

Sixth Grade Science Content Expectations Companion Document

SCIENCE

- Unit 1: Matter and Energy
- Unit 2: Ecosystems
- Unit 3: Composition, Properties, and Changes of the Earth
- Unit 4: Plate Tectonics and Fossils

- Big Ideas
- Clarifications
- Inquiry
- Vocabulary
- Instruments
- Measurements

- Instructional Framework
- Enrichment
- Intervention
- Real World Context
- Literacy Integration
- Mathematics Integration



Michigan State Board of Education

Kathleen N. Straus, President
Bloomfield Township

John C. Austin, Vice President
Ann Arbor

Carolyn L. Curtin, Secretary
Ewart

Marianne Yared McGuire, Treasurer
Detroit

Nancy Danhof, NASBE Delegate
East Lansing

Elizabeth W. Bauer
Birmingham

Reginald M. Turner
Detroit

Cassandra E. Ulbrich
Rochester Hills

Governor Jennifer M. Granholm
Ex Officio

Michael P. Flanagan, Chairman
Superintendent of Public Instruction
Ex Officio

MDE Staff

Sally Vaughn, Ph.D.
Deputy Superintendent/Chief Academic Officer

Betty Underwood, Director
Office of School Improvement

K - 7 Science Companion Document Workgroup

LaMoine Motz, Ph.D., Project Director

Nancy Karre, Project Coordinator

Kevin Richard, Michigan Department of Education, Science Consultant

Core Committee

Charles Bucinski
Herm Boatin, Ed.D.
Elizabeth Crowder
Paul Drummond
Elizabeth Larwa

Writers

Monica Hartman, Ph.D. Project Writer
Deborah Peek-Brown, Project Writer
Conni Crittenden, Project Writer
Maura Jung, Ed.D. Project Writer
Alycia Meriweather, Project Writer
Judith Grigg, Project Writer
Carole Gutteridge, Project Writer
Leesa Stumpf, Project Writer
Jason Ratkowski, Project Writer
Yonee Kuiphoff, Project Writer

Michigan Science Leadership Academy

Michigan Science Teachers Association

Michigan Mathematics and Science Center Network



Michigan Department of Education

Betty Underwood, Director

Office of School Improvement

www.michigan.gov/mde

Introduction to the K-7 Companion Document An Instructional Framework

Overview

The Michigan K-7 Grade Level Content Expectations for Science establish what every student is expected to know and be able to do by the end of Grade Seven as mandated by the legislation in the State of Michigan. The Science Content Expectations Documents have raised the bar for our students, teachers and educational systems.

In an effort to support these standards and help our elementary and middle school teachers develop rigorous and relevant curricula to assist students in mastery, the Michigan Science Leadership Academy, in collaboration with the Michigan Mathematics and Science Center Network and the Michigan Science Teachers Association, worked in partnership with Michigan Department of Education to develop these companion documents. Our goal is for each student to master the science content expectations as outlined in each grade level of the K-7 Grade Level Content Expectations.

This instructional framework is an effort to clarify possible units within the K-7 Science Grade Level Content Expectations. The Instructional Framework provides descriptions of instructional activities that are appropriate for inquiry science in the classroom and meet the instructional goals. Included are brief descriptions of multiple activities that provide the learner with opportunities for exploration and observation, planning and conducting investigations, presenting findings and expanding thinking beyond the classroom.

These companion documents are an effort to clarify and support the K-7 Science Content Expectations. Each grade level has been organized into four teachable units- organized around the big ideas and conceptual themes in earth, life and physical science. The document is similar in format to the Science Assessment and Item Specifications for the 2009 National Assessment for Education Progress (NAEP). The companion documents are intended to provide boundaries to the content expectations. These boundaries are presented as “notes to teachers”, not comprehensive descriptions of the full range of science content; they do not stand alone, but rather, work in conjunction with the content expectations. The boundaries use seven categories of parameters:

- a. **Clarifications** refer to the restatement of the “key idea” or specific intent or elaboration of the content statements. They are not intended to denote a sense of content priority. The clarifications guide assessment.
- b. **Vocabulary** refers to the vocabulary for use and application of the science topics and principles that appear in the content statements and expectations. The terms in this section along with those presented

within the standard, content statement and content expectation comprise the assessable vocabulary.

- c. **Instruments, Measurements and Representations** refer to the instruments students are expected to use and the level of precision expected to measure, classify and interpret phenomena or measurement. This section contains assessable information.
- d. **Inquiry Instructional Examples** presented to assist the student in becoming engaged in the study of science through their natural curiosity in the subject matter that is of high interest. Students explore and begin to form ideas and try to make sense of the world around them. Students are guided in the process of scientific inquiry through purposeful observations, investigations and demonstrating understanding through a variety of experiences. Students observe, classify, predict, measure and identify and control variables while doing “hands-on” activities.
- e. **Assessment Examples** are presented to help clarify how the teacher can conduct formative assessments in the classroom to assess student progress and understanding
- f. **Enrichment and Intervention** is instructional examples that stretch the thinking beyond the instructional examples and provides ideas for reinforcement of challenging concepts.
- g. **Examples, Observations, Phenomena** are included as exemplars of different modes of instruction appropriate to the unit in which they are listed. These examples include reflection, a link to real world application, and elaboration beyond the classroom. These examples are intended for instructional guidance only and are not assessable.
- h. **Curricular Connections and Integrations** are offered to assist the teacher and curriculum administrator in aligning the science curriculum with other areas of the school curriculum. Ideas are presented that will assist the classroom instructor in making appropriate connections of science with other aspects of the total curriculum.

This Instructional Framework is NOT a step-by-step instructional manual but a guide developed to help teachers and curriculum developers design their own lesson plans, select useful portions of text, and create assessments that are aligned with the grade level science curriculum for the State of Michigan. It is not intended to be a curriculum, but ideas and suggestions for generating and implementing high quality K-7 instruction and inquiry activities to assist the classroom teacher in implementing these science content expectations in the classroom.

Sixth Grade GLCE Companion Document

Unit 1: Matter and Energy

SCIENCE

- Big Ideas
- Clarifications
- Inquiry
- Vocabulary
- Instruments
- Measurements
- Instructional Framework
- Enrichment
- Intervention
- Real World Context
- Literacy Integration
- Mathematics Integration

Sixth Grade Companion Document

6-Unit 1: Matter and Energy

Table of Contents	Page 1
Curriculum Cross Reference Guide	Page 2
Unit 1: Matter and Energy	Page 3
Big Ideas (Key Concepts)	Page 3
Clarification of Content Expectations	Page 3
Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications	Page 9
Vocabulary	Page 10
Instruments, Measurements, and Representations	Page 10
Instructional Framework	Page 11
Enrichment	Page 15
Intervention	Page 15
Examples, Observations and Phenomena (Real World Context)	Page 16
Literacy Integration	Page 17
Mathematics Integration	Page 18

