CK-12 Earth Science For Middle School

Teacher's Edition

CK-12 Earth Science For Middle School Teacher's Edition

Jean Brainard, Ph.D.

To access a customizable version of this book, as well as other interactive content, visit www.ck12.org

Printed: August 22, 2014

AUTHOR
Jean Brainard, Ph.D.

CONTRIBUTORS
Dana Desonie, Ph.D.
Julie Sandeen

Contents

1 MS TE What is Earth Science? 1
1.1 Chapter 1: What Is Earth Science? . . . 3
1.2 Lesson 1.1: The Nature of Science . . . 5
1.3 Lesson 1.2: Earth Science and Its Branches . . . 8

2 MS TE Studying Earth's Surface 11
2.1 Chapter 2: Studying Earth's Surface . . . 12
2.2 Lesson 2.1: Introduction to Earth's Surface . . . 14
2.3 Lesson 2.2: Modeling Earth's Surface . . . 17
2.4 Lesson 2.3: Topographic Maps . . . 20
2.5 Lesson 2.4: Using Satellites and Computers . . . 23

3 MS TE Earth's Minerals 26
3.1 Chapter 3: Earth's Minerals . . . 27
3.2 Lesson 3.1: Minerals . . . 29
3.3 Lesson 3.2: Identification of Minerals . . . 32
3.4 Lesson 3.3: Formation of Minerals . . . 35
3.5 Lesson 3.4: Mining and Using Minerals . . . 38

4 MS TE Rocks 41
4.1 Chapter 4: Rocks . . . 42
4.2 Lesson 4.1: Types of Rocks . . . 44
4.3 Lesson 4.2: Igneous Rocks . . . 47
4.4 Lesson 4.3: Sedimentary Rocks . . . 50
4.5 Lesson 4.4: Metamorphic Rocks . . . 53

5 MS TE Earth's Energy 56
5.1 Chapter 5: Earth's Energy . . . 57
5.2 Lesson 5.1: Earth's Energy . . . 59
5.3 Lesson 5.2: Nonrenewable Energy Resources . . . 62
5.4 Lesson 5.3: Renewable Energy Resources . . . 65

6 MS TE Plate Tectonics 68
6.1 Chapter 6: Plate Tectonics . . . 69
6.2 Lesson 6.1: Inside Earth . . . 71
6.3 Lesson 6.2: Continental Drift . . . 74
6.4 Lesson 6.3: Seafloor Spreading . . . 77
6.5 Lesson 6.4: Theory of Plate Tectonics . . . 80

7 MS TE Earthquakes 83
7.1 Chapter 7: Earthquakes . . . 84
7.2 Lesson 7.1: Stress in Earth's Crust . . . 86

7.3 Lesson 7.2: Nature of Earthquakes . . . 89
7.4 Lesson 7.3: Measuring and Predicting Earthquakes . . . 92
7.5 Lesson 7.4: Staying Safe in Earthquakes . . . 95

8 MS TE Volcanoes 98
8.1 Chapter 8: Volcanoes . . . 99
8.2 Lesson 8.1: Volcanic Activity . . . 101
8.3 Lesson 8.2: Volcanic Eruptions . . . 104
8.4 Lesson 8.3: Types of Volcanoes . . . 107
8.5 Lesson 8.4: Igneous Landforms and Geothermal Activity . . . 110

9 MS TE Weathering and Formation of Soil 113
9.1 Chapter 9, Weathering and Soil Formation . . . 114
9.2 Lesson 9.1: Weathering . . . 116
9.3 Lesson 9.2: Soils . . . 119

10 MS TE Erosion and Deposition 122
10.1 Chapter 10: Erosion and Deposition . . . 123
10.2 Lesson 10.1: Erosion and Deposition by Flowing Water . . . 125
10.3 Lesson 10.2: Erosion and Deposition by Waves . . . 128
10.4 Lesson 10.3: Erosion and Deposition by Wind . . . 131
10.5 Lesson 10.4: Erosion and Deposition by Glaciers . . . 134
10.6 Lesson 10.5: Erosion and Deposition by Gravity . . . 137

11 MS TE Evidence About Earth's Past 140
11.1 Chapter 11: Evidence about Earth's Past . . . 141
11.2 Lesson 11.1: Fossils . . . 143
11.3 Lesson 11.2: Relative Ages of Rocks . . . 146
11.4 Lesson 11.3: Absolute Ages of Rocks . . . 149

12 MS TE Earth's History 152
12.1 Chapter 12: Earth's History . . . 153
12.2 Lesson 12.1: The Origin of Earth . . . 155
12.3 Lesson 12.2: Early Earth . . . 158
12.4 Lesson 12.3: History of Earth's Life Forms . . . 161

13 MS TE Earth's Fresh Water 164
13.1 Chapter 13: Earth's Fresh Water . . . 165
13.2 Lesson 13.1: Water on Earth . . . 166
13.3 Lesson 13.2: Surface Water . . . 169
13.4 Lesson 13.3: Groundwater . . . 172

14 MS TE Earth's Oceans 175
14.1 Chapter 14: Earth's Oceans . . . 176
14.2 Lesson 14.1: Introduction to the Oceans . . . 178
14.3 Lesson 14.2: Ocean Movements . . . 181
14.4 Lesson 14.3: The Ocean Floor . . . 184
14.5 Lesson 14.4: Ocean Life . . . 187

15 MS TE Earth's Atmosphere 190
15.1 Chapter 15: Earth's Atmosphere . . . 191
15.2 Lesson 15.1: The Atmosphere . . . 193
15.3 Lesson 15.2: Energy in the Atmosphere . . . 196

15.4 Lesson 15.3: Layers of the Atmosphere . . . 199
15.5 Lesson 15.4: Air Movement . . . 202

16 MS TE Weather 205
16.1 Chapter 16: Weather . . . 206
16.2 Lesson 16.1: Weather and Water in the Atmosphere . . . 208
16.3 Lesson 16.2: Changing Weather . . . 211
16.4 Lesson 16.3: Storms . . . 214
16.5 Lesson 16.4: Weather Forecasting . . . 217

17 MS TE Climate 220
17.1 Chapter 17: Climate . . . 221
17.2 Lesson 17.1: Climate and Its Causes . . . 223
17.3 Lesson 17.2: World Climates . . . 226
17.4 Lesson 17.3: Climate Change . . . 229

18 MS TE Ecosystems and Human Populations 233
18.1 Chapter 18: Ecosystems and Human Populations . . . 234
18.2 Lesson 18.1: Ecosystems . . . 236
18.3 Lesson 18.2: Cycles of Matter . . . 239
18.4 Lesson 18.3: The Human Population . . . 242

19 MS TE Human Actions and the Land 245
19.1 Chapter 19: Human Actions and the Land . . . 246
19.2 Lesson 19.1: Loss of Soil . . . 248
19.3 Lesson 19.2: Pollution of the Land . . . 251

20 MS TE Human Actions and Earth's Resources 254
20.1 Chapter 20: Human Actions and Earth's Resources . . . 255
20.2 Lesson 20.1: Use and Conservation of Resources . . . 257
20.3 Lesson 20.2: Use and Conservation of Energy . . . 260

21 MS TE Human Actions and Earth's Water 263
21.1 Chapter 21: Human Actions and Earth's Water . . . 264
21.2 Lesson 21.1: Humans and the Water Supply . . . 266
21.3 Lesson 21.2: Water Pollution . . . 269
21.4 Lesson 21.3: Protecting the Water Supply . . . 272

22 MS TE Human Actions and the Atmosphere 275
22.1 Chapter 22: Human Actions and the Atmosphere . . . 276
22.2 Lesson 22.1: Air Pollution . . . 277
22.3 Lesson 22.2: Effects of Air Pollution . . . 280
22.4 Lesson 22.3: Reducing Air Pollution . . . 283

23 MS TE Observing and Exploring Space 286
23.1 Chapter 23: Observing and Exploring space . . . 287
23.2 Lesson 23.1: Telescopes . . . 289
23.3 Lesson 23.2: Early Space Exploration . . . 293
23.4 Lesson 23.3: Recent Space Exploration . . . 296

24 MS TE Earth, Moon, and Sun 299
24.1 Chapter 24: Earth, Moon, and Sun . . . 300
24.2 Lesson 24.1: Planet Earth . . . 302

24.3 Lesson 24.2: Earth's Moon . . . 305
24.4 Lesson 24.3: The Sun . . . 308
24.5 Lesson 24.4: The Sun and the Earth-Moon System . . . 311

25 MS TE The Solar System **314**
25.1 Chapter 25: The Solar System . . . 315
25.2 Lesson 25.1: Introduction to the Solar System . . . 317
25.3 Lesson 25.2: Inner Planets . . . 320
25.4 Lesson 25.3: Outer Planets . . . 323
25.5 Lesson 25.4: Other Objects in the Solar System . . . 326

26 MS TE Stars, Galaxies, and the Universe **329**
26.1 Chapter 26: Stars, Galaxies, and the Universe . . . 330
26.2 Lesson 26.1: Stars . . . 332
26.3 Lesson 26.2: Galaxies . . . 336
26.4 Lesson 26.3: The Universe . . . 339

CHAPTER 1 MS TE What is Earth Science?

Chapter Outline

1.1 CHAPTER 1: WHAT IS EARTH SCIENCE?
1.2 LESSON 1.1: THE NATURE OF SCIENCE
1.3 LESSON 1.2: EARTH SCIENCE AND ITS BRANCHES

Contents: CK-12 Middle School Earth Science

Unit 1: Introduction to the Study of Earth

- Chapter 1: What Is Earth Science?
- Chapter 2: Studying Earth's Surface

Unit 2: Earth's Mineral and Energy Resources

- Chapter 3: Earth's Minerals
- Chapter 4: Rocks
- Chapter 5: Earth's Energy

Unit 3: Processes Inside Earth

- Chapter 6: Plate Tectonics
- Chapter 7: Earthquakes
- Chapter 8: Volcanoes

Unit 4: Processes on Earth's Surface

- Chapter 9: Weathering and Formation of Soil
- Chapter 10: Erosion and Deposition

Unit 5: Earth's Past

- Chapter 11: Evidence About Earth's Past
- Chapter 12: Earth's History

Unit 6: Earth's Water

- Chapter 13: Earth's Fresh Water
- Chapter 14: Earth's Oceans

Unit 7: Weather and Climate

- Chapter 15: Earth's Atmosphere

- Chapter 16: Weather
- Chapter 17: Climate

Unit 8: The Environment and Human Actions

- Chapter 18: Ecosystems and Human Populations
- Chapter 19: Human Actions and the Land
- Chapter 20: Human Actions and Earth's Resources
- Chapter 21: Human Actions and Earth's Waters
- Chapter 22: Human Actions and the Atmosphere

Unit 9: Astronomy

- Chapter 23: Observing and Exploring Space
- Chapter 24: Earth, Moon, and Sun
- Chapter 25: The Solar System
- Chapter 26: Stars, Galaxies, and the Universe

Middle School Earth Science Glossary

1.1 Chapter 1: What Is Earth Science?

Chapter Overview

This chapter explains how scientists do research, and describes Earth science and its branches.

Online Resources

Refer to the following links for appropriate laboratory activities:

This lab provides a good introduction to the scientific method. It is easy to set up and uses basic materials. Students will learn how to use the scientific method to design an experiment, and they will distinguish among independent, dependent, and control variables.

- http://serc.carleton.edu/sp/mnstep/activities/27393.html

In this lab, students will develop methods of collecting non-visual data by trying to determine the contents of several small boxes. They will use multiple senses to make observations, form hypotheses from their observations, and differentiate between hypotheses and predictions. They will come to an appreciation that other senses may be just as valuable as sight for making observations, and that an organized plan is needed to solve a problem.

- http://serc.carleton.edu/sp/mnstep/activities/20162.html

This hands-on lab on the scientific method uses inexpensive materials but requires more than one class period. Students will make observations and predictions, test their predictions, and create a model. The lab encourages thinking outside the box and group discussion. At the end of the lab, students will understand the different interactive steps involved in the scientific method. They will also understand that the goal of science is not absolute truth but falsifiability, and that science is limited to empirical data and cannot answer all questions.

- http://serc.carleton.edu/integrate/workshops/methods2012/activities/aquino.html

These links may also be helpful:

This site provides excellent background on student misconceptions and commonly confused concepts relating to the nature of science and scientific investigations. You may want to review the material before teaching this chapter.

- http://undsci.berkeley.edu/teaching/misconceptions.php

These sites provide concise general strategies and tips for teaching middle school students about the nature and process of science.

- http://undsci.berkeley.edu/teaching/68_implications2.php
- http://undsci.berkeley.edu/teaching/tips.php

Pacing the Lessons

TABLE 1.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
1.1 The Nature of Science	2.0
1.2 Earth Science and Its Branches	1.0

1.2 Lesson 1.1: The Nature of Science

Key Concepts

- Scientific method
- Scientific models
- Safety in science

Lesson Objectives

- State why it is important to ask questions in science.
- Explain how to use the steps of the scientific method to answer questions.
- Describe how scientists make models.
- List steps you should take to be safe while doing science.

Lesson Vocabulary

- **control**: Factor that is held constant in a scientific experiment.
- **dependent variable**: Variable that is measured in an experiment to see how it is affected by the independent variable.
- **hypothesis**: Possible answer to a question that can be tested to see whether it is false.
- **independent variable**: Variable that is changed in an experiment to see how it affects the dependent variable.
- **physical model**: Representation of something using objects.
- **theory**: Scientific explanation that is widely accepted because it has been tested repeatedly and not been proven false.

Teaching Strategies

Introducing the Lesson

Students are likely to know that water freezes if its temperature drops below 0 °C (32 °F). Demonstrate that salt water can be cooled to a lower temperature without freezing. Use beakers, ice cubes, water, salt, and thermometers in your demonstration. After the two samples of ice water have cooled to their lowest temperature, give students a chance to observe the temperatures on the thermometers.

Question: What questions are raised by your observations?

Sample answers: Does salt lower the freezing point of water? Do other dissolved substances also lower the freezing point of water? Is there a temperature below which water always freezes?

Discuss how students might find answers to their questions. Conclude by saying that questions raised by observations are the starting point in most scientific investigations. Tell them they will learn more about scientific investigations in this lesson.

Building Science Skills

Use the worksheet at the link below to give students practice identifying variables and controls in scientific experiments. The experiments involve everyone's favorite Porifera, SpongeBob SquarePants, so they will be sure to grab students' attention. Answers to the exercises are provided at the end of the PDF document.

http://sciencespot.net/Media/scimethodconvar.pdf

Building Science Skills

After students read about safety in science, give them a chance to build science safety skills. Have them complete the worksheet at the link below. It allows them to apply their knowledge of science safety rules to a hypothetical example of "bad science," which continues the SpongeBob theme. Hand out copies of the student pages, and ask students to underline all of the broken safety rules they can identify. After they finish, discuss the broken safety rules, and then work with the class to make a list of the correct safety rules on the board. As a homework assignment, ask students to create their own "bad science" cartoons, bumper stickers, or posters to illustrate the safety rules. Teacher notes and an answer key appear at the end of the PDF file.

http://sciencespot.net/Media/scimthdsafety.pdf

Differentiated Instruction

A word wall is a useful addition to the science classroom, especially for students who need reinforcement of vocabulary terms. Start a word wall with this lesson and have students continue to add important terms to it throughout the year. Assign two pairs of students (including any English language learners paired with native speakers) either the term "hypothesis" or the term "theory." On an index card, they should define and illustrate their term and then add it to the word wall.

Enrichment

Challenge a small group of students to create two different types of models of the same object, phenomenon, or system. For example, they might create a physical model of Earth with a ball, and a conceptual model of Earth with a description of Earth's spherical shape. Have students share their models with the class. Ask other students to discuss which model they prefer and why.

Science Inquiry

In this fun inquiry activity, groups of students will apply lesson concepts by designing their own experiment to make slime. They will form a hypothesis and use the scientific method to test it. They will also create a circle graph to display their results. The document includes teacher notes and a student worksheet.

http://www.lessonplansinc.com/lessonplans/slime_lab.pdf

Common Misconceptions

Students often have misconceptions about the nature of science and scientific research. The link below provides a list of many such misconceptions and explains why they are incorrect. Use the list as a true-false test to identify which misconceptions your own students believe. Then hold a class discussion to correct the misconceptions.

http://undsci.berkeley.edu/teaching/misconceptions.php

Real-World Connection

Students will see how the scientific method applies to the real world if you have them design an experiment to compare two different brands of the same product. Divide the class into groups, and have each group choose a product to test. For example, a group might choose two different brands of bath soap and design an experiment to see which brand lasts longer. Each group should develop a hypothesis, identify independent and dependent variables, and describe how they will control other relevant factors. Have a student in each group present the group's work to the class.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 1.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

What parts of Earth do you think are most important and should be better studied?

Describe a model that you have had experience with. What type of model was it? What did you learn from it?

What situations are both necessary and dangerous for scientists to study? What precautions do you think they should use when they study them?

If you could go anywhere, where would it be? What safety equipment or precautions would you take?

1.3 Lesson 1.2: Earth Science and Its Branches

Key Concepts

- Scope of Earth science
- Branches of Earth science

Lesson Objectives

- Describe Earth science and its branches.
- Identify the field of geology.
- Describe the field of oceanography.
- Define the field of meteorology.
- Understand what astronomy studies.
- List other branches of Earth science, and state how they relate to the study of Earth.

Lesson Vocabulary

- **astronomy**: Study of stars, solar systems, and galaxies.
- **geology**: Study of solid Earth, Earth processes, and the history of Earth.
- **meteorology**: Study of Earth's weather.
- **oceanography**: Study of Earth's oceans.

Teaching Strategies

Introducing the Lesson

As an introduction to the field of Earth science, define and describe the four spheres of Earth: lithosphere, hydrosphere, atmosphere, and biosphere. Start by showing the class the visualization of the four spheres at the first URL below. The second URL provides background on the four spheres for you or your more advanced students. Tell students they will read in this lesson about Earth scientists who focus on studying each of the four spheres.

http://www.classzone.com/books/earth_science/terc/content/visualizations/es0102/es0102page01.cfm

http://www.cotf.edu/ete/ess/ESSspheres.html

Discussion

Invite a local Earth scientist who specializes in one of the branches of Earth science to speak to the class about his or her field. The speaker might be a geologist, meteorologist, or oceanographer, for example. In addition to discussing the field as a scientific discipline, ask the speaker to talk about the nature of his or her career and how to train for it. Urge students to prepare questions ahead of time to ask the speaker, and allow time for questions and discussion at the end of the presentation.

Activity

Most students will be familiar with the water cycle. Use it as an example to show how Earth is a system and why it must be studied as a system. First have students explore the interactive flash animation of the water cycle at the link below. For each of the four parts of the water cycle delineated in the activity, ask students to identify the branch of Earth science that might focus on that aspect of the system. End with a discussion of how scientists in the different branches of Earth science must work together to fully understand Earth as a system.

http://www.epa.gov/ogwdw/kids/flash/flash_watercycle.html

Differentiated Instruction

Have pairs of students make a cluster diagram to organize and summarize lesson content. They should start by drawing a center circle surrounded by several surrounding circles. In the center circle, they should write the term Earth science and its definition. In each of the surrounding circles, they should write the name of one of the branches of Earth science and the aspects of Earth that it studies. Suggest that they save their cluster diagram in their science notebook.

Enrichment

Challenge a few students to identify and learn about one or more additional branches of Earth science that are not described in the lesson. Possibilities might include glaciology, hydrology, geomorphology, geochemistry, geophysics, petrology, and/or geodetics. Ask the students to write a short report or make a poster or PowerPoint presentation to share what they learn with the rest of the class.

Science Inquiry

Divide the class into a few large groups and assign each group one of the branches of Earth science. Ask the students within each group to brainstorm possible research questions that might be addressed by scientists in their assigned branch. After groups have identified several questions, discuss as a class how the questions might be investigated.

Life Science Connection

Help students appreciate how Earth science and life science are related by describing specific examples of the ways living things are influenced by, or depend upon, geological processes. A good example might be a hydrothermal vent ecosystem, which depends on geological processes releasing minerals from the mantle so that its bacterial producers can make food by chemosynthesis, both for themselves and for consumers such as tubeworms. Challenge students to think of other examples.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 1.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Why is Earth science so important?

Which branch of Earth science would you most like to explore?

What is the biggest problem that we face today? Which Earth scientists may help us to solve the problem?

What other branches of science or society are related to and necessary for Earth science?

CHAPTER 2

MS TE Studying Earth's Surface

Chapter Outline

2.1 CHAPTER 2: STUDYING EARTH'S SURFACE

2.2 LESSON 2.1: INTRODUCTION TO EARTH'S SURFACE

2.3 LESSON 2.2: MODELING EARTH'S SURFACE

2.4 LESSON 2.3: TOPOGRAPHIC MAPS

2.5 LESSON 2.4: USING SATELLITES AND COMPUTERS

2.1 Chapter 2: Studying Earth's Surface

Chapter Overview

This chapter informs students about Earth's landforms, map projections, and the use of computers and satellites to study and understand Earth's surface.

Online Resources

Refer to the following links for appropriate laboratory activities:

In this directed lab activity, students will make their own compass and in the process gain a better understanding of how compasses work. The activity will also introduce them to magnetic fields and the challenges of technological design.

- http://oceanservice.noaa.gov/education/for_fun/MakeyourownCompass.pdf

In this map lab, students will create three-dimensional clay mountains, use them to make a contour map, and explain what information the contour map conveys. The Web site includes complete instructions, background, and vocabulary.

- http://education.nationalgeographic.com/education/activity/make-contour-map/?ar_a=1

This lab will help students visualize features on a topographic map. They will build three-dimensional paper models that portray the features represented by the contour lines on the topographic map.

- http://www.ucmp.berkeley.edu/fosrec/Metzger1.html

These websites may also be helpful:

To learn about ways to use Google Earth as an educational tool for Earth science, go to the URL below. The website provides links to many activities that are relevant to this chapter.

- http://serc.carleton.edu/NAGTWorkshops/visualize04/tool_examples/google_earth.html

This URL has a concise overview of map projections for teachers.

- http://www.edu.gov.mb.ca/k12/cur/socstud/foundation_gr8/tns/tn3.pdf

If you need to review topographic maps, a useful article can be found at this URL: http://geology.isu.edu/geostac/Field_Exercise/topomaps/topo_interp.htm .

At the following link, you can access materials that explain how to teach Earth science concepts and skills using GPS and GIS.

- http://edcommunity.esri.com/arclessons/lesson.cfm?id=296

Pacing the Lessons

TABLE 2.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
2.1 Introduction to Earth's Surface	1.5
2.2 Modeling Earth's Surface	2.0
2.3 Topographic Maps	1.5
2.4 Using Satellites and Computers	1.0

2.2 Lesson 2.1: Introduction to Earth's Surface

Key Concepts

- Location and direction
- Topography
- Continents and landforms
- Constructive and destructive forces
- Ocean basins and their features

Lesson Objectives

- Describe how you can find location and direction on Earth's surface.
- Describe topography.
- Identify various landforms and briefly describe how they form.

Lesson Vocabulary

- **compass**: Device with a magnetic needle that is used to find magnetic north.
- **compass rose**: Figure on a map or nautical chart that shows the directions north, south, east, and west.
- **constructive force**: Force that causes landforms to grow.
- **continent**: Large land mass that lies above sea level.
- **destructive force**: Force that causes landforms to wear away.
- **elevation**: Height or depth measured relative to sea level.
- **relief**: Difference in elevation of landforms in a region.
- **topography**: Three-dimensional shape of a landform or region on Earth's surface.

Teaching Strategies

Introducing the Lesson

Call on a few volunteers to describe where they live without using street addresses. (They probably will try to describe the locations relative to local landmarks, using directions and distances, but are likely to find it difficult to describe the locations precisely.) Call on other students to try to guess the locations from the descriptions. Tell the class that locating features on Earth's surface is one of the most important and basic tools needed for Earth science, and that they will learn how it's done in this chapter.

Activity

Bring a compass to class and show students how to locate magnetic north. Pass the compass around the class to give students a chance to use it. Call on students to explain why the compass needle points north, and ask them to point out other directions.

Demonstration

When you teach your class about the forces that create or wear away landforms, demonstrate the destructive force of erosion. Mound some soil on a large baking pan or tray, and slowly pour water over the surface. Have students observe how the water picks up and carries away particles of soil. Explain how, on a large scale, the same force of erosion slowly creates landforms such as river valleys, even such huge valleys as the Grand Canyon.

Differentiated Instruction

Use a map or globe with raised topographic features to help kinesthetic learners understand the concepts of elevation, relief, and topography. Have students locate examples of landforms such as mountains, valleys, and plains, and then tell them to run their hands over the three-dimensional surface to feel the differences in height and shape.

Enrichment

Challenge a small group of students to make a three-dimensional model of the Atlantic Ocean basin, using materials such as modeling clay or paper mache. The model need not be to scale, but it should show major features of the ocean floor, including the continental shelf, slope, and rise; abyssal plains; and mid-ocean ridge. Display their model in the classroom, and encourage other students to examine it.

Science Inquiry

Call students' attention to the figure in the lesson that shows major landforms on continents and coastlines. Have them find specific landforms in the figure, and try to classify them as the result of either constructive forces or destructive forces. On the board or an overhead transparency, make a two-column table listing the landforms created by each type of force. Elaborate on the specific constructive or destructive forces involved in the formation of each landform. Have students make a copy of the table in their science notebook.

Common Misconceptions

A common student misconception is that Earth's surface is unchanging. Because most changes on Earth's surface are extremely show, students may find it hard to believe that the surface is constantly changing shape. For example, it may seem impossible to them that a towering mountain can be eroded to a low, flat plain. Explain that Earth is so old (4.6 billion years) that there has been plenty of time for such changes to occur, despite how slowly they take place. You also might want to show students examples of more rapid changes that take place on Earth's surface. For example, they can view volcanic eruptions in both videos linked below.

- http://www.youtube.com/watch?v=EupnfA-PDaw
- http://www.youtube.com/watch?v=f6sIWBIkaM4

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 2.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

A new volcano rises in Mexico. How would you describe its position in a scientific report?

Can you devise a system to show low areas and high areas on a map?

Why do you think continents are higher areas on Earth than the ocean basins?

2.3 Lesson 2.2: Modeling Earth's Surface

Key Concepts

- Maps as models
- Map projections
- Map coordinates
- Globes

Lesson Objectives

- Describe what information a map can convey.
- Identify some major types of map projections, and discuss advantages and disadvantages of each.
- Discuss advantages and disadvantages of globes.

Lesson Vocabulary

- **conic map**: Map made by projecting Earth's three-dimensional surface onto a cone.
- **coordinate system**: Grid that locates any specific point with a set of numbers.
- **gnomonic map**: Map made by projecting a point on Earth's curved surface onto a flat surface.
- **latitude**: Distance in degrees north or south of the equator.
- **longitude**: Distance in degrees east or west of the Prime Meridian in Greenwich, England.
- **map**: Any two-dimensional representation of Earth's surface.
- **Mercator projection**: Map made by projecting Earth's three-dimensional surface onto a cylinder.
- **projection**: Any way of projecting Earth's three-dimensional surface onto a two-dimensional map.

Teaching Strategies

Introducing the Lesson

Show students a globe and a map of the world. Explain that both objects are models of Earth's surface. Call on students to identify ways that the two models differ. Tell them they will learn more about modeling Earth's surface when they read this lesson.

Activity

You may want to use the award-winning "Mapping Our World" resource at the URL below when you teach this lesson. It contains nine structured middle school activities with teacher notes. The activities are designed for whole class learning on an interactive white board or PC. Using animations, students can flatten a globe, turn a map into a globe, and merge different map projections, among other activities.

http://www.digital-week.info/education/mapping_our_world/mapping_our_world/l/home/index.htm

Differentiated Instruction

Some students may find it difficult to visualize why projections are needed to show Earth on a map and how projections are made. Have them do the kinesthetic activity at the link below. Students will draw the continents on an orange and then peel the fruit to make a flat map. Detailed instructions and a lesson plan are provided at the website below.

http://www.educationworld.com/a_lesson/dailylp/dailylp/dailylp009.shtml

Enrichment

There are several other map projections in addition to the projections described in the lesson (see URL below). Assign each student one of these other projections to investigate. Ask them all to explain their assigned projections to the class. They should include a visual example of their projection.

http://egsc.usgs.gov/isb/pubs/MapProjections/projections.html

Science Inquiry

This interactive online activity challenges students to apply what they have learned about map projections to a different planet. They will draw three different representations of Mars and illustrate them with details of research they have conducted on the planet. Teacher notes are provided at the link below.

http://education.nationalgeographic.com/archive/xpeditions/lessons/01/g68/marsmap.html?ar_a=1

Social Studies Connection

How a map distorts the sizes of the different continents may affect our view of them. That's why an historian named Arno Peters introduced a new map projection in 1973. Peters argued that his map should replace the still-popular Mercator projection, which he viewed as racist. This is a good example of how society and science can influence each other. Before sharing it with students, you can learn more at the website below.

http://geography.about.com/library/weekly/aa030201a.htm

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 2.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

How does a flight between two cities drawn on a globe compare with the same flight drawn on a map?

How do people doing orienteering follow directions across wild terrain?

Latitude and longitude give your location in two dimensions. How do you give your location in three dimensions? What is that third dimension?

2.4 Lesson 2.3: Topographic Maps

Key Concepts

- Nature of topographic maps, contour lines, and contour intervals
- Interpreting topographic maps
- Information from topographic maps

Lesson Objectives

- Describe a topographic map.
- Explain what information a topographic map contains.
- Explain how to read and interpret a topographic map.
- Explain how various Earth scientists use topographic maps to study Earth.

Lesson Vocabulary

- **contour interval**: Constant difference in elevation between adjacent contour lines on a topographic map.
- **contour line**: Line connecting points with the same elevation on a topographic map.
- **topographic map**: Map that shows elevations above sea level of features on Earth's surface.

Teaching Strategies

Introducing the Lesson

Show the class a photo or sketch of an area with rugged terrain. Ask students how they could show the topography of the area on a map. Try to elicit a range of responses. Tell students they will learn how when they read this lesson.

Activity

In this hands-on activity, students will design and create a landform and then make a topographic map to represent it. The activity will help students understand what a topographic map shows and how to read topographic maps.

http://www.most.org/Earth_Science/Middle_School/Post/Topographic_Maps.pdf

Building Science Skills

Build students' topographic map reading skills by assigning the worksheet at the URL below.

http://s3.amazonaws.com/engrade-myfiles/4076994673549621/Topographicmap_1_ws.pdf

Differentiated Instruction

Help students focus their reading on the most important points by providing them with the following cloze prompts to complete as they read the lesson. Tell them that most of the blanks require more than one word to complete. Sample answers are given below in brackets.

1. A topographic map represents [elevations in an area].
2. Contour lines on a topographic map connect [all the points that have the same elevation].
3. The contour interval on a topographic map is the [constant difference in elevation between adjacent contour lines].
4. Closely spaced contour lines represent an area that has [a steep slope].
5. Widely spaced contour lines represent an area that has [a gentle slope].
6. Contour lines that form closed concentric loops represent [a hill].
7. V-shaped portions of contour lines represent [stream valleys].
8. The scale of a topographic map represents [horizontal distance].

Enrichment

Ask one or more students to investigate how topographic maps are made. They can start with the URL below. Have them make a PowerPoint presentation to share what they learn with the class. Knowing how topographic maps are made will help students use the maps more effectively.

http://www.maps-gps-info.com/how-topo-maps-are-made-1.html

Science Inquiry

In the guided inquiry activity in the PDF document below, students will use USGS topographic maps to analyze the impact of sea level rise on a coastal community. The activity will improve their ability to use and interpret topographic maps and convert between metric and English measurements. They will apply their knowledge of USGS topographic maps to a larger-scale topographic map of a coastal town and accurately map new coastlines based on predicted changes in sea level. Finally, students will make assessments and recommendations for residents and town departments based on the new coastlines.

http://www.armadaproject.org/img/sea_level_rise-teacher.pdf

Common Misconceptions

Many students think that rivers always flow south. This misconception can be illustrated as such by the activity at the link below. You will need to supply outline maps of the USA and the world for the activity.

http://newyorkscienceteacher.com/sci/files/user-submitted/Downstream_2005%28TMcG%29.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 2.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Imagine that you are a civil engineer. How could you use a topographic map to build a road, bridge, or tunnel through an area like the one shown in the figure above? Would you want your road to go up and down, or remain as flat as possible? What areas would need a bridge in order to cross them easily? Can you find a place where a tunnel would be helpful?

If you wanted to participate in orienteering, would it be better to have a topographic map or a regular road map? How would a topographic map help you?

2.5 Lesson 2.4: Using Satellites and Computers

Key Concepts

- Data from satellites
- Satellite orbits
- Scientific satellites
- Global positioning system
- Computer-generated maps

Lesson Objectives

- Describe various types of satellite images and the information that each provides.
- Explain how the global positioning system (GPS) works.
- Explain how computers can be used to make maps.

Lesson Vocabulary

- **geographic information system (GIS)**: System that links GPS data with any type of spatial information to create maps.
- **geostationary orbit**: Type of orbit that allows a satellite to stay over the same location on Earth's surface.
- **polar orbit**: Type of orbit that passes over both poles in a direction perpendicular to Earth's rotation.

Teaching Strategies

Introducing the Lesson

Show students the map at the URL below. It shows the worldwide distribution of non-polar arid lands. Ask students to describe in words what the map represents. Call on students to try to explain how maps showing the spatial distribution of ecosystems, resources, people, or anything else can be created. Tell them they will learn how when they read this lesson.

http://pubs.usgs.gov/gip/deserts/what/world.html

Building Science Skills

This is a fun way for students to learn how to use GPS. Have teams of students play GPS hide and seek. You can find a student worksheet and teacher pages at the URL below:

http://sciencespot.net/Media/GPSHideSeek.pdf

Demonstration

You may want to use the slide presentation at the URL below to introduce students to GIS and its real-world applications. The presentation is intended specifically for middle school students.

http://www.slideshare.net/aGISGuy/what-is-gis-1655272

Differentiated Instruction

English language learners and less proficient readers may have a better understanding of polar and geostationary orbits if they are modeled with three-dimensional objects. Call on student volunteers to demonstrate both types of orbits with a globe and a small object, such as a toy car to represent a satellite. Have one of the students slowly turn the globe on its axis while another student moves the satellite around the globe, first in a polar orbit and then in a geostationary orbit. The satellite in the polar orbit should be closer to the globe and move more quickly than the satellite in the geostationary orbit. Make sure students coordinate their movements for the geostationary orbit so the satellite remains over the same location on the surface of the globe. Give other students a chance to participate in the modeling if they wish.

Enrichment

Students who need extra challenges may enjoy doing the GIS activity at the URL below. In the activity, they will analyze 24 strange and unusual features on images from around the world using ArcGIS Explorer Online, which requires only a web browser. The activity will help them think spatially using scale and measurement. They will also consider human impacts on the landscape and get experience using ArcGIS Explorer Online as an analytical tool.

http://edcommunity.esri.com/arclessons/lesson.cfm?id=558

Science Inquiry

Students will learn how to use GIS while solving the "Left-Handed Chocolate Caper" (see URL below). The latest version of this fun adventure uses ArcGIS Explorer Online.

http://edcommunity.esri.com/arclessons/lesson.cfm?id=588

Common Misconceptions

A common misconception is that GPS is not available in remote areas. This misconception may arise from well-known problems with cell phone reception in rural areas. Explain that anyone with a clear view of the sky should be able to receive GPS signals with their receiver. In fact, tall buildings may limit the visibility of satellites and make reception worse in urban areas. This also explains why GPS may not work very well indoors.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 2.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

How is tracking a hurricane different from trying to predict where a tornado will strike?

People have GPS units in their cars. What skills are they no longer using if they use a GPS?

What do images of objects in space do for our view of humans and of the universe?

CHAPTER 3 MS TE Earth's Minerals

Chapter Outline

3.1 CHAPTER 3: EARTH'S MINERALS

3.2 LESSON 3.1: MINERALS

3.3 LESSON 3.2: IDENTIFICATION OF MINERALS

3.4 LESSON 3.3: FORMATION OF MINERALS

3.5 LESSON 3.4: MINING AND USING MINERALS

3.1 Chapter 3: Earth's Minerals

Chapter Overview

This chapter covers types of minerals and how they form, how to identify minerals based on their physical properties, and ways that minerals are used.

Online Resources

Refer to the following links for appropriate laboratory activities:

In this lab, students will use a dichotomous key to identify several different minerals.

- http://newyorkscienceteacher.com/sci/files/user-submitted/mineralidentification.pdf

Use this inquiry lab to allow students to model the formation of a geode.

- http://www.science-class.net/Lessons/Geology/Rocks_Minerals/geodes.pdf

In this lab, students will produce and advertise a product (toothpaste) that is made of several different minerals. In the process, they will learn about the properties and uses of a variety of common minerals.

- http://www.nvmineraleducation.org/Activities/APasteWithATaste_20060314.pdf

These websites may also be helpful:

This site has 19 classroom demonstrations about minerals. All of the demonstrations can be downloaded in a single PDF file.

- http://www.mineralseducationcoalition.org/classroom-demonstrations

You can find numerous pictures of minerals, grouped by class, at the mineral gallery below.

- http://www.rocksandminerals4u.com/minerals.html

You can find properties of a wide range of minerals at the URL below.

- http://www.galleries.com/

Pacing the Lessons

TABLE 3.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
3.1 Minerals	2.5
3.2 Identification of Minerals	2.5
3.3 Formation of Minerals	1.0
3.4 Mining and Using Minerals	1.5

3.2 Lesson 3.1: Minerals

Key Concepts

- Atoms and elements
- Molecules and chemical compounds
- Characteristics of minerals
- Groups of minerals

Lesson Objectives

- Describe the properties that all minerals share.
- Describe some different crystal structures of minerals.
- Identify the groups in which minerals are classified.

Lesson Vocabulary

- **atom**: Smallest particle of an element that still has the element's properties.
- **chemical compound**: Unique substance made of two or more elements in a certain ratio.
- **crystal**: Solid in which atoms or ions are arranged in a regular repeating pattern.
- **electron**: Negatively charged particle that orbits the nucleus of an atom.
- **element**: Substance that cannot be broken down to simpler substances by chemical means.
- **ion**: Charged particle that forms when an atom gains or loses electrons.
- **matter**: Anything that has mass and occupies space.
- **mineral**: Naturally occurring, inorganic, crystalline solid with a characteristic chemical composition.
- **molecule**: Smallest particle of a compound that still has the compound's properties.
- **neutron**: Uncharged particle in the nucleus of an atom.
- **nucleus**: Center of an atom consisting of protons and neutrons.
- **proton**: Positively charged particle in the nucleus of an atom.
- **silicates**: Largest group of minerals, containing silicon and oxygen.

Teaching Strategies

Introducing the Lesson

Show students a ball-and-stick or other simple model of a small molecule such as water. Ask them if they know what the model represents. Explain the model to them and then tell them they will learn more about molecules and other building blocks of matter in this lesson.

Activity

Have students use the interactive tutorial to learn about atoms at the URL below. The tutorial covers and extends lesson content. Students can test their comprehension with the quiz at the end of the activity.

http://www.teachersdomain.org/asset/lsps07_int_theatom/

Demonstration

Show students samples of a few minerals as well as samples of nonmineral solids, such as a piece of glass, lump of coal, and cube of sugar. Name each sample, and call on students to identify whether or not it is a mineral. If it is, they should try to classify it in the correct group. If it isn't, they should try to explain why.

Activity

Have students use the figure of halite in the lesson as a guide and create a three-dimensional model of a halite crystal. They might use colored marshmallows and toothpicks or similar materials for their model. Encourage them to be creative. Making the model will reinforce the fact that a mineral crystal has a regular repeating pattern. Display their models in the classroom.

Differentiated Instruction

Work with students to create a compare/contrast table for elements and compounds to help them organize important lesson concepts. A sample is shown in the **Table** below.

TABLE 3.2:

Type of Matter	Definition	Smallest Particle	Example
Element	pure substance	atom	hydrogen, oxygen
Compound	substance made of two or more elements	molecule	water (hydrogen + oxygen)

Differentiated Instruction

If you started a word wall with the first chapter, have students add the term mineral to it. They should include a complete definition of the term, a sketch, and examples of minerals. If you haven't started a word wall yet, start one now with the term mineral.

Enrichment

Ask one or more students to create a crossword puzzle using all of the lesson vocabulary terms. They can create a puzzle by hand or use a free crossword puzzle generator, like the one in the link below.

http://www.discoveryeducation.com/free-puzzlemaker/?CFID=1204798&CFTOKEN=11086118

Science Inquiry

Assign each student a different mineral, and have the students complete the Mighty Mineral challenge at the URL below. Make sure to assign at least one mineral from each of the eight mineral groups. Students will have to do basic research, using at least three reputable sources, to complete a mineral identification sheet for their assigned mineral.

Arrange students' completed work by mineral group, and bind together the sheets to make a booklet. Have students use the booklet as a mineral identification catalog as they study minerals throughout the rest of this chapter.

http://sciencespot.net/Media/mghtymin.pdf

Common Misconceptions

Some common student misconceptions about atoms are listed below. Call on students to reword each statement so it is true.

- Atoms are large enough to be seen with a (light) microscope.
- Atoms are always moving so they must be alive.
- Atoms are like cells, with a nucleus and membrane.

Life Science Connection

Students will learn the importance of minerals in the human body by doing activity 6, "Minerals in Your Body," on pages 15–16 in the PDF booklet below. They will learn which minerals are present in greatest amounts and how the human body uses them.

http://pubs.usgs.gov/gip/2005/17/gip-17.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 3.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

What is one way you could tell the difference between two different minerals?

Why would someone want to make minerals when they are found in nature?

Why are minerals so colorful? Can color be used to identify minerals?

3.3 Lesson 3.2: Identification of Minerals

Key Concepts

- Mineral color, streak, and luster
- Density of minerals
- Mineral hardness and Mohs hardness scale
- Cleavage and fracture of minerals
- Other identifying features of minerals

Lesson Objectives

- Explain how minerals are identified.
- Describe how color, luster, and streak are used to identify minerals.
- Summarize specific gravity.
- Explain how the hardness of a mineral is measured.
- Describe the properties of cleavage and fracture.
- Identify additional properties that can be used to identify some minerals.

Lesson Vocabulary

- **cleavage**: Tendency of a mineral to break along certain planes to make smooth, flat surfaces.
- **density**: Amount of mass per unit of volume.
- **fracture**: How a mineral breaks when it does not break along a cleavage plane.
- **hardness**: Ability of a mineral to resist being scratched.
- **luster**: How light reflects off the surface of a mineral.
- **streak**: Color of the powder of a mineral.

Teaching Strategies

Introducing the Lesson

Show students specimens of pyrite and gold. Explain that one specimen is the mineral gold and the other is the mineral pyrite, also called "fools' gold," but do not identify which is which. Point how the two samples look similar. Can students tell which is gold and which is pyrite? Can they think of a way they might be able to find out? Tell them they will learn how in this lesson.

Activity

Using a few simple materials and their own fingernails, students can test different minerals for hardness. The activity below will help them understand the property of mineral hardness and how to apply the Mohs hardness scale to identify minerals.

http://www.mineralseducationcoalition.org/pdfs/Soft_As_Baby_Skin.pdf

Differentiated Instruction

Use the simple mineral identification activity at the URL below. It ensures student success by using only minerals with distinctively different traits and providing students with the names of all the mineral specimens (and only those names) from which to choose. This is a good activity for the entire class to learn how to identify minerals and the properties of several common minerals.

http://www.skidmore.edu/~jthomas/fairlysimpleexercises/pdf/minid.pdf

Enrichment

Ask one or more students to demonstrate how to use the streak test to identify minerals. Provide them with the necessary materials (unglazed porcelain, several similar-looking mineral specimens), but require them to develop the demonstration on their own.

Science Inquiry

With the inquiry activity at the URL below, students will predict and then test the specific gravity of different minerals. The activity will develop their observational and analytic skills.

http://www.mineralseducationcoalition.org/pdfs/Sink_%26_Float_Rocks.pdf

History Connection

Early settlers used flint and steel to start fires because flint is such a hard mineral. Let students relive the days of the early pioneers by striking sparks from flint to make a fire. The document below includes the procedure and scientific explanation.

http://www.mineralseducationcoalition.org/pdfs/Fire_From_Rock.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook&reg student edition;.

Lesson Quiz

Check students' mastery of the lesson with Lesson 3.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Some minerals are colored because they contain chemical impurities. How did the impurities get into the mineral?

What two properties of a mineral sample would you have to measure to calculate its density?

3.4 Lesson 3.3: Formation of Minerals

Key Concepts

- Formation of minerals from magma and lava
- Formation of minerals from solutions

Lesson Objectives

- Describe how melted rock produces minerals.
- Explain how minerals form from solutions.

Lesson Vocabulary

- **lava**: Molten rock that has reached Earth's surface.
- **magma**: Molten rock deep inside Earth.
- **rock**: Mixture of minerals.

Teaching Strategies

Introducing the Lesson

Ask students to recall from Lesson 3.1 the criteria that must be met in order for a substance to be classified as a mineral. (It must be a solid, be inorganic, have a definite chemical composition, have a crystal structure, and form by natural processes.) Tell students they will learn in this lesson about some of the natural processes that lead to the formation of mineral crystals.

Demonstration

Use the demonstration at the URL below to show students the effects of cooling rate on crystal size. In the demonstration, you will simulate the growth of mineral crystals using some common materials (e.g., mothballs, crayons) because growing actual mineral crystals—for example, from a supersaturated solution of salt—takes too long for a classroom demonstration.

http://www.earth.northwestern.edu/people/seth/demos/XTAL/xtal.html

Activity

Have students grow their own mineral crystals from a solution. The activity at the URL below shows them how. This is an activity they can do at home or in the classroom over multiple days. Make sure that students make daily observations of their crystals and record their observations in their science notebook.

http://library.thinkquest.org/J002289/act.html

Differentiated Instruction

Have students make a KWL chart before reading the lesson and fill in the first two columns (Know, Want to Know) with regard to how minerals form. After they finish reading the lesson, have them fill in the last column (Learned). Did they learn everything they wanted to know? If not, provide the missing information if possible.

Enrichment

Tell the class that geodes have been called the "tootsie roll pops of the geology world" (http://www.rocksandminerals4u.com/geod

http://www.tpwd.state.tx.us/publications/nonpwdpubs/young_naturalist/earth_sciences/geodes/

Science Inquiry

In the activity at the URL below, students will observe four different minerals growing under magnification. They will draw what they observe and then answer a series of questions to analyze their observations and how they relate to the formation of mineral crystals in nature.

http://www.geosociety.org/educate/LessonPlans/FastCrystallization.pdf

Common Misconceptions

Some people hold the misconception that diamonds form from coal. Tell students that although both diamonds and coal consist only or mainly of carbon, diamonds rarely, if ever, form from coal. Almost all diamonds form in igneous rocks in the mantle and make their way to the surface by volcanic eruptions. Discuss the following evidence with students so they will see why the misconception is false. (You can learn more at http://geology.com/articles/diamonds-from-coal/

- Most diamonds that have been dated are older than the first land plants. Because coal formed from land plants, it must be younger than most diamonds. Therefore, most diamonds could not have formed from coal.
- Coal seams are sedimentary rocks that usually form more-or-less horizontal rock units. Diamonds, in contrast, form in vertical igneous rock units, called pipes.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook&reg student edition;.

Lesson Quiz

Check students' mastery of the lesson with Lesson 3.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

When most minerals form, they combine with other minerals to form rocks. How can these minerals be used?

The same mineral can be formed by different processes. How can the way a mineral forms affect how the mineral is used?

3.5 Lesson 3.4: Mining and Using Minerals

Key Concepts

- Ore deposits
- Finding and mining minerals
- Making metals from minerals
- Uses of ore minerals
- Gemstones and their uses
- Other useful minerals
- Mining and the environment

Lesson Objectives

- Explain how minerals are mined.
- Describe how metals are made from mineral ores.
- Summarize the ways in which gemstones are used.
- Identify some useful minerals.

Lesson Vocabulary

- **gemstone**: Mineral that is cut and polished to use in jewelry.
- **ore**: Rock that contains useful minerals.

Teaching Strategies

Introducing the Lesson

Introduce the many uses of minerals by doing the poster activity, "What Materials Are in My Subaru?" Tell students they will learn where these minerals come from in this lesson.

http://www.geosociety.org/educate/LessonPlans/Earth_Materials_in_Subaru.pdf

Activity

This activity will demonstrate the steps that are taken to find, extract, process, and use mineral resources. Students will be able to describe the major steps from discovery of a mineral deposit through consumption of the finished product.

http://www.mines.unr.edu/museum/activities/MiningInANutshell20030827.pdf

Building Science Skills

Students can simulate how geologists use core samples to locate underground ore deposits by doing the class activity at the URL below. In the activity, they will model core-sampling techniques to find out what sort of layers are in a cupcake.

http://www.nvmineraleducation.org/Activities/CupcakeCore_20060320.pdf

Differentiated Instruction

Pair beginning English language learners with more advanced English language learners, and have partners work together to make a flow chart that shows the steps in finding and mining minerals and making metals from minerals.

