



Comprehensive Curriculum

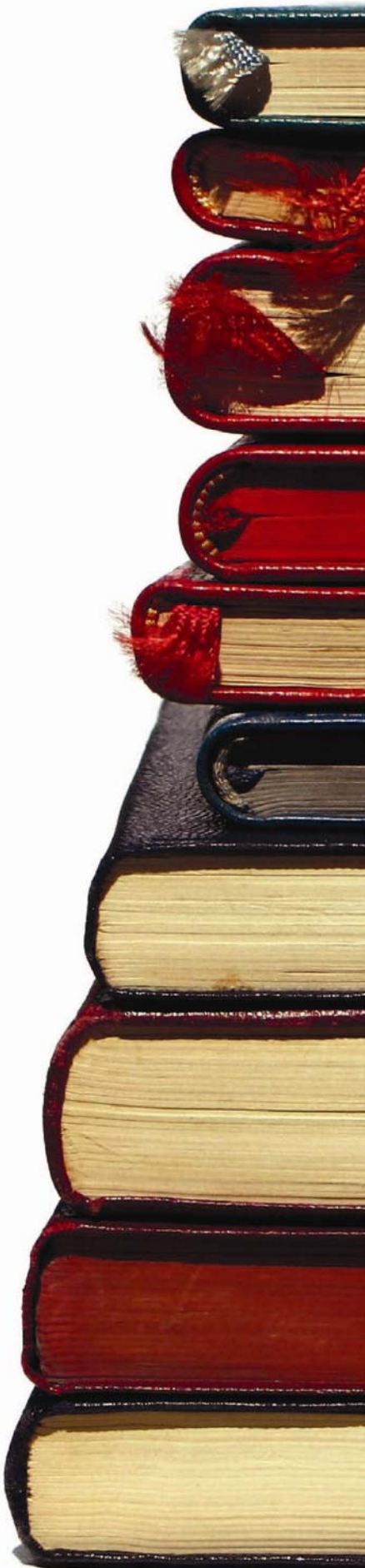
Revised 2008

Grade 5 Science



Louisiana Department of
EDUCATION

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**Grade 5
Science**

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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 5
Science
Unit 1: Properties**

Time Frame: Approximately 3 weeks



Unit Description

This unit presents hands-on activities that use metric tools to measure objects and substances. The organization of the periodic table by atomic number (number of protons), the structure of the atom, and the electrical charge of protons, neutrons, and electrons are emphasized. The characteristics of selected elements and their physical and chemical properties are investigated.

Student Understandings

Students will be able to measure, compare, and describe the properties of several samples of large and small objects using metric and customary units and use these properties to discriminate between objects that are similar. Students will be able to explain differences between physical and chemical properties of objects and identify some chemical reactions. Students will be able to identify the parts of an atom, and the charge for each. Students will be able to use the Periodic Table to identify elements by their atomic structure and describe some shared properties of elements on the Periodic Table.

Guiding Questions

1. Can students describe the differences between large and small quantities of similar masses, using metric and standard measurements?
2. Can students identify various objects by their measurements?
3. Can students describe the physical and chemical properties of various objects?
4. Can students describe some ways to group objects by properties and behaviors?
5. Can students use a periodic table and describe the structure of an atom, its relative mass, and the electrical charge?
6. Can students describe early models of the atom and explain how they have changed since first proposed by scientists?
7. Can students identify models of elements by their atom structure?

Unit 1 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry 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 Properties unit.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1)
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)
9.	Use computers and/or calculators to analyze and interpret quantitative data (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)
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)
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)
Physical Science	
1.	Measure a variety of objects in metric system units (PS-M-A1)
2.	Compare the physical properties of large and small quantities of the same type of matter (PS-M-A1)

GLE #	GLE Text and Benchmarks
3.	Describe the structure of atoms and the electrical charge of protons, neutrons, and electrons (PS-M-A2)
4.	Identify the physical and chemical properties of various substances and group substances according to their observable and measurable properties (e.g., conduction, magnetism, light transmission) (PS-M-A3)
6.	Describe new substances formed from common chemical reactions (e.g., burning paper produces ash) (PS-M-A6)

Sample Activities

Activity 1: Science and Safety in the Classroom (SI GLE: 23)

Materials List: chart paper; per student: Science Safety Contract BLM, ½ poster board for each student or pair of students

Safety should be an integral component of any science program and students should be instructed in science safety procedures at the beginning of each school year. Throughout the year, activities will be introduced that require students to make safety decisions. Teachers should be diligent in establishing safety rules and requiring students to follow them. Teachers can obtain safety guidelines using the link, *Science and Safety: It's Elementary Flip Chart*, at http://www.csss-science.org/downloads/scisaf_cal.pdf. Create a list of safety procedures on a large wall chart and display in the classroom. Discuss each procedure with the students and have them provide examples of when each should be followed. Review some of the lab activities that students will do this year and ask students to identify some safety concerns that might be an issue. Have students identify a safety procedure from the class chart that could be followed to protect students from injury.

After the class discussion on safety in science classes, have students create safety posters, using a ½ sheet of poster board to illustrate one of the safety guidelines. Assign a number to each poster that corresponds with the rule being illustrated. Use the posters to play a safety game. Hang posters around the classroom in clear view of the students. Create scenarios that require students to follow one or more of the rules in order to be safe. Have students decide which rules must be followed and move within the classroom to stand by that rule. Select one student to explain why the chosen rule is needed for each scenario. If students feel that more than one safety rule must be followed for a particular scenario, have them stand by the poster that they feel is the most important safety rule to follow and then identify the other rule(s).

Tell students that in each activity of this unit, they will be asked to identify procedures that should be followed to “be safe in science class.”

Give each student a copy of the Science Safety Contract BLM to sign. Emphasize the importance of what they are signing; then send it home for parents to read and sign. Keep signed contracts in a folder to refer to when students are not following the safety rules appropriately.

Throughout the course, refer back to the safety chart at the beginning of each activity, by having students identify appropriate safety procedures to follow. Include a sample scenario related to the skills being taught on every written test that requires students to identify safety rules that are being broken or followed correctly.

Activity 2: Qualitative Observations of Physical Properties (SI GLEs: 7, 22; PS GLE: 4)

Materials List: for each group of 4-6 students: small rubber ball, wooden block, spoon, quarter, glass marble, rubber eraser, wooden stick, another small object made from glass, quart-size re-sealable plastic bag; for each student: Identify that Object BLM

Place each group's objects in a re-sealable plastic bag and give one bag to each group. Give the Identify that Object BLM to each student. Ask students to remove objects from the bag and describe each object using their senses. Remind students that tasting is not allowed.

Direct students to record observations on the Identify that Object BLM. Once students have completed observations for each item, have students share them with the class. Ask students to categorize the types of observations that were made. They should notice that shape, size, color, hardness, and smell are the most common observations.

Ask students:

- Did your observations change the objects in any way?
- What did you use to make your observations? (senses)

Help students to develop the working definitions that *physical properties* are properties of an object that can be observed without changing the object, and that *qualitative* observations are physical properties that are observed without having to measure the object.

Select one of the Identify that Object BLM sheets from a group and read aloud the description of one of the objects. Display the group's objects, so everyone can see them. Ask students to identify the object that matches the description. Discuss with students the need to clearly describe each object so that others can identify it. Have students from one group read the descriptions of their objects to another group so they can determine the identities. If descriptions are unclear and create confusion, discuss with them the need to be as clear as possible. They should understand that scientists use evidence and observations to explain and communicate the results of their investigations, and communication needs to be precise.

Activity 3: Measure to Measure: Making Quantitative Observations (SI GLEs: 6, 7, 8, 9, 19, 22; PS GLEs: 1, 2)

Materials List: For demonstration: one large wooden block; for each group of 4-6 students: three different-sized wooden blocks made from the same material, metric rulers, balance with gram cubes or other standardized mass objects; Measure to Measure BLM; 5" x 7" index cards; calculators

Students will use metric measurement tools to make quantitative observations of three different-sized wooden blocks, and then use these quantitative observations to identify each block.

Review and demonstrate the proper procedure for measuring with a metric ruler and a balance, using the large wooden block and measuring the mass, length, width, and height of it. Review the measurement of volume. Provide students with the formula for finding volume (Length x Width x Height). Record all quantitative observations on the board. Introduce the term *quantitative*. Explain to students that quantitative observations are determined by using measurement tools such as thermometers, graduated cylinders, scales, rulers, etc. Discuss the need for making careful measurements.

Provide a set of 3 different-sized blocks and the Measure to Measure BLM to each group. First, instruct students to make qualitative observations to record physical properties such as color, smell, texture, etc., for each block on the Measure to Measure BLM. Working within their groups, students should then use metric rulers to measure the length, width, and height of the blocks to the nearest cm and should record findings on the Measure to Measure BLM. Once students have completed making linear measurements, they should first estimate, and then using appropriate equipment, determine the mass of the blocks using the balance and gram cubes. Students should then use calculators to determine the difference between estimation and actual mass. Group discussion should focus on accuracy between estimations and measured masses. Have students describe other physical properties of the wooden blocks and list these on the chart, also. Remind students that observations made without measurement tools are called *qualitative observations*.

Upon completion of the activity, ask students the following questions:

- What observations of all three objects are the same? (*color, hardness, smell*)
- What observations of all three blocks are different? (*length, width, height, mass, shape, size*)
- What observations were used to identify each block? (*the quantitative observations*)
- Were the objects changed into something new by measuring them? (*no*)
- Are quantitative measurements of objects used to identify physical or chemical properties? (*physical properties*)
- Why? (*Performing measurements does not change the object into something new with new properties.*)

Provide each group with a 5 x 7 index card on which to record the measurements of one of the three blocks. They should include the length, width, height, and mass of the block on the card. Once measurements are recorded, have each group trade their index card and three blocks with another group. Students should use the measurements on the card to determine which block is being described. Have students check with the original group for accuracy in identification.

Activity 4: Types of Measurements (SI GLEs: 6, 9, 10, 22; PS GLEs: 1, 2)

Materials List: graduated cylinders with wide mouths (25 ml, 100 ml, and 250 ml); calculators; spring scales; balances; several small regular and irregular shaped objects that can be weighed with spring scales and will fit into the mouths of graduated cylinders or can be measured with a metric ruler, such as rocks, marbles, etc.; a container for holding objects being weighed with attached string or wire; science learning logs; metric measuring tapes; metric rulers; calculators; string; container of water; paper towels; class chart for recording observations; for each group of 3-4 students: three objects to measure that are very similar in appearance and only slightly different in size such as sea shells, small rubber balls, marbles, rectangular blocks, dice, etc.; permanent marker; safety goggles

Safety Note: Have students review safety procedures and determine which one(s) should be followed during this activity. Students should identify those that address working with water, as well as reading all directions before beginning each experiment.

Introduce the activity by reviewing the definitions of physical properties, quantitative observations, and qualitative observations. The focus of this activity will be on quantitative observations and will be accomplished in three parts. In the first part, students will learn how to determine the mass and weight of objects. In the second part, students will learn how to determine the volume of regular and irregular objects. In the third part, students will use metric measurements to describe different objects, and then use the measurements to determine which object is being described. Students will then use observations to explain how the objects being measured are different.

Direct students to copy a chart such as the one below into their science *learning logs* ([view literacy strategy descriptions](#)) and include as many sections as there will be objects to measure. Science *learning logs* are journals created and used by students to record written and visual observations, make predictions, record new understandings, explain science processes, pose and solve problems, and reflect on what has been learned. Students will use their science *learning logs* throughout the school year as they investigate science concepts and build new knowledge.

MEASUREMENTS OF OBJECTS

OBJECT	SHAPE (Regular or Irregular)	WEIGHT	MASS	VOLUME (mL or cm ³)

The chart will be used to record measurements made throughout the activity.

Part 1

Review and demonstrate to students how to use a balance and spring scale. Guide students to understand the difference between *mass* and *weight* as they investigate how to use both instruments. The *mass* of an object refers to the amount of matter in an object; the *weight* of an object is the force of gravity acting upon that object.

A spring scale is used to measure weight. Weight is determined by the force of gravity pulling on the object. The force of gravity is the force with which the earth, moon, or other massive body attracts an object towards itself. Since different planets have different gravitational forces, the same amount of mass has different weights on different planets. Even on Earth, objects can have different weights at different locations (*due to the Earth's gravitational pull at that location, i.e., on top of Mount Everest the pull of gravity is less than at sea level*). The metric unit used to measure this force is the Newton. The U.S. uses the same measurement units for weight as they use for mass, which often causes confusion for students. Show students how to measure the weight of objects with spring scales. Provide each group with several small objects to use in determining weight and mass and allow some opportunity for investigation. Students should use the chart previously created in their science *learning logs* to record measurements.

Students should write an explanation of how mass and weight are similar and different in their science *learning logs*.

Part 2

Review with students the proper procedures for determining the volume of regular and irregular objects. (*The volume of an irregular object is determined by measuring a specific amount of water in the graduated cylinder, then dropping the object into it, and determining how much water is displaced. It is recorded in mL. The volume of a regular object is determined by finding the length, width, and height of the object and using the formula: $V = L \times W \times H$.*)

Provide students with the same objects used in Part 1 and have them determine the volume of each. Students may use calculators or mental math to determine volume of regular objects. Students should determine if the volume should be recorded in mL or cm³. Be sure students understand that 1 mL of liquid is equal to 1 cm³.

To reinforce what has been investigated, have students read about *mass*, *volume*, and *weight* in their textbooks, or view a video on the topic, such as “Matter and its Properties: Measuring Matter” available through LPB Cyberchannel site at <http://www.lpb.org/education/cyberchannel.cfm>.

Part 3

Show students a group of similar-looking objects that are slightly different in one measurement. Ask students to suggest ways that each object could be distinguished from the others. Guide students to determine that measurements can be used to distinguish objects that are otherwise very similar. Set up three stations: 1) Linear Measurements 2) Mass and 3) Volume. Station 1 should have calculators, metric rulers, metric tapes, and string. Station 2 should have three balances with mass units and spring scales, and Station 3 should have three graduated cylinders or calibrated beakers large enough to hold the objects, paper towels, safety goggles, and a container of water.

Have students prepare a chart in their science *learning logs* ([view literacy strategy descriptions](#)) to record the applicable measurements of mass, volume, and linear measurements of each object as well as one master wall chart (see example below) that will include all groups’ measurements. Each group’s objects should be labeled with a different letter.

QUANTITATIVE OBSERVATIONS

OBJECT	LINEAR MEASUREMENT			MASS (g)	VOLUME (ml or cm ³)
	L	W	H		
1A					
2A					
3A					
1B					
2B					
3B					
1C (etc.)					

Provide each group of students with a set of three different-sized, but similar objects to measure (e.g., same-type seashells, walnuts, marbles, bolts, metal ball bearings, rectangular blocks, other rectangular-shaped objects, etc.). For each group of objects, try to choose objects that are more similar than dissimilar, in order to assure that measurements must be made to distinguish between them. Label the objects in each set as A, B, and C. (*It would be helpful to provide written instructions at each station.*)

- Divide students into six groups. The first three groups will make initial measurements while the second three groups read in their textbooks about measurement; then the second three groups will re-measure the objects to determine which ones match the measurements, while the first three groups read.

- Assign each small group one of the three measuring stations at which to start. They should rotate through the stations, obtaining measurements of their three objects and recording them on the chart in their science *learning logs*. Once all measurements have been taken, have a group leader record data on the master wall chart.
- Then have the second group rotate through the stations to check initial measurements and determine which object in each group matches all of the measurements that were taken.
- Have students identify data that has been recorded on the chart that is not supported by the evidence. Have students explain how they could tell which object was which by using the measurements recorded on the chart.
- Once students have finished, have a class discussion about the value of having exact measurements to identify and/or distinguish objects that are similar.

Activity 5: Property Discovery (SI GLEs: 7, 16, 22, 23; PS GLEs: 4, 6)

Materials List: pairs of objects similar in all ways but one or two physical properties, such as a ping pong ball and a tennis ball, pear and green apple, a univalve and bivalve seashell, a block of wood and a metal rectangular rod; paper lunch bags; safety goggles; vinegar; raw potato slices; hydrogen peroxide; baking soda; matches; piece of paper; iodine; index cards; milk that has all its milk fat; small containers (test tubes, baby food jars); science learning logs

Properties of matter include both physical and chemical properties. Physical properties are easier to observe and describe and can be discovered without changing the material of the object into something new. Chemical properties, on the other hand, are typically observable during a chemical reaction. Every substance has its own physical and chemical properties that can be used in describing and identifying it. In this activity, students will observe and use physical and chemical properties to identify and describe different types of matter.

Part A: Physical Properties Discovery

Physical properties of objects include color, size, shape, texture, ability to transmit light, magnetism, ability to conduct electricity, heat, or sound, as well as boiling, melting, and freezing points.

In this activity, students will learn how to describe the physical properties of objects and then use others' descriptions to identify objects from a collection.

Gather enough objects for each student to have one. Try to find pairs of similar objects that are different in only one or two physical properties (e.g., two types of small balls such as a tennis ball and a ping pong ball). Put each object into a small brown paper bag and pass out to students. Have students look into the bag and describe as many physical properties as possible for the object without removing it from the bag. Tell students to be

careful not to name the object in their description. Have students record their descriptions on an index card. Collect the cards; then remove the objects from the paper bags and set them on a table in plain view. Read the physical properties and have students select the correct object based on the written description. Discuss with students the types of physical properties that were used to describe the objects and make a list of them on the board; then ask what other physical properties could be used in identification, such as ability to transmit light (*e.g., clear, translucent, opaque*), ability to be attracted to a magnet, ability to conduct heat and electricity, etc. Ask students the following questions:

- What was used to observe the properties of these objects? (*senses, measurement tools, magnets*)
- Did you notice any change in the object while it was being observed? (*no*)
- Does making observations change the object in any way? (*no*)
- What type of change occurs when an object is just observed? (*no change*)
- What type of properties can be observed without changing the object into a new substance? (*physical properties*)
- Define *physical properties*. (*Physical properties are those properties of an object that can be observed without making any change in the object.*)

B. Chemical Properties Discovery

Safety note: Review safety measures that should be considered when handling materials that can react with other materials. Have students refer to the wall chart created in the first activity. Remind students that they should never taste materials in a science lab unless specifically instructed to by the teacher. Review the procedure for detecting odors (hold object a safe distance from the face and use hand to waft odor towards you.)

Part 1

Prior to beginning the investigation of chemical properties and changes, read from the textbook or have students view an appropriate video about chemical properties and chemical changes such as “Matter and Its Properties: Changes in Matter” which can be obtained from LPBs’ Cyberchannel <http://www.lpb.org/education/cyberchannel.cfm>. Check to see if your school has a paid subscription. LPB’s Cyberchannel offers many video clips on educational topics to enhance teaching and learning.

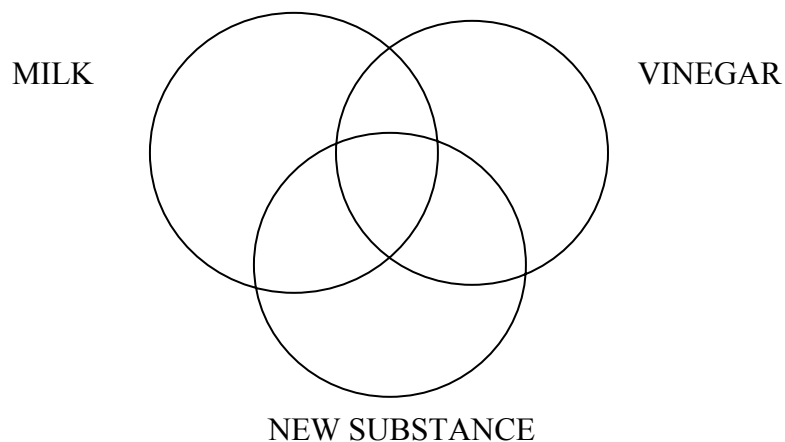
Discuss the definition of a chemical property with students. Ask students to explain what possible actions will be observed when a chemical reaction occurs (color change, creation of gas, temperature change, light, formation of a precipitate). Then, ask students to name some examples of chemical reactions that they have seen or heard about (*e.g., cut apple turning brown, fireworks exploding, firefly lights, tanning of the skin, candle burning, etc.*). Write all suggestions on the board. Ask students to predict what causes the chemical reactions to occur in each of the suggestions (combining of two or more substances, addition of heat, etc.). If needed, demonstrate some simple chemical reactions to help students understand, such as combining vinegar and baking soda, putting a raw potato slice in hydrogen peroxide, adding iodine to a cut slice of potato, or burning a piece of paper (if school policy allows). Ask students to identify the evidence that a change is taking place, such as the formation of bubbles, the potato turning black, and the

production of light and heat as paper turns to ash. Explain to students that chemical changes result in new materials with different properties than the original materials.

Part 2

Allow students to investigate a chemical change taking place. Provide each group with 10 mL of milk and 10 mL of vinegar in separate small containers (test tubes or baby food jars). Through class discussion and guided probing questions, have the students use their senses to generate a list of physical properties, such as odor, color, texture, hardness, and state of matter at room temperature. Students should also list other less obvious, but more advanced physical properties that are measurable, such as ability to conduct heat and electricity, and ability to transmit light (e.g., clear, translucent, opaque).

Then, combine most of the milk and vinegar into one container. Students should retain a small amount of each liquid to use when observing changes in the new substance. Students are to summarize the observed results in their science *learning logs* ([view literacy strategy descriptions](#)). (*The substance changed, demonstrating a chemical reaction in which vinegar and milk react.*) Have students compare the original physical properties to the physical properties of the new substance. Then, instruct students to create a *graphic organizer* ([view literacy strategy descriptions](#)) such as a Venn diagram in their science *learning logs* to compare and contrast the physical and chemical properties of the three substances (*the original two substances and the new one*). Graphic organizers are effective tools because they provide the learner with two avenues to memory—verbal (the text) and spatial (the placement of information in relation to other facts). The Venn diagram is useful when comparing similar and dissimilar characteristics of material.



Have students observe and describe any properties that milk and vinegar have in common, (*i.e., both are liquids*) and place them in the appropriate section of the Venn diagram. Students should also observe and describe characteristics of milk and vinegar that are not the same (*i.e., one is transparent and one is opaque, one has a pungent smell and one doesn't*) and place these observations on the Venn diagram. Once the two liquids are combined, students should notice similarities and differences between the new

substance and the original substances. These should be recorded on the Venn diagram. Ask students if a chemical reaction occurred and explain their decision based on their observations.

Explain to students that chemical properties are typically observed when one substance reacts with another substance, creating a new substance with different physical and chemical properties.

Activity 6: Magnetism, Heat, and Electricity (SI GLEs: 1, 6, 7, 8, 12, 13, 16, 22, 23; PS GLE: 4)

Materials List: safety goggles, lantern battery, 20 or 22 gauge insulated copper wire, light socket and miniature light bulbs, magnets, objects from Activity 5, paper clips, nails, wire, wood, rubber bands, glass, plastic, coins, rocks, unlabeled metal cans, glass bottles, plastic bottles, a container containing rice or sand, candle, candleholder, thermometer, science learning logs

Safety Notes: Have students refer to the safety procedures displayed on the wall (created in Activity 1) and identify the appropriate procedures to observe when working with electricity, batteries, light bulbs, and wire. Caution students never to place batteries in their mouths or remove their protective coverings. Review safety procedures for working with fire or heat and monitor carefully for appropriate use.

The purpose of this activity is to determine what common property or properties of objects allow them to be attracted to magnets, conduct heat, and/or conduct electricity. A pattern they should notice in the results of their investigation is that most objects made of metal share the properties of heat and electrical conduction and are often magnetic, too.

Show students objects that were described in Activity 5 and ask them to identify any other properties that these objects may have. Have students generate questions about additional properties that can be answered through scientific investigation. Guide students to elicit questions about the physical properties of (1) magnetism, (2) heat conduction, and the (3) ability to conduct electricity.

Have students create a chart in their science *learning logs* ([view literacy strategy descriptions](#)) to record observations (see example below).

OBJECT	MAGNETIC (YES-----NO)	MATERIAL IN OBJECT	CONDUCTS HEAT	CONDUCTS ELECTRICITY

Through a series of learning stations or demonstrations, students will investigate materials to determine which ones are magnetic, as well as conduct heat and/or conduct electricity.

The materials for Learning Center 1 (Attraction to Magnets) should include magnets, paper clips, nails, wood, rubber balls, glass marbles, plastic, coins, cork, and rocks. Have students test these objects to determine if they are magnetic. Results should be recorded on the chart.

The materials for Learning Center 2 (Conducting Electricity) include a lantern battery, 20 or 22 gauge pieces of insulated copper wire, and a small light socket with a miniature bulb. Review how to set up a complete circuit with students. Provide the same materials used in the investigation for magnetism. Students should test which items conduct electricity. Results should be recorded on the chart. After all items have been tested, students should look for patterns in the results (most metal objects conduct electricity and objects that are not metal do not). Introduce the term *insulator* and explain to students that insulators do not conduct electricity. This is a useful property of some objects that allows them to be used to protect people from electrical shock.

Learning Center 3 (Conducting Heat) should be designed to investigate what materials will conduct heat and could include such items as unlabeled metal cans, glass bottles, plastic bottles, a container containing rice or sand, and a candle in a candleholder. Have students place a thermometer in the container of sand or rice and record the temperature; then shake the container for several minutes and reinsert the thermometer. Have them take another reading, record temperature, and answer these questions: Did the temperature increase or decrease? (*increase*) Why do you think there was a change in temperature? (*the movement of the particles in the can generated friction which caused mechanical energy to be transformed into heat energy*) Next, place a can near a lit candle. Ask Does the opposite side of the can get warm, too? Why? Have students document the findings in their science *learning logs*. Next, have students try a glass bottle and a plastic bottle. Is there evidence that heat is conducted through these substances?

Ask students to look at the types of materials that share the properties of magnetism, heat conduction, and electricity conduction. Encourage students to make a generalization about the types of materials that conduct heat and electricity and are also magnetic.

Activity 7: Atoms (SI GLEs: 14, 15, 28, 35; PS GLE: 3)

Materials List: for each student: labeled diagram of the parts of an atom, science learning logs

Safety Note: Have students identify the safety rule for working with scissors and explain why it is important to follow such procedures.

Atoms are everywhere and are part of everything. If you could break down any substance into its smallest building blocks, you would have only atoms. As long ago as the times of Empedocles, Democritus, and Aristotle, people have tried to determine what makes up

matter. Democritus actually coined the term “atom” when he was describing the very small particles that make up matter.

Show students a diagram of an atom and explain to them that atoms are composed of even smaller parts that are called *protons*, *neutrons*, and *electrons*. These smaller parts are found in very specific places within the atom. Protons have a positive charge (+) and are found in the nucleus of the atom with neutrons, which have no charge (N). Electrons have a negative charge (-) and are found spinning around the nucleus of the atom in energy levels. Guide students to understand that as small as the atom is, there are even smaller parts that make it complete. Tell students that they will create human models of an atom in a later activity.

To help students understand the early theories about the atom, introduce the Greek philosophers, Empedocles and Democritus, and the English scientist, John Dalton, and share their “atomic theories” with students. Provide students with excerpts from an article called *Matter: Atoms from Democritus to Dalton*, available at http://www.visionlearning.com/library/module_viewer.php?mid=49 or *The Story of the Atom* by Joy Hakim, available at http://www.aft.org/pubs-reports/american_educator/spring2002/Atom.pdf. Have students use the literacy strategy, *SQPL* ([view literacy strategy descriptions](#)), to help them understand the concepts in the article. Student Questions for Purposeful Learning, or *SQPL*, is a strategy designed to gain and hold students’ interest in the material they are reading by having them ask and answer their own questions. When students, instead of teachers, pose the questions about what is to be learned, they become much more motivated to pay close attention to the information sources for answers to their questions.

To create motivation for reading the text, share the following statement with students:

Everything on Earth is composed of earth, air, fire or water.

Write the statement on the board and have students record it in their science *learning logs* ([view literacy strategy descriptions](#)). Have students pair up and, based on the statement, generate two or three questions they would like to have answered. The questions must be related to the statement and must make sense. Have students share their questions and write them on the board under the statement. Once all the questions have been shared, look over the list and decide if you need to add any of your own.

Some suggested questions include the following:

- What were the building blocks of everything, according to the hypotheses of early philosophers and scientists?
- Did the ideas of later philosophers and scientists build on earlier ones’ ideas?
- What did scientists do differently than philosophers to change ideas about atoms as time passed?
- Are living and non-living things made of the same matter?
- How small is the smallest particle that makes up matter?

- If we can't see the smallest particle that makes up matter, how can we be sure we know what it is?

Have them read to find the answers to their questions and the ones provided by the teacher. The material can be read as a group, in pairs, or by the teacher. As content is covered, stop periodically and have students discuss with their partners which questions could be answered; then ask for volunteers to share. Continue reading until all questions have been answered. Students can write questions and answers in their science *learning logs*.

Have students compare and contrast Democritus' and Dalton's theories, emphasizing the passage of time between the introductions of each. Students should be led to understand that Democritus did not base his theory on scientific investigation, but Dalton did. John Dalton's "atomic theory" marked the beginning of true scientific investigation into the study of atoms.

Activity 8: Become an Element Consultant (SI GLEs: 3, 11, 13, 15, 19; PS GLE: 3)

Materials List: large index cards, paper plates, markers, scissors, sticky dots, construction paper, hole punchers, split peas, glue, different sizes of circle templates to create energy levels on construction paper, chart paper or light colored shower curtain for wall chart, permanent marker, research materials, Internet

To develop an understanding of how the Periodic Table of Elements is organized, each student will research and present an element chosen from the chart. Students will gather the following information from the chart and various other research sources including the Internet: number of protons, neutrons, and electrons, classification on periodic chart and common physical characteristics, color, when discovered and by whom, and common uses. An excellent Internet site for this activity is "Chemical Elements," available at <http://www.chemicalelements.com>. This information gathered from their research will be placed on large index cards using the following format: name and symbol in the center, atomic number in the upper left corner, and atomic mass at the bottom. All other information will be on the back of the card. Students will use these cards to answer questions about their element.

Following a teacher demonstration, have students make Bohr models of their atoms to show placement of protons, neutrons, and electrons within the atom. They will use a paper plate, two colors of sticky dots (to represent protons and neutrons) for the nucleus, and split peas or other small beans to represent electrons in the energy levels. Students should determine how many energy levels are present in their element and use different colored construction paper circles to represent each level. These levels should be glued onto the paper plate in descending size, with the smallest circle in the center of the plate. This circle will represent the nucleus. An example of the Bohr model can be found in most science textbooks, as well as a website such as "HowStuffWorks," available at <http://science.howstuffworks.com/atom7.htm>. Ask students to identify limitations of the

models used to represent each element. Explain to students that this model has recently been replaced with a newer model, the electron cloud model of the atom, proposed by Louis de Broglie and Erwin Schrodinger. According to this model, electrons do not move about an atom in a definite path, like the planets around the sun. In fact, it is impossible to determine the exact location of an electron. The probable location of an electron is based on how much energy the electron has. The location of electrons in the cloud surrounding the nucleus depends upon how much energy the electron has.

Have students present their element résumés to the class by using the literacy strategy called *professor know-it-all* ([view literacy strategy descriptions](#)). With this strategy, students assume the roles of “know-it-alls” or experts who are to provide answers to questions posed by their classmates. This approach teaches students to ask a variety of questions at different levels of difficulty and requires the professor to be well-versed in the information being taught. Students should generate three to four questions about the element being presented, including at least one question about the use(s), physical properties, or chemical properties of the element.

Prepare a large wall chart on which to place element cards once they are complete. (Prior to having students place their cards on the chart, be sure to label the rows and columns of the wall chart appropriately with any additional information not provided by students’ research, such as element groups, numbers of rows and columns, and additional elements.)

Once everyone has had an opportunity to be *professor know-it-all*, have students place their cards on a chart to make a class model of a periodic element chart. Have students use the chart to answer the following questions:

- What pattern do you see on the chart for atomic numbers of elements? (*the atomic numbers increase from left to right and from one row to the next*)
- What pattern do you see on the chart for atomic masses of elements? (*the atomic masses increase as the atomic number increases, also from left to right and from one row to the next*)

To understand why these patterns exist, have students make a second periodic table wall chart with the paper plate models; then use the chart to answer the following questions:

- What pattern of electrons in the outer shell do you see in the first column? (*all elements in the first column have one electron in the outer shell*) Second column? (*two electrons in the outer shell*) Does this pattern continue across all of the columns? (*it doesn’t continue for columns 3-12, but once you get past the transition metals, column 13 has 3 electrons in the outer shell, column 14 has 4 electrons in the outer shell, column 15 has 5 electrons, etc.*)
- What pattern do you notice with the number of protons? (*the number of protons increases as you move from left to right and from row to row*) What does this number compare to on the other chart? (*the atomic number*)
- What pattern do you notice with the number of energy levels in each row or period? (*the number of energy levels equals the row number, i.e., row 1 has one energy level, row 2 has two energy levels, etc.*)

- What pattern do you see when you compare the number of protons to electrons in each element? (*the number of protons is equal to the number of electrons*) What charge does this give to the atom? (*a neutral charge*)
- What parts of the atom determine the atomic mass? (*the number of the protons and neutrons in the nucleus of the atom*) How can you find the number of neutrons in an atom if you only know the atomic mass and the number of protons and electrons? (*subtract the number of protons from the atomic mass and it will give you the number of neutrons*)

Explain to students that the elements are grouped on the periodic chart according to similarities in properties. Some of these properties will be explored in the next activity.

Activity 9: Human Models of Elements (SI GLEs: 15, 19, 23; PS GLE: 3)

Materials List: large sheet of chart paper or old solid-colored shower curtain or tarp for drawing diagram of Bohr model, Periodic Table for each student that includes atomic numbers and atomic masses or a large wall chart of Periodic Table that clearly shows atomic numbers and atomic masses, index card labels of “protons,” “neutrons,” and “electrons” with string attached to hang around students’ necks

Safety Note: Review and have students identify safety procedures for safely moving within the model.

Have students create a human model of an atom of an element. Divide students into two groups. In each group, allow students to select one of the elements on the periodic table to model. Determine how many students are needed to correctly model the atom. Students should decide among themselves how many protons, neutrons, and electrons are needed and who will represent each on the floor model. Once this is determined, students participating in the model should place a placard around their necks indicating what they represent. Use several sheets of bulletin board paper to draw a Bohr atom diagram with several energy levels that is large enough for students to stand within each part. Place the diagram on the floor. Students should arrange themselves in the correct place within the atom. Protons and neutrons should gather together closely in the nucleus and the electrons should move quickly around within the energy levels. Have the rest of the students in the class determine what element is being modeled. If possible, show students a picture of the element being modeled after it has been correctly identified. Repeat with other elements. Have students identify and explain the limitations of using this type of model to represent an element. Remind students that this model is useful in showing placement of protons, neutrons, and electrons within an atom, but has been replaced by the newer electron cloud model of the atom.

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 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 student's 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

- With emphasis on using metric units, the student will measure a variety of objects to assure that skills of estimation, measuring, and equipment used are grade-level appropriate. Objects that could be used are balls, erasers, pens, etc.
- The student will create a game using element cards created in Activity 2.
- After classifying materials as conductors or insulators, the student will problem-solve to determine the best safety practices to follow when using electrical equipment. The student can draw, diagram, or write the solutions. Students will share their work.
- The student will make a flow chart that describes how electrons light the bulb when using the conductors.
- The student will create a game about the theme of physical and chemical change. This could be a board game or a card game.
- Display the element models made in Activity 2. The student will match the element card to the model.
- The student will create a scavenger hunt for elements.
- The student will reflect on the journal entries and make a list of statements about how he/she encounters these living and nonliving substances.
- Provide students with one example of a chemical reaction. Each student will identify the process that creates it and the observable proof of the reaction (*gas bubbles, temperature change, color change, light emission, etc.*)
- Provide students with the physical and chemical properties of several very different substances and pictures. The student will identify the substance, using his/her understanding of these properties.

- The student will create a Jeopardy game board to review properties of different elements.