6th Grade Unit 1: Matter and Energy

Content Statements and Expectations

Code	Statements & Expectations	Page
P.EN.M.1	Kinetic and Potential Energy – Objects and substances in motion have kinetic energy. Objects and substances may have potential energy due to their relative positions in a system. Gravitational, elastic, and chemical energy are all forms of potential energy.	3
P.EN.06.11	Identify kinetic or potential energy in everyday situations (for example: stretched rubber band, objects in motion, ball on a hill, food energy).	3
P.EN.06.12	Demonstrate the transformation between potential and kinetic energy in simple mechanical systems (for example: roller coasters, pendulums).	5
P.EN.M.4	Energy Transfer – Different forms of energy can be transferred from place to place by radiation, conduction, or convection. When energy is transferred from one system to another, the quantity of energy before the transfer is equal to the quantity of energy after the transfer.	5
P.EN.06.41	Explain how different forms of energy can be transferred from one place to another by radiation, conduction, or convection.	5
P.EN.06.42	Illustrate how energy can be transferred while no energy is lost or gained in the transfer.	6
P.CM.M.1	Changes in State – Matter changing from state to state can be explained by using models, which show that matter is composed of tiny particles in motion. When changes of state occur, the atoms and/or molecules are not changed in structure. When the changes in state occur, mass is conserved because matter is not created or destroyed.	6
P.CM.06.11	Describe and illustrate changes in state, in terms of arrangement and relative motion of the atoms or molecules.	6
P.CM.06.12	Explain how mass is conserved as a substance changes from state to state in a closed system.	7

6 – Unit 1: Matter and Energy

Big Ideas (Key Concepts)

- Objects and substances in motion have kinetic energy.
- Objects and substances have potential energy due to their relative position in a system.
- Heat energy is transferred by radiation, conduction, and convections.
- Physically changing states of matter does not create a new substance.
- Everything we do is connected to energy in one form or another.

Clarification of Content Expectations

Standard: Energy

Content Statement – P.EN.M.1

Kinetic and Potential Energy – Objects and substances in motion have kinetic energy. Objects and substances may have potential energy due to their relative positions in a system. Gravitational, elastic, and chemical energy are all forms of potential energy.

Content Expectations

P.EN.06.11 Identify kinetic or potential energy in everyday situations (for example: stretched rubber band, objects in motion, ball on a hill, food energy).

Instructional Clarifications

1. Identify means recognize the properties of kinetic energy and potential energy in everyday situations.
2. Energy is the ability to do work or the ability to make things change. Energy occurs in two primary types, potential and kinetic.
3. Kinetic energy is energy of motion found in objects or substances. Only moving objects have kinetic energy.
4. Objects and substances may have potential energy due to their relative positions in a system. Common examples include:
 - a. An object placed on a high shelf has greater potential energy than one placed on a low shelf.
 - b. A stretched elastic band has greater potential energy than one that is not stretched.

- c. Large molecules such as sugar have greater potential energy than smaller molecules such as carbon dioxide and water.
5. Potential energy can be converted to kinetic energy. For example, potential energy of a battery can be converted to kinetic energy in an electric motor.
6. Kinetic energy can be converted to potential energy. For example, a windmill's kinetic energy can be converted to potential energy as it charges storage batteries.
7. Energy may be changed from one form to another, but the amount of energy stays the same.

Assessment Clarifications

1. Energy is the ability to do work or the ability to move an object. Energy occurs in two primary types, potential and kinetic
2. Kinetic energy is energy of motion found in objects or substances. Only moving objects have kinetic energy.
3. Potential energy is energy possessed by an object as a result of its position or height above the ground rather than its motion. The amount of potential energy depends on its mass and height. Potential energy can be converted to kinetic energy.

P.EN.06.12 Demonstrate the transformation between potential and kinetic energy in simple mechanical systems (for example: roller coasters, pendulums).

Instructional Clarifications

1. Demonstrate is to show through manipulation of materials, drawings, and written and verbal explanations the transformation between potential and kinetic energy in simple mechanical systems.
2. Energy is the ability to do work. Energy has many forms and can transfer from one form to another. Several different forms of energy, including kinetic, potential, thermal, gravitational, elastic, and chemical have been defined to explain all known natural phenomena.
3. Transformation between potential and kinetic energy is the change in the motion or position of an object from one form to another.
4. The transformation from potential energy to kinetic energy occurs when the object is in motion. The roller coaster car has potential energy at the top of each rise in the track and transforms to kinetic energy as the car moves down the track. The higher the roller coaster car, the greater the potential energy.
5. The transformation from kinetic energy occurs when an object transfers from a moving object to an object in a position with potential energy.
6. A mechanical system is an arrangement of parts that work together.
7. Simple mechanical systems use potential and kinetic energy, such as a roller coaster, pendulum, tossing a basketball, doing a long jump, a car going down a ramp, jumping on a pogo stick, and blowing on a pinwheel.

Assessment Clarifications

1. Potential energy changes to kinetic energy and back again.

2. The transformation from potential energy to kinetic energy occurs when the object is in motion. The roller coaster car has potential energy at the top of each rise in the track and transforms to kinetic energy as the car moves down the track. The higher the roller coaster car, the greater the potential energy.
3. The transformation from kinetic energy occurs when an object transfers from a moving object to an object in a position with potential energy.
4. A simple mechanical system like a roller coaster or pendulum shows that potential and kinetic energy change from potential energy and kinetic energy and back again.

Content Statement – P.EN.M.4

Energy Transfer – Different forms of energy can be transferred from place to place by radiation, conduction, or convection. When energy is transferred from one system to another, the quantity of energy before the transfer is equal to the quantity of energy after the transfer.

Content Expectations

P.EN.06.41 Explain how different forms of energy can be transferred from one place to another by radiation, conduction, or convection.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally how different forms of energy can be transferred from place to place by radiation, conduction, or convection.
2. Energy is the ability to do work. Several different forms of energy, including kinetic, potential, thermal, gravitational, elastic, chemical, and mass have been defined to explain all known natural phenomena.
3. Energy can be transferred (travel) from place to place.
4. Heat is given off when an object's thermal energy is transferred. Thermal energy can be transferred in three ways: by conduction, by convection, and by radiation.
5. Radiation is the transfer of energy by waves.
6. Conduction is the transfer of heat energy by direct contact between particles.
7. Convection is the transfer of heat energy through liquids and gases by moving particles.

Assessment Clarifications

1. Energy can travel from place to place.
2. Radiation is the transfer of energy by waves.
3. Conduction is the transfer of heat energy by direct contact between particles.
4. Convection is the transfer of heat energy through liquids and gases by moving particles.

P.EN.06.42 Illustrate how energy can be transferred while no net loss or gain of energy is lost or gained in the transfer.

Instructional Clarifications

1. Illustrate is to clarify by way of drawings, diagrams, verbally, and/or written examples or comparisons of how energy can be transferred while no net loss or gain of energy occurs in the transfer.
2. Energy is the ability to do work. Several different forms of energy, including kinetic, potential, thermal, gravitational, elastic, chemical, and mass have been defined to explain natural phenomena.
3. Energy is not lost or gained when it is transferred (moved) from potential to kinetic energy.
4. As an object falls, potential energy decreases and kinetic energy increases.
5. As an object is raised (elevated) kinetic energy decreases, and potential energy increases.

Assessment Clarifications

1. Energy is not lost or gained when energy is moved from potential to kinetic energy.
2. As an object falls, potential energy decreases and kinetic energy increases.
3. As an object is raised (elevated) kinetic energy decreases, and potential energy increases.

Standard: Changes in Matter

Content Statement – P.CM.M.1

Changes in State – Matter changing from state to state can be explained by using models, which show that matter is composed of tiny particles in motion. When changes of state occur, the atoms and/or molecules are not changed in structure. When the changes in state occur, mass is conserved because matter is not created or destroyed.

Content Expectations

P.CM.06.11 Describe and illustrate changes in state, in terms of arrangement and relative motion of the atoms or molecules.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words how changes in state happen in terms of arrangement and relative motion of atoms or molecules.

