



# Comprehensive Curriculum

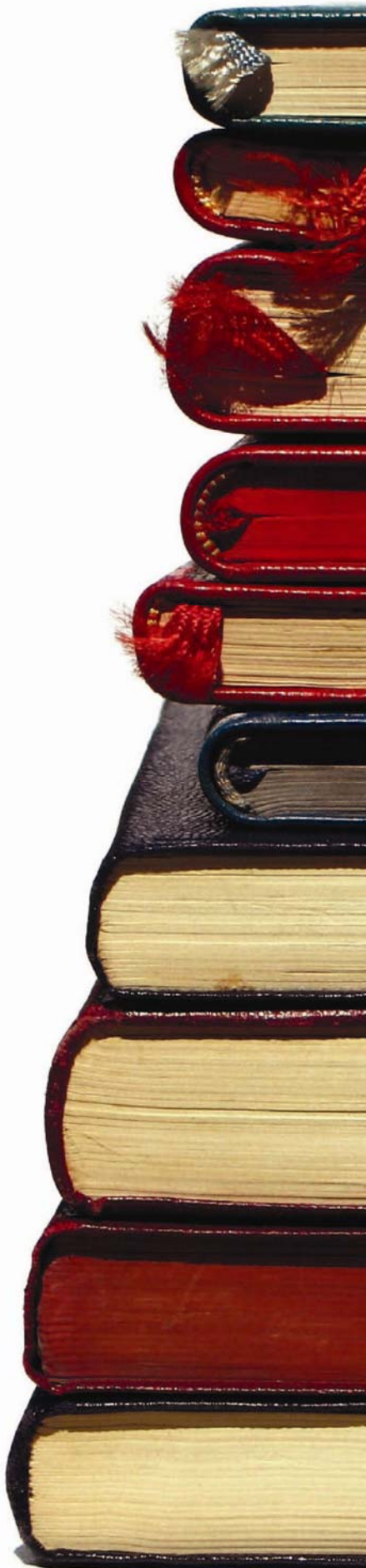
Revised 2008

## Grade 8 Science



Louisiana Department of  
**EDUCATION**

Paul G. Pastorek, State Superintendent of Education



## Table of Contents

<b>Unit 1: Properties of Matter.....</b>	<b>1</b>
<b>Unit 2: Earth's Crust.....</b>	<b>11</b>
<b>Unit 3: Geologic History of Earth.....</b>	<b>24</b>
<b>Unit 4: Landforms and Topography.....</b>	<b>39</b>
<b>Unit 5: Factors that Affect Earth.....</b>	<b>58</b>
<b>Unit 6: Earth's Forces.....</b>	<b>73</b>
<b>Unit 7: Astronomy and Space Exploration.....</b>	<b>87</b>
<b>Unit 8: Pollution and Its Effects.....</b>	<b>105</b>

## *Louisiana Comprehensive Curriculum, Revised 2008* Course Introduction

The Louisiana Department of Education issued the *Comprehensive Curriculum* in 2005. The curriculum has been revised based on teacher feedback, an external review by a team of content experts from outside the state, and input from course writers. As in the first edition, the *Louisiana Comprehensive Curriculum*, revised 2008 is aligned with state content standards, as defined by Grade-Level Expectations (GLEs), and organized into coherent, time-bound units with sample activities and classroom assessments to guide teaching and learning. The order of the units ensures that all GLEs to be tested are addressed prior to the administration of *iLEAP* assessments.

### **District Implementation Guidelines**

Local districts are responsible for implementation and monitoring of the *Louisiana Comprehensive Curriculum* and have been delegated the responsibility to decide if

- units are to be taught in the order presented
- substitutions of equivalent activities are allowed
- GLEs can be adequately addressed using fewer activities than presented
- permitted changes are to be made at the district, school, or teacher level

Districts have been requested to inform teachers of decisions made.

### **Implementation of Activities in the Classroom**

*Incorporation of activities into lesson plans is critical to the successful implementation of the Louisiana Comprehensive Curriculum.* Lesson plans should be designed to introduce students to one or more of the activities, to provide background information and follow-up, and to prepare students for success in mastering the Grade-Level Expectations associated with the activities. Lesson plans should address individual needs of students and should include processes for re-teaching concepts or skills for students who need additional instruction. Appropriate accommodations must be made for students with disabilities.

### **New Features**

*Content Area Literacy Strategies* are an integral part of approximately one-third of the activities. Strategy names are italicized. The link ([view literacy strategy descriptions](#)) opens a document containing detailed descriptions and examples of the literacy strategies. This document can also be accessed directly at <http://www.louisianaschools.net/1de/uploads/11056.doc>.

A *Materials List* is provided for each activity and *Blackline Masters (BLMs)* are provided to assist in the delivery of activities or to assess student learning. A separate Blackline Master document is provided for each course.

The *Access Guide to the Comprehensive Curriculum* is an online database of suggested strategies, accommodations, assistive technology, and assessment options that may provide greater access to the curriculum activities. The *Access Guide* will be piloted during the 2008-2009 school year in Grades 4 and 8, with other grades to be added over time. Click on the *Access Guide* icon found on the first page of each unit or by going directly to the url <http://mconn.doe.state.la.us/accessguide/default.aspx>.



**Grade 8  
Science  
Unit 1: Properties of Matter**

**Time Frame:** Approximately three weeks



**Unit Description**

This brief unit focuses on the structure of atoms, the atomic structure of elements and ions, and the basic use of the periodic table.

**Student Understandings**

Students should understand the structure of atoms, how that structure varies from element to element, and the relationship of atomic structure to the behavior of ions.

**Guiding Questions**

1. Can students select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations?
2. Can students determine the composition of elements using the periodic table?
3. Can student describe the properties of selected elements?
4. Can students learn about the elements from their use of the Internet and other resources to find additional information?
5. Can students predict how elements will form ions and react with other elements?

**Unit 1 Grade-Level Expectations (GLEs)**

GLE #	GLE Text and Benchmarks
<b>Science as Inquiry</b>	
<i>The following Science as Inquiry (SI) GLEs are embedded in the suggested activities for this unit. Additional activities incorporated by teachers may result in additional SI GLEs being addressed during instruction on the Atoms and Ions unit.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
3.	Use a variety of sources to answer questions (SI-M-A1)
5.	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)

GLE #	GLE Text and Benchmarks
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
28.	Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
<b>Physical Science</b>	
1.	Determine that all atoms of the same element are similar to but different from atoms of other elements (PS-M-A2)
2.	Recognize that elements with the same number of protons may or may not have the same charge (PS-M-A2)
3.	Define ions and describe them in terms of the number of protons, electrons, and their charges (PS-M-A2)

### Safety in the Science Classroom

In the course of his/her studies, a student using any device that can be potentially dangerous or hazardous to the eyes such as, acid or abrasives or any other dangerous devices, shall be furnished with and shall wear protective glasses or safety goggles made of a material suitable to protect eyes from such hazards. Students and parents should read and sign a safety contract; the teacher needs to keep this on file the entire year (See Student Safety Contract BLM). An alternative activity: Help students develop a safety contract, and have both parents and students sign it.

The wide ranges of experiences students will encounter when engaging in science lessons may put them at potential risk for injury if they, and the teacher, do not adhere to strict safety measures. Beyond following guidelines and position statements by professional organizations, teachers need to assess the risks associated with every activity. However, a great deal of science teaching occurs on field trips and in outdoor settings such as a school garden, greenhouse, or nature trail. In these instances, the teacher should also assess risks by considering poisonous plants, stinging insects, use of chemicals such as fertilizer, herbicides, and pesticides. A prudent teacher will incorporate safety considerations into his/her written lesson plans. Students should recognize and know the meaning of safety symbols found in most textbooks.

Note to the Teacher: For this unit, have each student maintain a science *learning log* ([view literacy strategy descriptions](#)). Explain that explorers, scientists, and mathematicians have always kept logs of the observations, thoughts, new understandings, hypotheses, and reflections. In this way, they could record progress, test new ideas, and document what they learned. Similarly, with the *learning logs* for this unit, students will record new understandings, explain science processes, pose and solve problems, make and check predictions, and reflect on what has been learned. Invite students to

personalize their science *learning log* covers with the names, illustrations, and/or pictures from magazines (students can create a foldable booklet for this strategy).

Each class session, present students with a science *learning log* writing prompt. This can be at the beginning of class, requiring predictive thinking for that day's lesson or reflective thinking about what was learned in the previous class. Structure the prompts so students write for no more than five to seven minutes. Prompts can be related to specific content or new understandings.

### Sample Activities

#### Activity 1: Thinking Like a Scientist (SI GLEs: 1, 2, 5, 6, 8, 11)

Materials List: Consumer Challenge One BLM, Consumer Challenge Two BLM, and Consumer Challenge Rubric BLM—each one per student or student group; three different brands of paper towels; tools to take measurements needed for activity

After reviewing safety procedures, challenge students in this two-day experiment by introducing them to scientific skills needed to design and conduct an investigation. Student groups will test paper towel absorbency. After collecting data, allow the student groups to discuss their results with each other. The students will take the lead in their learning and investigate their world using consistency and precision in data collection, analysis, and reporting.

Part A: Review the Consumer Challenge Rubric with whole class so that they know the expectations required of them. Student groups of 2-3 will write their own methodology, conduct the experiment, and evaluate the strengths and weaknesses of their methods. Students should consider the issues in combining data from other groups testing the same product. The students also should incorporate methods to ensure reliable results such as the use of consistency and precision in the collection and recording of data and to address safety concerns.

First, student groups should meet to brainstorm different methods for testing their product. Show the equipment available; ask the students how the equipment could be used to make quantitative observations.

Part B: This activity will introduce the idea of controlling other factors in the experiment. Use the plant example referenced on the Consumer Challenge One BLM to model with the students how to complete the chart for their individual experiment. Have students complete the chart listing all testable variables.

Part C: Students should record their results as they test their product (see Consumer Challenge Two BLM). After the experiment, students will use their data to construct a

graph and write a conclusion. Each student team can create a presentation to report their findings to their classmates, which includes answers to the conclusion questions.

**Activity 2: Atoms of Elements to Ions (SI GLEs: 3, 28; PS GLEs: 1, 2, 3)**

Materials List: Vocabulary Self-Awareness check BLM, 3X5 index cards for “word wall” (one card per word for each student), list of elements, Vocabulary Cards BLM (one for whole class viewing), a timeline-creating software or adding machine tape and metric ruler

Part A: Determine students’ prior knowledge of atoms using the *vocabulary self-awareness chart* ([view literacy strategy descriptions](#)). Provide a list of words to students at the beginning of this part of the unit and have them complete a self-assessment of their knowledge of the words using the Vocabulary Self-Awareness BLM. Do not give students definitions or examples at this stage. Ask students to rate their understanding of each word or law with either a “+” (understand well), a “√” (limited understanding or unsure), or a “-” (don’t know). Over the course of the readings and exposure to activities throughout the unit, students should be told to return often to the chart and add new information to it. The goal is to replace all the check marks and minus signs with a plus sign. Students will continually revisit their vocabulary charts to revise their entries, which will provide multiple opportunities to practice and extend their growing understanding of key terms related to the topic of chemical and physical properties of matter. If after studying these key terms, students still have checks or minuses, the teacher should be prepared to provide extra instruction for these students.

Review the basic components of the atom so that students will demonstrate an understanding of the structure and function of the Periodic Table. Students should construct and compare planetary (Bohr Model) and electron cloud models of a lithium atom in their learning log. Have students describe the properties of the elements in Part C of this activity. Students can make a list of common uses of elements and identify the elements in every day items containing those elements using the website *Chemical Elements* (<http://www.chemicalelements.com>).

Next, students should create a timeline depicting the development of our understanding of atoms from Empedocles, Democritus, and Aristotle to Sir J.J. Tompson, Ernest Rutheford, and Neils Bohr (see “Atoms” under Resources). Students can use a timeline-creating software or they can draw a timeline where 1 cm = 25 years.

Part B. To develop students’ knowledge of key terms, have them create *vocabulary cards* ([view literacy strategy descriptions](#)) for terms related to atoms (i.e., *atoms, protons, neutrons, electrons, valence electron, ion, isotope, electron cloud*). Distribute 3X5 inch index cards to each student for each key term and ask them to follow the teacher’s directions in creating a sample card. Copy the vocabulary card BLM onto a transparency or project it onto an interactive board. Place the word “ATOMS” in the middle of the box, where “term” is on the vocabulary card BLM. Guide students in providing a definition and writing it in the appropriate space. Invite students to list the characteristics

or description of the word and to write that information in the appropriate space. Now, ask for examples of the word and write that information in the appropriate space. Next ask for examples of the word and include one or two of the more accurate ones in the designated area on the card. Finally, create a simple illustration, if possible, of the word in the last area of the card.

Once the “ATOMS” card is created, ask students to make their own vocabulary cards for other atom-related words. Create a “word wall” using the vocabulary words. A word wall is a systematically organized collection of words displayed in large letters on a wall or other large display place in the classroom. Allow time for students to study their cards and quiz each other with their cards to reinforce word knowledge of atoms.

Part C. Student groups will select a pair of elements from the list below and provide the following information for their elements using resources such as websites (see Resources), history of the element, Bohr Model drawing of the atoms (including number of protons, number of neutrons, number of electrons in a neutral atom), physical properties, chemical properties, and any unique information. Students will produce a classroom presentation providing a short oral report on the element pairs. After groups present their report, the drawings of atoms will be posted for Part D of the activity.

- lithium – sulfur
- beryllium – phosphorus
- boron – chlorine
- aluminum – hydrogen
- carbon – oxygen
- silicon – nitrogen
- magnesium – fluorine
- sodium – helium
- potassium – neon
- calcium – argon

Through a class discussion that summarizes the oral reports, elicit the following student understandings that are fundamental assumptions for elements and atoms:

- All atoms of the same element are similar to but different from atoms of other elements.
- Atomic masses are average weights, including all of the isotopes of that element.

Part D. Have students review their *vocabulary self-awareness chart* for the term ion. Provide direct instruction on the prediction of ion formation based on the location of the element in the periodic table and the octet rule (all atoms try to achieve stability in the outer energy level – typically 8 electrons). Then have each student group review their atom model drawings of elements in Part C in order to add additional information on a second revised drawing. Next, have groups determine if their atom would or would not form an ion based on its location on the periodic table and the octet rule. Students are to describe why the atom does or does not form an ion. For elements that do form ions, students are to describe what type (positive or negative) of ion forms and how (loses or

gains electrons) the ion forms. Have students indicate the number of protons, neutrons, and electrons for each ion (see “Atoms” under Resources).

Through class discussion that summarizes the oral reports and displayed drawings, elicit the following student understandings:

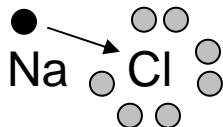
- An atom is mostly empty space.
- The number of protons for the neutral atom and the ion of the element remains the same. Only the number of electrons has changed. It is because of the unbalanced charges that an overall positive charge or negative charge results.
- It is very difficult for anything to penetrate the electron cloud and hit the nucleus.

### Activity 3: The Atoms Family (SI GLE: 3; PS GLE: 2, 3)

Materials List: various types of dried peas or beans; Word Grid (one per student) and Word Grid Answers BLMs and Observation Table BLM; Internet access; various pictures, models, etc. of elements and compounds; Periodic Table (1 for each individual); science learning logs

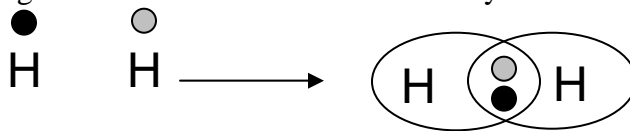
Part A: Provide students with samples, pictures/video clips, or models of elements and compounds and review the octet rule for valence electrons. Students will calculate the number of protons and electrons using a periodic table. Students can use different types of peas to represent valence electrons of atoms. Using the “valence electron” peas, students physically move the “electrons” as they bond.

- **Ionic Bonds:** Using an overhead, write the symbols for each element of sodium chloride. Use peas to create the Lewis structure for each—one sodium (1 valence electron) atom and one chlorine atom (7 valence electrons). Draw an arrow to show the transfer of the electrons and move the pea to the new location. Determine the charge for each ion and write the formula. Make sure the sum of the charges is zero and write the chemical formula ( $\text{Na}^+\text{Cl}^-$ ). Sodium has a positive charge because it now has 1 more proton than electrons, and chlorine has a negative charge because it now has 1 more electron than protons).



- **Covalent Bonds:** Using an overhead, write the symbols for each element for water. Use peas to create the Lewis structure for each – one hydrogen (for now – 2 valence electrons) atoms and one oxygen atom (6 valence electrons). Rearrange the electrons (or peas) to pair-up electrons from each atom. Students should start with one hydrogen atom and one oxygen atom. Remind the students of the octet rule: they should see that oxygen atom needs two electrons to fill its out shell ( $6+2$ ), which means they will need a total of two hydrogen atoms to complete the bond. Draw a circle around oxygen’s 6 and the two hydrogen’s 1 valence electrons. Also draw a circle around each hydrogen’s 1 valence electron and 1

oxygen electron to show the sharing of electrons. Draw the bond structure using symbols and lines to connect the bonds. Use one line for each pair of electrons that is shared. Write the chemical formula for each molecule. Have the students use a writing utensil to draw the electrons as they remove the peas.



Students should see the difference between covalent bonds (sharing of valence electrons) and ionic bonds (the giving/taking of valence electrons) and how the ions of elements are different from the atoms of the same element. Specifically include a sodium, chlorine, and sodium chloride set; an aluminum, chlorine, and aluminum chloride set; and an iron II oxide (FeO) and iron III oxide (Fe<sub>2</sub>O<sub>3</sub>) set.

Part B: Students complete a *word grid* ([view literacy strategy descriptions](#)). This strategy involves building a grid in which the individual elements, molecules, compounds, or mixtures are listed on the vertical axis of the grid and the characteristics or important ideas are listed on the horizontal axis, such as element, molecule, compound, mixture, ion, and ionic bond. Students fill in the grid, indicating the extent to which the key words possess the stated features. Students can work in pairs to review the differences among atoms, molecules, compounds, and mixtures. After about five minutes, the teacher can do a visual check while reviewing the answers with the whole class, such as thumbs up for got it right and knew it, flat horizontal hand for got it right but guessed, or thumbs down for got it wrong. Once the grid is completed, students are led to discover both the shared and unique characteristics of the properties of the items listed in the vertical axis. Allow students to study from the *word grid* and then be given questions that ask them to compare/contrast key terms.

Part C: Ask students to make observations of the physical properties of the element and compound samples with regard to the phase of matter, color, and other visual characteristics as well as the chemical formulas of the substances within each set. Students should record observations in a table similar to the Observation Table BLM in their science *learning logs*.

Show illustrations or a video clip of the sodium-chlorine reaction. A video clip of this reaction can be found at the *Chemistry Comes Alive!* web site, available online at <http://jchemed.chem.wisc.edu/JCESoft/CCA/CCA0/Movies/NAACL1.html>. As a teacher demonstration, place aluminum and aluminum chloride in water to emphasize a difference in properties such as solubility. (In this instance, the compound dissolves and metal does not.) The teacher should wear protective goggles and an apron for the demonstration. Students are to observe and record their observations in their science *learning logs*.

After students have completed this part of the activity, conduct a class discussion asking questions such as What did you observe? What did you note about the iron set versus the sodium set or the aluminum set? Why do you think the element alone had different

characteristics than when it was in a compound? Compare the structure of the atom (Na) to the ion that it formed. How does the aluminum ion differ from the aluminum atom? Continue discussion to elicit student understanding on the following key points:

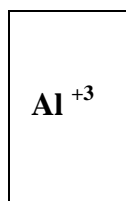
- Atoms of elements and ions with the same number of protons may or may not have the same charge. Property changes are brought about by a transfer of electrons.
- Some elements form more than one ion (more than one oxidation number), such as iron in iron II oxide and iron III oxide.
- The number of electrons in an ion is different from the number of electrons in the atom of the same element.

#### **Activity 4: It All Adds Up (SI GLE: 3; PS GLE: 3)**

Materials List: teacher-created element/ion cards, periodic tables, markers

In this activity, the students will use the periodic table and a set of teacher-created “element/ion cards” to create formulas for ionic compounds with a net ionic charge of zero. Through readings and direct instruction, students should be familiarized with the periodic table and how ions are formed.

To be consistent, atomic masses are recorded to the nearest tenth of an atomic mass unit. Element/ion cards can be made by using three-by-five-inch index cards for the first twenty elements, except those in Group 4, and additional elements in Groups 1, 2, 3, 6, and 7 or transition elements such as silver, zinc, iron, copper, etc. Print the symbol for an ion with the card oriented as shown below, and on the back. Write the number of protons, neutrons, and electrons; the location of the ion on the periodic table; and whether the ion is metal or nonmetal.



Students can play “speed bonding” by walking around the room trying to find an atom (person) they can bond with. Knowing that the compounds must have a net charge of zero (positive to negative), have students use the element/ion cards to predict the correct empirical formula for the following compounds:

1. sodium and chlorine
2. calcium and oxygen
3. magnesium and fluorine
4. aluminum and bromine
5. aluminum and oxygen

## Sample Assessments

### General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data-collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities.
- All student-developed products should be evaluated as the unit continues.
- When possible, students should assist in developing any rubrics that will be used and provided the rubrics during task directions.

### General Assessments

- Given an element and the periodic table, the student will identify the number of protons, neutrons, and electrons in the element.
- Using the periodic table, the student will predict the ion(s) and charge formed for a given element.
- The student will describe how an atom becomes positively charged or negatively charged.

### Activity-Specific Assessments

- Activity 1: Using the rubric as a guide (Consumer Challenge Rubric BLM), the student will design and conduct an experiment using scientific skills.
- Activity 2: The student will compare the arrangement of electrons in an atom, such as silicon, with those of other elements in the same family.
- Activity 3: The student will be able to explain the difference between electron sharing and the formation of ions.
- Activity 4: Using the periodic table, the student will explain how sodium and chlorine unite to form sodium chloride, an ionic compound. The student will be able to describe how ionic bonds are formed.

## Resources

### Safety in the Classroom

- *Inquiring Safely: A Guide for Middle School Teachers* NSTA Press: by Terry Kwan and Juliana Texley. 2003. Grades 6-8.
- [http://www.carnegieinstitution.org/first\\_light\\_case/horn/labsafety.html](http://www.carnegieinstitution.org/first_light_case/horn/labsafety.html)
- *Consumer Challenge- the original activity*  
<http://www.sciencespot.net/Pages/classgen.html>

### Periodic Table

- *Chemical Elements*. Available online at <http://www.chemicalelements.com/>
- "Sodium and Chlorine Reaction." *Chemistry Comes Alive*. Available online at <http://jchemed.chem.wisc.edu/JCESoft/CCA/CCA0/Movies/NaCl1.html>
- *Web Elements*. Available online at <http://www.webelements.com/>.

### Atoms

- *Science Spot*. A teacher-created website that offers activities in all areas of science under SCIENCE CLASSROOM – <http://www.sciencespot.net>. On the chemistry page, see *Bonding with a Classmate* and *Bonding Activity*

**Grade 8  
Science  
Unit 2: Earth's Crust**

**Time Frame:** Approximately three weeks



**Unit Description**

This unit introduces the layers that form Earth with a focus on the theory of plate tectonics. The unit includes the identification of minerals and rocks and the study of the rock cycle.

**Student Understandings**

Students develop an understanding that rocks are made of minerals and use established procedures to identify mineral samples. Research on the rock cycle shows student understandings of the dynamic processes that result in the formation of other rocks. Ending with an awareness of the four density layers of Earth, students gain an understanding of the theory of plate tectonics.

**Guiding Questions**

1. Can students classify a given rock or a mineral by its appearance and other physical characteristics?
2. Can students explain what changes the identity of one rock formation to another?
3. Can students compare causes and locations of earthquakes and volcanoes?
4. Can students discuss convection currents as an explanation of plate tectonics?
5. Can students describe the historical background and present the current theory of plate tectonics?

**Unit 2 Grade-Level Expectations (GLEs)**

<b>GLE #</b>	<b>GLE Text and Benchmarks</b>
<b>Science as Inquiry</b>	
<i>The following SI GLEs are embedded in the suggested activities for this unit. Additional activities incorporated by teachers may result in additional SI GLEs being addressed during instruction on Earth's Crust unit.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
3.	Use a variety of sources to answer questions (SI-M-A1)
4.	Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
10.	Identify the difference between description and explanation (SI-M-A4)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
13.	Identify patterns in data to explain natural events (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
15.	Identify and explain the limitations of models used to represent the natural world (SI-M-A5)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
23.	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
33.	Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
34.	Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5)
37.	Critique and analyze their own inquiries and the inquiries of others (SI-M-B5)
<b>Earth and Space Science</b>	
8.	Identify and describe the four density layers of Earth (ESS-M-A1)
9.	Explain the historical development of the theories of plate tectonics, including continental drift and sea-floor spreading (ESS-M-A2)

GLE #	GLE Text and Benchmarks
10.	Illustrate the movement of convection currents (ESS-M-A2)
11.	Illustrate the movements of lithospheric plates as stated in the plate tectonics theory (ESS-M-A2)
12.	Identify the edges of plate boundaries as likely areas of earthquakes and volcanic action (ESS-M-A3)
13.	Describe the processes responsible for earthquakes and volcanoes and identify the effects of these processes (e.g., faulting, folding) (ESS-M-A3)
16.	Compare the physical characteristics of rock and mineral specimens to observe that a rock is a mixture of minerals (ESS-M-A5)
17.	Describe the properties of minerals (e.g., color, luster, hardness, streak) (ESS-M-A5)
18.	Describe how sedimentary, igneous, and metamorphic rocks form and change in the rock cycle (ESS-M-A6)

Note to the Teacher: For this unit, have student maintain a science *learning log* ([view literacy strategy descriptions](#)). Explain that explorers, scientists, and mathematicians have always kept logs of their observations, thoughts, new understandings, hypotheses, and reflections. In this way, they could record progress, test new ideas, and document what they learned. Similarly, with the science *learning logs* for this unit, students will record new understandings, explain science processes, pose and solve problems, make and check predictions, and reflect on what has been learned. Invite students to personalize their science *learning log* covers with the names, illustrations, and/or pictures from magazines (students can create a foldable booklet for this strategy).

Each class session, present students with a science *learning log* writing prompt. This can be at the beginning of class, requiring predictive thinking for that day's lesson or reflective thinking about what was learned in the previous class. Structure the prompts so students write for no more than five to seven minutes. Prompts can be related to specific content or new understandings.

### Sample Activities

#### Activity 1: Mineral Identification (SI GLEs: 1, 3, 4, 6, 7, 8, 11, 22, 23, 34, 37; ESS GLEs: 16, 17)

Materials List: safety goggles, gloves (acid may burn skin), several mineral samples, Moh's hardness scale, plate of glass, iron nail, penny, water, beaker, spring scale in grams, magnifying lenses, streak plates (or porcelain tile-white and black), string, and diluted hydrochloric acid (10%), science learning logs

*Safety Note: Students should wear safety goggles and gloves when using dilute hydrochloric acid (HCl), as it is hazardous and may cause acid burns to the skin or eyes. Use a dropper bottle and only apply one or two small drops to the sample.*

Part A: Begin the activity by displaying several rock and mineral samples. Ask students probing questions such as “What is the difference between rocks and minerals? How can you tell if a substance is a mineral?” Continue to ask probing questions until student responses cover the basic characteristics for minerals: naturally occurring from inorganic material, crystalline structure, and definite composition. Emphasize that rocks are a mixture of minerals. Use magnifying lenses to examine samples of rocks such as granite, gneiss, diorite, conglomerate, or sandstone. In their science *learning logs* ([view literacy strategy descriptions](#)), students should draw and color the different minerals (crystals) they observe in the rock samples. Have the students generate a list of questions in their science *learning logs* about their observations of the minerals in the rocks; they will use these to test later after acquiring the necessary skills of mineral identification.

Part B: Students should review the safety procedures and equipment that will be used during this investigation such as safety gear and proper handling of chemicals prior to this investigation.

Ask the students to explain what is meant by physical properties of an object. Make a list on the board or on an overhead transparency of what the students think a mineral’s physical properties may consist of while examining the samples. Typical responses will include shape, texture, color, hard or soft, shiny, etc. Students will identify the physical properties of common minerals such as talc, gypsum, calcite, quartz, hematite, sulfur, galena, and pyrite. Students will create a chart in their science *learning log* to record the sample’s physical properties by using the steps of mineral identification. The chart should have the mineral name in rows on the left side and the properties (color, luster, hardness, streak, specific gravity) in columns at the top of the chart. Students may work in pairs or in groups of four depending on the number of samples available. Lead a whole-class discussion on why the students should use consistency and precision in data collection, analysis, and reporting for this investigation.

Using magnifying lenses, the students will examine each sample to determine its color. Students should be aware that the true color of the mineral samples is occasionally hidden by tarnish, rust, corrosion, or even soil. It should be noted that a specific mineral might be found in a wide variety of colors.

Luster is the way light reflects from a mineral. Nonmetallic minerals are often glassy, pearly, dull, or even sparkling but contain no metal. They often feel very light when tossed in your hand. Metallic minerals typically have reflective surfaces but can be covered with tarnish, rust, or corrosion. Metallic minerals feel heavier than nonmetallic minerals when tossed in the hand.

Provide students a copy of the Moh’s Scale of Hardness (see MINERALS under Resources), an iron nail, a penny, and a glass plate. The resistance of a mineral to being scratched is known as hardness. Use the Moh’s Scale of Hardness to determine the hardness of each sample. This scale uses common objects (fingernail, penny, nail, glass) of a known hardness to scratch the minerals and rank its hardness from 1 to 10. Have the students predict the hardness of the sample before testing it.

Distribute streak plates to students. Streak is one of the most reliable properties used in identifying minerals. Students should predict what the “true” color would be before testing for streak. Students will rub the mineral across the surface of a streak plate. The resulting color should be rubbed on the student’s finger and then examined with a magnifier. Streak is occasionally affected by tarnish, rust, corrosion, or even soil. Minerals with a hardness of 5 or above are usually too hard to leave a streak. A characteristic “high pitch” scratching sound is produced while conducting the streak test. Nonmetallic minerals often produce white streaks or none if they are too hard, and metallic minerals usually produce dark streaks.

Specific gravity is the comparison of the mineral’s density to the density of water (1g/mL). This can be determined using a mass spring scale, string, and a beaker of water. Gently tie one end of the string around the mineral. Tie the other end around the spring scale hook. Allow the mineral to hang and note the mass in grams. Now gently place the mineral (still tied to the spring scale) into the beaker of water. Measure the mass, again. Subtract the second measurement from the initial, and divide this difference into the initial mass; this is the mineral’s specific gravity. Remind the students that specific gravity is a ratio. If a sample weighs 60 N in air and 45 N in water then the weight loss is 15 N. The specific gravity is  $60\text{ N}/15\text{ N}$  or 3. This sample would be three times as heavy as the equal volume of water.