Activity-Specific Assessments

- Activity 3: Provide students with several regular and irregular shaped objects, as well as a graduated cylinder with water, metric ruler, and calculator. Have students determine the volume of each object using the appropriate tools. Then, provide students with a second set of objects and their pre-determined volumes and have students work backwards to determine which objects belong to each volume.
- Activity 4: Provide students with four nearly identical objects that have slightly different measurements. Label each object “A,” “B,” “C,” or “D.” The student will rotate through stations to measure and record measurements for each object. Provide students with official measurements of the objects and have them identify the objects that match each.
- Activity 8: Provide students with an enlarged copy of the Periodic Table on which many of the elements have been blocked out and five or more element cards that have the atomic number, classification, and/or energy levels listed. Students will use the information provided on the element cards and their knowledge of the patterns on the Periodic Table to determine where the elements should be placed.

Resources

Books

- American Institute of Physics. *Best of Wonder Science*. American Mathematical Society, American Chemical Society. Delmar Publishing.
- Wick, Walter. *A Drop of Water*.
- Woodruff, John. *Energy*.
- de Pinna, Simon. *Forces and Motion*.
- Tolman, Marvin N. *Hands-On Physical Science Activities for Grades K-8*. Parker Publishing.
- John Woodruff, John. *Magnetism*.
- Fowler, A. (1995). *Metric System*. Children’s Press
- Fitzgerald, Karen. *The Story of Oxygen*.
- *The Usborne Big Book of Experiments*. Smith, Alastair (Ed.) EDC Publications.

Websites

- *Atoms Family*. Available online at <http://www.miamisci.org/af/sln>
- Chemical Elements. Available online at <http://www.chemicalelements.com/index.html>
- *Elements and the Periodic Table*. Available online at PH @School http://www.phschool.com/atschool/sci_exp_lep/physical_science/Student_Area/PS_SC3_ACT_index.html
- *Interactive Periodic Table*. Available online at <http://www.chemistry.org/>
- Intermediate Infobook Activities 2002-2003. The Need Project, P.O. Box 10101, Manassas, VA 20108. Available online at <http://www.need.org/>.
- The Story of the Atom by Joy Hakim, available at http://www.aft.org/pubs-reports/american_educator/spring2002/Atom.pdf

**Grade 5
Science
Unit 2: Reactions**

Time Frame: Approximately 2.5 weeks



Unit Description

This unit focuses on reactions and provides additional information about the elements and matter. The properties and behavior of water in solid, liquid, and gaseous states are investigated; and chemical reaction investigations show how new substances are formed.

Student Understandings

Students understand that a variety of changes and reactions are found in the physical sciences. Examples that students should be aware of include the burning of combustible materials and the changing states of matter of substances, such as water. Examples of several types of simple physical changes and chemical changes provide students with a basis for understanding more complex chemical reactions.

Guiding Questions

1. Can students describe the differences in the properties of water in three different phases of matter?
2. Can students model the movement of molecules of water in different phases and explain how this movement affects the phase of water?
3. Can students differentiate between physical changes and chemical changes and recognize that a chemical reaction is taking place?
4. Can students describe the properties of a substance that has undergone a chemical reaction (e.g., ash from burning a piece of paper)?
5. Can students give examples of both physical changes and chemical changes that take place during cooking?

Unit 2 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry 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 Reactions unit.</i>	
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)
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)
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)
23.	Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8)
37.	Critique their inquiries and the inquiries of others (SI-M-B5)
Physical Science	
4.	Identify the physical and chemical properties of various substances and group substances according to their observable and measurable properties (e.g., conduction, magnetism, light transmission) (PS-M-A3)
5.	Describe the properties and behavior of water in its solid, liquid, and gaseous phases (states) (PS-M-A5)
6.	Describe new substances formed from common chemical reactions (e.g., burning paper produces ash) (PS-M-A6)
12.	Identify the sun as Earth's primary energy source and give examples (e.g., photosynthesis, water cycle) to support that conclusion (PS-M-C3)

Sample Activities

Activity 1: Going through the Phases (SI GLEs: 6, 7, 12, 13, 21, 22, 23: PS GLE: 5)

Materials List: For each group of students: Changing Phases BLM, five colored ice cubes, thermometers, plastic resealable bags large enough to close with a thermometer inside, balance, chart for recording temperature changes; For entire class: food coloring, ice cube trays, hot plate, glass or metal container for heating water, appropriate thermometer for measuring the temperature of boiling water or digital thermometer with software program for class demonstration, potholder or oven mitt, access to freezer, ice chest (optional)

Safety Note: Before beginning the activity, discuss safety procedures that should be followed when working with water, electricity, and hot plates.

In this activity, students will observe water as it goes through phases (*or changes in state*) and will use their observations to infer what is needed to change water from one phase into another.

Ask students to predict what is needed to make solid water (ice) change to liquid water and water vapor. Conversely, what is needed to change water vapor back to liquid water and ice? (*the addition or removal of heat energy*) Introduce the term *phase change* and explain to students that when water changes from one form into another, it is still water and has only changed its phase.

Tell students they will conduct an investigation to observe water going through phase changes. Provide each group of students with a baggie of 5 ice cubes that have been made with water colored with food coloring. Before removing the ice cubes from the freezer, the teacher should measure and record the temperature of the freezer. If the ice cubes are being transferred from the freezer to an ice chest, it will also be necessary to measure the temperature of the ice chest right before removing the ice cubes from it. Students should then quickly measure the mass of the baggie and the five ice cubes in grams, and record the temperature of the freezer and ice chest, as well as the mass measurements on the Changing Phases BLM. Have students observe, describe, and record the shape of the ice cubes. All data should be recorded using the metric system. Ask students to identify what phase of water is being observed.

Place a thermometer inside each baggie and record the temperature of the water at two minute increments until it completely melts. Allow ice cubes to melt in the baggie—observing, describing, and recording the shape of the melted ice cubes. Students should record the temperature of the water/ice mixture several times before the ice is completely melted. (*Students should observe that the temperature initially rose from the temperature of the freezer until it reached the melting point of water. Once the water began to melt, the temperature of the water/ice mixture should remain constant until the ice has completely melted.*) The thermometer can stay submerged in the baggie throughout the

melting time. Once the ice is totally melted, students should then take a final reading of the water's temperature, remove the thermometer from the baggie, measure the mass of the baggie and its contents, and record their results on the chart. The thermometer should then be placed back into the baggie and the bag should be sealed.

Ask students

- At what temperature was the water in its solid state? ($\leq 32^{\circ}\text{F}$ or 0°C)
- What was added to the solid state (ice) to cause it to change state? (*heat energy from the air surrounding the baggie or the student's hands*)

Have students use their observations and data to infer that a temperature change has caused the change of state to occur and to identify the phase of water being observed. (*Students should also be able to see that as long as the water was going through the phase, the temperature remained constant. It was not until the water was in its new phase that the temperature began to change again.*) Students should keep the thermometer in the bag for approximately four minutes as they continue to monitor the temperature every two minutes and record the temperature on their charts. Ask students to explain what is causing the rise in temperature once the ice has completely melted. Guide them to understand that heat energy from the surrounding air on the outside of the baggie is flowing into the baggie. The added energy makes the water molecules move more quickly. This increase in activity is recorded as the temperature of the water.

Ask students

- When did the student notice a change in temperature? (*when all of the ice finally melted, the temperature of the water began to rise*)
- What did the students observe about the temperature of the water over time once the ice was completely melted? (*the temperature rose until it reached room temperature and then stabilized*)
- Why did the temperature of the water stop rising? (*Students should infer that no more heat energy is being added to the water, so the temperature of the water is becoming equal to the air temperature.*)

The next step should be done as a teacher demonstration to ensure the safety of students. The teacher should pour the liquid from all of the groups' baggies into a glass or metal container that can be heated and then place a thermometer into the combined water to measure the temperature of this water. Have students record the temperature on the Changing Phases BLM. Demonstrating the safety procedures for working around hot plates and with boiling water, the teacher should apply heat and allow the water to evaporate (color will be left behind). While the water is heating, the teacher should read the temperature of the water every two minutes and have students record it. Students should note the temperature of the water as it begins to evaporate and record it on their Changing Phases BLM. If a computer program and digital thermometer are available, the thermometer should be placed in the container before the water heats up and begins to evaporate. Have students observe the temperature of the water as evaporation begins. (Students should observe that the water has not reached the boiling point yet, even though

evaporation has begun to occur.) Ask students to identify which change in phase is occurring. Explain to them that this is what it means to “infer,” (*i.e. to use the observations that they can see, smell, feel, hear, or taste, to come to a conclusion about what is being observed.*)

Ask students

- What was added to the water in the glass or metal container on the hot plate that caused the temperature to change? (*heat energy was added from the hot plate*)
- Describe the temperature of the water while it was being heated to the point of evaporation. (*it was steadily increasing*)
- Did the temperature reach boiling point before or after the water began to evaporate? (*the water began to evaporate before it reached the boiling point*)

Once the water is at a full boil, record the temperature again. (*Students should observe that once the water comes to a full boil, the temperature remains the same until all of the water is evaporated.*) Afterwards, the container which held the water starts heating up, and students will see the temperature rise again. Ask students if it is possible to measure the mass of the evaporated water. (*Students should observe that the water vapor is escaping and spreading out into the surrounding air. From this, they should be guided to infer that it would be difficult to measure the mass of the evaporated water.*) Guide students to understand that if the water vapor could be collected and contained, it could be measured; however, in this experiment, the mass of the water vapor will not be measured. Instruct students to record their visual observations of the evaporating water and the residue of color left behind, and then analyze temperature data on the chart to infer that a change in temperature was needed for water to change from one phase to another. Use the recorded data to compare the mass of the ice, ice/water mixture, and the water after it melted. Students should understand that a change in state does not change the mass of the water. Discuss with students the differences between observations and inferences.

Ask students

- What happened to the temperature of the water once it began to boil? (*the temperature of the water stopped rising and stayed the same*)
- What can you say about the temperature of the water as it is going through a phase change? (*Once the phase change begins, the temperature of the water stays the same until the phase change is over.*)

Have students write an explanation for what happens when water changes phase and include supporting evidence from the activity in their science *learning logs* ([view literacy strategy descriptions](#)). A science *learning log* is a notebook that students keep in order to record ideas, questions, reactions, and new understandings, as well as observations and data from science lab activities. In their explanation, students should provide evidence that they understand that heat energy is added to each phase of water, and that this increase in heat energy is what makes water change phase. Their explanation should also indicate that they recognize that while water is actually going through the phase change,

the temperature remains constant and only increases once the phase change has been completed.

The ability of substances to change phase is very important to many of the activities we do and the materials we use. Students study phase changes, but often don't think of how important this ability of substances is to their everyday lives. To provide students with an opportunity to really think about the importance of this process, provide them with the *SPAWN* prompt ([view literacy strategy descriptions](#)) called What If?

Present the following *SPAWN* prompts to students by writing it on the board or overhead projector and tell them to select one to write about.

- What if water was only available in its solid form? How would it affect our bodies?
- What if metals were only available in liquid form? How would it affect the way we travel?

Allow students to write their responses in a reasonable amount of time (*approximately 10 minutes*). Ask students to copy the prompt in their science *learning logs* before writing responses and record the date. Learning logs are journals created and used by students to record written and visual observations, make predictions, record new understandings, explain science processes, pose and solve problems, and reflect on what has been learned. Have students share their *SPAWN* responses with classmates. Their responses should demonstrate an understanding and appreciation of the ability of substances to exist in solid, liquid, or gaseous states.

Activity 2: How Are They Different? (SI GLEs: 7, 15, 22, 23; PS GLE: 5)

Materials List: For demonstration: hot plate, saucepan with water and larger pan with ice; for each student: science learning logs

Safety Note: Set up a demonstration for the water cycle using the hot plate, saucepan with water, and larger pan of ice. Before beginning the activity, show students the hot plate with the pot of water. Ask students to identify the poster which was created in the Safety Activity that demonstrates the proper procedures to follow when using heat and boiling water.

Have students read from their text or other source to learn about the behavior of water molecules in solid, liquid, and gaseous phases. Students will model molecules of water in each phase (*solid, liquid, or gas*). Place some ice in the larger pan and some water in the saucepan. Place the saucepan on the hot plate and heat the water. When the water is boiling, draw students' attention to the water in the pan and the water vapor rising from it. Hold the pan with ice about 6 inches above the saucepan with boiling water. Wait a few minutes until water vapor begins to turn back into liquid water and condense on the underside of the larger pan. Ask students to observe the liquid water, the water vapor, and the ice, and then compare and contrast all three phases. Have students write a short

description of each phase in their science *learning logs* ([view literacy strategy descriptions](#)) and then name several places where each phase is found in nature.

Tell students they will now model how molecules of water in each phase behave. First, ask students to look at the ice and describe what they think water molecules would act like in a solid state. To model the solid ice, the students will gather in a designated area (inside a set of desks or lines on playground). Have students act out the behavior of the water molecules that they would expect to see in a solid. Students should infer that the molecules of a solid are very close, so students should gather as closely as possible. Explain to students that the attraction of water molecules for each other (*cohesion*) exerts enough force to hold the water molecules together when there is a lack of heat energy. The water molecules stay very close together in one place and vibrate. Since water molecules are attracted to each other, their closeness increases the attraction. This makes the water remain as ice (*or a solid*). Ask students

- How is this model similar to what was observed when looking at the ice? How is it different?

Next, ask students how they think molecules of liquid water would act? Let students demonstrate their prediction and compare the movement with the movement of water. Guide them to demonstrate that liquid molecules of water will spread out and slowly move around, but again it should be confined to a limited area (*demonstrating that liquids take up space in the container or specific area*). Explain to students that, as heat is added to the ice, the molecules begin to move more, lessening the attraction they have for other water molecules. This allows them to slide past each other and act like a liquid. Ask students

- How is this model similar to what was observed when looking at the ice model?
- How is it different?
- Is it more difficult to create a model of liquid water or solid water? Why?

Last, ask students to reflect on the movement of water vapor and model it. As heat energy is added to liquid water molecules, they begin to move even faster. Allow students to move beyond the boundaries set for liquid molecules to show how molecules of gas can spread great distances. Explain to students that as more heat is added to the liquid water, the speed of the molecules becomes stronger than the cohesive property of water and can no longer hold the molecules close. This allows them to move out in all directions and rise into the air. Ask students

- How is this model similar to what was observed when looking at the water vapor?
- How is it different?
- Is it easier to model solid, liquid, or gaseous water molecules? Why?

Have students draw diagrams of the models in their science *learning logs*, including the boundaries of each. Ask students

- How is water’s ability to exist in three states important for living organisms?
- What are some important earth processes that are possible because of the ability for water to exist in three states?
- What are some activities that we would not be able to do if water only existed as a solid? A liquid? A gas?

Activity 3: Condensation Example—Water Cycle (SI GLE: 4, 5, 7, 10, 12, 16, 19, 21, 22; PS GLEs: 5, 12)

Materials List: clear bowl, clear plastic cup, small rock that will fit within the circumference of the plastic cup, clear plastic wrap, water, Water Cycle Vocabulary Chart BLM, science learning logs

Water’s ability to go through phases is what makes the water cycle possible. The water cycle is also called the *hydrologic cycle*. This is the cycle water makes as it passes from sea to land, water body to water body, land to land, and land to sea. Precipitation in the form of rain, sleet, hail, or snow falls to Earth from the clouds. Some of this water evaporates from the ground or water body and goes back into the air during the process of evaporation. Plants also takes in some of this water that falls on the ground and releases it back into the air during a process called *transpiration*. Some of the moisture that falls to the Earth will also pass into the soil. This water can take several paths: moving deep into the earth, remaining close to the surface, or flowing into the oceans, rivers, ponds or streams where it can eventually evaporate back into the air. Since the water cycle is such a vital process to life on Earth, understanding the process of the water cycle is an important concept for students to understand and be able to explain. Students may already know some of the vocabulary concepts associated with the water cycle. Others, such as *transpiration*, *infiltration*, and *condensation* may still cause some confusion.

Part 1

Before beginning the activity, it is helpful to have students complete a self-assessment of their knowledge of the water cycle vocabulary words using the literacy strategy *Vocabulary Self-Awareness* ([view literacy strategy descriptions.](#)) Provide each student with the Water Cycle Vocabulary Chart BLM. Identify the target vocabulary for this lesson and provide students with a list of terms. Included in the list should be the words *precipitation*, *condensation*, *infiltration*, *evaporation*, *runoff*, and *transpiration*. Students may also add terms to the list as they participate in the activity that follows. Each vocabulary word is rated according to the student’s understanding, including an example and a definition. If they are very comfortable with the word, they give themselves a “+” sign. If they think they know, but are unsure, they note the word with a “√”. If the word is new to them, they place a “-” next to the word. Over the course of the activity, students add new information to the chart. The goal is to replace all the check marks and minus signs with a plus sign. After the activity that follows, students should refer back to the chart to see if they can change the signs to indicate new vocabulary knowledge.

Part 2

In this activity, students will construct a model to demonstrate the water cycle. Have student groups use a clear bowl, a small cup, a rock, plastic wrap, tape, and water. Place an empty cup in the middle of the bowl. Pour water into the bowl until it surrounds the cup, but not so much that the cup floats. Cover and seal the bowl with clear plastic wrap, using tape if necessary. Allow the wrap to sag in the center. Place a small rock on the plastic wrap above the cup. Before setting the bowl in the Sun to observe the water cycle, have students create a chart such as the one below in their science *learning logs* ([view literacy strategy descriptions](#)) to record the starting time for each observed phase of the cycle.

1st Predicted Phase Change: _____ to _____

PHASE CHANGE	PREDICTION LENGTH OF TIME THAT PHASE CHANGE LASTS (s)	ACTUAL PHASE CHANGE (s)		ACTUAL TIME (s) LENGTH OF TIME THAT PHASE LASTS
		STARTING TIME	ENDING TIME	

As students conduct the investigation, they can use a *modified DR-TA* ([view literacy strategy descriptions](#)). This strategy encourages inductive and deductive reasoning by inviting predictions and then stopping at predetermined places during the investigation to check and revise predictions that were made. Have students predict what step of the water cycle will be observed first and record predictions on the chart. In the prediction, have the student include the amount of time expected before this step of the cycle begins, and then, place the bowl in the Sun. Have students record how long it takes for them to first observe any changes. Students should record the results, and then continue timing to find out how long it takes for the next observed step of the water cycle to begin.

Students should draw a pictorial diagram with labels to convey their observations about the water cycle, identify the phase changes that are taking place, and infer what is causing each phase to occur. Have students hypothesize what could be done to speed up or slow down the process of phase change, then design and conduct an experiment to test their hypotheses. In their design, students should identify independent, dependent, and variables that should be controlled. Students should use a similar chart to record new observations and then compare the data to determine what changes in time, if any, occurred. Students should use what was learned from Activity 2 to infer that a change in temperature will be needed to speed up or slow down the phase change process, and demonstrate this understanding when designing a new experiment. At the completion of this activity, students should be able to describe what happened during each phase change and explain what was causing the change.

Ask students to

- Identify the heat source that fuels the water cycle (*Sun*); then hypothesize what would happen to this cycle if the Sun's heat was diminished, increased, or disappeared entirely. Use this opportunity to introduce global warming and how scientists think it can affect global climate change.
- Identify what phase of water was not observed in this mini-water cycle model. (*solid phase*)

Also ask

- Is this phase necessary for the water cycle to take place? (*no, some areas in more tropical climates do not experience cold enough temperatures for ice or snow to develop*)
- Under what conditions are all three phases of water present in the water cycle? (*conditions with temperatures that vary enough for all three phases to occur*)
- Under what conditions are only the liquid and gaseous phases of water usually present? (*weather conditions that include temperatures that remain above freezing*)
- Is there any way for the water cycle to occur with only one phase of water? Explain why or why not. (*No, since the water cycle is a "cycle," there must be a change from one form of water into another; if water remained in one form only, there would be no need for cycling*)
- Is the length of time needed for water to evaporate from Earth and condense back into clouds always consistent? (*No*) Is the length of time needed for water to fall as precipitation or change into its solid form consistent? (*No*) Why or why not? (*Students should understand that temperature (and other factors) will determine the time it takes for phase changes to occur and that the length of time will vary because of this.*)

Have students use their science *learning logs* to write an explanation for the processes that occur during the water cycle that is based on their predictions and observations from the investigation.

Activity 4: What Is Rust? (SI GLEs: 4, 5, 7, 12, 22, 23; PS GLE: 5, 6)

Materials List: steel wool pads, test tubes, baby food jars, metric rulers, water, permanent marker, science learning logs

Safety Note: Have students identify the appropriate safety poster created during the first activity, and then discuss appropriate safety rules for working with water.

This activity demonstrates that properties of a substance change after a chemical reaction occurs. Working in cooperative groups of four, each group will set up their investigation and make observations over five days. They are to record results on student generated charts. Provide each group with steel wool pads, two test tubes, two baby food jars, a metric ruler, and water. Have students use the permanent marker to mark one of the jars

two cm up from the base. Fill the test tubes with 3 cm of loosely-packed steel wool and invert each one in its own baby food jar. Have students fill one of the jars to the 2 cm mark with water. The other jar should have steel wool in the test tube and no water in the jar. Ask students to identify the independent variable (*the presence or absence of water*) and dependent variable (*presence or absence of rust*) in the investigation. Place the jars in the window or under a light source. Start observations. Predict what will happen. Compare the groups' predictions and investigations. After two or three days, they will see the steel wool in the jar with water starting to rust (*iron oxide*). This is a chemical change. Compare it to steel wool that was not used (*control*).

Each group is to decide what happened and write an explanation in their science *learning logs* ([view literacy strategy descriptions](#)) by using their charts and answering questions such as the following:

- Can this sample be returned to its original state? (*no*)
- What are the properties of the new matter? (*reddish brown, brittle, powdery*)
- How did the water reach the steel wool? (*water in the baby food jar turned into water vapor and rose in the test tube to make contact with the steel wool*)
- What two elements combined to form a new compound? (*iron and oxygen*)
- What is the name of the new compound? (*rust or iron oxide*)
- What does iron react with to become rust? (*it reacts with oxygen, and the electrolyte [water vapor] which transfers electrons between the iron and the oxygen*)
- What was missing from the two experiments that did not create rust? (*there was no water in contact with the steel wool*)
- Was oxygen present in both experimental conditions? (*yes*)
- Was iron present in both experimental conditions? (*yes*)
- Was water present in both experimental conditions? (*no*)
- Why did rust only form in the baby food jar that had water, if only the iron and oxygen combine to form rust? (*water served as the electrolyte, or liquid that helped electrons move between the iron and the oxygen*)

Provide students with the definition of a chemical change; then ask them if the formation of rust on the surface of the steel wool satisfies the definition of a chemical change. Ask students to use the definition of a chemical change to also determine if water changing from liquid to water vapor is a physical change or a chemical change (*physical change because the molecules of water changed phase, not composition*).

Activity 5: Physical Change or Chemical Change? (SI GLEs: 7, 12, 21, 22, 23; PS GLE: 6)

Materials List: Suggested materials include: numbered labels for stations, paper, scissors, sticks of butter or margarine, paper plates, powdered drink mix, clear plastic cups, seltzer tablets, thermometers, spoons, potato slices, hydrogen peroxide, bread, toaster, alum (available from the grocery store in the spice section or at a pharmacy), knife for cutting potato slices, loose sediment, Is it Physical or Chemical? BLM

Safety Note: Explain the procedure students will follow at each station and have them identify the safety rules to follow when using water, chemicals, sharp instruments, electrical appliances, and heat.

Physical changes occur when a substance changes its shape, size, or state without changing the substance itself. Chemical reactions occur when the atoms in the substance, called the *reactants*, are rearranged to form new substances, called the *products*. Evidence that a chemical reaction is occurring can be a color change, temperature change, formation of a precipitate, or formation of gas. In this activity, students will use observation skills to infer when physical changes and chemical changes have occurred.

Set up stations for students to visit. At each station, set up one experiment that demonstrates a physical change or chemical reaction that results in a chemical change. Examples of physical changes can include activities such as changing the size of a piece of paper, melting butter, and adding powdered drink mix to a glass of water. Activities that demonstrate chemical reactions can include such activities as gas being produced when slices of potato are placed in hydrogen peroxide, bread being toasted, adding alum to water mixed with suspended soil particles, and adding a seltzer tablet to water.

Provide students with a copy of the Is it Physical or Chemical? BLM. Student should work in small groups to perform the investigation, describe what is observed, and infer if the event is a physical change or a chemical change. Have students explain which observations were used to make inferences. Students should be able to differentiate between observations and inferences.

Activity 6: Chemistry in Cooking (SI GLEs: 21, 22, 23, 37; PS GLEs: 4, 6)

Materials List: for demonstrations: paper, oven mitt, matches, metal container for burning paper demonstration, chalk, vinegar, baking soda, raw egg, hot plate, skillet, toaster; for each group: raw egg, paper plate, paper towel; piece of white bread, recipes using baking powder or baking soda

Safety Note: Before allowing students to perform the following demonstrations or activities, have them identify appropriate safety procedures for handling chemicals and fire. Only the teacher should handle the uncooked eggs, hot plate, skillet, and toaster.

Use teacher demonstration or stations with appropriate teacher monitoring and reviewing concepts covered in Activity 5, have students observe examples of chemical changes, such as the burning of paper, chalk in vinegar, and baking soda and vinegar. Ask students to explain what was observed as the change occurred (e.g., formation of a gas, a color change, a temperature change, etc.). Then, lead a class discussion about chemical properties of materials and certain characteristics that depend on the reaction of one substance with another substance to form new substances. Students should indicate when they know a chemical reaction has occurred.

Physical and chemical changes are very important in cooking. Without chemical changes, many of the foods we enjoy, such as bread or cakes, would not be possible. In this activity, students will explore the physical and chemical changes that occur in different recipes. Ask students if they think cooking involves physical or chemical changes. Have students provide justification for their thoughts.

For each group, the teacher should crack a raw egg and pour the contents onto a paper plate. Have the students observe the physical properties of the egg and draw and label a diagram showing the uncooked parts in their science *learning logs* ([view literacy strategy descriptions](#)). Provide students with proper terms for each part of the egg. Diagrams of egg parts can be found online at a website such as http://www.ext.vt.edu/resources/4h/virtualfarm/poultry/poultry_eggparts.html or <http://4hembryology.psu.edu/parts.html> . Then demonstrate what happens when heat is added to the raw egg by cooking an egg on a hot plate or other source of heat. Students should observe that the clear liquid part of the egg turns white and solid, and the yellow liquid part turns into a solid. Ask students if this is a physical change or a chemical change. (*A chemical reaction has occurred and is demonstrated by a color change in the clear part of the egg.*) Explain to students that the protein molecules in the egg whites uncurl and combine with other protein molecules when heat is applied. This is a chemical change, even though you still have an egg.

Next, give students a slice of white bread and have them observe and describe its physical properties in their science *learning logs*. Then toast the bread and have students observe any changes that occur. Ask students to identify whether the change is physical or chemical. (*A chemical change has occurred because the bread has changed color when the sugar turns to carbon. The hardening of the bread is a result of moisture removal and is a physical change.*)

Gather at least three recipes that call for the use of baking soda or baking powder, making sure that no other ingredient besides all-purpose flour and salt is common in the recipes. Examples of good recipes include simple biscuits, cookies made without eggs, and simple shortbreads. Make copies for the students to read. Have them determine the common ingredient(s) in all of the recipes and what is similar about the way the recipe is cooked (*the recipes require heating the ingredients*).

To illustrate the chemical reactions that occur in some recipes, show students what happens when vinegar is added to baking soda. Ask students

- What changes are observed? (*production of gas bubbles when carbon dioxide gas is created*)
- Is the production of a gas a chemical or physical change? (*chemical*)
- How can the creation of gas bubbles be useful in baking a cake or bread? (*it causes the batter or dough to rise*)
- What action is expected to happen when vinegar is added to the mixture(s)? (*Vinegar causes a chemical reaction as gas bubbles form. This causes the batter or dough to rise.*)

- What happens when all of these recipes are cooked in the oven? (*Heat solidifies the proteins and causes the liquid-like mixture to form a solid.*)
- What purpose do you think the baking soda or baking powder serves in the baking of the food? (*It creates and releases carbon dioxide gas in the dough which expands as bubbles and causes the dough to rise.*)
- What physical changes did you observe when comparing the recipe before and after it was cooked?
- How are the physical changes different from the chemical changes that occurred?

Have students locate a recipe from a cookbook at home, or provide them with one that requires a chemical or physical change to occur. Students should write each step of the recipe and identify whether a chemical or physical change is occurring in that step. Have other students in the class critique each step of the recipe to determine if it demonstrates a physical or chemical change. Students should provide justification for their critiques.

Have students prepare the recipes, if possible, and share with other students as they explain the procedure for creating the recipes. Remind students to follow appropriate safety procedures when preparing recipes at home. During the presentation of recipes, have students explain safety measures used when preparing the recipe to reinforce the importance of being safe when conducting experiments, even in the “safety” of their own homes.

Sample Assessments

General Guidelines

Assessment will be from 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 utilized 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 rubric during task directions.

General Assessments

- The student will create a flow chart for the water cycle.
- Cooperative groups of four should submit six 5" x 10" index cards with descriptions of a chemical change on them. Also, submit six 5" x 10" index cards with descriptions of a physical change on them. Mix the cards, and have groups exchange cards and then sort them by reactions.
- The student will create a game using the above cards.
- The student will find pictures in magazines and periodicals that show chemical change. Create a collage.
- The student will choose one of the examples of chemical change and reflect on the positive and negative impact for this. He/she should include ways the chemical change could be avoided. Place this in their portfolios. Use a rubric for evaluation.
- Have students observe a phase change occurring with matter that is different from water. Students should be able to identify each phase in the change and explain what caused it. Have students compare the temperature needed to change the state of water with the temperature needed to change the state of the new substance.
- Show students drawing of molecules of different types of matter in different phases. Have students compare and contrast the arrangement of molecules in each type of matter.
- Have students identify three examples each of matter that exists in nature as a solid, liquid, or a gas.

Activity-Specific Assessments

- Activity 3: Provide students with three related scenarios that demonstrate a change in phase from 1) solid to liquid, 2) liquid to solid, and 3) liquid to gas. Have students write an explanation for what must occur for each phase change to take place.
- Activity 4: Have students work in small groups to create an example of a physical change and a chemical change. Students in other groups should identify which change is being demonstrated and provide justification.
- Activity 6: Provide students with a written step-by-step recipe that has both physical and chemical changes. Have students identify which change is occurring with selected steps of the recipe and explain why.

Resources

Books

- *Best of Wonder Science* by American Institute of Physics, American Mathematical Society, American Chemical Society. Delmar Publishing.
- *Hands-On Physical Science Activities for grades K-8* by Marvin N. Tolman. Parker Publishing.
- *Project WET* by The Watercourse, Montana State University, and Western Regional Environmental Education Council.
- *The Story of Oxygen* by Karen Fitzgerald.

Websites

- *Chem4Kids*. Available online at <http://www.chem4kids.com/>
- *Science for Kids*. Available online at <http://www.ars.usda.gov/is/kids/>
- *Water Science for Schools: Water Properties*. U.S. Geological Survey. Available online at <http://ga.water.usgs.gov/edu/waterproperties.html>
- *Water SourceBooks*. U.S. Environmental Protection Agency. Available online at <http://www.epa.gov/safewater/kids/wsb/>
- *The Phantom's Portrait Parlor: Phases of Matter* Available online at <http://www.miamisci.org/af/sln/phases/index.html>
- *Food Network*. Available online at http://www.foodnetwork.com/food/lf_kids/
- *Food and Science Cook and Eat Chemistry*. Available online at http://www.uen.org/utahlink/lp_res/nutri375.html
- *What's That Stuff? Chicken Eggs*. Available online at <http://pubs.acs.org/cen/whatstuff/84/8434egg.html>

Grade 5
Science
Unit 3: Force, Motion, and Energy Transformations

Time Frame: Approximately 4 weeks



Unit Description

This unit will provide experiences to develop the concepts of force, motion, and energy and the relationships among them. Activities focus on the relationship of unbalanced forces causing motion, including gravity. Properties and sources of kinetic and potential energy will be investigated and renewable, nonrenewable, and inexhaustible energy resources will be explored. Characteristics of the Sun that produce the energy received on Earth will be identified, and reasons for the apparent movement of the Sun in creating shadows on Earth will be investigated. An exploration of how changes in the position of a light source and an object alter the size and shape of the shadow will also be completed.

Student Understandings

Students will explore the concepts of *force*, *motion*, and *energy* and the relationships among them in this unit. A basic understanding of magnitude and direction of motion when an unbalanced force acts on an object is to be developed. Students should be able to describe various forms of energy and how energy is transferred and interacts with objects and apparatus. Students will understand that the Sun is Earth's primary source of energy and how shadows are created and change as the position of the light source changes.

Guiding Questions

1. Can students describe how to demonstrate a change in speed or direction of an object's motion by using an unbalanced force?
2. Can students identify the forces affecting a falling object?
3. Can students explain how energy is transferred?
4. Can students describe how potential and kinetic energy are alike and different?
5. Can students describe how various energy resources differ and give examples?
6. Can students identify the types of energy transformations that occur when an electrical appliance is used?
7. Can students explain why the Sun is the Earth's primary source of energy?
8. Can students trace the flow of energy from the Sun through other energy resources to objects that use it?
9. Can students describe how the position of a light source affects a shadow?

Unit 3 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry 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 Force, Motion, and Energy Transformations 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-A4)
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)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (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)
16.	Use evidence to make inferences and predict trends (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)
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)
28.	Recognize that investigations usually begin with a review of the work of others (SI-M-B2)
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)

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)
38.	Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions, and form new ideas (SI-M-B6)
Physical Science	
7.	Compare, calculate, and graph the average speeds of objects in motion using both metric system and U.S. system units (PS-M-B1)
8.	Explain that gravity accelerates all falling objects at the same rate in the absence of air resistance (PS-M-B3)
9.	Demonstrate a change in speed or direction of an object's motion with the use of unbalanced forces (PS-M-B5)
10.	Compare potential and kinetic energy and give examples of each (PS-M-C1)
11.	Classify energy resources as <i>renewable</i> , <i>non-renewable</i> , or <i>inexhaustible</i> (PS-M-C1)
12.	Identify the Sun as Earth's primary energy source and give examples (e.g., photosynthesis, water cycle) to support that conclusion (PS-M-C3)
13.	Investigate how changes in the position of a light source and an object alter the size and shape of the shadow (PS-M-C4)
14.	Identify other types of energy produced through the use of electricity (e.g., heat, light, mechanical) (PS-M-C6)
Earth and Space Science	
39.	Identify the physical characteristics of the Sun (ESS-M-C1)
41.	Explain why the Moon, Sun, and other stars appear to move from east to west across the sky (ESS-M-C1)

Sample Activities

Activity 1: You Were Going HOW Fast? (SI GLEs: 9, 12, 31, 32; PS GLE: 7)

Materials List: Force, Motion, and Energy Vocabulary Chart BLM; for each group of four students: meter stick, yardstick, tape, toy car (wind-up), stopwatch, You Were Going *HOW* Fast? BLM

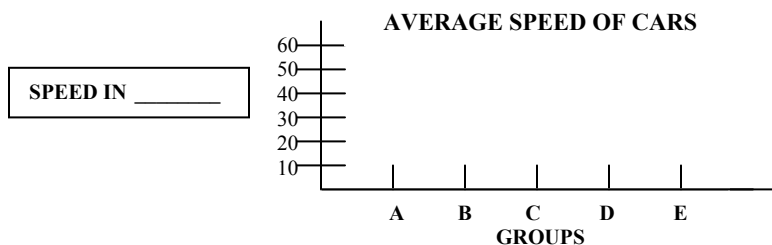
This activity builds on knowledge of speed gained from previous grades. *Speed* is a measure of how fast an object is moving. The average speed of a moving object can be determined by dividing the distance it has traveled by the time it takes to travel that distance.

