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Earth Science Teacher's Edition - Enrichment (Being Reviewed)

Earth Science Teacher's Edition - Enrichment

CK12 Editor

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CHAPTER 1 What is Earth Science?

Chapter Outline

1.1 What is Earth Science?

Lesson 1: Nature of Science

- **Enrichment Activity 1: Make a Display**

The scientific method will be an important theme throughout the course. "How did she do that? How was that discovered? What was the hypothesis? What observations were made? What was the conclusion?" These and similar questions could come up practically every day. Ask students to make a display depicting the scientific method. Have them explain their display to the class, and leave the display visible for all to see throughout the course. For additional understanding, they can put in an example of how scientific method has been used in science. A newspaper or magazine article may reveal a study in which scientific method helped scientists to find reliable results.

- **Enrichment Activity 2: A Most Important Word in Science – Theory**

The word theory is misused all the time in common language, even in science pieces in newspapers and on TV. A theory is not one of several accepted explanations for a phenomenon, that's a hypothesis. A theory is the explanation for a phenomenon that is accepted by virtually all scientists and has no data that is not consistent with it.

Explore the value of a theory to scientists. What is a theory? How is a theory different from a hypothesis? How is a theory different from a law?

Have the students break into groups of four and then teams of two. Each team will choose a side of this argument. Within a team, the partners should find ways to support their argument. Each team will then defend their argument against the other team.

Argument 1: Since scientists really believe in the "theory of evolution" or "the theory of plate tectonics", they should call the idea a law rather than a theory. After all, the law of gravity is a law.

Argument 2: A theory is as good as it gets as far as scientific explanations go. Although a law is something that happens all the time, a theory explains a complex set of phenomena. It is based on laws but it cannot be a law.

After the groups have worked together, have the class discuss the value of a theory and why the theories mentioned above are not called "laws."

- **Enrichment Activity 3: Class Discussion**

As a class discuss the following: How do scientific explanations differ from supernatural explanations? Where does faith play a role in each of these types of explanations?

- **Enrichment Activity 4: Poster**

Have the students make a poster depicting lab safety concepts and hang it on the wall where lab work will be done. Students can research accidents that have occurred in the laboratory and the consequences of those accidents to share with the class.

Lesson 2: Earth Science and Its Branches

- **Enrichment Activity 1: Take a Hike**

The direction this activity takes will depend on where you live. Have the students take a walk outdoors where rocks, landforms and sky are visible. It's good to include a water body if you live near one. Have the students write a paragraph or two on their observations to hand in or discuss as a class.

a. What do the nearby rocks look like in terms of their color, texture, hardness, etc.? What clues would you look for to determine whether these rocks are igneous, sedimentary or metamorphic?
b. What do the nearby landforms like look in their color, shape, height, plant cover, etc.?
c. Describe the weather: clouds, temperature, wind and other features. Is the weather changing or fairly stable at this time? How do you know?
d. If the sky is clear and the students can get away from city lights, have them describe the night sky. What phase is the moon in? Are any constellations visible? Do any of the visible stars or things that look like stars (could be planets) appear to be a color other than white?

- **Enrichment Activity 2: Rap Song Composition**

Have the students listen to the Lab Safety rap song. After they have listened, they can create one of their own to perform to the class.

http://www.educationalrap.com/67/lab-safety.html

Additional Web-based Resources

a. The National Institutes of Health has an exercise called Conducting a Scientific Investigation that students may be able to use to understand how a scientific investigation is done: http://science.education.nih.gov/supplements/nih6/Inquiry/guide/lesson3-a.htm#print
b. NSF Earth and Environment classroom resources: http://nsf.gov/news/classroom/earth-environ.jsp
c. Geography4Kids:
http://www.geography4kids.com.

   This site offers an introduction to the earth sciences that includes topics on the Earth's structure, atmosphere, hydrosphere and biosphere.
d. Exploring Earth - An incredible number of investigations, visualizations, data centers, and other resources to explain and expand on all aspects of Earth Science: http://www.classzone.com/books/earth_science/terc/navigation/home.cfm
e. NASA Science for Educators (this is a great site, lots of stuff): http://nasascience.nasa.gov/educators
f. NSF Research in Earth and Environmental Science overview: http://nsf.gov/news/overviews/earth-environ/index.jsp
g. NSF Education Classroom Resources: http://nsf.gov/news/classroom/education.jsp
h. The following websites have quizzes that test the students' knowledge of the scientific method:
   a. Online Scientific Method Quiz: http://mset.rst2.edu/portfolios/l/lautz_/Science%20Fair%20Handbook/SFquiz.html
   b. Discovery Online Scientific Method Quiz: http://school.discoveryeducation.com/quizzes15/biolessonscom/BasicsQuiz.html

c. Biology4Kids Online Scientific Method Quiz: http://www.biology4kids.com/extras/quiz_studyscimeth/q01_yes.html
d. Another Scientific Method Online Quiz: http://www.rcs.k12.va.us/csjh/woody/scientific_method.htm
e. Teams Review the information about the scientific method online, and then take the online quiz together: http://www.biology4kids.com/files/studies_scimethod.html

CHAPTER 2 Studying Earths Surface

Chapter Outline

2.1 Studying Earth's Surface

Lesson 1: Introduction to Earth's Surface

- **Enrichment Activity 1: Mapping with Political Locations/ Landforms**

a. Students will get a large blank political map of the world. Example: http://www.nationalgeographic.com/resources/ngo/education/xpeditions/atlas/.
b. Given a list of desert names and country locations, students will work alone or in partners to accurately place deserts onto the map. Further, using topographic information, students should label landforms correctly as given. (Note: Teachers may shorten the list to include only 10 or 15 deserts for ease of assignment).
c. Students can discuss if there are things in common about where deserts are located and why this might be. These maps can be saved and reexamined in later chapters.

Principal Deserts of the World

Deserts are arid regions, generally receiving less than 25 cm (ten") of precipitation a year, or regions where the potential evaporation rate is twice as great as the precipitation.
The world's deserts are divided into four categories. **Subtropical deserts** are the hottest, with parched terrain and rapid evaporation. Although **cool coastal deserts** are located within the same latitudes as subtropical deserts, the average temperature is much cooler because of frigid offshore ocean currents. **Cold winter deserts** are marked by stark temperature differences from season to season, ranging from 38° C (100° F) in the summer to –12° C (10° F) in the winter. **Polar regions** are also considered to be deserts because nearly all moisture in these areas is locked up in the form of ice.

TABLE 2.1: Deserts of the World

Desert	Location	Size	Topography
Sahara	Morocco, Western Sahara, Algeria, Tunisia, Libya, Egypt, Mauritania, Mali, Niger, Chad, Ethiopia, Eritrea, Somalia	3.5 million sq. mi.	70% gravel plains, sand, and dunes. Contrary to popular belief, the desert is only 30% sand. The world's largest non-polar desert gets its name from the Arabic word Sahara', meaning desert
Arabian	Saudi Arabia, Kuwait, Qatar, United Arab Emirates, Oman, Yemen	1 million sq. mi.	Gravel plains, rocky highlands; one-fourth is the Rub al-Khali ("Empty Quarter"), the world's largest expanse of unbroken sand
Kalahari	Botswana, South Africa, Namibia	220,000 sq. mi.	Sand sheets, longitudinal dunes
AUSTRALIAN DESERTS:			

TABLE 2.1: (continued)

Desert	Location	Size	Topography
Gibson	Australia (southern portion of the Western Desert)	120,000 sq. mi.	Sandhills, gravel, grass. These three regions of desert are collectively referred to as the Great Western Desert—otherwise known as "the Outback." Contains Ayers Rock, or Uluru, one of the world's largest monoliths
Great Sandy	Australia (northern portion of the Western Desert)	1150,000 sq. mi.	Sandhills, gravel, grass. These three regions of desert are collectively referred to as the Great Western Desert—otherwise known as "the Outback." Contains Ayers Rock, or Uluru, one of the world's largest monoliths
Great Victoria	Australia (southernmost portion of the Western Desert)	250,000 sq. mi.	Sandhills, gravel, grass. These three regions of desert are collectively referred to as the Great Western Desert—otherwise known as "the Outback." Contains Ayers Rock, or Uluru, one of the world's largest monoliths
Simpson and Sturt Stony	Australia (eastern half of the continent)	56,000 sq. mi.	Simpson's straight, parallel sand dunes are the longest in the world—up to 125 mi. Encompasses the Stewart Stony Desert, named for the Australian explorer
Mojave	U.S.: Arizona, Colorado, Nevada, Utah, California	54,000 sq. mi.	Mountain chains, dry alkaline lake beds, calcium carbonate dunes
Sonoran	U.S.: Arizona, California; Mexico	120,000 sq. mi.	Basins and plains bordered by mountain ridges; home to the Saguaro cactus
Chihuahuan	Mexico; southwestern U.S.	175,000 sq. mi.	Shrub desert; largest in North America
Thar	India, Pakistan	175,000 sq. mi.	Rocky sand and sand dunes

TABLE 2.1: (continued)

Desert	Location	Size	Topography
COOL COASTAL DESERTS:			
Namib	Angola, Namibia, South Africa	13,000 sq. mi.	Gravel plains
Atacama	Chile	54,000 sq. mi.	Salt basins, sand, lava; world's driest desert
COLD WINTER DESERTS:			
Great Basin	U.S.: Nevada, Oregon, Utah	190,000 sq. mi.	Mountain ridges, valleys, 1% sand dunes
Colorado Plateau	U.S.: Arizona, Colorado, New Mexico, Utah, Wyoming	130,000 sq. mi.	Sedimentary rock, mesas, and plateaus—includes the Grand Canyon and is also called the "Painted Desert" because of the spectacular colors in its rocks and canyons
Patagonian	Argentina	260,000 sq. mi.	Gravel plains, plateaus, basalt sheets
Kara-Kum	Uzbekistan, Turkmenistan	135,000 sq. mi.	90% gray layered sand—name means "black sand"
Kyzyl-Kum	Uzbekistan, Turkmenistan, Kazakhstan	115,000 sq. mi.	Sands, rock—name means "red sand"
Iranian	Iran	100,000 sq. mi.	Salt, gravel, rock
Taklamakan	China	105,000 sq. mi.	Sand, dunes, gravel
Gobi	China, Mongolia	500,000 sq. mi.	Stony, sandy soil, steppes (dry grasslands)
POLAR:			
Arctic	U.S., Canada, Greenland, Iceland, Norway, Sweden, Finland, Russia	5.4 million sq. mi.	Snow, glaciers, tundra
Antarctic	Antarctica	5.5 million sq. mi.	Ice, snow, bedrock

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Lesson 2: Modeling Earth's Surface

- **Enrichment Activity 1: Writing/ Debate Activity**

Have students answer the following question either verbally as a class discussion or in writing for homework. The next day, have students sit in groups based on the chosen map and engage in a class discussion.

QUESTION: If the school principal approached you with extra money in the budget to buy new classroom maps at your school, what type of map projection would you suggest for her to purchase? Give at least three reasons for your choice and why that map would be the best scientific instrument for students. Be sure students give specific

examples of the activities they would use for each type of map and why a particular map projection would best suit that activity.

Lesson 3: Topographic Maps

- **Enrichment Activity 1: Model**

Divide the students into groups. Have each group create a figure out of clay and then make a topographic map of that feature. Warn them that they shouldn't make their figure too complicated!

- **Enrichment Activity 2: Group Writing/ Problem Solving Activity**

a. Divide students into groups of 2 to 4 and pass out a different USGS topographic map to each group. These can be found online, can be borrowed from universities, or bought from outdoor stores or parks.
b. Each group of students should examine the map and write up a 1-3 paragraph narrative of the physical description of the area, leaving out city or region names that might easily identify the map. Students should describe what the area might look like if they drove through it or flew over the region describing elevation, landforms, water features, population sizes, vegetation and other pertinent features.
c. The following day in class, post the topographic maps from Day #1 around the classroom. Give each student group a packet of all of the paragraph descriptions, then have each group try and determine which map each describes.

Lesson 4: Using Satellites and Computers

- **Enrichment Activity 1: Satellite Images**

Find a satellite view of the city where you live. Have the students identify natural features such as rivers, hills, mountains, valleys. Identify cultural features such as roads, buildings, bridges. What evidence is there for intelligent life on the planet? How can we tell human-made from natural features? Now take a look at Figure 6 in Chapter 25 and answer the same question, how can we tell human-made from natural features? Use the database to find a location: http://earth.jsc.nasa.gov/.

- **Enrichment Activity 2: Online Scavenger Hunt**

Have the students do this activity from Cool Tools for Cool Teaching, Geocaching and GPS:

http://edweb.sdsu.edu/courses/EDTEC570/cooltools/gps.html

Additional Web-based Resources

a. Wonderful satellite images of Earth from space: http://earthobservatory.nasa.gov/

CHAPTER 3 Earths Minerals

Chapter Outline

3.1 Earth's Minerals

Lesson 1: What are Minerals?

- **Enrichment Activity 1: Crossword Puzzle**

Complete the crossword puzzle of minerals and mineral groups using the clues below.

http://www.crosswordpuzzlegames.com/create.html

If you would like to give the students the answers in advance, to make the exercise more of a matching assignment, they are:

TABLE 3.1: Puzzle_Answers_1

Element	Oxide	Gold
Mineral	Halide	Calcite
Crystal	Sulfide	Magnetite
Native Element	Halite	Pyrite
Phosphate	Feldspar	
Silicate	Gypsum	
Carbonate	Turquoise	

- **Enrichment Activity 2: Minerals and Mineral Groups Crossword Puzzle**

Words in this puzzle include: calcite, carbonate, crystal, element, feldspar, gold, gypsum, halide, halite, mineral, magnetite, native element (2 words), oxide, phosphate, pyrite, silicate, sulfide, turquoise.

PUZZLE 1

...coming soon...

TABLE 3.2: Puzzle_Questions_1

ACROSS	DOWN
• Carbonate mineral of calcium and oxygen; hardness of 3	• A substance in which all atoms have the same number of protons
• Native element example	• Minerals formed from carbon and oxygen plus other elements

TABLE 3.2: (continued)

ACROSS	DOWN
• The most common silicate mineral	• Mineral group that contains only atoms of one type of element (two words with space included)
• Minerals with one or two metals combined with oxygen	• Mineral from the oxide group, magnetic
• A naturally occurring, inorganic, crystalline solid with a characteristic chemical composition	• Mineral group that forms when saltwater evaporates
• Mineral group formed from tetrahedra made of phosphorous, arsenic or vanadium bonded to oxygen	• Halide of sodium and chlorine
• A solid in which all atoms are arranged in a regular, repeating pattern	• Metallic mineral of iron and sulfur; aka fools' gold
• Mineral group combined with sulfur	• Evaporates of sulfur atoms bonded to oxygen atoms
• Mineral group formed from tetrahedra made of silicon and oxygen	
• Copper aluminum phosphate mineral	

ANSWERS:

Across

2. Carbonate mineral of calcium and oxygen; hardness of 3 – **CALCITE**
4. Native element example – **GOLD**
7. The most common silicate mineral – **FELDSPAR**
9. Minerals with one or two metals combined with oxygen – **OXIDE**

10. A naturally-occurring, inorganic, crystalline solid with a characteristic chemical composition – **MINERAL**

11. Mineral group formed from tetrahedra made of phosphorous, arsenic, or vanadium bonded to oxygen –**PHOSPHATE**

14. A solid in which all atoms are arranged in a regular, repeating pattern – **CRYSTAL**

16. Mineral group combined with sulfur – **SULFIDE**

17. Mineral group formed from tetrahedral made of silicon and oxygen – **SILICATE**

18. Copper, aluminum, phosphate mineral - **TURQUOISE**

Down

1. A substance in which all atoms have the same number of protons – **ELEMENT**

3. Minerals formed from carbon and oxygen plus other elements – **CARBONATE**

5. Mineral group that contains only one type of element – **NATIVE ELEMENT**

6. KMineral from the oxide group, magnetic – **MAGNETITE**

8. Mineral group that forms when saltwater evaporates – **HALIDE**

12. Halide of sodium and chlorine – **HALITE**

13. Metallic mineral of iron and sulfur; aka fools' gold – **PYRITE**

15. Evaporates of sulfur atoms bonded to oxygen atoms – **GYPSUM**

Lesson 2: Identification of Minerals

- **Enrichment Activity 1: Mineral Identification**

Divide the class into 5 groups, one for each of the following sets of topics, or divide or combine the topics to make more or fewer groups:

a. Color, Streak and Luster
b. Density and Hardness
c. Cleavage and Fracture
d. Magnetism and Fluorescence
e. Taste and Smell

Using the internet, have the students create a poster or power point presentation with images of minerals to illustrate each of these mineral characteristics. Within each set of characteristics, each quality must be well defined and must be contrasted with the other characteristics; e.g. what are cleavage and fracture and how they are different from each other. Students will need to be creative when describing taste and smell.

- **Enrichment Activity 2: Style Mineral Identification Game**

Have students break into groups to create a twenty questions-style mineral identification game (although most minerals wouldn't need that many questions to identify). Each group is given two or three samples of different minerals that may superficially resemble each other but are identifiably different. The students will create questions and answers that lead to the correct mineral identification for each. For example, if the students are given calcite and quartz, the first question might be about color, then cleavage and eventually onto hardness or the ability to fizz in acid to seal the identification. Other groups of students will do each other's games after they are completed. After playing the game, have students rearrange the order of their questions to determine the quickest (fewest number of questions) way to correctly identify the mineral.

- **Enrichment Activity 3: Song**

Have the students listen to this rap song on Weight, Mass, Volume and Density:

http://www.educationalrap.com/66/weight-mass-volume-density.html

Lesson 3: Formation of Minerals

- **Enrichment Activity 1: National Geographic Article**

http://news.nationalgeographic.com/news/2007/04/070406-giant-crystals.html

Have the students read the National Geographic article about the Cave of Crystals in Mexico. What mineral or minerals are the crystals made of? How did the crystals form? What conditions are necessary for such enormous crystals to be able to form?

Lesson 4: Mining and Using Minerals

- **Enrichment Activity 1: Role of Mineral Resources**

Students can do outside research and present their results to the class regarding the role mineral resources have played in the development or downfall of various cultures in human history. Why were some minerals important? Did the need to acquire certain minerals cause an empire to expand? Did the presence of some types of mineral deposits allow the development of certain industries? Possible examples are:

- Ancient Rome and metal deposits
- The Inca and gold
- The California Gold Rush
- The Upper Midwest of the United States and the American auto industry
- Salt through the ages

- **Enrichment Activity 2: Online Scavenger Hunt**

Mountaintop removal (MTR) mining is exactly what it sounds like: A mountain top is removed to expose an ore deposit to mining. This is an extremely controversial method of mining that is increasingly common for mining coal in the Appalachian Mountains. Students can research both sides of the issue, report on their side to the class

and debate the two sides: What is MTR and why is this method of mining controversial? What is the alternative to MTR? What are the advantages of MTR? Why are some people opposed to MTR? How do politics affect how much MTR is taking place?

The structure or composition of snowflake obsidian could protect a person from nightmares? Hopefully, the students will conclude that minerals do not have metaphysical properties.

Additional Web-based Resources

a. The Mineral and Gemstone Kingdom: http://www.minerals.net/
b. Some beautiful photos of the Smithsonian Gem and Mineral Collection: http://www.gimizu.de/sgmcol/
c. The Diamond Deception, NOVA: http://www.pbs.org/wgbh/nova/diamond/

CHAPTER 4

Rocks

Chapter Outline

4.1 Rocks

Lesson 1: Types of Rocks

- **Enrichment Activity 1: The Rock Cycle Game**

Have students create a board game that illustrates the rock cycle. One idea is for each player to have a playing piece. "Bases" are the different rock types and cards have processes written on them. Players have to go to the next rock type based on the process. How does a player repeat being in the same rock type? The first player to visit all three rock types, including a revisit to the rock type s/he started on, wins.

- **Enrichment Activity 2: The Crayon Rock Cycle Lab**

Simulate the rock cycle using crayons! Students bring in old crayons and use them in groups to watch the different changes that rocks go through as they move through the rock cycle. Have them make observations and answer questions on each of the steps. This lab was developed by the Preuss School at the University of California, San Diego.

Go to: http://preuss.ucsd.edu, then search for Rock Cycle Simulation.

Lesson 2: Igneous Rocks

- **Enrichment Activity 1: Granite Like Ice Cream**

How is granite like ice cream? Have students explore the idea that granite is like ice cream: How are they the same, how are they different? Once they've brainstormed some ideas, they can check out Rob's Granite Page: http://uts.cc.utexas.edu/ rmr/analogy.html.

- **Enrichment Activity 2: Lava Lamp**

Bring a lava lamp into class to illustrate how magma would rise if it were rising through another liquid and not solid rock. Why does the "lava" of the lava lamp rise? How is this process different from lava rising through the rock of the Earth's crust or upper mantle? Students can discuss how magma rises in teams and then discuss their ideas together as a class.

- **Enrichment Activity 3: Igneous Rocks Vocabulary Crossword Puzzle**

This puzzle includes the words: andesite, basalt, composition, extrusive, felsic, granite, intermediate, intrusive, lava, mafic, magma, molten, rhyolite, solidify, ultramafic.

Created with: http://www.crosswordpuzzlegames.com/create.html.

PUZZLE 2

....coming soon...