Part C: Take this activity further by asking the students to identify samples of unknown minerals using mineral identification charts often found in textbooks, magnifying lenses, streak plates, tools to conduct hardness tests, and dilute Hydrochloric Acid (HCl); carbonate minerals effervesce (fizz) in the presence of dilute hydrochloric acid, producing bubbles of carbon dioxide gas (the same type of harmless gas bubbles that are found in carbonated beverages. Dilute HCl (a 10 percent solution) can be easily made by combining 1 part-HCl and 9-part water (1 mL of HCl and 9 mL of distilled water).

Afterwards, organize students into cooperative groups. They will share their results of their investigation with other groups. This will allow them to recognize the importance of communication. Scientists communicate about investigations so that they can further develop their own ideas and understandings. This opportunity will allow them to criticize and analyze their own inquiries as well as the inquiries of others.

If mineral samples are unavailable, see MINERALS under Resources section at the end of this unit for virtual mineral identification lab ideas.

**Activity 2: Rocks and the Rock Cycle (SI GLEs: 3, 19; ESS GLEs: 16, 18)**

Material List: Internet access for student groups; magnifying lenses; rock samples of sedimentary, metamorphic, and igneous rocks; Rock Cycle Concept Map BLM; rock and mineral field guide or appropriate resource guides; teacher-selected information resources on rock types; science learning logs; computer for each student or student pair with publishing software program

Note: Students need to realize that most of the rocks that they find in Louisiana have been transported here by river action or human activity. If actual rock samples are unavailable see ROCKS under Resources section for virtual lab possibilities.

Part A: If possible, have students collect several different kinds of rocks from the local area or provide the students with simple classroom rock sets. While observing the different kinds of rocks, have the students group categorize the rocks into different groups in their science *learning logs* ([view literacy strategy descriptions](#)). Students may group the rocks by physical characteristics such as color, shape, etc. Next, they will use a rock and mineral field guide or appropriate resource guides and magnifying lenses to identify as many as possible of the minerals that make up each rock. Students should focus on the texture and color of the rock. Typical classroom rock kits usually contain samples of the three major rock types—igneous, metamorphic, and sedimentary.

Part B: Assign students a specific rock sample such as granite, pumice, sandstone, chert, limestone, salt, coal, or marble and challenge the students to use available resources to discover common everyday uses and the economic values of the assigned rock. Assign students or student pairs to a computer with a publishing software program. Students will prepare a brochure advertising the rock and prepare a presentation explaining the economic importance of their sample.

Part C: Using teacher-selected information resources, students will conduct their own study of the three major types of rocks and then create a *graphic organizer* ([view literacy strategy descriptions](#)) such as a concept map to summarize information gathered and the understandings they developed. An example of such a concept map is the Rock Cycle Concept Map BLM. Using a computer program, students can create their concept map and add pictures similar to the ones in the Rock Cycle Concept Map BLM. Students should create this concept map in their science *learning logs* and document at least two resources used for each rock type. Students may present their findings and post the concept maps for a teacher-led summarizing class discussion.

Part D: Visit the [Rock Cycle](#) website (<http://www.minsocam.org/MSA/K12/rkcycle/rkcycleindex.html>) or use a picture of the rock cycle to identify the processes that change the rocks from one type into another. Have the students develop a science *story chain* ([view literacy strategy descriptions](#)) to summarize information and their understandings about the rock cycle. The science *story chain* can begin with the type of rock, but they must include the conditions or forces that must exist for one type of rock to change into another. The students are to write the

science *story chain* from the point of view of the rock, giving it a name and a personality. Put students in groups of four. On a sheet of paper, ask the first student to write the opening sentence of a rock cycle *story chain*. The story will describe the possible processes that created their rock sample. The student then passes the paper to the student sitting to the right, and that student writes the next sentence in the story. The paper is passed again to the right to the next student who writes the third sentence of the story. The paper is now passed to the fourth student who must finish the story with the rock type of their sample. All group members should be prepared to revise the story based on the last student's input as to whether it was clear or not.

### **Activity 3: Earthquakes and Volcanoes (SI GLEs: 19; ESS GLEs: 12, 13)**

Materials List: Internet access or teacher-selected research material on earthquakes and volcanoes, copies of Understanding Plate Motion (one per student), STARLAB Plate Tectonics Cylinder access (optional)

Part A: To begin the activity, students should generate questions they have about earthquakes and volcanoes based on a *Student Questions for Purposeful Learning, SQPL*, ([view literacy strategy descriptions](#)) statement (e.g., Plate boundaries are likely areas for earthquake and volcanic activity). The statement generated is related to the material that would cause students to wonder, challenge, and question. The statement does not have to be factually true as long as it provokes interest and curiosity, as in the example provided. Write the *SQPL* statement on the board. Next, students turn to a partner and think of one good question they have about the statement. As students respond, write their question on the board. A question that is asked more than once should be marked to signify it is an important question. When students finish asking questions, the teacher should contribute his/her own questions to the list in order to address concepts not asked by the students.

Next, provide students with copies of *Understanding Plate Motions* (<http://pubs.usgs.gov/gip/dynamic/understanding.html>). The web site leads to information on the Ring of Fire (Part B of this activity). If a computer is not available for research, students may be taken to the school library to research information for this activity or use teacher-selected reading resources. As students read the article, including the main boundary types and how they are used to explain earthquakes and volcanic activity and the effects of these processes, they should look for the answers to their questions. Ask the question from the *SQPL* list that is to be answered first. Allow students to confer with a partner before responding. Mark off questions as they are answered.

Part B: Students should develop a *graphic organizer* ([view literacy strategy descriptions](#), such as a concept map, to summarize information gathered from researching studies and theories about the *Ring of Fire* (<http://www.crystalinks.com/rof.html>) and understandings developed. Students can view the web page and its contents on a computer. Afterwards, they will discuss their *graphic organizer* with a partner and display the *graphic organizer*. The teacher will lead a class discussion to emphasize the key points found on *graphic organizers* by asking questions such as What information is similar on all the

*graphic organizers*? What did you find to be major causes of earthquakes? What factors determine a volcano's activity?

A unique compilation of activities focusing on plate tectonics, earthquakes, and volcanoes is available for the STARLAB Planetarium and the Plate Tectonics Cylinder, should a district have access to this technology.

#### **Activity 4: The Layers of Our Earth (SI GLEs: 14, 15; ESS GLE: 8)**

Materials List: teacher-selected reading material, cardstock (4 various colors), teacher-selected research material about Earth's layers and Earth's interior

Students should be given teacher-selected reading materials about Earth's layers to read. Afterward they should form groups of three or four. Tell them they will be called on randomly to come to the front of the room to be a team of *professor know-it-alls* ([view literacy strategy descriptions](#)) about Earth's layers. Students will construct a model of Earth's four layers from different colors of cardstock paper or other teacher-selected materials: an inner core, an outer core, a mantle, and a thin crust. Students will research dimensions of the Earth's layers to make models to scale. Through a jigsaw activity, each member of the group will serve as the "expert" for one of the four main layers of Earth's structure.

Divide students into "home groups" of four. Have students in each home group number themselves from one to four. All the ones will form one "expert group," all the twos will form the second "expert group," all the threes will form the third group, and all the fours will form the last group. Indicate that expert Group 1 will study the inner core, Group 2 the outer core, Group 3 the mantle, and Group 4 the crust. Have groups prepare by thinking up questions about the reading selection that require answers with vocabulary terms.

- What is the composition of the layer?
- What is the density and thickness of the layer?
- What makes the layer unique?
- How did scientists determine the information about this layer?
- What are the limitations of their model?

Students in each expert group will determine how and what information they will share with their home groups. After about 10 minutes, students will then move back to their home groups for expert presentations to their original group members. A common misconception often found in models of Earth's interior, as though it was cut in half, depicts the layers in perfect concentric circles. Students need to understand that each layer is of varying thickness and not one specific shape. Move around the room listening to questions from the other students and also ask questions. Remind the students that they are the *professor know-it-alls* and they should be able to answer the questions. Students should alternate until all students in each group have had a chance to serve as *professor*

*know-it-all*. Students asking the questions should hold the *professor know-it-alls* accountable for the correct answers.

**Activity 5: Convection Currents (SI GLEs: 7, 10, 12, 22, 23; ESS GLE: 10)**

Materials List: water; 1 hot air balloon picture; 1 hair dryer; 1 plastic grocery sack or trash bag; goggles; aprons; ring stand; two clear 2-liter soda bottles with the pouring spout cut off or some other large clear container; 1 baby food jar or small beaker; colored pencils or markers; 1 per group: large test tubes, source of heat (candle, Bunsen burner, etc.) match or lighter, plastic cup (hole cut in bottom large enough to accommodate the test tube when cup is upside down), test tube adjustable clamp or tongs, graduated cylinder, 20ml of light olive oil, 20ml of glycerin, red and blue food coloring, test tube clamp or container sized so that the test tube will sit in it upright, Scientific Process Record Sheet BLM

*Safety Note: Students should safety wear goggles when heating glycerin as there is a slight fire hazard when exposed to heat or flame. Above flash point, 199C (390F), vapor-air mixtures may cause flash fire. Use any means suitable for extinguishing surrounding fire. Water spray may be used to extinguish surrounding fire and cool exposed containers. Water spray will also reduce fume and irritant gases.*

Part A: Before starting the experiment, students should identify relevant safety procedures and equipment that will be necessary to conduct this scientific investigation. Students may be familiar with the phrase “convection currents” from listening to local weather forecasters discuss the formation of convection currents when warm and cold air masses meet in the atmosphere. They may not, however, be familiar with the fact that there are convection currents inside the Earth. In this activity, students will create a model to demonstrate these convection currents that are found inside the mantle of the Earth by layering a test tube with two liquids of different densities, the more dense liquid, glycerin, represents the superheated magma that wants to rise to the top. The less dense liquid, olive oil, represents another layer of magma that—in geologic terms—when cooled, becomes denser and cycles down to a lower level of the mantle where it will be superheated. Thus the principle behind hot matter rising and cool matter sinking is the basis for convection currents. The model shows hot glycerin becoming less dense and rising, allowing the cooler now denser red olive oil to sink. Bubbles of gas are formed and rise to the top much like gases inside the Earth’s crust rise and escape through volcanoes and other geothermal activity. Students should reflect upon the parallels modeled by the experiment and the actual activity related to convection currents within the Earth’s’ mantle and crust in their science *learning logs* ([view literacy strategy descriptions](#)). As students write, they should identify the difference between a description and an explanation of the activity.

Ask the students how heat affects the density of the air. Show a picture of a hot air balloon and then heat up the air inside of a plastic grocery sack with a hair dryer. After heating the air in the sack for about 20 seconds turn off the hair dryer and release the

sack. Lead the students into a discussion about heat and density (e.g., the heat from the hair dryer warms the air in the plastic grocery sack, causing the air mass to now be less dense than the air outside the plastic grocery sack), which should enable student understanding on the following key points: Hot air balloons rise because warm air is less dense than cold air. Similarly, warm water is less dense than cold water. Now direct the students to write a purpose question that addresses the influence heat has on the density of liquids. Guide students throughout the completion of the purpose question, hypothesis, and procedure sections of the Scientific Process Record Sheet BLM.

Procedure: Note- The following can be done as a teacher demonstration or as a group activity:

1. Place a large test tube inside the plastic cup that has been prepared and placed upside down on the table.
2. Measure out 20mL of glycerin syrup and carefully pour it into the large test tube.
3. Mix 20mL light olive oil and a few drops of red food coloring thoroughly in a container.
4. Carefully pour the 20mL of light olive oil/dye mixture into the large test tube containing the glycerin.
5. Fill a cup or beaker with room temperature water and set aside.

Hot over cold: Instruct students to put on their safety goggles and then light their heat source. Instruct students to gently remove the test tube from the plastic cup holder and secure the test tube clamp around it. Students should hold the bottom of the test tube over the heat source and note any observations as the densest material (glycerin) on the bottom heats up. After a period of time when the glycerin heats up, its density will change and it will begin to rise. The olive oil/red dye mixture will begin to slowly drop, as the heat does not directly affect its density while the glycerin rises to the top because its density is less than the oil/dye mixture, due to the heat. After the glycerin has risen to the top, remove the test tube from the heat source and slowly immerse it into the cup of room temperature water to cool off.

Have students complete the observation and conclusion sections of the Scientific Process Record Sheet BLM.

Part B: Cold over hot: This is a similar process to Part A, but uses hot and cold water. (Caution students to slowly lower the jar into the container, making sure it is not tilted.)

Procedure:

1. Fill one baby food jar with ice-cold water and dye it blue.
2. Place it in an open 2-liter bottle filled with warm water. The denser blue cold water stays in the baby food jar and the less dense warm water is confined to the top of the 2-liter bottle.
3. Fill a second baby food jar with warm water, dyed red.
4. Place it in another open 2-liter bottle with cold water; the denser cold water replaces the red warm water. The movement of warm and cold water inside the containers is referred to as the convection current.

In our daily life, currents can occur in oceans, like the warm Gulf Stream moving up north along the American Eastern seaboard. According to the theory of plate tectonics, Earth's surface (the rigid rocky layer of the lithosphere) is broken, or divided, into about a dozen "plates" that are moving relative to one another. These plates ride atop a part of Earth's mantle that is hot, dense, and partially molten (but not liquid). This part of the mantle is called the *asthenosphere* and moves as part of a convection cell.

Have the students use colored pencils or markers to record, and illustrate their observations in their science *learning logs*. Culminate the activity by holding a class discussion to review the results of the heating and cooling of materials and the effect it has on density.

**Activity 6: Plate Tectonics (SI GLEs: 1, 2, 13, 14, 15, 19, 33; ESS GLE: 9, 11)**

Materials List: materials provided by students for models, Plate Tectonic Summary Chart BLM (one per student), Plate Tectonic Model Rubric BLM (one per student group), Internet, computer software, library books, text book covering plate tectonics and plate movement

Students will work in groups of 3-4 to design, construct, and present a working model of one of the plate tectonic concepts from the Plate Tectonic Summary Chart BLM. Inform students well ahead of time of their assigned concept so they can begin thinking of ideas and collecting materials for the project. Reflect on Activity 5; have students develop an explanation of continental drift and sea-floor spreading processes from an historical viewpoint.

Groups should first work together to complete the Plate Tectonic Summary Chart BLM, using a variety of sources, such as the Internet, computer software, library books, text book, etc. They will use the Plate Tectonic Summary Chart BLM as a primary resource for their model. Students will be required to complete 7 tasks:

1. generate questions that can be answered through investigations,
2. record what materials will be needed to construct a model of a plate tectonic process,
3. construct the model,
4. answer questions,
5. demonstrate how it works,
6. explain how this process causes changes on Earth's surface, and
7. evaluate their model – identify problems in design and make recommendations for improvement.

Review the Plate Tectonic Model Rubric BLM with students and instruct them to review it often as they design their project. Students should bring their materials to school and construct their model in class. Upon completion, each group should present their model to the class. Student groups should evaluate their models, identify problems in design,

and make recommendations for improvement. The limitations of the model should be included in their presentation.

## Sample Assessments

### General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data-collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities via teacher observation of their work and lab notebook entries.
- All student-developed products should be evaluated as the unit continues.
- Student investigations should be evaluated with a rubric.
- For some multiple-choice items on written tests, ask students to write a justification for their chosen response.

### General Assessments

- The student will compare the layers of Earth with an apple or a cross-section of a hardboiled egg.
- The student will construct a timeline of the theory of plate tectonics and continental drift.
- The student will describe how convection currents might be the cause of plate tectonics.
- The student will construct a model of the rock cycle that includes the processes that show how rocks are changed.

### Activity-Specific Assessments

- Activity 1: The students will use the steps of mineral identification to identify unknown mineral samples. The students will work individually to conduct all tests.
- Activity 3: Given a map, students will plot the locations of earthquakes, volcanoes, and plate boundaries. Students should relate the features to the plate activity that occurs at these locations.

- **Activity 6:** Students' model of plate tectonics will be assessed using the Plate Tectonic Model Rubric BLM.

## Resources

### Weathering

- Hemler, Deb. *Whether It Weathers*. Adaptive Earth Science Activities. West Virginia Geological and Economic Survey, Publication ED-13. 1998

### Plate Tectonics

- *Historical Perspective of Plate Tectonics*. Available online at <http://pubs.usgs.gov/publications/text/historical.html>.
- *Plate Motion*. Available online at <http://pubs.usgs.gov/publications/text/understanding.html>.
- *Plate Tectonics*. Available online at <http://gpc.edu/~pgore/Earth&Space/platetectonics.html>.

### Minerals

- *Moh's Hardness Scale* <http://www.minerals.net/resource/property/hardness.htm>
- *The Rock Doctor*. <http://www.cobweb.net/~bug2/rock4.htm>
- *Minerals online*. This site can be used as a webquest instead of Activity 1 <http://volcano.und.edu/vwdocs/vwlessons/lessons/Minerals/Minerals1.html>
- *Mineral Identification*. <http://facweb.bhc.edu/academics/science/harwoodr/Geol101/Labs/Minerals/>
- *Mineral Identification – VIRTUAL LAB* [http://academic.brooklyn.cuny.edu/geology/leveson/core/linksa/mineral\\_invest\\_intro.html](http://academic.brooklyn.cuny.edu/geology/leveson/core/linksa/mineral_invest_intro.html) All instructions for using minerals identification with this virtual lab are online.
- *Mineral Identification Online Checking table*. [http://academic.brooklyn.cuny.edu/geology/leveson/core/wayne\\_web/mineral%20check/min\\_id\\_check.htm](http://academic.brooklyn.cuny.edu/geology/leveson/core/wayne_web/mineral%20check/min_id_check.htm) Students can go online and check their data to determine if they have the correct mineral or not.
- *Growing Crystals*. Available online at <http://trc.ucdavis.edu> <http://www.iit.edu/~smile/ch9008.html>.

### Rocks

- *Rock examples with descriptions of each rock and uses*. [http://www.sciencenetlinks.com/ebook/rocks2/rock\\_index.html](http://www.sciencenetlinks.com/ebook/rocks2/rock_index.html)
- *Rock identification key*. <http://www.rockhounds.com/rockshop/rockkey/index.html>
- *Rock Cycle*. Available online at [http://www.eos.ubc.ca/courses/eosc221/rock\\_cycle/rockcycle.html](http://www.eos.ubc.ca/courses/eosc221/rock_cycle/rockcycle.html).

### Other

- Adkins, Elsie. *And the Winner is . . .* Adaptive Earth Science Activities. West Virginia Geological and Economic Survey Publication ED-13. 1998.

**Grade 8  
Science  
Unit 3: Geologic History of Earth**

**Time Frame:** Approximately four weeks



**Unit Description**

This unit focuses on fossils and the evidence of past geologic eras that fossils provide. The methods used to understand the changes experienced by Earth and other planets since their formation are also emphasized. The activities in this unit are also intended to explore Earth's historical data and geological principles used to study Earth's composition, age, and processes that affect Earth's form.

**Student Understandings**

Students understand that Earth is always changing, yet ever the same, involving the processes that shape the surface today and throughout geologic time. Students learn that rock layers in outcrops can be correlated and read, revealing the geologic history of an area and the beginnings of life. Students develop an understanding that various types of geologic and biological evidence provide an awareness of the development of life.

**Guiding Questions**

1. Can students explain how scientists know what conditions existed on Earth long ago?
2. Can students describe the types of evidence that are available to scientists to interpret the history of Earth?
3. Can students describe how the relative age of a rock is determined?
4. Can students describe how geologists are able to discern the geologic history of a region by using rock layers?
5. Can students suggest how to correlate discontinuous rock columns from around the world?
6. Can students distinguish between relative and absolute dating and describe how actual geologic ages can be measured using known rates of radioactive decay?
7. Can students describe how certain fossils are indicators of ancient environments and how the evolutionary developments of life forms are inferred from the fossil record?

## Unit 3 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
<b>Science as Inquiry</b>	
<i>The following SI GLEs are embedded in the suggested activities for this unit. Additional activities incorporated by teachers may result in additional SI GLEs being addressed during instruction on the Fossil History unit.</i>	
3.	Use a variety of sources to answer questions (SI-M-A1)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
13.	Identify patterns in data to explain natural events (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
15.	Identify and explain the limitations of models used to represent the natural world (SI-M-A5)
16.	Use evidence to make inferences and predict trends (SI-M-A5)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
21.	Distinguish between <i>observations</i> and <i>inferences</i> (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
27.	Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1)
28.	Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
35.	Explain how skepticism about accepted scientific explanations (i.e., hypotheses and theories) leads to new understanding (SI-M-B5)
38.	Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)
39.	Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)
40.	Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7)
<b>Earth and Space Science</b>	
30.	Interpret a geologic timeline (ESS-M-B1)
31.	Compare fossils from different geologic eras and areas of Earth to show that life changes over time (ESS-M-B1)
32.	Interpret a timeline starting with the birth of the solar system to the present day (ESS-M-B2)
33.	Use historical data to draw conclusions about the age of Earth (e.g., half-life, rock strata) (ESS-M-B2)
34.	Apply geological principles to determine the relative ages of rock layers (e.g., original horizontality, superposition, cross-cutting relationships) (ESS-M-B3)

GLE #	GLE Text and Benchmarks
35.	Describe how processes seen today are similar to those in the past (e.g., weathering, erosion, lithospheric plate movement) (ESS-M-B3)
48.	Communicate ways that information from space exploration and technological research have advanced understanding about Earth, the solar system, and the universe (ESS-M-C8)
49.	Identify practical applications of technological advances resulting from space exploration and scientific and technological research (ESS-M-C)

Note to the Teacher: For this unit, have student maintain a science *learning log* ([view literacy strategy descriptions](#)). Each class session, present students with a *learning log* writing prompt. This can be at the beginning of class, requiring predictive thinking for that day's lesson or reflective thinking about what was learned in the previous class. Structure the prompts so students write for no more than five to seven minutes. Prompts can be related to specific content or new understandings.

### Sample Activities

#### Activity 1: It's Relative Dating, Just Not Your Cousin (SI GLEs: 13, 14, 16; ESS GLE: 31, 34)

Materials List: Who's On First Random Letters BLM (one per student group), Who's On First Fossils BLM (one per student group), Who's On First Fossils Key BLM

Part A: This activity, adapted with permission from the Denver Science Project at the Colorado School of Mines (<http://www.ucmp.berkeley.edu/fosrec/BarBar.html>), begins with a modified *SQPL* (Student Questions for Purposeful Learning) strategy ([view literacy strategy descriptions](#)). In groups of two, students should begin a sequencing activity with letters written on cards. The cards (Who's on First Random Letters BLM) are composed of nonsense letters that sometimes overlap other cards and are being used to introduce the students to the concept of sequencing. The cards should be duplicated, laminated, and cut into sets and randomly mixed when given to the students. Tell the students the letters "T" and "C" represent fossils in the oldest rock layer; they are the oldest fossils or the first fossils formed in the past for this sequence of rock layers. Allow students two minutes to sequence the cards. Each group should then write the order of their cards and also write a reason for the order. After the two minutes of challenge, give the students a clue about the sequence of the cards with reference to original horizontality (layers of sediment are usually deposited in horizontal layers). Write the *SQPL* statement on the board: "The Law of Superposition, which states that in an undisturbed horizontal sequence of rocks, the oldest rock layers will be on the bottom with successively younger rocks on top of these, helps geologists correlate rock layers around the world."

Next, ask students to turn to their partner and think of one good question they have about the statement. As students respond, write their questions on the board. A question that is asked more than once should be marked with a symbol signifying that it is an important question. When students finish asking questions, contribute your own questions to the list; this action will allow you to make sure important information is not missed by the students. Tell students to look carefully for the answers to their questions as they conduct this activity.

Guide the students to look for a card that “overlaps” card “TC.” Since this card has a common letter with the first card, it must go on top of the “TC” card. The fossils represented by the letters on this card are “younger” than the “T” or “C” fossils on the “TC” card which represents fossils in the oldest rock layer. Sequence the remaining cards by using the same process. When finished, students should have a vertical stack of cards, with the top card representing the youngest fossils of this rock sequence and the “TC” card at the bottom of the stack, representing the oldest fossils. After they have arranged the cards in order, write the sequence of letters (using each letter only once) on the board from youngest to oldest – MDXONBUAGCT. Please note that none of the letters in this sequence may be reversed and still be correct. The sequence must be exactly in the order as written. Remind students that these letters represent fossils in a rock layer and that one fossil next to another within a rock layer implies no particular sequencing; they both are approximately the same age as that particular rock layer. Also, point out that a letter does not reappear later in a sequence; once it disappears, it is extinct and cannot reappear later. If certain fossils are typically found only in a particular rock unit and are found in many places worldwide, they may be useful as index or guide fossils in determining the age of undated strata. After completing this section, ask students if they observed an answer to their question. Allow students to confer with a partner before responding. Check off questions that are answered. Continue this process until the entire activity is complete.

Part B: Give student groups the Who’s On First Fossils BLM and have them sequence the *fossil pictures* printed on “rock layer” cards in the same manner as they did the *letters* in Part A. You may want to color code each organism type (i.e., color the trilobites blue, etc.) before you laminate and cut the cards apart.

Sequencing the rock layers will show the students how paleontologists use fossils to give relative dates to rock columns from around the world. The oldest rock layer is marked with the letter “M” in the lower left-hand corner. Tell the students the letters on the first set of Who’s on First cards have no significance to the sequencing procedure and should be ignored. Students should find a rock layer that has at least one of the fossils found in the oldest rock layer. This rock layer would be younger, as indicated by the appearance of new fossils in the rock stratum. Remind them that extinction is forever. Once an organism disappears from the sequence, it cannot reappear later. Have them arrange the cards from oldest to youngest, with the oldest layer on the bottom and the youngest on top. The word “organism” is spelled when the sequence is correct. Use Who’s On First Fossil Key BLM to assess student work in Part B.

Once students begin to grasp the concept of The Law of Superposition and "relative" dating, they can extend their knowledge of geologic time by exploring radiometric dating and developing a timeline of Earth's history. Return to the list of questions generated in Part A to check which ones may still need to be answered. Use the teacher-selected readings or own knowledge to supply answers. Remind students they should ask questions before they learn something new, and then look for answers to their questions. While collecting the cards from the students, students can then complete the analysis questions from Who's on First Fossil BLM.

**Activity 2: Getting to the Core of it (SI GLEs: 13, 14, 15, 16, 19; ESS GLE: 34, 35)**

Materials List: 1 or 2 bags of "bite-size" candy bars such as Snickers® Brand, Milky Way® Brand, Mounds®, Reese's Peanut Butter Cup® (1 bar for each student); paper plates; Getting to the Core of it BLM (one per student); string; 3 inch cut clear plastic soda straw (1 per student); wet wipes (optional for clean-up); metric ruler with millimeters; Getting to the Core of it Answers BLM; science learning logs

*Note: Teachers should be aware of and address any students with allergies to these foods before conducting this activity.*

Part A: Give each student a copy of Getting to the Core of it BLM and review the basic principles of relative dating from Activity 1 – in an undisturbed rock sequence, the oldest rocks are on the bottom. Introduce the principles of *cross-cutting relationships* and *unconformities*: an unconformity is a break in the rock record caused by erosion and/or nondeposition of rock units; the disrupted rock strata are older than the cause of the disruption. Students should be able to describe how processes seen today are similar to those in the past, which is also known as uniformitarianism. Give each student two candy bar samples – they can be the same or different; it is important to tell the students not to eat the "rocks." Have students take a "core sample" by carefully and steadily drilling a straw into their candy bar. They should place their thumb at the top of the straw as they twist the "drill" into the "rock." Then ask them to complete the questions on the Getting to the Core of it BLM. Students will draw two separate cores (profile) of two different candy bar "rocks" and answer the questions from the Getting to the Core of it BLM in their science *learning logs* ([view literacy strategy descriptions](#)). The teacher should use the Getting to the Core of it Answers BLM to guide them with their answers.

Part B: Host a think-pair-share activity that involves giving each group of students a question like the ones below. Give students about a minute to think and record their answers in their science *learning logs*. The students turn to a partner and share and compare their ideas and/or drawings. Then each pair joins another and shares their ideas in a small group; each time identifying the limitations of the models. These groups are then ideal to begin work together providing specific reasons as to why they chose that answer. The students should be able to answer the following questions:

- What are the layers made of?
- Are there any repeated layers?

- Which layer(s) or feature(s) may have formed first?
- How does this model simulate coring in the real world, and how can it be improved?

**Activity 3: Reconstructing Gondwana (SI GLEs: 13, 14, 16, 21, 38; ESS GLE 31)**

Materials List: Gondwana Continents BLM, scissors, Gondwana Student Instructions BLM, Internet connection, science learning logs

Part A: Begin by presenting students with this *SQPL - Student Questions for Purposeful Learning* ([view literacy strategy descriptions](#)) statement: “Coal and oil have been found in frozen Antarctica.” Students should turn to a partner and think of one good question they have about the statement. As students respond, write their questions on the board. Tell students to listen carefully for the answers to their questions as you read the online article found at <http://www.parks.tas.gov.au/factsheets/geodiversity/Gondwana.pdf> (used with permission by the Utah State Office of Education). Pause periodically and ask students to reflect on which questions have been answered. They may write answers to their own *SQPL* questions in their science *learning logs* ([view literacy strategy descriptions](#)).

Part B: Tell students that the understanding of plate tectonics began from the work of the German scientist Alfred Wegener and Alexander Du Toit, a South African geologist. In early 1915, the Alfred Wegener developed a theory that the continents once formed a giant supercontinent that Wegener called Pangaea. He speculated that Earth took this form about 245 million years ago, during the Triassic period of the Mesozoic era. (The Mesozoic is the era in which dinosaurs lived.) A few years after Wegener proposed his theory, Alexander Du Toit further theorized that Pangaea divided into two supercontinents 205 million years ago. Du Toit called the northern supercontinent Laurasia and the southern one Gondwana. The scientists used many kinds of evidence to advance their theories. They found similar fossil remains of plants and animals on different present-day continents. The scientists hypothesized that the continents were once connected. From the early idea found in this activity, with the evidence and information gathered through exploration and the use of instruments scientists have advanced the understanding of Earth processes.

Tell students that in this activity they will follow steps to model those of Wegener and Du Toit to see if fossil evidence supports the theory that one supercontinent divided into two. Students will focus on Gondwana, the supercontinent that includes continents now called South America, Antarctica, Australia, Africa, Madagascar, and India.

Pass out the Gondwana Student Instructions BLM and Gondwana Continents BLM and instruct students to complete the activity as written. Before the students cut out the continent outlines, they will label and show supporting evidence of Gondwana on each continent (see Gondwana Student Instructions BLM). As a challenge have the students rebuild Laurasia with the remaining continents (see Resources).