To introduce key vocabulary for this unit, have students create a *vocabulary self-awareness chart* ([view literacy strategy descriptions](#)). For this literacy strategy, words are introduced at the beginning of the unit, and students complete a self-assessment of their knowledge of the words. Provide students with the Force, Motion, and Energy Vocabulary Chart BLM and target vocabulary words for this unit. Have students add

words to the chart as the unit progresses. Target vocabulary words should include (but are not limited to) *force, friction, motion, acceleration, speed, distance, gravity, air resistance, kinetic, potential, energy, rotation, parallel circuit, series circuit, transformation of energy, renewable, nonrenewable, inexhaustible, fossil fuel, biomass, geothermal, solar, nuclear, and fusion.*

Have students add new vocabulary to their chart at the beginning of each new activity. Students will rate each word according to their understanding, including an example and a definition. Words that are very familiar are given a “+” (plus sign). Students must be able to write a definition and an example for words that are given a “+”. If they think they know, but are unsure, they write a “√” (check mark) on the chart. Students can give themselves a “√” if they can either write a definition or example for the word, but not both. If the word is new to them, they place a “-” (minus sign) next to the word. Over the course of the unit, students add new information to the chart. The goal is to replace all the check marks and minus signs with a “+” sign. Because students constantly revisit their *vocabulary charts* to revise their entries, they have multiple opportunities to practice and extend their growing understanding of the terms.

Ask students how they might design an investigation using toy cars to gather information about speed. Their suggestions should focus on timing, determining distance traveled, etc. If possible, use guided questioning to direct students to the following, or similar activity, and provide them with the You Were Going How Fast?! BLM. Explain to students that they will use the BLM to record the results of each trial. Working in cooperative groups of five (e.g., Driver, Starter, Flagger, Timer, Recorder), students will use a meter stick, tape, a wind-up toy car and a stopwatch to determine the average speed of the car as it moves along a flat surface. Students should keep the same role throughout the activity to maintain consistency in measurements. On a signal from the starter, the driver will release the car and when the car’s nose passes by the tip of the meter stick, the starter will signal the timer to start the stopwatch. When the car’s nose passes the end of the meter stick, the flagger signals the timer to stop the stopwatch. The recorder records distance traveled in both metric and U.S. measurement units and elapsed time in seconds on the You Were Going *HOW* Fast? BLM. The same procedure should be repeated for a minimum of three trials. The students should record the time it takes for the car to travel the length of the measuring stick for each trial and then find the average time taken by the car to travel that distance. Once the average time is determined using a calculator, students should then find the average speed of the car by using the formula for speed (*distance divided by time*). Combine the final results for each group’s investigation on the same graph for ease in comparison (see example below).



Ask students why it is necessary to conduct multiple trials to obtain reliable data. Students should compare data collected by each group and determine if everyone's averages are similar. If they are not, have students infer the reasons for the variations. Students can revisit the Force, Motion, and Energy Vocabulary Chart BLM to revise their charts. Allow students to share definitions and examples of words covered in this activity.

Activity 2: Speed It Up or Slow It Down (SI GLEs: 1, 4, 5, 9, 11, 28, 36; PS GLE: 7)

Materials List: marble; several floor surfaces such as carpeting, cement, grass, or tile; for each group of four students: ramp, toy car (wind up), ruler, calculator, Force, Motion, and Energy Vocabulary Chart BLM (Activity 1); science learning log; chart paper

Using the safety posters created in Unit 1, have students determine what safety rules should be followed in this activity.

In this activity, students will design and conduct an experiment to determine how speed is affected by friction. Demonstrate the effect friction has on an object by rolling a marble across several different floor surfaces and having students observe how far it travels before stopping. Students should generate a list of questions that they could answer through this activity. Guide students to ask such questions as

- What force started the forward movement of the marble? (*push with the hand*)
- What force is acting on the marble to slow it down? (*friction*)
- How can we change the effect of this force? (*change the surface over which the marble rolls*)

Guide students to an understanding that friction is acting on the marble. Instruct students to use textbooks and other resources to research Newton's First Law of Motion (*An object at rest will remain at rest and an object in motion will remain in motion, at a constant speed and in a straight line, until an outside force acts on the object.*); then, as a class, use the information to design an experiment that tests the effects of different surfaces on the speed of toy cars. Through class discussion, have students identify dependent, independent, and controlled variables. (*The independent variable should be the different surfaces over which the car travels. The dependent variable should be the speed, and the controlled variables will be the height of the track and the car that is used.*) Encourage students to use prior research to predict which surface will provide the most friction. Guide students to develop a procedure to follow in investigating different ramp surfaces on the speed of a toy car and use a large sheet of chart paper to record the procedure that all students will follow. Students should also record the procedure in their science *learning logs* ([view literacy strategy descriptions](#)), including a predetermined metric and U.S. measurement for distance cars should travel (1 meter or 1 yard), and then create a chart in their science *learning logs* such as the one started below, for both meters and yards), to record individual and average speeds for three trials using different surfaces.

Average Speed on Different Surfaces

DISTANCE (m)	RAMP SURFACE TYPE	TIME (s) for three trials	AVERAGE TIME (s)	AVERAGE SPEED (m/s)

Divide students into cooperative groups of four students, instructing each group to follow the class-created directions to perform the experiment. If problems arise due to confusing directions, have students identify what is unclear and rewrite them to make more sense. Discuss with students why it is necessary to obtain data for a minimum of three different trials in order to determine the reliability of the results. Students will use calculators to determine the average time the car traveled over each surface, and then determine the average speeds of the car over each surface. Instruct them to create a bar graph to use for comparing the effect of surface type on the car's speed. Average Speed (m/s or yd/s) and Surface Types should be the two labels for the axes. What does the height or length of the bars representing the car's speeds on different surfaces tell about the motion of each car? *(the longer the bar, the faster the speed of the car; the shorter the bar, the slower the speed of the car)*

- Which surface allowed for the greatest speed? *(the surface that was the smoothest or had the least friction)*
- Which surface produced the most friction? *(the roughest surface)* Which surface produced the least friction? *(the smoothest surface)* How can you tell? *(the car with the least friction had the least amount of force acting against it, so it had a faster speed)*
- Explain Newton's First Law of Motion based on these results. *(An object in motion will continue moving in a straight line at a constant speed until a force acts on it. The forces acting on the cars are friction and gravity. All cars had the same force of gravity acting on them; that left the force of friction. The cars with the most friction acting against them slowed down the fastest.)*

Using what was learned through research, ask students to design a method to speed up or slow down the rate the car travels over these different surfaces and to then test their method which should include such responses as changing the slope of the track or adding/removing weight from the cars. Ask students to identify some of the limitations encountered by using toy cars to demonstrate the effect of friction on speed. What variables were hard to control? What can be done to make the results more reliable? How many trials should be done before the results can be accepted? Have students infer how the results obtained through this investigation relate to the movement of real cars on different surfaces.

Review the vocabulary associated with this activity and provide students with an opportunity to add new information to their Force, Motion, and Energy Vocabulary Chart BLM.

Activity 3: Balanced and Unbalanced Forces (SI GLEs: 16, 18, 19, 22; PS GLE: 9)

Materials List: Force, Motion, and Energy Vocabulary Chart BLM (Activity 1), book, table, large soft kickball, large rope for tug of war, bandana, two playground cones or markers, materials for designing another activity to show unbalanced forces, science learning log.

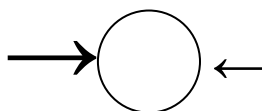
Safety Note: Remind students of appropriate behavior when playing Tug of War and kicking balls around other students.

Review with students the definition of a *balanced force*. Have students add vocabulary from Activity 2 to their Force, Motion, and Energy Vocabulary Chart BLM from Activity 1 prior to beginning this activity.

To help students understand the concept, point to a book sitting on a table. Ask students to identify the two forces at work (the table pushes up on the book and the book pushes down on the table). Ask students if these forces are balanced or unbalanced. (*Since there is no movement, the forces must be balanced.*) Ask students what needs to be done to make the forces unbalanced (*slant the table*). Which force is becoming stronger as the table is slanted? (*The force of gravity is able to exert a force over a greater vertical distance and it overcomes the force that is pushing up on the book and the force of friction that is acting against the book's movement down the table*). Direct students to read about balanced and unbalanced forces in their textbook and carefully examine the examples that are offered. Instruct students to work in small groups to discuss examples of activities that demonstrate balanced forces at work (e.g., a boat or other object floating on water, a person standing on a flat surface, water droplets suspended in the air in the form of clouds, etc.). Have each group draw an illustration of the activity in their science *learning logs* ([view literacy strategy descriptions](#)) and identify the opposing forces. Each entry in the science learning log should be dated. Science *learning logs* are journals that are used to record observations and illustrations, predictions, data collection, conclusions, etc. about what is being learned. Students should also explain to their classmates why this example is correct. Allow other students to critique classmates' explanations and refute faulty reasoning.

Next, demonstrate unbalanced forces for the students. Unbalanced forces occur when one force is greater than its opposite force. Review safety procedures to follow when kicking, spinning, pushing, pulling, and dropping objects. If students created a related safety poster in Unit 1, have those students explain the safety issues involved. If none was created, spend a few minutes discussing safety rules before continuing with the activity and add the rules to the safety chart in Unit 1. To demonstrate unbalanced forces, have a student gently kick a large, soft ball toward you; then kick the ball another direction, and

with more force, so it will have greater acceleration. Ask What was the greater force? (*the kick that made the ball move the farthest*) How can you tell? (*The ball changed direction so the force that kicked the ball must have been greater than the kick that started the ball moving and the force of friction that was opposing the movement of the ball. The force of gravity that was holding the ball to the Earth was equal to the force of the Earth pushing up on the ball, so these two forces were equal and had no effect on the ball's movement.*) Explain to students that the force applied to an object to move it can be shown with arrows. The length of the arrows and the direction in which they are drawn indicate the magnitude of the force (see example below). The example shows that the magnitude of the force to the right is stronger than the magnitude of the force to the left. Therefore, the forces are unbalanced and the ball will move to the right.



Have the students form two Tug of War teams with an equal number of students on each side. Remind students of the earlier discussion about safety when playing the game. Position the bandana in the middle of the rope and place one cone on each side of the rope directly in front of the two opposing lead players. Have both teams lift the rope and hold it taut. Ask students if this is a balanced or unbalanced force (*balanced, because the bandana is not moving its position*). Ask students to identify which forces are acting on the rope (*gravity pulls down, students pull up, each team is also pulling the rope toward them with enough force to make the rope taut*). The goal of the game is to pull the rope so that the bandana crosses over the cone. Have the two teams play a game of Tug of War and have the other students carefully note which forces are acting on the students and the rope (*the students are pulling up on the rope, gravity is pulling the rope downward, both teams are pulling the rope toward their teams, and friction is acting in opposition to each team's forward movement*). After one side wins, ask students to determine if the forces remained balanced throughout the game and explain how they were able to determine their answer (*the bandana moved over to one team's side which showed that their pulling force and the force of friction opposing their forward movement was stronger than the opposing team's, since there was movement, the forces had to be unbalanced*). Have students draw arrows to indicate the magnitude of each force acting on the rope, making sure to draw larger arrows for the stronger forces. Students should be sure to indicate the force of friction of the students' feet acting against the forward movement of the rope, as well as the upward force of students pulling up on the rope and the downward pull of gravity. Friction and pulling are the two major forces at work in the game of tug-of-war and should be given primary emphasis in the drawing. Student should also be sure to always to show forces acting in pairs against each other. Ask students to devise a way to make all forces balanced and try out their plan. Compare the two games. Have the students reflect in their science *learning logs* ([view literacy strategy descriptions](#)), describing the difference between balanced and unbalanced forces and how they would use what they learned to choose teams for a field day game of Tug of War.

Working in groups, have students design another example of an unbalanced force (e.g., use a rubber stopper tied to a string, a moving marble, and a dropped ball). They will then share their examples with classmates and describe what is happening. Using class demonstrations or classmate examples, students will draw pictures in their science *learning logs*, using arrows to illustrate opposing forces and explain why the forces are unbalanced. The teacher should lead a class discussion to include the following questions:

- What observation indicates that forces are balanced? (*lack of movement*)
- How is a balanced force different from an unbalanced force? (*balanced forces cause no movement and unbalanced forces cause movement to occur*)
- What is one activity that people do everyday that uses an unbalanced force? (*walking, moving around, getting up, and sitting down*)
- What athletic events use unbalanced forces? (*football, soccer, baseball, basketball, swimming, croquet, volleyball, golf, etc.*)
- Ask students to try and name one athletic event that does not use unbalanced forces. (*none known*)

Activity 4: Paper Race (SI GLEs: 7, 22, 38; PS GLE: 8)

Materials List: two identical sheets of paper, two resealable plastic sandwich bags, feathers, sand, book, Internet access, unbreakable objects to use for gravity experiments, science learning log

In this activity, students will observe the effect of air resistance on a moving object. Air resistance is the force of friction that acts against objects that are moving through air. Greater surface area allows for greater air resistance.

To determine a baseline assessment, have students participate in a paper race. The paper will be dropped from the same height to see how gravity and air resistance affect it. Use a flat sheet of paper and a crumpled ball of an identical piece of paper. Predict which will land first. Direct students to record predictions in science *learning logs* ([view literacy strategy descriptions](#)). Students should then drop both pieces of paper at the same time, from the same height. Have students repeat the procedure a minimum of three times to confirm that the results are reliable. They should observe that the crumpled ball lands first. Ask

- Why did this happen? (*there was less surface area coming into contact with the air, so the force of gravity was greater than the force created by the air resistance and pulled the paper down to the ground more quickly*)
- What forces are at work here? (*gravity and air resistance*)
- What variable allowed the crumpled ball of paper to fall faster than the flat sheet? (*size of surface area that interacted with the air resistance*)

Have students repeat the activity using two flat sheets (*students should notice that the air resistance acts equally on the two sheets of paper and they fall at the same rate*), then drop the flat sheet and the crumpled sheet sitting on the top of similar books. Predict

results, drop, and see if their reasoning demonstrates that both landed at the same time, because air resistance had no effect on the textbooks due to their mass. Have the students experiment with other objects such as a rock and crumpled paper, or a resealable plastic sandwich bag filled with feathers and one filled with sand to see if they land together. If not, the students should explain why or why not. Each time, have students determine if the forces at work are balanced or unbalanced. Have students record the results of their experimentation in science *learning logs*. Ask students if their results would change if the same activity were done on the surface of the Moon where there is no air resistance.

(Students need to understand that the two objects would fall at the same speed and land at the same time, in the absence of air resistance.) If possible, show students a video clip of the experiment that was done by astronauts on the moon's surface to demonstrate this concept. The following website can be used to access the video clip:

<http://www.teachersdomain.org/resources/phy03/sci/phys/mfw/galmoon/index.html>.

Give students an opportunity to test several different types of objects to prove that they do fall at the same rate. Students should pay attention to the possible effects of air resistance in their investigations.

Activity 5: Parachute Drop (SI GLEs: 2, 5, 14, 20, 33, 36; PS GLEs: 8, 9)

Materials List: small plastic toy figures such as Superman, Batman, Power Rangers, etc.; cotton string; needles; 30 cm x 30 cm square of fabric, scissors; place to drop parachutes; timer; meter stick; calculators; Parachute Drop BLM; Force, Motion, and Energy Vocabulary Chart BLM (from Activity 1); science learning log

Safety Note: Students should review safety procedures for climbing ladders and dropping objects from the top of staircases or any other high places. Use the safety poster that was created in Unit 1, if available, in the discussion. If a poster was not created, the new safety rule should be added to the safety rules chart that is posted in the room.

In this activity, student groups will use what was learned about air resistance from the previous activity to design a parachute that will keep an object aloft the longest. Divide students into small groups and have them discuss what was learned about surface area and air resistance (*the greater the surface area, the greater the air resistance*). Provide all groups with the same materials to create a parachute that will keep a small plastic toy figure aloft. (The toy figures should all be identical.) Their design should reflect what they understand about surface area and air resistance (*the greater the surface area, the greater the air resistance that opposes the force of gravity*). Once the parachute has been created, have each group measure and record its surface area on the Parachute Drop BLM. Instruct each group to design an experiment to test their parachute. Students should develop and write the procedure in their science *learning logs* ([view literacy strategy descriptions](#)). Determine a safe place from which to drop parachutes. Students should identify all variables that may affect the experiment and control for them. Discuss with students how many trials should be conducted to make a fair test and have them include this in the step-by-step directions they write for their experimental designs.

Provide students with the formula to determine rate of descent (Rate=distance/time). Using calculators, students should determine rates of descent, record trial results on the Parachute Drop BLM, and then transfer results to a class-generated chart, such as the one below, for whole group comparisons.

Average Rate of Descent for
Parachutes of Different Surface Areas

Group	Surface Area of Parachute (cm ²)	Average Rate of Descent (m/sec)

Have students identify the forces acting on the parachute. Through class discussion of results, guide students to understand that the more surface area the parachute has, the slower the rate of descent will be. Ask students How would the speed of descent change if the weight of the toy figure changed? What difference, if any, would occur if the weight of the material for the parachute changed? Ask students to identify limitations inherent in this investigation (*e.g., limits of height from which parachutes can be dropped, brevity of descent time due to short travel distance, etc.*). Then, identify other problems with the model and suggest improvements that could be made. Guide students to explain that through the use of scientific processes and the knowledge that is generated through such activities as this, people have been able to solve problems make decisions, and form new ideas, such as improving the design of parachutes. Have students revisit their *vocabulary self-awareness* charts to make revisions for the word *air resistance* and any other words for which they now have a better understanding.

Activity 6: Kinetic/Potential (SI GLEs: 7, 19, 22; PS GLE: 10)

Materials List: yo-yo; marbles; posterboard or foam pipe insulation (available from hardware stores); masking tape; science learning logs; Force, Motion, and Energy Vocabulary Chart BLM (from Activity 1)

To determine students' understanding of potential and kinetic energy, show students a tightly-wound yo-yo held in a position to be used. Ask students to identify what kind of energy is being demonstrated. (*potential mechanical energy*) Release the yo-yo and allow it to move up and down a few times. Ask students to identify the energy being demonstrated. (*kinetic mechanical energy*) Introduce the terms *potential energy* and *kinetic energy*. Have students explain the difference in the potential energy of the poised yo-yo, and kinetic energy of the moving yo-yo. Students should identify what gives the poised yo-yo its potential energy (*the raised position and the tightly-wound string*) and the moving yo-yo its kinetic energy (*gravity and upward thrust created when the yo-yo reaches the end of the string*).

Working in groups, students will participate in rolling a marble on a self-made roller coaster and answer this question: When does the marble have kinetic energy and when

does it have potential energy? Use two pieces of poster board or sections of foam pipe insulation (readily available at hardware stores) split in half, masking tape, marble, and a flat surface. Tape the poster board together and have two students hold either end of it or the foam pipe insulation section, so it will curve like a roller coaster. A third student will place the marble, and the other students will call out either kinetic (*rolling*) or potential (*waiting to roll*) energy. Have all the students roll and name. Students can then create roller coasters using the interactive website called Amusement Park Physics by Annenberg available at <http://www.learner.org/interactives/parkphysics/coaster.html> to learn more about the transformation of potential energy into kinetic energy during the ride.

In their science *learning logs* ([view literacy strategy descriptions](#)), students will diagram the model roller coaster and label the marble in different areas. They will then select another activity that demonstrates potential and kinetic energy and write an explanation for each in a paragraph. Have students add information about potential and kinetic energy to their Force, Motion, and Energy Vocabulary Chart BLM.

Activity 7: Classify Energy Resources that Live Up to Their “Potential” (SI GLEs: 16, 19; PS GLE: 11)

Materials List: Energy Resources: Which is Best? BLM, Energy Resources: Which is Best? Answer Key BLM, science learning logs, poster board, available resources, Internet access

Working in cooperative groups, students will choose an energy resource that they will develop into a presentation to the class. They will prepare a poster and an oral presentation about their chosen resource. Resources from which groups can select will include fossil fuels, biomass, hydropower, nuclear fission, and geothermal energy. Students can use textbooks, trade books, encyclopedias, or an online resource such as <http://www.darvill.clara.net/altenerg/index.htm> or <http://www.eia.doe.gov/kids/energyfacts/>. Students should be able to explain how their energy resource stores potential energy and how it is transformed into other types of energy, such as light, heat, mechanical energy, etc. Students should determine if their energy resource is renewable, nonrenewable, or inexhaustible. Direct students to write a paragraph in their science *learning logs* ([view literacy strategy descriptions](#)) describing how the loss of their energy resource would affect a personal activity that they do on a regular basis and what energy resource they would have to use instead, if applicable.

Before sharing posters and information with the rest of the class, provide students with the anticipation guide, Energy Resources: Which is Best? BLM to complete. An *anticipation guide* ([view literacy strategy descriptions](#)) prompts students to become active seekers of important information and ideas. It is provided before students are presented with new material as a method of engaging their attention. Its purpose is to help instill a situational interest in material in advance of its presentation to students. Ask students to respond to each statement on the Energy Resources: Which is Best? BLM by placing a

check under the word “agree” or “disagree.” After individual students initially respond to the statements, have them find a partner and share their responses. This step further builds and activates relevant prior knowledge and heightens anticipation. Gather responses from students and encourage several students to share their responses. Tell students that as they listen to other students’ oral presentations, they should try to determine whether their initial responses about each statement are supported by the material presented or if they need to be changed. If they are supported, their after-presentation and learning response will be the same as their before response. If not supported, their after-presentation and learning response will be different than their before response. Allow students time to reflect on their pre-presentation responses and make changes before moving on to the next presentation. After each presentation is complete, students should use the space below each “before” and “after” response to write a short explanation based on relevant content from the information given in the presentation. Students should use the back of the BLM for additional room in recording the explanations for their after-responses, if needed. Ask students to share some of their “before” and “after” responses with the rest of the class and their explanations. Allow students to identify faulty reasoning and statements that misinterpret or are not supported by the evidence.

Activity 8: Sun: The Primary Source of Energy (SI GLE: 19; PS GLE: 12; ESS: 39)

Materials List: Internet access, poster board, science learning log

The Sun is the source of all energy on Earth. To develop this understanding for students, ask them to identify the types of energy produced by the Sun. Have students access *Solar Anatomy* at <http://vathena.arc.nasa.gov/curric/space/sun/sunanat.html> to research the physical characteristics of the Sun and what reactions occur to produce light and heat energy. Instruct students to create a diagram of the Sun, identifying the reactions that occur to produce energy. Once students understand how the energy on the Sun is created, have them identify the energy pathways that exist between the Sun and different energy resources they learned about in the previous activity. Students should create posters that illustrate at least four steps in a pathway of each energy resource (e.g., *Sun*→*Aquatic plants*→*Ancient Sea Life*→*Oil Deposit*→*Refinery*→*Gasoline in a School Bus*).

Plants, through photosynthesis, are the link between the Sun’s energy and all living things, including humans.

In cooperative groups, students should discuss why this statement is valid and list the points on a chart. Students should also give examples and make flow charts in their science learning logs ([view literacy strategy descriptions](#)) to prove their statements (e.g., *Sun*→*Grass*→*Cattle*→*Steak Dinner*→*Person*).

To emphasize man's dependence on the Sun's energy, provide students with the following *SPAWN* prompt ([view literacy strategy descriptions](#)) to answer in their science *learning logs*:

W= What If?

What if the energy from the Sun was not available for 24 hours?
How would this affect me immediately?

SPAWN is an acronym that stands for five categories of writing options (*Special Powers, Problem Solving, Alternative Viewpoints, What If?* and *Next*). Each prompt offers students an opportunity to reflect on learning and use critical thinking. The writing prompted by *SPAWN* is typically short in length and can be kept in students' class notebooks or science *learning logs* ([view literacy strategy descriptions](#)). Students should be allowed to write their responses in a reasonable amount of time. In most cases, adequate responses can be written within 10 minutes. Students should record the date for each prompt.

Encourage students to trace the energy flow backwards to the Sun, identifying all effects of no solar energy, by using one of the posters that was just created when they answer their *SPAWN* prompt. Allow students to share their *SPAWN* responses with classmates.

Activity 9: Taking a Close Look at Electric Circuits (SI GLEs: 4, 7, 22, 23; PS GLE: 14)

Materials List: science learning logs, batteries, flashlight bulbs, insulated wires, light sockets, buzzers, electrical knife switches, string of Christmas light with a series circuit, string of Christmas light with a parallel circuit, posters from Activity 7

Safety Note: Remind students that batteries may get hot when wires are touching both terminals. Have students identify safety procedures for using electrical equipment, both at school and at home. Include such points as not handling electrical appliances and plugs when their hands are wet or using electrical appliances near water. Students should refer to any posters created in Unit 1 concerning safety in using electricity and add the rule to the safety chart if not already posted.

Using the posters created in Activity 7, have students identify which energy resources are used to generate electricity. For each energy resource that is identified, have students name an object that is powered by it. Ask students to explain how energy is transformed from the potential source to electricity and the path it follows. Explain to students that electricity travels by a path called a *circuit* to power the object, and that in this activity they will investigate several paths electricity can travel.

To introduce students to electric circuits, provide students with a battery, a light bulb, and a wire. Students should work in groups of two to determine how to get the light bulb to light. Have students draw a diagram in their science *learning logs* ([view literacy strategy](#)

[descriptions](#)) that shows what must be connected in order to get the bulb to light. Discuss the meaning of circuit (*going around in a complete circle*) with students. Tell students that they will be creating two different kinds of circuits: a series circuit and a parallel circuit. To illustrate types of circuits, plug two different strings of Christmas lights, one with a series circuit and one with a parallel circuit, into an electrical source. Remove one of the lights from each string. Have students observe what happens to the rest of the lights in the string. Ask students to hypothesize what makes each result different. Note: The teacher can also create a series circuit and a parallel circuit from wires, bulbs, and batteries and use them for demonstration purposes if Christmas tree lights are not available.

Working in groups of four, instruct students to use a battery, wires, a switch, and a buzzer or light bulb, and assemble them in a series circuit. They will then illustrate a diagram of the completed series circuit in their science *learning logs* and describe what is happening at each point. During the activity, the teacher should circulate around the room and question each group to see if the students have a complete understanding of a series circuit. Have students analyze diagrams to see if the buzzer will work or the bulb will light.

Upon successful assembly of a series circuit, challenge students to try to build a parallel circuit with some extra wires and an extra light bulb or buzzer. Have students draw and illustrate a diagram of the completed parallel circuit in their science *learning logs* and describe what is happening at each point.

Using the created parallel circuit diagram and series circuit diagram, have students analyze how the path of electricity is different for each. Have students infer why a parallel circuit is a better choice for supplying electricity for lighting to classrooms along a hallway (*classroom lights operate on parallel circuits so when one light in a classroom goes out, all of the others stay lit*). Ask students to identify appliances or machines that use either series or parallel circuits to operate. Using these examples, instruct students to identify what types of energy transformations occur. Explain to students that in the past, homes had series circuits that were wired to shut everything down when one event interrupted the series. Fuses were developed later to be used when an unsafe amount of electricity traveled along wires. In fuses, a metal strip would melt and stop the flow of electricity. Now, most modern homes are equipped with circuit breakers that are wired separately to trip off when there is an overload of electricity traveling along wires.

Activity 10: Transformations in Energy (SI GLEs: 11, 19, 22, 23; PS GLE: 14)

Materials List: hairdryer, lamp with light bulb, electric hand mixer

Safety Note: Using the safety posters safety posters created in Unit 1, students can identify and explain the necessity for electrical safety procedures before plugging in each small appliance. Add the rule to the safety chart if necessary.

To help students understand how electrical energy can be transformed into other forms of energy such as light, mechanical, and heat energy, ask students if they have ever ridden on a bike at a science museum that generated the power to light a bulb, start a fan, etc. Ask students to identify the type of energy transformation taking place when the person was riding the bike (chemical energy from food in the body was transformed into mechanical energy when pedaling the bike). Ask students to identify the energy transformation that was occurring to change the mechanical energy into light or wind energy (the mechanical energy of the moving pedals turned a turbine to generate electricity which was transformed into light energy (light bulb) or wind energy (fan). Now, show them a hairdryer, a lamp, and an electric hand mixer. Ask students what all three objects have in common (*all are powered by electricity*) and then ask students to explain what each one produces (*heat and sound, light, and mechanical movement*).

Briefly discuss the need for safety tags on electrical appliances. (*Safety tags warn consumers of possible dangers if used improperly such as the danger of using a hairdryer near a water source [electrocution] or handling a curling iron improperly [burns]*). Ask students to observe the hairdryer, mixer, and lamp while they are operating it and discuss how the electrical energy is transformed into heat and sound energy, light energy, and mechanical energy. Have students generate a checklist of other small appliances that are run by electricity and discuss with a partner what types of energy are produced through the use of electricity so that the appliance is able to work. Use the checklist of appliances that was generated in the class discussion to make a graph that shows the frequency of energy forms powered by electricity.

Activity 11: Shadow Clock (SI GLEs: 13, 14, 16, 20, PS GLE: 13; ESS: 41)

Materials List: stiff, light-colored cardboard; pencils; marker; yellow highlighter; directional or magnetic compasses; learning log; digital camera and color printer (optional); globe; flashlight or other light source, science learning log

Safety Note: Remind students that they should never look directly at the Sun and to take proper dress precautions to protect themselves from UV radiation.

The Sun is the source of energy on Earth, and as such, enables life on Earth to exist and continue. Besides its obvious importance to Earth, it also can be used by humans to determine the passage of time; even honeybees use the position of the Sun to navigate.

From early times, man has observed shadows cast by the Sun and have noticed the pattern created by them as the day passed. Shadows on Earth keep moving as Earth rotates. Tell students, “This shadow clock will help you find out about the way Earth spins. You can use it to tell the time, but make sure that you put it in a place that will get plenty of sunshine.” Have students cut a circle from stiff cardboard to make a dial. Push the pencil through the middle of it. Next, push the pencil into the ground. Have students use a compass to identify the position on the horizon from which the Sun appears to be rising. Be sure to review safety procedures for safely observing the Sun’s position in the

sky. Using the compass and a marker, students should label the directions N, S, E, and W on the cardboard circle after it has been secured on the ground. Mark on the dial where the pencil's shadow falls the first hour and record the time. Have students predict where the shadow will fall the next hour. (*The pencil's shadow moves steadily around the dial.*) While outside, students should also observe the length and direction of their own shadows. Have students draw each other's shadow on the cement, using chalk. Students should write their name and the time somewhere in the shadow for use later.

Send a pair of students outside every hour (*or two hours*) during the school day to observe the shadow's placement on the dial and their own shadow's movement. Students should stand in the exact position when observing their own shadows and draw the new shadow with chalk, marking the time. Also, have students mark on the dial where the pencil's shadow falls at each new time. (*This shows that Earth spins at a steady speed.*) Have students observe the size and shape of the shadow throughout the day. (*Shadows are long in the morning and the late afternoon. At noon, the shadow is very short.*) Students should use a yellow highlighter to also draw a ray of sunshine on the card each hour and indicate the time to show from which direction the Sun's light is striking the card. Have students make an illustration for each of the following: morning, noon, evening. Include the Sun, object, and shadow. Students can also use a digital camera to capture the shadow's image at each hour and arrange the digital pictures on a poster board in the shape of a clock to indicate the correct time for each shadow.

At the conclusion of the activity, instruct students to use the evidence they recorded to infer the directional path the Sun appears to take as it moves across the sky.

Ask students to share their observations about their own shadow's movement throughout the day. Ask them to consider the following questions:

- Did their shadow move position during the day? (*yes*)
- Did the length of their shadow also change? (*yes*) How? (*It became shorter until approximately noon and then lengthened as the day progressed.*)
- When was their shadow the shortest? (*around noon*)
- Did their shadows' movement and size changes correspond with the observations they made on the shadow clock? (*Yes, they both moved and changed size in the same direction and magnitude.*)
- Why were these changes observed? (*The Sun shines down on Earth and casts a shadow on the opposite side of any opaque object. As the Earth turns, the Sun's position in relation to the opaque object changes, creating the movement of the shadow and the change in the size of the shadow.*)
- How can this movement of Earth in relation to the Sun be useful in telling time? (*The Earth moves at a steady speed as it rotates toward and away from the Sun. The movement of the shadow is steady and makes one complete circle in 24 hours. As a result, we can tell the passage of one day, or 24 hours, by using the shadow.*)

Use a globe to show students the direction Earth must be moving as it rotates in order to produce the shadows they observed. Have students describe and explain in their science learning logs ([view literacy strategy descriptions](#)).

Sample Assessments

General Guidelines

Assessment will be from 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 utilized to evaluate inquiry and laboratory technique skills. All student-generated work (e.g., 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 create a race similar to the one in Activity 4, but change a variable. Predict if the speed will increase. Do three trials and take the average speed. Compare with classmates.
- The student will keep a journal, tracking all the activities they perform in one day where friction plays a role and including an explanation about how friction is involved.
- The student will create a list that ranks different surfaces according to the amount of friction they generate.
- Provide students with different examples of activities that demonstrate potential and kinetic energy. The student will identify each type of energy that is being demonstrated.
- The student will inventory small electrical appliances in his/her home and share the results with classmates. Have students record a list of the appliances on the board and how many times it was mentioned. Choose the most popular appliance and write a story telling what the world would be like without this appliance.
- The student will make a cause-and-effect chart using unbalanced forces.
- The student will create a concept map of energy sources.
- The student will research one of the energy sources and write a report explaining the availability of this energy source.
- The student will create a poster and oral presentation about his/her energy source.
- The student will keep a log of daily activities he/she participates in for one week. Next to each activity, list a way that he/she can change the activity to save energy resources.

- The student will make a human circuit by labeling students as “D-cell,” “bulb,” and “wire” and then join hands to show the path the electricity travels by squeezing hands to represent the current.

Activity-Specific Assessments

- Activity 3: The student will act out a physical activity for classmates, and ask the rest of the students to identify the forces in action, determining whether they are balanced or not. Students should record answers, including justifications, in a science *learning log* or on a teacher-created observation sheet.
- Activity 6: The student will create an illustration for an activity that demonstrates the changing from potential energy to kinetic energy and back again.
- Activity 9: The student will create a graphic organizer, such as a diagram, showing the path of electric current through each part of a series circuit and a parallel circuit, identifying the source of energy and explaining what transformation(s) in energy are being demonstrated.

Resources

Books

- Anderson, Margaret J. *Isaac Newton: The Greatest Scientist of All Time*
- Berger, Melvin. *Switch On, Switch Off*.
- *Best of Wonder Science*. American Institute of Physics, American Mathematical Society, American Chemical Society. Delmar Publishing.
- de Pinna, Simon. *Forces and Motion*.
- Doherty, Paul, & Rathjen, Don. *The Cool Hot Rod and Other Electrifying Experiments on Energy and Matter*.
- Kenda, Margaret, & Williams, Phyllis. *Barron’s Science Wizardry for Kids*.
- Woodruff, John. *Energy*.

Websites

- *Amusement Park Physics*. Annenberg/CPB. Available online at <http://www.learner.org/exhibits/parkphysics>
- *Discovery School: Forces and Motion*. Available online at <http://school.discovery.com/lessonplans/programs/forcesandmotion/>.
- *Force-Counterforce*. Discovery Channel School. Available online at <http://school.discovery.com/lessonplans/programs/airforces/>
- *Frank Potter’s Science Gems*. Available online at <http://www.sciencegems.com/>

- *Intermediate Infobook Activities 2002-2003*. The Need Project, P.O. Box 10101, Manassas, VA 20108. Available online at <http://www.need.org>.
- *Newton's First Law Activities*. Available online at http://swift.sonoma.edu/education/newton/newton_1/html/newton1.html
- *Physics 2000*. University of Colorado at Boulder. Available online at <http://www.colorado.edu/physics/2000/index.pl>.
- *Solar Anatomy*. Available online at <http://vathena.arc.nasa.gov/curric/space/sun/sunanat.html>
- *The Nine Planets: A Multimedia Tour of the Universe*. Available online at <http://www.nineplanets.org/sol.html>
- *The Usborne Big Book of Experiments* by Alastair Smith (Ed.), Howard Allman (Illustrator). EDC Publications.
- Tolman, Marvin N. *Hands-On Physical Science Activities for grades K-8*. Parker Publishing.