2. Illustrate is to clarify by way of drawings, diagrams, verbally, and/or written examples or comparisons changes in state, in terms of arrangement and relative motion of atoms or molecules.
3. The term change refers to physical change.
4. A material will change from one state to another at specific combinations of temperature and surrounding pressure.
5. The states of matter include solid, liquid, gas, and plasma.
6. Processes such as freezing, melting, evaporation, condensation, sublimation, and deposition are various changes in states of matter.
7. The temperature of a material will increase or decrease until it reaches the point where the change takes place. It will stay at that temperature until that change is completed.
8. The motion of molecules or atoms will increase or decrease as temperature increases or decreases.
9. Atoms are the smallest particles that make up all matter; molecules are a combination of two or more atoms.

Assessment Clarifications

1. The term change refers to physical change.
2. A material will change from one state to another at specific combinations of temperature and surrounding pressure.
3. The states of matter include solid, liquid, gas, and plasma.
4. Processes such as freezing, melting, evaporation (boiling point), condensation, are various changes in states of matter.
5. The temperature of a material will increase or decrease until it reaches the point where the change takes place. It will stay at that temperature until that change is completed.
6. The motion of molecules or atoms will increase or decrease as temperature increases or decreases.
7. Atoms are the smallest particles that make up all matter; molecules are a combination of two or more atoms.

P.CM.06.12 – Explain how mass is conserved as a substance changes from state to state in a closed system.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally how mass is conserved as it changes from state to state in a closed.
2. Mass is the amount of matter an object contains.
3. When mass is conserved the amount of matter stays the same.
4. A closed system is a contained or isolated environment without influence or interaction with outside environments.
5. An example of conservation of mass in a closed system would be an ice cube (solid) in a covered jar that is allowed to melt (liquid). The mass before and the mass after would be conserved or the same. The closed system ensures that the melting ice cube is not influenced by evaporation or other atmospheric conditions from the outside environment.

Assessment Clarifications

1. When mass is conserved its stays the same.
2. A closed system is a contained or isolated environment without influence or interaction with outside environments.
3. An example of mass in a closed system would be an ice cube (solid) in a covered jar and that is allowed to melt (liquid). The mass before and the mass after would be conserved or the same. The closed system ensures that the melting ice cube is not influenced by evaporation or other atmospheric conditions from the outside environment.

Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications

Inquiry Process
S.IP.06.11 Generate scientific questions based on observations, investigations, and research concerning energy and changes in matter.
S.IP.06.12 Design and conduct scientific investigations to understand energy and changes in matter.
S.IP.06.13 Use tools and equipment (models, thermometers) appropriate to scientific investigations of energy and changes in matter.
S.IP.06.14 Use metric measurement devices in an investigation of energy and changes in matter.
S.IP.06.15 Construct charts and graphs from data and observations dealing with energy and changes in matter.
S.IP.06.16 Identify patterns in data dealing with energy and changes in matter.
Inquiry Analysis and Communication
S.IA.06.11 Analyze information from data tables and graphs to answer scientific questions on energy and changes in matter.
S.IA.06.12 Evaluate data, claims, and personal knowledge through collaborative science discourse about energy and changes in matter.
S.IA.06.13 Communicate and defend findings of observations and investigations about energy and changes in matter using evidence.
S.IA.06.14 Draw conclusions from sets of data from multiple trials about energy and changes in matter using scientific investigation.
S.IA.06.15 Use multiple sources of information on energy and changes in matter to evaluate strengths and weaknesses of claims, arguments, or data.
Reflection and Social Implications
S.RS.06.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding energy and changes in matter.
S.RS.06.12 Describe limitations in personal and scientific knowledge regarding energy and changes in matter.
S.RS.06.13 Identify the need for evidence in making scientific decisions about energy and changes in matter.
S.RS.06.14 Evaluate scientific explanations based on current evidence and scientific principles dealing with energy and changes in matter.
S.RS.06.15 Demonstrate scientific concepts concerning energy and changes in matter through various illustrations, performances, models, exhibits, and activities.
S.RS.06.16 Design solutions to problems on energy and changes in matter using technology.
S.RS.06.17 Describe the effect humans and other organisms have on the balance of the natural world when matter is changed and/or energy is transferred.
S.RS.06.18 Describe what science and technology in regards to energy and changes in matter can and cannot reasonably contribute to society.
S.RS.06.19 Describe how science and technology of energy and changes in motion have advanced because of the contributions of many people throughout history and across cultures.

Vocabulary

Critically Important – State Assessable	Instructionally Useful
energy transfer heat transfer states of matter conduction convection radiation kinetic energy potential energy atoms molecules mass closed system transformation	matter mechanical systems motion solid liquid gas phase change plasma calorie Joule melting boiling point condensation freezing evaporation sublimation deposition conservation of energy

Instruments, Measurements, Representations

Measurements	Instruments/Tools	Representations
temperature	thermometer, hot plate	Celsius
time	stop watch, times, clock with second hand	seconds, minutes

Instructional Framework

The following Instructional Framework is an effort to clarify possible units within the K-7 Science Grade Level Content Expectations. The Instructional Framework provides descriptions of instructional activities that are appropriate for inquiry science in the classroom and meet the instructional goals. Included are brief descriptions of multiple activities that provide the learner with opportunities for exploration and observation, planning and conducting investigations, presenting findings, and expanding thinking beyond the classroom. The Instructional Framework is NOT a step-by-step instructional manual, but a guide intended to help teachers and curriculum developers design their own lesson plans, select useful and appropriate resources and create assessments that are aligned with the grade level science curriculum for the State of Michigan.

Instructional Examples

Kinetic and Potential Energy: P.EN.06.11, P.EN.06.12

Energy Transfer: P.EN.06.41, P.EN.06.42

Changes in State: P.CM.06.11, P.CM.06.12

Objectives

- Distinguish between kinetic and potential energies as found in everyday situations.
- Show how potential energy can become kinetic energy.
- Show how kinetic energy can become potential energy.
- Explain how heat energy is transferred from place to place by radiation, conduction, or convection.
- Describe changes in states of matter in terms of motion and arrangements of atoms and molecules.

Engage and Explore

- Students explore how different heights affect the potential energy of an object, and discover that a rubber ball and ping-pong ball bounce higher and a clay ball changes shape more when it is dropped from a high height. (P.EN.06.11, P.EN.06.12)
- Pop popcorn by using each of the transfer methods. (1) Pop popcorn in a pan on the stove – conduction, (2) Pop popcorn in a hot air popcorn popper – convection, and (3) Pop popcorn in the microwave – radiation. (P.EN.06.41, P.EN.06.42)
- Divide the students into groups. Each group selects at least three samples such as ice cream, stick of butter, gelatin, and ice cube. Place the items on a pie plate. Heat the items on the hot plate. Note the order in which items melt. Organize the data by placing the items that melted

last at the top of the list and the items that melted first at the bottom.
(P.CM.06.11, P.CM.06.12)

Explain and Define

- Students analyze and explain their investigations into different samples as they change state of matter.
- As a class define the terms kinetic and potential energy. Kinetic energy is energy of motion found in objects or substances. Potential energy is the energy possessed by a body as a result of its position or condition rather than its motion. Energy may be changed from one form to another, but the amount of energy stays the same. (P.EN.06.11, P.EN.06.12)
- Heat energy can travel only by being carried along in some kind of material. In a pan on the stove, the stove heats the pan by means of conduction. In a hot-air popcorn popper, the popcorn is heated by the hot air causing the popcorn to pop by means of convection. Finally, in a microwave oven, the popcorn is popped by means of radiation (micro-waves). (P.EN.06.41, P.EN.06.42)
- As a class, define the states of matter, solids, liquids, and gases in terms of the motion of the molecules. Make a "human model of a substance in each state. Have students stand shoulder to shoulder, packed closely together and jiggle or vibrate to demonstrate the motion of molecules in a solid. To make a "human model" of a liquid have students join hands and move around without letting go of each other. The final "human model" of a gas allows the students to roam around the room, bump into each other and move away, and move out the door if the door is open. Describe examples of weather conditions that show all three states of water. (P.CM.06.11, P.CM.06.12)