Host a whole-class discussion with the following questions:

1. What is the difference between an observation and an inference? (*Examples should relate to historical scientists and the development of plate tectonics.*)
2. Scientists have found *Mesosaurus* fossils on the east coast of the southern tip of South America and the west coast of South Africa. Give evidence to support your ideas. (*Even though we know this animal could swim, the presence of Mesosaurus fossil remaining in two places supports Wegener and Du Toit's theory.*)
3. Do you think that the breakup of Pangaea into Gondwana and Laurasia affected organisms originally living on Pangaea? Do you think that the breakup of Gondwana into the southern continents affected the organisms living in Gondwana? Give evidence to support your ideas. (*The breakup might trigger organisms to adapt to the new climates. If they remain in the original climate, then the breakup might cause changes in the food web, which also bring about adaptations.*)
4. How does this reconstruction help explain the evidence of glaciers in Africa where no glaciers currently exist? (*Africa was once in the upper latitudes, near the poles*)
5. Why do the continents not fit together exactly? What conclusion can be made about how the continents' coastlines changed? (*The true edge of a continent is around the continental slope; the junction between continental and oceanic crust usually occurs below sea level. The processes that were in effect still are working.*)
6. Scientists have evidence that *Glossopteris* was found in what is now India, Antarctica, Australia, and Madagascar. What does this tell you about *Glossopteris*? What can you conclude about the climate and environment of Gondwana? (*It lived in cool to warm climates with a lot of moisture.*)
7. Based on the geologic past, we can assume that Earth is always changing. What modern-day evidence supports this idea? Guided by the current direction of plate movement, predict the position of the continents in the next 100 million years. (*El Nino, global warming, and the increase in strength and number of tropical storms are some examples. The Paleomap Project, online at <http://www.scotese.com/future.htm>, shows an image of Earth's projected landscape 50 million years from present day.*)

As a culmination activity, show students the animation from the Exploratorium website (<http://www.exploratorium.edu/origins/antarctica/ideas/gondwana2.html>) which shows the breakup of Gondwana with a geologic timeline.

#### **Activity 4: Earth's Timeline (SI GLEs: 6, 14, 15; ESS GLEs: 30, 31, 32)**

Materials List: calculators (one per student), metric ruler, calendar pages, adding machine tape

Discuss with students the concept of relative age, perhaps asking what is the oldest thing that they know of, which now exists. Engage the students in a discussion of the unit of measurement of one million. Compare examples of what a million is to a billion. Ask the students if dinosaurs lived millions or billions of years ago. What lived before the dinosaurs?

Students will create a scaled timeline of the geologic history of Earth from the birth of the solar system to the present day, showing time periods, and drawing and labeling major developments/events, fossils in different geologic eras, and illustrations that show how life changed over time. Students can choose to present the information on a yearly calendar or students could create the geologic time on adding machine tape.

The model of choice should include first microscopic life (algae), first multi-cellular life (fish), formation of Pangaea, emergence and disappearance of dinosaurs, age of the mammals, appearance of humans, etc. Students will first need to sequence the events and then research to find the absolute time needed to determine the position on the timeline. If students choose a calendar, they should determine the month, day, and time each of the major developments occurred. (See the Kentucky Geologic Survey website [http://www.uky.edu/KGS/education/calendar\\_time2a.htm](http://www.uky.edu/KGS/education/calendar_time2a.htm) for instructions on how to convert geologic ages into a calendar year.) If students choose the linear timeline on adding machine tape, then decide on an appropriate scale that will allow the model to fit in the classroom such as 1 million years equals 1 millimeter. Students should be encouraged to identify and explain the limitations of their models.

**Activity 5: Half of What? (SI GLEs: 16, 22, 27, 28; ESS GLE: 33)**

Materials List: beans (2 colors); zip top bags; permanent marker; adding machine tape; Radioactive Decay/Half-life Student Sheet Answer Key BLM; Radioactive Timeline Key BLM; (one for each group): shoebox, 100 paper disks of a color, 100 paper disks (a shade of the first 100 paper disks), graph paper, graphing calculator, Paper Disk Radioactive Material BLM, Paper Disks Daughter Material BLM, Radioactive Decay/Half-life Student Sheet BLM, Radioactive Decay/Half-life Conclusion BLM, Radioactive Decay/Half-life Chart BLM, Radioactive Timeline BLM, calculator

Part A: Teacher preparation: The teacher will need to copy Paper Disk Radioactive Material BLM onto colored paper and Paper Disk Daughter Material BLM onto a similar colored paper and cut 100 paper disks of each BLM. For example, 100 disks are cut from bright yellow paper and 100 disks are cut from pastel yellow paper.

The geologic timeline is created using a variety of evidence and provides a sequence for the events in Earth's past. Studies of rock strata using the Law of Superposition have also given geologists important clues to the relative ages of rock layers, but it works best when rocks have not been affected by tectonic motion.

Ask the students the following questions:

- How do geoscientists determine which layer is oldest if the rock layers have been overturned or in discontinuous rock columns?
- What is meant by *decay*?
- What does the term *half-life* mean?

Many other methods of determining the age of rocks exist, such as the technique known as radioactive decay. Radioactive decay is defined as a process in which some isotopes break down into other isotopes and particles. Half-life is defined as the time it takes for half of the radioactive (parent) material to decay into a daughter material. By knowing the rate at which these isotopes decay, scientists are able to estimate the age of a rock or fossil. Modern calculations, using the technique of radioactive dating, tell us that the Earth is actually over 4 billion years old. For example,  $U^{238}$  (uranium with 92 protons and 146 neutrons in its nucleus) is radioactive. It decays into  $Pb^{206}$  (lead with 82 protons and 124 neutrons in its nucleus) with a half-life of 4.5 billion years. The decay of a nucleus is a random event, like popcorn popping on the stove top; the moment when one particular kernel will pop cannot be predicted. All that can be said is that a particular uranium nucleus has a 50% chance of decaying during one half-life.

It is important for students to understand that this method gives scientists a logical and empirical approach to determining age. The more data that supports investigations in science, the better the chances are of solving problems and making discoveries. Students should recognize that scientists usually begin an investigation with a review of the work of others. Ask students why they think this is the case.

Students will explore the concept of radioactive decay in the following activity. Using a shoebox and 100 disks of two different colors, students will shake the box for 5 seconds to represent one half-life for the radioactive (parent) element. Prepare 100 disks of one color (radioactive parent material) and 100 disks of a similar color (daughter material) in separate zip top bags for each group. The students place 100 paper disks radioactive (parent) material of the same color into the box with the “X” side down. After putting the shoebox lid on, the students should shake the box for 5 seconds. The box should be opened carefully, and all the paper disks that flipped to the “X” side should be removed and the number of disks remaining in the box should be recorded on the Radioactive Decay/Half-life Chart BLM. Replace the number of removed paper disks radioactive (parent) material with the same number of paper disks daughter material. The box top should be replaced and the process should be repeated until all the radioactive (parent) disks have been flipped and replaced with the daughter disks.

The Radioactive Decay/Half-life Student Sheet BLM provides instructions on how to use a graphing calculator. And Radioactive Decay/Half-life Student Sheet Answer Key BLM provides answers to questions and a sample graph the students should achieve. Students can also graph the information from their chart, and cooperative groups should compare their results. If students elect to draw the graphs, suggest to the students that they use different colors for lines on their graphs to make them easier to analyze. Students should discover that after each shake, as they remove the radioactive disks and replace them

with daughter disks, there is a definite pattern of decay. Students discover that it was impossible to predict when or how many disks would decay. Students' graph will show a definite decrease.

Guide a discussion allowing student discovery of the pattern of half-life and decay. In analyzing the data collected, students should be able to distinguish between observations and inferences. Students should research the terms *absolute age*, *relative age*, *alpha and beta decay*, *radiometric dating*, and *radiocarbon dating* and record their findings in their science *learning logs* ([view literacy strategy descriptions](#)).

Part B: In this activity (modified with permission from the Center for Integrating Research & Learning at the National High Magnetic Field Laboratory, original activity by Richard McHenry and David Rodriguez) students will correlate data that identifies the age of different rocks layers and the appropriate use of each parent-daughter pair in the dating of Earth's age, rocks, or other events in Earth's history.

Teacher preparation: Lay out a length of adding machine tape that will run the length of three sides of the classroom; leave one side of the room open. Mark one end of the tape "The Present" and the other end "4.6 billion years ago" (4.6 bya). Halfway between "The Present" and "4.6 bya," mark "2.3 bya." Halfway between the "The Present" and "2.3 bya," mark "1.15 bya." Halfway between "4.6 bya" and "2.3 bya," mark "3.45 bya." Fill the zip top bags with a variety of combinations that total 100 beans, such as the combinations listed on the Radioactive Timeline BLM. (The bags should be large enough that the students can count the beans without opening the bag.) The bags can have other ratios of beans as long as the total number of beans equals 100. The dark beans represent the daughter atoms and the light beans represent the radioactive parent atoms. As an option for higher level students, make the total number of beads in each bag different and have them calculate the percent decay. Label the bags with a permanent marker: "Rock A," "Rock B," "Rock C," etc. (see Radioactive Timeline Key BLM).

Give each student pair a bag of beans. Identify the radioactive and daughter atoms. The students should count the beans of each color in their bag. Ask them to examine the chart on the Radioactive Timeline BLM for the scenario they are given. They will multiply the length of the half-life by the number of half-lives their rock underwent, and they then stand under the position on the time line that best corresponds to the age of their rock. The Radioactive Timeline Key shows the answers.

For the first scenario, tell the students the radioactive-daughter pair is Uranium-235 and Lead-207; it has a half-life of 704 million years. With this half-life all of the students will be on the timeline. For example, the student with the Rock B bag will be at the 704 million mark because  $\frac{1}{2}$  of the radioactive original material decayed. The student with the Rock A bag will be nearest to "The Present". For the second scenario the radioactive-daughter pair can be Carbon-14 and Nitrogen-14 which has a half-life of 5730 years. With this scenario, all of the students will be crowded near "The Present". A third scenario can be carried out using the radioactive-daughter pair Uranium-238 and Lead-206 which has a half-life of 4.5 billion years. In this scenario some of the students will see that they are in the future and do not have a place on the timeline. More scenarios

can be completed so that all students participate (see Half-life calculator under Resources).

The students should be able to explain why they are standing in that spot on the timeline. After each scenario, discuss the appropriate uses for each radioactive-daughter pair while the students are on the timeline. Students will see that Carbon-14 would not work for dating Earth's age and that Uranium-238 would not work well for dating fossils that are only thousands of years old.

**Activity 6: What Came First? (SI GLEs: 3, 13, 16, 39, 40; ESS GLEs: 30, 33, 35)**

Materials List: eight to ten illustrations or images that reflect change over time in fashion, car design, housing styles, etc.; Louisiana Fossils BLM; Geologic Timeline BLM

Part A: Studying Earth's history is difficult for several reasons. For one thing, geologic time covers billions of years; in addition, geologic processes continue to change the surface features on Earth. Clues left in fossils or rock layers have helped scientists understand what happened in Earth's history, as well as establish an approximate time frame for these events. The following activity helps the students visualize how this is done and serves as a precursor to understanding relative dating.

Ask students to collect eight to ten illustrations or images that reflect change over time in fashion, car design, housing styles, or another topic of interest and explain how the change over time shows progression that can be understood by those who review the collection. Student understanding of the process should be advanced through discussion, asking what clues scientists would look for when examining actual fossils and tracing fossils found scattered in different locations.

Part B: Provide students a copy of the Louisiana Fossils BLM, the Geologic Timeline BLM, and a copy of a geologic map of Louisiana (black and white map: <http://www.lgs.lsu.edu/deploy/uploads/gengeolbw.pdf>, color map: <http://www.lgs.lsu.edu/deploy/uploads/gengeomapla.pdf>). A result of sediments deposited by river systems, Louisiana's formation can be dated back about 50 million years. Over time an ancient river system carried sediment here from the heartland of the North American continent and piled it on the rim of the Gulf of Mexico. Organic matter from highly productive marine waters is deeply buried and far offshore has turned into petroleum. During dry periods, large beds of salt were laid down through evaporation of the seas. The geologic maps of Louisiana (link provided above) show evidence of these changes. The Holocene Alluvium of the Mississippi River covers much of the state. As the Geologic Timeline BLM shows, the Holocene represents only the last 10,000 years of Earth's history. The river changed course many times over the coastal region, dumping its sediment and creating different deltaic lobes. Human engineering has limited this natural land-building process to the Atchafalaya Delta. As a result of our efforts to levee the river and natural subsidence, coastal Louisiana is sinking, starved of fresh material.

With this information, students will determine what Louisiana looked like, i.e., geological features and conditions, at the time the organisms shown on the BLM were living. Students should describe how some dynamic processes, such as erosion and weathering, might have contributed to the land changing. Remind students that the processes at work today are similar to those in the past. Allow students some research time to investigate the formation of the salt domes that give shape to places like Avery Island. Students should determine how discoveries made by scientists identify Earth events that have shaped and affected our environment. Have the students predict trends for Louisiana's future based on their knowledge of geologic events and processes. Students should include projections of sea level change according to current global warming studies.

**Activity 7: Technology and Today's Understandings of Earth (SI GLEs: 8, 14, 19, 28, 35, 38, 39, 40; ESS GLEs: 48, 49)**

Material List: Internet Access

Challenge the students to identify major discoveries and events related to the Antarctic Geologic Drilling Program (ANDRILL <http://www.andrill.org/>). The students should recognize that scientists usually begin their research by reviewing the current literature and work of others in that field. The ANDRILL Program recognizes that efforts to understand how the role of Antarctica's climatic, glacial, and tectonic history over the past 50 million years plays and played in the global climate system. Future scenarios of global warming require guidance and constraint from past history that will reveal potential timing frequency and the site of future changes.

Students should read the interactive online article *The Technology Behind the Drill Rig* found at <http://andrill.org/technology/rig> and utilize the literacy strategy *GISTing* ([view literacy strategy descriptions](#)) with this publication. The teacher models *GISTing* with the first paragraph of the article which follows below:

“The ANDRILL drilling system is based around a drilling rig constructed by UDR in Brisbane. This type of rig is commonly used in minerals drilling, but has been customized for ANDRILL scientific requirements and for Antarctic conditions.

Customization includes: Reconfiguration of the main winch for a double line pull to deploy sea riser casing, which weighs up to 30 tons. Tide compensation to allow for up to 1.5 meters of vertical tidal movement of the ice shelf or sea-ice platform. Enclosure to provide a warm environment for workers and equipment on the drill floor. Separation of the rig hydraulic power pack (in an insulated container) and the drill mast and winches to provide the best heated location.”

*Class GISTing statements for the first paragraph above:*

1. ANDRILL uses drilling rigs customized for Antarctic conditions
2. Main winch holds a sea riser casing weighing up to 30 tons
3. Tide movement up to 1.5 meters of vertical movement is compensated

4. Enclosure provided to warm workers and equipment on the ice
5. Drill mast and winches are separated from rig hydraulic power pack to keep the pack warm

Direct the students to write a summary of the first sentence using only 15 words. Allow students to work in pairs. Afterward, elicit the various first-sentences from several pairs of students and display the version that the whole class agreed upon. The teacher and the *GISTing* students continue the same process for the remaining sentences of the paragraph. As the students read the new sentences, they revise their original *GISTing* but keep it within the 15-word limit. By the teacher conducting the *GISTing* lesson with the students, the teacher is able to model and clarify the process throughout, until a final acceptable *GISTing* is crafted for the entire paragraph. Further practice with *GISTing* should occur until students are competent with the process and can readily form mental *GISTing* of paragraphs and larger sections of text.

Students should realize that the advances in science must undergo a great deal of scrutiny and skepticism from the scientific community. Students should research tools of technology that have advanced understanding of historical Earth and oceans. Have the students compile a list of “spin-offs” that are present in our world today that may have resulted from technological advances. Students should recognize that while using scientific processes and technology, people can solve problems, make discoveries, and change human lives.

As a result of the discoveries and benefits of technology that the students identified, ask them to write an evaluation of how the impact of ANDRILL’s research has affected scientific thought, society, and the environment.

## Sample Assessments

### General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data-collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities via teacher observations of their work and lab notebook entries.
- All student-developed products should be evaluated as the unit continues.
- Student investigations should be evaluated with a rubric.

- For some multiple-choice items on written tests, ask students to write a justification for their chosen response.

### General Assessments

- The student will interpret and provide the relative sequence of geologic events illustrated when provided with a cross section of rock layers.
- Given information on the number of radioactive atoms in a rock formation or substance, the student will determine the number of half-lives and provide an age for the material.
- The student will sequence the appearance and evolution of life forms as indicated on the geologic timeline.
- The student will write in his/her journal about taking a trip to the geologic period found on the geologic timeline.
- The student will describe the sequence of events that led to the formation of the solar system.
- The student will identify factors that would be necessary for life to exist on a planet in a distant solar system.

### Activity-Specific Assessments

- Activity 1: The student will interpret a model of Earth's crustal layers. Students should be able to explain the Law of Superposition and sequence the layers according to age.
- Activity 3: Students will correctly mark the landmasses, construct Gondwana, and participate actively in the final class discussion.
- Activity 6: Given a generalized geologic map of Louisiana and a geologic timeline, the student will determine the ages of the state's geologic features.

### Resources

#### Geologic Timelines

- GEMS *Life Through Time*.
- *Geologic Time Scale*. Available online at *Enchanted Learning* - <http://www.enchantedlearning.com/subjects/Geologictime.html>
- *The Geologic Timeline* - <http://gallery.in-tch.com/~earthhistory/geologic%20timepage.html>
- *The Geologic Time Line* - <http://www.sdnhm.org/fieldguide/fossils/timeline.html>
- *USGS Earth and Rocks Age*. Available online at <http://pubs.usgs.gov/gip/geotime/age.html>

- *USGS Historical Perspective of continents. Available online at <http://pubs.usgs.gov/gip/dynamic/historical.html>*
- *Half-life Calculator <http://www.hse.ubc.ca/rad/calc/calcframe.htm>*

#### Fossils

- *Fossils Rocks and Time <http://pubs.usgs.gov/gip/fossils/contents.html>*
- *Fossils and Fossil Collecting - <http://web.ukonline.co.uk/conker/fossils/>*
- *GEMS Stories in Stone.*
- *Rocks and Layers - <http://pubs.usgs.gov/gip/fossils/rocks-layers.html>*
- *Louisiana Geological Survey <http://www.lgs.lsu.edu>*
- *Water, Stones & Fossil Bones, NSTA Publication.*
- *Paul V. Heinrich, Louisiana Geological Survey, home page <http://members.cox.net/pyrophyllite/>*

#### Antarctica Facts and Its Roll in Geologic Time

- *Antarctica <http://www.andrill.org/about/antarctica>*
- *LSU's Museum of Natural Science [http://appl003.lsu.edu/natsci/education.nsf/\\$Content/Experience+Antarctica+Activities?OpenDocument](http://appl003.lsu.edu/natsci/education.nsf/$Content/Experience+Antarctica+Activities?OpenDocument)*
- *Exploratorium's from McMurdo to the South Pole <http://www.exploratorium.edu/origins/antarctica/index.html>*
- *Helpful links put together by ANDRILL <http://www.andrill.org/iceberg/educators/links/index.html>*

#### Coring

- *Antarctic Drilling Program <http://www.andrill.org/iceberg/index.html>*
- *Science Daily article <http://www.sciencedaily.com/releases/2004/06/040611080100.htm>*
- *Skittle Cores [http://www.bowserlab.org/skittlecore/lesson\\_plan.html](http://www.bowserlab.org/skittlecore/lesson_plan.html)*

**Grade 8  
Science  
Unit 4: Landforms and Topography**

**Time Frame:** Approximately five weeks



**Unit Description**

This unit focuses on human actions and natural processes that shape the landforms of Louisiana, with explanations of how weathering and erosion agents affect Earth's surface. Reading topographical maps and the topography of the continents and ocean floor are also addressed.

**Student Understandings**

Students should understand that the landforms and coastal areas of Louisiana present evidence of natural processes as well as the influences of human actions. Students learn that both mechanical and chemical weathering account for significant changes on Earth's surface. Students develop an understanding of the role of organic processes in soil formation and the relationship between plant types and soil compatibility of soil. They should understand the concept of relief by using and creating topographical maps. Students will compare and contrast ocean floor features to those found on the continents.

**Guiding Questions**

1. Can students describe the forces that have formed and shaped Louisiana?
2. Can students describe weathering processes and their agents?
3. Can students describe erosion processes and identify preventative measures?
4. Can students explain how soil is formed?
5. Can students interpret contour lines and topographic profiles?
6. Can students describe factors that have impacted Louisiana's coastal region?

**Unit 4 Grade-Level Expectations (GLEs)**

<b>GLE #</b>	<b>GLE Text and Benchmarks</b>
<b>Science as Inquiry</b>	
<i>The following SI GLEs are embedded in the suggested activities for this unit. Additional activities incorporated by teachers may result in additional SI GLEs being addressed during instruction on the Louisiana Landforms unit.</i>	
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
3.	Use a variety of sources to answer questions (SI-M-A1)
5.	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
10.	Identify the difference between description and explanation (SI-M-A4)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
13.	Identify patterns in data to explain natural events (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
15.	Identify and explain the limitations of models used to represent the natural world (SI-M-A5)
16.	Use evidence to make inferences and predict trends (SI-M-A5)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
20.	Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
23.	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
25.	Compare and critique scientific investigations (SI-M-B1)
31.	Recognize that there is an acceptable range of variation in collected data (SI-M-B3)
33.	Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
34.	Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5)

GLE #	GLE Text and Benchmarks
36.	Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5)
<b>Earth and Space Science</b>	
14.	Distinguish between chemical and mechanical (physical) weathering and identify the role of weathering agents (e.g., wind, water, ice, gravity) (ESS-M-A4)
15.	Illustrate the role of organic processes in soil formation (ESS-M-A4)
19.	Determine the results of constructive and destructive forces upon landform development with the aid of geologic maps of Louisiana (ESS-M-A7)
20.	Describe how humans' actions and natural processes have modified coastal regions in Louisiana and other locations (ESS-M-A8)
21.	Read and interpret topographic maps (ESS-M-A9)
22.	Compare ocean floor topography to continental topography by using topographic maps (ESS-M-A9)
28.	Use historical data to plot the movement of hurricanes and explain events or conditions that affected their paths (ESS-M-A12)
<b>Science and the Environment</b>	
51.	Analyze the consequences of human activities on global Earth systems (SE-M-A4)
52.	Describe the relationship between plant type and soil compatibility (SE-M-A9)
53.	Distinguish among several examples of erosion (e.g., stream bank, topsoil, coastal) and describe common preventative measures (SE-M-A10)

### Sample Activities

#### **Activity 1: Shaping the Land: Constructive and Destructive Forces (SI GLEs: 13, 15, 19, 23; ESS GLE: 19, 20, 28; SE GLE: 53)**

Materials List: Internet, computer projector, Vocabulary Self-Awareness Chart BLM, science learning logs, trays (ex: cookie sheets, foam), safety goggles, wax paper, sand, gravel, straws, water, other student chosen materials, two buckets (one supply and one catch), two pieces of plastic hose, two screw clamps, a stream table (a large plant tray or other long flat object can be used in place of a stream table), a box or large object to elevate the supply bucket, sand, blocks of wood, large spoon or spatula to set up a stream table, instant coffee, salt, rice, paper plates, spray bottles with water, blank hurricane tracking map (see Resources for printable maps), aerial maps, satellite maps or geologic maps of Louisiana

*Safety Note: Students should wear safety goggles when manipulating sand in stream tables. Consider holding class outdoors where students can more fully explore their task of moving sand without touching it.*

Part A: During this unit (natural processes shaping land), have students maintain a *vocabulary self-awareness chart* ([view literacy strategy descriptions](#)) utilizing the Vocabulary Self-Awareness Chart BLM. Begin by identifying target vocabulary. Provide a list of words to students at the beginning of this part of the unit and have them complete a self-assessment of their knowledge of the words. Do not give students definitions or examples at this stage. Ask students to rate their understanding of each word or law with either a “+” (understand well), a “√” (limited understanding or unsure), or a “-” (don’t know). Because students continually revisit their *vocabulary self-awareness charts* to revise their entries, they have multiple opportunities to practice and extend their growing understanding of key terms related to the topic of natural processes that shape Louisiana’s land.

Engage the students in a discussion about sediments. Generate a list of as many types of sediment as the students can identify. Ask students how sediments move from one place to another. Show students the online video (<http://www.nola.com/speced/lastchance/multimedia/flash.ssf?flashlandloss1.swf>) that depicts the rise and fall of the Louisiana coastline. Flash software is required, but it can be downloaded for free at the site above. Powered by the force of gravity, the world's rivers deliver about 20 billion tons of loosened rock and soil to the oceans each year. Since the Pleistocene period, redeposited sediment has gradually increased the size of the Mississippi River Delta as a result of this process. But over the past several decades, the coast of southern Louisiana has been losing rather than gaining land. After watching the online video, host a whole class discussion to answer the following questions:

1. How many different features of the Mississippi River Delta can you distinguish in these images?
2. Rivers are powerful agents of erosion and deposition. What do the satellite images show about the river delta and the way it has likely changed the shape of the coast?
3. How has human intervention and management of the river affected the delta over the past century? List two of the pros and cons.
4. Describe the impact of Hurricane Katrina on the Mississippi River Delta.

PART B: Discuss the effects of hurricanes on Louisiana’s coastline. Divide the class into groups of four. Each student in a group will plot a different hurricane that formed during the season or use data from the previous season (four hurricanes total). Online hurricane tracking data is available at Atlantic’s Hurricane Track Map and Images website (<http://fermi.jhuapl.edu/hurr/index.html>). Using NASA’s Observatorium website, *A Fierce Force In Nature – Hurricanes* (<http://observe.arc.nasa.gov/nasa/earth/hurricane/creation.html>), students should describe the level, damage, recovery, lessons learned, and changes that result from a hurricane’s impact on society and the environment. Students will then collect data on the hurricane provided using teacher-selected resources. After the data has been collected, students will share the data with their group and look for patterns between the four hurricanes, describe and record them, and present their findings to the class.

Part C: Provide students with trays, wax paper, sand, gravel, safety goggles, and investigative materials such as straws, water, or other items that students may request that are reasonable in solving the task. Students are to put a piece of waxed paper in the tray or on the table and place a small pile of sand and gravel on the paper. Tell them to devise ways of moving the sand from one place to another without touching it. Instruct them not to move the sand or gravel beyond the edges of the wax paper. Pose these questions to them: How many different ways can you move the mixture? Do you think nature could move these sediments in the same way?

Conclude the exploration activity with a class discussion by having students identify the methods they used for moving the sand and gravel, such as flushing it with water, blowing on it, tilting the surface on which it is lying, or taking another object and pushing it. Continue discussion to elicit student understanding that air, water, and gravity are forces that contribute to erosion.

Part D: The teacher must decide if this part of the activity will be conducted by student groups or by teacher demonstration. Ask students, “How does slope affect the flow of a stream?” If the activity will be conducted by students, then provide each group of 4-6 students with supplies for a stream table. They are to place the sand about 4 cm deep at one end of the stream table and then smooth out the sand and slope it down toward the other end of the stream table, which will be a reservoir. By using the screw clamp on the supply hose, students will adjust the flow of water to about 5 ml/second (about the amount from a slow running faucet).

Students are to place one or two blocks of wood under the stream table at the end where the sand is deepest and allow the water from the hose to flow onto the sand and form as a stream channel. They are to observe, describe, and sketch the stream channel that forms in their science *learning logs* ([view literacy strategy descriptions](#)). Next, students are to remove the blocks that were placed under one end in the previous step and smooth out the sand. (Remind students not to make the reservoir end higher than the other end of the stream table.) They are to allow water to flow onto the sand and form a stream channel as before. They are to observe, describe, and sketch the stream channel that forms. Be sure that the students identify and explain the limitations of their stream table models in studying constructive and destructive forces.

After the students have had enough time to observe their stream channels and make sketches, have them compare their sketches to streams or rivers found on aerial maps, satellite maps, or geologic maps of Louisiana. Students should also consider how areas of landform construction and destruction in the students’ stream tables compare to those found near Louisiana waterways (as seen on maps).

Students are to respond to the following questions in their science *learning logs*:

- How could the flow of water be increased?
- How could the flow of water from the supply bucket be slowed down?
- Describe the channel that was formed when the sand end was high. Describe when it was lower.

- Compare and contrast the two types of stream channels.
- Determine the cause of the differences between the two channels you made.
- What kind of stream channels would you expect to form on plains? What kind form in the mountainous areas?
- What are specific examples of this phenomenon in Louisiana?

Ask students, “How can streams carry away rock and soil?” Provide student pairs with instant coffee, salt, rice, paper plates, and spray bottles with water. Have students sprinkle some instant coffee grains, salt, and rice on a paper plate to represent loose soil and rock material. Have them squirt water from a spray bottle on one edge of the plate to act as rain. Students are to observe and record what happens to the material when the water droplets start to accumulate and flow downstream. They are to continue spraying as their partner tips the plate over a sink or other container to catch the water. Again, students are to observe and record their observations. Conclude the exploration with a class discussion by asking students to explain what the impact of the stream of water on the loose material and to share observations about the color of the water and reason for the color.

Ask students, “How do streams erode and deposit sediments?” Have students use the stream table and place the sand toward the middle and top of the table. The lower part of the stream table will be the lake into which your stream will flow. In the sand, use a block of wood to carve out a stream channel through which the water can flow. Put some slight meanders in the channel. Prior to starting the water flowing in the stream, students should predict what will happen to the channel, especially at the meanders, then observe and record the results. Next, they should increase the water flow into the stream and record their observations to changes in the stream channel. They should also observe what has happened where the stream flows into the lake at the lower end of the stream table. Be sure that the students identify and explain the limitations of their stream table models in studying constructive and destructive forces.

Through class discussion, have students respond to the following:

- Describe what happened to the meanders in the two trials.
- What happened where the water entered the lake?
- What effect(s) were observed after increasing the amount of water flow?
- What happened to the sand that was eroded from one part of a meander? Why was sand deposited there?
- Why do you think sand accumulated where the stream flowed into the lake?
- Where is the greatest amount of sediment found along a river’s course?
- Identify specific examples of these phenomena on a Louisiana geologic map.

**Activity 2: Water Impact (SI GLEs: 3, 14, 15, 19, 33; ESS GLEs: 19, 20; SE GLE: 51)**

Materials List: clay or student selected materials

Working in small groups, students will research and construct a model of a delta region, drainage basin, Chenier Plain, or coastline, using clay or other student-selected material. The students will label the appropriate parts of the model. Students will research the landform and develop a report and presentation on their model. They will make a short presentation to summarize their research at which time they will explain their model.

When all groups have presented, conduct a class discussion to compare and contrast the models and to summarize the impact of water on Louisiana landforms. Students should discuss the limitations of their model and make suggestions for improvement. The teacher may choose to instead have students create poster models to illustrate the impact of water on Louisiana landforms.

Discuss how human actions and natural processes, both good and bad, have affected the geologic regions modeled and analyze the consequences of human activities on global Earth systems.