Grade 5
Science
Unit 4: Cells to Living Organisms

Time Frame: Approximately 4 weeks



Unit Description

This unit is designed to develop a deeper understanding of cells as the basic unit of living things, the basic components of cells and their functions, and the likenesses and differences of plant and animal cells. Beginning with cells, the levels of structural organization in living things will be emphasized. Along with the study of cells, identification and understanding of the types of microbes that are responsible for the transmission of diseases is introduced. The stages of complete and incomplete metamorphosis are addressed, as are the processes of photosynthesis and respiration in green plants and the development and use of dichotomous keys to classify plants and animals.

Student Understandings

Students will understand that cells form the basic structure of living things. In addition, students will recognize that, while plant and animal cells have similarities, they also have different structures and functions in some cases. From the division of a cell comes the development of specialized cells, tissues, and organs with unique functions in plants and animals, which can also result in complete and incomplete metamorphosis of some organisms. Students will understand that some microbes, consisting of individual cells, can transmit diseases in humans. Students will recognize that photosynthesis and respiration are two functions plants use to survive and both plants and animals use cellular respiration to release energy from food stored in cells. Finally, students will understand that scientists have developed tools such as dichotomous keys to classify the many different organisms on Earth.

Guiding Questions

1. Can students identify the basic components of living cells of all living things?
2. Can students compare/contrast plant and animal cells?
3. Can students describe the structural organization of cells, tissues, organs, and systems in a human body?
4. Can students describe the ways diseases are transmitted from person to person?
5. Can students describe the stages of metamorphosis of amphibians and identify other organisms that go through metamorphosis?

6. Can students explain how photosynthesis and respiration are alike and different in green plants?
7. Can students explain how respiration in plants and animals is similar and different?
8. Can students develop and use a dichotomous key to classify common plants and animals?

Unit 4 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry 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 Cells to Living Organisms unit.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through scientific investigations (SI-M-A1)
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)
10.	Identify the difference between description and explanation (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)
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)
24.	Provide appropriate care and utilize safe practices and ethical treatment when animals are involved in scientific field and laboratory research (SI-M-A8)
28.	Recognize that investigations generally begin with a review of the work of others (SI-M-B2)
29.	Explain how technology can expand the senses and contribute to the increase and/or modification of scientific knowledge (SI-M-B3)
34.	Recognize the importance of communication among scientists about investigations in progress and the work of others (SI-M-B5)
39.	Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)

Life Science	
15.	Identify the cell as the basic unit of living things (LS-M-A1)
16.	Observe, identify, and describe the basic components of cells and their functions (e.g., cell wall, cell membrane, cytoplasm, nucleus) (LS-M-A1)
17.	Compare plant and animal cells and label cell components (LS-M-A2)
18.	Describe the metamorphosis of an amphibian (e.g., frog) (LS-M-A3)
19.	Describe the processes of photosynthesis and respiration in green plants (LS-M-A4)
20.	Describe the levels of structural organization in living things (e.g., cells, tissues, organs, organ systems) (LS-M-A5)
21.	Identify diseases caused by germs and how they can be transmitted from person to person (LS-M-A7)
22.	Develop and use a simple dichotomous key to classify common plants and animals (LS-M-C1)

Sample Activities

Activity 1: Cells (SI GLEs: 1, 3, 7, **28, 29, 34, 39**; LS GLEs: **15, 16**)

Materials List: samples of very thin cork slices, wood shavings, plant leaves, bird feathers, dead insects, etc., hand lenses, prepared animal and plant cell slides, simple student microscopes, science learning log, Internet access

Provide students with samples of thin cork slices, wood shavings, plant leaves, bird feathers, and small dead insects. Have students observe and draw what they see in their journals. Then provide students with a hand lens to observe and draw the same objects. Have students compare drawings and then generate questions about how magnification has improved scientists' understanding about organisms. Obtain and display prepared animal and plant cells. Have students use hand lenses to view the cells and create drawings of them in their science *learning logs* ([view literacy strategy descriptions](#)). A science learning log is a notebook that students keep in order to record ideas, questions, reactions, and new understandings, as well as observations and data from science lab activities.

Then, arrange learning centers around the room where students can work individually to view a cell through simple microscopes. Once again, have students draw what they observe. Using a resource such as the Internet, an encyclopedia, or trade books, students will label the cell parts in their drawings and describe their roles/functions. Good resources for viewing plant and animal cells are available at <http://www.cellsalive.com/cells/3dcell.htm> and <http://www.schools.utah.gov/curr/Science/core/7thgrd/sciber7/Cells/html/CELLPHOT.H TM>.

As a whole group, summarize results by making a class chart of cell parts. Building on prior knowledge of living and nonliving things as well as plants and animals, the teacher

should ask probing questions to help students understand that cells are the foundational unit of living things.

Have students explain how the use of microscopes helped them expand their senses. Share the story of Anton Von Leeuwenhoek's discovery of *animalcules* after he designed and constructed simple microscopes. Information about Leeuwenhoek can be found at <http://www.answers.com/topic/anton-van-leeuwenhoek?cat=health>. Ask students to explain how Leeuwenhoek's and the world's knowledge increased as a result of this new technology.

Check students' prior knowledge about classification of living organisms by asking students to identify the two kingdoms of organisms in which most microscopic organisms are placed (Protists and Monerans). Point out to students that these categories were not used prior to Leeuwenhoek's discovery because no one had ever observed these microscopic organisms. If students do not know about the basic kingdoms of classification, review the criteria for each kingdom briefly, using a website such as <http://www.usoe.k12.ut.us/curr/science/sciber00/7th/classify/sciber/intro.htm>. Students need to understand that the newer classification system of five kingdoms is in better alignment with what is now known about these organisms. Ask students how these discoveries increased our understanding of diseases and germs. Have students infer how the discovery of microscopic organisms improved health care. Ask students, individually or in small groups, to select one of the earlier types of microscopes that were instrumental in furthering our knowledge in life science and then identify a new discovery that was made possible with it.

Information about Robert Hooke's and Anton van Leeuwenhoek's microscopes can be found at the following website: <http://www.ucmp.berkeley.edu/history/hooke.html> and <http://www.ucmp.berkeley.edu/history/leeuwenhoek.html>.

Once students have acquired this new information, ask them to demonstrate their new knowledge by using the literacy strategy *RAFT writing* ([view literacy strategy descriptions](#)), which gives students the freedom to project themselves into unique roles and look at content from unique perspectives. Students are given the opportunity to be creative and informative in the way they share their new knowledge. In this activity, students will take on the role of a microbiologist who makes an important discovery, using a microscope that has recently been invented. He is using a scientific news article to share his new discovery with other scientists. Ask students to write the following *RAFTed writing* assignment in their science *learning log* ([view literacy strategy descriptions](#)) in the format of a scientific news article:

- R—Role (Microbiologist/Scientist who made the discovery)
- A—Audience (Other microbiologists in the same field of research)
- F—Form (News article in a scientific newspaper)
- T—Topic (Announcement of discovery and new microscope that made it possible)

The teacher can publish the news articles in a “scientific” newspaper that can be shared with the rest of the class. Most basic computer operating software programs have a template that can be utilized to create a newspaper.

A key understanding of this activity is that scientific investigations generally begin with a review of the work of others and that scientists communicate with one another to share their work and that of others.

Activity 2: Cell to Cell (SI GLEs: 6, 7, 10, 19, 22, 23; LS GLE: 17)

Materials List: art paper; colored pencils or crayons; pictures of plant and animal cells; microscopes; prepared slides of objects such as an insect leg, bee wing, pollen, etc.; prepared slides of plant and animal cells; or, if having students make their own wet mounts: clean slides and cover slips, samples of plant cells obtained from onion skin, eyedroppers, water; Plant and Animal Cell Parts BLM; Plant and Animal Cell Parts Answer Key BLM

This activity develops the concept that there are differences and similarities among plant and animal cells. Find pictures of plant and animal cells in a reference book, textbook, or on an Internet site such <http://www.cellsalive.com/cells/3dcell.htm>. Display example pictures of several plant and animal cells on the board and have students identify similarities and differences. Tell students that they will be using real microscopes to observe some of the parts of plant and animal cells. Before actually observing plant and animal cells, review the parts and use of simple microscopes with students; then give them an opportunity to observe prepared slides of objects larger than cells, such as the wing of a bee, a dandelion thistle, etc. Students should sketch each object and label its parts and magnification. Give students opportunities to practice focusing the microscope themselves to see the parts clearly. The teacher should then set up stations to allow students to view examples of prepared plant and animal cells. Divide students into pairs. Have each partner observe a different cell type (plant or animal), then use art paper to sketch and color their cells and label the parts (cell wall, cell membrane, cytoplasm, nucleus, chloroplasts, etc.) and type of cell they have drawn. Students should also identify the magnification under which each sample was observed. If time allows, when they have completed this task, have each partner view, sketch, and label the cell type that the partner studied, so both types of cells can be seen by all students.

The *word grid* literacy strategy ([view literacy strategy descriptions](#)) can be used to record observations. This strategy will help students learn important concepts about organelles in plants and animals and expand their reading vocabularies. Provide students with the Plant and Animal Cell Parts BLM. Across the top of the *word grid*, have students label organelles that can be found in either a plant or animal cell. Down the side of the grid, they should write the names “plant” and “animal.” Using what was sketched and labeled in their drawings, student pairs should place a “+” sign in the space that corresponds with a cell part found in plants or animal cells and a “-” sign in the space that corresponds with a cell part that is not found in a particular cell type. Cell shapes should be included within the word grid. Students should compare drawings and word grids to make sure all cell parts have been identified and drawn correctly. The teacher should then quiz students by asking questions about the words related to their similarities and differences, such as

“Which organelle is the primary control center in both plant and animal cells?” or “What function does the cell wall in the plant cell perform that is not necessary in the animal cell?”

Display student drawings on the board in categories (e.g., plant cells and animal cells) so that all students can see the different shapes and components of each type. Ask students to make a generalization about the similar components found in either plant cells or animal cells from their sketches. In their generalizations, students should be able to describe the similar components and explain why they are necessary for that type of cell. Have students explain how the use of microscopes expanded their senses and contributed to an increase in their knowledge about cell types.

Some students are proficient enough to make their own wet mount slides. For those students, provide various plant specimens such as inside membrane of an onion, algae, a scraping from a leaf or other plant so that they can mount, view, sketch, and label a representative cell type of that plant. It is not recommended that students handle animal tissue at this age level due to safety concerns. Supply students with prepared animal cell slides to use for comparisons. Discuss safety issues involved with handling glass (e.g., careful handling to preventing breakage of slides, etc.). Set the materials up at a distribution center. Prior to having students create slides, demonstrate the proper way to gently remove a thin membrane from an onion, carefully place it in a drop of water on a slide, and place a cover slip on it without wrinkling the membrane. In addition, provide students with written instructions for creating a wet mount and how to use the microscope to observe it. Instructions for properly preparing slides can be obtained from textbooks or a website such as *Comparing Plant and Animal Cells* available at <http://www.geocities.com/CapeCanaveral/Hall/1410/lab-B-18.html> or http://www.stam.mb.ca/Microscope_Activities.pdf. Students should label the magnification of each drawing that is made.

Activity 3: Cells to Systems (SI GLEs: 14, 19; LS GLE: 20)

Materials List: long sheets of butcher or bulletin board paper to trace outlines of students' bodies (one for each body system), crayons or markers, 3"x5" index cards, science learning log

Have the students create the KWL chart *graphic organizer* ([view literacy strategy descriptions](#)) to determine prior knowledge that students have about different types of organ systems in the human body along with the roles and functions of these systems. Place the letters K, W, and L across the top of the chalkboard or on a sheet of bulletin board paper. Invite students to share what they know about each organ system (see figure below). Under the K (What do I Know?) column, list students' responses. Next, ask students what they would like to learn about organ systems and write their responses under the W (What do I want to Know?) column. At the completion of the activity, return to the chart and ask students to review their initial knowledge and questions. In the L


(What have I learned?) column, record student responses about what they know as a result of their study.

K (What do I <i>Know</i> ?)	W (What do I <i>Want</i> to know?)	L (What have I <i>Learned</i> ?)
<ul style="list-style-type: none"> • Your brain and heart are organs. • Each system is made up of several organs. • 	<ul style="list-style-type: none"> • What are the organs in the circulatory system? • What tissues make up the heart? • 	<ul style="list-style-type: none"> • Blood tissue is part of the circulatory system. •

Show students an enlarged picture of each body system. (Make sure that the individual organs are easily recognizable.). Ask students to explain why they think there are so many differences in human body systems. (Different systems, such as the digestive, circulatory, respiratory, skeletal, and muscular systems, have different functions.)

Have teams of students choose an organ system to research using the Internet, textbooks, or trade books. In their *science learning logs* ([view literacy strategy descriptions](#)) have students illustrate the organs that make up their chosen organ system. Divide organs within each system among the team members. Students can then utilize the *vocabulary card literacy strategy* ([view literacy strategy descriptions](#)) to illustrate each organ and its function. The cards allow students to see connections between words, examples of the word, and the critical attributes associated with the word. Distribute 3 x 5 index cards to students. Fill out information on the board that students will fill out on their cards. On the board, place a targeted word in the middle box as students do the same on their cards. Ask students to provide a definition in the student’s own words. Write the definition in the appropriate space. In each additional space, place one of the following: characteristics or description of the word, examples of the term, and a simple illustration.

Sample Vocabulary Card

<p>Definition:</p> <p>An organ that is part of the digestive system in vertebrates</p>	<p>Characteristics:</p> <ul style="list-style-type: none"> • Helps body digest fats • Stores nutrients • Filters poisons and wastes from body
<p>LIVER</p>	
<p>System this Organ Belongs to:</p> <p>Digestive System</p>	 <p>Simple Illustration:</p>

Teams can then create their own organ system vocabulary cards. After using the cards to reinforce understanding, have students use textbooks or the Internet to explore how cells are organized into tissues, tissues into organs, and organs into the particular system they are illustrating. Create a full body outline showing the construction of all organs in the system. The system name should be displayed at the top of the drawing, followed by the outline of the body and properly located organs within the system. Each organ should be clearly labeled and include information about it. Each team member should also identify one tissue type within their assigned organ and one cell type that makes up the tissue (such as red and white blood cells that make up connective tissue or a myocyte cell in muscle tissue). Have students share models with classmates, using vocabulary learned from vocabulary cards in their explanations.

Activity 4: Microbes (SI GLEs: 3, 28, 29, 39; LS GLE: 21)

Materials List: books or information about Louis Pasteur and Joseph Lister, one poster board for each student or pair of students, markers or crayons, Internet access

Anton von Leeuwenhoek's discovery of *animalcules* opened the door to discovering the causes of many of the diseases that plague the human race. Two scientists that were instrumental in making the connection between microorganisms and diseases were Louis Pasteur and Joseph Lister. To provide background experience, share information with students about the investigations of both Pasteur and Lister, prior to doing this activity. This can be done by reading books about them and their work or finding information in encyclopedias or on websites such as <http://www.zephyrus.co.uk/louispasteur.html> and <http://www.zephyrus.co.uk/josephlister.html> to share with students. Have students listen for clues from the readings to clarify when discoveries were made by both scientists. From their discussion, they should be able to identify which scientist's investigations occurred first and which occurred later. They should be able to explain how they determined the order of the discoveries. Ask students to infer how having knowledge about previous investigations can help direct the investigations of scientists at a later date.

Assess prior knowledge about germs by having students suggest names for diseases that they know. Define *communicable* and *non-communicable diseases* and have students classify the names they suggested into the correct category. Encourage students to hypothesize how the causes of these diseases were discovered. Then, have students use textbooks, trade books, or a website such as CDC's Diseases and Conditions website at <http://www.cdc.gov/DiseasesConditions/> to research several of the diseases that were suggested. Required information for the assignment can be found on the fact sheets for each disease. Students should identify the microbe that is responsible for each disease and whether or not it is communicable. Current diseases of concern in the news that might be of interest include the West Nile Virus and Avian Flu. Stress to students that most of the diseases they will research are preventable.

Record research results in a chart like the one that follows:

NAME OF DISEASE	MICROBE RESPONSIBLE FOR DISEASE	COMMUNICABLE OR NOT COMMUNICABLE	HOW IT IS TRANSMITTED	HOW TO PROTECT AGAINST DISEASE
Hepatitis B	Hepatitis B virus	Communicable	Contact with the blood of an infected person	Hepatitis B vaccine

Activity 5: It’s a Frog’s Life (SI GLEs: 7, 22, 24; LS GLE: 18)

Materials List: Internet access, colored transparency of frog eggs and overhead projector, **or** real frog eggs and video microscope/television display, trade book *It’s a Frog’s Life*, pictures of animals that go through complete and incomplete metamorphosis, art supplies for student-created picture books, Internet access (**Note:** If using live frog eggs or frog growth kits, be sure to allow ample time to order and to have proper resources to care for eggs when they arrive. If using eggs obtained from local source, such as a pond, be sure to use all precautions when handling eggs and pond water.)

Try to obtain real frog eggs or enlarged pictures of frog eggs to introduce this activity. If available, show eggs on a television screen using a video microscope. Make a colored transparency of the picture of frog eggs if a video microscope is unavailable. Without identifying the source of the eggs (i.e., egg from a frog), have students try to guess what the object is. Relate each part of the frog egg to one of the animal cells they have studied in earlier activities. Tell students that in this activity they are going to learn about the life cycle of a frog, from individual cell to adult frog.

Have students share their own experiences with frogs and their prior knowledge of the life cycle of a frog. Discuss the book, *It’s a Frog’s Life*, if available. If not, use the Internet for resources such as *A Frog’s Life* available at <http://www.seagrant.wisc.edu> or *Frog Metamorphosis* available at <http://www.countrysideinfo.co.uk/metindex.htm>. If possible, order frog eggs or frog growth kits from a biological supplier. Have students study and observe the metamorphosis of the frog from egg to adult. Ask them to create their own picture books showing the life cycle of the frog by sketching, labeling, and describing each stage of development. Have students discuss appropriate care and ethical treatment that must be adhered to when animals are involved in scientific investigations and why this is important.

Discuss the process of complete metamorphosis in other animals and have students identify additional familiar animals that undergo the process, such as butterflies, moths, beetles, flies, caddis flies, ants, wasps, bees, etc. If available, show students pictures of some of these animals as they go through their life cycle.

To contrast complete metamorphosis with incomplete metamorphosis, show pictures of the life cycles of such animals as grasshoppers, mayflies, roaches, damsel flies, dragonflies, and cicadas that exhibit incomplete metamorphosis.

Divide students into two groups to research organisms going through complete or incomplete metamorphosis. Assign members of each group an organism that fits their particular category and instruct them to create a poster illustrating the life cycle of their organism.

Have students explain the difference between complete metamorphosis and incomplete metamorphosis by using the life cycle posters of at least two organisms.

Activity 6: Photosynthesis and Respiration (SI GLEs: 3, 10, 19; LS GLE: 19)

Materials List: poster board, resource materials

Photosynthesis and *respiration* are two vital processes that are necessary for life to exist. These two processes are responsible for keeping the carbon cycle in balance. Through the process of photosynthesis, plants produce sugar and oxygen from carbon dioxide and water; while through the process of respiration, animals (and plants) convert the sugar molecules into energy and produce carbon dioxide as a waste product. Have students use textbooks, trade books, or the Internet to learn about the processes of photosynthesis in plants and respiration in both plants and animals. Several websites that have videos, experiments, and background information include

- <http://www.newtonsapple.tv/> (Go to Animals and Plants: Photosynthesis)
- <http://chem.lapeer.org/Bio1Docs/PhotoLab.html>
- <http://photoscience.la.asu.edu/photosyn/education/learn.html>

Have students create posters to illustrate each step in both processes, making sure to identify the exchange of gases that occurs during photosynthesis and respiration. Posters for both types of organisms should focus on respiration at the cellular level. Have students use the posters to explain the relationship between the two processes. Students should be able to explain why plants would not be able to exist without the ability to perform photosynthesis and respiration, and how this would affect all other organisms on Earth. Ask students to contemplate if plants could exist on Earth without animals; could animals exist on Earth without plants? What vital gas exchange takes place between plants and animals? Explain to students that some organisms at the bottom of the ocean are able to produce their own food without sunlight by a process called *chemosynthesis*. Challenge students to learn more about the process of chemosynthesis and how it is similar and different to the photosynthesis/respiration process.

Activity 7: Dichotomous Key (SI GLEs: 13, 19, 20; LS GLE: 22)

Materials List: For each group: Classroom Objects Sort BLM, scissors, paper clip, textbook, plastic ruler, crayons, tack, glue, student schoolbags; Classroom Objects Sort Answer Key BLM

Classification is a useful way of organizing information so that it is easier to understand. Due to the enormous number of organisms that populate Earth, scientists have had to devise a method of describing, naming, and organizing these organisms for ease in communication within the scientific community.

Familiarize students with the work of Carolus Linnaeus to introduce them to the first classification scheme that included only plants and animals. Ask students to explain why Linnaeus only had two kingdoms in his classification scheme (He based it on what was known at the time as a result of limited technology). Next, share with students the work of Robert Whittaker and his five kingdom classification scheme, created in 1969. Ask students to explain why Robert Whittaker was able to group organisms into five kingdoms, instead of only two (*improved technology increased understanding of differences in organisms that were earlier believed to belong in the same groups*). Students should be aware that as technology becomes more sophisticated and structures of organisms are more easily observed, the classification scheme will change again. Share with them that when they get to high school they will probably study a 6 kingdom system. (*Due to the improved technology of microscopes, scientists are now able to use the organelles within cells of organisms to classify them. The most current classification scheme includes three domains instead of five kingdoms and was introduced by Carl Woess. It includes the Archaea, Prokarya, and Eukarya Domain.*)

Due to the complexity and multitude of organisms on Earth today, scientists have developed tools to assist them in classifying new organisms. One such tool is a dichotomous key. In this activity, students will learn how to use a prepared dichotomous key to determine an organism's identity and then create their own dichotomous key.

Demonstrate how to use a dichotomous key by having students use the Classroom Objects Sort BLM. Provide each group with a copy of the BLM and the materials to sort. Guide students to consider each statement and then determine which objects agree with it. Have students work through the activity and discuss how the key was useful in determining the characteristics that made it possible for each object to be identified. Provide each group with the Classroom Objects Sort Answer Key BLM to use in checking their own dichotomous keys.

Next, students should create their own dichotomous key by placing their own schoolbags in plain view of all students and then have them sort them according to one characteristic at a time. Characteristics that may be used to sort bags include has one pocket/has more than one pocket, is transparent/is opaque, has one strap/has two straps, has a laptop compartment/does not have a laptop compartment, etc.

Help students to determine one main characteristic that separates the schoolbags into two groups.

On the board, write the following:

- 1a Go to # _____
1b Go to # _____

Fill in the criteria or characteristic of one group of schoolbags next to the letter “a” and a characteristic of the other group of schoolbags next to the letter “b”. Help students determine characteristics that can be used to sort the remaining bags. Beginning with the group in 1a, write a number “2” in the “Go to # _____” space. Start breaking this group of school bags down into categories until you are left with just one schoolbag in each group. Add steps to the key as needed. Help students determine what statements to write and what number to move to in order to identify each schoolbag. Test the key to see if it makes sense and is useful in sorting the bags. Help students write each statement in the same format as the BLM as they sort the schoolbags. (View sample dichotomous keys for examples.)

Continue sorting the bags until each bag on one side of the key is by itself. Select one of the bags and have students identify all of the characteristics used to classify it. List them on the board. Discuss with students how the key was useful in determining all of the characteristics of a book bag that made it possible to be identified. Next, have students complete the other side of the dichotomous key until all bags have been sorted.

Next, provide students with other dichotomous keys that can be found by accessing one of websites found in the resource section of this unit. Once students are comfortable with using one of the examples, have them create their own dichotomous key to classify and identify common plants and animals such as trees, flowering plants, leaves, fish, birds, etc. Stress that dichotomous keys can be used in classification of living and non-living objects, as well as for plants and animals.

Discuss the usefulness of dichotomous keys in science.

Sample Assessments

General Guidelines

Assessment will be from 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 utilized 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 create a play about photosynthesis and respiration. Students can become a water molecule in each and trace its travels.
- The student will create cards illustrating the steps of germination for several plants. Use the cards to play a matching game.
- The student will design a poster that shows the life cycle of a frog.
- The student will choose a system of the human body. Create a demonstration that shows how that system is connected to another system.
- The student will make a Venn diagram to compare and contrast how the human lungs and heart work.
- Divide the class into teams. Each team will choose a human body system. Students will prepare and debate the value of their system to the whole body.
- Provide students with a prepared, unlabeled slide of a plant and an animal cell. The student will draw, identify cell parts, and determine if it is a plant or animal cell.
- The student will make a game board that reinforces the ways communicable diseases are transmitted and prevented.
- The student will make sets of cards illustrating the life cycles of different organisms. Have students arrange the cards in the correct order and explain what happens at each stage.

Activity-Specific Assessments

- Activity 3: Assess students on the proper arrangement and labeling of cells, tissues, organs, and systems by providing them with *vocabulary cards* ([view literacy strategy descriptions](#)) from another group's organ system. Students will use knowledge gained from their own body system and the *vocabulary cards* to organize them from cell to system and explain the relationship between each part of the system.
- Activity 5: The student will draw pictures on four index cards of different animals going through the stages of complete metamorphosis and four index cards with the labels of each stage. Trade cards with other students and have them arrange them into the correct order with the correct label by each one.

- Activity 7: Provide students with pictures and descriptions of several types of mollusks with univalve and bivalve seashells. Students will use them to create a dichotomous key to identify each seashell.

Resources

Books

- Allison, Linda. *Blood and Guts (A Working Guide to Your Insides)*.
- Bankston, John. *Joseph Lister and the Story of Antiseptics*.
- Burgess, Jeremy. *Under the Microscope: A Hidden World Revealed*.
- Cole, Joanna, & Degen, Bruce. *The Magic School Bus: Inside the Human Body*
- Cline, Densley. *It's a Frog's Life*.
- Gail Gibbons Gail. *From Seed to Plant*.
- *How Plants Survive*—Newbridge book.
- Levine, Shar, & Johnstone, Leslie. *The Microscope Book*.
- National Science Resource Center. *Microworlds*.
- Ruiz, Andres Llamas. *The Life of a Cell*.
- Sabin, Francene. *Louis Pasteur: Young Scientist*
- The Wadsworth Group. *The Big Book of Wonder Science Volume*.
- Vancleave, Janice. *The Human Body for Every Kid*.
- WGBH. *Evolution Video Series Race for Survival*.

Websites

- *Cells Alive*. Available online at <http://www.cellsalive.com/cells/3dcell.htm>
- *Cells—Plants and Animals* Available online at <http://www.orchardproject.org/cells.htm>
- *Creating a Dichotomous Key*. Available online at www.environmentaleducationohio.org/VirtualTour/TeachingTools/AnimalClassification/UseConstrDichotomous.pdf
- *Creating a Dichotomous Key*. Available online at <http://wow.osu.edu/experiments/plants/dichotkey.html>
- *Creating a Dichotomous Key*. Available online at <http://lamer.lsu.edu/classroom/edonahalfshell/dicotkey2.htm>
- *I Can Do That! Plant Cells*. Available online at <http://www.eurekascience.com/ICanDoThat/cells.htm>
- *Virtual Tour of Human Body*. Available online at <http://www.ehc.com/VBody.asp>
- *Joseph Lister*. Available online at <http://www.zephyrus.co.uk/josephlister.html>
- *Louis Pasteur*. Available online at <http://www.zephyrus.co.uk/louispasteur.html>
- *Anton Von Leeuwenhoek*. Available online at <http://www.answers.com/topic/anton-van-leeuwenhoek?cat=health>

**Grade 5
Science
Unit 5: Ecosystems**

Time Frame: Approximately 6 weeks



Unit Description

This unit provides a foundation for establishing an understanding of cycles and systems through a study of various ecosystems. Adaptations of organisms that enable them to survive are emphasized. The impact of physical events and chemical processes on the carrying capacity of an ecosystem are investigated.

Student Understandings

Students will develop an understanding of several fundamental concepts e.g., ecosystems, limiting factors, carrying capacity, food chains and webs, decomposition, natural cycles, adaptations, and pollution. The students will gain insight and an awareness of the interaction of populations in ecosystem communities and the effects of non-native species on population numbers. Students will describe the results of some human activity and natural events as they affect the equilibrium of a system.

Guiding Questions

1. Can students describe a system and state how changes to one part manifest themselves in others?
2. Can students name and describe a variety of ecosystems?
3. Can students identify essential components in a healthy ecosystem?
4. Can students describe the role decomposers play in the cyclical life process?
5. Can students identify limiting factors in an ecosystem?
6. Can students describe what is meant by *carrying capacity*?
7. Can students identify the levels of organisms in a food chain (producers, consumers, and decomposers) and explain the roles of each?
8. Can students explain the predator/prey relationship, using an example from one of the Louisiana habitats?
9. Can students identify the adaptations that were necessary for survival by plants and animals for some Louisiana ecosystems?
10. Can students identify the major chemical cycles that occur in ecosystems and explain what would happen if one of them did not exist?
11. Can students describe how changes, such as natural events like wildfires, hurricanes, or introductions of nonnative species, disrupt the populations of various animals in an ecosystem?

12. Can students describe naturally occurring cycles such as the carbon, nitrogen, water, and oxygen cycle and identify where they are found within an ecosystem?

Unit 5 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry 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 Ecosystems unit.</i>	
1.	Generate questions about objects, organisms, and events that can be answered through scientific investigations (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)
6.	Select and use appropriate equipment, technology, tools, and metric system units of measurement to make observations (SI-M-A3)
10.	Identify the difference between description and explanation (SI-M-A4)
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)
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 words, equations) (SI-M-A4)
21.	Distinguish between observations and inferences (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)
24.	Provide appropriate care and utilize safe practices and ethical treatment when animals are involved in scientific field and laboratory research (SI-M-A8)
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)

GLE #	GLE Text and Benchmarks
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)
Life Science	
23.	Construct food chains that could be found in ponds, marshes, oceans, forests, or meadows (LS-M-C2)
24.	Describe the roles of producers, consumers, and decomposers in a food chain (LS-M-C2)
25.	Compare food chains and food webs (LS-M-C2)
26.	Identify and describe ecosystems of local importance (LS-M-C3)
27.	Compare common traits of organisms within major ecosystems (LS-M-C3)
28.	Explain and give examples of predator/prey relationships (LS-M-C4)
29.	Describe adaptations of plants and animals that enable them to thrive in local and other natural environments (LS-M-D1)
Earth and Space Science	
36	Identify, describe, and compare climate zones (e.g., polar, temperate, tropical) (ESS-M-A11)
Science and the Environment	
48.	Determine the ability of an ecosystem to support a population (carrying capacity) by identifying the resources needed by that population (SE-M-A2)
49.	Identify and give examples of pollutants found in water, air, and soil (SE-M-A3)
50.	Describe the consequences of several types of human activities on local ecosystems (e.g., polluting streams, regulating hunting, introducing nonnative species) (SE-M-A4)
51.	Describe naturally occurring cycles and identify where they are found (e.g., carbon, nitrogen, water, oxygen) (SE-M-A7)

Sample Activities

Activity 1: Home, Sweet Home (SI GLEs: 21, 24, 37; LS GLE: 26)

Materials List: science learning log, pencil, large sheet of bulletin board paper (*optional*)

To introduce the unit on ecosystems, use a *graphic organizer* strategy ([view literacy strategy descriptions](#)) in the form of a modified KWL known as KWLQ to elicit what students know about ecosystems. KWLQ stands for “What do you *know*? What do you *want* to know? What have you *learned*? And *Questions* for further investigation? Arrange these questions into four columns on the chalkboard or on a large sheet of bulletin board paper (See Figure 1) and then invite students to share what they already know about ecosystems. Record their responses, right or wrong, on the chart or board. Next, ask students what they would like to know about ecosystems and record their responses in the appropriate column. Tell students they will revisit the chart as they finish their study of the unit. Have students copy the chart in their *science learning logs* ([view literacy](#)

[strategy descriptions](#)). Science *learning logs* are journals that are used to record observations and illustrations, predictions, data collection, conclusions, etc. about what is being learned. Each entry in the science *learning log* should be dated.

ECOSYSTEMS (Fig.1)
KWLQ Chart

K What do I know?	W What do I want to know?	L What have I learned?	Q Questions for Further Investigation

Take students outside into the schoolyard to observe a schoolyard ecosystem. Check around the school property to find an appropriate site prior to bringing students outside. (An appropriate site can be any spot that has as little as a few plants or weeds and some ants or other insects; or an area with many plants and lots of insects, birds, and other animals.) If no appropriate site is available, show students a picture from a poster, calendar or magazine of an area that includes the essential elements of an ecosystem. Review appropriate behavior while outside and safety procedures that should be followed when observing wildlife. Students should bring their science *learning logs* with them to record observations. They should work in pairs to identify and list all of the components they believe make up the schoolyard ecosystem (e.g., *air, soil, water, plants, animals, Sun, etc.*). Students should not be told what these components are until the end of the activity. Before students return to the classroom, ask them to create a sketch of the area they observed in their science *learning logs*, label all of its components, and draw arrows between components to indicate how they think each one interacts with another component in the ecosystem.

Once students return to the classroom, select student pairs to explain the difference between what they actually observed interacting and what they think (*infer*) is interacting. Ask them to justify their inferences. Each pair should share their sketches with the rest of the class and compare similarities and differences. Once all students have shared their ecosystem drawings, list on the board the components that were present in all of the drawings. Then provide students with the definition of an ecosystem and have them determine if they included both living (*biotic*) and non-living (*abiotic*) components. Instruct students to write a description of an ecosystem in their science *learning logs*, explaining how the schoolyard ecosystem is important to all of the organisms living in it. Revisit the KWLQ chart to see if any of their questions have been answered yet. If so, tell them to record what they have learned in the “What have I *learned?*” column. Ask students if their investigation created any new questions they would like to investigate. Questions should be recorded in the last column of the KWLQ chart. Discuss possible ways the questions could be investigated at a future date. If time allows, allow students to do further investigations.

Activity 2: Nature’s Balancing Act (SI GLEs: 3, 18, 37; ESS GLE: 36; SE GLE: 48)

Materials List: pictures of different types of ecosystems, science learning logs, The Evidence Speaks for Itself BLM

Using pictures of different types of ecosystems (e.g., *desert ecosystem, swamp ecosystem, marsh ecosystem, forest ecosystem, etc.*), assign student pairs a picture and instruct them to list everything they see in it in their science *learning logs* ([view literacy strategy descriptions](#)), labeling each item as “living” or “nonliving.” Introduce the terms *biotic* for “living” and *abiotic* for “non-living” telling students that these are the proper scientific terms for these two descriptions and as student “scientists,” they should be able to communicate using scientific language.

Student pairs should use a variety of sources to find information about each of the listed components of their ecosystem and its importance to maintaining balance in the ecosystem. If the presence or absence of a factor limits the growth of any organism in the ecosystem, it is called a *limiting factor*. Since organisms can only survive in environments where their needs are met, any component that is in limited supply becomes a limiting factor for an organism that needs it. There are several fundamental factors that limit ecosystem growth, including temperature, precipitation, sunlight, soil configuration, and soil nutrients. Ask students if limiting factors can be both biotic and abiotic? (yes)

Instruct each pair to discuss the ways each component in the picture interacts with the other components; then ask them to predict what would happen if one of the components was removed or increased dramatically. Introduce the concept of *carrying capacity* (*the maximum population of a given species that can be supported indefinitely with the amount of food, water, air, shelter, and space that is available to it*) and ask students to discuss what would happen if there was an overabundance of one of the animals in the picture. Students should infer what component(s) of the ecosystem would be depleted first and why. Which component(s) would not be affected? Why? Each pair should then select a component, either living or non-living (*biotic or abiotic*), to hypothetically remove or increase greatly; and then write an explanation in their science *learning logs*, telling how this would affect the ecosystem. Students can use their textbook, library resources about biomes, or a website such as *World Builders*, available at <http://curriculum.calstatela.edu/courses/builders/lessons/less/biomes/carryingcap.html> to obtain information about carrying capacity and the components of different ecosystems. Included in their explanations should be a statement that names their ecosystem and states how a selected organism in it will be affected by the increase or decrease of one of its components. The explanation should also include information about what factors in the ecosystem are needed by the organism to survive and the limiting factors in the ecosystem.