TABLE 4.1: Puzzle_Questions_2

ACROSS	DOWN
• Igneous rock that forms inside Earth	• Chemical makeup of a rock or other substance
• Igneous rock made of dense, dark minerals like olivine and pyroxene	• Igneous rock containing >90% mafic minerals
• Extrusive rock with intermediate composition	• Extrusive rock with mafic composition
• Molten rock below Earth's surface	• Igneous rock made of light minerals like quartz and feldspar
• Rock material or other substances that are melted	• Extrusive rock with felsic composition
• Igneous rock type between felsic and mafic in composition	
• Molten rock at Earth's surface	
• Igneous rock that forms above Earth's surface	
• To harden during cooling	
• Intrusive rock with felsic composition	

ANSWERS:

Across

2. Igneous rock that forms inside Earth - **INTRUSIVE**
5. Igneous rock made of dense, dark minerals like olivine and pyroxene - **MAFIC**

6. Extrusive rock with intermediate composition - **ANDESITE**

8. Molten rock below Earth's surface - **MAGMA**

9. Rock material or other substances that is melted - **MOLTEN**

10. Igneous rock type between felsic and mafic in composition - **INTERMEDIATE**

11. Molten rock at Earth's surface - **LAVA**>

12. Igneous rock that forms above Earth's surface - **EXTRUSIVE**

14. To harden during cooling - **SOLIDIFY**

15. Intrusive rock with felsic composition - **GRANITE**

Down

1. Chemical makeup of a rock or other substance - **COMPOSITION**

3. Igneous rock containing >90% mafic minerals - **ULTRAMAFIC**

4. Extrusive rock with mafic composition - **BASALT**

7. Igneous rock made of light minerals like quartz and feldspar - **FELSIC**

13. Extrusive rock with felsic composition - **RHYOLITE**

Lesson 3: Sedimentary Rocks

- **Enrichment Activity 1: Sedimentary Rocks**

How is a granola bar or rice crispy treat like a sedimentary rock? What holds a sedimentary rock together? What in the granola bar or rice crispy treat is like the sediments in a sedimentary rock? How does sediment become well sorted? What process in nature would produce a sedimentary rock like a granola bar

- **Enrichment Activity 2: Sediments**

Have students gather many different size sediments: gravel, coarse sand, medium sand, fine sand, silt and clay. Put these in a large clear plastic tube with water. Shake up the water and sediments and observe what happens as the particles settle. How long does it take for the largest particles to settle? How long does it take for the water to become clear?

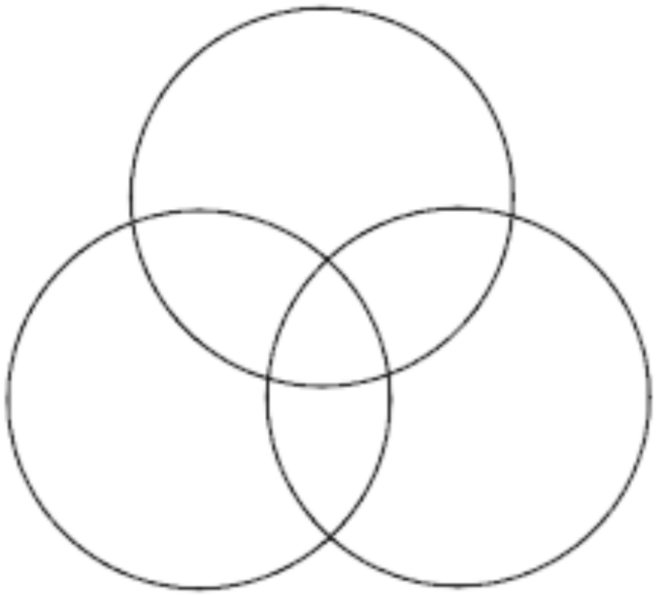
Lesson 4: Metamorphic Rocks

- **Enrichment Activity 1: Metamorphic Rock**

How is marble cake like a metamorphic rock? How is marble cake different? A laminating sheet is a solid before it is used. How is lamination like metamorphism? What properties have changed when something is laminated? Can you think of any industrial processes that are similar to metamorphism?

- **Enrichment Activity 2: Venn Diagram with Rocks**

Have the students create a Venn diagram on a large sheet of paper with igneous rocks, metamorphic rocks and sedimentary rocks in three of the corners. Characteristics that the three rock types share will be placed in the middle; characteristics that only two rock types share will be placed between those two rock types and characteristics that are unique to each rock type will be placed near that rock type. An example of a three-category Venn diagram is shown below.



- **Enrichment Activity 3: Metamorphic Rock**

Bring in rocks for the students to identify using The Rock Identification Key, by Don Peck. This is a very informative and useful website: http://www.rockhounds.com/rockshop/rockkey/index.html.

Additional Web-based Resources

a. Atlas of Igneous Rocks, Minerals, and Textures:
http://www.geolab.unc.edu/Petunia/IgMetAtlas/mainmenu.html
b. Metamorphic Rocks:
http://csmres.jmu.edu/geollab/Fichter/MetaRx/

CHAPTER 5 Earths Energy

Chapter Outline

5.1 Earth's Energy

Lesson 1: Energy Resources

- **Enrichment Activity 1: Survey**

Working in groups and with school personnel, students answer the questions on the following survey from the US Department of Energy. Students will think more deeply about how their school operates and how energy is used at the school.

http://www.eia.doe.gov/kids/classactivities/SchoolBuildingSurveyIntermediate.pdf.

- **Enrichment Activity 2: Research**

Energy is arguably the most controversial topic in Earth Science and the most important for citizens to understand. So that the students understand each type of energy and its pros and cons, students should prepare a Power Point presentation individually or in groups of two or three on an energy type. They should discuss the source of the energy, what resources it uses, how it is harnessed, what the environmental costs are, and how long that type of energy will last. Energy types can be lumped or split for the purpose of the research. Research should go into more depth than the material presented in the book or be on energy types not explored in the book.

TABLE 5.1: Possible_Energy_Types

Possible energy types to research include:	
Coal (lignite, bituminous, anthracite)	Hydroelectric dams
"Clean" coal	In-stream turbines
Coal for synthetic oil and natural gas	Wind
Oil	Biofuels (grains, wood, corn, algae, etc.)
Oil shale	Methane hydrates
Tar sands	Ocean waves
Natural gas	Tidal energy
Nuclear fission	Ocean thermal energy conversion
Nuclear fusion	Geothermal
Hydrogen/ Fuel cells	
Solar	

- **Enrichment Activity 3: Debate**

Using the information gleaned from the presentations suggested above, or just from the text, students can debate which types of energy should be developed or further developed. Should oil exploration be the dominant focus of energy development? Should wind and solar be made more affordable and widespread? There are many other aspects of energy that can be explored.

Lesson 2: Nonrenewable Energy Resources

- **Enrichment Activity 1: Poster**

Although nearly everyone gets around by automobile these days and nearly all automobiles are powered by gasoline, few people think about how the gas got into the gas tank and how it is able to power the car. Have the students create a poster outlining the voyage of gasoline from microorganisms to petroleum to the engine to the emissions it produces. The steps can be separated so that 2-4 students can work together to create a poster.

Lesson 3: Renewable Energy Resources

- **Enrichment Activity 1: Essay**

Have students write an essay comparing and contrasting four renewable resources. In their essay they should explain how each resource is harnessed and then used. What are the pros and cons of each resource? Which resource has the best chance of being important in the future and why? How might energy use in the future for the US look different from the way it looks now?

- **Enrichment Activity 2: Interview**

Many communities around the country are exploring alternative energy as a clean, inexpensive (at least in the future) alternative to traditional energy sources. Depending on what type of energy is being explored and developed in your community, have the students interview someone who is involved in developing or utilizing that alternative energy source. Possible questions include:

a. Why is this energy source being considered for this region?
b. What are the technical problems with developing this energy source?
c. What are the potential environmental problems with developing this energy source?
d. What are the political implications for developing this energy source: Are all people in the community in favor of developing this energy source? If not, why not?
e. What is the best possible future for this energy source in this community?

- **Enrichment Activity 3: Types of Energy Crossword Puzzle**

The words included in this puzzle are biomass, chemical (energy), fossil fuel (2 words), geothermal, hydrocarbon, kinetic (energy), nuclear, potential (energy), solar, water, wind.

Created with: http://www.crosswordpuzzlegames.com/create.html.

PUZZLE 3

...coming soon...

TABLE 5.2: Puzzle_Questions_3

ACROSS	DOWN
• Energy stored within a physical system	• Energy from the heat of the Earth
• Ancient plant and animal remains turned to coal, oil, and natural gas	• Energy stored in the connections between atoms
• Compound of carbon and hydrogen; fuel	• Energy from splitting or fusing atomic nuclei
• Energy that an object in motion has because it is in motion	• Energy from the Sun
• Energy from moving air	
• Energy from recently living plants and animals	

ANSWERS:

Across

2. Energy stored within a physical system – **POTENTIAL** (energy)
3. Ancient plant and animal remains turned to coal, oil and natural gas – **FOSSIL FUELS**
4. Compound of carbon and hydrogen; fuel - **HYDROCARBON**
7. Energy that an object in motion has because it is in motion - **KINETIC**
8. Energy from moving air - **WIND**
10. Energy from recently living plants and animals - **BIOMASS**

Down

1. Energy from the heat of the Earth - **GEOTHERMAL**
5. Energy stored in the connections between atoms – **CHEMICAL** (energy)

6. Energy from splitting or fusing atomic nuclei – **NUCLEAR** (energy)

9. Energy from the Sun – **SOLAR** (energy)

- **Enrichment Activity 4: Competition**

Have the students design and build a solar cooker and then cook a hot dog, small pizza or other food type in it. Have a competition to see which team can create the most effective solar cooker. An example of a solar cooker can be found on this Department of Energy website:

http://www.eia.doe.gov/kids/classactivitie/SolarCookingIntermediateActivity.pdf

Additional Web-based Resources

a. The PBS series, NOVA, looks at California's ambitious plan to cut greenhouse gas emissions. The website includes a program preview, relevant interviews and a teachers' guide: http://www.pbs.org/wgbh/nova/energy/
b. This Department of Energy website is a great teacher resource with extensive information on energy, lesson plans, energy facts and student activities: http://www.eia.doe.gov/kids/index.html

CHAPTER 6

Plate Tectonics

Chapter Outline

6.1 Plate Tectonics

Lesson 1: Types of Rocks

- **Enrichment Activity 1: Model**

Using clay, have the students create a model of the Earth's interior, including the two types of crust, mantle and inner and outer core. Have them identify where the lithosphere and asthenosphere would be on these models. They should try to make the layers proportional or state how much certain portions are magnified or diminished; e.g. the crust may have to be 10 or more times thicker in the model than it should be to be proportional.

- **Enrichment Activity 2: Rap Song**

Have the students listen to the Layers of the Earth rap song: http://www.educationalrap.com/59/layers-of-the-earth.html. Then have students create their own rap song or poem about the Earth's layers.

- **Enrichment Activity 3: Demonstration of Convection Currents**

The University Of California Museum Of Paleontology has a short course for San Francisco Unified School District teachers. One of the useful classroom activities is a demonstration of convection currents that can be done in the classroom: http://www.ucmp.berkeley.edu/education/dynamic/session1/sess1_act2.html.

Lesson 2: Continental Drift

The following activities are to be done before continental drift and plate tectonics are described in detail.

- **Enrichment Activity 1: Continental Drift Puzzle**

Photocopy one map from the link below for each student and cut the continents apart. First have them put the continents together like they are puzzle pieces to create their own supercontinent, which they can name if they like. They can also decide how long ago their supercontinent was together. Describe how people had observed that the continents appeared to fit together like puzzle pieces but didn't really know what to make of that idea. At the rate that plates move, how long would it have taken for their continents to move to these positions?

One possible map can be found here: http://commons.wikimedia.org/wiki/File:Pangaea_continents.png.

- **Enrichment Activity 2: Historic Reenactment**

Choose a student to be Wegener and have the rest of the class pretend to be his scientific contemporaries. Have Wegener present his evidence for continental drift and have the other students play his supporters or detractors. Without invoking evidence that was not available at the time, see if any students can have their minds changed by the other side.

Lesson 3: Seafloor Spreading

- **Enrichment Activity 1: Demonstration**

The class can demonstrate seafloor spreading and the meaning of bilateral symmetry. Have the students line up, preferably with two boys, then two girls alternating, down a central aisle in the classroom (you can also alternate by shirt color, two dark, then two light). In the central aisle, the students are "magma" in a "magma chamber." The students then slowly walk to the "surface" at the front of the room to "erupt" and flow outward in opposite directions, one boy left and the other boy right. Then the first girls diverge, one left and the other right, then boys and so on. When all the students have "erupted" onto the seafloor, a pattern emerges: boys are normal polarity, girls are reversed (or vice versa). Have one or the other raise their hands. The first erupted students are the oldest rocks and are furthest out from the ridge and the last erupted are the youngest rocks and are closest to the ridge.

- **Enrichment Activity 2: Sediments**

Use the following website from Mississippi State University to have students individually or in pairs create their own model of seafloor spreading. This activity will give students a good sense of how new seafloor forms, the relative ages of seafloor, and how the magnetic stripes look after the basalt has cooled.

http://www.msstate.edu/dept/geosciences/CT/TIG/WEBSITES/RESEARCH/Christine_Oxenford/lesson2.html

- **Enrichment Activity 3: Map Activity**

Present the evidence that scientists had when they developed the mechanism of seafloor spreading, including age of the ocean floor, oceanic crust is youngest at the ridge, high heat flow at the ridges, sediments are missing at the ridge and get thicker closer to the continents, paleomagnetic reversals etc. They should be given an ocean floor bathymetric map, a map showing the ages of ocean floor basalts, and a map showing the magnetic polarity of ocean floor basalts. In small groups, have the students brainstorm an explanation for these features.

Lesson 4: Theory of Plate Tectonics

- **Enrichment Activity 1: Discussion**

Go back to chapter 1 to review these concepts: hypothesis, data, facts, theory and law. Why is the plate tectonics idea a theory and not a hypothesis or a law? What portions of the plate tectonic idea are facts and what is the theory? Is continental drift a hypothesis or a theory and why?

- **Enrichment Activity 2: Discussion**

Plate tectonics is often called the "unifying theory of geology." Why is it called this? How does it explain the distribution of volcanoes, earthquakes, mountain ranges and mineral deposits?

Additional Web-based Resources

a. Great plate tectonics animations can be found at this National Park Service website. Different animations show the breakup of Pangaea, plate movement, seafloor spreading, and other relevant topics: http://www.nature.nps.gov/Geology/usgsnps/animate/pltecan.html

b. See recent plate tectonic motions using GPS data from NASA's Jet Propulsion Lab. Global Positioning System (GPS) receivers are used to determine precise geodetic position measurements each day. By piecing together movements from subsequent days, plate movements can be determined. Horizontal movement vectors, which are the result of plate tectonic motions, are shown on the map and motions for various locations can be graphed. http://sideshow.jpl.nasa.gov/mbh/series.html
c. The Restless Earth from The Burke Museum of Natural History and Culture, University of Washington, presents a good primer on plate tectonics, including some information from a Washington State perspective: http://www.washington.edu/burkemuseum/geo_history_wa/The%20Restless%20Earth%20v.2.0.htm

CHAPTER 7

Earthquakes

Chapter Outline

7.1 Earthquakes

Lesson 1: Stress in the Earth's Crust

- **Enrichment Activity 1: Diagrams/ Models**

Using clay or other medium, have the students create models of each of three different types of faults or folds. All parts should be labeled.

- **Enrichment Activity 2: Crossword Puzzle**

This puzzle was created using this website: http://www.crosswordpuzzlegames.com/create.html.

Stress-Strain Vocabulary Crossword

Some of the words from lesson one appear in this crossword puzzle of stress and strain. The included words are: anticline, basin, compression, deformation, dome, fault, fold, fracture, joint, monocline, shear, slip, strain, stress, syncline, tension, uplift.

PUZZLE 4

...coming soon...

TABLE 7.1: Puzzle_Questions_4

ACROSS	DOWN
• A bend in rocks caused by compression	• Stresses that push toward each other
• A bend in rocks that makes them inclined relative to the horizontal	• A break in rock along which there has been movement
• The upward rise of rock material	• A fold in rocks that bends downward so the youngest rocks are in the center
• Stresses that push past each other in opposite directions	• The distance rocks move along a fault

TABLE 7.1: (continued)

ACROSS	DOWN
• The change in shape a rock undergoes when it has been altered by stresses	• A break in rock along which there may or may not have been movement
• Force per unit area	• Stresses that pull material in opposite directions
• A block of rock that slips downward between normal faults	• A circular anticline with the oldest rocks in the center
• An upward-arching fold with older rocks in the center	
• A break in rock along which there has been no movement	
• Deformation in a rock due to stress	

ANSWERS:

Across

2. A bend in rocks caused by compression – **FOLD**
3. A bend in rock that makes them inclined relative to the horizontal – **MONOCLINE**
5. The upward rise of rock material – **UPLIFT**
6. Stresses that push past each other in opposite directions – **SHEAR**
7. The change in shape a rock undergoes when it has been altered by stresses – **DEFORMATION**
8. Force per unit area – **STRESS**
11. A block of rock that slips downward between normal faults – **BASIN**
12. An upward-arching fold with older rocks in the center – **ANTICLINE**
15. A break in rock along which there may or may not have been movement – **FRACTURE**

16. Deformation in a rock due to stress – **STRAIN**

Down

1. Stresses that push toward each other – **COMPRESSION**

4. A break in rock along which there has been movement – **FAULT**

6. A fold in rocks that bends downward so the youngest rocks are in the center – **SYNCLINE**

9. The distance rocks move along a fault – **SLIP**

10. A break in rock along which there has been no movement – **JOINT**

11. Stresses that pull material in opposite directions – **TENSION**

14. A circular anticline with the oldest rocks in the center – **DOME**

Lesson 2: Nature of Earthquakes

- **Enrichment Activity 1: Video/ News Report**

Using the following website on historic and more recent earthquakes, have the students choose a past earthquake and write a fictitious eyewitness report of a person who experienced the quake. This eyewitness report can be videotaped, written in the form of a newspaper article or can be voice recorded. All reports should be shared in class in historical order. A tsunami can be chosen as well. This activity is further described on the website of the Center for Innovation in engineering and Science Education. The website has other activities to be used in other lessons: http://www.ciese.org/curriculum/musicalplates3/en/studentenrichment3.shtml.

- **Enrichment Activity 2: Classroom Activity**

The Visiting Geoscientists website is for professional geoscientists who go to classrooms. Their lesson, Earthquake Waves, for grades 4 to 8, has students use their bodies to simulate different types of earthquake waves. This would likely only work for a class that is easily controlled: http://www.agiweb.org/education/aapg/invest/invest4.html.

Lesson 3: Measuring and Predicting Earthquakes

- **Enrichment Activity 2: Jobs**

Students will each choose two jobs that are associated with predicting or measuring earthquakes. Research these jobs on-line and then create job descriptions for these jobs that could be used in a "mock" ad for the job. Include the location where the job will be done in the ad. You can then create a classified ad for these jobs and have students choose jobs of interest to apply for.

Lesson 4: Staying Safe in Earthquakes

- **Enrichment Activity 1: Poster**

Make a safety poster explaining/ illustrating the following things:

a. Explain how sometimes events that occur after an earthquake can be worse than the actual earthquake. Be sure to discuss aftershocks, fires, liquefaction and tsunamis. Be clear and specific.
b. Explain what a person(s) should do during and after an earthquake to be and stay safe.

Be certain the poster is neat, colorful, easy to read, accurate and informative.

- **Enrichment Activity 2: Earthquake Resistant Structure**

The Visiting Geoscientists website has a lesson for grades 4 to 8 on Building and Testing Earthquake-Resistant Structures. Students build a structure, expose it to an "earthquake", and rebuild the structure stronger to better withstand the next quake: http://www.agiweb.org/education/aapg/invest/invest13.html.

- **Enrichment Activity 3: Map Activity**

If you live in an earthquake-prone area, try to find a map of fault locations and another of shaking intensity like the one for the San Francisco Bay Area (Figure 7) of the flexbook. Have students look at these maps and see where they think hospitals and schools should be located. If you do not live in an earthquake-prone area, have the students choose a town in the San Francisco Bay Area and make the same determinations.

Additional Web-based Resources

a. The Northern California Earthquake Data Center collects seismological data for Northern and Central California. They have data collections and a "make your own seismogram" activity: http://www.ncedc.org/, http://www.ncedc.org/bdsn/make_seismogram.html
b. If you live in the Pacific Northwest you might be interested in the Pacific Northwest Seismograph Network's Earthquake Prediction page. Although that region of the country seems to have little seismic activity, the truth is much more complicated: http://www.geophys.washington.edu/SEIS/PNSN/INFO_GENERAL/eq_prediction.html

CHAPTER 8 Volcanoes

Chapter Outline

8.1 Volcanoes

Lesson 1: Volcanic Activity

- **Enrichment Activity 1: Global Volcanism Program Map**

All sorts of volcanoes appear on this map created by the Global Volcanism Program: http://www.volcano.si.edu/world/region.cfm?rnum=13. In addition to this map, provide students with a map that shows plate boundaries. Have the students study the Global Volcanism Program map and identify the geologic reason for each of the groups of volcanoes. The students should be as specific as possible, even mentioning the type of lithosphere involved in plate interactions. The groups are:

a. Yellow triangles that appear in two separate lines in the western part of the Pacific Ocean
b. Red triangles that appear singly
c. Red triangles that appear in a group or a line in the middle of the Pacific
d. Red triangles that appear singly or in groups offshore in the eastern Pacific
e. Yellow triangles that run in a line along western North, Central and South America
f. Yellow triangles that appear east of the coastal areas in North America

Answers: The reasons for these are:

a. Subduction zone volcanoes with ocean-ocean crust convergence.
b. Hot spot volcanoes where the triangle is on the location of the hotspot.
c. Hotspot volcanoes where older volcanoes are identified.
d. Mid-ocean ridge volcanoes. The ones off of Washington State outline the Juan de Fuca Ridge.
e. Subduction zone volcanoes with continent-ocean crust convergence.
f. Extension of the continental crust. Beneath Yellowstone is a massive mantle plume that has erupted in the past as a supervolcano.

Lesson 2: Volcanic Eruptions

Younger kids will enjoy a demonstration of how gas causes an explosive eruption. Bring a 2 liter bottle of club soda to class and take it outside with the students. It is best if the soda is warm. Hold the bottle near the ground and describe how magma moves its way up through the crust and shake the bottle. When it's time for the eruption, open the lid and watch the water squirt everywhere. It's best if you wear quick dry clothes that day!

- **Enrichment Activity 1: Identify Volcanoes**

Find some photos of volcanoes – some erupting, if possible – and distribute among the students. Have the students identify which type each volcano is. Locate the volcanoes on a map and identify their plate tectonic setting. Have the students link the types of volcanoes and eruption types to the plate tectonic setting. If your classroom has access to a computer and a projector, this can be done using Google Earth which is a free download. Volcanoes can be viewed from above to see their map view location and then the image can be rotated to see them from the side.

