It occurred very close to shore.
  - d. It killed 11 workers.
5. Thermal pollution occurs when
  - a. hot water is released into a body of water.
  - b. very cold water is released from a reservoir.
  - c. the sun heats ocean water to higher-than-normal temperatures.
  - d. two of the above
6. The purpose of spraying chemical dispersants on an oil spill in the ocean is to
  - a. help the oil mix with the water.

- b. absorb the oil from the surface of the water.
  - c. prevent the oil from sticking to aquatic animals.
  - d. cause the oil to clump together for easier removal.
7. Where do dead zones occur?
- a. only in ocean water
  - b. in all bodies of still water
  - c. only in the Gulf of Mexico
  - d. in many bodies of water

---

### Lesson 21.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. any contaminant that gets into lakes, streams, or oceans
- \_\_\_\_\_ 2. potent neurotoxin that contaminates water in San Francisco Bay
- \_\_\_\_\_ 3. major source of water pollution in developing countries
- \_\_\_\_\_ 4. area in a body of water where nothing lives because of lack of oxygen
- \_\_\_\_\_ 5. how most ocean pollution enters ocean water
- \_\_\_\_\_ 6. any change in water temperature that is unrelated to weather
- \_\_\_\_\_ 7. water contaminant that may leads to dead zones

#### Terms

- a. dead zone
- b. thermal pollution
- c. mercury
- d. water pollution
- e. nitrate
- f. sewage
- g. runoff

---

### Lesson 21.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Runoff containing fertilizer nutrients promotes the growth of \_\_\_\_\_ in bodies of water.
- 2. The decomposition of algae uses up dissolved \_\_\_\_\_ in the water.
- 3. A large dead zone in the Gulf of Mexico occurs because of pollutants carried there mainly by the \_\_\_\_\_ - \_\_\_\_\_ River.

4. \_\_\_\_\_ is the method of cleaning up oil spills by corralling and burning the oil.
5. Floating containment \_\_\_\_\_ are placed on the surface of water to trap spilled oil.
6. Heated water from power plants that is returned to the environment causes \_\_\_\_\_ pollution.
7. In developed countries, sources of water pollution include municipal, industrial, and \_\_\_\_\_ sources.

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### Lesson 21.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Some people think that the ocean is too large to be seriously affected by pollution. Using information in the lesson, explain why this is not true.

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## 21.4 Protecting the Water Supply

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### Lesson 21.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The goal of all water treatment is to make water safe to drink.
- \_\_\_\_\_ 2. Many developed nations have no water treatment facilities.
- \_\_\_\_\_ 3. Wastewater generally contains just a few contaminants.
- \_\_\_\_\_ 4. A wastewater treatment plant must use multiple processes to produce useable water.
- \_\_\_\_\_ 5. Water purification removes organisms such as bacteria and fungi from water.
- \_\_\_\_\_ 6. Water pollution can be reduced by preventing water pollution and treating polluted water.
- \_\_\_\_\_ 7. The EPA has the authority to finance wastewater treatment plants.
- \_\_\_\_\_ 8. The long-term effects of oil spills are well understood.
- \_\_\_\_\_ 9. Lawn watering is a good way to conserve water because all the water sinks into the ground.
- \_\_\_\_\_ 10. In the future, water conservation will become less important.

---

### Lesson 21.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Reducing Water Pollution

Water pollution can be reduced in two general ways:

- Prevent water from becoming polluted in the first place.
- Treat water that has already become polluted.

In the U.S., the Clean Water Act gives the Environmental Protection Agency (EPA) the authority to address water pollution in both ways. The agency is charged with setting standards for water quality, reducing the discharge of pollution into waterways, and managing runoff. The EPA is also charged with financing construction of wastewater treatment plants. Since the passage of the Clean Air Act in 1972, more wastewater treatment plants have been built and the release of wastes into the water supply is better controlled.

Internationally, the United Nations and other international groups are working to improve global water quality. They provide technology for treating water. They also educate people on how to protect and improve the quality of the water they use.

There are several things that individuals can do to protect water quality:

- Find approved recycling or disposal facilities for motor oil and household chemicals rather than pouring them down the drain or into a gutter.
- Use lawn and garden chemicals sparingly and according to directions.
- Repair automobile and boat engine leaks immediately.
- Keep pet litter and wastes, leaves, and grass clippings out of street gutters and storm drains.

### Questions

1. Identify two general ways of reducing water pollution.
2. Explain how the EPA protects water quality in the U.S.
3. What is being done internationally to improve global water quality?
4. What can you do to protect water quality?

---

## Lesson 21.4: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Types of contaminants in wastewater may include
  - a. harmful bacteria.
  - b. suspended solids.
  - c. inorganic compounds.
  - d. all of the above
2. The agency that sets standards for water quality in the U.S. is the
  - a. Clean Water Agency.
  - b. National Standards Agency.
  - c. Environmental Protection Agency.
  - d. National Oceanic and Atmospheric Agency.
3. Methods used to treat contaminated water depend on
  - a. which contaminants the water contains.
  - b. how clean the water needs to be.
  - c. how the water will be used.
  - d. all of the above
4. Which of the following is the best way to dispose of pet wastes?
  - a. Throw them in the trash.
  - b. Flush them down the toilet.
  - c. Toss them in a street gutter.
  - d. Wash them down a storm drain.
5. What does a wastewater treatment plant use to remove impurities from water?
  - a. filters
  - b. chemicals
  - c. biological agents
  - d. all of the above
6. Water that has been treated by any process
  - a. contains fewer contaminants.

- b. is no longer contaminated.
  - c. is safe to drink.
  - d. all of the above
7. The Clean Water Act was passed in
- a. 1952.
  - b. 1972.
  - c. 1992.
  - d. 2012.

---

### Lesson 21.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. U.S. agency that monitors pollution of the oceans and atmosphere
- \_\_\_\_\_ 2. U.S. law controlling the pollution of water
- \_\_\_\_\_ 3. taking steps to avoid wasting and polluting water
- \_\_\_\_\_ 4. removal of contaminants such as solids from sewage
- \_\_\_\_\_ 5. U.S. agency that protects the environment
- \_\_\_\_\_ 6. removal of pollutants in order to make water safe to drink

#### Terms

- a. sewage treatment
- b. NOAA
- c. water purification
- d. EPA
- e. Clean Water Act
- f. water conservation

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### Lesson 21.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Water purification makes water suitable for \_\_\_\_\_.
- 2. \_\_\_\_\_ is the general term for contaminated water from municipal uses.
- 3. Wastewater is treated in a series of steps, each of which produces water with fewer \_\_\_\_\_.
- 4. In the U.S., the \_\_\_\_\_ regulates the discharge of pollution into waterways.
- 5. \_\_\_\_\_ showerheads reduce the amount of water used during showers.
- 6. \_\_\_\_\_ from the Exxon Valdez still coats rocks and sand beneath beaches in Alaska.

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## Lesson 21.4: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Write a brief public service announcement that explains how to conserve water in and around the home.

## CHAPTER

**22****HS Human Actions and the Atmosphere Worksheets****Chapter Outline**

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**22.1 AIR POLLUTION****22.2 EFFECTS OF AIR POLLUTION****22.3 REDUCING AIR POLLUTION**

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- Lesson 22.1: Air Pollution
- Lesson 22.2: Effects of Air Pollution
- Lesson 22.3: Reducing Air Pollution



## 22.1 Air Pollution

### Lesson 22.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Ozone is a gas that both protects and harms human beings.
- \_\_\_\_\_ 2. All air pollutants are the result of human activities.
- \_\_\_\_\_ 3. Air pollution became a crisis in the developed nations in the mid-1900s.
- \_\_\_\_\_ 4. Pollutants regulated by the U.S. Clean Air Act include particulates and lead.
- \_\_\_\_\_ 5. Air quality in a region depends only on the amounts of pollutants released into the atmosphere in that location.
- \_\_\_\_\_ 6. The state in the U.S. with the most polluted air is New York State.
- \_\_\_\_\_ 7. Secondary pollutants are pollutants that are less harmful than primary pollutants.
- \_\_\_\_\_ 8. Particulates in the air may include ash, dust, and fecal matter.
- \_\_\_\_\_ 9. In the presence of sunlight, nitrogen dioxide forms ozone.
- \_\_\_\_\_ 10. At least three-quarters of air pollution in the U.S. comes from transportation.

### Lesson 22.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Primary Air Pollutants

There are two basic types of air pollutants: primary air pollutants and secondary air pollutants. Primary air pollutants enter the atmosphere directly. Secondary air pollutants form in the atmosphere from chemical reactions involving other pollutants. Some primary air pollutants have natural sources. Volcanic ash is an example. Dust is also a primary pollutant with natural sources, but humans also put dust into the air with activities such as plowing fields and building roads. Most other primary pollutants are the result of human activities alone. The majority of them enter the air directly from vehicles exhaust systems and smokestacks. These primary pollutants include carbon, nitrogen, and sulfur oxides; particulates; lead; and volatile organic compounds.

- Carbon oxides include carbon monoxide and carbon dioxide. Both are colorless, odorless gases. Carbon monoxide is toxic to both plants and animals. Both carbon monoxide and carbon dioxide are greenhouse gases.
- Nitrogen oxides are produced when nitrogen and oxygen in the atmosphere come together at high temperatures. This occurs in hot exhaust gases from vehicles, power plants, and factories. Nitrogen oxides are greenhouse gases and also contribute to the formation of acid rain and ozone.

- Sulfur oxides include sulfur dioxide and sulfur trioxide. These compounds enter the air when coal is burned. Sulfur oxides contribute to the formation of acid rain.
- Particulates are solid particles, such as ash, dust, and fecal matter. Other particulates form from the combustion of fossil fuels. Particulates can produce smog and contribute to health problems such as asthma and heart disease.
- Lead is a heavy metal that was once widely used in automobile fuels, paints, and pipes. It is now banned for these uses. Lead can cause brain damage and blood poisoning.
- Volatile organic compounds (VOCs) are mostly hydrocarbons. The major VOC is methane, which occurs naturally but is increasing because of human activities, such as livestock raising. Methane is a greenhouse gas.

## Questions

1. Distinguish between primary air pollutants and secondary air pollutants.
2. Identify two natural sources of primary pollutants.
3. List three primary pollutants that enter the air due to human actions. Describe their sources and adverse effects.

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## Lesson 22.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Where and when did photochemical smog first become a problem?
  - a. in Pennsylvania in 1948
  - b. in London, England, in 1952
  - c. in New York City in the late 1800s
  - d. in southern California after World War II
2. Pollutants regulated by the U.S. Clean Air Act include
  - a. sulfur dioxide.
  - b. nitrogen dioxide.
  - c. carbon monoxide.
  - d. all of the above
3. What is the result of the Clean Air Act in the U.S.?
  - a. There is no more air pollution.
  - b. The air is much cleaner.
  - c. Visibility is better.
  - d. two of the above
4. The smoggiest city in the U.S. in 2012 was
  - a. Houston, Texas.
  - b. Chicago, Illinois.
  - c. San Diego, California.
  - d. Los Angeles, California.
5. Examples of primary air pollutants include all of the following except
  - a. carbon monoxide.
  - b. nitrogen dioxide.
  - c. sulfur trioxide.

- d. ozone.
- 6. Most air pollutants come from
  - a. burning.
  - b. farming.
  - c. building.
  - d. volcanoes erupting.
- 7. The most common VOC is
  - a. dioxin.
  - b. methane.
  - c. carbon monoxide.
  - d. chlorofluorocarbon.

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## Lesson 22.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. type of air pollution that forms when car exhaust is exposed to sunlight
- \_\_\_\_\_ 2. any pollutant released directly into the environment
- \_\_\_\_\_ 3. cutting and burning forests to make way for planting crops
- \_\_\_\_\_ 4. any pollutant that forms from another pollutant by a chemical reaction
- \_\_\_\_\_ 5. any type of solid particle that pollutes the air
- \_\_\_\_\_ 6. type of chemical that pollutes the air when it evaporates
- \_\_\_\_\_ 7. major component of photochemical smog

### Terms

- a. ozone
- b. primary pollutant
- c. photochemical smog
- d. volatile organic compound
- e. secondary pollutant
- f. slash-and-burn agriculture
- g. particulate

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## Lesson 22.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Earth's organisms are protected from ultraviolet radiation by the \_\_\_\_\_ layer.

2. Air pollution started to become a serious problem when fossil fuels began to be burned during the \_\_\_\_\_.
3. In the U.S., the 1970 \_\_\_\_\_ Act regulates almost 190 air pollutants.
4. Air pollutants may be trapped close to the ground within a cool air mass by a temperature \_\_\_\_\_.
5. A mountain range can trap air pollutants on its \_\_\_\_\_ side.
6. The main source of sulfur oxides in the air is the burning of \_\_\_\_\_.
7. \_\_\_\_\_ is the total amount of living material in an ecosystem.

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### Lesson 22.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain conditions that led to passage of the U.S. Clean Air Act. Also explain how passage of the act changed U.S. air quality.

## 22.2 Effects of Air Pollution

### Lesson 22.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The Clean Air Act regulates global air pollution.
- \_\_\_\_\_ 2. Millions of Americans must breathe unhealthy air.
- \_\_\_\_\_ 3. All air pollution causes some damage to living things.
- \_\_\_\_\_ 4. The effects of ozone pollution accumulate in plants.
- \_\_\_\_\_ 5. The only danger of nitrogen dioxide is that it causes acid rain.
- \_\_\_\_\_ 6. Asthma attacks increase when particulate levels rise.
- \_\_\_\_\_ 7. Normal rainwater has a neutral pH of 7.0.
- \_\_\_\_\_ 8. No fish can live in water with a pH below 5.6.
- \_\_\_\_\_ 9. CFC molecules create ozone from oxygen in the stratosphere.
- \_\_\_\_\_ 10. The ozone hole forms over Antarctica in the winter.

### Lesson 22.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Acid Rain

Acid rain is caused by sulfur and nitrogen oxides emanating from power plants or metal refineries. Tall smokestacks allow the emissions to rise high into the atmosphere and travel up to 1,000 km (600 miles) downwind. As the pollutants move, they combine with water vapor in the atmosphere to form sulfuric and nitric acids. The acid droplets form acid fog, rain, or snow; or they may be deposited dry. Most typical is acid rain.

Acid rain is rainwater that is more acidic than normal rainwater. Acidity is measured on the pH scale. Neutral substances have a pH of 7.0. Acidic substances have lower pH values, and basic (or alkaline) substances have higher pH values. Normal rain is somewhat acidic with a pH of 5.6. To be considered acid rain, rainwater must have a pH of less than 5.0. A small change in pH represents a large change in acidity. For example, rain with a pH of 4.6 is 10 times more acidic than normal rain with a pH of 5.6, and rain with a pH of 3.6 is 100 times more acidic than normal rain.

Acid precipitation ends up in soil and bodies of water. Some forest soils in the northeastern U.S. that receive a lot of acid rain are five to ten times more acidic than they were two or three decades ago. Acid rain that soaks into soil strips the soil of metals and nutrients. Soils may no longer have enough nutrients for plants to grow. Runoff from the soils carries the metals and nutrients to streams and lakes, and it makes these bodies of water even more acidic.

When lakes become too acidic, aquatic organisms die off. No fish can live if the pH of the water drops below 4.5, and organic material also cannot decay. Wildlife that depends on the lakes for drinking water may suffer population declines.

Plants—including food crops—that are exposed to acids in soils and rainwater become weak. They are more likely to be damaged by bad weather, insect pests, or disease. Snails and some other small soil organisms die in acid soils, so many birds do not have as much food to eat. Young birds and mammals do not build bones as well and may not be as strong. Eggshells may also be weak and break more easily.

### Questions

1. What is acid rain? What causes it?
2. How does acid rain affect soils and bodies of water?
3. Explain the effects of acid rain on living things.

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## Lesson 22.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. When air contains high levels of particulates
  - a. precipitation may decrease.
  - b. air temperature may increase.
  - c. photosynthesis may be reduced.
  - d. all of the above
2. Effects on human health of nitrogen and sulfur oxides include increased rates of
  - a. asthma.
  - b. emphysema.
  - c. viral infections.
  - d. all of the above
3. Air pollutants that cause lung disease include
  - a. lead.
  - b. mercury.
  - c. particulates.
  - d. two of the above
4. Which statement about bioaccumulation is false?
  - a. Compounds that bioaccumulate are usually stored in fat.
  - b. Bioaccumulation is usually greatest in large predatory animals.
  - c. Substances that bioaccumulate include mercury, lead, and VOCs.
  - d. none of the above
5. The pH of acid rain is
  - a. about 5.6.
  - b. at least 7.0.
  - c. less than 5.0.
  - d. greater than 5.5.
6. Acid rain may

- a. increase the pH of lakes.
  - b. add nutrients to soils.
  - c. damage buildings.
  - d. all of the above
7. The ozone hole can affect human health by increasing
- a. sunburns.
  - b. cataracts.
  - c. skin cancers.
  - d. all of the above

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## Lesson 22.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. precipitation that forms when the air contains sulfur and nitrogen oxides
- \_\_\_\_\_ 2. type of air pollutant that reduces visibility
- \_\_\_\_\_ 3. measure of acidity
- \_\_\_\_\_ 4. buildup of toxins in organisms throughout life
- \_\_\_\_\_ 5. opposite of acidic
- \_\_\_\_\_ 6. stratospheric cloud of frozen nitric acid molecules
- \_\_\_\_\_ 7. area where the stratospheric ozone layer is dangerously thin

### Terms

- a. alkaline
- b. particulate
- c. bioaccumulation
- d. ozone hole
- e. pH
- f. acid rain
- g. PSC

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## Lesson 22.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The most common toxic material in the environment is the heavy metal \_\_\_\_\_.
- 2. Mercury bioaccumulates in organisms as the compound called \_\_\_\_\_.
- 3. Ozone is a pollutant when it occurs in the atmospheric layer known as the \_\_\_\_\_.

4. Ozone is beneficial when it occurs in the atmospheric layer called the \_\_\_\_\_.
5. The primary chemicals creating the ozone hole are \_\_\_\_\_.
6. Air pollutants called \_\_\_\_\_ reduce the amount of sunlight that reaches the ground.
7. Acid rain is caused by air pollution with nitrogen and sulfur \_\_\_\_\_.

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### Lesson 22.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Summarize how air pollution affects human health.



## 22.3 Reducing Air Pollution

### Lesson 22.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The Clean Air Act has decreased the emissions of six major air pollutants by more than 50 percent.
- \_\_\_\_\_ 2. Solar and wind energy are now less expensive to use than fossil fuels.
- \_\_\_\_\_ 3. Catalytic converters break down VOCs to harmless compounds.
- \_\_\_\_\_ 4. The use of clean coal releases large amounts of carbon dioxide into the atmosphere.
- \_\_\_\_\_ 5. The battery of a hybrid car is charged by sunlight hitting the car's roof.
- \_\_\_\_\_ 6. A hydrogen fuel cell uses biofuel to produce energy and hydrogen gas.
- \_\_\_\_\_ 7. It takes much less energy to use clean coal than regular coal.
- \_\_\_\_\_ 8. More chlorofluorocarbons are used today than at any time in the past.
- \_\_\_\_\_ 9. Carbon is naturally captured and sequestered in a forest.
- \_\_\_\_\_ 10. A carbon tax reduces carbon dioxide emissions by encouraging conservation.

### Lesson 22.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Reducing Greenhouse Gases

Climate scientists agree that climate change is a global problem that must be attacked by a unified world with a single goal. All nations must come together to reduce greenhouse gas emissions. However, getting nations to agree on useful measures has been difficult. The first attempt to control greenhouse gas emissions was the 1997 Kyoto Protocol, which was not very successful in getting nations to participate or in cutting emissions.

The easiest and quickest way to reduce greenhouse gas emissions is to increase energy efficiency and conservation. An effective way to encourage conservation is a carbon tax placed on carbon dioxide emissions. The tax is placed on gasoline, carbon dioxide emitted by factories, and energy bills so people or businesses that emit more carbon pay more taxes. The money collected from a carbon tax can be used for research into alternative energy resources.

Another approach to reducing greenhouse gases is the development of energy alternatives, including biofuels. Biofuels can replace gasoline in vehicles. They reduce greenhouse gas emissions, but they have other problems. So far, most biofuels are produced from food crops such as corn. When food crops are used for fuel, the price of food goes up. Modern agriculture is also extremely reliant on fossil fuels for pesticides, fertilizers, and the physical work of farming. Therefore, not much energy is gained from using these biofuels instead of fossil fuels. More promising biofuel crops—including algae—are now being researched. Algae can be grown in areas that are not

useful for agriculture, and they contain much more usable oil than crops such as corn.

Removing greenhouse gases from the atmosphere after they are emitted is another option. Carbon capture and sequestration occurs naturally when carbon dioxide is removed from the atmosphere by trees in forests. An obvious way to remove more carbon is to plant more trees. Unfortunately, more forests are currently being lost than gained. Carbon can also be artificially sequestered. For example, carbon can be captured from the emissions of gasification plants and then stored underground. Some small sequestration projects are in development, but large-scale sequestration has not yet been attempted.

### Questions

1. What is a carbon tax? How would a carbon tax reduce greenhouse gas emissions?
2. What are the pros and cons of using biofuels instead of gasoline to power motor vehicles?
3. Explain carbon sequestration and how it tackles the problem of greenhouse gases.

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## Lesson 22.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Energy resources that do not create greenhouse gas emissions include
  - a. wind.
  - b. gasoline.
  - c. clean coal.
  - d. two of the above
2. Ways to reduce air pollution from motor vehicles include
  - a. using catalytic converters.
  - b. making vehicles more fuel-efficient.
  - c. using fuel cells instead of fossil fuels.
  - d. all of the above
3. The success of the Montreal Protocol means that
  - a. there will be fewer cases of skin cancer in the future.
  - b. global warming will slow down and start to reverse.
  - c. there will be less carbon in Earth's atmosphere.
  - d. two of the above
4. The Kyoto Protocol
  - a. set limits on CFC production.
  - b. devised a cap-and-trade system.
  - c. placed a ban on all fossil fuel use.
  - d. controlled emissions of lead and mercury.
5. Which statement about hydrogen fuel cells is false?
  - a. They produce no pollutants.
  - b. They are extremely efficient.
  - c. They use hydrogen and oxygen.
  - d. They are widely used in hybrid cars.
6. Scrubbers reduce the formation of acid rain by

- a. gasifying high-sulfur coal to create syngas.
  - b. filtering particulates out of industrial emissions.
  - c. using catalysts to break down sulfur and nitrogen oxides.
  - d. capping the amount of carbon dioxide released in exhaust gases.
7. Carbon sequestration can be increased by
- a. planting trees.
  - b. using less coal.
  - c. driving electric cars.
  - d. all of the above

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## Lesson 22.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. vehicle that runs on both electricity and gasoline
- \_\_\_\_\_ 2. technology that turns coal to gas so it is less polluting when burned
- \_\_\_\_\_ 3. any means of storing carbon so there is less carbon dioxide in the atmosphere
- \_\_\_\_\_ 4. device on motor vehicles that breaks down harmful pollutants before they are emitted in exhaust
- \_\_\_\_\_ 5. system that provides financial incentives to cap greenhouse gas emissions
- \_\_\_\_\_ 6. battery that converts chemical energy into electrical energy to run a vehicle
- \_\_\_\_\_ 7. device that removes particles and waste gases from factory or power plant exhaust

### Terms

- a. catalytic converter
- b. hybrid car
- c. fuel cell
- d. scrubber
- e. gasification
- f. cap-and-trade
- g. carbon sequestration

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## Lesson 22.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. A tax placed on carbon dioxide emissions to help reduce greenhouse gases is called a(n) \_\_\_\_\_ tax.
2. A(n) \_\_\_\_\_ is a fuel made from plants or algae that can replace gasoline and reduce fossil fuel use.
3. A chemical that speeds up chemical reactions is a(n) \_\_\_\_\_.

4. The \_\_\_\_\_ Protocol is an international agreement to reduce CFCs.
5. The \_\_\_\_\_ Protocol is an international agreement to reduce greenhouse gases.
6. The goal of the Montreal Protocol is to protect the \_\_\_\_\_ layer.
7. The goal of the Kyoto Protocol is to prevent \_\_\_\_\_ change.

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### Lesson 22.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Identify and explain three ways to reduce air pollution from motor vehicles.

## CHAPTER

**23****HS Observing and  
Exploring Space Worksheets****Chapter Outline**

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- 23.1**    **TELESCOPES**
  - 23.2**    **EARLY SPACE EXPLORATION**
  - 23.3**    **RECENT SPACE EXPLORATION**
- 

- **Lesson 23.1: Telescopes**
- **Lesson 23.2: Early Space Exploration**
- **Lesson 23.3: Recent Space Exploration**

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## 23.1 Telescopes

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### Lesson 23.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Light travels faster than anything else in the universe.
  - \_\_\_\_\_ 2. It takes 1 light-year for light from the sun to reach Earth.
  - \_\_\_\_\_ 3. When we look at stars, we are seeing back in time.
  - \_\_\_\_\_ 4. Visible light makes up most of the electromagnetic spectrum.
  - \_\_\_\_\_ 5. EM waves with longer wavelengths have higher frequencies.
  - \_\_\_\_\_ 6. The color of visible light is determined by its wavelength.
  - \_\_\_\_\_ 7. Hotter stars give off light with longer wavelengths.
  - \_\_\_\_\_ 8. Scientists can see more clearly with space telescopes because they are closer to stars.
  - \_\_\_\_\_ 9. With his telescope, Galileo discovered that Jupiter has orbiting moons.
  - \_\_\_\_\_ 10. From the spectrum of a star, an astronomer can determine the star's temperature.
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### Lesson 23.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Optical Telescopes

Optical telescopes are telescopes that gather and focus visible light from distant objects and make the objects appear bigger and closer. The earliest true optical telescopes, which were made in Europe in the late 16th century, were optical telescopes. They used a combination of two curved lenses to focus light. The term telescope was coined by the Italian scientist and mathematician Galileo Galilei (1564–1642). Galileo built his first telescope in 1608 and subsequently made many improvements to telescope design, which allowed him to make important observations of our solar system and galaxy.

Optical telescopes that use lenses focus light by refracting, or bending, it. These optical telescopes are called refracting telescopes. The earliest telescopes, including Galileo's, were all refracting telescopes. Many of the small telescopes used by amateur astronomers today are refracting telescopes. The largest refracting telescope in the world is at the University of Chicago's Yerkes Observatory in Wisconsin and was built in 1897. Its largest lens has a diameter of 102 cm.

Around 1670, another famous scientist and mathematician—Sir Isaac Newton (1643–1727)—built a new kind of optical telescope using mirrors instead of lenses. The mirrors were curved to reflect and focus light. This type of telescope is called a reflecting telescope. Reflecting telescopes have advantages over refracting telescopes. One

advantage is that mirrors are easier than lenses to make precisely. The mirrors in a reflecting telescope are also much lighter than the heavy glass lenses in a refracting telescope, so reflecting telescopes can be larger without becoming too heavy. Larger telescopes can collect more light, so they allow scientists to view dimmer or more distant objects. The largest optical telescopes in the world today are reflecting telescopes.

### Questions

1. What is an optical telescope? When were optical telescopes first invented?
2. Compare and contrast refracting and reflecting telescopes.
3. Describe contributions to telescope technology that were made by Galileo and Newton.

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## Lesson 23.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The main source of information used by astronomers to learn about objects in space is
  - a. comets.
  - b. meteorites.
  - c. constellations.
  - d. electromagnetic waves.
2. The speed of light through space is
  - a. 9.5 million m/s.
  - b. 300 million m/s.
  - c. 4.2 billion m/s.
  - d. 3 billion m/s.
3. Higher frequency electromagnetic waves have
  - a. less energy.
  - b. longer wavelengths.
  - c. greater speeds.
  - d. none of the above
4. EM radiation from the faintest, most distant objects in the universe are in the form of
  - a. X-rays.
  - b. gamma rays.
  - c. infrared light.
  - d. radio waves.
5. The first telescopes were made in Europe in the late
  - a. 1300s.
  - b. 1500s.
  - c. 1700s.
  - d. 1900s.
6. All of the following are optical telescopes except
  - a. radio telescopes.
  - b. reflecting telescopes.
  - c. refracting telescopes.
  - d. catadioptric telescopes.

7. NASA's four space-based Great Observatories were designed to view the universe
- in different seasons of the year.
  - at different angles from Earth's axis.
  - in different ranges of the EM spectrum.
  - at different distances from Earth's surface.

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### Lesson 23.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. energy that is transmitted across space as waves
- \_\_\_\_\_ 2. device that uses both mirrors and lenses to make distant objects appear larger
- \_\_\_\_\_ 3. type of EM radiation emitted by very cool stars
- \_\_\_\_\_ 4. type of EM radiation with the lowest frequencies
- \_\_\_\_\_ 5. device that bends light with lenses to make distant objects appear larger
- \_\_\_\_\_ 6. type of EM radiation with the shortest wavelengths
- \_\_\_\_\_ 7. device that breaks down light into its component colors

#### Terms

- spectrometer
- gamma waves
- catadioptric telescope
- radio waves
- electromagnetic radiation
- refracting telescope
- infrared light

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### Lesson 23.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- Scientists who study the universe beyond Earth are called \_\_\_\_\_.
- The distance that light travels in one year is a unit called the \_\_\_\_\_.
- A pattern in the sky made by stars as seen from Earth is known as a(n) \_\_\_\_\_.
- The Hubble telescope is an example of a(n) \_\_\_\_\_ telescope.
- Some very hot stars emit primarily \_\_\_\_\_ light.
- Isaac Newton used mirrors to create the first \_\_\_\_\_ telescope.
- Telescopes that collect radio waves instead of visible light are called \_\_\_\_\_ telescopes.



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## Lesson 23.1: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain what astronomers can learn about distant objects in the universe from electromagnetic radiation.

## 23.2 Early Space Exploration

### Lesson 23.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The first rockets ever used were launched in the 20th century.
- \_\_\_\_\_ 2. The first liquid-fuel rockets to be built were designed by Robert Goddard.
- \_\_\_\_\_ 3. Wernher von Braun joined NASA and helped design rockets for space travel.
- \_\_\_\_\_ 4. The first satellite ever to orbit Earth was put into space by the United States.
- \_\_\_\_\_ 5. The scientist who first explained how satellites stay in orbit was Hermann Oberth.
- \_\_\_\_\_ 6. Over the past 50 years, thousands of artificial satellites have been put into orbit around Earth.
- \_\_\_\_\_ 7. The speed of a satellite depends on how high it is above the object it is orbiting.
- \_\_\_\_\_ 8. U.S. Mariner missions sent space probes to the outer solar system.
- \_\_\_\_\_ 9. U.S. Voyager probes are now traveling toward the sun.
- \_\_\_\_\_ 10. The U.S.S.R. sent probes to Venus and landed some of them on the surface.

### Lesson 23.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Types of Satellites and Their Orbits

Since the first artificial Earth satellite was launched more than 50 years ago, thousands of artificial satellites have been put into orbit around our planet. We have even put satellites into orbit around the Moon, the Sun, and several other planets. Depending on their purpose, there are four main types of satellites: imaging satellites, communications satellites, navigational satellites, and the International Space Station.

- Imaging satellites take pictures of Earth's surface that are used for military or scientific purposes. For example, meteorologists use imaging satellites to study Earth's weather. Astronomers use them to study the Moon and other planets.
- Communications satellites are designed to receive and send signals for telephone, television, or other types of communications.
- Navigational satellites are used for navigation systems, such as the Global Positioning System (GPS).
- The International Space Station (ISS), the largest artificial satellite, allows humans to live in space while conducting scientific research.

The speed of a satellite depends on how high it is above Earth's surface. Satellites that are relatively close to Earth are said to be in low-Earth orbit (LEO). Satellites in LEO are often in polar orbit. This means that they travel over

the North and South Poles and move in a direction that is perpendicular to the direction of Earth's rotation. Because Earth rotates beneath a polar-orbit satellite, the satellite is over a different part of Earth's surface each time it circles the planet. Imaging satellites and weather satellites are often put in low-Earth, polar orbits. A satellite placed at just the right distance above Earth—35,786 km (22,240 miles)—orbits Earth at the same rate of speed that Earth spins on its axis. When such a satellite orbits Earth in the same direction as Earth's rotation, it is always over the same position on Earth's surface. This type of orbit is called a geostationary orbit (GEO). Many communications satellites are in geostationary orbits.

### Questions

1. Identify four main types of satellites based on their purpose.
2. Describe a polar orbit, and explain why a satellite in a polar orbit is over a different part of Earth's surface each time it circles the planet.
3. What is a geostationary orbit? What is required for a satellite to be in this type of orbit? Which of the four main types of satellites have geostationary orbits?

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## Lesson 23.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The scientist who first developed the idea of multi-stage rockets was
  - a. Tsiolkovsky.
  - b. Goddard.
  - c. Oberth.
  - d. von Braun.
2. Newton's law of universal gravitation explains
  - a. how the moon stays in orbit around Earth.
  - b. why objects on Earth always fall toward the ground.
  - c. why objects in motion stay in motion unless acted upon by a net force.
  - d. two of the above
3. Human beings have put satellites into orbit around
  - a. Earth.
  - b. the sun.
  - c. the moon.
  - d. all of the above
4. Satellites in low-Earth orbit generally orbit over the
  - a. poles.
  - b. equator.
  - c. same place on Earth's surface.
  - d. two of the above
5. The space race was a competition to explore space that occurred after World War II between the U.S. and
  - a. Germany.
  - b. Saudi Arabia.
  - c. the Soviet Union.
  - d. the European Union.

6. The first human being to travel into space was the U.S. astronaut
  - a. John Glenn.
  - b. Buzz Aldrin.
  - c. Alan Shepherd.
  - d. Neil Armstrong.
7. The U.S. Viking missions landed space probes on
  - a. Mars.
  - b. Venus.
  - c. Jupiter.
  - d. Mercury.

---

### Lesson 23.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. any object that orbits a larger object
- \_\_\_\_\_ 2. name of the force that pushes a rocket forward
- \_\_\_\_\_ 3. type of spacecraft that does not have human occupants
- \_\_\_\_\_ 4. law that explains how satellites stay in orbit
- \_\_\_\_\_ 5. vehicle propelled by particles flying out of one end
- \_\_\_\_\_ 6. law that explains how a rocket works
- \_\_\_\_\_ 7. circular or elliptical path around an object

#### Terms

- a. rocket
- b. law of universal gravitation
- c. orbit
- d. thrust
- e. satellite
- f. space probe
- g. third law of motion

---

### Lesson 23.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. According to Newton's \_\_\_\_\_ law of motion, to every action there is an equal and opposite reaction.
2. To escape Earth's gravity, rockets must use fuels in the \_\_\_\_\_ state.