Enrichment

Urge interested students to learn about the uses, mining, and refining of specific minerals, such as copper and molybdenum (see URLs below). Ask them to share with the class some of the most interesting things they learn.

- http://www.mineralseducationcoalition.org/pdfs/copper.pdf
- http://www.mineralseducationcoalition.org/pdfs/molybdenum.pdf

Science Inquiry

The inquiry activity at the link below allows students to simulate mining ores. In the activity, a variety of chocolate chip cookies represent the ore and toothpicks are used to represent the mining technique. Students will model the mining process including environmental considerations and economics.

http://www.womeninmining.org/activities/Cookie_Mining_Rebaked.pdf

Language Arts Connection

If you assign the "Mineral Haiku" activity below, students will closely observe and draw a mineral and learn what products are made from it. They will also practice language arts and use their creativity.

http://www.mines.unr.edu/museum/activities/Mineral%20Haiku.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 3.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Are all mineral deposits ores?

An open-pit diamond mine may one day be turned into an underground mine. Why would this happen?

Diamonds are not necessarily the rarest gem. Why do people value diamonds more than most other gems?

CHAPTER 4 MS TE Rocks

Chapter Outline

4.1 CHAPTER 4: ROCKS
4.2 LESSON 4.1: TYPES OF ROCKS
4.3 LESSON 4.2: IGNEOUS ROCKS
4.4 LESSON 4.3: SEDIMENTARY ROCKS
4.5 LESSON 4.4: METAMORPHIC ROCKS

4.1 Chapter 4: Rocks

Chapter Overview

This chapter discusses the rock cycle and each of the three major types of rocks that form on Earth. Separate lessons focus on igneous, sedimentary, and metamorphic rocks.

Online Resources

Refer to the following links for appropriate laboratory activities:

The purpose of this introductory rock lab is to observe and describe physical characteristics of a familiar model (candy bars) and apply them to rocks. This is an excellent lab activity to introduce the geological terminology used in describing rocks. Examples of all three rock types (igneous, sedimentary, and metamorphic) are presented. The lab has a strong focus on observational skills.

- http://www.geosociety.org/educate/LessonPlans/IF_YOU_BIT_A_ROCK.pdf

In this online lab, students will learn how to identify sedimentary rocks based on composition, texture, and grain size.

- http://facweb.bhc.edu/academics/science/harwoodr/geol101/labs/sediment/index.htm

In this inquiry lab, groups of students will collect and analyze data while simulating searching for coal deposits on Earth's surface and under the ground. They will create sedimentary and metamorphic rock models, compare them to conglomerate and marble, and simulate how sedimentary and metamorphic rocks form.

- http://pti.lsu.edu/Activities/A06%20Metamorphic_Rock__Melting_Rock.pdf

These websites may also be helpful:

For photos of different types of rocks to share with students, see these URLs:

- http://geology.com/rocks/igneous-rocks.shtml
- http://geology.com/rocks/sedimentary-rocks.shtml
- http://geology.com/rocks/metamorphic-rocks.shtml

You may want to use the PowerPoint presentations at the following URLs when you teach your students about (1) the rock cycle and (2) the three types of rocks (igneous, sedimentary, and metamorphic).

1. http://www.science-class.net/PowerPoints/Predicting%20the%20Rock%20Cycle_files/frame.htm
2. http://schools.paulding.k12.ga.us/ischooldistrict/teacherhome_more.php?TeacherHomePage_ID=6391&school_ID=52&user_ID=2708

This resource contains several activities for teaching students the processes of the rock cycle.

- http://geoscience.msc.sa.edu.au/library/dynamic_rock_cycle.pdf

If you need a review of the three types of rocks, try this URL: http://www.jersey.uoregon.edu/~mstrick/AskGeoMan/geoQuerry13.html .

A fun way to review chapter content is by having teams of students play the "Rocks Jeopardy" game at the following URL.

- https://jeopardylabs.com/play/litchfield-middle-school-rocks

Pacing the Lessons

TABLE 4.1: **Pacing the Lessons**

Lesson	Class Period(s) (60 min)
4.1 Types of Rocks	1.5
4.2 Igneous Rocks	1.5
4.3 Sedimentary Rocks	1.5
4.4 Metamorphic Rocks	1.5

4.2 Lesson 4.1: Types of Rocks

Key Concepts

- Overview of the rock cycle
- Three main categories of rocks
- Processes of the rock cycle

Lesson Objectives

- Define rock and describe what rocks are made of.
- Know the three main groups of rocks.
- Explain how each of these three rock types is formed.
- Describe the rock cycle.

Lesson Vocabulary

- **deposit**: Collection of sediment that has been dropped by wind, water, or another agent of erosion.
- **sediment**: Small particle of soil or rock deposited by wind, water, or another agent of erosion.

Teaching Strategies

Introducing the Lesson

Ask students to recall the definition of minerals from the chapter "MS Minerals." (Minerals are naturally occurring, inorganic crystalline solids, each with a definite chemical composition.) Explain that rocks are made of minerals. Specifically, rocks are collections of mineral crystals that are held together in a firm, solid mass. Tell students they will learn how rocks form from minerals when they read this chapter.

Building Science Skills

Assign the interactive activities at the following URLs. In the first activity, students will learn key characteristics that are used to identify types of rocks (igneous, sedimentary, or metamorphic). Then they will "collect" a sample of rocks and try to identify them by type. In the second activity, students will learn about the processes that change rocks from one type to another. They will try to apply the processes to specific rocks. In the third activity, they will explore the rock cycle and then try to complete the cycle by filling in the correct types of rocks and processes.

- http://www.learner.org/interactives/rockcycle/types.html

- http://www.learner.org/interactives/rockcycle/change.html
- http://www.learner.org/interactives/rockcycle/diagram.html

Activity

Engage students in learning about the rock cycle by having them play the "Rock Cycle Race" at the URL below. Students play the game by following paths that replicate rock cycle processes. They advance on the game board by correctly answering questions about the processes and the types of rocks formed.

http://edweb.sdsu.edu/courses/edtec670/cardboard/board/r/rockcyclerace/index.htm

Differentiated Instruction

Work with struggling students to create a simple cycle diagram of the rock cycle. Have them create sketches for the diagram to represent the different processes involved. Tell students to add the diagram to their science notebook.

Enrichment

Ask a few advanced students to create well-illustrated rock cycle posters. Tell them to include, on their posters, definitions of the three types of rocks and brief descriptions of the processes involved in the cycle. Ask students to present their posters to the class, and then display the posters in the classroom.

Science Inquiry

Simulation is an important science inquiry approach to understanding large, complex, and long-term processes. The simple activity below is an easy way for students to gain hands-on experience with the rock cycle. They will use sugar cubes and other common materials to simulate some of the main processes that occur in the cycle.

http://www.science-class.net/Lessons/Geology/Rocks_Minerals/sugar_rock_cycle.pdf

Language Arts Connection

Challenge students to create a story about Roger, a metamorphic rock, and how he goes through the rock cycle. They should describe at least three transitions that occur during Roger's life. The descriptions should be given from Roger's point of view. You might want to give students the option of expressing their story as a diary, cartoon, or children's book.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 4.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

What processes on Earth are involved in forming rocks?

What rocks are important to modern humans and for what purposes?

4.3 Lesson 4.2: Igneous Rocks

Key Concepts

- Formation of igneous rocks
- Intrusive and extrusive igneous rocks
- Composition of igneous rocks
- Uses of igneous rocks

Lesson Objectives

- Describe how igneous rocks form.
- Describe properties of common igneous rocks.
- Relate some common uses of igneous rocks.

Lesson Vocabulary

- **extrusive rock**: Igneous rock that forms on Earth's surface from rapidly cooling lava.
- **intrusive rock**: Igneous rock that forms beneath Earth's surface from slowly cooling magma.

Teaching Strategies

Introducing the Lesson

Tell students that one of the three major types of rocks is called "fire rock." Ask them to guess which type of rock it is (igneous), and explain why it has that name (it forms from molten rock). Tell students they will learn more about igneous rock in this lesson.

Building Science Skills

Students can learn about igneous rocks with the hands-on activity at the URL below. In the activity, they will study samples of common igneous rocks (basalt, granite, pumice, and obsidian), model rates of cooling and relate them to crystal formation in the rocks, and identify the environments in which the rock samples formed.

http://www.pdesas.org/module/content/resources/13983/view.ashx

Activity

In this igneous rock activity, you can make pancakes to model the formation of igneous rocks—and students get to eat the "rocks" at the end of the activity! From the activity, students will learn to differentiate between intrusive and extrusive igneous rocks by texture. They will also learn why some extrusive rocks have holes and why both intrusive and extrusive rocks may vary in color.

http://www.learnnc.org/lp/pages/3688

Differentiated Instruction

Give visual and kinesthetic learners an opportunity to examine several igneous rock specimens that demonstrate important lesson concepts, such as intrusive and extrusive rocks and igneous rocks with a variety of different textures. Have them relate the features they are seeing and touching to the text in the lesson.

Enrichment

Have a few creative students collaborate on an illustrated poster showing a diversity of uses of igneous rocks. Display the poster in the classroom, and urge other students to examine it.

Science Inquiry

Students can actively model the formation of intrusive and extrusive igneous rocks with the kinesthetic game at the URL below. Students will learn how rate of cooling affects the type of rock that forms and how to classify igneous rocks based on texture.

http://www.nps.gov/brca/forteachers/randmact3.htm

Science Inquiry

Show the class one or more specimens of intrusive and extrusive igneous rocks. The intrusive specimens should have markedly larger crystals than the extrusive specimens. Call on volunteers to describe the features of the two rocks. Ask students to decide which rock formed under the surface and which formed on the surface. Have them explain their reasoning.

Common Misconceptions

A documented misconception held by middle school students is that all rocks are the same, and it's hard to tell how they originated. Use actual rock specimens or photos to show students how igneous rocks differ from other types of rocks such as sedimentary rocks, and how intrusive and extrusive igneous rocks differ from each other. In both cases, relate the differences in rock features to the ways the rocks formed. For example, relate the coarser texture of intrusive igneous rock to slow cooling below Earth's surface.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 4.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Do you think igneous rocks could form where you live?

Would all igneous rocks with the same composition have the same name? Explain why they might not.

Could an igneous rock cool at two different rates? What would the crystals in such a rock look like?

4.4 Lesson 4.3: Sedimentary Rocks

Key Concepts

- Deposition of sediments
- Formation of sedimentary rocks
- Clastic and chemical sedimentary rocks

Lesson Objectives

- Describe how sedimentary rocks form.
- Describe properties of some common sedimentary rocks.
- Relate some common uses of sedimentary rocks.

Lesson Vocabulary

- **cementation**: Sticking together of sediments by mineral crystals from fluids.
- **compaction**: Squeezing together of sediments by the weight of overlying sediments.
- **fossil**: Preserved remains or traces of a once-living organism.

Teaching Strategies

Introducing the Lesson

Ask students to recall what they learned about sedimentary rocks and how they form from the first lesson in the chapter. (Sedimentary rocks form by the compaction and cementing together of sediments or by the formation of chemical precipitates from liquids.) Tell students they will learn more about sedimentary rocks in this lesson. You also might want to have them read the brief introduction to sedimentary rocks and look at examples of sedimentary rocks at the URL below.

http://www.rocksforkids.com/R&M/sedimentary.htm

Demonstration

Model the formation and disruption of sedimentary rock layers with the gelatin activity at the URL below. You can do the activity as a class demonstration with the help of student volunteers. Ask students to explain how the model represents the processes of rock layer formation and disruption, and then let students eat the "rocks."

http://www.coaleducation.org/lessons/sme/elem/34.pdf

Building Science Skills

The activity "Making Sedimentary Rocks" at the URL below relates sedimentary rock formation to the environment. In the activity, students will model how sedimentary rocks form in layers over time and observe how different types of sedimentary rock layers represent different environments. They will also relate changes in the types of sedimentary rock layers to changes in the environment.

http://www.windows2universe.org/teacher_resources/teach_makerock.html

Differentiated Instruction

Have students read the brief "Schoolyard Geology" article at the link below as a simpler alternative to the lesson in their textbook. The illustrated analogies in the article (e.g., a dump truck carrying sand as an analogy for erosion) may help them understand the processes involved in the deposition of sediments and the formation of sedimentary rocks.

http://education.usgs.gov/lessons/schoolyard/RockSedimentary.html

Enrichment

Ask one or more students to read the article about coal at the URL below. Have them summarize the main points and then present their summary to the class. Discuss with the class why coal is classified as an organic sedimentary rock.

http://www.rhnet.org/webpages/cwhite/files/coal%20extension%20reading.pdf

Science Inquiry

Take a field trip to your schoolyard, and let students play the role of a naturalist and investigate sedimentary rocks. Students should identify any sedimentary rocks (concrete and asphalt can be used as substitutes for naturally occurring rocks to increase the sample of rocks observed). Tell students to look closely at the rocks and describe their properties. Discuss what the properties mean. You can use the activity at the URL below as a guide. It provides background, instructions, rock tables, and many other resources that will allow your students to get the most out of this inquiry activity.

http://education.usgs.gov/lessons/schoolyard/RockActivity.html

Common Misconceptions

Students may think that all rocks with visible bands are sedimentary rocks. Tell them that other types of rocks may also have visible bands. Explain that many properties of rocks generally must be used to accurately identify rocks.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 4.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

If you were interested in learning about Earth's history, which type of rocks would give you the most information?

Could a younger layer of sedimentary rock ever be found under an older layer? How do you think this could happen?

Could a sedimentary rock form only by compaction from intense pressure?

4.5 Lesson 4.4: Metamorphic Rocks

Key Concepts

- Formation of metamorphic rocks
- Contact and regional metamorphism
- Uses of metamorphic rocks

Lesson Objectives

- Describe how metamorphic rocks are formed.
- Describe the properties of some common metamorphic rocks.
- Relate some common uses of metamorphic rocks.

Lesson Vocabulary

- **contact metamorphism**: Changes in rock due to heating by contact with hot magma.
- **foliation**: Formation of layers in rock due to extreme pressure.
- **regional metamorphism**: Changes in rock over a large area due to pressure from other rock.
- **stable**: State of minerals in rock after metamorphism.

Teaching Strategies

Introducing the Lesson

Introduce metamorphic rock with the excellent animation of metamorphism at the URL below. Point out how heat and pressure turn sedimentary and igneous rocks into metamorphic rocks. Tell students they will learn more about metamorphic rocks in this lesson.

http://www.fi.edu/fellows/fellow1/oct98/create/metamorph.htm

Discussion

Discuss the causes of metamorphism. Explain how magma causes high temperatures in contact metamorphism and how masses of rock cause great pressure in regional metamorphism. Make sure students know that high temperatures and great pressure often occur together and affect the same rock. Point out that the extreme temperatures that cause metamorphism do not melt rocks completely.

Question: If the rocks melted completely and then new rocks formed, what type of rocks would they be?

Sample answer: They would be igneous rocks, or rocks that form when minerals crystallize from melted rock.

Differentiated Instruction

Have pairs of students make a Venn diagram that compares and contrasts contact and regional polymorphism. Make sure they understand that extreme heat causes contact metamorphism, and extreme pressure (often with heat) causes regional polymorphism.

Enrichment

Ask one or more students to create a Web page about a specific example of metamorphism, such as limestone changing to marble when exposed to high temperatures (contact metamorphism). Suggest that they describe, and use photos to illustrate, the two types of rocks, and also list some of their important uses. Encourage other students to visit the Web page.

Science Inquiry

Use the inquiry activity "Metamorphic Sandwiches" (see URL below) so students can model the processes of metamorphism. Discuss how the processes they apply to their "metamorphic sandwiches" relate to the high pressures and temperatures that cause metamorphism in rocks.

http://www.womeninmining.org/activities/METAMORPHIC_SANDWICHES.pdf

Common Misconceptions

Students may think incorrectly that foliated metamorphic rocks are sedimentary rocks, because the foliated rocks appear to have layers like the depositional layers of sediments. Ask them to explain the different causes of the layers in the two types of rocks. Correct any misconceptions that their explanations reveal.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 4.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

What type of plate boundary would produce the most intense metamorphism of rock?

Do you think new minerals could form when an existing rock is metamorphosed?

Chapter 5 MS TE Earth's Energy

Chapter Outline

5.1 Chapter 5: Earth's Energy
5.2 Lesson 5.1: Earth's Energy
5.3 Lesson 5.2: Nonrenewable Energy Resources
5.4 Lesson 5.3: Renewable Energy Resources

5.1 Chapter 5: Earth's Energy

Chapter Overview

This chapter discusses nonrenewable energy resources, including fossil fuels and nuclear energy, as well as renewable energy resources, including solar, wind, and water energy.

Online Resources

See the following Web sites for appropriate laboratory activities:

Students can learn about kinetic and potential energy and energy conservation using the simulation-based lab at this URL: http://phet.colorado.edu/en/contributions/view/3186 .

Students can explore nuclear energy with the lab at the URL below. The lab is based on a nuclear fission simulation at the same Web site.

- http://phet.colorado.edu/en/contributions/view/3170

There are two biomass lab activities for middle school students at the following URL (pages 102–110). In these labs, the students will demonstrate the production of two biofuels from solid organic wastes. In the first lab, students will investigate the fermentation of sugar to produce ethanol. In the second lab, they will demonstrate the production of methane from manure. You could assign either or both labs.

- http://www.tvakids.com/teachers/pdf/renewable_middle.pdf

These Web sites may also be helpful:

This Web site has links to a wide variety of middle school teaching resources on energy, including activities, labs, slide shows, graphic organizers, interactive Web sites, and online quizzes.

- http://science-class.net/Physics/energy.htm

The URL below provides a long list of resources and lesson plans available on the Internet that deal with energy and science education for middle school teachers.

- http://www.energyquest.ca.gov/teachers_resources/lesson_plans.html

Pacing the Lessons

TABLE 5.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
5.1 Earth's Energy	1.5
5.2 Nonrenewable Energy Resources	2.0
5.3 Renewable Energy Resources	2.0

5.2 Lesson 5.1: Earth's Energy

Key Concepts

- Earth's energy resources
- The need for energy
- Conservation of energy
- Energy changes
- Energy, fuel, and heat
- Types of energy resources

Lesson Objectives

- Compare ways in which energy is changed from one form to another.
- Discuss what happens when we burn a fuel.
- Describe the difference between renewable and nonrenewable resources.
- Classify different energy resources as renewable or nonrenewable.

Lesson Vocabulary

- **chemical energy:** form of energy obtained from food
- **energy:** ability to do work or to move or change matter
- **fuel:** material that can release energy in a chemical change
- **kinetic energy:** energy that a moving object has because of its motion
- **law of conservation of energy:** law stating that energy cannot be created or destroyed
- **potential energy:** stored energy that has the potential to do work

Teaching Strategies

Introducing the Lesson

Play a word association game with the word energy. Call on one student after another to say the first word that comes to mind when they hear the word energy. (Possible words might include activity, sports, fitness, drink, and bar.) Relate their words to energy as defined above. Tell them they will learn more about energy in this lesson.

Building Science Skills

The lesson at the URL below is an excellent way to introduce the chapter and teach the concepts in this lesson. Students will brainstorm a definition of energy, learn about potential and kinetic energy, identify examples of potential and kinetic energy, and classify energy as potential or kinetic.

http://whatwillfuelthefuture.com/fileshare/lessons/MiddleSchool/What%20is%20Energy-Middle.pdf

Differentiated Instruction

Kinesthetic and limited English proficiency students may increase their understanding of kinetic and potential energy by experiencing them physically. They can do this in a variety of simple activities, such as using a playground slide, swinging on a swing, or just jumping up and down. Point out how their energy changes back and forth between kinetic and potential energy as they participate in the activity.

Differentiated Instruction

Ask a pair of students to add the term energy to the word wall. They should write the term on an index card, define it, and draw a simple sketch to represent it. If you haven't started a word wall yet, this is a good time to start one because energy is one of the most important and basic concepts in Earth science.

Enrichment

Ask a group of students to take a survey of other students in the school about their knowledge and views of renewable and nonrenewable energy resources. The group should analyze the survey results and present a summary of their work to the class.

Science Inquiry

Divide the class into groups and have each group devise a research procedure to answer one of the following questions: How much energy do I get from my food? How much energy do I use? To point them in the right direction, tell them to:

- refine their question to make it more specific (e.g., What is the average amount of kilocalories I consume in one day? How many kilocalories do I use in a typical 24-hour period?)
- find online tables showing how much energy specific food items provide or how much energy specific activities use.
- develop a detailed procedure and materials list.
- describe the data to be collected, how it will be collected, and how it will be analyzed.

Common Misconceptions

Students will hear or read that some energy is generally "lost" to the environment whenever energy changes form. They may think that this energy is "destroyed" and that the law of conservation of energy doesn't apply. Explain that the "lost" energy is not destroyed. It is still there. It just spreads out in the environment and is not available to use for other purposes.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 5.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

How long do fossil fuels take to form?

Are all fossil fuels nonrenewable resources?

Do all fossil fuels affect the environment equally?

5.3 Lesson 5.2: Nonrenewable Energy Resources

Key Concepts

- Formation of fossil fuels
- Coil, oil, and natural gas
- Problems with fossil fuels
- Nuclear energy

Lesson Objectives

- Describe how fossil fuels are formed.
- Describe different fossil fuels, and understand why they are nonrenewable resources.
- Explain how fossil fuels are turned into useful forms of energy.
- Understand that when we burn a fossil fuel, most of its energy is released as heat.
- Describe how the use of fossil fuels affects the environment.

Lesson Vocabulary

- **hydrocarbon:** any chemical compound consisting only of hydrogen and carbon

Teaching Strategies

Introducing the Lesson

Ask students to recall from the previous lesson which energy resources are nonrenewable (the fossil fuels coal, oil, and natural gas) and why they are nonrenewable (they are being used faster than they take to form). Tell students they will learn more about fossil fuels and other nonrenewable energy resources in this lesson.

Activity

In this series of interactive energy lessons, students can learn about the history of fossil fuels and their future potential.

http://www.fe.doe.gov/education/energylessons/index.html

Building Science Skills

In this hands-on activity, students will be introduced to the process of obtaining, refining, and converting fossil fuels into electricity, as well as the consequences associated with that process. They will also calculate the average energy capacity of different fossil fuels.

http://ceeri.boisestate.edu/wp-content/uploads/2012/07/Fossil-Fuels-6-26.pdf

Differentiated Instruction

Have students create a picture flow chart to represent the series of processes involved in finding, drilling, refining, and using oil. This will help them understand how everyday items, such as cars, receive their fuel and why the world's supply of oil will eventually run out if alternative resources are not used. This, in turn, will help them appreciate the need for renewable energy resources.

Enrichment

Ask students to make a collage of articles and pictures relating to controversial issues about petroleum. For example, they might include articles and pictures about offshore oil drilling, pipeline construction, oil spills, or political and economic problems with obtaining oil from other countries. Display their collage in the classroom so other students can learn more about the issues.

Science Inquiry

In this problem-solving class activity, students will do two experiments in which they learn how dependent they are on electricity, most of which is produced from coal, and how controlling the rate of energy use makes a resource such as coal last longer.

http://www.fe.doe.gov/education/energylessons/coal/Conserving_Electric_Energy.pdf

Common Misconceptions

The activity below can be used to identify and correct common student misconceptions about fossil fuels. The misconceptions include:

- Oil forms in large empty spaces underground.
- Oil comes from dead dinosaurs.
- Oil won't be found under an ocean/desert/forest.

http://www.sciencelearn.org.nz/Contexts/Future-Fuels/Teaching-and-Learning-Approaches/Misconceptions-about-fossil-fuels

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 5.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

How are renewable sources of energy different from nonrenewable sources of energy?

Are all renewable energy sources equally practical?

Are all renewable energy sources equally good for the environment?

5.4 Lesson 5.3: Renewable Energy Resources

Key Concepts

- Solar energy
- Water energy
- Wind energy
- Biomass energy
- Geothermal energy

Lesson Objectives

- Describe different renewable resources, and explain why they are renewable.
- Describe how the sun is the source of most of Earth's energy.
- Describe how energy is carried from one place to another as heat and by moving objects.
- Understand how conduction, convection, and radiation transfer energy as heat when renewable energy sources are used.
- Understand that some renewable energy sources cost less than others and some cause less pollution than others.
- Explain how renewable energy resources are turned into useful forms of energy.
- Describe how the use of different renewable energy resources affects the environment.
- Describe how a nuclear power plant produces energy.

Lesson Vocabulary

- **conduction:** transfer of heat by direct contact from a higher-temperature to a lower-temperature object
- **convection:** transfer of heat by the movement of molecules in currents through a fluid
- **radiation:** transfer of energy through space or matter by electromagnetic waves such as light

Teaching Strategies

Introducing the Lesson

Students will be familiar with hand-held solar-powered calculators. Show students a solar calculator and ask them what powers it. (They are likely to say the sun or sunlight.) Explain that light energy enters the calculator and is changed by a special solar battery (photovoltaic cell) into electric current. Tell students they will learn more about solar and other types of renewable energy when they read this lesson.

Building Science Skills

With the "Renew-a-Bean" activity at the following URL, students will use beans to represent renewable and nonrenewable energy resources and do a simulation of how nonrenewable resources are depleted. The activity will give them a better understanding of why nonrenewable resources will eventually be depleted, how changing rates of use will affect resource depletion, the role of conservation, and the need to develop renewable resources.

http://www.ucsusa.org/assets/documents/clean_energy/renewablesready_fullreport.pdf

Activity

In this activity, students will learn how wind propeller design affects the efficiency of windmills and how wind energy can be used to generate electricity.

http://www.ucsusa.org/assets/documents/clean_energy/renewablesready_fullreport.pdf

Differentiated Instruction

Assign each of three pairs of students one of the terms for heat transfer (conduction, convection, and radiation), and ask them to add their term to the word wall. On an index card, they should write the term, define it, and draw a simple sketch to represent it. For example, for radiation they might draw a sketch of the sun and Earth with arrows going from the sun to Earth to represent rays of light.

Enrichment

Have students choose one type of renewable energy, such as solar, biomass, or geothermal energy, and write an essay on which fossil fuel this energy resource could eventually replace. They should also discuss economic, health, and environmental changes that might come about if the replacement occurs.

Science Inquiry

In Activity 8 ("Which Has More Heat?") at the following URL, students will measure the amount of heat generated by a nonrenewable fuel (motor oil) and a renewable fuel (vegetable oil). They will learn that different types of fuel produce different amounts of heat energy.

http://www.nrel.gov/docs/gen/fy01/30927.pdf

Common Misconceptions

Discuss the common misconceptions below about renewable energy resources. Explain why each misconception is false. You can learn more at this URL: http://2ndgreenrevolution.com/2011/10/10/common-misconceptions-about-alternative-energy-sources/ .

- Renewable energy resources never produce any pollution.
- All renewable energy resources have unlimited availability.
- Renewable energy resources are always cheaper than nonrenewable energy resources.
- Renewable energy resources will now completely replace nonrenewable energy resources.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 5.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

What areas do you think would be best for using solar energy?

What causes the high temperatures deep inside Earth that make geothermal energy possible?

Do you think your town or city could use wind or water power?

CHAPTER 6 MS TE Plate Tectonics

Chapter Outline

6.1 CHAPTER 6: PLATE TECTONICS

6.2 LESSON 6.1: INSIDE EARTH

6.3 LESSON 6.2: CONTINENTAL DRIFT

6.4 LESSON 6.3: SEAFLOOR SPREADING

6.5 LESSON 6.4: THEORY OF PLATE TECTONICS

6.1 Chapter 6: Plate Tectonics

Chapter Overview

This chapter describes properties of earth's interior, continental drift, seafloor spreading, the theory of plate tectonics, and types of plate boundaries.

Online Resources

See the following Web sites for appropriate laboratory activities:

The inquiry lab at the URL below guides students through the history of continental drift. Students will gather evidence and use scientific reasoning to reconstruct Pangaea. They will also propose their own mechanism for how drift occurs.

- http://www.wilson.wnyric.org/david/images/stories/history_labs/pt_history_cont_drift.doc

In the following lab, students will use actual data from historic oceanographic cruises to examine sea floor spreading. They will also model sea floor spreading at a spreading center such as the Mid-Atlantic Ridge. The lab involves plotting data on a diagram, drawing conclusions from the data, and making predictions.

- http://www.oceanleadership.org/education/deep-earth-academy/educators/classroom-activities/grades-5-8/modeling-plate-tectonics/

With the "Musical Plates" problem-solving lab at the URL below, students use real-time earthquake and volcano data from the Internet to explore the relationship between these types of geologic activity and tectonic plate interactions.

- http://ciese.org/curriculum/musicalplates2/index.shtml

These Web sites may also be helpful:

If you want to review chapter content, especially plate tectonics, read the excellent USGS publication called This Dynamic Earth (see URL below).

- http://pubs.usgs.gov/gip/dynamic/dynamic.html

You can find links to many Web sites that deal with plate tectonics at this URL: http://www.tectonicplate.com/resource/

For videos about seafloor spreading and plate tectonics, try those listed below.

- http://www.youtube.com/watch?v=ryrXAGY1dmE
- http://www.youtube.com/watch?v=1-HwPR_4mP4
- http://www.youtube.com/watch?v=JmC-vjQGSNM

Pacing the Lessons

TABLE 6.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
6.1 Inside Earth	1.5
6.2 Continental Drift	1.0
6.3 Seafloor Spreading	1.0
6.4 Theory of Plate Tectonics	2.5

6.2 Lesson 6.1: Inside Earth

Key Concepts

- Evidence about Earth's interior
- Oceanic and continental crust
- Mantle and convection
- Inner and outer core
- Lithosphere and asthenosphere

Lesson Objectives

- Compare and describe each of Earth's layers.
- Compare some of the ways geologists learn about Earth's interior.
- Define oceanic and continental crust and the lithosphere.
- Describe how heat moves, particularly how convection takes place in the mantle.
- Compare the two parts of the core and describe why they are different from each other.

Lesson Vocabulary

- **asthenosphere:** part of the upper mantle below that lithosphere that can flow and bend
- **convection cell:** circular current of warm material rising and cool material sinking that transfers heat
- **continental crust:** thicker, denser part of Earth's crust that makes up the continents
- **core:** dense, metallic center of Earth, consisting of the inner and outer core

crust thin, brittle outer shell of Earth, consisting of continental and oceanic crust

- **lithosphere:** rigid part of Earth that consists of the crust and upper mantle, lying above the asthenosphere
- **mantle:** middle layer of Earth, consisting of hot, solid rock
- **meteorite:** metallic object from the early solar system that strikes Earth's surface from space
- **oceanic crust:** thinner, less dense part of Earth's crust that makes up the ocean basins
- **plate tectonics:** theory that Earth's lithosphere is divided into plates that move over the asthenosphere
- **seismic wave:** earthquake wave that transports energy from an earthquake through the ground in all directions

Teaching Strategies

Introducing the Lesson

Display a simple cross-section of Earth showing its layers, such as the image at the URL below. Point out how Earth consists of three main layers. Challenge the class to brainstorm how scientists learned that Earth has layers. Accept all reasonable responses at this point, and tell students they will find out for sure when they read this lesson.

http://www.uvm.edu/~inquiryb/webquest/fa05/lkenney/

Activity

Students can explore Earth's layers with the interactive "Dynamic Earth" module at this URL: http://www.learner.org/interactives/dynamicearth/ .

Building Science Skills

Students may be familiar with convection in a fluid but not in a solid and assume that the asthenosphere is molten. Model the asthenosphere with silly putty so students can see how a solid can slowly flow and bend.

Question: What could you use to model the lithosphere?

Sample answer: You could model the lithosphere with something thin and brittle, such as a broken china plate.

Differentiated Instruction

Use the labeling and coloring worksheet at the following URL to help students learn the basics about Earth's layers and to reinforce the most important lesson content.

http://www.havefunteaching.com/worksheets/science/earth-science/layers-of-the-earth.pdf

Enrichment

Challenge a small group of students to write a song or rap about the interior of Earth. The lyrics should identify and describe Earth's layers. Invite the students to perform the song or rap for the rest of the class.

Science Inquiry

In the inquiry activity at the URL below, students construct a 3-D model of Earth's interior. This will help them visualize the layers as well as illustrate their relative volumes. The activity also provides practice in problem solving and math skills.

http://web.ics.purdue.edu/~braile/edumod/threedearth/threedearth.htm

Common Misconceptions

Students commonly have the misconception that the crust and lithosphere are synonymous terms. Make sure they realize that the lithosphere includes not only the crust but also the brittle uppermost part of the mantle. Draw a simple sketch of Earth's three main layers by composition (crust, mantle, and core), and then indicate the lithosphere on the sketch, showing that it includes mantle as well as crust. Students need a correct conception of the lithosphere in order to understand plate tectonics.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 6.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

The oceanic crust is thinner and denser than continental crust. All crust sits atop the mantle. What might our planet be like if this were not true.

If sediments fall onto the seafloor over time, what can sediment thickness tell scientists about the age of the seafloor in different regions?

How might convection cells in the mantle affect the movement of plates of lithosphere on the planet's surface?

6.3 Lesson 6.2: Continental Drift

Key Concepts

- Idea of continental drift
- Evidence for continental drift

Lesson Objectives

- Be able to explain the continental drift hypothesis.
- Describe the evidence Wegener used to support his continental drift idea.
- Describe how the north magnetic pole appeared to move and how that is evidence for continental drift.

Lesson Vocabulary

- **continental drift:** early 20th century hypothesis that the continents move over Earth's surface
- **magnetic field:** area surrounding a magnet over which it exerts magnetic force

Teaching Strategies

Introducing the Lesson

Show students a map of the world. Ask them if the continents have always been where they are now. Students may think that the continents are unmoving. They may be surprised when you tell them that the continents used to be in very different positions millions of years ago. Have them look at the map of Pangaea in the FlexBook® student edition lesson, and explain that this is how Earth looked about 250 million years ago. Tell them they will see evidence for it when they read this lesson.

Demonstration

Demonstrate continental drift to the class with the animation at the URL below. The animation shows the movement of the continents over the past 250 million years, starting at the time of the dinosaurs, when all of today's continents formed the supercontinent Pangaea. Students can watch as Pangaea breaks apart and the continents move to their present positions. Point out how quickly India travels toward Asia near the end of the animation at about 60 million years ago. Explain that when the two landmasses collided, the collision formed the Himalaya Mountains.

http://www.tectonics.caltech.edu/outreach/animations/anim_pangaea/Resources/anim_pangaea.mov

Building Science Skills

You may want to use the lesson plan at the following URL when you teach students about Wegener's hypothesis and the evidence that supports it. Students will follow steps similar to those taken by Wegener to examine fossil evidence for continental drift. They will map the locations of fossils and discuss how well the fossil evidence supports the hypothesis.

http://www.discoveryeducation.com/teachers/free-lesson-plans/continental-drift.cfm

Differentiated Instruction

Provide kinesthetic learners with cutouts of the continents (see URL below). Have them try to fit the continents together to form the supercontinent Pangaea. Tell them to look at the map of Pangaea in the FlexBook® student edition lesson if they need help. In simple terms, relate the puzzle to the hypothesis of continental drift. Ask students how the shapes of the continents help support the hypothesis.

http://www.williamsclass.com/SixthScienceWork/PangeaProject.htm

Enrichment

Assign interested students the self-paced lesson "Continental Drift: What's the Big Idea?" at the URL below. The online lesson, which reviews and extends FlexBook® content, includes a video and reading passage, as well as several quizzes. As a final assignment, students are asked to choose one of two topics and write an essay that includes supporting details and vocabulary from the lesson. Ask students to read their essay to the class.

http://www.teachersdomain.org/resource/midlit10.sci.splwegener/

Science Inquiry

You can use the "Great Continental Drift Mystery" at the following URL when you teach the lesson. It allows students to explore and interpret a diversity of evidence for continental drift. Students will study and draw maps and add clues to maps as they try to solve the mystery.

http://www.yale.edu/ynhti/curriculum/units/1991/6/91.06.05.x.html

Common Misconceptions

Students may have many misconceptions about continental drift. For example, they may think that continents drift because they float on the oceans. This and other misconceptions about continental drift are discussed at the URL below. The Web site also provides links to multi-media materials you can use to counter the misconceptions.

http://sci-misconceptions.wikispaces.com/

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 6.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Why is continental drift referred to as a hypothesis and not a theory?

Why is Wegener's continental drift idea accepted today?

Explain how each of these phenomena can be used as evidence for continental drift:

- the fit of the continents
- the distribution of fossils
- the distribution of similar rock types
- rocks from ancient climate zones

6.4 Lesson 6.3: Seafloor Spreading

Key Concepts

- Seafloor bathymetry and seafloor features
- Seafloor magnetism
- Seafloor spreading hypothesis

Lesson Objectives

- List the main features of the seafloor: mid-ocean ridges, deep-sea trenches, and abyssal plains.
- Describe what seafloor magnetism tells scientists about the seafloor.
- Describe the process of seafloor spreading.

Lesson Vocabulary

- **echo sounder:** device that uses sound waves to calculate distances to underwater objects and the seafloor
- **seafloor spreading:** hypothesis explaining how the ocean floor forms and how continents can drift
- **trench:** deep crack in the ocean floor

Teaching Strategies

Introducing the Lesson

Introduce seafloor spreading by showing students the animation at the following URL. Challenge students to describe what they are observing. (Magma is erupting onto the ocean floor, and the ocean floor is moving away from both sides of the eruption.) Tell students they will learn more about seafloor spreading and how scientists learned about it when they read this lesson.

http://education.sdsc.edu/optiputer/flash/seafloorspread.htm

Demonstration

You may want to use the excellent PowerPoint presentation at the URL below when you teach this lesson. It provides a concise, logical overview of lesson content.

http://www.callutheran.edu/BioDev/marcey/assi_04/lessonplans_04/earth/delamore/spread.ppt

Demonstration

Use the simple demonstration "Seafloor Spreading Made Easy," which is described at the URL below, to show students how seafloor spreading occurs. Student volunteers will be actively involved in the classroom demonstration, which could be done as a student activity instead. The demonstration takes about 30 minutes.

http://www.geosociety.org/educate/LessonPlans/SeaFloorSpreading.pdf

Differentiated Instruction

Do a think-pair-share activity for seafloor spreading. Ask students to think about the following questions:

1. What is seafloor spreading?
2. What evidence is there for seafloor spreading?
3. How is seafloor spreading related to continental drift?

After students have had time to consider the questions, divide the class into pairs, and ask partners to share their ideas about the answers to the questions. Be sure to pair any less proficient readers and English language learners with other students in the class.

Enrichment

Ask a student who needs enrichment to make a diagram representing seafloor spreading and the magnetic stripes on the seafloor. Then ask the student to use the diagram to explain the magnetic evidence for seafloor spreading to the rest of the class. A sample diagram can be found at this URL: http://ase.tufts.edu/cosmos/print_images.asp?id=4 .

Science Inquiry

With the inquiry activity at the URL below, students will make a paper model illustrating the concept of sea-floor spreading and the development of symmetrical magnetic stripes on either side of a mid-ocean ridge. The Web site provides teacher information as well as a student procedure.

http://www.ucmp.berkeley.edu/fosrec/Metzger3.html

History Connection

Share with students the importance of the American geologist Harry Hess in our understanding of seafloor spreading and its contribution to the theory of plate tectonics. You can find details at this URL: http://pubs.usgs.gov/gip/dynamic/HHH.html .

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 6.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

How were the technologies that were developed during World War II used by scientists for the development of the seafloor-spreading hypothesis?

In what two ways did magnetic data lead scientists to understand more about plate tectonics?

How does seafloor spreading provide a mechanism for continental drift?

Describe the features of the North Pacific Ocean basin described in terms of seafloor spreading.

6.5 Lesson 6.4: Theory of Plate Tectonics

Key Concepts

- Earth's tectonic plates
- How tectonic plates move
- Divergent, convergent, and transform plate boundaries
- Earth's changing surface and the supercontinent cycle
- Intraplate activity and hotspots

Lesson Objectives

- Describe what a plate is and how scientists can recognize its edges.
- Explain how the plates move by convection in the mantle.
- Describe the three types of plate boundaries and the features of each type of boundary.
- Describe how plate tectonics processes lead to changes in Earth's surface features.

Lesson Vocabulary

- **continental rifting:** splitting of a continent at a divergent plate boundary
- **convergent plate boundary:** location where two lithospheric plates come together
- **divergent plate boundary:** location where two lithospheric plates move apart
- **intraplate activity:** geologic activity that takes plates within a plate away from plate boundaries
- **island arc:** line of island volcanoes resulting from subduction of one oceanic plate beneath another oceanic plate
- **plate:** slab of lithosphere that can move over Earth's surface
- **plate boundary:** location where two lithospheric plates meet
- **plate tectonics:** theory that Earth's surface is divided into lithospheric plates that move over the planet's surface
- **subduction:** sinking of one lithospheric plate beneath another
- **subduction zone:** area where two lithospheric plates come together and one sinks beneath the other
- **transform fault:** fracture in rock where one plate slides past another
- **transform plate boundary:** location where two lithospheric plates slide past one another in opposite directions

Teaching Strategies

Introducing the Lesson

Ask students to recall what they know about the lithosphere from previous lessons. (The lithosphere is the brittle outer layer of Earth that includes the crust and part of the mantle.) Tell them that the lithosphere is broken into pieces that can move around on Earth's surface. Ask students to think about what might happen if the pieces collided or scraped against each other as they moved. Tell them they will find out when they read this lesson.

Demonstration

You can show students animations of the three types of plate boundaries at the first URL below. You can show them a video lecture on types of plate boundaries at the second URL.

http://www.classzone.com/books/earth_science/terc/content/visualizations/es0804/es0804page01.cfm?chapter_no=visualization (animations)

http://www.iris.edu/hq/programs/education_and_outreach/animations/11 (video lecture)

Activity

The interactive activity "Mountain Maker, Earth Shaker" (see URL below) allows students to build mountains, trigger volcanoes, and create new seafloor with the click of a mouse. Four types of plate tectonic interactions are demonstrated in the activity. A map shows where in the world each type of plate interaction takes place.

http://www.pbs.org/wgbh/aso/tryit/tectonics/indext.html

Differentiated Instruction

If you have students who are visual or kinesthetic learners or have limited English proficiency, teach them about plate tectonics with the drawing exercise outlined at the following URL. The draw-with-me presentation will engage students and help them understand the spatial and movement aspects of plate boundary interactions. Drawing enhances their learning, understanding, and retention; and at the end of the exercise, they will have a set of illustrations for their science notebook that can be used for study and reference.

http://geology.com/nsta/

Enrichment

Have one or more students create a crossword or other word puzzle for at least ten of the lesson vocabulary terms. They can create their puzzle by hand or use a free online puzzle maker (see URL below). Make copies of their puzzle and distribute them to other students to solve as a review of lesson vocabulary.

http://www.discoveryeducation.com/free-puzzlemaker/?CFID=512270&CFTOKEN=93102964

Science Inquiry

The inquiry activity at the URL below is a tasty way for students to model plate interactions. With their models, students will see how the density, thickness, and pliability of plates affect how they interact at plate boundaries. Students can create drawings of the different interactions as an assessment.

http://www.windows2universe.org/teacher_resources/teach_snacktectonics.html

Common Misconceptions

Students commonly think that plate boundaries always fall at the edges of continents. Show them the map of 15 major plates at the URL below. Point out the continents and then point out where the plate boundaries fall. The interactive plate boundary map at the bottom of the Web page uses color-coding to identify the plate boundaries as convergent, divergent, or transform boundaries.

http://www.learner.org/interactives/dynamicearth/plate.html

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 6.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

On the map in the figure above, the arrows show the directions that the plates are going. The Atlantic has a mid-ocean ridge, where seafloor spreading is taking place. The Pacific Ocean has many deep-sea trenches, where subduction is taking place. What is the future of the Atlantic plate? What is the future of the Pacific plate?

Using your hands and words, explain to someone how plate tectonics works. Be sure you describe how continents drift and how seafloor spreading provides a mechanism for continental movement.

Now that you know about plate tectonics, where do you think would be a safe place to live if you wanted to avoid volcanic eruptions and earthquakes?

CHAPTER 7 MS TE Earthquakes

Chapter Outline

7.1 CHAPTER 7: EARTHQUAKES
7.2 LESSON 7.1: STRESS IN EARTH'S CRUST
7.3 LESSON 7.2: NATURE OF EARTHQUAKES
7.4 LESSON 7.3: MEASURING AND PREDICTING EARTHQUAKES
7.5 LESSON 7.4: STAYING SAFE IN EARTHQUAKES

7.1 Chapter 7: Earthquakes

Chapter Overview

This chapter discusses stresses on rocks and mountain building, causes of earthquakes, seismic waves, measuring and predicting earthquakes, and earthquake safety.

Online Resources

See the following Web sites for appropriate laboratory activities:

In the quick, simple lab activity at the following URL, students will model the different types of stresses that act on rocks. Use the lab with the first lesson, "Stress in Earth's Crust." It is a good way to launch the chapter.

- http://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_rock/cub_rock_lesson01_-activity1.xml

The lab at the URL below allows students to investigate tsunamis and the destruction they cause. They will compare tsunamis in oceans and fjords and learn why they behave differently.

- http://www.discoveryeducation.com/teachers/free-lesson-plans/tsunami.cfm

This kinesthetic lab has students move as propagating seismic waves. They will compute wave velocities from their travel time along a string of measured length. Then they will simulate an earthquake and use the time lag between wave arrival times and their computed speeds to calculate the position of the epicenter.

- http://nagt.org/nagt/programs/teachingmaterials/11342.html

These Web sites may also be helpful:

This URL has straightforward, clear animations of different types of faults: http://www.iris.edu/gifs/animations/faults.htm .

This resource provides a series of short articles on earthquake basics for students, teachers, and parents. The articles were originally published as weekly features in The San Francisco Chronicle.

- http://pubs.usgs.gov/gip/2006/21/

You can link with several earthquake photo collections at these URLs:

- http://earthquake.usgs.gov/learn/photos.php
- http://www.exploratorium.edu/faultline/activezone/photos.html

The URL below has links to several short video lectures on earthquakes.

- http://www.iris.edu/hq/programs/education_and_outreach/videos#H

Numerous useful publications and other media relating to earthquakes can be accessed at this URL: http://www.exploratorium.edu/faultline/activezone/links.html

A series of seismology resources for teachers from the Seismological Society of America can be accessed at the following URL. The resources include reference information, maps, slide sets, videotapes, computer hardware and software, seismographs, and data sets.

- http://web.ics.purdue.edu/~braile/edumod/seisres/seisresweb.htm

Pacing the Lessons

TABLE 7.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
7.1 Stress in Earth's Crust	2.5
7.2 Nature of Earthquakes	2.0
7.3 Measuring and Predicting Earthquakes	1.5
7.4 Staying Safe in Earthquakes	1.5

7.2 Lesson 7.1: Stress in Earth's Crust

Key Concepts

- Causes and types of stress in Earth's crust
- Folds, fractures, joints, and faults
- Stress and mountain building

Lesson Objectives

- List the different types of stresses that change rock.
- Compare the different types of folds and the conditions under which they form.
- Compare fractures and faults, and define how they are related to earthquakes.
- Compare how mountains form and at what types of plate boundaries.

Lesson Vocabulary

- **anticline:** fold in rocks that arches upward so older rocks are at the center
- **basin:** circular syncline that forms a depression in the ground
- **compression:** stress that squeezes rocks together
- **confining stress:** stress from the weight of material above buried rocks that does not allow the rocks to change shape
- **deformation:** change in the shape of rocks due to stress
- **dip-slip fault:** fault in which the dip of the fault plane is inclined relative to the horizontal surface of Earth
- **dome:** circular anticline that forms a mound on the ground
- **fault zone:** fracture along which one side has moved relative to the other
- **fold:** bend in rocks caused by compression
- **footwall:** block of rocks that is beneath a dip-slip fault plane
- **'fracture:** crack in rocks caused by stress
- **hanging wall:** block of rocks that is above a dip-slip fault plane
- **joint:** break in rocks along which there is no movement
- **monocline:** bend in rocks that causes them to be inclined relative to the horizontal
- **normal fault:** dip-slip fault in which the hanging wall drops down relative to the footwall
- **reverse fault:** dip-slip fault in which the hanging wall pushes up relative to the footwall
- **shear:** parallel stresses on rocks that push them past each other in opposite directions
- **slip:** distance rocks move along a fault
- **stress:** force per unit area on rocks
- **strike-slip fault:** fault in which the dip of the fault plane is vertical
- **syncline:** fold in rocks that bends downward so younger rocks are at the center
- **tension:** stress that pulls rocks in opposite directions
- **thrust fault:** reverse fault in which the dip of the fault plane is nearly horizontal

Teaching Strategies

Introducing the Lesson

While students observe, use modeling clay, Silly Putty®, or Play-Doh® to demonstrate the stresses of compression and tension. Ask students what they think might happen to rocks if they were placed under these types of stress. Tell them they will read what happens in this lesson.