**Activity 3: Wind Impact (SI GLEs: 13, 14, 15, 19, 23; ESS GLEs: 19, 20)**

Materials List: Wind Erosion Table BLM, fine sand, flat pans, water, clay, gravel, hair dryer, cardboard sheets, metric rulers, protractors, masking tape, spray bottle for water, liter measuring cup, safety goggles

*Safety Note: Be sure the students wear their safety goggles when the hair dryer is blowing sand. Proper safety procedures should be followed when using electrical appliances. Begin preparing materials one day prior to and the day of the procedure.*

*Optional Procedure: Student groups can test each pan (A, B, C, D, E, and F) instead of groups testing different investigations.*

Demonstrate wind erosion by blowing sand across a smooth flat surface with the hair dryer. Next, add a structure (e.g., a block of wood, soda can) in front of the flow of air. Man-made structures will cause disruptive airflow, creating sand dunes and craters.

In this part of the activity, students will work in groups to investigate factors that affect wind erosion of different surface materials. Provide students with safety goggles, a spray bottle filled with water, five flat pans, 1.5 liters of fine sand, 1 liter of clay, 0.5 liters of gravel, hair dryer, cardboard sheet, metric ruler, protractor, marker, and masking tape. Student groups will each investigate a different pan. After investigation, groups will compare data.

Preparation of materials: Students are provided pans labeled as either “A-1,” “B-1,” “C-1,” “D-1,” “E-1,” or “F-1,” depending on their investigation. The numbers after the letters will change depending on the how many groups are needed (i.e., A-2 is for the second group, A-3 for the third, etc.). Those with pans A and B put 0.5 liters of sand into their pan, those with pans C and D put 0.5 liters of clay into theirs, and those with E and F mix 0.5 liters of sand and 0.5 liters of gravel and put in their pans. Pans A, C, and F should be dampened with the spray bottle of water.

Procedure: Students are to place the cardboard at the end of the pan. Holding the hair dryer about 10 cm from the pan at an angle of  $45^\circ$  at the opposite end from the cardboard, they are to direct a stream of air onto the pan for one minute. Students are to record in the table Wind Erosion Table BLM every effect of the air that they observe. Afterwards, students are to smooth out the media in each pan as they were prior to the investigation.

For the next set of investigations, students are to change the angle of the hair dryer to  $10^\circ$  and repeat the process at the same distance of 10cm. (Students may need to re-dampen the media in pans A, C, and E before completing these trials.) Students are to record all observations and sketches in the Wind Erosion Table BLM.

Next, students will use the hair dryer at a distance of 20 cm, holding the hair dryer at an angle of  $45^\circ$ . (The distance of the hair dryer to the pan represents the force.) The fourth investigation will be at a distance of 20 cm, at an angle of  $10^\circ$ . Students are to re-dampen pans A, C and F as needed.

Students are to respond to the following questions in the combined student groups:

- How do dry sand and clay react to the wind? Explain how moisture changed this effect.
- How does the addition of gravel to the sand affect its reaction to the wind?
- How does the change in force (distance of hair dryer to pan) affect movement?
- How does the angle of the wind affect movement?
- Is wind a more effective erosion agent in wet or dry climates? Which pan(s) give evidence to support your answer?
- Does this represent a “good” model for wind erosion? What are some of its limitations as a model?
- What would be the effect of hurricane winds on Louisiana’s coastline?

Students should present findings to the class. The teacher should then facilitate a whole-class discussion of all findings from each group’s investigation tying the findings to Louisiana (i.e., How does hurricane wind damage affect all of Louisiana? What would be the effect of hurricane winds on Louisiana’s coastline where there is no beach but marsh?).

**Activity 4: Whether It Weathers—Chemically? (SI GLEs: 6, 7, 8, 11, 12, 22, 23; ESS GLE: 14)**

Materials List: safety gloves, salt, vinegar (white) at room temperature, aprons, safety goggles, beakers (100 mL), copper strips (dirty), graduated cylinders, iron (II) sulfate ( $\text{FeSO}_4$ ), pie pans (disposable), test tubes, water, Chemical Weathering Table BLM

*Safety Note: Discuss safety issues with the students before beginning the investigation. If it is a student-led investigation, make sure everyone is wearing the appropriate safety equipment at all times, especially when handling Iron (II) Sulfate ( $\text{FeSO}_4$ ). Iron (II) sulfate is poisonous. Avoid contact with skin. The material formed in this activity is an acid. Avoid contact with skin and clothing.*

*Teacher Note: The teacher should decide if this activity is conducted by the students or done as a demonstration. See Resources for information on locating Iron (II) Sulfate.*

Rocks are mixtures of minerals that are either elements or chemical compounds. Chemical weathering is the chemical reaction of these minerals with carbon dioxide, water, oxygen, or other substances at Earth's surface. For example, in minerals containing iron, the iron reacts with oxygen in the air to form rust. Rotted plant material combines with water to form carbonic acid that causes chemical weathering.

Part A: Lead a whole-class discussion on how the students can use consistency and precision in data collection, analysis, and reporting for this investigation. Students are to observe a chemical reaction between iron and atmospheric oxygen and cause a chemical reaction between a copper strip and combined salt and vinegar at room temperature. Provide student groups with aprons, safety goggles, safety gloves, beakers (100 mL), copper strips (dirty), graduated cylinders, iron (II) sulfate ( $\text{FeSO}_4$ ), pie pans (disposable), salt, test tubes, vinegar (white), water, and a copy of the Chemical Weathering Table BLM.

Direct student groups to mix 5 grams of iron (II) sulfate in 50 mL of water in a beaker. (*Caution: Iron (II) sulfate is poisonous. Avoid contact with skin.*) They are to record the color of the solution and any other observations in the table provided.

Next, have student groups place a copper strip in the pie pan and place 5 grams of salt on the strip and carefully pour 30 mL of vinegar over the copper and record their observations. After five minutes, students should wash the salt and vinegar off the copper and let the beaker and the pie pan both stand undisturbed overnight. The next day, have students observe the beaker and the pie pan and record their observations on the Chemical Weathering Table BLM.

Through class discussion, elicit student response and understanding of the following:

- Explain observations of the beaker of  $\text{FeSO}_4$ . Is this a chemical or physical change?
- Explain the rust-colored stains you see on some rocks.

- What happened to the copper when you poured the vinegar over the salt? Is cleaning copper a chemical or physical process?
- Explain what happens to the clean copper left in the air overnight. Why does this reaction follow the cleaning of the copper?
- How might a soil layer protect bedrock from chemical weathering?

Part C: Students complete a Venn diagram, a type of a *graphic organizer* ([view literacy strategy descriptions](#)), to compare and contrast mechanical weathering and chemical weathering. After completion, have students do a quick “round robin” where each student cites one similarity or one difference. Student-created Venn diagrams could be posted for display and class analysis.

**Activity 5: Weather or Not?? (SI GLEs: 7, 10, 13, 16; ESS GLE: 14; SE GLE: 51, 53)**

Materials List: 3X5 index cards, list of mechanical and chemical weathering and erosion agents, Vocabulary Card (BLM from Unit 1) – one per word for each student, Erosion Project BLM, Erosion Project Rubric BLM, digital still or video cameras and computer for student use (optional), cards with “erosion” and “deposition” (set for each student group)

Part A. Engage the students in a discussion about weathering. Solicit student explanations of how soil is formed and its composition. From this discussion, students should be able to identify statements they make as either a description or an explanation. Be sure that students understand the difference. To develop students’ knowledge of key terms, have them create *vocabulary cards* ([view literacy strategy descriptions](#)) for weathering agents (i.e., mechanical weathering, chemical weathering, wind, water, animal, plant). On the board, place the term “mechanical weathering” in the middle of the card (white board, smart board, chalk board). Guide students as they provide a definition and then write the definition in the appropriate space. Next, invite students to list the characteristics or description of the word and write that information in the appropriate space. Next, ask for examples of the word and write that information in the appropriate space. Next, ask for examples of the term and include one or two of the more accurate ones in the designated area on the card. Finally, create a simple illustration, if possible, of the term in the last area of the card. Once the “mechanical weathering” card is created, ask students to make their own word cards for other weathering-related and erosion-related terms. Students will use an index card for each key term. Allow time for students to study their cards and quiz each other with their cards to reinforce word knowledge of weathering agents.

Part B: Students should be able to differentiate mechanical weathering and chemical weathering. They should understand that by mechanical weathering, rocks are broken apart by physical processes. Chemical weathering breaks down rocks through chemical processes that dissolve the minerals in rocks or may cause them to form different compounds. Common examples of mechanical weathering students should be able to relate to may include sidewalks cracked by tree roots, burrows created by small animals,

or ice expanding and contracting on or in rocks causing them to crack or break. Common examples of chemical weathering include the formation of caves, a bicycle rusting outdoors, or outside statues turning dark or discolored.

Take the students on an outdoor field trip around the school campus. Students will identify and distinguish examples of chemical and mechanical (physical) weathering and keep track of the number of times they observe each type of weathering. As the students walk around the campus, they will complete a table that lists examples of chemical and mechanical weathering, the name of the object affected (e.g., paint peeling, exposed metal rusting, cracked sidewalks or concrete), and possible agents responsible for the weathering. If digital still or video cameras are available, students can create podcasts, information videos, or slide show presentations of their findings. If student computers are available, students can generate a spreadsheet graph to compare and analyze the observed occurrences of mechanical and chemical weathering. They can then draw a schoolyard map to identify the locations of observed weathering. Students should predict the long-term effects on the affected areas or objects if not corrected.

Part C: Students should use the *vocabulary cards* to distinguish among several examples of erosional features/areas of deposition (e.g., stream bank, topsoil, coastal) and describe common preventative measures. Pass out a pair of cards with “erosion” and “deposition” printed (one on each). In small groups, students should organize the *vocabulary cards* with different erosional feature or area of deposition examples into two groups. Students should place the title cards on opposite sides of the work area, and they should work together to separate the *vocabulary cards* into erosional features and areas of deposition. Walk around the room and guide students who might have a card under the incorrect title to correct its position. After an appropriate time period, review where each key term belongs by asking one group at a time where they placed a specific key term; rotate through the groups until each key term has been classified. Have each group defend why they put that card under the specific title, and students should check their cards’ location. Next, students should then draw a “T” chart in their science *learning logs* ([view literacy strategy descriptions](#)). On one side, students should list the examples of erosional features and on the other students list the areas of deposition.

Part D: Students often use the terms *weathering* and *erosion* as one concept. As a means to address this misconception, students will construct and present 3-D models representing objects in motion using the three major types of erosion (wind, water, and glacial). Students will present the following for a natural process:

1. the characteristics of -
2. the major contributors to -
3. specific vocabulary describing -
4. the affects on our Earth produced by -
5. preventative measures taken for -

Pass out the Erosion Project BLM and the Erosion Project Rubric BLM to each student or student group. Students will provide the materials for the project. The Erosion Project rubric describes in detail the total number of points students can earn. The students also

give their own score and a group member's score. These four scores will be averaged together to find the final group participation grade. Students can work in class on this project – plus any after school hours that may be needed.

Following class presentations, lead the students in a discussion of how human activities influence chemical and mechanical weathering and identify possible long-term effects these activities may have on Earth's systems.

**Activity 6: Soil Characteristics (SI GLEs: 2, 3, 5, 6, 7, 11, 13, 19, 20, 25, 31, 34, 36; ESS GLE: 15; SE GLEs: 52)**

Material List: computer and projecting system (optional - individual student computers); soil samples from community/school campus; paper plates (to put soil samples on); gloves; plastic spoons (to probe, dig, and move soil around with); disposable gloves; relief map for classroom display; magnifying lens; local area map; several soil samples from locations in which different plant species grow; trowel; sealable plastic bag; masking tape; markers; red and blue litmus paper (optional-pH probes or Hydrion paper); petri dishes (or small dishes); eye droppers; teaspoons; science learning logs Soil pH and Plants BLM; plant seeds (quick-growing plants such as pea plants, rye grass are ideal); Soil Texture Dichotomous Key BLM (one per student), push pins for map flags; teacher-selected research material for plant growth in environmental conditions of local areas such as forests, marsh, wetlands, coastal plains, etc.; soil cards (see Part C); small paper plates

Part A: The teacher and students are to collect samples of soil from a variety of places in the community and school campus. The teacher could also alert students early in the semester about this activity and have them collect samples as they travel to other parts of the state and country. Have students to look for patterns of a specific characteristic with a specific location. They are to observe closely with a magnifying lens and describe the different particles found. Students should answer the following observation questions:

- Is there evidence of organic matter; if so, where would they have come from?
- Are there living things in the soil; if so, what are they?
- How many different kinds of particles are there; what are the differences?

Students can use the Soil Texture Dichotomous Key BLM to help determine the soil type of their sample. Color comparisons should relate to the chemical composition and provide extensions into what plants/crops grow well in what soils. A county agent or soil specialist can provide information about soil profiles for comparing soils from different areas and determining which types of plants grow best in these areas.

Part B: Small student groups will research and analyze soil pH to determine if their seed plants are compatible with the soil. For this experiment, collect a number of soil samples from locations in which different plant species are growing (i.e., soil samples from under a pine tree, a maple tree, a spruce pine tree, a tomato plant, a watermelon, an azalea bush,

clover, or goldenrod). These soil samples can be collected ahead of time or students can collect them on a soil gathering expedition around the school (this could be incorporated into a plant identification hike). Students could also bring in soil samples from home (encourage them to only gather soil from under plants that they can positively identify).

To collect the soil samples, use a trowel to dig down 10-15 cm into the soil (harming the root system of the plant as little as possible in the process). Place a soil sample into a sealable small plastic bag. Label the container with the name of the plant using masking tape and a marker. Fill in the hole dug as best as possible.

Provide each group with one soil sample, several pieces of red and blue litmus paper (optional-pH probes or pH paper), an eyedropper, and two petri dishes (or small dishes). Review what litmus paper is for and how to read the results from this pH indicator. Instruct the students to place a piece of blue litmus paper in one petri dish and a piece of red litmus paper in the other petri dish. The students should then place approximately a teaspoon of their soil sample on top of each strip. Using the eyedropper, the students should then moisten the soil until the strips of litmus paper become wet. Finally, instruct the students to brush the soil away with their hands and determine if it is acidic or alkaline, as indicated by the color of the litmus/pH paper or reading on the probe. Direct the students to construct a table in their science *learning logs* ([view literacy strategy descriptions](#)) consisting of two columns titled “Acidic Soil” and “Alkaline Soil.” In the appropriate column, the students should record the name of the plant species under which their soil was found.

Instruct each student group to display their soil sample on a small paper plate (with the plant species name clearly visible) and the results of the pH tests in their work area.

Allow the students to circulate throughout the room, recording the findings for each soil sample. After all data is recorded, students will use the data to answer the Soil pH and Plants BLM. Design and conduct an experiment to test the growth of a variety of plant species in different soil pH. Design and conduct an experiment to test the effect of soil nutrients on plant growth.

Part C: The students can take this investigation further by designing and conducting investigations that replicate plant growth in environmental conditions of local areas, such as forests, marsh, wetlands, coastal plains, etc. The students should write clear, step-by-step instructions that others can follow to carry out procedures or repeat the investigation. The students should identify problems, factors, and questions that must be considered when designing an investigation such as safety concerns and the independent, dependent, and controlled variables that must be considered in growing plants and simulating environmental conditions. Upon the completion of the design of the investigations, students should exchange plans with other students for comparison, critiquing, and offering suggestions as to how the investigation may be improved. Students should recognize the importance of communicating with scientists and specialists when conducting investigations, such as contacting the local county agent or other soil specialist for information about soil conditions and native plants in a given area. Students

should plan to collect data during the investigations and recognize that an acceptable range in the data is very common. Students should also recognize that verification of findings of experiments is accepted only after multiple trials and investigations are conducted and the results are constant. This would have to be an ongoing activity, merging into the next unit as students continue to collect data from their group designed investigations.

Part C: Prior to this part of the activity, download Discovery Channel's Soil Safari to a computer desktop that can be used with a projector for whole class viewing or download to individual student computers

(<http://school.discoveryeducation.com/schooladventures/soil/download.html>). Print the soil cards for each student

(<http://school.discoveryeducation.com/schooladventures/soil/cards.pdf>).

Display a soil sample and a rock sample and ask students if they know of a process that would allow the rock sample to become the soil sample. Guide students' responses to weathering, connecting to students' prior learning. Ask students how long they think it would take for the rock sample to weather into the soil sample. Accept all and display them on overhead, chart paper, or board. Inform students that geologists have estimated that it takes approximately 12,000 years for rocks to weather into soil. Explain that this time varies with certain conditions, such as parent material (sediment type), climate (and weathering), organisms (flat vs. rugged land), topography, and time (rate of soil formation, which is dependent upon all of the above). The biological activity imparts organic debris (litter), and installs decomposer bacteria and other life forms (e.g., worms, millipedes, ants). This added organic matter is called humus. Thus, we could sum up soil formation as Solid products of weathering (sediments) + Humus = Soil.

Students will focus on the biological factors in soil formation using the Discovery Channel's Soil Safari. This virtual field guide profiles species selected from each major type of soil organism, ranging from the largest animals to live underground to the smallest micro-organisms. Each profile provides information on the organism's size and ecological role in creating and maintaining soil health. Pass out soil cards to students. Begin with a brief discussion on how animals contribute to its environment. Pass out the soil cards with the instructions that students use in Soil Safari. Soil cards can be found at the following link:

([http://school.discoveryeducation.com/schooladventures/soil/teacher\\_tips.html](http://school.discoveryeducation.com/schooladventures/soil/teacher_tips.html))

Students are to note the contribution an animal provides to the soil, along with basic information (its size, its food source) and any facts of particular interest to the student. After they complete the activity, students should refer back to their soil cards. These cards can then be used to evaluate students reading comprehension, understanding of how a variety of animals make important contributions to soil and their environment.

**Activity 7: Ooh, What a Relief It Is (SI GLEs: 13, 14, 19; ESS GLE: 21)**

Materials List: two pounds of clay, wooden craft sticks, toothpicks (used as tools), clear container with clear lid, stackable clear plastic lids, overhead markers, water, topographic map of [Angel Island](#), topographic maps of a local Louisiana area, metric ruler (one per student group), optional metric ruler with centimeters marked

The purpose of this activity is for students to create a model that will demonstrate their understanding of major landforms. Introduce students to the topic of elevation with a relief map. Discuss and review the basic landforms of mountains, plains, and plateaus and a similar feature of these landforms—rivers. Challenge student groups to make cross-sectional profiles. Using a relief map, introduce the use of contour lines. Rules for using contour lines should include the following:

- In areas of high relief (steep areas), contour lines are closer together.
- In areas of low relief (flat areas), contour lines are farther apart.
- Contour lines never cross.
- Contour lines “V” upstream.
- Hachure marks show a depression in elevation.

Part A: Divide the class into small groups to construct the landform models. Each group will use the following materials: approximately two pounds of clay, wooden craft sticks, toothpicks (used as tools), and clear container with clear lid. Each group will be responsible for constructing a Louisiana landform model with the materials provided. Let the models dry overnight. Each student should draw a cross-sectional profile of his or her model and write a short paragraph describing the features of its environment.

- Measure and mark every 1 cm on the side of the container.
- Pour water into the container around the clay feature until the water is level with the lowest cm mark.
- Place the lid on the container.
- Mark the water line around the clay feature on the lid using overhead markers.
- Continue pouring water up to the next cm line and marking the rising water level until 2-D model of the feature is drawn.
- Drain the water off of the landform models and dispose of it.

Part B: Using the directions at the USGS website

([http://online.wr.usgs.gov/outreach/topo\\_instructions.html](http://online.wr.usgs.gov/outreach/topo_instructions.html)) instruct students to make their 3-D model Angel Island using stackable clear plastic lids (one for each contour line). See MAPS under Resources for a link showing pictures of stackable clear plastic lids modeling a topographic map. After students have constructed their 3-D model, students will present their completed projects to the class, illustrating their understanding of

- How elevation is shown on topographic maps.
- How contour maps relate to cross-sectional profiles and contour intervals.
- How the distance between contour intervals indicates the steepness of the slope of the landform and basic landform features.

Students can exchange contour maps and draw cross-sectional profiles from this information, identify features, and then match them with appropriate models. The Earth Science Information Center at the U.S. Geological Survey (<http://edc.usgs.gov/>) is a good source for other maps. See TOPOGRAPHIC under Resources for pictures of what this might look like.

Part C. Provide groups of students with 7.5-minute (1:24000) topographic maps of a local Louisiana area and have students identify various landform features. Have a topographic treasure hunt and have students locate specific information on topographic maps. Topographic maps for several Louisiana locations are available online on the WETMAAP (<http://www.wetmaap.org/>) website. Click on the “site map” button; on the next page click on “topographic maps”. From this list a choice can be made of the maps’ scale for a variety of maps.

### **Activity 8: Ocean Floor (SI GLEs: 3, 11, 13, 14, 19; ESS GLE: 22)**

Materials List: KWL Chart BLM (one per student), Ocean Depth Data Sheet BLM (one per student), graph paper, world map, teacher-selected materials, markers, colored pencils or crayons, relief map of the United States

Students will complete a class KWL chart, a type of *graphic organizer* ([view literacy strategy descriptions](#)), on the ocean floor. First, activate students' prior knowledge by asking them what they already **Know** about the ocean floor; accept every response. Guide the students (collaborating as a classroom unit or within small groups) in setting goals specifying what they **Want** to learn; don't attempt to correct any misconceptions yet, but be sure to address them during the activities. After reading, students will discuss what they have **Learned**. Students should apply higher-order thinking strategies which will help them construct meaning from what they read and investigate and help them monitor their progress toward their goals.

The class will discuss and label each feature of the ocean floor on the graph, including the geological features, such as continental shelf/slope/rise and mid-Atlantic ridges, rifts, and trenches. Students should have experience making line graphs from data, but the teacher should decide whether to review graphing techniques or not. Students will work in pairs on this activity. Provide student groups with line graph paper, Ocean Depth Data Sheet BLM, and a world map. Have them tape three pieces of graph paper together (short ends) before they plot the data. They will turn the paper so that the longest side is the horizontal axis. Give each team a copy of the Ocean Depth Data Sheet BLM. They will need to set-up the sheets with the distance in kilometers on the horizontal axis (*x*-axis) at the top of the paper and the depth in meters on the vertical axis (*y*-axis); the top of the vertical axis will be the 0 mark, with the depth advancing from that mark. Once they have done this (model it on the board or overhead), instruct students to plot a line graph of the ocean depths. Tell students this data is the ocean floor from New Jersey to Portugal. Teachers should use data from the coastal zone off Louisiana and other southern coastal states, which can be found at <http://www.lib.noaa.gov/edocs/stratton/chart23.gif>, as a first

step and then extend to data that crosses the Atlantic from New Jersey to Portugal. Wunderground shows a great picture of the Gulf of Mexico's continental shelf (<http://www.wunderground.com/hurricane/history/GulfofMexico.jpg>). Point this out on a world map. Assist any students having difficulty. Once they have plotted the depths, they need to connect the dots. Have the students color in the bottom portion of their graph so it resembles land. Tell them the picture they have drawn shows many of the features found on the ocean floor. Once the graphs are all completed, have students identify each feature on the graph using teacher selected resources. Discuss each one and have students label them. Hang these in the hall to share with everyone.

Students next should complete the KWL chart on the ocean floor and then share what they have learned. This is a good time to address any misconceptions that may have been placed on the "Know" side. Have the students review and adjust their KWL chart or complete the chart together.

To conclude, ask the students to predict how ocean floor features would compare to continental features. Use a relief map of the United States to compare topographic features of the continents to those of the ocean floor.

## **Sample Assessments**

### **General Guidelines**

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data-collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities via teacher observation of their work and lab notebook entries
- All student-developed products should be evaluated as the unit continues.
- Student investigations should be evaluated with a rubric.
- For some multiple-choice items on written tests, ask students to write a justification for their chosen response.

## General Assessments

- The student will diagram how landforms result from the interaction of constructive and destructive forces.
- The student will list man-made and natural causes of coastal erosion and describe the steps taken to prevent it.
- The student will compare and contrast topographic features of the ocean floor to those formed above sea level.
- The student will find stream-carved “Vs” on a topographic map and use them to explain the direction of water flow.
- The student will create a 3-D model of the ocean floor, with all of the specified geological features labeled.

## Activity-Specific Assessments

- Activity 1: The student will describe methods used on Louisiana’s coastline to reduce the effects of erosion by waves. He/she will include illustrations to support the discussion.
- Activity 3: The student will describe the effects of hurricane winds on the Louisiana coastlines.
- Activity 5: Given a list of human activities that influence chemical and mechanical weathering and agents of erosion (still, slow, and fast water; precipitation; and wind), students will write a paper to identify possible long-term effects these activities may have on Earth’s systems.
- Activity 7: The student will design a concept map that would link terms to continental topography and ocean floor topography: *mountains, volcanoes, trenches, canyons, river channels, ridges, plains, and slopes*.

## Resources

### Louisiana Geologic Development

- Formation and evolution of the Mississippi River Delta  
<http://www.loyno.edu/lucec/mrddocs/11.doc>
- Atmospheric Archive Distribution System <http://ladsweb.nascom.nasa.gov/>
- Louisiana Geological Survey  
<http://www.lgs.lsu.edu/depoy/content/GINFO/index.php>
- UCMP <http://www.ucmp.berkeley.edu/geology/tectonics.html>
- *Louisiana GIS CD: A Digital Map of the State*
- *New Orleans: A Natural History DVD*.

- NOAA Ocean Explorations  
<http://oceanexplorer.noaa.gov/explorations/explorations.html>
- Saaco, Christine. *Doughy Topos*. Adaptive Earth Science Activities. West Virginia Geological and Economic Survey. Publication ED-13. 1998.
- Smith, Tanya. *Oooh, What A Relief It Is ...* Adaptive Earth Science Activities. West Virginia Geological and Economic Survey. Publication ED-13. 1998.
- <http://coastal.er.usgs.gov/hurricanes/katrina/>

#### Printable Hurricane Tracking Maps

- NOAA's Hurricane tracking chart is available at  
[http://www.nhc.noaa.gov/gifs/track\\_chart.gif](http://www.nhc.noaa.gov/gifs/track_chart.gif)
- City of New Bedford's Hurricane tracking charts [http://www.ci.new-bedford.ma.us/PSAFETY/EMGMGT/hurr/em\\_main\\_opt14.htm](http://www.ci.new-bedford.ma.us/PSAFETY/EMGMGT/hurr/em_main_opt14.htm)

#### Maps

- Pictures of stackable clear plastic lids <http://sf-rocks.sfsu.edu/lessons/saladtray.htm>
- US Relief map [http://www.geo.wvu.edu/~jtoro/geol101/mountains/usa\\_dem.gif](http://www.geo.wvu.edu/~jtoro/geol101/mountains/usa_dem.gif)
- Wetmaap has topographic maps for several Louisiana sites <http://www.wetmaap.org/>

#### Iron (II) Sulfate

- Sargent Welch [http://www.sargentwelch.com/product.asp?pn=WLC94139-06\\_EA](http://www.sargentwelch.com/product.asp?pn=WLC94139-06_EA) (online ordering page)
- SK Science Kit and Boreal Laboratories  
<http://sciencekit.com/product.asp?pn=IG0015304&sid=mercent&mr:trackingCode=F6B565C3-92A7-DC11-AC6C-000423C27502&mr:referralID=NA> (online ordering page)
- Flinn Scientific <http://www.flinnsci.com/> (you must know product code or request a catalog to order products)
- Agrium  
[http://www.agrium.com/uploads/Ultra\\_Yield\\_Iron\\_Sulfate\\_20\\_percent\\_MSDS14171.pdf](http://www.agrium.com/uploads/Ultra_Yield_Iron_Sulfate_20_percent_MSDS14171.pdf) (iron (II) sulfate material data sheet)

**Grade 8  
Science  
Unit 5: Factors that Affect Earth**

**Time Frame:** Approximately six weeks



**Unit Description**

This unit focuses on the Earth's atmosphere, the processes of the water cycle, and the factors that affect the rate of water movement through the cycle. Weather patterns, historical trends, and the use of data to predict future weather conditions are emphasized.

**Student Understandings**

Students should recognize Earth's climatic conditions and its dependency on the structure and dynamics of its atmosphere. They should be able to identify or diagram the water cycle as it affects climate. Students will use data to make predictions about future weather conditions.

**Guiding Questions**

1. Can the students identify the Sun as a primary source of energy for the water cycle?
2. Can students illustrate the water cycle and describe the processes that occur?
3. Can students describe how water flows through the ground and its effects on stream levels?
4. Can students describe general climate conditions and what affects those conditions?
5. Can students use weather maps to observe patterns and trends and be able to make weather predictions based on that knowledge?
6. Can the students use models to demonstrate how the tilt of the Earth is a major cause of the seasons?
7. Can students describe contributing factors to hurricanes and tornadoes?

## Unit 5 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
<b>Science as Inquiry</b>	
<i>The following Science as Inquiry SI GLEs are embedded in the suggested activities for this unit. Additional activities incorporated by teachers may result in additional SI GLEs being addressed during instruction on the Cycles of the Earth unit.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
3.	Use a variety of sources to answer questions (SI-M-A1)
4.	Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
9.	Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
13.	Identify patterns in data to explain natural events (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
15.	Identify and explain the limitations of models used to represent the natural world (SI-M-A5)
16.	Use evidence to make inferences and predict trends (SI-M-A5)
17.	Recognize that there may be more than one way to interpret a given set of data, which can result in alternative scientific explanations and predictions (SI-M-A6)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
21.	Distinguish between <i>observations</i> and <i>inferences</i> (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
27.	Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1)
28.	Recognize that investigations generally begin with a review of the work of others (SI-M-B2)

<b>GLE #</b>	<b>GLE Text and Benchmarks</b>
29.	Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3)
30.	Describe why all questions cannot be answered with present technologies (SI-M-B3)
31.	Recognize that there is an acceptable range of variation in collected data (SI-M-B3)
32.	Explain the use of statistical methods to confirm the significance of data (e.g., mean, median, mode, range) (SI-M-B3)
33.	Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
38.	Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)
39.	Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)
40.	Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7)
<b>Earth and Space Science</b>	
23.	Explain the processes of evaporation, condensation, precipitation, infiltration, transpiration, and sublimation as they relate to the water cycle (ESS-M-A10)
24.	Investigate and explain how given factors affect the rate of water movement in the water cycle (e.g., climate, type of rock, ground cover) (ESS-M-A10)
25.	Explain and give examples of how climatic conditions on Earth are affected by the proximity of water (ESS-M-A11)
26.	Describe and illustrate the layers of Earth's atmosphere (ESS-M-A11)
27.	Identify different air masses, jet streams, global wind patterns, and other atmospheric phenomena and describe how they relate to weather events, such as El Niño and La Niña (ESS-M-A12)
28.	Use historical data to plot the movement of hurricanes and explain events or conditions that affected their paths (ESS-M-A12)
29.	Make predictions about future weather conditions based on collected weather data (ESS-M-A12)
43.	Identify the processes involved in the creation of land and sea breezes (ESS-M-C6)
44.	Describe how unequal heating of Earth's surface affects movement of air masses and water in the atmosphere and hydrosphere (ESS-M-C6)
45.	Explain how seasonal changes are caused by the tilt of Earth as it rotates on its axis and revolves around the Sun (ESS-M-C7)
46.	Illustrate and explain how the angle at which Sunlight strikes Earth produces changes in the seasons and length of daylight (ESS-M-C7)
47.	Compare the relative distances from Earth to the Sun on the first day of summer and the first day of winter (ESS-M-C7)

## Sample Activities

### Activity 1: Water Cycle Details (SI GLEs: 19, 33; ESS GLEs: 23, 43, 44)

Materials List: white copy paper, colored pencils, crayons or markers, large sealable plastic bags, water, ice cube tray, blue food coloring (to make colored ice), masking tape, non-mercury thermometer with large range (like an outdoor thermometer), Water Cycle Story Chain Rubric BLM, cloth, construction paper, Water Cycle Story Chain Example BLM

Prior to this lesson, create the model for the water cycle using the Oceans Alive! Website (<http://www.mos.org/oceans/planet/watercycle.html>). Put about a cup of water into the baggie. Add a drop or two of food coloring. Carefully seal the baggie and tape it onto a sunny window. If necessary, the set-up can be placed under a lamp. Fill an ice cube tray with enough water to make ice for all classes, and add a drop of food coloring to each cube.