- **Enrichment Activity 2: Make a Dictionary**

Students of all ages love volcanoes so have the class put together a Dictionary of Volcanic Terms. Each person or group chooses 1 – 5 terms to research and draw a picture of to put together as a class. The end result can be distributed to lower grades or younger siblings. Some terms to include are:

TABLE 8.1: Dictionary_of_Volcanic_Terms

VOLCANO	SHIELD VOLCANO	HOT SPOT
MAGMA	COMPOSITE VOLCANO	MANTLE PLUME
MAGMA CHAMBER	CINDER CONE	PILLOW LAVA
LAVA	SUPERVOLCANO	ACTIVE VOLCANO
PYROCLASTIC FLOW	SILL	EXTINCT VOLCANO
PAHOEHOE	BATHOLITH	DORMANT VOLCANO
A'A LAVA	FISSURE	GEYSER
PYROCLAST	PIPE	HOT SPRING
VENT	LAVA DOME	
CALDERA	LAVA PLATEAU	

- **Enrichment Activity 3: Class Discussion - Predicting Eruptions**

Review this story for the students and then engage them in a class discussion about the importance of being a volcanologist and ask if any of them would like to be a volcanologist. What do they think the positives and negatives of the job might be?

On January, 14, 1993, scientists meeting to discuss the science of predicting volcanic eruptions took a field trip, led by volcanologist Stanley Williams, into the crater of Galeras volcano in the Columbian Andes. After 40 years of dormancy, Galeras had come to life in March 1989 and had erupted on July 16, 1992 when the lava dome blew apart and ash rose 3.5 miles into the air. After that, Galeras was quiet. During their trip into the crater, Williams and his colleagues made measurements that they hoped would someday help them to predict volcanic eruptions. As they were about to descend, tons of red- and white-hot ash and rock were thrown from the crater's mouth. The eruption was small and brief, but it was enough to kill six of the scientists and three hikers who were on the crater that day. Williams himself was seriously injured. Important data collected before the disaster allowed scientists to learn more about eruptions and since then, volcanologists have predicted several eruptions by monitoring earthquakes, the location of magma within a volcano, and the swelling in the flanks of a volcano. Between 1979 and 2000, 23 volcanologists died while working on volcanoes. Yet the importance of this work is underscored by the approximately 30,000 people who were killed by volcanoes in the previous 20 years. Dr. Williams has written a book about the experiencing, Surviving Galeras, 2001.

Lesson 3: Types of Volcanoes

- **Enrichment Activity 1: Finding the Epicenter of an Earthquake**

Have the students divide into small groups to create a four-way Venn Diagram that compares and contrasts the four types of volcanoes: composite, shield, cinder cone and the supervolcano. Try to include at least five facts in each area of the Venn diagram. After the students have completed their own diagram, create a large class model of the Venn diagram to hang on the wall. A sample 4-way Venn Diagram is illustrated here: http://en.wikipedia.org/wiki/File:Venn4.svg. If the class attempts this, use of different colors for different volcano types will be helpful. Alternatively, have the students create a 3-way Venn diagram, leaving out supervolcano.

Lesson 4: Volcanic Landforms and Geothermal Activity

- **Enrichment Activity 1: Volcanoes, Volcanic Eruptions and Volcanic Landforms Crossword**

Created using: http://www.crosswordpuzzlegames.com/create.html.

PUZZLE 5

...coming soon...

TABLE 8.2: Puzzle_Questions_5

ACROSS	DOWN
• A gentle sloped volcano composed of fluid lava flows	• A fixed region of hot magma above a mantle plume (2 words with space)
• Circular shaped feature due to volcano collapse	• A small volcano composed of cinders that usually erupts only once (2 words with space)
• A volcano that is erupting or about to erupt	• Molten rock beneath the Earth's crust
• A long crack from which lava erupts onto the surface	• A volcanic eruption that is gaseous and violent
• A volcano that has not erupted in recorded time and likely won't again	• Jagged and sharp lava from a more viscous magma
• A volcano that is not erupting but has recently erupted and could again	• Lava that erupts beneath water forming a rounded structure
• A steep volcano composed of alternating ash and lava flows	
• Molten rock that erupts at the surface	

TABLE 8.2: (continued)

ACROSS	DOWN
• The volcano that creates the most massive eruption type, extremely rare	
• Smooth lava flow from a less viscous magma	
• A volcanic eruption that is relatively gentle and non-explosive	
• A hot water fountain that erupts at regular or random intervals	

ANSWERS:

Across

1. A gentle sloped volcano composed of fluid lava flows – **SHIELD**
3. Circular shaped feature due to volcano collapse – **CALDERA**
4. A volcano that is erupting or about to erupt – **ACTIVE**
5. A long crack from which lava erupts onto the surface – **FISSURE**
6. A volcano that has not erupted in recorded time and likely won't erupt again – **EXTINCT**
7. A volcano that is not erupting but has recently and could again – **DORMANT**
9. A steep volcano composed of alternating ash and lava flows – **COMPOSITE**
12. Molten rock that erupts at the surface – **LAVA**
13. The volcano that creates the most massive eruption type, extremely rare – **SUPER**
15. Smooth lava flow from a less viscous magma – **PAHOEHOE**
16. A volcanic eruption that is relatively gentle and non-explosive - **EFFUSIVE**
17. A hot water fountain that erupts at regular or random intervals - **GEYSER**

Down

2. A fixed region of hot magma above a mantle plume – **HOT SPOT**

3. A small volcano composed of cinders that usually erupts only once – **CINDER CONE**

8. Molten rock beneath the Earth's crust – **MAGMA**

10. A volcanic eruption that is gaseous and violent – **EXPLOSIVE**

11. Jagged and sharp lava from a more viscous magma – **AA**

14. Lava that erupts beneath water forming a blobby structure - **PILLOW**

Additional Web-based Resources

a. This website describes the United States Geological Survey's volcano hazards program, which includes facts about volcano monitoring and how the USGS attempts to keep communities safe: http://www.usgs.gov/themes/volcano.html
b. The Smithsonian Institution—Global Volcanism Program has an extensive database of volcanic eruptions, maps and recent volcanic activity reports: http://www.volcano.si.edu/
c. Volcano World, currently run by Oregon State University, has volcano news and activities for kids and educators focusing on land-based and submarine volcanoes: http://volcano.oregonstate.edu/education/index.html
d. Cascades Volcano Observatory has news and updates about the United States most active volcanoes, the Cascades of the Pacific Northwest: http://vulcan.wr.usgs.gov/home.html. The site also includes virtual volcano field trips: http://volcano.oregonstate.edu/kids/adventure/index.html
e. NOVA, the PBS science series, has websites detailing segments of their show that deal with volcanoes, including:
    a. Deadly Shadow of Vesuvius: http://www.pbs.org/wgbh/nova/vesuvius/
    b. Mystery of the Megavolcano: http://www.pbs.org/wgbh/nova/megavolcano/

CHAPTER 9 Weathering and Formation of Soil

Chapter Outline

9.1 Weathering and Formation of Soil

Lesson 1: Weathering

- **Enrichment Activity 1: Weathering Crossword Puzzle**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

The words used are vocabulary words from Lesson 1 in Chapter 9, including: abrasion, carbonic acid (2 words), chemical (weathering), differential (weathering), erosion, hydrolysis, ice wedging (2 words), leaching, mechanical (weathering), oxidation, sediment, weathering

PUZZLE 6

...coming soon...

TABLE 9.1: Puzzle_Questions_6

ACROSS	DOWN
• A weak acid from carbon dioxide and water that increases weathering (2 words)	• Mechanical weathering in which water expands and contracts as it freezes and melts
• The process that changes rock into sediments	• The type of weathering that decomposes rock by changing its
• Dissolved minerals travel down from upper to lower layers of soil	• The type of weathering that disintegrates rock without changing its chemistry
• A form of mechanical weathering that occurs when one rock hits another	• The transport of weathered materials by water, wind, ice or gravity
• Term describing how different types of rock weather at different rates	
• Chemical weathering in which oxygen reacts with elements in the rock	

TABLE 9.1: (continued)

ACROSS	DOWN
• Bits of weathered rock in a range of sizes	
• Chemical weather in which hydrogen or hydroxide ions replace cations in minerals	

ANSWERS:

Across

2. A weak acid from carbon dioxide and water that increases weathering – **CARBONIC ACID**
5. The process that changes rock into sediments - **WEATHERING**
6. Dissolved minerals travel down from upper to lower layers of soil – **LEACHING**
7. A form of mechanical weathering that occurs when one rock hits another – **ABRASION**
8. Term describing how different types of rock weather at different rates – **DIFFERENTIAL** (weathering)
10. Chemical weathering in which oxygen reacts with elements in the rock – **OXIDATION**
11. Bits of weathered rock in a range of sizes – **SEDIMENT**
12. Chemical weather in which hydrogen or hydroxide ions replace cations in minerals - **HYDROLYSIS**

Down

1. Mechanical weathering in which water expands and contracts as it freezes and melts – **ICE WEDGING**
3. The type of weathering that decomposes rock by changing its chemical composition – **CHEMICAL**
4. The type of weathering that disintegrates rock without changing its chemistry – **MECHANICAL**
9. The transport of weathered materials by water, wind, ice or gravity – **EROSION**

Lesson 2: Soils

- **Enrichment Activity 1: Research and Write**

Land plants did not evolve until about 475 million years ago leaving the land exposed for about 4 billion years before that. Have the students write a paragraph on how chemical and mechanical weathering might have been different then. What might the landscape have looked like? Next they can do some research to find out if there is a planet or satellite that might look similar today.

- **Enrichment Activity 2: Connecting to Your Community**

Soils consist mainly of a mixture of sand, silt and clay. Have examples of these three types of textures for students to examine. After they've observed these textures, discuss with them the climate type in which your school is located. Now have the students hypothesize as to what type of soil is in the school yard. Why do they think this? Next, have the students research the type of soil that is actually found in your region. Open the discussion to explore what past conditions in an area might have created the regional soil. How might the soil type in your region affect the economy of your area? How does soil type affect the economy of locations in general? For example, what makes the Central Valley of California such a productive agricultural region? Of course, other factors than just soil play into this. What are they?

- **Enrichment Activity 3: Discussion**

The tropical rainforests of Southeast Asia have been a source of ready cash for the nations with rainforests for several decades. Widespread deforestation has lead to environmental damage in a number of areas and has even caused death among human communities. One major cause of death has been landslides on the steep slopes where trees no longer hold the soil in place, resulting in hundreds or even thousands of fatalities during rainstorms. For example, in the Philippines, a massive landslide killed more than 1,000 people in the town of Guinsaugon in February 2006. As a result of these landslides, the Philippine government has severely restricted logging and banned the logging of old growth forests and forests that are on steep slopes. The government has a very difficult time implementing the logging bans and protecting the forests. Many illegal loggers cut down trees and process the logs at mini-illegal sawmills! Have the students discuss the pros and cons of rainforest logging. What possible reasons could make people willing to go into a forest and log illegally? What are the long term implications of rainforest logging around Southeast Asia?

- **Enrichment Activity 4: Soil Components**

A Visiting Geoscientists activity in which students check soils for various components including pH, nitrogen, phosphorous and potassium. Students will have a chance to discover how people do chemical analyses on bulk samples: http://www.agiweb.org/education/aapg/invest/invest5.html.

- **Enrichment Activity 5: Soils Crossword Puzzle**

Created using: http://www.crosswordpuzzlegames.com/create.html.

The words used are vocabulary terms from Lesson 2 in Chapter 9, including: deciduous, humus, inorganic, laterite, loam, organic, pedalfer, pedocal, permeable, residual, horizon, profile, subsoil, topsoil, transported.

PUZZLE 24

...coming soon...

TABLE 9.2: Puzzle_Questions_24

ACROSS	DOWN
• Trees that lose their leaves each winter	• Partially decayed remains of living things; the organic component in soil
• Soil with connecting spaces, water can move through easily	• Not from living organisms, e.g. minerals and rocks
• Nutrient-poor, red, tropical soil; supports rainforests	• A soil above the bedrock that supplies its components
• The B horizon, where iron oxides and clays accumulate	• The A horizon, most fertile layer, where humus, plant roots and organisms are found
• Soil texture with roughly equal amounts of sand, salt and clay	• From living organisms
• Fertile soil, forms in drier, grassland regions	• Very fertile, dark, mid-latitude soil; supports forests
• All the horizons for a particular soil	• An individual layer within a soil profile; e.g. A, B, & C
• A soil that has components that were moved from a different area	

ANSWERS:

Across

2. Trees that lose their leaves each winter – **DECIDUOUS**
7. Soil with connecting spaces, water can move through easily – **PERMEABLE**
8. Nutrient-poor, red, tropical soil; supports rainforests – **LATERITE**
9. The B-horizon, where iron oxides and clays accumulate – **SUBSOIL**

11. Soil texture with roughly equal sand, silt and clay – **LOAM**

12. Fertile soil, forms in drier, grassland regions – **PEDOCAL**

13. All the horizons for a particular soil – **PROFILE**

14. A soil with components that were moved in from a different area – **TRANSPORTED**

Down

1. Partially-decayed remains of living things; the organic component of soil – **HUMUS**

3. Not from living organisms; e.g. minerals and rocks – **INORGANIC**

4. A soil above the bedrock that supplies its components – **RESIDUAL**

5. The A-horizon, most fertile, where humus, plant roots and organisms are found – **TOPSOIL**

6. From living things – **ORGANIC**

7. Very fertile, dark, mid-latitude soil; supports forests – **PEDALFER**

10. An individual layer within a soil profile; e.g. A, B & C - **HORIZON**

Additional Web-based Resources

a. The website for Bill Nye: The Science Guy, http://www.billnye.com, has experiments that are easy to do in class. Try Erosion Explosion or Acid Attack for this chapter.
    a. On the Bill Nye website to go Home Demos, Planetary Science, Earth Science, Erosion Explosion.
    b. On the Bill Nye website to go Home Demos, Physical Science, Chemistry, Acid Attack.

b. NASA has a Soil Science Education Home Page with information, featured profiles and activities: http://soil.gsfc.nasa.gov/

c. "Dr. Dirt," aka Dr. Clay Robinson of West Texas Z&M University, has K-12 teaching activities, videos and demonstrations involving soil on his website: http://www.wtamu.edu/ crobinson/drdirt.htm

CHAPTER 10 Erosion and Deposition

Chapter Outline

10.1 Erosion and Deposition

Lesson 1: Water Erosion and Deposition

- **Enrichment Activity 1: Identify Features**

Show the students photos of the Grand Canyon. Have them try to determine something of its geologic history. Why do some rock layers form cliffs and others more gentle slopes? What caused the cross bedding in the Coconino sandstone? How did the Colorado River erode the canyon? The following website has some information on the geology of the Grand Canyon suitable for middle school and high school students: http://www.bobspixels.com/kaibab.org/geology/gc_geol.htm.

- **Enrichment Activity 2: Diagram / Model**

Have students divide into groups to make either a diagram or a 3D model of some of the water features created by erosion and deposition. They may create an imaginary country that includes some or all of the following features drawn, molded in clay or otherwise represented:

TABLE 10.1: Water_Features

Meandering stream	Valley	Tributary
Delta	Natural Level	Alluvial Fan
Distributary	Oxbow lake	River
Cave	Flood plain	Stream
Sinkhole	Beach	

Lesson 2: Wave Erosion and Deposition

- **Enrichment Activity 1: Research and Discussion**

How are the waves that move in the ocean like the S- and P-waves that are created during an earthquake? If S- and P-waves cause destruction during an earthquake, how do ocean waves cause similar "destruction" to beaches, the ocean bottom etc.? How do people try to deal with erosion at the shore?

Have the students research and write a paragraph or two about a favorite beach that they have visited or would like to visit. What if anything have people done to reduce erosion and/ or deposition from the ocean? Have the students present their research to the class and discuss.

- **Enrichment Activity 2: Wave Erosion & Deposition Crossword Puzzle**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

Words that are included are from Lesson 2 in Chapter 10: arch, barrier island, breakwater, groin, sea stack, (sea) wall, spit, (wave-cut) platform, (wave) crest, (wave) height, (wave) length, (wave) trough.

PUZZLE 7

...coming soon...

TABLE 10.2: Puzzle_Questions_7

ACROSS	DOWN
• An erosional landform that is produced when waves erode through a cliff	• Long, narrow, sandy land area offshore (2 words w/ space)
• Vertical distance from wave crest to wave trough	• Lowest part of a wave form
• Narrow sandbar; forms as waves transport sand	• Manmade structure parallel to shore to protect against strong waves
• Horizontal distance between two wave crests	• Wave-cut level area formed by erosion
• Isolated tower of rock (2 words w/space)	• Humanmade piles of stone perpendicular to shore to trap sand
• Manmade structure parallel to shore; protects harbors	
• Highest part of a wave form	

ANSWERS:

Across

2. An erosional landform that is produced when waves erode through a cliff - **ARCH**
3. Vertical distance from wave crest to wave trough – **HEIGHT**
5. Narrow sandbar; forms as waves transport sand – **SPIT**
7. Horizontal distance between two wave crests – **LENGTH**
8. Isolated tower of rock – **SEA STACK**

10. Manmade structure parallel to shore, protects harbors - **BREAKWATER**

11. Highest part of a wave form – **CREST**

Down

1. Long, narrow sandy land offshore – **BARRIER ISLAND**

4. Lowest part of a wave form - **TROUGH**

5. Humanmade structure parallel to shore to protect against strong waves – **SEA WALL**

6. Wave-cut level area formed by wave erosion - **PLATFORM**

9. Manmade piles of stone perpendicular to shore to trap sand - **GROIN**

Lesson 3: Wind Erosion and Deposition

- **Enrichment Activity 1: Research**

The Dust Bowl in the 1930s was considered by many people to be one of the worst natural disasters in US history. The conditions of the environment had an impact on the sociological and economic history of Americans. Using the websites and other sources, have the class discover and share what they learn about the Dust Bowl, and what impact science and nature played on the entire nation. Could anything have been done to prevent the impact of the Dust Bowl? How did wind create problems for farmers? How did weather conditions add to the problems? Could we be facing similar problems today or in the future? Here are some websites where they can get started:

http://www.oznet.ksu.edu/fieldday/kids/wind/dust_bowl.htm

http://www.weru.ksu.edu/vids/

http://www.usd.edu/anth/epa/dust.html

- **Enrichment Activity 2: Wind Erosion and Deposition Vocabulary Crossword Puzzle**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

Words that are included are from Lesson 3 in Chapter 10: barchan (dune), bed load, deflation, (desert) pavement, (desert) varnish, loess, petroglyphs, saltation, (sand) dune, slip face, suspended load, ventifact.

PUZZLE 8

...coming soon...

TABLE 10.3: Puzzle_Questions_8

ACROSS	DOWN
• Crescent-shaped dune in regions with ample sand, wind and hard ground	• Sediments carried by wind that roll, bump and jump along ground
• Desert surface of rocks and pebbles where wind removed fine sediments	• Desert coating of dark minerals on stable rock surfaces
• Wind removes finer sediments causing ground surface to subside	• Human made rock carvings cut into exposed rock surfaces
• Extremely fine, wind-born silts and clays in near-vertical cliffs	• Fine sediments carried within the air or water
• Steeper downwind side of dune	• Movement of sand-sized particles along ground surface
• General term for a sand deposit in regions with sand and wind	
• Stones that are polished and faceted by sand abrasion	

ANSWERS:

Across

1. Crescent-shaped dunes in regions with ample sand, wind and hard ground - **BARCHAN**
4. Desert surface of rocks and pebbles where wind removed fine sediments - **PAVEMENT**
5. Wind removes finer sediments causing ground surface to subside - **DEFLATION**
7. Extremely fine, wind-born silts and clays in near-vertical cliffs - **LOESS**
9. Steeper downwind side of dune – **SLIP FACE**

10. General term for a sand deposit in regions with sand and wind - **DUNE**

11. Stones that are polished and faceted by sand abrasion - **VENTIFACT**

Down

1. Sediments carried by wind that roll, bump and jump along the ground – **BED LOAD**

2. Desert coating of dark minerals on stable rock surfaces - **VARNISH**

3. Human made rock carvings cut into exposed rock surfaces - **PETROGLYPHS**

6. Fine sediments carried within the air or water – **SUSPENDED LOAD**

8. Movements of sand-sized particles along the ground surface – **SALTATION**

Lesson 4: Wind Erosion and Deposition

- **Enrichment Activity 1: Vocabulary Review Game**

Write a vocabulary word from this lesson (listed below) on a note card. Without students seeing the words, tape a different word to each student's back. Students should then walk around asking "yes" or "no" questions about the words to try and determine which vocabulary word he/she has on his/her back.

Vocabulary words:

TABLE 10.4: Glacial_Erosion_Vocabulary

Abrasion	Glacial erratic	Moraine
Arête	Glacial striations	Plucking
Cirque	Glacial till	Rouche Moutonnee
Drumlin	Ground moraine	Rock Flour
End moraine	Horn	Tarn
Esker	Kettle lake	Varve
Additional words that can be added for larger classes:		
Drift	Hanging Valley	
Bedrock	Loess	
Valley	Outwash Plain	

- **Enrichment Activity 2: Identify Features**

Find a topographic map or a satellite image of Yosemite National Park, particularly the Yosemite Valley. One way to do this is to search for Yosemite Valley on Google maps, but it might be easier for students to identify features on a topographic map. Once they have a map, have the students locate glacial features. They can then search the web for photos of these features to put on the map. Include U-shaped valleys, hanging valleys, half dome, roche moutonnees, glacial polish, glacial striations. Have the students go to this site for a virtual field trip of Yosemite:

http://virtual.yosemite.cc.ca.us/ghayes/roadside.htm.