3. One of the first uses of rockets in space was to launch \_\_\_\_\_.
4. Satellites that take pictures of Earth's surface are called \_\_\_\_\_ satellites.
5. Earth's largest artificial satellite is the \_\_\_\_\_.
6. An artificial satellite that orbits Earth at the same speed that Earth rotates has a(n) \_\_\_\_\_ orbit.
7. The first artificial satellite ever put into orbit around Earth was named \_\_\_\_\_.

---

### Lesson 23.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how a rocket works and why multi-stage rockets are needed to escape Earth's gravity.

## 23.3 Recent Space Exploration

### Lesson 23.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The first space station was put into orbit by the United States.
- \_\_\_\_\_ 2. Skylab studied the effects on humans of living in space.
- \_\_\_\_\_ 3. The ISS was constructed piece by piece over time.
- \_\_\_\_\_ 4. The Soviets put a total of three Salyut space stations into orbit.
- \_\_\_\_\_ 5. Early space exploration was driven by competition between the U.S. and U.S.S.R. during the cold war.
- \_\_\_\_\_ 6. There have been eight American space shuttles.
- \_\_\_\_\_ 7. The American space shuttle program was terminated in 2011.
- \_\_\_\_\_ 8. The Mars Pathfinder was a rover that explored the surface of Mars.
- \_\_\_\_\_ 9. The Cassini mission has been studying the rings and moons of Saturn.
- \_\_\_\_\_ 10. The stardust mission collected tiny dust particles from the surface of Jupiter.

### Lesson 23.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Recent Space Missions

The U.S. and other nations have had many missions around the solar system in recent years. For example, the U.S. has sent several rovers—essentially spacecraft on wheels—to roam over the surface of Mars in order to collect data. The Mars Pathfinder spacecraft, which landed on Mars in 1997, carried the rover named Sojourner. Sojourner moved over the Martian surface collecting data on rocks, soils, and weather factors such as wind. This was the first of a series of missions to Mars that included rovers. Sojourner was followed by two rovers, named Spirit and Opportunity, which landed on Mars in 2003. They explored the Martian surface and the planet's geology. The goal of their mission was to search for and characterize a wide range of rocks and soils that hold clues to past water activity on Mars. Another Mars rover, named Curiosity, is currently exploring the Martian surface. Curiosity is a car-sized robotic rover that was launched in 2011 and landed on Mars in 2012. Curiosity's goals include investigating Martian climate and geology and whether life ever could have existed on Mars.

Other planets and bodies of our solar system are also being explored. For example, the Cassini mission has been studying Saturn, including its rings and moons, since 2004. The Huygens probe, built by the European Space Agency, is studying Saturn's moon Titan. They are interested in Titan because it has some of the conditions that are needed to support life. Other missions are studying the smaller objects in our solar system. For example, the Deep Impact probe was sent to collide with a comet and collect particles from it. The Stardust mission collected particles

from another comet. Missions are currently underway to study some of the larger asteroids and the dwarf planet Pluto. Studies of these smaller objects in the solar system may help us to understand how the solar system formed.

### Questions

1. Identify some of the rovers that have explored Mars and what they have investigated.
2. List three recent non-Martian missions and their objectives.
3. What might we learn by studying smaller objects in the solar system?

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## Lesson 23.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Which statement about Skylab is false?
  - a. It was launched in 1973.
  - b. It was a U.S. space station.
  - c. Astronauts never lived on it.
  - d. It was used to study the sun.
2. Which statement about Mir is false?
  - a. It was launched by the U.S.
  - b. It fell into the Pacific Ocean.
  - c. It was a modular space station.
  - d. American astronauts lived on it.
3. Countries sponsoring the ISS include
  - a. Japan.
  - b. Brazil.
  - c. Canada.
  - d. all of the above
4. The International Space Station
  - a. was begun in 1987.
  - b. was completed in 2011.
  - c. was first occupied in 1995.
  - d. all of the above
5. People have been transported to and from the International Space Station mainly by
  - a. Russian space shuttles.
  - b. American space shuttles.
  - c. Russian Soyuz spacecraft.
  - d. American Apollo spacecraft.
6. The part(s) of a space shuttle that is (are) reused include the
  - a. orbiter.
  - b. fuel tank.
  - c. booster rockets.
  - d. two of the above
7. Which of the following craft has (have) explored the surface of Mars?

- a. Spirit
- b. Atlantis
- c. Explorer
- d. two of the above

---

### Lesson 23.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. first space station ever put into orbit
- \_\_\_\_\_ 2. space station that is a joint project of the U.S. and several other nations
- \_\_\_\_\_ 3. any large spacecraft on which humans can live for extended periods
- \_\_\_\_\_ 4. part of a space shuttle that can be navigated like an airplane
- \_\_\_\_\_ 5. first space station launched by the U.S.
- \_\_\_\_\_ 6. reusable spacecraft for carrying people and cargo
- \_\_\_\_\_ 7. first space station designed for long-term use

#### Terms

- a. space station
- b. Salyut 1
- c. Skylab
- d. Mir
- e. International Space Station
- f. orbiter
- g. space shuttle

---

### Lesson 23.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Early space exploration was driven by competition between the U.S. and the \_\_\_\_\_.
- 2. The first space station that involved international cooperation was the \_\_\_\_\_.
- 3. The primary purpose of the International Space Station is \_\_\_\_\_.
- 4. The part of a space shuttle that astronauts land back on Earth is the \_\_\_\_\_.
- 5. The space shuttles named Challenger and \_\_\_\_\_ exploded or burned up, killing all aboard.
- 6. NASA's \_\_\_\_\_ satellites take detailed images of Earth's continents and coasts.
- 7. Spacecraft on wheels that explore planets are called \_\_\_\_\_.



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## Lesson 23.3: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how the end of the Cold War changed space exploration.

## CHAPTER

**24****HS Earth, Moon, and Sun  
Worksheets****Chapter Outline**

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- 24.1**    **PLANET EARTH**
  - 24.2**    **EARTH'S MOON**
  - 24.3**    **THE SUN**
  - 24.4**    **THE SUN AND THE EARTH-MOON SYSTEM**
- 

- **Lesson 24.1: Planet Earth**
- **Lesson 24.2: Earth's Moon**
- **Lesson 24.3: The Sun**
- **Lesson 24.4: The Sun and the Earth-Moon System**

## 24.1 Planet Earth

### Lesson 24.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Earth's diameter is longer through the poles than through the equator.
- \_\_\_\_\_ 2. Earth's magnetic field extends several thousands of kilometers into space.
- \_\_\_\_\_ 3. Earth's axis of rotation passes through the north and south poles.
- \_\_\_\_\_ 4. One complete rotation of Earth requires a little more than 24 hours.
- \_\_\_\_\_ 5. A swinging pendulum appears to change direction because of Earth's revolution.
- \_\_\_\_\_ 6. Earth's speed of rotation is greatest at the equator.
- \_\_\_\_\_ 7. Earth has seasons because its orbit around the sun is elliptical.
- \_\_\_\_\_ 8. Earth travels about 150 million kilometers during one revolution.
- \_\_\_\_\_ 9. Earth revolves around the sun at a constant speed.
- \_\_\_\_\_ 10. Earth's axis is tilted  $23\frac{1}{2}$  degrees relative to a line drawn perpendicular to the equator.

### Lesson 24.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Earth's Motions

Imagine a line passing through the center of Earth that goes through both poles. This imaginary line is called an axis. Earth spins around its axis in a movement called rotation. Earth also orbits, or revolves around, the sun. This movement is called revolution.

In 1851, long before Earth could be viewed from space, a French scientist named Léon Foucault determined that Earth rotates. He did this by watching the movement of a pendulum. A pendulum is a heavy weight that swings back and forth on a string. Foucault knew that after a pendulum is set in motion, it will keep moving in the same direction. When Foucault observed his pendulum, it seemed to change direction, so he concluded that Earth must be moving beneath the swinging pendulum.

Earth requires 23 hours, 56 minutes, and 4 seconds to make one complete rotation on its axis. However, because Earth revolves around the sun at the same time that it is rotating, the planet must turn a little bit more to reach the same position relative to the sun. This explains why the length of a day on Earth is actually 24 hours. At the equator, Earth rotates at its maximum speed of about 1,700 km/h. It rotates more slowly at high latitudes, down to a speed of little more than zero km/h at the poles.

For Earth to make one complete revolution around the sun takes 365.24 days. The amount of time Earth—or any

planet—takes to revolve around the sun is the definition of a year. The gravitational pull of the sun keeps Earth and the other planets in orbit around it. Like the orbits of the other planets, Earth's orbit is elliptical rather than circular, so the planet is farther away from the sun at some points in its orbit than others. The closest Earth gets to the sun each year is about 147 million km, which is called perihelion. It occurs on about January 3rd. The farthest Earth gets from the sun each year is about 152 million km, which is called aphelion. It occurs on about July 4th. Earth revolves around the sun at an average speed of about 27 km/s, but it moves more slowly at aphelion and more quickly at perihelion.

### Questions

1. Define and describe Earth's rotation and revolution.
2. Why did Foucault conclude that Earth rotates?
3. Why does a day last slightly longer than it takes Earth to make one complete rotation?
4. Compare and contrast Earth's perihelion and aphelion.

---

## Lesson 24.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Earth is similar to the other inner planets in the solar system in its
  - a. size.
  - b. shape.
  - c. composition.
  - d. all of the above
2. When a ship sails away from shore, people watching from shore see the bottom of the ship disappear first. This is because the
  - a. atmosphere obscures it.
  - b. surface of Earth is curved.
  - c. planet is rotating on its axis.
  - d. ship sinks deeper into the water.
3. Earth's magnetic field resembles the magnetic field of a
  - a. bar magnet.
  - b. spherical magnet.
  - c. horseshoe magnet.
  - d. none of the above
4. Earth's magnetic field
  - a. extends far out into space.
  - b. shields the planet from solar radiation.
  - c. is small in comparison with the size of Earth.
  - d. two of the above
5. Earth is farthest from the sun during
  - a. summer in the Northern Hemisphere.
  - b. winter in the Northern Hemisphere.
  - c. summer in the Southern Hemisphere.
  - d. different seasons from year to year.

6. Compared with Earth when it is at its aphelion, when the planet is at its perihelion, it is
  - a. closer to the sun.
  - b. moving more quickly around the sun.
  - c. rotating on its axis at a slower speed.
  - d. two of the above
7. Earth has seasons because of changes in
  - a. its distance from the sun.
  - b. the direction its axis tilts.
  - c. the angle at which its axis tilts.
  - d. its direction of rotation on its axis.

---

### Lesson 24.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. place in Earth's orbit where it is farthest from the sun
- \_\_\_\_\_ 2. spinning of an object around an axis
- \_\_\_\_\_ 3. imaginary line through Earth between the poles
- \_\_\_\_\_ 4. half of a sphere such as Earth
- \_\_\_\_\_ 5. movement of an object in an orbit around another object
- \_\_\_\_\_ 6. place in Earth's orbit where it is closest to the sun
- \_\_\_\_\_ 7. shape of Earth's orbit

#### Terms

- a. hemisphere
- b. ellipse
- c. revolution
- d. perihelion
- e. rotation
- f. aphelion
- g. axis

---

### Lesson 24.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. Earth has a magnetic field because of convection of molten metals in its \_\_\_\_\_ core.
2. In 1851, the French scientist Foucault observed a swinging \_\_\_\_\_ and concluded that Earth rotates.

3. Earth rotates \_\_\_\_\_ quickly at its poles than it does at its equator.
4. The amount of time it takes Earth to revolve around the sun is the definition of a(n) \_\_\_\_\_.
5. During summer in the Southern Hemisphere, the \_\_\_\_\_ tilts toward the sun.
6. The exact shape of Earth is not a perfect sphere but a(n) \_\_\_\_\_.
7. Earth is one of the \_\_\_\_\_ planets of our solar system.

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### Lesson 24.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain two ways that people knew Earth was spherical long before they could observe the shape of Earth from space.

---

## 24.2 Earth's Moon

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### Lesson 24.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Astronauts first walked on the moon in 1969.
  - \_\_\_\_\_ 2. The moon is about one-third the size of Earth.
  - \_\_\_\_\_ 3. The same side of the moon always faces Earth.
  - \_\_\_\_\_ 4. The far side of the moon has a thinner crust and more maria.
  - \_\_\_\_\_ 5. The moon gives off no light of its own.
  - \_\_\_\_\_ 6. The far side of the moon has been seen only by spacecraft.
  - \_\_\_\_\_ 7. The moon's surface temperature is always very low.
  - \_\_\_\_\_ 8. Volcanic activity ceased on the moon more than a billion years ago.
  - \_\_\_\_\_ 9. The moon has several high mountain ranges.
  - \_\_\_\_\_ 10. There is evidence of ancient life on the moon.
- 

### Lesson 24.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### The Lunar Surface

The moon has no atmosphere. Because an atmosphere moderates temperature, the moon's average surface temperature has a lot of variation. During the day, the surface temperature averages about 225 degrees F, but it drops to -243 degrees F at night. The coldest temperatures on the moon, at around -397 degrees F, occur in craters in the permanently shaded south polar basin. These are among the coldest temperatures recorded in the entire solar system.

The landscape of the moon is unchanging. With no plate tectonics, new surface features are not built. With no atmosphere, existing surface features are not weathered away. A major type of surface feature on the moon is craters, which are caused by meteorite impacts. Most of these occurred at least a billion years ago, but because there is no weathering, the craters still look as they did when they first formed.

Even without a telescope, you can see from Earth that the moon has dark-colored areas and light-colored areas. The dark-colored areas are called maria, and they cover about 16 percent of the moon's surface, mostly on the near side of the moon. The term maria means "seas," because people long ago thought the dark areas were seas of water, like those on Earth. However, the maria are not areas of water but areas of flat basaltic rock. From about 3.0 to 3.5 billion years ago the moon was continually bombarded by meteorites. Some of these meteorites were so large that they broke through the moon's newly formed surface. Then magma flowed out and filled the craters, forming the

basaltic maria. Scientists estimate that this activity ceased about 1.2 billion years ago.

The light-colored parts of the moon are called terrae, or highlands. Terrae have higher elevations than maria and include several high mountain ranges. Terrae consist of light silicate minerals that precipitated out of the ancient magma ocean and formed the early lunar crust.

There are no lakes, rivers, or even small puddles of liquid water anywhere on the moon's surface. However, this doesn't mean that the moon lacks water. Frozen water has been found in the extremely cold craters of the moon and also bound up in the lunar soil.

### Questions

1. Explain why surface temperatures on the moon vary from extremely hot to extremely cold.
2. Why is the landscape of the moon unchanging?
3. Compare and contrast maria and terrae on the moon's surface, including how each type of feature formed.
4. Where and in what state is water found on the moon?

---

## Lesson 24.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Areas on the moon called maria
  - a. are seas of water.
  - b. consist of basaltic lava.
  - c. formed a million years ago.
  - d. two of the above
2. The surface of the moon includes
  - a. craters.
  - b. mountains.
  - c. polar ice caps.
  - d. two of the above
3. The moon's core
  - a. is relatively small.
  - b. contains very little iron.
  - c. consists mostly of nickel.
  - d. is composed of igneous rock.
4. The mantle of the moon
  - a. is composed of two layers.
  - b. may have high levels of iron.
  - c. contains the mineral olivine.
  - d. all of the above
5. The moon's crust is rich in the elements
  - a. silicon.
  - b. oxygen.
  - c. magnesium.
  - d. all of the above



6. For the moon to make one complete rotation, it takes about 4
- hours.
  - days.
  - weeks.
  - none of the above
7. The moon has no
- water.
  - atmosphere.
  - plate tectonics.
  - two of the above

---

## Lesson 24.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. dark-colored, flat areas on the surface of the moon
- \_\_\_\_\_ 2. relating to the moon
- \_\_\_\_\_ 3. the moon's innermost layer
- \_\_\_\_\_ 4. amount of time it takes the moon to make one complete revolution
- \_\_\_\_\_ 5. bowl-shaped depression caused by a meteorite impact
- \_\_\_\_\_ 6. light-colored, highland areas on the surface of the moon
- \_\_\_\_\_ 7. the moon's outermost layer

### Terms

- orbital period
- crust
- crater
- lunar
- maria
- core
- terrae

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## Lesson 24.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- Earth's only natural satellite is the \_\_\_\_\_.
- The moon orbits Earth because of the force of \_\_\_\_\_.

3. The moon is \_\_\_\_\_ dense than Earth.
4. Earth's gravity is \_\_\_\_\_ times greater than the moon's gravity.
5. The moon's orbital period is \_\_\_\_\_ days.
6. We can see the moon from Earth only because it \_\_\_\_\_ light from the sun.
7. Features on the moon's surface do not wear down because the moon has no \_\_\_\_\_.

---

### Lesson 24.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

The footprints of astronauts in dust on the moon will remain undisturbed for as long as the moon exists unless they are struck by a meteorite. Explain why.

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## 24.3 The Sun

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### Lesson 24.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The sun is divided into definite internal layers.
- \_\_\_\_\_ 2. The hottest part of the sun has a temperature of about 27 million °C.
- \_\_\_\_\_ 3. During nuclear fusion inside the sun, helium combines to form hydrogen.
- \_\_\_\_\_ 4. A photon may travel through the radiative zone in just a few seconds.
- \_\_\_\_\_ 5. Material that rises through the convective zone cools at the sun's surface.
- \_\_\_\_\_ 6. The photosphere has a grainy appearance because it has several different colors.
- \_\_\_\_\_ 7. The sun's corona has a much cooler temperature than its photosphere.
- \_\_\_\_\_ 8. The sun's atmosphere consists of three layers.
- \_\_\_\_\_ 9. A sunspot occurs where a loop of the sun's magnetic field breaks through the solar surface.
- \_\_\_\_\_ 10. Sunspots usually occur in cycles that repeat every 21 years.

---

### Lesson 24.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Surface Features of the Sun

The most noticeable surface features of the sun are dark spots known as sunspots. Sunspots are located where loops of the sun's magnetic field break through the surface. This disrupts the smooth transfer of heat from lower layers of the sun, making sunspots cooler and darker than the rest of the surface. Sunspots are also marked by intense magnetic activity. Sunspots usually occur in pairs. When a loop of the sun's magnetic field breaks through the surface, a sunspot is created where the loop comes out of the surface. Another sunspot is created where the loop goes back into the surface.

There are other types of interruptions of the sun's magnetic field that are apparent on the surface. If a loop of the sun's magnetic field snaps and breaks, it creates a solar flare, which is a violent explosion that releases huge amounts of energy. A solar flare releases streams of highly energetic particles that make up solar wind. Solar wind sends out large amounts of radiation that can harm the human body, so it can be dangerous to astronauts in spacecraft. On Earth, solar flares have knocked out entire power grids and disturbed radio, satellite, and cell phone communications.

Another highly visible feature on the sun's surface is a solar prominence. A solar prominence is a glowing arch that forms where plasma flows along a loop of the sun's magnetic field from sunspot to sunspot. A solar prominence may reach thousands of kilometers into the sun's atmosphere. Prominences can last for a day to several months. They are

clearly visible during a total solar eclipse.

### Questions

1. Explain how sunspots form. Describe how they look and why they look this way.
2. Why do sunspots usually occur in pairs?
3. What is a solar flare. How do solar flares cause solar wind?
4. Describe a solar prominence. Explain how a solar prominence is related to sunspots.

---

## Lesson 24.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. About what percent of the total mass of the solar system consists of the sun?
  - a. 1 percent
  - b. 15 percent
  - c. 75 percent
  - d. 99 percent
2. Convective movement in the sun helps to create
  - a. solar flares.
  - b. sunspots.
  - c. photons.
  - d. two of the above
3. Which of the following layers of the sun has the highest temperature?
  - a. photosphere
  - b. chromosphere
  - c. radiative zone
  - d. corona
4. Solar flares can
  - a. knock out power grids.
  - b. be dangerous to astronauts.
  - c. disturb radio communications.
  - d. all of the above
5. Which statement about solar prominences is true?
  - a. They can reach thousands of kilometers into the sun's atmosphere.
  - b. They are never visible, even during a total solar eclipse.
  - c. They last at most for a few minutes.
  - d. all of the above
6. NASA's Solar Dynamics Observatory is
  - a. landing rovers on the sun's surface.
  - b. providing high clarity images of the sun.
  - c. examining the sun's innermost core.
  - d. two of the above
7. The matter of the sun

- a. is made of superheated gas.
- b. has a negative electrical charge.
- c. forms a defined outer boundary.
- d. has a maximum temperature of 1 million °C.

---

## Lesson 24.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. outermost plasma layer of the sun that forms a halo around the sun
- \_\_\_\_\_ 2. layer of the sun just outside the core through which energy from the core travels very slowly
- \_\_\_\_\_ 3. glowing arch formed when plasma flows along a loop from sunspot to sunspot
- \_\_\_\_\_ 4. layer of the sun just outside the radiative zone through which hot material rises
- \_\_\_\_\_ 5. thin layer of the sun that glows red when heated by energy from the photosphere
- \_\_\_\_\_ 6. violent explosion that occurs when a loop of the sun's magnetic field snaps and breaks
- \_\_\_\_\_ 7. relatively cool visible surface of the sun that emits sunlight

### Terms

- a. chromosphere
- b. corona
- c. photosphere
- d. solar flare
- e. solar prominence
- f. convection zone
- g. radiative zone

---

## Lesson 24.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The sun's energy comes from the type of reaction called nuclear \_\_\_\_\_.
- 2. Light energy travels as particles called \_\_\_\_\_.
- 3. Most atoms in the sun exist in the state of matter referred to as \_\_\_\_\_.
- 4. The sun is composed almost entirely of the elements hydrogen and \_\_\_\_\_.
- 5. Relatively cool, dark areas on the surface of the sun are known as \_\_\_\_\_.
- 6. A stream of highly magnetic particles from a solar flare makes up solar \_\_\_\_\_.
- 7. The innermost layer of the sun is called the \_\_\_\_\_ of the sun.

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## Lesson 24.3: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain why the sun has so much energy and how this energy travels from the sun's core to its surface.

## 24.4 The Sun and the Earth-Moon System

### Lesson 24.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. If the moon is full on March 1st, it will be full again on March 15th.
- \_\_\_\_\_ 2. From Earth, the moon appears to rise in the west and set in the east.
- \_\_\_\_\_ 3. Earth is closest to the sun when it is summer in the Northern Hemisphere.
- \_\_\_\_\_ 4. The sun rises earlier and sets later in the summer than in the winter.
- \_\_\_\_\_ 5. During a solar eclipse, the moon casts a shadow on the sun.
- \_\_\_\_\_ 6. During a lunar eclipse, Earth casts a shadow on the moon.
- \_\_\_\_\_ 7. A lunar eclipse occurs only when Earth, the moon, and the sun are in the ecliptic.
- \_\_\_\_\_ 8. During a full moon, the far side of the moon is completely dark.
- \_\_\_\_\_ 9. The waning gibbous phase of the moon occurs after the first quarter phase.
- \_\_\_\_\_ 10. A high tide occurs only on the side of Earth facing the moon.

### Lesson 24.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Earth's Tides

Earth's tides are the regular rising and falling of Earth's surface waters in response to the gravitational attraction of the moon and sun. The moon's gravity pulls most strongly on Earth's waters on the side of Earth facing the moon. This causes the water to bulge out from the surface in the direction of the moon. At the same time, another high tide occurs on the opposite side of Earth. This high tide occurs because the moon pulls Earth slightly away from the overlying surface water. The overlying water bulges out from the surface because it is pulled by the moon less strongly. The places in between the two high tides experience low tides because some of the water is drawn away to the high tide locations. There are two high tides and two low tides each day in a given location. Because Earth is rotating on its axis, the tidal cycle moves around the globe in a 24-hour period.

The gravity of the sun also pulls Earth's surface waters toward it, but the sun's pull is weaker than the moon's pull because the sun is so much farther away. When the sun and moon are in a straight line with respect to Earth, which occurs during the new and full moon phases, their gravities combine to create a spring tide. During a spring tide, high tides are at their highest and low tides are at their lowest, creating the greatest tidal range during each two-week period. When the sun and moon are at right angles with respect to Earth, which occurs during the first and third quarter moon phases, their gravities pull in different directions to create a neap tide. During a neap tide, high tides are at their lowest and low tides are at their highest, creating the least tidal range during each two-week period.

**Questions**

1. Explain how the moon causes high and low tides.
2. What is a spring tide? When and why does it occur?
3. What is a neap tide? When and why does it occur?

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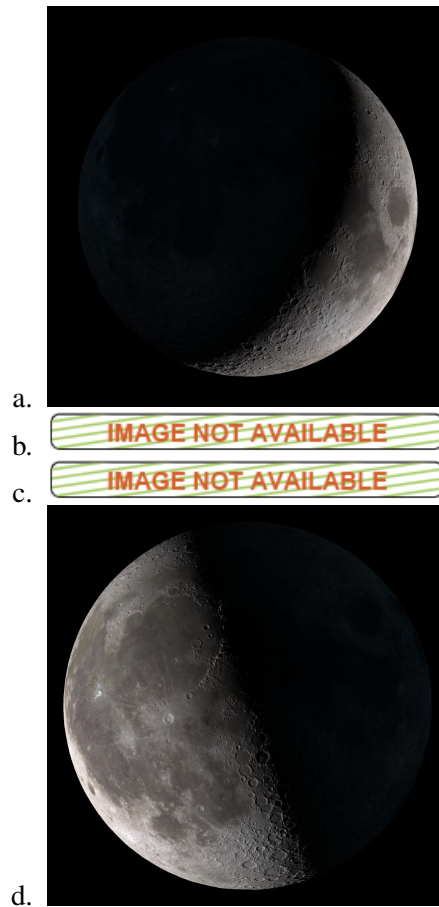
**Lesson 24.4: Multiple Choice**

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Motions of the moon and sun relative to Earth are responsible for
  - a. tides.
  - b. eclipses.
  - c. moon phases.
  - d. all of the above
2. The sun appears to move from east to west across the sky each day because Earth
  - a. rotates in a clockwise direction.
  - b. rotates from east to west.
  - c. rotates from west to east.
  - d. two of the above
3. When does the winter solstice occur in the Northern Hemisphere?
  - a. June 21
  - b. March 21
  - c. September 21
  - d. December 21
4. Which statement about solar eclipses is false?
  - a. They are rare.
  - b. They last only a few minutes.
  - c. They may be partial or total eclipses.
  - d. They occur during the full moon phase.
5. Which statement about lunar eclipses is false?
  - a. They can be seen from any place with a view of the moon.
  - b. They cause the moon to disappear completely.
  - c. They occur at least twice a year.
  - d. They may last for hours.
6. When does the first quarter phase of the moon occur?
  - a. one week after the full moon phase
  - b. two weeks after the new moon phase
  - c. three weeks after the new moon phase
  - d. two weeks after the third quarter phase
7. How does the moon appear during the first quarter phase?





## Lesson 24.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

Match each definition with the correct term.

### Definitions

- \_\_\_\_\_ 1. event that occurs when the full moon moves through Earth's shadow
- \_\_\_\_\_ 2. dark area shaped like an object that occurs where the object obstructs light
- \_\_\_\_\_ 3. phase of the moon when the near side is more than half lit but not full
- \_\_\_\_\_ 4. event that may occur when the new moon passes directly between Earth and the sun
- \_\_\_\_\_ 5. outer part of Earth's shadow during a lunar eclipse where light is only partly blocked
- \_\_\_\_\_ 6. phase of the moon when the near side is less than half lit but not new
- \_\_\_\_\_ 7. inner part of Earth's shadow during a lunar eclipse where light is completely blocked

### Terms

- a. crescent
- b. gibbous
- c. lunar eclipse
- d. penumbra

- e. shadow
- f. solar eclipse
- g. umbra

---

### Lesson 24.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. In the Northern Hemisphere, the sun is directly over the Tropic of Cancer on the day called the \_\_\_\_\_.
2. A(n) \_\_\_\_\_ solar eclipse occurs when the moon's shadow completely blocks the sun.
3. A(n) \_\_\_\_\_ lunar eclipse occurs when only part of the moon is within Earth's umbra.
4. The moon is in the \_\_\_\_\_ phase when Earth is between the moon and the sun.
5. The moon is in the \_\_\_\_\_ phase when the moon is between Earth and the sun.
6. A(n) \_\_\_\_\_ tide occurs when there is the greatest difference between high and low tides.
7. A(n) \_\_\_\_\_ tide occurs when there is the least difference between high and low tides.

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### Lesson 24.4: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Compare and contrast solar and lunar eclipses.

## CHAPTER

**25**

# HS The Solar System Worksheets

## Chapter Outline

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- 25.1 INTRODUCTION TO THE SOLAR SYSTEM**
  - 25.2 INNER PLANETS**
  - 25.3 OUTER PLANETS**
  - 25.4 OTHER OBJECTS IN THE SOLAR SYSTEM**
- 

- **Lesson 25.1: Introduction to the Solar System**
- **Lesson 25.2: Inner Planets**
- **Lesson 25.3: Outer Planets**
- **Lesson 25.4: Other Objects in the Solar System**

## 25.1 Introduction to the Solar System

### Lesson 25.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The ancient Greeks believed that Earth was at the center of the universe.
- \_\_\_\_\_ 2. Ptolemy's geocentric model was rejected after about 100 years.
- \_\_\_\_\_ 3. Copernicus thought that planets orbit the sun in ellipses.
- \_\_\_\_\_ 4. Galileo was found guilty of heresy for supporting Copernicus' model.
- \_\_\_\_\_ 5. Other stars besides our sun have planets revolving around them.
- \_\_\_\_\_ 6. Thousands of extrasolar planets have been discovered.
- \_\_\_\_\_ 7. The asteroid belt lies between Earth and Mars.
- \_\_\_\_\_ 8. The length of a day on a planet can be determined from its orbital period.
- \_\_\_\_\_ 9. One astronomical unit is equal to about 93 million kilometers.
- \_\_\_\_\_ 10. The strength of gravity between two objects depends on their mass and distance apart.

### Lesson 25.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Formation of the Solar System

All of the planets in our solar system lie in nearly the same plane. All of them also orbit the sun in the same direction. These two features provide important clues about how the solar system formed.

The most widely accepted explanation for the formation of the solar system is called the nebular hypothesis. According to this hypothesis, the sun and planets of our solar system formed about 4.6 billion years ago from the collapse of a giant cloud of gas and dust called a nebula. The nebula collapsed because it was drawn together by gravity. Gravity increased at the center of the collapsing nebula, and the cloud started to spin. As the nebula collapsed further, the spinning got faster. Much of the cloud's mass migrated to its center, but the rest of the material flattened out in an enormous disk.

As gravity pulled matter toward the center of the disk, the density and pressure at the center became intense. When the pressure at the center was high enough, nuclear fusion began. At this point, the sun came into existence. The outward force of nuclear energy from the sun countered the inward pull of gravity, and this stopped the disk from collapsing further.

Meanwhile, the outer parts of the disk were starting to cool. Matter condensed from the cloud, and small pieces of dust started clumping together. These clumps collided and combined with other clumps. Larger clumps, called

planetesimals, attracted smaller clumps with their gravity. Eventually, the planetesimals formed protoplanets, which grew to become the planets and moons that exist in the solar system today. Gravity at the center of the disk attracted heavier particles, such as rock and metal, while lighter particles remained farther out toward the edge of the disk. Because of this gravitational sorting of material, the inner planets—Mercury, Venus, Earth, and Mars—formed from dense rock and metal, whereas the outer planets—Jupiter, Saturn, Uranus and Neptune—formed from lighter materials such as hydrogen, helium, water, ammonia, and methane.

### Questions

1. List two features of the solar system that provide clues about its formation.
2. In the nebular hypothesis, why did the nebula start to collapse?
3. Describe how the sun formed, according to the nebular hypothesis.
4. How does the nebular hypothesis account for the formation of planets?
5. Based on the nebular hypothesis, why are the inner planets denser than the outer planets?

---

## Lesson 25.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. A problem with the geocentric model is that some planets seem to move backwards. Ptolemy resolved this problem by introducing the idea of
  - a. nebulas.
  - b. epicycles.
  - c. elliptical orbits.
  - d. heliocentric orbits.
2. Copernicus' model of the solar system was an improvement on Ptolemy's model because it
  - a. was less complicated.
  - b. perfectly described planetary movements.
  - c. included planetary motions called deferents.
  - d. two of the above
3. Using his telescope, Galileo made observations that supported the heliocentric model. They included the observation(s) that
  - a. Venus has phases like the moon.
  - b. Jupiter has moons orbiting around it.
  - c. planets have elliptical orbits called epicycles.
  - d. two of the above
4. Our solar system includes
  - a. more than 500 moons.
  - b. four dwarf planets.
  - c. nine planets.
  - d. all of the above
5. Exoplanets are often detected indirectly from evidence such as periodic changes in a star's
  - a. radial velocity.
  - b. temperature.
  - c. brightness.

- d. two of the above
6. Which of the following planets has the smallest mass?
- a. Venus
  - b. Earth
  - c. Mars
  - d. Uranus
7. Which of the following planets has the longest day?
- a. Mercury
  - b. Venus
  - c. Earth
  - d. Mars

---

### Lesson 25.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. scientist who revised the geocentric model of the solar system to account for retrograde motions of some planets
- \_\_\_\_\_ 2. shift from an Earth-centered to a sun-centered model of the solar system
- \_\_\_\_\_ 3. model of the solar system that places the sun at the center
- \_\_\_\_\_ 4. scientist who discovered that the orbits of planets are elliptical rather than circular
- \_\_\_\_\_ 5. model of the solar system that places Earth at the center
- \_\_\_\_\_ 6. most widely accepted explanation for how the solar system formed
- \_\_\_\_\_ 7. scientist who provided evidence for the heliocentric model of the solar system

#### Terms

- a. geocentric model
- b. heliocentric model
- c. Ptolemy
- d. nebular hypothesis
- e. Galileo
- f. Kepler
- g. Copernican revolution

---

### Lesson 25.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

1. Planets orbiting stars other than our own sun are called \_\_\_\_\_.
2. Astronomers now know that the solar system contains a total of \_\_\_\_\_ planets.
3. The planet in the solar system with the greatest diameter and mass is \_\_\_\_\_.
4. When planets are farther from the sun, the distance between their orbits is \_\_\_\_\_.
5. The distance from Earth to the sun is equal to one \_\_\_\_\_.
6. A planet that has a greater distance from the sun has a(n) \_\_\_\_\_ year.
7. The giant cloud of gas and dust from which our solar system formed is called a(n) \_\_\_\_\_.