Part A: While teaching, be aware of students' ideas as to how the conservation of matter, phase changes, clouds, the Sun, and rain are interrelated and contribute to understanding the water cycle. Wet a cloth and wipe it on the chalk board (if no chalk board is available, wipe a colored piece of construction paper and tape it to the board), and leave it alone for the class to view. Host a whole-class discussion on the word *cycle*. As students provide their explanations of *cycle*, begin to connect their ideas with lines to construct a *graphic organizer* ([view literacy strategy descriptions](#)) such as a concept map. Students will build on this model and create a mind map of the "water cycle" on a sheet of copy paper. Mind maps are forms of concept maps. To draw a mind map, start in the center of the page with the words "water cycle" and work outward in all directions, producing a growing and organized structure composed of key words, images, shapes, and ideas. Mind maps begin to take on the same structure as the memory itself. Because of the large amount of association involved, they can be very creative, tending to generate new ideas and associations that have not been thought of before. Students map the relationships between the ideas using lines, arrows, colors, and words to link them. As an alternative to drawing the mind map, Science-Class.net has a pdf file of instructions using a *graphic organizing* software program for creating a mind map ([http://science-class.net/Water Cycle/Inspiration\\_instructions\\_water\\_cycle.pdf](http://science-class.net/Water Cycle/Inspiration_instructions_water_cycle.pdf)).

Refer students back to the board or the piece of paper that was dampened. Ask the students what happened to the water wiped on the board/paper. Solicit student responses and guide them to relate this action to the water cycle. Now draw students' attention to the model created before class from the Ocean's Alive! Website – one sealable plastic bag is taped to the window for the water cycle investigation. Ask the students the following questions: "Where did the tiny droplets of water on the inside of the bag come from?" "Can you tell if there is any less water in the bottom of the bag?" "How would you find out?" Hold a piece of colored ice against the condensed water vapor in the bag. This action should cause more water vapor to condense and precipitate down the sides of

the bag. Move the bag to a location where there is no Sun. How does this new situation affect the water cycle model? Point out that the process of water changing phases is powered by the Sun, and drives weather patterns, the movement of water around the globe, and the resulting erosion that shapes our landscape. Also point out that the quantity of water in the bag stayed the same just like the quantity of water on the planet has stayed the same since the planet was formed. However, mention water is “created” daily through photosynthesis, burning of fossil fuels, etc. Just like in the bags, the water on the planet continually changes phase and moves around from place to place.

Move on to relating the model to the water cycle.

- When and why does it rain?
- What happens to the rainwater once it reaches the ground?
- What happens to the water when the Sun comes out?
- What happens to the vapor in the air when it gets cold?

Part B: Put students in groups for a *story chain* ([view literacy strategy descriptions](#)). Pass out the Water Cycle Story Chain Rubric BLM to the groups. The process should include a small group of students writing a story that includes and explains *run-off, evaporation, groundwater, condensation, precipitation, infiltration, transpiration, and sublimation* as they relate to the water cycle model. Students should also include components that demonstrate the unequal heating of Earth’s surface and how it is responsible for the movement of air and water (vapor). The first student initiates the story. The next adds a second line. The next, a third line, etc. until the last student in the group is expected to complete the cycle. All group members should be prepared to revise the story based on the last student’s input as to whether it was clear or not. Students can be creative and use information and characters from their every day interests and media. The Water Cycle Story Chain Example BLM provides an idea of how the story chain should begin. See the USGS water cycle story (<http://ga.water.usgs.gov/edu/followadrip.html>) for ideas to support student creativity.

**Activity 2: Water Movement in the Water Cycle (SI GLEs: 2, 4, 13, 19, 21, 22 28; ESS GLE: 24, 44)**

Materials List: NASA Article BLM, 3 colors of construction paper, paper plates of different sizes (10 per student group), yarn cut 6 feet long (2 lengths per student group)

Part A: Provide students with the NASA Article BLM NASA PREDICTS MORE TROPICAL RAIN IN A WARMER WORLD, which also can be found at <http://www.nasa.gov/centers/goddard/news/topstory/2003/1224rainfall.html>. The article begins, “As the tropical oceans continue to heat up, following a 20-year trend, warm rains in the tropics are likely to become more frequent, according to NASA scientists.” Use the *Directed Reading-Thinking Activity (DR-TA)* strategy ([view literacy strategy descriptions](#)) to invite the students to make predictions and then check their prediction during and after the reading. Begin with a discussion about the opening sentence quoted

above. Elicit information students may already know about factors that affect the rate of water movement, such as climate, ground cover, and type of rock. Discuss the title of the article and record students' predictions about the text content on the board. Invite the students to make predictions about what they might learn from the article. Read a section of the article, stopping at predetermined places to check and revise students' predictions. This is a crucial step in *DR-TA* instruction. There are numerous opportunities for the teacher to model his/her predictions, revisions, and evidence. The teacher can also prod students' growing understanding of the text with questions, such as "What do you know so far from this reading?" "What evidence do you have to support what you know?" "What do you expect to read next?" Once the reading is completed, use student predictions as a discussion tool to further explore their understanding of the movement of water through the water cycle. Ask, "What did you expect to learn before we began reading?" and "What did you actually learn?" Use the *DR-TA* process often to reinforce effective reading and thinking strategies for science content.

Part B: Students will describe how water flows through the ground by distinguishing the difference between soil permeability and porosity. Prior to this activity cut circles out of construction paper (a different color for sand, silt, and clay—see <http://soils.gsfc.nasa.gov/pvg/texture1.htm> for relative sizes for each particle). Show the students the paper out of which the circles were cut and ask how this might serve as a model to demonstrate soil porosity (the paper represents the soil; the spaces represent the pores in the soil).

To model permeability, students will use paper plates and yarn. Provide each student group with 10 paper plates of different sizes and 2 pieces of yarn. Ask students how they might use these materials to model permeability. Allow time for students to work on this task. Students should arrange the plates in a pattern and weave the yarn through the plates to show a path from top to bottom. The arrangement of the plates represents the pattern of soil particles, and the yarn represents the water moving through the soil particles: the straighter the yarn is through the plates, the faster the water moves through the ground.

Host a whole-class discussion on how the water moves through rock. Guide the discussion to focus on the following key principles:

- Groundwater is continually moving, often very slowly.
- Gravity is the major driving force on the movement of water, and thus groundwater is always moving from areas of higher elevation to lower elevation.
- Knowing the direction of groundwater movement is increasingly important because of the danger of contaminating groundwater supplies. Shallow water table aquifers are especially susceptible to surface contaminants such as sewage, manure, pesticides, and petroleum products when they enter the ground at higher elevations than the source (well) from which the water is drawn.

**Activity 3: Climates (SI GLEs: 3, 7, 11, 16, 21, 28, 31, 32; ESS GLE: 25)**

Materials List: world average water vapor content map (see Part B resource); World Climate Data Table BLM; Internet access; scenery pictures of Cairo, Egypt in the Sahara Desert and the town of Sitka, Alaska in North America can be downloaded from the Internet; computer and projector; poster paper; tape; markers

Part A: Create a modified *opinionnaire* ([view literacy strategy descriptions](#)) by providing students with pictures of Cairo, Egypt in the Sahara Desert and the town of Sitka, Alaska in North America. Designate a side of the room as the Sahara Desert and the opposite side of the room as Sitka, Alaska. Hang poster paper and a marker on the wall for each geographic area. Ask the students to move to the side of the room, or geographic place, they believe has the greatest amount of water vapor contained in a column of air from the ground to the top of the atmosphere of the two locations. While in their groups, students should discuss their opinions and develop reasons for their opinions on the poster paper, emphasizing how the water vapor got into the atmosphere as the explanations of the groups are drawn out. Invite one of the group members to report their opinions about each picture. The emphasis is on students' points of view and not the "correctness" of their opinions.

Part B: Go to the following webpages:

[http://www3.shastacollege.edu/dscollon/images/Maps-Images/world\\_climate\\_map.jpg](http://www3.shastacollege.edu/dscollon/images/Maps-Images/world_climate_map.jpg) or <http://www1.cira.colostate.edu/climate/NVAP/jul1089b.gif>, and make a copy of one of the maps of the world showing average total water vapor content. Distribute the copy to the students or display to the whole class with an overhead or a computer and projector. In small groups, have students interpret the map together and then solicit their ideas. Make sure the students can distinguish between observations and inferences. Guide the students so they recognize that the depth of water that would be produced by condensing the entire vapor in a column of air extending from the surface to the top of the atmosphere. Discuss their findings and reasoning for the greater vapor concentration over the desert.

Using a whole-group discussion, ask the students what they think the temperature is like during the year in these two places. Have them gather data from the World Climate website (<http://www.worldclimate.com/>) for the average 24-hour temperatures in degrees Celsius and precipitation month-by-month in millimeters through the year for Cairo, Egypt in the Sahara Desert, Sitka, Alaska, and a city somewhere else in the world chosen by the class. The data should be recorded in the World Climate Data Table BLM, or students can create their own spreadsheet to analyze the data. Remind the students that investigations often begin by reviewing evidence gathered by others. Students should recognize that there is an acceptable range of variation in collected data. They are to complete a chart of their findings and discuss their findings relating the data to the pictures and to the water cycle. Students should be able to explain the use of statistical methods to confirm the significance of the data (e.g., mean, median, mode, range). Ask the students what kind of clothes they would take if they were moving to one of these places and have them justify their responses.

Ask the students to identify the factors that they believe determine the climate of a location. The primary influences on climate to discuss are latitude, elevation, and proximity to large bodies of water. Discussion should include why and how the climate is influenced.

Once content is covered for this activity, have students return to their opinionnaires to reconsider their initial responses. Discuss and clarify as a whole class.

**Activity 4: ‘Tis the Season (SI GLEs: 1, 4, 6, 9, 19; ESS GLEs: 45, 46, 47)**

Materials List: ring stand and utility clamp, globe of the Earth, masking tape, metric ruler, lamp with 100-watt bulb, 20 cm length of string, stop watch or timer, non-mercury thermometer or temperature probe and computer or graphing calculator, ‘Tis the Season BLM, “Tis the Season Key BLM

Part A: Because Earth’s axis is tilted at  $23\frac{1}{2}^{\circ}$ , Earth receives different amounts of solar radiation at different times of the year. The amount of solar radiation received by the Earth or another planet is called *insolation*. The tilt of the axis produces the seasons. In this experiment, which can be completed by students or as a teacher demonstration, students will observe how the tilt of the globe influences warming caused by the lighted bulb.

Introduce seasons with a teacher demonstration. Tie a string around a flashlight to maintain a constant distance between the light source and the wall. The light represents the Sun, and the wall represents the surface of the Earth. Vary the angle of the "Sun" on the wall to show how the light as seen on the wall varies in intensity. When the "Sun" is at a low angle, the light on the wall seems less intense (less bright), and students will notice that it is spread out over a larger area. Apply this concept to the altitude of the Sun during the different seasons.

Pass out the ‘Tis the Season BLM. This can be completed in student groups of 3-4 or as a whole class. Use a ring stand and utility clamp to hold a lamp with a 100-watt bulb. Position the globe with the North Pole tilted away from the lamp and the bulb at the same height as the Tropic of Capricorn. Note: The Sun is directly over the Tropic of Capricorn on December 21, the first day of winter in the Northern Hemisphere. Provide students with major cities in both the Southern and Northern Hemispheres, or have them choose where they would like to visit. Tape the thermometer to the globe with the bulb of the thermometer at each location. Check to make sure the globe is turned for winter data collection (the hemisphere will tilt away from the lamp). Use the 20-cm length of string to position your location on the globe 20 cm from the bulb. Note the initial temperature and after five minutes record the final temperature. Find the change in temperature for winter. Position the globe for summer (the hemisphere will tilt toward the lamp) data collection. Note: This represents the position of the Northern Hemisphere on June 21, the first day of summer in the Northern Hemisphere. Again, use the string to make sure it the same distance from the lamp as before. Repeat the same procedure as above for this

position. Compare the temperature changes for the two readings. Students should use the information and answer the Data Analysis questions on the 'Tis the Season BLM. This can be done as a whole-class discussion.

Use this set-up to also discuss the fact that the hemispheres have opposite seasons. Also apply this concept to the distance misconception and include the fact that the Earth is closest to the Sun in January and that the variation in distance is only about 3%.

Part B: Show students this animation on seasons:

(<http://www.astro.uiuc.edu/projects/data/Seasons/seasons.html>) with a computer projector system (Flash Player plug-in is required, but can be downloaded at the site). While viewing the page, students should be able to

- discuss the connection between day length and heating
- discuss what "seasons" on the Earth would be like if the Earth was not tilted or if it was tilted at a greater angle

**Activity 5: Weather Predicting (SI GLEs: 2, 6, 7, 8, 9, 11, 12, 17, 22, 27, 30, 39, 40; ESS GLE: 29)**

Materials List: teacher-selected reading material on weather, weather page of local newspaper (one per student), Internet access, Reciprocal Teaching Example BLM, Daily Weather Observation Log BLM, Daily Weather Discussion Guide BLM, Weather Station Symbols BLM, weather reading equipment (anemometer, hygrometer, barometer, rain gauge, thermometer) (see resources for making weather equipment), guest speaker (possible local meteorologist), science learning logs

Part A: Use *reciprocal teaching* ([view literacy strategy descriptions](#)) to address summarizing, questioning, clarifying, and predicting weather phenomena. Begin by placing students into groups of three or four. Each group completes the following steps:

Step 1: Reading: Students take turns reading aloud a few passages of a text to one another. Each reader chooses when to pass the reading to the next student. Decide when the group has read enough and is ready for the next step, a summarization.

Step 2: Summarizing: Provide a summary of the section just read or choose a student to offer a summary. Students should write the summary in the science *learning logs* ([view literacy strategy descriptions](#)). Improve the summary by adding missing elements or voicing thoughts on the passage.

Step 3: Clarifying: If a student is unclear about something or does not fully understand, the group does its best to help. Invite others to voice individual confusions or questions, which the group then addresses. If no clarification is needed, then move to step 4.

Step 4: Stating Outcomes: Reflect back on the reading, seeking some learning outcomes for the students. Advance to the next passage to read, and the four-step process is repeated. Each group can summarize a different text on weather phenomena or a way to measure weather. See Reciprocal Teaching Example BLM for an idea on how to execute

this strategy. Be sure to monitor student groups by moving throughout the room. Provide extra support and modeling for groups having difficulty with the reciprocal process.

Part B: Distribute the Daily Weather Observation Log BLM. Students will observe daily weather and use weather equipment to measure air temperature, wind speed/direction, air pressure, humidity, and precipitation for a two-week period. Students will use the Weather Station Symbols BLM from the New Jersey Department of Environmental Protection (<http://www.state.nj.us/dep/seeds/wssym.htm>) as a guide for writing symbols on the Daily Weather Observation Log BLM. After recording several measurements, students have the chance to compare their results with classmates as well as identify any problems, factors, and questions including how taking accurate measurements and the reliability of their equipment is important. Use the Daily Weather Discussion Guide BLM as a tool to analyze the data collected. Students can take the project further by creating weather graphs to share their data and forecasting the weather based on their observations. Class values should be compared with those of the other classes in the same school or another school in the same system. Students should study the collected data and generate questions that will identify relationships between various weather components such as air pressure and temperature, humidity and air pressure, and dew point and temperature. This study will continue throughout the rest of the unit.

Note: If time permits, students can construct their own weather instruments. Websites that provide directions for constructing them are provided under the Resources section found at the end of this unit.

Part C: Ask students to identify what weather conditions can be shown on a weather map. Using a local newspaper or Internet connection, students will describe symbols for different weather conditions, identify weather patterns, and make predictions. In addition, they will follow weather predictions in newspapers or on TV and evaluate their accuracy. Discuss recent technology advances and their limitations in weather prediction. The students should recognize that meteorologists often interpret meteorological data in several ways that may result in alternative explanations and predictions. If practical, invite a local meteorologist to speak to the class about selected weather topics.

### **Activity 6: Layers of the Atmosphere (SI GLEs: 14, 15, 19; ESS GLE: 26)**

Materials List: one per student group- Atmosphere Layers BLM, adding machine tape 6 meters in length, metric ruler, Atmosphere Layers Analysis, BLM, The Atmosphere Layers Rubric BLM, teacher-selected research/reading material on atmospheric layers, colored pencils

In groups of two, students will use the Atmosphere Layers BLM to construct scale models of Earth's atmospheric layers (troposphere, stratosphere, mesosphere, and ionosphere) on adding machine tape. Students will use their model to determine characteristics of each layer and answer analysis questions on the Atmosphere Layers Analysis BLM.

Note: The Atmosphere Layers Rubric BLM can be used to assess the model.

Background information: The atmosphere can be divided into four layers based on temperature variations. The layer closest to the Earth is called the troposphere. Above this layer is the stratosphere, followed by the mesosphere, then the thermosphere.

Temperature variations in the four layers are due to the way solar energy is absorbed as it moves downward through the atmosphere. The Earth's surface is the primary absorber of solar energy. Some of this energy is absorbed by the Earth as heat, which warms the troposphere. The global average temperature in the troposphere rapidly decreases with altitude until it reaches the tropopause, the boundary between the troposphere and the stratosphere.

The temperature begins to increase with altitude in the stratosphere. A form of oxygen called ozone (O<sub>3</sub>) absorbs ultraviolet radiation from the Sun, which causes this warming. Ozone protects us from most of the Sun's ultraviolet radiation, which can cause skin cancer, genetic mutations, and sunburn. Scientists are concerned that human activity is contributing to a decrease in the amount of ozone in this layer. Nitric oxide, which is the exhaust of high-flying jets, and chlorofluorocarbons (CFCs), which are used as refrigerants in some countries (the US has banned the use of CFC's), may also contribute to ozone depletion.

At the mesosphere, the temperature stops increasing with altitude. The mesosphere does not absorb solar radiation, so the temperature decreases with altitude. At the thermosphere, temperature begins to increase with altitude. Here solar radiation first hits the Earth's atmosphere and heats it. Because the atmosphere is so thin, a thermometer cannot measure the temperature accurately and special instruments are needed. A thin layer in the thermosphere is the ionosphere. Here charged atoms are ionized (have gained or lost electrons so they have a net electrical charge). The ionosphere is very thin, but it is where auroras take place and is responsible for absorbing the most energetic photons from the Sun. Radio waves are bounced off the ions and reflect waves back to Earth. This generally helps radio communication. However, solar flares can increase the number of ions and can interfere with the transmission of some radio waves.

**Activity 7: Air Masses (SI GLEs: 11, 14, 15, 16, 22, 28; ESS GLEs: 27, 43, 44)**

Materials List: covered aquarium tank, punk stick (used to light fireworks), hot water, frozen glass marbles, teacher-selected materials (see Part B), science learning logs

Part A: Create, as a teacher demonstration, a model of a front as follows. Using a covered aquarium tank, set a container of hot water at one end and one with frozen marbles at the other. Place a small piece of punk stick (used to light fireworks) between the hot water and marbles. Cover the tank and observe the air movement in the tank; a small amount of smoke will serve to make circulation patterns more visible. Host a whole class discussion to explain the movement of the smoke in the tank. Using teacher-selected materials, students will compare and contrast the four kinds of fronts (cold, warm, occluded, and

stationary) that occur in their science *learning logs* ([view literacy strategy descriptions](#)). Include in the discussion the limitations of this model.

Identify the processes involved in the creation of land and sea breezes. Land and sea breezes are caused by the difference in temperature between the land and bodies of water. As the air near the land is heated by radiation and conduction, it expands and begins to rise, being less dense than the surrounding air. To replace the rising air, cooler air is drawn in from the surface of the water. This is called a sea breeze. Air above the sea sinks and moves in over the land. Land cools more rapidly than water. In the evening as land cools, air pressure over it increases, resulting in a cool breeze moving out to the water; this process is called a land breeze. Visuals and animation are available under Resources. Students should apply the term *convection currents* while discussing air masses.

Part B: Students should generate a *graphic organizer* ([view literacy strategy descriptions](#)) to summarize the information on all fronts. Students will diagram on the *graphic organizer* the primary air masses that invade the United States and describe where they originated. Using appropriate teacher-selected materials, students can conduct a search to identify and describe different air masses, high and low pressure systems, jet streams, global wind patterns, and other atmospheric phenomena (wind belts, Coriolis Effect). Discuss the movement and collision of air masses and how they affect weather and climate conditions. Describe how unequal heating of Earth's surface affects movement of air masses. Students will then write how the air masses affect weather events. Students need to include in their responses how El Niño and La Niña affect weather and climate globally. Students should examine collected data about these two weather phenomena, make inferences about their effects on Louisiana weather, and predict future weather trends for our state.

**Activity 8: Hurricanes VS Tornadoes (SI GLEs: 12, 19, 29, 30, 38 39; ESS GLE: 27, 28, 44)**

Materials List: teacher-selected reading material, Internet access, publication software, student computers, printing resource, Raft Writing BLM, copy paper

Provide students, individually or in small groups, the Raft Writing BLM. Using the Internet and/or teacher-selected reading materials, instruct students to research contributing factors to hurricanes and tornadoes. They should establish other weather-related data, such as temperatures, rainfall, etc., for each. Once students have acquired this information, ask them to demonstrate their understanding of hurricanes and tornadoes by completing a *RAFTed writing* ([view literacy strategy descriptions](#)) assignment in the form of an informative brochure using a publication software program or copy paper folded to represent a pamphlet. This form of writing gives students the freedom to project themselves into unique roles and look at content from unique perspectives. From these roles and perspectives, students will use *RAFT writing* to explain processes,

describe a point of view, and apply modern technology to our current understandings of hurricanes and tornadoes.

R – Role (role of the writer – Meteorologist)

A – Audience (to whom or what the RAFT is being written – elementary students)

F – Form (the form the writing will take, as in letter, song, etc. – Information Brochure)

T – Topic (the subject focus of the writing – Tornado and Hurricane information)

In their *RAFTed* brochures, students must include pictures of a hurricane and a tornado and identify the following:

1. Anatomy – Include the different “structural components” that make up a tornado and hurricane.
2. Rating Scale – What are the names of the scales used to measure the intensity of hurricanes and tornadoes?
3. Technology – How has technology changed the way hurricanes and tornadoes are studied? Explain why present technology cannot answer all questions regarding hurricanes.
4. Human Impact – How have tornadoes and hurricanes impacted human lives? What preventative measures are in place to ensure human safety?

The students should recognize that meteorologists use logical and empirical data in predicting hurricane and tornado paths and typically leave room for a margin of error in their predictions. Allow students to share their *RAFTed* assignments with the class. Students should look closely for accuracy and logic in the brochures. Students should then visit a local 5<sup>th</sup> grade or distribute the brochures to the teacher for them to use as a resource.

## Sample Assessments

### General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data-collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities via teacher observation of their work and lab notebook entries.
- Student investigations should be evaluated with a rubric.
- All student-developed products should be evaluated as the unit continues.

- For some multiple-choice items on written tests, ask students to write a justification for their chosen response.

### General Assessments

- The student will identify the Sun as the primary source of energy in the water cycle.
- The student will illustrate how water circulates in the water cycle.
- The student will explain how the atmosphere interacts with the hydrosphere to affect weather and climate conditions.
- Given a map with weather patterns, the student will predict the weather.
- Given copies of a U.S. map, the student will draw isotherms, symbols to indicate atmospheric pressure, and graphics to indicate types of weather.

### Activity-Specific Assessments

- Activity 1: The student will illustrate the interactions of water and landforms in the water cycle for their region of the state. The student will identify the major components of the water cycle as well as areas of the region that may be affected by unequal heating, such as lake effect and land and sea breezes.
- Activity 5: Given four successive local weather maps, the student will predict what the weather would be like on the fifth day for a given location. The student will draw the positions of fronts, rain locations, cloud cover, and temperatures of various cities on his/her prediction map. The students will also identify and explain relationships between temperature and air pressure, temperature and humidity, dew point and rainfall, and temperature and humidity
- Activity 6: The students will provide distinguishing characteristics of each atmospheric layer using a bubble map, or flow chart, and include three facts for each layer.

### Resources

#### Water Cycle

- *Water Cycle, Weather, and Climate, Model Lessons for Grade 8*. Available online at <http://www.doe.state.la.us/lde/uploads/2540.pdf>

#### Weather and Climate

- *Bad Meteorology*. Available online at <http://www.ems.psu.edu/~fraser/BadMeteorology.html>

- *World Average Water Vapor Map*. Available online at [http://www.engr.colostate.edu/~ramirez/ce\\_old/classes/ce422\\_ramirez/CE422\\_Web/WaterVapor/water\\_vapor\\_CE322.htm](http://www.engr.colostate.edu/~ramirez/ce_old/classes/ce422_ramirez/CE422_Web/WaterVapor/water_vapor_CE322.htm)
- *Earth's Atmosphere*. Available online at <http://csep10.phys.utk.edu/astr161/lect/earth/atmosphere.html>
- *Build Your Own Weather station* <http://www.fi.edu/weather/todo/todo.html>
- Konvicka, Tom. (1999). *Teacher's Weather Sourcebook*. Teacher Ideas Press. Englewood, Colorado.
- *Make a Weather Station* <http://www.k12science.org/curriculum/weatherproj2/en/activity1.shtml>
- *World Climate*. [http://www3.shastacollege.edu/dscollon/images/Maps-Images/world\\_climate\\_map.jpg](http://www3.shastacollege.edu/dscollon/images/Maps-Images/world_climate_map.jpg)
- *Beaufort Wind Speed Scale* <http://www.unc.edu/~rowlett/units/scales/beaufort.html>
- *Water Cycle, Weather, and Climate: Model Lessons for Grade 8*. Available online at <http://www.doe.state.la.us/1de/uploads/2540.pdf>.
- *Twenty Questions and Answers About the Ozone Layer* <http://www.esrl.noaa.gov/csd/assessments/2006/twentyquestions.html>
- *Sea breeze/land breeze* [http://www.classzone.com/books/earth\\_science/terc/content/visualizations/es1903/es1903page01.cfm?chapter\\_no=visualization](http://www.classzone.com/books/earth_science/terc/content/visualizations/es1903/es1903page01.cfm?chapter_no=visualization)
- *USA Today Sea breeze/land breeze* <http://www.usatoday.com/weather/wseabrze.htm>

#### Hurricanes

- *NOAA's Hurricanes* <http://hurricanes.noaa.gov/>
- *The Visualization of Remote Sensing Data (VRSD)* Web site is available at <http://rsd.gsfc.nasa.gov/rsd/> and has spectacular satellite images, movies, and QuickTime virtual reality movies.

#### Printable Hurricane Tracking Maps

- *NOAA's Hurricane tracking chart* is available at [http://www.nhc.noaa.gov/gifs/track\\_chart.gif](http://www.nhc.noaa.gov/gifs/track_chart.gif)
- *NOAA's Atlantic tracking chart* [http://www.nhc.noaa.gov/AT\\_Track\\_chart2.pdf](http://www.nhc.noaa.gov/AT_Track_chart2.pdf)
- *NOAA's Pacific tracking chart* [http://www.nhc.noaa.gov/EPAC\\_Track\\_chart.pdf](http://www.nhc.noaa.gov/EPAC_Track_chart.pdf)

**Grade 8  
Science  
Unit 6: Earth's Forces**

**Time Frame:** Approximately two weeks



**Unit Description**

This unit focuses on demonstrating the magnetic fields of bar magnets and making comparisons to those of Earth; demonstrating Newton’s laws of motion; defining gravity and its relationship to mass and distance between objects; and explaining relationships between force, mass, and acceleration.

**Student Understandings**

Students develop an understanding of magnets and magnetism and how this force exists in nature. Students demonstrate Newton’s laws of motion and how it relates to gravity. Students develop an understanding of the force of gravity and its effect on the behavior of objects on or near Earth, as well as in space.

**Guiding Questions**

1. Can students use a compass to determine the direction of a magnetic field??
2. Can students explain how two magnetic fields combine?
3. Can students describe the changes in the force of gravity as the distance between two masses changes?
4. Can students demonstrate examples of Newton’s Laws of Motion?
5. Can students describe Newton’s Second Law of Motion and explain how it relates to gravity?

**Unit 6 Grade-Level Expectations (GLEs)**

GLE #	GLE Text and Benchmarks
<b>Science as Inquiry</b>	
<i>The following SI GLEs are embedded in the suggested activities for this unit. Additional activities incorporated by teachers may result in additional SI GLEs being addressed during instruction on the Magnetism and Gravity unit.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)

<b>GLE #</b>	<b>GLE Text and Benchmarks</b>
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
3.	Use a variety of sources to answer questions (SI-M-A1)
4.	Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2)
5.	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
10.	Identify the difference between description and explanation (SI-M-A4)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
13.	Identify patterns in data to explain natural events (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
20.	Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7)
21.	Distinguish between <i>observations</i> and <i>inferences</i> (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
23.	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
25.	Compare and critique scientific investigations (SI-M-B1)
27.	Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1)
28.	Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
34.	Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5)
<b>Physical Science</b>	
4.	Demonstrate that Earth has a magnetic field by using magnets and compasses (PS-M-B2)
5.	Define gravity and describe the relationship among the force of gravity, the mass of objects, and the distance between objects (PS-M-B2)
6.	Predict how the gravitational attraction between two masses will increase or decrease when changes are made in the masses or in the distance between the objects (PS-M-B2)

GLE #	GLE Text and Benchmarks
7.	Explain the relationships among force, mass, and acceleration (PS-M-B5)
<b>Earth and Space Science</b>	
39.	Relate Newton's laws of gravity to the motions of celestial bodies and objects on Earth (ESS-M-C3)

### Sample Activities

#### Activity 1: Magnetism (SI GLEs: 1, 2, 4, 7, 11, 12, 13, 19, 22, 23; PS GLE: 4)

Materials List: safety goggles, iron filings, transparencies, trays, flux path compasses (one per student group), bar magnets (two per student group), sticky-paper notes, yarn, ring stand (optional)

*Safety Note: Students should wear safety glasses or goggles to prevent iron filings used in this activity from getting into their eyes.*

The magnetic field around a permanent magnet, like the gravitational field around a massive object, is not only invisible but also hard for many students to comprehend. With no concrete experience to draw from, they tend to ignore this basic concept or, at best, memorize facts about it. This activity allows students to map a magnetic field and find out how a bar magnet's field models Earth's magnetic field.