Lesson 5: Erosion and Deposition by Gravity

- **Enrichment Activity 1: PowerPoint Presentation**

Using websites and other sources, students will work in groups of 2-4 students to create a PowerPoint presentation describing a landslide, discussing factors influencing landslides, the different types of landslides and what measures can be taken to both prevent and stay alive during a landslide. Students will share Power Points with the class. Some websites to start with:

http://www.ussartf.org/landslides.htm

http://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html

http://landslides.usgs.gov/

http://www.dnr.wa.gov/ResearchScience/Topics/GeologicHazardsMapping/Pages/landslides.aspx

http://www.redcross.org/images/pdfs/code/landslides.pdf

- **Enrichment Activity 2: Play in the Sand**

If a significant number of your students have been to a beach or a playground with a sandbox and ready access to water, you can ask them to relate their experiences with building sand castles and what insight that gives them into mass wasting. How steep can a sand castle be? Is it easier to build a steep pile with wet or dry sand? Why? If a sand castle is built wet and then dries, what happens to the structure? If the sand is mixed with too much water, is it possible to build a sand castle? What happens to the sand? If the students have not had this experience, maybe bringing some sand and water into an outdoor area at school will allow them to better understand the behavior of sediments.

- **Enrichment Activity 3: Class Discussion**

The people who live in the 160 homes that make up the town of La Conchita, California have it all: A spot just across the highway from a beautiful Southern California beach, a nice hillside and generally nice weather. But the land beneath that part of California rises slowly, about 15 feet every 1,000 years, making it unstable. Additionally, rainstorms are common in winter, particularly in El Niño years. The unstable ground and occasional severe rainstorms have resulted in the town's history of severe landslides. In January 2005, 10 people were fatally buried by a landslide. In March 1995, two slides hit the town, although no one was killed. A retaining wall built after the March 1995 slide costing $400,000 came down easily in the January 2005 slide. Geologists warn that further slides are inevitable and are likely to be even larger. While some of the town's residents have packed up and moved, some are unwilling to do so, saying that their location is beautiful and that most of California is subject to natural disasters.

To foster class discussion, divide the students into groups and have them act out different roles in this saga. One or two can be town residents; one can be a county commissioner; one an insurance agent. What is each person's viewpoint of this problem and what questions would a person in that job likely have? What can be done to save the town? Should it be done given the costs and potential risks? Think about the location of earthquake faults. Should the potential for devastating earthquakes be a factor? Should residents be discouraged from staying in the town? Forced to leave? Or helped in any way possible to keep their homes? Should new homes be allowed to be built? If the residents are forced to leave their town, why not have people evacuate California within two miles or 10 miles or 100 miles of any active fault? How about tornado zones? Hurricane-prone regions? Are there some places that are

too dangerous for people to be allowed to live and who decides? The students present their various arguments to the class.

A photo of La Conchita, California: http://en.wikipedia.org/wiki/File:LaConchitaN.jpg.

Additional Web-based Resources

a. The US Geological Survey has a lot of information on landslides since they are an important natural hazard. U.S.G.S. Geologic Hazards Site: http://geohazards.cr.usgs.gov/; Geologic Hazards Team - National Landslide Information Center: http://landslides.usgs.gov/nlic/
b. PBS's NOVA series episode and website, Descent into Ice, follows a team of "glacionauts" into glacier caves in the French Alps: http://www.pbs.org/wgbh/nova/mtblanc/

CHAPTER 11 Evidence About Earths Past

Chapter Outline

11.1 Evidence About Earth's Past

Lesson 1: Fossils

- **Enrichment Activity 1: Fossilization Research**

Divide the class into five groups. Each group should become the experts on one of the types of fossilization: Preserved Remains, Permineralization, Molds and Casts, Replacement, and Compression. Students will take notes together, find examples of their type of fossilization and prepare a short 5-10 minute presentation about their type of fossilization while other students take notes. Students should find an example from somewhere in the world where this kind of fossilization is found. Have students determine what the conditions were in this location that allowed this type of fossilization.

- **Enrichment Activity 2: Humor Writing**

It's very difficult to become a fossil and very few individuals are able to achieve that great distinction. Have each student pretend their goal is to become a fossil and write a humorous piece on how s/he would go about it. Students should explore several possibilities for fossilization in a humorous, but accurate, way. Why would becoming a fossil be a worthy goal? Students might want to explore those that tried and failed!

- **Enrichment Activity 3: Group Discussion**

Uniformitarianism recognizes that Earth changes slowly over long periods of time. Catastrophism is the idea that Earth changes in short, sudden events. As the students go through the next two chapters, have them come up with a few examples of uniformitarianism and catastrophism in Earth history individually. After this is complete, have them discuss these events as a class. Does only one philosophy have to be right or can some events be explained by slow change and others by abrupt change?

Lesson 2: Relative Ages of Rocks

- **Enrichment Activity 1: Make a Poster**

Divide the class into groups and have each group make a poster that explains the basic principles of relative dating based on Steno's Laws. Include a cross section that another student could practice on, with the correct order of the rock layers on the back.

- **Enrichment Activity 2: Practice Deciphering Relative Ages in Cross Sections**

Students in 8th and 9th grades can do an exercise in determining relative ages of a geologically complex area and also learn about radiometric dating at this website from the University of California, Berkeley: http://www.ucmp.berkeley.edu/fosrec/McKinney.html.

Lesson 3: Absolute Ages of Rocks

- **Enrichment Activity 1: Create a game**

Divide the students into groups. Each group will create a game that will help other students understand radioactivity, including half life and other important concepts, and radiometric dating. The goal should be to determine the age of a rock or at least learn how. The game can be a board game or any other type of game that would be useful as a teaching tool. Groups can each play the others games or can share with other classes in the school.

- **Enrichment Activity 2: Earth's Past - Jeopardy!**

Create a Jeopardy-style game for your students to play. This can be done in large form on a poster or white board in the classroom or in Power Point (instructions on how to do this: http://www.joe.org/joe/2003april/tt2.php) or in small groups. Example answers and questions follow. If power point is not available, students could also make a poster Jeopardy style board and use note cards or post it notes for the questions in each category.

TABLE 11.1: Earths_Past_Jeopardy_0

Answers	Questions

Category - Earth's Past General

TABLE 11.2: Earths_Past_Jeopardy_I

The age of an object in years.	What is absolute age?
The age of an object as compared with other objects	What is relative age?
Remains or traces of ancient life.	What is a fossil?
Of or belonging to the land.	What is terrestrial?
Of or belonging to the sea.	What is marine?

Category - Fossil

TABLE 11.3: Earths_Past_Jeopardy_II

A fossil that must be studied with the aid of a microscope.	What is a microfossil?
Evidence of an ancient organism; e.g. worm burrows or dinosaur tracks.	What is a trace fossil?
A fossil organism that was widespread but was alive geologically relatively briefly.	What is an index fossil?
The remains of an ancient organism; e.g. shells, bones, teeth and leaves.	What is a body fossil?
An organism that exists today and has for millions of years without much change.	What is a living fossil?

Category - Fossilization

TABLE 11.4: Earths_Past_Jeopardy_III

Empty space in sediments in the shape of a shell or bone.	What is a mold?
A fossil that formed as a filled mold.	What is a cast?
Fossilization in which minerals are deposited into an organism's hard parts.	What is permineralization?
Fossilized tree sap.	What is amber?
Coal, oil or natural gas formed from the remains of ancient organisms.	What is fossil fuel?

Category - Steno's Principles

TABLE 11.5: Earths_Past_Jeopardy_IV

In a sedimentary sequence, the oldest layer is at the bottom and the youngest is at the top.	What is superposition?
A sedimentary rock layer extends as wide as the area in which it formed.	What is lateral continuity?
Sedimentary layers were laid down horizontally.	What is original horizontality?
An intrusion or fault is younger than the rocks it cuts through.	What is cross-cutting relationship?
Man who recognized that fossils were once living creatures or parts of them.	What is Nicholas Steno?

Category - Absolute Age

TABLE 11.6: Earths_Past_Jeopardy_V

Time required for half of the atoms of a radioactive substance to decay.	What is half-life?
Atoms of the same element with different numbers of neutrons?	What are isotopes?
The stable product of radioactive decay.	What is a daughter product?
Particle ejected during radioactive decay consisting of a single electron.	What is a beta particle?
Particle ejected during radioactive decay consisting of two protons and two neutrons.	What is an alpha particle?

Category - How would you date...?

TABLE 11.7: Earths_Past_Jeopardy_VI

. . . a wooden ax handle in an archeological site.	What is tree-ring dating? (or carbon dating)
. . . a lava rock estimated to be about 1 million years old.	What is potassium-argon dating?
. . . a dike striking across sedimentary layers.	What is cross-cutting relationships?
. . . a small shelled creature that lived briefly but over a large area.	What is an index fossil?

TABLE 11.7: (continued)

. . . the oldest rock ever found on Earth.	What is Uranium-Lead dating?

Note: *This category, the 6th (Jeopardy is played with 5) is difficult and can replace the first category for more advanced students.*

Additional Web-based Resources

a. An in depth look at sequence stratigraphy can be found at this website from the Society for Sedimentary Geology: http://strata.geol.sc.edu/seqstrat.html
b. The website http://www.fossils-facts-and-finds.com has a lot of information about fossils and educating kids about fossils. The site also has fossil activities for kids, which includes crosswords, word searches and coloring pages: http://www.fossils-facts-and-finds.com/fossil_activities.html.
c. The PBS Nova program and website, Jewel of the Earth, looks at ancient life forms preserved in amber: http://www.pbs.org/wgbh/nova/jewel/. Another show, Last Extinction, also from NOVA: http://www.pbs.org/wgbh/nova/clovis/
d. The NOVA scienceNOW website has information for teachers and students on the broader topic of mass extinctions: http://www.pbs.org/wgbh/nova/sciencenow/3318/01.html

CHAPTER 12 Earths History

Chapter Outline

12.1 Earth's History

Lesson 1: Geologic Time Scale

- **Enrichment Activity 1: Short Essay**

There are people who say that radiometric dating is unreliable and there is no way to know that rocks are millions or billions of years old by using the techniques. What evidence is there that radiometric dating is correct? Have the students explain how it works and how the principles that govern its use are the same principles that allow us to use nuclear energy for other purposes; e.g. for nuclear power plants or nuclear weapons. Have the students write two to three paragraphs explaining their findings.

- **Enrichment Activity 2: Power Point Presentation**

Most classes will have at least one student who believes that the Earth's age can be measured in thousands rather than billions of years. Have the students divide into groups and then list the evidence that our planet is 4.5 billion years old. Have each student then research one type of evidence and create a power point slide. Each group can then show its presentation to the class.

- **Enrichment Activity 3: Research**

Take a tour of geologic time at the University of California Museum of Paleontology website: http://www.ucmp.berkeley.edu/exhibits/geologictime.php. While being sure that all the major time periods are covered, have each student choose a period of time that interests him or her and write a paragraph or two about it. Have the students then share their research with the class. Be sure students include interesting visuals about what life or the environment was like on Earth at this time.

Lesson 2: Early Earth

- **Enrichment Activity 1: Earth's Baby Book**

Divide the class into groups and have the students create a "baby book" for Earth with photos or drawings. Each student can write and draw a page of the book to outline one of the major events in early Earth. Where did the planet come from? What did it look like when it was "born?" What were its early years like? How is it similar to and different from its siblings (the other planets)? Under what conditions did life originate?

- **Enrichment Activity 2: Create a Venn Diagram**

Students will create a Venn diagram comparing the early Earth to the modern day Earth, focusing on atmosphere, life, landscape, water and other topics in the book. For those students who want to add more research to their Venn diagram, here are two good articles:

http://ngm.nationalgeographic.com/2006/12/early-earth/appenzeller-text

http://www.nytimes.com/2008/12/02/science/02eart.html?_r=1

Lesson 3: History of Earth's Life Forms

- **Enrichment Activity 1: Drawings**

Have the students choose two organisms known to be closely linked evolutionarily and have them draw some sketches to show what would have to have changed for the older one to have evolved into the younger one. This could also be done with computer graphics programs, if available.

- **Enrichment Activity 2: Research and discussion**

This will likely only be possible for students who have already had biology. Have the students break into teams to research different lines of evidence for evolution by natural selection. Some suggestions are: similarities in biological processes (e.g. protein synthesis), embryonic development in vertebrates, homologous structures (forelimbs of vertebrates), small evolutionary changes that occur (e.g. insects evolving resistance to pesticides), vestigial structures, etc.. Have them present their evidence to the class and then discuss how evolutionary theory fits together as a whole.

- **Enrichment Activity 3: Hanging Mural**

Give each student or group of students a unit of geological time and have them research the life forms that were present during that period. Using a hanger, have the students create a mobile of life in that time period with drawings. In the order from earliest to latest, groups will hang their mobile and then present short oral reports on the life of each period. Some useful websites are:

http://www.ucmp.berkeley.edu/exhibits/geologictime.php

http://pubs.usgs.gov/gip/geotime/

http://paleobiology.si.edu/geotime/main/

- **Enrichment Activity 4: Teaching Evolution**

Have students choose different topics in evolutionary theory to research and then teach them to the class. Possible topics include: natural selection, speciation, mutation, punctuated equilibrium, patterns of evolution, living fossils and fossils.

- **Enrichment Activity 5: Chapter Vocabulary Crossword Puzzle**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

The words used are vocabulary words from Chapter 12, including: glacier, condense, density, radiation, species, variation, fossil, extinction, adaptation, evolution, paleontologist, atmosphere.

PUZZLE 9

...coming soon...

TABLE 12.1: Puzzle_Questions_9

ACROSS	DOWN
• A group of living organisms with similar characteristics that can interbreed	• Change through time; e.g. the change in a species' traits, sometimes resulting in a new species
• Large sheet of flowing ice	• Having many differences
• An inherited trait that helps an organism survive	• The mixture of gases that surrounds a planet
• A scientist who studies past life forms	• Remains or traces of past life
• When a species dies out	
• To change from a liquid to a vapor	
• Mass per volume12. Energy given off by the Sun	

ANSWERS:

a. A group of living organisms with similar characteristics that can interbreed – **SPECIES**
b. Change through time; e.g. the change in a species' traits, sometimes resulting in a new species – **EVOLUTION**
c. Having many differences – **VARIATION**
d. Large sheet of flowing ice – **GLACIER**
e. An inherited trait that helps and organisms survive – **ADAPTATION**
f. A scientist who studies past life forms – **PALEONTOLOGIST**
g. The mixture of gases that surrounds a planet – **ATMOSPHERE**
h. Remains or traces of past life – **FOSSIL**
i. When a species dies out – **EXTINCTION**
j. A change from a vapor to a liquid state – **CONDENSE**
k. Mass per volume – **DENSITY**
l. Energy given off by the sun - **RADIATION**

Additional Web-based Resources

a. PBS offers courses, tools and lessons for teachers teaching evolution to their students: http://www.pbs.org/wgbh/evolution/educators/index.html. Their more general website for students and others is at: http://www.pbs.org/wgbh/evolution/.
b. This Exploring Evolution Web Lab allows students to examine the evolutionary history of a whale using three types of evidence: http://www2.edc.org/weblabs/ExploringEvolution/ExploringEvolutionMenu.html.
c. The story of the Scopes trial is told in this website and video from PBS: http://www.pbs.org/wgbh/evolution/library/08/2/l_082_01.html.
d. Also from the PBS series, NOVA: Judgment Day: Intelligent Design on Trial: http://www.pbs.org/wgbh/nova/id/
e. The University of California Museum of Paleontology has a number of topics that are relevant including the History of Life through Time: http://www.ucmp.berkeley.edu/exhibits/historyoflife.php

CHAPTER 13 Earths Fresh Water

Chapter Outline

13.1 Earth's Fresh Water

Lesson 1: Water on Earth

- **Enrichment Activity 1: Power Point Presentation**

Many of Earth's most interesting features are due to the unique properties of water and to the planet having the right environmental conditions for water to be present in all three states. Have the students research and present a Power Point to the class outlining some of the unique chemical and physical properties of water and what their implications are for Earth and its life. Let them find their own or use the following as a guide:

Water is a polar molecule.

Water molecules bind loosely together by weak hydrogen bonds.

Water is densest just above freezing.

Water molecules in the solid form an open hexagonal framework.

Hydrogen bonds take energy to break.

Freezing temperature is 0oC (32oF) and boiling temperature is 100oC (212oF).

- **Enrichment Activity 2: Rap Song**

Have the students listen to the Water cycle Rap Song and then create one of their own to perform for the class: http://www.educationalrap.com/65/water-cycle.html.

Lesson 2: Surface Water

- **Enrichment Activity 1: Debate**

Have the students break into smaller groups and list the positive and negative consequences of floods. Have each group divide in half and debate whether society should try to eradicate floods or not with each side taking one position. After they have debated the issue in small groups, expand the debate to the whole class.

- **Enrichment Activity 2: Freshwater Crossword**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

Words used in the puzzle are from Lesson 2, Chapter 13: aphotic, brackish, confluence, divide, estuary, floodplain, lake, levee, limnology, littoral, marsh, photic, pool, source, stream, swamp, tributary, wetland.

PUZZLE 10

...coming soon...

TABLE 13.1: Puzzle_Questions_10

ACROSS	DOWN
• Land that holds a great deal of water for significant periods	• Water that is a mixture of freshwater and saltwater
• The zone in a water body where no sunlight reaches	• A raised structure that holds back the waters of a stream in flood
• A larger body of freshwater, usually drained by a stream	• Where two streams join together
• A moving body of water of any size with a bank and bed	• A ridge that separates one water basin from another
• The zone in a water body where sunlight penetrates	• A low-lying wetland where water moves slowly
• Where a river meets the sea and freshwater mixes with saltwater	• Where a stream overflows during high water
• The study of freshwater bodies and their organisms	• A stream that flows into a larger stream
• The zone in a water body closest to shore	• Where a stream starts

TABLE 13.1: (continued)

ACROSS	DOWN
• Where a stream enters a larger body of water	• A deep, slow-moving portion of a stream
	• A wetland where there are grasses and reeds but no trees

ANSWERS:

Across

2. Land that holds a great deal of water for significant periods - **WETLAND**
7. The zone in a water body where no sunlight reaches - **APHOTIC**
10. A larger body of freshwater, usually drained by a stream - **LAKE**
11. A moving body of water of any size with a bank and bed - **STREAM**
12. The zone in a water body where sunlight penetrates – **PHOTIC**
13. Where a river meets the sea and freshwater mixes with saltwater - **ESTUARY**
15. The study of freshwater bodies and their organisms - **LIMNOLOGY**
17. The zone in water body closest to shore - **LITTORAL**
18. Where a stream enters a larger body of water - **CONFLUENCE**

Down

1. Water that is a mixture of freshwater and saltwater - **BRACKISH**
3. A raised structure that holds back the waters of a stream in flood - **LEVEE**
4. Where two streams join together - **CONFLUENCE**
5. A ridge that separates one water basin from another - **DIVIDE**
6. A low-lying wetland where water moves slowly - **SWAMP**

8. Where a stream overflows during high water – **FLOODPLAIN**

9. A stream that flows into a larger stream - **TRIBUTARY**

11. Where a stream starts - **SOURCE**

14. A deep, slow-moving portion of a stream - **POOL**

16. A wetland where there are grasses and reeds but no trees - **MARSH**

Lesson 3: Ground Water

- **Enrichment Activity 1: Design**

The more scientists look, the more they find life in extreme places. Some of the most amazing life forms occupy the spaces between sand grains in porous groundwater aquifers and karst features. Why is this amazing? It is amazing because creatures are living where there is no light, and little oxygen or nutrients. These organisms are named stygobionts for the River Styx, one of the five rivers in the underworld of Greek mythology. Have the students break into small groups with each group designating an artist and a writer. Each group should be given a large piece of drawing paper and a sharp pencil. Have the students think about the environment in which these organisms live – what is available and what is not compared with microorganisms in fresh water at the surface. Keeping these conditions in mind, the students should then design a stygobiont or set of these organisms. What features would they have to take advantages of the scarce resources available to them? How would they move and metabolize food? What senses do they have? What do they eat and what is the food web?

Real stygobionts are colorless, eyeless, worm-shaped microorganisms. They move and metabolize slowly since there is little food. They live longer than other aquatic organisms. With no photosynthesis, food energy comes from the surface as organic matter. The food web is short: organic matter is consumed by microbes, which is consumed by slightly larger invertebrate predators. Most stygobionts will eat whatever they can find.

- **Enrichment Activity 2: Problem Solving**

It is estimated that about 1 billion people on Earth do not have access to clean, safe water for drinking or sanitation. A large part of the world's population lives in regions, such as much of Africa, where fresh water is scarce. The large populations mean that much of the available water is polluted. There are many scientists, political leaders and aid organizations that are working to turn this around and increase the number of people who have good water, while the world's population continues to climb. Have the students brainstorm ways in which more people can have access to safe water. Have them be aware of the environmental implications of their solutions; e.g. hauling fresh water in trucks uses fossil fuels, which causes other problems.

Additional Web-based Resources

a. The Environmental Protection Agency (EPA) has a set of water sourcebooks for different grades from K-12. These books contain information and activities for the relevant age groups: http://www.epa.gov/OGWDW/kids/wsb/index.html

CHAPTER 14 Earths Oceans

Chapter Outline

14.1 Earth's Oceans

Lesson 1: Introduction to the Oceans

- **Enrichment Activity 1: Board Game**

Divide the students into small groups. Have each group create a board game using each of the different zones of the ocean, so that as they move throughout the board they go deeper into the ocean zones. On the board game, include the environmental conditions found in each zone and pictures of the organisms found there. Students could have movement cards such as, move towards a zone with more (or less) sunlight, nutrients, dissolved oxygen, colder (or warmer) temperatures, higher (or lower) salinity or pressure etc. What are the adaptations that living organisms must have to succeed in each zone? What stresses must organisms withstand in order to survive here? This is a good activity for review at the end of the unit.

- **Enrichment Activity 2: Venn Diagram**

Divide the class into groups and have them create a 3-way Venn diagram with different ocean zones. They should include the conditions found in the zones, the types of organisms that live in the zones, and the adaptations an organism must have to live in that zone. Some possibilities for zone combinations would be: littoral – neritic – oceanic; epipelagic – mesopelagic – abyssal pelagic; littoral – sublittoral – everything deeper; or euphotic – disphotic – aphotic. A 2-way diagram could be made for photic – aphotic.