---

## Lesson 25.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Summarize how our understanding of the solar system changed from the ancient Greeks through Galileo and Kepler.

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## 25.2 Inner Planets

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### Lesson 25.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Venus is the only inner planet that has been explored by rovers.
  - \_\_\_\_\_ 2. All of the inner planets have iron cores.
  - \_\_\_\_\_ 3. Mercury's surface is covered with volcanoes.
  - \_\_\_\_\_ 4. From Earth, Venus appears very bright because its surface is so hot that it glows.
  - \_\_\_\_\_ 5. Clouds on Venus contain carbon dioxide, sulfur dioxide, and sulfuric acid.
  - \_\_\_\_\_ 6. Venus has more volcanoes than any other planet in the solar system.
  - \_\_\_\_\_ 7. Volcanic activity on Venus is caused by plate tectonics.
  - \_\_\_\_\_ 8. Mars has been studied more thoroughly than any other planet except Earth.
  - \_\_\_\_\_ 9. Mars appears to be red in color because of iron oxide in its soil.
  - \_\_\_\_\_ 10. Water cannot stay in the liquid state on Mars because its temperature is too low.
- 

### Lesson 25.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Venus

Of all the planets in our solar system, Venus is most similar to Earth in size and density. Venus is also our nearest neighbor. In addition, Venus' interior structure is similar to Earth's, with a large iron core and a silicate mantle. But the resemblance between the two inner planets ends there.

One way that Venus differs from Earth—and from all of the other planets in the solar system—is its direction of rotation. Venus rotates in a direction opposite to the direction that it orbits the sun, whereas the rest of the planets rotate in the same direction that they orbit the sun. Venus' rotation is also extremely slow, with just one rotation every 243 days. This is longer than the 224 days it takes Venus to orbit the sun, so a day on Venus is longer than a year.

Like Earth, Venus has an atmosphere, but the atmosphere is very different from Earth's atmosphere. Venus' atmosphere consists mostly of carbon dioxide with some sulfur dioxide and sulfuric acid, which is highly corrosive. Because carbon dioxide is a greenhouse gas, Venus' atmosphere traps heat from the sun and creates a powerful greenhouse effect. Although Venus is farther from the sun than Mercury, the greenhouse effect makes Venus hotter than Mercury. In fact, Venus is the hottest planet in the solar system. Temperatures at the surface reach 465 degrees Celsius, which is hot enough to melt lead! The atmosphere of Venus is also extremely thick. Because of the thickness



of the atmosphere, the atmospheric pressure on the planet's surface is 90 times greater than the atmospheric pressure on Earth's surface.

Like Earth, Venus has many volcanoes. In fact, the surface of the planet is covered by large areas of volcanoes surrounded by plains of lava, and some of the volcanoes may be active. On Earth, volcanoes erupt along tectonic plate boundaries. On Venus, which lacks tectonic plates, heat builds up inside the planet and has no way to escape. The heat keeps building up until it finally destroys the crust and allows magma to erupt onto the surface.

### Questions

1. In what ways does Venus resemble Earth?
2. How is Venus' rotation unique among all the planets in the solar system?
3. Explain how Venus' atmosphere compares with that of Earth.
4. Describe volcanic activity on Venus.

---

## Lesson 25.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The terrestrial planets include
  - a. Mars.
  - b. Venus.
  - c. Mercury.
  - d. all of the above
2. All of the inner planets
  - a. have one or more moons.
  - b. are made of igneous rock.
  - c. have been geologically active.
  - d. two of the above
3. Compared with the outer planets, the inner planets have
  - a. slower rotations.
  - b. longer orbits.
  - c. more rings.
  - d. more moons.
4. Temperatures vary widely on Mercury because it has
  - a. almost no atmosphere.
  - b. water on the surface.
  - c. rapid rotation.
  - d. a thin crust.
5. Venus is very similar to Earth in terms of its
  - a. size.
  - b. density.
  - c. atmospheric pressure.
  - d. two of the above
6. On which planet is a year shorter than a day?

- a. Mercury
  - b. Venus
  - c. Earth
  - d. Mars
7. Compared with Earth, Mars is
- a. smaller.
  - b. colder.
  - c. drier.
  - d. all of the above

---

## Lesson 25.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. any of the four planets closest to the sun
- \_\_\_\_\_ 2. smallest planet in the solar system
- \_\_\_\_\_ 3. feature shared by all of the inner planets
- \_\_\_\_\_ 4. any planet farther from the sun than Mars
- \_\_\_\_\_ 5. planet with the highest temperatures
- \_\_\_\_\_ 6. feature found only on Earth and Mars
- \_\_\_\_\_ 7. inner planet that has two moons

### Terms

- a. ice cap
- b. Mars
- c. Mercury
- d. outer planet
- e. iron core
- f. Venus
- g. inner planet

---

## Lesson 25.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The inner planets are also called \_\_\_\_\_ planets because they are similar to Earth.
- 2. The only inner planet that has a large moon is \_\_\_\_\_.
- 3. About 42 percent of Mercury's volume consists of its \_\_\_\_\_.

4. The planet that is Earth's closest neighbor is \_\_\_\_\_.
5. The planet with the largest mountain in the solar system is \_\_\_\_\_.
6. The only planet that rotates in a direction opposite to the direction it revolves is \_\_\_\_\_.
7. The moons of Mars are thought to be captured \_\_\_\_\_.

---

## Lesson 25.2: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Of all the inner planets besides Earth, Mars is the most likely ever to have had life. Explain why.

## 25.3 Outer Planets

### Lesson 25.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. All of the outer planets are much larger than the inner planets.
- \_\_\_\_\_ 2. The gas giant Jupiter has a total of 27 known moons.
- \_\_\_\_\_ 3. The upper layer of Jupiter's atmosphere contains clouds of ammonia.
- \_\_\_\_\_ 4. Jupiter's moon Europa is heated by radiation from Jupiter.
- \_\_\_\_\_ 5. Voyager series spacecraft visited Jupiter and its moons.
- \_\_\_\_\_ 6. There are more storms on Saturn than any other outer planet.
- \_\_\_\_\_ 7. Saturn's rings are firmly attached to the surface of the planet.
- \_\_\_\_\_ 8. Saturn's largest moon Titan is bigger than the planet Mercury.
- \_\_\_\_\_ 9. Scientists think that Uranus was knocked over by a collision with a planet-sized object.
- \_\_\_\_\_ 10. Uranus was discovered by Galileo in the early 1600s.

### Lesson 25.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Neptune

Neptune is the only planet that cannot be seen from Earth without a telescope. Scientists predicted the existence of Neptune before it was actually discovered. They noticed that Uranus was not always located exactly where it should be. They assumed that the gravitational pull of another planet beyond Uranus was affecting Uranus' orbit. Neptune was discovered in 1846, in the position that had been predicted. In many respects, Neptune is similar to Uranus, although Neptune has slightly more mass and a slightly smaller diameter. Neptune is also much farther from the sun, at nearly 4.5 billion kilometers. It takes Neptune 165 Earth years to complete one orbit.

Neptune's composition is similar to that of the other gas giants. It has an atmosphere composed of hydrogen, helium, and methane gas; a mantle of water, ammonia, and methane ice; and a core of rock and ice. Neptune's blue color is mostly due to its frozen methane. Neptune has a very turbulent atmosphere. The winds on Neptune are stronger than those on any other planet in the solar system, reaching speeds of 1100 kilometers per hour, which is close to the speed of sound. This extreme weather surprised astronomers, because the planet receives little energy from the sun to power weather systems. Neptune is also one of the coldest places in the solar system. Temperatures at the top of the clouds are about -218 degrees Celsius.

Like the other outer planets, Neptune has rings of ice and dust. However, the rings are faint and may change or

disappear over fairly short periods of time. Neptune has 13 known moons. The only one that has enough mass to be pulled into a spherical shape by its own gravity is Triton. This moon orbits in the opposite direction to the orbit of Neptune. Scientists think that Triton did not form near Neptune but instead was captured by Neptune's gravity as it passed by.

### Questions

1. How did scientists predict the existence of Neptune before it was discovered?
2. In what ways is Neptune similar to the other outer planets?
3. Describe Neptune's weather.
4. Why do scientists think that Triton did not form near Neptune?

---

## Lesson 25.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. The outer planets include all of the following planets except
  - a. Jupiter.
  - b. Saturn.
  - c. Uranus.
  - d. Venus.
2. All of the outer planets have
  - a. multiple moons.
  - b. planetary rings.
  - c. solid surfaces.
  - d. two of the above
3. From Earth, Jupiter appears to be very bright in the night sky because it is
  - a. very large and reflects a lot of sunlight.
  - b. one of the hottest planets in the solar system.
  - c. almost as close to Earth as Venus, the brightest planet.
  - d. none of the above
4. The largest moon in the solar system is the moon named
  - a. Titan.
  - b. Triton.
  - c. Oberon.
  - d. Ganymede.
5. Besides Earth, which planet in the solar system has been observed to have thunderstorms?
  - a. Jupiter
  - b. Saturn
  - c. Uranus
  - d. Neptune
6. Why does Uranus appear blue?
  - a. It is covered with a thick layer of bluish ice.
  - b. Only blue light can travel that far from the sun.
  - c. It has clouds of methane that filter out red light.

- d. none of the above
7. How many moons does Uranus have?
- a. 13
  - b. 27
  - c. 63
  - d. 67

---

### Lesson 25.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

#### Definitions

- \_\_\_\_\_ 1. largest planet in the solar system
- \_\_\_\_\_ 2. least dense of all the planets in the solar system
- \_\_\_\_\_ 3. dust and other small particles that encircle an outer planet
- \_\_\_\_\_ 4. planet with stronger winds than any other planet in the solar system
- \_\_\_\_\_ 5. huge storm on the surface of Jupiter
- \_\_\_\_\_ 6. gap in the methane clouds on Neptune
- \_\_\_\_\_ 7. only planet in the solar system with an axis almost parallel to its orbit

#### Terms

- a. Great Dark Spot
- b. Jupiter
- c. Saturn
- d. planetary ring
- e. Uranus
- f. Great Red Spot
- g. Neptune

---

### Lesson 25.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The outer planets are made largely of gases, so they are also called \_\_\_\_\_.
- 2. The outer planets consist mainly of the elements helium and \_\_\_\_\_.
- 3. The four moons of Jupiter named Io, Europa, Ganymede, and Callisto are called collectively \_\_\_\_\_-moons.
- 4. The only planet with rings that are easy to see from Earth is \_\_\_\_\_.
- 5. The only planet that cannot be seen from Earth without a telescope is \_\_\_\_\_.

6. The existence of \_\_\_\_\_ was predicted before it was discovered because of its influence on Uranus' orbit.
7. Most of the moons of \_\_\_\_\_ are named for characters in Shakespeare's plays.

---

### Lesson 25.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

The inner planets are also called the terrestrial planets. The outer planets could accurately be called the non-terrestrial planets. Explain why.

## 25.4 Other Objects in the Solar System

### Lesson 25.4: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Most asteroids are geologically active.
- \_\_\_\_\_ 2. Asteroid impacts are linked to mass extinctions in Earth's past.
- \_\_\_\_\_ 3. A total of about 5000 asteroids have been discovered.
- \_\_\_\_\_ 4. Scientists think that the asteroid belt formed more recently than the rest of the solar system.
- \_\_\_\_\_ 5. Meteors range from the size of boulders down to the size of grains of sand.
- \_\_\_\_\_ 6. Most meteors burn up in the atmosphere.
- \_\_\_\_\_ 7. The Kuiper belt contains comets, asteroids, and dwarf planets.
- \_\_\_\_\_ 8. Ceres is a dwarf planet located in the Kuiper belt.
- \_\_\_\_\_ 9. Eris was once considered to be the tenth planet in the solar system.
- \_\_\_\_\_ 10. Astronomers think there may be many undiscovered dwarf planets in our solar system.

### Lesson 25.4: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Planet or Dwarf Planet?

From the time it was discovered in 1930 until 2006, Pluto was considered the ninth planet in our solar system. When astronomers first observed Pluto, telescopes were not as powerful as they are now, so Pluto and its moon Charon were thought to be one larger object. With stronger telescopes, astronomers realized that Pluto was much smaller than they had thought. Over time, astronomers learned more about Pluto and found that it differed from the other planets in additional ways. For example, unlike the outer planets, which are gas giants, Pluto is icy and rocky. Pluto's orbit is also tilted relative to the orbits of the other planets, and its orbit is longer and narrower. Scientists also discovered that Pluto's orbit is part of the Kuiper belt, a distant region of the solar system where more than 200 million small objects orbit the sun.

Astronomers began to debate whether Pluto and other newly discovered, similar objects should be classified as planets. They decided that they needed to refine their definition of planet. According to the new definition, a planet must:

- orbit a star rather than another planet so it is not a moon.
- be small enough that it isn't a star.
- have enough mass that its gravity pulls it into a spherical shape.



- have enough gravity to have cleared its orbit of smaller objects.

Pluto does not fit the revised definition of a planet. It meets the first three criteria in the list above, but as part of the Kuiper belt, it does not meet the fourth criterion. To classify Pluto and similar orbiting objects, astronomers came up with a new category, the dwarf planet. A dwarf planet is an object that meets all the criteria of a planet except for clearing its orbit of other objects. In addition to Pluto, there are currently three other known dwarf planets in the solar system: Eris, Ceres, and Makemake.

### Questions

1. How does Pluto differ from the planets in our solar system?
2. What is the new (post-2006) definition of a planet?
3. What is a dwarf planet? Why is Pluto classified as a dwarf planet?

---

## Lesson 25.4: Multiple Choice

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Circle the letter of the correct choice.*

1. An asteroid lacks all of the following except
  - a. a spherical shape.
  - b. an atmosphere.
  - c. internal heat.
  - d. gravity.
2. Possible origins of meteoroids include
  - a. asteroids.
  - b. comet tails.
  - c. the planet Mars.
  - d. all of the above
3. Water may have been brought to early Earth when it collided with
  - a. comets.
  - b. asteroids.
  - c. meteoroids.
  - d. other planets.
4. Why does the tail of a comet always point away from the sun?
  - a. The tail is pulled by planetary gravity.
  - b. The tail is pushed by particles from the sun.
  - c. The tail has a hooked shape because of the comet's spin.
  - d. none of the above
5. Comets with periods of thousands or millions of years originate in a region of the solar system called the
  - a. asteroid belt.
  - b. Kuiper belt.
  - c. Oort cloud.
  - d. outer belt.
6. Which of the following is classified as a dwarf planet?
  - a. Hydra

- b. Charon
  - c. Dysnomia
  - d. Makemake
7. Which of the following statements describes a planet but not a dwarf planet?
- a. It has enough mass to form a spherical shape.
  - b. It has cleared its orbit of smaller objects.
  - c. It is not a moon of a larger planet.
  - d. It orbits around a star.

---

## Lesson 25.4: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. what a meteor is called after it lands on Earth
- \_\_\_\_\_ 2. small, icy object with a very elliptical orbit around the sun
- \_\_\_\_\_ 3. very small, rocky body that orbits the sun
- \_\_\_\_\_ 4. one of Pluto's moons
- \_\_\_\_\_ 5. what a meteor is called before it enters Earth's atmosphere
- \_\_\_\_\_ 6. one of the solar system's dwarf planets
- \_\_\_\_\_ 7. small piece of rock burning up as it passes through Earth's atmosphere

### Terms

- a. asteroid
- b. Hydra
- c. meteorite
- d. Ceres
- e. meteor
- f. comet
- g. meteoroid

---

## Lesson 25.4: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Most of the asteroids in the solar system are found between Mars and Jupiter in a band called the \_\_\_\_\_.
- 2. Earth's moon is thought to have originated from Earth when the planet was struck by a large \_\_\_\_\_.
- 3. Asteroids with orbits that cross Earth's orbit are called \_\_\_\_\_ asteroids.
- 4. A(n) \_\_\_\_\_ occurs when Earth passes through a cluster of meteoroids.

5. The time between one appearance of a comet and the next is called the comet's \_\_\_\_\_.
6. Comets that reappear every 200 years or less originate in a region of the solar system called the \_\_\_\_\_.
7. The largest known dwarf planet in the solar system is named \_\_\_\_\_.

---

### Lesson 25.4: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Scientists are very interested in studying asteroids. Explain why.

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# CHAPTER **26** HS Stars, Galaxies, and the Universe Worksheets

## Chapter Outline

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- 26.1 STARS**
  - 26.2 GALAXIES**
  - 26.3 THE UNIVERSE**
- 

- Lesson 26.1: Stars
- Lesson 26.2: Galaxies
- Lesson 26.3: The Universe

## 26.1 Stars

### Lesson 26.1: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

Write true if the statement is true or false if the statement is false.

- \_\_\_\_\_ 1. A given constellation is always in the same place in the sky.
- \_\_\_\_\_ 2. All the stars in a constellation are actually very close together.
- \_\_\_\_\_ 3. Many stars produce much more energy than our sun.
- \_\_\_\_\_ 4. Gravity prevents nuclear fusion from causing a star to collapse.
- \_\_\_\_\_ 5. All the energy from stars is in the form of visible or ultraviolet light.
- \_\_\_\_\_ 6. An orange star is hotter than a yellow star.
- \_\_\_\_\_ 7. For main sequence stars, temperature is directly related to brightness.
- \_\_\_\_\_ 8. Larger stars spend more time as main sequence stars than smaller stars do.
- \_\_\_\_\_ 9. A star that is a red giant will next become a white dwarf.
- \_\_\_\_\_ 10. All elements with an atomic number greater than lithium formed in stars by nuclear fusion.

### Lesson 26.1: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

Read this passage based on the text and answer the questions that follow.

#### How Stars Are Classified

The color of a star reflects its surface temperature. The temperature of a star, in turn, is influenced by the star's size. Smaller stars produce less energy, so they generally have cooler surface temperatures than larger stars. Relatively cool stars are red, warmer stars are orange or yellow, and extremely hot stars are blue or blue-white. Color is the most common way to classify stars. The **Table 26.1** shows the classification system. The class of a star is given by a letter, and each letter corresponds to a color and range of temperatures.

**TABLE 26.1: Classification of Stars By Color and Temperature**

Class	Color	Temperature Range	Sample Star
O	Blue	30,000 K or more	Zeta Ophiuchi
B	Blue-white	10,000–30,000 K	Rigel
A	White	7,500–10,000 K	Altair
F	Yellowish-white	6,000–7,500 K	Procyon A
G	Yellow	5,500–6,000 K	Sun
K	Orange	3,500–5,000 K	Epsilon Indi

**TABLE 26.1:** (continued)

Class	Color	Temperature Range	Sample Star
M	Red	2,000–3,500 K	Betelgeuse, Proxima Centauri

### Questions

1. Relate the color of a star to its surface temperature.
2. Explain how a star's size influences its temperature.
3. About how much hotter is a class G star such as our sun than a class M class star such as Betelgeuse? Which class has stars about twice as hot as the sun? Give an example of a star in this class.

---

## Lesson 26.1: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Main sequence stars may differ in all of the following ways except
  - a. age.
  - b. size.
  - c. temperature.
  - d. composition.
2. What may change about a constellation?
  - a. its location in the sky
  - b. the stars it contains
  - c. the relative positions of its stars
  - d. none of the above
3. In main sequence stars, nuclear fusion results in the formation of
  - a. hydrogen.
  - b. helium.
  - c. carbon.
  - d. all of the above
4. Which color indicates a star with the highest temperature?
  - a. red
  - b. orange
  - c. yellow
  - d. blue
5. For main sequence stars, a Hertzsprung-Russell diagram shows the stars' temperature and
  - a. color.
  - b. brightness.
  - c. mass.
  - d. size.
6. In which stage do stars spend most of their life?
  - a. red giant

- b. blue giant
  - c. white dwarf
  - d. main sequence
7. After a supernova explosion, the core of a star may become a(n)
- a. red supergiant.
  - b. neutron star.
  - c. black hole.
  - d. b or c above

---

## Lesson 26.1: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. stage in which a star's force of nuclear fusion balances its force of gravity
- \_\_\_\_\_ 2. violent explosion of a red supergiant
- \_\_\_\_\_ 3. stage in which a star consists almost entirely of neutral particles
- \_\_\_\_\_ 4. stage in which a star's outer layers have started to cool and grow outward
- \_\_\_\_\_ 5. stage in which a typical star has completely stopped fusion
- \_\_\_\_\_ 6. cluster of stars that appear close together in the sky
- \_\_\_\_\_ 7. collapsed core of a star that is too dense for light to escape its gravity

### Terms

- a. asterism
- b. main sequence
- c. neutron star
- d. red giant
- e. white dwarf
- f. supernova
- g. black hole

---

## Lesson 26.1: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. A giant ball of glowing gas at a very high temperature is a(n) \_\_\_\_\_.
- 2. \_\_\_\_\_ is an apparent shift in position that is used to measure a star's distance.
- 3. All stars get their energy from a type of reaction called \_\_\_\_\_.
- 4. The color of a star is an indication of the star's \_\_\_\_\_.

5. A bigger star tends to have a(n) \_\_\_\_\_ temperature than a smaller star.
6. What happens to a red giant after it burns up all of its helium depends on its \_\_\_\_\_.
7. When our own sun completely stops fusion, it will become a(n) \_\_\_\_\_.

---

### Lesson 26.1: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how parallax is used to measure the distance of stars.



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## 26.2 Galaxies

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### Lesson 26.2: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. There are a total of about 5 million galaxies in the universe.
- \_\_\_\_\_ 2. Star clusters contain greater numbers of stars than galaxies do.
- \_\_\_\_\_ 3. The Pleiades, or Seven Sisters, is an example of a star cluster.
- \_\_\_\_\_ 4. Globular clusters have a lot of dust in addition to stars.
- \_\_\_\_\_ 5. The Andromeda Galaxy is an example of an irregular galaxy.
- \_\_\_\_\_ 6. The reason we can't see many dwarf galaxies is that they are so distant.
- \_\_\_\_\_ 7. The Milky Way Galaxy has a disk and central bulge.
- \_\_\_\_\_ 8. Our solar system is at the outermost edge of our galaxy.
- \_\_\_\_\_ 9. Constellations are binary or multiple star systems.
- \_\_\_\_\_ 10. More than half of the bright stars we see in our galaxy are actually star systems.

---

### Lesson 26.2: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Types of Galaxies

Galaxies are the biggest groups of stars in the universe. They can contain anywhere from a few million to many billions of stars. Galaxies are divided into three types according to shape: spiral, elliptical, and irregular galaxies.

- Spiral galaxies spin and appear as a rotating disk of stars and dust, with a bulge in the middle. Several spiral arms reach outward from the central bulge like the arms of a pinwheel. Spiral galaxies have lots of gas and dust. Most of their stars are young and blue in color.
- Elliptical galaxies are more-or-less egg shaped. The smallest elliptical galaxies are as small as some globular clusters. The largest elliptical galaxies can contain over a trillion stars. Most stars in elliptical galaxies are reddish to yellowish in color because they are old stars. Most elliptical galaxies contain very little gas and dust because these particles have already formed into stars.
- Irregular galaxies are neither elliptical nor spiral in shape. Most irregular galaxies were once spiral or elliptical galaxies that were then deformed. This may have happened by gravitational attraction to a larger galaxy or by collision with another galaxy.

Dwarf galaxies are small galaxies containing only a few million or billion stars. Dwarf galaxies are the most common type of galaxies in the universe. However, because they are small, they are also dim, so we don't see very many

dwarf galaxies from Earth. Most dwarf galaxies are irregular in shape. However, there are also dwarf elliptical galaxies and dwarf spiral galaxies. Dwarf galaxies are often found near larger galaxies. They sometimes collide and merge with their larger neighbors.

### Questions

1. What are galaxies?
2. Compare and contrast spiral, elliptical, and irregular galaxies.
3. Describe dwarf galaxies.

---

## Lesson 26.2: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Stars in an open cluster are generally
  - a. red.
  - b. old.
  - c. from the same nebula.
  - d. two of the above
2. Groups of stars that contain the greatest numbers of stars are
  - a. globular clusters.
  - b. open clusters.
  - c. star systems.
  - d. galaxies.
3. Types of galaxies by shape include
  - a. dwarf galaxies.
  - b. elliptical galaxies.
  - c. regular galaxies.
  - d. all of the above
4. Dwarf galaxies are
  - a. relatively rare.
  - b. not very bright.
  - c. mostly spiral shaped.
  - d. two of the above
5. The Milky Way Galaxy
  - a. is a dwarf galaxy.
  - b. is an elliptical galaxy.
  - c. has spiral arms.
  - d. has 1 to 2 million stars.
6. Which statement(s) about irregular galaxies is (are) true?
  - a. Most were once spiral or elliptical galaxies.
  - b. They became irregular when they were deformed.
  - c. They were changed by gravity or a collision.
  - d. all of the above
7. Globular clusters

- a. are spherical in shape.
- b. contain mostly blue stars.
- c. have widely spaced stars.
- d. contain billions of stars.

---

## Lesson 26.2: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Match each definition with the correct term.*

### Definitions

- \_\_\_\_\_ 1. group of up to a few thousand stars held loosely together by gravity
- \_\_\_\_\_ 2. type of galaxy that forms a rotating disk
- \_\_\_\_\_ 3. group of many thousand stars held tightly together by gravity
- \_\_\_\_\_ 4. type of galaxy that is shaped like an egg
- \_\_\_\_\_ 5. type of galaxy that is most common in the universe
- \_\_\_\_\_ 6. any group of millions, billions, or even trillions of stars
- \_\_\_\_\_ 7. type of galaxy that has no definite shape

### Terms

- a. dwarf galaxy
- b. elliptical galaxy
- c. globular cluster
- d. irregular galaxy
- e. open cluster
- f. spiral galaxy
- g. galaxy

---

## Lesson 26.2: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. Our solar system is located in the \_\_\_\_\_ Galaxy.
- 2. A set of stars that are grouped closely together is called a star \_\_\_\_\_.
- 3. Hundreds or thousands of stars that are grouped closely together make up a star \_\_\_\_\_.
- 4. A system of two stars orbiting each other is called a(n) \_\_\_\_\_.
- 5. A spiral galaxy has projections called \_\_\_\_\_.
- 6. Based on its shape, the Milky Way Galaxy is classified as a(n) \_\_\_\_\_ galaxy.
- 7. At the center of most galaxies is a supermassive \_\_\_\_\_.

---

## Lesson 26.2: Critical Writing

Name\_\_\_\_\_ Class\_\_\_\_\_ Date\_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

Explain how scientists determined the shape of the Milky Way Galaxy, including the types of evidence they used.

## 26.3 The Universe

### Lesson 26.3: True or False

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Hubble was the first scientist to discover that the universe is much larger than our own galaxy.
- \_\_\_\_\_ 2. Today we know that there are as many galaxies in the universe as there are stars in our galaxy.
- \_\_\_\_\_ 3. The existence of redshift demonstrates that other stars in the Milky Way Galaxy are moving away from our solar system.
- \_\_\_\_\_ 4. Evidence has proven conclusively that the Big Bang theory is correct.
- \_\_\_\_\_ 5. Scientists think that light-emitting objects now make up most of the matter in the universe.
- \_\_\_\_\_ 6. Dark matter has no mass so it has no gravity.
- \_\_\_\_\_ 7. Most astronomers think that the universe will expand more slowly in the future than it is expanding now.
- \_\_\_\_\_ 8. Some scientists estimate that there is currently more dark energy than ordinary energy in the universe.
- \_\_\_\_\_ 9. Gravitational lensing provides evidence for the existence of dark matter.
- \_\_\_\_\_ 10. A similar principle explains both redshift and the Doppler effect.

### Lesson 26.3: Critical Reading

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Read this passage based on the text and answer the questions that follow.*

#### Formation of the Universe

The Big Bang theory is the most widely accepted cosmological explanation for how the universe formed. According to the Big Bang theory, the universe began about 13.7 billion years ago, before which everything in the universe was squeezed into a very small volume. This means that at the beginning, the entire known universe was a single, hot, chaotic mass. Then, an enormous explosion—a big bang—caused the universe to start expanding rapidly. According to the Big Bang theory, all of the matter and energy in the universe, and even space itself, came out of this explosion.

In the first few moments after the Big Bang, the universe was unimaginably hot and dense. As the universe expanded, it became less dense and began to cool. After only a few seconds, protons, neutrons, and electrons began to form. After a few minutes, protons and neutrons came together to create hydrogen nuclei. Energy in the universe was great enough to initiate nuclear fusion, and hydrogen nuclei fused together to become helium nuclei. However, the first neutral atoms (atoms that included electrons) did not form until about 380,000 years later. Scientists think that matter in the early universe was not evenly distributed across space. Instead, there existed dense clumps of matter held together by gravity. Eventually, these clumps became the countless trillions of stars, billions of galaxies, and other structures we now know to make up the visible mass of the universe.

When it was first proposed, the Big Bang theory was just a hypothesis. Many astronomers did not accept it and thought that the universe was static. However, nearly all astronomers came to accept the hypothesis when an important line of evidence for the Big Bang was discovered in 1964. After that, the Big Bang hypothesis achieved the status of a scientific theory. Two researchers at Bell Laboratories, using a microwave receiver, learned that the background radiation of the universe gave space a temperature of 3 Kelvin, not 0 Kelvin, which would be expected in a static universe. Although this is a small amount of heat, it was enough for most scientists to agree that it must be left over from the Big Bang.

### Questions

1. What is the Big Bang theory?
2. Outline the events that occurred after the initial big bang.
3. What evidence convinced most astronomers that the Big Bang hypothesis should be considered a scientific theory?

---

### Lesson 26.3: Multiple Choice

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Circle the letter of the correct choice.*

1. Dark bands in the spectrum of light from a star show where elements in the star
  - a. absorb light.
  - b. reflect light.
  - c. refract light.
  - d. shift light.
2. What occurs as the universe expands?
  - a. Solar systems get larger.
  - b. Galaxies increase in size.
  - c. The space between galaxies increases.
  - d. all of the above
3. Prior to their acceptance of the Big Bang theory, most astronomers thought that the universe was
  - a. unchanging.
  - b. growing bigger.
  - c. shrinking in size.
  - d. alternately contracting and expanding.
4. After the Big Bang occurred, scientists think that the universe
  - a. started to expand.
  - b. grew less dense.
  - c. began to cool.
  - d. all of the above
5. How do scientists know that dark matter exists?
  - a. Its heat raises the temperature of space.
  - b. Its gravity affects objects around it.
  - c. It gives off electromagnetic waves.
  - d. all of the above
6. Astronomers have discovered recently that the rate at which the universe is expanding is

- a. increasing.
  - b. decreasing.
  - c. staying the same.
  - d. impossible to determine.
7. Massive astrophysical compact halo objects (MACHOS) include objects in
- a. black holes.
  - b. neutron stars.
  - c. white dwarfs.
  - d. two of the above

---

### Lesson 26.3: Matching

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

#### Definitions

- \_\_\_\_\_ 1. all the matter, energy, space, and time that ever existed and will ever exist
- \_\_\_\_\_ 2. observation that more distant galaxies are moving away from us more quickly than closer galaxies
- \_\_\_\_\_ 3. change in the color of light absorbed by an object as it moves away from an observer
- \_\_\_\_\_ 4. proposed form of energy that we currently are unable to detect
- \_\_\_\_\_ 5. most widely accepted explanation for how the universe formed
- \_\_\_\_\_ 6. matter in the universe that does not give off electromagnetic radiation
- \_\_\_\_\_ 7. shift in the pitch of sound as the sound source moves away from the listener

#### Terms

- a. Hubble's law
- b. Big Bang theory
- c. dark energy
- d. Doppler effect
- e. universe
- f. dark matter
- g. redshift

---

### Lesson 26.3: Fill in the Blank

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Fill in the blank with the appropriate term.*

- 1. The study of the universe is called \_\_\_\_\_.
- 2. The scientist who discovered that there are galaxies beyond the Milky Way Galaxy was \_\_\_\_\_.
- 3. The element helium was first discovered in the \_\_\_\_\_.

4. Based on Hubble's law, scientists concluded that the universe is \_\_\_\_\_.
5. According to the Big Bang theory, the universe began about \_\_\_\_\_ years ago.
6. Scientists think that about 80 percent of matter in the universe is \_\_\_\_\_ matter.
7. \_\_\_\_\_ occurs when light from a very distant source bends around a super-massive object.

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### Lesson 26.3: Critical Writing

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

*Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.*

An inflating balloon is sometimes used as an analogy for an expanding universe. Critique this analogy.



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# CHAPTER **27** CK-12 Earth Science For High School Workbook Answers

## Chapter Outline

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- 27.1 CHAPTER 1: WHAT IS EARTH SCIENCE?
  - 27.2 CHAPTER 2: STUDYING EARTH'S SURFACE
  - 27.3 CHAPTER 3: EARTH'S MINERALS
  - 27.4 CHAPTER 4: ROCKS
  - 27.5 CHAPTER 5: EARTH'S ENERGY
  - 27.6 CHAPTER 6: PLATE TECTONICS
  - 27.7 CHAPTER 7: EARTHQUAKES
  - 27.8 CHAPTER 8: VOLCANOES
  - 27.9 CHAPTER 9: WEATHERING AND FORMATION OF SOIL
  - 27.10 CHAPTER 10: EROSION AND DEPOSITION
  - 27.11 CHAPTER 11: EVIDENCE ABOUT EARTH'S PAST
  - 27.12 CHAPTER 12: EARTH'S HISTORY
  - 27.13 CHAPTER 13: EARTH'S FRESH WATER
  - 27.14 CHAPTER 14: EARTH'S OCEANS
  - 27.15 CHAPTER 15: EARTH'S ATMOSPHERE
  - 27.16 CHAPTER 16: WEATHER
  - 27.17 CHAPTER 17: CLIMATE
  - 27.18 CHAPTER 18: ECOSYSTEMS AND HUMAN POPULATIONS
  - 27.19 CHAPTER 19: HUMAN ACTIONS AND THE LAND
  - 27.20 CHAPTER 20: HUMAN ACTIONS AND EARTH'S RESOURCES
  - 27.21 CHAPTER 21: HUMAN ACTIONS AND EARTH'S WATER
  - 27.22 CHAPTER 22: HUMAN ACTIONS AND THE ATMOSPHERE
  - 27.23 CHAPTER 23: OBSERVING AND EXPLORING SPACE
  - 27.24 CHAPTER 24: EARTH, MOON, AND SUN
  - 27.25 CHAPTER 25: THE SOLAR SYSTEM
  - 27.26 CHAPTER 26: STARS, GALAXIES, AND THE UNIVERSE WORKSHEETS
- 

- The answer keys can be found in the Resource tab above the Table of Contents.