Part A: Students create a *split-page notes* ([view literacy strategy descriptions](#)) document on notebook paper. Fold the notebook paper in half, vertically (like a hotdog). On the left side of the fold, students will write questions about magnets and magnetic fields. On the right side of the fold, they will write their observations from the experiment that answers each question. Elicit at least one question from each group and write their questions on the board or project them with an overhead.

Model the following set-up to the whole class. Provide student groups with two bar magnets, sticky-paper notes, and yarn. Have the students wrap the pole of one of the magnets with sticky-paper notes (or other paper) to conceal the pole names and tie a string around the middle of the pole-covered magnet. Students can use a ring stand or hold the magnet by the yarn to allow it to hang freely in the air. Make sure the knots around the magnets are tight; dropping the magnets can de-magnetize them. Students should use the second bar magnet to experiment how the poles interact with each other. Ask the students to write down their observations from their experimentation and questions they may still have about magnetic force fields on their *split-page notes*. After several minutes, ask group members to share observations, ideas, and questions; write these on the board next to the questions they answer or generate a new list of questions, observations, or ideas. Ask probing questions that will lead to suggestions by the students as to how a magnetic field can be made visible. Upon agreement that something has to be put into the magnetic field for it to be seen, explain to the students how they can

demonstrate the field around a bar magnet with iron filings. After completing the *split-page notes* on magnetism, gather the class back together. Solicit observations from each group and discuss their findings with the class. Compare student findings. Some teacher guidance may be needed.

Part B: Have students place a bar magnet in the center of a cookie sheet or tray made of aluminum foil and place the overhead transparency on top of the magnet (this can also be done as a teacher demonstration using an overhead projector). Sprinkle iron filings on top of the transparency around the magnet. Gently tap on the tray around the magnet to line up the iron filings with the magnetic field. The students then draw and label the magnet and field lines they see. Caution students that when spreading iron filings on the transparency, it is very important that they do not blow on or accidentally sneeze on the filings. After careful observation of the field lines, the students should answer the following questions:

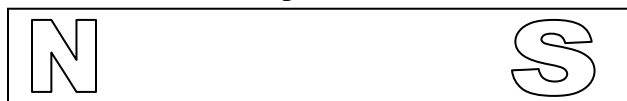
- What do you notice about the magnetic field at the poles compared to the center of the magnet? Why do you think this happens?
- Where are the magnetic field lines parallel to the magnet?
- Where are the field lines directly toward the magnet?

Part C: Explain that Earth's magnetic field is very similar to those produced by the bar magnet. Naturally, there is not really an enormous bar magnet hidden deep underground, but the Earth behaves as if there was. A compass needle does not point to Earth's true geographic North Pole. Earth's magnetic field lines enter the north geographic pole and exit the south geographic pole, as the following link indicates (<http://solar.physics.montana.edu/YPOP/Spotlight/Magnetic/what.html>). Earth's geographic poles correspond to the "exit points" of the imaginary axis on which it rotates. So as Earth rotates on its axis, its magnetic pole wobbles around the rotational axis. The following link shows the change of rotation of the axis ([http://www.jb.man.ac.uk/distance/strobel/nakedeye/nakedeya\\_files/precess.gif](http://www.jb.man.ac.uk/distance/strobel/nakedeye/nakedeya_files/precess.gif)). There is geologic evidence that supports Earth's physical north and south poles shifting prior to their present-day locations; in other words, the axis of rotation had been "shifted."

About 70,000 years ago, a compass needle would have pointed south. This difference indicates that over time Earth's magnetic field is periodically inverted. These magnetic inversions are recorded in rock with high ferrous content, such as basaltic lava, and can be used to date lava flows. They can also be used to visualize the way the ocean floor expands, starting at the oceanic rift ridges.

Ask the students to suggest ways to make the magnet's and Earth's geomagnetic field visible and show how it interacts with the magnetic field. The students should suggest putting small compasses (*flux path compasses*) around the magnet. Have the students place a bar magnet on a piece of notebook paper. Label the North and South poles of the magnet on the paper. Allow the students time to experiment with the way the compass reacts when moved around the perimeter of the magnet. Now have students lay a small compass on the paper, touching the bar magnet at the North Pole. Place a dot outside the compass case on the notebook paper, in line with the end of the needle pointing away

from the magnet. Move the compass in the direction the needle points until it is just beyond the dot you just made. Place a second dot where the needle points now. Continue to move the compass and make dots until you reach another point on the bar magnet or the edge of the paper. Connect the dots with a smooth curve. Repeat for other lines, spread out more or less evenly over the area. Determine and label a direction for each line. The N-seeking tip of a compass will point to the North Pole of Earth or the S end of a bar magnet. Draw arrowheads on each line. Find and label areas where each of the two fields dominates so much that they appear to be the only factor. Find and label an area where the two fields cancel and explain their evidence for this canceling.



Post students' geomagnetic field maps. Have students on each team explain which side of their map faced geomagnetic North and how the geomagnetic lines were "warped" by the bar magnet. After examining the geomagnetic field maps, the students should answer the following:

- Explain why the magnetic North Pole is in a different location from the geographic North Pole.
- Explain that in the Northern Hemisphere, the needle of the compass will point to the magnetic north because it is magnetized. When a compass is held on Earth, Earth's magnetic field exerts a force on the needle. This should help the students understand that Earth also has magnetic properties. If the north-seeking part of a compass is attracted to the magnetic north pole of Earth, then the polarity of Earth's north magnetic pole is actually south.

Review the concepts learned from this investigation by drawing the Earth on an overhead transparency and labeling the geographic poles. Place a bar magnet on the overhead. Be careful not to drop the magnet on the glass surface. Rotate the "Earth" transparency so that Earth's geographic poles make an 11.5-degree angle with the N and S poles of the magnet. Sprinkle iron filings over the transparency and tap it lightly. Ask the students to describe how this model is similar to Earth and its magnetic field and its changing position over time, as evidenced in the orientation of magnetic minerals.

Challenge the students to research ways that technology has been used to increase our knowledge of Earth's magnetic field.

### **Activity 2: Gravity (SI GLEs: 1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 21, 22; PS GLEs: 5, 7)**

Materials List: Vocabulary Self-Awareness Chart BLM (one per student), Internet access, feather, ball (i.e., tennis, baseball, large bouncing ball, etc.)

Part A: Create an *opinionnaire* ([view literacy strategy descriptions](#)) by generating statements about gravity that force students to take positions and defend them. The statements should be written in such a way as to elicit attitudes and feelings, which in

turn activate relevant prior knowledge and lead to engaged reading and listening (examples: all objects fall to the ground at the same rate; a bowling ball will fall to the ground faster than a baseball). Afterward, invite students to share their opinions for each statement and separate supporters from non-supporters; the emphasis is on students' points of view and not the "correctness" of their opinions. Encourage each student to take a stand; they can go to two corners of the room – agree or disagree. Then, ask the two groups to briefly debate the statement and allow for any students who have changed their minds to move to the other group. By taking a stand on issues related to gravity and engaging in critical discussion about those issues, students will heighten their expectation of the content about gravity to follow and make many new connections from their opinions and ideas to those of their classmates.

Part B: During this part of the unit, students maintain a *vocabulary self-awareness* ([view literacy strategy descriptions](#)) chart using Vocabulary Self-Awareness Chart BLM. Begin by identifying target vocabulary. Provide a list of words to students at the beginning of this part of the unit and have them complete a self-assessment of their knowledge of the words using the Self-Awareness Check BLM. Do not give students definitions or examples at this stage. Ask students to rate their understanding of each word or law with either a "+" (understand well), a "✓" (limited understanding or unsure), or a "-" (don't know). Over the course of the readings and exposure to activities throughout the unit, students should be told to return often to the Self-Awareness Chart BLM and add new information to it. The goal is to replace all the check marks and minus signs with a plus sign. Because students continually revisit their vocabulary charts to revise their entries, they have multiple opportunities to practice and extend their growing understanding of vocabulary related to the topics of *forces of motion* and *gravity*. If after studying these key terms, students still have checks or minuses, the teacher should be prepared to provide extra instruction for these students.

Without air resistance, all objects would fall with the same acceleration, regardless of mass. Gravity is the force that causes objects to fall. Air resistance, a type of friction, works against gravity to decrease the acceleration of a falling object.

Ask students to predict what would happen if they dropped a feather and a ball from the same height (they should perform this as a demonstration). Solicit all results such as drop time and actions of the objects. Next, ask the students to predict what would happen to these items if dropped in a vacuum tube, which has no air in it. (The feather would fall at the same rate of speed as a ball.) Identify the independent and dependent variables that should be controlled in designing such an experiment. Students then should be given a story to read or read aloud the short story about Galileo Galilei (1564–1642) and his famous experiment with the Leaning Tower of Pisa (see <http://www.seed.slb.com/en/scictr/lab/galileo/index.htm>). Click on Galileo's name for the story. Next, click on the picture for a virtual lab and display it for the entire class to view. This works well with an interactive board; if unavailable, a computer and projector will display the virtual lab. The instructions are online; students can "remove the air" around the tower and Galileo by putting him in a vacuum. Have students observe what

happens when different objects are dropped at the same time with and without air resistance.

If Internet connection is unavailable in the classroom, then the teacher can download a NASA QuickTime video from <http://www.hq.nasa.gov/alsj/a15/a15v.1672206.mov> showing the feather and hammer experiment on the moon. The video can also be downloaded with REALPLAYER from <http://www.hq.nasa.gov/alsj/a15/a15v.1672052.rm> (the experiment actually begins about one minute into the video). The teacher can save these from an Internet connected computer onto a DVD or a disc, and the students can view them without Internet connection. Ask the students if the same experiment on other planets would produce the same results (assuming no air resistance).

Each student should write a report explaining the results of the experiments and drawing conclusions regarding the effects of both gravity and air resistance on the acceleration of falling objects and the relationship among force, mass, and acceleration. Encourage students to accompany their paragraphs with labeled drawings and diagrams. Discuss reasons why scientists must use a variety of techniques, such as experimentation and data collection to solve problems and make discoveries. Remind students to include the difference between descriptions and explanations and observations and inferences during their discussion.

Part C: Ask the students to think about the word *gravity*. Draw a picture of Earth on the board or overhead (see Figure 1-picture shown not to scale). Have students brainstorm in small groups what would happen to the ball as it is dropped to Earth at each of the positions on Earth (see Figure 1). Students should draw the path of the ball and its path towards Earth. In a whole-class discussion, show the students that the ball will fall toward Earth's center. Students should show the ball falling with a straight line towards Earth's surface, near each figurine's feet.

Figure 1



PART D: Divide the class into groups to research, discuss, and answer one of the following question groupings. Each group should prepare a presentation for the class.

- Compare and contrast the force of gravity on Earth with the force of gravity on one of the other rocky planets in our solar system. Which planet has a

stronger gravitational force? What would be the effects on astronauts' bodies when visiting the other planet for an extended period of time?

- Use data to find the gravitational forces of the selected planets compared to Earth and recalculate Olympic records in weightlifting, track and field, etc. for the chosen planet (use metric measure). Describe the performance of Olympic athletes on these planets.
- Describe the physical features on Earth's surface that were influenced by gravity during their formation or that are influenced by it now. How would these features look if Earth's gravitational force were significantly weaker or stronger?
- Describe the gravity experiments conducted by Galileo, Newton, and Cavendish. How were these experiments similar? How did these scientists build on each other's research and observations to make their discoveries?

Students should revisit their *vocabulary self-awareness* chart to see if they can replace any of the check marks and minus signs with a plus sign.

**Activity 3: Newton's Law of Universal Gravitation (SI GLEs: 2, 12, 19, 25, 27, 28, 34; PS GLEs: 5, 6)**

Materials List: teacher-selected reading material about Galileo Galilei, books for research or Internet access, poster-size paper, string or yarn, index cards, computer projector, optional software for concept map

Part A: Have the students compare and critique scientific investigations of Johannes Kepler, Tycho Brahe, Galileo Galilei, and Nicholas Copernicus. Kepler theorized that planets closest to the Sun moved faster than those farther away. However, it was Isaac Newton that finally explained Kepler's theory. Newton's Law of Universal Gravitation states that the force of gravity depends on the product of the masses of the objects divided by the square of the distance between them. If two objects have a mass of 1kg and are moved twice as far apart, the gravitational attraction between them will decrease by a factor of  $\frac{1}{4}$ . How can something you multiply (factor/times) show a reduction? This is because of the division by the square of the distance:  $F_{\text{grav}} = (m_1 \times m_2) / d^2$ , where  $F_{\text{grav}}$  = the force of gravity between the two objects,  $m_1$  and  $m_2$  are the two objects' masses,  $d$  is the distance. As in the previous example,  $(1\text{kg} \times 1\text{kg}) / 2^2 = \frac{1}{4}$  the force of gravity. Challenge the students to calculate how much of a gravitational decrease would occur if the same objects were moved 10 times farther apart ( $10 \times 10 = 100$  times less than the original force of gravity).

Challenge the students to work cooperatively to solve the following separate problems. "If you could increase Earth's mass by two times, how much gravitational influence would Earth have on an orbiting satellite?" (*twice as much*) "If the satellite is boosted three times farther from Earth, would the gravitational pull on the satellite be more or less?" (*less*) "How much of a difference would there be?" ( $3 \times 3 = 9$  *times less than the original force of gravity*).

For closure, have students form groups of three or four to construct a concept map, a *graphic organizer* ([view literacy strategy descriptions](#)), of gravity. Provide students with poster-size paper, string or yarn, and cards that have key terms and phrases as well as blank cards for student-generated terms and phrases. If software programs for concept maps are available, students can construct their concept map using a computer and the program. Students should be able to print these. Allow a two-minute talk for each student group to share their concept map with the class. Students' concept maps could be displayed in the classroom.

**Activity 4: Modeling Newton's Laws of Motion (SI GLEs: 4, 6, 12, 13, 14, 20, 22; PS GLE: 5, 7; ESS GLE: 39)**

Materials List: six pennies, chair with wheels or plant base with wheels for students to ride, balloon, straw, tape, fishing string, computer and projecting system (optional-one computer per student); one per student: Reciprocal Teaching: Teacher Notes BLM, Reciprocal Teaching: Discussion Guide BLM; several student textbooks, one old tennis ball, golf ball, baseball, softball, basketball, 10 yards of one-inch-wide cloth ribbon, force spring scale, teacher-selected resource material on the Solar System's planets, chart of planetary orbital speed (see Part C)

*Safety Note: When demonstrating motion students should be attentive to the location of other people and the amount of space needed to complete the exercise.*

Newton's First Law of Motion states that an object at rest will remain at rest and an object in motion will remain moving in a straight line, until an outside force acts on the object. Students can demonstrate inertia by observing a book at rest on a desk or table. It will remain at rest until some force acts upon it. Students should identify the forces acting on each part of the demonstration.

The term *inertia* refers to the tendency of an object to stay at rest. To model the first law, inertia, stack five pennies, one above the other, on a flat surface. Use a pen or pencil to flick one penny toward the stack of coins. One penny at the bottom of the stack will come out and the stack will shift down. Students should notice that a force is applied to the card and not to the coin. Students should identify the forces acting on each part the demonstration.

Part A: Using teacher-selected reading material, guide the students to a *reciprocal teaching* strategy ([view literacy strategy descriptions](#)) using the Reciprocal Teaching: Discussion Guide BLM. This will allow the student to summarize, question, clarify, and predict about Newton's Laws of Motion. (See Reciprocal Teaching: Teacher Notes BLM). Begin by introducing students to the technique of summarizing. Share several short sections at the beginning of a text taken from a teacher-selected reading source about Newton's Laws of Motion and write a summary statement with the class. Talk out loud about how you summarized the reading material with the students. Put the statements on the board for analysis and revision. Next, have students work in groups of

four to read a following short section of text and generate a summary statement. Write the various statements on the board and work with the class to select the best one.

Follow the process for each of the remaining comprehension processes that comprise reciprocal thinking: questioning, clarifying, and predicting. After modeling the comprehension process of *reciprocal teaching*, have students work in their groups of four with each one taking responsibility for one of the comprehension processes as in summarizer, questioner, clarifier, and predictor. Assign the next section of text about Newton's Laws of Motion and tell students to interact while reading with each student, taking the lead to model and guide the others in comprehension process over which s/he is responsible. Students should use Reciprocal Teaching: Discussion Guide BLM to help them fulfill their roles. Monitor student groups by moving throughout the room. Provide extra support and modeling for groups having difficulty with the reciprocal processes.

Part B: Newton's First Law of Motion also addresses a very common event that most students will recognize. The more massive an object, the more it resists any change in motion. Use the example of riding in a car. When a car accelerates, a body falls back. If the car stops, the body continues forward. It should be noted that the body is continually resisting motion but forces are causing the motions. Students can experience this law by using a rolling chair with a student seated in it. Another student can accelerate the seated student from a dead stop to a safe speed in a short distance. Both the student seated and student pushing the chair should describe the forces involved in their demonstration as well as what each student was feeling during the demonstration. *Safety note: warn students about pushing students too fast in the chair.*

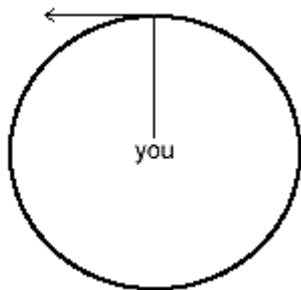
Newton's Second Law of Motion states acceleration is equal to force divided by mass; the greater the force (the less the mass), the greater the acceleration ( $\text{force} = \text{mass} \times \text{acceleration}$ ). Students can view and interact with the following website: <http://www.ic.arizona.edu/~nats101/n2.html>. The higher the number you type into the box, the more force you are using. Pay special attention to the relationship between the force and how fast the rhinoceros moves. Have students create other situations that are similar to this demonstration. For example, a child will not easily move a wheelbarrow filled with dirt as a construction worker might. However, if the mass of the wheelbarrow is increased, the construction worker will not be able to move it as easily as before.

Newton's Third Law of Motion states for every action, there is an equal and opposite reaction. Students should research this law to find out how to demonstrate "action-reaction." Student demonstrations may include blowing up a balloon, taping it to a straw that has been placed outside a length of fishing line. The fishing line should be pulled tight between two objects and let the air out of the balloon. Students should notice that the balloon moves in the opposite direction of the expelled air. When asked, the students should identify that the action force is the escaping air and the reaction force is the forward movement of the balloon. Other common examples of action/reaction are kicking a ball, hot gases coming out the bottom of a rocket, and a person walking.

Part C: Challenge the students to examine a chart of average orbital speed of the planets, which can be found online at

<http://www.enchantedlearning.com/subjects/astronomy/planets/>. Have the students suggest reasons why the planets orbital speeds vary and identify how Newton's Laws relate to the motion of celestial bodies ([http://www.spacegrant.hawaii.edu/class\\_acts/OrbitsTe.html](http://www.spacegrant.hawaii.edu/class_acts/OrbitsTe.html)). Using a tennis ball and ribbon, the teacher should demonstrate orbital motion – conduct this investigation outside and students should stand a safe distance from the demonstration where possibly flying tennis balls will not harm people or property. The pull of the hand through the ribbon represents gravity. Collect the following: one old tennis ball, golf ball, baseball, softball, basketball, 10 yards of one-inch-wide cloth ribbon, and a force spring scale. (This can also be done as a small group activity instead of a teacher demonstration.)

To construct: Wrap one end of the ribbon around the tennis ball in multiple directions, creating “wedges” on the surface of the ball, and tie the end closed so that a leash is created for the tennis ball. Repeat for other balls. Attach a spring scale at the end of the ribbon for measurement. When released, the ball will fly off on a tangent to the circle.



Attach the free end of the ribbon of one of the balls to the force spring scale and swing the ball in a circle on the ground (preferably large smooth area such as gym floor or parking lot). While holding the spring scale, begin to swing the ball in a circle on the ground and record the force needed to initially move the ball. After completing a circle, let go of the spring scale and watch which direction the ball travels. The ribbon makes it easier to follow the direction of the ball. The circle shown above represents the path of the ball while you were swinging it with the ribbon. Students should draw an arrow from the circle to represent the path of the ball when released on their paper or on the concrete. Repeat with the different balls, remembering to record the force needed for each.

In this activity, the centripetal force on the ball is produced by ribbon tension. In other words, the ribbon transmits the centripetal force, which pulls the ball into a circular path. For a satellite orbiting Earth, remind the students that there is no ribbon connection! Students should mass and calculate the volume of each ball. Discuss with the students what produces the centripetal force. Have them note the initial force needed to start the ball moving and the force required to keep the ball moving in a circle. An explanation: A center-directed force that causes an object to follow a circular path is called a *centripetal force*. Part of Newton's First Law of Motion states that an object in motion will move in a straight line unless acted on by an unbalanced force. In the case of the tennis ball, the inward pull on the ribbon is the unbalance force that keeps the ball traveling in a circle instead of a straight line. Upon release, the ball travels away in a straight line in the exact

direction it was traveling at that very moment of release. In the case of a satellite in space, the launch vehicle that carried it up to orbit aimed it in a direction parallel to the Earth's surface. Earth's gravity acts as an unbalance force, pulling on the satellite and causing the satellite to follow a circular path. Newton's Second Law of Motion is addressed as the balls with different masses are related to the forces needed (initial and continuing) for centripetal motion. Students can then calculate the acceleration of the balls using the formula,  $\text{force} = \text{mass} \times \text{acceleration}$ .

## Sample Assessments

### General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data-collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities via teacher observation of their and lab notebook entries
- All student-developed products should be evaluated as the unit continues.
- Student investigations should be evaluated with a rubric.
- For some multiple-choice items on written tests, ask students to write a justification for their chosen response.

### General Assessments

- Students will predict the location of areas where two fields can cancel each other to leave no resultant field.
- Students will draw and describe Earth's magnetic fields.
- Students will identify various examples of Newton's Laws of Motion.
- Students will explain how gravity keeps a planet orbiting the Sun.

### Activity-Specific Assessments

- Activity 1: Students will compare the pattern made by the iron filings near a bar magnet to pictures of magnetic fields around Earth and sunspots.
- Activity 3: Students will analyze planetary data that includes the mass, diameter, and composition and infer reasons why some planets have a stronger gravitational

force than Earth. Students will respond to hypothetical problems such as the following: Suppose that two objects attract each other with a force of 16 units. If the distance between the two objects is doubled, what is the new force of attraction between the two objects?

- **Activity 4:** Using an old CD, balloon, water bottle pull-up top, and hot glue, students will explain how Newton's Laws of Motion apply to the movement of the mini-hovercraft. Blow up the balloon, and with the bottle top close (or pushed down), fit the inflated balloon around the mouth of the mechanism. Glue the top to the center of the CD. Pull up the top and give the mini-hovercraft a little flick with a finger.

### Resources

#### Magnetism

- "Circles of Magnetism I" Exploratorium  
[http://www.exploratorium.edu/snacks/circles\\_magnetism\\_I.html](http://www.exploratorium.edu/snacks/circles_magnetism_I.html)
- *The effects of Magnetic Fields*  
[http://www.esa.int/SPECIALS/Lessons\\_online/SEM4W1V7D7F\\_0.html](http://www.esa.int/SPECIALS/Lessons_online/SEM4W1V7D7F_0.html)
- *Windows to the Universe*  
[http://www.windows.ucar.edu/tour/physical\\_science/magnetism/magnetic\\_field.html](http://www.windows.ucar.edu/tour/physical_science/magnetism/magnetic_field.html)

#### Gravity

- *Interactive Vacuum Experiment* –  
<http://www.hazelwood.k12.mo.us/~grichert/explore/dswmedia/freefall.htm> will need to download free software *SHOCKWAVE* –  
<http://www.adobe.com/shockwave/download>
- *NASA video of hammer and feather experiment on the Moon*  
<http://www.hq.nasa.gov/alsj/a15/video15.html#closeout3>
- *Gravity on Other Planets (alternate activity)*  
<http://www.sciencespot.net/Media/gravlab.pdf>
- *Galileo and his experiment with Pisa*  
<http://www.pbs.org/wgbh/nova/pisa/galileo.html>
- *Sir Isaac Newton: The Universal Law of Gravitation*. Available online at  
<http://csep10.phys.utk.edu/astr161/lect/history/newtongrav.html>
- *Windows to the Universe*. Available online at <http://www.windows.ucar.edu>
- *Explore Learning* website requires a subscription fee, but it has a great gravity virtual lab [www.explorelearning.com](http://www.explorelearning.com)

#### Forces

- *Stop Faking it Force and Motion*. NSTA Press

## Motion

- *Science Spot Activities on Newton's Laws* at <http://www.sciencespot.net/Pages/classphys.html>
- *Newton's laws webquest* <http://www.can-do.com/uci/ssi2001/newtonphysicsnb.html>
- *The Physics Classroom* <http://www.glenbrook.k12.il.us/GBSCCI/PHYS/Class/newtlaws/newtltoc.html>
- *Physics Center – Interactive websites* <http://www.physicscentral.com/resources/interactive.html>

**Grade 8  
Science  
Unit 7: Astronomy and Space Exploration**

**Time Frame:** Approximately six weeks



**Unit Description**

This unit focuses on astronomy and space exploration: how the study of the Solar System’s structure, movements, and the continuing developments in technology enable us to understand Earth and its place in the solar system—in the Milky Way galaxy.

**Student Understandings**

The student will understand the basics of astronomy (i.e., bodies and events associated with the solar system, stars, and the universe, as well as Earth’s particular characteristics and how it is affected by the Sun, the Moon, etc.). The student will understand discoveries made by modern astronomy and the technology that has been developed for space exploration. Students will learn about those who paved the way for space flight and the knowledge gained from manned and unmanned space explorations.

**Guiding Questions**

1. Can students order persons, events, and discoveries in the history of astronomy and space exploration?
2. Can students compare relative distances, motions, and sizes of astronomical bodies?
3. Can students explain the cause of Earth’s seasons?
4. Can students describe and predict the patterns of change that result in Moon phases and eclipses?
5. Can students identify angular relationships between Earth, the Sun, and Moon that result in the various phases of the moon?
6. Can the students identify the alignments of Earth, the Sun, and Moon that result in solar and lunar eclipses?
7. Can the students use data to verify the dates of Earth’s perihelion and aphelion?
8. Can students describe how scientists determine the size, composition, and temperature of astronomical bodies?
9. Can students demonstrate their knowledge of the relationships between improvements in technology and subsequent discoveries in space?

**Unit 7 Grade-Level Expectations (GLEs)**

<b>GLE #</b>	<b>GLE Text and Benchmarks</b>
<b>Science as Inquiry</b>	
<i>The following Science as Inquiry SI GLEs are embedded in the suggested activities for this unit. Additional activities incorporated by teachers may result in additional SI GLEs being addressed during instruction on the Astronomy and Space Exploration unit.</i>	
3.	Use a variety of sources to answer questions (SI-M-A1)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
13.	Identify patterns in data to explain natural events (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
15.	Identify and explain the limitations of models used to represent the natural world (SI-M-A5)
18.	Identify faulty reasoning and statements that misinterpret or are not supported by the evidence (SI-M-A6)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
29.	Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3)
33.	Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
35.	Explain how skepticism about accepted scientific explanations (i.e., hypotheses and theories) leads to new understanding (SI-M-B5)
38.	Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)
39.	Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)
40.	Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7)
<b>Earth and Space Science</b>	
32	Interpret a timeline starting with the birth of the solar system to the present day (ESS-M-B2)
36.	Describe the life cycle of a star and predict the next likely stage of the Sun (ESS-M-C1)

GLE #	GLE Text and Benchmarks
37.	Use a Hertzsprung-Russell diagram and other data to compare the approximate mass, size, luminosity, temperature, structure, and composition of the Sun to other stars (ESS-M-C1)
38.	Use data to compare the planets in terms of orbit, size, composition, density, rotation, revolution, and atmosphere (ESS-M-C2)
39.	Relate Newton's laws of gravity to the motions of celestial bodies and objects on Earth (ESS-M-C3)
40.	Identify and illustrate the relative positions of Earth, the Moon, and the Sun during eclipses and phases of the Moon (ESS-M-C4)
41.	Describe the effects of the Moon on tides (ESS-M-C4)
42.	Interpret a scale model of the solar system (ESS-M-C5)
48.	Communicate ways that information from space exploration and technological research have advanced understanding about Earth, the solar system, and the universe (ESS-M-C8)
49.	Identify practical applications of technological advances resulting from space exploration and scientific and technological research (ESS-M-C8)

Note to the Teacher: For this unit, have student maintain a science *learning log* ([view literacy strategy descriptions](#)). Explain that explorers, scientists, and mathematicians have always kept logs of their observations, thoughts, new understandings, hypotheses, and reflections. In this way, they could record progress, test new ideas, and document what they learned. Similarly, with the science *learning logs* for this unit, students will record new understandings, explain science processes, pose and solve problems, make and check predictions, and reflect on what has been learned.

Each class session, present students with a science *learning log* writing prompt. This can be at the beginning of class, requiring predictive thinking for that day's lesson or reflective thinking about what was learned in the previous class. Structure the prompts so students write for no more than five to seven minutes. Prompts can be related to specific content or new understandings.

### Sample Activities

#### Activity 1: In This Little Corner (SI GLEs: 3, 14, 19, 29, 38, 40; ESS GLE: 32)

Materials List: teacher-selected research material, index cards, This Little Corner Rubric BLM, student-selected materials for model, Vocabulary Self-Awareness Chart

Part A: Determine students' prior knowledge of astronomy using the *vocabulary self-awareness chart* ([view literacy strategy descriptions](#)). Provide a list of words to students at the beginning of this part of the unit and have them complete a self-assessment of their knowledge of the words using the Vocabulary Self-Awareness Chart BLM. Do not give students definitions or examples at this stage. Ask students to rate their understanding of

each word or law with either a “+” (understand well), a “√” (limited understanding or unsure), or a “-” (don’t know). Over the course of the readings and exposure to activities throughout the unit, students should be told to return often to the chart and add new information to it. The goal is to replace all the check marks and minus signs with a plus sign. Students will continually revisit their vocabulary charts to revise their entries, which will provide multiple opportunities to practice and extend their growing understanding of key terms related to stars. If after studying these key terms, students still have checks or minuses, the teacher should be prepared to provide extra instruction for these students.

Part B: Note, this part of the activity is mostly completed outside of the classroom, and students should spend approximately two weeks completing their research. In advance, prepare a set of cards identifying various solar system objects (a nebula, the Sun, planets, asteroids, meteoroids, moons, comets) that will be used to assign topics to student groups.