- **Enrichment Activity 3: Thought Experiment**

Divide the students into teams and have them pretend that they are going to build a colony on the bottom of the ocean. What will be the major difficulties they will need to overcome? Can they design a colony that will allow humans to survive under these conditions? Now the students should think about the creatures that live at the bottom of the sea. What adaptations do marine organisms have for living in these extremely harsh conditions? Would it be harder or easier to build the colony on the continental shelf or the abyssal plain? Why?

- **Enrichment Activity 4: Introduction to the Oceans Vocabulary Crossword**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

Words to be placed in this puzzle include: water column (2 words), aphotic, current, photic, density, intertidal, salinity, biomass, Pangaea, oceanic, neritic.

PUZZLE 11

...coming soon...

TABLE 14.1: Puzzle_Questions_11

ACROSS	DOWN
• The zone in the ocean that is between low and high tid	• The total mass of living organisms in a certain region
• The supercontinent that broke apart 200 million years ago	• The zone in a water body that receives sunlight
• The zone in a water body where no sunlight reaches	• The movement of water in a stream, lake or ocean
• The zone of the ocean where the seafloor is deep	• A measure of the dissolved salt in water
• The zone of the ocean over the continental shelf	• Mass per volume
• A vertical column of water that is divided into zones according to depth (2 words)	

ANSWERS:

Across

2. The zone in the ocean that is between low and high tide - **INTERTIDAL**
3. The supercontinent that broke apart 200 million years ago - **PANGAEA**
4. The zone in a water body where no sunlight reaches - **APHOTIC**
7. The zone of the ocean where the seafloor is deep - **OCEANIC**
8. The zone of the ocean over the continental shelf - **NERITIC**
10. A vertical column of water that is divided into zones according to depth – **WATER COLUMN**

Down

1. The total mass of living organisms in a certain region - **BIOMASS**
3. The zone in a water body that receives sunlight - **PHOTIC**

5. The movement of water in a stream, lake or ocean - **CURRENT**

6. A measure of the dissolved salt in water - **SALINITY**

9. Mass per volume - **DENSITY**

Lesson 2: Ocean Movements

- **Enrichment Activity 1: Model**

Break the students into small groups. Have each group create a poster, diagram or 3D model to show the cycle of spring and neap tides through a month, focusing on the position of the Sun, Moon and Earth in each diagram. They should give a brief description of how the tide is affected by the positions of these large bodies.

- **Enrichment Activity 2: Demonstrate Currents**

Try Bill Nye's demonstration, Current Event. This experiment demonstrates currents and what happens when water temperature changes dramatically. To find the experiment, go to the Bill Nye website, http://www.billnye.com/, then Home Demos, Planetary Science, Earth Science, Current Event.

- **Enrichment Activity 3: Teaching**

To master the different types of ocean movements, have the students break into small groups with each group being responsible for teaching one concept to the class. Possible topics include waves, tides, surface currents, deep currents, upwelling and Coriolis Effect. Students could make models, a game, a power point or an activity that depicts their concept.

- **Enrichment Activity 4: Ocean Movement Crossword Puzzle**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

Words in this puzzle include: amplitude, Coriolis, crest, high tide, low tide, neap, spring, tidal range, tide, trough, upwelling, wave, wavelength, tsunami, deep current.

PUZZLE 12

...coming soon...

TABLE 14.2: Puzzle_Questions_12

ACROSS	DOWN
• The tide with the minimum height in a day	• The effect that causes objects to appear to be moving in a curved path due to Earth's rotation
• The tide with the maximum height in a day	• The distance between adjacent crests or troughs in a wave

TABLE 14.2: (continued)

ACROSS	DOWN
• The height of a wave from crest to trough	• Tides with the smallest tidal range; Moon, Earth and Sun are at 90-degrees
• Tides with the greatest tidal range; Moon, Earth and Sun are aligned	• The difference between high and low tide
• The highest point of a wave	• Ocean currents that move near the ocean floor
• The lowest point in a wave	• A seismic sea wave caused by a shock to the ocean, such as an earthquake
• Cold, nutrient-rich water rises from ocean depths to the surface	• A form that transfers energy with crests and troughs
• The daily rise and fall in sea level due to the position of the Moon and Sun	

ANSWERS:

Across

3. The tide with the minimum height in a day – **LOW TIDE**
5. The tide with the maximum height in a day – **HIGH TIDE**
8. The height of a wave from crest to trough – **AMPLITUDE**
9. Tides with the greatest tidal range; Moon, Earth and Sun are aligned – **SPRING**
10. The highest point of a wave – **CREST**
12. The lowest point in a wave – **TROUGH**
13. Cold, nutrient-rich water rises from ocean depths to the surface – **UPWELLING**
15. The daily rise and fall in sea level due to the position of the Moon and Sun – **TIDE**

Down

1. The effect that causes objects to appear to be moving in a curved path due to Earth's rotation – **CORIOLIS**
2. The distance between adjacent crests or troughs in a wave - **WAVELENGTH**
4. Tides with the smallest tidal range; Moon, Earth and Sun are at 90-degrees – **NEAP**
6. The difference between high and low tide – **TIDAL RANGE**
7. Ocean currents that move near the ocean floor – **DEEP**
11. A seismic sea wave caused by a shock to the ocean, such as an earthquake – **TSUNAMI**
14. A form that transfers energy with crests and troughs - **WAVE**

Lesson 3: The Seafloor

- **Enrichment Activity 1: Creative Thinking and Drawing**

The ocean is deep, dark and completely inhospitable to humans. Yet we know a great deal about the oceans, from the surface to the deep, from living things to the rocks of the deep sea trenches. We know the ocean's depth, the properties of the water, the rocks that are found at the bottom, and the creatures that live throughout among many other things. Have the students work in groups to design methods for learning about the oceans. Their ideas do not currently need to exist, but they do need to follow physical laws and be at least realistic. They can describe their devices in words and/or drawings. How do these imagined exploration tools match up with what scientists really use to understand the sea?

- **Enrichment Activity 2: Mystery Underwater Sonar Activity**

This activity takes more than the average amount of prep time for the teacher. Using one shoebox or similarly sized cardboard or plastic box with heavy paper as a cover for each group, you will create a "seafloor" in each box. Glue down various objects of different heights in the bottom and then seal the boxes. The students will use "sonar" to describe the "seafloor" by poking 10 to 15 holes in the lid using a straw, stick, wooden skewer or piece of cardboard to measure the depth from the top of the box to the top of the "seafloor". At least several of these holes should fall on a line traversing the length of the box. Have the students keep good records of these measurements. Be sure the students know what they are actually measuring. Once measurements are taken, students should try to describe what is at the bottom of their box and create a drawing. Using the data from the line along the bottom of the box, they can use graph paper and create a cross section. Once the cross sections are done, have students remove the lid and see what the actual profile looks like. What are some possible reasons for inaccuracy? Were there any features that your 'sonar' readings missed? Could there be inaccuracies in our visions of the actual ocean floor?

Lesson 4: Ocean Life

- **Enrichment Activity 1: Ocean Life Power Point or Bulletin Board**

Marine biology is a topic that can generate a lot of excitement among the students. Have each student or team of two students create a power point presentation on a particular type of ocean life. These could be presented by habitat or by organism type. Possibilities include coral reefs (coral, reef fish, and invertebrates); marine mammals (dolphins, seals, and whales); abyssal organisms; rocky intertidal organisms; sharks; hydrothermal vents; and deep sea trenches, such as the Marianas. Each presentation can be made to the class so that everyone learns more about marine organisms.

A similar activity without the technology would be to have the student create a drawing and a note card of their organism and then place their organism on a classroom bulletin board in the right ocean zone for that organism. A good resource might be the Marine Biology Coloring Book.

- **Enrichment Activity 2: Marine Food Web**

Divide the students into small groups and have each create a marine food web. Each group can use organisms in a different habitat such as coral reefs, hydrothermal vents and others or they can do the same. Make sure they know what the energy source for their environment is; this is especially fun with hydrothermal vents!

Additional Web-based Resources

a. The National Oceanic and Atmospheric Administration Oceans website deals with all aspects of the oceans: http://www.noaa.gov/ocean.html. One very interesting site deals with research on hydrothermal vents: http://www.pmel.noaa.gov/vents/. Ocean Explorer is a good site for kids: http://oceanexplorer.noaa.gov/welcome.html
b. The PBS Nova science series has an episode on hydrothermal vents off the Pacific Northwest coast, Into the Abyss: http://www.pbs.org/wgbh/nova/abyss/
c. Woods Hole Oceanographic Institution puts out a magazine, Oceanus, that explores recent ocean research results: http://www.whoi.edu/oceanus/index.do.

CHAPTER 15 Earths Atmosphere

Chapter Outline

15.1 Earth's Atmosphere

Lesson 1: The Atmosphere

- **Enrichment Activity 1: Teaching to the Class**

The atmosphere is extremely important to Earth as we know it. Divide the class into five groups and make each group responsible for preparing a very short power point presentation to the rest of the class on one aspect of the significance of the atmosphere. Each group should go into more detail on their topic than is covered in the text. The five topics are:

- Why are atmospheric gases indispensable for life on Earth?
- Explain how the atmosphere is a crucial part of the water cycle.
- How does ozone in the upper atmosphere make life on Earth possible?
- Explain how the atmosphere keeps Earth's temperatures moderate.
- For what types of waves are atmospheric gases necessary? What would be different without these waves?

- **Enrichment Activity 2: Essay**

Have the students write a short essay comparing and contrasting the effects of the ocean and the atmosphere on moderating global temperatures. Students should consider the high heat capacity of water, the role of ocean surface currents, and major patterns of atmospheric circulation. Students could contrast conditions on Earth with the Moon or Mercury, both without oceans or atmospheres.

- **Enrichment Activity 3: Atmosphere Vocabulary Crossword Puzzle**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

Words in this puzzle include: air pressure (2 words), altitude, climate, condense, evaporation, respiration, greenhouse (gases), weather, humidity, noble (gases), ozone, water vapor (2 words), precipitation, evapotranspiration.

PUZZLE 13

...coming soon...

TABLE 15.1: Puzzle_Questions_13

ACROSS	DOWN
• The force of air pressing on a given area	• Distance above sea level
• The gaseous form of water	• Water loss by plants to the atmosphere

TABLE 15.1: (continued)

ACROSS	DOWN
• Condensed moisture; e.g. rain, sleet, snow	• The process in which animals and plants use oxygen and produce CO2
• The change in state from liquid to gas; e.g. liquid water to water vapor	• The type of gases that do not react chemically; they are inert
• The temporary state of the atmosphere in a region including temperature, humidity	
• The long-term average of weather	
• The type of gases that trap heat in the atmosphere, includes carbon dioxide	
• Molecule made of three oxygen atoms	
• A measure of the water held in air	
• Change from gas to liquid; e.g. water vapor to liquid water	

ANSWERS:

Across

1. The force of air pressing on a given area – **AIR PRESSURE**
4. The gaseous form of water – **WATER VAPOR**
5. Condensed moisture; e.g. rain, sleet, snow - **PRECIPITATION**
6. The change in state from liquid to gas; e.g. liquid water to water vapor - **EVAPORATION**
7. The temporary state of the atmosphere in a region including temperature, humidity - **WEATHER**

9. The long-term average of weather - **CLIMATE**
10. The type of gases that trap heat in the atmosphere, includes carbon dioxide - **GREENHOUSE**
11. Molecules made of three oxygen atoms - **OZONE**
12. A measure of the water held in air - **HUMIDITY**
13. Change from gas to liquid; e.g. water vapor to liquid water - **CONDENSE**

Down

1. Distance above sea level - **ALTITUDE**
2. Water loss by plants to the atmosphere - **EVAPOTRANSPIRATION**
3. The process in which animals and plants use oxygen and produce carbon dioxide- **RESPIRATION**
8. The type of gases that do not react chemically; they are inert - **NOBLE**

Lesson 2: Atmospheric Layers

- **Enrichment Activity 1: Venn diagram**

Have the students create a 3-way Venn diagram with troposphere, stratosphere and mesosphere or just a 2-way with troposphere and stratosphere. They should be sure to include information on gas composition, pressure, thickness, heat source, temperature gradient, importance in weather and other important features of each layer.

- **Enrichment Activity 2: Atmospheric Layers Vocabulary Crossword Puzzle**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

Words in this puzzle include: aurora, exosphere, inversion, ionosphere, mesosphere, mesopause, ozone (layer), solar wind (2 words), stratopause, stratosphere, thermosphere, tropopause, troposphere, ultraviolet (radiation).

PUZZLE 14

...coming soon...

TABLE 15.2: Puzzle_Questions_14

ACROSS	DOWN
• Third layer of atmosphere where temperature decreases with altitude	• The outermost layer of the atmosphere; gas molecules rare
• Fourth layer of atmosphere where gases are very thin	• Thin transition layer between stratosphere and mesosphere

TABLE 15.2: (continued)

ACROSS	DOWN
• Thin transition layer between troposphere and stratosphere	• Second layer of atmosphere; temperature increases with altitude
• Layer in stratosphere with concentrated ozone gas	• High energy solar radiation of three types
• High-speed protons and electrons racing from the Sun	• Light display in the ionosphere near the poles
• Thin transition between mesosphere and thermosphere	• First layer of atmosphere where all weather takes place
• Warm air above cold air in the troposphere	• Ionized layer in the thermosphere

ANSWERS:

Across

1. Third layer of atmosphere where temperature decreases with altitude - **MESOSPHERE**
7. Fourth layer of atmosphere where gases are very thin -**THERMOSPHERE**
8. Thin transition layer between troposphere and stratosphere - **TROPOPAUSE**
10. Layer in stratosphere with concentrated ozone gas – **OZONE (LAYER)**
11. High-speed protons and electrons racing from Sun – **SOLAR WIND**
12. Thin transition between mesosphere and thermosphere - **MESOPAUSE**
13. Warm air above cold air in the troposphere - **INVERSION**

Down

2. The outermost layer of the atmosphere; gas molecules are rare - **EXOSPHERE**
3. Thin transition layer between stratosphere and mesosphere - **STRATOPAUSE**

4. Second layer of atmosphere; temperature increases with altitude -**STRATOSPHERE**
5. High energy solar radiation of three types - **ULTRAVIOLET**
6. Light display in the ionosphere near the poles - **AURORA**
7. First layer of atmosphere where nearly all weather takes place - **TROPOSPHERE**
9. Ionized layer in the thermosphere- **IONOSPHERE**

Lesson 3: Energy in the Atmosphere

- **Enrichment Activity 1: Diagram**

Have the students draw a diagram of a student standing in a parking lot on a hot summer day. The diagram should show how things are being heated around her by all three types of heat transfer: conduction, convection and radiation. Use arrows and words to show each of these transfers in action. Students should identify which transfer (if any) is most responsible for the hot air she feels around her face?

- **Enrichment Activity 2: Write a Story**

While the greenhouse effect is good for living organisms, too much greenhouse effect is not. Venus is an example of where the greenhouse effect is too much of a good thing. The planet has what is known as runaway greenhouse effect. Have the students hypothesize how runaway greenhouse effect on Venus came to be and then write a story about it. While the story should be fictional, it should be scientifically plausible. To be sure the students understand greenhouse effect, somewhere in the story they must present an accurate description of what greenhouse effect is. Here are some websites to start with:

http://www.eia.doe.gov/bookshelf/brochures/greenhouse/Chapter1.htm

http://www.spacetoday.org/SolSys/Venus/VenusGreenhouse.html

- **Enrichment Activity 3: Rap Song**

Have the students listen to this rap song entitled Radiation, Conduction, Convection and then have them write one of their own.

http://www.educationalrap.com/60/radiation-conduction-convection.html

- **Enrichment Activity 4: Model Convection**

If the students could benefit from more models of convection, there is a Visiting Geoscientists activity in which students model convection here:

http://www.agiweb.org/education/aapg/invest/invest14.html

- **Enrichment Activity 5: Atmospheric Energy Vocabulary Crossword Puzzle**

Words in this puzzle include: albedo, conduction, convection, convection cell, electromagnetic, energy, greenhouse effect, insulation, latent heat, radiation, reflection, specific heat.

PUZZLE 15

...coming soon...

TABLE 15.3: Puzzle_Questions_15

ACROSS	DOWN
• The amount of energy needed to raise the temperature of 1 gram of material by 1oC	• Heat transfer between molecules in motion
• The amount of light that reflects back off a surface	• A material that inhibits heat or electrical conduction
• Type of radiation wave with both electrical and magnetic properties	• The ability to do work
• Heat transfer; warm material rises, cool sinks and transfer occurs between	• The return of a wave from a surface
• The energy taken in or released as a substance changes from a higher to a lower energy state	
• The movement of energy by electromagnetic waves	
• The trapping of heat that is radiated out from the planet's surface by atmospheric gases	

ANSWERS:

Across

1. The amount of energy needed to raise the temperature of 1 gram of material by 1C – **SPECIFIC HEAT**
3. The amount of light that reflects back off a surface - **ALBEDO**
5. Type of radiation wave with both electrical and magnetic properties - **ELECTROMAGNETIC**
7. Heat transfer; warm material rises, cool sinks, and transfer occurs between – **CONVECTION CELL**
8. The energy taken in or released as a substance changes from a higher to a lower energy state – **LATENT HEAT**

9. The movement of energy by electromagnetic waves - **RADIATION**

10. The trapping of heat that is radiated out from the planet's surface by atmospheric gases – **GREENHOUSE EFFECT**

Down

2. Heat transfer between molecules in motion - **CONDUCTION**

4. A material that inhibits heat or electrical conduction - **INSULATION**

5. The ability to do work - **ENERGY**

6. The return of a wave from a surface - **REFLECTION**

Lesson 4: Air Movement

- **Enrichment Activity 1: Winds Twenty Questions**

Students divide into groups. One student is "It" and the rest of the students are given a card that says what type of wind "It" is. "It" must ask questions to try to figure out what type of wind she is. Students receive a point for each question they ask up to 20. If the student gets to 20 and still hasn't figured out what type of wind she is, she receives 5 more points. The student who ends the game with the least number of points wins. Student groups should be small enough so that each student can be two to three wind types. Winds to include are: land breeze, sea breeze, monsoon, mountain breeze, valley breeze, katabatic wind, foehn (Chinook) wind, Santa Ana wind, desert wind, haboob, trade winds, and westerly winds.

- **Enrichment Activity 2: Names**

Look at a map of global air circulation and the global wind belts. What is the origin of the names of the wind belts: Trade Winds, doldrums, horse latitudes. Where does your town fit into the global air circulation pattern?

http://geography.about.com/od/physicalgeography/a/tradewinds.htm

CHAPTER 16 Weather

Chapter Outline

16.1 Weather

Lesson 1: Weather and Atmospheric Water

- **Enrichment Activity 1: PowerPoint Presentation**

For review, have each student create one slide of a PowerPoint presentation about one cloud type using photos from the internet or that they take themselves. Have each student write a quiz question about their cloud type and at the end of the presentation, give the quiz to the class.

- **Enrichment Activity 2: Cloud and Precipitation Types Vocabulary Crossword Puzzle**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

Words in this puzzle include: altocumulus, altostratus, cirrocumulus, cirrostratus, cirrus, cloud, cumulonimbus, stratocumulus, glaze, hail, nimbostratus, sleet, stratus.

PUZZLE 16

...coming soon...

TABLE 16.1: Puzzle_Questions_16

ACROSS	DOWN
• Gray puffy stripes of globular clouds in lines across the sky	• Thicker than cirrostratus; like a gray veil that hides the Sun or Moon
• Pellets of ice or ice and snow from cumulonimbus clouds	• High, small, white, puffy clouds in groups or lines
• Thin, whitish, veil-like clouds that make a halo around the Sun or Moon	• Thick, dark, continuous, low clouds with nonstop rain or snow
• High, wispy clouds of ice crystals	• Low continuous clouds with drizzle but no hard rain
• Tall, dark thunderstorm clouds	• Smooth transparent ice layer on a cold surface

TABLE 16.1: (continued)

ACROSS	DOWN
• Tiny water or ice particles grouped together in the atmosphere	
• Soft, low, globular clouds in groups or lines: rarely precipitate	
• Partly frozen rain or partly melted snow or ice	

ANSWERS:

Across

1. Gray, puffy stripes of globular clouds in lines across the sky - **ALTOCUMULUS**
4. Pellets of ice or ice and snow from cumulonimbus clouds - **HAIL**
5. Thin, whitish, veil-like clouds that make a halo around the Sun or Moon - **CIRROSTRATUS**
6. High, wispy clouds of ice crystals - **CIRRUS**
7. Tall, dark thunderstorm clouds - **CUMULONIMBUS**
8. Tiny water or ice particles grouped together in the atmosphere - **CLOUD**
11. Soft, low, globular clouds in groups or lines, rarely precipitate - **STRATOCUMULUS**
12. Partly frozen rain or partly melted snow or ice - **SLEET**

Down

1. Thicker than cirrostratus; like a gray veil that hides the Sun or Moon - **ALTOSTRATUS**
2. High, small, white, puffy clouds in groups or lines - **CIRROCUMULUS**
3. Thick, dark, continuous, low clouds with nonstop rain or snow - **NIMBOSTRATUS**
9. Low continuous clouds with drizzle but no hard rain - **STRATUS**
10. Smooth transparent ice layer on a cold surface – **GLAZE**

Lesson 2: Ocean Movements

- **Enrichment Activity 1: Weather Maps**

Find a current weather map of the United States that shows isobars (lines of equal pressure) for the students to look at. Have them locate the high and low pressure cells. Which way is the wind blowing relative to the cells? They should identify the types of fronts on the map. Have each group or individual find a location that appears to be experiencing some interesting weather. What on the weather map made makes the weather seem interesting? What weather is that location having?

http://weather.unisys.com/index.html

http://www.weather.com/maps/maptype/currentweatherusnational/index_large.html

(On the dropdown bar below this map, are choices to view many other types of maps. It's fun to take a look and maybe find something useful. Some of the choices are current temperatures, lightning strikes, winds & gusts, and departures from normal highs or lows, among others.)