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## 27.1 Chapter 1: What is Earth Science?

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### Lesson 1.1 Worksheet Answer Key

#### True or False

1. true
2. false
3. true
4. false
5. false
6. true
7. false
8. true
9. false
10. false

#### Critical Reading

1. Peer review is the review by other scientists in the same field of a scientist's research paper before it is accepted for publication. Peer review is important because it helps to ensure that scientific publications are trustworthy and significant.
2. The scientific community influences the quality and type of scientific research that is done by helping to determine which research projects receive funding. Scientific research can be very expensive. Scientists generally must submit research proposals to funding agencies, such as the National Science Foundation, in order to obtain the needed money. The proposals are reviewed by other scientists in the field, who make recommendations as to which projects are most worthy of funding.
3. The scientific community promotes scientific integrity by training new scientists to conduct and report scientific investigations fairly and honestly. New scientists are trained in how to conduct good scientific experiments. They are taught to report their results completely and openly. They also learn how to fairly evaluate data and the work of other scientists. In addition, any scientists who do not act with integrity are strongly condemned by the scientific community.

#### Multiple Choice

1. a
2. c
3. c
4. b
5. d
6. b
7. c

**Matching**

1. a
2. g
3. c
4. e
5. b
6. d
7. f

**Fill in the Blank**

1. question
2. research
3. physical
4. theory
5. conceptual
6. conclusion
7. mathematical

**Critical Writing**

*Sample answer:* Models are used in science to study systems or objects that are very complex, extremely large or small, or difficult to work with for any other reason. Examples of systems and objects that are likely to be easier to study with models include Earth's climate, a single cell, and the solar system. Models are simpler than the real thing, and they allow scientists to manipulate objects and systems that they could not control in real life. Three types of models used in science are physical, conceptual, and mathematical models. All of them represent the real world in simpler ways, but the nature of the three types of models differs. Physical models are physical representations of the real world. A map or globe is a physical model of Earth's surface. Conceptual models link ideas in an attempt to explain phenomena. An example is the idea that the moon formed from Earth after an interplanetary collision. A mathematical model is a set of equations that represents a complex system. An example is a mathematical model of climate change.

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**Lesson 1.2 Worksheet Answer Key****True or False**

1. true
2. true
3. false
4. false
5. true
6. true
7. false
8. true
9. false
10. false

### Critical Reading

1. Earth science is the study of all aspects of planet Earth, including its lands, interior, atmosphere, and oceans. Earth science has many branches because Earth is a very large and complex set of systems.
2. The main branches of Earth science are geology, meteorology, climatology, oceanography, and environmental science.
3. The focus of geology is Earth's solid materials and structures and the processes that create them. Geology is divided into many branches, including mineralogy, planetary geology, marine geology, and seismology.
4. Scientists in different branches of Earth science must generally work together to answer complex questions because all of Earth's systems are interconnected.

### Multiple Choice

1. d
2. c
3. c
4. c
5. c
6. c
7. d

### Matching

1. d
2. a
3. c
4. g
5. b
6. f
7. e

### Fill in the Blank

1. mineralogists
2. Planetary geologists
3. hydrology
4. oceanography
5. physical oceanographer
6. marine geologist
7. marine biologist

### Critical Writing

*Sample answer:* A question that might be investigated by an environmental scientist is: How are human actions contributing to global climate change? Another branch of Earth science that might be called upon to help answer the question is climatology. Climatology is the study of Earth's atmosphere. Climatologists focus on climate and how it changes over time.

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## 27.2 Chapter 2: Studying Earth's Surface

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### Lesson 2.1 Worksheet Answer Key

#### True or False

1. false
2. true
3. false
4. true
5. false
6. false
7. true
8. false
9. true
10. true

#### Critical Reading

1. Continents are large land areas extending from high mountaintops to sea level. Landforms such as mountains and valleys are physical features on Earth's surface.
2. Both constructive and destructive forces are forces that change Earth's surface. Constructive forces build up landforms, whereas destructive forces wear down landforms.
3. A volcano is a constructive force when it results in the buildup of a mountain. This happens over time as magma keeps flowing over the surface and hardening to form solid rock. A volcano is a destructive force when it erupts explosively and blows apart a mountain, leaving a crater. A river is a constructive force when it deposits the sediments it is carrying. For example, a river builds up a delta where it deposits sediments as it flows into a body of still water. A river is a destructive force when it erodes rocks as it flows over the land, creating a valley.

#### Multiple Choice

1. d
2. d
3. d
4. b
5. b
6. a
7. b

#### Matching

1. e

2. d
3. f
4. a
5. g
6. c
7. b

### Fill in the Blank

1. destructive
2. destructive
3. constructive
4. destructive
5. erosion
6. destructive

### Critical Writing

*Sample answer:* The quote applies to planet Earth because constructive and destructive forces cause Earth to change constantly. The changes may occur over short periods of time as well as over long periods of time. Constructive forces, such as volcanic activity and uplift of the crust, cause new features to form on Earth's surface. Destructive forces, such as weathering and erosion, modify features on the surface or even wear them away completely. For example, beneath the oceans, volcanic activity forms new seafloor, while old seafloor is destroyed as it is pulled under crust at ocean trenches.

---

## Lesson 2.2 Worksheet Answer Key

### True or False

1. false
2. false
3. true
4. true
5. false
6. true
7. false
8. true
9. false
10. true

### Critical Reading

1. Latitude is a measure of the distance north or south of the equator. The line of latitude that is 45 degrees north circles the globe parallel to the equator halfway between the equator and the north pole in the Northern Hemisphere.
2. Longitude is a measure of the distance east or west of the prime meridian. The line of longitude that is 90 degrees east circles the globe perpendicular to the equator halfway between the prime meridian and the international dateline in the Eastern Hemisphere.

3. Elevation is the height of a place. It is measured relative to sea level. Elevation may be either above or below sea level. Sea level, which is the same everywhere on Earth, is the average height of the ocean's surface, or the midpoint between high and low tides.

### Multiple Choice

1. b
2. a
3. c
4. c
5. c
6. d
7. a

### Matching

1. g
2. b
3. a
4. e
5. f
6. c
7. d

### Fill in the Blank

1. Triangulation
2. magnetic
3. geographic
4. prime meridian
5. latitude
6. sea level
7. Relief

### Critical Writing

*Sample answer:* Earth has north and south geographic poles and also north and south magnetic poles. The geographic north pole is the point where the axis upon which Earth rotates intersects the planet's surface in the Northern Hemisphere. The latitude of the geographic north pole is 90 degrees north. The magnetic north pole is the point in the Northern Hemisphere to which a magnetic compass needle points. The magnetic north pole is near—but not in exactly the same location—as the geographic north pole. The latitude of the magnetic north pole is offset by 11.5 degrees from the geographic north pole.

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## Lesson 2.3 Worksheet Answer Key

### True or False

1. false
2. false
3. false
4. true
5. true
6. false
7. true
8. true
9. false
10. true

### Critical Reading

1. Projections are maps created by projecting part of Earth's curved surface onto a flat surface. Projections are used to make maps of Earth's surface because Earth's surface is three-dimensional whereas maps are two-dimensional.
2. A Mercator projection is made by wrapping a flat piece of paper around a globe at the equator to make a cylinder. The features of Earth's surface are projected outward onto the cylinder. When the cylinder is unrolled, the result is a flat Mercator projection. A disadvantage of Mercator projections is the way they stretch out features near the poles. For example, on a Mercator projection Greenland is stretched out to look almost as big as the United States.
3. *Sample answer:* Two other types of map projections are conic projections and gnomonic projections. A conic projection uses a cone rather than a cylinder to project Earth's curved surface onto a flat map. It best depicts the area where the cone touches the globe. A gnomonic projection projects Earth's surface onto a flat map from a single point. The projection is most accurate for features near that point.

### Multiple Choice

1. d
2. a
3. d
4. b
5. b
6. b
7. c

### Matching

1. d
2. a
3. b
4. c
5. f
6. g



7. e

### Fill in the Blank

1. globe
2. map
3. projection
4. climate
5. weather
6. geologic
7. Winkel Tripel

### Critical Writing

*Sample answer:* A globe is the most accurate way to represent Earth's surface because it is spherical in shape like planet Earth. On a globe, sizes and shapes of features are not distorted and distances are true to scale. However, globes do have some cons. For example, they are difficult to make and to carry around. They also cannot be enlarged to show the details of a particular area.

---

## Lesson 2.4 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. false
5. true
6. true
7. false
8. true
9. false
10. false

### Critical Reading

1. Contour lines represent elevations. Each contour line represents a specific elevation and connects all the points that have that same elevation.
2. From the spacing of contour lines, you can learn about the slope of the land. The closer together adjacent contour lines are, the steeper the slope.
3. Hills are represented on a topographic map by contour lines that form concentric closed loops. The smallest loop encloses the top of the hill. Depressions are represented on a topographic map by hatched contour lines that form concentric closed loops. The smallest hatched loop encloses the bottom of the depression.
4. A group of V-shaped contour lines indicates a stream valley. The narrow part of the Vs point uphill. Water always flows from higher to lower elevations, so the Vs also tell you the direction the water is flowing.

**Multiple Choice**

1. a
2. d
3. d
4. b
5. a
6. a
7. d

**Matching**

1. g
2. a
3. b
4. d
5. c
6. e
7. f

**Fill in the Blank**

1. elevation
2. steep
3. horizontal
4. stream valley
5. depths
6. geologic
7. colors

**Critical Writing**

*Sample answer:* A bathymetric map shows features on the ocean floor in the same way that a topographic map shows features on the land surface. However, the contour lines on a bathymetric map show depth below sea level, rather than elevation about sea level, which is shown by contour lines on a topographic map. On a bathymetric map, a ridge would be represented by closely spaced contour lines that have lower numbers (less depth below sea level) than surrounding areas. A trench would be represented by closely spaced contour lines that have higher numbers (greater depth below sea level) than surrounding areas. A flat plain would be represented by contour lines that are spaced far apart, indicating that the area has little or no change in elevation.

---

**Lesson 2.5 Worksheet Answer Key****True or False**

1. true
2. false
3. false
4. false

5. true
6. true
7. true
8. true
9. false
10. true

### Critical Reading

1. GPS stands for Global Positioning System. It is a system that uses satellites in orbit and receivers on Earth's surface to locate exact positions on the surface.
2. A GPS receiver uses information from GPS satellites to determine its exact location. The receiver detects radio signals from at least four nearby GPS satellites. There are precise clocks on each satellite and in the receiver. The receiver measures the time it takes for the radio signals from each satellite to reach it. It uses these times, together with the constant speed of radio waves, to calculate its distance from each satellite. Then the receiver uses the four distances to triangulate its exact location.
3. GIS stands for Geographic Information Systems. GIS is a technology for uses geographic locations along with any type of spatial information to create maps and images. It uses GPS to determine exact locations of the information being mapped.

### Multiple Choice

1. d
2. b
3. d
4. b
5. d
6. b
7. b

### Matching

1. b
2. e
3. c
4. a
5. d

### Fill in the Blank

1. geostationary
2. 24
3. polar
4. 1.5
5. four
6. computers
7. Geographic Information

**Critical Writing**

*Sample answer:* A geostationary orbit circles Earth in the same direction that the planet rotates at an altitude of 36,000 kilometers above the surface. A satellite in this type of orbit makes one complete revolution in 24 hours, which is the same amount of time it takes Earth to complete one rotation. This keeps the satellite over the same spot on the surface. Geostationary orbits are used for weather satellites that monitor weather conditions over a given area. They are also used for communications satellites. A polar orbit circles Earth by passing over the poles at an altitude of several hundred kilometers above the surface. A satellite in this type of orbit makes one complete revolution in 90 minutes. Earth rotates only slightly underneath the satellite, so the satellite can see the entire surface of Earth in less than a day. Polar orbits are used for weather satellites that monitor weather conditions over the entire globe. Some satellites that observe the lands and oceans also use polar orbits.

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## 27.3 Chapter 3: Earth's Minerals

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### Lesson 3.1 Worksheet Answer Key

#### True or False

1. true
2. true
3. false
4. true
5. false
6. false
7. true
8. false
9. false
10. true

#### Critical Reading

1. Elements are unique substances that cannot be broken down to simple substances by ordinary chemical means. Atoms are the smallest units of elements that still have all the properties of the elements.
2. Atoms consist of smaller particles, called subatomic particles. At the center of an atom is a nucleus. The nucleus consists of subatomic particles called protons and neutrons. Protons and neutrons are about the same size, but protons have a positive electrical charge whereas neutrons are neutral in charge. Electrons are tiny subatomic particles that have a negative electrical charge. They orbit the nucleus at various energy levels in a region known as the electron cloud.
3. Isotopes are atoms of an element with different numbers of neutrons. An example of an isotope is carbon-14. It has 8 neutrons instead of the 6 neutrons in most other carbon atoms.

#### Multiple Choice

1. d
2. d
3. a
4. d
5. a
6. a
7. d

#### Matching

1. g
2. d

3. e
4. a
5. c
6. b
7. f

### Fill in the Blank

1. element
2. atom
3. proton
4. electron
5. polar
6. atomic mass
7. molecular mass

### Critical Writing

*Sample answer:* Both ionic and covalent bonds are types of chemical bonds. A chemical bond is the joining of ions or atoms to make chemical compounds. In ionic bonds, electrons are transferred between atoms. Ionic bonds form between a metal and nonmetal when atoms of the metal give up one or more electrons to atoms of the nonmetal. In covalent bonds, electrons are shared between atoms. The electrons may or may not be shared equally between the atoms. If one atom attracts the electrons more than the other atom, it gives one side of the molecule a slightly negative charge and the other side a slightly positive charge. This type of covalent molecule is called a polar molecule.

---

## Lesson 3.2 Worksheet Answer Key

### True or False

1. false
2. true
3. true
4. true
5. false
6. false
7. true
8. true
9. false
10. false

### Critical Reading

1. A mineral is an inorganic crystalline solid that forms through natural processes and has a definite chemical composition.
2. A crystalline solid is a substance that forms crystals. Crystals are solid structures in which atoms or ions are arranged in a regular, repeating pattern.
3. Organic substances are made by living things, whereas inorganic substances are not made by living things.

4. Diamond, but not coal, is a mineral because diamond is inorganic whereas coal is organic. Diamond is created deep in Earth's crust when carbon is put under extreme pressure. Coal, on the other hand, is a rock made of the remains of organisms.

### Multiple Choice

1. d
2. b
3. a
4. a
5. b
6. c
7. b

### Matching

1. e
2. c
3. g
4. f
5. a
6. d
7. b

### Fill in the Blank

1. compound
2. specific gravity
3. Fracture
4. physical
5. silicate
6. carbonate
7. oxygen

### Critical Writing

*Sample answer:* Two mineral groups are silicate minerals and phosphate minerals. The silicate group is the largest mineral group. The basic building block for all silicates is the silica tetrahedron. It consists of one silicon atom bonded to four oxygen atoms. Silica tetrahedrons combine together in different ways to create different types of silicates. Silica tetrahedrons often bond to other elements such as calcium to create the wide variety of silicate minerals. Feldspar and quartz are the two most common silicate minerals. The phosphate group contains many different minerals, but most of them are rare. The basic building block for all phosphate minerals is a tetrahedron, as in silicate minerals. However, the tetrahedrons of phosphates consist of phosphorus, arsenic, or vanadium bonded to oxygen. Turquoise is an example of a phosphate mineral. It includes copper and aluminum in addition to phosphorus.

---

## Lesson 3.3 Worksheet Answer Key

### True or False

1. false
2. false
3. false
4. true
5. true
6. false
7. false
8. false
9. true
10. false

### Critical Reading

1. Color alone is rarely very useful for identifying minerals because color is not a unique, unvarying property of a mineral. Different minerals may be the same color, and the same mineral may vary in color.
2. Streak is the color of a mineral's powder. You can check a mineral's streak by scraping a piece of the mineral across an unglazed porcelain plate. Streak is more useful than color for identifying minerals because a mineral's streak does not vary and even minerals with the same color differ in the color of their streak.
3. Luster is the way a mineral's surface reflects light. Minerals are classified on the basis of luster in two major groups: those with metallic luster and those with non-metallic luster. Minerals with metallic luster are opaque and shiny. Minerals with non-metallic luster are further divided into six types. They include adamantine, earthy, pearly, resinous, silky, and vitreous luster.

### Multiple Choice

1. c
2. a
3. c
4. c
5. c
6. c
7. c

### Matching

1. f
2. c
3. a
4. g
5. b
6. d
7. e



### Fill in the Blank

1. color
2. mineralogists
3. streak
4. metallic
5. non-metallic
6. Hardness
7. Mohs

### Critical Writing

*Sample answer:* Hardness is a physical property of minerals. It is a measure of whether a mineral will scratch, or be scratched by, another mineral. Hardness can be used to help identify minerals because different minerals have characteristic hardnesses. The Mohs hardness scale is a reference for mineral hardness. It ranges from talc, which is the softest mineral with a hardness of 1, to diamond, which is the hardest material with a hardness of 10. The Mohs hardness scale can be used to determine the hardness of an unknown mineral. For example, two other minerals on the scale are apatite with a hardness of 5 and feldspar with a hardness of 6. If an unknown mineral can scratch apatite but is scratched by feldspar, then it has a hardness between 5 and 6. Only certain minerals have a hardness in this range. Therefore, this limits the number of possible minerals the unknown mineral could be.

---

## Lesson 3.4 Worksheet Answer Key

### True or False

1. false
2. false
3. true
4. true
5. true
6. false
7. false
8. false

### Critical Reading

1. Three ways minerals can form from solutions are evaporation, precipitation, and sedimentation.
2. Minerals form by evaporation when a solution of water and elements evaporates, leaving mineral crystals behind. Precipitation also involves the formation of minerals from a water solution. However, in precipitation, particles come together to form mineral solids when the water cannot hold any more dissolved elements. Then, mineral crystals precipitate out of the water and sink to the bottom.
3. When underground water is heated by nearby magma, it can dissolve a lot of minerals from rock. As the water flows through cracks and spaces in rock, it cools and deposits mineral crystals. Long, narrow deposits called veins form when water flows through cracks in rock. Larger deposits called geodes form when water flows through open spaces in rock.

**Multiple Choice**

1. d
2. a
3. a
4. d
5. b
6. a
7. a

**Matching**

1. b
2. c
3. d
4. a
5. e

**Fill in the Blank**

1. smaller
2. precipitation
3. deposition
4. small
5. molecules

**Critical Writing**

*Sample answer:* Minerals form when melted rock cools. Magma is melted rock that is under Earth's surface. Lava is melted rock that is on Earth's surface. When melted rock cools underground, it cools slowly. This gives mineral crystals enough time to grow large. Therefore, mineral deposits that form from magma have large crystals. When melted rock cools on the surface, it cools quickly. This does not give mineral crystals enough time to grow large. Therefore, mineral deposits that form from lava have small crystals.

---

**Lesson 3.5 Worksheet Answer Key****True or False**

1. false
2. false
3. true
4. false
5. true
6. true
7. false
8. true
9. false
10. true

### Critical Reading

1. An ore deposit is a deposit of minerals that would be profitable to mine. Factors that determine whether a mineral deposit is profitable to mine include the size of the deposit and the concentration of mineral ore.
2. Ore deposits close to the surface are mined by some method of surface mining. These methods include open-pit mining, strip mining, mountain-top removal, and placer mining.
3. Ore deposits deep under the surface are mined by underground mining. Tunnels are blasted into rock to gain access to the ore. Miners use the tunnels to reach and extract the ore. This type of mining is especially dangerous because of toxic gases, lack of fresh air, total darkness, and the potential for accidents such as explosions and mine collapses.

### Multiple Choice

1. a
2. a
3. d
4. d
5. b
6. b
7. c

### Matching

1. g
2. e
3. c
4. d
5. b
6. f
7. a

### Fill in the Blank

1. aluminum
2. surface
3. refinery
4. underground
5. smelting
6. diamond
7. halite

### Critical Writing

*Sample answer:* Mining can harm the environment in several ways. Surface mining clears the landscape of trees and soil, and nearby streams and lakes are inundated with sediments. The sediments may contain pollutants such as heavy metals, which pollute the water. Acids flow from some mine sites, changing the composition of water in nearby bodies of water. Mined land is reclaimed by being returned to a natural state. For example, surface mines may be refilled or reshaped and planted with vegetation. Alternatively, they may be allowed to fill with water and become lakes. Underground mines may be sealed off or left open as homes for bats.

---

## 27.4 Chapter 4: Rocks

---

### Lesson 4.1 Worksheet Answer Key

#### True or False

1. false
2. true
3. false
4. false
5. true
6. true
7. false
8. true
9. false
10. false

#### Critical Reading

1. Rocks are naturally formed, non-living Earth materials. They are made of collections of mineral grains that are held together in a hard, solid mass.
2. Rocks are identified primarily by the minerals they contain and by their texture.
3. Rock texture is a description of the size, shape, and arrangement of mineral grains in rock. The texture of rock is determined by its history. For example, rocks that form from molten rock have smaller grains if the molten rock cools quickly on the surface than if it cools slowly under the surface.

#### Multiple Choice

1. a
2. d
3. a
4. c
5. d
6. d
7. d

#### Matching

1. g
2. e
3. f
4. b
5. a

6. d
7. c

### Fill in the Blank

1. Texture
2. crystallization
3. metamorphism
4. rock cycle
5. Sedimentation
6. weathering
7. lava

### Critical Writing

*Sample answer:* The three main categories of rocks are igneous, sedimentary, and metamorphic rocks. Rocks are categorized this way on the basis of how they form. Igneous rocks form when magma or lava cools and minerals crystallize from the molten rock. Sedimentary rocks form when sediments are deposited and lithified, or turned to rock. The sediments may be rock particles, remains of living things, or chemical precipitates that have come out of a water solution. Metamorphic rocks form when any type of parent rock is put under extreme temperature and/or pressure, which changes it into a different type of rock.

---

## Lesson 4.2 Worksheet Answer Key

### True or False

1. false
2. true
3. true
4. false
5. false
6. false
7. false
8. true
9. true
10. true

### Critical Reading

1. Magma forms when rock beneath Earth's surface is heated to high enough temperatures that it melts. The melted rock is magma.
2. Different magmas have different compositions. Magmas contain whatever elements were in the rock that melted. Magmas also contain gases. The main elements found in magma are the same as the elements that are found in crust, with oxygen and silicon being the most prevalent.
3. Factors that influence the melting of rock include temperature, rock composition, pressure, and water content. Rock melts only when the temperature reaches hundreds of degrees Celsius. Some minerals melt at higher temperatures than others, so rock composition influences whether rock melts. Extreme pressure on rock raises

its melting temperature and influences whether it melts. Adding water to rock lowers its melting temperature and also influences whether it melts.

### Multiple Choice

1. c
2. c
3. d
4. b
5. a
6. a
7. a

### Matching

1. c
2. e
3. b
4. g
5. a
6. d
7. f

### Fill in the Blank

1. temperatures
2. Partial
3. olivine
4. extrusive
5. ultramafic
6. pumice
7. felsic

### Critical Writing

*Sample answer:* Granite is the most common intrusive igneous rock. Intrusive rocks form when magma cools and hardens below Earth's surface. Igneous rocks that form by volcanic activity, in contrast, are extrusive rocks that form on Earth's surface when lava cools and hardens. Therefore, granite never forms from volcanic activity, so the mountains could not have formed by volcanic activity. Instead, the mountains must have formed by geological processes that lifted up granite from below the surface.

---

## Lesson 4.3 Worksheet Answer Key

### True or False

1. true
2. true

3. true
4. false
5. false
6. true
7. false
8. true
9. false
10. false

### Critical Reading

1. Lithification is the process in which accumulated sediments harden into sedimentary rock. Lithification occurs in two steps: compaction and cementation. Compaction occurs when sediments are squeezed together by the weight of all the sediments on top of them. Cementation occurs when spaces between sediments are filled in with minerals that crystallize from water as it seeps through the sediments.
2. Sedimentary rock can form from sediments with a wide range of sizes. The type of sedimentary rock that forms depends on the size of the sediments. If sediments are large and rounded, they form rock called conglomerate. If sediments are large and angular, they form rock called breccia. Smaller, sand-sized sediments form sandstone. Still smaller, silt-sized sediments form siltstone. The smallest, clay-sized sediments form shale.
3. Any layer of sedimentary rock is younger than the layer below it as long as the layers have not been disturbed because sediments are laid down in horizontal layers, with the older layer below the younger layer.
4. Biochemical sedimentary rocks are rocks that form from shells. They form at the bottom of an ocean or salt lake. They form when shells of dead organisms accumulate and then become compacted and cemented into sedimentary rocks.

### Multiple Choice

1. b
2. a
3. d
4. c
5. b
6. c
7. d

### Matching

1. g
2. f
3. b
4. a
5. e
6. c
7. d

### Fill in the Blank

1. sandstone

2. erosion
3. cementation
4. breccia
5. shale
6. conglomerate
7. compaction

### Critical Writing

*Sample answer:* Sandstone and limestone are both sedimentary rocks, but sandstone is clastic rock, whereas limestone is bioclastic rock. Clastic rock forms from inorganic sediments. Bioclastic rock forms from organic sediments. Sandstone forms from sand-sized rock sediments and contains no organic matter. Limestone, in contrast, forms from organic sediments such as the shells of once-living things.

---

## Lesson 4.4 Worksheet Answer Key

### True or False

1. false
2. false
3. true
4. true
5. false
6. false
7. true
8. true
9. true
10. false

### Critical Reading

1. Rocks undergo metamorphism when they are subject to enough heat and/or pressure to alter their physical or chemical makeup without melting.
2. Rocks change during metamorphism because their minerals must be stable under the new temperature and pressure conditions. The need for stability may cause the structure of minerals to rearrange so new minerals form. Ions may move between minerals to create minerals with different chemical compositions.
3. Foliation is the formation of layers in rocks as they are squeezed by extreme pressure. This occurs when pressure is exerted on the rocks from one direction only.

### Multiple Choice

1. a
2. b
3. d
4. b
5. a
6. a



**Matching**

1. d
2. a
3. b
4. c
5. e

**Fill in the Blank**

1. Metamorphism
2. shale
3. quartzite
4. limestone
5. minerals
6. parent

**Critical Writing**

*Sample answer:* Regional and contact metamorphism are the two main ways that metamorphism can occur. Regional metamorphism refers to changes in enormous quantities of rock over a wide area. It occurs because of extreme pressure from overlying rock or from compression caused by geologic processes. Contact metamorphism refers to changes in rock that is in contact with magma. It occurs because of the magma's extreme heat.

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## 27.5 Chapter 5: Earth's Energy

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### Lesson 5.1 Worksheet Answer Key

#### True or False

1. false
2. true
3. true
4. true
5. false
6. false
7. false
8. true
9. true
10. true

#### Critical Reading

1. Nonrenewable resources are natural resources that either cannot be replaced at all or cannot be replaced as quickly as they are used. Renewable resources are natural resources that either are virtually limitless in supply or can be replaced as quickly as they are used.
2. Common nonrenewable energy resources are fossil fuels, which include coal, oil, and natural gas. The use of fossil fuels releases air pollutants and carbon dioxide, which causes global warming.
3. *Sample answer:* Some renewable energy resources are solar energy and energy from flowing water. A pro of using renewable energy resources is that their use does not release air pollutants and carbon dioxide. A con of using renewable energy resources is that some of them are currently expensive to use.

#### Multiple Choice

1. d
2. c
3. d
4. b
5. b
6. b
7. d

#### Matching

1. c
2. f
3. g

4. e
5. b
6. a
7. d

### Fill in the Blank

1. conservation of energy
2. Potential
3. heat
4. fossil
5. nonrenewable
6. renewable
7. chemical

### Critical Writing

*Sample answer:* Energy is the ability to do work or produce change. One source of energy is fuel. A fuel is any material that releases energy in a chemical change. For example, wood is a fuel that releases energy when it burns. Generally, when a fuel produces energy, some of the energy is released as heat. In most cases, the heat is used to do work. For example, the heat released by a campfire can be used to keep people warm and to cook food.

---

## Lesson 5.2 Worksheet Answer Key

### True or False

1. true
2. true
3. false
4. true
5. false
6. false
7. false
8. false
9. true
10. false

### Critical Reading

1. Crude oil forms from the remains of tiny organisms that live at the sea surface and then sink to the seafloor when they die. Eventually, layers of deposits build up. As they do, heat and pressure increase. Over millions of years, the dead organisms turn into liquid oil.
2. Crude oil is a mixture of many different hydrocarbons. It is refined to separate the different hydrocarbons for different uses. Each hydrocarbon in crude oil boils at a different temperature. When oil is boiled in a refinery, the different hydrocarbons boil off at different times and are collected separately.
3. Fuels from crude oil include gasoline, diesel, and jet fuel. These fuels are so widely used for transportation because they are rich sources of energy and can be transported easily.

4. Besides fuels, products that can be made from crude oil include waxes, plastics, and fertilizers.
5. The United States has only about 1.5 percent of the world's known oil reserves. The nation produces oil but only about one-quarter as much as it uses. The main oil-producing regions of the United States are the Gulf of Mexico, Texas, Alaska, and California. Most offshore drilling occurs in the Gulf of Mexico.

### Multiple Choice

1. c
2. b
3. d
4. b
5. a
6. d
7. d

### Matching

1. d
2. f
3. a
4. g
5. e
6. b
7. c

### Fill in the Blank

1. coal
2. crude oil
3. natural gas
4. Fracking (Hydraulic fracturing)
5. nuclear
6. uranium
7. Nuclear

### Critical Writing

*Sample answer:* Both fossil fuels and the uranium used to produce nuclear energy are nonrenewable energy resources. Therefore, both types of fuels will run out eventually. Using fossil fuels to produce electricity produces air pollution as well as carbon dioxide, which causes global warming. Producing nuclear energy does not pollute the atmosphere or release carbon dioxide. However, it does produce nuclear waste that is difficult to dispose of safely because it remains hazardous for thousands of years.

---

## Lesson 5.3 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. false
5. true
6. false
7. true
8. false
9. true
10. true

### Critical Reading

1. Solar energy comes from nuclear fusion reactions in which hydrogen atoms fuse to form helium atoms. Solar energy reaches Earth by traveling through space as radiation.
2. Solar energy can be used to heat water or provide electricity for individual homes. It can also be used in devices such as calculators and outdoor lights. On a larger scale, solar energy can be used in power plants to generate electricity.
3. Solar power plants collect and focus solar energy using a large groups of mirrors. The mirrors focus sunlight on one place, called a receiver. A liquid, such as oil or water, flows through the receiver and is heated to a high temperature by the focused sunlight. The heated liquid transfers its heat to a nearby object that has a lower temperature. This transfer occurs through the process of conduction. The energy conducted by the heated liquid is used to make electricity.
4. Pros of solar energy use include the availability of solar energy. It is extremely abundant and widespread, and it will never run out. There are several cons of using solar energy. It is not available at night and not reliable in locations that are often cloudy. Other drawbacks include the expense of the technology needed to use solar energy and the relatively large amount of space required by solar panels.

### Multiple Choice

1. c
2. a
3. b
4. d
5. d
6. c
7. d

### Matching

1. c
2. f
3. d
4. e

5. b
6. g
7. a

### Fill in the Blank

1. renewable
2. sun
3. receiver
4. hydroelectric power
5. potential
6. wind turbine
7. biofuel

### Critical Writing

*Sample answer:* Both moving air and flowing water have kinetic energy that can be used to turn a turbine and generate electricity. Using these alternative energy resources does not create air pollution or release carbon dioxide, a cause of global warming. Therefore, both energy sources are much better for the environment than fossil fuels. In addition, neither alternative energy resource will run out. However, harnessing the energy of moving air and flowing water is not without problems. Both forms of alternative energy are only reliably available in certain areas. Specific problems with flowing water include the need to dam streams, because damming streams floods land upstream and may displace or kill living things. The reduced flow of water downstream can also create environmental problems. Specific problems with wind include the expense of wind turbines, which also quickly wear out. Also, people may not like having wind farms built near them.

---

## 27.6 Chapter 6: Plate Tectonics

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### Lesson 6.1 Worksheet Answer Key

#### True or False

1. true
2. true
3. false
4. false
5. true
6. false
7. true
8. true
9. false
10. false

#### Critical Reading

1. Scientists know about Earth's interior mainly from indirect evidence such as seismic waves.
2. Both P-waves and S-waves are types of seismic waves, which are waves that travel outward in all directions from an earthquake. P-waves are the fastest seismic waves, so they are always the first waves to arrive at seismometers. They travel more slowly through liquids than solids. S-waves are only about half as fast as P-waves, so they arrive later at seismometers. They cannot travel through liquids at all.
3. By tracking seismic waves with seismometers all over Earth, scientists have learned that the mantle is solid and the outer core is liquid. For example, P-waves travel more slowly through liquids than solids, and they slow down as they pass from the mantle to the outer core. S-waves cannot travel through liquids, and they stop when they reach the outer core.

#### Multiple Choice

1. d
2. a
3. d
4. d
5. b
6. b
7. d

#### Matching

1. a
2. d

3. c
4. b
5. g
6. e
7. f

### Fill in the Blank

1. oceanic
2. continental
3. mantle
4. convection
5. core
6. outer
7. inner

### Critical Writing

*Sample answer:* The crust and mantle are two of Earth's layers that are based on composition. The crust is the thinnest, outermost layer. The mantle is the thickest, middle layer. The lithosphere and asthenosphere are divisions of the crust and mantle that are based on mechanical properties. The lithosphere is brittle and rigid, whereas the asthenosphere is flexible and can flow. The lithosphere consists of the crust and very top part of the mantle. The asthenosphere consists of the rest of the upper mantle below the lithosphere.

---

## Lesson 6.2 Worksheet Answer Key

### True or False

1. false
2. true
3. false
4. false
5. true
6. false
7. true
8. true
9. false
10. false

### Critical Reading

1. Earth has a magnetic field like that of a bar magnet, with magnetic north and south poles. The magnetic poles are located near the geographic poles.
2. Rocks are useful for studying Earth's magnetic history because the alignment of magnetite crystals in rocks is a permanent record of the direction of Earth's magnetic field when the rocks formed. Magnetite crystals are like tiny magnets that point to the north magnetic pole as they crystallize from magma. Once the crystals form, their magnetic alignment, or polarity, is locked in place.