Elaborate and Apply

- Hold a rubber ball and a ping-pong ball at the height of 1 m. Release the balls and another student measures how high the balls bounce. Record the heights. Do this three times with each ball. Then drop the rubber ball and ping-pong ball from 2 m. Again record the height. Repeat the activity with a clay ball the same size as the rubber and ping-pong balls at both 1 m and 2 m. What happened to the clay ball? (P.EN.06.11, P.EN.06.12, S.IP.06.11)
- Graph the results of the ping-pong ball and rubber ball. What was the relationship between the height and the bounce? What was expected/predicted when the height was raised? When was potential energy changed to kinetic energy? When did the kinetic energy change back to potential energy? Was any energy lost in the process? (P.EN.06.11, P.EN.06.12)
- After popping the popcorn, the class will do a taste test as the preferred method of popping popcorn. Which method took the longest? Which of the methods - conduction, convection, radiation - was the "messiest?"

Poll the class as to the preferences. Make a table to show the results. (P.EN.06.41, P.EN.06.42)

- Each group selected at least three samples such as ice cream, stick of butter, gelatin, and ice cube. The items were placed on a pie plate and heated. Note the order in which items melt. Organize the data by placing the items that melted last at the top of the list and the items that melted first at the bottom. This activity focuses on solids and liquids. Is there a way that the items can be changed to a gas? Graph the results on a graph within the small group, then compile a list for the whole group and graph the results on a large graph. Were the results predicted by the group before starting? Did the predictions and the results match? What type of materials melted the fastest? (P.CM.06.11, P.CM.06.12, S.IP.06.12)

Evaluate Student Understanding

Formative Assessment Examples

- What evidence was observed for potential energy using the ping-pong ball and rubber ball prior to being released at 1 m and then at 2 m? What happened to the amount of energy stored in the balls as they were raised from 1 m to 2 m? What happened to the energy stored in the balls when they were released? Some materials store energy when they change shape as they strike a surface. Then they release the energy. Which material, rubber, plastic, or clay, stores energy this way? How was this determined? (P.EN.06.11, P.EN.06.12)
- Experiments that use transferring of energy, states of matter, and potential and kinetic energy and make inferences on what is expected to happen in each case. (P.EN.06.41, P.EN.06.42, P.EN.06.11, P.EN.06.12)
- Classroom discussion on transferring energy, states of matter, and potential and kinetic energy. (P.EN.06.41, P.EN.06.42, P.EN.06.11, P.EN.06.12)
- Student journal explaining the results of experiments conducted concerning transferring of energy, states of matter, and potential and kinetic energy. (P.CM.06.11, P.CM.06.12, P.EN.06.41, P.EN.06.42, P.EN.06.11, P.EN.06.12)
- With a partner or as a group, role play changes in matter and how potential energy changes to kinetic energy and back again. (P.EN.06.11, P.EN.06.12)
- Take a museum tour and/or alternative energy tour. What was learned about different forms of alternative energy? (P.EN.06.41, P.EN.06.42)
- Was there a time difference on how long it took the popcorn to pop? Was there a flavor difference? Each student is to write an essay on the three types of heat transfers, and how they apply to the popcorn. (P.EN.06.41, P.EN.06.42)
- After graphing the results, is there any inference that can be made about types of materials and how fast they melt? Individually, write a paragraph explaining the results of the experiment. What statements can

be made about matter changing states? (P.CM.06.11, P.CM.06.12, S.IP.06.15, S.IP.06.16)

Summative Assessment Examples

- End of unit test covering states of matter, transferring energy, and kinetic and potential energy. (P.CM.06.11, P.CM.06.12, P.EN.06.41, P.EN.06.42, P.EN.06.11, P.EN.06.12)
- Each student designs and presents a poster, brochure, or Power Point presentation on energy transfer. (P.EN.06.41, P.EN.06.42)
- Each student writes report on uses/benefits of alternative power. (P.EN.06.41, P.EN.06.42)

Enrichment

- Observing kinetic and potential energy: Have the students jump on a pogo stick.
- Have students divide into groups and design a roller coaster. What happens if they change the design of their roller coaster? Students can research different roller coasters at amusement parks. What are some unique characteristics of the most popular roller coasters? What makes each roller coaster unique? When are the potential and kinetic energy the greatest and least for these roller coasters?
- Testing States of Matter: Students should take home and inflate and tie off the balloon. Carefully tie the string so that it is tight around the outside of the balloon. Put the balloon and string inside of the freezer for 30 minutes. After that time, check the balloon and record your observations. Check the balloon after an hour and record your observations. Write predictions as to what will happen to the balloon over time. The following class asks students: (a) What happened to the balloon? (b) How did the size change? (c) In what way might particle movement have changed for this to be observed? (d) Would collisions between particles have increased, decreased, or stayed the same? (e) Would the overall movement of the particles have increased, decreased, or stayed the same? (f) What might happen if the balloon was heated instead of cooling it? (g) Is there a way to test this?
- Writing: Explain to students that early Greek thinkers assumed that all matter was composed of fire, water, air, and earth. The properties of these ingredients include hot, cold, wet, and dry. Have students create a story that explains why the early thinkers had such ideas about matter.

Intervention

- Energy transfer: Using a pinwheel: (1) spin with your finger, (2) spin by blowing, and (3) spin when holding over a lamp. Questions to ask the class: (a) How was the pinwheel used to show transferring of energy? (b) Compare and contrast each situation making the pinwheel move.
- Potential Energy and Kinetic Energy: Using a rubber band and a Styrofoam cup that has been cut in half lengthwise. Use the half-cup and a smooth level surface to figure out how the potential energy in a stretched rubber band depends on the distance it is stretched. Stretch the rubber band and fire it at the half-cup so that it hits the cup at center back. Note how far the rubber band was stretched and how far the cup was moved. Now stretch the rubber band twice as far and repeat. What happened to the distance the cup moved?
- Student wearing roller skates is standing still. Another student walks up and pushes the student on roller skates. Student walking stops his/her motion, student on skates moves forward. Note movement of students. Explain energy transfer. Two students wear roller skates facing each

other. Students push against each other. What was the movement? What energy was transferred?

Examples, Observations, and Phenomena (Real World Context)

The investigation of wind power, solar power, hydroelectric power, and bio-diesel provides a timely exploration into radiation, conduction, and convection heat transfer and the means to incorporate the concepts.

Conduction is the transfer of heat and electrical energy from one molecule to another. This transfer occurs when molecules hit against each other, similar to a game of pool where one moving ball strikes another, causing the second to move. Conduction takes place in solids, liquids, and gases, but works best in materials that have simple molecules that are located close to each other. For example, metal is a better conductor than wood or plastic, Newton's cradle transfers impact energy from one to another. A common example of conduction is the conduction of electrons through a copper wire to produce electricity and heat.

Convection is the movement of heat by a liquid such as water or a gas such as air. The liquid or gas moves from one location to another, carrying heat along with it. This movement of a mass of heated water or air is called a current. Examples of the above can be observed in weather and ocean currents, the space above a candle flame.