Give each student a copy of The Evidence Speaks for Itself BLM. Review the questions on the BLM and show students how to use it to determine if other groups have justified their claim that the removal of certain components from an ecosystem will cause it to get

out of balance. Students should listen to the presentations to determine if statements were made that were supported by evidence. Assign each group a partner group to evaluate by using the BLM. Students should give the completed rubric to the group that was presenting.

Each pair of students should share their ecosystems and explanations with the rest of the class. Students presenting the information should be able to provide evidence from their research to prove their claim.

Activity 3: How Many Is Too Many? (SI GLEs: 16, 22, 38; SE GLE: 48, 50)

Materials List: colored index cards or construction paper tokens for activity simulation

Use an activity simulation such as Project Wild's *Classroom Carrying Capacity*, or one of several similar activities found online such as the T.E.A. classroom activity called *How Many Penguins Does it Take? Studying Carrying Capacity and Limiting Factors* available at

http://tea.armadaproject.org/activity/elliott/howmanypenguinsdoesittake_main.html to develop the understanding that all life forms need certain resources—food, water, shelter, and space. The amount of these that are readily available will determine the carrying capacity for any one location and will serve as limiting factors for a population. The game model will show normal population fluctuations.

After completing the activity simulation for carrying capacity, mark off a small area in the classroom (*or outside*) and attempt to fit as many students as possible into the small prescribed area. Elicit their comments as things get more and more crowded and the individuals find themselves confined to a small section and unable to move. Ask students to identify resources that may become limited as space decreases and explain their thinking (*i.e., food, shelter, water, etc.*).

Selecting an organism from one of the previously developed ecosystems, students should develop a list of conditions and events, both natural and human-induced (*e.g., number of predators, loss of habitat, disease, extreme weather, lack of food, land development*) that would stress or reduce the population. Determine an action that would remove the stress and allow for a rebound of the population. Ask students to determine how the action helped the population. What negative effect could this rebound in the population have on other populations in the ecosystem? Revisit and discuss the concept of carrying capacity. Ask students if there is ever a time when a condition and event that decreases the population works toward the benefit of the ecosystem? Explain (*For example, when there is a decrease in the nutria population of a wetland due to regulated trapping, there is an increase in the plant growth, which provides food, nesting material, hiding spots, shade, etc. for organisms in the wetland ecosystem*). Students should use specific examples of what people do to alter the carrying capacity of an ecosystem in an effort to repair it and how scientific processes and knowledge were used in making the decision.

Activity 4: Ecosystems in Different Climate Zones (SI GLEs: 3, 19; ESS GLE: 36)

Materials List: class world map, atlases, available resources

To begin this lesson, instruct students to identify, describe, and compare how the components of one ecosystem differ from others in different climate zones. Assign a different climate zone to each group of three or four students. Climate zones can include tropical, polar, temperate, mild, continental, and high elevations. Students should identify on a world map the general location for their climate zone. Utilizing various resources such as textbooks, trade books, atlases, and the Internet, groups should identify the components of an ecosystem in their climate zone. Students should be able to explain the role that climate plays in making each ecosystem different and which components are not affected by climate differences.

Once students have gathered information about an ecosystem within a particular climate zone, give them an opportunity to show what they have learned by using the *professor know-it-all strategy* ([view literacy strategy descriptions](#)). With this strategy, students assume roles of “know-it-alls” or experts who are to provide answers to questions posed by their classmates. Tell students they will be called up to the front of the room and must provide expert answers to questions from their peers about their ecosystem and climate zone. Before coming to the front of the room, have each group generate three to five questions about their climate zone and ecosystem they might anticipate being asked and that they can ask other experts. Call a group to the front of the room and have them stand shoulder to shoulder. Invite questions from the other groups. Students should ask their prepared questions first, then add others if needed. Experts should confer with each other before answering the questions. If further clarification is needed, students may ask additional questions. Make sure students are holding the “know-it-alls” accountable for the completeness and accuracy of their answers. Have each group represent *professor know-it-all*.

Activity 5: Ecosystem in a Bottle (SI GLEs: 1, 2, 5, 6, 15, 17, 33, 34; SE GLE: 48)

Materials List: two to three empty, clean 2-liter bottles or large glass or plastic jar with lid (*per group*); soil; rocks; sphagnum moss; water; plants or grass seeds; small animals such as worms, fish, tadpoles, ants, mealworms, or isopods; thermometer; spray bottle or other suggested materials from research

In this activity, students will prepare a bottle aquarium/terrarium to establish an ecosystem that includes living and non-living things. Directions for creating these systems can be found at a site such as *Bottle Biology: TerraAqua Column* available at http://www.bottlebiology.org/investigations/terraqua_main.html or *Make a Soda Bottle Terrarium* at <http://www.stormthecastle.com/terrarium/soda-bottle-terrarium.htm>.

Using what was learned in Activities 1, 2, and 3, students should identify the abiotic and biotic features in an aquarium or terrarium and what is necessary for a balanced

ecosystem (*animals, plants, decomposers, water, oxygen, carbon dioxide, carbon, nitrogen, temperature, light, pH.*) Students should create a classroom bottle aquarium/terrarium to use in the following activity or have each group design/customize and build their own model, based on research. When they are assembled, students should observe them for one week and record in their science *learning logs* ([view literacy strategy descriptions](#)) any changes in living and nonliving components, in order to determine a baseline for the ecosystem. At the end of a week, students should make any necessary adjustments to their ecosystems and then seal them. Ask students how each non-living component interacts with each living component. Suggested questions include the following:

- What changes, if any, did you notice in the organisms in the ecosystem?
- What might be the cause for the changes you observed?
- What interactions did you observe? (*animals eating plants and breathing air, plants utilizing sunlight to grow; evapo-transpiration creating condensation on the inside of the bottle from an interaction between sunlight, water in the soil, and plants; water turning green as algae population increase; etc.*)
- How does your ecosystem resemble a natural ecosystem? How does it differ?
- What effects did the abiotic factors in the ecosystem have on the biotic factors? (*Sunlight increased algae growth and plant growth, etc.*)
- How did the biotic factors affect the abiotic factors (*e.g., temperature, moisture, sunlight*)?
- How did one abiotic factor affect another abiotic factor? (*heat energy from the Sun increased the water temperature and/or soil temperature, increase in water temperature decreased amount of dissolved oxygen in aquatic chamber, etc.*)
- How did one biotic factor affect another biotic factor? (*One animal may have eaten the plant or another animal; decomposers may break down the dead organisms in the aquatic or terrestrial chamber, etc.*)

Guide students to generate testable questions that they can answer by designing a new investigation; then they should design an experiment to test the effects of removing or changing one of the abiotic or biotic components from/of the aquarium/terrarium. Guide students to identify the independent and dependent variables they will use and what information they will use as baseline data for comparisons. After teacher approval of their design, students should begin the investigation. Students should create a chart or table to record observations over a two-week period. Include in the chart daily temperature readings, amount of condensation (*if any*), height of plants, number of organisms still alive, activity of organisms, clarity of water (*for aquarium ecosystem*), and any other important factors observed. Instruct students to observe all other students' ecosystems and share progress with each other. Students need to recognize the importance of communication with each other about their investigations and others' progress as a tool for understanding what is happening in their own investigations. After the two weeks, students should explain what they observed and what factors were necessary to try and maintain equilibrium in the aquarium/terrarium. Students should utilize what is occurring with their own ecosystems and the daily communication that has happened with other groups, in order to identify faulty reasoning with observations and inferences of

classmates. Guide students to understand that there may be more than one way to interpret a given set of data, which may result in different inferences by classmates. Students should explain limitations of the models they created and make recommendations for improvement. They should keep the models in the classroom to be used again in Activity 11.

Activity 6: Food Chains and Webs (SI GLEs: 3, 16, 19; LS GLEs: 23, 24, 25, 28)

Materials List: example of an energy pyramid, labels that represent the Sun and various plants and animals found in one general ecosystem, ball of yarn or string, Food Chains and Food Webs Vocabulary Self-Awareness Chart BLM

Use the *vocabulary self-awareness* strategy ([view literacy strategy descriptions](#)) to assess students understanding of important terms for understanding food chains and food webs. In this strategy, the teacher identifies target vocabulary for the lesson and provides students with a list of terms. Each vocabulary word is rated according to the student's understanding, including an example and a definition. If they are comfortable with the word, they give themselves a "+" (plus sign). If they think they know, but are unsure, they note the word with a "√" (check mark). If the word is new to them, they place a "-" (minus sign) next to the word. Over the course of the assignment, students add new information to the chart. The goal is to replace all of the check marks and minus signs with a plus sign. Provide students with the Food Chains and Food Webs Vocabulary Self-Awareness Chart BLM and have them fill in as much as they can. Students should also include any words that were suggested during the brainstorming session. Suggested words to include are *energy pyramid, producer, decomposer, scavenger, food web, food chain, primary consumer, secondary consumer, tertiary consumer, herbivores, carnivores, omnivores, predator, prey, and energy source*.

Select one general ecosystem and have the students provide a list of several plants and animals representative of that location. During this discussion, encourage students to create a table of producers and first- and second-level consumers. The chart can be drawn on the board and copied into science *learning logs* ([view literacy strategy descriptions](#)). Be sure to include a variety of animals. Students can find examples of food webs and energy pyramids for different biomes online by accessing one of several websites such as <http://curriculum.calstatela.edu/courses/builders/lessons/less/biomes/introbiomes.html>, or <http://www.ftexploring.com/me/me2.html>, or by using textbooks or trade books. Use the created table of first- and second-level consumers to develop an energy pyramid, and through discussion, generate an awareness of the number of organisms found at each level. Draw the energy pyramid on the board and have students sketch it in their *science learning logs* ([view literacy strategy descriptions](#)).

To help students understand the interconnectedness of organisms in a food web, play the following game. Select a food web that is present in one of the ecosystems previously studied. Designate one student to represent the Sun, the energy source. The rest of the students should be assigned roles as plants or animals. Instruct the "Sun" to stand in the middle of the room. Have each student wear a label around his/her neck to identify which

organism he/she represents, and stand in a large circle around the Sun. Give a ball of yarn to the “Sun” and have him/her hold onto the end of the string and toss the ball to a “producer.” Have the “producer” explain how they obtain their energy from the Sun. The “producer” should toss the ball of yarn to a “primary consumer,” making sure to hold onto a length of the string. The “primary consumer” should explain how he/she receives energy from the producer, and ultimately, the Sun. From a primary consumer, the yarn should be tossed to a “secondary consumer” and so on until the yarn is tossed to an organism that doesn’t have a predator. At each move, have students identify the predator/prey relationship being demonstrated. If no such relationship exists at that move, have students identify the producer/consumer relationship. Have all students hang on to their yarn and start the game again. All students can participate in the second round, demonstrating how a producer can be food for more than one consumer, and a consumer can be food for several other consumers. Be sure that students understand that the food web is primarily describing the flow of energy through the ecosystem.

Ask students to predict what other organisms would be affected once the first groups disappeared. Are there other organisms within in the web that could be substituted as a food source? To demonstrate how food webs can be negatively affected, allow one or two of the organisms to die. Trace the effect backwards by following this organism’s string in order to find out what other organisms are negatively affected by this event. Have students draw illustrations of their created food web in their science *learning log* and describe how each part is interconnected. Students should revisit their *vocabulary self-awareness* chart to update it as their understanding of important terms increases. The vocabulary chart can be used to review for upcoming tests and in communicating scientifically when discussing food webs and food chains.

Activity 7: Home to Whom? (SI GLEs: 3, 19; LS GLEs: 23, 24, 25, 26, 28)

Materials List: pictures of Louisiana habitats, chart paper, map of Louisiana that shows the land features, poster or mural paper, cardstock, scissors, colored markers or pens

Show students pictures of different Louisiana habitats (*e.g., marsh, prairie, bottomland hardwoods, flatwoods, longleaf pine forests, shortleaf pine-oak-hickory forests, and upland hardwoods*). To assess prior knowledge, have students generate questions they would like to have answered about each habitat and list these questions under its name on a piece of chart paper or on the board. Divide the class into cooperative groups. Each group should choose one of the Louisiana habitats and determine one of its geographic location(s) in the state. Using a variety of resources, including the websites listed in the resource section, students should develop a description of the habitat and make a list of plants and animals found in that region. They should prepare an illustration (*poster, mural, etc.*) of the habitat and geographic location (*using words or pictures*) and create a food web of the organisms they wish to include, drawing arrows from food sources to all appropriate consumers to illustrate the complex nature of a food web. Students should use a minimum of three abiotic elements, three plants, three herbivores, three omnivores, and three carnivores. Students should identify producers, consumers, and decomposers as

they identify different food chains within each food web, and then explain the difference and similarity between food chains and food webs. The predator/prey relationships within each habitat should also be identified.

Students should draw their selected habitat with food web illustration on a reinforced material such as cardstock and then cut the drawing into puzzle pieces. Allowing time for the students to complete the puzzles from a number of groups in the class provides an introduction to a variety of habitats.

Activity 8: Who Are the Players? (SI GLEs: 1, 10, 21, 23; LS GLE: 24)

Materials List: leaf detritus, dried and fresh leaves of same type as leaf detritus, hand lenses, gloves, Food Chains and Food Webs Vocabulary Self-Awareness Chart BLM (from Activity 6), newspaper or paper towels, hand washing soap

Collect samples of leaf detritus for students to examine or, if possible, take students on a walk to observe leaf detritus at the edge of a swamp, marshy area, the floor of a forest/wooded area, or under a rotting log. Have students also observe dried and fresh leaves from the same area for comparison. Ask students to suggest some questions that might be asked about the decomposing, fresh, and dried leaves, based on their observations. Encourage students to ask such questions as Are these the same kinds of leaves? If they are, what has caused them to change so much? How long have they been decomposing? What will they look like if they are left here for another week? Month? Students should wear gloves when handling the detritus, and wash their hands immediately following the activity. Students should use their senses (*except taste, of course*) to describe its appearance and smell, and then infer what the original material was. Ask students to hypothesize how the leaves were transformed into detritus. Encourage a discussion about the smell associated with the detritus and what caused it.

Discuss how the decomposers in compost piles work to break down organic material into nutrients that can be recycled back into soil. If one is available, have students visit it to see some of the organisms that live in compost piles and to observe how the organic material changes over time. Introduce the term *decomposer* and guide a discussion about the role decomposers play in a food chain/web and in composting. Students should also revisit the Food Chains and Food Webs Vocabulary Self-Awareness Chart ([view literacy strategy descriptions](#)) BLM to update their understanding of the word *decomposer*.

Direct students to look at the food web created in Activity 6 and make sure that decomposers are identified on it. If necessary, students should add decomposers to their food web to make it more complete.

Students can access the following websites to learn more about decomposition:

- <http://www.lpb.org/education/classroom/itv/envirotacklebox/teacherguide/module5/5rot.htm>
- <http://www.ftexploring.com/me/me2.html>

- http://www.bottlebiology.org/investigations/decomp_bkgreading.html

The video, *Rotten But Not Forgotten, an EnviroTacklebox™ module* produced by Louisiana Public Broadcasting is available through United Streaming, at <http://www.lpb.org/education/cyberchannel.cfm>, for those who subscribe to this service. Several school libraries and individual teachers have copies of this series, as well.

Activity 9: Acetate Ants and Adaptations (SI GLEs: 2, 22; LS GLEs: 27, 29)

Materials List: hole puncher; red, blue, yellow, green, and clear acetate; timer; masking tape; colored pencils or crayons

To introduce students to the concept of adaptations, conduct the following activity. Using a hole puncher, punch out 30 circles each from sheets of red, yellow, blue, green and clear acetate. Before students arrive, scatter the circles all over the floor of the classroom. Students will be told that the floor will represent the habitat for a population of a very small ant, *Acetatis antus* and that they (*the students*) will represent a predator that feeds on this particular species of ant. The students will be given two minutes to search for the prey (*circles*). When the two minutes are up, have students record their findings and make a class tally, recording total number of ants by color, including the number of individuals originally in the habitat, the number captured and the number remaining in the habitat. Students should individually construct a graph to illustrate these findings. Students should explain which animals were the most difficult to find and why and to predict what would eventually happen to those animals who were least adapted.

Following this activity, elicit a class discussion, asking students to list organisms that live in their local area. Have students identify any adaptations that enable each organism to be successful there. Challenge students to use a variety of sources to obtain information about one animal from a local ecosystem and adaptations that have made it suitable to its environment. Have students make an illustration of the animal in its habitat utilizing this adaptation. Ask students how this adaptation would make it difficult to survive in other ecosystems. Guide students to understand that the adaptations that help an animal survive in one ecosystem may make it difficult or impossible to survive in other ecosystems. Have students share their research and illustrations with classmates.

Ask students to list some human adaptations. To illustrate one important primate adaptation, have students tape their thumb down with masking tape, so that it is no longer an opposable thumb, and ask them to try and pick up things, etc. Ask students why the thumb is an important characteristic of humans and other primates. Discuss this adaptation of primates and how it is used to perform daily activities. Ask students to identify activities that would be difficult for them to do without this adaptation.

Activity 10: The Cycle Starts Here (SI GLEs: 21; SE GLE: 51)

Material List: aluminum can, section from a newspaper, plastic drink bottle, ecosystems in a bottle from Activity 5, posterboard for each group

Introduce students to the chemical cycles in nature by showing them three familiar objects that we commonly recycle. Explain briefly to students the process by which each object is recycled (e.g., aluminum can, newspaper, plastic bottle, etc.) or show a segment on recycling from a video such as EnviroTacklebox™'s *Tackle Trash*, which can be accessed through the Louisiana Public Broadcasting service, United Streaming site at <http://www.lpb.org/education/cyberchannel.cfm>. This is a fee-based service. Many school libraries and individual teachers have copies of this series. Other appropriate recycling videos can be used, as well. Ask students how recycling these materials help the environment. What would eventually happen if these objects were not recycled? Write ideas on the board to refer to during the next part of the activity.

Next, show students one of the aqua/terrariums from the Activity 5 that has been successful in staying balanced. Ask the students that created it to identify any new materials they placed into their model ecosystem over the last two weeks. (*Students should be able to state that no new material has been added to the ecosystem; in effect, the ecosystem has been maintaining its own equilibrium.*) Ask students to reiterate what the organisms in the ecosystem need to stay alive and predict where these materials are coming from if they were not added by students.

Divide students into three groups and assign them one of the major chemical cycles (e.g., oxygen, nitrogen, carbon). Have each group research to find out how this cycle occurs in their ecosystem and create a drawing on poster board to illustrate this process. Have students use their aqua/terrarium when explaining to the rest of the class what they discovered. They should emphasize that these cycles return materials to the ecosystem that can be reused over and over. Have students explain what would happen if these chemical cycles did not exist.

Activity 11: Non-Native Invasion (SI GLEs: 26, 27, 34; SE GLE: 50)

Materials List: book or video about non-native invasion, pictures of invasive species

To introduce students to the topic of invasive species (alien species), use the *SQPL* literacy strategy ([view literacy strategy descriptions](#)) to get the students' attention and to hold their interest as they read. *SQPL*, Student questions for purposeful learning, is a strategy designed to gain and hold students' attention by having them ask and answer their own questions. Use the following teacher prompt, or one of your own, to stimulate student questions:

The Louisiana ecosystems are being destroyed by aliens.

Write the statement on the board before the students arrive for science class. Have students pair up, and based on the statement, generate two or three questions they would like answered. The questions must be related to the statement and should not be purposely farfetched. When all student pairs have thought of their questions, ask someone from each team to share the questions with the class. Write the questions on the board, so they can be reviewed while or after reading. Look over the list and add any pertinent questions that have been omitted. Now students are ready to seek answers to their questions. Remind them to listen carefully as you read to see if any of their questions get answered. As you read, stop periodically to see if any questions can be answered and have volunteers share. Any questions that are not answered should be revisited after the rest of the activity to see if they can be answered. Unanswered questions may serve as the focus for independent study and further research opportunities.

Non-native invasive species have severely impacted local ecosystems in many places around the world, including the state of Louisiana. Introduce students to non-native (alien) invasion by reading a book such as *Oh No! Hannah's Swamp is Changing* by Marilyn Barrett-O'Leary or having them view the *EnviroTacklebox™* video, *Non-Native Invasion*, available through the Louisiana Public Broadcasting's United Streaming which is a subscription based service, available at <http://www.lpb.org/education/cyberchannel.cfm>.

Show photos of and discuss organisms that have posed problems to Louisiana ecosystems, such as the nutria, water hyacinth, giant salvinia, hydrilla, Chinese tallow tree, kudzu, etc. Students should select one of these organisms to research; then write a story about how it was introduced into a local ecosystem, why it was successful in invading the area, and the problems it has caused. Through their research, students should identify a method that was tried and failed or one that can be used to remove or control the non-native species and include it in their story. Share stories with the class.

Explain to students that scientists aren't always successful in their first attempts in solving problems, but use processes that involve logical and empirical, but flexible approaches to problem solving that many times result in successful solutions. Provide students with an example such as trying to manually remove Giant salvinia and hydrilla from aquatic habitats while not realizing that the plant fragments left behind produce new growth. Students need to understand that scientists often try alternative methods to try to solve the same problem. Through communication of their successes and failures, eventually new methods that work are discovered. Highlight any examples from student stories that corroborate this concept.

Activity 12: Pollution (SI GLEs: 16, 27; SE GLEs: 49, 50)

Materials List: photos of activities causing pollution in an ecosystem, chart paper, Internet access, science learning logs

Show pictures of locations where pollution can possibly occur in different ecosystems (e.g., sewage pouring into a river, exhaust from car exhaust pipes, rusting cans of toxic waste buried in the soil, heavy sediment loading in a river) as well as not-so-obvious types of pollution (e.g., spraying fertilizers and pesticides on golf courses, animal wastes being deposited on lawns and from animals in pastures near rivers or streams, noise pollution created by the driving of piles to create foundations for homes in new neighborhoods, burning a large amount of trash, etc.) to students. On a large chart make three columns for “soil,” “water,” and “air.”

Divide students into cooperative groups and provide each group with one of the pictures. Have students in each group identify the types and source(s) of pollution being shown. Provide students with an opportunity to find out about how each type of pollution affects an ecosystem by using the EPA websites: <http://www.epa.gov/students/> or <http://www.epa.gov/highschool/> or other environmental websites that provide information about pollution. Bring all groups together and have them share what was discussed with the rest of the class. On the chart, list the identified pollutants under the correct column. Discuss what effect each type of pollution might have on the ecosystems created earlier.

Ask students to work in their cooperative group to *brainstorm* ([view literacy strategy descriptions](#)) possible solutions to the type of pollution they just investigated. Brainstorming allows students to activate previously gained knowledge about methods that they know about for cleaning up pollution. Have each group record their ideas in their science *learning logs* ([view literacy strategy descriptions](#)). Then, instruct students to use the same website or another one to learn about methods that have been devised to clean up or protect against the type of pollution they previously researched.

Ask students:

- Did any of the ideas suggested while *brainstorming*, match any of the solutions being used for cleaning up your type of pollution? (*answers will vary*) If so, which ones?
- Have any of the methods you investigated been discontinued? If so, which ones and why? (*some students may have found out that previously used methods of solving pollution problems created new ones or didn't work effectively*)
- When scientists meet with failure in one of their methods, what do they do? (*they try something new*)
- Can you give an example of a new method of pollution control that came about as a result of a previously failed method? (*recycling paper instead of putting it in landfills, since the landfills are reaching capacity and it is difficult to find additional land to use, full, etc.*)

Guide students to understand that science uses processes that involve a logical and empirical, but flexible approach to problem solving.

Sample Assessments

General Guidelines

Assessment will be from 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 utilized 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 create mobiles of ecosystems with food webs.
- The student will create a postcard using the front to illustrate the ecosystem and the back to describe the system.
- The student will prepare placemats for a selected ecosystem by drawing or using images.
- The student will keep a journal about a selected ecosystem. Discuss interactions in the local ecosystem and determine if they are predator or prey. Make a flow chart. Explain how nutrients are recycled in an ecosystem.
- The student will create a set of Jeopardy-style questions using the components of their selected habitats. Putting all the habitats together, the students will make a game show for the class to play. Cooperative groups may play as teams against each other. No student group should have an opportunity to answer the questions they wrote.
- The student will compare and contrast the interaction of one species in different ecosystems.
- Using a Venn diagram, the student will compare the player levels in the different food chains from different systems.
- The student will create trading cards to illustrate the important components of a particular ecosystem.
- The student will create a set of “I have... Who has...?” cards that show pictures of all of the biotic and abiotic components of an ecosystem. Have students play

the game to review all of the interactions between the components. Descriptions should be specific enough to allow only one answer to each card.

- The student will create cards with pictures of predators and prey that are in the ecosystem they researched. Allow students an opportunity to trade decks with other groups to play a matching game.

Activity-Specific Assessments

- Activity 1: The student will search through a magazine to find a picture of an ecosystem, or take a picture of one near his/her home. The student should write a description of the ecosystem, identifying the living and non-living components and possible interactions between them.
- Activity 2: Provide students with a description of an ecosystem they have not studied yet. Students will identify the non-living and living components and explain their interactions. At least one food web within the ecosystem should be identified and labeled appropriately with producers, consumers, and decomposers
- Activity 3 and 11: The student will create a game to demonstrate how carrying capacity is compromised when a non-native species competes for necessary nutrients. Students should create a game board illustrating one of the habitats studied in this unit. Game pieces should represent native organisms competing for nutrients, shelter, etc. Game cards should describe events that occur in the ecosystem to keep it in balance or disrupt the balance. At least 5 game cards should describe a negative effect of a non-native species introduced into the ecosystem. At least three game cards should describe appropriate and inappropriate methods of removing the invasive species from the ecosystem. Have students move forward or retreat in response to the event on the card.

Resources

Books

- *Common Ground: The Water, Earth, and Air We Share* by Molly Garrett Bang.
- *Compost Critters* by Bianca Lavies
- *Ecology* by Janet Van Cleave.
- *Hands-on Earth Science Activities for Grades K-8* by Marvin Tohman. Parker Publishing.
- *Oh No! Hannah's Swamp is Changing!* by Marilyn Barrett-O'Leary
- *One Small Square Series: African Savanna, Arctic Tundra, Backyard, Cave, Pond, and Seashore* by Donald M. Silver
- *Pond* by Gordon Morrison.
- *The Magic School Bus Gets Eaten: A Book about Food Chains* by Patricia Relf, Bruce Degen, and Joanna Cole.

Websites

- *Bottle Biology: The Microbiology of Decomposition* Available online at http://www.bottlebiology.org/investigations/decomp_bkgreading.html
- *Cycles*. Available online at <http://www.uen.org/themepark/cycles/index.shtml>
- *Elements—Carbon and Nitrogen*. Available online at <http://chem4kids.com/files/elements>
- *Global Warming*. Available online at www.epa.gov/globalwarming/kids/index.html
- *Science of the Earth System: Carbon Cycle and Ecosystems*. Available online at <http://www.earth.nasa.gov/science/carbon.html>
- *The Nature Conservancy: Lower West Gulf Coastal Plain*. Available online at <http://nature.org/wherewework/northamerica/states/louisiana/preserves/>
- *LPB Cyberchannel* available online at www.lpb.org/cyberchannel

Sponsored and paid for by local school systems. Educational video clips available online for teachers

Teacher Resource Guides

- *Project Aquatic Wild* by Western Regional Environmental Education Council.
- *Project Learning Tree* by American Forest Foundation
- *Project Wild* by Western Regional Environmental Education Council
- *WOW: The Wonders of Wetlands* by U.S. Environmental Protection Agency and U.S. Department of the Interior.

**Grade 5
Science**

Unit 6: Earth: Its Lithosphere, Hydrosphere, and Atmosphere

Time Frame: Approximately 5 weeks



Unit Description

The unit will focus on activities that investigate components of the lithosphere, hydrosphere, and atmosphere of Earth. Inquiry activities in this unit include a study of the composition of soil samples, classification of rocks, mineral identification, fossils, and the agents of weathering and erosion and their effects on landforms. Also, the compositions and ratio of components in the atmosphere and hydrosphere on Earth will be investigated.

Student Understandings

Students will develop an understanding and appreciation of Earth materials—soils, rocks, and minerals. An understanding of erosion assists students in relating to the landforms around them. Knowing the components of the atmosphere and hydrosphere helps students to begin to realize the components required to sustain human life, as well as the life of all plants and animals on Earth.

Guiding Questions

1. Can students describe the processes they would use to identify the materials contained in the soil?
2. Can students identify and demonstrate some ways to classify rocks and minerals of Earth?
3. Can students describe some common uses of rocks and minerals?
4. Can students explain the economic value of common rocks and minerals?
5. Can students use a stream table representing the land to model destructive and constructive forces?
6. Can students explain how the forces of wind, ice, and water create erosion and model each type of erosion?
7. Can students explain when erosion could be a beneficial event?
8. Can students explain how the atmosphere and the hydrosphere differ?
9. Can students identify evidence that natural events have happened on Earth for a long period of time?
10. Can students communicate the differences in atmospheric components between Earth and other planets?
11. Can students generalize that the components of Earth's atmosphere make it

uniquely able to support life as we know it?

Unit 6 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry 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 Earth and the Atmosphere unit.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through 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)
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)
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)
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)
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)
39.	Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)

Earth and Space Science	
30.	Identify organic and inorganic matter in soil samples with the aid of a hand lens or microscope (ESS-M-A4)
31.	Identify common rocks and minerals and explain their uses and economic significance (ESS-M-A5)
32.	Demonstrate the results of constructive and destructive forces using models or illustrations (ESS-M-A7)
33.	Identify the processes that prevent or cause erosion (ESS-M-A7)
34.	Identify the components of the hydrosphere (ESS-M-A11)
35.	Identify the atmosphere as a mixture of gases, water vapor, and particulate matter (ESS-M-A11)
38.	Estimate the range of time over which natural events occur (e.g., lightning in seconds, mountain formation over millions of years) (ESS-M-B3)
43.	Describe the characteristics of the inner and outer planets (ESS-M-C2)

Sample Activities

Activity 1: Soil (SI GLEs: 6, 7, 10, 22, 23, 29; ESS GLE: 30)

Materials List: soil samples from three different areas, liter-sized jars or containers, 250 mL graduated cylinder, stocking, 2 liter plastic bottle, scissors (to cut the 2L bottle), container to capture water, disposable gloves, toothpicks, hand lenses, insect viewers, white poster board, paper towels, snack-sized plastic bags, tweezers, toothpicks, plastic tray, Soil Savvy BLM, science learning logs, flex cam (if available), scope-on-a-rope, student microscope and/or a stereo microscope

Safety Note: Remind students of safety procedures for handling soil or have them refer to the safety posters they created in Unit 1 and determine safety procedures they should follow.

In this lesson, students will observe and identify the organic and inorganic components of soil. Introduce students to the lesson by showing them liter-sized jars of different types of soil. (Try to include soil from at least three different areas that show distinctive color differences.) Ask students to look at the samples and describe similarities and differences based on sight only and then to hypothesize what makes the soil different colors. Ask students if they can identify the components of soil, and which ones are responsible for the different colors of the soils.

To assess prior knowledge and prepare students for this unit, provide students with the Soil Savvy BLM *anticipation guide* ([view literacy strategy descriptions](#)). Anticipation guides present students with statements that can be answered “yes/no,” “agree/disagree,” or “true/false” and are written in such a way that will grab students’ attention, challenge preconceived and naïve notions, or arouse curiosity. More importantly, since they are

given before students are provided with information, they are useful in assessing prior knowledge and misconceptions about the topic about to be studied. Ask students to look at each statement using the required response option. After individual students initially respond to the statements, have them find a partner and share their responses. Gather responses from students. Tell students that as they view the soil samples in this activity, they should try to determine whether their initial responses to each statement are supported by their observations or if they need to be changed.

Provide each group of students with snack-size plastic bag samples of soil from a number of different areas, a plastic tray or white piece of poster board, tweezers, toothpicks, a hand lens, insect viewer, and disposable gloves. Tell students to pour one sample of soil at a time onto the tray to observe. Students should use the tweezers or toothpicks, hand lens, and insect viewers to determine items in each soil sample. Introduce the terms *organic* and *inorganic* to students and explain what they mean. Organic materials can include twigs, leaf litter, plant roots, fungi, and bacteria, insects and other macro-invertebrates, excrement from these organisms, feathers, animal bones and/or shells. Inorganic materials can include trash items from humans such as plastic, glass, or aluminum as well as minerals such as rocks, silt, gravel, clay, or sand. (Students should be made aware that minerals and organic materials are actual components of soil; whereas, trash items are often found in soil, but are not actual components.)

Students should then sort the materials into two categories—organic and inorganic materials—and create a chart in their science *learning logs* ([view literacy strategy descriptions](#)) to record their observations. Science *learning logs* are journals created and used by students to record written and visual observations, make predictions, record new understandings, explain science processes, pose and solve problems, and reflect on what has been learned. Students should then take a closer look at the inorganic materials and further classify these materials into groups that share similar properties. Repeat the classification process with organic materials.

Have students observe soil samples under a flex cam, scope-on-a-rope student microscope, or stereomicroscope, if available, to identify smaller, less noticeable materials. Students should identify objects that were not visible when viewed with the naked eye or the hand lens, but visible with the microscopes. Have students compare what they are able to see with their eyes, a hand lens, and a microscope and explain how this technology can expand the senses, and contribute to the increase and/or modification of scientific knowledge. Students should be able to describe what an inorganic soil and an organic soil look like and then explain why they are classified differently. Students should be able to determine the difference between description and explanation when talking about scientific investigations. When they describe the components of the soil, they are using one process skill, and when they use their description to explain the difference between organic and inorganic soils, they are using a different process skill. All observations should be recorded in their science *learning logs*.

To demonstrate the components of water and air in soil, fill one container with 200 ml of dry soil. Have students gather around and watch closely as you pour 150 ml water into

the container, on top of the soil. Students should notice bubbling coming up through the soil, indicating that air is being replaced with the water. Next, prepare a filter by cutting the top and bottom from a 2 liter plastic bottle, and securely taping part of a stocking to the bottom to allow the water to pass through. Add 250 mL of soil to the bottle and slowly pour 250 ml water through the soil. Capture the water below in a container and measure its amount. Compare this amount to what was poured through the soil. Students should notice that some of the water was retained in the soil. Explain to students that the water that is in the soil adheres to the surface area of the earth materials and is used by organisms living in the soil, such as small insects and plants.

After comparing various soil samples, students should revisit the *anticipation guide* to correct any initial responses and provide information to support or refute each statement.

Activity 2: Rocks and Minerals (SI GLEs: 3, 7, 11, 21, 22, 23; ESS GLE: 31)

Materials List: (for each group of 3-4 students) unglazed white tile; iron nail; sample of quartz mineral; penny; sample minerals to test; samples of igneous, sedimentary, and metamorphic rocks; magnet; safety goggles; vinegar; eyedropper; paper towel piece of white paper; science learning logs; Mineral Identification Chart BLM; several rock and mineral identification books; trade book: *Dave's Down-to-Earth Rock Shop* by Stuart J. Murphy

Safety Note: Have students identify safety procedures for handling sharp objects and chemicals such as acids, using the safety posters created at the beginning of the school year.

In this activity, students will investigate the characteristics of a mineral using some of the techniques that are actually used by scientists. Provide students with a penny, nail, unglazed white tile, magnet, piece of white paper, and Mineral Identification Chart BLM.