Activity

In the activity "You're Stressing Me Out!" at the following URL, students will use clay to simulate rocks and then demonstrate the different types of stresses that act on rocks. Students will also sketch and describe what happens when each type of stress is applied. Conclude the activity by discussing with the class how the simulations relate to actual stresses in Earth's crust.

http://www.nps.gov/cave/forteachers/upload/geology_ms_clams.pdf

Differentiated Instruction

Have students make a compare/contrast table for the different types of folds and how they affect rock layers. Tell students to include a sketch of each type of fold in their table.

Enrichment

Ask one or more students to create a geological travel brochure for the Himalaya Mountains. They should include online photos and descriptions of the mountains and also explain how the mountains formed. Suggest that they add a sidebar of interesting facts and figures about the mountains. Pass the brochures around the class so other students can read them and look at the photos.

Science Inquiry

With the activity "Achy Breaky Earth" at the URL below, students will build physical models of the major types of folds and faults. Be sure to share the excellent background material with your students. It explains which types of stresses produce the different types of faults.

http://www.nps.gov/cave/forteachers/upload/geology_ms_clams.pdf

Common Misconceptions

Many students may have the misconception that when two rocks pull apart, as they do at a divergent plate boundary, there is little stress on the rocks. Instead, students think of stress as being created when objects collide. Use a simple demonstration to show them how tensional force creates stress as two rocks (or other objects) are pulled apart. Use a caramel and chocolate candy bar in the demonstration. Pull on opposite ends of the candy bar as students observe what happens to the caramel and chocolate. They should see some cracks and stretching from the tensional force you are applying. Explain that the same thing happens as rocks undergo tensional stress.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 7.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Think about stresses in the ocean basins. Where in the ocean basins are plates pulling apart? Where do plates come together?

Earthquakes are primarily the result of plate tectonic motions. What type of stress would cause earthquakes at each of the three types of plate boundaries?

Which type of plate boundary do you think has the most dangerous earthquakes? How do earthquakes cause the greatest damage?

7.3 Lesson 7.2: Nature of Earthquakes

Key Concepts

- Causes of earthquakes
- Earthquake focus and epicenter
- Earthquake zones
- Seismic waves
- Tsunamis

Lesson Objectives

- Be able to identify an earthquake's focus and epicenter.
- Identify earthquake zones and what makes some regions prone to earthquakes.
- Compare the characteristics of the different types of seismic waves.
- Describe how tsunamis are caused by earthquakes, using the 2004 Boxing Day Tsunami as an example.

Lesson Vocabulary

- **amplitude:** height of a wave from the center to the top of a crest (or bottom of a trough)
- **body wave:** type of seismic wave that travels through Earth's interior; either a primary wave or a secondary wave
- **crest:** highest point of a wave
- **earthquake:** ground movement caused by the sudden release of energy stored in rocks
- **elastic rebound theory:** theory that earthquakes occur when rocks break and snap back to their original position after being deformed elastically until they cannot deform any more
- **epicenter:** point on the surface directly above the focus of an earthquake
- **focus:** point beneath the surface where rocks break and start an earthquake
- **Love wave:** type of seismic wave that travels over the surface and has a side-to-side motion
- **primary wave (P-wave):** type of seismic wave that travels through Earth and arrives first at a seismometer
- **Rayleigh wave:** type of seismic wave that travels over the surface and has an up-and-down motion
- **secondary wave (S-wave):** type of seismic wave that travels through Earth and arrives second at a seismometer
- **surface wave:** type of seismic wave that travels along the surface of the ground; either a Love wave or a Rayleigh wave
- **trough:** lowest point of a wave
- **tsunami:** large water wave cause by any shock to ocean water, such as an earthquake, meteorite impact, landslide, or nuclear explosion
- **wavelength:** horizontal distance between two corresponding points on adjacent waves, such as the distance between two crests or two troughs

Teaching Strategies

Introducing the Lesson

Introduce earthquakes by telling students that you are 100 percent certain an earthquake will occur today. Explain that earthquakes are so common on Earth that this statement can accurately be made every day. In fact, thousands of earthquakes occur worldwide each day and millions occur each year, although some are so mild that they go unnoticed by people. Tell students they will learn more about earthquakes and where they are most likely to occur when they read this lesson.

Building Science Skills

Have students do the "Seismic Slinky" activity at the following URL to model seismic waves. Alternatively, you can ask a student volunteer to help you demonstrate seismic waves to the class.

http://www.exploratorium.com/faultline/activezone/slinky.html

Demonstration

When you discuss the 2004 Indonesian tsunami, preface your talk with the animated demonstration of the tsunami at the URL below.

http://en.wikipedia.org/wiki/File:2004_Indonesia_Tsunami_Complete.gif

Differentiated Instruction

Kinesthetic learners and students with limited English proficiency can model P-waves and S-waves with the simple activity at the following URL. Relate the waves students are modeling to actual seismic waves. Point out similarities and differences between the two types of waves.

http://earthquake.usgs.gov/learn/teachers/HumanWave.pdf

Enrichment

Suggest to interested students that they read about some of the important seismologists who have contributed to our knowledge of earthquakes. The URL below provides short biographies with photos. Ask the students to choose one of the seismologists and share his or her contribution with the rest of the class.

http://earthquake.usgs.gov/learn/topics/people.php

Science Inquiry

In the following inquiry activity, students will plot the locations of faults and then map recent earthquakes in order to see the relationship between earthquakes and faults.

http://www.teachingboxes.org/earthquakes/lessons/lesson2.jsp

Common Misconceptions

Tsunamis are commonly referred to as tidal waves, which may lead to the misconception that they are caused by tides. Make sure students realize that tsunamis have nothing to do with tides and are unusually high waves caused by a disturbance to ocean water. You might want to demonstrate how tsunamis occur by generating waves in a large, shallow pan of water. Show students how the size of the waves depends on the size of the disturbance that generates the waves.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 7.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

The last time there was a large earthquake on the Hayward fault in the San Francisco Bay area of California was in 1868. Use elastic rebound theory to describe what may be happening along the Hayward fault today and what will likely happen in the future.

Why is California so prone to earthquakes?

How could coastal California be damaged by a tsunami? Where would the earthquake occur? How could such a tsunami be predicted?

7.4 Lesson 7.3: Measuring and Predicting Earthquakes

Key Concepts

- Measuring seismic waves
- Finding the epicenter of an earthquake
- Scales of earthquake intensity
- Earthquake prediction

Lesson Objectives

- Describe how seismologists can use seismic waves to learn about earthquakes and Earth's interior.
- Describe how to find an earthquake's epicenter.
- Describe the different earthquake magnitude scales and what the numbers for moment magnitude mean.
- Describe how earthquakes are predicted and why the field of earthquake prediction has had little success.

Lesson Vocabulary

- **Mercalli intensity scale:** scale of earthquake intensity based on what people feel and the extent of damage caused by the earthquake
- **moment magnitude scale:** scale of earthquake magnitude based on the total amount of energy released by an earthquake
- **Richter magnitude scale:** scale of earthquake magnitude based on the amplitude of the largest seismic wave produced by an earthquake
- **seismogram:** paper record of seismic activity produced by a seismograph
- **seismograph:** older type of device that measures and records seismic waves using a suspended, weighted pen that writes on a drum of paper that moves with the ground
- **seismometer:** modern device that uses electronic motion detectors to measure and record seismic waves and other ground motions

Teaching Strategies

Introducing the Lesson

Show students a seismogram (readily available online) and explain that it shows the amplitude and timing of seismic waves from an earthquake. Tell students they will learn how seismograms are made and used when they read this lesson.

Demonstration

In the lesson at the following URL, students will become familiar with the damage caused by earthquakes. They will view a slide show showing the effects of earthquakes, record information about them, and discuss their observations.

http://www.teachingboxes.org/earthquakes/lessons/lesson1.jsp

Demonstration

Show students some or all of the 1990 NOVA video "Earthquake!" You can download the video at the first URL below. The second URL below provides guidelines for using the video and a worksheet for students to complete after they watch it. The video begins with scenes of ground shaking, damage, and people's reactions to the 1989 Loma Prieta earthquake near San Francisco. It covers the development of our current understanding of the earthquake process, how buildings respond, and how earthquakes are monitored using seismographs. A central theme of the video is the possibility of earthquake prediction in the future.

http://www.sidereel.com/NOVA/season-17/episode-15

http://web.ics.purdue.edu/~braile/edumod/usevideo/usevideo.htm

Building Science Skills

In the problem-solving activity at the URL below, students will evaluate seismic activity along major San Francisco faults. They will assume that their job is to make recommendations to a local land developer about where to build new apartments that are far from active faults. In the activity, students will use Landsat images, a fault map, and other resources to identify active and inactive faults.

http://www.ebsinstitute.com/EBS.EQ2_RS.html

Differentiated Instruction

Arrange a gallery walk for the lesson by posting four large sheets of paper on the walls of the classroom and labeling them as follows: Measuring Seismic Waves; Finding the Epicenter of an Earthquake; Earthquake Intensity; and Earthquake Prediction. Divide the class into groups, including any special needs students in groups with other students. Ask groups to move around the room, from poster to poster, and add to each poster the most important information they know about the topic. They should also add comments about what other groups have written. After the groups have visited all of the posters, discuss the recorded information and comments as a class. Make sure that any errors are corrected and that the most significant information is stressed.

Enrichment

Make a copy of the following figure at the URL below and give it to a small group of students. Have the students discuss the figure and decide which seismic monitoring station is closest to the earthquake (TEIG) and which is farthest from the earthquake (SSPA). Then ask the students to show the figure to the class and explain how they know the relative distances of the monitoring stations from the earthquake (by the timing of the arrival of the first seismic waves and by the difference in arrival times of the P-waves and S-waves).

http://www.geohazards.info/images/Unsorted%20Images/BGS18517.jpg

Science Inquiry

In the activity at the following URL, students will gather data about two major earthquakes, make comparisons between the two, and determine the factors that influence the amount of shaking that occurs in an area due to an earthquake.

http://www.teachingboxes.org/earthquakes/lessons/lesson5.jsp

Real-World Connection

Use the cooperative learning activity at the URL below to demonstrate the real-world effects of earthquakes on people and how earthquake intensity differs from earthquake magnitude.

http://earthquake.usgs.gov/learn/teachers/Mag_vs_Int_Pkg.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 7.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

If you live in an earthquake-prone area, how do you feel about your home now that you've read this section? Since earthquakes are unlikely to be predicted, what can you do to minimize the risk to you and your family? If you do not live in an earthquake-prone area, what would it take to get you to move to one? Also, what risks from natural disasters do you face where you live?

What do you think is the most promising set of clues that scientists might someday be able to use to predict earthquakes?

What good does information about possible earthquake locations do for communities in those earthquake-prone regions?

7.5 Lesson 7.4: Staying Safe in Earthquakes

Key Concepts

- Damage from earthquakes
- Earthquake-safe structures
- Protecting yourself in an earthquake

Lesson Objectives

- Describe different types of earthquake damage.
- Describe the features that make a structure more earthquake safe.
- Describe the ways that a person and a household can protect themselves in earthquake country.

Lesson Vocabulary

- **liquefy:** for soil to become saturated with water and behave like quicksand

Teaching Strategies

Introducing the Lesson

Call on one student after another to answer the question, "What should you do if you are caught in an earthquake?" Accept all reasonable responses at this point, and continue around the room until you have received a range of ideas. Then tell students they will find out in this lesson what they should do to stay safe in an earthquake.

Activity

Use the activity at the URL below to introduce students to earthquake-resistant building construction. In the activity, students will assume they are engineers, and they will try to build structures (using toothpicks and marshmallows) that can withstand a simulated earthquake (a pan of gelatin). In the process, they will learn how engineers construct buildings to resist damage from earthquakes.

http://msms.ehe.osu.edu/2012/03/06/building-quake-resistant-structures-in-the-classroom/

Differentiated Instruction

Have students make a KWL chart for the lesson. Tell them to fill in the first two columns (Know, Want to Know) of the chart before they read the lesson and to fill in the last column (Learned) after they read the lesson. Discuss what they learned from the lesson and anything they still want to know.

Enrichment

Ask a few students to create a public service announcement about how to stay safe in earthquakes. They should make a video of the announcement. If your school is in an earthquake-prone region, arrange to show the video to the class or even to the entire student body.

Science Inquiry

Students can model liquefaction by doing the inquiry activity at the URL below. They will learn why this dangerous condition occurs during certain earthquakes.

http://www.exploratorium.edu/faultline/activezone/liquefaction.html

Common Misconceptions

Students may have heard that the safest place to be in a building during an earthquake is under a doorway. That is true only if you live in an unreinforced adobe home. In most modern buildings, the doorway isn't stronger than the rest of the building. In fact, if you stand in a doorway you might be hurt by the door swinging against you. In a public building, you could be in danger from people trying to hurry outside. Make sure students know that the safest place to be in a building during an earthquake is under a table or desk.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 7.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Many people think that in a large earthquake California will fall into the ocean and that Arizona and Nevada will be beachfront property. Why is this not true?

If you were the mayor of a small city in an earthquake-prone area, what would you like to know before choosing the building site of a new hospital?

How are decisions made for determining how much money to spend preparing people and structures for earthquakes?

CHAPTER 8 MS TE Volcanoes

Chapter Outline

8.1 CHAPTER 8: VOLCANOES
8.2 LESSON 8.1: VOLCANIC ACTIVITY
8.3 LESSON 8.2: VOLCANIC ERUPTIONS
8.4 LESSON 8.3: TYPES OF VOLCANOES
8.5 LESSON 8.4: IGNEOUS LANDFORMS AND GEOTHERMAL ACTIVITY

8.1 Chapter 8: Volcanoes

Chapter Overview

This chapter explain how and where volcanoes form, types of volcanic eruptions, and landforms from lava and magma.

Online Resources

See the following Web sites for appropriate laboratory activities:

In the lab at the following URL, students will experiment with different liquids to simulate different types of lava and how the different types flow. The lab includes pre-lab and post-lab learning experiences.

- http://www.msnucleus.org/membership/html/k-6/pt/volcanoes/1/ptv1.html

The lab at the URL below has students construct models of the three different types of volcanoes described in Lesson 8.3 ("Types of Volcanoes").

- http://mjksciteachingideas.com/pdf/VolConstLab.pdf

These Web sites may also be helpful:

For a diversity of educational resources on volcanoes, see this URL:

- http://vulcan.wr.usgs.gov/Outreach/framework.html

You can link with a variety of volcano videos at the following URL.

- http://dsc.discovery.com/video-topics/other/other-topics-volcano-videos.htm

These URLs have links to volcano Web sites for teachers and students:

- http://voices.yahoo.com/great-volcano-web-sites-teachers-students-3069577.html
- http://exworthy.tripod.com/sciearthvolcanoes.htm
- http://www.lpi.usra.edu/education/step2012/participant/VolcanoResources.pdf

Pacing the Lessons

TABLE 8.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
8.1 Volcanic Activity	1.0
8.2 Volcanic Eruptions	2.5
8.3 Types of Volcanoes	1.5
8.4 Igneous Landforms and Geothermal Activity	1.0

8.2 Lesson 8.1: Volcanic Activity

Key Concepts

- How volcanoes form
- Volcanoes at divergent and convergent plate boundaries
- Volcanic hot spots

Lesson Objectives

- Explain how volcanoes form.
- Describe places where volcanoes occur.
- Describe what volcanic hot spots are and where they occur.

Lesson Vocabulary

- **fissure:** crack in the crust at a divergent plate boundary where magma may erupt
- **hot spot:** place where a plume of hot molten rock rises through the mantle and may cause volcanoes
- **mantle plume:** column of hot molten rock that rises through the mantle

Teaching Strategies

Introducing the Lesson

Have students look at the chapter opener photo of the 2010 volcanic eruption in Iceland, and ask them to read the opening paragraph. Tell the class that the intense volcanic activity resulted in the biggest disruption of air travel since World War II. Ask students why they think air travel was disrupted by the volcanic eruptions. (Airlines feared that the thick clouds of ash would ruin airplane engines.) Tell students they will learn what causes volcanoes such as these when they read this lesson.

Building Science Skills

Use the activity "Gelatin Volcanoes" at the URL below, in which students will model a volcano to understand how and why magma moves inside volcanoes. The activity was inspired by a series of experiments using gelatin models, which were conducted by researchers in the 1970s to explain the growth and orientation of Hawaiian rift zones. In the activity, gelatin molded in bowls or bread pans is used as transparent models of volcanic landforms. Colored water is used as magma.

http://www.spacegrant.hawaii.edu/class_acts/GelVolTe.html

Differentiated Instruction

Make sure students understand how most volcanoes occur. Ask them to create a drawing showing how volcanoes occur in subduction zones around the Pacific Ocean, where the edge of the Pacific plate sinks beneath continental crust. Have them explain their drawing to you, and help them add appropriate labels. Suggest that they save their drawing in their science notebook. This is a good activity for kinesthetic and visual learners as well as English language learners and less proficient readers.

Enrichment

Ask a few students who need extra challenges to look in greater depth at Icelandic volcanoes, which are used as an example in the opening to the chapter. Suggest that students find answers to questions such as those listed below. Then have them report back to the class on what they learn.

1. What tectonic plate activity explains these volcanoes?
2. How many volcanoes are there?
3. How active are the volcanoes?
4. What is it like to live in a land of active volcanoes?

Science Inquiry

In the activity "Surrounded by Volcanoes" at the URL below, students will recognize individual Cascade volcanoes as part of an extensive volcanic mountain range and as part of the Pacific Ring of Fire. They will also draw conclusions about relationships between plate movements and volcanic activity.

http://vulcan.wr.usgs.gov/Outreach/Publications/GIP19/chapter_one_surrounded_by_volcanoes.pdf

Common Misconceptions

Use the following three common student misconceptions about volcanoes as a true-false quiz. Discuss as a class any misconceptions that students think are true. Make sure students understand why volcanoes are found where they are. These and other misconceptions about volcanoes are discussed at this URL: http://beyondpenguins.ehe.osu.edu/issue/earths-changing-surface/common-misconceptions-about-weathering-erosion-volcanoes-and-earthquakes .

1. Volcanoes are randomly located across the earth's surface.
2. Volcanoes are found only on land.
3. Volcanoes are found only in hot climates.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 8.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

When you look at the map of tectonic plates, what areas besides the Pacific Ring of Fire would you expect to have volcanic activity?

Why do you think some volcanoes are no longer active and probably never will be again?

Why do you think it's hard to study hot spots?

8.3 Lesson 8.2: Volcanic Eruptions

Key Concepts

- How volcanoes erupt
- Types of eruptions
- Magma and lava
- Predicting volcanic eruptions

Lesson Objectives

- Explain how volcanoes erupt.
- Describe and compare the types of volcanic eruptions.
- Distinguish between different types of lava and understand the difference between magma and lava.
- Describe a method for predicting volcanic eruptions.

Lesson Vocabulary

- **active volcano:** volcano that is currently erupting of showing signs that it will erupt soon
- **dormant volcano:** volcano that is not currently erupting but has erupted in recorded history and may erupt again
- **eruption:** release of lava, tephra, and gases from a volcano
- **explosive eruption:** violent eruption of rock, lava, ash, and large amounts of gas from a volcano
- **extinct volcano:** volcano that has not erupted in recorded history and is unlikely to erupt again
- **magma chamber:** region in the crust below a volcano where magma and gases collect
- **pyroclast:** hot volcanic rock fragments thrown into the air by an explosive volcanic eruption

Teaching Strategies

Introducing the Lesson

Show students brief video segments of explosive and non-explosive volcanic eruptions (see URLs below). Call on students to describe how the two eruptions differ. Tell them they will learn why volcanic eruptions may differ in these ways when they read this lesson.

- http://www.youtube.com/watch?v=488BkTUsMa4 (non-explosive eruption of Kilauea)
- http://www.youtube.com/watch?v=nXzQT52Sdec (explosive eruption of Krakatoa)

Collaborative Learning

Assign each of several groups of student a different volcano that has erupted in the last 100 years. Students in each group are to research and report on their volcano. Their reports should include the following information:

- type of volcano
- geographic location
- name, distance, and population of nearest major city
- date of most recent eruption and date of most destructive eruption
- other events associated with the last eruption (earthquakes, floods, mudslides, etc.)

To their report, students should attach a one-page description of the major hazards to humans in the vicinity of this volcano. They should also speculate on what they would do if they were in charge of minimizing the risk to the population. Set aside time for students to report to the class on their volcano. Direct students to the URL below to find resources to start their research.

http://www.mcli.dist.maricopa.edu/tut/tut16_ex/proj.html

Activity

Suggest that students explore the interactive volcano animation at the URL below. They will see how a tall volcano has been built up by layers of ash and lava from previous eruptions and how and why it erupts again after a period of dormancy.

http://www.pbs.org/wnet/savageearth/animations/volcanoes/index.html

Differentiated Instruction

Have students make a Venn diagram showing the similarities and differences between explosive and non-explosive volcanic eruptions and the type of magma associated with each type of eruption.

Enrichment

Ask one or more interested students to learn about careers in volcanology and report back to the class. The following URL is a good place for them to start.

http://vulcan.wr.usgs.gov/Outreach/StudyVolcanoes/framework.html

Science Inquiry

Use the inquiry activity at the following URL so students can identify factors that cause explosive eruptions. In the activity, you will use an impressive soda eruption as an analogy to help students understand how and why explosive volcanic eruptions occur.

http://nagt.org/nagt/programs/teachingmaterials/15949.html

Real-World Connection

By doing the group activity "Volcano!" described at the following URL, students will act as teams of volcanologists assigned to advise the president of the United States. Each group is to give the president a report on what can be expected to happen, and what steps can be taken to help people cope with, the eruption of a certain volcano. Objectives of the activity are for students to understand that:

- Volcanic eruptions that take place near populated areas can be disastrous.
- The level of destruction caused by a volcanic eruption depends on several factors, including the type of volcanic eruption and the speed at which the lava or ash flows.
- Volcanic eruptions can often be predicted.
- Measures can be taken to help people cope with the disaster of a volcanic eruption.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 8.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

What types of evidence would scientists use to determine whether an ancient volcanic eruption was explosive or non-explosive?

Are all volcanoes shaped like tall mountains with a crater on the peak?

What language do you think gives us the names a'a and pāhoehoe?

What changes in the pattern of earthquakes might indicate a volcano is about to erupt?

8.4 Lesson 8.3: Types of Volcanoes

Key Concepts

- Composite volcanoes, shield volcanoes, and cinder cones
- Calderas
- Supervolcanoes

Lesson Objectives

- Describe the basic shapes of volcanoes.
- Compare the features of volcanoes.
- Describe the stages in the formation of volcanoes.

Lesson Vocabulary

- **caldera:** large, circular hole formed when the top of a volcano collapses after an eruption empties the magma chamber
- **cinder cone:** small volcano composed of rock fragments piled on top of one another
- **composite volcano:** tall, cone-shaped volcano with steeply sloping sides that is composed of alternating layers of ash and lava
- **shield volcano:** broad-based, shield-shaped volcano with gently sloping sides that is composed almost entirely of lava
- **strata:** layers of sediments or of lava and ash deposited by a volcano
- **supervolcano:** massive volcano that can produce rare but enormous eruptions

Teaching Strategies

Introducing the Lesson

Ask students to recall the two types of volcanic eruptions they read about in the previous lesson, "Volcanic Eruptions." (The two types are explosive and non-explosive eruptions.) Then ask them to predict how volcanoes might differ if they erupt in these two different ways. Accept all reasonable responses at this point, and tell students they will learn in this lesson how the type of eruption affects the type of volcano that forms.

Building Science Skills

Do the activity at the following URL as a group activity. Each group will research a different volcano and present information about it to the class. Then the rest of the students will try to identify the type of volcano based on the information provided.

http://science-edu.larc.nasa.gov/EDDOCS/Aerosols/Volcano_Types_Lesson.html

Differentiated Instruction

Set up a gallery walk for types of volcanoes. Attach four pieces of poster board to different walls of the classroom, and label them "Composite Volcano," "Shield Volcano," "Cinder Cone," and "Supervolcano." Divide the class into groups that incorporate any differential learners with other students. Ask groups to move around the room from poster to poster and list what they know about each type of volcano. Afterward, review the posters with the class and correct any errors.

Enrichment

Tell students that Jupiter's moon Io is the most volcanically active body in the solar system. Have them investigate Io's volcanic activity, starting with the URLs below. The students should find out why Io is so active volcanically and how volcanic activity has affected its surface. Ask students to share what they learn in a brief oral report to the class. Discuss as a class how the cause of Io's volcanic activity differs from that of Earth.

http://www.geology.sdsu.edu/how_volcanoes_work/io.html

http://volcano.oregonstate.edu/oldroot/volcanoes/planet_volcano/Io/Overview.html

Science Inquiry

At the URL below, you can find an activity in which students make a three-dimensional paper model of a volcano. The model will help students visualize a composite volcano (inside and out) and understand how it forms. Students will also gain an understanding of how the volcano's shape is related to its internal structure. Included at the URL are the paper model, instructions for assembly, a teachers' guide, and a simple description of volcanoes.

http://jclahr.com/alaska/aeic/taurho/volcano/volcano.html

Common Misconceptions

Discuss the following common volcano misconceptions with the class. Call on students to explain why each statement is false. Help them find examples of specific volcanoes that show the misconceptions do not apply. You can learn more at the following URL.

http://beyondpenguins.ehe.osu.edu/issue/earths-changing-surface/common-misconceptions-about-weathering-erosion-volcanoes-and-earthquakes

- All volcanoes erupt violently.
- Volcanoes only erupt straight up through the top vent.
- If a volcano doesn't erupt for a hundred years, it must be extinct.
- If a volcano does not produce lava, it is not dangerous.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 8.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Composite volcanoes usually have craters on the top. Why are the craters sometimes U- or horseshoe-shaped?

A shield volcano is relatively flat and a composite volcano is relatively steep because of the type of magma that creates them. What type of lava might create a volcano that is steeper than a shield volcano but not as steep as a composite volcano?

Some people believe there would be a worldwide catastrophe if a huge asteroid hits the Earth. How might an asteroid impact and a supervolcano eruption be similar?

8.5 Lesson 8.4: Igneous Landforms and Geothermal Activity

Key Concepts

- Landforms from lava
- Landforms from magma
- Hot springs and geysers

Lesson Objectives

- List and describe landforms created by lava.
- Explain how magma creates different landforms.
- Describe the processes that create hot springs and geysers.

Lesson Vocabulary

- **geyser:** fountain of hot groundwater and steam that erupts under pressure onto the surface
- **hot spring:** place where hot water bubbles or flows continuously out of the ground
- **intrusion:** igneous rock mass that forms when magma cools under the ground
- **lava dome:** dome-shaped landform of igneous rock that forms when thick lava cools near the vent of a volcano
- **lava plateau:** large, flat landform of igneous rock that forms when large amounts of thin lava flow quickly over the ground

Teaching Strategies

Introducing the Lesson

Show students several photos of lava domes, such as those at the URLs below. Ask students how they think these structures form. Accept all reasonable responses at this point, and then tell students they will learn how lava domes and other volcanic landforms are created when they read this lesson.

- http://vulcan.wr.usgs.gov/Imgs/Jpg/MSH/Images/MSH84_st_helens_crater_dome_from_NNW_09-13-84_med.jpg
- http://www.volcanodiscovery.com/kelud/nov07/lava_dome_2/image4.html
- http://www.summitpost.org/the-extinct-lava-dome-with/146302

Discussion

Discuss the conditions under which lava domes form. Point out that lava domes are formed by viscous (thick) magma that erupts effusively onto the surface and then piles up around the vent. Compare and contrast the lava that forms a dome with the lava flow of a shield volcano. Like a lava flow, the lava that forms a dome generally does not have enough gas or pressure to erupt explosively. Unlike a lava flow, the lava that forms a dome is viscous, so it can't flow very far, explaining why it piles up around the vent and forms a dome shape.

Differentiated Instruction

Help students recognize word parts that can help them figure out the meaning of unfamiliar terms now and in the future. Write the terms intrusive and extrusive on the board. Underline the prefix in- and say that it often means "in," and underline the prefix ex- and say that it means "out." Then define intrusive as "projecting inward" and extrusive as "projecting outward." Explain that intrusive rocks form inside Earth whereas extrusive rocks form outside of Earth, that is, on Earth's surface. Ask students if they can think of other words that contain the prefixes in- and ex- (e.g., interior/exterior, inhale/exhale, and internal/external). Challenge them to define these words.

Enrichment

If students want to learn about other geysers besides Old Faithful, direct them to the excellent article "The World's Ten Most Amazing Geysers" at the URL below. The article contains vivid color images and links to videos about ten geysers that are each exceptional for various reasons.

http://webecoist.momtastic.com/2011/08/16/blowing-off-steam-the-worlds-10-most-amazing-geysers/

Science Inquiry

Have students do the inquiry activity "Cake Batter Lava" at the URL below. By doing the activity, students will understand some of the geological processes that occur and structures that form as lava flows across Earth's surface, using cake batter to simulate lava.

http://www.spacegrant.hawaii.edu/class_acts/CakeLavaTe.html

Common Misconceptions

There are many misconceptions about Old Faithful. One of the commonest is that the geyser erupts every hour. Some people even think that it erupts on the hour, say at precisely 1:00 PM, then at 2:00 PM, and so on. Tell students that Old Faithful actually erupts less regularly than that, with intervals between eruptions ranging from about 35 minutes to 2 hours, with an average interval of about 90 minutes. Students may also think that Old Faithful is the biggest or most regular geyser in Yellowstone Park. Inform them that it isn't the most regular or the biggest, but it is the biggest regular geyser in the park.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 8.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

What might Earth look like if there were no tectonic plates? Can you think of any planets or satellites (moons) that may not have tectonic plates? How is their surface different from that of the Earth?

What kind of land formations have you seen that may have been created by volcanic activity? Did these rocks cool above or below the Earth's surface?

Water is not the only material that can be ejected from geysers and hot springs. What other materials might be ejected from geysers and hot springs?

CHAPTER 9 MS TE Weathering and Formation of Soil

Chapter Outline

9.1 CHAPTER 9, WEATHERING AND SOIL FORMATION

9.2 LESSON 9.1: WEATHERING

9.3 LESSON 9.2: SOILS

9.1 Chapter 9, Weathering and Soil Formation

Chapter Overview

This chapter describes the mechanical and chemical weathering of rock. It also explains how soil forms, identifies soil horizons, and relates soil type to climate.

Online Resources

See the following Web sites for appropriate laboratory activities:

In the lab at the following URL, students will simulate mechanical and chemical weathering. They will perform two lab procedures, collect and analyze data, and apply what they learn from the simulation to identify examples of mechanical and chemical weathering on the school grounds.

- http://pti.lsu.edu/Activities/B03%20Weathering_Experiments.pdf

In the lab at the URL below, students will simulate the effects of weathering by wind. They will develop a hypothesis to answer the question: How does the size of rock carried by the wind affect the weathering of a larger rock? Then students will design and carry out an experiment to test their hypothesis.

- http://www.science-class.net/Lessons/Geology/Weathering_Erosion/weathering_wind.pdf

An important role of soils is to filter and clean water. In the lab activity at the URL below, students will investigate how the size of soil particles influences the ability of the soil to filter water.

- http://www.il.nrcs.usda.gov/news/publications/education/filtrationfs/fs_filtration.html

These Web sites may also be helpful:

The National Geographic article below has excellent images of weathering.

- http://education.nationalgeographic.com/education/encyclopedia/weathering/?ar_a=1

At the following URL, you can find 18 short, narrated video clips on different types of soil organisms.

- http://www.agron.iastate.edu/~loynachan/mov/

The USDA provides many soil resources for teachers and students at this URL: http://soils.usda.gov/education/index.html .

You can find an entire multimedia library devoted to soils at the following URL.

- http://forces.si.edu/soils/04_00_00.html

Pacing the Lessons

TABLE 9.1: **Pacing the Lessons**

Lesson	Class Period(s) (60 min)
9.1 Weathering	1.5
9.2 Soils	2.5

9.2 Lesson 9.1: Weathering

Key Concepts

- Definition of weathering
- Mechanical weathering
- Chemical weathering
- Rates of weathering

Lesson Objectives

- Define mechanical and chemical weathering.
- Discuss agents of weathering.
- Give examples of each type of weathering.

Lesson Vocabulary

- **abrasion:** form of mechanical weathering that occurs when rocks and rock particles scrape against other rocks
- **chemical weathering:** type of weathering that changes the mineral composition of rocks
- **erosion:** transport of weathered material by water, wind, ice, or gravity
- **ice wedging:** form of mechanical weather that occurs when water enters a crack in rock, expands as it freezes, and wedges the rock apart
- **mechanical weathering:** type of weathering that breaks rocks into smaller pieces without changing their mineral composition

Teaching Strategies

Introducing the Lesson

Use the PowerPoint slide presentation at the URL below to introduce students to weathering. The slides alternately present and answer basic questions about the topic. In addition to introducing lesson content, the questions will allow you to assess what students already know before they start studying the chapter. You can revisit the slides at the end of the lesson as a quick review of lesson content.

http://www.science-class.net/Warm_Ups/Warm_up_Erosion.ppt

Activity

Have students play the weathering and erosion game at the following URL. In the game, they will explore how different agents of erosion change the landscape and the time spans they take to bring about observable changes.

http://www.kineticcity.com/mindgames/warper/

Building Science Skills

Set up one or more of the stations described in the PDF documents below. At each station, students will investigate a different aspect of weathering, including weathering by wind (station 1), dissolving rock (station 3), mechanical weathering (station 4), and/or chemical weathering (station 5). The last URL below is a student handout that contains background information and answer sheets for all of the stations.

- http://www.science-class.net/Lessons/Geology/Weathering_Erosion/WandE_1.pdf
- http://www.science-class.net/Lessons/Geology/Weathering_Erosion/WandE_3.pdf
- http://www.science-class.net/Lessons/Geology/Weathering_Erosion/WandE_4.pdf
- http://www.science-class.net/Lessons/Geology/Weathering_Erosion/WandE_5.pdf
- http://www.science-class.net/Lessons/Geology/Weathering_Erosion/WandEBackground%20Information.pdf

Differentiated Instruction

Ask a pair or small group of students to add the word weathering to the word wall. On a large index card, they should write the term and its definition. They should also include separate definitions of mechanical weathering and chemical weathering, with examples of each type.

Enrichment

Ask a small group of students to use the following Web site to organize a class game of weathering-and-erosion jeopardy. One of the students should act as the MC. The Web site includes questions and answers weighted by difficulty with different amounts of money awarded for correct answers. Suggest that the students use play money to reward players who answer questions correctly.

http://www.regentsearthscience.com/jeopardy/erosion/jeopardy.htm

Science Inquiry

In the inquiry activity at the URL below, students hypothesize the effects of water and dilute hydrochloric acid on limestone. Then they devise an experiment to test their hypotheses. Relate the results of their experiments to the acceleration of chemical weathering by acid rain.

http://www.science-class.net/Lessons/Geology/Weathering_Erosion/weathering_lab.pdf

Common Misconceptions

Students often confuse the terms weathering and erosion and may consider them to mean essentially the same thing. As a result, they often use the words interchangeably. Make sure your students know the difference between these two related processes. Stress that weathering breaks down rock but does not involve transport of the sediments. The latter is the work of erosion, which moves but does not break down rock. You can demonstrate the difference between weathering and erosion with the excellent 5-minute activity “Erosion and Weathering in My Mouth” (activity # 20) at the following URL.

http://www.colorado.edu/geolsci/courses/DEMOS/seicontribution/101_lowtech_earth_science%20demos.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Points to Consider

What types of surfaces other than rock are affected by weathering?

What might the surface of Earth look like if weathering did not occur?

Do you think that you would be alive today if water did not dissolve elements?

Would the same composition of rock weather the same way in three very different climates?

9.3 Lesson 9.2: Soils

Key Concepts

- Characteristics and importance of soil
- Soil formation
- Soil texture
- Soil horizons and profile
- Types of soils
- Soil conservation

Lesson Objectives

- Discuss why soil is an important resource.
- Describe how soil forms from existing rocks.
- Describe the different textures and components of soil.
- Draw and describe a soil profile.
- Define the three climate-related soils: pedalfer, pedocal, and laterite soil.

Lesson Vocabulary

- **deciduous forest:** forest that consists mainly of trees that lose their leaves once a year
- **humus:** organic portion of soil that consists of partially decayed remains of plants and animals
- **inorganic:** not related to life or living organisms; not organic
- **laterite:** nutrient-poor, red soil that forms in tropical rainforests
- **loam:** type of soil that contains about equal proportions of sand, silt, and clay
- **organic:** related to life or living organisms
- **pedalfer:** very fertile, dark soil that forms in mid-latitude deciduous forests
- **pedocal:** moderately fertile soil that forms in grasslands
- **residual soil:** soil that forms from the bedrock upon which it is found
- **soil horizon:** individual layer of a soil profile; A, B, or C horizon
- **soil profile:** entire set of soil layers, or horizons, for a particular soil
- **subsoil:** B-horizon of a soil profile, which lies beneath the topsoil
- **topsoil:** A horizon of a soil profile, which is the uppermost and most fertile layer of soil
- **transported soil:** soil that forms from weathered components that have been transported from a different area

Teaching Strategies

Introducing the Lesson

Introduce soil by letting students examine a soil sample. The sample should contain a good mix of sizes of rock particles and plenty of organic matter. Give any students who wish a chance to look at the soil with a hand lens. Ask them to name anything they can identify in the soil. Tell students they will learn what soil is made of and how it forms when they read this lesson.

Activity

Have students do the activity "What's in My Soil?" at the following URL. They will separate, examine, and identify the major components of soil to better understand how these components give soil its unique physical characteristics.

http://education.usgs.gov/lessons/soil.pdf

Demonstration

One of the easiest to overlook, yet one of the most important, components of soil is air. Air in soil is needed by soil organisms and it keeps open soil pores for water to pass through. Do the simple demonstration described at the URL below to show students that soil contains air. By doing the demonstration with different soil samples, you can show the class that soils vary in the amount of air they contain.

http://soils.usda.gov/education/resources/lessons/experiments/soil_air/

Differentiated Instruction

Pair any English language learners or less proficient readers with other students, and ask partners to make a flow chart showing how soil forms (in situ), starting with unweathered bedrock. Suggest that they add the flow chart to their science notebook.

Enrichment

Ask one or more interested students to investigate careers in soil science. The following URL is an excellent place to start their investigation. They should report back to the class on at least one or two of the careers.

http://soils.usda.gov/education/facts/careers.html

Science Inquiry

Have groups of students do the activity "Who Did It?" at the URL below. In this soil forensics activity, students will identify physical characteristics of soil, determine the density of soil samples, and conclude who committed a crime based on the evidence and laboratory investigations. The Web site includes a lesson plan, lecture notes, lab handouts, and homework.

http://www.teachersfirst.com/lessons/forensics/soil-lesn.cfm

Real-World Connection

The acidity, or pH, of soil is an important factor in plant growth. Most plants do best in soil with a small range of pH values. Give students a chance to test the pH of garden soil. Soil testing kits are available at garden centers. After they determine the pH of the soil, have them go online to find garden plants that would do well in soil with that pH. If the pH is very low or very high, then students should investigate how to correct the pH of the soil.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 9.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Why is soil such an important resource?

Do you think a mature soil would form faster from unaltered bedrock or from transported materials?

If soil erosion is happening at a greater rate than new soil can form, what will eventually happen to the soil in that region?

Do you think there are pollutants that could not easily be removed from soil?

CHAPTER 10 MS TE Erosion and Deposition

Chapter Outline

10.1 CHAPTER 10: EROSION AND DEPOSITION

10.2 LESSON 10.1: EROSION AND DEPOSITION BY FLOWING WATER

10.3 LESSON 10.2: EROSION AND DEPOSITION BY WAVES

10.4 LESSON 10.3: EROSION AND DEPOSITION BY WIND

10.5 LESSON 10.4: EROSION AND DEPOSITION BY GLACIERS

10.6 LESSON 10.5: EROSION AND DEPOSITION BY GRAVITY

10.1 Chapter 10: Erosion and Deposition

Chapter Overview

This chapter explains how erosion and deposition shape Earth's surface through the action of streams, groundwater, waves, wind, glaciers, and gravity.

Online Resources

See the following Web sites for appropriate laboratory activities:

In the lab at the following URL, students will investigate how a stream's velocity affects its ability to cause erosion. The lab requires a stream table.

- http://www.science-class.net/Lessons/Geology/Weathering_Erosion/streams.pdf

The lab "Huff 'N Puff" at the URL below allows students to investigate sand dune formation and the effect of obstacles on sand dune migration. Included are background material, materials list, procedure, assessment, and extensions.

- http://www.nps.gov/cave/forteachers/upload/geology_ms_gravel.pdf

With the investigation "Glaciers" described at the following URL, students will investigate factors that affect how fast a glacier melts.

- http://pbskids.org/dragonflytv//web_assets/pdf/dftv_gpsedguide_glaciers.pdf

These Web sites may also be helpful:

Visit the URL below for information on building and using a stream table to simulate erosion and other processes involving sediment transport by water.

- http://www.mostreamteam.org/pdfs/bldusng.pdf

The following URL is a database of incredible photos for many glacier education topics including glacier hazards, how glaciers shape the landscape, and benefits of glaciers.

- http://www.swisseduc.ch/glaciers/earth_icy_planet/glaciers16-en.html

This URL contains common questions and myths about glaciers.

- http://ak.water.usgs.gov/glaciology/FAQ.htm

At the URL below, you can download a free handbook on landslides titled "The Landslide Handbook—A Guide to Understanding Landslides." The handbook answers questions such as: What are landslides? Where do they occur? What causes them? How are they monitored? How can they be prevented? What safety measures can you follow if you live near steep hills? Written for a general audience, it is heavily illustrated with diagrams and photographs taken at locations around the globe.

- http://pubs.usgs.gov/circ/1325/

Pacing the Lessons

TABLE 10.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
10.1 Erosion and Deposition by Flowing Water	2.0
10.2 Erosion and Deposition by Waves	1.5
10.3 Erosion and Deposition by Wind	1.5
10.4 Erosion and Deposition by Glaciers	1.0
10.5 Erosion and Deposition by Gravity	1.0

10.2 Lesson 10.1: Erosion and Deposition by Flowing Water

Key Concepts

- How flowing water causes erosion and deposition
- Erosion and deposition by surface water
- Erosion and deposition by groundwater

Lesson Objectives

- Explain how flowing water causes erosion and deposition.
- Describe how runoff, streams, and rivers change Earth's surface.
- Identify features caused by groundwater erosion and deposition.

Lesson Vocabulary

- **alluvial fan:** landform created where a mountain stream suddenly flows onto flatter land and deposits its sediments
- **cave:** underground hole or cavern eroded by groundwater
- **delta:** triangular landform created where a river empties into a body of still water and deposits its sediments
- **deposition:** process by which eroded sediments are dropped somewhere else by an agent of erosion
- **erosion:** transport of sediments by moving water, wind, glaciers, or gravity
- **floodplain:** broad flat area on both sides of a river where it deposits its sediments when it floods its banks
- **levee:** raised strip of sediments deposited along the bank of a river when it overflows its channel
- **meander:** large curve in a stream caused by erosion of the outside of a curve and deposition on the inside of a curve
- **oxbow lake:** body of water that forms when a meander is cut off from the rest of the river
- **saltation:** transport of small particles such as sand in little jumps along a streambed
- **sinkhole:** circular hole in the surface of the ground that forms when the roof of a cave collapses
- **suspension:** transport of very small particles such as clay that are carried by the main stream flow but are not dissolved by the water
- **traction:** transport of large particles such as gravel and stones by rolling or dragging along the bottom of the water

Teaching Strategies

Introducing the Lesson

Introduce erosion by flowing water with a simple demonstration. Pour a small stream of water from a pitcher on top of a mound of soil containing a mix of particle sizes including small pebbles. Ask students to identify and describe the process they are observing. (erosion by flowing water) Tell students they will learn how flowing water causes erosion in this lesson.

Activity

You may want to use the lesson plan and one or more of the four activities presented at the URL below when you teach erosion and deposition by flowing water. The lesson plan uses as a focus the formation of the Grand Canyon, which also opens this chapter in the FlexBook® resource. In the activities, students can model erosion and deposition by flowing water. They can also investigate how slope and volume of water affect water velocity and erosion. Skills students will practice include making models, making and recording observations, and identifying and controlling variables.

http://www.lesley.edu/WorkArea/DownloadAsset.aspx?id=9174

Differentiated Instruction

Have less proficient readers make a concept map of the important concepts in the lesson. This will help them see how lesson content is organized and how the concepts are related. They should include the following concepts: erosion by streams, types of load (dissolved, suspended, and bed loads), stages of streams, and deposition by streams (natural levees, alluvial fans, and deltas).

Differentiated Instruction

The words erosion and deposition from this lesson's vocabulary list are good words to add to a word wall. Assign each word to a different pair of students. Partners should write the term on a large index card, define the term, and add an example and sketch.

Enrichment

Ask a few students to collaborate on making a diorama to illustrate erosion and deposition by a river. The diorama should represent a three-dimensional landscape with a river running through it. It should show how the river erodes its bed near its headwaters where the slope is steep and how it erodes its banks closer to its base level where its slope is gentle. The diorama should also include features such as an alluvial fan, meanders, a floodplain, and a delta. Each feature should be labeled. Display the completed diorama in a prominent place in the classroom.

Science Inquiry

Have students investigate the effect of slope on erosion by flowing water with an activity like the one at the URL below (Station 12, "Slope and Erosion"). Discuss how the activity relates to erosion by actual streams.

http://www.science-class.net/Lessons/Geology/Weathering_Erosion/WandE_12.pdf

Common Misconceptions

Students often think that erosion is always bad. Stress that erosion also has positive aspects. Floodplains and deltas are covered with sediments deposited by rivers. The soils in these areas are rich and fertile, making them excellent for farmland. These areas would not exist without erosion.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 10.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Ocean waves are another form of moving water. They also cause erosion and deposition. How do waves erode shorelines?

What landforms are deposited by waves?

10.3 Lesson 10.2: Erosion and Deposition by Waves

Key Concepts

- Waves and energy
- Wave erosion
- Wave deposition
- Protecting shorelines

Lesson Objectives

- Explain how waves cause erosion of shorelines.

Describe features formed by wave deposition.

- Identify ways to protect shorelines from wave erosion.

Lesson Vocabulary

- **barrier island:** long, narrow island that forms parallel to shore when a sandbar builds up enough to rise above the water's surface
- **breakwater:** artificial barrier built in the water parallel to shore that reduces beach erosion by incoming waves
- **groin:** artificial barrier built in the water perpendicular to shore to trap sand that is carried along the shore by longshore drift
- **longshore drift:** movement of sediment along a shore by waves that strike the shore at an angle
- **sandbar:** underwater ridge of sand running parallel to shore that is deposited by waves
- **sea arch:** landform that results when waves create a hole in a wave-cut cliff
- **sea stack:** landform that results when waves erode the top of a sea arch
- **spit:** ridge of sand extending out from shore that is deposited by longshore drift

Teaching Strategies

Introducing the Lesson

Show students a short video, such as one of those at the URLs below, of ocean waves crashing on rocks along a shore. Point out the loud sound of the surf and the foam and spray caused by the waves to help students realize how much energy they carry. Explain that waves like these can cause a lot of erosion. They can carve rocks into cliffs, arches, and other interesting shapes. Tell students they will learn about wave erosion and also wave deposition when they read this lesson.

- http://www.youtube.com/watch?v=N2yYnMA-WzM
- http://www.youtube.com/watch?v=9Xi21u0gV4Q
- http://www.youtube.com/watch?v=NxJH-sBf954

Demonstration

Demonstrate features created by wave erosion and wave deposition by projecting dramatic images of sea cliffs, sea arches, sea stacks, barrier islands, and spits (see URLs below). Call on students to describe how each type of feature formed.

- http://www.touropia.com/most-dramatic-sea-cliffs-in-the-world/
- http://www.touropia.com/spectacular-sea-stacks/
- http://www.naturalarches.org/gallery-Greece.htm
- http://en.wikipedia.org/wiki/File:Atlantic_Beach_and_Long_Beach_Aeriel_View.JPG
- http://en.wikipedia.org/wiki/File:Baie_de_Mobile.jpg
- http://commons.wikimedia.org/wiki/File:Provincetown_Spit_Cape_Cod.jpg
- http://pages.uoregon.edu/millerm/spits.html

Differentiated Instruction

Have students do a think-pair-share activity to improve their understanding of basic lesson concepts. Ask students to think about the three questions listed below. Then pair English language learners with native English speakers and less proficient readers with more proficient readers. Ask partners to share and discuss their answers to the questions.

1. How do waves cause erosion of shorelines?
2. How can shorelines be protected from erosion?
3. What features are formed by wave deposition?

Enrichment

Ask a few students to look at a map of the coastline nearest to their community and identify areas of erosion and deposition. Then have students predict how the coastline in these areas may change shape in the future. They should write a paragraph justifying their predictions.