3. In the 1950s, scientists observed that young rocks are aligned with Earth's current magnetic north pole regardless of the continent on which they formed. Old rocks of about the same age that formed on the same continent have the same magnetic alignment, but it is different from Earth's current magnetic alignment. Old rocks of different ages, regardless of where they formed, are not aligned with each other or with Earth's current magnetic field alignment.
4. The observations in question 3 support the continental drift hypothesis because they show that the continents have had different orientations relative to the magnetic poles at various times in the past. This would occur if the continents had drifted over Earth's surface and changed their positions through time.

### Multiple Choice

1. a
2. c
3. a
4. d
5. d
6. c
7. a

### Matching

1. f
2. c
3. b
4. e
5. a
6. g
7. d

### Fill in the Blank

1. magnetometer
2. magnetic north pole
3. 20th
4. Canada
5. Africa
6. drifted
7. rejected

### Critical Writing

*Sample answer:* Wegener collected a great deal of evidence to support the continental drift hypothesis. He determined that there are identical rocks, of the same type and age, on both sides of the Atlantic Ocean. He also noted that mountain ranges with the same rock types, structures, and ages are located on opposite sides of the Atlantic Ocean. In addition, he cited evidence of ancient fossils of the same species in rocks of the same age but on continents that are now widely separated. He identified evidence of glaciers in places that are currently close to the equator, and he pointed out coral reefs and coal seams in locations that are currently much too cold for these structures to form. The geologic and fossil evidence suggest that today's continents were once part of the same supercontinent and have

since drifted apart. The climate evidence suggests that the climates of continents have changed over time because their position on Earth's surface has shifted.

---

## Lesson 6.3 Worksheet Answer Key

### True or False

1. true
2. false
3. true
4. false
5. true
6. false
7. false
8. false
9. true
10. true

### Critical Reading

1. Normal polarity occurs when Earth's north and south magnetic poles are located in their current positions. Reversed polarity occurs when Earth's north and south poles are located in the opposite positions.
2. Reversals of Earth's polarity result in rocks on the seafloor having a pattern of alternating stripes of normal and reversed polarity. The rocks have normal polarity at mid-ocean ridges. On either side of the ridges, the patterns of stripes form mirror images. The stripes end abruptly at the edges of continents or deep-sea trenches.
3. As distance from mid-ocean ridges increases, seafloor rocks become older, thicker, and cooler. They also have more overlying sediments.
4. The oldest rocks in oceanic crust are less than 180 million years old. They are younger than the oldest rocks in continental crust. Seafloor rocks are destroyed in a relatively short time after they are created.

### Multiple Choice

1. d
2. c
3. c
4. a
5. b
6. b
7. c

### Matching

1. g
2. d
3. e
4. f
5. c

6. b
7. a

### Fill in the Blank

1. mid-ocean ridge
2. deep-ocean trench
3. speed
4. bathymetric
5. volcanoes
6. normal
7. mid-ocean ridges

### Critical Writing

*Sample answer:* The seafloor-spreading hypothesis provides a mechanism to explain how continental drift occurs. According to the seafloor-spreading hypothesis, new seafloor continuously forms at a mid-ocean ridge as magma erupts onto the surface. As more magma erupts, it pushes the seafloor horizontally away from the axis of the ridge. The moving seafloor also pushes continents away from the ridge, as though the continents were on a conveyor belt. Because of the moving seafloor, over millions of years the continents slowly travel over the planet's surface.

---

## Lesson 6.4 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. false
5. true
6. false
7. true
8. true
9. false
10. true

### Critical Reading

1. The lithosphere is divided into a dozen major and several minor plates. A single plate may consist only of oceanic lithosphere or only of continental lithosphere, but nearly all plates are made of a combination of both types of lithosphere. Plates are constantly moving over Earth's surface at a rate of a few centimeters a year.
2. Plates move because of seafloor spreading, which is due to convection currents in the mantle. Hot material rises at a mid-ocean ridge; gradually moves horizontally away from the axis of the ridge, dragging seafloor with it; and eventually sinks back deep into the mantle at deep-sea trenches.
3. A plate boundary is the edge where two tectonic plates meet. Types of plate boundaries include divergent plate boundaries, where two plates move away from each other; convergent plate boundaries, where two plates move toward each other; and transform plate boundaries, where two plates slide past each other.

**Multiple Choice**

1. c
2. b
3. a
4. b
5. a
6. b
7. b

**Matching**

1. e
2. a
3. g
4. c
5. d
6. b
7. f

**Fill in the Blank**

1. plate
2. plate boundary
3. Subduction
4. subduction zone
5. plate tectonics
6. island arc
7. intraplate

**Critical Writing**

*Sample answer:* At a convergent plate boundary, two plates move toward each other. The geologic activity that results depends on the type of crust on either side of the plate boundary. When one plate is oceanic crust and the other is continental crust, the plate with oceanic crust sinks under the plate with continental crust because oceanic crust is denser. This is called subduction. The crust shakes and earthquakes result. The subducting plate melts in the mantle, so magma erupts, forming volcanoes. Coastal volcanic mountains arise all along the edge of the subducting plate, creating a continental arc. When both plates are continental crust, neither plate subducts. Instead, both move upward, forming large mountains where they push together. Magma cannot penetrate the thick continental crust, so there are no volcanoes. With enormous slabs of crust smashing together, many large earthquakes occur.

---

## 27.7 Chapter 7: Earthquakes

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### Lesson 7.1 Worksheet Answer Key

#### True or False

1. true
2. false
3. true
4. false
5. false
6. false
7. true
8. false
9. true
10. false

#### Critical Reading

1. In geology, stress is defined as the force per unit area that is applied to rock.
2. A rock's response to stress is determined by many factors, including the type of rock, the surrounding temperature and pressure, the type of stress, and the length of time the rock is under stress.
3. Both elastic and plastic deformations are changes in the shape of rock that occur when stress is applied to rock. In elastic deformation, the rock returns to its original shape after the stress is removed. In plastic deformation, the rock does not return to its original shape after the stress is removed.
4. The four types of stresses that can act on rock are confining stress, compression, tension, and shear. Confining stress is stress that is applied to a deeply buried rock by the weight of all the material above it. Because the rock cannot move, it cannot deform or fracture. Compression is stress that squeezes rocks together. It causes rocks to fold or fracture. Compression is the major type of stress that occurs at convergent plate boundaries. Tension is stress that pulls rocks apart. Rocks under tension lengthen or break apart. Tension is the major type of stress that occurs at divergent plate boundaries. Shear is stress that occurs when forces are parallel but applied in opposite directions. Shear stress is the major type of stress that occurs at transform plate boundaries.

#### Multiple Choice

1. c
2. a
3. b
4. c
5. b
6. c
7. a

### Matching

1. g
2. d
3. b
4. e
5. a
6. c
7. f

### Fill in the Blank

1. confining
2. Elastic
3. Plastic
4. anticline
5. syncline
6. slip
7. dip

### Critical Writing

*Sample answer:* The two major types of faults are dip-slip faults and strike-slip faults. A dip-slip fault is a fault in which the dip is inclined relative to the horizontal. This type of fault generally occurs when rocks are experiencing tension stress. There are two types of dip-slip faults: normal faults and reverse faults. In a normal fault, the hanging wall drops down relative to the footwall. In a reverse fault, the footwall drops down relative to the hanging wall. A strike-slip fault, in contrast, is a fault in which the dip is vertical. This type of fault occurs when rocks are experiencing shear stress. There are two types of strike-slip faults: left-lateral faults and right-lateral faults. If you were to stand with one foot on each side of a strike-slip fault, rock under one of your feet would move toward you. If the rock under your left foot moves toward you, the fault is a left-lateral fault. If the rock under your right foot moves toward you, the fault is a right-lateral fault.

---

## Lesson 7.2 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. true
5. false
6. true
7. false
8. false
9. true
10. false

### Critical Reading

1. Body waves and surface waves are the two major types of seismic waves. Body waves travel through the solid body of Earth and originate at the focus of an earthquake. Surface waves travel through the surface of the ground and originate at the epicenter of an earthquake.
2. P-waves move rocks forward and backward in the same direction that the waves are traveling. S-waves move rocks up and down perpendicular to the direction that the waves are traveling.
3. Love waves move the ground back and forth perpendicular to the direction that the waves are traveling. Rayleigh waves cause the ground to move in a circular motion. The combined ground movements of Love and Rayleigh waves give the surface of the ground a rolling motion.

### Multiple Choice

1. b
2. b
3. a
4. a
5. a
6. c
7. d

### Matching

1. d
2. e
3. g
4. b
5. a
6. c
7. f

### Fill in the Blank

1. earthquake
2. plate boundaries
3. more
4. body
5. surface
6. elastic rebound
7. seismology

### Critical Writing

*Sample answer:* Many earthquakes take place around the Pacific Ocean basin because it is lined with plate boundaries. Almost all earthquakes take place at plate boundaries because this is primarily where compression, tension, and shearing stresses are placed on rock. According to the elastic rebound theory of earthquakes, rocks will deform when stress is placed upon them. However, when too much stress builds up for rocks to deform any further, they will fracture and suddenly move. The sudden movement of the rocks releases the built-up energy and generates earthquakes.

---

## Lesson 7.3 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. true
5. true
6. true
7. false
8. true
9. false
10. false

### Critical Reading

1. It would be important to make accurate predictions of earthquakes so sound decisions could be made about evacuating people in order to keep them safe. An unnecessary evacuation due to an inaccurate prediction would be expensive and might cause people to disregard future evacuation orders.
2. The easiest factor to predict about earthquakes is where they will occur. Scientists know that earthquakes take place at plate boundaries and tend to occur where they have occurred before.
3. Signs that sometimes precede large earthquakes include small foreshocks, tiny fractures in rocks, fluctuating water levels in wells, tilting of the ground, and animals behaving erratically. These signs are not very useful for predicting earthquakes because they do not always occur before major earthquakes strike.

### Multiple Choice

1. d
2. a
3. a
4. d
5. a
6. d
7. b

### Matching

1. c
2. b
3. a
4. e
5. g
6. f
7. d



### Fill in the Blank

1. moment magnitude
2. amplitude
3. epicenter
4. three
5. 100
6. moment magnitude
7. surface

### Critical Writing

*Sample answer:* To locate an earthquake's epicenter, data from three different seismometers are needed. The first step is to find the distance of each seismometer from the epicenter. The greater the difference is in arrival times of P- and S-wave, the greater the distance is to the epicenter. Therefore, the difference in the P- and S-wave arrival times can be used to calculate the distance between each seismometer and the epicenter. The next step is to draw a circle around each seismometer location with a radius equal to the distance to the epicenter. The point where all three circles intersect is the epicenter.

---

## Lesson 7.4 Worksheet Answer Key

### True or False

1. true
2. false
3. true
4. false
5. true
6. true
7. false
8. false
9. true
10. true

### Critical Reading

1. Damage and deaths during earthquakes are caused primarily by buildings and other structures collapsing. Another major cause of damage and deaths are the fires that follow most earthquakes.
2. Factors in addition to quality of structures that influence how destructive and deadly an earthquake is include population density, whether an earthquake triggers a tsunami, and the type of ground.
3. The magnitude 9.2 earthquake that occurred near Anchorage, Alaska, in 1964 caused only 131 deaths because relatively few people lived in the area. The 9.0 magnitude earthquake that occurred in the Indian Ocean in 2004 killed 230,000 people, mainly because of the tsunami that followed the earthquake. During the 1985 Mexico City earthquake, many buildings collapsed because they were constructed on sediments rather than bedrock and the sediments liquefied during the earthquake.

**Multiple Choice**

1. d
2. a
3. a
4. d
5. d
6. b
7. c

**Matching**

1. b
2. e
3. a
4. c
5. d

**Fill in the Blank**

1. Chile
2. tsunami
3. bedrock
4. Fires
5. fluorescent

**Critical Writing**

*Sample answer:* People who live in earthquake-prone areas can do several things to protect themselves before, during, and after earthquakes. Before earthquakes occur, they can take steps to ensure that their home is as safe as possible. They can have an engineer evaluate the house for structural integrity. Floors, walls, roofs, and foundations should all be well attached to each other. Brick chimneys should be bracketed or braced to the roof. Inside the house, people can make sure that heavy objects are not stored in high places and heavy furniture is bolted to walls. They can also prepare an earthquake kit, keep fire extinguishers and flashlights handy, and draw up an evacuation plan. During an earthquake, people can try to stay in the safest place possible until the shaking stops. If they are inside a building, they should get beneath a sturdy table. If the building is not structurally sound, they should leave as quickly as possible. If they are outside, they should stay away from anything that might fall on them, such as buildings, power lines, and highway overpasses. After an earthquake, people should expect aftershocks and avoid dangerous areas such as hillsides, which might experience landslides. They should also turn off water, power, and gas lines to their home. Unless they have an emergency, they should avoid using the phone so that people who do have an emergency can get through.

---

## 27.8 Chapter 8: Volcanoes

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### Lesson 8.1 Worksheet Answer Key

#### True or False

1. false
2. false
3. true
4. true
5. false
6. false
7. false
8. true
9. true
10. false

#### Critical Reading

1. A hotspot volcano is a volcano that occurs over a mantle plume, which is a column of hot rock in the mantle. The Hawaiian Islands are examples of hotspot volcanoes.
2. As a plume of hot rock rises through the mantle, pressure is released and mantle melts to create a hotspot of melted mantle rock. The molten rock penetrates the lithosphere, forming a volcano.
3. There are about 50 known hotspots. Most of them are in the oceans because magma can more easily penetrate oceanic than continental lithosphere. Known hotspots beneath continents are extremely large. For example, a huge hotspot is located beneath the Yellowstone volcano on the North American continent.
4. The youngest volcano in a chain of hotspot volcanoes is always at the start of the chain, directly over the mantle plume. Each volcano after that is older than the one before it, with the oldest volcano at the opposite end of the chain. As the plate drifts over the mantle plume, it carries the newly formed hotspot volcano with it. After the first hotspot volcano moves away from the hotspot, a new hotspot volcano forms over the mantle plume. This keeps repeating as the plate continues to drift, explaining the relative ages of the volcanoes in the chain.

#### Multiple Choice

1. d
2. d
3. c
4. d
5. d
6. b
7. b

**Matching**

1. c
2. e
3. b
4. d
5. a
6. g
7. f

**Fill in the Blank**

1. mantle
2. convergent
3. Central
4. hotspot
5. hotspots
6. youngest
7. more

**Critical Writing**

*Sample answer:* At convergent plate boundaries, mantle rock melts because the subducting plate heats up as it sinks into the mantle. Also, water is mixed in with the sediments lying on top of the subducting plate. The water lowers the melting point of the mantle material, which increases melting. At divergent plate boundaries, mantle rock melts because hot mantle rises where the plates move apart. This releases pressure on the mantle, which lowers its melting point and allows mantle rock to melt.

---

**Lesson 8.2 Worksheet Answer Key****True or False**

1. false
2. false
3. true
4. false
5. true
6. false
7. true
8. true
9. true
10. false

**Critical Reading**

1. Signs that a volcano may be likely to erupt include a recent history of previous volcanic activity, earthquakes, slope deformation, and gas emissions.
2. Earthquakes often precede volcanic eruptions because moving magma shakes the ground.

3. Deformation of the ground may be detected directly by observation if it is great enough. More subtle changes can be detected with a tiltmeter, which is an instrument that measures the angle of a slope.
4. Scientists measure gases released on or around a volcano to help predict eruptions because gases may escape from a volcano before magma reaches the surface. The amounts of gases and their ratios are calculated in making the predictions.

### Multiple Choice

1. d
2. d
3. a
4. c
5. a
6. d
7. d

### Matching

1. e
2. c
3. g
4. f
5. d
6. b
7. a

### Fill in the Blank

1. pāhoehoe
2. lahar
3. magma chamber
4. tephra
5. Mafic
6. Felsic
7. volcanologists

### Critical Writing

*Sample answer:* There are two basic types of magma: mafic and felsic. Mafic magma has effusive eruptions, whereas felsic magma has explosive eruptions. Mafic magma is low in silica and is not viscous. Felsic magma, in contrast, is high in silica and is viscous. A viscous liquid resists flowing. Viscosity of magma determines how the magma will behave and what type of eruption occurs. Not being viscous, mafic magma flows easily to the surface. It does not build up much pressure in the magma chamber because it can flow through fissures and erupt gently through vents. Being viscous, felsic magma does not flow easily to the surface. It builds up a great deal of pressure in the magma chamber because it gets stuck and trapped under the ground. Eventually, the building pressure becomes great enough to trigger an explosive eruption.

---

## Lesson 8.3 Worksheet Answer Key

### True or False

1. true
2. true
3. false
4. false
5. true
6. false
7. false
8. true
9. true
10. false

### Critical Reading

1. Composite volcanoes are large volcanoes with steeply sloping sides, giving them a cone shape. Composite volcanoes are created by viscous felsic magma. Viscous magma cannot travel far down the sides of a volcano before it solidifies. This explains why composite volcanoes have steep sides and are cone shaped.
2. Shield volcanoes are shield shaped. They have gently sloping sides but cover a relative large area. Shield volcanoes are created by non-viscous mafic magma. Non-viscous magma flows readily down the sides of a volcano and can travel quite a distance before it solidifies. This explains why shield volcanoes have gentle sides and are shield shaped.
3. Composite volcanoes tend to have explosive eruptions because of their viscous felsic magma. Explosive eruptions include ash, small rocks, and lava. Therefore, composite volcanoes consist of alternating layers of ash and rock. Shield volcanoes, in contrast, tend to have effusive eruptions because of their non-viscous mafic magma. Effusive eruptions consist mainly of lava. Therefore, shield volcanoes consist of layer upon layer of solidified lava, rather than alternating layers of ash and rock.

### Multiple Choice

1. b
2. d
3. d
4. c
5. d
6. c
7. a

### Matching

1. e
2. d
3. a
4. f
5. b
6. g

7. c

### Fill in the Blank

1. felsic
2. effusive
3. Cinder cones
4. shield
5. composite
6. crater
7. supervolcano

### Critical Writing

*Sample answer:* A supervolcano eruption is a volcanic eruption in which a huge volume of material erupts all at once. The exact cause of a supervolcano eruption is not known for certain. However, scientists think that a supervolcano eruption occurs when a very large magma chamber erupts entirely in one catastrophic explosion. A supervolcano eruption could change life all over Earth. The vast amount of ash that explodes into the atmosphere could block sunlight to the extent that photosynthesis would be reduced and global temperatures would fall. Scientists think that supervolcano eruptions could have contributed to some of the mass extinctions in our planet's history.

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## Lesson 8.4 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. false
5. true
6. false
7. true
8. true
9. false
10. true

### Critical Reading

1. Landforms created by lava include volcanoes, lava domes, lava plateaus, and volcanic islands.
2. A lava dome is a large, rounded landform that forms when slow-flowing viscous lava cools and hardens before it can travel far from the vent of a volcano. It forms when there is not enough magma or pressure to cause an explosive eruption.
3. Thin, non-viscous lava forms a lava plateau. Non-viscous lava flows quickly, so it can cover a wide area before it solidifies.
4. The Hawaiian Islands formed from shield volcanoes in the ocean floor. Over the last 5 million years, lava from volcanic eruptions solidified to form new land on one after another of the islands.

**Multiple Choice**

1. d
2. c
3. b
4. a
5. b
6. d
7. c

**Matching**

1. c
2. e
3. b
4. g
5. d

**Fill in the Blank**

1. composition
2. more
3. lava plateau
4. shield
5. magma
6. United States
7. volcanoes

**Critical Writing**

*Sample answer:* When underground water is heated by magma, the water may emerge at the surface as either a hot spring or a geyser. A hot spring forms where heated underground water rises through a crack and bubbles out onto the surface. A geyser forms where heated underground water erupts onto the surface. This occurs only when the hot water is trapped in a narrow passageway so that heat and pressure build up. Eventually the pressure grows so great that the superheated water bursts out onto the surface as a geyser. There are fewer geysers than hot springs in the world because of the specific requirements for a geyser to form.



## 27.9 Chapter 9: Weathering and Formation of Soil

### Lesson 9.1 Worksheet Answer Key

#### True or False

1. false
2. true
3. true
4. true
5. true
6. false
7. true
8. true
9. false
10. false

#### Critical Reading

1. Chemical weathering is the type of weathering that occurs when rocks undergo chemical reactions that change their mineral composition. Chemical weathering occurs because minerals that form under Earth's surface are unstable when they reach the surface where temperature and pressure are much lower.
2. Water causes chemical weathering by dissolving minerals in rocks. This occurs because water is a polar molecule, with one side that is slightly positive and one side that is slightly negative. The positive side attracts negative ions and the negative side attracts positive ions. In this way, water molecules separate ions from their compounds and surround them.
3. Both carbon dioxide and oxygen are important agents of chemical weathering. Carbon dioxide in the atmosphere combines with water in raindrops to form the weak acid called carbonic acid. This acid dissolves minerals in rocks. Oxygen is very reactive chemically. It reacts with certain minerals in rocks and changes them to different substances. For example, oxygen reacts with iron-rich minerals and changes the iron to iron oxide, or rust, in the chemical reaction called oxidation.

#### Multiple Choice

1. d
2. d
3. a
4. d
5. d
6. b
7. d

### Matching

1. g
2. d
3. b
4. a
5. e
6. f
7. c

### Fill in the Blank

1. abrasion
2. water
3. precipitation
4. carbonic acid
5. oxidation
6. more
7. climate

### Critical Writing

*Sample answer:* Ice causes mechanical weathering by ice wedging and abrasion. Ice wedging occurs in areas that have repeated freeze-thaw cycles. It begins when water seeps into cracks in rock. When the water freezes, it expands and puts pressure on the rock. Over time, the cracks get larger because of the pressure of the ice. Abrasion occurs when ice in glaciers flows over rocks. Sediments frozen into the ice at the bottom of a glacier scrape over rocks and wear them down.

---

## Lesson 9.2 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. false
5. true
6. true
7. true
8. false
9. false
10. true

### Critical Reading

1. Residual soil forms over many years, as mechanical and chemical weathering slowly change solid rock into soil. Soil formation begins when bedrock cracks because of ice wedging or other processes of mechanical weathering. Water, oxygen, and carbon dioxide seep into the cracks and cause chemical weathering. Plants

eventually start growing and cause biological weathering. As the weathered material collects, layers called soil horizons develop. The greatest degree of weathering is in the top layer, and each successive lower layer is less altered by weathering.

2. A soil profile is a cross-section of all the layers, or horizons, of soil.
3. The three horizons found in most soils are the A, B, and C horizons. The A horizon is the top layer, also called topsoil. It has had the most weathering, contains the greatest amount of organic material, and is darkest in color. This is where all soil organisms live. The B horizon is the next layer below the A horizon, also called subsoil. Compared to the A horizon, the B horizon is less weathered, contains less organic material, and is lighter in color. It contains dissolved minerals and tiny clay particles washed down from the A horizon. The C horizon is the bottom layer. It is the least weathered, although some evidence of weathering is present.

### Multiple Choice

1. b
2. b
3. d
4. a
5. a
6. c
7. d

### Matching

1. g
2. b
3. e
4. a
5. f
6. c
7. d

### Fill in the Blank

1. climate
2. residual
3. transported
4. permeable
5. profile
6. C horizon
7. aluminum

### Critical Writing

*Sample answer:* Pedalfer and pedocal soils are two common soil types based on climate. Pedalfers are soils that form in deciduous forests in wet temperate climates. The name pedalfer comes from the aluminum (Al) and iron (Fe) these soils contain. Pedalfers are usually very fertile, dark brown or black soils because of all the organic matter that falls on the ground in deciduous forests. Because of the high precipitation, most soluble minerals are dissolved and leached out of these soils. Pedocals are soils that form in grasslands and brushy areas in drier temperate climates. The name pedocal comes from the calcite (cal) layer that forms in these soils. This layer marks how far the limited

rainfall travels through the soil before it begins to evaporate. Because of the lower precipitation, more soluble minerals remain in these soils than in pedalfer soils. The drier climate produces less vegetation, so pedocal soils also have less organic material and are less fertile than pedalfer soils.

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## 27.10 Chapter 10: Erosion and Deposition

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### Lesson 10.1 Worksheet Answer Key

#### True or False

1. true
2. false
3. true
4. false
5. true
6. true
7. false
8. true
9. false
10. true

#### Critical Reading

1. Groundwater is water that flows under the ground through soil or rock. Groundwater is a strong erosional force because it contains the weak acid called carbonic acid. This acid can dissolve and carry away minerals from rocks.
2. Over many years of moving through cracks in rocks, groundwater slowly dissolves and carries away rock minerals. This enlarges the cracks little by little, and eventually a cave may form.
3. Deposition of minerals by groundwater may form stalactites and stalagmites. Stalactites are icicle-like features that form on the ceiling of caves. Stalagmites are similar features that form on the floor of caves. A column may form if a stalactite and stalagmite join together.
4. A sinkhole forms when the roof of a cave collapses. This forms a hole on the surface that may be large enough to swallow a home or even several homes.

#### Multiple Choice

1. a
2. a
3. a
4. a
5. d
6. d
7. a

#### Matching

1. g

2. f
3. a
4. e
5. b
6. c
7. d

### Fill in the Blank

1. stream
2. groundwater
3. floodplain
4. natural levees
5. cave
6. column
7. sinkhole

### Critical Writing

*Sample answer:* A stream does the work of eroding and depositing sediments. As a stream flows from higher elevations near its headwaters toward lower elevations near its base level, the work of the stream changes. At its headwaters, a stream usually has a steep gradient and high velocity. It does a lot of work eroding its streambed. As the stream approaches its base level, its gradient generally decreases and its velocity lessens. Now the stream does more work eroding the edges of its banks. At this point, the stream also starts depositing more sediments than it erodes. When the stream enters a body of standing water, its velocity slows to a stop, and it drops its remaining sediments. The sediments may form a deposit called a delta.

---

## Lesson 10.2 Worksheet Answer Key

### True or False

1. true
2. true
3. false
4. false
5. true
6. false
7. true
8. true
9. true
10. true

### Critical Reading

1. Waves are most likely to deposit sand and form beaches in quiet areas along a shoreline. For example, a beach may form where water comes ashore in a protected bay. Waves are more likely to deposit sand on beaches during the summer when the waves have lower energy. In the winter, waves have higher energy and may carry the sand back offshore.

- Barrier islands form when waves deposit sand parallel to a shore in a long, narrow band. The islands tend to form along shores that are flat or gently sloping. In their natural state, barrier islands are the first defense against powerful wave erosion during hurricanes and other storms. They bear the brunt of the wave energy and protect shorelines from serious wave erosion.
- Spits are sand deposit that are connected to land and extend out into the water. Tombolos are spits that develop a curved, hook-like end.

### Multiple Choice

- d
- a
- b
- a
- a
- d
- c

### Matching

- c
- d
- a
- g
- b
- f
- e

### Fill in the Blank

- refraction
- tombolo
- sea wall
- wave-cut platform
- sea stacks
- delta
- summer

### Critical Writing

*Sample answer:* Two artificial structures that are built to protect shorelines from wave erosion are groins and breakwaters. A groin is a long, narrow pile of rocks built perpendicular to the shoreline. It prevents waves from transporting sand from a beach down the shore. It works by interrupting wave motion along the shoreline and traps sand on the up-current side of the groin. A breakwater is a structure built in the water parallel to the shore. It protects the shore from strong incoming waves. It works like a barrier island to block the erosive action of waves on the shore.

---

## Lesson 10.3 Worksheet Answer Key

### True or False

1. false
2. false
3. false
4. false
5. true
6. true
7. false
8. false
9. true
10. true

### Critical Reading

1. Sand dunes are small hills of sand deposited layer upon layer by the wind.
2. A sand dune forms when a strong wind slows down—often when it blows over some type of obstacle, such as a rock or clump of grass—and drops its sand. As the wind moves up and over the obstacle, it increases in speed. It carries the sand grains up the gently sloping, upwind side of the dune by saltation. As the wind passes over the crest of the dune, its speed decreases. Sand cascades down the other side, forming the steeper slip face of the dune.
3. The sands of different dunes may vary in their composition. For example, sand in beach dunes often consists mainly of quartz, whereas sand in desert dunes is typically more varied in the minerals it contains. The sand particles in different dunes are similar and usually very uniform in size and shape. Typically, the particles are sand-sized and rounded.
4. Factors that affect the type of sand dune that forms include the amount of sand available, the strength and direction of winds, and the type of ground over which the sand is moving. For example, crescent-shaped dunes form where a large amount of sand is available, winds blow consistently in one direction, and the ground is hard. Linear dunes form long straight lines parallel to the wind direction. They form in areas with less sand and where the winds come together from different directions.

### Multiple Choice

1. d
2. d
3. b
4. d
5. b
6. c
7. a

### Matching

1. g
2. b
3. f



4. a
5. e
6. d
7. c

### Fill in the Blank

1. suspension
2. abrasion
3. saltation
4. suspension
5. Dune
6. wind
7. Loess

### Critical Writing

*Sample answer:* Wind transports small particles such as silt and clay over great distances. Particles this size make up the suspended load. They are suspended in the moving air and may remain suspended for days. Sand-sized particles make up the bed load. They may move by creep or sometimes by saltation. In creep, the particles roll over the ground. In saltation, the particles move in short “hops” over the ground. Sand-sized particles usually remain within a meter of the ground. Smaller particles can travel higher above the ground.

---

## Lesson 10.4 Worksheet Answer Key

### True or False

1. false
2. true
3. false
4. false
5. false
6. true
7. false
8. false
9. true
10. true

### Critical Reading

1. Glacial till is a deposit of glacial sediments that are not sorted by size. A moraine is a linear deposit of glacial till.
2. Five types of glacial moraines are lateral, medial, ground, terminal, and end (recessional) moraines. Lateral moraines form at the edges of an alpine glacier from material that drops onto the glacier from erosion of the valley walls. A medial moraine forms where the lateral moraines of two tributary glaciers join together in the middle of a larger glacier. Ground moraines form from sediment underneath the glacier. Terminal moraine forms a long ridge at the farthest point a glacier reaches. End moraines form wherever a receding glacier stops long enough to drop a ridge of sediments.

3. Sediments deposited by glacial ice are unsorted because they drop to the ground in a mix of sizes as the glacier melts. Regardless of size, the sediments fall wherever they are when the ice melts. Glacial meltwater passes through glacial deposits. As it flows, the water erodes smaller sediments, such as silt and sand, but not larger sediments. When the meltwater slows down, it drops its sediments. It drops the larger sediments first, followed by the smaller sediments. This forms layers of sediments, sorted by size.
4. *Sample answer:* Two depositional features of glacial meltwater are eskers and outwash plains. An esker is a winding ridge of sand and other sediments deposited by a meltwater stream flowing under a glacier. An outwash plain is a broad area of stratified drift deposited by meltwater at the end of a receding glacier.

### Multiple Choice

1. b
2. d
3. b
4. a
5. d
6. b
7. c

### Matching

1. d
2. g
3. f
4. a
5. e
6. b
7. c

### Fill in the Blank

1. continental
2. alpine (valley)
3. hanging
4. horn
5. U
6. esker
7. drumlin

### Critical Writing

*Sample answer:* Alpine and continental glaciers are the two major types of glaciers. Continental glaciers are large ice sheets that cover relatively flat ground. They flow outward from the greatest accumulation of snow and ice. Alpine (or valley) glaciers flow down mountains through existing stream valleys. The two types of glaciers both erode rocks in the same basic ways, by abrasion and plucking. However, alpine glaciers erode some special features, including cirques and arêtes. Alpine and continental glaciers also form different depositional features. Alpine glaciers deposit lateral and medial moraines, whereas continental glaciers (or their meltwaters) deposit features such as drumlins and eskers.

---

## Lesson 10.5 Worksheet Answer Key

### True or False

1. true
2. false
3. true
4. true
5. false
6. false
7. true
8. false
9. true
10. true

### Critical Reading

1. Mass movement is any movement of Earth materials by the force of gravity. Four types of rapid mass movement are landslides, avalanches, mudflows, and lahars.
2. Landslides are one of the most dramatic, sudden, and dangerous types of mass movement. They are sudden falls of rock that move downhill quickly and with tremendous force. Landslides are exceptionally destructive. They may bury homes or even entire villages. If a landslide dams a stream, it may create a lake. If a landslide falls into a lake or bay, it may cause a tsunami.
3. Conditions that promote mudflows include soils rich in clay, little vegetation to hold the soil in place, and a period of heavy rain that thoroughly saturates the soil. Mudflows follow river channels and may wash out any bridges, trees, and homes that are along their path.
4. Lahars are mudflows that flow down the side of a composite volcano. They occur when ash from an eruption mixes with snow and ice. The snow and ice melt and contribute to the formation of hot, fast-moving mud.

### Multiple Choice

1. d
2. c
3. d
4. d
5. b
6. d

### Matching

1. c
2. d
3. b
4. a
5. g
6. f
7. e

**Fill in the Blank**

1. mass movement
2. lake
3. tsunami
4. earthquake
5. slump
6. clay

**Critical Writing**

*Sample answer:* Factors that increase the chances of mass movement include steep hillsides or cliffs, dry or semi-arid climate, lack of vegetation, period of heavy rains, soils high in clay, and ground shaking from earthquakes or volcanoes. Mass movement occurs when the force of gravity pulls rocks or soil downhill, so a change in elevation is obviously necessary. The steeper the slope, the easier it will be for rocks and soil to fall to a lower elevation. If the climate is dry or semi-arid, the soil is unlikely to contain moisture that can help hold it together, increasing the risk that soil and rocks will fall. Roots of plants also help to hold soil together, explaining why lack of vegetation increases the risk of mass movement. A period of heavy rain may make soils slippery and more likely to slide downhill. This is especially true if the soils are high in clay, because clay becomes very slippery when wet. Any ground movement, such as ground shaking due to earthquakes or volcanoes, may trigger mass movement when other conditions are present for this to occur.

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## 27.11 Chapter 11: Evidence About Earth's Past

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### Lesson 11.1 Worksheet Answer Key

#### True or False

1. true
2. true
3. false
4. true
5. false
6. false
7. true
8. true
9. true
10. true

#### Critical Reading

1. A fossil is any preserved remains or traces of a once-living organism. Body fossils are the preserved remains of actual body parts. Trace fossils are the preserved traces of organisms, such as their burrows, tracks, or feces.
2. Fossilization is rare because the remains or traces of organisms usually decay or are fragmented before there is a chance for preservation to occur.
3. Fossilization is more likely if an organism has hard parts, such as bones, shells, or teeth. It is also more likely if the remains are quickly buried before decay and fragmentation can occur. Fossilization of marine organisms is more likely than fossilization of land organisms because quick burial is more likely on the seafloor.