Heat travels from the sun by a process called radiation. Radiation is the transfer of heat by electromagnetic waves. When infrared rays strike a material the molecules in that material move faster. In addition to the sun, light bulbs, irons, and toasters radiate heat. When we feel heat around these items, however, we are feeling convection heat (warmed air molecules) rather than radiated heat since the heat waves strike and energize surrounding air molecules. Example would be a pizza solar oven. Cells burn food to release energy, some of which is changed into heat energy. Through cellular activity, organisms are able to maintain their body temperature through radiation.

A swimming pool and a teacup filled with water might both be at the same temperature; their molecules would be moving at the same rate. The swimming pool would contain much more potential thermal energy because it contains more molecules. Potential and kinetic energy can be seen in a swing. The potential energy is at each end of the swinging motion, while the kinetic energy is the actual motion of the swing.

Literacy Integration

Students will...

Reading

R.IT.06.01 analyze the structure, elements, features, style, and purpose of informational genre, including research reports, “how-to” articles, and essays.

R.CM.06.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.06.02 retell through concise summarizations grade-level narrative and informational text.

R.CM.06.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Books:

Energy (Eye-Witness), Jack Challoner, 1993

Energy (See for Yourself), DK Publishing, Chris Woodford, 2007

Read the book *Energy (Eye-Witness)* by Jack Challoner, 1993. After the students have read the book, have them compile lists of different ways they use energy each day.

Writing

W.PR.06.01 set a purpose, consider audience, and replicate authors’ styles and patterns when writing a narrative or informative piece.

W.PR.06.03 revise drafts for clarity, coherence, and consistency in content, voice, and genre characteristics with audience and purpose in mind.

W.PS.06.01 exhibit personal style and voice to enhance the written message in both narrative and informative writing.

- Students are to write a poem about a drop of water that changes state. Have students read their poems to the class.
- Students create a diagram showing three different ways (conduction, convection, and radiation) in which energy can be transferred.

Speaking

S.CN.06.01 adjust their use of language to communicate effectively with a variety of audiences and for different purposes by asking and responding to questions and remarks to engage the audience when presenting.

S.CN.06.02 speak effectively using rhyme, rhythm, cadence, and word play for effect in narrative and informative presentations.

- Small groups of students create and perform skits that show physical properties of the three states of matter.

Mathematics Integration

N.ME.06.16 Understand and use integer exponents, excluding powers of negative bases; express numbers in scientific notation.

N.FL.06.11 Find equivalent ratios by scaling up or scaling down.

A.PA.06.01 Solve applied problems involving rates, including speed.

A.RP.06.08 Understand that relationships between quantities can be suggested by graphs and tables.

M.UN.06.01 Convert between basic units of measurement within a single measurement system.

D.PR.06.02 Compute the probabilities of events from simple experiments with equally likely outcomes.

Sixth Grade GLCE Companion Document

Unit 2: Ecosystems

SCIENCE

- Big Ideas
- Clarifications
- Inquiry
- Vocabulary
- Instruments
- Measurements
- Instructional Framework
- Enrichment
- Intervention
- Real World Context
- Literacy Integration
- Mathematics Integration

Sixth Grade Companion Document

6-Unit 2: Ecosystems

Table of Contents	Page 1
Curriculum Cross Reference Guide	Page 2
Unit 2: Ecosystems	Page 4
Big Ideas (Key Concepts)	Page 4
Clarification of Content Expectations	Page 4
Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications	Page 12
Vocabulary	Page 13
Instruments, Measurements, and Representations	Page 13
Instructional Framework	Page 14
Enrichment	Page 18
Intervention	Page 18
Examples, Observations and Phenomena (Real World Context)	Page 18
Literacy Integration	Page 19
Mathematics Integration	Page 20

6th Grade Unit 2: Ecosystems

Content Statements and Expectations

Code	Statements & Expectations	Page
L.OL.M.5	Producers, Consumers, and Decomposers - Producers are mainly green plants that obtain energy from the sun by the process of photosynthesis. All animals, including humans, are consumers that meet their energy by eating other organisms or their products. Consumers break down the structures of the organisms they eat to make the materials they need to grow and function. Decomposers, including bacteria and fungi, use dead organisms or their products to meet their energy needs.	4
L.OL.06.51	Classify producers, consumers, and decomposers based on their source of food (the source of energy and building materials).	4
L.OL.06.52	Distinguish between the ways in which consumers and decomposers obtain energy.	5
L.EC.M.1	Interactions of Organisms - Organisms of one species form a population. Populations of different organisms interact and form communities. Living communities and nonliving factors that interact with them form ecosystems.	6
L.EC.06.11	Identify and describe examples of populations, communities, and ecosystems including the Great Lakes region.	6
L.EC.M.2	Relationships of Organisms – Two types of organisms may interact with one another in several ways: They may be in a producer/consumer, predator/prey, or parasite/host relationship. Some organisms may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other.	7
L.EC.06.21	Describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey).	7
L.EC.06.22	Explain how two populations of organisms can be mutually beneficial and how that can lead to interdependency.	8
L.EC.06.23	Predict and describe how changes in one population might affect other populations based upon their relationships in the food web.	8

Code	Statements & Expectations	Page
L.EC.M.3	Biotic and Abiotic Factors – The number of organisms and populations an ecosystem can support depends on the biotic (living) resources available and abiotic (nonliving) factors, such as quality of light and water, range of temperatures, and soil composition.	9
L.EC.06.31	Identify the living (biotic) and nonliving (abiotic) components of an ecosystem.	9
L.EC.06.32	Identify the factors in an ecosystem that influence changes in population size.	9
L.EC.M.4	Environmental Impact of Organisms – All organisms (including humans) cause change in the environment where they live. Some of the changes are harmful to the organism or other organisms, whereas others are helpful.	10
L.EC.06.41	Describe how human beings are part of the ecosystem of the Earth and that human activity can purposefully, or accidentally, alter the balance in ecosystems.	10
L.EC.06.42	Predict and describe possible consequences of overpopulation of organisms, including humans, (for example: species extinction, resource depletion, climate change, pollution).	10

6 - Unit 2: Ecosystems

Big Ideas (Key Concepts)

- All life forms, including humans, are part of a global food chain in which food is supplied by plants, which need light to produce food.
- Ecosystems continually change with time as environmental factors and populations of organisms change.

Clarification of Content Expectations

Standard: Organization of Living Things

Content Statement – L.OL.M.5

Producers, Consumers, and Decomposers - Producers are mainly green plants that obtain energy from the sun by the process of photosynthesis. All animals, including humans, are consumers that meet their energy needs by eating other organisms or their products. Consumers break down the structures of the organisms they eat to make the materials they need to grow and function. Decomposers, including bacteria and fungi, use dead organisms or their products to meet their energy needs.

Content Expectations

L.OL.06.51 Classify producers, consumers, and decomposers based on their source of food (the source of energy and building materials).

Instructional Clarifications

1. Classify is to arrange or order producers, consumers, and decomposers by the source of food for growth and development.
2. Producers obtain food by trapping light energy to make food and supply their energy needs (plants are examples of producers).
3. Consumers obtain their food directly from another organism by eating it or being a parasite on or in it (animals, including humans are examples of consumers).
4. Decomposers use plants and animals as well as animal waste products as their food source (examples include bacteria and fungi).

5. Decomposers release chemicals into the soil and water to break down these materials. This allows the decomposers to take in small particles and release minerals back to the environment to be recycled into plants.
6. A common misconception is that food accumulates in an ecosystem so that a top consumer (predator) has all the food from the organisms below it.