Science Inquiry

Have students do the inquiry activity at the following URL (Station 6, "Wave Action"). In the activity, students will simulate waves and observe their effects on a sand "beach."

http://www.science-class.net/Lessons/Geology/Weathering_Erosion/WandE_6.pdf

Common Misconceptions

A commonly held misconception about ocean waves is that they are generated by the water itself. Explain that most waves are generated by wind. As wind blows over the surface of water, its energy is transferred to the water. Another common misconception is that water moves toward shore with a wave. Explain that only energy moves through the water with a wave. Individual particles of water just move in little circles, and they do not move toward shore in the direction that the wave moves. Giving students experiences that challenge misconceptions is generally the most effective way to overcome the erroneous ideas. In the simple set of activities at the following URL, students can model generating waves with wind and model energy moving through water without the water moving along with the energy. The activities will help to allay the two misconceptions stated above.

http://www.eduplace.com/rdg/gen_act/ocean/wave.html

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 10.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Moving air, like moving water, causes erosion. Moving air is called wind. How does wind cause erosion? Does the wind carry particles in the same ways that moving water does?

What landforms are deposited by wind?

10.4 Lesson 10.3: Erosion and Deposition by Wind

Key Concepts

- Wind erosion
- Wind deposition
- Preventing wind erosion

Lesson Objectives

- Explain how wind causes erosion.
- Describe sediments deposited by wind.
- Identify ways to prevent wind erosion.

Lesson Vocabulary

- **loess:** type of deposit that forms when wind drops layers of silt and clay in nearly vertical cliffs
- **sand dune:** small hill of sand deposited by wind in a region with abundant sand and wind

Teaching Strategies

Introducing the Lesson

Introduce wind erosion with a video of Arches National Park in Utah (see URL below). Challenge students to guess how the beautiful rock sculptures formed. Tell they them will learn how when they read this lesson.

http://www.youtube.com/watch?v=YB_p3jjER6c

Demonstration

Demonstrate how the wind moves particles of different sizes by using a hairdryer (no heat) to simulate the wind and blowing it across a small amounts of clay, sand, and pebbles. Ask students to describe what they observe and relate particle size to the way particles are transported by the "wind."

Differentiated Instruction

Help students relate erosion by wind with deposits formed by wind. Have them make a flowchart to show what happens to fine particles of clay and silt from the time they are first picked up by the wind to the time they are deposited as loess many miles away. They can add the flow chart to their science notebook.

Enrichment

Have one or more students who need extra challenges teach the topic of sand dune formation to the rest of the class. Suggest that they use multimedia in their presentation. For example, they might show video clips of a diversity of sand dunes and use diagrams to show how wind and gravity create the characteristic dune shape.

Science Inquiry

With the activity at the URL below, students can model sand dunes and simulate wind and other factors that affect wind erosion. Extensions to the basic activity allow students to investigate the following questions:

1. How does the shape of the dunes affect their erosion?
2. How does changing wind direction affect dune erosion?
3. How does water influence wind erosion of the dunes?
4. How do plants influence dune erosion?

http://sciencemuse.com/2012/04/02/bring-the-beach-to-the-classroom/

History Connection

Tell students about the Dust Bowl, which occurred during the 1930s following a prolonged drought in Oklahoma and neighboring states. The land had been plowed but without rain to allow crops to grow, the results were dust storms and soil destruction of disastrous proportions. The "black blizzards" of the Dust Bowl caused great hardships for people and lasting devastation of the land. The Dust Bowl has been called our nation's worst ecological disaster. Discuss the factors that led to the tremendous wind erosion of the dust bowl and how it might have been prevented. You (or your students) can learn more at these URLs:

- http://www.ksre.ksu.edu/fieldday/kids/wind/dust_bowl.htm
- http://www.history.com/topics/dust-bowl

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 10.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Abrasion is the main way that wind wears away rock. The next lesson explains how glaciers wear away rock. How do you think it happens?

Do you think glaciers might cause abrasion, like the wind?

10.5 Lesson 10.4: Erosion and Deposition by Glaciers

Key Concepts

- How glaciers form
- Erosion by glaciers
- Deposition by glaciers

Lesson Objectives

- Describe how continental and valley glaciers form.
- Explain how glaciers cause erosion.
- Identify landforms deposited by glaciers.

Lesson Vocabulary

- **continental glacier:** mass of flowing ice that covers a large area and is not confined to a valley
- **glacial till:** mixture of particles and rocks of different sizes deposited by a glacier
- **glacier:** large mass of flowing ice
- **moraine:** any linear deposit of unsorted sediments that have been dropped by a glacier
- **plucking:** process in which a glacier picks up sediments as it flows over the ground and the sediments freeze to the bottom of the glacier
- **valley glacier:** mass of ice that flows downhill through a mountain valley

Teaching Strategies

Introducing the Lesson

Introduce glaciers by showing students impressive images of glaciers (see URL below). Ask students to describe what they are observing, and challenge them to explain how glaciers form. Accept all reasonable responses. Then tell students they will learn how glaciers form when they read this lesson.

http://www.vivapatagonia.com/en/33/actividades-patagonia/4x4/Three-glaciers-Moreno–-Upsala-–Viedma

Demonstration

Use the demonstration "Glacier in a Milk Jug" (no. 58 in the document below) to show your class how a glacier deposits landforms as it recedes. Students will observe how the surface may be altered by a glacier as it melts. Students can also predict how deposition and runoff might affect vegetation and the numbers of species in an area.

http://www.colorado.edu/geolsci/courses/DEMOS/seicontribution/101_lowtech_earth_science%20demos.pdf

Building Science Skills

Students can model a glacier and observe how it moves and interacts with objects with the simple activity "Watch a Glacier Model on the Move," which is described at the following URL.

http://pbskids.org/dragonflytv//web_assets/pdf/dftv_gpsedguide_glaciers.pdf

Differentiated Instruction

Pair any struggling students with students who are doing well in the class. Then ask partners to create a Venn diagram showing similarities and differences between continental and valley glaciers.

Enrichment

If students want to learn more about glaciers, direct them to the National Snow and Ice Data Center's Web site (see below). The site includes publications, data, images, quick facts, and much more.

http://nsidc.org/cryosphere/glaciers/

Science Inquiry

In the inquiry activity at the URL below, students can simulate ways that landforms are affected by glaciation. In addition to the activity materials and procedure, the URL provides discussion questions, evaluation, extensions, and vocabulary.

http://school.discoveryeducation.com/lessonplans/programs/iceberg/index.html

Common Misconceptions

Students commonly think that glaciers erode by pushing rocks like a bulldozer. Explain how pressure, melting, and freezing cause glaciers to erode. For example, when a glacier encounters a boulder, the boulder presses against the ice. The increase in pressure causes the ice to melt around the boulder. When the water refreezes, it encases the boulder in ice. This allows the glacier to pick up the boulder and carry it off.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 10.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

So far in this chapter, you've read how moving water, air, and ice shape Earth's surface. Water and ice move because of gravity. Do you think gravity can erode and deposit sediment without the help of water or ice?

How might gravity alone shape Earth's surface?

10.6 Lesson 10.5: Erosion and Deposition by Gravity

Key Concepts

- Landslides and mudslides
- Slump and creep

Standards

Lesson Objectives

- Identify causes and effects of landslides and mudslides.
- Explain how slump and creep occur.

Lesson Vocabulary

- **creep:** extremely slow movement of rock and soil downhill because of gravity
- **landslide:** rapid movement of soil, loose rock, and debris downhill under the influence of gravity
- **mass movement:** any erosion in which soil, rock, debris, and/or mud move down a slope due to gravity
- **mudslide:** movement of saturated, slippery soil downhill under the influence of gravity
- **slump:** movement of a large block of rock and soil as a single unit down a slope due to gravity

Teaching Strategies

Introducing the Lesson

Ask students to recall the agents of erosion and deposition they read about in previous lessons (running water, waves, wind, and glaciers). Tell them that gravity is another agent of erosion and deposition and they will read about it in this lesson.

Question: How do you think gravity causes erosion and deposition? How can gravity transport Earth materials and drop them somewhere else?

Answer: Gravity can move Earth materials by pulling them downhill.

Question: Where do you think erosion and deposition by gravity is most likely to occur?

Answer: Gravity is most likely to move materials on hills and mountains.

Activity

You may want to use the lesson plan at the following URL when you teach this lesson. If you use the lesson plan, students will learn about earthquake-induced landslides and the associated hazards, and how and why landslides occur. Students will also discuss steps they can take to reduce landslide hazards. The lesson plan includes a hands-on landslide activity in which students will observe the three phases of landslide development (slope failure, transport of materials, and final deposition of slide materials).

http://www.nature.com/scitable/topicpage/lesson-8-landslides-hazards-8704578

Differentiated Instruction

Have students makes a compare/contrast table for types of mass movement (landslides, mudslides, slump, and creep). They should compare the types in terms of how quickly they occur and how much destruction they cause.

Enrichment

Ask a small group of creative students to write a rap about mass movement. The rap should explain what causes mass movement and describe several different types of mass movement. Have the students teach their rap to the class.

Science Inquiry

Use the inquiry activity at the following URL when you teach students about landslides. In the activity, students will design a controlled experiment to test how different soil materials can produce different types of landslides. They will also explore how scientists predict where landslides may occur.

http://www.discoveryeducation.com/teachers/free-lesson-plans/landslides.cfm

Real-World Connection

Share with students the following real-world impacts of landslides:

- Loss of human lives and damage to property
- Loss of tourist revenues and loss of industrial, agricultural, and forest productivity as a result of damage to land or facilities or interruption of transportation systems
- Reduced real estate values in areas threatened by landslides
- Loss of tax revenues from properties that are devalued because of landslides
- Cost of measures to prevent or lessen landslide damage
- Adverse effects on water quality in streams and irrigation facilities outside the landslide area
- Loss of human or animal productivity because of injury, death, or psychological trauma
- Secondary physical effects such as landslide-caused flooding
- Reduction in amount of stable land suitable for agriculture, homes, and businesses

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 10.5 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Erosion and deposition are always changing Earth's surface. Do you think that the same forces that cause erosion today—moving water, wind, ice, and gravity—were also at work in the past?

How might observations of erosion and deposition today help us understand Earth's history?

CHAPTER 11 MS TE Evidence About Earth's Past

Chapter Outline

11.1 CHAPTER 11: EVIDENCE ABOUT EARTH'S PAST

11.2 LESSON 11.1: FOSSILS

11.3 LESSON 11.2: RELATIVE AGES OF ROCKS

11.4 LESSON 11.3: ABSOLUTE AGES OF ROCKS

11.1 Chapter 11: Evidence about Earth's Past

Chapter Overview

This chapter explains ways that fossils form and the methods of relative and absolute dating of rocks.

Online Resources

See the following Web sites for appropriate laboratory activities:

With the lab at the following URL, students will develop a better understanding of the basic principles used to determine the ages of rocks and fossils. The lab consists of several parts in which students demonstrate relative and radiometric dating and how ages of rocks and fossils can be narrowed even if they cannot be dated absolutely.

- http://www.ucmp.berkeley.edu/fosrec/McKinney.html

After completing the lab exercises at the URL below, students will understand how fossils help us understand past life; the conditions needed for fossilization to occur; how organisms are adapted to their environments; and the relationships of communities to their environments.

- http://www.ucmp.berkeley.edu/fosrec/Breithaupt2.html

In the lab described at the following URL, students will use simple materials to simulate radiometric dating and determine the absolute age of a "fossil."

- http://evolution.about.com/od/teaching/a/Radiometric-Dating-Modeling-Lab.htm

These Web sites may also be helpful:

This highly recommended Web site has detailed descriptions of different types of fossils and how they form.

- http://www.ucmp.berkeley.edu/paleo/fossils/

At the URL below, you can find detailed information about fossilization that goes beyond lesson content.

- http://www.fossilmuseum.net/fossilrecord/fossilization/fossilization.htm

This Web site is all about fossils. It includes fossil lesson plans, activities, articles, and extreme fossil facts.

- http://www.fossils-facts-and-finds.com/

You can find a fossil image gallery at this URL: http://www.fossilmuseum.net/FossilGalleries.htm .

For more in-depth coverage of methods of dating fossils and rocks, go to this URL: http://paleobiology.si.edu/geotime/main/foundation_dating1.html .

At the following URL, you can find a much more detailed geologic time scale.

- http://paleobiology.si.edu/geotime/main/pdf/timescale_isc_american.pdf

Pacing the Lessons

TABLE 11.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
11.1 Fossils	1.5
11.2 Relative Ages of Rocks	2.5
11.3 Absolute Ages of Rocks	1.0

11.2 Lesson 11.1: Fossils

Key Concepts

- Definition and types of fossils
- How fossils form
- What can be learned from fossils

Lesson Objectives

- Explain what fossils are.
- Describe how fossils form.
- State what scientists can learn from fossils.

Lesson Vocabulary

- **fossilization:** any process by which remains or traces of once-living organisms become fossils
- **index fossil:** fossil of a species that was widespread but short-lived and can be used to determine the age of rock layers in different areas

Teaching Strategies

Introducing the Lesson

Pass around some actual fossils or replicas of fossils. Lead the class in brainstorming what they can infer about the organisms from the fossils. Tell students they will learn about fossils and how they form in this lesson.

Activity

With level 1 of the interactive activity at the URL below, students will gain a basic understanding of what a fossil is and how fossilization occurs. The URL includes a suggested lesson plan, classroom handouts, and assessments.

http://www.ucmp.berkeley.edu/education/explorations/tours/fossil/index.html

Building Science Skills

Have students use plaster of Paris to make a mold of a shell. After the plaster dries, have them use the mold to make a clay cast. Tell students to compare the cast with the original shell and discuss how it is similar and how it is different. Relate the activity to the actual formation of mold and cast fossils.

Discussion

Discuss why most fossils are preserved in sediments that are deposited beneath water. First, review conditions needed for fossilization to occur: rapid burial of remains, oxygen deprivation, limited decay, lack of disturbance of remains, and continued sediment accumulation. Explain why these conditions occur more commonly under water than on land.

Question: What is another reason so many fossils are deposited beneath water?
Answer: Water covers the majority (about 70 percent) of Earth's surface.

Differentiated Instruction

Have students make a flowchart outlining the steps that typically must occur for a fossil to form (death, burial by sediments, buildup of more sediment layers, permineralization). Suggest that they include sketches in their flowchart to illustrate the steps. Tell students to add their flowchart to their science notebook.

Enrichment

Middle school students may be fascinated by fossilized feces, called coprolites. They can learn more about them, including what they look like and what can be learned from them, at these URLs:

- http://www.enchantedlearning.com/subjects/dinosaur/glossary/Coprolite.shtml
- http://webecoist.momtastic.com/2010/08/10/coprolites-a-few-words-on-prehistoric-turds/
- http://www.oceansofkansas.com/coprolite.html

Science Inquiry

Use the activity at the following URL to help students relate fossils to environments. Student will be given sets of at least two fossil animals or plants that are from the same environment. Then they will hypothesize about the environment of the fossils. They will also look for evidence to support or refute their hypothesis.

http://www.agiweb.org/education/aapg/invest/invest3.html

Common Misconceptions

Students commonly believe that fossils are actual pieces of dead animals and plants. Make sure they understand that most fossils are only impressions or casts of the original living things. The actual living parts decay away but their shape is permanently recorded in the rock as it hardens.

Language Arts Connection

Have students write a short story about fossilization from the point of view of the organism that was fossilized. Suggest that they include points such as the following:

- type of organism that became a fossil
- time period when the organism lived
- manner in which the organism died

- type of environment where the organism died
- specific conditions that led to fossilization
- how the fossil was found and interpreted

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 11.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Fossils can help scientists estimate the ages of rocks. Some types of evidence show only that one rock is older or younger than another. Other types of evidence reveal a rock's actual age in years. What evidence might show that one rock is older or younger than another?

What evidence might reveal how long ago rocks formed?

11.3 Lesson 11.2: Relative Ages of Rocks

Key Concepts

- Laws of stratigraphy
- Unconformities
- Key beds and index fossils
- The geologic time scale

Lesson Objectives

- Explain how stratigraphy can be used to determine the relative ages of rocks.
- State how unconformities occur.
- Identify ways to match rock layers in different areas.
- Describe how Earth's history can be represented by the geologic time scale.

Lesson Vocabulary

- **geologic time scale:** division of Earth's history into blocks of time distinguished by major geologic and evolutionary events
- **key bed:** thin rock layer that is unique and widespread so it can be used to match rock layers by age in different areas
- **law of superposition:** law stating that younger layers of sedimentary rock are deposited on top of older layers of sedimentary rock
- **relative age:** the age of an object (younger or older) in comparison with the ages of other objects
- **stratigraphy:** study of rock layers
- **unconformity:** gap in a sequence of rock layers

Teaching Strategies

Introducing the Lesson

Introduce the idea of relative age by asking students to describe the relative ages of their friends and relatives. For example, ask students to name a friend or sibling and then ask who is older and who is younger. Then ask the class what, if anything, relative age alone reveals about age in years. Tell students they will learn how to determine the relative ages of rocks and fossils when they read this lesson.

Building Science Skills

Have pairs of students complete Skill Sheet 28-A, "Relative Dating," at the following URL. First they will examine several situations (such as making brownies) that illustrate relative dating concepts, and they will match each situation to a law of stratigraphy. Then they will apply the laws of stratigraphy to illustrations of rock layers.

http://www.cposcience.com/home/Portals/2/Media/post_sale_content/FPS-ESS%202nd/Ancillaries/U10/U10_Skill_-and_Practice_Sheets/FPSESS_U10_SS.pdf

Activity

With the simple activity at the URL below, students can dig for "fossils" and find the relative age of the fossils with the help of an index fossil.

http://evolution.about.com/od/teaching/a/Fossil-Relative-Dating-Lab.htm

Differentiated Instruction

Work with students to make a simplified geologic time scale to keep in their science notebook for reference while reading this and subsequent chapters.

Enrichment

Urge interested students to learn more about the history of the geologic time scale and then to share what they learn with the rest of the class. Suggest that they start with the URL below.

http://www.ucmp.berkeley.edu/exhibit/histgeoscale.html

Science Inquiry

In the activity at the following URL, students will use fossil sequences to determine the relative ages of rock layers.

https://docs.google.com/document/d/1Sq-r86lkJkj-dQC60hYLejwasFdYU28QS8neqPhuPMI/edit

Common Misconceptions

Students often grossly underestimate the time it takes for sedimentary rock layers (and any organic remains they contain) to be laid down and turned to rock. Make sure they realize that these processes take hundreds of thousands to millions of years.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 11.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In this lesson, you read how scientists determine the relative ages of sedimentary rock layers. The law of superposition determines which rock layers are younger or older than others. What about the actual ages of rocks? Is there a way to estimate their ages in years?

And what about other kinds of rocks? For example, is there a way to estimate the ages of igneous rocks?

11.4 Lesson 11.3: Absolute Ages of Rocks

Key Concepts

- Radioactive decay
- Radiometric dating

Lesson Objectives

- Describe radioactive decay.
- Explain radiometric dating.

Lesson Vocabulary

- **absolute age:** actual age of a rock or fossil in years
- **carbon-14 dating:** method of radiometric dating based on the decay of the radioactive isotope of carbon known as carbon-14
- **half-life:** rate of decay of a radioactive isotope, equal to the time it takes for one-half of an original amount of the isotope to decay
- **isotope:** atom of an element with a different number of neutrons than other atoms of the same element
- **radioactive decay:** breakdown of unstable elements into stable elements
- **radiometric dating:** use of radioactive decay to estimate the absolute age of a fossil or rock

Teaching Strategies

Introducing the Lesson

Help students recall what they already know about atoms and subatomic particles before they start reading about isotopes and radioactive decay in this lesson.

Question: What is an atom?
Answer: An atom is the smallest particle of an element that has the element's properties
Question: What is the nucleus of an atom?
Answer: The nucleus is a mass in the center of an atom.
Question: What particles are found inside the nucleus?
Answer: The nucleus contains positive protons and neutral neutrons.

Remind students that all the atoms of a given element have the same number of protons. However, atoms of the same element may differ in their number of neutrons. Tell students they will learn why this is important for determining the ages of fossils and rocks when they read this lesson.

Activity

Have teams of students do the interactive simulation game activity "Radioactive Speed Dating" at the URL below. The object of the game is to correctly estimate the age of various virtual fossils and rocks using the principles of radiometric dating. The activity is designed as an in-class competition between teams of students. An answer key is available by e-mail.

http://phet.colorado.edu/en/contributions/view/3416

Differentiated Instruction

Assign the questions below for students to think about. Then pair English language learners with other students and ask them to share and discuss their answers to the questions.

1. How do the absolute ages of rocks differ from their relative ages?
2. What are isotopes?
3. What is radioactive decay, and why does it happen?
4. What is the half-life of a radioactive isotope?
5. How is radioactive decay used to estimate absolute ages of rocks?

Enrichment

Challenge students to think of a way to model the concept of half- life. Tell them that the model may be a physical, conceptual, or a mathematical model. Invite the students to explain their model to the rest of the class.

Science Inquiry

Have students estimate the age of a tree by counting tree rings in a cross-section of a tree trunk (either an actual cross-section or a clear image of one). Explain how the darker, narrower rings represent times of slower growth (winters) and the lighter, wider rings represent times of faster growth (summers), so each light/dark pair represents one year of growth. Ask students whether the annual light/dark pairs are all the same width or if some are narrower than others. Have them explain what might cause variations in width from year to year and what they could learn about past environments from these observations.

Common Misconceptions

Students may think that carbon-14 dating can be applied to rocks or to materials of any age. Explain that carbon-14 dating can be used only to date organic remains, so it cannot be used to date rocks. While this makes carbon-14 dating ideal for dating fossils, it can be used only for very recent fossils. In fact it is limited to a maximum age of about 50,000 years, which covers just a tiny fraction of geologic time.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 11.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Scientists estimate the ages of rock layers in order to better understand Earth's history and the history of life. What do you already know about Earth's history? For example, do you know how Earth formed?

How old is Earth? When did the planet first form? And when did life first appear?

Chapter 12 MS TE Earth's History

Chapter Outline

12.1 Chapter 12: Earth's History
12.2 Lesson 12.1: The Origin of Earth
12.3 Lesson 12.2: Early Earth
12.4 Lesson 12.3: History of Earth's Life Forms

12.1 Chapter 12: Earth's History

Chapter Overview

This chapter explains how Earth formed, how its atmosphere and oceans developed, and how its continents changed. It also traces the evolution of life on Earth, from its earliest beginnings to the present.

Online Resources

See the following Web sites for appropriate laboratory activities:

In this lab, students will gain an understanding of deep time—the 4.6 billion years of Earth's history. They will become familiar with events in Earth's history and how they relate to one another by sequencing the events.

- http://www.ucmp.berkeley.edu/fosrec/ScotchmoorFirst.html

Use the evolution lab at the first URL below when you teach Lesson 12.3 ("History of Earth's Life Forms"). The activity examines how natural selection works to bring about the evolution of adaptations. Using an online simulation tool, students can slow down the process to watch all the steps involved or speed it up to see how the population evolves over time. You can find a worksheet to guide students through the lab at the second URL.

- http://biologyinmotion.com/evol/index.html
- http://www.biologycorner.com/worksheets/evolutionlab.html

These Web sites may also be helpful:

You (or your students) can review more detailed information on the origin of Earth and the moon, including some earlier theories, at these URLs:

- http://solarsystem.nasa.gov/scitech/display.cfm?ST_ID=446
- http://www.onlineuniversity.net/earth-science/origin-of-the-moon/

This website offers a growing collection of teaching materials and research results that will aid in the understanding of and teaching about early Earth.

- http://serc.carleton.edu/NAGTWorkshops/earlyearth/index.html

You can find free online access to the National Academy of Sciences book "Teaching Evolution and the Nature of Science" at the following URL. It provides great perspective on a topic that is still controversial in some school districts. The book includes a discussion of the importance of teaching evolution and describes several classroom activities on the subject.

- http://www.nap.edu/openbook.php?record_id=5787&page=R1

Pacing the Lessons

TABLE 12.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
12.1 The Origin of Earth	1.5
12.2 Early Earth	1.0
12.3 History of Earth's Life Forms	2.5

12.2 Lesson 12.1: The Origin of Earth

Key Concepts

- Formation of the solar system
- Formation of Earth and the moon
- Formation of the atmosphere and oceans

Lesson Objectives

- Describe how the solar system formed more than 4 billion years ago.
- Explain how Earth's atmosphere has changed over time.
- Explain how Earth's oceans formed.

Lesson Vocabulary

- **atmosphere:** sphere of gases that surround a planet such as Earth
- **nuclear fusion:** nuclear reaction in which two atomic nuclei fuse, or join together, to create a larger nucleus and release a huge amount of energy
- **water vapor:** water in the gaseous state

Teaching Strategies

Introducing the Lesson

Introduce the formation of the solar system with the Orion Nebula, which is forming new stars and solar systems today. You can project the NASA image of the Orion Nebula at the following URL. Ask students if they know what the image represents. Tell them it shows a great swirling cloud of gas and dust out of which stars and solar systems are forming. Explain that if they could travel back in time about 5 billion years, this is how our own solar system might look, as they will learn in this lesson.

http://www.nasa.gov/multimedia/imagegallery/image_feature_693.html

Demonstration

Students can see how the solar system formed by watching the short National Geographic video clip at this URL: http://video.nationalgeographic.com/video/kids/science-space-kids/solar-system-101-kids/ .

Activity

With the activity "Birth of the Earth" at the following URL, students can make a timeline of Earth history. From the project, students will learn Earth's age, milestones in Earth's development, and how early Earth differed from the planet we know today.

http://www.discoveryeducation.com/teachers/free-lesson-plans/birth-of-the-earth.cfm

Differentiated Instruction

Work with students to make a flow chart that represents the sequence in which the following formed: the sun, Earth, the moon, Earth's atmosphere, and Earth's oceans.

Enrichment

Have one or more creative students write a short story about the "birth" of the moon. The story should be told from the point of view of someone who lived on Earth at the time the moon formed. Ask the students to read their story to the class.

Science Inquiry

In this FlexBook® lesson, students learn that Earth's initial atmosphere lacked oxygen. Point out that Earth's present atmosphere is about 20 percent oxygen. Challenge students to predict how oxygen was added to Earth's atmosphere. (It was added by the process of photosynthesis after the first photosynthetic organisms evolved.) Accept all reasonable responses at this point, and then tell students they will learn where the oxygen came from when they read the next lesson.

Common Misconceptions

Misconceptions about Earth's age are common. Students may think that scientists disagree about the age of Earth or that Earth is only thousands, not billions, of years old. Made sure students are aware that scientists agree Earth is nearly 4.6 billion years old and that this estimate of Earth's age is based on multiple sources of data.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 12.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

How did life on Earth originate?

- [Life began in the oceans, perhaps more than once. It probably began with the formation of the first biological molecule, perhaps RNA. Eventually, the earliest cells evolved.]

What were early landmasses like?

- [Billions of years ago, landmasses came together to form a single supercontinent, and then they broke apart again. This happened five times in Earth's history. Because early Earth was very hot, there was a lot of plate tectonic activity, including volcanoes and earthquakes.]

What happened when large amounts of oxygen entered the atmosphere?

- [When large amounts of oxygen entered the atmosphere after photosynthesis evolved, some of the oxygen became ozone. The ozone protected Earth from harmful radiation, which allowed complex life forms to evolve. However, the oxygen was toxic to many existing organisms, which went extinct as a result.]

12.3 Lesson 12.2: Early Earth

Key Concepts

- Earth's continents and supercontinents
- Ancient life
- Addition of oxygen to the atmosphere
- Evolution of multicellular organisms

Lesson Objectives

- Describe the supercontinents that have existed in Earth history.
- Discuss how life began and what early life was like.
- Trace the evolution of life from the first cells to multicellular organisms.

Lesson Vocabulary

- **DNA (deoxyribonucleic acid):** type of nucleic acid, an organic compound that stores genetic information and passes it to the next generation
- **eukaryote:** type of organism whose cells contain a nucleus
- **nucleic acid:** organic compound that stores genetic information and passes it to the next generation; either DNA or RNA
- **prokaryote:** type of organism whose cells lack a nucleus
- **RNA (ribonucleic acid):** type of nucleic acid, an organic compound that stores genetic information and passes it to the next generation

supercontinent singe, massive continent that formed when all of Earth's landmasses came together

Teaching Strategies

Introducing the Lesson

Introduce the origin of life by asking students to brainstorm ways that living things differ from non-living things. (Some ways include the ability to use energy, respond to the environment, grow, and reproduce.) Tell students they will learn in this lesson when living things first appeared on Earth and what the earliest living things were like.

Activity

In the activity at the URL below, students take a simulated "voyage" back in time to the beginning of our planet. They will "witness" that beginning, the origin of life, and a number of key events from then to the present. This will help students relate physically to the relative timing of events in geological and biological history and to the vastness of that history.

http://www.indiana.edu/~ensiweb/lessons/time.mac.html

Discussion

Discuss why life may have existed on Earth for hundreds of millions of years without leaving a trace. Point out that the earliest life forms consisted of single cells, like modern bacteria, which can be seen only with a microscope. In fact, bacteria are so small that there are 10 times more bacteria in and on the human body than there are body cells.

Differentiated Instruction

Outlining a reading passage can help students see the organization of the material, making it easier to master. Have students make an outline of this lesson in the FlexBook® lesson. Suggest that they use the headings and subheadings of the lesson as the framework for their outline and then add important details to the outline as they read the lesson.

Enrichment

The famous 1952 experiment by Miller and Urey showed that organic molecules (amino acids) could form spontaneously under simulated conditions believed to be similar to those on early Earth. Have a few students learn about this famous experiment and then report back to the class. The URLs below are a good place for them to start.

http://www.chem.duke.edu/~jds/cruise_chem/Exobiology/miller.html

http://chemistry.beloit.edu/Origins/pages/spark.html

Science Inquiry

Point out how the evolution of photosynthesis added oxygen to Earth's atmosphere, which had lacked oxygen prior to that time. The FlexBook® lesson stresses how oxygen benefited organisms by forming ozone, which protects living things from harmful solar radiation. Tell the class that the introduction of oxygen to Earth's atmosphere also harmed many organisms. Challenge students to infer why. (Oxygen was toxic to many organisms because they had evolved in, and adapted to, an oxygen-free atmosphere.)

Real-World Connection

The career of paleontologist may sound exciting to many students. They can learn firsthand what it's like to be a paleontologist with the interactive "Digging in the Dirt; a Paleontologist's Field Journal" at the first URL below. The second URL provides links to several other sites that offer more information about the paleontologist career.

http://nature.ca/discover/exf/dggngnthdrt/index_e.cfm

http://www.paleoportal.org/index.php?globalnav=doing_paleo&sectionnav=careers&type_id=6

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 12.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Early life was very simple by comparison with the biodiversity we see today. How did so much diversity come to be?

How do organisms change through time (how do they evolve)?

Are humans the pinnacle of evolution?

12.4 Lesson 12.3: History of Earth's Life Forms

Key Concepts

- Biological diversity
- Variation and adaptation in living things
- Biological evolution
- Studying the fossil record
- Eras of the Phanerozoic Eon
- Mass extinctions

Lesson Objectives

- Describe how adaptations develop.
- Explain how the fossil record shows us that species evolve over time.
- Describe the general development of Earth's life forms over the last 540 million years.

Lesson Vocabulary

- **adaptation:** inherited trait that helps an organism survive or reproduce in a given environment
- **evolution:** change in the genetic makeup of a population or species over time
- **paleontologist:** scientist who finds and studies fossils to learn about the history of life
- **tropical:** type of climate that is warm year-round and may be wet
- **variation:** difference in an inherited trait in a population

Teaching Strategies

Introducing the Lesson

Introduce evolution by giving students examples of common uses of the term evolve. For example, say: "My ideas on this subject have evolved." "Our plan of action is still evolving."

Question: Based on these examples, how would you define evolution?
Answer: Evolution means "change."
Question: What does evolution mean in biology?
Answer: Evolution means a change in traits (or genes) over time.

Tell students they will learn in this lesson how life on Earth evolved since it first began.

Demonstration

Demonstrate how continents moved throughout the Phanerozoic with the interactive timeline below. You can relate the positions of the continents to changing climates during the eon.

http://nature.ca/discover/exf/clmtpst/index_e.cfm

Activity

Point out that the Mesozoic was the age of reptiles. Giant marine reptiles were the top predators in Mesozoic marine food chains. They ruled the sea just as dinosaurs ruled the land. Students are likely to be familiar with dinosaurs already. They can explore some of the marine reptiles from the Mesozoic with the interactive activity "Marine Reptiles" at this URL: http://nature.ca/discover/exf/mrnrptls/index_e.cfm .

Discussion

Students are sometimes confused about how mutations, which occur randomly, can lead to the evolution of adaptive traits. Explain that the appearance of new genes through mutation is random but that the increase (or decrease) in the frequency of a mutation is not. A mutation will increase in frequency when it makes individuals who have the mutation more likely to survive and reproduce. This is natural selection, and what nature selects depends on the environment.

Differentiated Instruction

Kinesthetic learners and students with less proficient language or reading skills may have a better understanding of natural selection if they do a hands-on simulation of natural selection, such as the one at this URL: http://www.indiana.edu/~ensiweb/lessons/ns.chips.html .

Enrichment

Refer interested students to the amazing evolution animation at the following URL. It shows how human hands, bat wings and whale flippers all evolved from the generalized forelimb of an early mammalian common ancestor. The demonstration may give the students a more sophisticated insight into evolution and adaptation.

http://nature.ca/discover/exm/evltnfppndgs/index_e.cfm

Science Inquiry

Have students do one or more of the inquiry activities described in the article at the URL below. All of the activities allow students to practice science process skills, collaborate with others, and model how scientists work while solving problems relating to evolution and the fossil record.

http://www.nabt.org/websites/institution/File/pdfs/american_biology_teacher/2009/Feb%20online/071-02-0106.pdf

Common Misconceptions

Many people believe that evolution is a theory about the origin of life rather than a theory about how living things change through time by natural selection. Explain that while scientists may still disagree about how life began, there is virtually no disagreement about how evolution changes species through time.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 12.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

The processes of evolution are fundamental to much of biology. Why do people have such a hard time understanding them?

A lot of organisms are dying out now due to changes in climate and effects of human activities. How does what's happening now resemble a mass extinction?

The amount of biodiversity on Earth is staggering. Why are there so many different types of organisms?

CHAPTER 13 MS TE Earth's Fresh Water

Chapter Outline

13.1 CHAPTER 13: EARTH'S FRESH WATER

13.2 LESSON 13.1: WATER ON EARTH

13.3 LESSON 13.2: SURFACE WATER

13.4 LESSON 13.3: GROUNDWATER

13.1 Chapter 13: Earth's Fresh Water

Chapter Overview

This chapter describes the water cycle and sources of Earth's fresh water, including streams, lakes, wetlands, and groundwater.

Online Resources

See the following Web sites for appropriate laboratory activities:

In the modeling lab at the following URL, students will learn the components of a watershed, identify examples of point- and nonpoint-source pollution, and then build a 3-D model of a watershed.

- http://education.nationalgeographic.com/education/activity/in-your-watershed/?ar_a=1

This lab addresses groundwater by asking: How much runoff is created by an average shopping mall parking lot? Students will calculate the yearly runoff created by a parking lot and the loss of water that would have entered the groundwater system.

- http://www.geosociety.org/educate/lessonplans/Groundwater.pdf

These Web sites may also be helpful:

You can access many teaching resources from the USGS Water Science School at this URL: http://ga.water.usgs.gov/edu/ .

Another Web site with water-related resources for teachers and students is: http://thewaterproject.org/resources/ .

You can find numerous teaching resources and lesson plans about water at the following URL.

- http://www.epa.gov/students/teachers.html#epawater

Pacing the Lessons

TABLE 13.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
13.1 Water on Earth	1.5
13.2 Surface Water	2.0
13.3 Groundwater	2.0

13.2 Lesson 13.1: Water on Earth

Key Concepts

- Description of water
- Distribution of Earth's water
- The water cycle

Lesson Objectives

- Describe water and where it occurs on Earth.
- Give an overview of the water cycle.

Lesson Vocabulary

- **condensation:** process in which a gas changes to a liquid
- **evaporation:** process in which a liquid changes to a gas
- **fresh water:** water that contains little or no dissolved salts and is found in streams, lakes, ice, the ground, and the atmosphere
- **infiltration:** process in which water seeps into the ground
- **precipitation:** water that falls from clouds to the ground as rain, snow, sleet, or hail
- **runoff:** precipitation that flows over the surface of the land
- **transpiration:** release of water vapor into the atmosphere from the leaves of plants
- **water:** simple chemical compound, each molecule of which contains two atoms of hydrogen and one atom of oxygen (H2O)
- **water cycle:** continuous movement of water through the oceans, atmosphere, ground, and living things

Teaching Strategies

Introducing the Lesson

Students are likely to have prior knowledge of the water cycle from earlier science classes. Help them recall this prior knowledge. Call on students to state what they already know about the water cycle. Ask a volunteer to record their statements on the board. Tell students they will learn more about the water cycle when they read this lesson.

Demonstration

Use the aquarium demonstration at the following URL to show students how Earth's water is distributed. The demonstration will impress upon them how little fresh water is available for human use. The demonstration procedure is followed by a handout worksheet and discussion questions.

http://www.epa.gov/region1/students/pdfs/gndw_712.pdf

Using Visuals

Have students look at the figure in the FlexBook® lesson that shows the distribution of the world's water. Make sure they realize that fresh water accounts for only 3 percent of all water on Earth. Discuss how the fresh water is distributed so they understand how to read the diagram.

Question: In what state is most of the fresh water on Earth?
  Answer: Most (79%) of the fresh water on Earth is in the solid state as ice in ice caps and glaciers.
Question: Of all the fresh water on Earth, what percent is liquid water on Earth's surface or water vapor?
  Answer: Only 1 percent of all fresh water is liquid surface water or water vapor.
Question: Where is the majority of fresh surface water found?
  Answer: The majority (52%) of fresh surface water is found in lakes.
Question: Where is more of Earth's fresh water located: under the ground or in the atmosphere?
  Answer: Much more is located under the ground than in the atmosphere.

Demonstration

Demonstrate the water cycle to the class by playing the water cycle animation at this URL: http://www.epa.gov/safewater/kids/flash/flash_watercycle.html .

Differentiated Instruction

Give students copies of an unlabeled water cycle diagram, such as the diagram at the URL below. Tell students to label the diagram with the correct processes. They can refer to the water cycle diagram in the FlexBook® lesson if they need help with any of the processes.

http://ellerbruch.nmu.edu/classes/cs255f02/cs255students/aklee/P9/wc/wcworksheet1.pdf

Enrichment

Ask one or more students to make a crossword puzzle using all of the lesson's vocabulary terms. They can create their puzzle by hand or use a free online puzzle maker (see URL below). Distribute copies of their puzzle for the rest of the class to solve as a review of lesson vocabulary.

http://www.discoveryeducation.com/free-puzzlemaker/?CFID=90372&CFTOKEN=25954423

Science Inquiry

Have students model the water cycle in a closed environment. This will give them a better understanding of the processes involved. You can use the activity at this URL:

http://www.science-class.net/Lessons/Water%20Cycle/water_cycle_model.pdf

Common Misconceptions

Students tend to have a number of misconceptions about the water cycle. For example, they may think that the water cycle involves freezing and melting of water. Make sure they understand that the water cycle involves evaporation of liquid water, condensation of water vapor, and precipitation (rain, sleet, hail, or snow). You can find other misconceptions about the water cycle at the following URL. The Web site also explains how the misconceptions develop and how to correct them.

http://beyondpenguins.ehe.osu.edu/issue/water-ice-and-snow/common-misconceptions-about-states-and-changes-of-matter-and-the-water-cycle

Language Arts Connection

Using the activity at the URL below, students will create the life story of a single drop of water. This will reinforce their understanding of the water cycle and the processes it includes.

http://www.kineticcity.com/controlcar/activity.php?act=3&virus=terrora

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 13.1 Quiz in CK–12 MS Earth Science Assessments.

Points to Consider

As water moves through the water cycle, it spends some time on Earth's surface as fresh water. Where is fresh water found on Earth's surface?

How do people use fresh water on Earth's surface?

13.3 Lesson 13.2: Surface Water

Key Concepts

- Streams and rivers
- Ponds and lakes
- Wetlands
- Floods

Lesson Objectives

- Identify features of streams and rivers.
- Describe ponds and lakes and how they form.
- Explain why wetlands are important.
- State how floods occur.

Lesson Vocabulary

- **flood:** event in which a stream or river overflows its banks
- **lake:** large body of standing water that is usually fresh but may be salty
- **pond:** small body of standing fresh water
- **river:** large body of moving fresh water that flows downhill in a channel
- **stream:** any body of moving fresh water that flows downhill in a channel
- **wetland:** area that has soggy soil or is covered with water for at least part of the year

Teaching Strategies

Introducing the Lesson

Show the class a vivid image of people having fun by white-water rafting (see URL below). Ask students for ways they like to have fun in a river or lake. Tell them they will learn about these water features when they read this lesson.

http://paradiserafting.com/images/slideshow/HomeRemember.JPG

Activity

In this outdoor activity/field trip, students locate and study plants and animals in several freshwater pond habitats. Students will take various samples from the pond, identify organisms using a pond guide, and collaborate to create a pond map. Background information is included.

http://www.outdoorbiology.com/files/resources/activities/HabitatsofthePond.pdf

Building Science Skills

In the activity at the URL below (pages 48–49), students create models of erosion and floods and learn to recognize both in their environment. Their models use sand, wax paper, and water. They will allow students to observe the processes of erosion and flooding.

http://www.terc.edu/downloads/Astrobio-Afterschool.pdf#page=57

Differentiated Instruction

Help students make a table comparing and contrasting the different types of freshwater wetlands. A sample is shown in the **Table** 13.2. You can provide students with the row and column headings and then have them fill in the cells of the table.

TABLE 13.2: Freshwater Wetlands Comparison and Contrast

Type of Wetland	How Wet Is It?	What Types of Plants Does It Have?
Marsh	usually under water	grassy plants such as cattails
Swamp	may or may not always be covered with water	shrubs or trees
Bog	soggy soil	mosses

Enrichment

Have interested students do the activity "Pollution in Our Watershed" at the following URL. They will build a simple watershed with paper and markers and then use a spray bottle to simulate precipitation. Plan to have them demonstrate their model to the class. It will help students understand how pollution accumulates in our water sources and how it can contaminate distant areas by getting into the water cycle.

http://www.calacademy.org/teachers/resources/lessons/pollution-in-our-watershed/

Science Inquiry

In the quick activity at the URL below, students will model how wetlands act as natural filters for the environment. They will prepare a mixture of water, soil, gravel, and leaves and then pour it down a piece of artificial grass, observing how much gets trapped in the grass. Then they will compare the water that has been filtered by the "grass" with the initial "polluted" sample.

http://pbskids.org/dragonflytv/web_assets/pdf/dftv_gpsedguide_wetlands.pdf#page=2

Geography Connection

Have students find, map, and learn important facts about Earth's major rivers. This can be a collaborative project with several groups of students each taking on a different river. You can follow the guidelines for the activity "Mapping Famous Rivers" at the following URL.

http://www.educationworld.com/a_lesson/01-1/lp239_01.shtml

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 13.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In the desert, water runs in channels after a storm. The channels are dry otherwise. Is this a stream?

It may seem hard to believe, but most of Earth's freshwater is under our feet. It is stored below the surface of the ground. How do you think water gets under the ground?

What happens to water after it goes under the ground? Is it trapped there forever?

13.4 Lesson 13.3: Groundwater

Key Concepts

- Rock layers and the water table
- Aquifers
- Springs and geysers
- Wells

Lesson Objectives

- Explain how water enters an aquifer.
- Explain how water leaves an aquifer.
- Define aquifer, and give an example.
- Define springs and geysers.
- State the purpose of wells and how they work.

Lesson Vocabulary

- **aquifer:** permeable layer of underground rock that is saturated with groundwater
- **groundwater:** fresh water below Earth's surface
- **spring:** place where the water table meets the surface so groundwater bubbles out of the ground onto the surface
- **water table:** top of an underground rock layer that is saturated with groundwater
- **well:** circular hole dug or drilled down into an aquifer to allow people to access groundwater

Teaching Strategies

Introducing the Lesson

Introduce groundwater with the lesson at the following URL from the National Groundwater Association. The lesson introduces students to important groundwater concepts and demonstrates the concepts with a groundwater simulator. Problems with groundwater pollution are also introduced.

http://www.ngwa.org/Fundamentals/teachers/Pages/Ground-Water-Introduction-and-Demonstration.aspx

Activity

With the activity at the URL below, groups of students can build a model of groundwater using simple materials. The model-building activity is a follow-up activity to the groundwater introduction and demonstration described above under "Introducing the Lesson." Students will be able to use their model to investigate the effects of different sediments on recharge rates, permeability, and porosity.

http://www.ngwa.org/Fundamentals/teachers/Pages/Make-Your-Own-Ground-Water-Model.aspx

Building Science Skills

Use the hands-on activity "Where Does All the Water Go?" (see URL below) so students can actually see how groundwater flows. In the activity, they will explore a groundwater model and find the velocity of groundwater flow through the model.

http://www.teachengineering.org/view_activity.php?url=http://www.teachengineering.com/collection/cub_/activities/cub_enveng/cub_enveng_lesson03_activity1.xml

Differentiated Instruction

Help students understand lesson vocabulary as well as learn a skill for understanding other unfamiliar terms. First define the word permeable ("able to be penetrated by water"). Then explain that the prefix im- or in- generally means "not." Therefore, the word impermeable means "not permeable," or "not able to be penetrated by water." Challenge the class to think of other examples of words that are negated by the addition of the prefix in- or im- (e.g., secure/insecure, valid/invalid, mature/immature).

Enrichment

Challenge a few students to design and create a model of an aquifer. Have them use their model to show the class how an aquifer is recharged.

Science Inquiry

Use the classroom activity at the URL below so students can investigate groundwater and how sites for drinking-water wells are selected. Students will create their own groundwater well model using a coffee can and wire screening. They will also add food coloring to see how a pollutant can migrate through groundwater into drinking water resources.

http://www.teachengineering.org/view_activity.php?url=http://www.teachengineering.com/collection/cub_/activities/cub_enveng/cub_enveng_lesson04_activity1.xml

Common Misconceptions

Students may hold the misconception that groundwater flows in underground rivers. Explain that this is uncommon and that most groundwater seeps slowly through cracks and pores in rocks and sediments. Demonstrate how groundwater moves by pouring water through a sieve that is full of a mixture of sand, pebbles, and gravel. Let students observe as the water slowly drips out of the bottom of the sieve.

Question: Like water through a sieve, water seeps through rocks underground only in one direction: from the top down. Why?

Answer: Gravity pulls water down toward the center of Earth.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 13.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Fresh water is needed by many living things on Earth. However, most of Earth's water is not fresh. Instead, it is salt water in the oceans. What do you know about Earth's oceans? For example, how deep are they? And why is their water salty?

Ocean water moves in waves, tides, and currents. Do you know what causes these ocean water movements?

CHAPTER 14 MS TE Earth's Oceans

Chapter Outline

14.1 CHAPTER 14: EARTH'S OCEANS

14.2 LESSON 14.1: INTRODUCTION TO THE OCEANS

14.3 LESSON 14.2: OCEAN MOVEMENTS

14.4 LESSON 14.3: THE OCEAN FLOOR

14.5 LESSON 14.4: OCEAN LIFE

14.1 Chapter 14: Earth's Oceans

Chapter Overview

This chapter describes how Earth's oceans formed, the composition of ocean water, and different types of ocean water motions. It also describes the ocean floor and ocean organisms.

Online Resources

See the following Web sites for appropriate laboratory activities:

In this hands-on lab, students will learn that all the oceans on Earth are really one world ocean. They will also learn that warmer equatorial water rises to the top, while colder polar water sinks to the bottom. In addition, they will learn that deep ocean currents are caused by the rising and sinking of warmer and colder water and that surface ocean currents affect weather and life all over the globe.

- http://www.discoveryeducation.com/teachers/free-lesson-plans/understanding-oceans.cfm

The tide activity below allows students to collect data by observing and measuring; to organize, analyze, evaluate, make inferences, and predict trends from direct and indirect evidence; and to communicate valid conclusions. From the data, students will be able to explain how and why the timing of high and low tides changes from one day to the next.

- http://science-class.net/Lessons/Ocean/TimingtheTide.pdf

These Web sites may also be helpful:

You can find several excellent videos pertaining to Earth's oceans at this URL: http://climate.nasa.gov/climate_reel/ .

You can access NeMO Explorer at the URL below. NeMO Explorer allows students to explore the NeMO seafloor observatory at Axial Seamount either geographically or by subject matter.

- http://www.pmel.noaa.gov/vents/nemo/explorer.html

The URL below provides 165 lesson plans developed to bring entire classrooms "on board" for exploration and discovery of ocean-related topics. Topics include deep-sea hydrothermal vents and benthic creatures on the ocean floor.

- http://oceanexplorer.noaa.gov/edu/welcome.html

You can find excellent articles on Earth's oceans at the Oceans Alive! URL below.

- http://legacy.mos.org/oceans/planet/index.html

At the following URL, you can access many videos and interactives pertaining to the oceans and the atmosphere.