It is widely accepted that the solar system is approximately 4.6 billion years old. In order for students to investigate further the ages of celestial bodies within the solar system, each student team should draw a card from those prepared by the teacher and research the specific celestial body selected. Students have the opportunity to choose how they present their information: as a research report or to create a model.

Students will first create a *graphic organizer* ([view literacy strategy descriptions](#)) such as a flow chart that shows clear, logical relationships between all topics and subtopics of their assigned body. Distribute This Little Corner Rubric BLM to students so that they may understand how their *graphic organizer* and presentation will be scored. Students should research using available teacher-selected resources and determine the order of formation of their body. Students should research how planetary exploration and the technology that has developed along with it have provided valuable evidence to support or negate the current theory of the solar system’s origin and how it is helping scientist make predictions about the future of our own planet. Students will prepare and present their information to the class—oldest to most recent—thus interpreting a timeline starting with the birth of the solar system to the present day.

**Activity 2: Scale Model of the Solar System (SI GLEs: 13, 14, 15, 19, 33; ESS GLEs: 38, 42)**

Materials List: Word Grid Example BLM, Word Grid Example With Answers BLM; one of each- 6ft diameter yellow paper circle, small purple bead, regular-size yellow marble, regular-size blue and white marble, 2-silver BBs, 1/3 inch red bead or marble, white soccer ball, decorated; foam ball (about 8 inches in diameter) with paper rings, greenish tennis ball, blue racquet ball, grains of sand, landscape marking flags, distance measuring wheel or other measuring tool, index cards, index cards, STARLAB Planetarium (optional)

Part A: Using common items, students will create a distance and size scale model of the solar system. Students should be able to identify and explain the limitations of this model.

Prior to this activity place pictures or words of the planetary bodies listed below on index cards and provide a set to each student pair.

Materials:

- Sun: 2 meter diameter yellow paper circle (all objects measured from the Sun)
- Mercury: small purple bead (75 meters)
- Venus: regular size yellow marble (141 meters)
- Earth: regular size blue and white marble (196 meters)
- Earth's Moon: silver BB (50 cm from Earth)
- Mars: 8mm red bead or marble (298 meters)
- Asteroid Belt: grains of sand (547 meters)
- Jupiter: white soccer ball, decorated (1,015 meters)
- Saturn: foam ball with paper rings (1.905 meters)
- Uranus: greenish tennis ball (3,000 meters)
- Neptune: blue racquet ball (5,926 meters)
- Pluto: silver BB (7620 meters)
- Small flags may be necessary to show their location.

Randomly place items on a table in front of the class, and pass out index cards with the names of the items on them. Tell the students that each item represents a body in our Solar System. Do not give them the key as to what planets the items represent yet. Students should work in pairs for one minute to place the cards in the correct planet order from the Sun. After that minute, instruct student pairs to compare their order with another group. Host a whole class discussion guiding students to correctly match the everyday items to the planetary bodies in the Solar System. Students should be able to provide reasons for their answers. Use small flags to mark the planetary bodies that fit on the school's campus, and then use a local area map to measure and plot where the others would be located. As an option, ask owners (or managers) of well-known sites to put up a sign to "host" the scaled planetary body for about a week allowing students to an opportunity to see the distance between the other planetary bodies in space.

Students will use a *word grid* ([view literacy strategy descriptions](#)) to learn important concepts about stars. Co-construct the *word grid* with students so as to maximize participation in the word learning process; use the Word Grid Example BLM as a guide. Create a *word grid* on chart paper or bulletin board to demonstrate to the whole class how it is constructed and used. After analyzing a demonstration *word grid*, students will be much better prepared to create and utilize this technique more effectively.

Provide students a blank *word grid* with plenty of columns and rows for this activity. The large version of the *word grid* could be attached to the wall or projected from an overhead or computer. As critical related terms and defining information are encountered, students should write them into the *word grid*. The teacher can invite students to suggest key terms and features, too. Once several related terms are written along the vertical dimension of the grid, add features, characteristics, or other defining information in the spaces at the top of the grid moving left to right.

Using the *word grid*, students should be able develop a definition of a planet, which explains Pluto's "new" status. (It is possible that in time, Pluto may be restored to its former status as a planet.) After this, quiz students by asking questions about the words related to their similarities and differences, so that students will make a connection between the effort they put into completing and studying the grid and the positive outcome on word knowledge quizzes.

Part B: The following activity will clearly demonstrate the distances between the planets. Ask the students to explain why they think it takes planetary space probes so long to get to other planets. Students should estimate the space needed to model the distances between the planets. At a suitable location chosen in advance, like a school football field, the whole class will measure or step off the distances of the planets from the Sun using the Solar System on a Football Field model, which can be found at [http://www.nasa.gov/audience/foreducators/9-12/features/F\\_Solar\\_System\\_Scale.html](http://www.nasa.gov/audience/foreducators/9-12/features/F_Solar_System_Scale.html) (Teachers who don't have access to Internet in their classroom can print out a copy to duplicate for students). Use landscape-marking flags for temporary markings of planet positions. Discuss the planets' characteristics along the walk, which can be found at the website mentioned. Younger students from other grades could be invited to walk the planet path with the help of the older students.

Upon completion of the solar system model, the students should compare and contrast the two models; they should also evaluate and suggest ways to improve them.

Finally, revisit the *word grid* to have students write what they have learned about the Solar System so far. Through class discussion, elicit student responses to the following:

- How do the distances between the inner planets compare to the distances between the outer planets?
- Describe how distances between planets change as the distance from the Sun increases.

If the district has a STARLAB Planetarium and the Solar System and Galaxy Cylinder, the scale model of the planets may be used for this activity as well as the cylinder's data to compare the inner and outer planets.

### **Activity 3: Planetary Comparison (SI GLEs: 7, 8, 19, 38; ESS GLE: 38)**

Materials List: teacher-selected research material for planetary data, computer (one for each student group) and projector, chart paper or bulletin board paper, Internet connection, Mission/Project Rubric BLM, science learning logs, white copy paper

Part A: Working in groups of four or five, have the students create a chart of planetary data that include revolution (orbital period), revolution (day), diameter, density, temperature, atmosphere (and composition), etc. similar to the data chart found at [http://www.nasm.si.edu/ceps/etp/ss/ss\\_planetdata.html](http://www.nasm.si.edu/ceps/etp/ss/ss_planetdata.html), and they will research how planetary mission(s) and space probes provided this information. Students will research

the information and record the data for each planet, using teacher-selected research material. Have the students list five ways the inner planets are different from the outer planets in their science *learning logs* ([view literacy strategy descriptions](#)). Students may list these differences on chart paper to hang around the room. Have each group discuss their findings.

After the students have finished discussing the planets, ask them to work in groups once again to answer the following question:

- After studying the planetary data charts, which planet—other than Earth—would best support an exploratory Earth colony?

Part B: Have the students research the discoveries made by Pioneer 10 and 11, Voyager 1 and 2, Mars Rover Expeditions, Venera project, Galileo mission, Cassini, the Hubble Space Telescope, Magellan, Mariner 9 and 10, Gemini, Viking, and New Horizons. Assign each student pair a space probe/mission. They will display the information on white copy paper; it should be displayed in a data table organizing the principle objective(s), planet(s) researched, and data results. Hang these in gallery style so that students can walk around and view information from each. Some available Internet links are provided under Resources.

Part C: Assign each student a planet in our Solar System; do not give easy planets for repetition. Students will design and construct a mobile that displays the major details from the missions/projects above. As student walk through the gallery, they will collect information about their planet from the researched material. Student mobiles must include all planetary missions and space probes used to gather information about their planet in our Solar System, their principle objectives, as well as information received for each objective. A rubric (The Mission/Project Rubric BLM) for this activity on planetary missions and space probes is provided. Explain to the students that in the same way they analyzed planetary data, scientists have used planetary knowledge and data to make decisions on developing planetary exploration missions throughout the solar system. By sending space probes to the planets, we have a better idea of how and when the solar system formed, as well as theories about the planets' future as well as our own Earth's future.

As an extension, students can use a computer and projector or have students work in pairs on a computer to build a 10<sup>th</sup> planet (assuming Pluto is the 9<sup>th</sup> planet) in our solar system at Planet 10 World Builder

(<http://www.scienceyear.com/randomise/index.html?page=/planet10/>). With World Builder, students work their way through each of the creation screens, but only certain conditions will ensure their planet is a successful place for life to grow and evolve. If an interactive board is accessible, have student groups go to the board and manipulate the planet. The whole class can participate by providing building ideas.

**Activity 4: Planetary Orbits (SI GLEs: 6, 13, 15; ESS GLE: 39)**

Materials List: Internet access, computer and projector, thumbtacks, heavy cardboard, string, Ellipse BLM

Early astronomers believed that the planets and the Sun revolved around Earth. During the sixteenth century, scientists such as Nicholas Copernicus and Galileo Galilee were challenging this theory. Although the heliocentric theory (planets orbiting the Sun) later became widely accepted, the belief that the planets moved at constant speeds and in circular paths was still prevalent. Johannes Kepler, working with Tycho Brahe's data, discovered that the paths of the planets were slightly elliptical and that the planets moved at different speeds at various points in their orbits. Isaac Newton's laws of gravity later supported this discovery. Newton found that the gravitational force between two bodies grows weaker the farther apart they are. Not only does the force of gravity depend on distance between the centers of mass, but on their masses as well. Show students the following site with a computer and projector (<http://liftoff.msfc.nasa.gov/academy/space/solarsystem/solarsystemjava.html>). This site states that Pluto is a planet; point out to students that its title is still being debated. During the initial animation, review the points of the solar system discussed so far. After the animation, the image can be altered, showing the orbital paths of the planets.

Students will draw an ellipse using two thumbtacks or push-pins, heavy cardboard, and string. Students will insert the tacks approximately 20 centimeters (best if students vary the distances so that ellipses of different eccentricities will be made; see Ellipse BLM) apart on the cardboard. This link, <http://www.astro.umass.edu/courseware/java/planets/ecc.html>, provides background information about eccentricity and ellipses. They will tie a 50 cm (may vary) length of string in a loop and place it on the cardboard so that it encircles the tacks. A pencil should be positioned inside the string so that it moves as far as the string allows. Repositioning the tacks can change the resulting ellipse's shape. Ellipses should be compared. Emphasize that the eccentricities (shape) of the planets' orbits are slight. If viewed from above the solar system, the orbits would appear almost circular; refer back to online animation shown previously.

Students should discuss the limitations of this model, evaluate the design, and make suggestions as to how it could be improved.

Through class discussion, elicit student responses to the following:

- Relate eccentricity, foci, and semi-major axes to the orbits of the planet.
- Use the laws of gravity to explain why planets increase orbital speed as they get closer to the Sun.
- Use data to verify the dates of Earth's *perihelion* (closest to Earth) and *aphelion* (furthest from Earth).

**Activity 5: Phases of the Moon and Eclipses (SI GLEs: 14, 15, 19, 33; ESS GLE: 40)**

Materials List: foam balls (3 in. in diameter, ½ of ball is shaded with black marker), pen cap (has leg that clips on paper), flashlight, science learning logs, STARLAB Planetarium (optional), cardstock and modeling clay (for assessment), pictures of moon phases

**Part A: Modeling Moon Phases**

As a safety note, students should clear the area of their book bags and binders. This part of the activity can be found at the Lunar Lollipops activity ([http://www.windows.ucar.edu/tour/link=/teacher\\_resources/lunar\\_edu.html](http://www.windows.ucar.edu/tour/link=/teacher_resources/lunar_edu.html)). If room space is available, mark a circle with eight points on the floor with tape for each student group. Follow directions as written. Provide students with the following materials: foam balls, pen cap, and a strong flashlight. Have the students carefully stick the point of the pen cap into a foam ball. Indicate that this is their Moon. The second person stands about six feet away from the student with the Moon. In a darkened room, have students hold their Moon with the dark side facing them (white side facing Sun), a little above their heads and between their eyes and the flashlight (New Moon phase). If students place their Moons a little above their heads, they will see the “full moon” phase, and this physical placement will help show the difference between full moons and lunar eclipses (Part B). Students rotate around the light counter-clockwise, stopping at each point (see Figure 1).

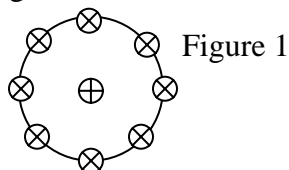


Figure 1

As students revolve counter clockwise around the light source, they should face one direction the entire time (they will not model Earth’s rotation). Remind students that we only see one side of the moon. Students should shade the shadowed area of their Moon in their science *learning logs* ([view literacy strategy descriptions](#)).

Ask students the following questions:

1. How much of the ball facing you is illuminated?
2. How much of the ball’s surface area is dark?

Record the data obtained from student responses. Tell students to make five additional 90° turns. Instruct them to record their data after completing each turn. At the conclusion of the turns, ask students how many different phases did they see and what caused the phases? Have students list the phases represented in order. Ask students to discuss and identify the limitations of this model and how they might improve on the model.

Provide students with pictures of Moon phases (can be found online at [http://www.moonphases.info/moon\\_phases.html](http://www.moonphases.info/moon_phases.html)). The students are to sequence correctly the pictures from New Moon to New Moon. Particular emphasis should be put on identifying First Quarter, Full Moon, and Third Quarter. The students should also learn that “waxing” phases of the Moon occur between New and Full Moon and “waning” phases occur between Full and New Moon. What portion of the Moon is illuminated

during the “waxing” phases? What section of the Moon is illuminated during the “waning” phases?

#### Part B: Modeling Eclipses

Provide the students the same equipment used to model Moon phases and instruct them to stand in a circle around the light source. Place the foam Moon ball directly in front of the light source. The students should answer the following questions: Does the Moon appear dark or lit up? Why? Look at the person’s face across from you. What do you see? (*shadow*). Where is this shadow on their face coming from? If the shadow was on the real Earth, what would happen? The students should then correctly identify the angular and physical alignment of the Sun, Earth, and Moon.

Now have the students reverse positions so that their backs are facing the Sun and the Moon is just above the shadow of their heads on the wall. Slowly move the Moon into the heads’ shadow. What happens to the Moon when it enters the shadow? The students should then correctly identify the angular and physical alignment of the Sun, Earth, and Moon. Students should discuss the limitations of this model and suggestions as how it could be improved.

Through class discussion, elicit student responses to the following questions:

- What is the angle that forms when the Sun, Moon, and Earth align during New Moon? (*180 degrees*)
- What is the angle that forms when the Sun, Earth, and Moon align during First Quarter? (*90 degrees*)
- What is the angle that forms when the Sun, Earth, and Moon align during a Full Moon? (*180 degrees*)
- What is the angle that forms when the Sun, Earth, and Moon align during Third Quarter? (*90 degrees*)
- What is the alignment sequence of the Sun, Earth, and Moon during a solar eclipse? (*Sun, Moon, Earth*) During a lunar eclipse? (*Sun, Earth, Moon*)

If a STARLAB Planetarium is available, modeling of Moon phases and eclipses in its dark environment greatly enhances the understanding of these phenomena.

#### **Activity 6: Tides: What’s The Moon Got To Do With It? (SI GLEs: 13, 14, 15, 19, 33; ESS GLE: 41)**

Materials List: local tide data for Louisiana coast area, graph paper, computer, Internet access

Obtain student prior knowledge of tides by hosting a whole class discussion. Some students may relate fishing to the tide schedule. Students should find local tide data for a Louisiana coastal area. Students should correlate times of high and low tides for a given day to the phases of the Moon. Have the students relate how the Moon’s phases play a role in the generation of tides.

Acquire several tide tables from different parts of the country (<http://www.tides.info/>). Remember to point out to students that Louisiana's flat, low-lying coastline is one of many variables as to why we do not have the typical two high and two low tides generally expected (<http://www.louisianasportsman.com/tide-guides.htm>). Students will plot tide data for a period of one month and draw the tidal curve for this data. Correlation between the graph and Moon phases should be included. Challenge students to create models that will demonstrate the angular positions of Earth, Moon, and Sun that result in the tides. Have the students identify the limitations of their models and offer suggestion as to how they can be improved.

Through class discussion, elicit student responses to the following:

- Discuss gravitational influences on Earth and explain why the Moon is the primary influence on the tides.
- Identify the angular positions of the Sun, Earth, and Moon during spring and neap tides.
- Identify the phases of the Moon that are associated with spring and neap tides.

### **Activity 7: Star Colors and Temperatures (SI GLEs: 15, 33; ESS GLE: 37)**

Materials List: A light source (clamp-on lamp) and a clear, tubular bulb (40-60W) that shows the wire filament inside light source and wired to a dimmer switch that will serve as a star simulator; chart paper or bulletin board paper; overhead or computer projector system; Vocabulary Self-Awareness Chart BLM (see Activity 4); computer with Internet access (for each student); computer projection system (optional); mason jar with blue notebook covers or acetates

Part A: Review the Vocabulary Self-Awareness Chart BLM. Students should be able to add new information to the chart. The goal is to bring all students to a comfortable level with the unit's content vocabulary.

Part B: Prepare the following apparatus: Secure a light source (clamp-on lamp) and a clear, tubular bulb (40-60W) that shows the wire filament inside light source and wired to a dimmer switch that will serve as a star simulator. The dimmer switch controls the amount of electricity to the bulb allowing the bulb's filament to appear different colors depending on the amount of power it receives. When the clear bulb is fully illuminated, the filament appear a very bright white color and very hot. This is much like the hot white dwarf stars that are typically around 15,000 degrees Celsius. As the dimmer switch reduces the power, the filament starts to turn yellow, much like our Sun. At this setting, the yellow filament represents the color of yellow stars that are approximately 10,000 degrees Celsius. Stars like our Sun are considered to be average in size. Turn the dimmer switch down a little more until the filament takes on an orange color. This setting represents orange stars. These stars are usually around 6,000 degrees Celsius. Turn the dimmer switch down a bit more until the bulb (filament) is about to turn completely off. At this setting the filament will glow a faint red. This is the coolest setting possible with the filament. This represents the red stars that are usually around 3,000 degrees Celsius.

Cycle the bulb back through the colors from white, to yellow, to orange, and to red. Have the students identify that white is hotter than yellow, yellow hotter than orange, and orange hotter than red.

Students should be challenged to identify the limitations of this model, identify the problems, and suggest ways to improve the model. Typical student responses should include that the bulb does not get hot enough, the Sun is not a bulb, and the bulb does not simulate the color blue, the hottest temperature stars.

It is generally known that blue stars are the hottest types of common stars. The temperatures are usually above 20,000 degrees Celsius. Students have most likely seen fires or even the tips of cutting torches glowing blue. It is not possible to make the filament on the star simulator blue, but a simulation of this can be achieved by lining a mason jar with blue notebook covers or acetates, and placing the jar over the bulb during full brightness. The filament will then appear bluish.

Part C: Relate the basic properties of waves and the electromagnetic spectrum to stars using the Star Light, Star Bright webpage (<http://amazing-space.stsci.edu/resources/explorations/light/>). *Star Light, Star Bright* is divided into four modules, "Catch the Waves," "Making Waves," "Heating Up," and "Stellar Encounters." The first three modules can be done in no particular order. However, the "Stellar Encounters" module is an application activity that asks students to practice what they have learned in the three previous modules. Discuss with the students the module(s) needed for reviewing background information for the electromagnetic spectrum. As an optional activity, students can work in small groups using computers with Internet access to read and complete the modules.

### **Activity 8: Fingerprints of the Stars (SI GLEs: 6, 13; ESS GLE: 37)**

Materials List: spectroscopes, sources for spectral analysis may include simple flame tests, spectrum or gas tubes (H, He, Hg, Ne, O, etc), fluorescent lights, mercury vapor or sodium streetlights (often found on campus), STARLAB Planetarium (optional), science learning logs

Students often ask how astronomers know so much about the composition of stars. Scientific instruments, such as the spectroscope, have revealed a wealth of information about the Sun and other stars through its fingerprint, or spectrum. Using diffraction grating or spectroscopes (possibly constructed by the students—see Web site resource references for construction directions), the spectral patterns of various light sources will be analyzed. Students will accurately record order, color, and width of the visible spectral lines in their science *learning logs* ([view literacy strategy descriptions](#)). Sources for spectral analysis may include simple flame tests, spectrum or gas tubes (H, He, Hg, Ne, O, etc), fluorescent lights, mercury vapor, or sodium streetlights (often found on campus). Each gas has a unique spectrum. Some spectroscopes have calibrated scales that allow spectral lines to be analyzed by wavelengths (measured in angstroms). Students may compare the detection of elements in space to bar codes used in product

identification. Spectral studies of stars have also led to a greater understanding of the movement of stars and the expansion of the universe. To further develop this understanding, students may research assigned topics, such as the *Doppler Effect*, *absorption spectra*, *bright-line spectra*, *red shift*, *blue shift*, and the *Hubble Space Telescope* and record their findings in their science *learning logs*.

If a STARLAB Planetarium is available, the study of gas tubes using spectroscopes or diffraction grating in its dark environment greatly enhances the viewing of spectra.

Through class discussion, elicit student responses to the following questions:

- What does spectral analysis reveal about the composition and age of a star?
- What does spectral analysis reveal about a star's movement with respect to Earth?

### **Activity 9: Hertzsprung-Russell Diagram (SI GLEs: 12, 13, 19; ESS GLEs: 36, 37)**

Materials List: HR Diagram BLM, HR Star Data BLM, computer (1 for each student or student group), Internet access, computer projector (optional), HR Diagram Simulation BLM

So much has been learned about the stars over the years that it became necessary to organize this information into a diagram that could easily be interpreted. The Hertzsprung-Russell Diagram classifies stars by various characteristics and makes comparing them relatively simple.

Part A: Students will create a data table using star data of nearby and/or bright stars found on the HR Star Data BLM. Next, they will create a scatter-plot graph on the HR Diagram BLM; the graph should be labeled “brightness” on the *y-axis* and “temperature” on the *x-axis*. This is a model of the HR Diagram; to check students' graphs, use any HR diagram, which can be found in most textbooks. Students determine the correct placement of their star on the graph. (Four groups of stars should be formed. Students can use an open circle “o” to represent white and outline a yellow circle for yellow-white colored stars.) Allow time for students to individually examine the data and look for any inferences and observations that they can make from the data. Then ask students, What do the groups have in common? How are they different? Where are the oldest stars? How is the color of the star related to its temperature and its age? What is the order of star colors in the main sequence? Why are supergiant, giant, and white dwarf stars not found in the main sequence? How does the life cycle of a star relate to where certain stars are found on the H.R. Diagram? Massive stars, such as the supergiants, eventually become neutron stars or possibly black holes and low mass stars reside in the main sequence and typically go through the order of colors. Students should understand that not all stars start their life cycles at blue. Some may start their life cycle as white, yellow, orange, or red. How does the Sun compare to other main sequence stars? Have students research what the letters of the mnemonic OBAFGKM (*Spectral class*) represent, and submit a written paragraph on their meaning.

Part B: Students will observe the evolution of a star, which is largely determined by its initial mass. The computer simulation shows large stars burn their fuel fast and have short lives; similarly, small stars burn fuel slowly and last a long time. The Main Sequence is the expected relationship between temperature and luminosity (brightness). Students will be able to relate the initial mass of a star to its developmental stages and ultimate fate, especially as these relate to the Sun. To explore more about the evolution of stars, go to the HR Diagram Simulator at <http://www.astro.ubc.ca/%7Eescharein/a311/Sim/hr/HRdiagram.html>. First, click the button labeled "100" one time to add one hundred stars to your diagram. The linear grouping that you see is called the Main Sequence. For the second set of questions, click on an individual blue star and write down its mass and main-sequence lifetime. To start the simulation, click on the button labeled "Evolve." Start the simulation again, but this time, click on an individual star and observe its luminosity as the simulation progresses.

Distribute the HR Diagram Simulation BLM to students. They can work independently on computers with Internet access in small groups of two, or this part of the activity can be completed as a whole class with a computer and projector. There is a HR Diagram Simulation Key for the teacher's use.

### **Activity 10: Space Technology (SI GLEs: 18, 35, 38, 39, 40; ESS GLEs: 48, 49)**

Materials List: teacher-selected research resources for space-related technology/inventions, Split-Page Notes BLM

Galileo was the first to use a telescope to study the heavens and conclude that all celestial bodies, other than the Moon, do not orbit Earth. Throughout history, improvements in technology and achievements in astronomy have developed along parallel paths and have become intertwined. Students should understand that opposition to astronomical theories throughout history successfully changed thinking of the scientific community of the day. Discuss with the students observations of Mars made by Percival Lowell in the early 1900s. Have the students create a Venn diagram, a type of *graphic organizer* ([view literacy strategy descriptions](#)), to compare what Lowell theorized about Mars and what we know about it today.

As students research the history of space exploration using teacher-selected resources, they should record important information in a *split-page notetaking* ([view literacy strategy descriptions](#)) format. Model the approach by placing on the board or overhead sample *split-page notes* from the upcoming topic about inventions derived from space-related activities (see Split-Page Notes BLM). Explain the value of taking notes in this format by saying it logically organizes information and ideas from multiple sources; it helps separate big ideas from supporting details; it promotes active reading and listening; it allows inductive and deductive prompting for rehearsing and remembering the information.

Next, ask students to take *split-page notes* over a brief lecture you provide on a particular invention (*Velcro*<sup>™</sup> is the example used on the Split-Page Notes BLM). In advance, prepare a model of the information in *split-page* format. Tell students to draw a line from top to bottom, approximately 2 to 3 inches from the left edge on a sheet of notepaper. They should try to split the page into one third and two thirds. After your lecture, have students compare their notes with a partner and then answer questions and provide clarification using your prepared model notes as a guide. Show them how they can prompt recall by bending the sheet of notes so that information in the right or left columns is covered. Continue to periodically model and guide students as they take *split-page notes* and increase their effectiveness with this technique. Your assessments should sample information that students should record in their *split-page notes*. In this way, they will see the connection between taking notes in this format and achievement on quizzes and tests.

They will research the relationship between invention and discovery. Students will use their *split-page notes* to organize their research. As students compile their data, they will find that during the last 100 years, the *split page notes* will become very complicated and require more detail. Weather, communications, and military satellites should be included. Students may make predictions for the next 100 years.

*Research Project:* Student groups will research inventions, prepare a report, and provide a presentation to the class of their space-related products resulting from new technology breakthroughs used in or developed because of the space program. Examples could include bar codes, satellite dishes, cordless tools, composite materials in sports equipment, *Velcro*<sup>™</sup>, smoke detectors, edible toothpaste, fire-fighting equipment, joysticks, invisible braces, shock-absorbing helmets, ski boots, thermal gloves and boots, toys, etc.

## Sample Assessments

### General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data-collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities via a teacher observation of their work and lab notebook entries.
- All student-developed products should be evaluated as the unit continues.

- Students should be evaluated with a rubric. For some multiple-choice items on written tests, ask students to write a justification for their chosen response.

### General Assessments

- The student will identify stars in order of color and temperature.
- The student will compare the inner and outer planets.
- The student will identify and sequence phases of the Moon.
- The student will use models of the Sun, Earth, and Moon to show their alignments during a solar and lunar eclipse.
- The student will model the angular alignments of the Sun, Earth, and Moon to demonstrate spring and neap tides.
- The student will create a diagram that illustrates the phases of the Moon associated with spring and neap tides.
- The student will explain why the Moon is the primary influence on the tides.
- The student will explain how and why the amount of energy received from the Sun varies during the year.
- The student will label a diagram showing the distances from Earth to the Sun at the beginning of each season.
- The student will describe the technological advances they would like to see developed in the next 100 years. What would be the effect of these technological advances on space exploration and travel?
- The student will use models to demonstrate how the angular alignments of Earth, the Moon, and the Sun causes phases, eclipses, and tides.

### Activity-Specific Assessments

- Activity 2: The student will design a scale representation of the planets' distances from the Sun that will fit on the top of a lab table or counter top in the classroom. The scale of distances may also be done on the classroom floor. The student will record the scale in a table and reflect on the correct units of SI measurement.
- Activity 3: Students should design a mobile that displays the major details of a planet in our Solar System using the information from the gallery walk. Use the Mission/Project Rubric BLM to assess the mobiles.
- Activity 5: The student will use cardstock models of the Sun, Moon, and Earth supported on a small piece of modeling clay to model correctly the angular positions of the Sun, Moon, and Earth during new Moon, First Quarter, Full Moon, and Third Quarter. The student will draw and label the model set-up he/she creates for each phase and identify the angles associated with each alignment (phase).

- **Activity 9:** Given the color of a star, the student will estimate its age, temperature, and position on the H-R diagram. He/she will compare well-known stars, such as the Sun, Betelgeuse, Rigel, Arcturus, Antares, a white dwarf, and a red dwarf. Using information on the HR Diagram, the student will explain the differences between any two or more of the stars previously identified. Student responses will identify differences in brightness, temperature, and color among comparison stars.

## Resources

### Solar System

- Scale model calculator - [http://www.exploratorium.edu/ronh/solar\\_system/](http://www.exploratorium.edu/ronh/solar_system/)
- Planet data comparison <http://solarsystem.nasa.gov/planets/index.cfm>
- Exploring the planets - <http://www.nasm.si.edu/ceps/ETP/>
- Amazing Space <http://www.stsci.edu/pubinfo/amazing-space.html>
- *Cosmic Voyage*. DVD. IMAX. 1996.
- Eames, Charles and Ray. *Powers of Ten*. Video. Santa Monica, CA: Eames Office Gallery
- GEMS *Earth, Moon and Stars*.
- GEMS *Living with a Star*
- GEMS *Messages from Space*.
- GEMS *Moons of Jupiter*.
- GEMS *The Real Reasons for Seasons*.
- Windows to the Universe  
[http://www.windows.ucar.edu/tour/link=/our\\_solar\\_system/solar\\_system.html](http://www.windows.ucar.edu/tour/link=/our_solar_system/solar_system.html)
- Solar System Missions [http://science.hq.nasa.gov/missions/solar\\_system.html](http://science.hq.nasa.gov/missions/solar_system.html)
- Planetary Missions <http://nssdc.gsfc.nasa.gov/planetary/planets.html>
- Space Missions <http://www.windows.ucar.edu/tour/link=/missions/links.html>

### Life Cycle of Stars

- Journey Through the Galaxy. <http://filer.case.edu/sjr16/index.html>
- How Supernovas are Formed.  
[http://imagine.gsfc.nasa.gov/docs/teachers/lessons/xray\\_spectra/background-lifecycles.html](http://imagine.gsfc.nasa.gov/docs/teachers/lessons/xray_spectra/background-lifecycles.html)
- Project STAR

### Spectroscope Construction

- <http://stardate.org/teachers/activities/spectroscope.html>,  
[http://www.opticsforkids.org/resources/6\\_Constructing\\_Spectroscope.pdf](http://www.opticsforkids.org/resources/6_Constructing_Spectroscope.pdf).
- *Star Date*. Available online at  
<http://stardate.org/teachers/plans/spectroscope.html>
- *Starry Night Backyard*. CD-ROM. Sienna.