Assessment Clarification

1. Classify plants, animals (including humans), bacteria and fungi based on their source of energy into the categories: producer, consumer, and decomposer.
2. Producers obtain food by trapping light energy to make food and supply their energy needs (plants are examples of producers).
3. Consumers obtain their food directly from another organism by eating it or being a parasite on or in it (animals, including humans are examples of consumers).
4. Decomposers use plants and animals as well as animal waste products as their food source (examples include bacteria and fungi).
5. Decomposers release chemicals into the soil and water to break down these materials. This allows the decomposers to take in small particles and release minerals back to the environment to be recycled into plants.

L.OL.06.52 Distinguish between the ways in which consumers and decomposers obtain energy.

Instructional Clarifications

1. Distinguish means to recognize or know the difference between the ways in which consumers and decomposers obtain energy.
2. Consumers obtain their energy directly from another organism by eating it or being a parasite on or in it. Examples: rabbit eating a plant, mosquito eating blood.
3. Decomposers include a variety of organisms. Bacteria and fungi obtain their energy as they play a more fundamental role in the process of decomposition and nutrient recycling. Other decomposers help decomposition by breaking down larger particles of organic matter.

Assessment Clarifications

1. Consumers obtain their energy directly from another organism by eating it or being a parasite on or in it, such as a rabbit eating a plant or a mosquito eating blood.
2. Bacteria and fungi obtain their energy as they play a more fundamental role in the process of decomposition and nutrient recycling. Other decomposers help decomposition by breaking down larger particles of organic matter.

Standard: Ecosystems

Content Statement: LEC.M.1

Interactions of Organisms - Organisms of one species form a population. Populations of different organisms interact and form communities. Living communities and nonliving factors that interact with them form ecosystems.

Content Expectations

L.EC.06.11 Identify and describe examples of populations, communities, and ecosystems, including those within the Great Lakes region.

Instructional Clarifications

1. Identify and describe means to recognize and to tell or depict in spoken or written words examples of populations, communities, and ecosystems including those within the Great Lakes region.
2. A population is a group of organisms of the same species living in a particular area at a particular time and can include plant or animal examples.
3. A community consists of populations of organisms living in a general area. Communities could include urban examples such as squirrels, bird populations, trees and other plants.
4. An ecosystem is an area whose communities are determined by the environmental conditions (abiotic factors) of the area. Example: Forests of Michigan thrive with certain soil conditions and amounts of rainfall per year. Michigan ecosystems include forests, wetlands, ponds, lakes and others.
5. The Earth supports diverse populations, communities and ecosystems.

Assessment Clarifications

1. A population is a group of organisms of the same species living in a particular area at a particular time and can include plant or animal examples.
2. A community consists of populations of organisms living in a general area. Communities could include urban examples such as squirrels, bird populations, trees and other plants.
3. An ecosystem is an area whose communities are determined by the environmental conditions (abiotic factors) of the area. Example: Forests of Michigan thrive with certain soil conditions and amounts of rainfall per year. Michigan ecosystems could include forests, wetlands, ponds, lakes, dunes, prairies, and others.
4. Differentiate between the concepts of populations, communities and ecosystems.

5. Name or describe populations, communities or ecosystems within a local or regional area. Examples of populations and communities should be limited to major ecosystems of Michigan --- forests, wetlands and lakes.
6. The Earth supports diverse populations.

Content Statement – L.EC.M.2

Relationships of Organisms – Two types of organisms may interact with one another in several ways: They may be in a produce/consumer, predator/prey, or parasite/host relationship. Some organisms may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other.

Content Expectations

L.EC.06.21 Describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey).

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words patterns of competition and predator/prey interactions between populations.
2. Organisms interact with one another in a variety of ways.
3. Populations of similar organisms have similar needs and compete more directly than dissimilar organisms. Example: Populations of two species of squirrels compete more directly than a population of squirrels and a population of rabbits.
4. Symbiosis describes types of relationships or interactions between different species. One symbiotic relationship can be explained as organisms living together mutually benefiting (as with the lichen, an alga photosynthesizes and produces food to itself and a fungus in whose body it lives and is protected from drying out).
5. Parasitism is a type of relationship where one organism benefits (the parasite) from living on or within its host with the host being harmed, but not necessarily killing it. Examples: a lamprey attaches to a living fish; a brown-headed cowbird lays its eggs in another bird's nest.
6. Predator populations may be limited by the size of prey populations they depend upon. Prey populations may be prevented from overpopulating an area by predation limiting their population growth. Examples may include, among others, robin-worm, human-deer, coyote-mice, spider-fly, frog-insect, bat-moth.
7. The terms "beneficial" and "harmful" may be applied to describe relationship patterns between populations. For example:
 - a. Competition may be negative for both populations in the competitive relationship. Examples of competition include gray

squirrels and fox squirrels competing for acorns and forest trees competing for light.

- b. Parasitism is beneficial to the parasite and has a harmful effect on the host.
- c. Predator populations benefit and prey populations are harmed.

Assessment Clarifications

1. Give an example of a predatory prey relationship found in a Michigan ecosystem. Examples may include, among others, robin-worm, human-deer, coyote-mice, spider-fly, frog-insect, bat-moth.
2. Give an example of a symbiotic relationship such as lichens.
3. Give an example of competition such as gray squirrels and fox squirrels, and forest trees competing for light.
4. Give an example of a parasitism. Examples: a lamprey attaches to a living fish; a brown-headed cowbird lays its eggs in another bird's nest.

L.EC.06.22 Explain how two populations of organisms can be mutually beneficial and how that can lead to interdependency.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally ways in which populations of organisms may benefit from each other and become interdependent.
2. Two populations may develop a mutually beneficial relationship and come to depend upon one another. For example, the flowers of a particular plant population may come to depend on the services of a particular pollinator such as bees, just as the bee population comes to depend on the flower population.
3. Lichens are examples of mutually beneficial organisms with algae and fungi.

Assessment Clarifications

1. Two populations may develop a mutually beneficial relationship and come to depend upon one another. For example, the flowers of a particular plant population may come to depend on the services of a particular pollinator such as bees, just as the bee population comes to depend on the flower population.
2. Explain how a flower population and bee population have a mutually beneficial relation and are interdependent upon one another.

L.EC.06.23 Predict and describe how changes in one population might affect other populations based upon their relationships in the food web.

Instructional Clarifications

1. Predict and describe means to foretell and depict in spoken or written words how populations are dynamic and change over time.
2. An increase in the population of a predator could decrease the population of its prey. For example, as a fox population increases, the mouse and grasshopper populations may decrease.

3. An increase in the population of a prey species could increase the population of species preying upon it. For example, as the fly population increases, the population of spiders and frogs may increase.
4. An increase in the population of plant eaters could decrease the populations of several plants species.

Assessment Clarifications

1. Describe what will happen to the populations of prey in an area where the population of predators increases such as an increasing fox population causing the mouse and grasshopper populations to decrease.
2. Describe what will happen to the population of plants in an area where the population of plant eaters decreases.

Content Statement – L.EC.M.3

Biotic and Abiotic Factors – The number of organisms and populations an ecosystem can support depends on the biotic (living) resources available and abiotic (nonliving) factors, such as quality of light and water, range of temperatures, and soil composition.

Content Expectations

L.EC.06.31 Identify the living (biotic) and nonliving (abiotic) components of an ecosystem.

Instructional Clarifications

1. Identify means to recognize that biotic (living) components of an ecosystem include all forms of life including plants, animals, and microorganisms such as bacteria.
2. Abiotic component examples include sunlight, air, water, heat, soil and other non-living factors that may affect living things.