Distribute samples of igneous, metamorphic, and sedimentary rocks from a rock kit or a collection to the group. The teacher should know the classification of each rock as the accuracy of groupings will need to be checked later. Using this collection of rocks, have the students classify them, using properties *they* choose. After they finish, ask what property they used to sort the rocks. Have them sort them using another property. Once students have had practice grouping rocks according to various “non-scientific” properties, introduce the scientific categories of *igneous*, *metamorphic*, and *sedimentary* rocks by having students read about them in their textbook or a trade book such as *Dave's Down-to-Earth Rock Shop* by Stuart J. Murphy. Then, help students regroup the rocks into these categories, using a dichotomous key such as the one found on The Rock Identification Key's website located at <http://www.rockhounds.com/rockshop/rockkey/> or the Sourcebook for Teaching Science Dichotomous Key, located at http://www.csun.edu/~vceed002/geoscience/geology/key/dichotomous_key.html. Direct students to carefully examine each group of rocks and describe observations that make each group different from the other two (e.g., size and/or presence of crystals, difficulty

in separating grains of the rock, presence of fossils, etc.) Using a rock and mineral book, students should identify each rock sample and read about its particular properties.

Stress to students that there is no start or end to the rock cycle; rather, rocks are continually being changed through the forces of nature. If the students are unfamiliar with the rock cycle, give them time to research the three types of rocks and to discover how they are formed, where they are found, and what factors affect the rock cycle. There are many web sites that show the rock cycle such as <http://www.cotf.edu/ete/modules/mseese/earthsysflr/rock.html> or http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/earth_materials_structure/rock_cycle.html, as well as books, videos, and CDs.

Rocks are made of minerals. Minerals have physical properties and chemical compositions that either are fixed or vary within a limited range. A rock is often an aggregate of minerals. Minerals can be identified by specific properties such as streak color, hardness, reaction to weak acids, magnetic properties, and ability to conduct electricity. Minerals are scaled in hardness in a range of 1 to 10, with 1 being soft and 10 being hard. A common method of determining hardness is the “scratch test.” Fingernails have a hardness of 2.5, so if a mineral will scratch the fingernail, the mineral has a hardness that is greater than 2.5. If the fingernail can scratch the mineral, the mineral has a hardness that is less than 2.5. A penny has a hardness of 3, so if a mineral scratches the penny, it has a hardness that is greater than 3. A nail that does not scratch a mineral indicates the mineral is harder than 5.5.

Provide students with a set of minerals representative of the MOHS hardness scale. The MOHS hardness scale is used by scientists to determine the hardness of minerals in relationship to other common available minerals. It is based on a hardness scale of 1 to 10, with 1 being the softest (talc) and 10 being the hardest (diamond). A mineral’s “hardness” is the ability of one mineral to be scratched by or to scratch another mineral. Have students scratch all of the minerals with the fingernail and record the results. Next, have students attempt to scratch each mineral with a penny and a nail. Have students use each mineral to try and scratch the penny and other minerals. Provide each student with a piece of quartz, if possible, to use on the minerals. Its hardness is 7. Once students have performed the scratch test with all objects, they should use a magnifying lens to check for scratches. Results should be recorded on the Mineral Identification Chart BLM, along with a physical description of each mineral.

Have students perform the streak test to determine each mineral’s true color. Students should rub the mineral against an unglazed ceramic tile. The streak left on the tile is the rock’s true color. If there is no streak, the mineral is harder than the tile. Record the results of the streak test on the Mineral Identification Chart BLM.

To determine the presence of carbonates in a mineral, perform the acid test on each mineral. Have students identify the safety procedures for handling acids in a lab activity and explain their importance. (Students should use safety goggles and wear disposable gloves when handling acids.) Scrape the surface of the mineral with a nail and then with

an eyedropper, apply two or three drops of acetic acid (vinegar) on each sample. In the presence of carbonates, the acid will fizz. Record results on the Mineral Identification Chart BLM.

Use a magnet to test the magnetic property of each mineral and record the results on the Mineral Identification Chart BLM.

Provide students with a sample of a mineral that they have not previously tested and instruct them to examine the mineral and record the color and smell. Then, direct students to test it for hardness, magnetism, color streak, and reaction to vinegar. Students should record the results of testing on their Mineral Identification Chart BLM in the section labeled “Identification of Unknown Mineral”.

Encourage students to read books or search the Internet to find accurate information about the different properties of their mineral, then sketch and describe all its properties in their science *learning logs* ([view literacy strategy descriptions](#)). Students should explain the difference between the observations they made and the inferences they could draw based on these observations. Students should be able to identify the mineral based on the observations that were made and the information from their research.

Activity 3: Gifts from the Earth: How Rocks and Minerals are used by People (SI GLEs: 3, 19, 22, 39; ESS GLE: 31)

Materials List: Gifts From the Earth BLM, access to Internet and/or library resources, materials for creating individual displays or one group poster display

Ask students to *brainstorm* ([view literacy strategy descriptions](#)) some ways people use rocks and minerals. Brainstorming helps to activate what students already know about a topic. In the brainstorming session, include the use of rocks and minerals for building, medicine, food products, makeup, fertilizers, jewelry, road construction, photography, etc. (The Mineral Information Institute provides free materials about everyday minerals and can be accessed at <http://www.mii.org/>.) Record the students’ responses on the board. Encourage students to identify each rock and its uses when brainstorming. Then have students name specific rocks and minerals found in Louisiana and their economic uses (salt, sulfur, gypsum, coal, agate, etc.). Once again, these should be listed on the board. Allow students to select a common rock or mineral of Louisiana to research. Have each student identify and record information about rock or mineral such as locations where the object has been found, common uses of the rock/mineral, unusual uses of the rock/mineral, past and present technologies used to mine the object, and any other important information, using the Gifts from the Earth BLM. A map showing the parishes that mine these rocks and minerals can be found at <http://minerals.usgs.gov/minerals/pubs/state/2002/lastmyb02.pdf>. Accompanying the map is information about the quantity and value of the minerals that are mined.

Students should explain how these minerals/rocks have changed human lives. Have students use pictures from the Internet to prepare a visual display of the mineral/rock and examples of common uses. Individual visual displays can be created, or students can combine their pictures into a large poster titled “Gifts from the Earth.” Students should report what they have learned in class.

Activity 4: Landform Changes: Good or Bad? (SI GLEs: 7, 13, 14, 15, 19, 22, 23, 33; ESS GLEs: 32, 33, 38)

Materials List: pictures of landforms caused by weathering and erosion, stream table or large pan with hole drilled in one end, duct tape, soil, sand, and clay, metric ruler, bucket or large tub to collect water, blocks, ½ liter container, drinking straw, clay, sturdy piece of cardboard or flat piece of plywood, plant tray (can be used as the stream table), ring stand (for the water container), science *learning logs*

Safety Note: Review safety procedures for working with water and have students identify the safety posters created in Unit 1 that illustrate working with water.

Introduce the term *lithosphere* to students and explain that the lithosphere is the solid outer part of Earth consisting of the crust and upper mantle. Show students a diagram of the parts of Earth by using a poster or picture from a website such as <http://mediatheek.thinkquest.nl/~II125/en/fullstruct.htm>.

Ask students to name some landforms that are part of the lithosphere (mountains, volcanoes, hills, valleys, rivers, cliffs, beaches, deserts, etc.) and some natural events that can change the lithosphere (weathering, erosion, deposition from wind, water, and glacier ice flows). Explain to students that different forces act on the land, breaking down and moving loose bits of weathered rocks and soil great distances. These forces include wind, water, gravity, and ice. Many of the landforms we see such as the Grand Canyon, Table Top Mesa, U-shaped valleys, Rainbow Arch, and others are the result of these forces.

Show students several pictures of landforms that were created by a form of weathering and erosion. Ask students to explain how wind, water, or ice could have created each landform. Tape each picture to the board and record ideas underneath. Do not correct misconceptions at this point. Remind students how ice, wind, and water can break rocks into smaller fragments, or provide them with activities to demonstrate chemical and physical weathering. Note: DLESE is a website that offers many different types of activities, videos, lesson plans, case studies, and other teaching materials on science topics and can be accessed at <http://www.dlese.org/library/index.jsp>.

In this activity, students will model the effects of water-created erosion using a stream table or similar container, and determine what landform(s) is/are created as a result. They will also determine if the effects of erosion are always negative.

Working in cooperative groups, students will construct a landform model in a stream table. (If stream tables are not available, a large aluminum pan or plant tray in which a

hole has been drilled at one end to drain water works well. Place a piece of duct tape over the hole until the investigation begins.)

Place a mixture of 200 ml of sand, 200 ml of soil, and 100 ml of clay in the stream table. Place a mark 20 cm from the end opposite the hole. Lay a ruler across the pan at this 20 cm mark. Level the mixture with a paint stirrer or ruler into this marked area. The depth will be about 4 cm. Have the students discuss and predict what will happen to the mixture as a little water, more water, and a lot of water flows through it. Place the tray on a table so it extends over the edge. Place a tub below the table's edge to collect the run-off water. Raise the end with the mixture 10 cm by placing it on books or blocks. Prepare a half-liter of water to pour into a half-liter container (cottage cheese tub) with a hole near the bottom rim. Place one-half of a straw into the hole so that most of it is extending out of the container over the sand and secure it with clay. Lay a sturdy piece of wood or heavy cardboard across the upper end of the tray and set the container on it. This can be stabilized by a student. This container will introduce the water onto the stream table in a controlled manner. Prepare to pour the water into the container. Students should predict what will happen. Then pour the water. Students should record the results with an illustration in their science *learning log* ([view literacy strategy descriptions](#)). Introduce appropriate vocabulary as students describe a delta and/or alluvial fan that may form at the bottom of the stream table. (*A delta is a landform where the mouth of a river flows into an ocean, sea, desert, estuary, lake or another river. As the current slows, the sediment drops out of the water; building up a flat area of sediment and forming new land. Alluvial fans are fan-shaped deposits of water-transported material known as alluvium that often form where a fast-flowing stream flattens out.*)

Ask students if the creation of a delta or alluvial fan is a good or bad effect of weathering and erosion. (*The creation of a delta is usually a good effect because of the rich soil deposits left behind. The creation of an alluvial fan is not always beneficial because the soil deposited is often poorly sorted and more coarsely grained.*)

Increase the water to one liter and observe the differences. Force counts, so the water should be released at the same height to control this variable. After predicting what will happen, students should investigate and compare their predictions to what is observed. Students should complete a labeled sketch of each trial and write the results in paragraph form in their science *learning logs*. Have students evaluate the stream table model, identify problems in design, and make recommendations for improvement.

Ask students

- What aspect of weather would the increase in water represent? (*heavy rains*)
- What happened to the land through which the water flowed? (*It was eroded and the stream was made larger by the force of the moving water.*)
- Where did the eroded soil end up? (*at the end of the river*)
- What negative effect did the erosion cause? (*removal of soil from the banks of the river*)
- What, if any, positive effect did the erosion create? (*The creation of land at the end of the stream becomes a delta or alluvial fan.*)

- Is erosion always a negative event? Explain. (*When deposition of eroded materials creates new land, like a new beach or a fertile delta, the creation of the new land is a positive event. However, the area where the soil was removed experiences a negative effect.*)
- How long does it take for a delta to be created? (*thousands of years*) For a riverbank to be eroded? (*Depending on the velocity of the water and the material composing the river banks, they can be greatly eroded in hundreds of years or it may take thousands of years.*)
- Was the creation of the Mississippi River Delta good or bad for Louisiana? Explain. (*The Mississippi River Delta Basin encompasses more than a half-million acres in southern Louisiana. Of the 101,000 acres of low-lying land created from river deposits within the basin, about 60 percent is made of bayous, marshes, and other coastal wetlands. It was beneficial because it created a large area of rich, fertile land on which people could live. In addition, the coastal wetlands are a critical resource, providing habitats for a variety of birds, fish, and shellfish. Wetlands provide an important buffer zone, protecting the mainland against hurricane winds and storm surges.*)
- What modifications or changes could be made to this particular stream table model to better demonstrate erosion and deposition? How could this be improved?

Activity 5: Types of Erosion (SI GLEs: 4, 7, 15, 22, 23; ESS GLEs: 32, 33, 38)

Materials List: (for each group of four students) safety goggles, flat pan, shoebox lid or tray, flat piece of cardboard or tray, coarse and fine sand, modeling clay, shallow plastic cup or jar lid, 250 ml graduated cylinder with water, area in school yard with bare soil, handful of grass to cover bare soil, three ice cube trays, pebbles, newspaper, spoon, paper towels, science learning log, Sample Vocabulary Card BLM

Safety Note: Safety procedures should be reinforced before allowing students to perform the activities. Students should wear safety goggles to prevent wind-blown sand from getting into their eyes. Students should be reminded always to direct the blowing sand away from other students' faces. The teacher should closely monitor activities done in class using water. Students should immediately clean up any water spills to prevent accidents.

In addition to water-related weathering and erosion, other forces are at work moving weathered materials to new places. These forces include ice and wind. Students will perform the following explorations to demonstrate how wind, ice, and water weight can move weathered materials to new locations. These investigations are best completed outside, if at all possible. After group discussion, all observations and results should be recorded in their science *learning logs* ([view literacy strategy descriptions](#)).

As students learn new concepts about weathering and erosion, they have an opportunity to build new vocabulary. Have students use the *vocabulary card* literacy strategy ([view](#)

[literacy strategy descriptions](#)) to develop vocabulary competency. Provide students with the Sample Vocabulary Card BLM. It provides a sample of how students should construct their vocabulary cards. Have students create a vocabulary card for each new vocabulary word as it is encountered within the lesson. Students should place the targeted word in the middle of the card, and provide a definition of the word, characteristics or a description for the word, several examples and non-examples of the word, and an illustration. Have students add to their vocabulary cards as they encounter new vocabulary about weathering and erosion. Allow time for students to quiz each other with the vocabulary cards in preparation for tests and other class activities.

Sand dunes: To model how sand dunes form, have students place 150 mL of a mixture of coarse and fine sand in a pile at one side of a pan or tray. Place a 3 or 4 inch pencil-shaped roll of clay about 3 inches from the other side of the tray to provide a base for the sand to build up against. Blow the sand gently in the direction of the clay. Observe what happens. What will happen if you blow harder? What happens to the sand when you quit blowing? How does a sand dune form? How long do you think it takes for a sand dune to form? How long does it take for it to change form and move? (Help students see that sand dunes are created, moved, and destroyed more frequently than many other types of landform changes because the wind constantly blows and moves the sand that forms them.) Direct the students to record observations as illustrations and answer questions in their science *learning logs*.

Windblown deposits: Provide the following: newspaper, a mixture of coarse and fine sand particles in a shallow plastic cup or jar lid, shoebox lid or tray, safety goggles, and spoon. Place the box lid on the center of the paper. Place the container of sand inside the box lid near the center. Blow gently on the sand, then increase the strength of your breath until sand is being thrown from the lid onto the newspaper. Continue blowing for five to ten seconds at this rate. Examine the material on the paper by rubbing your finger over it. Do the same to the material trapped in the box lid. Record observations and answers to questions in science *learning logs*. Ask students

- What effect did your breath have on the sand in the jar? (*It moved the sand to a new location.*)
- What do you notice about the texture of the wind-blown sand versus the sand that stayed in the box lid? (*wind-blown sand was finer in texture*) the sand that stayed in the container? (*sand left in container was coarser and heavier*)
- What statement can you make about the materials carried by wind? (*Students should recognize that wind carries the lightest particles the farthest, while the heaviest particles drop out first.*)
- How do you think blowing sand can weather rocks and mountains? (*It acts like sandpaper, wearing away the rocks as the sand comes in contact with them.*)
- What new landforms are created as a result? (*Mountains are worn away or sculpted into mesas or arches. Sand dunes are created when the sand is deposited.*)
- Review the landform pictures (Activity 4) hanging on the board. Ask students which landforms could have been created by this type of weathering and erosion? What evidence suggests this?

- How many years do you think it would take for windblown sand to create landforms like these? (*thousands of years*)

Water weight erosion: Find a spot of bare dry ground. Use the graduated cylinder to pour about 250 ml of water on it. Repeat on the same spot, but this time, hold the graduated cylinder as high as possible. Observe and describe what happened when you poured your first 250 ml of water and the impact on the surface materials when you poured the second amount from a greater height. What changes were caused by the weight of water in various places on the Earth? Cover a new spot of bare dry ground with handfuls of loose grass. Repeat the same activity, then remove the loose grass and observe the surface of the ground. Record results in science *learning logs*. Ask the following:

- How did the grass affect the degree of water weight erosion?
- What statement can you make about how to prevent water weight erosion? (*plant ground cover to reduce erosion*)
- How can this information be used to help farmers protect the soil in which they plant crops? (*leave some plant material as soil cover after harvesting crops*)
- What landforms shown on the board could have been created by this type of weathering and erosion? What evidence suggests this?

Have students research Best Management Practices (BMPs) that farmers use to prevent soil erosion and explain how it works (*leaving the roots of some crops in the soil, planting crops that grow in different seasons to keep plant roots anchoring the soil at all times*). This should be recorded in their science *learning logs*.

Guide students to understand that soil erosion can take place within one growing season if extreme conditions exist, but typically becomes a problem over many years when BMPs are not utilized or when drought conditions exacerbate the situation. Scientists that study soil, known as agronomists, study soil conditions and their causes to solve problems, make decisions, and form new ideas about how to grow crops and preserve or improve the soil in which they grow. Many new BMPs such as reduced tillage, no tillage, and modified fertilizing methods have been developed as a result of increased knowledge about soil.

Glacial erosion: Freeze pebbles and water in one ice cube tray, sand and water in another tray, and only water in a third tray. Provide students with paper towels, a plastic tray or piece of cardboard, and some modeling clay. Explain to students that they will be investigating how glaciers cause weathering and erosion. Have each group create a mountain with smooth sides in the center of the tray, using the clay. Once mountains have been made, give each group an ice cube with no rocks or sand. Tell students to press the ice cube lightly on the flat surface of one side of the clay mountain. Students should move it up and down several times. Describe what happens to the clay and the ice. Then, draw a sketch of what is observed in science *learning logs*. (*clay should get wet with little change to the actual surface*) Next, give students an ice cube with sand embedded in it. Have students repeat the same process using a new section of the clay mountain. Have them describe what happens to the clay and the ice, then sketch and record observations.

(sand should create shallow cuts into the clay showing how its contact with the clay scratched the surface). Finally, provide students with an ice cube embedded with the pebbles. Students should repeat the process using a new section of the clay mountain. Relate this model to what occurs to the surface of the land when a glacier drags rock and other materials over it. *(deep grooves in the clay should be evident, showing how boulders and rocks remove underlying layers of soil as the ice moves them down the mountain)*

Ask students

- Which ice cube investigation most accurately represents glacial ice moving down a mountain? *(the ice cube with the pebbles)*
- How do rocks become embedded in glacial ice? *(The ice on the underside of the glacier is constantly melting and freezing as it moves down the mountain. When it freezes, rocks at the surface of the mountain become embedded in the ice and are carried down by the force of gravity.)*
- What force causes the ice to move down the mountain? *(gravity)*
- How is the underlying surface of the mountain changed by the moving rocks embedded in the ice? *(it is gouged out, leaving behind a rounded u-shaped valley)*
- Where are the rocks deposited as the ice cube “glacier” melts? *(at the bottom of the mountain or at the leading edge of the glacier)*
- What new landform is created by the rocks and dirt that are pushed ahead of the advancing glacier? *(moraines)*
- How long does it take for glacial activity to change the shape of landforms? *(thousands or millions of years)*

What new landforms can be created as a result of Earth materials being moved by glacial action? *(moraines, cirques, crevasses, horns, arêtes, hanging valleys, erratics, etc.)* Help students develop glacier vocabulary as you discuss different landforms by adding new vocabulary terms to their collection of *vocabulary cards*. Once students have mastered the vocabulary words, have them use appropriate vocabulary in all discussions about glacial activity.

Review with students the limitations of the models they used. Have students suggest ways to improve the models, and thus, the investigations. A key point in the discussion about the activities should include the understanding that the natural process of erosion works slowly but surely. In hundreds of thousands or even millions of years, erosion can wear away a mountain until it is level with the plain. Emphasize that the more people know about the causes and effects of erosion and the means of preventing erosion, the more people can do to stabilize a region. Guide students to understand that erosion processes can be studied by scientists in order to create BMPs that prevent or minimize the negative effects of erosion. Students should understand that scientific processes enable people to make decisions, solve problems, and form new ideas.

Activity 6: Weathering and Fossil Preservation (SI GLEs: 7, 15, 16, 22, 33; ESS GLE: 38)

Materials List: samples of trace, mold, and cast fossils; for each group: 3 disposable cups, clay, 3 sugar cubes, water, stirrer or spoon

Students should recall from Activities 2 and 3 the difference between sedimentary, igneous, and metamorphic rocks. Ask students what types of rocks *usually* contain fossils (*sedimentary rocks*). How are sedimentary rocks formed? (*Sediments removed by weathering from parent rocks are cemented together by pressure.*) How are fossils preserved in sedimentary rock? (*The organism dies and falls to the bottom of a water body or on land. Sediments being carried by wind or water are deposited on top of the dead organism and cover it. Over time, more and more sediments are deposited above the previous layers, compressing them. When this happens, the hard part of the organism remains to be fossilized and the soft part decomposes. Fossils in sedimentary layers are protected from the weathering processes and agents of erosion.*)

Show students samples of different types of fossils (mold, cast, and trace fossils). Have students discuss how fossils are formed, and then generate questions they would like to have answered about fossil formation. Tell students that they are going to perform an investigation to model how fossils in sedimentary rocks can be eroded and how they are sometimes preserved.

Provide each group with disposable cups, two balls of clay (approximately three centimeters in diameter), three sugar cubes, plastic spoons, and water. Working in pairs, instruct students to wrap a piece of clay tightly around one of the sugar cubes so that one half of it is covered with the clay. Next, wrap clay entirely around the second sugar cube and seal it tightly. The third sugar cube is not wrapped. Place all three sugar cubes into the cup filled with water. The sugar cubes represent an organism that has died and the clay represents sediments that surround it and turn it into rock. Stir the cubes in water (a simulation of water erosion) until the bare sugar cube is dissolved. Remove the other cubes from the water and examine the remains.

In science *learning logs* ([view literacy strategy descriptions](#)), have students record their findings about the conditions of the three sugar cubes, including both illustrations and written observations. Which organism (sugar cube) is better protected from weathering? Have students make inferences and comparisons as to how weathering and erosion affect the formation and destruction of fossils. (*Organisms that are completely covered by sediments are better preserved than organisms that are exposed to the elements of weathering. Organisms that are exposed to the elements that cause weathering are destroyed, i.e., the sugar cube that completely dissolved. The fossil that was protected from the elements, i.e., the sugar cube covered with clay representing a fossil that is buried deep enough to avoid weathering, was preserved.*) Have students estimate how long it takes for a fossils and sedimentary rock to form and how long it takes for weathering and erosion to expose it. (*Fossils are formed over millions of years and weathering and erosion can expose them gradually over thousands of years or very suddenly, depending on movement events or severe storms. A recent example of sudden*

exposure occurred in Texas at Canyon Lake Gorge, when a torrent of water from an overflowing lake sliced open the in 2002, exposing rock formations, fossils and even dinosaur footprints in just three days. Often when a storm reveals a fossil it is the last step in a process that has taken place over time.)

Student partners should judge the value of this investigation that is demonstrating weathering and fossil preservation. They should consider the following: What changes would improve this investigation? How is this example a good model of a fossil? How is it not a good model? What are the limitations of such a model?

Activity 7: The Evidence Speaks for Itself: Finding Examples of Weathering and Erosion from Long Ago (SI GLEs: 3, 16, 18, 22; ESS GLEs: 32, 33, 38)

Materials List: photographs of landforms created by erosion

Group students into pairs to locate pictures and information of landforms created by erosion activity, such as the Grand Canyon, Black Canyon of the Gunnison, Rainbow Bridge, Balancing Rock, Devil’s Tower, Bryce Canyon, Grand Tetons in Wyoming, Hanging Valley, Ice Fields Parkway, etc. Information and pictures can be gathered from encyclopedias, trade books, or an Internet site such as *Erosional Landforms* at <http://www.smate.wvu.edu/teched/geology/Erosion.html> and *Landforms* at <http://vathena.arc.nasa.gov/curric/land/landform/landform.html>. Once students have found evidence of weathering and erosion in the photos, have students research further to determine what force of nature created the landform and what happened to the weathered material. Students should gather information about the climate, geographical history, and current geography of the area to find evidence of wind, water, glacier, or other activities.

Each group will decide whether to make an accurate claim about how the landform was created or manufacture false evidence that tries to get students to believe otherwise. Tell students that they will represent a jury that is trying to decide if there is enough evidence to prove that examples of landforms were created by a certain type of weathering and/or erosion. Have each group offer their landform and true-or-false evidence to the “jury” (rest of the class). The “jury” should also be provided with accurate historical climate and/or geographical information (such as the presence of strong winds, fast-moving river, etc.) to aid them in judging the validity of the claims. Using this information and what they have learned about different types of erosion from Activities 4 and 5, jury members should make an informed decision about the evidence. Have jury members refute or agree with the evidence, justifying their choices. Then provide students with enough information to determine how each landform was really created. Ask students

- How does the study of certain landforms reveal clues to the history of Earth events? *(Rock layers contain clues about Earth’s past. When these clues are revealed through weathering and erosion of some landforms, it allows scientists an opportunity to study them and learn about organisms that lived and events that occurred at earlier times. Studying the layers of rocks that are revealed allows scientists to determine how long it took for certain landforms*

to be created.)

- How long do you think it took for the Mississippi Delta to be formed? What events helped to shape it? Did weathering and/or erosion have any part in its creation? (*at least 100 million years to be formed, weathering of rocks and soil along the river banks from Canada down to the Gulf of Mexico and erosion caused by moving water brought sediment that was deposited over time in several different lobes, creating the delta we see today*).
- Can you predict how long it probably took for each landform that was studied to be created? Explain your prediction.

Have students discuss differences of opinion and provide evidence to support them.

Teacher Note: In the interest of saving time, the teacher can locate photos and information about each landform for the students; then have students study the photos and read the information to create claims.

Activity 8: Modeling Destructive and Constructive Forces in Nature (SI GLEs: 1, 4, 7, 10, 12, 14, 15, 22, 25; ESS GLEs: 32, 38)

Materials List: clay, diagrams depicting three different types of earthquake faults, stiff piece of cardboard or plastic tray, Internet access, science learning logs

Many landforms are created or destroyed through the geological processes of earthquakes and volcanic eruptions. In this activity, students will model the different ways that earthquakes affect the landscape. Using books and/or an Internet source, such as the one found in the Resource section called *Earthquakes-the Rolling Earth*, students should research one type of earthquake movement and then create a 3-D clay model to demonstrate it. Students should generate a testable question about how this earthquake movement will affect the land around it. After students predict outcomes, have them conduct experiments to answer their question. A description of observations should be recorded in science *learning logs* ([view literacy strategy descriptions](#)), and an explanation of experimental results should be developed and shared with classmates.

Have students compare and critique each others' scientific investigations, identifying similarities and differences in design and outcomes. Students should draw and label a before-and-after picture of each landscape, and then describe the actions that changed it and explain how the new landform was created, if applicable. Have students use evidence from the investigation to predict what will happen to land that is having a particular type of earthquake.

Ask students to estimate how long it takes for an earthquake event to occur. (*This energy can be built up and stored for many years and then released in seconds or minutes.*) Have students evaluate the models they created and suggest ways to improve them. Discuss with students the benefits of designing investigations and using models to study the effects of earthquakes. Students should recognize that a very important aspect of

scientific investigations is the use of processes that are logically designed and flexible, and that these investigations many times lead to solutions to problems.

To illustrate this important concept, and if available, show students the segment from EnviroTacklebox's video, Module 4: *Forces in the Environment: The Earth: Work in Progress*. The series is in many school libraries and is also available through Louisiana Public Broadcasting's Cyberchannel site at <http://www.lpb.org/education/cyberchannel.cfm>. (This is a subscription-based service; check with your administration to see if it is available in your school district.) Segments of the video illustrate the equipment and models developed by scientists to understand how earthquakes occur and how different types of earthquakes damage or destroy buildings. Through investigation and modeling, scientists have been able to design earthquake-proof buildings and have developed advance warning systems to signal imminent quake activity. You may also use any other video that shows how scientists use models and tools to understand the effects of earthquake activity.

Activity 9: Atmosphere and Hydrosphere (SI GLEs: 3, 11, 19; ESS GLEs: 34, 35)

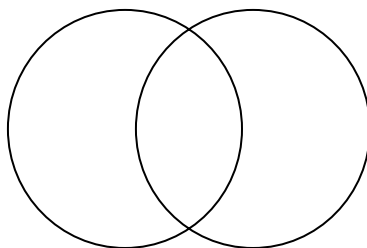
Materials List: Internet access, resource books, poster paper, science learning logs

Students have been investigating the lithosphere, one of the five major spheres of Earth, and the forces of nature that act to change it. In this activity, students will now explore two more spheres, the hydrosphere and the atmosphere, in order to identify the major components of each.

Have students conduct research using the Internet and other resources to gather information and statistics about the composition of the atmosphere and the components of the hydrosphere (bodies of fresh and salt water), using a site such as Vision Learning, available at http://www.visionlearning.com/library/module_viewer.php?mid=107 or Geography4Kids, available at http://www.geography4kids.com/files/water_intro.html. Have students generate a two-circle Venn diagram on a large sheet of poster paper or the board, depicting their findings. Students should also copy circle graphs into their science *learning logs* ([view literacy strategy descriptions](#)). Have students use the Venn diagram to compare and contrast the components of each.

Atmosphere

Hydrosphere

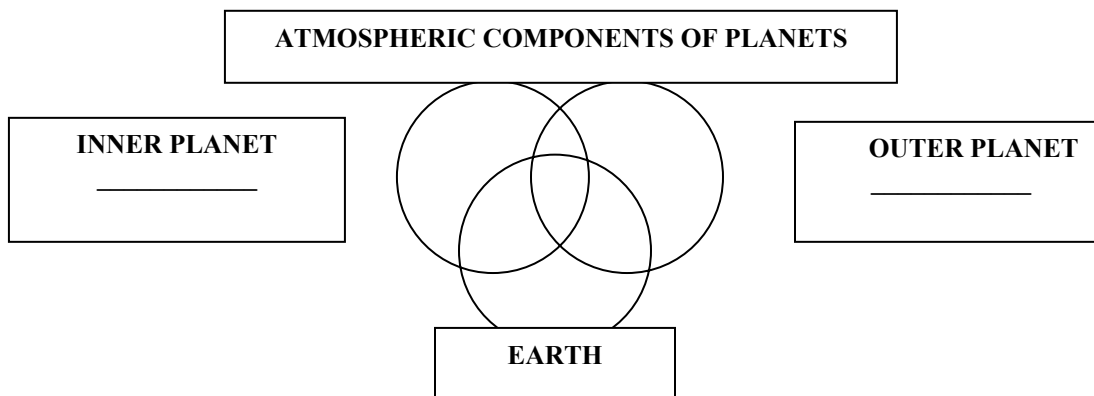


Activity 10: Atmospheric Comparisons (SI GLEs: 3, 11, 16, 19; ESS GLEs: 35, 43)

Materials List: trade books about the planets, magazine resources, Internet access, science learning logs

Earth has a unique combination of just the right components of atmosphere, lithosphere, biosphere, and hydrosphere to support life as we know it. It is a balancing act that creates just the right environment for all of the life forms with which we are familiar. In this activity, students will compare the atmospheric components of other planets in our solar system with Earth's to identify which components responsible for life on Earth are missing on other planets.

Have students use astronomy trade books about the planets, magazines, or the Internet to gather information about the atmosphere of each of the inner planets and the outer planets. Assign each group one inner planet other than Earth, one outer planet, and Earth to compare. Students should use the information gathered about Earth's atmosphere from Activity 9 to complete the comparisons. Each group should use the *graphic organizer* literacy strategy ([view literacy strategy descriptions](#)) to create a three-circle Venn diagram in their science *learning logs* ([view literacy strategy descriptions](#)) that shows the components of each planet's atmosphere; then write a paragraph explaining what Earth has (if anything) that is missing from the other two planets.



After all groups have completed their Venn diagrams and paragraphs, have each group share them with the rest of the class. Have students generalize which components of Earth's atmosphere are more or less abundant than those of the other two planets, and/or which components make Earth's atmosphere unique.

Have students hypothesize what would happen to life on Earth if one of the components of Earth's atmosphere were to disappear or increase/decrease dramatically. Students should justify their opinions with facts about the altered component. Provide students with one of the following SPAWN prompts ([view literacy strategy descriptions](#)) for W: What If?

- What if all of the oxygen that was present in the atmosphere suddenly started to disappear? What effect would it have on plants, animals, and people? How soon would the effects begin to take place? What would we need to do to replenish the

oxygen?

- What if nitrogen which makes up such a large percent of Earth’s atmosphere suddenly disappeared? What organisms would be affected first? Why?

The writing prompted by SPAWN is typically short in length and can be kept in students’ science *learning logs*. Allow students to write their responses within a reasonable amount of time. Ask students to copy the prompt in their science *learning logs* before writing responses and record the date.

Activity 11: Water, Water Everywhere, But How Much to Drink? (SI GLEs: 16, 22; ESS GLE: 34)

Materials List: map of the world, 1,000 ml graduated cylinder, 25 ml graduated cylinder, 10 mL graduated cylinder, eyedropper, labels, clear plastic cups, water

Through a visual presentation, the students will learn the sources of fresh water and the relative ratios of these water sources on Earth and be able to conclude just how little drinking water we have on Earth.

- Show the students the map of the world or the globe. Ask them what the color blue represents (*water*). Ask them what percentage of the globe/Earth is covered in water (*approximately 72 percent*) and if it is all usable by humans.
- Show the students 1,000 ml of water in a clear graduated cylinder. Explain that the water in the graduated cylinder represents all the water on Earth. Ask the students to think about the different places that we find water. Ask where we find the majority of the water on Earth (*approximately 97 percent is found in oceans*). Tell them that because the majority of the water is in the ocean, we will leave that water in the graduated cylinder. Tell the students that you will be removing all water that is from a source other than the ocean.
- Ask the students to tell you the different areas/sources in which we find water (*rivers, glaciers, atmosphere, etc.*). As they give you answers, remove the correct amount of water for the area (refer to the chart below), and place each amount into its own small clear labeled container.

Water Source (% total)	Representation Amount
oceans (97.2%)	water remaining in the pitcher
icecaps/glaciers (2.0%)	20 ml
groundwater (0.620%)	6 ml
freshwater lakes (0.009%)	9 drops
inland seas/salt lakes (0.008%)	8 drops
atmosphere (0.001%)	one drop
rivers (0.0001%)	one flick

- After you have removed all the different water sources (other than oceans), ask the students if all the water you have removed and put into the clear container is usable by humans. Discuss the sources, and put the water back into the pitcher with the oceans if it is not usable by humans.

(icecaps/glaciers, some of the groundwater, inland seas/salt lakes, and the atmosphere).

- Show the students the small amount of water that is available for humans to use.
- Have students use the observations from the investigation to infer how much water is available for people and animals on Earth.
- Review the sources of fresh water on Earth and how little water is available for human use. Have students write an essay on ways they can conserve water in their homes, schools, and communities.

Sample Assessments

General Guidelines

Assessment will be from 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 utilized 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 use the list of organic and inorganic material found in different soil types to infer what events in nature or by humans would have resulted in the presence of each.
- The student will create a flow chart for the rock cycle.
- The student will research a local river and report on how it has affected the surrounding area.
- The student will create a model of a glacier and demonstrate how it affects the surrounding landscape.
- The student will create a Venn diagram for comparing and contrasting a mountain and a volcano.
- The student will make a graph illustrating different water sources and the amount of water stored in each.

- The student will create power point presentations showing what they have learned about different types of rocks (igneous, metamorphic, and sedimentary), the steps of fossil formation, or properties of minerals. Share these presentations with the class.
- The student will create rubrics that assess the student's ability to interpret correctly the models they have made to demonstrate erosion.

Activity-Specific Assessments

- Activity 2: The student will demonstrate understanding of mineral characteristics by accurately performing the scratch test, streak test, and other mineral tests. Set up several stations and allow students to rotate through the stations, demonstrating their ability to perform required tests on minerals.
- Activity 3: The student will write an explanation of how life would change if rocks could not be mined for use by people. In their explanation, students will identify only one important use of rocks and how their unavailability would affect people's lives.
- Activity 7: The student will observe landform pictures and determine how each was formed, using historical climate and geographic information provided by the teacher. Students will then write an explanation that describes how the landform was created and include a justification for their beliefs.