- **Enrichment Activity 2: Dangerous Weather?**

Look at the weather warnings posted by the National Weather Service on this map of the United States. Are there currently any warnings in your state? What location appears to be the most dangerous at the moment? If the weather is still summery, look for warnings for excessive heat, tornados and thunderstorms, hurricanes, gales, hazardous seas and floods, among other things. If the weather is wintery, look for excess snow, ice, wind and other potentially hazardous events. What weather events are occurring where two air masses meet? What locations produce lightning?

http://www.nws.noaa.gov/

Lesson 3: Storms

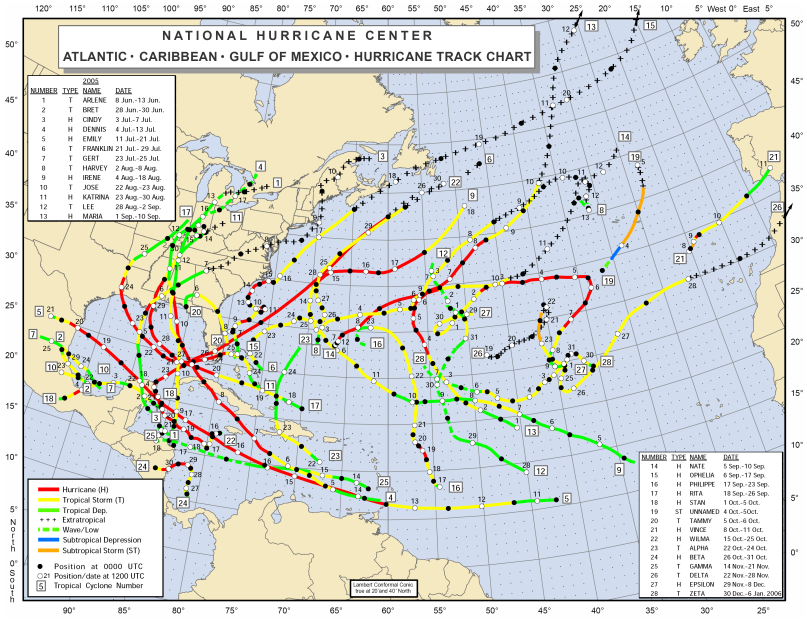
- **Enrichment Activity 1: Storm Safety Poster**

Divide the class into groups and have each group choose a type of storm. Be sure there is no overlap. Each group should then create a safety poster to warn people about that storm type. What are the warning signs that this type of storm is brewing? Where should a person go to escape the storm? If a person can't escape the storm, what is the next best thing to do? After the storm, what should a person do to keep safe and also help others who may have been harmed in the storm? Storm types include thunderstorms, tornadoes, mid-latitude cyclones, hurricanes, blizzards. Extreme weather, such as extreme heat and drought, can also be included. The posters should be neat, colorful, easy to read, accurate and informative.

- **Enrichment Activity 2: Hurricane Tracking**

Look at the map of 2005 hurricane tracks. Note that the color of the line indicates the intensity of the storm with red being hurricanes. Where do the storms typically start? Where do they build in intensity the most? Where do they lose intensity? What does a hurricane need to grow and what causes it to fail?

http://upload.wikimedia.org/wikipedia/commons/7/78/2005_Atlantic_hurricane_season_map.png



- **Enrichment Activity 3: Hurricane Tracking**

Try Bill Nye's demonstration, Twistin' Tornado. By duct taping two 2 liter plastic bottles together with water and food coloring, you can demonstrate how a twister works as the water travels down from one bottle to the other. Go to the Bill Nye website, http://www.billnye.com/, then Home Demos, Planetary Science, Earth Science, Twistin' Tornado

- **Enrichment Activity 4: Catastrophic Weather Event Presentation**

a. Have each student choose an historic weather event. Be sure there are no duplicates.
b. Have each student research this event looking for
    a. What the event was
    b. When it occurred
    c. The economic and human (death) toll
    d. The science behind the event
    e. What we learned (science, safety, economics). *Good sources of information include websites, magazine and newspaper articles, and books, if available.*
c. To complete the project, students should
    a. Create a poster or power point as a visual display about the event
    b. Write a three paragraph essay about the event including:
        i. A summary of the event
        ii. The economic and human toll
        iii. What was learned
    c. Present the event to the class in approximately five minutes
    d. Include a bibliography of all websites, articles and books. Be sure students cite sources for each piece of information in the presentation.

Lesson 4: Weather Forecasting

- **Enrichment Activity 1: Weather Forecasting**

Have students choose a city in the world and get the past week's weather in terms of temperature, precipitation, relative humidity and pressure. Cities should represent a diverse set of environments, but one should be your own town. Students should watch the change (or lack of) weather conditions daily and work to determine if there were clues from the previous day's weather that led to the next day's conditions. Students should learn about the global and local winds in the region and the locations and temperatures of water bodies. Students should also look at weather patterns in nearby states, cities or countries. Which direction will the weather be coming from? After completing this background, students can then predict the weather for the next few days. Now have the students check the forecast for their city in a newspaper or on the internet. Over the next few days, see which forecast is more accurate. Students should write a short paper to answer the following questions:

- By what factors or evidence did you predict the weather?
- What was correct about your predictions?
- What went differently and can you explain why?
- Is weather predicting an easy/ accurate science?
- What factors will make it difficult for forecasters to be correct each day?

- **Enrichment Activity 2: Barometer in a Bottle**

Try Bill Nye's demonstration, Barometer in a Bottle. Using a clean glass jar, a balloon and other household objects, students can create a barometer to measure the barometric pressure of the atmosphere around them. Go to the Bill Nye website, http://www.billnye.com/, then Home Demos, Planetary Science, Earth Science, Barometer in a Bottle.

- **Enrichment Activity 3: Jobs**

Students will each choose two jobs that are associated with weather. Some ideas include meteorologist, storm chaser, air traffic control –weather specialist and storm preparation for a town or city. Research these jobs on-line and then create job descriptions for these jobs that could be used in a "mock" ad for the job. Include location where the job will be done in the ad. You can then create a classified ad for these jobs and have students choose jobs of interest to apply for.

Additional Web-based Resources

a. NOVA from PBS has relevant episodes and websites:
    a. Hunt for the Supertwister: http://www.pbs.org/wgbh/nova/tornado/
    b. Hurricanes, science NOW: http://www.pbs.org/wgbh/nova/sciencenow/3204/02.html
b. This site from UCAR, the University Corporation for Atmospheric Research has a tremendous number of resources for teachers. Topics include clouds, Hurricanes, Blizzards/Winter Weather, Thunderstorms/Tornadoes, and Forecasting, http://www.eo.ucar.edu/webweather/.

The site also has activities, such as Make convection currents!, Make a hot air balloon!, Make it rain!, Make lightning!, How far away is that storm?, Make a tornado!, and Twister in a jar. The activities include Teacher Tips to help you be sure to get the activity right.

CHAPTER 17 Climate

Chapter Outline

17.1 Climate

Lesson 1: Climate and its Causes

- **Enrichment Activity 1: Climate Where You Live**

What is the climate of the region where you live? Have the students look up the factors that affect climate in the book (latitude, prevailing winds, continental position, ocean currents, altitude and position relative to mountain ranges) and try to rank which has the greatest influence on your town's climate from most to least. Discuss the effect of each as a class and try to create a class ranking. Don't forget to include local factors that are not listed, especially if they have a strong effect, e.g. lake-effect snow. Students could contact a meteorologist from your local weather station and have that person come and talk to the class about the factors that influence weather in your region.

Lesson 2: World Climates

- **Enrichment Activity 1: Climate Zone Where You Live**

Have the student look at the Köppen-Geiger Climate Classification Map to determine where in which of the six main climate classifications you live. In which of the 24 subcategories is your region located? Have the students support these choices using climate characteristics, vegetation, etc. How do organisms adapt to the climate in your area? How do people adapt? How have people adapted the climate to suit themselves? Next have the students think about other places they may have spent time. What is the classification for that location and why? Which regions have high biodiversity and why? Some background information can be found here:

http://geography.about.com/od/physicalgeography/a/koppen.htm

- **Enrichment Activity 2: Climate Patterns**

Divide the students into small groups with access to the World Map of Köppen-Geiger Climate Classification. Have the students study the climate zones and try to use what they know regarding atmospheric and oceanic circulation and other characteristics that determine a location's climate to figure out why different climate zones are located where they are. First have them identify interesting features of the map, and figure out why these climate zones are where they are. Here are some obvious features for the students to explore:

- The red swatch in northern Africa and Arabia,
- The reason that red region doesn't continue into India and southern Asia
- The red swatch in the southwestern United States – why doesn't that red continue across the southern US?
- The mixed up appearance of the western North America relative to eastern North America
- The blue zones of northern South America, central Africa and Indonesia
- The difference in climate zone between western Europe and the same latitude of Canada
- The dark grey of Greenland and Antarctica

- **Enrichment Activity 3: Student Created Crossword Puzzle**

This time instead of giving the students a crossword puzzle, have them create one. The words in the puzzle should be all the major climate zones in the world with the clues being their characteristics. They will need to shorten the climate zone names in some cases. Crossword puzzles should be typed or created using an online program. When puzzles are completed, students should exchange them and do each other's puzzles for review. An example of an online crossword puzzle maker can be found at this site:

http://www.crosswordpuzzlegames.com/create.html

Lesson 3: Climate Change

- **Enrichment Activity 1: El Niño**

Look at the map of Pacific equatorial sea surface temperatures from the National Oceanic and Atmospheric Administration and see if we are in a current El Niño or if one is forecast for the next year. What happens in your town or region during an El Niño year? Do you get more or less rainfall? Are hazards such as landslides more common? The site from the Gulf of Maine Aquarium shows how to recognize an El Niño year. Have students present their findings to the class.

http://www.elnino.noaa.gov/

http://octopus.gma.org/surfing/weather/elnino.html

- **Enrichment Activity 2: Study Map**

Have the students study the Köppen-Geiger Climate Classification Map and brainstorm how they think climate change would affect each of the climate zones mentioned. What will happen to the zones that are good for agriculture? What would happen to forested regions? Use the jigsaw cooperative learning technique to reinforce this activity. Divide students into groups of four. Have each group choose a particular climate zone, then redistribute group members with the member of each first group teaching the rest of their new group what they learned.

- **Enrichment Activity 3: Climate Change Debate**

The climate change debate is really over with scientists. The vast majority of scientists accept the enormous amount of evidence that supports the idea that global temperatures are warming and human activities are largely the cause. Yet, the public in large part hasn't kept up. Have the students divide into groups to debate each side. Have each group find evidence that supports its side and the other group find arguments to counter it. To keep it firmly rooted in the science of climate change, the evidence must be scientifically supported and opinions cited (e.g. of politicians or celebrities) must be based in facts. Now ask the students why they think public opinion lags behind the opinion of nearly all scientists who are familiar with this research. What role does the media play and how much influence does the media have? Who are the individuals who make up the media and what sort of background do they have to understand scientific issues?

There are many useful links including:

http://www.brighton73.freeserve.co.uk/gw/paleo/paleoclimate.htm

http://www.esrl.noaa.gov/gmd/ccgg/trends/

- **Enrichment Activity 4: King or Queen for a Day Speech**

Ask the students to pretend: If you were in charge of the world for a day, what changes would you implement to help reduce greenhouse gas emissions and to help curb global warming? How would you motivate the people to make the

change? What are you, the most powerful person in the world, going to do? Write a speech addressing the people of the world and telling them how you would like to begin to solve this problem. Read these speeches dramatically or videotape them.

- **Enrichment Activity 5: Rap Song**

If your students have enjoyed the rap song activities, have them listen to this one on climate change, 'Take Aim at Climate Change', and then write and perform their own: http://passporttoknowledge.com/polar-palooza/whatyoucando/taacc/

Additional Web-based Resources

a. NOVA, from PBS, has some relevant shows and websites:
    a. Dimming the Sun: http://www.pbs.org/wgbh/nova/sun/
    b. Extreme Ice: http://www.pbs.org/wgbh/nova/extremeice/
b. For students who may be interested in paleoclimatology, this site from NOAA is a useful resource: http://www.ncdc.noaa.gov/paleo/primer.html

CHAPTER 18

Ecosystems and Human Populations

Chapter Outline

18.1 Ecosystems and Human Populations

Lesson 1: Ecosystems

- **Enrichment Activity 1: Research and Report**

Divide the students into small groups and have each group choose an ecosystem that's near where you live or the ecosystem that your town is in. What are the environmental conditions that define the ecosystem? How large a region does this ecosystem cover? What organisms are in it? What is the health of the ecosystem? How does its health compare with the same ecosystem in another location or the US as a whole? How have humans impacted that ecosystem? Are humans considered to be a part of that ecosystem? A field trip to some ecosystems would be great, if possible.

Some background information can be found at this website:

http://www.marietta.edu/ biol/102/ecosystem.html.

Students can also choose to do an offshore ecosystem if you live near a coast. The California Current is one example of an offshore ecosystem that has received a lot of study:

http://cce.lternet.edu/

http://www.eoearth.org/article/California_Current_large_marine_ecosystemhttp://cce.lternet.edu/ .

- **Enrichment Activity 2: Ecosystem Food Web**

Using the ecosystem from Enrichment Activity #1, give each group a large sheet of paper or poster board and have them create a food web for the ecosystem they chose. What are the main producers, consumers, decomposers, predators, prey, herbivores, carnivores and scavengers? Each major role should have at least one organism assigned to it. Don't forget humans if they play a natural part. Students can then compare webs and come to come to a consensus about the area in which they live.

Website with excellent information - California ecosystems:

http://www.saltonsea.water.ca.gov/

http://www.laspilitas.com/comhabit/habitat.htm

- **Enrichment Activity 3: Species Relationship Theater**

In small groups, have the students act out the different sorts of relationships between species either by pretending they are other types of organisms or by creating human relationships that illustrate the species relationships. Species relationships include competition, symbiosis, mutualism, commensalism, and parasitism. This can also be done as charades.

- **Enrichment Activity 4: Ecosystems Vocabulary Crossword Puzzle**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

Words in this puzzle include: carnivore, chemosynthesis, commensalism, competition, consumer, decomposer, herbivore, mutualism, omnivore, parasitism, photosynthesis, predator, prey, producer, scavenger, symbiosis.

PUZZLE 17

...coming soon...

TABLE 18.1: Puzzle_Questions_17

ACROSS	DOWN
• The creation of food energy by breakdown of chemicals	• A symbiotic relationship for two species in which both benefit
• The creation of food energy from sunlight, carbon dioxide, and water	• A rivalry for resources between two species or individuals
• An animal that only eats other animals	• An organism that consumes producers and consumers
• An animal that eats only producers	• An organism that uses other organisms for food
• A two species relationship when one species benefits and one is not harmed	• An animal that could be killed and eaten by a predator
• An animal that eats dead animals	
• A symbiotic relationship when one species is harmed and one benefits	
• An organism that converts another energy source into usable food energy	
• An animal that kills and eats other animals	
• Two species relationship in which at least one benefits	

TABLE 18.1: (continued)

ACROSS	DOWN
• An organism that breaks down dead tissue for food	

ANSWERS:

Across

1. The creation of food energy by the breakdown of chemicals - **CHEMOSYNTHESIS**
4. The creation of food energy from sunlight, carbon dioxide and water - **PHOTOSYNTHESIS**
5. An animal that only eats other animals - **CARNIVORE**
6. An animal that only eats producers - **HERBIVORE**
8. A two species relationship when one species benefits and one is not harmed - **COMMENSALISM**
9. An animal that eats dead animals - **SCAVENGER**
10. A symbiotic relationship when one species is harmed and one benefits - **PARASITISM**
11. An organism that converts another energy source in to usable food energy - **PRODUCER**
12. An animal that kills and eats other animals – **PREDATOR**
13. Two species relationship in which at least one benefits - **SYMBIOSIS**
14. An organism that breaks down dead tissue for food - **DECOMPOSER**

Down

2. A symbiotic relationship for two species in which both benefit - **MUTUALISM**
3. 3. A rivalry for resources between two species or individuals - **COMPETITION**
7. 7. An organism that consumes producers and consumers - **OMNIVORE**
8. 8. An organism that uses other organisms for food - **CONSUMER**
11. 11. An organism that could be killed and eaten by a predator - **PREY**

Lesson 2: The Carbon Cycle

- **Enrichment Activity 1: Carbon Cycle Game**

Have the students create a board game that illustrates the carbon cycle. The games must include rocks and minerals, oceans, plants, animals, decomposers, fossil fuels, ocean hard-shelled organisms, atmosphere, and whatever else seems important. "Bases" can be reservoirs; playing pieces are carbon atoms. Otherwise, the students can be creative!

- **Enrichment Activity 2: Carbon Cycle Brochure**

Have the students create a tri-fold brochure for the public describing the carbon cycle with a diagram. Discuss the importance of the carbon cycle for the planet and its life, and then argue why humans should minimize interference with the natural carbon cycle. Give specific ideas as to how people can reduce their impact. Students that do a particularly good job on the assignment may be invited to send these to legislators with an attached letter.

- **Enrichment Activity 3: Carbon Cycle Roles Crossword**

In this crossword puzzle, the word is something that has a role in the carbon cycle and the hint refers to its role in that cycle.

PUZZLE 18

...coming soon...

TABLE 18.2: Puzzle_Questions_18

ACROSS	DOWN
• Process by which plants use CO2 and make oxygen and sugar	• CO2 from mantle enters atmosphere through these
• Stores gas form of carbon, CO2	• Makes calcium carbonate shells from CO2
• Burning fossil fuels or plant tissue releases CO2 into the atmosphere	• Production of this commodity releases CO2 from limestone
• Small water bodies that absorb CO2 gas	• Large water body that absorbs CO2 gas
• Stores carbon from long dead organic material, can be released when burned	• Stores carbon at bottom of ocean; can return to mantle

TABLE 18.2: (continued)

ACROSS	DOWN
• Stores carbon from vegetation	• Process by which organic material breaks down and carbon is released
• Stores carbon in leaves and other tissues	
• Process by which organisms convert food and oxygen into CO2	

ANSWERS:

Across

2. Process by which plants use CO2 and make oxygen and sugar - **PHOTOSYNTHESIS**
5. Stores gas form of carbon, CO2 - **ATMOSPHERE**
6. Burning fossil fuels or plant tissue releases CO2 into the atmosphere - **COMBUSTION**
8. Small water bodies that absorb CO2 gas - **RIVERS**
9. Stores carbon from long dead organic material, can be released when burned – **FOSSIL FUELS**
11. Stores carbon from vegetation - **SOILS**
13. Stores carbon in leaves and other tissues - **PLANTS**
14. Process by which organisms convert food and oxygen into CO2 - **RESPIRATION**

Down

1. CO2 from mantle enters atmosphere through these - **VOLCANOES**
3. Makes calcium carbonate shells from CO2 – **SEA LIFE**
4. Production of this commodity releases CO2 from limestone - **CEMENT**
7. Large water body that absorbs CO2 gas - **OCEAN**
10. Stores carbon at bottom of ocean, can return to mantle - **SEDIMENTS**
12. Process by which organic material breaks down and carbon is released - **DECAY**

Lesson 3: Human Populations

- **Enrichment Activity 1: Research**

China has had a one child policy since 1979 with few exceptions. Why did the government impose this restriction? What was the policy in the 1960s, known as the Great Leap Forward, and what were the consequences of that policy? What is the history of the one-child policy? What are the consequences of the policy, both intended and unintended? Students can present their results in a short talk or essay.

- **Enrichment Activity 2: Debate**

Should a government be allowed to regulate how many children an individual can have? Should China's policy be expanded to other nations? In poor nations it is often difficult for people to have enough resources to survive and their quest for sustenance places challenges on ecosystems and the environment. People in wealthier countries take resources unsustainably from their region and from around the globe. Pose the following extremely controversial question and allow students one night to write down thoughts and arguments for their assigned side. The following day in class, students should debate the two sides of the issue. Should governments create and enforce laws that limit human growth? You can use an alternate question, such as, "Should humans be required to live more sustainably?" or "Should families be charged taxes for children over the second child to discourage overpopulation?"

Additional Web-based Resources

a. The State of the Nation's Ecosystems 2008 is a report put out by the H. John Heinz III Center for Science, Economics, and the Environment. Fact sheets from the report are available at this website: http://www.heinzctr.org/ecosystems/index.shtml. They include highlights of the report, climate, wildlife, contaminants, and others.
b. UCAR has an interactive online carbon cycle game that students can do in about 20 minutes. Instructions and a link to the game are here: http://www.windows.ucar.edu/tour/link=/teacher_resources/teach_carbongame.html.

CHAPTER 19 Human Actions and the Land

Chapter Outline

19.1 Human Actions and the Land

Lesson 1: Loss of Soils

- **Enrichment Activity 1: Community Action**

Using the table provided in the "Preventing Soil Erosion" section of the book, examine the leading causes of erosion. Decide as a class on the top three erosion problems facing your local community. Create posters that can be hung in community areas (with permission) to increase awareness, and/or write letters to the city council informing the communities about local erosion problems and why this can hurt the entire area.

- **Enrichment Activity 2: Research**

Tropical rainforests have the most biodiversity of any terrestrial environment. It would seem that their soils would be extremely rich, but they are not. Have the students research and write 2-3 paragraphs on slash-and-burn agriculture. How can rainforests thrive in such poor soils? What happens to these soils after they are farmed? Is there some way this type of farming can be eliminated or scaled back?

- **Enrichment Activity 3: Sustainable Farming**

Break the class into small groups. Give each group a large sheet of paper. Using the information at the end of the chapter and in this lesson, have the students design a farm that is sustainable. How can soil erosion be avoided? How will the crops be given what they need - water, nutrients, protection from pests, soil preparation, etc. - without long term damage to the farm and the greater environment? How can a farming community be designed that allows for natural wildlands to coexist?

- **Enrichment Activity 4: Class Discussion**

Is soil a renewable or nonrenewable resource? Have the students choose one side of the other and compose their arguments in their side's favor. What are some actions that humans take that make soils nonrenewable? Are there ways that humans can preserve soil as a renewable resource?

Lesson 2: Pollution of the Land

- **Enrichment Activity 1: Current Events**

Have the students look at recent newspaper or magazine articles to find a recent event involving hazardous wastes. Each student should write a one paragraph summary explaining what happened and where and what the damage was. How was the environment impacted? How were living organisms including humans impacted? Have students present their information to the class.