Assessment Clarification

1. Given a description of an ecosystem, identify its biotic and abiotic components. Ecosystem examples may include forests, wetlands and lakes.

L.EC.06.32 Identify the factors in an ecosystem that influence changes in population size.

Instructional Clarifications

1. Identify means to recognize different factors or conditions that may lead to the change in population size within an ecosystem.
2. Changes in the amount of rainfall or average temperature may directly influence some populations such as plants and indirectly influence others such as the animal populations that depend on these plants for food.
3. Factors that influence the population size in an ecosystem include food supply, temperature, rainfall, disease, pollution, invasive species, and human development.

4. Changes in populations may be influenced by the introduction of new species to the ecosystem. Invasive species such as zebra mussels and purple loosestrife cause change in the populations of native species.

Assessment Clarifications

1. Identify biotic factors in an ecosystem that may influence changes in populations. For example invasive species such as zebra mussels and purple loosestrife.
2. Identify abiotic factors in an ecosystem that may influence changes in populations such as temperature and rainfall.
3. Factors that influence the population size in an ecosystem include food supply, temperature, rainfall, disease, pollution, invasive species, and human development.

Content Statement – L.EC.M.4

Environmental Impact of Organisms – All organisms (including humans) cause change in the environment where they live. Some of the changes are harmful to the organism or other organisms, whereas others are helpful.

Content Expectations

L.EC.06.41 Describe how human beings are part of the ecosystem of the Earth and that human activity can purposefully, or accidentally, alter the balance in ecosystems.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words one or more ways in which humans alter ecosystems.
2. Human populations have the same basic biological needs (food, water, shelter) as other animal populations in ecosystems.
3. Human activity may intentionally destroy ecosystems as cities are built, for example, filling in wetlands and removing forests.
4. Human activity may accidentally alter ecosystems, for example, raising average global temperatures.
5. Human activity may positively alter the balance of an ecosystem through environmental programs and preservation of ecosystems.
6. A common misconception is that humans only have a negative effect on ecosystems.

Assessment Clarifications

1. Humans are part of ecosystems.
2. Humans may intentionally destroy ecosystems as cities or roads are built, by deforestations or filling wetlands.
3. Humans may accidentally destroy ecosystems by introducing invasive species or raising average global temperatures.

L.EC.06.42 Predict and describe possible consequences of overpopulation of organisms, including humans, (for example: species extinction, resource depletion, climate change, pollution).

Instructional Clarifications

1. Predict and describe means to foretell and depict, in spoken or written words, the effect of human overpopulation on
 - a. habitat destruction
 - b. species extinction
 - c. resource depletion
 - d. climate change
 - e. pollution
2. As human population of the world has increased, habitat destruction has led to species extinction.
3. Historical data is used to:
 - a. Compare increases in human populations and deforestation.
 - b. Compare use of fossil fuels and changes in world temperature.
4. Overpopulation of invasive species often displaces native species, possibly leading to localized extinction of them.

Assessment Clarifications

1. Describe the consequences of overpopulation of organisms in an ecosystem.
2. Predict and describe the effect of human overpopulation on
 - a. species extinction
 - b. resource depletion
 - c. climate change
 - d. pollution
3. Overpopulation of invasive species often displaces native species, possibly leading to localized extinction.

Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications
--

Inquiry Process
S.IP.06.11 Generate scientific questions about populations, communities and ecosystems, based on observations, investigations, and research.
S.IP.06.12 Design and conduct scientific investigations to study the communities within ecosystems (such as collecting water and organisms from different bodies of water and comparing them).
S.IP.06.13 Use tools and equipment (hand lens, microscopes, thermometer) appropriate to the scientific investigation.
S.IP.06.15 Construct charts and graphs from data and observations (such as number of organisms, growth of organisms, temperature).
S.IP.06.16 Identify patterns in data collected from the various ecosystems.
Inquiry Analysis and Communication
S.IA.06.11 Analyze information from data tables and graphs to answer scientific questions on the patterns of relationships between the communities within ecosystems.
S.IA.06.12 Evaluate data, claims, and personal knowledge of ecosystems through collaborative science discourse.
S.IA.06.14 Draw conclusions from sets of data from multiple trials (all of the students' model ecosystems) of the scientific investigation.
S.IA.06.15 Use multiple sources of information to evaluate strength and weaknesses of claims and data of the populations and communities within the Great Lakes region.
Reflection and Social Implication
S.RS.06.22 Describe limitations in personal and scientific knowledge regarding the relationships of populations within an ecosystem.
S.RS.06.25 Demonstrate the relationships between populations through various illustrations.
S.RS.06.27 Describe the effect humans and other organisms have on the natural balance of ecosystems.
S.RS.06.29 Describe how the study of ecosystems has advanced because of the contributions of many people (such as Rachel Carson, Ed Ricketts, Simon Levin, Drew Lanham) throughout history and across cultures.

Vocabulary

Critically Important–State Assessable	Instructionally Useful
ecosystem	ecological role or niche
biotic components	climate change
abiotic components	environmental impact
population	balance in ecosystems
community	source of energy
producers	habitat
consumers	food web
decomposers	forests
bacteria	wetlands
fungus	ponds
parasite	lakes
predator	tropical rainforest
prey	tundra
symbiosis	desert
competition	coral reef
pollution	dunes
resource depletion	prairies
species extinction	

Instruments, Measurements, Representations

meter tape	use to measure for area of a "habitat"
representations	create & utilize population data tables
representations	labeled ecological collages and brochures
model	symbolic representation of a select ecosystem

Instructional Framework

Instructional Examples

Producers, Consumers, Decomposers: L.OL.06.51, L.OL.06.52
Interactions of Organisms: L.EC.06.31, L.EC.06.11, L.EC.06.21, L.EC.06.22, L.EC.06.23, L.EC.06.32, L.EC.06.41, L.EC.06.42

Objectives

- Students identify the biotic and abiotic factors in ecosystems.
- Students define and identify producers, consumers and decomposers in ecosystems that could be found in Michigan.
- Students describe the characteristics of populations and communities within Michigan ecosystems.
- Students identify characteristics of parasitic relationships.
- Students understand how human activities change environmental conditions and positively and negatively impact ecosystems.

Engage and Explore

- While sitting comfortably on the ground in the schoolyard, students sketch all that they see in the surrounding area in a map format (to scale). After making the map drawing of the schoolyard, students create two separate lists, one listing the living things they saw or drew and another listing the nonliving things they observed such as the sun, wind, clouds, temperature, soil. (L.EC.06.31, L.OL.06.51, S.IP.06.11)
- Introduce the terms biotic and abiotic. From the list of living things, students discuss with each other the ways in which the living things obtain energy to sustain life. Introduce the terms producers, consumers, and decomposers and the ways in which these groups obtain energy to sustain life. (L.EC.06.31, L.OL.06.51, S.IP.06.11)
- Take students on a walk around the school building to look for biotic and abiotic components and identify examples of producers, consumers, and decomposers. Have students explain why they categorized organisms into these particular categories. (L.OL.06.51, L.OL.06.52, L.EC.06.41, S.IP.06.11, S.IP.06.16, S.RS.06.27)
- Introduce the terms populations and communities. Have students use these terms in relation to the living things they observed in the schoolyard and listed. For example, students could make note of a population of ants (consumers) and hypothesize about the ways in which it obtains energy for survival. Students observe the schoolyard and surrounding area to talk about how the original land was altered in order to build the school. (L.OL.06.51, L.OL.06.52, L.EC.06.41, S.IP.06.11, S.IP.06.16, S.RS.06.27)