Resources

Books

- Farndon, John. *How the Earth Works*.
- Knick, Clifford. *Incredible Earth*.
- Mogil, H. Michael, & Levine, Barbara G. *The Amateur Meteorologist*.
- Tohman, Marvin. *Hands-on Earth Science Activities for Grades K-8*. Parker Publishing.
- Van Cleave, Janice. *Earth Science for Every Kid*.
- Walker, Colin. *Saving Our Earth*.
- *Weather: An Explore Your World Handbook from Discovery Channel*. (1999). Random House.

Video

- Envirotacklebox: Module 4: *Forces in the Environment: The Earth: Work in Progress*. Available online at LPB's paid Discovery streaming website, www.lpb.org/education/cyberchannel.cfm

Websites

- *Soil Science Education Homepage* available online at <http://soil.gsfc.nasa.gov/>
- *Rocky, the Rock Hound*. Available online at <http://www.fi.edu/fellows/payton/rocks/>
- *Science of the Earth System: Atmospheric Composition*. Available online at <http://science.hq.nasa.gov/earth-sun/science/atmosphere.html>
- *Science of the Earth System: Water and the Energy Cycle*. Available online at <http://www.earth.nasa.gov/science/water.html>
- *Water Science for Schools: Earth's Water*. Available online at <http://ga.water.usgs.gov/edu/mearth.html>
- *Mining Resources by State* through the Mine Safety and Health Administration, available online at <http://www.msha.gov/KIDS/MRHP.HTM>
- *Erosional Landforms*: Includes pictures of landforms that were created due to erosional activity. Available online at the following website: <http://www.smate.wvu.edu/teched/geology/Erosion.html>
- *Earthquakes and Volcanic Eruptions*: A list of all known major Holocene eruptions can be obtained by visiting the Global Volcanism Program at the following website: www.volcano.si.edu/world
- *Earthquakes—the Rolling Earth*: Diagrams and explanations of the plate movements that cause different kinds of earthquakes. Available online at http://volcano.und.edu/vwdocs/vwlessons/lessons/Rolling_earth/Rolling_earth1.html
- *Healthy Water, Healthy People*. Teacher guides that provide classroom activities and information on additional resources on water quality. <http://www.projectwet.org/hwhp/resources.html>
- *StarDate Online/Solar System Guide*: Provides an explanation about the composition of the core and atmosphere of the inner and outer planets <http://stardate.org/resources/ssguide/>
- *VisionLearning: Earth's Atmosphere*. Information about the components of the atmosphere on Earth that cause the climates we experience. Available online at http://www.visionlearning.com/library/module_viewer.php?mid=107
- *Geography4Kids*: Provides information, pictures, diagrams, and explanations on the hydrosphere, atmosphere, lithosphere, and biosphere in easy-to-understand language. Available online at http://www.geography4kids.com/files/water_intro.html

Teacher Resource Guides

- *Project Aquatic Wild* by Western Regional Environmental Education Council.
- *Rocks and Minerals*, Discovery Channel Science Collection CD-ROM.
- *Project Earth Science: Geology*, an NSTA Press Book, available through NSTA's website.

Grade 5
Science
Unit 7: Cycles and Climates

Time Frame: Approximately 5 weeks



Unit Description

Adding to content from past units, activities in this unit will examine many of Earth's continuous cycles, including the study of climate zones and an introduction to the use of weather maps.

Student Understandings

Students will develop an understanding that different cycles operate in the environment and that cycles are continuous and repetitive. Students will be able to explain how matter can be changed in a cycle or a recycling process from one form into another and why all organisms on Earth are dependent on these cycles. They should be able to summarize how the hydrologic (water) cycle influences world climates and how our increased understanding of weather and climate improves the lives of people.

Guiding Questions

1. Can students describe how the processes of the hydrologic (water) cycle interact with one another?
2. Can students identify the processes in the hydrologic cycle that are affected by the Sun?
3. Can students describe different natural Earth cycles such as the carbon cycle, hydrologic cycle, nitrogen cycle, etc.?
4. Can students identify, describe, and compare the major climate zones?
5. Can students read a weather map?
6. Can students explain how progress in weather technology has improved the lives of people?

Unit 7 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
Science as Inquiry	
<i>Note: The following Science as Inquiry 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 and Climates unit.</i>	
1.	Generate testable questions about objects, organisms, and events that can be answered through 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)
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)
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 to represent the natural world (SI-M-A5)
16.	Use evidence to make inferences and predict trends (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)
20.	Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7)
21.	Distinguish between observations and inferences (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)
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)
33.	Evaluate models, identify problems in design, and recommendations for improvement (SI-M-B4)
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)
Physical Science	
5.	Describe the properties and behavior of water in its solid, liquid, and gaseous phases (states) (PS-M-A5)
12.	Identify the Sun as Earth’s primary energy source and give examples (e.g., photosynthesis, water cycle) to support that conclusion (PS-M-C3)
Earth and Space Science	
36.	Identify, describe, and compare climate zones (e.g., polar, temperate, tropical) (ESS-M-A11)
37.	Identify typical weather map symbols and the type of weather they represent (ESS-M-A12)
38.	Estimate the range over which natural events occur (e.g., lightning in seconds, mountain formation over millions of years) (ESS-M-B3)
39.	Identify the physical characteristics of the Sun (ESS-M-C1)
46.	Identify and explain the interaction of the processes of the water cycle (ESS-M-C6) (ESS-M-A10)
Science and the Environment	
49.	Identify and give examples of pollutants found in water, air, and soil (Se-M-A3)
50.	Describe the consequences of several types of human activities on local ecosystems (e.g., polluting streams, regulating hunting, introducing nonnative species) (SE-M-A4)
51.	Describe naturally occurring cycles and identify where they are found (e.g., carbon, nitrogen, water, oxygen) (SE-M-A7)

Sample Activities

Activity 1: Round and Round It Goes! (SI GLEs: 10, 18, 37; SE GLE: 51)

Materials List: pictures or diagrams of life cycles of frogs and butterflies; diagrams of the water cycle, the rock cycle, and seed to plant cycle, etc.; sections from a newspaper; rolling pin; large section of window screening; whisk or blender; bucket or large bowl; art materials for creating diagrams of natural cycles

This lesson will act as an initial assessment of the students’ background knowledge of natural cycles. Show pictures of different cycles found in nature, such as the life cycle of a frog or butterfly, the water cycle, rock cycle, lunar cycle, and plant cycle. Have students describe what happens in each step of the illustrated cycle, and then have them explain what makes each of them a cycle. Use their explanations to write a definition of a natural cycle on the board. (Be sure to include only those suggestions that fit the definition of a natural cycle.) Have students generate additional cycles and list them on the board along

with the cycles shown in the pictures. Students should critique their own suggestions and determine if they match the criteria of a complete cycle.

Then ask students to look at the following list of cycles to determine if they fit the definition created earlier:

- seed to plant to seed
- food web
- aluminum can recycling
- four seasons
- paper/newspaper recycling
- night/day
- glass bottle recycling
- life cycle of an insect or animal not used in the introduction

Ask students to identify the cycles that are man-made. Ask how they are similar to and different from natural cycles.

Use a website such as <http://www.talkabouttrees.org/acts/p16.html> or http://www.ecokids.ca/pub/fun_n_games/printables/activities/assets/science_nature/paper_making.pdf or a book to find directions for making recycled paper. Have students follow the directions to create the recycled paper. Then ask

- How is this cycle like a natural cycle? How is it different?
- What is the benefit of recycling paper? What is the benefit of recycling water?
- What other objects or items in nature are beneficial to recycle?
- How is the life cycle of an organism similar to recycling paper, aluminum, or glass? How is it different?

Have students choose a natural cycle to illustrate creatively and present to the class. Ask students why cycles in nature are important. (*Cycles allow materials to be used over and over again, which allows life to continue.*) Have students identify cycles from the list above and/or suggest new ones that reuse materials found on Earth. Have other students identify faulty reasoning and any statements that misinterpret or are not supported by the definition of a cycle.

Summarize the lesson by guiding students to understand that there is a continual cycling and recycling of materials in the environment such as the nutrients and minerals in plants and animals, carbon, nitrogen, and water. Emphasize to them that there is a finite amount of matter on Earth, which is used over and over again. This recycling of materials allows life on Earth to continue.

Activity 2: Water Cycle Interaction (SI GLEs: 1, 15, 22, 23, 33; PS GLEs: 5, 12, ESS GLE: 39, 46; SE GLE: 51)

Materials List: for each group: plastic shoe box or cardboard box covered with heavy-duty plastic wrap, a building medium such as Plaster of Paris, papier-mâché, or clay,

sealant (optional) or plastic wrap, ice cubes, resealable plastic sandwich bag, lamp with light bulb

Explain the activity to students and have them identify the safety concerns that should be considered when working with electricity and water. Have students identify the safety rule that should be followed and explain its importance. If safety posters from Unit 1 are still posted on the wall, students can refer to them in their discussion.

In this activity, students will build a model that demonstrates the water cycle, also known as the hydrologic cycle. Students should use information about the water cycle that was learned in Unit 2 to generate questions that can be tested with their models. One class model can be created or students can create individual models, depending on time and the availability of materials.

Students will need a closed box with a clear lid. This could be a plastic-lined cardboard box with clear plastic stretched over the top or a plastic box with a clear lid. Instruct students to make a landform in the box, including a mountain at one end of the box that slopes into a lake or sea at the other end. Plaster of Paris, papier-mâché, and clay are several mediums that work well for making the landform. Painting it with a sealer or covering it securely with clear plastic wrap should waterproof the landform. If using a sealer, it should be applied to the landform model in a well-ventilated area, preferably outside, as the fumes can be potentially toxic.

To continue, instruct students to put some water in the lake, and find a way to put a few ice cubes at the other end, over the mountain on top of the clear plastic cover. A resealable plastic sandwich bag should be used to contain the ice. This bag of ice will act as the cold air mass in the upper atmosphere. Students will need to include a warm Sun. The Sun could be a lamp, with the bulb positioned near the lake end, near the plastic cover. Once the model is ready, encourage students to be patient for a few minutes, and watch the rain come down on the mountain and flow down into the lake. If group models were created, students should share their models with others, and describe what's happening, step-by-step, through the water cycle. Have students identify the physical characteristics of the Sun that enable it to fuel the entire water cycle process. If not already known by students, introduce the term *hydrologic cycle* and explain to students that it is the scientific term for the water cycle. For the remainder of the activity, encourage students to correctly use the term "hydrologic cycle" when discussing the water cycle.

The importance of the Sun as the Earth's primary energy source and its importance in fueling the hydrologic cycle should be emphasized in explanations by students. Read a trade book about the Sun to students and ask them to identify the characteristics of the Sun that create and provide to Earth the energy needed to fuel the hydrologic cycle. Students should understand that without the Sun, there would be no water cycle on Earth and that the hydrologic cycle is the world's largest recycling operation. Have students hypothesize some events that could happen that would change the model's weather pattern (such as larger cold air masses coming in contact with evaporating water or less

water being available to evaporate) and then set up an experiment to check their hypothesis. Have students critique the hydrologic cycle model they created to identify any limitations it poses in representing the natural world and make suggestions for improving it. Allow students time to improve upon their model if time allows.

Activity 3: Go Flow (SI GLEs: 14, 18, 19; PS GLEs: 5, 12; ESS GLEs: 46)

Materials List: pictures drawn by students of different stages of hydrologic cycle, plants, land scenes, individual water drops, large sheets of drawing paper, lamp with light bulb, Round and Round I Go! BLM, learning logs

Prior to beginning this activity, remind students of appropriate behavior when moving around the room, to minimize injuries.

This is an interactive lesson in which the students act out the hydrologic cycle. Students should draw pictures of the parts of this cycle on large poster boards and label them or locate appropriate pictures from the Internet to use. Included in their drawings/photos should be several bodies of water (e.g., puddles, oceans, streams, rivers, lakes, aquifers), land scenes (e.g., mountain, desert, rainforest, farmland, underground pictures, etc.), clouds, plant types (e.g., trees, bushes, grasses, soft stemmed plants, etc.), to allow students choices when making their moves from one station to another. Place the drawings around the room and instruct one student to stand next to each picture, while holding a picture of an accurately drawn large water molecule. Show students the lamp and ask them what it represents (*the Sun*). Ask students to explain the importance of the Sun in the water cycle (*It provides the energy that is absorbed by Earth and reradiated back. This energy fuels the hydrologic cycle and without it, there would be no hydrologic cycle or even life on Earth*). Remind students of the previous activity where they built a water cycle model and used the lamp (Sun) to fuel it. On your signal, turn on a lamp and have them move to a new picture that shows a possible way that water can move in the cycle. Have each person explain what happened to bring him/her to the new step in the cycle. Ask students to identify the change in phase that water molecules go through as they move through the cycle. Emphasize to students that each water molecule itself does not change its shape or composition. Instead, the water molecules move closer together or farther apart as each phase occurs. If a move is made to a picture that does not make sense, have others in the group explain what is wrong with the move and suggest other more reasonable moves. After playing the game enough times to allow everyone a chance, ask students to write an explanation of the hydrologic cycle in their science *learning logs* ([view literacy strategy descriptions](#)). Science *learning logs* are journals created and used by students to record written and visual observations, make predictions, record new understandings, explain science processes, pose and solve problems, and reflect on what has been learned. Included in their explanation should be a labeled drawing or diagram of the hydrologic cycle. Students should be able to explain that water doesn't move in a circle, but travels in many directions as it evaporates, condenses, transpires, precipitates, infiltrates, etc. Students can also acquire information about the water cycle by accessing one of the following websites:

- *Round and Round It Goes! The Water Cycle*
<http://www.dnr.state.wi.us/org/caer/ce/ee/earth/groundwater/watercycle.htm>
- *United States Geological Survey*
<http://ga.water.usgs.gov/edu/watercycle.html>
- *Global Warming Kids Site: Water Cycle Model*
http://www.epa.gov/globalwarming/kids/water_cycle_version2.html

To demonstrate understanding of the interconnectedness of each part of the water cycle, have students respond to the following *RAFT* prompt ([view literacy strategy descriptions](#)):

- R (Role): A water molecule in one of the stages of the water cycle
A (Audience): Teacher and classmates
F (Format): Diary Entry
T (Topic): What is happening to them in the stage they have chosen and what happens to move them into another stage

Instruct students to select one of the stages in the water cycle as their role for the *RAFT* (evaporation, transpiration, condensation, precipitation, infiltration, and runoff). Students will write a diary entry about their experience as a water molecule in the selected stage and what happens to cause them to move into another part of the cycle. The importance of the Sun as Earth's primary energy source should be stressed in their diary entries. It should be scientifically accurate but written in an entertaining style. Provide students with the Round and Round I Go! BLM on which to record their diary entries.

Allow time for students to share their *RAFTs* with the class. Classmates should pay attention for inaccuracies in scientific statements made in the diary entries and identify them as each *RAFT* is read.

Activity 4: Other Important Earth Cycles (SI GLE: 38; ESS GLE: 38; SE GLE: 51)

Materials List: *Starting All Over Again* materials, Internet access

Prior to class, access the *Starting All Over Again* materials at <http://www.cfaitc.org/LessonPlans/pdf/402a.pdf>. Prepare student handouts with descriptions and diagrams for the nitrogen cycle and the carbon/oxygen cycle found in *Read All About It!* (also from the *Starting All Over Again* materials). Look carefully through all the material to find the needed handouts, as they are not in numerical order.

Explain to the students they will read about different cycles that occur in nature and examine diagrams that illustrate the cycles. They will use a method that will help them pick out the main points of the reading and share what they read with other students. Instruct each student to individually read the Nitrogen and the Nitrogen Cycle handout. Then instruct the students to do a think-pair-share activity. Think-pair-share is a quick

way to have student partners exchange their thoughts and ideas on a topic, or react to a new question. After the students have read the handout, have them think about it for a minute or two and then share their thoughts and ideas with a partner. As a class discussion, have students share their thoughts to summarize the important points of the nitrogen cycle.

Be sure to

- Identify the key organisms in the recycling of a molecule of nitrogen.
- Determine how raising various crops affect the nitrogen cycle.
- Discuss how fertilizer application affects the nitrogen cycle.
- Discuss how nitrogen can become a pollutant.
- Discuss the possibility of nitrogen pollutants being recycled into a usable form of nitrogen.
- Discuss the length of time that nitrogen takes to travel through the nitrogen cycle (*a biological cycle that is dependent on temperature, moisture, and available bacteria resources and can take from as little as 2-6 weeks in aquariums and ponds or much longer in nature for the cycle to be completed*).

Repeat the think-pair-share process for the carbon/oxygen cycle.

Class discussion questions for the carbon/oxygen cycle are

- What are three things you do that affect the carbon/oxygen cycle?
- How do large forest or grass fires affect the carbon/oxygen cycle?
- Suppose a farmer plants ten acres of pecan trees on desolate land. How might this affect the carbon/oxygen cycle?
- How long does it take for carbon and/or oxygen to cycle through the carbon/oxygen cycle? (*The geological carbon cycle operates on a time scale of millions of years, whereas the biological carbon cycle operates on a time scale of days to thousands of years. The oxygen cycle operates on a time scale of hours to days.*)

To summarize and expand upon what has been learned through the think-pair-share process, share an article about the “dead zone” in the Gulf of Mexico with the students. Several articles that explain the causes of the dead zone in the Gulf of Mexico are available online such as “*Gulf of Mexico: The Dead Zone*” available at http://www.americanrivers.org/site/PageServer?pagename=AMR_content_e345 or “*Hypoxia in the Gulf of Mexico*,” available online at <http://www.enviroliteracy.org/article.php/1128.html>. In addition, there are articles that investigate how different environmental and governmental groups are addressing the issue, including “*Study Finds Farm Runoff Feeds Dead Zone in Gulf of Mexico*,” available at <http://www.ewg.org/node/22580> or “*Limiting Dead Zones*,” available at <http://www.sciencenews.org/articles/20040612/bob9.asp>.

After reading the article, have students respond to the following questions previously addressed after reading about the nitrogen cycle:

- Determine how raising various crops affect the nitrogen cycle.
- Discuss how fertilizer application affects the nitrogen cycle.
- Discuss how nitrogen can become a pollutant.

Ask students to identify how scientists and other people are using knowledge about the causes of dead zones in their efforts to solve its associated problems.

Activity 5: Nature’s Cycles In Action: The Carbon Cycle and the Nitrogen Cycle (SI GLEs: 3, 4, 5, 20, 21, 22, 40; SE GLEs: 49, 50, 51)

Materials List: Internet access, diagrams of nitrogen and carbon cycles, poster board, markers, soil, water, decomposing plant matter, sterilized manure, disposable gloves, legumes, topsoil, fertilizer, soil and/or water test kit, containers for soil and/or water

Be sure that students discuss safety concerns about working with soil, manure, decomposing plant material, soil and water testing chemicals, etc. before beginning the first activity and determine proper safety procedures to follow to conduct the experiment.

To further investigate the carbon cycle and the nitrogen cycle, have students perform the following:

Part A: Carbon Cycle—(1-2 class periods)

Provide students with a diagram of the carbon cycle, such as the one found at the following website: *Carbon: the Element of Surprise*, <http://www.lpb.org/education/classroom/itv/envirotacklebox/modules/m5crbntrack.htm#fast> or an animated diagram, such as the one that can be found at the following website: *EPA Climate Change Kids Page: The Carbon Cycle Movie*, http://www.epa.gov/climatechange/kids/carbon_cycle_version2.html

Students should view the movie to learn about the carbon sinks on land, in the air, and in water. Students should use the diagrams to determine where the carbon sinks on Earth can be found. (A carbon sink is a place on Earth where carbon is stored in large quantities.) List the places on the board; then ask students to explain how each sink was created. Students may draw on material previously read at the beginning of the activity to form their explanations or use information found at one of the new websites. Instruct pairs of students to choose one carbon sink to research further. They should find out how it was formed, how carbon cycles through it and how fast it cycles. Student pairs should identify key vocabulary words for their carbon sink and use the *vocabulary card* strategy ([view literacy strategy descriptions](#)) to create vocabulary cards (refer to Unit 4, Activity 3 for an example of a card). Students should create cards for words such as *slow-track carbon recycling*, *fast-track carbon recycling*, *carbon sink*, *atmosphere*, *fossil fuel*, *deforestation*, *transpiration*, *respiration*, etc. Using the word “carbon sink,” for example, students would write the word in the middle of the card. In the left top corner of the card, students would write the definition of a carbon sink (*an area which traps and stores carbon*). On the top right of the card, students should describe characteristics of a carbon sink (*contains a large amount of carbon in the form of carbon dioxide or elemental carbon*). On the bottom left of the card, students can write examples of carbon sinks (*oceans, forests, and the atmosphere*). Finally, on the bottom right of the card, students can draw an illustration of a carbon sink (*an ocean, forest, or the atmosphere*).

Explain to students that carbon cycles through each sink and moves from one sink into another as part of the carbon cycle. Students should draw their carbon sink and share it with the rest of the class. Their sink should be the main emphasis in the drawing; however, it may be necessary to include one or more aspect of another sink to show how carbon enters a carbon sink or how it is released from it. (For example, when illustrating the atmosphere, students may need to include a drawing of how carbon from a factory is being released into the air, in addition to showing molecules of CO₂ floating in the atmosphere, along with oxygen molecules, nitrogen molecules, and other atmospheric components.) Have students explain how long carbon remains in each sink and identify if it is an example of fast track carbon cycling or slow track carbon cycling. Students should use the vocabulary words identified for their carbon sink in their explanation. Hang all drawings on the wall in front of the class. Once all students have shared their carbon sinks, have students use large poster board arrows to make connections between each other's sinks to illustrate how carbon cycles through different sinks. Vocabulary cards can be attached to the diagram to help other students understand the terms. Be sure that students identify whether each cycling process is a slow track or fast track cycle.

Additional information on the carbon cycle can be obtained from the video, *Carbon: Element of Surprise*, available through Louisiana Public Broadcasting's Instructional Television broadcast (viewing and taping dates can be found at <http://www.lpb.org/education/classroom/itv> and by video streaming from United Streaming, provided by LPB. Accompanying lessons can be found online at <http://www.lpb.org/education/classroom/itv/envirotacklebox/>.

Part B: Nitrogen Cycle (1 class period)

Students should review a diagram showing the nitrogen cycle and discuss how nitrogen moves through the atmosphere into the soil, how bacteria fix nitrogen for plant use, how plants utilize nitrogen, and how it is released back into the atmosphere and soil. Ask students to list different natural materials that provide nitrogen to the soil and water. Elicit from students sources from which nitrogen can be obtained, including decomposing plant material, animal waste, legumes, and fertilizers (man-made). Guide students to design an experiment that would help them determine which source provides the most nitrogen to the soil or water. Students could set up containers of equal amounts of soil or water and then use equal amounts of the nitrogen sources. If an actual experiment is performed, starting and ending levels of nitrogen in the soil or water should be determined using a soil or water testing kit that tests for nitrogen. Students should identify independent and dependent variables and controls needed to perform a viable experiment. Students need to write the steps that should be followed to test their hypothesis correctly. Students should perform the experiment, record results, and discuss outcomes. This activity will take at least two weeks to determine the outcomes. Ask students

- How have scientists used knowledge about the nitrogen cycle to improve crop production? (*Understanding the chemistry of nitrogen in soils and how nitrogen is "fixed" for plant use can help farmers supply sufficient nitrogen for crop needs.*)

- Which method of increasing nitrogen was most effective in the shortest amount of time? What observations were used to determine which soil or water sample had the greatest increase in nitrogen? (*Measurements of increases in nitrogen were observations.*) How can these results be used to help farmers improve crop production? Explain.
- What evidence in the water samples indicates an increase in nitrogen? (*increases in algae growth*) Students should understand that they are making an inference about increased nitrogen from the increase in algae. Actual measurements of the nitrogen levels are quantifiable observations.
- What effect does excess nitrogen have on algae growth in waterways? How have scientists used this knowledge to decrease pollution in waterways? (*Excess nitrogen increases algae growth in waterways, causing depleted oxygen supply for organisms with gills when the algae die and decompose. Increased algae blooms cloud the water and cause temperature increases which allow less oxygen to remain dissolved in water and decrease water quality. Scientists have created best management practices to be used to control excess nitrogen from entering water bodies.*)

Activity 6: Zones (SI GLEs: 3, 11, 13, 16, 19, 22; ESS GLE: 36)

Materials List: large world map, poster board, trade books about climate, Internet access, resource materials such as encyclopedias, optional multimedia presentation software, Climate Zone Investigation BLM

Outline and label the major climate zones on a large world map, including Tropical, Moderate, Dry, Continental, and Polar (or similar descriptions). Divide students into cooperative groups and assign each a climate zone to research, using various sources such as trade books, encyclopedias, and the Internet. Provide each group with a copy of the Climate Zone Investigation BLM and instruct them to only complete section 1 at this time. Research should include types of severe weather events that can be expected to occur in each zone, species of plants and animals, and typical precipitation amounts and temperature ranges. Identify greatest/least rainfall, highest/lowest recorded temperature, hurricane and/or tornado activity, dust storm occurrences, etc. Have students find photos of vegetation and animals of their area and include the information and photos on a poster. Provide students with the opportunity to view and study all posters. Then instruct each group to choose another climate zone from the posters created by classmates and use Section 2 of the Climate Zone Investigation BLM to complete a Venn diagram *graphic organizer* ([view literacy strategy descriptions](#)) with the two climate zones. Using information displayed in diagrams and posters, have students make inferences that suggest why weather events might differ in different climate zones and why plants and animals also differ in each zone. Have students create a large Venn diagram to display with posters when making inferences or create a multimedia presentation to illustrate what has been learned.

Activity 7: Climate Zones around the World (SI GLEs: 11, 16, 19; ESS GLE: 36)

Materials List: Taking A Closer Look at Climate Zones BLM; class comparison chart; atlases that have maps showing physical features, global wind patterns, ocean currents, and temperatures of different climate zones; available resources such as textbooks, encyclopedias, Internet

Using what was learned from Activity 6 about differences in the climates for each zone, have students hypothesize about what causes these differences. (*nearness to a water body, altitude, latitude, center of large land mass, ocean currents, wind patterns, etc.*) As students suggest possible causes for climate differences, list them on the board. Ask each group to gather further information about the climate zone previously researched to determine what factors affect its climate. Students should use textbooks, encyclopedias, or an Internet site such as <http://www.blueplanetbiomes.org/climate.htm> to identify each of the factors that affect their climate zone and include the information in the Taking a Closer Look at Climate Zones BLM. Have each group record what was learned about their climate zone on a class chart for comparison (see sample diagram below).

CLIMATE ZONES COMPARISON CHART

	TROPICAL	DRY	*MODERATE	*CONTINENTAL	POLAR
Latitude					
Altitude					
Distance from Ocean or Sea					
Predominant Landforms					
Ocean Currents Affecting Area					
Temperature Range					
Angle of Sunlight					
Average Precipitation					
Direction of Global Winds					

*Names of zones vary with references used. Substitute the zones in the chart with ones used in your research.

Once students have investigated and listed the factors that affect a certain zone’s climate, have them use the recorded data on their chart to infer and predict trends, using the prompts below:

- Does the location on Earth and the angle of sunlight affect temperature? (*direct sunlight is more intense than sunlight that hits Earth at a greater angle; therefore, sunlight is bent over a larger area near the poles causing lower temperatures than near the equator where the Sun hits the Earth more directly; also regions far from the ocean experience greater extremes of hot and cold weather, and may also be drier.*)

- How does temperature affect climate?
(temperature affects the amount of evaporation, transpiration, and precipitation that occurs)
- How does the size and shape of land (topography) affect climate? *(the temperature of air located in low and high altitudes and the direction and speed of winds created by temperature differences and land barriers are examples of how climate is affected by the land's shape; air masses that develop or are located at the center of a large land mass will have different characteristics than air masses close to water bodies)*
- How does a water body affect the climate of an area?
(water requires more energy to raise its temperature and takes longer than land to cool off once the temperature is raised, affecting the direction of the winds and the temperature of the air close to water bodies)
- How does an area's latitude affect the climate?
(areas closer to the equator receive more of the direct rays of the sun than areas closer to the poles, creating large global temperature differences)
- How does an area's altitude affect the climate?
(pressure and density of air molecules decrease as altitude increases; the temperature of the air becomes cooler as this occurs)
- How do ocean currents affect climate?
(Ocean currents are either warm or cold. Warm water currents also warm the air, creating a warmer, moist climate. Cool air does not hold as much water, resulting in cooler and drier climates.)
- How do global winds affect climate?
(global winds move weather from one area to another and are created by the uneven heating of the Earth's surface)
- Explain how the interaction of the hydrosphere, lithosphere, and atmosphere all affect the climate of an area.
(Have students synthesize information from each sphere to determine how each contributes to the climate of an area.)
- Which climate zones are most affected by water bodies? By latitude? By landforms? By altitude?

Activity 8: Weather Symbols (SI GLEs: 3, 19; ESS GLE: 37)

Materials List: 5"x7" unruled index cards, large U.S. map, weather maps from local newspapers or weather-related websites, variety of resources for learning about map symbols, double stick tape

Use weather maps from <http://www.weather.com/> or <http://www.nws.noaa.gov> or local newspapers. Make a class list of symbols that appear on the maps. Students will develop a set of meteorology flash cards by placing each map symbol and station model symbol on a separate card. Have students use a variety of resources to determine the meanings of the symbols. Students are to place the description on the back of the card with the appropriate symbol.

To evaluate student understanding, assign a particular city in the United States to each group and find the previous day's weather forecast for each. Students will be asked to illustrate a television station's forecast model by correctly using the symbols. Laminate a large U.S. map and students' weather symbol flash cards. Provide students with their assigned city's local forecast in paragraph form and have them use the double-stick tape to place the symbols on the map in order to illustrate the forecast. Have students determine if the correct symbols have been used.

Activity 9: Weather Watch (SI GLEs: 7, 13, 19, 22, 29, 39; ESS GLE: 37)

Materials List: previous day's weather forecast from local newspaper with weather symbols, U.S. map, weather symbols from Activity 8, five 8 ½" x 11" blank U.S. maps per group, Internet access, Danger: Severe Weather Warning! BLM

To understand further the concept of weather and weather forecasting, have students use the *Opinionnaire* strategy ([view literacy strategy descriptions](#)) to complete the Danger: Severe Weather Warning! BLM. This strategy is used as a tool for eliciting attitudes about a topic. Students will respond to several statements about the need for weather forecasting before reading about the hurricane that hit Galveston, Texas in 1900. After completing the questionnaire, have students discuss their responses, then save it until after the reading.

Ask students to identify the sources used by the general public to find out weather forecasts (e.g., watching the weather reports on television, looking at a newspaper, checking a weather website on the Internet). Discuss ways that weather was predicted before modern technology (weather folklore, observations of changes taking place in nature, animal behavioral changes, identifying patterns of weather that had been experienced over many years in an area). Ask students to identify the ways that were most and least effective in predicting severe weather (animal behavioral changes, changes in the clouds, temperature, and wind patterns).

Make students a copy of the local weather forecast from the previous day. Include a map of the country with weather symbols. Students should use what they learned about interpreting weather symbols from Activity 8 to interpret the map. Then have them compare the forecast to what is actually occurring with the weather. Instruct each group to choose one of the different types of sources mentioned above to obtain weather predictions. Provide students with four blank maps and instruct them to record the weather symbols each day for three days while they are comparing the forecast to what really happens. Students should sequentially line the first three maps up along a wall and use them to predict what will happen the next day. Direct students to use the fourth blank map to record their predictions by placing the weather symbols associated with the prediction on it. Check their predictions against what really occurs. Students can create their own interactive five-day weather forecast using skills just learned by accessing the Weather Channel Kids website at <http://www.theweatherchannelkids.com/>

Ask students

- What kinds of data does a weather report show?
- How closely did the predictions compare with what really happened on each day?
- What general weather pattern is indicated by the changing positions of the symbols?
- How do forecasts benefit people?
- How were forecasts used to warn people along the Gulf Coast and in Louisiana about the approaching Category 5 hurricane called “Katrina”?

Read pertinent portions of a news article about the hurricane that hit Galveston, Texas in 1900 with students, emphasizing the lack of modern technology to predict the path of the storm. A synopsis of the event can be found on NASA’s website at http://nasadaacs.eos.nasa.gov/articles/2006/2006_hurricanes.html or the Texas Almanac which provides complete documentation of this storm and can be accessed at <http://www.texasalmanac.com/history/highlights/storm/>. Have students revisit the Danger: Weather Warning BLM and change any opinions they now disagree with. Discuss with students how the outcome of the storm might have been different if modern methods of predicting storms were available to the citizens of Galveston.

- Discuss the technology used to predict Hurricanes Katrina and Rita and its success in helping thousands of people evacuate safely from the path of the storms. Ask students to predict how the outcome of the storm would have been different if no one knew that Katrina was approaching until it was too late to do anything.
- Ask students to describe some of the new technology in weather forecasting and how it has improved the forecasting of weather, especially severe weather such as hurricanes. Students can get information about this technology by accessing NASA’s Hurricane website at http://www.nasa.gov/mission_pages/hurricanes/features/technology_list.html

Activity 10: Predicting the Weather (SI GLEs: 3, 29, 30, 38, 39, 40)

Materials List: roll of white paper or butcher paper for creating timeline, Internet access or books about the history of weather-forecasting technology

Weather forecasting has progressed from use of human observation and primitive instruments to very sophisticated weather satellites, such as GOES. In this activity, students will learn about the progress in weather forecasting technology over the last 100 years and create a weather technology timeline.

Students can use trade books, magazines, textbooks, and the Internet to research the progress in weather-forecasting technology over the last 100 years. Divide students into two groups: “weather instruments” and “weather satellites.” Direct each student in the

“weather instrument” group to work independently to find information on the invention and use of one of the following: weather lore, clinometers, wind calculators, computers, weather balloons, ground stations, as well as weather instruments such as the barometer, anemometer, thermometer, hydrometer, rain gauge, hygrometer, etc. Each student in the “weather satellite” group should research one of the weather satellites launched by the United States: TIROS I-X Series, ESSA I-IX Series, NIMBUS I-IX Series, ITOS/NOAA Series, TIROS-N/NOAA Series, ATN/NOAA Series, ATS Series GOES I-M Series, and GOES Next Series.

Information on the satellites can be obtained by accessing NOAA’s or NASA’s websites (listed in the resource section) as well as from *The Florida EXPLORES! Weather Satellite Resource Guide*, <http://www.met.fsu.edu/explores/Guide/satguide.html>. After learning when each instrument was invented and first used, students in each group can use a software program such as Tom Snyder’s *Timeliner*[®] software or make a timeline on butcher paper to show the progress of weather forecasting. Students should include a picture of each satellite, as well as a brief description of the instrument’s capabilities and limitations. Each instrument/satellite should be arranged on the timeline to demonstrate how technological progress has improved weather forecasting.

Timelines should be posted and used to answer the following questions:

- How did people forecast weather 100 years ago? 50 years ago? 25 years ago? 10 years ago? The present time?
- What were some of the limitations of using weather instruments?
- During which time period did weather forecasting change the most? Why?
- What invention made the biggest difference in accuracy of weather forecasting? Why?
- What types of weather can weather satellites depict?
- What are some limitations of using weather satellites?
- What weather-related questions cannot be answered using present-day technology? Give reasons.
- What are some major weather-related events that were accurately predicted by using one or some of the researched technology?
- How did this prior knowledge affect the lives of people or the environment? Was the effect negative or positive?

Sample Assessments

General Guidelines

Assessment will be from teacher observation/checklist notes of students’ 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 utilized 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 their 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 will be provided the rubrics during task directions.

General Assessments

- The student will create a water cycle poem.
- The student will choose a zone and compare and contrast it to another zone in another hemisphere. Give as much information as possible.
- The student will bring weather maps from the newspaper and present a weather forecast using the weather map.
- The student will use the newspaper weather map to record weather patterns, then predict tomorrow's weather and graph the results.
- The student will identify one weather event that is specific to each climate zone and determine why it would occur there more often than in other places.
- The student will provide three weather forecasts and weather maps, and have other students match the correct forecast with the correct map.
- The student will write a story about a water drop's trip through the water cycle, using proper terms for each step of the cycle that the drop travels through.