- http://www.teachersdomain.org/browse/?start=0&fq_hierarchy=k12.sci.ess.watcyc.asint

Pacing the Lessons

TABLE 14.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
14.1 Introduction to the Oceans	1.5
14.2 Ocean Movements	2.0
14.3 The Ocean Floor	1.0
14.4 Ocean Life	1.5

14.2 Lesson 14.1: Introduction to the Oceans

Key Concepts

- How the oceans formed
- Influence of the oceans on the atmosphere, climate, and living things
- Composition of ocean water
- Ocean zones

Lesson Objectives

- Describe how the oceans formed.
- State how the oceans influence Earth.
- Describe the makeup of ocean water.
- Identify ocean zones.

Lesson Vocabulary

- **aphotic zone:** ocean zone deeper than 200 meters where too little sunlight penetrates for photosynthesis to occur
- **benthic zone:** ocean zone that consists of the ocean floor
- **intertidal zone:** ocean zone that is closest to shore, between the high tide and low tide marks
- **neritic zone:** ocean zone that lies over the continental shelf between the intertidal zone and the oceanic zone
- **oceanic zone:** ocean zone that consists of the open ocean farther from shore than the neritic zone
- **photic zone:** ocean zone in the top 200 meters of water that receives enough sunlight for photosynthesis to occur

Teaching Strategies

Introducing the Lesson

Introduce Earth's oceans with a guessing game. Tell students you are going to provide them with up to a dozen clues about a particular feature on Earth's surface (the world ocean). Ask students to try to guess what feature you are describing. Challenge them to identify it with as few clues as possible.

1. It is the largest space in the universe known to be inhabited by living things.
2. Less than 10 percent of it has been explored by humans.
3. It holds the longest continuous mountain chain known to exist in the universe.

4. Its average temperature is 2 ºC (about 39 ºF).
5. At its lowest point, its pressure is the same as one person trying to hold 50 jumbo jets.
6. It contains nearly 20 million tons of gold.
7. The largest animal that ever lived on Earth still lives there.
8. The longest migration of any mammal occurs there.
9. It contains the largest living structure on Earth, a structure so large that it can be seen from the moon.
10. Animals that live there supply the greatest percentage of the world's protein consumed by humans.
11. More than 3.5 billion people depend on it as their primary source of food.
12. Three-quarters of the world's biggest cities are located next to it.

Building Science Skills

In this lesson, students learn about the photic and aphotic zones of Earth's oceans. With the activity "All that Glitters" at the following URL, students can investigate what happens to light in the ocean and how deep-sea organisms compensate for lack of light.

http://oceanexplorer.noaa.gov/edu/curriculum/section5.pdf

Differentiated Instruction

Have students create a Venn diagram comparing and contrasting the photic and aphotic zones.

Enrichment

Ask students to use resources such as the URLs below to determine the meaning of salinity (saltiness of ocean water) and how salinity is usually measured (parts per thousand). Also have them investigate variations in the salinity of ocean water and factors that affect salinity (e.g., nearness to rivers, amount of rainfall, and rate of evaporation). Finally, have the students create a PowerPoint presentation to share what they learn with the rest of the class.

http://www.sciencelearn.org.nz/Contexts/The-Ocean-in-Action/Science-Ideas-and-Concepts/Ocean-salinity

http://www.onr.navy.mil/focus/ocean/water/salinity1.htm

Science Inquiry

Challenge students to develop a hypothesis that explains why it is easier to float in ocean water than the water of a freshwater lake. (Ocean water is about 3.5 percent salt, and the salt gives ocean water greater density than freshwater. This makes you more buoyant in ocean water.) Tell students that the water in the Great Salt Lake in Utah ranges from about 5 percent to 27 percent salt.

Question: Would it be easier to float in the Great Salt Lake or in the ocean? Why?

Answer: It would be easier to float in the Great Salt Lake because its water has a higher concentration of salt than ocean water. Therefore, its water would have greater density and make you more buoyant than ocean water.

Common Misconceptions

Students may think that Earth's oceans are separate and not connected. Use a globe or world map to show students how Earth's oceans are all connected and part of one global ocean system.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 14.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Most nutrients enter ocean water from the land. However, they may be carried far from shore by currents. Many large ocean currents have names. Can you name any ocean currents?

Currents are like rivers flowing through the ocean. Rivers always flow downhill because of gravity. What do you think causes ocean currents to flow?

14.3 Lesson 14.2: Ocean Movements

Key Concepts

- Waves
- Tsunamis
- Tides
- Surface currents
- Deep currents
- Upwelling

Lesson Objectives

- Describe how waves move through water.
- Explain what causes tides.
- Give an overview of surface currents.
- Identify the cause of deep currents.
- Describe upwelling.

Lesson Vocabulary

- **convection current:** current that flows through a liquid or gas because of differences in density
- **Coriolis effect:** effect of Earth's rotation on the direction of global winds and surface ocean currents
- **deep current:** current caused by differences in density of ocean water that flows deep below the surface
- **density:** amount of mass per unit volume of a substance
- **neap tide:** tide with the least difference between high and low tides that occurs during the first and third quarters of the moon
- **spring tide:** tide with the greatest difference between high and low tides that occurs during the new and full moon
- **surface current:** ocean current caused mainly by wind that flows through the surface of the water
- **tide:** constant change in the level of ocean water caused by the pull of the moon's and sun's gravity
- **upwelling:** process in which deep ocean water rises to the surface and brings nutrients with it
- **wave:** transfer of energy through matter, such as the transfer of wind energy through water in an ocean wave

Teaching Strategies

Introducing the Lesson

Show students an image of ocean waves approaching a shore, like the images below. Ask them to identify two ways that the ocean water in the image is moving. (Students will no doubt identify the waves but may or may not realize that the water is also rising or falling as part of the daily tidal cycle.) Tell students they will read about waves, tides, and other ocean motions in this lesson.

- http://www.lifeinroam.com/2012/04/roam-flashback-great-ocean-road.html
- http://www.123rf.com/photo_5657097_sunny-view-of-the-ocean-shore-with-different-blue-colors.html
- http://www.city-data.com/picfilesc/picc54407.php

Activity

Have students do the activity "Of Tides and Time" at the URL below. In the activity, they will use the Internet as a source of current data on tides, demonstrate the rhythmic pattern of tides throughout the month, and chart the relationship between tides and phases of the moon.

http://legacy.mos.org/oceans/motion/graphingtides.html

Building Science Skills

With the activity at the following URL, students can develop mapping skills and improve their knowledge of ocean currents. In the activity, they will map ocean currents in order to predict where a spill of rubber ducks will move.

http://education.nationalgeographic.com/education/activity/mapping-ocean-currents/?ar_a=1

Differentiated Instruction

Provide students with cloze prompts about important lesson concepts, and instruct them to complete the sentences as they read the lesson. Sample cloze prompts are listed below with sample answers in brackets. Make sure students realize that correctly completing the sentences may require more than one word.

1. Most ocean waves are caused by __________.
2. A wave is the transfer of __________.
3. A tsunami is a wave that is usually caused by __________.
4. Tides are daily changes in __________.
5. In most places, there are two high tides and two low tides every __________.
6. The main cause of tides is __________.
7. Surface currents are caused mainly by __________.
8. Deep currents are caused by differences in __________.
9. Upwelling occurs when strong winds blow surface water away from shore and __________.

Enrichment

Interested students can learn more about upwelling and downwelling by doing the activity at the URL below. They will explore differences between upwelling and downwelling, study graphics and photographs illustrating upwelling and downwelling, and then answer questions about each process. Maps of the world's major surface and deep currents are included as resources to help students understand where and how upwelling and downwelling occur.

http://oceanexplorer.noaa.gov/edu/learning/8_ocean_currents/activities/currents.html

Science Inquiry

In the inquiry activity at the following URL, groups of students will investigate the question: What is the relationship between temperature, salinity, pressure, and density of seawater? After groups finish the activity, discuss with the class how their results relate to the formation of deep ocean currents.

http://oceanexplorer.noaa.gov/explorations/04mountains/background/edu/media/MTS04.density.pdf

Common Misconceptions

Students commonly have the misconception that spring tides are seasonal and occur in the spring. Tell the class that the word spring in spring tide does not refer to the season. In fact, spring tides occur twice each month, during the new moon and full moon. This happens month after month, regardless of season.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 14.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Upwelling brings nutrients to the surface from the ocean floor. Nutrients are important resources for ocean life. However, they aren't the only resources on the ocean floor. What other resources do you think might be found on the ocean floor?

It's hard to get resources from the ocean floor. Can you explain why?

14.4 Lesson 14.3: The Ocean Floor

Key Concepts

- How scientists study the ocean floor
- Traveling to the ocean floor
- Features of the ocean floor
- Resources from the ocean floor

Lesson Objectives

- Describe how scientists study the ocean floor.
- Identify major features of the ocean floor.
- List resources found on the ocean floor.

Lesson Vocabulary

- **abyssal plain:** one of the flat areas that make up much of the ocean floor
- **continental shelf:** gently sloping ocean floor at the edges of continents
- **continental slope:** steeply sloping ocean floor between the continental shelf and abyssal plain
- **mid-ocean ridge:** mountain range that runs through all the world's oceans where tectonic plates pull apart
- **oceanic trench:** deep canyon on the ocean floor where one tectonic plate subducts under another tectonic plate
- **seamount:** volcanic mountain on the ocean floor
- **sonar:** instrument that uses sound waves to study distant objects or surfaces such as the ocean floor

Teaching Strategies

Introducing the Lesson

Impressive facts about the ocean floor will help pique students' interest in this intriguing place on Earth. Share these facts with your class:

- The deep sea is the largest museum on Earth. There are more artifacts and remnants of history on the ocean floor than in all of the world's museums combined.
- Scientists have explored less than 5 percent of the ocean floor. We have better maps of Mars than we do of the ocean floor.

- The longest mountain range in the world is the mid-oceanic ridge, which runs through the middle of the Atlantic Ocean and into the Indian and Pacific oceans. It is more than 35,000 miles long, has peaks higher than those in the Alps, and makes up almost a quarter of Earth's total surface.
- We didn't send divers down to explore the mid-ocean ridge until 1973, four years after Neil Armstrong and Buzz Aldrin walked on the moon!

Activity

Use the activity at the following URL so students can investigate the deepest place on Earth: Challenger Deep in the Mariana Trench. They will locate the Mariana Trench on a map and identify the challenges of exploring the deepest place on Earth.

http://education.nationalgeographic.com/education/activity/mariana-trench-deepest-place-earth/?ar_a=1

Differentiated Instruction

For visual learners and English language learners, use the diagram "Major Features on the Ocean Floor" in the FlexBook® student edition lesson when you discuss the features. Have students find each feature in the diagram as you describe it. Then ask them to describe in their own words how each feature looks. Illustrate how to use the depth scale on the left side of the diagram, and have students compare the depths of different features. Discuss how the features compare with similar features on land.

Enrichment

Have students who need extra challenges solve the mystery "Find the Sunken Sub" at the URL below. To solve the mystery, they will use data points to sketch a profile of the seafloor and then use the profile to decide where to look for a sunken World War II submarine.

http://www.smithsonianeducation.org/educators/lesson_plans/ocean/acrobat/secret.pdf

Science Inquiry

In the inquiry activity at the URL below, students will make predictions about deep-sea resources. Then they will investigate those resources and learn about their value to science and business.

http://education.nationalgeographic.com/education/activity/resources-in-the-deep-sea/?ar_a=1

Common Misconceptions

Students may have the erroneous impression that ocean basins are bowl-shaped and deepest in the middle. Or they may think that the ocean floor is flat and the same depth everywhere. Make sure students understand that the ocean floor is very irregular, with the highest mountains and deepest trenches that exist on Earth. The best way to dispel the misconceptions is to show students 3-D bathymetric maps of the ocean floor. You can find a gallery of maps, including some that are animated, at this URL: http://oceanexplorer.noaa.gov/gallery/maps/maps.html .

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 14.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Many organisms live on the ocean floor. Others live elsewhere in the ocean. Where else do organisms live in the ocean?

- [Organisms live everywhere in the ocean but especially near the top of the water where enough sunlight can penetrate for photosynthesis to occur.]

How might organisms that live on the ocean floor differ from those that live in other parts of the ocean?

- [Organisms that live on the ocean floor have special adaptations to help them withstand the extreme pressure of the water. They may also have adaptations that help them survive in the total darkness.]

14.5 Lesson 14.4: Ocean Life

Key Concepts

- Types of ocean organisms (plankton, nekton, and benthos)
- Marine food chains

Lesson Objectives

- Identify three major groups of marine life.
- Describe marine food chains.

Lesson Vocabulary

- **benthos:** major group of marine organisms consisting of organisms that live on the ocean floor
- **marine organism:** ocean organism, adapted for life in salt water
- **nekton:** major group of marine organisms consisting of organisms such as fish that swim through the water
- **phytoplankton:** "plant-like" plankton such as algae that make food by photosynthesis
- **plankton:** major group of marine organisms consisting mainly of microscopic organisms that are suspended in the water of the photic zone; include phytoplankton and zooplankton
- **zooplankton:** "animal-like" plankton that consume phytoplankton

Teaching Strategies

Introducing the Lesson

To introduce life in the ocean, show the entertaining and amazing video "Underwater Astonishments" at the URL below. Students will see a diversity of astonishing ways that ocean organisms have adapted to their aquatic environments.

http://www.ted.com/talks/lang/en/david_gallo_shows_underwater_astonishments.html

Building Science Skills

Continue the theme of underwater adaptations with the activity at the following URL. Students will review what animal adaptations are, identify marine animal adaptations in photographs, and predict how types of adaptations vary with ocean habitats.

http://education.nationalgeographic.com/education/activity/animal-adaptations-ocean/?ar_a=1

Activity

The intertidal zone presents a unique set of challenges for the organisms that live there. Conditions keep changing dramatically as the tide goes in and out. Students can investigate adaptations of organisms in the intertidal zone with the activity at the URL below.

http://www.pbs.org/americanfieldguide/teachers/oceans/oceans_unit.html

Building Science Skills

Students can explore marine organisms with a focus on coral reefs by doing the activity at the URL below. The main goal of their investigation is to identify the major functions that organisms must perform in a coral reef ecosystem. Specific objectives include comparing and contrasting coral reefs in shallow and deep water; explaining the importance of physical factors in coral reef ecosystems; and inferring the fundamental source of energy in a deep-water coral reef ecosystem.

http://oceanexplorer.noaa.gov/explorations/06laserline/background/edu/media/LLS_06_designreef.pdf

Differentiated Instruction

Suggest that students make a compare/contrast table for the three major groups of marine organisms: plankton, nekton, and benthos. They should where the organisms live, how they move, and examples of each group of organisms.

Enrichment

Ask students to create a two- or three-dimensional model of a hydrothermal vent food chain. It should include organisms to fill at least three tropic levels, and the organisms and their trophic levels should be identified. Have the students display their model in the classroom.

Science Inquiry

Use the inquiry activity below to test students' ability to apply knowledge of ocean zones to living things. In the activity, students will create a diagram of the ocean zones and their features. Then they will use critical thinking skills to determine where in the ocean each organism lives based on its limits for survival.

http://www.cesn.org/cosee_CD/web/activity/Intro_to_Ocean_Zones.pdf

Common Misconceptions

There are many common misconceptions about the classification of ocean organisms. For example, students commonly think that most organisms in the ocean are animals and that most of the animals are vertebrates. Several other misconceptions about the classification of ocean organisms are listed below. Share these misconceptions with the class. Then assign each of the organisms named in the list to a different student. Have the students find out how the organisms are actually classified and why they are classified this way. Tell them to report back to the class with the correct information.

- Algae are plants.
- Sponges, corals, anemones, and sea cucumbers are plants.
- Starfish and jellyfish are fish.
- Whales are fish.

- Sharks are not fish.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 14.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

This chapter describes how the oceans influence Earth's atmosphere. What else do you know about the atmosphere? For example, what gases does it contain?

The ocean is divided into zones. Do you think the atmosphere is divided into zones as well?

Chapter 15 MS TE Earth's Atmosphere

Chapter Outline

15.1 Chapter 15: Earth's Atmosphere
15.2 Lesson 15.1: The Atmosphere
15.3 Lesson 15.2: Energy in the Atmosphere
15.4 Lesson 15.3: Layers of the Atmosphere
15.5 Lesson 15.4: Air Movement

15.1 Chapter 15: Earth's Atmosphere

Chapter Overview

This chapter describes the properties, significance, and layers of Earth's atmosphere. It also explains how energy is transferred through the atmosphere and how air moves through the atmosphere and over Earth's surface.

Online Resources

See the following Web sites for appropriate laboratory activities:

Students can observe convection currents and how they affect the atmosphere by doing the hands-on modeling lab "Atmospheric Processes—Convection" (see URL below). Students will understand that temperature changes can cause density changes in water and that the same phenomenon happens in air. The lab includes background information, assessments, and suggested modifications for differentiated instruction.

- http://www.ucar.edu/learn/1_1_2_7t.htm

The global winds lab at the following URL simulates global wind patterns in a cake pan. After students have completed the lab, they should be able to explain how heat energy is redistributed through the atmosphere; why rising air is associated with low atmospheric pressure and why sinking air is associated with high atmospheric pressure; and how and why Earth's rotation deflects the wind in both Northern and Southern Hemispheres.

- http://www.csuchico.edu/~abykerk-kauffman/courses/geos142/packet/pdf/65GlobalWindsLab.pdf

These Web sites may also be helpful:

You can find many common student misconceptions about the atmosphere at this URL:

- http://www.csulb.edu/~lhenriqu/NARST2000.htm

The URL below is an online teaching module for middle school science teachers. It deals with many aspects of Earth's atmosphere, including the greenhouse effect and the stratospheric ozone layer. It includes a large selection of student activities on a diversity of specific topics.

- https://www.ucar.edu/learn/1.htm

The following URL is a video clip in which Bill Nye the Science Guy explains the layers of the atmosphere in his usual entertaining fashion.

- http://www.watchknowlearn.org/Video.aspx?VideoID=25695&CategoryID=2666

The excellent video "The Precious Envelope" from the University of Maryland introduces students to the atmosphere and its importance as well as how human actions are changing the atmosphere.

- http://www.watchknowlearn.org/Video.aspx?VideoID=18356&CategoryID=2666

You can find a useful set of slides covering the information in the lesson "Air Movement" at this URL: http://www.slideshare.net/cpelfrey/global-and-local-winds .

Pacing the Lessons

TABLE 15.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
15.1 The Atmosphere	1.5
15.2 Energy in the Atmosphere	1.5
15.3 Layers of the Atmosphere	1.5
15.4 Air Movement	1.5

15.2 Lesson 15.1: The Atmosphere

Key Concepts

- Why the atmosphere is important
- Composition of the atmosphere
- Air density and pressure

Lesson Objectives

- Explain why Earth's atmosphere is important.
- Describe the composition of the atmosphere.
- List properties of the atmosphere.

Lesson Vocabulary

- **air pressure:** weight of the air pressing against a given area
- **altitude:** distance above sea level
- **sound:** form of energy that starts with a disturbance of matter, travels in waves through matter, and allows us to hear

Teaching Strategies

Introducing the Lesson

Help students recall what they may already know about Earth's atmosphere. Go around the class, from one student to the next, and have each student state one fact about it. (Sample responses might include: the atmosphere contains gases such as oxygen, it surrounds the planet like a blanket, and it developed after the planet formed.) Tell students they will learn much more about the atmosphere in this chapter.

Activity

You may want to use the lesson plan at the following URL when you teach students about the composition and importance of Earth's atmosphere. The lesson plan includes activities, a video, a reading, and an assessment.

http://betterlesson.com/lesson/7951/the-composition-and-importance-of-earth-s-atmosphere

Demonstration

Do demonstration #21 ("Why No Flood?") at the URL below so students can observe the effects of air pressure. You will place an index card is placed over a glass full of water and then quickly turn the glass upside down. The index card should remain in place and the water should stay in the glass because the pressure of the air outside the glass is greater than the pressure of the water inside the glass. (You may want to practice the demonstration before showing it to the class.) Before you turn the glass upside down, ask students to predict what they think will happen when the glass is inverted. After the demonstration, challenge students to explain what they observed.

http://www.colorado.edu/geolsci/courses/DEMOS/seicontribution/101_lowtech_earth_science%20demos.pdf

Differentiated Instruction

Have less proficient readers make a main ideas/details chart of lesson content. They should divide a sheet of paper down the center and list main ideas in the left column, leaving enough space between main ideas to add supporting details in the right column. Show students how to use the heading structure of the lesson to identify main ideas, and help them identify supporting details for the first main idea as an example.

Enrichment

Ask a few creative students to make a two- or three-dimensional model that represents changes in air density and pressure with altitude. Have them explain their model to the rest of the class, and then put it on display in the classroom.

Science Inquiry

Comparing Earth's atmosphere with that of other planets will help students appreciate how Earth's atmosphere affects its climate. In the modeling activity at the following URL, students will understand that our two closest neighbors, Venus and Mars, have very different atmospheres than Earth does in terms of air pressure and chemical composition. They will also be able to explain why Earth's moderate temperature is due primarily to its unique atmosphere. Included are assessment ideas and suggested modifications for differentiated instruction.

https://www.ucar.edu/learn/1_1_2_1t.htm

Common Misconceptions

A number of misconceptions about the composition of the atmosphere have been identified in students. Four of them are listed below. Provide students with counter evidence showing that each misconception is false.

- The composition of air may vary from place to place.
- Air and oxygen are the same thing.
- Greenhouse gases such as carbon dioxide make up a major portion of the atmosphere.
- The atmosphere contains only molecules of gases (no solid particles).

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 15.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In this lesson, you read that air density and pressure change with altitude. The temperature of the air also changes with altitude. Air temperature measures the heat energy of air molecules. What heats the atmosphere? Where does air gets its energy?

What causes the atmosphere to lose energy and become cooler?

15.3 Lesson 15.2: Energy in the Atmosphere

Key Concepts

- Definition and forms of energy
- Energy from the sun
- Electromagnetic spectrum
- Radiation, conduction, and convection

Lesson Objectives

- Define energy.
- Describe solar energy.
- State how heat moves through the atmosphere.
- Describe how solar energy varies across Earth's surface.
- Explain the greenhouse effect.

Lesson Vocabulary

- **electromagnetic spectrum:** total range of wavelengths of energy given off by the sun
- **energy:** ability to do work
- **greenhouse effect:** warming of Earth by gases in the atmosphere that absorb energy
- **greenhouse gas:** gas such as carbon dioxide that absorbs energy in the atmosphere and keeps Earth warm
- **infrared light:** light with wavelengths longer than those of visible light that humans can feel as heat
- **photon:** tiny packet of energy given off by the sun that travels in an electromagnetic wave
- **ultraviolet (UV) light:** light with wavelengths shorter than those of visible light that harms living things
- **visible light:** range of wavelengths of light that humans can see

Teaching Strategies

Introducing the Lesson

If the day is sunny, you can use a simple demonstration to introduce solar radiation and the electromagnetic spectrum. Do demonstration #25 ("Track Star") at the following URL. You will place a sheet of paper on the ground beside a drinking glass half-filled with water and held in full sunlight. Explain to the class that the glass of water acts as a prism and breaks the sunlight into the different wavelengths (colors) of visible light. Tell students they will learn more about sunlight, its range of wavelengths, and how its energy affects the atmosphere when they read this lesson.

http://www.colorado.edu/geolsci/courses/DEMOS/seicontribution/101_lowtech_earth_science%20demos.pdf

Demonstration

Conduction is one of the ways that energy is transferred through Earth's atmosphere. Illustrate the process of conduction with the creative demonstration at the following URL. After watching the demonstration, students should be able to provide a molecular explanation of conduction and explain why different materials conduct heat at different rates. They will also be able to identify air as a poor heat conductor (an insulator).

https://www.ucar.edu/learn/1_1_2_6t.htm

Building Science Skills

This lesson describes how the greenhouse effect helps to moderate Earth's temperature. In the activity at the URL below, students will build simple models to investigate how a greenhouse retains heat. After the activity, discuss with the class how Earth's atmosphere is like a greenhouse and how the atmospheric greenhouse effect retains heat.

https://www.ucar.edu/learn/1_3_2_12t.htm

Differentiated Instruction

Work with students to make a table comparing and contrasting the three methods of heat transfer (conduction, convection, and radiation). Suggest that they add sketches to the table to illustrate each method of heat transfer.

Enrichment

Challenge a small group of students to model the way the tilt of Earth on its axis affects the angle at which solar radiation strikes Earth's surface and the degree to which the energy is concentrated or spread out over the surface. They could use a Styrofoam ball with a skewer pushed through its center to model Earth and its axis, and they could use a flashlight to model the sun. After the demonstration, conduct a class discussion relating the demonstration to Earth's seasons.

Science Inquiry

Students will develop an understanding of how heat is transferred by radiation with the inquiry activity at the URL below. Specifically, students will observe how the physical characteristics of a surface affect the way the surface absorbs and releases heat from the sun. They will also understand that radiation of heat occurs without the involvement of a physical object. Then they will apply what they learn from the activity to interpret real-world situations involving solar radiation. The activity includes background information and assessments.

https://www.ucar.edu/learn/1_1_2_5t.htm

Common Misconceptions

Most people believe incorrectly that the atmosphere is heated directly by sunlight. They do not understand the contributions of the three heat transfer mechanisms—conduction, convection, and radiation—to warming the atmosphere. Therefore, they do not appreciate that the atmosphere is heated from the ground up, even though the original energy comes from the sun. Discuss and correct the misconceptions with your students.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 15.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Energy from the sun heats the air in Earth's atmosphere. You might predict that air temperature would increase steadily with altitude. After all, the higher you go, the closer you are to the sun. But it's not that simple. Besides the sun, what might heat up the atmosphere?

How do you think air temperature might change with altitude?

15.4 Lesson 15.3: Layers of the Atmosphere

Key Concepts

- Temperature of the atmosphere
- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere
- Exosphere

Lesson Objectives

- Describe how the temperature of the atmosphere changes with altitude.
- Outline the properties of the troposphere.
- Explain the role of the ozone layer in the stratosphere.
- Describe conditions in the mesosphere.
- Explain how the sun affects the thermosphere.
- Identify the exosphere.

Lesson Vocabulary

- **exosphere:** outermost layer of Earth's atmosphere above the thermosphere
- **mesosphere:** layer of Earth's atmosphere between the stratosphere and thermosphere
- **ozone:** gas with molecules consisting of three oxygen atoms (O_3) that absorbs UV light in the stratosphere but pollutes the air when it forms in the troposphere
- **stratosphere:** layer of Earth's atmosphere between the troposphere and mesosphere
- **temperature inversion:** reversal of normal temperatures in the troposphere, with cooler air closer to the ground and warmer air above it
- **thermosphere:** layer of Earth's atmosphere between the mesosphere and exosphere
- **troposphere:** lowest, densest layer of Earth's atmosphere where weather occurs

Teaching Strategies

Introducing the Lesson

Introduce the layers of the atmosphere with the cartoon video at the following URL. The video briefly describes each of the layers and some of their important characteristics.

http://studyjams.scholastic.com/studyjams/jams/science/weather-and-climate/earths-atmosphere.htm

Activity

Students can learn about the layers of the atmosphere by doing the foldable activity at the URL below.

http://www.campaignforcleanair.org/tl_files/cfca/docs/No_Idling_Toolkit/Lesson_Plans/Stage%201%20Activity%202%202%20Foldable.pdf

Demonstration

Use the modeling activity "Stratospheric Ozone: A Balancing Act" (see URL below) as a demonstration to illustrate the concept of equilibrium as it applies to stratospheric ozone. In the activity, you will build a model that represents the natural balance of stratospheric ozone production and destruction. Then you will alter the model to represent changes human actions have caused in the ozone balance.

https://www.ucar.edu/learn/1_6_2_25t.htm

Differentiated Instruction

The kinesthetic activity at the following URL will help less proficient readers and English language learners understand the stratospheric ozone balance. Students will play the roles of atoms and molecules and simulate the formation and destruction of ozone molecules in the stratosphere. From the activity, students should be able to understand how ozone is formed and destroyed in the stratosphere and why stratospheric ozone is important.

https://www.ucar.edu/learn/1_6_2_26t.htm

Differentiated Instruction

Visual learners might benefit from watching a video version of lesson content. They can learn about the layers of the atmosphere in the video "Reveal the Atmosphere" at the following URL.

http://www.watchknowlearn.org/Video.aspx?VideoID=5126&CategoryID=2666

Enrichment

Have a few students collaborate to make a to-scale model of atmospheric layers that shows their relative thicknesses, temperature gradients, and a few distinguishing features of each layer. Display their model in the classroom and urge other students to examine it.

Science Inquiry

The two-part inquiry activity at the URL below demonstrates the relative thickness of the thin layer that includes the troposphere and stratosphere. By doing the activity, students will be able to explain how relatively thin the atmosphere is, relative to the size of the planet, and will understand the relative extent of the four major atmospheric layers.

https://www.ucar.edu/learn/1_1_2_2t.htm

Physical Science Connection

Explain the role of the ionosphere in the transmission of AM and FM radio waves. At night, AM radio waves reflect off this layer of the atmosphere and can thereby travel to places on Earth's surface that lie beyond the horizon from the radio transmission tower. FM radio waves, in contrast, pass straight through the ionosphere and out into space, at night as well as during the day. Because FM waves are not reflected back to Earth's surface, they cannot travel to places on the surface that lie beyond the horizon from the transmission tower. As a result, at night you can hear an AM radio station from farther away than an FM radio station. You can learn more about this phenomenon at the following URLs:

- http://www.cybercollege.com/frtv/frtv017.htm
- http://www.fcc.gov/encyclopedia/why-am-radio-stations-must-reduce-power-change-operations-or-cease-broadcasting-night
- http://www.modestoradiomuseum.org/how%20it%20works.html

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 15.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Energy from the sun is responsible for winds that blow in the troposphere. What is wind?

How does energy cause winds to blow?

15.5 Lesson 15.4: Air Movement

Key Concepts

- Why air moves
- Land and sea breezes
- Monsoons
- Global winds
- Jet Streams

Lesson Objectives

- Explain why air moves.
- Identify causes of local winds.
- Describe global winds and jet streams.

Lesson Vocabulary

- **global wind:** wind that occurs in a belt that circles the planet
- **jet stream:** fast-moving air current high in the troposphere
- **land breeze:** local wind that blows from land to water during the night or in the winter when air over the land is cooler than air over the water
- **local wind:** wind that blows over a limited area because it is influenced by local geography, such as nearness to an ocean
- **monsoon:** local wind that blows from water to land in the summer and from land to water in the winter due to seasonal changes in the temperatures of land and water
- **sea breeze:** local wind that blows from water to land during the day or in the summer when air over the water is cooler than air over the land
- **wind:** air that flows over Earth's surface because of differences in heating of the atmosphere

Teaching Strategies

Demonstration

Use demonstration #24 ('Light Bulb Air Current and Wind") at the URL below to show students how warm air rises and starts a convection current. In the demonstration, you will sprinkle talcum powder over a lamp. Then, when you turn on the lamp, the powder will rise up from the bulb because the bulb is heating the air above it and causing it to rise. State that this vertical movement of air is an air current and that similar air currents form over warm ocean water and the equator. Explain that as the warm air rises, cooler air flows in to take its place. This horizontal movement of air is similar to wind, which is horizontal movement of air over Earth's surface.

http://www.colorado.edu/geolsci/courses/DEMOS/seicontribution/101_lowtech_earth_science%20demos.pdf

Activity

With the instructions and materials at the following URL, students can make a global winds flipbook. Making a flipbook is a great way for students to organize information and prepare for assessments.

http://www.griffin.uga.edu/aemn/k-12/Middle/Global%20Wind%20Patterns%20Flipbook.pdf

Differentiated Instruction

Visual learners and verbally challenged students may have a better understanding of land and sea breezes (and other local winds) if they interact with the land and sea breeze animation at this URL: http://oceanservice.noaa.gov/education/pd/oceans_weather_climate/media/sea_and_land_breeze.swf .

Enrichment

Arrange for a few students to interview a local meteorologist about the types of winds experienced in their part of the country. For example, they should ask about the prevailing winds in their area and the types of weather they bring as well as about specific local winds and their causes. Have the students summarize and share what they learn in a brief oral report to the class.

Science Inquiry

Students can model the Coriolis effect to see how it affects global winds with the activity at the first URL below. Then, with the second URL below, they can apply their knowledge of global winds to complete a global winds map and infer how global wind patterns affected sailing vessels in the past.

http://kids.earth.nasa.gov/archive/nino/wind.html

http://kids.earth.nasa.gov/archive/nino/global.html

Common Misconceptions

Students often think that monsoons always bring heavy rain. Use the monsoon figure in the lesson to point out how the winter monsoon blows from the land to the ocean and is therefore a dry wind. Explain that only the summer monsoon, which blows from the ocean to the land, brings large amounts of rain. You (or your students) can learn more by reading this article: http://employees.oneonta.edu/baumanpr/geosat2/Dry_Monsoon/Dry_Monsoon.htm .

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 15.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Temperature differences in the atmosphere cause winds. They also cause other weather conditions, such as clouds and rain. How do temperature differences cause clouds to form?

How do temperature differences in the atmosphere affect precipitation?

CHAPTER 16 MS TE Weather

Chapter Outline

16.1 CHAPTER 16: WEATHER
16.2 LESSON 16.1: WEATHER AND WATER IN THE ATMOSPHERE
16.3 LESSON 16.2: CHANGING WEATHER
16.4 LESSON 16.3: STORMS
16.5 LESSON 16.4: WEATHER FORECASTING

16.1 Chapter 16: Weather

Chapter Overview

This chapter describes weather and weather factors. It also explains why weather occurs, how different types of storms develop, and how meteorologists forecast the weather.

Online Resources

See the following Web sites for appropriate laboratory activities:

Use the lab at the following URL when students are learning about storms in Lesson 16.3, "Storms." In the lab, students will use a combination of internet research and hands-on modeling (making a tornado in a bottle) to learn that a tornado is a vortex, which is a spiral motion of fluid that sucks everything near it toward its center. They will also learn how tornadoes form and how damaging they can be.

- http://www.discoveryeducation.com/teachers/free-lesson-plans/wonders-of-weather.cfm

The problem-based lab activity at the URL below is designed to be used at the end of a chapter on weather to help students apply their knowledge to real-world problems. Students become the events manager for a music group that is planning a world tour. They have to use their knowledge of weather to decide which cities the group will visit on the tour in order to avoid weather hazards.

- [www.strategies.org/TRMM/Weather_04.pdf www.strategies.org/TRMM/Weather_04.pdf]

These Web sites may also be helpful:

At the following URL, you can connect with five lessons plans to teach weather-related topics to your students. With the lesson plans, students will develop a basic understanding of how weather can be described in measurable quantities, such as temperature, wind, and precipitation. They will also use hands-on activities and real-time data investigations to study factors that affect the weather.

- http://ciese.org/curriculum/weatherproj2/en/index.shtml

You can find a large collection of weather-related games and simulations at this URL: http://spark.ucar.edu/longcontent/games-sims-weather-climate-atmosphere

The URL below provides 10 satellite meteorology learning modules for middle and high school students that include exciting activities and hands-on tools for investigation, inquiry, and analysis.

- http://cimss.ssec.wisc.edu/satmet/index.html

Go to this URL for a wide variety of teaching resources relating to weather and the atmosphere: http://www.education.noaa.gov/Weather_and_Atmosphere/

At the following URLs, you can access lesson plans and activities in the National Weather Service's Jetstream Online Weather School.

- http://www.srh.noaa.gov/jetstream/append/lessonplans.htm
- http://www.srh.noaa.gov/jetstream/append/coolstuff_matrix.htm

You can find weather-related science fair project ideas at this URL: http://scijinks.jpl.nasa.gov/weather-science-fair

At the following URL are links to 20 different videos, each focusing on a specific weather topic. Most of the videos are suitable for middle school students.

- http://weatherthings.com/TeacherVideos.html

This URL has more than 30 weather experiments for middle school science classes.

- http://www.weatherwizkids.com/weather-experiments.htm

Pacing the Lessons

TABLE 16.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
16.1 Weather and Water in the Atmosphere	1.5
16.2 Changing Weather	1.5
16.3 Storms	1.5
16.4 Weather Forecasting	1.0

16.2 Lesson 16.1: Weather and Water in the Atmosphere

Key Concepts

- Definition and causes of weather
- Weather and the water cycle
- Humidity
- Clouds
- Precipitation

Lesson Objectives

- Explain what causes weather.
- Describe humidity and its role in weather.
- Explain how clouds are classified.
- Identify types of precipitation and how they form.

Lesson Vocabulary

- **cirrus cloud:** thin, wispy cloud that forms from ice crystals high in the troposphere
- **cumulus cloud:** puffy white cloud that grows vertically because it forms in the updraft of a convection current
- **dew point:** temperature at which water vapor condenses out of the air
- **fog:** cloud that forms just above the ground surface
- **freezing rain:** precipitation that falls as rain but freezes on contact with cold surfaces near the ground, forming a glaze of ice
- **hail:** precipitation that falls as balls of ice and forms when strong updrafts carry rain high into the troposphere, where the rain freezes
- **heat index:** measure of what the temperature feels like because of humidity
- **humidity:** amount of water vapor in the air
- **relative humidity:** percent of water vapor in the air relative to the maximum amount the air can hold
- **sleet:** precipitation that falls as small ice pellets and forms when snow melts as it falls through a layer of warm air and then refreezes as it passes through a layer of cold air near the ground
- **stratus cloud:** cloud that forms low in the troposphere in layers that spread horizontally
- **weather:** conditions of the atmosphere, such as temperature and humidity, at a given time and place

Teaching Strategies

Introducing the Lesson

Introduce weather by presenting the following amazing weather facts to your class. If possible, compare the weather extremes in the list with typical weather in your area to put the extremes in context. Then tell students they will learn more about weather when the read this chapter.

- The highest temperature ever recorded on Earth was 58 °C (136 °F). It occurred in Libya in 1922.
- The coldest temperature ever recorded on Earth was -90 °C (-130 °F). It occurred in Antarctica in 1983.
- The wettest place on Earth is Mawsynram, India. It averages more than 11 meters (433 inches, or 36 feet) of rain per year.
- The driest place on Earth is Antofagasta, Chile. It receives less than 0.1 mm (0.004 inches) of rain per year, with many years having no rainfall at all.

Building Science Skills

Every day for a week, have students go or look outside at the same time and observe the clouds (or absence of clouds). If clouds are presents, students should record the type of clouds (cirrus, stratus, or cumulus) and draw a sketch of them. They should also record weather conditions, such as "rainy," "cold," and "windy." At the end of the week, have students review their notes and look for weather patterns associated with the different cloud types.

Activity

Students can practice classifying clouds with the interactive activity at this URL: http://urbanext.illinois.edu/treehouse/activity_cloud.cfm .

Differentiated Instruction

Have students make a table comparing and contrasting the different types of precipitation described in the lesson. For each type of precipitation, they should include its state (liquid or solid) when it reaches the ground and how it forms.

Enrichment

Ask interested students to learn about the health effects of a high heat index. Suggest that they go to one or more of the URLs below. They should find out specific signs and symptoms of overheating at different levels of the heat index. Ask them to present what they learn to the class. Tell them to include a graph or chart in their presentation.

- http://www.health.state.mn.us/divs/eh/emergency/natural/heat/heatindex.html
- http://www.nws.noaa.gov/os/heat/index.shtml
- http://www.nsis.org/weather/heatindex.html

Science Inquiry

Have students do the animated simulation at the following URL to investigate the effects of changes in air and dew point temperatures on precipitation. Students can select air and dew point temperatures for different elevations above the ground and then see what type of precipitation (if any) falls to the ground. They can also see how an updraft in a cloud affects precipitation.

http://profhorn.meteor.wisc.edu/wxwise/precip/precip.html

Common Misconceptions

Student misconceptions about weather are numerous. Two misconceptions about clouds are listed below. Write each misconception on the board, and then discuss with your students why each misconception is false. Ideas for the discussion are included below in parentheses.

Clouds are made of water vapor.

- (If clouds were made of water vapor, they would be invisible. Clouds form when water vapor condenses. They are made of tiny water droplets or ice crystals that collect around particles of dust, smoke, or other solids in the atmosphere.)

Clouds always produce rain.

- (Clouds are necessary for rain, but many clouds do not produce rain or other precipitation. Puffy, white cumulus clouds, for example, are unlikely to produce rain. That's why they are commonly called "fair weather clouds.")

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 16.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

A clear sky can quickly become covered with clouds. The clouds may bring a change in the weather. Why does a clear day turn cloudy?

What causes weather to change?

16.3 Lesson 16.2: Changing Weather

Key Concepts

- Formation and movement of air masses
- Fronts
- Cyclones and anticyclones

Lesson Objectives

- Describe air masses and how they move.
- Identify types of fronts and the weather they bring.
- Define cyclone and anticyclone.

Lesson Vocabulary

- **air mass:** large body of air that has about the same conditions of temperature and humidity throughout
- **anticyclone:** system of winds that rotate around a center of high air pressure
- **cold front:** boundary between two air masses that forms when a faster-moving cold air mass runs into a slower-moving warm air mass
- **cyclone:** system of winds that rotate around a center of low air pressure
- **front:** boundary between two air masses
- **occluded front:** boundary between air masses that forms when a warm air mass is trapped between two cold air masses
- **stationary front:** boundary between air masses that are stalled in the same place
- **warm front:** boundary between air masses that forms when a faster-moving warm air mass runs into a slower-moving cold air mass

Teaching Strategies

Introducing the Lesson

Introduce air masses and fronts with the teacher-created song "Weather Fronts" at the following URL. Play the song and then tell students they will understand all the lyrics by the time they finish reading this lesson.

http://www.youtube.com/watch?v=LD4hSW2mys0&list=PL7B47E65BD8908A6F&index=12

Demonstration

Demonstrate how warm and cold fronts form and the weather associated with them by showing the class the animated video "Cold Fronts and Warm Fronts" at this URL: http://www.youtube.com/watch?v=huKYKykjcm0 .

Differentiated Instruction

Have kinesthetic learners use a globe to identify where different types of air masses form, including maritime polar, maritime continental, maritime tropical, and continental tropical air masses. Ask them to describe the temperature and humidity of each type of air mass and use their finger to trace the direction it is likely to move.

Enrichment

Ask a few volunteers to learn how the four different types of fronts are represented on weather maps. Then have them teach the topic to the class. Tell the students to use one or more sample weather maps to illustrate their lesson.

Science Inquiry

Have students do the Janice Van Cleave activity "Fronts: Moving Air Masses" at the following URL. In the activity, they will model a warm front. Doing the activity will help them learn about air masses and see how differences in density cause warm and cold fronts. http://www.education.com/science-fair/article/fronts-moving-air-masses/

Common Misconceptions

Students may develop the misconception that fronts always bring rainy or stormy weather and that all bad weather occurs because of fronts. Explain that some fronts have little or no weather change associated with them. The only indication that a front has gone through might be a slight change of temperature or change in wind direction. Also, bad weather can develop without the passage of a front. For example, as students will learn in the next lesson, "Storms," severe thunderstorms may develop in an air mass far from a front.

Reinforce and Review

Lesson Worksheets

Copy and distribute the Lesson 16.2 worksheets in *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 16.2 in *CK-12 Earth Science for Middle School*. Answers are provided below.

Lesson Quiz

Check students' mastery of the lesson with Lesson 16.2 Quiz in *CK–12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Remember the tornado on the first page of this chapter? Tornadoes usually occur along cold fronts. Tornadoes are one type of storm. What are some other types of storms?

Tornadoes usually form during severe thunderstorms or hurricanes. Do you know why?

16.4 Lesson 16.3: Storms

Key Concepts

- Definition of storm
- Thunderstorms
- Tornadoes
- Hurricanes
- Blizzards and lake-effect snow

Standards

Lesson Objectives

- Define storm.
- Explain why thunderstorms occur.
- Describe tornadoes.
- Explain how hurricanes form.
- Identify two types of winter storms.

Lesson Vocabulary

- **blizzard:** snow storm with high winds and reduced visibility because of wind-blown snow
- **hurricane:** large storm with high winds and heavy rains that develops from a tropical cyclone over warm ocean water
- **lake-effect snow:** heavy snowstorm that occurs when winter winds pick up moisture as they pass over a relatively warm lake and then drop the moisture as snow on the leeward side of the lake
- **lightning:** huge spark that jumps between oppositely charged parts of the same cloud, between one cloud and another, or between a cloud and the ground during a thunderstorm
- **storm:** episode of severe weather caused by a major disturbance in the atmosphere
- **storm surge:** high water that rushes ashore when the eye of a hurricane passes over the coastline
- **thunder:** loud sound that occurs following lightning because the air heats and expands so quickly that it explodes
- **thunderstorm:** storm with heavy rain and lightning
- **tornado:** small but powerful storm with very strong, whirling winds that may occur with a thunderstorm or hurricane
- **wind chill:** temperature the air feels like that takes into account actual air temperature and wind speed

Teaching Strategies

Introducing the Lesson

Introduce storms by asking students if they have ever heard the expression "lightning never strikes the same place twice." Point out that lightning often strikes the same place more than once, even when it comes to people. Although an individual's chances of being hit by lightning are very low (estimated to be between 1 in 350,000 and 1 in 600,000), some people have been stuck by lightning more than once. In fact, a park ranger named Roy C. Sullivan has been struck by lightning an amazing seven times! He survived all seven strikes, although he lost a toenail, had his eyebrows burned off and his hair seared twice, and also suffered shoulder and leg burns. Close by telling students they will learn more about lightning and other types of severe weather when they read this lesson.

Activity

Have students do the activity at the following URL to gain a better understanding of lightning and how it forms. In the activity, students will perform a series of simple demonstrations showing how an accumulation of electrical charges inside a cloud causes a lightning strike.

http://www.discoveryeducation.com/teachers/free-lesson-plans/stormy-weather.cfm

Differentiated Instruction

Have students start a KWL chart before they read the lesson. They should list anything they already know about storms in the K ("Know") column and anything they want to know in the W ("Want to Know") column. Then, after they read the lesson, they should fill in the most important points that they learned in the L ("Learned") column. Help students find answers to anything they wanted to know but didn't learn by reading the lesson.

Enrichment

Share with students that in March of 1925, thousands of people in three states (Missouri, Indiana, and Illinois) experienced one of the most devastating weather disasters on record. Called the Tri-State Tornado, it was ranked an F5 in tornado intensity on the Fujita scale. This is the highest level of intensity. The tornado destroyed four towns, killed 695 people, and injured 2,000 more. Along with the number of deaths it caused, this tornado also held the record for the longest tornado track and the longest continuous time on the ground. Have students research more recent storms to find out if the Tri-State Tornado still holds these three records and, if not, which tornadoes do.

Science Inquiry

Students can model the role of convection in the formation of a thunderstorm by doing the simple activity at the following URL. Call on students to explain how the model relates to the actual formation of thunderstorms.

http://www.weatherwizkids.com/experiments-make-thunderstorm.htm

Real-World Connection

Have students do the activity at the URL below to learn how houses and other buildings can be designed to resist destruction by tornadoes. Divide the class into groups and have each group use materials you provide and Internet research to design a building that is tornado proof. Each student should sketch a building design and write a paragraph describing the building and explaining its tornado-proof features. Then students within each group should discuss the individual designs and choose the best one. Finally, a representative of each group should present its best design to the class. If possible, invite an architect or engineer to review the students' plans and explain why each would or would not be suited to withstand a tornado.

http://static.discoveryeducation.com/feeds/www/media/FETC-2011/pdf/Tornado1.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the Lesson 16.3 worksheets in *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 16.3 in *CK-12 Earth Science for Middle School*. Answers are provided below.

Lesson Quiz

Check students' mastery of the lesson with Lesson 16.3 Quiz in *CK–12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Storms can be very dangerous. But with advance warning, people can take steps to stay safe. For example, if a hurricane is predicted, they can leave the coast and move inland. How can storms be predicted?

What data are needed to predict storms? How are the data collected?

16.5 Lesson 16.4: Weather Forecasting

Key Concepts

- How meteorologists predict weather
- Technology and computers in weather forecasting
- Weather instruments
- Weather maps

Lesson Objectives

- State how meteorologists predict the weather.
- Outline how technology and computers are used to forecast the weather.
- Describe what weather maps show.

Lesson Vocabulary

- **anemometer:** instrument that measures wind speed
- **barometer:** instrument that measures air pressure
- **hygrometer:** instrument that measures humidity
- **meteorologist:** scientist who studies weather and makes weather forecasts
- **rain gauge:** instrument that measures the amount of rainfall
- **snow gauge:** instrument that measures the amount of snowfall
- **thermometer:** instrument that measures temperature
- **weather balloon:** balloon that rises into the troposphere where it gathers weather data and sends them to the surface
- **weather map:** map that shows actual or predicted weather conditions for a particular geographic area
- **weather satellite:** satellite that orbits Earth and constantly collects and transmits weather data from high above the surface
- **weather station:** one of thousands of devices that each collect weather data at a specific point on Earth's surface
- **wind vane:** instrument that measures wind direction

Teaching Strategies

Introducing the Lesson

Call on students to predict what the weather in their area is likely to be the next day. Then show them tomorrow's weather forecast for their region. (You can obtain a weather forecast from a newspaper or Web site.) Ask students if they know how the weather was predicted. Accept all reasonable responses at this point, and then tell students they will learn how weather is predicted when they read this lesson.