- **Enrichment Activity 2: Community Service**

There are a number of hazardous wastes that people throw away with regular trash either because they don't realize that they're hazardous or they don't know what to do with them. These include batteries, paints, new energy efficient light bulbs containing mercury, medical waste used by individuals in homes and many others. Have the students work on a project to assist people with better waste disposal:

- Research the services offered by your city or county to help citizens dispose of these wastes.
- Educate the people in the school or community about the importance of disposing properly of such hazardous materials (set up a meeting, create an info sheet, posters, etc).
- Offer help at school by collecting batteries or paint cans, and giving people an easy way to deal with some of these waste products (DO NOT offer to collect medical waste or other materials that could be hazardous to humans in the short term).

- **Enrichment Activity 3: Superfund Story**

Some really good books have been written about people whose health has suffered due to environmental damage. Read about the Superfund at the Environmental Protection Agency's Superfund site: http://www.epa.gov/superfund/.

- What Superfund sites are in your area?
- What are the health effects of common contaminants and cleanup efforts?
- How can you become involved in cleanup activities in your community?
- Consider contacting local representatives with your findings.

- **Enrichment Activity 4: Love Canal Film and Discussion**

A 1983 video documentary about Love Canal, In Our Own Backyard: The First Love Canal, follows the people involved in this defining moment in American history. The discovery of the events at Love Canal was a major factor that led to the passage of the Superfund law. After viewing the hour-long film, students can discuss the timeline leading to the passage of the Superfund law and what the government did at Love Canal and should do in similar cases.

Additional Web-based Resources

a. A high school soil erosion lesson estimating the rate of soil loss and presenting the damage of soil erosion on agriculture and the environment can be found here: www.edu.pe.ca/agriculture/erosion.pdf
b. Additional information on hazardous wastes from Annenberg Media: http://www.learner.org/interactives/garbage/hazardous.html

CHAPTER 20 Human Actions and Earths Resources

Chapter Outline

20.1 Human Actions and Earth's Resources

Lesson 1: Use and Conservation of Resources

- **Enrichment Activity 1: Analyze Your Lunch**

If your class is after lunch, have the students write a list of what they had. If the class is before lunch, they can list what they had for dinner the night before or lunch the previous day. Now have them list the resources that went into making that lunch or dinner. They should go back to the original resource: the soil the crop that the cow ate was grown in, the bauxite that produced the aluminum foil the burger was wrapped in, etc. After they each write their own resource list, have the students evaluate which lunches used the least amount of resources and which used the most. Is buying lunch more or less resource-friendly than bringing it from home? Is there a way to lessen the impact of the student's lunch on the environment?

- **Enrichment Activity 2: Bulletin Board**

As a class, find a bulletin board in your classroom, school or community that can be used to educate viewers about resources. Have students separate into groups and make posters for different topics. Divide the bulletin board into separate sections:

- Renewable vs. non-renewable resources
- Common everyday items that we use and what they are made of
- Ideas for items that you can use/ buy that use renewable resources
- Recycling or conservation ideas

For further education, provide handouts, websites or other information to educate people.

Lesson 2: Energy Conservation

- **Enrichment Activity 1: Class Discussion**

Conserving energy may seem less interesting than going solar or designing ocean wave energy generating plants but conserving energy is much more cost effective than finding alternative sources of energy. Have the students discuss the value of conserving energy and brainstorm ideas on how they can reduce energy consumption in their own lives. Challenge students to make changes to conserve energy at home. Students could take readings of daily energy use before they start and then their daily energy use afterwards. How much energy were they able to save through conservation measures?

- **Enrichment Activity 2: Alternative Energy**

One of the ideas behind alternative energy is that a region will utilize the type of energy that is most readily available to it and that energy will not need to travel very far. Divide the class into groups. Have students review their notes

and text from the alternative energy section of Chapter 5. Students should evaluate each type of alternative energy for how suitable it is where you live. Then they should rank the types of energy in terms of most to least suitable. Investigate what types of alternative energy are already being used in your community? What types of alternative energy are being planned?

Additional Web-based Resources

a. Teacher packets on six topics, including one on natural resources, can be downloaded from this website by the Mineral Information Institute: http://www.mii.org/teacherhelpers.php

CHAPTER 21 Human Actions and Earths Water

Chapter Outline

21.1 Human Actions and Earth's Waters

Lesson 1: Humans and the Water Supply

- **Enrichment Activity 1: Research Solutions for Water Overuse**

Farming in the Midwestern US has depended on water for irrigation from the Ogallala Aquifer for decades. This enormous water source stretches through South Dakota, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, Texas, and New Mexico, and irrigates more than 57,000 square km (14 million acres) of land, providing an estimated one-third of all irrigation water in the United States. This water is also used for the region's cities and industries. On average, water is being pumped at eight times the rate that it is being recharged, and the water table is dropping rapidly, in some areas as much as 90 to 150 cm (3 to 5 feet) per year. It is estimated that one-fourth of the aquifer's original supply of water will be depleted by 2020. Some of the shallow regions may already be dry and other areas will be without water in 60 to 220 years. What will happen if water continues to be used at a rate so much higher than it is being replenished? What alternatives will farmers have for watering their crops and what will happen to this important farming region? What is the best plan of action for the Ogallala Aquifer? What can be done to reduce the overconsumption of water from this important aquifer? Have students research water conservation methods for agriculture, industry and residential use. Students should prepare a presentation for the class or community members about their results.

Lesson 2: Problems with Water Distribution

- **Enrichment Activity 1: Essay**

Have the students write an essay discussing water distribution. Start with the common misconception that there is a great deal of available fresh water on the Earth, meaning humans do not need to worry about water as a resource. Then introduce the facts about actual amounts of usable water, the number of people on the planet who live without adequate water, and what will happen to water resources in the future without conservation efforts. What is needed to provide communities with clean water that do not already have it? What are the possible sources and costs? Are the solutions ordinarily sustainable? Interested students can research the problem of arsenic in the well water in Bangladesh, a sad story in which a good deed turned out to be extremely harmful.

- **Enrichment Activity 2: Research, Compare and Contrast**

Where does the water in your town come from? Is there a political agreement with other cities, regions and states to determine who gets how much of the different water resources? What treatment does the water get? Compare and contrast what happens in your town with what happens in a very different sort of community. For example, if you live in a community with lots of rivers and lakes and abundant rainfall contrast water resources with a community in the arid Southwest or vice versa. Present your findings to the class.

- **Enrichment Activity 3: Image Analysis**

Have the students study the images depicting the dramatic decline of Lake Chad in West Africa, once the sixth largest lake in the world. What has caused the lake to diminish so much in size? Have students research both the natural and human causes of water loss. What is the consequence of the loss of this important fresh water source? What can be done to improve the situation for the people who live around Lake Chad? After the students have studied the images, they can prepare a short presentation to give to the class. How would they recommend to the people around Lake Chad to deal with this important resource?

http://edcwww.cr.usgs.gov/earthshots/slow/LakeChad/LakeChad

- **Enrichment Activity 4: Research, part 1**

Students can choose a topic for research from among suggestions in this part (part 1) or the next part (part 2). Then they can move to part 3. Of course, any of the three parts can be done separately, although if only part 3 were done, some of the background from part 2 would be necessary.

Having limited water is not a new problem. In the southwestern US, native people farmed and built homes thousands of years ago. For example, the Hohokam and Anasazi people had thriving cultures and then vanished. How did these cultures find and utilize water? What role did water play in their cultures? What are the ideas anthropologists have for what happened to these people? Students working on these topics can write up the results in a short paper or give a short presentation to the class.

- **Enrichment Activity 4: Research, part 2**

What are the water sources in the desert southwest now? One large water source is the Colorado River, which provides water to rapidly growing desert cities in California (Los Angeles), Nevada (Las Vegas), and Arizona (Phoenix and Tucson), primarily from the dams at Lake Mead and Lake Powell. Agricultural areas also want a share in the water, such as the Imperial Valley of Southern California. The river originates as snowmelt and groundwater high in the Rocky Mountains of Colorado. As the river travels across the parched lands of Utah, Arizona, and into Mexico, evaporation far exceeds precipitation. A drought has gripped this region in the past decade. In response to the drier climate and to the likelihood that climate change will cause further rainfall reductions in the region, states and districts must look realistically at the water that will be available and agree to new water allocations. Students doing research in this group will each choose a city or agricultural region to find out about its water use. How much Colorado River water does it get and what are its other water sources? What does it use the water for? What is the role of conservation in each region? In locations that use far more water than they receive in rainfall, should growth be limited? Should water use be restricted? At least one student needs to research the amount of water that is available from the Colorado River, how much will likely be available in the coming five years, and how that water is currently allocated. For this part of the activity, the students need good notes and perhaps a short paper to turn in.

- **Enrichment Activity 4: Water Allocations, part 3**

Have the students who did part 1 of the activity now sit on the "Water Allocation Board." Have the students who did part 2 appeal to the water board for their water allocation for the coming five year period. How does the board know how much water will be available given changing conditions from year to year? How much water does each group need? Is it more important for one group to receive water than another? If so, who should be given preferences, agricultural areas or suburbs and why? Should cities be rewarded for enacting conservation measures? Have the board decide on a final allocation for each group.

Lesson 3: Water Pollution

- **Enrichment Activity 1: A Civil Action Book Report**

The 1996 non-fiction novel, **A Civil Action**, by Jonathan Harr, focuses on a trial in which the citizens of a town sue a tannery for poisoning the town's water which caused a high incidence of leukemia. Have students read the book and write a report focusing on how the cause of the leukemia cluster was found, the chemical that caused the problem, and what was done about the problem. An alternative would be to watch the 1998 film to learn about the case.

Lesson 4: Protecting the Water Supply

- **Enrichment Activity 1: Field Trip**

Ask the students to think about how waste water treatment works within a city. What types of pollution would likely be present in your town's water supply? What sorts of methods is your town likely to use to clean up these types of pollution?

Visit a wastewater treatment plant or a water treatment facility with the students. Have each write a short report following the visit explaining what s/he learned.

- **Enrichment Activity 2: The Clean Water Act**

Research the history of the Clean Water Act of 1972. Have each student choose a water body and learn about the quality of water at that body during the 1950s and 1960s and then in the 1990s and 2000s. What protections were put in place as a result of the Clean Water Act on that water body? How is the water cleaner than it was (if it is cleaner)? What other types of pollution should this water body be protected from? For example, is there a problem in the water with pharmaceuticals or endocrine disrupting compounds? Each student should make two slides of a before and after view of their water body and then those slides can be put together as a class wide Power Point presentation. This should show the power of a federal law to protect the environment as well as the weaknesses in the law as new scientific information becomes available.

Additional Web-based Resources

a. This National Geographic lesson, Water, Water Everywhere, on water supply in nations around the world is for grades 9 to 12: http://www.nationalgeographic.com/xpeditions/lessons/04/g912/newswater.html
b. An interesting lesson for grades 6 through 8 illustrating the distribution of water in the world put out by Penn State is found a the following site. Students will also learn about taking care of water resources and water conservation: http://sftrc.cas.psu.edu/LessonPlans/Water/Everywhere.html
c. Some background information on water pollution in the US can be found at Clean Water Our Precious Resource: http://www.chewonki.org/cleanwater/water_pollution.asp
d. A lesson for middle school or high school students on water pollution from the Safe Drinking Water Foundation is found at Lesson on Safe Water: http://www.safewater.org/PDFS/owp/Lesson1.pdf
e. The EPA's website on groundwater and drinking water: http://www.epa.gov/safewater/

CHAPTER 22

Human Actions and the Atmosphere

Chapter Outline

22.1 Human Actions and the Atmosphere

Lesson 1: Air Pollution

- **Enrichment Activity 1: Air Pollution Crossword Puzzle**

Crossword puzzle created using: http://www.crosswordpuzzlegames.com/create.html.

The words in this crossword puzzle include: acid rain (2 words), bioaccumulation, biomass, carbon oxides (2 words), evaporation, fossil fuels (2 words), lead, mercury, nitrogen oxides (2 words), ozone, particulates, photochemical (smog), smog, sulfur oxides (2 words), VOCs

PUZZLE 19

...coming soon...

TABLE 22.1: Puzzle_Questions_19

ACROSS	DOWN
• Buildup of toxic compounds in an organism over its life	• Greenhouse gases contribute to acid rain, produced in exhaust
• Word created as combination of smoke and fog; air pollution	• Colorless, odorless greenhouse
• Greenhouse gas created by chemical reaction of sun and pollutants	• Oil, coal and natural gas
• Ash, dust and fecal matter traces given off during combustion	• Smog type from chemical reaction of pollutants and sunshine
• Mostly from coal, contains sulfur, acid rain components	• Heavy metal from coal plants; highly toxic in organic form
• Poisonous heavy metal	• Falling water with low pH due to pollution

TABLE 22.1: (continued)

ACROSS	DOWN
• Short for hydrocarbons that include chlorofluorocarbons, methane and dioxin	• Process by which volatile organic compounds enter the atmosphere
	• Type of burning that is a large cause of air pollution, warming temperatures

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ANSWERS:

Across

5. Buildup of toxic compounds in an organism over its life - **BIOACCUMULATION**
8. Word created as combination of smoke and fog; air pollution - **SMOG**
9. Greenhouse gas created by chemical reaction of sun and pollutants - **OZONE**
10. Ash, dust and fecal matter traces given off during combustion - **PARTCULATES**
13. Mostly from coal, contains sulfur, acid rain components – **SULFUR OXIDES**
14. Poisonous heavy metal - **LEAD**
15. Short for hydrocarbons that include chlorofluorocarbons, methane and dioxin - **VOCs**

Down

1. Greenhouse gases contribute to acid rain, produced in exhaust – **NITROGEN OXIDES**
2. Colorless, odorless greenhouse gases, contain carbon – **CARBON OXIDES**
3. Oil, coal and natural gas – **FOSSIL FUELS**
4. Smog type from chemical reaction of pollutants and sunshine - **PHOTOCHEMICAL**
6. Heavy metal from coal plants; highly toxic in organic form - **MERCURY**
7. Falling water with low pH due to pollution – **ACID RAIN**
11. Process by which volatile organic compounds enter the atmosphere - **EVAPORATION**
12. Type of burning that is a large cause of air pollution and warming temperatures - **BIOMASS**

- **Enrichment Activity 2: Word Web**

A word web links words with a topic that is placed at the center. A word web sample template is shown here: http://www.eduplace.com/graphicorganizer/pdf/cluster_web3.pdf In this activity, use the following questions to create a word web that describes ACID RAIN.

- What is it?
- When was it discovered as a problem?
- Who discovered it?
- How is it formed?
- How can we stop it?

Websites on acid rain include:

http://www.epa.gov/acidrain/what/index.html

http://library.thinkquest.org/CR0215471/acid_rain.htm

http://library.thinkquest.org/26026/Environmental_Problems/acid_rain.html

Lesson 3: Reducing Air Pollution

- **Enrichment Activity 1: Jigsaw**

There are a number of ways to reduce air pollution: Reducing vehicle air pollution, industrial air pollution, ozone destruction, and greenhouse gases. Give each student one of the above topics randomly, by handing out slips of paper with a topic. For homework, each student should read the section in the book on the topic, as well as do additional internet research. Students doing the same topic should come together the next day, make certain all group members clearly understand the topics and teach each other new information learned. The following day or later in the class period, the teacher will make new groups, each group having 4 members, one from each of the subgroups. Within these smaller groups, each member will teach the rest of the 3 members about his/ her topic. Students are responsible for taking notes on each topic and asking questions to assist in understanding. Teacher can check understanding with a quiz, a game or a writing assignment.

Websites dealing with air pollution include the following:

Clean Air: http://www.cwac.net/air_pollution/tips.html

Fifty Things You Can Do: http://www.arb.ca.gov/html/brochure/50things.htm

EPA and Air: http://www.epa.gov/oar/actions/

Cooperative learning activities, including “Jigsaw” including descriptions and helps are found at this website by Kagan: http://edtech.kennesaw.edu/intech/cooperativelearning.htm#activities

- **Enrichment Activity 2: Read and Discuss**

The following article links air pollution to the water supply in California, providing a good example of the way all of Earth’s systems are linked. The article explores how smog lowers precipitation in the Sierra Nevada, which provides much of the water the state depends on. The article is by the Scripps Institution of Oceanography of the University of California, San Diego: http://explorations.ucsd.edu/Research_Highlights/2009/Apr/Air_Pollution/.

Have the students read the article and learn about the relationship between water and air pollution. Then open the topic up for a class discussion. Can they think of other instances in which a change in one system affects another? Examples might include El Niño in which rising sea surface temperatures in the Pacific affect weather around the globe.

CHAPTER 23 Observing and Exploring Space

Chapter Outline

23.1 Observing and Exploring Space

Lesson 1: Telescopes

- **Enrichment Activity 1: Report**

How does a telescope work? Allow students to look at actual telescopes, do research online and read books to determine how a telescope works. The students can research what types of information can be gathered from different types of telescopes. What are the advantages and disadvantages to each type? Students should include telescopes that use various wavelengths of the electromagnetic spectrum, as well as Earth based vs. space telescopes. Here are a few good websites for background information:

http://www.yesmag.ca/how_work/telescope.html

http://amazing-space.stsci.edu/resources/explorations/groundup/

http://galileo.rice.edu/sci/instruments/telescope.html

For an extra challenge, students may use one of many informational telescope websites to build their own simple telescope. Here is a sample: http://www.howstuffworks.com/question568.htm.

- **Enrichment Activity 2: Telescopes and Energy Vocabulary Crossword Puzzle**

Words in this puzzle include: catadioptric, electromagnetic, gamma rays (2 words), infrared, microwave, radio (telescope), radio wave, reflecting, refracting, space, spectrometer, ultraviolet, visible light (2 words), wavelength, X rays.

PUZZLE 20

...coming soon...

TABLE 23.1: Puzzle_Questions_20

ACROSS	DOWN
• Telescopes that orbit above Earth's atmosphere	• Radiation transmitted through space as a wave
• Telescope using a combination of mirrors and lenses to focus light	• A tool that uses a prism to break light into component colors
• Long wavelength electromagnetic waves, between radio waves and red light	• Portion of electromagnetic spectrum that humans can see

TABLE 23.1: (continued)

ACROSS	DOWN
• The shortest wavelength radio wave	• Horizontal distance in a wave from crest to crest or trough to trough
• A penetrating form of electromagnetic radiation	• The longest wavelength electromagnetic wave
• High energy electromagnetic waves, shorter wavelengths than violet	
• Telescope type with an antenna to collect radio waves	
• Electromagnetic radiation between gamma and ultraviolet	
• Telescope type using convex lenses to collect and focus light	
• Telescope type using mirrors to collect and focus light	

ANSWERS:

Across

3. Telescopes that orbit above Earth's atmosphere - **SPACE**
4. Telescope using a combination of mirrors and lenses to focus light - **CATADIOPTRIC**
7. Long wavelength electromagnetic waves, between radio waves and red light - **INFRARED**
8. The shortest wavelength radio waves - **MICROWAVES**
9. A penetrating form of electromagnetic radiation – **GAMMA RAYS**
11. High energy electromagnetic waves, shorter wavelengths than violet - **ULTRAVIOLET**

12. Telescope type with an antenna to collect radio waves - **RADIO**
13. Electromagnetic radiation between gamma and ultraviolet – **X RAYS**
14. Telescope type using convex lenses to collect and focus light - **REFRACTING**
15. Telescope type using mirrors to collect and focus light - **REFLECTING**

Down

1. Radiation transmitted through space as a wave - **ELECTROMAGNETIC**
2. A tool that uses a prism to break light into component colors - **SPECTROMETER**
5. Portion of electromagnetic spectrum that humans can see – **VISIBLE LIGHT**
6. Horizontal distance in a wave from crest to crest or trough to trough - **WAVELENGTH**
10. The longest wavelength electromagnetic wave – **RADIO WAVE**

Lesson 2: Early Space Exploration

- **Enrichment Activity 1: Engineering Thought Problems**

The students have grown up knowing that men have landed on the Moon but actually getting men to the Moon was a technologically difficult problem. It's one thing to lose an unmanned spacecraft and an entirely different one to lose one with people on board. Have the students pretend that they are engineers and scientists trying to prepare for the first moon walk by a human. Students can be divided into groups and each member of the group is given a topic to research outside class. Some of the questions to be answered are these: How can you get a spacecraft with people aboard to the Moon? How do you get something to land on the Moon with people inside? How do you know what the people will need to survive on the lunar surface? How do the people get back to Earth? What sorts of backup plans should they make? Then the students will come back together in their group and design their lunar mission, which they will later present to the class. The presentation should include drawing and plans, perhaps even some models, like a model spacesuit!

- **Enrichment Activity 2: Essay**

Getting a man to walk on the Moon and return home safely was the work of countless scientists and engineers (and even a few politicians and events) over many centuries. Students can choose a person who played a role in getting a man on the Moon and describe their role in this accomplishment in a few paragraphs. Some people to include are Galileo Galilei, Isaac Newton, Konstantin Tsiolkovsky, Robert Goddard, Hermann Oberth, Wernher von Braun, John F. Kennedy, Sputnik, Alan Shepherd, John Glenn, Lunar Orbiter, Lunar Surveyor, Neil Armstrong, and many others.

- **Enrichment Activity 3: Video**

After the discussion outlined in Enrichment Activity #1, watch the film, Apollo 13, as a class. Discuss the film using the following questions as a guide:

- Why were humans sent to the Moon rather than orbiters and probes during the Apollo days?
- NASA is trying to decide what to do with their human spaceflight program. What is your opinion? Should people be sent back to the Moon? Are there benefits to sending humans rather than orbiters and probes?
- Some NASA scientists would like to send humans to Mars. What are the disadvantages and advantages of sending people into space for that long and that complex a mission? Would you like to go?