#### Multiple Choice

1. b
2. a
3. d
4. d
5. c
6. a
7. d

#### Matching

1. a
2. d
3. e
4. f

5. b
6. g
7. c

### Fill in the Blank

1. body
2. trace
3. Permineralization
4. imprint
5. fossils
6. short
7. replacement

### Critical Writing

*Sample answer:* Two different methods of fossilization are preservation and permineralization. Preservation is the least common method of fossilization and permineralization is the most common. Preservation occurs when an organism is completely preserved. For example, insects may be covered by tree sap that hardens to form amber; and mammoths may be buried in snow and preserved in a glacier. In preservation, soft tissues such as skin, hair, and organs may be well preserved. Scientists may even be able to collect and analyze DNA from the remains. Permineralization occurs when an organism's remains such as bones are buried in sediment. Mineral-rich water moves through the buried remains and deposits minerals. The minerals infiltrate the remains and gradually turn them into rock.

---

## Lesson 11.2 Worksheet Answer Key

### True or False

1. true
2. true
3. true
4. false
5. false
6. false
7. false
8. true
9. true
10. false

### Critical Reading

1. If rock formations are distinctive, they may be recognizable in different locations. The rocks in the different locations presumably formed under the same conditions and at the same time. Therefore, they must be the same age.
2. Index fossils are useful for finding rock layers that are the same age because the organisms they represent lived at about the same time no matter where they are found. A good index fossil represents an organism that was widespread but existed for only a short period of time.

3. A key bed is a distinctive layer of rock that is found in many areas of the world or even worldwide. The famous key bed that formed at the boundary between the Cretaceous and Tertiary Periods is a thin layer of clay that is rich in iridium. Iridium is rare on Earth but common in asteroids. This led to the hypothesis that a large asteroid struck Earth late in the Cretaceous and was a cause of the Cretaceous-Tertiary mass extinction, as well as the source of iridium in the key bed.

### Multiple Choice

1. a
2. a
3. d
4. c
5. c
6. b
7. c

### Matching

1. c
2. e
3. g
4. d
5. f
6. b
7. a

### Fill in the Blank

1. lateral continuity
2. relative
3. uniformitarianism
4. Hutton
5. microfossils
6. biozone
7. key bed

### Critical Writing

*Sample answer:* James Hutton worked to decipher Earth's history based on evidence and basic principles. One of those principles was his idea of uniformitarianism. This is the idea that the same geological processes that operate on Earth today operated in the past. Therefore, knowledge of modern geology is the key to understanding geological events in Earth's history. In other words, "the present is the key to the past."

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## Lesson 11.3 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. true
5. false
6. true
7. false
8. true
9. false
10. true

### Critical Reading

1. Radiometric dating is the process of using concentrations of radioactive isotopes and their daughter products to estimate the ages of materials. Different isotopes are used to date materials of different ages because they have different rates of decay. Using more than one isotope also helps scientists check the accuracy of the ages they calculate.
2. A tiny and constant percentage of carbon in the atmosphere is carbon-14. Plants take in carbon-14, along with nonradioactive isotopes of carbon, from the atmosphere during photosynthesis. Animals consumer this carbon when they eat plants or other animals that have eaten plants. The carbon-14 in organisms decays, but it is continuously replaced as long as an organism is alive. After an organism dies, the carbon-14 it contains continues to decay, while no new carbon-14 is taken into replace it, so the carbon-14 content of the remains constantly declines. Radiocarbon dating is useful only for relatively young specimens because the half-life of carbon-14 is relatively short at only 5730 years. After about 50,000 years, too little carbon-14 remains to accurately date materials.
3. Other radioisotopes that are used for radiometric dating include the following: potassium-40, which decays to argon-40 with a half-life of 1.26 billion years; uranium-238, which decays to lead-206 with a half-life of 4.47 billion years; and uranium-235, which decays to lead-207 with a half-life of 704 million years. Potassium-argon dating can be used to date materials between 100,000 and over a billion years old. Uranium-lead dating can be used to date materials between 1 million and 4.6 billion years old.

### Multiple Choice

1. d
2. a
3. d
4. d
5. c
6. a
7. d

### Matching

1. f



2. c
3. a
4. g
5. e
6. b
7. d

### Fill in the Blank

1. absolute
2. tree-ring
3. half-life
4. ice cores
5. Radioactive decay
6. radiocarbon
7. carbon-14

### Critical Writing

*Sample answer:* When radioactivity was discovered in the 1890s, some scientists thought that Earth was only about 100 million years old. This amount of time was too short to allow time for geological and evolutionary processes to take place. It was a blow to geologists and also to supporters of Darwin's theory of evolution. The 100 million years estimate of Earth's age was based on the time it was presumed to have taken for Earth to reach its present temperature. This age was actually a gross underestimate, which was apparent when scientists realized that radioactive decay of elements inside Earth's interior provides a steady source of heat to the planet. Radioactivity also provides a way to find the absolute ages of Earth materials, including rocks and fossils. This use of radioactive decay is referred to as radiometric dating. In this method, the constant rate of spontaneous decay of certain radioactive isotopes is used as a clock to determine the absolute ages of materials that contain the isotopes. By using different radioactive isotopes with a variety of rates of decay, scientists have been able to calculate absolute ages of materials that range from only 100 years old to those that are well over 4 billion years old. Radiometric dating has allowed scientists to push the age of Earth back to 4.6 billion years as well as to reconstruct major events in Earth's history and the evolution of its life forms.

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## 27.12 Chapter 12: Earth's History

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### Lesson 12.1 Worksheet Answer Key

#### True or False

1. false
2. true
3. false
4. true
5. false
6. true
7. false
8. false
9. false
10. true

#### Critical Reading

1. When they tried to determine how the moon formed, scientists considered several lines of evidence, including the relatively large size of the moon, the similarity in composition and place of origin of the moon and Earth, the extreme age of the moon, the moon's relatively small core, and Earth's relatively fast spin.
2. According to the "birth" story of the moon, a little more than 4.5 billion years ago, Earth was struck by a huge asteroid. The tremendous energy from the impact melted both Earth and the asteroid, and their molten materials mixed together. The dense metals remained on Earth but some of the molten materials were flung into orbit around Earth. These materials eventually accreted into a single body, the moon.
3. Earth has such a fast spin because of the energy imparted to it by the asteroid impact.

#### Multiple Choice

1. d
2. a
3. c
4. b
5. a
6. a
7. d

#### Matching

1. c
2. f
3. e

4. a
5. b
6. d
7. g

### Fill in the Blank

1. gravity
2. core
3. asteroid
4. comets
5. oxygen
6. cool
7. 4.6 billion

### Critical Writing

*Sample answer:* Earth's first atmosphere consisted of hydrogen and helium from the solar nebula, but these light gases were blown away by solar wind. Earth's second atmosphere formed from gases given off by volcanoes and ices from comets. It consisted of water vapor, carbon dioxide, nitrogen, and methane, but almost no oxygen. Oxygen was added to the atmosphere after plants evolved and began photosynthesis. When Earth was cool enough, water vapor condensed and rain began to fall. The water cycle began. Runoff carried the precipitation over the surface. Eventually, enough precipitation collected to form oceans.

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## Lesson 12.2 Worksheet Answer Key

### True or False

1. false
2. false
3. false
4. true
5. true
6. true
7. false
8. true
9. false
10. true

### Critical Reading

1. Photosynthesis is the process in which certain living cells use sunlight and inorganic molecules to create chemical energy they can use for food. Photosynthesis evolved around 3 billion years ago. Before photosynthesis evolved, organisms obtained nutrients by absorbing them from the organic soup that surrounded them.
2. Photosynthesis added oxygen to Earth's atmosphere. After photosynthesis evolved, oxygen was soon present in the atmosphere in far greater concentrations than ever before. The addition of oxygen from photosynthesis created Earth's third atmosphere.

3. The addition of oxygen to the atmosphere was a catastrophe for life on Earth because most organisms were adapted to an oxygen-free environment and oxygen was toxic to them. As a result, many organisms died out. The addition of oxygen to the atmosphere was also a great opportunity for life because the few organisms that survived developed a vital use for oxygen (cellular respiration) and were able to flourish.

### Multiple Choice

1. d
2. a
3. a
4. b
5. c
6. a
7. b

### Matching

1. c
2. d
3. b
4. e
5. g
6. a
7. f

### Fill in the Blank

1. Precambrian
2. smaller
3. Snowball Earth
4. microcontinents
5. amino
6. nucleic
7. RNA world

### Critical Writing

*Sample answer:* Eukaryotes evolved about 2 billion years ago. Unlike prokaryotic cells, eukaryotic cells have a nucleus that encloses their DNA. They also have other structures in their cells, called organelles, that perform specific functions. Scientists hypothesize that eukaryotes evolved from prokaryotic cells that began to live together in a symbiotic relationship. In this relationship, different types of small cells were able to help each other without harming one another. The small cells each took on a specialized function, such as supplying energy or breaking down wastes. Eukaryotic cells were much better able to live and replicate themselves. They continued to evolve and became the dominant life forms on Earth, although prokaryotic cells continued to exist and still exist today.

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## Lesson 12.3 Worksheet Answer Key

### True or False

1. false
2. true
3. false
4. true
5. false
6. true
7. false
8. true
9. true
10. true

### Critical Reading

1. At the beginning of the Mesozoic Era, there was just one continent, named Pangaea, and a single ocean, called the Panthalassa Ocean.
2. Supercontinents break up because they do not allow mantle heat to escape effectively. As a result, heat builds up beneath supercontinents, and continental rifting begins. Basaltic lavas fill in the rifts and eventually lead to seafloor spreading and the formation of new ocean basins.
3. The Atlantic Ocean basin formed as Pangaea broke apart and seafloor spreading pushed Africa and South America apart. This seafloor spreading is still occurring, and it continues to enlarge the Atlantic Ocean basin.
4. Much of North America was under water as Pangaea broke apart early in the Mesozoic because of marine transgression. This occurred because seafloor spreading was so vigorous that the mid-ocean ridge buoyed upward and displaced a huge amount of water.
5. In the Mesozoic, moving continents collided with island arcs and microcontinents. The collisions caused subduction of the oceanic Farallon plate beneath western North America. This produced igneous intrusions that have since been uplifted to form the Sierra Nevada Mountains.

### Multiple Choice

1. c
2. a
3. d
4. a
5. a
6. d
7. d

### Matching

1. b
2. e
3. d
4. c
5. g

6. a
7. f

### Fill in the Blank

1. Phanerozoic
2. glaciers
3. Panthalassa
4. Cenozoic
5. Pleistocene
6. Gondwana
7. Pangaea

### Critical Writing

*Sample answer:* During the Cenozoic, continents moved apart. As they did, the climate began to cool. When Australia and Antarctica separated, the circumpolar current could move the frigid water around Antarctica and spread it around the planet. Antarctica drifted over the south polar region and the continent began to grow a permanent ice cap. Starting in the late Miocene, glaciers began to form. During the Pleistocene, which began 2.6 million years ago, glaciers advanced and retreated four times, creating the Pleistocene ice ages.

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## Lesson 12.4 Worksheet Answer Key

### True or False

1. true
2. false
3. true
4. false
5. true
6. false
7. true
8. true
9. false
10. false

### Critical Reading

1. The “Cambrian explosion” was a tremendous diversification of marine life forms that occurred during the Cambrian Period.
2. There are more and better-preserved fossils from the Cambrian forward because animals evolved shells and other hard parts in the Cambrian.
3. Major evolutionary events that occurred during the Paleozoic Era include the first fish, first land plants and fungi, first insects, first amphibians, and first reptiles.
4. The Permian mass extinction occurred about 250 million years ago at the end of the Paleozoic. It was the largest mass extinction in Earth’s history. More than 95 percent of marine species and 70 percent of land species went extinct. Possible causes of the Permian mass extinction include an asteroid impact, intense volcanism, and changes in the composition of the atmosphere.

**Multiple Choice**

1. d
2. a
3. c
4. b
5. a
6. b
7. a

**Matching**

1. d
2. f
3. g
4. c
5. a
6. b
7. e

**Fill in the Blank**

1. Ediacara fauna
2. Paleozoic
3. Mesozoic
4. mass extinction
5. bird
6. Permian
7. mammals

**Critical Writing**

*Sample answer:* A population could evolve a new trait that helps its members adapt to a change in the environment through natural selection. If the trait was beneficial in the new environment, individuals with the trait would be more likely to survive and pass on the trait to their offspring. An example of evolution of a new trait by natural selection occurred in a deer mouse species in Nebraska. This mouse is typically brown, but after glaciers carried light-colored sand over the darker-colored soil where they live, predators could more easily spot the brown mice. Natural selection favored light-colored mice, who were more likely to survive and pass on their trait of light coloring. Over time, all the members of the population were light colored.

## 27.13 Chapter 13: Earth's Fresh Water

### Lesson 13.1 Worksheet Answer Key

#### True or False

1. false
2. true
3. true
4. false
5. false
6. false
7. false
8. true
9. true
10. true

#### Critical Reading

1. The sun provides the energy that drives the water cycle. It supplies the energy needed for evaporation, in which liquid water changes to water vapor. The sun's energy evaporates water from the oceans and from bodies of water on land.
2. Water vapor in the air may condense into tiny water droplets and form clouds. If the droplets collide with each other and grow large enough, they fall toward the surface as precipitation. Precipitation may be either liquid water (rain) or frozen water (snow, sleet, or hail).
3. Most rain falls into the oceans, where it may stay until it evaporates and re-enters the atmosphere. Rain that falls onto a continent may fall directly into a body of water, or it may run off the land into a stream, lake, or ocean, from which it may evaporate into the atmosphere. Alternatively, the rain may soak into soil, where it may be taken up by plants and given off by plant leaves as water vapor in the process of transpiration. If the rain soaks deeper into the ground, it may eventually reach the surface as groundwater discharge. For example, it may flow out onto the surface at a spring. Once on the surface, the water can evaporate and enter the atmosphere to continue the water cycle.
4. Solid precipitation may melt sooner or later and then follow one of the same paths as rain back to the atmosphere and thereby re-enter the water cycle. Alternatively, snow may become part of the ice in a glacier, where it may remain for hundreds or even thousands of years. A small amount of snow and ice may change directly to water vapor by sublimation and re-enter the water cycle without going through any additional steps.
5. Animals take in liquid water in food and drink. They may release water in the gaseous state when they exhale. They may release water in the liquid state when they sweat or urinate. Plants take up liquid water from the soil and release large amounts of water vapor into the air through their leaves by the process of transpiration.

#### Multiple Choice

1. a
2. c



3. a
4. d
5. c
6. b
7. d

### Matching

1. d
2. f
3. e
4. b
5. g
6. a
7. c

### Fill in the Blank

1. solid
2. residence
3. water vapor
4. hydrologic (water) cycle
5. agriculture
6. groundwater
7. oceans

### Critical Writing

*Sample answer:* Water is the only substance on Earth that can exist in all three states of matter under normal Earth temperatures. Because water is present on Earth in all three states, it can get into a variety of environments around the planet and continuously cycle through the hydrologic cycle. It does so by changing state as temperatures fluctuate. For example, when water changes from a liquid to a gas, it leaves Earth's surface and enters the atmosphere. When water changes from a gas to a liquid, it leaves the atmosphere and returns to Earth's surface. In these and other ways, water keeps moving on or under Earth's surface, through bodies of water, and through the atmosphere.

---

## Lesson 13.2 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. true
5. false
6. true
7. false
8. true

9. false
10. true

### Critical Reading

1. Lakes are relatively large bodies of still water. They are usually fed by streams and drained by streams as well. Most lakes contain fresh water, but a few have salty water.
2. Lakes can form in depressions carved out by glaciers or in calderas of volcanoes.
3. Three ecological zones in lakes include the surface, open-water, and deep-water zones. The surface zone is the relatively shallow region close to shore. The open-water zone is the top part of the water away from shore where there is enough sunlight for photosynthesis. The deep-water zone is the deep part of the water away from shore where there is not enough sunlight for photosynthesis.
4. Lakes are not permanent features of the landscape because lakes eventually disappear. They may fill with sediments, the springs or streams that feed them may diminish, or their outlets may expand due to erosion. Lakes may also disappear if the climate changes and precipitation decreases.

### Multiple Choice

1. d
2. b
3. a
4. b
5. a
6. c
7. d

### Matching

1. d
2. b
3. g
4. e
5. c
6. f
7. a

### Fill in the Blank

1. tributary
2. divide
3. limnology
4. flood
5. surface (littoral)
6. lakes
7. levee

### Critical Writing

*Sample answer:* Wetlands should be protected for two main reasons. First, wetlands are important ecosystems. They are unique ecosystems with a great deal of biological diversity, and they provide homes to many endangered species. They also remove pollutants from water and help maintain the quality of the water supply. Second, wetlands need protection. They can be fragile ecosystems that are sensitive to the amounts and quality of water.

---

## Lesson 13.3 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. true
5. false
6. false
7. true
8. false
9. true
10. false

### Critical Reading

1. Groundwater is significant because it is the largest reservoir of liquid fresh water on Earth. Most groundwater is located in aquifers.
2. An aquifer is a layer of permeable rock, sand, or gravel that holds large amounts of groundwater. Aquifers are located at different depths, from just below the surface to much deeper underground. Aquifers lie beneath most regions of land, even deserts.
3. Factors that influence the amount of water that is available to enter groundwater in a region include the local climate, slope of land, type of surface rock, vegetation cover, land use in the area, and water retention.
4. The residence time of groundwater in an aquifer is how long the water remains there. It can range from just a few minutes to hundreds of thousands of years. Water in aquifers may date back to the end of the Pleistocene ice ages.

### Multiple Choice

1. d
2. d
3. c
4. d
5. d
6. c
7. b

### Matching

1. g

2. f
3. a
4. e
5. b
6. c
7. d

### Fill in the Blank

1. impermeable
2. recharge
3. discharge
4. Pores
5. hydrogeology
6. well
7. fossil

### Critical Writing

*Sample answer:* People obtain groundwater from springs or wells. A spring is a place where the water table naturally intersects the surface of the ground so water comes bubbling out onto the surface. A well is a long, narrow shaft that is dug or drilled down into the ground to a point below the water table. Water may be brought to the surface through a well by a pump or bucket. Groundwater is an extremely important water source for people. People use groundwater for many purposes, including home and municipal uses such as drinking and bathing. Groundwater is also used for agricultural needs, especially irrigation. Groundwater may be at risk because in many places it is used more quickly than it is replenished. For example, about eight times more water is taken from the huge Ogallala aquifer each year than is replenished. Overuse of groundwater may cause water tables to fall, wells to go dry, and subsidence of surface land to occur. In coastal areas, overuse of groundwater may result in saltwater contamination of aquifers, which makes the water less useful for drinking and irrigation.

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## 27.14 Chapter 14: Earth's Oceans

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### Lesson 14.1 Worksheet Answer Key

#### True or False

1. false
2. true
3. false
4. true
5. false
6. true
7. false
8. true
9. true
10. false

#### Critical Reading

1. Ocean zones based on depth are the photic and aphotic zones. Ocean zones based on distance from shore are the littoral (intertidal), neritic, and oceanic zones.
2. The photic zone is the top 200 meters of water. This is the depth to which enough sunlight can penetrate to allow for photosynthesis. Therefore, this is the zone in which all photosynthetic marine organisms are found. Most other marine organisms also live in, or at least visit, the photic zone. The aphotic zone is the rest of ocean water below the top 200 meters. Too little sunlight penetrates the aphotic zone to allow for photosynthesis. Therefore, photosynthetic organisms do not live in this zone. Although the aphotic zone makes up the majority of the ocean, it contains a relatively small proportion of the ocean's organisms, both in diversity and in numbers.
3. The littoral, neritic, and oceanic zones are all defined based on distance from shore. The littoral zone is the zone that is closest to shore. It is also called the intertidal zone because it is the region between high and low tide marks. The neritic zone is next after the littoral zone. It extends from the low tide mark to the edge of the seaward side of the continental shelf. The oceanic zone is the rest of the ocean beyond the continental shelf. All three zones include the photic zone by depth. Only the neritic and oceanic zones also include the aphotic zone by depth.

#### Multiple Choice

1. b
2. a
3. b
4. b
5. c
6. d
7. b

### Matching

1. b
2. g
3. d
4. f
5. a
6. e
7. c

### Fill in the Blank

1. biomass
2. sodium chloride
3. margin
4. salinity
5. Challenger Deep
6. 200
7. intertidal (littoral)

### Critical Writing

*Sample answer:* Without its oceans, Earth would be a very different planet. The oceans play a major role in keeping temperatures fairly constant worldwide by distributing heat around the planet. The range of temperatures on Earth is only about 125 degrees Celsius. Without the oceans, Earth temperatures would have a much wider range, perhaps similar to temperatures on Mercury, which have a range of more than 600 degrees Celsius. Earth's oceans also moderate local climates, keeping places near an ocean cooler in summer and warmer in winter than places farther from an ocean. This moderating effect occurs because ocean water takes a long time to heat up and cool down. Earth's oceans are an essential part of the water cycle. Most water that evaporates and enters the atmosphere comes from the oceans. Most precipitation falls in the oceans as well. Without the oceans, water might cycle but much more slowly. Earth's oceans are home to the majority of Earth's biomass, and they have tremendous biodiversity. Without the oceans, Earth's living things would be far fewer in number and less diverse.

---

## Lesson 14.2 Worksheet Answer Key

### True or False

1. false
2. true
3. false
4. false
5. true
6. true
7. true
8. false
9. false
10. false

### Critical Reading

1. As the moon revolves around Earth, its gravity pulls Earth toward it. The lithosphere is unable to move much, but ocean water can, and it bulges outward toward the moon. This creates a high tide on the side of Earth facing the moon. The moon's gravity pulling Earth toward it leaves behind water on the opposite side of the planet. This creates another high tide bulge on the opposite side of Earth from the moon. Because so much water is pulled into the two high tide bulges low tides occur at places in between.
2. Earth rotates beneath the moon once each day, so any given place on the coast will experience two high tides and two low tides every day.
3. The sun has only a secondary effect on Earth's tides because it is much farther away from Earth than the moon is.
4. Both spring tides and neap tides are tides with unusual tidal ranges. Both also occur twice a month. Spring tides occur when the gravitational pull of both the moon and the sun are in the same direction. This happens when the moon is in its new or full moon phase. During spring tides, the high tides are higher and the low tides are lower than at other times of the month, so the tidal range is at a maximum. Neap tides occur when the gravitational pull of the moon and the sun are at right angles. This happens during the first and third quarter phases of the moon. During neap tides, the high tides are lower and the low tides are higher than at other times of the month, so the tidal range is at a minimum.

### Multiple Choice

1. d
2. b
3. d
4. a
5. d
6. a
7. d

### Matching

1. c
2. a
3. e
4. f
5. g
6. b
7. d

### Fill in the Blank

1. storm surge
2. tsunami
3. moon's
4. tidal range
5. Spring
6. Coriolis effect
7. Downwelling

### Critical Writing

*Sample answer:* Thermohaline circulation is the circulation of ocean water in deep ocean currents. The currents result from density differences in water masses because of their different temperatures (*thermo-*) and salinities (*haline*). Water near the poles is very cold and saline, which makes it very dense, so it sinks to the bottom. This is called downwelling. The dense water pushes less dense water out of its way and flows toward the equator. It mixes with less dense water as it flows. At the same time, surface currents move water to the poles and into the space at the surface vacated by the downwelling. All these ocean water movements make up thermohaline circulation.

---

## Lesson 14.3 Worksheet Answer Key

### True or False

1. true
2. false
3. true
4. false
5. false
6. true
7. true
8. false
9. true
10. false

### Critical Reading

1. Samples of seawater from different depths in the ocean can be collected remotely with bottles placed along a cable at regular depths and closed as a weight is dropped down the cable. Samples of rocks and sediments on the seafloor can be collected remotely with dredges or gravity corers. A dredge is a giant rectangular bucket that is dragged behind a ship to collect loose rocks from the seafloor. Gravity corers are metal tubes that fall to the seafloor and slice into sediments to collect samples.
2. A submersible is a special underwater vehicle that can travel deep below the ocean surface to collect samples, take photographs, or carry scientists to make direct observations. The HOV (human-operated vehicle) named Alvin can dive up to 4500 meters beneath the surface and has made more than 4000 dives since 1964.
3. ROVs are remotely operated submersible vehicles. Using ROVs instead of HOVs in researching deep-sea environments avoids the expense, dangers, and limitations of human deep-sea missions.

### Multiple Choice

1. d
2. c
3. d
4. c
5. a
6. c
7. c



**Matching**

1. b
2. d
3. e
4. g
5. a
6. c
7. f

**Fill in the Blank**

1. seawater
2. Alvin
3. human-operated
4. natural gas
5. platforms
6. reproduction

**Critical Writing**

*Sample answer:* Nonliving natural resources on or beneath the seafloor include oil, natural gas, and minerals. Oil and natural gas are obtained from the seafloor by drilling into the oceanic crust from oil platforms on the ocean surface. Potential problems of obtaining these resources are the risks of explosions and fires on oil platforms and of oil spills from wells and oil tankers. These problems can threaten human lives and cause a great deal of damage to ocean and coastal ecosystems. Minerals are found on the seafloor in manganese nodules. Potential problems of obtaining these minerals include the expense of collecting them from so far beneath the ocean surface where there is absolute darkness, very low temperatures, and extremely high pressure. Collecting the minerals would also be likely to threaten deep-sea ecosystems.

---

**Lesson 14.4 Worksheet Answer Key****True or False**

1. true
2. false
3. false
4. true
5. false
6. true
7. true
8. true
9. false
10. true

### Critical Reading

1. In the intertidal zone, organisms need adaptations to protect them from the pounding waves and from drying out due to air exposure at low tide. The water is always moving in this zone, so many also need a way to securely attach themselves to rocks.
2. Coral reef ecosystems consist of organisms that live in or around coral reefs. They are among the most densely inhabited and diverse ecosystems on Earth. Because coral reefs are close to shore, they are subject to pollution from land. Corals are also very sensitive to temperature and are stressed by rising ocean temperatures.
3. Fish that live far below the surface of the ocean have adaptations that allow them to get by on little food because food is scarce in this ecosystem. For example, they may have small body size and a very low metabolic rate. They may also have adaptations that maximize their chances of catching prey, such as jaws that unhinge to accept larger fish. To adapt to the absolute darkness, many fish can produce light with chemical reactions.
4. Hydrothermal vent ecosystems are unique because their primary producers make food by chemosynthesis rather than photosynthesis, which is not possible on the ocean floor. The vent producers are bacteria that use chemicals in the hot water for energy to make food.

### Multiple Choice

1. d
2. a
3. d
4. a
5. b
6. c
7. d

### Matching

1. e
2. g
3. f
4. a
5. d
6. c
7. b

### Fill in the Blank

1. photic
2. bioluminescence
3. fish
4. coral reefs
5. atoll
6. chemosynthesis
7. oxygen

**Critical Writing**

*Sample answer:* Fish are a class of marine vertebrates. Examples of fish include sardines, salmon, and sharks. Fish have many adaptations that help them live in their marine environment. Some of their adaptations include: fins, which help them move and steer through the water; gills, which allow them to extract oxygen from the water; swim bladders, which let them rise and sink to different depths of the water column; and bioluminescence, which allows them to produce light by chemical reactions in the darkness of the deep ocean.

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## 27.15 Chapter 15: Earth's Atmosphere

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### Lesson 15.1 Worksheet Answer Key

#### True or False

1. true
2. true
3. true
4. false
5. false
6. true
7. true
8. false
9. true
10. false

#### Critical Reading

1. Plants use carbon dioxide to make food by photosynthesis, and they release oxygen as a waste product of photosynthesis. By producing oxygen and food, plants have made an environment that is favorable for other organisms. Most organisms use respiration to break down food for energy. This process uses oxygen from the atmosphere and releases carbon dioxide as a waste product.
2. The ozone layer in the atmosphere absorbs high-energy ultraviolet radiation from the sun. It protects living things on Earth's surface from these harmful rays. Without ozone for protection, only the simplest life forms would be able to live on Earth.
3. Greenhouse gases in the atmosphere trap heat and moderate Earth's atmosphere. Without these gases, Earth's temperatures would be frigid at night and scorching during the day.
4. Gas molecules in the atmosphere transmit sound waves to our ears so we can hear.

#### Multiple Choice

1. d
2. a
3. d
4. c
5. c
6. d

#### Matching

1. e
2. c

3. d
4. b
5. a
6. f
7. g

### Fill in the Blank

1. atmosphere
2. photosynthesis
3. ozone
4. Greenhouse
5. oxygen
6. decreases
7. air pressure

### Critical Writing

*Sample answer:* The atmosphere has different properties at different altitudes. The density of the air, which is the number of molecules in a given volume, is greatest at sea level and decreases with increasing altitude. This is because the effect of gravity on gas molecules in air is greatest at sea level, and it pulls the molecules close to Earth's surface. At high altitudes, molecules are more spread out and air is less dense. Air pressure also decreases with increasing altitude. Gases at sea level are most compressed by the weight of the atmosphere above them, giving them the greatest air pressure. This pressure is less at higher altitudes where the compression of the atmosphere is not as great.

---

## Lesson 15.2 Worksheet Answer Key

### True or False

1. false
2. false
3. false
4. true
5. true
6. false
7. true
8. true
9. false
10. true

### Critical Reading

1. In the troposphere, the temperature of the air is generally highest near Earth's surface and decreases with altitude. Throughout the troposphere, the temperature falls by an average of 6.5 °C per 1000 meters of increase in altitude. The major direct source of heat in the troposphere is Earth's surface. The surface absorbs sunlight and radiates it back into the atmosphere as heat.

2. Because of the temperature gradient in the troposphere, warmer air is located below cooler air. This condition is unstable. Warmer air near the surface rises because it is less dense, and cooler air higher in the troposphere sinks because it is denser. As a result, air in the troposphere does a lot of mixing.
3. A temperature inversion is the situation in which warmer air in the troposphere sits over colder air at the surface. Temperature inversions often occur during the winter when the ground is very cold at night. The cold ground cools the air directly above it, making this layer of air denser than the air above it. Temperature inversions may also occur near a coast when cold seawater cools the air above it. The cooler, denser air moves inland and slides beneath warmer air over the land. A temperature inversion is stable because denser, cooler air is already closer to the ground than warmer, less dense air.
4. The tropopause prevents air in the troposphere and stratosphere from mixing. The tropopause is a thin layer of air at the top of the troposphere in which the temperature does not change with altitude. The air in the tropopause traps the cooler, denser air of the troposphere beneath the warmer, less dense air of the stratosphere.

### Multiple Choice

1. a
2. a
3. b
4. a
5. d
6. a
7. c

### Matching

1. f
2. g
3. a
4. e
5. b
6. d
7. c

### Fill in the Blank

1. temperature
2. lower
3. decrease
4. sun
5. decrease
6. ionosphere
7. wind

### Critical Writing

*Sample answer:* Temperatures in the mesosphere decrease with altitude. This occurs because there are too few gas molecules in the mesosphere to absorb the sun's radiation. Instead, the heat source of the mesosphere is the stratosphere below it. This makes the lower mesosphere warmer than the upper mesosphere. The top of the mesosphere is extremely cold, with a temperature of about  $-90^{\circ}\text{C}$ .

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## Lesson 15.3 Worksheet Answer Key

### True or False

1. false
2. true
3. false
4. true
5. false
6. false
7. false
8. true
9. false
10. true

### Critical Reading

1. The Northern Hemisphere is warmer in the summer than in the winter because sunlight is more concentrated on the Northern Hemisphere in the summer than in the winter. The sun's rays are more direct in the summer because the Northern Hemisphere is tilted toward the sun.
2. Heat from Earth's surface is transferred to the atmosphere mainly by radiation. Radiation is the transfer of energy between two objects by electromagnetic waves. Heat from Earth's surface also travels to the lower atmosphere by conduction. Conduction is the transfer of energy between two objects by direct contact between molecules.
3. Heat is transferred throughout the troposphere by convection. Convection occurs when molecules of air move in currents because of differences in density.

### Multiple Choice

1. d
2. c
3. a
4. d
5. d
6. a
7. d

### Matching

1. c
2. e
3. f
4. g
5. b
6. a
7. d

### Fill in the Blank

1. heat
2. reflects
3. visible
4. ultraviolet
5. summer
6. equator
7. conduction

### Critical Writing

*Sample answer:* Temperature is a measure of how fast the atoms in a material are vibrating. The higher the temperature of the material, the faster its atoms are vibrating. Heat is a measure of the total energy of a material. It depends on how fast its atoms are vibrating (its temperature) and also on the total number of atoms it has (its mass). For example, the flame of a candle has a higher temperature than warm bath water, but the bath water has more heat because there is so much more of it.

---

## Lesson 15.4 Worksheet Answer Key

### True or False

1. true
2. false
3. true
4. false
5. false
6. true
7. false
8. true
9. true
10. false

### Critical Reading

1. The three major convection cells in the Northern Hemisphere are the Hadley, Ferrell, and polar cells. In the Hadley cell, warm air rises over the equator, creating a low-pressure zone, and flows north at the top of the troposphere, cooling as it flows. At about 30 degrees north latitude, the air sinks to the ground, creating a high-pressure zone, and then returns over the ground to the equator. In the Ferrell cell, air rises at about 60 degrees north latitude, creating a low-pressure zone, and flows south to about 30 degrees north latitude. There it sinks to the ground at a high-pressure zone and then returns over the ground to 60 degrees north latitude. In the polar cell, air rises at about 60 degrees north latitude at a high-pressure zone and flows north to the pole. At the pole, the air sinks to the ground, creating high-pressure zone, and then returns over the ground to 60 degrees north latitude. The direction of the circulating air in all three cells is deflected to the right by the Coriolis effect.
2. The three global wind belts in the Northern Hemisphere are the trade winds, westerlies, and polar easterlies. The trade winds blow from northeast to southwest between 30 and 0 degrees north latitude. The westerlies



blow from southwest to northeast between 30 and 60 degrees north latitude. The polar easterlies blow from northeast to southwest between 90 and 60 degrees north latitude.

3. The global wind belts are caused by the global circulation cells. The winds are the flowing air at the bottom of the cells. Their direction is affected by the Coriolis effect, which causes them to blow toward the northeast or southwest rather than due north or south.