Activity

Students can create natural "hygrometers" to measure humidity with the activity at the following URL. The activity uses pine cones as indicators of humidity. Pine cones open their scales in dry weather in order to disperse their seeds and close their scales in wet weather in order to protect the seeds.

http://school.discoveryeducation.com/curriculumcenter/weather/activity1.html

Building Science Skills

With the activity at the following URL, students will learn some basic rules of thumb for predicting the weather. Then they will practice using the rules to make weather predictions.

http://urbanext.illinois.edu/treehouse/activity_pressure.cfm

Differentiated Instruction

Make a display of several of the common weather instruments described in the lesson (e.g., thermometer, barometer, anemometer, hygrometer, rain or snow gauge, and/or wind vane). Write the name of each instrument on a card and the weather factor it measures. Give students a chance to manipulate and observe the instruments, and have them practice reading current conditions from the instruments. The activity will help students—especially kinesthetic and visual learners—appreciate how weather instruments are used to collect atmospheric data.

Enrichment

Have creative students do the activity at the URL below. They will read a comic about predicting the weather and then use a comic template to create their own weather comic. Make copies of their creations to share with the class.

http://urbanext.illinois.edu/treehouse/activity_comic.cfm

Science Inquiry

In the inquiry activity at the following URL, students will build an anemometer and use it to measure wind speed. They will also apply the Beaufort wind scale to describe the wind speed they measure.

http://school.discoveryeducation.com/curriculumcenter/weather/activity2.html

Real-World Connection

Have groups of students assume they are TV meteorologists and make a weather report. Assign each group a different recent date, and have groups research what the weather was like in their community on that date. They should find data on temperature, precipitation, wind, clouds, and other weather elements. Then they should use the data to make a weather map depicting the weather on that date. Finally, each person in the group should assume the role of a TV meteorologist and use the weather map to describe one of the weather elements.

Reinforce and Review

Lesson Worksheets

Copy and distribute the Lesson 16.4 worksheets in *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions at the end of Lesson 16.4 in *CK–12 Earth Science for Middle School*. Answers are provided below.

Lesson Quiz

Check students' mastery of the lesson with Lesson 16.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In this chapter you learned about weather. Weather is sometimes confused with climate. The two are related but not the same. What is climate?

How does climate differ from weather?

CHAPTER 17 MS TE Climate

Chapter Outline

17.1 CHAPTER 17: CLIMATE
17.2 LESSON 17.1: CLIMATE AND ITS CAUSES
17.3 LESSON 17.2: WORLD CLIMATES
17.4 LESSON 17.3: CLIMATE CHANGE

17.1 Chapter 17: Climate

Chapter Overview

This chapter describes factors that affect climate, the different climates found worldwide, and the causes and effects of climate change.

Online Resources

See the following Web sites for appropriate laboratory activities:

The two-part lab at the following URL is a good way to begin the chapter. Students will collect and graph local weather data and understand that daily weather measurements are highly variable compared to long-term climate data.

- http://www.science-class.net/Lessons/Weather/climate_weather.pdf

Use a simulation lab to help students understand climate change. The URL below provides access to the simulation and to a worksheet that will guide students through it. With these tools, students will be able to investigate the following research questions: How do greenhouse gases affect the climate? What happens when you add clouds? How do changes in greenhouse gas concentrations affect temperature? Do all atmospheric gases contribute to the greenhouse effect?

- http://phet.colorado.edu/en/contributions/view/3546

Have groups of students do the lab "Global Warming in a Jar," which is described in the following document. The lab provides a set of simple experiments in which students will use models of Earth's atmosphere to learn how it is heated. They will also discover how large bodies of water affect atmospheric warming by storing and releasing energy from the sun.

- http://www.starhop.com/library/pdf/studyguide/elementary/GloJar-7.pdf

These Web sites may also be helpful:

The URL below is one of the best online climate change resources for teachers. It includes a variety of materials for teaching about climate, climate change, and sustainability across the curriculum. You can explore tips, advice, and ideas for teaching this potentially controversial and misunderstood topic, addressing misconceptions, making interdisciplinary connections, and making the topics relevant to students' lives.

- http://serc.carleton.edu/teachearth/site_guides/climate.html

Go the following URL for "Climate Change," a technology-supported middle school science inquiry curriculum. The curriculum focuses on essential climate literacy principles with an emphasis on weather and climate, Earth system energy balance, greenhouse gases, paleoclimatology, and how human activities influence climate change.

Students can use geospatial information technology tools (Google Earth), Web-based tools (including an interactive carbon calculator and geologic timeline), and inquiry-based lab activities to investigate important climate change topics. "Climate Change" is aligned with Essential Principles of Climate Literacy in addition to national science and environmental education standards.

- http://www.ei.lehigh.edu/eli/cc/

At the following URL, you can download a climate change guide that contains information and activities relating to climate change that are suitable for grades 7–12.

- http://dnr.wi.gov/org/caer/ce/eek/teacher/climatechangeguide.htm

You can access many climate change resources for teachers and students at this URL: http://www.globalsystemsscience.org/uptodate/cc .

At the URL below, you can link to numerous games and simulations relating to climate.

- http://spark.ucar.edu/longcontent/games-sims-weather-climate-atmosphere

This guide points K-12 educators to the best sites for teaching about climate change: several that offer first-rate background material, and others that include detailed lesson plans and experiments. It begins with the top ten things students people need to know about global warming and why there is so much controversy surrounding this issue.

- http://hdgc.epp.cmu.edu/teachersguide/teachersguide.htm

Explore best practices for teaching global climate change to middle- and high-school students with these free, self-paced modules for teachers. Each module includes STEM resources that will increase your knowledge of climate change concepts and can be used directly with students.

- http://climate.nasa.gov/education/pbs_modules

Pacing the Lessons

TABLE 17.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
17.1 Climate and Its Causes	1.5
17.2 World Climates	1.5
17.3 Climate Change	1.5

17.2 Lesson 17.1: Climate and Its Causes

Key Concepts

- Definition of climate
- Latitude and climate
- Effects of oceans on climate
- Mountains and climate

Lesson Objectives

- Define climate.
- State how climate is related to latitude.
- Explain how oceans influence climate.
- Describe how mountains affect climate.

Lesson Vocabulary

- **climate:** average weather of a place over many years
- **rain shadow:** area that receives very little precipitation because of a nearby mountain range

Teaching Strategies

Introducing the Lesson

Introduce climate by relating it to weather. Call on volunteers to define weather and identify factors that make up weather. (Weather refers to conditions of the atmosphere at a given time and place. Weather factors include temperature, air pressure, humidity, and precipitation.) Explain to students that climate is the average weather of a given place over a period of many years. State that temperature and precipitation are the most important weather factors when it comes to climate, because climates are classified on the basis of average temperature and precipitation. Tell students they will learn more about climate and how it is classified when they read this chapter.

Activity

Discuss the important role of latitude in determining the climate of a place, particularly a place's temperature. Then have students investigate the effects of latitude on average temperature with the interactive illustration at the following URL. They can compare cities in the New World that are located at a range of different latitudes, from Moosonee, Canada (about 52 degrees north latitude), to Quito, Ecuador (0 degrees latitude).

http://people.cas.sc.edu/carbone/modules/mods4car/ccontrol/controls/latitude.html

Building Science Skills

Have students do the first activity (Part A) at the URL below. The activity is written for Wisconsin students but it can be used by students in any location. In the activity, students will gather and graph weather data for specific previous years and also average weather data for their locality. They will consider how graphs for specific years compare with the average graph. Then they will explain what the graphs say about the differences between weather and climate. The PDF document includes sample data, a student worksheet, discussion questions, and extension ideas.

http://dnr.wi.gov/org/caer/ce/eek/teacher/Climateguide/pdf/01-1017-weatherclimate.pdf

Differentiated Instruction

Ask a pair of students to add the term climate to the word wall. They should write the term and its definition on an index card and post the card on the wall along with other terms for the course.

Differentiated Instruction

Divide the class into pairs that include students of different ability levels or learning modalities. Then have partners work together to make a concept map entitled "Factors that Affect Climate." The concept map should relate the effects of latitude, oceans, and mountain ranges on climate.

Enrichment

Ask a few students to make a two- or three-dimensional model that illustrates the rain shadow effect and why it occurs. Have the students explain their model to the class, and then display it in the classroom. Call on other students to identify areas on Earth where they think rain a shadow effect is likely to occur.

Enrichment

If students are interested in learning more about global air circulation, which is a main determinant of climate, they can view one or more of the animations at the following URLs:

- http://www.informmotion.biz/EarthLabs/Moving_Heat.html
- http://higheredbcs.wiley.com/legacy/college/strahler/0471417416/animations/ch05/page6.mov
- http://www.geography.hunter.cuny.edu/tbw/wc.notes/7.circ.atm/animations/GlobalWind.html
- http://kisdwebs.katyisd.org/campuses/MRHS/teacherweb/hallk/Teacher%20Documents/AP%20Biology%20Materials/Ecology/Tropical%20Atmospheric%20Circulation/50_A01s.swf
- http://www.youtube.com/watch?v=DHrapzHPCSA

Science Inquiry

Divide the class into groups, and have students within each group collaborate in making a table or graph that compares altitudes and average temperatures of several different cities that are located at about the same latitude but at very different altitudes. (They can find a list of cities by of latitude at the first URL below.) They should choose inland cities to avoid introducing another factor that might influence temperature. Alternatively, you can have groups do the activity "Elevation and Temperature" at the second URL below. The activity guides students through a comparison of temperature data for several locations at different elevations in Ecuador to discover the effect that elevation has on temperature.

http://en.wikipedia.org/wiki/List_of_cities_by_latitude

http://www.ciese.org/curriculum/weatherproj2/en/activityC3.shtml

Science Inquiry

Have students do the inquiry activity at the URL below to gain a better understanding of the effects of land and ocean heating on climate. Using a few simple materials, students will collect and graph data that illustrate how dark land surfaces, light land surfaces, and water heat at different rates. After the activity, relate the results to differences in local climates that are caused by location relative to an ocean.

http://www.science-class.net/Lessons/Weather/heating_the_earth.pdf

Common Misconceptions

A common misconception is that climate is simply long-term weather and therefore can't be predicted. Make sure students understand that climate is the statistical analysis of weather. It is weather averaged over a long period of time and generally over a large area. As a result, it is more predictable than weather. The activity at the following URL is an excellent way to make sure students have a complete and correct understanding of weather and climate and how they are related.

http://www.ciese.org/curriculum/weatherproj2/en/activityC5.shtml

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 17.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In this lesson, you read how latitude, oceans, and mountains affect climate. Do you think you could predict the climate of a place, based on its location?

Do you think that similar locations around the globe might have the same climate?

17.3 Lesson 17.2: World Climates

Key Concepts

- Major climate types
- Microclimates

Lesson Objectives

- Identify world climates and where they are found.
- Define microclimate, and give an example.

Lesson Vocabulary

- **alpine tundra:** polar climate found at high altitudes at any latitude
- **biome:** major climate type and the organisms that live there
- **continental climate:** climate that is harsh and may be dry because it is inland and not affected by an ocean
- **desert:** very dry climate that receives less than 25 centimeters (10 inches) of precipitation each year
- **humid continental climate:** moist inland climate found between 40 ° and 60 ° north latitude
- **humid subtropical climate:** moist temperate climate found on the east sides of continents between about 20 ° and 40 ° latitude
- **marine west coast climate:** temperate climate found on the western coasts of continents between 45 ° and 60 ° latitude
- **Mediterranean climate:** climate with dry summers that occurs on the western sides of continents between 30 ° and 45 ° latitude
- **microclimate:** local climate that differs from the major climate type of the region where it is located
- **polar climate:** climate found near the poles or at high altitudes at lower latitudes that has very cool summers, frigid winters, and low precipitation
- **polar tundra:** polar climate found near the poles and characterized by permafrost
- **steppe:** semi-arid climate that receives up to 40 centimeters (16 inches) of precipitation each year
- **subarctic climate:** continental climate found between 60 ° and 70 ° north latitude
- **temperate climate:** climate that has moderate temperatures
- **tropical climate:** climate found near the equator that has warm temperatures year round
- **tropical rainforest:** forest that grows in tropical climates that have high rainfall year round

Teaching Strategies

Introducing the Lesson

Call on students to describe the climate where they live. Ask them specifically to describe what the weather is typically like during each season of the year. Tell them how their climate is classified, i.e., the name of their climate type. Then tell them they will learn more about their climate type and other types of climates when they read this lesson.

Cooperative Learning

Have students play the role of scientists who are participating in a poster session at a scientific conference. Their job is to create a poster about a given climate type and present it to other "scientists" attending the conference. Divide the class into five groups, and assign each group one of the five major climate types described in the FlexBook® lesson. Tell group members to collaborate on learning more about their climate type and making a poster that illustrates typical weather and examples of plants and animals found in that climate. Students should be prepared to answer any questions other groups may have about their climate type during the poster presentation.

Building Science Skills

Students can investigate the effects of latitude, elevation, and local geography on temperature with the activity at the URL below. In the activity, students will draw on their own knowledge and experience with weather to predict current temperatures in their country and in other countries around the world. Then they will compare their predictions with real-time weather data. Finally, they will develop hypotheses regarding how and why latitude, elevation, and local geography affect temperature.

http://www.ciese.org/curriculum/weatherproj2/en/activityC1.shtml

Differentiated Instruction

Advise struggling students to focus on the five major climate types and their basic characteristics, rather than trying to learn all the details about all the subtypes. Suggest to the students that they make a simple chart in which they list the names of the five major types and add a few key terms that summarize the main characteristics of each type.

Enrichment

Ask one or more students to make a crossword puzzle that incorporates all or most of the lesson vocabulary terms. They can use the free puzzle maker at the following URL. Tell them to be creative with their clues in order to make the puzzle more challenging. Make copies of their puzzle for other students to solve as a review of lesson vocabulary.

http://www.discoveryeducation.com/free-puzzlemaker/?CFID=306515&CFTOKEN=62553182

Science Inquiry

Students can develop science classification skills and at the same time learn more about specific types of climate with this simple activity. First, have each student research the climate of a particular city that interests them. They should compile basic climate statistics for the city, such as the average high and low temperatures and the average timing and amount of precipitation. They should also learn how the climate of the city is classified. This part of the activity could be done outside of class as a homework assignment. After students have gathered the information, call on each student in turn to describe the climate of his or her chosen city without revealing its name and location. Challenge the rest of the class to correctly classify the climate based on the information provided.

Life Science Connection

Point out how the type of climate in a region is related to the types of plants and animals that live there. Then introduce students to biomes. Explain that biomes are the world's major communities of living things, classified according to the predominant vegetation and characterized by adaptations of organisms to that particular environment. Then have students go to the URL below. They will be able to view dozens of slides of organisms that live in different biomes around the world. Tell students to think about how the organisms in each biome are adapted to the type of climate in which they live.

http://www.saburchill.com/chapters/chap0051.html

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 17.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Earth's overall climate is getting warmer. Why is Earth's climate changing?

How is climate change affecting living things?

17.4 Lesson 17.3: Climate Change

Key Concepts

- How Earth's climate has changed
- Earth's recent temperature trends
- Causes of long-term climate change
- Short-term climate changes and their causes
- Predicting future climate change

Lesson Objectives

- Outline how Earth's climate has changed over time.
- Identify causes and effects of climate change.
- Describe El Niño and La Niña.

Lesson Vocabulary

- **El Niño:** naturally occurring, short-term worldwide climate change that occurs when the Pacific Ocean is warmer than usual
- **global warming:** recent increase in Earth's temperature due mainly to human actions, especially the burning of fossil fuels
- **ice age:** period when Earth's temperatures are cooler than normal and glaciers spread to lower latitudes than usual
- **La Niña:** naturally occurring, short-term worldwide climate change that occurs when the Pacific Ocean is cooler than usual

Teaching Strategies

Introducing the Lesson

Share the following startling facts and figures about recent global climate change with your class. Then tell students they will learn more about climate change when they read this lesson.

- Earth's average temperature has risen by 1.4 °F over the past century and is projected to rise another 2 to 11.5 °F over the next century.
- In Alaska, western Canada, and eastern Russia, average temperatures have increased as much as 4 to 7 °F in just the past 50 years.

- Fourteen of the hottest years on record have occurred in the last 16 years.
- Small changes in the average temperature of the planet can translate into large and potentially dangerous shifts in climate and weather.
- The current pace of rising global temperatures puts as many as 30 percent of plant and animal species at significant risk of extinction.

Activity

Students will have a better understanding of El Niño by doing the hands-on activity at the first URL below. In the activity, they will use simple materials to model El Niño. Questions are provided to help students analyze their data, interpret the results, and draw conclusions. After the hands-on activity, students can go to the second URL below to track occurrences of El Niño through time with an interactive timeline.

http://www.science-class.net/Lessons/Weather/ElNinoinBowl.pdf

http://www.pbs.org/wgbh/nova/elnino/reach/time.html

Activity

You may want to have students explore the excellent EPA climate change learning module at the URL below. Using a variety of interactive multimedia, the module offers background information, online activities, and other resources on recent climate change, including its causes and impacts around the world.

http://www.epa.gov/climatechange/kids/index.html

Building Science Skills

In the activity at the following URL, students will examine graphs of greenhouse gas emissions and their increases associated with human activity. They will also calculate their personal contributions to CO_2 emissions. By doing the activity, students will be able to identify sources of the major greenhouse gases and current trends in atmospheric concentrations. They will also be able to calculate greenhouse gas emissions on personal and larger scales.

http://www.ucar.edu/learn/1_4_2_20t.htm

Building Science Skills

Have students do the second activity (Part B) at the URL below. They will evaluate data and graphs depicting very long-term climate trends extending over hundreds or thousands of years to see what this information indicates about climate and climate change on Earth. The PDF document includes a student worksheet, discussion questions, and extension ideas.

http://dnr.wi.gov/org/caer/ce/eek/teacher/Climateguide/pdf/01-1017-weatherclimate.pdf

Differentiated Instruction

Ask a pair of students to add the term global warming to the word wall. They should write the term and its definition on an index card. Suggest that they also list some of the major causes and effects of global warming on the card before posting it on the wall.

Differentiated Instruction

Have students think about the questions listed below. Then pair less proficient readers and English language learners with other students, and ask partners to share and discuss their answers to the questions.

1. How has Earth's average temperature changed since 1960?
2. How has the amount of carbon dioxide in the atmosphere changed since 1960?
3. How are the changes in temperature and carbon dioxide related?

Enrichment

Ask a few students to collaborate on creating a visual display, such as a slide show or PowerPoint presentation, on the Pleistocene ice ages. The display should include maps that show the extent of glaciation in North America during the epoch and images of typical vegetation and animals that lived in North America during that time. Schedule class time for the students to present their slide show or PowerPoint to the class.

Science Inquiry

The following simple experiment serves as an introduction to the greenhouse effect. Students can see for themselves the effects of a greenhouse on air temperature and relate it to what occurs in the atmosphere. Specific objectives include helping students understand the greenhouse effect as a physical phenomenon and developing their basic science skills of observing and recording data, using a control, using a model, and drawing conclusions from results.

http://sln.fi.edu/tfi/activity/earth/earth-5.html

Common Misconceptions

There are many misconceptions about global warming. For example, some people think that it is caused by the hole in the ozone layer, which they believe allows more solar radiation to reach Earth's surface. Stress that global warming is caused by increased greenhouse gases in the atmosphere. These gases include carbon dioxide and water vapor, which trap infrared radiation from the warmed surface of Earth so it doesn't escape into space. Point out that, although the ozone hole does allow more UV light to reach the surface, this is not an important factor leading to increased temperatures on Earth. You can find additional misconceptions about climate change at these URLs:

- http://cires.colorado.edu/education/outreach/climateCommunication/CC%20Misconceptions%20Handout.pdf
- http://www.c2es.org/publications/realities-vs-misconceptions-about-science-climate-change

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 17.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

A place's climate determines what kinds of plants and animals can live there. Would you expect similar plants and animals to be found in the same type of climate all over the world?

Besides climate, what factors might influence which plants and animals are found in a place?

CHAPTER 18 MS TE Ecosystems and Human Populations

Chapter Outline

18.1 CHAPTER 18: ECOSYSTEMS AND HUMAN POPULATIONS
18.2 LESSON 18.1: ECOSYSTEMS
18.3 LESSON 18.2: CYCLES OF MATTER
18.4 LESSON 18.3: THE HUMAN POPULATION

18.1 Chapter 18: Ecosystems and Human Populations

Chapter Overview

This chapter describes ecosystems and explains how matter and energy flow through ecosystems. It also describe how the human population has grown and how it affects our global ecosystem

Online Resources

See the following Web sites for appropriate laboratory activities:

In the lab at the following URL, students will simulate predator-prey interactions. The number of predator and prey "animals" in their "ecosystem" will be recorded and graphed to represent a predator-prey cycle in an ecosystem.

- http://www.biologycorner.com/worksheets/predatorsim.html

In the classic owl pellet lab described at the first URL below, students will dissect owl pellets to determine the organisms an owl eats and identify its niche. As an alternative option, students can do the virtual owl pellet dissection at the second URL below.

- http://www.biologycorner.com/worksheets/owlpellet.html
- http://www.kidwings.com/owlpellets/flash/v4/index.htm

Use the excellent NSTA inquiry-based module at the following URL to teach your class about the carbon cycle. The module includes complete instructions for a classroom experiment that introduces students to the chemistry of the carbon cycle. It allows students to observe the influence of the carbon cycle on algae growth, form a hypothesis, explore experimental design, collect data, and draw a conclusion. Pre- and post-assessment questions, diagrams, student data sheets, several worksheets, and additional activities are all included.

- http://www.nsta.org/images/news/legacy/scope/0601/DrouinExtension.pdf

In the carbon cycle lab at the following URL, students will investigate how carbon cycles through the Earth system, including the atmosphere, hydrosphere, geosphere, and biosphere. As students investigate the cycle, they will find answers to the following questions: How does carbon move from one sphere to another? How does carbon change as it moves from one part of the carbon cycle to another? Where is carbon stored and for how long is it stored? After they complete the lab, students will be able to describe the processes of photosynthesis, cellular respiration, and decomposition; identify the major carbon reservoirs and describe how carbon is stored in these reservoirs; describe the effects of positive and negative feedback on the carbon cycle; and provide examples of the various time scales at which carbon moves through Earth's spheres.

- http://serc.carleton.edu/eslabs/carbon/lab2.html

These Web sites may also be helpful:

At this URL, you can find a large collection of teacher-approved videos about ecosystems, biomes, and populations.

- http://www.neok12.com/Ecosystems.htm

For more information and many links on ecosystems, biomes, and habitats, go to this URL: http://www.fi.edu/tfi/units/life/habitat/ .

A more sophisticated overview of cycles of matter, including some cycles not covered in the chapter, is available here: http://www.lenntech.com/matter-cycles.htm .

You can find an educator's guide to cycles of matter and the flow of energy through ecosystems at the following URL.

- http://astroventure.arc.nasa.gov/teachers/pdf/AV-Biolesson-6.pdf

Go to the URLs below for collections of middle school activities related to the human population.

- http://www.worldof7billion.org/teacher_resources
- http://education.nationalgeographic.com/education/collections/population-7-billion/?ar_a=1

Pacing the Lessons

TABLE 18.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
18.1 Ecosystems	2.0
18.2 Cycles of Matter	1.5
18.3 The Human Population	1.5

18.2 Lesson 18.1: Ecosystems

Key Concepts

- Definition of ecosystem
- Abiotic factors
- Biotic factors
- Roles in ecosystems
- Flow of energy through ecosystems
- Flow of matter through ecosystems

Lesson Objectives

- Define ecosystem, and give examples.
- Identify abiotic factors in ecosystems.
- Describe biotic factors in ecosystems.
- Explain how energy flows through ecosystems.
- Outline how matter moves through ecosystems.

Lesson Vocabulary

- **abiotic factor:** nonliving part of an ecosystem such as air or soil
- **biotic factor:** living part of an ecosystem such as a species of producers
- **carnivore:** consumer that eats only animals
- **community:** all the populations of all the species that live together in an ecosystem
- **consumer:** organism that consumes other living things
- **decomposer:** organism that breaks down dead organisms or the wastes of living things and releases their nutrients back into the environment
- **ecosystem:** group of living things and their environment
- **food chain:** simple diagram showing one way that energy flows through an ecosystem
- **food web:** complex diagram showing multiple ways that energy flows through an ecosystem
- **grazer:** organism that feeds on other living things without killing them
- **habitat:** place where a species is best suited to live
- **herbivore:** consumer that eats only plants
- **niche:** a species' particular way of "making a living"
- **nutrient:** nonliving matter that living things need
- **omnivore:** consumer that eats both plants and animals
- **population:** all the members of a species that live in the same area
- **predator:** consumer that hunts and captures other living things for food
- **prey:** organism that is hunted by a predator
- **producer:** organism that uses energy to make food for itself and other living things

- **scavenger:** consumer that eats organisms that are already dead
- **species:** unique group of organisms that can interbreed and produce fertile offspring together but not with members of other such groups

Teaching Strategies

Introducing the Lesson

Most students will have been introduced to ecosystems in prior classes, such as life science. Help them recall what they already know. Call on volunteers to define the term ecosystem. Call on other students to give examples of ecosystems or to state facts they know about ecosystems. Accept all reasonable responses at this point. Then tell students they will learn more about ecosystems when they read this lesson.

Building Science Skills

Students can practice identifying the roles played by different species in an ecosystem by playing the game at the URL below. They have the option to play the game with four different ecosystems.

http://www.gould.edu.au/foodwebs/kids_web.htm

Activity

Have students complete the food web worksheet at the following URL. They will identify the roles played by different organisms in a food web and then create a food web of their own.

http://www.biologycorner.com/worksheets/foodweb.htm

Differentiated Instruction

This lesson introduces many new vocabulary terms, and some of them are extremely important and basic terms. Assign several of the most important vocabulary terms from the lesson to pairs of students, and ask partners to add their term to the world wall. For each word, students should write the term on an index card, define it, and give examples. Important terms to assign include all or some of the following: ecosystem, community, niche, population, and/or species.

Enrichment

Ask a few students to make crossword puzzles that include at least 12 of the lesson vocabulary terms. Suggest that they avoid straightforward definitions of the terms as clues in order to make their puzzles more challenging. Make copies of the puzzles to distribute to the rest of the class, and have the other students complete the puzzles as a homework assignment.

Science Inquiry

In the inquiry activity "Ecosystems at School" (see URL below), students will demarcate an outdoor ecosystem, study it, and identify its biotic and abiotic components. The activity could be done on the school grounds or in a park or other natural area.

http://www.science-class.net/Lessons/Ecology/Ecosystems_Biomes/Ecosystems_at_School.pdf

Common Misconceptions

Students commonly think that organisms higher in a food chain eat everything that is lower in the food chain. Be sure to correct this misconception in your students. Explain that organisms higher in a food chain eat some, but rarely all, of the organisms below them in the food chain. Give them concrete examples that demonstrate this point. For example, call students' attention to the sample food chain in the FlexBook® lesson, and discuss how the hawk (tertiary consumer) may eat the other bird (secondary consumer) but is unlikely to eat the snail (primary consumer) because it is so small, and it would never eat the grasses or other plants (producers) because the hawk is a carnivore.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 18.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In this lesson, you read that matter is recycled in ecosystems. You already know how water is recycled. Its cycle includes living things, the air, and the oceans. In the next lesson, you'll read about the cycles of two important nutrients, starting with carbon. Can you predict how carbon cycles?

Do you think carbon cycles between living and nonliving things?

18.3 Lesson 18.2: Cycles of Matter

Key Concepts

- Elemental carbon
- Carbon cycle
- Nitrogen cycle

Lesson Objectives

- Explain why carbon is important to life.
- Outline the carbon cycle.
- Give an overview of the nitrogen cycle.

Lesson Vocabulary

- **carbon cycle:** continuous cycle in which carbon moves through living and nonliving things, including the atmosphere and fossil fuels
- **dead zone:** area in a body of water where nothing grows because there is too little oxygen
- **nitrogen cycle:** continuous cycle in which nitrogen moves through living and nonliving things, including the atmosphere and soil

Teaching Strategies

Introducing the Lesson

Introduce the carbon and nitrogen cycles by reviewing the elements carbon and nitrogen. Share some of the information about these two elements that is provided at the URL below. Then tell students they will learn in this lesson how these two types of matter cycle through ecosystems.

http://www.webelements.com/

http://periodic.lanl.gov/index.shtml

Demonstration

Give students a detailed visual overview of the carbon cycle by showing them the animated Carbon Cycle Cartoon at this URL: http://www.neok12.com/php/watch.php?v=zX670b656f7c786e7d674f63&t=Carbon-Cycle .

Activity

The activity at the following URL uses a game to introduce students to the carbon cycle. It will help them see how carbon in the atmosphere is connected to living things. Specific activity objectives are for students to describe the carbon cycle, the journey a carbon atom might take on its way through the cycle, and how trees help to store carbon.

http://www.rainforest-alliance.org/curriculum/climate/activity2

Differentiated Instruction

Work with students to make simplified cycle diagrams of the biotic and abiotic carbon cycles. Their diagrams can be based on the carbon cycle diagram in the FlexBook® lesson, but they should include less detail. For example, the amount of carbon stored in various reservoirs should not be included. Tell students to keep their cycle diagrams in their science notebook.

Enrichment

Ask a group of students to do the nitrogen cycle role-playing activity on pages 40–45 of the PDF document below. Through the role-play, the students will consider the agricultural and environmental consequences that occur when the nitrogen cycle is interrupted. After students prepare for the role-play, set aside 20 minutes for them to present it to the class. The role-play will help reinforce the idea that human actions affect natural cycles and that their own individual actions can make a difference to environmental quality.

http://www.cfaitc.org/lessonplans/pdf/402a.pdf

Science Inquiry

With the inquiry activity at the following URL, students will construct a scientific model of the carbon cycle to show how matter is continuously transferred within and between organisms and their physical environment.

http://summit.cecs.ucf.edu/v2/w2file.php?id=233

Real-World Connection

The activity at the URL below will show students how communities can help with carbon sequestration by preventing deforestation of their local forest resources. The activity involves a real-world case study. From the activity, students will learn the importance of forests for carbon sequestration and how sequestration can be used to boost a local economy through the sale of carbon credits.

http://www.rainforest-alliance.org/curriculum/climate/activity5

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 18.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In this lesson, you read how human actions influence the carbon and nitrogen cycles. Human actions influence many natural processes. The influence may be great. One reason is that there are so many people on the planet. Do you know how many people live in the world today?

Why has the human population grown so large?

18.4 Lesson 18.3: The Human Population

Key Concepts

- Population growth rate and carrying capacity
- Human population growth
- Human population and the environment

Lesson Objectives

- Explain how populations grow.
- Describe how the human population has grown.
- State how the human population affects the environment.

Lesson Vocabulary

- **carrying capacity:** maximum population of a species that can be supported by its environment
- **demographic transition:** changes in population birth, death, and growth rates that first occurred in Europe and North America beginning around the time of the industrial revolution
- **green revolution:** revolution in agriculture that began in the mid-1900s and increased food production with the use of new methods and products such as chemicals to control weeds
- **population growth rate (r):** speed at which a population grows
- **sustainable development:** using resources in such a way that people will have what they need but the resources will not run out and the planet will not be harmed

Teaching Strategies

Introducing the Lesson

Introduce the human population by showing students a worldwide human population clock at one of the following URLs. It will show them how quickly the human population is growing. Tell students they will learn why there are so many people and why the human population is growing so rapidly when they read this lesson.

- http://www.census.gov/popclock/
- http://www.worldometers.info/world-population/
- http://galen.metapath.org/popclk.html

Demonstration

Demonstrate population growth with the video at the following URL. The video will help students visualize how changing birth and death rates affected human population growth in different areas of the world over the past 1000 years.

http://www.npr.org/2011/10/31/141816460/visualizing-how-a-population-grows-to-7-billion

Building Science Skills

With the hands-on activity at the URL below, students can experience the changing pace of human population growth by simulating Earth's population growth over the last 500 years. In addition to the activity procedure and materials, the PDF document includes discussion questions and a follow-up activity.

http://www.worldof7billion.org/images/uploads/w7b_Population_Circle.pdf

Differentiated Instruction

Have students make a KWL chart for the lesson. It will help them recall anything they may already know about the human population and focus their reading on what they would like to know. Tell them to make a three-column chart with the headings Know, Want to Know, and Learned. They should fill in the Know and Want to Know columns before they read the lesson and the Learned column after they read the lesson. Ask students what they think is the most important thing they learned from the lesson.

Enrichment

Suggest that interested students do a Web quest to find answers to the following questions:

1. Who was Thomas Malthus?
2. What did Malthus write about populations?
3. How did Malthus' writings influence Darwin and his theory of evolution?
4. Do Malthus' ideas apply to the human population? Why or why not?

Science Inquiry

Use the activity at the URL below so students can analyze the way the human population has affected the planet. In the activity, students will learn about the Human Footprint data set, analyze a map showing where and to what extent humans have influenced Earth, and participate in a class discussion. The URL provides all of the materials and instructions needed for the activity.

http://education.nationalgeographic.com/education/activity/mapping-our-human-footprint/?ar_a=1&ar_r=999

Common Misconceptions

There are many misconceptions about the human population, its growth rate, and the causes and consequences of human overpopulation. The article at the following URL discusses ten of these misconceptions. Discuss some or all of the misconceptions with your students. Explain how the misconceptions originated as well as why they are incorrect.

http://discovermagazine.com/1996/apr/tenmythsofpopula737

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 18.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In this chapter, you read how humans are harming the environment. For example, we are quickly using up many natural resources. Soil is one of our most precious natural resources. It takes a very long time to form. But it can be washed away in a single rainstorm. How do you think human actions are affecting the soil?

What can people do to protect this important resource?

CHAPTER 19 MS TE Human Actions and the Land

Chapter Outline

19.1 CHAPTER 19: HUMAN ACTIONS AND THE LAND

19.2 LESSON 19.1: LOSS OF SOIL

19.3 LESSON 19.2: POLLUTION OF THE LAND

19.1 Chapter 19: Human Actions and the Land

Chapter Overview

This chapter discusses how human actions have caused soil erosion and pollution of the land surface, as well as how these problems can be prevented.

Online Resources

See the following Web sites for appropriate laboratory activities:

The "Soil and Erosion" lab at the following URL allows students to use science inquiry to investigate the effects of rainfall-induced erosion on bare soil versus vegetated soil. Students will form and test a hypothesis and control variables. The lab uses simple materials, available from a supermarket and garden center, including aluminum pans, soil, and plants. The lab could easily be extended or modified to test the effects of other variables, such as slope, on erosion of soil by water.

- http://oregonstate.edu/precollege/GK12/Activities/ACT_EnvironStudies/ENVIRON_68_SoilAndErosion/SoilAndErosion.html

With the lab described at the URL below, students will gain an appreciation for how scientists determine the human health effects of hazardous substances. Students will also demonstrate how hazardous substances can affect the health of test animals. (Note: This activity involves the exposure of worms to a hazardous substance. Some students may object to this on ethical grounds. Provide these students with an alternative activity.)

- http://www.epa.gov/superfund/students/clas_act/haz-ed/act05.htm

These Web sites may also be helpful:

At the following URL from the Soil Science Society of America, you can find a collection of middle school teaching resources pertaining to soil.

- https://www.soils.org/about-soils/lessons/resources

You can find excellent photos and videos of soil erosion, including historical images from the Dust Bowl, at this URL: http://www.soilerosion.net/doc/photos_videos.html .

Additional soil erosion videos are available here: http://www.ewg.org/losingground/index.html .

At the following URL, you can access Hazed teaching materials from the EPA. The materials include interdisciplinary activities that focus on scientific, technical, and policy issues relating to hazardous waste sites and the Superfund. They are designed to help middle and high school students develop skills in critical thinking, problem solving, and decision making. They also increase environmental awareness and encourage an environmental ethic in students.

- http://www.epa.gov/superfund/students/clas_act/haz-ed/hazindex.htm

Pacing the Lessons

TABLE 19.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
19.1 Loss of Soil	1.5
19.2 Pollution of the Land	1.5

19.2 Lesson 19.1: Loss of Soil

Key Concepts

- How human actions cause soil erosion
- Ways to prevent soil erosion

Lesson Objectives

- Identify human actions that increase soil erosion.
- List ways to reduce soil loss.

Lesson Vocabulary

- **contour cropping:** planting crops in curved rows to follow the contour of hills in order to reduce runoff and soil erosion
- **cover crop:** crop that is planted to cover and protect the soil from erosion during seasons when other crops do not grow
- **no-till planting:** planting crops without plowing first, so the soil is not disturbed and dead plants remain to protect the soil from erosion
- **strip cropping:** planting strips of groundcover plants between fields of crops to reduce runoff and soil erosion
- **terracing:** building step-like terraces on slopes for planting in order to reduce runoff and soil erosion
- **windbreak:** row of trees planted between fields to slow down the wind and reduce soil erosion

Teaching Strategies

Introducing the Lesson

Use the apple peel demonstration at the following URL to introduce students to the limited amount of soil on Earth. Using an apple to represent planet Earth, you will cut progressively smaller pieces of peel until you have a very small sliver of peel that represents the total amount of soil on the planet. Tell students they will learn how soil is lost and how the loss can be prevented when they read this lesson.

http://soil.gsfc.nasa.gov/index.php?section=70

Building Science Skills

The URL below contains five soil erosion activities. In the activities, students can identify erosion problems at their school and propose solutions. They can also investigate different types of soil erosion through hands-on classroom activities. In addition, they can research erosion in depth and involve their parents in erosion activities.

http://www.cas.miamioh.edu/scienceforohio/Erosion/L.html

Activity

In the activity at the following URL, students will demonstrate the impact of soil erosion using a soil profile. The PDF document provides a detailed lesson plan, student worksheets, and all other materials needed for the activity.

https://www.ffa.org/documents/learn/MS.NR.4.1.pdf

Differentiated Instruction

Work with students to make a cluster diagram of human actions that accelerate soil erosion. You can make the diagram on a chalkboard, whiteboard, or overhead transparency. Surrounding a central circle labeled "Human Actions and Soil Erosion," add circles labeled with each of the following: "Growing Crops," "Grazing Animals," "Logging," "Mining," "Construction," and "Recreation." Call on students to contribute important details to each of the surrounding circles.

Enrichment

Some students may be interested in reading first-hand or fictional accounts of people who experienced the Dust Bowl. Some recommendations are listed below. Ask the students to write a short book review and share it with the class.

- Voices of the Dust Bowl (2012), by Sherry Garland
- Survival in the Storm (2002), by Katelan Janke
- Out of the Dust (2005), Karen Hesse
- No More Tears, No More Tears! (2011), by Chloe Noble Kavanaugh

Science Inquiry

If you do the demonstration described in the URL below, you will create an apparatus to simulate soil erosion by water. Then you will use the device to demonstrate how various mulches and organic soil additives affect the amount of soil that eroded. Before you test each type of mulch or additive, have students predict how well they think it will reduce soil erosion. They can determine if they are correct by observing the water that collects from the device. They should infer that darker colored water contains more eroded soil.

http://soils.usda.gov/education/resources/lessons/experiments/erosion/

Common Misconceptions

A common misconception is that erosion is the process by which weathered particles are deposited in a new location. Explain to students that erosion is the transport, or movement, of particles but it does not involve the settling and accumulation of particles in a new location. The process by which particles are deposited and build up in a new location is called deposition. Deposition is responsible for creating sand dunes, deltas, alluvial fans, loess deposits, and some mountains.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 19.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Increasing soil erosion isn't the only way that human actions can affect the land. Many human actions also pollute the land. What is pollution?

What human actions might pollute the land?

19.3 Lesson 19.2: Pollution of the Land

Key Concepts

- The Love Canal Disaster
- Pollution by hazardous waste
- Controlling hazardous waste

Lesson Objectives

- Describe the disaster of Love Canal and what it taught us.
- Identify hazardous waste.
- List ways to control hazardous waste.

Lesson Vocabulary

- **hazardous waste:** waste that is harmful to people or the environment because it is toxic, corrosive, flammable, or explosive
- **pollution:** act of contaminating the environment

Teaching Strategies

Introducing the Lesson

The following URLs are two parts of an excellent video about the Love Canal disaster, which opens this FlexBook® lesson. The video is an excellent way to introduce pollution of the land.

- http://www.youtube.com/watch?v=PKUyOLXtUsQ
- http://www.youtube.com/watch?v=MXSE9kcBQCI

Activity

Students can learn about hazardous waste with the activity described at the following URL. In the activity, students will define and explore the relationship between hazardous substances and hazardous waste. They will also identify some commonly used hazardous chemicals, describe how they are used and disposed of, and sort them into the various types of hazardous waste. Finally, students will discuss how the improper use and disposal of the chemicals may affect people and the environment.

http://www.epa.gov/superfund/students/clas_act/haz-ed/def_hazw.htm

Building Science Skills

The activity at the URL below will help students understand what can be done to reduce the amount of solid and hazardous wastes that must be disposed of. Students will also review the characteristics of hazardous wastes and develop an estimate of the amount of household hazardous waste in their community.

http://www.epa.gov/superfund/students/clas_act/haz-ed/act10.htm

Activity

According to the U.S. Environmental Protection Agency, an estimated 200 million gallons of used motor oil are improperly disposed of each year in the United States by being dumped on the ground, tossed in the trash (ending up in landfills), or poured down storm sewers and drains. Used oil is insoluble and slow to degrade. It also sticks to everything from beach sand to bird feathers and may contain toxic chemicals and heavy metals that pose a health threat to humans, other animals, and plants. The activity "Used Motor Oil" (pages 46–50 at the following URL) examines the potential environmental effects and legal consequences of improperly disposing of used motor oil. It also investigates the environmental and economic benefits of recycling the used oil. The PDF document includes ideas for differentiated instruction.

http://www.greenvillecounty.org/solid_waste/funzone/Lesson_Plans/Palmetto_Pride/Middle.pdf

Differentiated Instruction

Pair a student who is an English language learner or less proficient reader with a student is doing well in the class. Then ask partners to add the term pollution to the word wall. They should write the term and its definition on an index card and also list examples of substances that pollute the land.

Enrichment

Encourage interested students to learn about Superfund sites in their region, such as their state, county, or municipality. An excellent resource is "Superfund Sites Where You Live" at the URL below. Tell the students to find the nearest site; locate it on a map, and then determine its clean-up type. They should also find out who is responsible for the contamination, the chemicals or other hazards involved, and how or if the site has been cleaned up. Ask the students to share what they learn about the site with the rest of the class.

http://www.epa.gov/superfund/sites/

Science Inquiry

In the inquiry activity "What Effect Does Litter Have on the Acid Balance, Temperature, and Permeability of Soil?" (pages 12–17 in the URL below), students can investigate the impact that litter has on soil. They will examine three characteristics of soil—acid balance (pH), temperature, and permeability—in a series of tests that compare uncontaminated soil with soil that has been contaminated by litter.

http://www.greenvillecounty.org/solid_waste/funzone/Lesson_Plans/Palmetto_Pride/Middle.pdf

Real-World Connection

Take your class on a field trip and have them collect samples of soil from a variety of different locations in the community, making note of each location on a map. Take the samples back to school and use test kits to check for levels of lead. (Contact your local extension office for information about lead testing.) Background concentrations of lead that occur naturally in surface agricultural soils in the United States average 10 parts per million (ppm), with a range of 7 to 20 ppm. Lead levels above this range are primarily the result of lead contamination. You may want to expand on the activity by having students to a Web quest to learn about possible sources of lead contamination in soils and the risks of lead contamination to people and the environment. You can learn more about lead in soils at the first URL below. You can find a detailed description of the activity at the second URL.

http://www.extension.umn.edu/distribution/horticulture/DG2543.html

http://www.sciencebuddies.org/science-fair-projects/project_ideas/EnvSci_p001.shtml#summary

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 19.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Besides soil, humans depend on many other natural resources. These other natural resources also must be protected. What are some other natural resources?

What can people do to protect them?

CHAPTER 20 MS TE Human Actions and Earth's Resources

Chapter Outline

20.1 CHAPTER 20: HUMAN ACTIONS AND EARTH'S RESOURCES

20.2 LESSON 20.1: USE AND CONSERVATION OF RESOURCES

20.3 LESSON 20.2: USE AND CONSERVATION OF ENERGY

20.1 Chapter 20: Human Actions and Earth's Resources

Chapter Overview

This chapter describes the human use of renewable and nonrenewable natural resources, including energy resources. It also explains how resources can be conserved.

Online Resources

See the following Web sites for appropriate laboratory activities:

In this lab from the Museum of Science and Industry in Chicago, students will learn the difference between renewable and nonrenewable resources and discover why sustainable use of natural resources is important.

- http://www.msichicago.org/fileadmin/Education/learninglabs/lab_downloads/RE_renewable_or_not.pdf

The lab activity "Old MacDonald Made Some Fuel" on pages 100–110 in the PDF document below allows students to explore how biomass can be used to produce ethanol and methane fuels. Specific student objectives include defining biomass and naming at least 10 sources of biomass, describing fermentation and the production of ethanol, describing the production of methane from manure, and listing advantages and disadvantages of using biomass for energy.

- http://www.tvakids.com/teachers/pdf/renewable_middle.pdf

These Web sites may also be helpful:

You can find a collection of teacher-reviewed educational games, videos, lessons, puzzles, and quizzes pertaining to natural resources at this URL: http://www.neok12.com/Natural-Resources.htm .

There are additional materials for teaching about natural resources at the URL below.

- http://www.teachervision.fen.com/conservation/teacher-resources/55944.html

For a selection of National Geographic educational content relating to natural resources, go to this URL: http://education.nationalgeographic.com/education/topics/natural-resources/?ar_a=1

At the following URL, you can find several middle school activities relating to energy use and energy conservation. The document also contains fact sheets and a glossary.

- http://www.tvakids.com/teachers/pdf/renewable_middle.pdf

Go to the URL below to download the U.S. Department of Energy's teachers' guide Energy Literacy: Essential Principles and Fundamental Concepts for Energy Education.

- http://www1.eere.energy.gov/education/energy_literacy.html

The documents at the URLs below are the teacher and student pages, respectively, of 11 different activities for middle and high school students that teach students basic concepts of energy use and energy conservation. The hands-on activities allow students to explore energy sources and energy efficiency both at school and at home.

- http://need.org/needpdf/Saving%20Energy%20Teacher%20Guide.pdf
- http://need.org/needpdf/Saving%20Energy%20Student%20Guide.pdf

More information and activities on energy use and energy efficiency are available at these URLs. The materials were developed specifically for middle school students. The first PDF document below is intended for teachers and the second document for students. The teachers' guide provides fact sheets about energy, the major energy sources, electricity, energy consumption, energy efficiency, and energy conservation. The background section includes an introduction to energy and details about individual energy sources. There are also sections on global climate change and several detailed fact sheets on electricity and energy consumption and efficiency. The companion student activities book reinforces the general information and facts about the energy sources. The activities include worksheets and crossword puzzles among other types of activities.

- http://www1.eere.energy.gov/education/pdfs/basics_intermediateenergyinfobook.pdf
- http://www1.eere.energy.gov/education/pdfs/basics_intermediateenergyactivities.pdf

You can find several lesson plants on energy for middle school students at this URL: http://www.infinitepower.org/lessonplans.htm .

Pacing the Lessons

TABLE 20.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
20.1 Use and Conservation of Resources	2.5
20.2 Use and Conservation of Energy	1.5

20.2 Lesson 20.1: Use and Conservation of Resources

Key Concepts

- How we use natural resources
- Renewable and nonrenewable resources
- Ways to conserve natural resources

Lesson Objectives

- Describe how people use natural resources.
- List ways to conserve natural resources.

Lesson Vocabulary

- **conservation:** act of saving resources
- **natural resource:** anything in nature that humans need
- **precycling:** buying items with packaging that can be reused or recycled

Teaching Strategies

Introducing the Lesson

Many students are likely to have been introduced to the terms natural resource, renewable resource, and nonrenewable resource in previous classes. Call on volunteers to define or give examples of each term. Accept all reasonable responses. Then tell students they will learn more about natural resources and whether specific resources are renewable or nonrenewable when they read this lesson.

Cooperative Learning

Hold a "conservation contest" to help students identify resources they commonly use and ways they might conserve them. Have teams of students make lists of resources they use during an average day. For each resource, have students on each team brainstorm ways to reduce the amount of the resource they use and/or ways to reuse or recycle the resource. Have a spokesperson for each team report the team's resource list and conservation ideas to the class. The team with the most suggestions for conserving resources wins the contest.