Activity-Specific Assessments

- Activity 1: The student will be shown an example of an incomplete natural cycle and then identify what is missing and how it affects the cycle. Students will then redraw the cycle including the missing part.
- Activity 3: Provide students with a copy of the water cycle without any labels. Have students label and describe three different paths that water can take as it moves through the water cycle. An explanation of why water moves in this way should be included in the diagram. Have students use arrows of different colors to illustrate each path in the diagram.
- Activity 9: The student will be provided with three consecutive days of weather forecasts for a different area of the country. Have them use the weather symbols to record the forecasts on blank maps and then predict what the weather will be on the fourth day. Students should write their prediction and justifications for it and create a weather map that shows the prediction.

Resources

- *Fresh and Flowing Waters* pamphlet from Coca-Cola Company.
- *Starting All Over Again (The Cycles of Nature)* written by Lois Andre Bechely and Karen Beth Traiger. California Foundation for Agriculture in the Classroom, in cooperation with the California Department of Education, California Department of Food and Agriculture, California Farm Bureau Federation, Fertilizer Inspection Advisory Board, and Fertilizer Research and Education Program. California Foundation for Agriculture in the Classroom. 1601 Exposition Boulevard Sacramento, CA 95815 (916) 924-4380.
- *The Weather and the Climate* by Fiona Watt and Francis Wilson.
- *Weather Explained: A Beginner's Guide to the Elements* by Steven Jenkins.
- *AWS WeatherNet*. Available online at <http://aws.com/globalwx.html>
- *NOAA: NOAA's Environmental Satellites*: Available online at www.oso.noaa.gov/history
- *NASA: Weather Satellites History*: Available online at
- <http://www.hq.nasa.gov/office/pao/History/weathsat.html>
- *Science of the Earth System: Water and the Energy Cycle*. Available online at <http://www.earth.nasa.gov/science/water.html>
- *The Nitrogen Cycle*. Available online at
- <http://www.physicalgeography.net/fundamentals/9s.html>
- *Weather Underground*. Available online at <http://www.wunderground.com/education/education.asp>
- *World Weather Information Service*: Available online at <http://worldweather.wmo.int/>

**Grade 5
Science
Unit 8: Space**

Time Frame: Approximately 5 weeks



Unit Description

This unit fosters an understanding of objects in space, in general, and the solar system, specifically. Modeling is used for explanations of perceived constellation movement, as well as Earth motion. Assigned readings and research reveal how questioning and probing have resulted in the development of better tools and technology to study space.

Student Understandings

Students will be able to identify the physical characteristics of the Sun and explain the Sun's significance to life on Earth. Through research and comparing/contrasting activities, students will understand the difference between the inner and outer planets of our solar system, as well as minor objects such as asteroids, meteoroids, and comets. Students will be able to model the difference between rotation and revolution and explain the effects each have on a planet. Students will be able to model and explain the apparent movement of stars. Exposure to different models helps students to evaluate the effectiveness of each in illustrating important concepts. Finally, students will be able to identify the different types of and advances in technology that have enabled and furthered space exploration.

Guiding Questions

1. Can students describe and draw a picture of the Sun that shows understanding of its components?
2. Can students explain the importance of the Sun to Earth and what effects, both positive and negative, it has on the Earth?
3. Can students describe what similarities and/or differences they would encounter if they could leave Earth, the "third rock from the Sun," and travel to an inner or outer planet of their choice?
4. Can students explain how the celestial bodies (moons, asteroids, comets, meteoroids, meteors, and meteorites) are alike and different?
5. Can students model Earth's rotation and revolution?
6. Can students describe the direction the stars appear to travel across the sky and explain the reason for this apparent movement?
7. Can students explain why Polaris is important?

8. Can students describe what tools and advances in technology have facilitated space exploration and the study of the universe?
9. Can students identify the basic sequence of events in space exploration?

Unit 8 Grade-Level Expectations (GLEs)

GLE #	GLE Text and Benchmarks
<i>Note: The following Science as Inquiry 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 Space unit.</i>	
Science as Inquiry	
3.	Use a variety of sources to answer questions (SI-M-A1)
7.	Record observations using methods that complement investigations (e.g., journals, tables, charts) (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)
16.	Use evidence to make inferences and predict trends (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)
22.	Use evidence and observations to explain and communicate the results of investigations (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)
30.	Describe why all questions cannot be answered with present technologies (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)
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)
39.	Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7)
Earth and Space Science	
38.	Estimate the range of time over which natural events occur (e.g., lightning in seconds, mountain formation over millions of years) (ESS-M-B3)
39.	Identify the physical characteristics of the Sun (ESS-M-C1)
40.	Describe the significance of Polaris as the North Star (ESS-M-C1)

GLE #	GLE Text and Benchmarks
41.	Explain why the Moon, Sun, and stars appear to move from east to west across the sky (ESS-M-C1)
42.	Differentiate among moons, asteroids, comets, meteoroids, meteors, and meteorites (ESS-M-C2)
43.	Describe the characteristics of the inner and outer planets (ESS-M-C2)
44.	Explain rotation and revolution by using models or illustrations (ESS-M-C4)
45.	Identify Earth's position in the solar system (ESS-M-C5)
47.	Identify and explain advances in technology that have enabled the exploration of space (ESS-M-C8)

Sample Activities

Activity 1: Sun (SI GLEs: 3, 15, 30, 33; ESS GLE: 39)

Materials List: Internet access, Sun Facts and Stats BLM

Use the NASA Observatory Image Gallery at http://observe.arc.nasa.gov/nasa/gallery/image_gallery/solar_system/solar_sun.html, the Solar Data Analysis Center at <http://umbra.nascom.nasa.gov/images/latest.html>, and Views of the Solar System, located at <http://www.solarviews.com/eng/sun.htm#views> to obtain information, pictures, and video clips of the Sun. The Sun-Earth system has many important aspects that reveal the physical characteristics of the Sun. After previewing the site, have students prepare questions for which they would like to find answers as they explore the website. Instruct students to record facts and information on the Sun Facts and Stats BLM, including a labeled drawing of the Sun. They should locate various illustrations of the Sun in their research and make recommendations for improving the models they find. Students should infer why there is still so much to learn about the Sun. Be sure students realize that even though we have a tremendous amount of knowledge about the Sun, there are still many questions that cannot be answered, because our present-day technology is not sophisticated enough and the Sun is too hot to visit. Guide students to realize that as our technology improves, scientists will be able to gather new knowledge that can be used to solve problems, make decisions, and form new ideas (such as minimizing the effects of solar flares on Earth's communication systems and protecting people against the harmful effects of UV radiation).

Activity 2: Creating an Edible Model of the Sun (SI GLEs: 14, 15, 19, 33; ESS GLE: 39)

- Materials List: (For edible model) for a class of 30: tub of yellow icing, shakers of red and orange sprinkles, and white, red, and orange tubes of icing; for each student: 3 inch diameter sugar cookie, small paper plate, 5-8 Red Hots[®], 2-3 strips of red licorice, two 1 ½ inch strips of black or chocolate licorice, 3 inch square of

wax paper, craft stick, Scintillating Sun worksheets; (For non-edible model) yellow, white, orange, red, yellow, and black clay, small paper plates; inflatable or teacher-made 3-D model of the Sun; colorful, labeled drawing of the Sun (easily obtained from the Internet at a site such as Layers of the Sun available at <http://solarviews.com/cap/vss/VSS00031.htm>)

Use the Scintillating Sun worksheets (pages 2, 3, and 4) on the NASA website at <http://sunearth.gsfc.nasa.gov/sunearthday/scintillatingsun3.pdf> to create an edible model of the Sun. Have the students use the worksheet provided at this website to label a diagram of their model and include a short, written description of each labeled part. Show students a three-dimensional model of the Sun, either store-bought or teacher-made, and a drawing of the Sun with labeled parts. Using the edible model as one example, ask students to critique the three models, asking which model best illustrates the parts of the Sun and helps them to understand the characteristics of it. Students should explain their choices, using differences in the models to illustrate their point. Ask students to suggest a different way that a model of the Sun could be created that better illustrates its components. Challenge students to create a new and better model and explain it to others. Improved models will illustrate the components of the Sun more effectively than the ones presented by the teacher and the cookie model.

Students with dietary considerations can substitute clay for each section of the Sun and still complete the activity.

Activity 3: Understanding the Importance of the Sun to Earth (SI GLE: 16; ESS GLE: 39)

Materials List: science learning logs, *The Sun* by Seymour Simon or other book about the characteristics of the Sun, poster of the Solar System, *The Effect on Earth—Is There Life on other Planets?* available from the Solar Week website at <http://solarweek.org/index.html>

Ask students to *brainstorm* ([view literacy strategy descriptions](#)) beneficial and harmful effects of the Sun to people and animals on Earth. Brainstorming allows students to activate previously gained knowledge. As students suggest possible beneficial and harmful effects of the Sun, direct them to record suggestions in their science *learning logs* ([view literacy strategy descriptions](#)). A science *learning log* is a notebook that students keep in order to record ideas, questions, reactions, and new understandings, as well as observations and data from science lab activities. Under the list of suggestions in their science *learning logs*, have students create a *graphic organizer* ([view literacy strategy descriptions](#)), such as a T chart to record facts from what is read.

Effects of the Sun

Beneficial Effects Harmful Effects

Read the book *The Sun* by Seymour Simon (or another book that gives information about the beneficial and harmful effects of the Sun) to students. Without discussing what was read, have students identify five beneficial uses and at least three harmful effects of the Sun and record comments in the T chart. Discuss answers with class. Ask students to identify the characteristics of Earth that protect it from these harmful effects of the Sun. (Students should mention Earth's atmosphere, specifically the ozone layer.) Using a poster of the Solar System, have students identify Earth's position from the Sun. Ask students if they think this position has anything to do with the fact that only Earth appears to have any life. Ask students what effect the position and distance of the Earth from the Sun has on living things (*affects the amount and intensity of the energy that reaches Earth, which affects the growth and health of all living things*). Have students hypothesize what would happen if the Sun were larger, farther away, closer to Earth, etc. (*larger Sun would release more energy, farther distance from Earth would decrease the temperature on Earth and the intensity of the Sun's energy, closer distance to Earth would increase the temperature on Earth and the intensity of the Sun's energy, all of which would affect the growth of plants and the ability of other organisms to survive on Earth*).

To develop students' understanding of how the Sun makes life on Earth possible and the characteristics of Earth that are necessary for life to exist, have students respond to a SPAWN prompt ([view literacy strategy descriptions](#)). SPAWN represents five categories of prompts: S (Special Powers), P (Problem Solving), A (Alternative Viewpoints), W (What If?) and N (Next). These prompts can be designed to stimulate students' meaningful thinking about content area topics. The writing prompted by SPAWN is typically short in length and can be kept in students' science *learning logs*. In this activity, students will be responding to W (What If?) or A (Alternative Viewpoints) prompts. Provide students with a reading selection such as "The Effect on Earth—Is There Life on other Planets?" available from the Solar Week website at <http://solarweek.org/index.html> or similar source. Students should record additional facts about the Sun on their T charts and note any facts about Earth that make it uniquely able to support life in a list below the chart. After reading the article, students should use facts about the characteristics of Earth and what they have learned about the Sun to respond to one of the following prompts:

- W-What If?-----What if scientists found a planet in another solar system that was very similar to Earth? What would scientists at NASA need to find out about it to determine the possibility that life, as we know it, exists on it?
- A-Alternative Viewpoints-----Imagine that you are the scientist who has just discovered a planet in another solar system that is identical in all ways to Earth,

including its distance from a sun that is the same size as ours. Write a convincing speech that supports your belief that life on that planet can exist. Use information from your readings.

Have students share their SPAWN prompt writings with classmates.

Guide students to understand that it is a combination of the characteristics of Earth and the exact position of Earth from the Sun, as well as the size and temperature of our Sun, that makes life on Earth, as we know it, possible and life like ours, on other planets in our Solar System highly unlikely. Have students explain why the Sun is Earth's most important star, using class discussions and information learned from their readings.

Activity 4: Solar System Travel Company (SI GLEs: 3, 7, 19; ESS GLEs: 43, 45)

Materials List: Planetary Research BLM, sample travel posters from Internet or travel agency, *Postcards from Pluto* by Loreen Leedy, sample postcards, posterboard, unruled index cards, Planet Poster Rubric BLM

Introduce students to our solar system by reading and discussing information from student textbooks. First, have students find the definition of a planet from their textbook. Write this definition on the board. Refer to the definition as students read about each planet's characteristics to determine if each planet meets the criteria to be considered a planet. Share the definition of a planet as determined by the International Astronomical Union (IAU) in August, 2006:

1. A "planet"¹ is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape (in other words, is spherical in shape), and (c) has cleared the neighborhood around its orbit (in other words, is composed of most of the debris in its orbit and is the major object in its orbit). Scientists estimate that for a rocky body, hydrostatic equilibrium will happen for an object that is about 800 km (500 miles) and has a mass about 1/12,000 that of the Earth (Ceres is about 950 km and has a mass about 1/7000 that of Earth).
2. A "dwarf planet" is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape², (c) has not cleared the neighborhood around its orbit, and (d) is not a satellite.
3. All other objects³, except satellites orbiting the Sun, shall be referred to collectively as "Small Solar-System Bodies."

Once again, review the characteristics of each planet described in students' textbooks. Have students determine if each planet meets the criteria set forth by the IAU. Briefly explain to students that Pluto is no longer considered a planet but that they will review the characteristics of Pluto in the next activity and determine why it is no longer classified as a planet.

Show students a poster or diagram of the Solar System. Have students identify the location of Earth and explain its position within the Solar System. Review the characteristics of the “inner planets” and the “outer planets” and ask students to identify in which group Earth belongs. After reviewing each planet’s characteristics and location within the solar system, assign students to cooperative groups of three or four. Have students select either a planet or moon within our solar system to “visit” and create an informative, yet interesting poster that will entice earthlings to vacation there. Groups will have two days to do research for their exploratory trip. They should discover basic information and interesting facts about their planet/moon that would be important to the tourists. Some of these include size, distance from Earth, position in space in relation to Earth, day/night length, length of year, average temperature (day/night), atmospheric composition and characteristics, surface composition characteristics and geology, number of moons and if they would make a good side trip (briefly describe), and any other information that makes their chosen heavenly body unique or special. Provide students with the Planetary Research BLM to ensure the collection of quality data.

Determine the criteria for producing a travel poster. Students should use the information on their Planetary Research BLM to design their posters. Web sites contain many pictures and much information that can be utilized by students. Samples of travel posters from the local tourism bureau are helpful to have on hand. Examples of travel posters can also be accessed online by searching “travel posters.” Posters should be presented during class. Have students critique their peers’ work, using the Planet Poster Rubric BLM. Teachers who wish to have students create their own rubrics can find examples of scoring rubrics at the *RubiStar*® website at <http://rubistar.4teachers.org/index.php>.

Activity 5: Comparing and Contrasting Characteristics of Inner Planets and Outer Planets (SI GLEs: 3, 7, 19, 22; ESS GLEs: 43)

Materials List: Planetary Research BLM from Activity 4, Planet Comparison BLM, white butcher or bulletin board paper, Pluto Opinionnaire BLM

Have students use data collected from Activity 4 to compare and contrast the characteristics of inner and outer planets. Use the literacy strategy, *graphic organizer* ([view literacy strategy descriptions](#)), to create a Venn diagram that can be used in comparing characteristics of both types of planets with Earth. A graphic organizer is a tool that provides the learner with two avenues to memory—verbal (the text) and spatial (the placement of information in relation to other facts).

Students can use the same Planetary Research BLM from Activity 4 to gather information. Student pairs should share collected data between themselves and, then, create a Venn diagram showing the similarities and differences between the two types of planets. A sample Venn diagram template can be found at <http://www.lpb.org/education/classroom/opom/opompdf/006d0.pdf> or teachers can use the Planet Comparison BLM for comparisons. Have students use the Venn diagram that they create to record findings and then create large Venn diagrams on white butcher

paper to share with the class. After all groups have presented, have students summarize the major differences and similarities noted between all groups of inner and outer planets and how each type compares to Earth. Encourage students to utilize what was learned in Activity 4 about Earth and, also Unit 6 (Earth and the Atmosphere), to classify it as an inner or outer planet.

To help students become critical thinkers of what they read and to force them to take a position and defend it, use the *Opinionnaire* literacy strategy ([view literacy strategy descriptions](#)). The emphasis is on students' point of view and not the "correctness" of their opinions. Have students work in small groups to read and discuss each statement, then write down the reasons for their opinions. They should rely partly on the information they received in the previous activity. Provide students with the Pluto Opinionnaire BLM. After students have completed the *opinionnaire* and discussed what they have written, explain to students that Pluto recently was removed from the list of planets and is now considered a "dwarf planet" due to the fact that it has not cleared the neighborhood around its orbit. In other words, it is not, by far, the dominant mass in its region of space; it has not cleared its neighborhood of all other significant masses through its gravitational pull; and it is not composed of the accumulation of most of the debris in its orbit. Read an article about the debate that is still ongoing from the website <http://www.iau.org/iau0603.414.0.html> and then allow students to revisit their *opinionnaires* to see if they would like to change their opinions.

Activity 6: Visitors from Space: Understanding the Differences between Moons, Meteoroids, Meteors, Asteroids, and Comets (SI GLEs: 7, 19, 22, 37; ESS GLE: 42)

Materials List: For each group of 3-4 students: photographs of moons, meteorites, meteors, meteoroids, asteroids, and comets (NASA lithographs can be printed from the Internet by visiting the NASA Educator site at http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Our_Solar_System_Lithograph_Set.html), large sheet of butcher or bulletin board paper, markers, white drawing paper; for the entire class: the book *Comets, Meteors, and Asteroids* by D. Darling

Gather large colorful examples of moons, meteorites, meteors, meteoroids, asteroids, and comets from books or the Internet. Provide students with some clues, if you feel it is necessary, but do not identify the pictures for the students. Try to get at least two or three example pictures of each object. Divide students into cooperative groups of three to four members. Make a copy of each example picture for each group. To introduce students to the similarities and differences between these space visitors, read the book *Comets, Meteors, and Asteroids* by D. Darling or another comparable book. On a large sheet of butcher paper, create and display a class definition of each of the following: *moon*, *meteorite*, *meteor*, *meteoroid*, *comet*, and *asteroid*. Have students in each group sort through their pictures to classify each type according to the class definition. Encourage students to discuss their thinking strategies with others in the group by requiring them to justify reasons for placing each picture in a certain category. Differences of opinions

should be backed up with scientific information gleaned from the class definitions on the chart. Have students share their classification charts with classmates, encouraging students in other groups to challenge any incorrectly placed pictures. Students in each group should be able to justify their placements.

Visual learners and ESL students may benefit from creating a picture dictionary of each type of space object. Students should draw, label, and define each space object on a half-sheet of paper, then collate them into a booklet.

Activity 7: Earth Goes Round and Around: Understanding the Effects of Rotation and Revolution of the Earth (SI GLEs: 7, 12, 15, 22; ESS GLEs: 38, 41, 44)

Materials List: basketball or kickball, globe, lamp with light bulb (battery-operated if possible), sticky note, modeling clay, two straws, toy top, science *learning logs*

Safety Note: Caution students not to touch the light bulb while holding the lamp. Be sure to tape down electrical cords to avoid knocking over the lamp and breaking the light bulb during movement.

Rotation is the 360° degree turn that a planetary body makes on its own axis. This movement gives the planet its day and night. Earth's rotation, or day, takes 24 hours. Provide students with a visual demonstration of Earth's rotation by asking a student to spin a ball in a counterclockwise direction on the tip of their finger or by spinning a toy top on the floor while the class watches. Ask a student to describe what the ball/ top is doing. *(The ball/top is staying in one place and spinning around.)* Ask students to identify in which direction the ball/top is spinning. *(Students should recognize that it is moving in a counterclockwise direction.)* Ask students to name objects in our solar system that have the same movement as was demonstrated with the spinning ball/top. *(Most objects in space rotate, including Earth, other planets, and our Moon. Rotation is different for some planets. For example, the rotation of Venus is retrograde and the tilt of the axis of Uranus is so great, the planet appears to roll.)* Ask students if they know what effect, if any, this rotation has on Earth. *(responsible for night and day)*

Place a sticky note on the globe on top of North America. Project the light from the lamp toward the globe and direct students to focus on the sticky note as you rotate the globe in a counterclockwise direction, slowly. Ask students to identify in which direction the Sun appears to move across the sky. *(It appears to move from East to West.)* Have students explain this effect in their science *learning logs* ([view literacy strategy descriptions](#)) as well as draw and label an illustration. Students need to understand that the movement of the Earth in a counterclockwise direction causes objects in space to appear to move from East to West as they come into view and we continue to turn away from them

Besides rotating on its axis, Earth also revolves, or orbits the Sun. The Earth orbits the Sun at a mean distance of about 150 million kilometers or 93 million miles. It takes 365 $\frac{1}{4}$ days for Earth to revolve, or orbit, around the Sun. This movement is also called

revolution. To better understand the effects of Earth's revolution, have students role-play. Draw a slightly elliptical (*more circular than elliptical*) path around a center position in the classroom. Place a model Sun (*battery-operated lantern or lamp without lampshade*) in the center of the circle. Each child should take a turn rotating in a counterclockwise direction and revolving around the model Sun, being careful not to knock over the lamp. Ask

- How long does it take Earth to revolve around the Sun? (*365 $\frac{1}{4}$ days*)
- What time reference is given to this amount of time? (*a year*)
- How long does it take for the Earth to make one complete rotation on its axis? (*24 hours*)
- What is the time reference given to this amount of time? (*a day*)

After students have walked through rotating and revolving, have students explain one of the actions to another student. Students should record the experience in their science *learning logs*, using the following prompts:

- Which action causes day and night? (*the Earth's rotation*)
- Which motion takes Earth a year to complete? (*the Earth's revolution*)
- When is Earth closest to the Sun? (*Be sure that students understand that the Earth is actually closer to the Sun in January in the Northern hemisphere and is actually farther away in the summer. Show students the tilt of Earth on a globe. Explain to them that the tilt of Earth is what causes the seasons, not the distance from the Sun.*)
- What effect does the counterclockwise movement of Earth have on the direction that the Sun appears to move across the sky? (*The Sun appears to move from East to West across the sky, because Earth is rotating from West to East.*)

To help students understand the reason for the seasons on Earth, have them model Earth's movement again. Keep the sticky note in place on North America and ask students to identify in which hemisphere North America is located. Attach a straw to each end of the globe with a piece of clay to emphasize the tilt of the earth. Shine the lamp on the earth as a student revolves around the lamp, making sure to keep the 23.5 ° tilt accurately positioned. Students should demonstrate how the tilt of Earth causes some areas to receive less direct light and some areas to receive more direct light, and then use evidence from their demonstration to infer how this tilt affects the seasons. (*When the northern part of Earth is getting the most direct sunlight, it is experiencing summer. At the same time, the southern part of Earth is receiving less direct sunlight, so it is experiencing winter. As the Earth moves around the Sun, the tilt of Earth causes different parts of Earth to receive greater or lesser amounts of direct sunlight. This causes the seasons.*)

Ask students to identify and explain the limitations of these models.

Activity 8: East to West (SI GLEs: 18, 22; ESS GLEs: 41, 44)

Materials List: black construction paper; white paint, wet chalk, or self-stick stars; compass; lamp or lantern (battery-operated if possible); night sky maps for each month of the year; science *learning logs*; STARLAB (if available)

Divide students into four groups and assign each group one of the four seasons. Have each group identify constellations that are found in the night skies of the *Northern Hemisphere* during their assigned season by using astronomy magazines, the Internet, or astronomy resource books. Then, have students create constellation pictures on pieces of black construction paper, using white paint, wet chalk, or self-stick stars—using only constellations that appear in the season they have been assigned. Use a compass to mark the four cardinal directions on the classroom walls. Place one student, holding a lantern/lamp, in the center of the room to represent the Sun. Have other students use night sky maps for their particular season to position themselves in one section around the outer edge of the room, holding up constellation pictures. Remind students of Earth’s rotation by demonstrating its movement with a globe. Ask students to identify the direction of Earth’s rotation (*from west to east, in a counter-clockwise direction*) by using the posted cardinal directions. Place one student between the Sun and the constellations and have him/her slowly turn in a counter-clockwise direction to face the Sun and then the constellations. Ask

- What do you see when you rotate away from the Sun? (*The constellations in one section of the night sky*)
- What do you see when you face the Sun? (*light*)
- Why can’t you see the constellations on the other side of the Sun? (*The light from the Sun is too bright to see beyond it.*)
- Are the constellations on the other side of the sun still there? (*yes*)

Have the student face North and slowly repeat the movement, paying special attention to notice the direction the constellation seems to be moving as the student rotates toward it and then rotates away from it. (Students that are rotating should observe the constellation appearing in the East and slowly moving toward the West as he/she rotates away from it.) Then ask

- In what direction is Earth rotating? (*West to East*)
- In what direction do the constellations appear to be moving? (*East to West*)

Repeat the activity, having students observe the apparent movement of the Sun. (Students should observe that the Sun appears to follow the same path as the constellations. (*East to West*)). Next, have the student that is rotating begin to revolve slowly around the Sun.

Ask

- What constellations do you see now? (*Students should start seeing new constellations as previously seen constellations become difficult to observe because of the new position of Earth in its orbit around the Sun.*)
- In which direction does the Sun appear to be moving? (*east to west*)
- What object’s movement is actually causing the Sun and stars to appear to move? (*the movement of Earth*)

Have students explain why we see certain constellations in different seasons. Have students identify faulty reasoning and statements made by peers that misrepresent or are not supported by the evidence. Students should record observations and write explanations in their science *learning logs* ([view literacy strategy descriptions](#)), adding detailed drawings to illustrate what was observed. Have students research various myths that explain why certain constellations are only seen in certain seasons, such as Scorpius and Orion. Have students summarize the myth and then write the scientific explanation for seeing those constellations during different seasons.

If your school has access to a portable STARLAB, this can be used to show the constellations. A field trip to a planetarium or a school star party would also be a worthwhile experience for students, if possible.

Activity 9: Polaris (SI GLEs: 12, 13, 22, 35, 38; ESS GLE: 40)

Materials List: globe, black construction paper, white paper punches from a hole puncher and glue or self-stick stars, story about the Little Dipper, chart paper, seasonal star map that shows the position of Polaris, story called “Why the North Star Stands Still” from the Indians.org website, STARLAB (if available)

Teacher Note: Given the celestial position and importance of Polaris, it is sometimes expected to be a bright star. In actuality, Polaris is a distant variable star and often hard to find without using the constellations of Ursa Major and Ursa Minor for reference.

This activity is designed to help students grasp the true significance of Polaris, the North Star. Before beginning this activity, have students look in constellation books and locate the constellation in which Polaris is located.

Read several myths about the Little Dipper (Ursa Minor) and locate Polaris (the last star in the handle of the Little Dipper). Select a story that provides an explanation for why the Little Dipper seems to revolve around one star (Polaris). One such myth can be found at Indians .org website at <http://www.indians.org/welker/northsta.htm>. Prior to reading the story, introduce students to the *DR-TA* literacy strategy ([view literacy strategy descriptions](#)). This strategy is useful in helping students make predictions during reading, and then to check their predictions during and after reading.

Begin by asking students why they think some stars are used for navigation. Explain to students that, throughout history, people have observed patterns and changes in nature and have used these observations to guide their daily lives. Examples include the changing colors of leaves and flocks of migrating birds that announce the arrival of autumn and the first sighting each year by people in Egypt of Sirius, the bright star in Canis Major, which preceded the flooding of the Nile River each year. These dependable observations helped people plant and harvest crops, predict changes in weather, and plan daily activities. Explain to students that one observation made by people long ago was that all the stars and constellations moved across the sky each evening, but that one star

seemed to stay in the same place. This observation led many early people to write stories about the significance of what had been observed. These stories helped create order in a confusing world. Many of the stories they created were passed down through time and have become the myths we read today. As scientists discover new evidence about the universe, these myths are replaced with modern theories and scientific facts. The myths remain as clues to how people made sense of their world.

Now, direct students to look at the title of the story, “Why the North Star Stands Still.” Ask students to predict what possible explanations might be given about this observation by Native Americans. Record predictions on the board or chart paper. Next, ask students to read the first three paragraphs to hear one explanation. Guide the students through a section of the text, stopping at predetermined places to ask students to check and revise their predictions. At each stopping point, have students reread the predictions they have written and change them, if necessary, based on what was read. Once the reading is completed, use the predictions as a discussion tool. Ask students if the myth they just read does a good job in making sense of what was observed in the night sky.

To demonstrate a more scientific explanation for the apparent stationary position of Polaris, have students perform the following activity: Have students create a pattern of the Little Dipper, using black construction paper, the paper holes from a hole puncher, and a self-stick star to indicate Polaris. Have one student sit cross-legged on the floor and hold a globe above his/her head. Have a second student hold the pattern of the Little Dipper face down above the globe with the North Star placed immediately above the North-South axis. Have a second student lie on the floor with his/her head close to the globe and slowly slide his/her body in a circle around the student holding the globe, as the globe turns. Have the student slowly rotate the globe in a counter-clockwise direction while students observe the position of the North Star and the Little Dipper.

Ask

- Imagine you are on Earth looking into space. What happens to the North Star as Earth rotates on its imaginary axis? (*It stays in the same place.*)
- How does what was observed match the myth that was just read? What appears to happen to the constellation Little Dipper? (*It appears to move in a circle around Polaris.*)

Give other students an opportunity to observe the movement of the Little Dipper and the lack of movement of Polaris. Explain to students that this apparent movement of the Little Dipper can be observed to regularly move around Polaris. This movement of stars around Polaris can also be demonstrated if you have access to STARLAB. Have students identify the Little Dipper and Polaris, then focus a laser on Polaris as you allow the STARLAB to make one complete rotation. Students will observe the movement of the stars in the Little Dipper around Polaris.

Have students use what was observed to create a scientific explanation for why Polaris is significant as a navigation tool. (*Since Polaris does not move and because it is located over the North Pole, it can be used to find directions. Moving in a direction toward Polaris is heading in a northerly direction, moving in a direction opposite Polaris is*

heading in a southerly direction. The other directions can be determined from sighting Polaris.)

Activity 10: One Small Step for Man, One Giant Leap for Mankind: Space Technology that Fueled Space Exploration (SI GLEs: 29, 30, 38, 39; ESS GLE: 47)

Materials List: Internet access, books about space exploration and inventions

Begin with a “then and now” research of space technology. Through direct instruction and student research, have students compare the types of technology fifty years ago, including the capabilities and limitations, with the types of technology available today. Technology needed for space exploration includes propulsion, communication, power and energy sources, navigation, and imaging/mapping technologies. Divide students into five groups. Have each group select one aspect of technology needed for space exploration and research how it has advanced the exploration of space and/or the lives of humans. Each group will role-play a talk show called *Science Live*. One student will be the talk show host interviewing a panel of three NASA engineers and scientists. “NASA engineers” and “scientists” will prepare their reasons with examples that the technological advance has aided space exploration and the limitations that still exist. The presentation must be in an interview format, and all students must participate. Have students in each group create one or two interview questions that demonstrate their understanding of how technology *could* advance space exploration or how it could improve humans’ lives, e.g., “How did the invention of the rocket allow people to send satellites into space?” or “How has the invention of the satellite improved weather forecasting?” or even, “How has improved weather forecasting, made possible due to the invention of the satellite, positively affected people’s lives?” Useful websites for this activity include NASA’s Space Place at <http://spaceplace.nasa.gov/en/kids> or “NASA Spinoffs” at <http://www.thespaceplace.com/nasa/spinoffs.html>.

Have students create a list of new facts they learned about space technology from the interviews. Share the facts with classmates.

Activity 11: Timeline of Space Exploration (SI GLEs: 3, 19, 29, 30, 35; ESS GLE: 47)

Materials List: Bulletin board paper, newsprint, or adding machine tape; software that creates timelines (optional)

Create a class timeline or group timelines of space exploration using the information learned during Activity 10. Make a list on the board of all inventions that were researched, including the dates they were invented. Students can use a software program that creates timelines such as *Tom Snyder’s Timeliner Software*® or other available software programs, to create a computer-generated timeline, or students can create their own using long sheets of bulletin board paper, newsprint, or adding machine tape. Have students try to find examples that show a link between one invention and the creation of

the next one. If possible, have each invention that is displayed on the timeline directly linked to the previous one. Display the students' timeline(s) and have them explain the link from one invention to the next.

Sample Assessments

General Guidelines

Assessment will be from teacher observation/checklist notes of students' 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 utilized 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 make cards that represent constellations. Place them on a blank sky. Use a reference book.
- The student will choose a first-magnitude star and locate it on a sky map, and then write directions for the class to locate it.
- The student will compare and contrast *revolving* and *rotating*.
- The student will create an informational chart with all the positive inventions and products that have been created because of the NASA Space Program.
- The student will assess the value of the NASA Program.
- The student will create rubrics that assess each step of the research process as well as the final product. Provide rubrics in advance and discuss components that will be used for grading. Allow students to assess themselves as well as providing a teacher assessment.
- The student will create and use a KWL chart or pretest before beginning a specific activity. Repeat the pretest as a posttest to determine student growth or have students evaluate how the "Learned" part of the KWL chart corrects any misconceptions mentioned in the "Know" part.
- The student will assess growth of writing skills through evaluation of journal writing from beginning to the end of the unit. Length and detail in descriptions

should increase as students become more adept in writing observations, explanations, and feelings.

Activity-Specific Assessments

- Activity 1: The student will prepare written critiques for the models of the Sun found on the website(s) and then create a new and better model. Allow peers to critique the new models by using the written critiques previously done on the website models. Students should share critiques and new models with classmates, explaining the obvious improvements or providing evidence of flaws in the newer model.
- Activity 5: Provide students with information on an inner and an outer planet to be compared and contrasted. The students will draw and complete a Venn diagram, using the information received. The data collection sheet, conference between student pairs, Venn diagram, and oral presentation can all be used as assessment tools. Students demonstrate research abilities, communication skills, and logical reasoning as they perform the four-step process of this activity.
- Activity 6: Student understanding can be assessed by having students find new pictures of asteroids, meteors, etc. to create their own charts similar to the ones made in Activity 6. These charts should then be shared with a new partner. Each new partner should critique the placement of the pictures and explain any errors in picture classification.
- Activity 8: Provide students with pairs of constellations that appear in the same season during different times in the night. The student will use a star map to determine when each constellation appears and then create a moving night sky scene containing these constellations by using butcher paper stretched between two poles. Students should be able to explain the apparent movement of the stars from east to west as they slowly turn their bodies from west to east.

Resources

Books

- Artell, Mike. *Starry Skies*.
- Cole, Joanna, & Degen, Bruce. *The Magic School Bus: Lost in the Solar System*.
- Dickinson, Terence. *Exploring the Night Sky*.
- Hillerman, Anne, & Yamashita, Mina. *Done in the Sun: Solar Projects for Children*.
- Kenda, Margaret, & Williams, Phyllis S. *Science Wizardry for Kids*.
- Nicolson, Iain. *The Illustrated World of Space*.

- Schatz, Dennis. *Astronomy Activity Book. The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook I and II* by Andrew Fraknoi (Editor) and Dennis Schatz (Editor).

Websites

- *NASA Quest*. Available online at <http://quest.arc.nasa.gov/>
- *Origins: NASA Jet Propulsion Laboratory*. Available online at <http://origins.jpl.nasa.gov/>
- *Solar System---NASA Jet Propulsion Laboratory*. Available online at http://www.jpl.nasa.gov/solar_system/index.cfm
- *Spacelink—NASA Educational Resources*. Available online at <http://spacelink.nasa.gov/index.html>
- *A Multimedia Tour of the Solar System*. Available online at <http://www.nineplanets.org>
- *The Space Place—NASA Jet Propulsion Laboratory*. Available online at <http://spaceplace.jpl.nasa.gov/index.shtml>