### Multiple Choice

1. a
2. b
3. d
4. d
5. b
6. a
7. d

### Matching

1. f
2. a
3. b
4. g
5. e
6. d
7. c

### Fill in the Blank

1. low
2. advection
3. haboob
4. Coriolis
5. westerlies
6. low
7. jet stream

### Critical Writing

*Sample answer:* Both land and sea breezes are local winds that occur along the coast of an ocean or large lake up to a distance of 50 to 100 kilometers inland. The underlying reason for both types of breezes is the difference in specific heat of land and water. Water has higher specific heat than land, so it heats up and cools down more slowly than land. This results in temperature and pressure differences in the air over land and water. Like all winds, both land and sea breezes blow from an area of higher pressure to an area of lower pressure, or from an area that is cooler to an area that is warmer. Therefore, sea breezes blow from the cooler ocean to the warmer land during the daytime and/or in the summer, whereas land breezes blow from the cooler land to the warmer ocean at night and/or in the winter.

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## 27.16 Chapter 16: Weather

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### Lesson 16.1 Worksheet Answer Key

#### True or False

1. false
2. false
3. true
4. true
5. true
6. false
7. true
8. false
9. false
10. true

#### Critical Reading

1. Clouds are a big influence on weather. They are needed for precipitation. They also moderate temperatures by blocking both solar radiation during the day and radiation of heat from the surface during the night.
2. Clouds form when air reaches the dew point and water vapor starts condensing. The condensation of many water molecules around a nucleus, such as a speck of dust, forms a tiny droplet of liquid water. Billions of these water droplets make up a cloud.
3. By altitude, clouds are classified as high, middle, low, or vertical clouds. High clouds, such as cirrus clouds, form at high altitudes and consist of ice crystals. Middle clouds, such as altostratus clouds, form at middle altitudes and consist of ice crystals, water droplets, or both. Low clouds, such as stratus clouds, form at low altitudes and consist only of water droplets. Vertical clouds, such as cumulus clouds, grow upward and have their bases at low altitude and their tops at middle or high altitude.

#### Multiple Choice

1. c
2. d
3. a
4. a
5. c
6. c
7. c

#### Matching

1. b

2. d
3. e
4. a
5. f
6. g
7. c

### Fill in the Blank

1. Weather
2. energy
3. climate
4. altitude
5. fog
6. Dew
7. Frost

### Critical Writing

*Sample answer:* Relative humidity is the percentage of water vapor in a given volume of air relative to the total amount of water vapor the air can hold. The amount of water vapor the air can hold depends on its temperature. Warmer air can hold more water vapor than cooler air.

---

## Lesson 16.2 Worksheet Answer Key

### True or False

1. true
2. false
3. true
4. false
5. true
6. true
7. true
8. false
9. true
10. false

### Critical Reading

1. An air mass is a very large batch of air that has nearly the same temperature and humidity throughout.
2. An air mass acquires its characteristics from the region over which it forms, called its source region. A warm, moist air mass would form over the ocean in a tropical region, so it might form over the Atlantic or Pacific Ocean near the equator.
3. Air masses move because they are slowly pushed along by high-level winds. When air masses move over a region, they bring their temperature and humidity to the region. Storms may arise if an air mass moves over a region with different characteristics.

**Multiple Choice**

1. d
2. b
3. c
4. a
5. d
6. b
7. a

**Matching**

1. b
2. d
3. f
4. g
5. a
6. c
7. e

**Fill in the Blank**

1. high
2. equator
3. poles
4. densities
5. low
6. density
7. high

**Critical Writing**

*Sample answer:* Both warm fronts and cold fronts are boundaries between a cold air mass and a warm air mass. They differ in which air mass overtakes the other. A warm front forms when a warm air mass overtakes a cold air mass and slides up over the cold air mass. A cold front forms when a cold air mass overtakes a warm air mass, slides beneath it, and pushes it up. With both types of fronts, the rising warm air cools and is likely to produce clouds and precipitation. At a cold front, there is likely to be rain or snow, and thunderstorms with blustery winds may occur in a squall line along the front. At a warm front, cloudy weather moves in more slowly, and storms are less likely.

---

**Lesson 16.3 Worksheet Answer Key****True or False**

1. false
2. true
3. false
4. true
5. false

6. false
7. false
8. true
9. true
10. true

### Critical Reading

1. A Northern Hemisphere cyclone is a large system of winds rotating counterclockwise around a low-pressure center. The swirling air rises and cools, creating clouds and precipitation. A cyclone in the Southern Hemisphere would have winds rotating clockwise around a low-pressure center.
2. Mid-latitude cyclones are the main cause of middle-latitude winter storms, including blizzards and nor'easters. Tropical cyclones are also known as hurricanes or typhoons.
3. Both cyclones and anticyclones are large systems of rotating winds. However, in cyclones the winds rotate around a low-pressure center, whereas in anticyclones they rotate around a high-pressure center. Cyclones cause storms, whereas anticyclones generally bring fair weather.

### Multiple Choice

1. d
2. d
3. b
4. d
5. b
6. a
7. d

### Matching

1. f
2. e
3. g
4. d
5. c
6. b
7. a

### Fill in the Blank

1. thunderstorms
2. counterclockwise
3. mid-latitude
4. depression
5. Tornadoes
6. Hurricanes
7. lake-effect

## Critical Writing

*Sample answer:* Tornadoes are storms that form at the leading edge of severe thunderstorms. They may have extremely high winds that cause incredible destruction. Fortunately, tornadoes generally cover a relatively narrow area and do not last very long. Hurricanes are tropical cyclones that form over a tropical depression. They have high-speed winds, but not as high as the highest-speed tornado winds. However, hurricanes cover a much larger area than tornadoes, and they also last much longer. Therefore, the total amount of damage they do is likely to be far greater. In addition, hurricanes cause storm surge, which adds to the destruction caused by the high winds.

---

## Lesson 16.4 Worksheet Answer Key

### True or False

1. true
2. true
3. false
4. true
5. false
6. true
7. false
8. true
9. true
10. false

### Critical Reading

1. *Sample answer:* Two weather instruments are thermometers and barometers. Thermometers measure temperature, and barometers measure air pressure.
2. Weather stations are small collections of weather instruments. There are about 10,000 weather stations located on land all over the world. Weather stations are also located on about 15 satellites, 700 buoys, 3000 aircraft, and 7300 ships.
3. Radiosondes add to our knowledge of atmospheric conditions by collecting data on temperature, air pressure, and other weather factors as they travel through the atmosphere. Weather radar uses radio waves to detect water in the atmosphere. It can show the location and intensity of precipitation. Weather satellites collect data on atmospheric conditions all over Earth by creating images of storms, clouds, temperatures, and other weather characteristics.

### Multiple Choice

1. d
2. d
3. a
4. d
5. c
6. c
7. d

**Matching**

1. g
2. f
3. e
4. c
5. b
6. a
7. d

**Fill in the Blank**

1. falls
2. radar
3. satellites
4. computers
5. isotherms
6. fair
7. balloon

**Critical Writing**

*Sample answer:* Weather forecasts are better now than they ever have been. A 5-day weather forecast today is as reliable as a 2-day forecast was 20 years ago. This is because forecasters now use advanced technologies, such as weather satellite, to gather weather data, and they use the world's most powerful computers to analyze the data. Together, the data and computers produce complex models that more accurately represent the conditions of the atmosphere. These models can be programmed to predict how the atmosphere and the weather will change.

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## 27.17 Chapter 17: Climate

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### Lesson 17.1 Worksheet Answer Key

#### True or False

1. false
2. true
3. true
4. true
5. false
6. false
7. true
8. false
9. false
10. false

#### Critical Reading

1. A maritime climate is found along a coast where winds usually blow from the ocean to the land. This type of climate is moderate, with relatively small differences in temperatures seasonally or daily. A continental climate is found too far inland to be influenced by the ocean. This type of climate is extreme, with relatively large differences in temperatures seasonally and daily.
2. Surface currents may contribute to the influence of the water on a coastal climate. For example, the cold California current keeps California's coastal climate cooler than it would be otherwise.
3. Mountain ranges may influence climate by causing rainshadows and continental climates in regions relatively close to a coast. Rainshadows occur when precipitation falls on the windward side of a mountain range so the air on the leeward side is too dry to produce rain. Maritime air masses may have trouble rising over a mountain range, so the coastal area will have a maritime climate but the inland area on the leeward side of the range will have a continental climate.

#### Multiple Choice

1. d
2. c
3. a
4. c
5. d
6. a
7. d



**Matching**

1. g
2. b
3. c
4. f
5. d
6. a
7. e

**Fill in the Blank**

1. latitude
2. jet stream
3. stormy
4. heat
5. leeward
6. Hadley
7. westerlies

**Critical Writing**

*Sample answer:* Most of Earth's major deserts are located at about 30 degrees north or south latitude because this is the region between Hadley and Ferrell cells, where air sinks toward the surface. The sinking air is already dry because it lost its moisture when it rose over the equator. As it sinks, the air warms and can hold more moisture. The air is too dry to bring precipitation and instead causes evaporation from the surface. As a result, these regions are very dry and classified as deserts.

---

**Lesson 17.2 Worksheet Answer Key****True or False**

1. true
2. false
3. false
4. true
5. false
6. true
7. false
8. true
9. true
10. false

**Critical Reading**

1. The Köppen classification system is a system for classifying climates into zones that are based on temperature and amount and timing of precipitation. The major climate groups in this system are tropical moist, dry, moist subtropical mid-latitude, continental, and polar climates.

2. Of the five major climate groups, tropical moist climates and moist subtropical mid-latitude climates are moist. Tropical moist climates are moist because they are located near the equator where warm air rises and creates clouds and precipitation. Moist subtropical mid-latitude climates are moist because they are coastal climates.
3. Group B dry climates are found at about 30 degrees north and south latitude and also at higher latitudes in rainshadows and within continents. Other climate groups that are dry are continental climates and polar climates. Continental climates are dry because they are within continents far from coasts. Polar climates are dry because the air is too cold to hold much moisture.

### Multiple Choice

1. a
2. d
3. b
4. a
5. a
6. b
7. b

### Matching

1. e
2. f
3. g
4. a
5. b
6. d
7. c

### Fill in the Blank

1. deserts
2. tropical rainforest
3. five
4. Permafrost
5. tundra
6. ice cap
7. microclimate

### Critical Writing

*Sample answer:* The natural vegetation in an area can be used to identify the area's climate zone because climate determines what types of plants are likely to live in an area. The same climate zones all over the world have similar vegetation because their environments have similar advantages and challenges. The plants have adapted to their similar environments in similar ways. For example, different species of cactus plants live in dry climates on different continents. Therefore, if cacti are growing in an area, it indicates that the climate is dry.

---

## Lesson 17.3 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. false
5. true
6. true
7. false
8. true
9. false
10. true

### Critical Reading

1. The ENSO, or El Niño southern oscillation, is a short-term climate change that cycles between El Niño and La Niña. The ENSO repeats every 2 to 7 years.
2. An El Niño differs from what happens during a normal year in several ways. First, an El Niño occurs when the water of the Pacific Ocean is warmer than it is during normal years. Also, during an El Niño, trade winds blow across the Pacific in the opposite direction from normal, that is, from west to east instead of from east to west. This results in warm water piling up in the eastern Pacific rather than in the western Pacific where it normally piles up. During an El Niño there is no upwelling off the western coast of South America, where upwelling normally occurs.
3. By altering atmospheric and oceanic circulation, an El Niño changes global climate patterns. Some regions receive more rainfall than normal, including the west coasts of North and South America. Other regions receive less rainfall than normal, including parts of South America, Australia, and Indonesia.
4. A La Niña is a period that may follow an El Niño. A La Niña is an exaggeration of the normal pattern of atmospheric and oceanic circulation. During a La Niña, the trade winds blow in their normal direction, but ocean temperatures are colder than normal along the western coast of South America, and cold water reaches farther into the western Pacific Ocean than normal. A La Niña's effects on global climate are generally opposite the effects of an El Niño. For example, parts of Australia and Indonesia that are drier than normal during an El Niño are typically wetter than normal during a La Niña.

### Multiple Choice

1. b
2. d
3. d
4. d
5. b
6. c
7. d

### Matching

1. e

2. a
3. f
4. b
5. d
6. c
7. g

### Fill in the Blank

1. greenhouse
2. rise
3. warmer
4. fossil fuels
5. slash-and-burn
6. reduce
7. increases

### Critical Writing

*Sample answer:* The recent rise in global temperatures correlates well with the increase in carbon dioxide levels in the atmosphere that first began at the time of the Industrial Revolution. Carbon dioxide is a greenhouse gas, and greenhouse gases trap heat that radiates off the planet's surface. Carbon dioxide levels have varied throughout Earth's history, but for at least the past 650,000 years have never risen above 300 parts per million. The current carbon dioxide level is about 392 parts per million. This high level appears to be largely due to the human action of burning fossil fuels. The use of fossil fuels began with the Industrial Revolution and has skyrocketed over the past several decades. There is now nearly 40 percent more carbon dioxide in the atmosphere than there was before the Industrial Revolution. About two-thirds of this increase occurred since the late 1950s. Levels of other greenhouse gases have risen as well, and human actions are largely responsible for these gases. For example, raising livestock and producing rice have increased methane levels, and motor vehicle exhaust has increased tropospheric ozone levels. With more greenhouse gases trapping heat, average annual global temperatures are rising and appear to be causing the current period of global warming.

## 27.18 Chapter 18: Ecosystems and Human Populations

### Lesson 18.1 Worksheet Answer Key

#### True or False

1. true
2. true
3. false
4. true
5. true
6. false
7. true
8. false
9. true
10. false

#### Critical Reading

1. The role of producer is to produce food in the form of chemical energy. Major producers are algae in the oceans, plants on land, and bacteria at hydrothermal vents.
2. Consumers are organisms that obtain food by consuming other organisms. Three types of consumers are herbivores, which eat plants or other producers; carnivores, which eat other animals; and omnivores, which eat plants, animals, and organisms from other kingdoms.
3. Both predation and scavenging are feeding relationships in which consumers eat other consumers. Predation is a feeding relationship in which an organism kills and eats other animals, called prey. For example, a lion is a predator that kills and eats prey animals such as antelope. Scavenging is a feeding relationship in which an organism eats animals that are already dead. For example, a hyena is a scavenger that might feed on the remains of an antelope that was killed and partly consumed by a lion.
4. Decomposers obtain food energy by breaking down dead organisms or the waste products of living organisms. Two examples of decomposers are bacteria and fungi.

#### Multiple Choice

1. d
2. c
3. b
4. a
5. d
6. d
7. a

### Matching

1. b
2. e
3. a
4. c
5. d
6. g
7. f

### Fill in the Blank

1. ecosystem
2. population
3. community
4. Biotic
5. Abiotic
6. producer
7. consumer

### Critical Writing

*Sample answer:* A food chain is a model of one way that energy flows through an ecosystem. It is a set of organisms that pass energy from one energy, or trophic, level to the next. A food chain always begins with a producer at the first trophic level, followed by a consumer at each higher trophic level, up to at most four or five trophic levels. A food chain is much simpler than reality because it shows each organism consuming just one type of organism at a single trophic level. In a real ecosystem, many organisms consume a variety of different organisms, often at multiple trophic levels.

---

## Lesson 18.2 Worksheet Answer Key

### True or False

1. true
2. false
3. true
4. true
5. false
6. true
7. false
8. false
9. false
10. true

### Critical Reading

1. Nitrogen is fixed by soil bacteria that change nitrogen gas to compounds such as ammonia. Fixing nitrogen is important because without it plants would not have nitrogen in a form they could use.

2. The nitrogen in a deceased organism is recycled by bacteria and fungi in the soil that fix the organic nitrogen and return it to the soil as ammonia. Nitrifying bacteria oxidize the ammonia to nitrites and then to nitrates, which can be used by the next generation of plants.
3. Nitrogen from fertilizers may enter to the atmosphere as nitrous oxide, which breaks down the ozone layer, or as ammonia, which contributes to smog and acid rain. Nitrogen from fertilizers may also run off into ponds and other bodies of water, where they cause too much growth of bacteria. When the bacteria die, decomposition depletes the water of oxygen so fish and other larger water organisms cannot survive there.

### Multiple Choice

1. d
2. c
3. d
4. a
5. d
6. c
7. d

### Matching

1. c
2. g
3. b
4. a
5. d
6. e
7. f

### Fill in the Blank

1. photosynthesis
2. deforestation
3. bacteria
4. hydrogen
5. nitrates
6. ozone
7. dead

### Critical Writing

*Sample answer:* Carbon sinks are reservoirs where carbon is stored. Carbon sources are reservoirs from which carbon enters the environment. A reservoir can change from a sink to a source or vice-versa. For example, a healthy, living forest is a carbon sink. The tissues of the trees are made of carbon compounds. However, if the forest is burned, it becomes a carbon source. Combustion of the trees adds carbon dioxide to the atmosphere. Burning forests is one of many ways that human actions change carbon sinks to carbon sources. Another way is by burning fossil fuels. When fossil fuels form they are carbon sinks. They remain sinks until they are mined and burned. Then they are carbon sources. Combustion of fossil fuels, like trees, adds carbon dioxide to the atmosphere. Carbon dioxide is a greenhouse gas, and increasing its concentration in the atmosphere contributes to global warming.

---

## Lesson 18.3 Worksheet Answer Key

### True or False

1. true
2. false
3. false
4. true
5. true
6. true
7. false
8. false
9. true
10. true

### Critical Reading

1. Sustainable development is any economic development that allows people to escape a life of poverty while conserving resources and protecting the environment.
2. Reducing the rate of human population growth would help achieve sustainable development by slowing the increase in human numbers. With fewer people, fewer resources would be needed and smaller amounts of pollution and greenhouse gases would be released. Education plays a role in slowing population growth because when women are educated, they tend to have fewer children.
3. A technology that helps reduce resource depletion is fish farming. Raising fish on farms reduces the need to catch wild fish and the risk of overharvesting wild fish populations. A technology that helps reduce harm to the environment is the development of cleaner energy resources. They produce less pollution and greenhouse gas emissions.
4. Individuals—especially those in the developed nations—can promote sustainable development by consuming only what they need and avoiding wasting resources. They can also try to limit purchases to products that are produced sustainably. For example, they can purchase wood products from companies that plant new trees to replace those that are cut down.

### Multiple Choice

1. a
2. c
3. c
4. d
5. b
6. d
7. c

### Matching

1. b
2. g
3. e
4. f



5. a
6. c
7. d

### Fill in the Blank

1. Industrial
2. Green
3. greater
4. abiotic
5. carrying capacity
6. 7
7. more

### Critical Writing

*Sample answer:* I think that the global human population has reached its carrying capacity and may already have exceeded it. Many members of the global human population do not have enough resources. Some lack adequate food, and many do not have access to clean water or effective sanitation systems. Human actions are also having a negative impact on the planet. For example, we are using up nonrenewable natural resources. We are also polluting the planet and making it unhealthy for ourselves and other species. In addition, human actions are causing other species to go extinct at a rapid rate. All of these factors suggest that there are already too many people on the planet.

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## 27.19 Chapter 19: Human Actions and the Land

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### Lesson 19.1 Worksheet Answer Key

#### True or False

1. true
2. false
3. false
4. true
5. false
6. false
7. true
8. true
9. true
10. true

#### Critical Reading

1. Natural agents of soil erosion are water, wind, ice, and gravity.
2. Human activities that are likely to increase the rate of soil erosion include farming, grazing livestock, logging, mining, construction, and recreation.
3. Farming is the most significant activity that accelerates soil erosion because of the amount of land that is farmed and how greatly farming disturbs the soil. If farmers use traditional farming methods, they remove native vegetation and plow the soil before planting. Because most crops grow only in spring and summer, the soil is left bare and exposed during the rest of the year.

#### Multiple Choice

1. a
2. c
3. d
4. c
5. a
6. d
7. b

#### Matching

1. d
2. e
3. f
4. c

5. a
6. g
7. b

### Fill in the Blank

1. grasses
2. gravity
3. slash-and-burn
4. Overgrazing
5. runoff
6. decreased
7. drip

### Critical Writing

*Sample answer:* The Dust Bowl of the 1930s was an area of the prairie states where farmers were forced from their lands as the soil was blown away in windstorms. The Dust Bowl was caused by bad farming practices in a region that was not naturally suited for farming. Initially, rains fell and the land was productive. But in 1931, the rains stopped. Without the natural vegetation of grasses to hold the prairie soil in place, the wind was able to pick up the bare, dry soil and transport it far across the country. The eroded soil reached as far as the eastern United States. We learned many lessons from the Dust Bowl. We learned that soil is precious and can quickly be lost to erosion, which causes permanent degradation of the land. We also learned that better farming methods are needed to protect the soil. The soil has to be kept covered so it will not be as vulnerable to erosion.

---

## Lesson 19.2 Worksheet Answer Key

### True or False

1. false
2. true
3. true
4. false
5. false
6. true
7. false
8. true
9. true
10. false

### Critical Reading

1. Hazardous waste is any waste material that is dangerous to human health or that degrades the environment. Hazardous wastes include substances that are toxic, chemically active, corrosive, or flammable. Examples may vary. *Sample answer:* Examples of hazardous waste include used motor oil, old batteries, medical wastes, paints, and pesticides.
2. Health problems commonly associated with exposure to hazardous wastes include cancers, miscarriages, birth defects, and nervous system damage.

3. A single cancer case is not enough to suspect contamination by hazardous wastes because cancer occurs fairly often and has many possible causes. Contamination is suggested by more cancers than normal in a particular area.

### Multiple Choice

1. d
2. d
3. a
4. d
5. d
6. b
7. d

### Matching

1. f
2. c
3. e
4. d
5. a
6. g
7. b

### Fill in the Blank

1. Love Canal
2. Superfund
3. pesticides
4. cancer cluster
5. nervous
6. United States
7. Superfund

### Critical Writing

*Sample answer:* The story of Love Canal in Niagara Falls, New York, began in the 1950s, when a local chemical company placed drums of hazardous wastes in an old canal and covered them with soil. A school, a playground, and 100 homes were later built on the site. Over time, the drums rusted and the chemicals were released into the ground. Residents noticed bad odors, children developed burns after playing in the soil, and they were often sick. Residents organized to try to get help. The soil was tested and discovered to contain 82 toxic chemicals. Residents demanded that the government take action to clean up the chemicals and relocate people to safe areas. The Love Canal incident was instrumental in the passage of the Superfund Act of 1980. This law requires companies to be responsible for hazardous chemicals that they put into the environment and to pay to clean up contaminated sites. Love Canal was named a Superfund site in 1983. Measures were taken to secure the site and prevent it from contaminating surrounding areas.

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## 27.20 Chapter 20: Human Actions and Earth's Resources

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### Lesson 20.1 Worksheet Answer Key

#### True or False

1. false
2. true
3. true
4. false
5. false
6. true
7. false
8. true
9. false
10. false

#### Critical Reading

1. Some non-renewable resources vary in their availability. Some are very abundant, whereas others are very rare. Politics may play a role in determining resource availability if resources are located in a limited number of countries but needed in others.
2. Besides abundance, the cost of a resource is determined by how easy it is to locate and extract. Politics may also be part of determining resource cost if resources must be imported from other countries.
3. Only 11 countries have nearly 80 percent of all the world's oil. They are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela. This situation is a potential source of political conflict because other countries need oil, and the three biggest users of oil—the United States, China, and Japan—are not among those with the largest oil reserves. As a result, the availability and price of oil is determined largely by oil-producing countries, which have their own interests to look out for. Wars may even be fought over oil.

#### Multiple Choice

1. d
2. d
3. a
4. d
5. b
6. a
7. b

**Matching**

1. c
2. g
3. a
4. f
5. b
6. d
7. e

**Fill in the Blank**

1. conservation
2. non-renewable
3. renewable
4. non-renewable
5. Overconsumption
6. pollution
7. Recycling

**Critical Writing**

*Sample answer:* The distinction between renewable and non-renewable resources depends not only on the availability of resources and how quickly, if at all, they are replaced. It also depends on how they are used. For example, forests are renewable resources in the sense that they can be replaced by growing more trees. However, new trees may not be planted to replace all those that are cut down. Even if more trees are planted, it takes many years for them to grow large enough to be used, so forests of mature trees may not be renewed as quickly as existing forests are cut down and used. Another example is fish, which are a renewable resource because fish can reproduce and replace those that have been caught. However, if fish are overharvested, there may not be enough fish left to regenerate their numbers through reproduction, so fish populations may die out.

---

**Lesson 20.2 Worksheet Answer Key****True or False**

1. true
2. true
3. false
4. false
5. true
6. false
7. true
8. false
9. true
10. true

### Critical Reading

1. Net energy is the amount of useable energy available from a resource after taking into account the amount of energy needed to obtain it. It is calculated by subtracting the amount of energy needed to make the energy from that resource available from the total amount obtained.
2. The net-energy ratio is the ratio of energy obtained to the energy needed to obtain it. For example, if it takes 2 units of energy to make available 10 units of energy, then the net-energy ratio is  $10/2$ , or 5.0.
3. Solar energy has a higher net-energy ratio than fossil fuels do because sunshine is abundant and does not need to be located, extracted, or transported very far.

### Multiple Choice

1. d
2. a
3. c
4. d
5. b
6. d

### Matching

1. a
2. c
3. d
4. f
5. b
6. e

### Fill in the Blank

1. one
2. greater
3. heat
4. less
5. more
6. transportation

### Critical Writing

*Sample answer:* Energy efficiency is the ability of a device to get useful work out of the energy it uses. When a device operates, some energy is always used to produce heat and not to do useful work. The less energy that is lost as heat, the more energy efficient the device is. Using energy-efficient devices conserves energy because less energy is being wasted.

## 27.21 Chapter 21: Human Actions and Earth's Water

### Lesson 21.1 Worksheet Answer Key

#### True or False

1. true
2. false
3. false
4. false
5. false
6. true
7. true
8. false
9. true
10. false

#### Critical Reading

1. Three common irrigation methods that waste water are sprinkler, trench, and flood irrigation. In sprinkler irrigation, water is sprayed onto the fields from overhead sprinklers. In trench irrigation, canals carry water from a water source to the fields and through the fields along the rows of crops. In flood irrigation, water flows over the fields like the floodwaters of a river. These irrigation methods waste water because much of the water never reaches the crops. Instead, it evaporates or runs off the fields.
2. Drip irrigation is a method of irrigation in which pipes and tubes deliver small amounts of water directly to the soil at the roots of each plant. A pro of drip irrigation relative to the irrigation methods identified in answer 1 is that nearly all of the water goes directly into the soil near plant roots, and very little water is lost to evaporation or runoff. A con of drip irrigation relative to the other methods is that drip irrigation systems are expensive to install and maintain.
3. Ways to motivate farmers to use more water-efficient irrigation systems might include subsidizing installation of the systems, requiring them to pay for all the water they use, and fining them if they waste water.

#### Multiple Choice

1. a
2. a
3. d
4. a
5. a
6. d
7. d



**Matching**

1. e
2. g
3. f
4. d
5. a
6. b
7. c

**Fill in the Blank**

1. agriculture
2. drip
3. Africa
4. Non-consumptive
5. trench
6. aquaculture
7. 1

**Critical Writing**

*Sample answer:* Consumptive uses of water are uses that allow water to escape from the ecosystem. Non-consumptive uses of water, in contrast, are uses that keep water in the ecosystem by recycling and re-using it. An example of a consumptive use of water is sprinkler irrigation. Much of the water sprayed on the fields through sprinklers is lost to the ecosystem through evaporation and runoff. An example of a non-consumptive use of water is bathing. Water that goes down the drain from a bathtub or shower is treated and re-used, so it stays in the ecosystem.

---

**Lesson 21.2 Worksheet Answer Key****True or False**

1. false
2. false
3. false
4. true
5. true
6. true
7. true
8. true
9. false
10. false

**Critical Reading**

1. Fresh water that people can use is distributed unevenly around the world. Large portions of the world receive very little water from rainfall or rivers. This includes much of northern Africa and central Asia. Even areas that normally receive enough rainfall may periodically receive too little.

2. Droughts are periods of water scarcity that occur when areas receive less-than-normal amounts of rainfall for an extended period of time. Human actions such as deforestation can make droughts more likely. When trees are cut down, there is less transpiration of water vapor into the air, so there are fewer clouds and less precipitation.
3. Global warming is changing worldwide patterns of rainfall and water distribution. As the planet warms, regions that currently receive an adequate supply of rain may receive less. Regions that rely on snowmelt for water may find that there is less snow and that it melts earlier and faster in the spring so less water is available in the summer. Over time, as global temperatures increase and human populations grow, there will be less water per person.
4. Future conflicts over water are likely to occur because water supplies will become scarcer while human populations grow. This will result in greater competition for water.

### Multiple Choice

1. c
2. d
3. b
4. c
5. d
6. d
7. c

### Matching

1. d
2. g
3. a
4. b
5. c
6. e
7. f

### Fill in the Blank

1. 50
2. water
3. Waterborne
4. larvae
5. wells
6. water
7. wars

### Critical Writing

*Sample answer:* In many parts of the world, water is scarce relative to the number of people who live there. In more developed nations, water may be brought in from other regions to meet the needs of the people. The water is of high quality in these nations because it is treated and purified. In less developed nations, people must find ways to get by with much less water and may need to carry what little water they use over long distances. The water that is available may also be of poor quality because it is contaminated. For example, millions of people must get all of their water

from the Ganges River, which is used both for bathing and drinking. The water is polluted by human wastes and garbage, so it is likely to cause disease in the people who must drink it.

---

## Lesson 21.3 Worksheet Answer Key

### True or False

1. true
2. true
3. false
4. false
5. true
6. false
7. true
8. false
9. true
10. true

### Critical Reading

1. Water pollution is any contaminant that gets into lakes, streams, or oceans.
2. The main cause of polluted water in less developed countries is raw sewage, which is dumped into water that people must use for drinking and bathing.
3. The three major sources of water pollution in more developed countries are municipal, industrial, and agricultural sources.
4. Nutrients such as nitrates in fertilizers promote the growth of algae, so bodies of water polluted with fertilizers become clogged with algae. When the algae die, they decompose, and decomposition uses up all the dissolved oxygen in the water. Without oxygen, the water can no longer support aquatic organisms, including plants and fish, creating a dead zone.

### Multiple Choice

1. d
2. d
3. d
4. c
5. d
6. a
7. d

### Matching

1. d
2. c
3. f
4. a
5. g

6. b
7. e

### Fill in the Blank

1. algae
2. oxygen
3. Mississippi
4. Removal
5. booms
6. thermal
7. agricultural

### Critical Writing

*Sample answer:* The ocean has already become seriously affected by pollution. Most ocean pollution enters the water as runoff from land. It originates as agricultural, industrial, and municipal wastes. This explains why coastal ocean waters are dangerously polluted in many places. The water is unsafe for humans and also for wildlife, including many species of aquatic organisms. Fertilizers that pollute ocean water at the mouths of rivers may cause dead zones to develop in ocean water. These are areas where virtually nothing can live. The ocean is also polluted by ships, which dump their refuse at sea, and by oil spills from oil drills and tankers. For example, the Deepwater Horizon oil rig explosion in 2010 caused millions of barrels of oil to gush into the Gulf of Mexico over a period of many weeks. This had wide-reaching effects on wildlife and habitats in and around the Gulf and also on the Gulf Coast economy.

---

## Lesson 21.4 Worksheet Answer Key

### True or False

1. false
2. false
3. false
4. true
5. true
6. true
7. true
8. false
9. false
10. false

### Critical Reading

1. Two general ways of reducing water pollution are preventing water from becoming polluted and treating water that is already polluted.
2. The EPA sets standards for water quality, reduces the discharge of pollution into waterways, and manages runoff. It also finances construction of wastewater treatment plants.
3. Internationally, the United Nations and other international agencies are working to improve global water quality. They provide technology for treating water and educate people on how to protect and improve water quality.

4. There are several things you can do to protect water quality. For example, you can properly dispose of motor oil and household chemicals, apply yard chemicals sparingly, immediately repair engine leaks, and keep pet and yard wastes out of the water supply.

### Multiple Choice

1. d
2. c
3. d
4. a
5. d
6. a
7. b

### Matching

1. b
2. e
3. f
4. a
5. d
6. c

### Fill in the Blank

1. drinking
2. Wastewater
3. contaminants
4. Environmental Protection Agency (EPA)
5. Low-flow
6. Oil

### Critical Writing

*Sample answer:* Everyone can help to save water in and around the home. In the bathroom, use low-flow shower-heads and toilets, take shorter showers, and turn off the tap while brushing your teeth. In the yard, water lawns less or not at all, and sweep rather than hose down sidewalks and driveways.

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## 27.22 Chapter 22: Human Actions and the Atmosphere

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### Lesson 22.1 Worksheet Answer Key

#### True or False

1. true
2. false
3. true
4. true
5. false
6. false
7. false
8. true
9. true
10. false

#### Critical Reading

1. Primary air pollutants and secondary air pollutants are two basic type of air pollutants. Primary air pollutants enter the atmosphere directly, whereas secondary air pollutants form in the atmosphere from chemical reactions involving other pollutants.
2. *Sample answer:* Two natural sources of primary pollutants are volcanic eruptions, which pollute the air with particles of ash, and soil, which pollutes the air with particles of dust.
3. *Sample answer:* Three primary pollutants that enter the air due to human actions are nitrogen oxides, sulfur oxides, and lead. Nitrogen oxides are produced when nitrogen and oxygen combine in hot exhaust gases from vehicles, power plants, and factories. They are greenhouse gases that contribute to global warming, and they help form acid rain and ozone. Sulfur oxides enter the air when coal is burned. They also contribute to the formation of acid rain. Lead is a heavy metal that was formerly used in automobile fuels, paints, and pipes. Lead can cause brain damage and blood poisoning.

#### Multiple Choice

1. d
2. d
3. d
4. d
5. d
6. a
7. b

**Matching**

1. c
2. b
3. f
4. e
5. g
6. d
7. a

**Fill in the Blank**

1. ozone
2. Industrial Revolution
3. Clean Air
4. inversion
5. leeward
6. coal
7. Biomass

**Critical Writing**

*Sample answer:* Air pollution became a crisis in the developed nations in the mid-20th century. Coal smoke and auto exhaust combined to create toxic smog that in some places caused lung problems and even death. For example, in London, England, in 1952, smog killed 4000 people over a period of just five days, and many thousands more likely died of health complications from the smog over the next several months. Photochemical smog first became a problem in southern California around the same time as the London toxic smog event. Photochemical smog forms when car exhaust and oil refinery emissions are exposed to abundant sunshine. Events such as the London smog event, plus recognition of the hazards of photochemical smog, led to the passage of the Clean Air Act in the U.S. in 1970. This act regulates 189 air pollutants. As a result of the Clean Air Act, the air in the U.S. is much cleaner, visibility is better, and people are no longer incapacitated by industrial smog. However, pollutants are still added to the air and air pollution remains a problem in the U.S.