Activity

In the activity at the following URL, students will explore changing logging practices in the Congo Republic and research the many roles of tropical forests as a natural resource. To synthesize their understanding, students will write letters to companies logging in the Congo Republic, urging them to adopt responsible logging practices.

http://www.nytimes.com/learning/teachers/lessons/20020821wednesday.html

Differentiated Instruction

Pair English language learners with native English speakers, and ask partners to make a Venn diagram comparing and contrasting renewable and nonrenewable resources. Then have partners brainstorm examples of each type of natural resource.

Enrichmen

Have students make a brochure or public service announcement about ways that young teens can conserve resources by reducing, reusing, and recycling. They can start gathering ideas at the following URLs.

- http://www2.epa.gov/recycle
- http://www.nrdc.org/thisgreenlife/0802.asp
- http://www.homemadesimple.com/en-US/HomeOrganization/Pages/reduce-reuse-recycle-ideas.aspx

Science Inquiry

The inquiry activity described in the PDF document below will hone students' abilities to classify resources. Students will learn about renewable, nonrenewable, and perpetual natural resources by examining products made from natural resources. Then they will work in pairs to classify various items as renewable, nonrenewable, or perpetual resources. They will also identify ways to conserve different types of natural resources. The document includes a student worksheet, an assessment rubric, and extension ideas. Worksheets are presented in both English and Spanish.

http://www.stopwaste.org/docs/schools/Lesson01.pdf

Real-World Connection

Have students do the real-world activity "Learn to Recycle" on pages 131–134 of the PDF document below. The objective of the activity is to teach students the specifics of recycling in their own community or to help them understand why their community does not recycle. Students will research local recycling options, including where to recycle, what can be recycled, and how to prepare items for recycling. The PDF document includes a student worksheet and ideas for enrichment.

http://www.epa.gov/osw/education/quest/pdfs/sections/u2_chap2.pdf

Real-World Connection

Urge students to go to the URL below for a documentary trailer about a Paraguayan community built on a landfill. Students in the community play musical instruments made from trash. Use the video to start a class discussion of creative and unusual ways to reuse or recycle items that typically end up in a landfill. The video trailer is also a good jumping off point for discussing differences in resource use between wealthy and poor nations.

http://earth911.com/news/2012/12/28/landfill-harmonic-documentary/

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 20.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Like other resources, we use energy resources in many ways. Energy resources also need to be conserved. What are some of the ways we use energy?

How can we conserve energy?

20.3 Lesson 20.2: Use and Conservation of Energy

Key Concepts

- Energy use in the U.S.
- Types of energy resources
- Ways to conserve energy resources

Lesson Objectives

- Describe how people use energy.
- List ways to conserve energy.

Lesson Vocabulary

No new vocabulary terms are introduced in this lesson.

Teaching Strategies

Introducing the Lesson

Use questions such as those below to help students recall what they already know about energy from prior chapters or classes.

Question: What is energy?
Answer: Energy is the ability to do work or to change matter.
Question: Where do we get energy?
Answer: We get energy from fuels, the sun, water, the food we eat, and many other sources.

Tell students they will learn more about energy, including how to conserve it, when they read this lesson.

Building Science Skills

At the following URL, you will find four activities that give students the opportunity to use the Internet as a research and learning tool. In the activities, students will do online research to try to answer the following questions:

1. Where are the best renewable and non-renewable energy resources in the U.S. and the world?
2. How much energy do we consume while driving?

3. How much total energy do we use?
4. Are renewable energy resources economically feasible on a small scale?

http://www1.eere.energy.gov/education/pdfs/basics_computerenergyprojects.pdf

Activity

When you teach your students about alternative energy resources, you may want to use some of the activities on solar energy that are described in the lesson plan at the following URLs (the first URL is the teacher's guide and the second URL is the students' version). The activities are hands-on explorations that teach the scientific concepts behind solar energy. They include making a photovoltaic cell and a solar oven.

http://www.need.org/needpdf/EnergyfromtheSunTeacherGuide.pdf

http://www.need.org/needpdf/EnergyfromtheSunStudentGuide.pdf

Differentiated Instruction

Work with students to make a flow chart showing the steps involved in obtaining a nonrenewable energy resource such as petroleum, from finding the resource under the ground to delivering the refined resource to the user. Discuss with students why energy is needed for each step in the flow chart.

Enrichment

Challenge a small group of students to create a board game titled "Saving Energy." The game should require players to repeatedly choose between different options that use more or less energy, such as riding a bus to school vs. carpooling, or buying a compact fluorescent light bulb vs. an incandescent light bulb. The object of the game should be to use the least amount of energy overall. Give other students in the class a chance to play the game. You might reward game winners with token prizes or extra credit.

Science Inquiry

With the two experiments at the following URL, students will use the scientific method to investigate energy savings in lighting at their school. In the first experiment, students use a light meter to measure the amount of light in each classroom in the school. In the second experiment, students compare the energy use of a compact fluorescent bulb to an incandescent bulb.

http://www1.eere.energy.gov/education/pdfs/efficiency_energysavingslighting.pdf

Common Misconceptions

Students commonly think that energy is a fuel. Explain that a fuel is a substance that is burned to provide energy but is not itself energy. A fuel is a resource such as coal, oil, or the food we eat. Energy, in contrast, is the ability to do work or change matter in some way. When we speak of energy resources, what we really mean is resources that provide us with energy. Energy resources include resources such as flowing water in addition to fuels such as fossil fuels. All of them provide energy, but they are not energy.

Real-World Connection

At the following URL, you will find an interdisciplinary energy module designed for middle school students to investigate energy efficiency in their home. With the module, students will learn about the importance of home energy management. They will also conduct an energy inventory of their home, review simple ways to increase energy efficiency in their home, and learn how to effectively communicate ideas about energy efficiency to others.

http://www1.eere.energy.gov/education/pdfs/lesson301.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 20.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In this chapter, you learned how people use natural resources such as fossil fuels. You also learned about ways to protect these natural resources. In the next chapter, you'll learn about another important natural resource: water. What are some ways that humans use water?

How do human actions endanger the water supply?

How can the water supply be protected?

CHAPTER 21 MS TE Human Actions and Earth's Water

Chapter Outline

21.1 CHAPTER 21: HUMAN ACTIONS AND EARTH'S WATER
21.2 LESSON 21.1: HUMANS AND THE WATER SUPPLY
21.3 LESSON 21.2: WATER POLLUTION
21.4 LESSON 21.3: PROTECTING THE WATER SUPPLY

21.1 Chapter 21: Human Actions and Earth's Water

Chapter Overview

This chapter describes how we use water and how water is distributed on Earth. It also outlines types and sources of water pollution and how to protect the water supply.

Online Resources

See the following Web sites for appropriate laboratory activities:

With the "Global Water Crisis 'Water Commons' Lab" at the following URL (pages 18–19), students will do a hands-on investigation to determine how one person's or institution's wastes affect another person's or institution's access to safe, clean drinking water.

- http://static.water.org/docs/curriculums/WaterOrg%20MidCurricFULL.pdf

The inquiry lab at the URL below will allow students to test the quality of various samples of water, evaluate the effect of common pollutants on water quality, research the influence of human activities on pollutants in their own water source, and determine the impact of the pollution.

- http://www.learnnc.org/lp/editions/criticalthinking/6650

These Web sites may also be helpful:

This Web site provides background information on a wide variety of water topics. It also includes online activities, data tables, maps, and a glossary of terms.

- http://ga.water.usgs.gov/edu/

You can find a world map showing Earth's fresh water supplies by nation (as of 2000) at this URL: http://www.learner.org/courses/envsci/visual/visual.php?shortname=world_freshwater .

At the following URL, you can find a variety of resources on water pollution and protection of the water supply.

- http://www.nrdc.org/water/

Pacing the Lessons

TABLE 21.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
21.1 Humans and the Water Supply	2.0
21.2 Water Pollution	1.5
21.3 Protecting the Water Supply	1.0

21.2 Lesson 21.1: Humans and the Water Supply

Key Concepts

- How we use water
- Water shortages
- Poor water quality

Lesson Objectives

- List ways that humans use water.
- State why some people don't have enough water.
- Explain why poor quality water is a problem.

Lesson Vocabulary

- **drought:** period of unusually low rainfall
- **irrigation:** any method of providing extra water to plants

Teaching Strategies

Introducing the Lesson

Read the following facts and figures about the water supply to your students. Tell them to think about the facts and figures as they learn more about the water supply in this lesson.

- Only about 0.007 percent of all water on Earth is readily accessible for direct human use.
- A person can live for weeks without food but for only about three days without water.
- An individual should have at least 4 to 5 gallons of water a day for all purposes just to survive.
- The average family in Africa uses only about 5 gallons of water a day.
- The average individual in the U.S. uses at least 100 gallons of water a day.

Cooperative Learning

Students can gain a deeper appreciation of the global water crisis by doing the jigsaw activity "Global Water Crisis" on pages 10–17 of the PDF document below. Groups of students will be assigned to research one of five nations where water shortages are a serious problem (Bangladesh, Ethiopia, Honduras, India, or Kenya). Students within each group will individually complete the activity chart for the country they have been assigned. Then group members will work together to organize and present information on their assigned country to the rest of the class. The other students in class will record the information on their activity charts.

http://static.water.org/docs/curriculums/WaterOrg%20MidCurricFULL.pdf

Differentiated Instruction

A picture is worth a thousand words—especially for visual learners. Use images like those at the URLs below to show how sprinkler and drip irrigation systems differ. Point out that all the water goes into the air when sprinkler irrigation is used. Explain that some of this water evaporates. Also, with sprinklers some water usually runs off or overshoots the field so it is wasted in terms of providing the crops with water.

http://img.hgtv.com/HGTV/2011/03/17/TS-E000404_irrigation-sprinkler-system_s4x3_lg.jpg

http://images.nationalgeographic.com/wpf/media-live/photos/000/132/cache/dams03-drip-irrigation-israel_13203_-600x450.jpg

Enrichment

Ask interested students to learn about diseases spread by contaminated water, such as cholera, typhoid, and dysentery. Suggest that they start their research with the excellent article at the following URL. Have the students create a poster to share what they learn. Display their poster in the classroom. http://www.learner.org/courses/envsci/unit/text.php?unit=8&secNum=9

Science Inquiry

Groups of students can explore how much water is wasted with the simple action of leaving on the faucet while brushing teeth. First have students predict that amount of water that is wasted. Then have them design a procedure to determine the actual amount of water that goes down the drain in this way. They will have to select an appropriate amount of time to leave the tap open and a way to collect and measure the water that comes out. If you approve of their procedure, give them the green light to carry it out. Afterward, give groups a chance to compare their results. Then have them apply what they learned to calculate the total water wasted in this way by a family of four over the course of a year. Students are likely to be surprised at the amount of water that is wasted in this way. Discuss as a class other ways that people waste water in their daily lives.

Real-World Connection

Students can appreciate the difficulty of living in a water-scarce country with the activity "Walking on Water" on pages 29–36 of the URL below. First students will read about countries in which women carry most of the water their families use, often over long distances. Then they will do an activity in which they carry a gallon of water over a distance of a half mile. They will also try to lift more than one gallon of water. Students will use these experiences to help them realize how difficult it would be to work so hard just to get enough water to survive day in and day out. The PDF document includes a related reading, fact sheet, set of reading comprehension questions, and word puzzles.

http://static.water.org/docs/curriculums/WaterOrg%20MidCurricFULL.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 21.1 Quiz in *CK–12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In this lesson, you learned that many people don't have clean water to drink. They must drink polluted water instead. How does water become polluted?

Can polluted water be treated so it is safe to drink?

21.3 Lesson 21.2: Water Pollution

Key Concepts

- Point and non-point source pollution
- Sources of water pollution
- Ocean water pollution
- Thermal water pollution

Lesson Objectives

- Define point and non-point source pollution.
- List sources of water pollution.
- Describe ocean water pollution.
- Identify causes and effects of thermal pollution.

Lesson Vocabulary

- **point source pollution:** pollution that enters water at a single point
- **non-point source pollution:** pollution that enters water in many places rather than at a single point
- **thermal pollution:** pollution that raises the temperature of water

Teaching Strategies

Introducing the Lesson

Introduce water pollution by helping students recall what they already know about pollution.

Question: What is pollution?
  Answer: Pollution is the act of contaminating the environment.
Question: How do you think water might become polluted?
  Answer: Students might mention sources of water pollution that have received a lot of media attention, such as oil spills or illegal dumping of toxic wastes by industry.

Tell students they will learn about these and other sources of water pollution when they read this lesson.

Activity

Help students realize how our daily activities can affect the water supply. One of the most common chemicals in the products that we regularly use is phosphorus. In addition to fertilizers, it is found in cleaning products such as dishwasher detergents. Excess phosphorus is a serious pollutant in aquatic ecosystems. In the activity at the following URL, students will estimate the amount of phosphorus in water discharged from a dishwasher and relate that amount to the EPA's recommended limits on phosphorus in bodies of surface water.

http://earthecho.org/images/uploads/wpc_uploads/Phosphates_in_Dishwasher_Detergents_MS.pdf

Differentiated Instruction

Ask students to make a Venn diagram comparing and contrasting point source and non-point source pollution. Then discuss examples of each type of pollution.

Enrichment

Suggest that students who want to learn more about water pollution read the EPA report "What's Up With Our Nation's Waters?" at the following URL. The report includes science projects and a home water survey that students can undertake on their own with your approval or the approval of a parent or guardian. Ask the students to create a written summary of what they learned from the report, projects, and/or survey.

http://water.epa.gov/learn/resources/nationswaters_index.cfm

Science Inquiry

Most water pollution comes from non-point sources, specifically, from runoff. The inquiry activity at the URL below shows how building and other development affect the amount and quality of runoff. In the activity, students will make a model that simulates different land use situations. Then they will use the model to investigate how water infiltrates or runs off depending upon whether the land is covered with vegetation, bare, or developed.

http://omp.gso.uri.edu/ompweb/doee/teacher/pdf/act10.pdf

Common Misconceptions

Students may think that the ocean is so large that pollution of ocean water is not a serious problem. Discuss why this is not the case. Explain how pollution in the ocean can affect entire marine food webs. Tiny marine organisms such as plankton take in pollutants, and the pollutants are passed on to the larger animals that feed on them. Because of bioaccumulation, the effects of pollution are greatest in the top predators of marine food webs.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 21.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

People can't live without water. They need it for life itself. More than almost any other resource, water must be protected. How can water pollution be prevented?

How can we use less water?

21.4 Lesson 21.3: Protecting the Water Supply

Key Concepts

- Reducing water pollution
- Water treatment
- Conserving water

Lesson Objectives

- List ways to reduce water pollution.
- Describe how water is treated.
- Identify ways to conserve water.

Lesson Vocabulary

- **water treatment:** series of processes that remove unwanted substances from water

Teaching Strategies

Introducing the Lesson

Introduce the lesson by first asking students if they would drink toilet water. This is sure to get their attention, as well as a lot of "Yucks" and similar comments. Follow up by explaining how some cities, such as Singapore, recycle wastewater and use it for drinking water. In other words, water goes from toilet to tap. (You can learn more at the following URL). Point out that the water is treated in between so it is completely pure and perfectly safe. Add that this type of wastewater recycling is being considered in several U.S. cities where water shortages are a problem. Tell students they will learn in this lesson how even toilet water can be treated and purified so it is safe to drink.

http://www.earthmagazine.org/article/drinking-toilet-water-science-and-psychology-wastewater-recycling

Activity

Have students read the EPA article "Stop Pointless Personal Pollution!" at the first URL below. Then have them do one or more of the four related exercises at the second URL. In Exercise 1, students are encouraged to take charge of their environment through an Adopt-A-Street program. Exercise 2 uses math to lead students to think about a more water-conservative strategy for car washing. Exercise 3 uses a case study to help students realize the dangers of pet-waste sources of bacteria in the water supply. Exercise 4 is a lab experiment that helps students appreciate the effects of phosphates on waterways. Each exercise is designed to take between 30 and 45 minutes to complete.

http://www.epa.gov/owow/nps/nps_edu/pdf/stop.pdf

http://www.epa.gov/owow/nps/nps_edu/pdf/act_stop.pdf

Differentiated Instruction

For visual learners and less proficient readers, use the video at the URL below to convey important ways to save water at home.

http://video.nationalgeographic.com/video/environment/going-green-environment/green-home-makeover/conserve-water-greenguide/

Enrichment

Ask a few students to work together to create a public service announcement about the importance of protecting the water supply and ways individuals and families can help by conserving water and keeping harmful substances out of the water. If possible, arrange for students to present their public service announcement to the entire student body.

Science Inquiry

Have students do the experiment at the following URL to determine how much water is wasted by a leaky faucet. First they will predict how much water leaks out of the faucet and then they will measure it. The activity will help students appreciate how much water is wasted even when only a drop at a time is lost and more generally how easy it is to waste water.

http://www.nsf.org/consumer/earth_day/earthday_experiment.asp

Real-World Connection

Arrange a fieldtrip to tour the local wastewater treatment plant. Before the tour, have students read in the FlexBook® lesson about the steps involved in treating and purifying wastewater. Ask the tour leader to explain what happens during each process and what pollutants are removed at each step.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 21.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

We can survive for a few days without water. We can survive for just a few minutes without air. Like water, air is polluted by human actions. What causes air pollution?

What can be done to keep air clean?

CHAPTER 22 MS TE Human Actions and the Atmosphere

Chapter Outline

22.1 CHAPTER 22: HUMAN ACTIONS AND THE ATMOSPHERE
22.2 LESSON 22.1: AIR POLLUTION
22.3 LESSON 22.2: EFFECTS OF AIR POLLUTION
22.4 LESSON 22.3: REDUCING AIR POLLUTION

22.1 Chapter 22: Human Actions and the Atmosphere

Chapter Overview

This chapter discusses types of air pollution, their causes and effects, and ways to reduce air pollution.

Online Resources

See the following Web site for an appropriate laboratory activity:

With the lab at the following URL, students will use simple materials to collect particulate air pollution in several different locations. From their results, they will identify variables that may influence the amount of particulate pollution in the air.

- http://www.starteaching.com/AirPollutionExperiment.pdf

These Web sites may also be helpful:

This URL lists curriculum resources, activities, and Web sites about air quality.

- http://airnow.gov/index.cfm?action=learning.forteachers

You may want to follow the lesson plan at the following URL when you teach this chapter. In the lesson, students will examine the topic of air pollution, its possible solutions, and the government agencies that are responsible for dealing with it. Specific topics addressed include: ingredients, causes, effects, and solutions of air pollution; individual actions to improve air quality; misuse of the atmosphere; federal laws and agencies that address air quality; stratospheric and tropospheric ozone; and criteria pollutants.

- http://www.dnrec.state.de.us/DNREC2000/Divisions/AWM/aqm/education/airqualityLesson1.pdf

You can find some excellent air pollution images as well as background information on air pollution at this URL: http://education.nationalgeographic.com/education/encyclopedia/air-pollution/?ar_a=1 .

Pacing the Lessons

TABLE 22.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
22.1 Air Pollution	1.5
22.2 Effects of Air Pollution	1.5
22.3 Reducing Air Pollution	1.0

22.2 Lesson 22.1: Air Pollution

Key Concepts

- Air quality
- Clean Air Act
- Primary and secondary air pollutants
- Sources of air pollution

Lesson Objectives

- Describe factors that affect air quality.
- Identify primary and secondary air pollutants.
- List the main sources of air pollution.

Lesson Vocabulary

- **air quality:** measure of the pollutants in air
- **particulate:** solid particle such as dust in the air
- **photochemical smog:** brown haze in the air that results when certain pollutants react together in the presence of sunlight
- **primary pollutant:** pollutant that enters the environment directly
- **secondary pollutant:** pollutant that forms when primary pollutants undergo chemical reactions after they are released into the environment

Teaching Strategies

Introducing the Lesson

Introduce air pollution—and students' own contributions to it—with the simple activity described at the URL below. Each student will be given a cup of tap water and have access to food coloring. Students will listen carefully while you describe several activities that cause air pollution, such as lawn mowing and applying nail polish. For each activity a student has participated in during the past 24 hours, he or she will add one drop of the appropriate color of food coloring to the cup of water. The activity will show students that everyone contributes to air pollution and that each individual's contribution to air pollution is unique. After the activity, tell students they will learn more about human actions and air pollution when they read this chapter.

http://www.cleanair.utah.gov/docs/school_program_activity.pdf

Cooperative Learning

Students can learn about criteria air pollutants with the lesson plan at the following URL. The lesson plan includes cooperative activities in which students role-play the pollutants, link them to everyday activities, and create posters about them.

http://www.uni.edu/storm/downloads/middleschool/Criteria%20Pollutants%20final%20update.pdf

Activity

Download the Unit 2 curriculum at the following URL and use it to teach your students about air quality. Students will be introduced to the Air Quality Index (AQI) through a teacher-led interactive discussion using provided charts and mini-posters as teaching props. Then students will discuss how to access real-time AQI information and maps. They will also complete a study guide and map activity using an AQI map of the United States. The class as a whole will conduct a role-play activity in which students act out appropriate actions given different AQI values as other students try to guess the AQI values. Students are encouraged to continue daily monitoring of their local AQI using different sources (newspapers, television, and/or Internet).

http://www.cleanairpartners.net/onTheAir.cfm

Differentiated Instruction

Suggest that students create a simple flow chart to show how the ozone in photochemical smog forms from nitrogen oxides and VOCs when they are heated by sunlight. Then discuss with them the role of sunlight in the production of smog ozone, Relate the role of sunlight to the severity of the ozone problem in sunny cities such as Los Angeles, California.

Enrichment

Challenge students to investigate the problem of indoor air pollution. Have them do a Web quest, starting with the URL below, to find answers to questions such as these:

1. What are the major indoor air pollutants?
2. What health problems are associated with these air pollutants?
3. What is the source of these air pollutants?
4. How can indoor air pollution be eliminated or reduced?

http://www.epa.gov/iaq/ia-intro.html

Science Inquiry

Have students analyze a real research development that was inspired by a middle school student's science fair project. The researchers designed an artificial "tree" that removes carbon dioxide from the air. Analyzing the research will give students insights into how research is done and the challenges of technological design. First show the Nova video "Capturing Carbon" at the following URL. Have students take notes on the video and then use their notes to answer the questions below.

http://www.pbs.org/wgbh/nova/tech/capturing-carbon.html

1. How did the student remove carbon dioxide from the air?

2. In general terms, what type of device were the researchers trying to develop?

3. What is the "energy penalty," and how did it constrain the technological design?

4. What design allowed air to flow through the "leaves" without using up too much energy to force the air through? How were the "leaves" tested?

5. The student used NaOH in her science fair experiment and it worked well. Why did the researchers develop a material to replace NaOH?

6. At the time the video was made, what was happening to the carbon dioxide that was collected by the device?

7. What was the next problem the researchers were trying to solve?

Common Misconceptions

It is a common misconception that air pollution simply disperses over time into the vastness of the atmosphere. Explain that air pollutants are often trapped close to the ground. Cities with some of the worst air quality, such as Los Angeles, California, have mountains around them that trap air pollution. A related misconception is that air pollution is confined to big cities. Therefore, if you move away from the city, you no longer have to worry about air pollution. This is not the case. Explain that rural areas are subject to local sources of air pollution as well as secondary effects from urban areas. For example, many rural people around the world cook and heat their homes with fuels such as coal or wood, and this can create a lot of pollution in the home. Slash-and-burn agriculture is another source of air pollution in many rural areas of the world.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 22.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Despite the Clean Air Act, the air over many U.S. cities is still polluted. In some other countries, the problem is even worse. That's because they don't have laws like the Clean Air Act to protect the air. How do you think air pollution affects human health?

How might it affect other living things?

22.3 Lesson 22.2: Effects of Air Pollution

Key Concepts

- Effects of specific pollutants
- Causes and effects of acid rain
- Causes and effects of high-level ozone loss

Lesson Objectives

- Outline the effects of pollutants in the air.
- Identify the cause and effects of acid rain.
- Relate air pollution to loss of the ozone layer.

Lesson Vocabulary

- **acid rain:** rain with a pH of less than 5 that forms when nitrogen and sulfur oxides in the air dissolve in rainwater
- **bioaccumulation:** increase in concentration of pollutants in organisms at higher levels of a food chain

Teaching Strategies

Introducing the Lesson

Many students are likely to have heard about mercury warnings for tuna fish. Explain that eating fish is good for heart health but tuna and other large fish contain high levels of mercury. Point out that small fish, such as anchovies and sardines, have much lower levels of mercury. Ask students if they know why large fish but not small fish contain high levels of mercury if they all swim in the same ocean water. (The answer, in a word, is bioaccumulation.) Tell students they will understand why after they read this lesson.

Activity

Students can learn about the health effects of air pollution with the Unit 5 activity at the following URL. The first part of the activity introduces students to the human respiratory system, using posters provided at the URL. Students will also be directed to online animations depicting how the respiratory system works and how air pollution affects the lungs. In the second part of the activity, students will conduct before and after measurements on each other to see the effects that exercise has on heart and breathing rates. Then they will relate the results to physical activity on pollution alert days.

http://www.cleanairpartners.net/onTheAir.cfm

Building Science Skills

Have students use the interactive air pollution simulator "Smog City 2" at the URL below. Students will learn how individual choices, environmental factors, and different types of land use affect air pollution and human health.

http://www.smogcity2.org/

Differentiated Instruction

Pair less proficient readers and English language learners with other students, and ask partners to make a compare/contrast table for the human health and environmental effects of different pollutants. They should include the following pollutants in their table: particulates, low-level ozone, nitrogen and sulfur oxides, carbon monoxide, heavy metals (mercury and lead), and VOCs.

Enrichment

Ask students to write a questionnaire and take a survey of other students in their school about the causes and effects of the ozone hole and global warming. These are two issues around which there is a lot of confusion and misinformation (see Common Misconceptions below). Tell the students to submit their questionnaire to you for approval before undertaking their survey. Make sure their questions are not "leading" questions that encourage respondents to link the two phenomena. The students should survey at least 20 other students and then write a summary of their survey results. Give them a chance to share the results with the rest of the class. Then use the results as a platform to launch a discussion of common misconceptions about these issues.

Science Inquiry

With the activity at the following URL, students will do an experiment to show the effect of acid rain on rocks, buildings, and sculptures. They will use chalk and a vinegar solution to demonstrate the chemical reaction of acid on limestone. They will identify the compounds involved and explain how acid rain originates.

http://www.reachoutmichigan.org/funexperiments/quick/academy/acidrain.html

Common Misconceptions

A common misconception is that climate change and the loss of the ozone layer are pretty much the same thing or that the loss of the ozone layer is causing climate change. In fact, climate change and the loss of the ozone layer are two different problems that are not very closely connected. The largest contributor to global warming is carbon dioxide gas released when coal, oil, and natural gas are burned. Chlorofluorocarbons (CFCs), gases that cause stratospheric ozone depletion, play only a minor role in climate change. The depletion of the stratospheric ozone layer, including the ozone hole, is a serious environmental problem because it causes an increase in ultraviolet radiation, which can harm people, animals, and plants. However, this is a different problem from climate change and it does not cause climate change.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 22.2 Quiz in *CK–12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Air pollution damages both human health and the health of the environment. What steps have already been taken to reduce air pollution?

What problems do you think remain?

22.4 Lesson 22.3: Reducing Air Pollution

Key Concepts

- Reducing air pollution from fossil fuels
- Preventing ozone loss
- Controlling global warming

Lesson Objectives

- List ways to reduce air pollution from fossil fuels.
- Describe worldwide efforts to protect the ozone layer and control global warming.

Lesson Vocabulary

- **cap-and-trade system:** system of caps, or upper limits, on carbon dioxide emissions in which nations can trade allowances for emissions
- **carbon sequestration:** any way of removing carbon dioxide from the atmosphere and storing it in another form

Teaching Strategies

Introducing the Lesson

Introduce the lesson by challenging students to brainstorm reasons why it is important to reduce air pollution. (Students are likely to identify human health and environmental problems that would be prevented if air pollution were controlled.) Tell students they will learn in this lesson ways that air pollution can be reduced, including actions they can take to reduce their own contribution to air pollution.

Discussion

Students may not realize that their use of energy, especially electrical energy, contributes to air pollution. Discuss with the class the connection between energy use and the release of pollutants into the air. Make sure students appreciate that the major cause of air pollution is the burning of fossil fuels, which provide energy for almost everything we do, from turning on a lamp to driving to the mall.

Differentiated Instruction

Recommend that students make a main ideas/details chart as they read the lesson. They should divide a sheet of paper down the middle and record the main ideas on the left side of the paper and the details on the right side of the paper. Share the tip that the main idea in a paragraph is often the first sentence of the paragraph.

Enrichment

Students who are interested in cars may want to learn more about catalytic converters and how they work. Tell them to watch videos about catalytic converters, such as those at the URLs below. After they watch the videos and are confident that they understand how catalytic converters work, ask them to share their "expert" knowledge with the rest of the class. Suggest that they draw one or more diagrams to help other students understand how catalytic converters work.

http://www.youtube.com/watch?v=1zH22Qpe2GA

http://www.youtube.com/watch?v=rmtFp-SV0tY

Science Inquiry

Students can learn more about controlling industrial air pollution by investigating specific methods of removing pollutants from exhaust. They can build a wet scrubber and/or an electrostatic precipitator. The URL below describes both activities and also places them in a lesson plan context.

http://www.reachoutmichigan.org/funexperiments/agesubject/lessons/tnrcc/airpollutionlesson.html

Real-World Connection

Discuss the connection between carbon dioxide emissions into the atmosphere and global warming. Tell students that many of their actions release carbon dioxide into the air and contribute to global warming. Have them use the carbon calculator at the following URL to measure their own carbon emissions and learn ways to reduce them.

http://www.cooltheworld.com/kidscarboncalculator.php

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 22.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

This chapter focuses on the atmosphere. Beyond the atmosphere is space. The next chapter introduces the study of space. What do you already known about space? For example, what objects are found in space?

How do you think scientists learn about space?

CHAPTER 23 MS TE Observing and Exploring Space

Chapter Outline

23.1 CHAPTER 23: OBSERVING AND EXPLORING SPACE
23.2 LESSON 23.1: TELESCOPES
23.3 LESSON 23.2: EARLY SPACE EXPLORATION
23.4 LESSON 23.3: RECENT SPACE EXPLORATION

23.1 Chapter 23: Observing and Exploring space

Chapter Overview

This chapter begins with a discussion of electromagnetic radiation, types of telescopes, and ways of gathering information from our universe. It provides information about early space exploration and concludes with a description of recent and current space exploration.

Online Resources

See the following Web sites for appropriate laboratory activities:

Students can learn how optics are used in telescopes with the lab at the following URL (go to Lesson 3). In the lab, students will experiment with different types of lenses until they identify a combination of lenses that can magnify a distant object. As an adjunct to the lab, give students an opportunity to use a telescope if possible. Otherwise, let them use binoculars to give them an idea of how a telescope works.

- http://www.msnucleus.org/membership/html/jh/earth/spaceexplore/jhspaceexpl.pdf

The lab activity "Mapping Worlds that Look Like Stars" (see URL below) will allow students to simulate methods developed by astronomers to map objects too distant to show detail when viewed with a telescope.

- http://saturn.jpl.nasa.gov/files/Mapping_Worlds.pdf

These Web sites may also be helpful:

The following interactive Web site is an in-depth exploration of the telescope, including the history of the telescope and the basic science behind it. It is a useful addition to the first lesson in this chapter for you and/or your students.

- http://amazing-space.stsci.edu/resources/explorations/groundup/

Students can explore space and take telescopic images with the Harvard-Smithsonian Center for Astrophysics' MicroObservatory network of automated telescopes, which can be controlled over the Internet. You can learn more about the program at this URL: http://mo-www.harvard.edu/OWN/about.html

At the URLs below, you can find links to a wide variety of educational resources on astronomy.

- http://www.astrosociety.org/education/educational-resources/
- http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_astronomy/activities.html

You can find a detailed interactive space exploration timeline at the following URL. It covers space exploration for the period 1957 to 2007.

- http://science.nationalgeographic.com/science/space/space-exploration-timeline/

Go to the URL below for a collection of space exploration videos.

- http://www.neok12.com/Space-Exploration.htm

For more on NASA and its space missions, you can find a large collection of links suitable for middle school students at this URL: http://www.kidinfo.com/science/space_travel.html .

Pacing the Lessons

TABLE 23.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
23.1 Telescopes	2.0
23.2 Early Space Exploration	2.5
23.3 Recent Space Exploration	1.5

23.2 Lesson 23.1: Telescopes

Key Concepts

- Electromagnetic spectrum and electromagnetic waves
- The speed of light
- Optical, radio, and space telescopes
- Observations made with telescopes
- Studying starlight with spectrometers

Lesson Objectives

- Explain how astronomers use light to study the universe beyond Earth.
- Describe some different types of telescopes.
- Discuss what we have learned by using telescopes.

Lesson Vocabulary

- **constellation:** group of stars that appear from Earth to form a recognizable pattern
- **electromagnetic radiation:** energy transmitted through space as waves
- **electromagnetic spectrum:** total range of wavelengths of electromagnetic radiation
- **frequency:** number of waves that pass a given point each second
- **gamma ray:** type of electromagnetic radiation that has the shortest wavelengths
- **infrared light:** type of electromagnetic radiation that has wavelengths longer than visible light but shorter than radio waves and that humans can feel as heat
- **light-year:** distance light can travel in one year; equal to 9.5 trillion kilometers
- **microwave:** type of electromagnetic radiation with wavelengths between radio waves and infrared light; generally considered to be high-frequency radio waves
- **planet:** object in space that orbits a star and has cleared its orbit of smaller objects
- **radio telescope:** type of telescope that collects radio waves instead of visible light
- **radio wave:** type of electromagnetic radiation that has the longest wavelengths
- **reflecting telescope:** type of optical telescope that uses mirrors to collect and focus visible light
- **refracting telescope:** type of optical telescope that uses lenses to collect and focus visible light
- **space telescope:** telescope that is placed into orbit around Earth above Earth's atmosphere
- **spectrometer:** device that breaks light into different wavelengths, or colors
- **ultraviolet light:** type of electromagnetic radiation that has wavelengths shorter than visible light but longer than X-rays and that harms living things
- **wavelength:** horizontal distance between corresponding points on two adjacent waves, such as the distance between two crests or two troughs
- **visible light:** type of electromagnetic radiation that has wavelengths between ultraviolet and infrared light and that can be detected by the human eye

- **X ray:** type of electromagnetic radiation with wavelengths between ultraviolet light and gamma rays

Teaching Strategies

Introducing the Lesson

Introduce students to space by helping them recall where Earth's atmosphere ends and space begins.

Question: What is the outermost layer of the atmosphere?
Answer: The outermost layer of the atmosphere is the exosphere.
Question: How far out does it extend?
Answer: Because the exosphere gradually fades into outer space, there is no clear upper boundary to this layer of the atmosphere.

Explain that some scientists put the upper boundary of Earth's atmosphere at about 100,000 km (62,000 miles) above Earth's surface. Other scientists extend it to about 190,000 km (120,000 miles) above Earth's surface. Point out that space is considered to begin where the exosphere leaves off. Tell students they will start learning about space in this chapter.

Activity

Students can use an interactive animated reflecting telescope at the following URL to gain a deeper understanding of how a reflecting telescope works.

http://www.faulkes-telescope.com/files/faulkes-telescope.com/archive/flash/ft_light.swf

Building Science Skills

The light-year is a difficult concept for some students to grasp. Use the fun activity at the URL below to help students understand it. They will generate their own unit of measurement based on the distance they travel in a set time interval and then draw parallels between their unit and the light-year.

http://www.carolina.com/teacher-resources/Interactive/light-year-activity/tr10881.tr

Activity

Students can learn about the wavelengths, frequencies, and energy levels of different types of electromagnetic waves with the "Spin-A-Spectrum" manipulative at the following URL. The teacher's guide for the activity presents a series of riddles that require students to know facts about the electromagnetic spectrum and which objects are best observed in each region of the spectrum.

http://swift.sonoma.edu/education/spectrum.html

Differentiated Instruction

Have students make a compare/contrast table for refracting and reflecting telescopes. The table might compare and contrast the two types of telescopes in terms of how they gather and focus light, which type was invented first, and which type is potentially stronger.

Enrichment

Students can make a star finder by following the instructions at the following URL. Then they can use it learn their way around the night sky by finding constellations. The Web site includes a star finder game and background information on stars and constellations.

http://spaceplace.nasa.gov/starfinder/

Science Inquiry

Students are likely to think that the stars in constellations are actually grouped closely together in space. In fact, most are located at very different distances from Earth. The activity at the URL below will help students realize that the sky is not just a dome as it appears from Earth but a three-dimensional space and that objects that look like they are grouped together may actually be very far apart.

http://www.astrosociety.org/edu/activities/F7_3D_Constellations.pdf

History Connection

Help students appreciate the significance of Galileo's discoveries with the telescope, in particular, the evidence his discoveries provided for the Copernican view of the solar system. Have students watch the video clip at the following URL. In the clip, actors play Galileo and Copernicus in a game show, in which they explain the sun-centered theory of the solar system and some of the evidence for it.

http://www.bbc.co.uk/learningzone/clips/copernicus-and-galileo-the-movement-of-the-earth/5589.html

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 23.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Radio waves are used for communicating with spacecraft. A round-trip communication from Earth to Mars takes anywhere from 6 to 42 minutes. What challenges might this present for sending unmanned spacecraft and probes to Mars?

The Hubble space telescope is a very important source of data for astronomers. The fascinating and beautiful images from the Hubble also help to maintain public support for science. However, the Hubble is growing old. Missions to service and maintain the telescope are extremely expensive and put the lives of astronauts at risk. Do you think there should be another servicing mission to the Hubble?

23.3 Lesson 23.2: Early Space Exploration

Key Concepts

- Rockets
- Satellites
- The Space Race
- Reaching the moon
- Exploring other planets

Lesson Objectives

- Explain how a rocket works.
- Describe different types of satellites.
- Outline major events in early space exploration, including the Space Race.

Lesson Vocabulary

- **orbit:** circular or elliptical path of one object around another
- **rocket:** vehicle propelled by gas particles flying out one end of it at high speed
- **satellite:** natural or human-made object that orbits another object
- **space probe:** spacecraft that is sent without a crew to collect data by flying near or landing on a distant object in space
- **Space Race:** competition during the Cold War (1945–1990) between the United States and the Soviet Union, in which each nation strove to have the best space technology
- **thrust:** forward force produced by gases flying out of the end of a rocket

Teaching Strategies

Introducing the Lesson

Ask if any students have ever wanted to be astronauts. Generate a discussion of this exciting career by asking follow-up questions such as:

- Why would you want to be an astronaut?
- What do you think it would be like to be an astronaut?
- Where would you want to go if you were an astronaut?

Encourage a diversity of responses from multiple students. Then tell students they will learn about astronauts and space travel when they read this lesson and the next.

Building Science Skills

Students can apply Newton's third law of motion and basic rocket science to build and launch a model rocket powered by an antacid tablet reacting with water. Detailed instructions are provided on pages 58–61 of the following document. The process of completing the project will help students understand the basic science behind rockets.

http://www.nasa.gov/pdf/265386main_Adventures_In_Rocket_Science.pdf

Differentiated Instruction

Suggest that students make a simple timeline of space exploration, starting with 1957 (Sputnik 1) in this lesson and ending with the present time in the next lesson. This will help students focus on the most important events in space exploration and their correct sequence.

Enrichment

Ask students with a strong interest in history to learn more about the Cold War context of the Space Race and the effects of the space race on U.S. citizens. Then have the students teach the topic to the rest of the class. The URLs below are some useful sources they might consult.

http://www.nebraskastudies.org/0900/frameset_reset.html?http://www.nebraskastudies.org/0900/stories/0901_0105.html

http://curiosity.discovery.com/question/space-race-and-war

Science Inquiry

Students can use microsets of NASA satellite data to study Earth's climate zones, learn how to interpret satellite images, and gain an appreciation of the value of using satellites to gather data about Earth. The URL below provides a lesson plan for the study. The Web site includes instructions for accessing the satellite data. The lesson plan itself includes background information, the procedure, a set of questions, ideas for extension, and useful links. Teacher notes are also available.

http://mynasadata.larc.nasa.gov/lesson-plans/lesson-plans-middle-school-educators/?page_id=474?&passid=52

Common Misconceptions

A common misconception is that satellites remain in orbit because they have "escaped Earth's gravity." Of course, this is false, because gravity still exists in space. Explain to students that if it weren't for gravity, satellites would fly off into space rather than stay in orbit. The only thing that keeps them from falling back to Earth because of gravity is their horizontal velocity. Because of this velocity, they keep falling "over the horizon" rather than crashing into Earth's surface. In short, speed, not lack of gravity, keeps satellites up in space.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 23.2 Quiz in CK–12 MS Earth Science Assessments.

Points to Consider

The Space Race and the USA's desire to get to the moon brought about many advances in science and technology. Can you think of any challenges we face today that are, could be, or should be a focus of science and technology?

If you were in charge of NASA, what new goals would you set for space exploration?

23.4 Lesson 23.3: Recent Space Exploration

Key Concepts

- Space stations
- Space shuttles
- Recent space missions

Lesson Objectives

- Outline the history of space stations and space shuttles.
- Describe recent developments in space exploration.

Lesson Vocabulary

- **orbiter:** main part of the space shuttle that has wings like an airplane
- **space shuttle:** reusable spacecraft capable of carrying large pieces of equipment or parts of a space station
- **space station:** large spacecraft that orbits Earth and on which humans can live for extended periods of time

Teaching Strategies

Introducing the Lesson

Pique students' interest in current space explorations by impressing them with the following facts about the Cassini spacecraft that is exploring Saturn and its moons.

- The Cassini spacecraft has traveled all the way to Saturn, a distance of about 1.5 billion kilometers.
- To travel that far requires a very large spacecraft in order to hold all of the fuel needed, and the Cassini spacecraft is the biggest interplanetary spacecraft ever built.
- The Cassini is about the same size as a 30-passenger school bus and weighs a whopping 5650 kg (6 tons)!
- The Cassini's elaborate electrical system has more than 12 km (almost 7.5 miles) of cables.

Tell students they will learn more about the Cassini spacecraft and its mission, as well as about other recent or current space missions, when they read this lesson.

Demonstration

Show the class the NASA animated video at the following URL. From the video, students can learn how the space shuttle was developed, how it blasts off, and how it lands. Be sure to tell students that the space shuttle was retired in 2011 and a new spacecraft to replace it is in the works.

Shuttle http://www.kidsknowit.com/interactive-educational-movies/free-online-movies.php?movie=Space Shuttle

Activity

In the interactive module at the URL below, students can simulate how astronauts have serviced the Hubble Space Telescope (or have done other repair work in space). The module includes activities (such as simulating working in space by wearing thick gloves and trying to manipulate objects behind a screen) and online interactions. Make sure students are aware that no future repair flights will be made to the Hubble, but it is expected to continue to operate until at least 2014 and possibly all the way until 2020. Another space telescope to replace the Hubble is expected to be launched in 2018.

http://amazing-space.stsci.edu/service-top-level.html

Differentiated Instruction

Suggest that students create a concept map for space shuttles and space stations based on the content of the lesson. This will help less proficient readers and English language learners hone in on the most important ideas about these two types of spacecraft.

Enrichment

Ask creative students to watch videos and read articles about living and working on the International Space Station (ISS). Then have the students use the information to write a realistic short story about, or diary of, a fictional astronaut aboard the ISS.

Science Inquiry

The Mars Student Imaging Project (MSIP) is a nationally recognized award-winning, inquiry-based, student-centered education project. Your students can get involved through distance learning or as an independent research project. There is no fee. Students will learn how science works by engaging in authentic scientific research using data from a NASA spacecraft orbiting Mars. To learn more, go to this URL:

http://marsed.mars.asu.edu/msip

Common Misconceptions

A common misconception is that a space shuttle could have been used to fly to the moon. At the following URL you can find a math-based argument to demonstrate to students why this would have been impossible. The thrust of the argument is that too much fuel would be required to travel that far for the shuttle to carry.

http://spacemath.gsfc.nasa.gov/weekly/7Page85.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 23.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

To date, a total of 22 people have died on space missions. In the two space shuttle disasters alone, 14 people died. However, space exploration and research have led to many great discoveries and new technologies. Do you think sending people into space is worth the risk? Why or why not?

In the past several years, private companies have been developing vehicles and launch systems that can take people into space. What applications can you think of for such vehicles? What advantages and disadvantages are there to private companies building and launching spacecraft?

CHAPTER 24 MS TE Earth, Moon, and Sun

Chapter Outline

24.1 CHAPTER 24: EARTH, MOON, AND SUN

24.2 LESSON 24.1: PLANET EARTH

24.3 LESSON 24.2: EARTH'S MOON

24.4 LESSON 24.3: THE SUN

24.5 LESSON 24.4: THE SUN AND THE EARTH-MOON SYSTEM

24.1 Chapter 24: Earth, Moon, and Sun

Chapter Overview

This chapter describes the basic properties and motions of Earth, the moon, and the sun, including eclipses and phases of moon. It also describes the sun's layers and solar activity.

Online Resources

See the following Web sites for appropriate laboratory activities:

Students can make a model and investigate the moon's surface with the lab activity "Lunar Surface" on pages 53–56 of the document below. They will consider the rocks and geological processes in different areas of the lunar surface.

- http://www.nasa.gov/pdf/58199main_Exploring.The.Moon.pdf

With the lab activity at the following URL, students will make a cereal box spectroscope and use it to analyze the wavelengths of sunlight and of light given off by other sources. They will learn why light from different sources produces different spectra. Be sure to warn students not to look directly at the sun.

- http://sohowww.nascom.nasa.gov/classroom/spectroscope.html

The online interactive lab at the URL below challenges students to correctly construct the lunar cycle. There are three levels of challenges for students to complete.

- http://sciencenetlinks.com/interactives/moon/moon_challenge/moon_challenge.html

These Web sites may also be helpful:

At the following URL, you can access an excellent resource from NASA, "Exploring the Moon," which is a teacher's guide with activities for Earth and space science for grades 4–12. In addition to the activities, the document includes extensive background information, fact sheets, and links to other resources.

- http://www.nasa.gov/pdf/58199main_Exploring.The.Moon.pdf

Another excellent resource from NASA is available at the URL below. It covers the SOHO mission, which is exploring the sun from space. You and/or your students can learn more about the sun and how it is being studied. The site also has excellent solar images and educational materials.

- http://sohowww.nascom.nasa.gov/home.html

The following Web site provides a collection of multi-disciplinary, interactive exercises and activities based on the sun and solar science, most geared to students in grades 4–12.

- http://solar-center.stanford.edu/teachers/

Several teacher-reviewed videos about eclipses can be accessed at this URL: http://www.neok12.com/Eclipse.htm

At the URL below, you can find a diversity of educational resources on solar eclipses.

- http://www.exploratorium.edu/eclipse/index.html

Pacing the Lessons

TABLE 24.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
24.1 Planet Earth	2.0
24.2 Earth's Moon	1.0
24.3 The Sun	1.5
24.4 The Sun and the Earth-Moon System	1.5

24.2 Lesson 24.1: Planet Earth

Key Concepts

- Earth's shape, size, and mass
- Earth's gravity
- Earth's rotation
- Earth's day and night
- Earth's seasons
- Earth's revolution

Lesson Objectives

- Describe some of the characteristics of Earth.
- Describe how gravity affects Earth in the solar system.
- Explain Earth's magnetism and its effects.
- Describe Earth's rotation on its axis.
- Describe Earth's revolution around the sun.

Lesson Vocabulary

- **axis:** imaginary line that runs between the North and South Poles through the center of Earth
- **biosphere:** all of the living things on Earth
- **gravity:** force of attraction that exists between all objects in the universe
- **hemisphere:** half of a sphere, such as half of planet Earth
- **hydrosphere:** all of the water on Earth
- **magnetic field:** region around a magnet over which it exerts magnetic force
- **revolution:** orbital movement of one object around another, such as the moon around Earth or Earth around the sun
- **rotation:** spinning of an object such as Earth on its axis

Teaching Strategies

Introducing the Lesson

Students are likely to have some basic knowledge about planet Earth from prior science classes. Help them recall this knowledge by asking students at random to state anything they know about Earth the planet. (They may know, for example, that Earth is the third planet from the sun and that it rotates on its axis and revolves around the sun.)

Encourage a diversity of responses. Then tell students they will learn more about planet Earth when they read this lesson.

Demonstration

Use a globe to demonstrate to students basic features of planet Earth, including the location of Earth's axis, how Earth is tilted on its axis, and how Earth rotates. Use a single light bulb (in a darkened room) to represent the sun, and spin the globe to show the class how Earth's rotation causes day and night. Move the globe around the light bulb to simulate Earth's revolution around the sun. Point out how the tilt of Earth on its axis causes either the Northern Hemisphere or the Southern Hemisphere to tilt toward the sun and receive more direct and intense solar radiation. Relate this to Earth's seasons.

Demonstration

Use the animation at the URL below to demonstrate Foucault's pendulum and how he used it to show that Earth rotates.

http://physics-animations.com/Physics/English/f01-tmp.htm

Differentiated Instruction

Pair any visual or English language learners with other students who are doing well in the class. Tell the students who are doing well to make a sketch, without labels, that illustrates why Earth experiences cycles of day and night. Then ask the other student in each pair to label the diagram. Suggest that the students add the labeled diagram to their science notebook.