Lesson 3: Recent Space Exploration

- **Enrichment Activity 1: Time Line**

Create a time line of space shuttle launches and space station important dates in the US and Soviet Union/Russian Federation. For each event, show a photo or drawing and a two sentence explanation of the event. Two good space exploration history websites are:

http://www.history.com/content/space

http://spaceflight.nasa.gov/history/

- **Enrichment Activity 2: Jobs**

Being an astronaut is just one type of job that someone interested in space exploration can have. Have the students check out the NASA website for the sorts of things the space agency does and see what sorts of jobs they might be interested in. Have them pretend there are ads for the job they're interested in and have them write a hypothetical cover letter and resume to submit for that job. They should think about what qualifications are needed for the job and design their resumes to be extremely competitive for that job. Of course, applying for a job as an astronaut is okay too! The NASA website is here: http://www.nasa.gov/home/index.html.

There is also a section for students with a career corner here: http://www.nasa.gov/audience/forstudents/5-8/career/index.html.

- **Enrichment Activity 3: News Summary**

Using the NASA website or a newspaper or magazine, have the students find an interesting article that discusses a new finding made using one of the telescopes on Earth or in orbit today. They should then write a summary of the story, being sure to include the important scientific findings. Students will need to evaluate the reliability of the article they find. Are the scientists who made the discovery quoted in the article? What institutions do they work for? If there are no direct quotes from scientists, is there anything else about the article that would show its credibility?

- **Enrichment Activity 4: Hubble Space Telescope Power Point**

Hubble has completely changed our view of the universe, galaxies, nebulae, stars and our solar system with its incredible images. Divide the students into groups with each group responsible for a different category of images (the universe, exotic: includes black holes, dark matter, gamma ray bursts & gravitational lensing, galaxies, nebulae, solar system, and stars are the picture album categories on Hubblesite). Within the group have each student find an image that they like for a Power Point slide, being sure not to choose the same image as other students in the group. On that slide the student should include a few points indicating what the image is showing. Then each of the groups can put their slides together into a single slide for the whole class to see and enjoy.

http://hubblesite.org/gallery/album/

Alternatively, some of the class could work on images from the Chandra X-ray Observatory: http://xrtpub.harvard.edu/.

Additional Web-based Resources

a. Hubble Space Telescope WebQuest module for 9th grade from the Canadian Space Agency is a guided research activity designed to take about one class period: http://www.ioncmaste.ca/homepage/resources/web_resources/CSA_Astro9/files/html/module7/lessons/lesson3/hubbleWebquest.html
b. This website shows the drawings Galileo made and modern images of what he was looking at for comparison: http://www.pacifier.com/ tpope/Photo_Drawing_Comparison_Page.htm#Venus
c. NASA has websites for all of its missions and telescopes.
    a. Hubblesite has a wealth of information for everyone, including educators, about the Hubble Space Telescope. Get ideas for classes or just look at the great images: http://hubblesite.org/
    b. The Chandra X-ray Observatory has images and discoveries taken by the X-ray telescope: http://xrtpub.harvard.edu/
    c. The Spitzer Space Telescope that "sees" in the infrared has a website located here: http://www.spitzer.caltech.edu/spitzer/. On that site you can link to what features at Yellowstone National Park look like in the infrared: http://coolcosmos.ipac.caltech.edu/image_galleries/ir_yellowstone/index.html

CHAPTER 24 Earth, Moon, and Sun

Chapter Outline

24.1 Earth, Moon, and Sun

Lesson 1: Planet Earth

- **Enrichment Activity 1: Image Analysis**

One of the most important accomplishments of the space program is how satellite images of Earth show global change. Have the students find a set of images on the USGS Earthshots website and then write a paragraph or two of what change is being shown in them.

http://edcwww.cr.usgs.gov/earthshots/slow/tableofcontents

- **Enrichment Activity 2: Exploring Gravity**

Have students brainstorm what they already know about gravity. Then use the following online worksheet on misconceptions to help students talk through what they might not understand about how gravity works: http://www.adlerplanetarium.org/education/resources/gravity/5-8_cb1-4.shtml.

The magnetic field is covered in this worksheet: http://www.sciencenetlinks.com/lessons.php?BenchmarkID=4&DocID=266.

Use the jigsaw cooperative teaching method to ensure that students clear up any misconceptions.

- **Enrichment Activity 3: Rap Song**

Have the students listen to the Sun, Earth Moon rap song. Then let them compose their own.

http://www.educationalrap.com/61/sun-earth-moon.html.

Lesson 2: Earth's Motions

- **Enrichment Activity 1: Pictionary**

Write the following terms 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). Students will play Pictionary with one student receiving the index card and then drawing a clue on a piece of paper or whiteboard for the rest of his/her team to guess. Keep the guessing to one minute and assign a point for each correct guess. An incorrect guess ends the point for that team. Terms to include are rotation, revolution, tilt, gravity, orbit, axis, hemisphere, ellipse, satellite, solar eclipse, lunar eclipse, full moon, first quarter, last quarter, new moon, spring tide, neap tide and any others that the students have a chance of guessing.

- **Enrichment Activity 2: Class Discussion**

How would the weather on Earth be different (if at all) if the Earth were not on a tilted axis? What evidence that we can see with the unaided eye let early scientists know that the Earth rotates? (stars moving across the sky, the Moon

moving, the Sun moving, ships appearing to sink into the ocean rather than just getting smaller). What else could early people have thought was happening, if not the Earth rotating? If the Earth is rotating and revolving, we don't we get thrown off?

Lesson 3: Earth's Moon

- **Enrichment Activity 1: Venn Diagram**

Divide the students into small groups and give each group a large sheet of paper. Have each group make a 3-section Venn diagram comparing the Earth and the Moon. Each of the three sections must include at least five facts. After the groups have finished, make a large Venn Diagram on the board and be sure to include all the points from the student groups.

- **Enrichment Activity 2: Demonstration**

Try Bill Nye's demonstration, Baseball Moon. Using a swiveling stool, a lamp and a baseball, you can demonstrate the seasons, night and day, rotation, revolution and other important concepts. To find this demonstration, go to the Bill Nye website, http://www.billnye.com/, then Home Demos, Planetary Science, Space Science, Baseball Moon.

Lesson 4: The Sun

- **Enrichment Activity 1: Sun Model**

Using clay or other craft supplies, have the students create a 3D cross section of the Sun and its different layers. On each model students should label each layer and be prepared to discuss what each layer represents. What is the temperature of each layer? What activity occurs in each layer (e.g. convection)? Here is some background information on the layers of the Sun:

http://www.solarviews.com/cap/vss/VSS00031.htm

http://imagine.gsfc.nasa.gov/docs/science/know_l1/sun.html

- **Enrichment Activity 2: Sun Observations**

SOHO mission is devoted to exploring the Sun. Have the students study the SOHO website to learn about the Sun. What is the solar wind speed? How does the STEREO spacecraft take images of the Sun? What is the current number of sunspots on the Sun today? Are we at sunspot minimum or maximum or somewhere in between? Have the students find some images and show the various features of the Sun to the rest of the class. What changes about the Sun from day to day or year to year?

http://sohowww.nascom.nasa.gov/

- **Enrichment Activity 3: Sun Vocabulary Crossword Puzzle**

Words in this puzzle include: chromosphere, convection zone, core, corona, photosphere, plasma, radiation, radiative zone, solar flare, solar wind, sunspot.

PUZZLE 21

...coming soon...

TABLE 24.1: Puzzle_Questions_21

ACROSS	DOWN
• Sun's visible surface	• Layer of Sun out from core; energy moves by atoms as electromagnetic waves
• Violent explosion on Sun's surface	• Thin layer of Sun's atmosphere above the photosphere; glows red
• Stream of radiation emitted by solar flare	• Electromagnetic energy; photons
• Innermost portion of Sun or planetary body	• Sun's outermost layer; plasma extends far into space
• Layer of Sun where energy moves as flowing cells of gas	• High energy, high temperature form of matter with no electrons
• Cooler, darker area on Sun's surface	

ANSWERS:

Across

3. Sun's visible surface - **PHOTOSPHERE**
4. Violent explosions on Sun's surface – **SOLAR FLARE**
5. Stream of radiation emitted by solar flare – **SOLAR WIND**
8. Innermost portion of Sun or planetary body - **CORE**
9. Layer of Sun where energy moves as flowing cells of gas – **CONVECTION ZONE**
10. Cooler, darker area on Sun's surface - **SUNSPOT**

Down

1. Layer of Sun out from core; energy moves by atoms as electromagnetic waves – **RADIATIVE ZONE**
2. Thin layer of sun's atmosphere above the photosphere; glows red - **CHROMOSPHERE**

6. Electromagnetic energy; photons - **RADIATION**

7. Sun's outermost layer; plasma extends far into space - **CORONA**

11. High energy, high temperature form of matter with no electrons - **PLASMA**

Lesson 5: The Sun and the Earth-Moon System

- **Enrichment Activity 1: Moon Phase Inquiry**

- In the month before beginning the lesson on the Moon, have students take nightly / daily observations of the Moon.
- Each day when it gets dark, at the same time, students should draw the moon they see or leave blank if they do not see a moon.
- Each day during class, the students should make the same observations.
- After a month of data, students will create a class chart showing the time and shape of the moon on a daily basis.
- Why would there be changes? Is there a pattern? Can one predict what will happen next?
- As a class, try and give reasons for the phase changes before looking at the diagram in the book.
- Students can also create a set-up of the Earth, Moon and the Sun (using balls and a flashlight or an overhead projector as the Sun). As students explore what happens as each moves, patterns will emerge.

- **Enrichment Activity 2: Fact Challenge**

Divide the students into a few groups and then each group into two subgroups with one or more independent observers. One of the sub-groups will be responsible for "new moon" and the other for "lunar eclipse." Students are allowed to spend a few minutes in their group collecting facts about their topic, and possibly make diagrams to illustrate it. The two groups will then their facts to the independent observers. The independent observer will decide which group gives the best description of their phenomenon and declare them the winner of the fact challenge. At the end the students should know the difference between a new moon and a lunar eclipse.

Additional Web-based Resources

a. Earth Moon Viewer has a lot of interesting features, including a map of the Earth that shows day and night, a way to view any location on Earth from space, from a satellite or above various cities. You can also view the Moon from various vantage points: http://www.fourmilab.ch/earthview/
b. A catalog of NASA images and animations of Earth, most from satellites: http://visibleearth.nasa.gov/
c. Since you can't stare at the Sun, this website does it for you with images and other resources: http://sungazer.net/
d. The importance of the Sun in other cultures is explored on the Solar Folklore site: http://solar-center.stanford.edu/folklore/folklore.html

CHAPTER 25 The Solar System

Chapter Outline

25.1 The Solar System

Lesson 1: Introduction to the Solar System

- **Enrichment Activity 2: Class Discussion**

Historically, both Copernicus and Galileo faced opposition from many people due to deeply held religious beliefs that placed the Earth at the center of the universe. Have the student research and discover the events surrounding each scientist's life and discoveries. Who opposed their ideas? How did the society at the time deal with them? How did each scientist handle the controversy? In a larger context, how is scientific discovery sometimes tempered or slowed by culture and society? Are there times when this a bad thing? Are there times when this is a good thing? Give examples from what is going on right now.

- **Enrichment Activity 3: Planet Booklet**

Have the students search for planetary fun facts and create a small booklet with pictures. On which planet would you weigh the most? On which planet would you weigh the least? How did the planets get their names? How do planet names relate to the days of the week in English, Spanish, French, Italian (or Latin)? How did those names come about? Who were the gods that the planets were named for? Do their traits fit the planets at all? The students can choose any direction they'd like to explore for this.

You can start at this website from the Exploratorium in San Francisco to calculate weights: http://www.exploratorium.edu/ronh/weight/.

- **Enrichment Activity 4: Demonstration**

Try Bill Nye's demonstration, Orbiting Marbles. Using a paper plate, marbles and a pair of scissors, you can demonstrate how the space shuttle orbits the Earth. Go to the Bill Nye website, http://www.billnye.com/, then Home Demos, Planetary Science, Space Science, Orbiting Marbles.

Lesson 2: Inner Planets

- **Enrichment Activity 1: Research and Discussion**

Have the students list the properties that make Earth habitable. What do advanced life forms need? Given these conditions, is there likely to be life elsewhere in the solar system? The students may not yet know this, but there are many life forms on Earth that live in what we think of as extreme environments. What are some of these extremophiles? How are the conditions they live in like the conditions found on some other planets and their satellites? Where might life be found and why? Ask the students if they think that life will be found elsewhere in our solar system in their lifetime? How about elsewhere in the galaxy? What evidence do scientists need to look for to find the most basic life forms? What do scientists need to look for to find intelligent life?

Lesson 3: Outer Planets

- **Enrichment Activity 1: Travel Brochure**

This is an individual project for students to do. Choose an inner planet or outer planet (if you chose and outer planet you may do the assignment to be or include one of the more of its satellites) to learn more about. Using your research, create a "Travel Brochure" enticing others to visit your planet for a vacation. Talk about the unique features of your planet, what one might expect while visiting etc. Assume your traveler would have access to oxygen and protection from the environment. Make the brochure neat, colorful and informative.

- **Enrichment Activity 2: Planet Presentation**

Students will be divided into teams of two or more and each team will present a portion of a class – no more than 20 minutes. The presentation will be about one of the planets or another feature from Chapter 25 or Chapter 26. If the topic is a planet, the presentation should include information about:

- physical features, size, color, material, temperature(s)
- atmosphere and climate
- rotation and revolution, including speeds
- what telescopes, spacecraft or rovers have studied the planet
- other interesting facts

Other topics include the dwarf planets, asteroid belt, comets, or meteors. Students should use visuals, put notes on the board or a note sheet that the viewing students fill in, share the stage amongst group members, and include an activity, such as a model.

Lesson 4: Other Objects in the Solar System

- **Enrichment Activity 1: Research**

Earth has many impact craters, including some that caused big changes in Earth's history, some that we can visit and learn from, and others that are barely visible. Choose an impact crater of interest. Research when it occurred, the size and look of the crater left, and any effects the impact had on the environment. How would you be able to recognize an impact crater versus a volcanic crater?

TABLE 25.1: Craters

Chicxulub crater (Mexico)	Meteor Crater, also called Barringer (Arizona, US)
Wolf Creek (Australia)	Sudbury (Canada)
Roter Kamm (Namibia)	Chesapeake Bay (Virginia, US)
Clearwater Lakes (Canada)	
Vredefort (South Africa)	

A list of Earth's impact craters can be found here: http://en.wikipedia.org/wiki/List_of_impact_craters_on_Earth and a map of known impact craters here: http://www.lpi.usra.edu/publications/slidesets/craters/slide_2.html. There are also some interesting impact craters on other bodies in the solar system, such as Herschel Crater on Saturn's

moon, Mimas.

- **Enrichment Activity 2: Planets and Dwarf Planets Crossword Puzzle**

PUZZLE 22

...coming soon...

TABLE 25.2: Puzzle_Questions_22

ACROSS	DOWN
• Dwarf planet, gaseous	• Tiny, scorching, dense planet, craters on surface, nearest Sun
• Moon, larger than Mercury, atmosphere like Earth's, may have liquid water	• Rocky planet, liquid water oceans, gaseous atmosphere, 3rd from Sun
• Icy blue planet, axis almost parallel to orbit, has rings and moons	• Galilean moon, possible liquid water beneath ice layer
• Thick atmosphere, volcano covered planet, nearest Earth in location and size	• Reddish planet, evidence of past liquid water, rocky, relatively well known
• Furthest planet, blue, turbulent atmosphere, has rings and moons	• Largest dwarf planet in solar system, farthest out from Sun
• Largest gas planet, stormy atmosphere, has rings and moons	• Dwarf planet, rocky, has 3 moons
• Gaseous, 2nd largest planet in solar system, has rings and moons	• Dwarf planet, largest body in asteroid belt, spherical

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ANSWERS:

Across

1. Dwarf planet, gaseous – **MAKE MAKE**

5. Moon, larger than Mercury, atmosphere like Earths, may have liquid water - **TITAN**

6. Icy blue, axis almost parallel to orbit, has rings and moons – **URANUS**
7. Thick atmosphere, volcano covered, nearest to Earth in location and size - **VENUS**
8. Furthest planet, blue, turbulent atmosphere, has rings and moons - **NEPTUNE**
12. Largest gas planet, stormy atmosphere, has rings and moons - **JUPITER**
13. Gas, 2nd largest planet in solar system, has rings and moons - **SATURN**

Down

1. Tiny, dense planet, craters on surface, nearest Sun - **MERCURY**
2. Rocky, liquid water oceans, gaseous atmosphere, 3rd from Sun - **EARTH**
3. Galilean moon, possible liquid water beneath ice layer - **EUROPA**
4. Reddish, evidence of pat liquid water, rocky, relatively well known - **MARS**
9. Largest dwarf planet in solar system, farthest out from Sun - **ERIS**
10. Dwarf planet, rocky, has three moons - **PLUTO**
11. Dwarf planet, largest body in asteroid belt, spherical - **CERES**

Additional Web-based Resources

a. A great deal of information about our eight planets can be found here: http://www.nineplanets.org/
b. NASA has many sites of interest on a variety of topics. One is on asteroid and comet impact hazards: http://impact.arc.nasa.gov/ and another on the near-earth object program http://neo.jpl.nasa.gov/
c. An Asteroids, Comets, Meteors Theme Page: http://www.cln.org/themes/asteroids.html
d. Astrobiology is the study of life in space. Since there hasn't yet been any found, a lot of what astrobiologists do is to look on Earth for extremophiles to see if they might also exist on other planets and to look at other planets and satellites for potentially habitable regions. Astrobiology news is found at this site: http://www.astrobio.net/astrobiological_news.php

CHAPTER 26

Stars, Galaxies, and the Universe

Chapter Outline

26.1 Stars, Galaxies, and the Universe

Lesson 1: Stars

- **Enrichment Activity 1: Star Obituary**

News people write obituaries all the time for stars, but this star's obituary is a bit different. Have the students choose a type of star, including the size and temperature, and write an obituary. Like a movie star, the obituary should discuss how the star was born, the major events of her life, how long she lived and the circumstances of her death as a star. Will this star leave behind a "legacy" after death? Some background information from NASA: http://www.science-teachers.com/constellation_flashcards.htm.

- **Enrichment Activity 2: Children's Book**

Have each student research a constellation that can be seen in the night sky in your local area. Using black construction paper and either white/ yellow paint or crayons, create a nice night sky view of the constellation. On a white piece of paper on the adjacent page include a short summarized mythological story of the constellation, when it can be seen, and anything else pertinent. Students can look at the visible bright stars in the night sky and make up their own constellation and story about it. Share the book with a group of children, if possible. Some background information from UCAR: http://www.windows.ucar.edu/tour/link=/the_universe/Constellations/north_constellations.html.

- **Enrichment Activity 3: Art**

Students can choose their favorite galaxy, and using water colors, paints or oil pastels, they can create a picture of their galaxy on paper. Alternatively, student can create a galaxy and create a story to go with it.

Lesson 2: Galaxies

- **Enrichment Activity 1: Categorizing**

Using an overhead projector or preferably a Smartboard or computer projector, show various images of galaxies as taken from the Hubble Telescope. This is a good website to start: http://hubblesite.org/gallery/album/galaxy/. Use these pictures as a start point of inquiry. How do these galaxies compare? What are the similarities between all elliptical galaxies, spiral galaxies and dwarf galaxies? How do scientists decide that a galaxy is irregular? By viewing these images of galaxies, students will determine their own list of criteria for each type of galaxy. Use a chart to help collect notes and data.

TABLE 26.1: Galaxies

Type of Galaxy	Features	Examples
Spiral		
Elliptical		
Dwarf		
Irregular		

- **Enrichment Activity 2: Stars and their Lives Vocabulary Crossword Puzzle**

Words in the puzzle include: asterism, binary, black hole (2 words), constellation, fusion, light year (2 words), main sequence (2 words), nebula, neutron, parallax, red giant (2 words), supernova.

PUZZLE 23

...coming soon...

TABLE 26.2: Puzzle_Questions_23

ACROSS	DOWN
• Tremendous explosion when core of star is mostly iron	• An apparent pattern of stars in the sky
• Used to calculate distance to nearby stars	• A cluster of stars that appears close together in the sky
• The super dense core left after a supernova explosion	• Stage of star's life when inner helium core contracts, outer hydrogen layers expand
• A star that fuses hydrogen to helium; in its middle age	
• The distance light travels in one year; 9.5 trillion kilometers	
• Two stars that orbit each other	
• An interstellar cloud of gas and dust	
• Two nuclei join, giving off tremendous energy	
• The remnant of a massive star after a supernova explosion	

ANSWERS:

Across

2. Tremendous explosion when core of star is mostly iron - **SUPERNOVA**
3. Used to calculate distance to nearby stars – **PARALLAX**
5. The super dense core left after a supernova explosion – **BLACK HOLE**
6. A star that fuses hydrogen to helium; in its middle age – **MAIN SEQUENCE**
7. The distance light travels in one year; 9.5 trillion kilometers – **LIGHT YEAR**
9. Two stars that orbit each other - **BINARY**
10. An interstellar cloud of gas and dust - **NEBULA**
11. Two nuclei join, giving off tremendous energy - **FUSION**
12. The remnant of a massive star after a supernova explosion - **NEUTRON**

Down

1. An apparent pattern of stars in the sky - **CONSTELLATION**
4. A cluster of stars that appears close together in the sky - **ASTERISM**
8. Stage of star's life when inner helium core contracts, outer hydrogen layers expand – **RED GIANT**

Lesson 3: The Universe

- **Enrichment Activity 1: Space Timeline**

Have the students create a timeline in the classroom of the events listed below. Attach a "picture" and short description of each event to a large rope or strip of paper that represents time. Create a timeline that has the correct ratio of space to time on the rope. Run the rope around the classroom.

- The Big Bang
- Elements form
- Stars and Galaxies Form
- Our Sun is "born"
- The Solar System Forms
- Earliest life forms appear on Earth
- First life on land
- Dinosaurs become extinct
- First humans appear
- Galileo builds first telescope

Additional Web-based Resources

a. Astronomers are looking for other planets and have found hundreds so far. Find out how the search for other planets is going on PlanetQuest: http://planetquest.jpl.nasa.gov/index.cfm
b. Make a shoebox planetarium in this lesson: http://www.middleschoolscience.com/shoeboxplanetarium.htm
c. Teach children the constellations with flash cards: http://www.science-teachers.com/constellation_flashcards.htm