Planetarium Activities for Student Success (PASS),

- “Activities for the School Planetarium,” Volume 2, Lawrence Hall of Science, the New York Hall of Science, and Learning Technologies, Inc
- “Colors from Space,” Volume 8, Lawrence Hall of Science, the New York Hall of Science, and Learning Technologies, Inc.

Tide Guides

- Louisiana Sportsman Guide. <http://www.louisianasportsman.com/tide-guides.htm>
- Tides info. <http://www.tides.info/>

Miscellaneous

- *Sky and Telescope Magazine*. Accessible on line at: [www.skyandtelescope.com](http://www.skyandtelescope.com)
- Space-Based Astronomy Teacher’s Guide with Activities. National Aeronautics and Space Administration, 1994. [http://www.latech.edu/ideaplace/nerc/space-based-astronomy/space\\_astronomy\\_teacher\\_guide\\_part\\_1.pdf](http://www.latech.edu/ideaplace/nerc/space-based-astronomy/space_astronomy_teacher_guide_part_1.pdf).
- *The Universe at Your Fingertips Notebook*. Project ASTRO. Astronomical Society of the Pacific.
- *More Universe at Your Fingertips*. Project Astro, Astronomical Society of the Pacific.
- National Radio Astronomy Observatory <http://www.gb.nrao.edu>.

**Grade 8  
Science  
Unit 8: Pollution and Its Effects**

**Time Frame:** Approximately three weeks



**Unit Description**

This unit focuses on human activities that affect Earth’s systems and resources, such as point source and non-point source pollution. The importance of clean water and factors that would be considered methods of protecting water resources are also addressed in this unit.

**Student Understandings**

Students will be able to describe the effects of soil composition on plant growth. The students will understand that natural and human-induced pollution serves as a major threat to our water and air. Local issues provide motivation for an investigation of pollutants, and students will learn to focus on issues related to the quality of life, and the degradation of habitats.

**Guiding Questions**

1. Can students describe the importance of soil compatibility and plant type as it relates to Louisiana crops and vegetation?
2. Can students identify point and non-point sources of pollution?
3. Can students distinguish among several effects of water erosion and preventative measures?
4. Can students articulate the importance of conserving water?
5. Can students analyze the effects of human activities on the environment?

**Unit 8 Grade-Level Expectations (GLEs)**

GLE #	GLE Text and Benchmarks
<b>Science as Inquiry</b>	
<i>The following Science as Inquiry SI GLEs are embedded in the suggested activities for this unit. Additional activities incorporated by teachers may result in additional SI GLEs being addressed during instruction on the Pollution and Its Effects unit.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)

<b>GLE #</b>	<b>GLE Text and Benchmarks</b>
2.	Identify problems, factors, and questions that must be considered in a scientific investigation (SI-M-A1)
3.	Use a variety of sources to answer questions (SI-M-A1)
4.	Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2)
5.	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (SI-M-A3)
8.	Use consistency and precision in data collection, analysis, and reporting (SI-M-A3)
11.	Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4)
12.	Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
13.	Identify patterns in data to explain natural events (SI-M-A4)
14.	Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
15.	Identify and explain the limitations of models used to represent the natural world (SI-M-A5)
19.	Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)
20.	Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7)
22.	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7)
25.	Compare and critique scientific investigations (SI-M-B1)
26.	Use and describe alternate methods for investigating different types of testable questions (SI-M-B1)
27.	Recognize that science uses processes that involve a logical and empirical, but flexible, approach to problem solving (SI-M-B1)
33.	Evaluate models, identify problems in design, and make recommendations for improvement (SI-M-B4)
34.	Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5)
35.	Explain how skepticism about accepted scientific explanations (i.e., hypotheses and theories) leads to new understanding (SI-M-B5)
37.	Critique and analyze their own inquiries and the inquiries of others (SI-M-B5)
38.	Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)

GLE #	GLE Text and Benchmarks
39.	Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)
40.	Evaluate the impact of research on scientific thought, society, and the environment (SI-M-B7)
<b>Science and the Environment</b>	
50.	Illustrate possible point and non-point source contributions to pollution and natural or human-induced pathways of a pollutant in an ecosystem (SE-M-A3)
51.	Analyze the consequences of human activities on global Earth systems (SE-M-A4)
52.	Describe the relationship between plant type and soil compatibility (SE-M-A9)
53.	Distinguish among several examples of erosion (e.g., stream bank, topsoil, coastal) and describe common preventive measures (SE-M-A10)

For this unit, have students maintain a science *learning log* ([view literacy strategy descriptions](#)). Explain that explorers, scientists, and mathematicians have always kept logs of their observations, thoughts, new understandings, hypotheses, and reflections. In this way, they could record progress, test new ideas, and document what they learned. Similarly, with their science *learning logs* for this unit, students will record new understandings, explain scientific processes, pose and solve problems, make and check predictions, and reflect on what has been learned.

### Sample Activities

#### Activity 1: Soil Sleuths (SI GLEs: 1, 4, 5, 6, 8, 37, 38, 39, 40; SE GLE: 52)

Materials List: science learning logs, Internet access for students, chart paper or poster board, pH indicators (hydronium paper or probes), school campus map for students and enlarged map for whole-class viewing, optional – state and national wall maps

For this activity it may be advantageous to have a variety of plants on display in the room, e.g., a succulent or cactus, an African violet, some ivy, and/or a planter of herbs.

#### Part A:

Some areas are known for particular types of vegetables and crops. Ask students if they have heard Kentucky referred to as the bluegrass state or if they have heard people talk about vadalia onions. See if they know why the red peppers from Avery Island are so unique that today people from all over buy souvenir items that show Tabasco® when they come to Louisiana. (Many students may not know that while the seeds are started in Louisiana the plants are actually shipped to Latin America where they are grown and picked.) A special condition/variable for each of these and other locations is the soil.

Continue the class discussion asking students to name the vegetable crops and agricultural products grown in Louisiana. Offer hints to secure responses that include sugar cane, cotton, rice, soybean, peppers, pine forests, pecans, etc. Using the student responses, create a list for the class to view. Once the list is generated, turn their attention to focus on where these plants are generally grown in the state. As the geographic locations are given, write them besides the appropriate plant(s). Continue the questioning, asking why the different types of plants and trees are found in different locations. Ask why, since the climate generally is the same in Louisiana, we do not find cypress tupelo trees right along side longleaf pines or next to pecan trees. If a map of the US is available, have students identify the types of plants found in locations along the same line of latitude in states to the east and west. Ask them to propose why the flora is so different in the various locations. Use the plants on display to bring the differences in soils to focus. The soil that is best for the African violet is nothing like the soil that is preferred by cacti.

Many types of soil exist in Louisiana. They are transported (alluvial and aeolian) rather than residual soils. Understanding the characteristics of these soil types is not only vital to the agricultural and forestry industries, but also to the home gardener and to efforts to save the wetlands. Most shrubs, garden vegetables, crops, and trees prefer slightly acidic to very acidic soils; there are common varieties that grow best in alkaline soils.

Distribute copies of the Nature Conservancy page Places We Protect in Louisiana <http://www.nature.org/wherewework/northamerica/states/louisiana/preserves/> and the Louisiana Soils page from the LSU Ag Center publication *Understanding Louisiana Soils* <http://www.lsuagcenter.com/NR/rdonlyres/DB1BE3F5-C7F6-444B-83E7-079302758610/43127/pub3034UnderstandingLouisianaSoilsHIGHRES.pdf>.

Students may also use the Louisiana Online Soil Manuscripts and click on General Soil Map for their parish ([http://soils.usda.gov/survey/online\\_surveys/louisiana/](http://soils.usda.gov/survey/online_surveys/louisiana/)) to identify the soil in their area. However, the soil surveys for several major parishes like Calcasieu, East Baton Rouge, Lafayette, Jefferson, and Orleans are not online. Hard copies may be found at local libraries or by contacting the US Department of Agriculture. Additional soil area maps can be located in Louisiana atlases and on websites.

Divide the students into cooperative groups to complete this investigation. To provide an awareness and understanding of soil as a critical resource with unique properties, the students will investigate both the historical vegetation and the economic crops being grown in various locations at this time. Assign each student group one of the physiographic regions of the state or other section as identified in the resources. In their science *learning logs* ([view literacy strategy descriptions](#)), have students suggest a list of plants and trees they believe will easily be grown in the area. Using all available resources, students should study the region they were assigned to find information on native plants and changes that occurred when the region was settled. Students should record their research in their *learning log*. Particularly important will be identifying how land use changed with population growth and economic development in our state.

The information collected should include the properties of the soil that make it compatible for the vegetation found in the area as the state was settled and for the crops that are cultivated in the area now. Students should also review the data on the effects of the local crop choices as they relate to the soil's natural nutrients and determine the importance of this information. They should compare the predictions they made to the list of plants actually found in the area. Students will often predict the plants in their area will be found everywhere in the state and are surprised when they realize that sugar cane is not a crop grown in Ruston.

Student class presentations should be made providing a journey around the state. The wrap-up should include a discussion that addresses the different variable factors that influence the composition of local soils.

#### Part B

Separate the school campus into sections for teacher selected student observation and testing. Provide students with a map of the school campus divided into these sections. Take a walk around the campus with students and provide each group with a test site. The students will determine the soil's pH in their section, using available pH indicators, record the slope of the land and direction water might run off, and record the amount of sunlight and weather exposure at various times of the day in their science *learning logs*. Review Unit 4 for how to test for soil pH. Back in the classroom, all student groups will record their observations on the enlarged school campus map. Post this information in the classroom for whole-class viewing.

Using the information on local soils presented in Part A and the pH information collected above, students will design and present a proposal for a school garden on chart paper. The proposal should be done to scale and include the type of garden, types of plants and preferred soil pH, current soil pH, physical design and layout of the garden, as well as the school campus location. The proposal should include the number of each type of plant and other equipment required. The physical design, layout of the garden, and school campus location must all be accompanied by an explanation with data for support.

In determining what types of plants to include in their garden plan, students will need to determine if the plants are compatible with the local soil type and other surface conditions noted during their onsite inspection. Information on the pH Preference of Plants can be found at (<http://www.colostate.edu/Depts/CoopExt/TRA/PLANTS/acidlove.html>). They can use The Savvy Gardener website ([http://www.savvygardener.com/Features/soil\\_ph.html](http://www.savvygardener.com/Features/soil_ph.html)) to suggest how to alter the soil pH if needed. After determining if their plants and soil are compatible, they will research the plant to find out the amount of sunlight their plants need. Some students will need to rethink their design, location, and/or plants after their initial investigation. Remind them that scientists use the same scientific processes and knowledge to solve problems, make decisions, and form new ideas.

As an option, host a competition (grade, class, etc.) to plant a school garden; the winning team's proposal will be the "contractors" for the project. See Resources for information

on school gardens. Students can vote on the garden to be planted or, as an option, bring in school administration or local gardening experts.

**Activity 2: Where Does Water Run? (SI GLEs: 2, 8, 11, 27; SE GLE: 50, 51)**

Materials List: maps of school grounds or local area with street names (city planning map), markers, trundle wheel (or other distance-measuring device such as a tape measure), calculators, Internet access, science learning logs, teacher selected resources (see part A), optional guest speaker

Part A: To introduce the concept of water pollution, ask students to imagine what life would be like without clean air. What would life be like without clean water? Students should work in groups of two or three to generate a list of things or actions that might contaminate, or make unsafe, the air we breathe and the water we use to drink, cook, and bathe. They should note the ideas in their science *learning logs*. A group spokesperson should present each set of ideas to the class. Have a student create a master list of suggestions as the group reports are shared that will be visible to the entire class.

Continue the discussion asking students How many remember seeing brown rings of water (terrestrial runoff) or lines of leaves and sticks around the school along the sidewalk or across their lawns after storms and hurricanes? Have they noticed grease spots on the driveways in their neighborhood or in parking lots at shopping centers? Where are storm drains on their street? Have any seen the drains or drainage ditches clogged with tree branches and other debris? Why should we be concerned about storm-water runoff? Where does the runoff that enters the storm drains go?

Stress to students that the runoff will contain what is termed *non-point source* pollution as opposed to *point source* pollution. Non-point source pollution originates at one site and is carried by water to another site, making the source difficult to determine in many cases. Point-source pollution occurs at one site, and the source is usually easily identified. Discuss agricultural sources of pollutants, such as fertilizers, manure, pesticides, etc. These contaminants can reach the river either via groundwater or through drainage ditches. Remind students that the drink cups and popcorn bags dropped on the ground during an outdoor sporting event have chemicals; so during rainstorms, not only are the packaging materials moved by the running water the butter, sugar and other ingredients that dissolve in water enter the runoff stream. As a class, prepare a list of examples of both point and non-point pollutants.

Pass out the maps of the school grounds or other study site to each group. Identify what area is pictured and discuss the map's features with the students. Have the students identify whether the area is predominantly residential, industrial, commercial, or mixed use. Using the definition of non-point source pollutants, allow the students time to explore all the possible pollution sources in the area and indicate each on the map with a colored dot. Students will create a "key" for their map by choosing a different color to represent the type of non-point source pollutants that is contributing to the storm water runoff in that area. The students will then consider the physical layout (topography) of

the area and discuss what runoff will enter the different storm drains. Discuss where the runoff from the drains goes. If different sections of a city map are provided to small groups of students, a large complete map could be prepared for display on the class wall. Have the students prepare an informational handout that can be used to describe the problem of local non-point source pollutants.

Part B: To reinforce what the students have learned in the classroom, select a study site near the school building to determine the effects of non-point source pollutants. (If an area is not available on urban school grounds, the teacher could seek nearby community or business support, such as a site at an urban park or on church grounds. This is an excellent opportunity to have public involvement.) Explain to the students that scientists conduct investigations much like they will do in this activity: the use of scientific processes and knowledge can help solve problems, assist in decision-making, and inspire new ideas. Students will take a walk through the study site chosen. In their science *learning logs* ([view literacy strategy descriptions](#)), they will list the storm debris they find around the storm drains and identify pollutants that might degrade the habitats and constitute a health risk for people, plants, or animals.

Back in the classroom, the students should indicate on a street map of the area the storm drains and outlets and possible sources of non-point source pollutants that might reach that drain; they should also provide an explanation of non-point source pollutants and storm-water runoff.

As a whole class, analyze the consequences of human activities, not only on the local community, but also on global Earth systems. Review the questions previously discussed in Part A. Students should compare their previous understandings in Part A with what they investigated in Part B. Display the maps around the school campus and at local areas in the community. Students can also write an article to the local newspaper along with any pictures taken from the study site.

Following the investigation, students should write their answers to the following questions in their science *learning logs*.

- What is storm water runoff?
- What types of potential pollutants does the water come in contact with?
- Where does the water go when it leaves the study site?
- What can we do to slow down and reduce storm-water runoff?
- What are storm drains and where are they found?
- What do storm drains do?

Students should generate new questions or identify problems that they would like to investigate based on their observations. Provide resources and materials for these investigations to be developed, when possible. See Resources for borrowing an Enviroscope for the classroom.

As an option, invite a guest speaker to learn how storm-water runoff is treated locally, or discover this through another field investigation.

**Activity 3: Campus Pollution Patrol (SI GLEs: 3, 7, 11, 13, 19; SE GLE: 50)**

Materials List: science learning logs, Pollutant Walk Word Grid BLM, graph paper, various old magazines (with pictures of pollution), scissors, poster paper

In preparation for a class walk over the school campus, the teacher should look for signs of and sources of pollution ahead of time for the success of the activity.

Part A: Students will learn important concepts about pollution and expand their reading vocabularies using a *word grid* ([view literacy strategy descriptions](#)). On the board or a piece of chart paper, draw a word grid like the Pollutant Walk Word Grid BLM. Model how to complete the *word grid*; students will complete the *word grid* on the walk. As they identify a source or type of pollution they should enter it in the Pollution Found column. Students will fill in the *word grid* by placing a “✓” in the space linking the pollution observed to the type of pollution, “point” or “non-point,” and provide evidence to defend their classification.

Review what was learned about non-point source pollutants from Activity 2. Take the students on the walk (outdoors or indoors) to look for pollution or pollutants with the Pollutant Walk Word Grid BLM. Students should classify their findings as point or non-point source pollution in their science *learning logs* ([view literacy strategy descriptions](#)) (*some point pollutants may become non-point sources at some future time*). During the walk, have the students identify pollution they can see (litter, smoke), hear (honking horns, airplanes), or smell (diesel fumes, fresh paint). Alternatively, have students find examples of pollution on land (litter), in the air (car exhausts), and in the water (pollutants that could wash into storm drains). As students spot different examples, they should explain on the Pollutant Walk Word Grid BLM why each one could be considered a pollutant.

During the walk, ask students the following questions: What kind of plants or animals (including people) could be affected by each type of pollution or pollutant seen? What might have caused each form of pollution? Could the pollution or pollutant be avoided or lessened?

Back in the classroom, student groups will compare what was found on the walk. Student groups could identify the same pollution but categorize it differently. Or after graphing, will they discuss to see why the graphs may not be the same?

Part B: Once students return to the classroom, instruct them to create a bar graph on poster paper, depicting the number of pollutants in each category (point/non-point) they identified on the outdoor or indoor walk. Students will also draw pictures of pollution they spotted on the walk and list things that might cause pollution, even odors. As an alternative, students can look through magazines for examples of the pollution found. They should try to find at least one example (sight, smell, and sound or air, land, and water). Have the students take turns placing the pictures they drew into the pollution categories. Each group will then take turns discussing the finished chart, identifying

patterns in the data that might explain natural events (for example, how a piece of litter got on the ground; how oil got on the pavement).

Part C: Students will use “quick writes” to reflect upon their learning of pollution, which forces the students to write their knowledge of content under a time constraint. The students they will have two minutes to write a short essay in their science *learning logs*, describing the pollution they spotted on the walk and listing the things that might cause pollution, even odors. They can use their charts created in Part B as a visual reference.

**Activity 4: Erosion Prevention (SI GLEs: 7, 12, 14, 15, 20, 25, 26, 33, 34, 35; SE GLEs: 53)**

Materials List: stream tables or large pans; sand; silt; loam; gravel; or clay to model stream and river erosion; wood or bricks; water; pouring container; grass blades; bean plants; science learning logs; teacher-selected research materials on preventative measures for stream, river, and coastal erosion; one for each student group: poster paper, makers, colored paper, scissors, glue

**Part A: River or Stream Erosion**

In order to distinguish among the effects of water erosion and preventative measures against them, groups of three to four students will set up stream tables or large pans with sand, silt, loam, gravel, or clay to model stream and river erosion. For each stream and river erosion trial, all stream tables should be placed at the same inclination (using wood or bricks to raise one end of the table or pan). First, students should pour water at a constant flow to observe the rate of erosion for each material. They should record their observations in their science *learning logs* ([view literacy strategy descriptions](#)). After the initial test, students should use teacher selected materials to research preventative measures for erosion based on their observations. Next, independently, student groups should develop a hypothesis based on this research. Student groups should test a different type of preventative material for each trial, with the stream table placed at the same inclination for each trial. The tests might include placing a variety of plants along streams and rivers or building containment walls. Students should write step-by-step instructions of their investigation so that other students could replicate it. During the testing process, discuss the significance of erosion reduction with each preventative measure with the students. Following the experimentation, provide the groups testing the same hypothesis the opportunity to discuss their findings together; students should also develop ideas to improve their preventative measure. These combined groups should select a spokesperson and present their findings to the whole class. Conclude with, through the use of scientific processes and knowledge, people can propose solutions to problems, make decisions, and form new ideas. During the wrap-up discussion, make sure the students understand that historically the greatest area of wetland loss has been along the Mississippi River as it changed course and people removed the bottom land hardwood forests to extend the agricultural reach of farms along the river’s banks.

### Part B: Coastal Erosion

Students will research processes limiting coastal erosion, using all available resources. Some suggested plans include placing a variety of plants along coastlines, shorelines, and off-shore natural and man-made barriers; building jetties; burying barges; dredging material into marshes; and restoring barrier islands. Allow student groups to select one of the coastal protection methods they found interesting during their research. Students should develop a poster displaying the preventative measure for coastal erosion which indicates the pros and cons of the action. Provide student groups with poster paper, markers, colored paper, scissors, and glue. During group presentations of the posters to the class, students observing should critique each design and make recommendations for improvement. They should record their observations and ideas in their science *learning logs*. Following this discussion, solicit the results and write on the board or overhead the preventative measures and the pros and cons for each. See the Resources list for information on coastal erosion and preventative measures. Student presentations should address the proposed costs for each of the erosion reduction techniques. It will be important for students to understand that it is not easy to place a value on some conditions, such as the loss of a bird rookery.

Part C: Students should understand that finding and implementing solutions to reducing coastal erosion is an enormous task. Many different federal and state agencies are involved along with citizen networks and community organizations in projects around the state. Students should discuss the concept that many ideas and models have been presented and looked upon with skepticism, especially here in Louisiana. In their research, students will find numerous models and plans for saving Louisiana's coastline.

In the world of science, skepticism is often the reason that better alternate solutions and new understandings are reached. Furthermore, students should cite evidence that communication among scientists completing similar investigations, as well as reviewing the work of others, is of great importance to the scientific community.

### **Activity 5: Every Drop Counts (SI GLEs: 7, 13, 22; SE GLE: 51)**

Materials List: one liter container, eye dropper or pipette, science learning logs, computer and projecting system, student computers with Internet access, aluminum pie plate

Water is necessary for all living things, but rarely do we stop and think about how much water a person uses in one day. In this activity, students will research their personal everyday water usage. After showing students a liter container as a reference point of volume, direct them to predict the amount of water they think that they use in one day. Tally the student predictions in liters. Tell students that they will be monitoring their water usage throughout the day, and that the next class day, they will calculate their total water usage. Students will then compare their predictions with the actual usage. The class will discuss possible water uses. Direct students' thoughts toward some of the less obvious or hidden uses of water, if not named, such as industrial use for manufacturing the products they used, irrigation of the fields for the food they ate, fast food preparation,

hydroelectric use, and fire control. While they may not have actually turned the tap on to use water for these purposes, the fact is the water was part of their day.

In order to identify patterns in data to explain natural events, students should calculate their actual water usage, followed by a student discussion about the percentage of fresh, drinkable water that is present on planet Earth. With one liter representing all of Earth's water, show students that only one drop represents all the potable water available. (For dramatic effect, one liter can be shown to the class and guesses of the amount of available fresh water can follow. An eyedropper or pipette can then show the one drop of potable water. If the class is kept quiet, dripping the one drop of water into an aluminum pie plate makes a striking sound.)

Refer students to what was learned from Activities 2 and 3. Discuss the variety of pollution sources. Students should include examples from recreational, commercial, construction, agricultural, municipal, and residential areas. Next, students will research water conservation practices using the following websites: *Water Education Foundation* (<http://www.water-ed.org/kids.asp>), *Clean Water Program* (<http://www.oceansidecleanwaterprogram.org/kids.asp>), and *Water Conservation Tips* ([http://www.penlight.org/pages/water/water\\_cnsrvntips.html](http://www.penlight.org/pages/water/water_cnsrvntips.html)). The variety of pollution sources need to be brought into focus with the students

After viewing the information, students need to be able to discuss the following questions:

- How do people use water?
- How do people pollute water?
- What would happen if we didn't have enough clean water to drink and for other uses?
- What can we do to protect the Earth's supply of usable water?

Students should respond in writing in their science *learning logs* ([view literacy strategy descriptions](#)) to the following questions:

- What would happen if greater and greater volumes of our drinkable water became polluted?
- What are some things that I can do to personally conserve the amount of water I use?

As an option, the video "Source of Life: Water in Our Environment" is available from the LPB Cyberchannel ([www.lpb.org/cyberchannel](http://www.lpb.org/cyberchannel)) if the school participates in this service. Find out as a class how conserving water can positively impact the environment by watching this video.

**Activity 6: Can We Fix It? (SI GLEs: 2, 3, 19, 38, 39, 40; SE GLE: 51)**

Materials List: Likert Scale Example BLM, Human Impacts/Activities Rubric BLM, Human Impacts/Activities Links BLM, Internet access, all available research materials including teacher-selected resources, access to a printer for publication of a newsletter

With the students, prepare a list of potential environmental problems found in Louisiana. Some suggested topics are the following:

- Agricultural runoff into streams and rivers
- Fertilizer runoff into streams and rivers from golf courses, and subdivisions
- Clear-cutting timber in forested areas
- Saltwater intrusion into a nearby cypress swamp
- Increasing dependency upon petroleum products
- Habitat destruction
- Rapid removal of water from state aquifers

Pass out and review the Human Impacts/Activities Rubric BLM so that students understand the scoring criteria for this activity. Allow student groups to select a potential problem or assign a problem to each group. Students will research their potential water resource problem to identify solutions and find statistics to support the reduction of the stress caused on Earth systems. They should use the Human Impacts/Activities Links BLM and the Internet and/or teacher selected research resources. Using the information collected, students will produce a two-page public service newsletter that outlines the problem, poses questions, relates research, and gives possible solutions. Students should also discuss what new “problems” their possible solutions could cause to the environment.

In groups of four, students will use the following steps to guide them through the completion of this activity.

1. As a group, designate what roles each team member will fill: researcher, graphic designer, writer, editor/proof reader. The teacher should receive a list of the position information for each group.
2. Once those roles are filled,
  - the researcher will investigate the topic
  - the graphic designer will search for pictures, create illustrations, and find images for the public service newsletter
  - the writer and editor will prepare a masthead for the newsletter
3. After the research, group members will reconvene to share and update the information about their topic and layout plans for their newsletter.
4. Student writers will use the information to develop the text while the graphics person will share possible images to illustrate the information to be shared.
5. Student editors will proof and finalize the newsletter.
6. All members of the group will need to review the Human Impacts/Activities Rubric BLM to verify that all required details have been addressed.

Copy the newsletters from each group for distribution to the class. Students will read each of the newsletters and decide whether the problems can be easily corrected and quick solutions found. The students will rate decisions on a Likert Scale from 1 to 4 (1-strongly agree, 4-strongly disagree). The Likert Scale Example BLM is an idea of how to set up a Likert Scale. The students must be prepared to defend their decisions on the issue.

## Sample Assessments

### General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Science *learning log* entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory technique skills. All student-generated work, such as drawings, data-collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities via teacher observation of their work and lab notebook entries
- All student-developed products should be evaluated as the unit continues.
- Student investigations should be evaluated with a rubric.
- For some multiple-choice items on written tests, ask students to write a justification for their chosen response.

### General Assessments

- The student will contrast point and non-point source pollution when given examples of each type.
- The student will explain how pollutants can contaminate multiple resources such as air and land or land and water?
- The student will identify pollutants that might constitute a health risk for people, plants, or animals.
- The student will identify several ways humans have changed the environment in a local area and describe changes that were good and changes that were not so good.
- The student will visit areas of erosion on the school campus such as sidewalks, gutter downspouts, drainage ditches, or areas of runoff and suggest ways to prevent or combat it.
- The student will write a description of how to model coastal erosion after modeling stream and river erosion.
- Collect and check students' science *learning logs* for data accuracy and reasoning.

- The student will record in laboratory notebooks and determine their own water usage and reduction plans.

### Activity-Specific Assessments

- Activity 3: Collect pictures of potential pollution sources (e.g., fertilizing a lawn, plastic six-pack holders, motor oil being pour into a drain or on the ground, cars on the highway, person walking a dog, person listening to a portable stereo). Make transparencies of the pictures. The student will explain how the object in the picture might generate pollution and suggest ways to prevent or reduce it.
- Activity 4: A common “solution” to coastal erosion is to build a wall known as a jetty between the private dry land and the public beach. Direct students to write an essay explaining why they support or reject this approach and what arguments might be offered by someone with a view that opposes their own.
- Activity 5: The students will design a newsletter that could be distributed to the citizens of a local community, suggesting methods of addressing water problems and conservation.

### Resources

- *Enviroscape Model* <http://www.envirosapes.com/>: Borrow an Enviroscape Model from your parish Louisiana Cooperative Extension Service [http://www.lsuagcenter.com/en/our\\_offices/parishes/](http://www.lsuagcenter.com/en/our_offices/parishes/).
- *Rising Seas, Coastal Erosion, and Takings Clause*: <http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsSLRTakings.html>
- *Every Drop Counts. Project Learning Tree*. American Forest Foundation.
- *Agriculture and Pollution* <http://www.ehso.com/ehshome/agriculture.htm>
- *Pollution from Agriculture* <http://www.naturegrid.org.uk/rivers/gt%20stour%20case%20study-pages/pllnfrm.html>
- *GEMS Environmental Detectives*.
- *Environmental Resource Guide: Nonpoint Source Pollution Prevention; description of book found online at* <http://www.p2pays.org/ref/32/31853.pdf>
- *You are the Solution*: <http://protectingwater.com>.
- *Polluted Runoff – non point solution*: <http://www.epa.gov/owow/nps>
- *Pollution Search*. Project Learning Tree. Environmental Education Activity Guide.
- Project WET, K-12 Curriculum & Activity Guide& Activity Guide.

- Soil Profiles. Water, Stones, & Fossil Bones. Council for Elementary Science International and National Science Teachers Association.
- Soil Stories. Project Learning Tree. Environmental Education Activity Guide.
- Where Does Water Run Off After School? Project Wild Aquatic. Western Regional Environmental Education Council.
- “Water: From Earth for You,” “Erosion: On the Move, Erosion: On The Move...Defending The Coast Against Wave Attack,” “Water; Water Everywhere, and Not a Drop to Drink or Can You Survive a Flood” (all available online at <http://www.lpb.org/education/classroom/itv/envirotacklebox/>)
- Human Impact on the Natural Environment.  
<http://www.hobart.k12.in.us/jkousen/Biology/impact.html>
- What’s up Hot Topics in the Environment  
[http://www.thirteen.org/edonline/wue/hot\\_topics.html](http://www.thirteen.org/edonline/wue/hot_topics.html)
- What’s up in the Environment Class projects  
[http://www.thirteen.org/edonline/wue/class\\_projects.html#projects](http://www.thirteen.org/edonline/wue/class_projects.html#projects)
- Nature.org  
<http://www.nature.org/wherewework/northamerica/states/louisiana/preserves/>
- Agclassroom <http://www.agclassroom.org/kids/stats/louisiana.pdf>;
- Understanding Louisiana Soils  
<http://www.lsuagcenter.com/NR/rdonlyres/DB1BE3F5-C7F6-444B-83E7-079302758610/43127/pub3034UnderstandingLouisianaSoilsHIGHRES.pdf>
- USDA *online soil surveys*  
[http://soils.usda.gov/survey/online\\_surveys/louisiana/index.html](http://soils.usda.gov/survey/online_surveys/louisiana/index.html)
- School Garden Wizard <http://www.schoolgardenwizard.org/>
- Improve Your Garden Soil <http://www.improve-your-garden-soil.com/soil-classification.html>
- Information on agriculture and industry in Louisiana  
<http://www.theus50.com/louisiana/information.shtml>