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**Lesson 22.2 Worksheet Answer Key****True or False**

1. false
2. true
3. true
4. true
5. false
6. true
7. false
8. false
9. false
10. true

### Critical Reading

1. Acid rain is rainwater that is more acidic than normal rainwater, with a pH of less than 5.0. Acid rain is caused by sulfur and nitrogen oxides emanating from power plants or metal refineries. When these pollutants combine with water vapor in the air, they form sulfuric and nitric acids.
2. Acid rain ends up in soil and bodies of water and makes both of them acidic. Acid rain that soaks into soil strips soil of metals and nutrients. Runoff from the soil carries the metal, nutrients, and acidic water to lakes, making them even more acidic.
3. Acidic soils that have been stripped of nutrients may not be able to provide enough nutrients for plants to grow. Plants that do survive exposure to acid in soils and rain become weak and are more likely to be damaged by bad weather, insect pests, or disease. Snails and some other soil organisms die in acid soils, so animals such as songbirds that eat them have less food than normal. Young birds and mammals do not build bones as well and may not be as strong. Eggshells may also be weak and break more easily. Aquatic organisms in acid lakes may die off. No fish, for example, can live if the pH of the water drops below 4.5. Wildlife that depend on the lakes for drinking water may suffer population declines.

### Multiple Choice

1. c
2. d
3. c
4. d
5. c
6. c
7. d

### Matching

1. f
2. b
3. e
4. c
5. a
6. g
7. d

### Fill in the Blank

1. lead
2. methyl mercury
3. troposphere
4. stratosphere
5. CFCs (chlorofluorocarbons)
6. particulates
7. oxides



## Critical Writing

*Sample answer:* The World Health Organization estimates that 22 million people die each year from complications caused by air pollution. All air pollutants cause some damage to human health, but different types of pollutants cause different types of harm. For example, lead causes lead poisoning. Carbon monoxide can quickly kill people in poorly ventilated spaces. Nitrogen and sulfur oxides cause lung disease and increased rates of asthma, emphysema, and viral infections such as flu. Ozone also causes lung disease and may cause heart disease and cancer. Particulates enter the lungs and cause heart and lung disease. High levels of particulates increase rates of asthma attacks. Mercury that pollutes the air becomes harmful when it is deposited and converted by bacteria to methyl mercury. If consumed in large quantities, it can cause nervous system and brain damage, especially in infants and children.

---

## Lesson 22.3 Worksheet Answer Key

### True or False

1. true
2. false
3. true
4. true
5. false
6. false
7. false
8. false
9. true
10. true

### Critical Reading

1. A carbon tax is a tax on gasoline, carbon dioxide emitted by factories, and energy bills so people or businesses that emit more carbon have to pay more money. A carbon tax would reduce greenhouse gas emissions by encouraging people to use less energy from fossil fuels in order to reduce the amount of taxes they must pay.
2. Biofuels reduce greenhouse gas emissions relative to gasoline when they are used to power motor vehicles. However, when food crops are used to make biofuels, the price of food goes up. Also, fossil fuels are used to produce the crops, so the actual reduction in fossil fuel use may not be very great.
3. Carbon sequestration is any means of removing carbon dioxide from the atmosphere and storing it in another form. It tackles the problem of greenhouse gases by removing one of the chief greenhouse gases, carbon dioxide, from the atmosphere after it has already been emitted.

### Multiple Choice

1. a
2. d
3. a
4. b
5. d
6. c
7. a

**Matching**

1. b
2. e
3. g
4. a
5. f
6. c
7. d

**Fill in the Blank**

1. carbon
2. biofuel
3. catalyst
4. Montreal
5. Kyoto
6. ozone
7. climate

**Critical Writing**

*Sample answer:* Three ways to reduce air pollution from motor vehicles are using catalytic converters, making vehicles more fuel-efficient, and developing technologies that do not use fossil fuels. Catalytic converters contain a catalyst that speeds up chemical reactions and breaks down nitrogen oxides, carbon monoxide, and VOCs in vehicle exhausts before they are emitted from the tail pipe. Lighter, more streamlined vehicles use less fuel so they produce less air pollution. Hybrid vehicles, which can run on electricity as well as gasoline, also reduce fossil fuel use and the pollution they produce. Using fuel cells or other alternatives to fossil fuels for energy has the potential to reduce air pollution the most. For example, hydrogen fuel cells harness the energy released when hydrogen and oxygen combine to create water. Fuel cells are extremely efficient and produce no pollutants, but many problems must be overcome to develop this technology.

## 27.23 Chapter 23: Observing and Exploring Space

### Lesson 23.1 Worksheet Answer Key

#### True or False

1. true
2. false
3. true
4. false
5. false
6. true
7. false
8. false
9. true
10. true

#### Critical Reading

1. An optical telescope is a device that gathers and focuses visible light from distant objects to make the objects appear bigger and closer. Optical telescopes were first invented in Europe in the late 16th century.
2. Both refracting and reflecting telescopes are types of optical telescopes that collect and focus visible light. Refracting telescopes focus light with lenses that refract light, whereas reflecting telescopes focus light with mirrors that reflect light. Refracting telescopes were invented first, and reflecting telescopes were invented somewhat later. The mirrors of reflecting telescopes are easier to make precisely than the lenses of refracting telescopes. The mirrors of reflecting telescopes are also lighter than the lenses of refracting telescopes, so reflecting telescopes can be made larger without becoming too heavy. Because reflecting telescopes can be larger than refracting telescopes, they can collect more light and allow scientists to view dimmer or more distant objects.
3. Galileo built his first telescope in 1608. It was a refracting telescope like the earliest telescopes from the late 1500s. Galileo subsequently made many improvements to the design of refracting telescopes, which allowed him to make important observations of our solar system and galaxy. Newton's major contribution to telescope technology was the invention of the reflecting telescope. He built the first telescope of this kind in 1670. Reflecting telescopes have advantages over refracting telescopes. For example, they can be larger than refracting telescopes and thus used to view more distant objects than refracting telescopes can.

#### Multiple Choice

1. d
2. b
3. d
4. d
5. b
6. a

7. c

### Matching

1. e
2. c
3. g
4. d
5. f
6. b
7. a

### Fill in the Blank

1. astronomers
2. light-year
3. constellation
4. space
5. ultraviolet
6. reflecting
7. radio

### Critical Writing

*Sample answer:* For the most part, astronomers have one main source of data on distant objects in the universe: electromagnetic radiation, commonly called light. This type of energy can travel across empty space and carry information about distant objects to Earth. Objects in space are so far away that it may take a long time for their light to reach Earth. Therefore, when astronomers look at distant stars and galaxies, they are not just seeing over great distances; they are also seeing back in time. The image they see of a distant object is an image of how the object used to look. For example, the Andromeda Galaxy is about 2.5 million light-years from Earth, so images of this galaxy actually show how it looked 2.5 million years ago. Modern astronomers use strong telescopes to gather and focus electromagnetic waves from distant stars and galaxies. However, they do more than just view images of these distant objects in space. They also use devices called spectrometers to analyze light from the objects. A spectrometer uses a prism or other device to break down light into its component colors and produce a spectrum. From a single spectrum of a star, an astronomer can tell how hot the star is, what elements it contains, and whether and how fast it is moving relative to Earth. In general, by studying electromagnetic radiation from the universe, astronomers can learn how stars evolve, what kind of matter is found throughout the universe, how that matter is distributed, and even how the universe might have formed.

---

## Lesson 23.2 Worksheet Answer Key

### True or False

1. false
2. true
3. true
4. false

5. false
6. true
7. true
8. false
9. false
10. true

### Critical Reading

1. Four main types of satellites based on their purpose are imaging satellites, communications satellites, navigational satellites, and the International Space Station. Imaging satellites take pictures of Earth's surface for military or scientific purposes. Communications satellites receive and send communications signals. Navigational satellites are used for navigation systems such as GPS. The International Space Station allows humans to live in space while conducting scientific research.
2. A polar orbit is a low-Earth orbit that circles Earth over the poles. This type of orbit is perpendicular to the direction that Earth rotates. A satellite in a polar orbit is over a different part of Earth's surface each time it circles the planet because Earth rotates beneath it.
3. A geostationary orbit is an orbit that keeps a satellite over the same position on Earth's surface. For a satellite to be in this type of orbit, it must be at just the right distance (35,786 km) above Earth's surface and circle Earth in the same direction as Earth's rotation. Many communications satellites have geostationary orbits.

### Multiple Choice

1. a
2. d
3. d
4. a
5. c
6. c
7. a

### Matching

1. e
2. d
3. f
4. b
5. a
6. g
7. c

### Fill in the Blank

1. third
2. liquid
3. satellites
4. imaging
5. International Space Station (ISS)
6. geostationary

## 7. Sputnik 1

**Critical Writing**

*Sample answer:* Newton's third law of motion explains how rockets work. This law states that to every action, there is an equal and opposite reaction. In a rocket, fuel is ignited in a chamber, which causes an explosion of gases. The explosion creates pressure that forces the gases out of one end of the rocket. As these gases rush out, the rocket's reaction force, called thrust, pushes the rocket forward. Multi-stage rockets are needed to escape Earth's gravity because this system makes rockets lighter in weight as they burn up fuel. Each time a container of fuel is used up, the empty fuel container drops away to reduce the mass of the rocket and thus the force of gravity acting to pull the rocket back down toward Earth.

---

**Lesson 23.3 Worksheet Answer Key****True or False**

1. false
2. true
3. true
4. false
5. true
6. false
7. true
8. false
9. false
10. false

**Critical Reading**

1. The first rover to explore Mars was Sojourner, which landed on Mars in 1997. It collected data on rocks, soils, and weather factors such as winds. Sojourner was followed by two rovers, named Spirit and Opportunity, which landed on Mars in 2003. They explored the Martian surface and its geology, including rocks and soils, looking for clues to past water activity on Mars. Currently, the rover named Curiosity is investigating Martian climate and geology and whether life ever could have existed on Mars. Curiosity landed on Mars in 2012.
2. *Sample answer:* Three recent non-Martian missions include the Cassini mission, the Huygens probe, and the Stardust mission. The objective of the Cassini mission is to study Saturn, including its rings and moons. The objective of the Huygens probe is to study Saturn's moon Titan, which has some of the conditions needed to support life. The objective of the Stardust mission is to collect tiny dust particles from a comet.
3. By studying smaller objects in the solar system, we might gain a better understanding of how the solar system formed.

**Multiple Choice**

1. c
2. a
3. d
4. b

5. c
6. d
7. a

### Matching

1. b
2. e
3. a
4. f
5. c
6. g
7. d

### Fill in the Blank

1. U.S.S.R. (Soviet Union)
2. Mir
3. research
4. orbiter
5. Columbia
6. Landsat
7. rovers

### Critical Writing

*Sample answer:* Early space exploration was driven by competition between the United States and the Soviet Union during the Cold War. Since the end of the Cold War in 1991, space exploration has benefited from cooperation between the United States and Russia, which was part of the former Soviet Union. For example, in 1993, The U.S. and Russia announced American involvement in the Russian space station Mir, as well as plans for what was to become the International Space Station (ISS). After that, American space shuttles transported supplies and people to and from Mir, and Americans astronauts lived on Mir for months at a time. This cooperation allowed the United States to learn from Russia's experience with space stations and living in space for long periods of time. It also allowed Russia to take advantage of the United States' success with its shuttle program. The ISS was a huge undertaking, made possible by cooperation among the United States, Russia, and several other countries. It was launched in 1997, and the first crew arrived to live on the space station in 2000. Since then, American space shuttles have transported most of the supplies and equipment to the ISS, and Russian Soyuz spacecraft have carried people to and from the station.

## 27.24 Chapter 24: Earth, Moon, and Sun

### Lesson 24.1 Worksheet Answer Key

#### True or False

1. false
2. true
3. true
4. false
5. false
6. true
7. false
8. true
9. false
10. false

#### Critical Reading

1. Earth's rotation is its spinning motion on its north-south axis. It takes 24 hours for one complete rotation. Rotation occurs at an average speed of 1700 km/h, but it is fastest at the equator and slowest at the poles. Earth's revolution is its orbital motion around the sun. Earth revolves in an elliptical orbit that takes the planet closer to the sun at some points in the orbit than others. Perihelion is where the orbit is closest to the sun, and aphelion is where the orbit is farthest from the sun. It takes 365.24 days for Earth to make one complete revolution. Revolution occurs at an average speed of about 27 km/s, but is faster at perihelion and slower at aphelion.
2. Foucault concluded that Earth rotates by observing a pendulum swinging. Foucault knew that after a pendulum is set into motion, it will keep moving in the same direction. When Foucault observed his pendulum, it seemed to change direction, so he concluded that Earth must be moving beneath the swinging pendulum.
3. A day lasts slightly longer than it takes Earth to make one complete rotation because Earth revolves around the sun at the same time that it is rotating. Therefore, the planet must turn a little bit more on each rotation to reach the same place relative to the sun.
4. Earth's perihelion is the place in its orbit where it is closest to the sun. This distance is 147 million km. Earth's aphelion is the place in its orbit where it is farthest from the sun. This distance is 152 million km. Earth is at its perihelion on about January 3rd each year. It is at its aphelion on about July 4th each year.

#### Multiple Choice

1. d
2. b
3. a
4. d
5. a
6. d



7. b

### Matching

1. f
2. e
3. g
4. a
5. c
6. d
7. b

### Fill in the Blank

1. outer
2. pendulum
3. less
4. year
5. South Pole
6. oblate spheroid
7. inner

### Critical Writing

*Sample answer:* There were many ways that people knew Earth was spherical long before they could observe the shape of Earth from space. One way was by observing ships from shore as they sailed out to sea. When the ships got far from shore, the bottoms of the ships seemed to disappear as they sailed over the curved surface of the planet. Another way people knew Earth was spherical was by observing Earth's shadow on the moon during a lunar eclipse. The shadow showed that Earth has a curved surface.

---

## Lesson 24.2 Worksheet Answer Key

### True or False

1. true
2. false
3. true
4. false
5. true
6. true
7. false
8. true
9. true
10. false

### Critical Reading

1. Surface temperatures on the moon vary from extremely hot to extremely cold because an atmosphere moderates temperatures and the moon has no atmosphere.
2. The landscape of the moon is unchanging because there are no plate tectonics on the moon to build up features and no atmosphere to causing the weathering away of features.
3. Maria are dark-colored flat areas on the moon, and terrae are light-colored highland areas on the moon. Maria formed when meteorites crashed through the moon's newly formed surface, causing magma to flow out and fill craters with dark-colored basaltic lava. Terrae formed when light silicate minerals precipitated out of the ancient magma ocean and formed the early lunar crust.
4. Water is found on the moon in the solid state as ice. It is found in the extremely cold craters of the moon and bound up in the lunar soil.

### Multiple Choice

1. b
2. d
3. a
4. d
5. d
6. c
7. d

### Matching

1. e
2. d
3. f
4. a
5. c
6. g
7. b

### Fill in the Blank

1. moon
2. gravity
3. less
4. six
5. 27.3
6. reflects
7. atmosphere

### Critical Writing

*Sample answer:* The footprints of astronauts in the dust on the moon will remain undisturbed unless they are struck by a meteorite because the moon's surface is unchanging. Without an atmosphere, the moon has no weather or weathering. The moon also has no liquid water. Therefore, the footprints will not be blown away by wind or washed

away by precipitation or flowing water. In addition, the moon lacks plate tectonics, so there will be no volcanic activity to cover the footprints with lava.

---

## Lesson 24.3 Worksheet Answer Key

### True or False

1. true
2. true
3. false
4. false
5. true
6. true
7. false
8. true
9. true
10. false

### Critical Reading

1. Sunspots are relatively dark areas on the sun where loops of the sun's magnetic field break through the surface. They are darker than the rest of the surface because they are cooler. They are cooler because their formation disrupts the smooth transfer of heat from lower layers of the sun.
2. Sunspots usually occur in pairs because when a loop of the sun's magnetic field breaks through the surface, a sunspot is created where the loop comes out of the surface, and another sunspot is created where the loop goes back into the surface.
3. A solar flare is a violent explosion that occurs when a loop of the sun's magnetic field snaps and breaks. This releases a huge amount of energy and streams of highly energetic particles. These particles make up solar wind.
4. A solar prominence is a highly visible feature on the sun's surface. It is a glowing arch that may reach thousands of kilometers into the sun's atmosphere and last for a day to several months. A solar prominence forms where plasma flows along a loop of the sun's magnetic field from sunspot to sunspot.

### Multiple Choice

1. d
2. d
3. c
4. d
5. a
6. b
7. a

### Matching

1. b
2. g

3. e
4. f
5. a
6. d
7. c

### Fill in the Blank

1. fusion
2. photons
3. plasma
4. helium
5. sunspots
6. wind
7. core

### Critical Writing

*Sample answer:* The sun has a huge amount of energy because of the nuclear fusion reactions that take place in its core. The plasma in the core has extremely high temperatures of about 27 million degrees Celsius. At such high temperatures, hydrogen atoms combine to form helium atoms by nuclear fusion. This process releases vast amounts of energy, which moves outward from the core toward the outer layers of the sun. Energy released in the core first travels extremely slowly through the radiative zone. It travels as particles of light called photons. Each photon travels only a few millimeters before it hits another particle. The photon is absorbed by the particle and then released again. A photon may take as long as 50 million years to travel all the way through the radiative zone to the convection zone. In the convection zone, hot material near the radiative zone rises to the sun's surface, where it give off heat and cools. It then plunges back down to the radiative zone to repeat the process.

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## Lesson 24.4 Worksheet Answer Key

### True or False

1. false
2. false
3. false
4. true
5. false
6. true
7. true
8. true
9. false
10. false

### Critical Reading

1. The moon's gravity pulls most strongly on Earth's waters on the side of Earth facing the moon. This causes the water to bulge out from the surface in the direction of the moon, creating a high tide. At the same time,

a high tide occurs on the opposite side of Earth. This high tide is produced because the moon pulls Earth slightly away from overlying surface water. The water bulges out from the surface because it is pulled by the moon less strongly. The places in between the two high tides experience low tides because some of the water is drawn away to the high tide locations. There are two high tides and two low tides each day in a given location as Earth rotates on its axis.

2. A spring tide is the situation in which high tides are at their highest and low tides are at their lowest, creating the greatest tidal range during each two-week period. A spring tide occurs during the new and full moon phases when the sun and moon are in a straight line with respect to Earth. As a result, the sun's and moon's gravities combine to pull Earth's waters in the same direction.
3. A neap tide is the situation in which high tides are at their lowest and low tides are at their highest, creating the least tidal range during each two-week period. A neap tide occurs during the first and third quarter phases of the moon when the sun and moon are at right angles with respect to Earth. As a result, the sun's and moon's gravities pull Earth's waters in different directions.

### Multiple Choice

1. d
2. c
3. d
4. d
5. b
6. d
7. b

### Matching

1. c
2. e
3. b
4. f
5. d
6. a
7. g

### Fill in the Blank

1. solstice
2. total
3. partial
4. full moon
5. new moon
6. spring
7. neap

### Critical Writing

*Sample answer:* A solar eclipse occurs when the new moon passes directly between Earth and the sun. The moon casts a shadow on Earth and blocks Earth's view of the sun. A lunar eclipse occurs when the full moon passes through Earth's shadow. Light from the sun cannot reach the moon's surface and reflect back to Earth. Solar eclipses

are rare and usually last only a few minutes because the moon casts a small shadow. Lunar eclipses occur at least twice a year, last for hours, and can be seen from any place on Earth with a view of the moon. This is because Earth's shadow is large relative to the size of the moon.

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## 27.25 Chapter 25: The Solar System

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### Lesson 25.1 Worksheet Answer Key

#### True or False

1. true
2. false
3. false
4. true
5. true
6. true
7. false
8. false
9. false
10. true

#### Critical Reading

1. Two features of the solar system that provide clues about its formation are: all of the planets lie in nearly the same plane, and all orbit the sun in the same direction.
2. In the nebular hypothesis, the nebula started to collapse because it was drawn together by gravity.
3. According to the nebular hypothesis, the sun formed when gravity pulled matter toward the center of the spinning disk of gas and dust of a nebula. The density and pressure at the center of the disk became increasingly intense until the pressure was high enough for nuclear fusion to begin. At that point, the sun came into existence.
4. The outer parts of the disk started to cool, and matter condensed from the cloud. Small pieces of dust started colliding and clumping together. The particles grew larger, forming clumps called planetesimals, which were big enough to attract smaller clumps with their gravity. Eventually, the planetesimals became large enough to form protoplanets, which continued to grow until they became the planets and moons of our solar system today.
5. Based on the nebular hypothesis, the inner planets are denser than the outer planets because gravitational sorting of materials occurred. Gravity at the center of the disk attracted heavier particles, such as rock and metal, while lighter particles remained farther out toward the edge of the disk. As a result, the inner planets formed from dense rock and metal, whereas the outer planets formed from lighter materials such as hydrogen, helium, water, ammonia, and methane.

#### Multiple Choice

1. b
2. a
3. d
4. b
5. d

6. c
7. b

### Matching

1. c
2. g
3. b
4. f
5. a
6. d
7. e

### Fill in the Blank

1. exoplanets (extrasolar planets)
2. eight
3. Jupiter
4. greater
5. astronomical unit (AU)
6. longer
7. nebula

### Critical Writing

*Sample answer:* The ancient Greeks believed that Earth is at the center of the universe. This view is called the geocentric model of the universe. In the geocentric model, the sky consists of a set of spheres layered on top of one another. Each object in the sky is attached to a sphere and moves around Earth as the sphere rotates. The geocentric model worked fairly well to explain how stars and planets move except that some planets seemed to move backwards. Around 150 A.D., Ptolemy resolved this problem with a new version of the geocentric model. He proposed that each planet moves in a small circle, called an epicycle, and that the epicycle and planet move around Earth in a larger circle, called a deferent. This idea better fits planetary movements, but it is overly complicated. Nonetheless, Ptolemy's model was accepted for more than a thousand years. Then, at the beginning of the 16th century, Copernicus proposed the heliocentric model, in which Earth and the other planets orbit the sun. This model was improved upon by Kepler, who discovered that planets move around the sun in elliptical rather than circular orbits. With this revision, the heliocentric model could correctly predict planetary movements. The model was more widely accepted when it was supported by Galileo's observations of the solar system through his telescope. The shift from the geocentric to heliocentric view of the solar system was so important that it is called the Copernican Revolution.

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## Lesson 25.2 Worksheet Answer Key

### True or False

1. false
2. true
3. false



4. false
5. true
6. true
7. false
8. true
9. true
10. false

### Critical Reading

1. Venus resembles Earth in size and density. Venus' interior structure is also similar to Earth's, with a large iron core and a silicate mantle.
2. Among all the planets in the solar system, Venus is the only planet that rotates in a direction opposite to the direction that it orbits the sun. Venus' rotation is also very slow. As a result, a day on Venus is longer than a year on Venus.
3. Compared with Earth's atmosphere, Venus' atmosphere consists of more harmful substances and is thicker. Earth's atmosphere consists mainly of harmless nitrogen and oxygen, whereas Venus' atmosphere consists mainly of carbon dioxide with small amounts of sulfur dioxide and sulfuric acid, which is highly corrosive. The carbon dioxide in Venus' atmosphere is a greenhouse gas that gives the planet a powerful greenhouse effect. The greenhouse effect is responsible for Venus being the hottest planet in the solar system. Because Venus' atmosphere is so thick, the atmospheric pressure on the planet's surface is 90 times greater than the atmospheric pressure on Earth's surface.
4. Venus has many volcanoes, some of which may be active. In fact, the surface of the planet is covered by large areas of volcanoes surrounded by plains of lava. Venus lacks tectonic plates at the edges of which magma could erupt onto the surface. Instead, volcanic activity occurs on Venus when heat builds up so much inside the planet that it finally destroys the crust, allowing magma to flow out.

### Multiple Choice

1. d
2. d
3. a
4. a
5. d
6. b
7. d

### Matching

1. g
2. c
3. e
4. d
5. f
6. a
7. b

### Fill in the Blank

1. terrestrial
2. Earth
3. core
4. Venus
5. Mars
6. Venus
7. asteroids

### Critical Writing

*Sample answer:* Mars is the most likely of the inner planets ever to have had life because there is evidence that there was once liquid water on Mars and water is essential to life as we know it. There is currently a lot of water on Mars in the form of ice, including prominent ice caps. Scientists think that there is also a lot of ice present just under the Martian surface. This ice can melt when volcanoes erupt, and water can flow temporarily across the surface of the planet. Scientists think that water once flowed over the Martian surface because there are surface features that look like water-eroded canyons.

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## Lesson 25.3 Worksheet Answer Key

### True or False

1. true
2. true
3. false
4. false
5. true
6. false
7. false
8. true
9. true
10. false

### Critical Reading

1. Scientists predicted the existence of Neptune before it was discovered by the effect of its gravity on Uranus. They noticed that Uranus was not always located exactly where it should be. They assumed that the gravitational pull of another planet beyond Uranus was affecting Uranus' orbit. When Neptune was discovered in 1846, it was in the position that had been predicted.
2. Neptune is like the other outer planets in its composition. It has an atmosphere composed of hydrogen, helium, and methane gas; a mantle of water, ammonia, and methane ice; and a core of rock and ice.
3. Neptune has a very turbulent atmosphere, with stronger winds than any other planet. It is also one of the coldest places in the solar system. Temperatures at the tops of its clouds are about -218 degrees Celsius.
4. Scientists think that Triton did not form near Neptune because it revolves in the opposite direction. If it had formed near Neptune from the rotating disk that formed the entire solar system, it would revolve in the same direction as Neptune and the rest of the planets.

**Multiple Choice**

1. d
2. d
3. a
4. d
5. b
6. c
7. b

**Matching**

1. b
2. c
3. d
4. g
5. f
6. a
7. e

**Fill in the Blank**

1. gas giants
2. hydrogen
3. Galilean
4. Saturn
5. Neptune
6. Neptune
7. Uranus

**Critical Writing**

*Sample answer:* The inner planets are also called the terrestrial planets because they are all like planet Earth. Like Earth, they are relatively small and consist of igneous rocks, so they are very dense. Their orbits keep them relatively close to the sun. The inner planets also have no moons or just one or two moons, and they lack planetary rings. The outer planets could accurately be called the non-terrestrial planets because they are all unlike planet Earth in each of these ways. The outer planets are large and consist mainly of light gases and liquids, so they are not very dense. Their orbits take them far from the sun. Each of the outer planets also has many moons as well as planetary rings, although the rings may be very faint.

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**Lesson 25.4 Worksheet Answer Key****True or False**

1. false
2. true
3. false
4. false

5. true
6. true
7. true
8. false
9. true
10. true

### Critical Reading

1. The main way Pluto differs from the planets in our solar system is that it has not cleared its orbit of smaller objects. This is one of four criteria for an orbiting object to be classified as a planet. Pluto's orbit is in the Kuiper belt, an area of the outer solar system where millions of other small objects orbit the sun. Pluto's orbit is also tilted relative to the orbits of the other planets, and its orbit is longer and narrower as well.
2. The new (post-2006) definition of a planet includes four criteria. A planet must: orbit a star and not a planet, be small enough that it isn't a star, have enough mass to have a spherical shape, and have cleared its orbit of smaller objects.
3. A dwarf planet is an orbiting body that meets all the criteria of a planet except that it hasn't cleared its orbit of smaller objects. Pluto is classified as a dwarf planet because it meets all the criteria of a planet except for clearing its orbit. Its orbit is in the Kuiper belt, which has millions of other orbiting objects.

### Multiple Choice

1. d
2. d
3. a
4. b
5. c
6. d
7. b

### Matching

1. c
2. f
3. a
4. b
5. g
6. d
7. e

### Fill in the Blank

1. asteroid belt
2. asteroid
3. near-Earth
4. meteor shower
5. period
6. Kuiper belt
7. Eris

**Critical Writing**

*Sample answer:* Scientists are very interested in studying asteroids for several reasons. One reason is to predict potential asteroid collisions with Earth. Past asteroid impacts have been implicated in mass extinctions, so astronomers try to discover new asteroids and to follow known near-Earth asteroids so they can identify potential collisions as soon as possible. By identifying them early, they hope that steps might be taken to possibly prevent these events. Scientists are also interested in studying asteroids because they formed when the rest of the solar system formed. Therefore, learning more about asteroids might help scientists learn more about the earliest solar system. A third reason for studying asteroids is that they might eventually have practical uses. They might be mined for rare minerals, for example, or for minerals needed for construction projects in space.

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## 27.26 Chapter 26: Stars, Galaxies, and the Universe Worksheets

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### Lesson 26.1 Worksheet Answer Key

#### True or False

1. false
2. false
3. true
4. false
5. false
6. false
7. true
8. false
9. true
10. true

#### Critical Reading

1. Red stars have the coolest surface temperature, followed by orange, yellow, white, and blue stars, with blue stars having the hottest surface temperature.
2. Smaller stars produce less energy than larger stars, so smaller stars generally have cooler surface temperatures than larger stars.
3. A class G star such as our sun is about twice as hot as a class M star such as Betelgeuse. Class B has stars about twice as hot as the sun. An example of a star in this class is Rigel.

#### Multiple Choice

1. d
2. a
3. b
4. d
5. b
6. d
7. d

#### Matching

1. b
2. f
3. c
4. d
5. e

6. a
7. g

### Fill in the Blank

1. star
2. nuclear fusion
3. (surface) temperature
4. higher
5. mass
6. white dwarf
7. Parallax

### Critical Writing

*Sample answer:* Distances to stars that are relatively close to us can be measured using parallax. Parallax refers to the apparent shift in position of an object against its background when the position of the observer changes. An astronomer first observes the position of a star relative to more distant stars. Then, six months later, when the astronomer is observing the star from the greatest possible difference in position of Earth in its orbit, the position of the same star is measured again relative to more distant stars. Parallax causes the star to appear to be in a different position. From the size of this shift, the distance to the star can be calculated, because parallax is greater over shorter distance.

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## Lesson 26.2 Worksheet Answer Key

### True or False

1. false
2. false
3. true
4. false
5. false
6. false
7. true
8. false
9. false
10. true

### Critical Reading

1. Galaxies are the biggest groups of stars in the universe. They can contain anywhere from a few million to many billion stars.
2. Spiral, elliptical, and irregular galaxies have different shapes. Spiral galaxies are rotating disks with a bulge in the middle and several spiral arms reaching outward from the central bulge. Spiral galaxies have lots of dust and gas, and most of their stars are young and blue in color. Elliptical galaxies are more-or-less egg shaped. Most elliptical galaxies have little dust or gas, and their stars are mainly old and red or yellow in color. Irregular galaxies are neither elliptical nor spiral in shape. They probably formed when elliptical or spiral galaxies were deformed.

3. Dwarf galaxies are small galaxies containing only a few million or billion stars. They are relatively dim and most are irregular in shape. They are often found near larger galaxies. They are the most common type of galaxies in the universe.

### Multiple Choice

1. c
2. d
3. b
4. b
5. c
6. d
7. a

### Matching

1. e
2. f
3. c
4. b
5. a
6. g
7. d

### Fill in the Blank

1. Milky Way
2. system
3. cluster
4. binary star
5. spiral arms
6. spiral
7. black hole

### Critical Writing

*Sample answer:* It is difficult to know the shape of the Milky Way Galaxy because we are inside of it. However, astronomers have determined that it is a typical spiral galaxy, containing about 100 to 400 billion stars. They based this determination on several types of evidence, including its disk-like shape as we see it from our position in the galaxy. Other evidence includes the velocities of stars and gases in the galaxy, which show the rotational motion typical of a spiral galaxy. Also, the star color, gases, and dust of the Milky Way Galaxy are typical of other spiral galaxies.



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## Lesson 26.3 Worksheet Answer Key

### True or False

1. true
2. true
3. false
4. false
5. false
6. false
7. false
8. true
9. true
10. true

### Critical Reading

1. The Big Bang theory is the most widely accepted cosmological explanation for how the universe formed. According to the Big Bang theory, the universe began about 13.7 billion years ago. Just before that time, everything in the universe was squeezed into a very small volume. Then an enormous explosion (big bang) occurred and caused the universe to start expanding rapidly. According to the theory, all of the matter and energy in the universe, and even space itself, came out of this explosion.
2. In the first few moments after the Big Bang, the universe was unimaginably hot and dense. As the universe expanded, it became less dense and began to cool. After only a few seconds, protons, neutrons, and electrons began to form. After a few minutes, protons and neutrons came together to create hydrogen nuclei. Energy in the universe was great enough to initiate nuclear fusion, and hydrogen nuclei fused together to become helium nuclei. The first neutral atoms with electrons formed about 380,000 years later. Eventually, everything we now know to exist came into being in the expanding universe.
3. At first the Big Bang theory was just a hypothesis, and many astronomers did not accept it. Then, in 1964, two researchers used a microwave receiver to learn that the background radiation of the universe gave empty space a temperature of 3 Kelvin, not 0 Kelvin, which would be expected in a static universe. This evidence supported the Big Bang hypothesis and convinced most astronomers that the hypothesis should be considered a scientific theory.

### Multiple Choice

1. a
2. c
3. a
4. d
5. b
6. a
7. d

### Matching

1. e
2. a

3. g
4. c
5. b
6. f
7. d

### Fill in the Blank

1. cosmology
2. Hubble
3. sun
4. expanding
5. 13.7 billion
6. dark
7. Gravitational lensing

### Critical Writing

*Sample answer:* As an analogy of an expanding universe, an inflating balloon has both pros and cons. Imagine a balloon, representing the universe, covered with tiny dots, each of which represents a galaxy. When you inflate the balloon, this is like the expansion of the universe. The dots on the balloon move away from each other because the rubber stretches in the space between them. If you could stand on one of the dots, you would see the other dots moving away from you. You would also observe that the more distant dots move away faster than nearby dots. In these ways, the balloon is a good analogy for what happens to galaxies and how they appear to us in an expanding universe. However, the balloon is not a very good analogy in some other ways. For one thing, the expanding rubber surface of the balloon is more-or-less two-dimensional, whereas the expanding galaxy is three-dimensional. Another problem with the balloon analogy is that the dots (galaxies) on the surface of the balloon expand as the balloon is inflated. In the actual universe, galaxies do not expand as the universe expands. Only the distance between galaxies increases.