Enrichment

Ask a few students to create an "Earth Photo Gallery" online or on a bulletin board in the classroom. The gallery should include a wide range of photos of Earth that were taken from space. Each photo should be labeled with the date the photo was taken, who or what took the photo, and from what distance it was taken. Tell the students to include such photos as the first television image of Earth (1960, by TIROS-I satellite) and the photo from the greatest distance (1990, by Voyager 1 from more than 4 billion km away), both of which can be found at this URL: http://www.space.com/21627-earth-from-space-pictures-gallery.html .

Science Inquiry

Help students appreciate the relative sizes of Earth and the sun and also develop modeling skills. Challenge groups of students to determine the relative sizes of planet Earth and the sun and then to think of objects they could use as scale models of these two celestial bodies. If necessary, explain that scale models correctly represent the difference in size of Earth and the sun. (The sun's diameter is about 1.4 million km and Earth's diameter is almost 1300 km, so the sun's diameter is almost 110 times that of Earth. If Earth were the size of a single grain of sand with a diameter of less than 1 mm, then the sun would be about as big as a softball with a diameter of about 100 mm.)

Common Misconceptions

The statements listed below are common misconceptions about Earth's orbit and the seasons. Read each statement to the class and then discuss as a class why the statement is false. Brief explanations are given in parentheses. If possible, show students diagrams or other images that illustrate why the misconceptions are false (see this URL as an example: http://img.timezone.com/img/articles/tmachine0004/TBfig1-4.gif

1. Earth's orbit around the sun is a highly elongated (skinny) ellipse, making the distance between Earth and the sun vary dramatically over the course of a year.

- [Earth's orbit is elliptical but very close to being a circle. Therefore, the distance between Earth and the sun does not vary that much over the course of a year. At its closest, Earth is about 147 million km from the sun. At its most distant, Earth is about 152 million km from the sun. That's only a 3 percent difference in distance from the sun.]

2. The sun is pretty far off-center within Earth's orbit, making the distance between Earth and the sun vary even more throughout the year.

- [The sun is nearly in the center of Earth's orbit, so this does not contribute much to variation in the distance between Earth and the sun.]

3. The seasons are controlled by the distance between Earth and the sun. During winter, Earth is farther from the sun than in summer.

- [Earth is actually closer to the sun when it is winter in the Northern Hemisphere. The seasons are not controlled by the distance between Earth and the sun. The actual cause of the seasons is the tilt of Earth on its axis. Whichever hemisphere is tilted toward the sun receives more direct and intense solar radiation and experiences summer.]

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 24.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

What would other planets need to have if they were able to support life?

What type of experiment could you create to prove that Earth is rotating on its axis?

If you lived at the equator, would you experience any effects due to Earth's tilted axis?

If Earth suddenly increased in mass, what might happen to its orbit around the sun?

24.3 Lesson 24.2: Earth's Moon

Key Concepts

- Lunar characteristics
- Surface of the moon
- Interior of the moon

Lesson Objectives

- Find similarities and differences between the moon and Earth.
- Describe the features of the moon.

Lesson Vocabulary

- **crater:** bowl-shaped depression on the surface of the moon that is caused by the impact of a meteorite
- **landscape:** surface features of an area
- **lunar:** of or relating to the moon
- **maria:** dark-colored flat areas on the moon's surface that are made up of ancient lava
- **meteorite:** fragment of a planetary body that strikes Earth's surface
- **terrae:** light-colored highlands on the moon's surface

Teaching Strategies

Introducing the Lesson

Introduce the moon by helping students recall anything they may already know about the moon. Quiz them on basic moon facts with these questions:

Question: Does the moon ever appear during the day?
Answer: yes
Question: Does the moon rise in the East like the sun or in the West?
Answer: the East
Question: Does the moon rotate on its axis like Earth?
Answer: yes
Question: How long does it take for the moon to complete one orbit around Earth?
Answer: about 4 weeks
Question: What is the source of the moon's light?

Answer: the sun

Tell students they will learn more about the moon when they read this lesson.

Activity

The engineering design unit at the following URL is a good way to give students technological design practice while they learn about the moon. The unit introduces students to the engineering challenges involved in supporting a sustained human presence on the lunar surface. Groups of students will design a lunar plant growth chamber and build and test a prototype, following the technological design process.

http://er.jsc.nasa.gov/seh/main_EDC_Packing_Up_for_the_Moon.pdf

Demonstration

Ask students if they have ever noticed that when the moon is near the horizon it may appear to be much larger than it looks when it is higher in the sky. Do the demonstration at the URL below to explain why the moon seems to change in size in this way. Students will learn that when the moon is close to the horizon, our brain automatically compares it with things on the ground. Compared with buildings and trees, the moon is far larger, and this comparison makes it seem to be larger than it otherwise would.

http://www.billnye.com/for-kids-teachers/home-demo-details/

Differentiated Instruction

Suggest that students make a table comparing and contrasting Earth and the moon. They might compare them in terms of size, gravity, atmosphere, temperature range, water, weathering, rotation, and revolution.

Enrichment

Have a small group of students either review how the moon formed in the FlexBook® chapter "Earth's History" or else learn how by reading about it online. Then have the students create and present a role-play in which they act out how the moon formed. The moon, Earth, and a large asteroid should be characters in their role-play. Give them a chance to present their role-play to the class. From the presentation, ask other students to summarize how the moon formed.

Science Inquiry

Challenge groups of students to solve this problem by applying lesson concepts: If the moon were to revolve more slowly than it does now, how would it change what we see of the moon from Earth? (We would eventually see the moon's entire surface, instead of just the near side, because the moon would rotate more than once in each revolution. This would result in each side of the moon facing Earth at some point in the moon's revolution.)

Common Misconceptions

Students commonly think that the moon has no gravity. They may have seen images of astronauts on the moon jumping high into the air or hitting golf balls over great distances. Stress that everything in the universe that has mass also has gravity, including the moon. However, because the moon's mass is only 1/6 that of Earth, the gravity of the moon is also only 1/6 of Earth's gravity. This explains why things weigh less on the moon than on Earth even when they have the same mass. For example, if you weigh 120 pounds on Earth, you would weigh only 20 pounds on the moon.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 24.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

What things would be different on Earth if Earth did not have a moon?

If the moon rotated on its axis twice as fast as it does now, would we see anything different than we do now?

How do we know that the moon has been geologically inactive for billions of years?

24.4 Lesson 24.3: The Sun

Key Concepts

- Layers of the sun
- The sun's atmosphere
- Sunspots, solar flares, and solar prominences

Lesson Objectives

- Describe the layers of the sun.
- Describe the surface features of the sun.

Lesson Vocabulary

- **chromosphere:** thin layer of the sun's atmosphere that lies directly above the photosphere and glows red
- **convection zone:** layer of the sun that surrounds the radiative zone and through which energy moves by convection
- **core:** dense metallic center of a planet such as Earth, or the innermost layer of the sun where nuclear fusion reactions take place
- **corona:** outermost layer of the sun's atmosphere that consists of plasma and extends millions of kilometers into space
- **photosphere:** visible surface of the sun
- **plasma:** high-energy, high-temperature state of matter that consists of charged ions instead of atoms
- **'radiative zone:** layer of the sun surrounding the core where energy moves slowly by electromagnetic waves away from the core
- **solar flare:** violent explosion on the sun's surface
- **solar wind:** stream of radiation emitted by a solar flare that extends millions of kilometers out into space
- **sunspot:** relatively cool, dark area on the sun's surface

Teaching Strategies

Introducing the Lesson=

Introduce students to the sun with some of the incredible images of the sun taken by NASA's SOHO mission. The images are available at the following URL. After showing students the images, tell them they will learn more about the sun when they read this lesson.

http://sohowww.nascom.nasa.gov/gallery/

Activity

Have students do the interactive comparison activities at the following URL. They will be able to compare the size of the sun and solar features, the sun's temperature, and the distance to the sun with familiar objects. This will give students a more meaningful conception of these aspects of the sun.

http://solar-center.stanford.edu/compare/comparison.html

Demonstration

Show students the brief animation of sunspot formation and solar flares at the following URL. Discuss what they are viewing and why these phenomena occur. The animation will help students understand how sunspots and solar flares develop on the solar surface.

http://sohowww.nascom.nasa.gov/gallery/Movies/10th/SunspotsForm.mpg

Activity

Students can learn about safe ways of viewing the sun and also about sunspots at the URL below. Instructions are provided for making a pinhole camera for viewing the sun indirectly. Information is also provided for safely viewing the sun through a telescope with filters and for accessing a solar telescope online.

http://solar-center.stanford.edu/observe/observe.html

Differentiated Instruction

Set up a solar gallery walk for this lesson. On different walls of the classroom, post three large sheets of paper or poster board. Label them "The Sun's Layers," "The Sun's Atmosphere," and "Surface Features of the Sun." Divide the class into groups that include differential learners with other students, and ask groups to go from poster to poster adding anything they know about the topics to the posters. They should also add comments about the contributions of other groups, particularly anything with which they disagree. After the gallery walk, discuss as a class the facts and comments recorded on the posters. Be sure to point out and correct any erroneous statements.

Enrichment

Have students use clay and/or other craft supplies to create a three-dimensional cross-sectional model of the sun and its layers. They should label the layers and prepare to describe each layer's characteristic features, such as its temperature and the activity that occurs there (e.g., nuclear fusion, radiation, or convection). Ask students to present and explain their models to the rest of the class, and encourage other students to ask the presenters any questions they may have about the sun's layers. For additional background on the layers of the sun, students can go to these URLs:

- http://imagine.gsfc.nasa.gov/docs/science/know_l1/sun.html
- http://sohowww.nascom.nasa.gov/classroom/classroom.html

Science Inquiry

Challenge students to match the sun's magnetic activity with active regions on the solar surface. The URL below provides instructions for the activity, the images to match, and a solution key. This fun activity will hone students' observational skills as well as help them connect the magnetic activity of the sun with features that we can see on the sun's surface.

http://sohowww.nascom.nasa.gov/classroom/matching_activity.html

Common Misconceptions

Use the class activity at the following URL to explore common misconceptions revealed in how we talk about the sun. The activity will help students understand that some common phrases about the sun are incorrect. Following the activity, they should be able to describe correctly how Earth's rotation affects how we perceive the sun's path and shadows.

http://www.fsec.ucf.edu/en/education/k-12/curricula/sm2/documents/SM2_sun-misconceptions.pdf

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 24.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

If something were to suddenly cause nuclear fusion to stop in the sun, how would we know?

Are there any types of dangerous energy from the sun? What might be affected by them?

If the sun is all made of gases like hydrogen and helium, how can it have layers?

24.5 Lesson 24.4: The Sun and the Earth-Moon System

Key Concepts

- Solar eclipses
- Lunar eclipses
- Phases of the moon

Lesson Objectives

- Explain solar and lunar eclipses.
- Describe the phases of the moon and explain why they occur.

Lesson Vocabulary

- **crescent moon:** phase of the moon in which the near side of the moon appears to be less than half lit; occurs between the new moon and the first or third quarter
- **gibbous moon:** phase of the moon in which the near side of the moon appears to be more than half lit; occurs between the full moon and the first or third quarter
- **lunar eclipse:** event in which Earth casts a shadow on the moon so the moon cannot be seen from anywhere on Earth
- **penumbra:** outer part of a shadow where light is only partly blocked
- **solar eclipse:** event in which the moon casts a shadow on Earth so the sun cannot be seen from the area on Earth's surface where the shadow falls
- **umbra:** inner part of a shadow where light is completely blocked

Teaching Strategies

Introducing the Lesson

Ask students if they have ever heard the expression, "once in a blue moon." Call on volunteers to describe how the expression is used. (It is used to refer to the occurrence of a rare event.) Explain that a "blue moon" is a full moon that rises twice in one month. A full moon is the phase of the moon in which the moon appears from Earth to be a full circle. If a full moon occurs at the beginning of a month, a second full moon can occur toward the end of the month. A blue moon occurs only about once every three years. Tell students they will learn more about phases of the moon in this lesson.

Demonstration

Use the demonstration described at the following URL to show students how the phases of the moon occur. The demonstration uses a baseball to represent the moon and a lamp to represent light from the sun. The demonstration will show students that the phases of the moon are due to the portion of Earth's lit surface that is visible from Earth as the moon revolves around the planet.

http://www.billnye.com/for-kids-teachers/home-demo-details/

Activity

Have students explore the interactive animation at the URL below for a better understanding of what causes the phases of the moon.

http://astro.unl.edu/classaction/animations/lunarcycles/lunarapplet.html

Differentiated Instruction

A fun way for visual and English language learners to improve their comprehension of lesson vocabulary and related words is with a game modeled on Pictionary. Write the terms listed below on index cards, and divide the class into two teams (if the class is too large, there may need to be two or more games going on). To play the game, a student receives an index card and then draws a clue on a piece of paper or whiteboard for the rest of his or her team to guess. Keep the guessing to one minute and assign a point for each correct guess. Terms to include are:

- revolution
- orbit
- solar eclipse
- lunar eclipse
- umbra
- penumbra
- full moon
- first quarter
- last quarter
- new moon
- crescent moon
- gibbous moon

Enrichment

Some students may be interested in learning the many different names that may be given to the full moon at different times of the year. Suggest they go to this URL: http://www.windows2universe.org/earth/moon/full_moon_names.html .

Science Inquiry

The activity at the following URL is a tasty way for students to model the sun-Earth-moon system and how it produces the sequence of phases of the moon as viewed from Earth.

http://www.science-class.net/Lessons/Space/Space%20Cycles/Moon%20Phases/modeling_moon_phases.pdf

Common Misconceptions

A common misconception is that phases of the moon are caused by a shadow from Earth, clouds, or Earth's or the moon's rotation. Make sure that students understand that it is just our view of the moon's sunlit side that changes as the moon orbits Earth. Use a visual like the diagram at the following URL to make sure students understand how the moon's position relative to Earth and the sun causes the moon to appear different to people on Earth as the moon revolves.

http://www.windows2universe.org/the_universe/uts/moon2.html

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 24.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Why don't eclipses occur every single month at the full and new moons?

The planet Mars has a tilt that is very similar to Earth's. What does this produce on Mars?

Venus comes between Earth and the sun. Why don't we see an eclipse when this happens?

CHAPTER 25 MS TE The Solar System

Chapter Outline

25.1 CHAPTER 25: THE SOLAR SYSTEM

25.2 LESSON 25.1: INTRODUCTION TO THE SOLAR SYSTEM

25.3 LESSON 25.2: INNER PLANETS

25.4 LESSON 25.3: OUTER PLANETS

25.5 LESSON 25.4: OTHER OBJECTS IN THE SOLAR SYSTEM

25.1 Chapter 25: The Solar System

Chapter Overview

This chapter discusses the motion of the planets and the formation of the solar system. It also describes the inner and outer planets, dwarf planets, meteors, asteroids, and comets.

Online Resources

See the following Web sites for appropriate laboratory activities:

The purpose of the lab activity at the following URL is for students to learn the factors that influence the habitability of a planet. The lab consists of three activities that build on each other. The activities are (1) playing a board game that introduces habitability factors, (2) creating a model or drawing of a habitable planet, and (3) creating a model or drawing of an uninhabitable planet.

- http://www.lpi.usra.edu/education/explore/our_place/activity_glance.shtml#top

In the lab activity "Changing Faces: A Study of Solar and Planetary Rotation Rates" at the URL below, students work as NASA scientists to make repeated observations of our sun and the planets of the solar system in order to determine their rotation rates. First, students create a playground model of rotation and draw diagrams to represent the model. Then they observe NASA images of sunspots to determine the rotation rate of the sun. Finally, they download NASA videos from the Internet and measure rotation rates for other objects in the solar system.

- http://btc.montana.edu/ceres/html/Faces/faces1.html

These Web sites may also be helpful:

The following URL is an excellent series of more than 80 PowerPoint slides that you can use throughout the teaching of this chapter. It covers all of the planets and other objects in the solar system.

- http://www.lpi.usra.edu/education/resources/s_system/solar_sys_overview.ppt

Links to several recommended videos about the solar system can be found at the first URL below. Links to several exceptional Web sites with information, images, and other resources about the solar system can be found at the second URL below. The third URL is a large collection of three-dimensional images of planets and moons that were taken from NASA spacecraft.

- http://www.lpi.usra.edu/education/skytellers/solar_system/audio_video.shtml
- http://www.lpi.usra.edu/education/skytellers/solar_system/web_sites.shtml
- http://www.lpi.usra.edu/publications/slidesets/3dsolarsystem/3d_index.shtml

You can find several solar system activities at this URL: http://hea-www.harvard.edu/ECT/the_book/Chap5/Chapter5.html .

You can access many teacher-reviewed videos about the solar system and individual planets at this URL: http://www.neok12.com/Solar-System.htm .

Pacing the Lessons

TABLE 25.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
25.1 Introduction to the Solar System	1.5
25.2 Inner Planets	2.5
25.3 Outer Planets	2.0
25.4 Other Objects in the Solar System	1.5

25.2 Lesson 25.1: Introduction to the Solar System

Key Concepts

- Earth-centered and sun-centered models of the solar system
- Definition of planet
- Extrasolar planets
- Size and shape of planetary orbits
- Formation of the solar system

Lesson Objectives

- Describe some early ideas about our solar system.
- Name the planets, and describe their motion around the sun.
- Explain how the solar system formed.

Lesson Vocabulary

- **astronomical unit:** unit of length that is used in astronomy; equals the distance between Earth and the sun
- **dwarf planet:** celestial body orbiting a star that meets all the criteria of a planet except that it has not cleared its orbit of other objects
- **nebula:** cloud of gas and dust in space
- **nuclear fusion:** nuclear reaction in which two nuclei fuse, or join together, to form a larger nucleus and release a huge amount of energy
- **planet:** celestial body orbiting a star that has enough gravity to be spherical and has cleared its orbit of smaller objects
- **solar system:** our sun and all of the objects that revolve around it because of the sun's gravity

Teaching Strategies

Introducing the Lesson

Challenge students to name all of the planets in our solar system in order, starting with the planet closest to the sun. (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune) Ask a volunteer to write the names of the planets on the board. If students omit planets, add planets (such as Pluto), or mix up their order, call on other students to try to find and correct the mistakes. After the list is complete and correct, tell students they will learn more about the planets in our solar system in this chapter.

Activity

The Web quest activity at the following URL is a good way to introduce students to the solar system. Students will find information about each of the planets to complete a worksheet that is also available at the URL. They will learn a few facts about each planet in the solar system as background for their more in-depth study of the planets in the next two lessons of this FlexBook® chapter.

http://teach.fcps.net/trt8/SolarSystem/Planets.htm

Building Science Skills

With the activity at the following URL, students can model a planetary orbit. The activity is written about the International Space Station orbiting Earth, but it applies as well to planets orbiting the sun. From their model, students will appreciate that when a planet is in orbit, the gravity of the sun combined with the forward motion of the planet causes it to constantly change direction and stay in orbit. They will see that if it weren't for gravity, the planet would fly off in a straight line into space. At the conclusion of the exercise, discuss with the class how the model is similar to a planet orbiting the sun and how it is different.

http://www.billnye.com/for-kids-teachers/home-demo-details/

Activity

This activity is designed to help middle school students understand that planets travel in nearly circular orbits around the sun, and that planetary motion obeys laws defined by Kepler and Newton. Students will explore interactive Web sites demonstrating orbital motion and complete a series of modeling activities.

http://btc.montana.edu/ceres/html/58Orbits/58orbits.html

Differentiated Instruction

Students who need reinforcement of basic solar system terminology and facts can use the interactive solar system flashcards at this URL: http://www.studystack.com/flashcard-52478 .

Enrichment

Challenge students who are interested in extrasolar planets and science fiction to take the interactive quiz "Alien Fact or Fiction Quiz" at this URL: http://planetquest.jpl.nasa.gov/interactives .

Science Inquiry

Have students make a scale model of the solar system. This will allow them to use math and modeling skills and also give them an appreciation for the vastness of interplanetary space, which is difficult for most people to grasp because of its magnitude. You can follow the procedure outlined in the following document, which also includes other useful information for teaching middle school students about the solar system.

http://www.units.muohio.edu/cryolab/education/documents/Scale_SolarSystem_Dunford.pdf

Common Misconceptions

A commonly held misconception is that our solar system includes other stars besides the sun. To help students realize that this idea is incorrect, discuss with them what might happen if the solar system contained even one additional star. Tell them to consider how it would affect the orbits of the planets if another massive object with tremendous gravity (like the sun) were relatively close to them.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 25.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Would you expect all the planets in the solar system to be made of similar materials? Why or why not?

The planets are often divided into two groups: the inner planets and the outer planets. Which planets do you think are in each of these two groups? What do members of each group have in common?

25.3 Lesson 25.2: Inner Planets

Key Concepts

- Mercury
- Venus
- Earth
- Mars

Lesson Objectives

- Describe the main features of each of the inner planets.
- Compare each of the inner planets to Earth and to one another.

Lesson Vocabulary

- **inner planet:** one of the four planets closest to the sun that are solid, dense, and rocky; Mercury, Venus, Earth, or Mars
- **year:** amount of time it takes for a planet to complete one revolution around the sun

Teaching Strategies

Introducing the Lesson

Inform students that the word terra means "Earth" in Latin (and Italian). Then ask them what they think the English word terrestrial means. ("Earth-like") Point out that the first four planets from the sun, or the inner planets, are also called terrestrial planets. Tell students they will learn in this lesson the ways in which these planets are all like Earth.

Cooperative Learning

Students can learn about the inner planets using a jigsaw-type of activity in which different groups of students become "experts" on different inner planets and then share their knowledge with the other groups. Assign each of four groups of students one of the inner planets. Within each group, students should decide who will be responsible for different types of information about their planet, such as its location and size, composition and density, atmosphere, temperature, surface features, and so on. After collecting the requisite information, students within each group should collaborate to create a brochure about their planet. The brochure should include images as well as basic information, interesting facts, and unique characteristics of the planet. Put the completed brochures on display in the classroom and give groups time to examine each other's work. Some resources for information and images about the inner planets include:

- http://nineplanets.org/
- http://www.neok12.com/Solar-System.htm
- http://airandspace.si.edu/research/resources/rpif/index.cfm
- http://www.solstation.com/stars/4planets.htm

Building Science Skills

Have students do the hands-on activity "Recipe for a Planet" at the URL below. They will create edible models of Earth and Mars to compare their sizes and illustrate their internal layers.

http://www.lpi.usra.edu/education/explore/mars/inside_mars/recipe_planet.shtml

Differentiated Instruction

Help students distinguish the four Earth-like inner planets by having them make a table comparing and contrasting their important features. They might compare the four planets in terms of size, mass, distance from the sun, length of rotation and revolution, atmosphere, temperature range, and number of moons.

Enrichment

A group of students who need enrichment can do the creative activity at the URL below. They will assume it is the year 2025, and their team has been hired as travel guides for visitors to Mars. They must become Mars experts so the travelers will be prepared for their visit, know what time of year to visit, and the best spots to tour while on Mars. Their challenge is to make the best use of SpaceQuest probes, Internet resources, and NASA data to create a Martian Travel Guide. After the students complete the project, encourage other students in the class to peruse the guide.

http://btc.montana.edu/ceres/html/MarsQuest/Quemarsintro.html

Science Inquiry

With the inquiry activity "Analyzing Meteorological Data from Mars" at the following URL, students will compare real-time Earth and Mars meteorological data (including temperature, wind speed, humidity, and atmospheric pressure) by accessing Internet data resources from NASA. They will describe the weather on Mars based on the data and compare it to Earth's weather. After students complete the activity, discuss as a class why Mars and Earth have different weather.

http://btc.montana.edu/ceres/html/MarsWeather/mars1.htm

Common Misconceptions

Perhaps because it appears red from Earth, many people hold the misconception that Mars is very hot. Many also believe incorrectly that Mars is bigger than Earth, perhaps because the other inner planets increase in size as you travel away from the sun. Make sure your students know the facts. Mars is very cold because of its distance from the sun and very thin atmosphere, and its diameter is only about half of Earth's diameter.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 25.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

We are planning to send humans to Mars sometime in the next few decades. What do you think it would be like to live on Mars? Why do you think we are going to Mars instead of Mercury or Venus?

In what ways are the four inner planets like Earth? What might a planet be like if it weren't like Earth?

25.4 Lesson 25.3: Outer Planets

Key Concepts

- Jupiter
- Saturn
- Uranus
- Neptune
- Pluto

Lesson Objectives

- Describe main features of the outer planets and their moons.
- Compare the outer planets to each other and to Earth.

Lesson Vocabulary

- **Galilean moons:** Jupiter's four largest moons, which were discovered by Galileo
- **gas giant:** one of the four outer planets, which are composed mainly of the gases hydrogen and helium
- **Great Red Spot:** enormous, oval-shaped, long-lasting storm visible on Jupiter
- **outer planet:** one of the four planets that are located beyond the asteroid belt in the solar system; Jupiter, Saturn, Uranus, or Neptune
- **planetary ring:** ring of gases, ice, dust, and/or rock encircling a planet in a thin plane

Teaching Strategies

Introducing the Lesson

Introduce the outer planets by showing students impressive images of one or more of them. You can find examples of good images at the URLs below. As students view the images, ask them to point out any differences they see with the inner planets that they studied in the previous lesson. Tell students they will learn more about the outer planets and how they differ from the inner planets when they read this lesson.

http://www.sciencekids.co.nz/pictures/space.html

http://solarsystem.nasa.gov/multimedia/display.cfm?Category=Planets&IM_ID=15764

Cooperative Learning

Divide the class into groups of four students each, and assign each student in a group one of the four outer planets. Tell students to learn certain basic information about their assigned planet, such as its diameter and mass, distance from the sun, length of day and year, composition, moons, rings, and unique characteristics. Then have the four students within each group collaborate to make an illustrated PowerPoint presentation on the outer planets. Set aside class time for the groups to present their PowerPoint shows to the rest of the class. Some resources they can use are available at these URLs:

- http://nineplanets.org/
- http://www.neok12.com/Solar-System.htm
- http://airandspace.si.edu/research/resources/rpif/index.cfm
- http://solarsystem.nasa.gov/planets/

Building Science Skills

The activity at the following URL will introduce students to planetary research. Using some of the most famous and interesting images of the solar system, students will learn to focus on details by studying uncaptioned images. Next, they will increase their knowledge of the planets and their features by comparing their observations to those of actual researchers. Finally, they will organize their findings to infer a key difference between the inner and outer planets.

http://cse.ssl.berkeley.edu/SegwayEd/abtbest.html

Differentiated Instruction

Have students do the online drag-and-drop activity at the URL below to label a model of the solar system. This activity will reinforce solar system basics for visual and kinesthetic learners.

http://www.neok12.com/diagram/Solar-System-01.htm

Enrichment

Ask students to create a three-dimensional model of one or more of the outer planets. They can get some ideas at the URL below. Give them an opportunity to show their completed models to the class, and then put the models on display in the classroom.

http://www.ehow.com/info_12029168_ideas-3d-models-planets.html

Science Inquiry

With the activity "How Much Would You Weigh on Distant Planets?" (see URL below), students will study the effects of gravity on the planets of the solar system. They will view movies from the lunar Apollo missions, calculate their own weight on other planets, and predict what they might weigh on newly discovered planets around other stars.

http://btc.montana.edu/ceres/html/Weight/weight1.htm

Language Arts Connection

The activity at the following URL focuses on the decision to reclassify Pluto from a planet to a dwarf planet. Students will read about the decision and the new criteria for a planet and watch an actual news cast from around the time the decision was made to "demote" Pluto. Then they will write a paragraph explaining why removing Pluto from the list of planets is a good example of the nature of science. A scoring rubric is provided at the Web site.

http://science-class.net/Lessons/Space/Solar%20System/pluto.htm

Common Misconceptions

Students commonly think that only stars consist of gases and that all planets have hard, rocky surfaces. Make sure students understand that the gas giants are so-named because their outer layers are in the gaseous state and that only their inner cores are made of rock.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 25.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

The inner planets are small and rocky, while the outer planets are large and made of gases. Why might the planets have formed into these two groups?

We have discussed the sun, the planets, and the moons of the planets. What other objects can you think of that can be found in our solar system?

25.5 Lesson 25.4: Other Objects in the Solar System

Key Concepts

- Asteroids
- Meteoroids
- Comets
- Dwarf planets

Lesson Objectives

- Locate and describe the asteroid belt.
- Explain where comets come from and what causes their tails.
- Discuss the differences between meteors, meteoroids, and meteorites.

Lesson Vocabulary

- **asteroid:** small, irregularly shaped rocky body that orbits the sun, typically in a belt of asteroids that is located between the orbits of Mars and Jupiter
- **asteroid belt:** region between the orbits of Mars and Jupiter where the majority of asteroids are located
- **comet:** small icy, dusty object with a bright tail that orbits the sun
- **Kuiper belt:** region of the solar system beyond the orbit of Neptune that contains millions of frozen objects
- **meteor:** chunk of rock from space that burns up as it passes through Earth's atmosphere
- **meteoroid:** small rock in interplanetary space that has not entered Earth's atmosphere
- **meteor shower:** event in which many meteors fall through the atmosphere because Earth passes through a cluster of meteoroids

Teaching Strategies

Introducing the Lesson

Lead the class in brainstorming other objects in the solar system than the sun, planets, and moons. (Other solar system objects include dwarf planets, comets, asteroids, and meteoroids.) Tell students they will learn about these other solar system objects and where they are located when they read this lesson.

Building Science Skills

Use the activity at the following URL so students can explore the nature and composition of comets. They will create their own "comets" and identify different types of comet tails.

http://amazing-space.stsci.edu/resources/explorations/comets/lesson/lab.html

Cooperative Learning

Have students work together to create a bulletin board display about non-planetary objects in the solar system that orbit the sun. Divide the class into eight groups, and assign each group one of the five dwarf planets or one of the other types of bodies (asteroids, meteoroids, and comets) in the solar system. Then tell students in each group that they are responsible for adding information and images to the bulletin board about their assigned body or type of body.

Differentiated Instruction

The different terms that are used to name meteoroids as they fall through Earth's atmosphere (meteor) and land on Earth's surface (meteorite) are likely to be confusing for some students. Have students sketch and label a simple drawing to distinguish among the three terms. Their drawings should include a meteoroid in space beyond Earth's atmosphere, a meteor falling through Earth's atmosphere, and a meteorite lying on Earth's surface.

Enrichment

Direct students who want to learn more about comets to the excellent interactive Web site below. At the Web site, they can learn all about comet facts, myths, and legends.

http://amazing-space.stsci.edu/resources/explorations/cometmyth/

Science Inquiry

Have students do the activity "Planet Impact!" at the URL below. The activity is actually a series of learning modules that was inspired by the crash of the comet Shoemaker-Levy 9 into Jupiter. Students will investigate how the gravity of a large body such as Jupiter affects the path of a smaller body such as a comet. Using an interactive animation, students will launch a comet and observe how gravity changes its path. They will learn how changing the speed, angle of approach, or masses of large and small bodies affects the force of gravity acting on the smaller body. Then students will apply what they learned from the simulation to try to make a comet crash into Jupiter or fly past the planet without colliding with it. You can make the activity inquiry-based by having students pose questions prior to beginning it. The activity includes options for classrooms without computers.

http://amazing-space.stsci.edu/resources/explorations/impact/home.html

Common Misconceptions

Students may hold the misconception that the solar system consists only of the sun and planets. They may have developed this impression from simple diagrams they have seen of the solar system in which only these bodies are represented. Make sure students know that there are actually millions of objects in the solar system. Although some of the objects are very small, there are close to 90 objects orbiting the sun that are greater than 200 miles in diameter. Students can see a list of many solar system objects ranked by size at this URL: http://en.wikipedia.org/wiki/List_of_solar_system_objects_by_radius .

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 25.4 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In 2006, astronomers changed the definition of a planet and created a new category of dwarf planets. Do you think planets, dwarf planets, moons, asteroids, and meteoroids are clearly separate groups?

What defines each of these groups, and what do objects in these different groups have in common? Could an object change from being in one group to another? How?

We have learned about many different kinds of objects that are found within our solar system. What objects or systems of objects can you think of that are found outside our solar system?

CHAPTER 26 MS TE Stars, Galaxies, and the Universe

Chapter Outline

26.1 CHAPTER 26: STARS, GALAXIES, AND THE UNIVERSE

26.2 LESSON 26.1: STARS

26.3 LESSON 26.2: GALAXIES

26.4 LESSON 26.3: THE UNIVERSE

26.1 Chapter 26: Stars, Galaxies, and the Universe

Chapter Overview

This chapter describes constellations and the classification of stars. It explains how stars produce energy and how stars evolve. Also included are multiple star systems, types of galaxies, black holes, the Big Bang Theory, and dark matter and dark energy.

Online Resources

See the following Web sites for appropriate laboratory activities:

The URLs below are two parts of an investigation of stars and how Earth's axial tilt, rotation, and revolution explain the apparent movement of constellations across the sky.

- http://www.lpi.usra.edu/education/skytellers/constellations/activities/zodiac.shtml
- http://www.lpi.usra.edu/education/skytellers/constellations/activities/celestial.shtml

In the investigation "Star Light, Star Bright: Exploring How Stars Are Classified" (see URLs below for instructions and materials), students will work in small groups to organize stars into different categories based on observations of properties in a collection of stars.

- http://www.middleschoolscience.com/starclassification.pdf
- http://middleschoolscience.com/startemplates.pdf
- http://www.enchantedlearning.com/subjects/astronomy/stars/bright.shtml
- http://www.enchantedlearning.com/subjects/astronomy/stars/startypes.shtml

In the lab activity at the following URL, students will model the collapse of a massive star and observe changes in mass, volume, and density as it becomes a black hole.

- https://s3.amazonaws.com/NSTA1/1532521/what_happens_to_a_star_as_it_becomes_a_black_hole.doc?AWSAccessKeyId=AKIAIMRSQAV7P6X4QIKQ&Expires=1378835881&Signature=YtVQr0HQyYLkP0vq2idbPn2Ti1g%3d

These Web sites may also be helpful:

You can find numerous links to useful star and galaxy Web sites at this URL: http://www.lpi.usra.edu/education/skytellers/galaxies/web_sites.shtml .

Go to this URL for recommended videos on galaxies, including the Milky Way Galaxy: http://www.lpi.usra.edu/education/skytellers/galaxies/audio_video.shtml .

At the URL below, you can find a long list of frequently asked questions and answers in cosmology.

- http://www.astro.ucla.edu/~wright/cosmology_faq.html

NASA provides more information about chapter topics at these URLs:

- Stars: http://science.nasa.gov/astrophysics/focus-areas/how-do-stars-form-and-evolve/
- Galaxies: http://science.nasa.gov/astrophysics/focus-areas/what-are-galaxies/
- The Big Bang: http://science.nasa.gov/astrophysics/focus-areas/what-powered-the-big-bang/
- Black holes: http://science.nasa.gov/astrophysics/focus-areas/black-holes/
- Dark matter and dark energy: http://science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy/

Pacing the Lessons

TABLE 26.1: Pacing the Lessons

Lesson	Class Period(s) (60 min)
26.1 Stars	2.0
26.2 Galaxies	1.5
26.3 The Universe	1.0

26.2 Lesson 26.1: Stars

Key Concepts

- Constellations
- Energy of stars
- Classification of stars
- Lifetimes of stars
- Measuring Stars
- Star systems

Lesson Objectives

- Define constellation.
- Classify stars based on their color and temperature.
- Outline the stages of a star.
- Use light-years as a unit of distance.

Lesson Vocabulary

- **binary stars:** system of two stars that orbit a common center of mass
- **black hole:** super-dense core left after a supergiant star explodes as a supernova
- **main sequence star:** star that is actively fusing hydrogen atoms to form helium; considered to be a star in the main portion of its "life"
- **neutron star:** core of a massive star after it explodes as a supernova
- **red giant:** stage in a star's "life" in which the inner helium core contracts and the outer hydrogen layers expand
- **supernova:** tremendous explosion that occurs when a star's core has become mostly iron
- **star:** glowing sphere of gases that produces light through nuclear fusion reactions in its core

Teaching Strategies

Introducing the Lesson

Recite this part of the child's song, "Twinkle, Twinkle Little Star:"

Twinkle, twinkle, little star, How I wonder what you are. Up above the world so high, Like a diamond in the sky.

Point out that the song expresses well how stars appear to us from Earth. Ask students if they know why stars look like twinkling diamonds in the sky. Accept all reasonable responses, and then explain as necessary that stars are huge but look like tiny diamonds because they are so far away. Add that stars appear to twinkle because their light is bent as it passes through the turbulence of Earth's atmosphere. (You or students can learn more about why stars twinkle but planets do not at the following URLs.) Tell students they will learn more about stars, including how big and how far away they are, when they read this lesson.

http://articles.chicagotribune.com/2011-09-10/news/ct-wea-0910-asktom-20110910_1_planets-stars-twinkle-light

http://www.enchantedlearning.com/subjects/astronomy/stars/twinkle.shtml

Building Science Skills

With the activity "What Types of Stars Are in Our Universe?" at the following URLs, students will investigate different types of stars and how they differ in temperature, brightness, and stage of "life." They will create a class wall chart of star temperature and brightness and describe the general trend between temperature and brightness. They will also discuss characteristics of the stars that do not conform to the graph's trend and decide whether the sun is typical or exceptional. The activity includes two short reading selections that explain how astronomers classify stars and how they determine habitability zones around different types of stars.

- http://www.science-class.net/Lessons/Space/Stars/sgc2a3.pdf
- http://www.science-class.net/Lessons/Space/Stars/starcircles.pdf
- http://www.science-class.net/Lessons/Space/Stars/tgc2a3.pdf

Activity

With materials at the URL below, students can play a fast-paced game of matching and sequencing to discover fascinating facts about, and reinforce their understanding of, star life cycles. Groups of three to five students will compete to be the first group to successfully match sets of Star Stage and Stage Description cards and line them up in correct chronological order, from star birth to star death. (After the protostar stage, the order line will diverge into two lines, one for small-mass stars, and one for medium- to large-mass stars.) You can print and cut out the cards from a page at the Web site.

http://www.lpi.usra.edu/education/skytellers/stars/activities/scramble.shtml

Differentiated Instruction

Involve differential learners in a simple demonstration to show them what parallax is and how it can be used to determine the distance of stars. Tell students to hold up one finger in front of their eyes just a few inches from their face. Explain that their finger represents a star. Tell students to look at their finger with just their right eye and make a mental note of the background behind it. Then tell students to look at their finger with just their left eye and observe how the background shifts. Now have students move their finger a few more inches from their face and repeat the exercise. They will notice that the shift in the background as they switch from eye to eye is less when their finger is farther away. Explain that a similar method is used to tell the distance of stars based on the way the stars in the background behind them shift when viewed from Earth at different positions in its orbit.

Enrichment

Have students go to the URLs below to learn about, and see examples of, a Hertzsprung–Russell diagram. Have them make a simplified version of the diagram, explain it to the class, and point out where on the diagram main-sequence stars fall. They should include the sun on their diagram as well as examples of other types of stars, including white dwarfs, giants, and supergiants. They should also be prepared to explain what the magnitude of a star measures.

http://aspire.cosmic-ray.org/labs/star_life/hr_diagram.html

http://www.atlasoftheuniverse.com/hr.html

Science Inquiry

Use the math-oriented inquiry activity at the following URL so students can explore apparent star magnitude (brightness scaling for stars), using integers and problem solving. Student and teacher pages are included.

http://www.nasa.gov/pdf/371707main_SMII_Problem21.pdf

Science Inquiry

With the inquiry activity "How Big is that Star" at the URL below, students will determine the sizes of stars in eclipsing binary star systems. Specific objectives of the activity are for students to be able to explain the relationship between radius and mass among a list of stars, to understand how a binary star system's orbit can cause changes in the observed brightness of the system, and to determine the diameters of stars by analyzing data and manipulating equations.

http://imagine.gsfc.nasa.gov/docs/teachers/lessons/star_size/star_size.html

Common Misconceptions

A very common misconception is that our own sun is not a star. This misconception probably arises from the fact that it appears so different to us on Earth than the other stars that are visible from our planet. Make sure students realize that the sun looks different from other stars only because it is so much closer to us than other stars. A good way to help students appreciate the effect of distance on how stars appear is with the diagram at the following URL. It shows how large (or small) the sun would appear if you could view it from other planets in our solar system. Share this diagram with your students.

http://www.burtonmackenzie.com/2009/02/sun-as-seen-from.html

Common Misconceptions

The resource "Myths vs. Reality: Stars" at the URL below contains several common misconceptions about stars and stellar evolution, in addition to the "sun is not a star" misconception described above. Activities are provided to help you identify and remedy the misconceptions held by your own students. http://amazing-space.stsci.edu/resources/myths/stars.php.p=Teaching+tools%40%2Ceds%2Ctools%2C%3EStellar+evolution%40%2Ceds%2Ctools%2Ctopic%2Cstars.php%3EOverview%3A+Star+myths%40%2Ceds%2Coverviews%2Cmyths%2Cstars.php.r%3Dstars&a=%2Ceds

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 26.1 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Although stars in constellations appear to be close together, they are usually not close together out in space. Can you think of any groups of astronomical objects that are relatively close together in space?

Most nebulas contain more mass than a single star. If a large nebula collapsed into several different stars, what would the result be like?

26.3 Lesson 26.2: Galaxies

Key Concepts

- Star clusters
- Types of galaxies
- Milky Way Galaxy

Lesson Objectives

- Identify different types of galaxies.
- Describe our own galaxy, the Milky Way Galaxy.

Lesson Vocabulary

- **elliptical galaxy:** oval-shaped galaxy with older stars and little gas and dust
- **galaxy:** group of a millions or billions of stars held together by gravity
- **globular cluster:** group of tens to hundreds of thousands of stars tightly held together by gravity
- **irregular galaxy:** galaxy that is neither a spiral galaxy nor an elliptical galaxy
- **Milky Way Galaxy:** spiral galaxy in which Earth and our solar system are located
- **open cluster:** group of up to a few thousand stars loosely held together by gravity
- **spiral arm:** region of gas, dust, and young stars that winds outward from the central bulge of a spiral galaxy
- **spiral galaxy:** rotating galaxy with a central bulge and spiral arms
- **star cluster:** group of thousands of stars held together by gravity

Teaching Strategies

Introducing the Lesson

Show students several images of the Milky Way Galaxy, including how it appears from Earth and how it looks from space. The URLs below offer suitable images. Ask students if they can guess what the images show. Explain that they show the galaxy where our solar system is located. Point out our place in the galaxy in the image at the second URL. Define a galaxy as a huge group of stars that are held together by gravity, and add that the universe contains at least 100 billion galaxies! Tell students they will learn more about the Milky Way and other galaxies when they read this lesson.

- http://science.nationalgeographic.com/science/photos/galaxies-gallery/#/milky-way_1090_600x450.jpg
- http://www.bignose.ca/wp-content/uploads/2011/09/20101209e.gif
- http://www.space.com/14249-milkyway-galaxy-photos.html

Activity

At the following URL, students can explore the Milky Way Galaxy in three dimensions with the interactive "3-D Guide to the Galaxy."

http://planetquest.jpl.nasa.gov/interactives

Building Science Skills

A related activity can be found at the URL below. In this activity, students will create a 3-D map of a galaxy in order to better understand the entire galaxy.

http://www.reachoutmichigan.org/funexperiments/agesubject/lessons/newton/GlxyMpng.html

Differentiated Instruction

Tell students to make simple sketches of the different types of galaxies to reinforce their knowledge of the different shapes. The students should label each of their sketches with the type of galaxy it represents. Have pairs of students exchange sketches and explain in words to each other how the types of galaxies differ.

Enrichment

Suggest that interested students watch the interactive video at the following URL to learn how galaxies evolve through collisions with other galaxies. The video also outlines the eventual fate of our own galaxy, the Milky Way Galaxy, which is expected to collide with the Andromeda Galaxy. In addition, the video introduces the expanding universe, which students will learn more about in the next lesson.

http://hubblesite.org/explore_astronomy/cosmic_collision/cosmic_collision.swf

Science Inquiry

Help students build basic science inquiry skills such as observing, comparing/contrasting, and classifying with the activity at the following URL. In the activity, students will study Galaxy Trading Cards (and other materials supplied as part of the activity) to observe and record the properties of galaxies. Then they will create a Venn diagram to compare and contrast different types of galaxies.

http://amazing-space.stsci.edu/resources/print/classroom_activities/find_the_right_circle.pdf

Common Misconceptions

A common misconception is that our solar system is a galaxy or that the Milky Way is the name of our solar system. Show students an image of the Milky Way Galaxy that shows the location of our solar system within the galaxy to help them overcome these erroneous ideas. The image at this URL is a good one to use for this purpose: http://solarsystem.nasa.gov/multimedia/display.cfm?IM_ID=8083

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 26.2 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

Objects in the universe tend to be grouped together. What might cause them to form and stay in groups?

Can you think of anything that is bigger than a galaxy?

26.4 Lesson 26.3: The Universe

Key Concepts

- Expanding universe
- Big Bang Theory
- Dark matter and dark energy

Lesson Objectives

- Explain the evidence for an expanding universe.
- Describe the formation of the universe according to the Big Bang Theory.
- Define dark matter and dark energy.

Lesson Vocabulary

- **Big Bang Theory:** theory that all matter and energy were at one time compressed into a very small volume and then exploded in a "big bang" that started everything expanding outward and formed the universe
- **dark energy:** as yet undiscovered form of energy that we cannot detect
- **dark matter:** matter in the universe that we cannot see because it does not emit light
- **universe:** everything that exists; all matter, energy, space, and time

Teaching Strategies

Introducing the Lesson

Introduce the universe and its incredible vastness with the creative video "How Big is the Universe for Kids" at the following URL. The video shows that if we could travel in a spaceship at the speed of light, it would take 2 seconds to reach our moon, 100,000 years to reach the edge of our galaxy, and 13 billion years to reach the edge of the known universe!

http://www.youtube.com/watch?v=c-akAq20vb0

Activity

Many students are familiar with the names of objects in space, but they have an incomplete mental model of where the objects are located, their relative size and scale, and how they fit into the cosmic scheme of things. In the activity at the URL below, a three-part questionnaire launches discussions about where objects in space are located and when they formed. The activity also allows students to represent their own mental models of space and time by physically manipulating images of objects in space. The survey can serve as a pre-lesson assessment to show how your students think about the universe. You can also use it to design follow-up activities that help students improve their understanding.

http://www.cfa.harvard.edu/seuforum/download/CosmicSurvey2003.pdf

Activity

Students can learn how black holes affect the space and time around them by playing the board game "Black Hole Explorer" (see URL below). Recommendations and materials for playing in large groups are included.

http://www.cfa.harvard.edu/seuforum/einstein/resource_BHExplorer.htm

Differentiated Instruction

Students can practice identifying basic terms about the universe with the flashcards at this URL: http://www.studystack.com/flashcard-50278 .

Enrichment

Students might want to learn more about how the universe formed and what will happen to it in the future, as well as how scientists have gained this knowledge of the universe. Suggest they watch the fascinating four-part video series "Birth of the Universe" at the following URLs.

- http://www.neok12.com/php/watch.php?v=zX7c7d6c6243404e4e4c5845&t=Universe
- http://www.neok12.com/php/watch.php?v=zX056f5f777266007e064f02&t=Universe
- http://www.neok12.com/php/watch.php?v=zX7a576e014e7e6e7261407b&t=Universe
- http://www.neok12.com/php/watch.php?v=zX534001457650677377 4e41&t=Universe

Science Inquiry

Have students do the inquiry activities in the learning module "Hubble Deep Space Academy" at the URL below. Students will estimate the number of objects in the Hubble Deep Field and compare their estimate with astronomers' estimates. Then they will classify objects in the Hubble Deep Field, describe their characteristics, and use a table to display the data. They will also estimate distances from Earth of objects in the Hubble Deep Field, using relationships between size, brightness, and distance. Finally, they will demonstrate their knowledge of galaxies by answering a series of questions.

http://amazing-space.stsci.edu/resources/explorations/hdf/

Common Misconceptions

Some students may think that our solar system formed during the Big Bang along with the rest of the universe. Make sure they are aware of the timing of these two events. The Big Bang occurred about 13.7 billion years ago, whereas the solar system formed a "mere" 4.6 billion years ago.

Reinforce and Review

Lesson Worksheets

Copy and distribute the lesson worksheets in the *CK-12 Earth Science for Middle School Workbook*. Ask students to complete the worksheets alone or in pairs to reinforce lesson content.

Lesson Review Questions

Have students answer the Review Questions listed at the end of the lesson in the FlexBook® student edition.

Lesson Quiz

Check students' mastery of the lesson with Lesson 26.3 Quiz in *CK-12 Earth Science for Middle School Quizzes and Tests*.

Points to Consider

In what ways is an expanding balloon a good model of the universe, and in what ways is it incorrect? Can you think of a different way to model the expansion of the universe?

The Big Bang Theory is currently the most widely accepted scientific theory for how the universe formed. What is another explanation of how the universe could have formed? Is your explanation one that a scientist would accept?