Explain and Define

- Students work in groups to select, from a suggested list, a Michigan ecosystem on which they focus. Each group researches a different ecosystem. Students brainstorm on all the types of populations and communities of organisms they might see in their ecosystem and then confirm this information by finding actual pictures of animals, plants and abiotic factors (from magazines or Internet) which are found within their selected ecosystem. (L.EC.06.31, L.OL.06.51, L.OL.06.52, L.EC.06.11, S.IP.06.11, S.IP.06.15)
- Using these pictures, students make an ecosystem collage that is placed on the classroom walls. In a classroom discussion, students identify the attributes and value of each ecosystem (such as the interdependence of biotic and abiotic factors) and well as discuss their benefits to the world and how humans alter these natural ecosystems. (L.EC.06.31, L.OL.06.51, L.OL.06.52, L.EC.06.11, S.IP.06.11, S.IP.06.15)
- Ask students why they eat (to obtain energy and building materials to sustain life). Then have students list what they have eaten for one or two days. For each food item, have students identify from what their food item was derived and how the item obtained its energy to sustain life. For example, if students gain energy from eating a hamburger, the meat would be traced back to a steer, which gained its energy from eating grass and the grass made its own food by converting energy it gained from the sun. (L.OL.06.51, L.OL.06.52, S.IP.06.11)
- Have students trace back where the food energy came from select items and make a representation of this in a form of a diagram. Have students find out from where the non-food items are from (such as plastic utensils, paper plates). Students identify the sources of energy as having come from producers or consumers. (L.OL.06.51, L.OL.06.52, S.IP.06.11)
- Pairs of students work together with one student researching information about symbiotic and parasitic relationships. Students think-pair-share with each other about what they found interesting about these relationships. Students get together with others to compare the similarities between the organisms they studied. Students uncover the characteristics of these types of relationships. (L.EC.06.21, S.IP.06.11, S.IP.06.16)
- Build a classroom habitat with a variety of organisms that are indigenous to Michigan, (pill bugs, snail, slug, earthworms, grass, fern, millipede, etc.). Conduct long-term observations of the role of the organisms in the model ecosystem.

Elaborate and Apply

- Ask students to brainstorm how the number of individuals in a group (population) may affect other organisms of its own kind and of other populations. Students do an activity to see how much space each person

has in the classroom. Students work in pairs to measure the length and width of the classroom to find the area of the room in square meters. Students divide the number of square meters in the classroom by the number of individuals to find out how much space each person has. Have students calculate the population density of the class by dividing the number of individuals by the area to get individuals per unit area. (L.EC.06.23, L.EC.06.32, S.IP.06.11, S.IP.06.14, S.RS.06.27)

- Have students role play changes in population and loss of space by physically moving closer or further apart as they calculate new numbers as the population of the class doubles or if the size of the room (loss of habitat space) is reduced. Have students note how they feel as their amount of space is reduced. Class discussion focuses on factors that influence changes in populations within ecosystems students have studied. Adapted from:
<http://sftrc.cas.psu.edu/LessonPlans/Wildlife/Organisms.html>
(L.EC.06.23, L.EC.06.32, S.IP.06.11, S.IP.06.14, S.RS.06.27)
- Students research data for the moose/wolf population on Isle Royale in Lake Superior and focus upon how they are interdependent and how the populations have changed over time and what has happened as either population changed in numbers. (L.EC.06.21, L.EC.06.22, L.EC.06.23, L.EC.06.32, L.EC.06.41, S.IP.06.11, S.IP.06.15, S.IP.06.16, S.IA.06.11, S.IA.06.14)
- Students research the deer population in Michigan and understand hunting assists in managing the deer population due to deer no longer having a natural predator (the wolf). Students uncover case studies for managing deer populations in local county or state parks where hunting is not permitted. (L.EC.06.21, L.EC.06.22, L.EC.06.23, L.EC.06.32, L.EC.06.41, S.RS.06.22, S.RS.06.27, S.IA.06.11)
- Students use an indigenous vegetation map of the United States to observe the defined eco-regions such as deciduous forests, prairies, deserts, and others. Relate the abiotic factors (such as climate and soil types) to the various zones of indigenous vegetation. Students compare current and historical maps to identify changes in human related changes in ecosystems. Through guided observations and questioning have students think about how these areas could be or could have been managed or developed in a way so that there is less of a loss of habitat for native plants and animals. Have students discuss in groups of 3-4 how these changes by people affect other organisms and how humans could reduce negative impacts. (L.EC.06.41, L.EC.06.42, S.RS.06.27, S.IP.06.11, S.IP.06.16, S.IA.06.11, S.IA.06.14, S.RS.06.27)
- Groups of students research one of three topics affecting watersheds: waste water treatment, invasive “water” species (purple loosestrife, Zebra or Quagga mussels) and impervious surfaces (pavement and buildings). Each group becomes “expert” on the history of its selected topic as well as understanding differing views or issues related to its topic. (L.EC.06.41, L.EC.06.42, S.IA.06.13, S.IA.06.15, S.RS.06.21, S.IP.06.13, S.IP.06.11, S.IP.06.12, S.IP.06.16, S.IA.06.12, S.IA.06.14, S.RS.06.22, S.RS.06.27, S.RS.06.25)

- Groups design their own scientific study, then generate questions to study such as how an invasive species spread or arrived, the amount of impervious surfaces in their school yard or local area, how waste water treatment works and how it could be improved. Each group conducts activities appropriate to its selected topic. Water filtration columns are used to remove water contaminants and demonstrate infiltration through pervious surfaces. Students then present findings (including data tables if applicable), discuss the topic, and develop a reasonable solution to the problem where appropriate. (L.EC.06.41, L.EC.06.42, S.IA.06.13, S.IA.06.15, S.RS.06.21, S.IP.06.13, S.IP.06.11, S.IP.06.12, S.IP.06.16, S.IA.06.12, S.IA.06.14, S.RS.06.22, S.RS.06.27, S.RS.06.25)

Evaluate Student Understanding

Formative Assessment Examples

- Select an ecosystem found in Michigan (forests, wetlands or lakes) and create a tri-fold brochure to “sell its value”. A rubric of requirements such as naming some animals (from several group classifications), plants, and defining populations and communities within this ecosystem, human uses of this ecosystem (positive and negative uses), and ways in which these can be managed for sustainability is developed and then provided to students. Students design a promotional campaign convincing classmates why they should visit their selected ecosystem during their summer vacation. (L.EC.06.11, L.EC.06.41)

Summative Assessment Examples

- Divide the class into groups to research an assigned ecosystem in the Great Lakes region and prepare a report. Students find out about the unique features of their ecosystem including plant and animal populations and communities. Students design an ecosystem poster displaying the ecosystem for a class presentation. Students label or list the producer, consumer, decomposer and abiotic components in the ecosystem. (L.OL.06.51, L.EC.06.31)
- Make diagrams or illustrations of relationships and connections found within ecosystems. (L.OL.06.51, L.EC.06.31, L.EC.06.32)
- Create a concept map with linking words representing relationships and connections within ecosystems. (L.EC.06.11, L.EC.06.21, L.EC.06.22, L.EC.06.23, L.EC.06.31, L.EC.06.32, L.EC.06.41, L.EC.06.42)

Enrichment

- Museums or science centers with appropriate displays
- Naturalist guided tours of various ecosystems at local parks
- Assembly with educational programming related to ecosystems
- Students participate in activities from Project Wild (for example: Oh Deer! for demonstrating changes in populations).

Intervention

- Students view a short video relevant to the above content expectations, from United Streaming, Annenberg or other sources.
- Provide alternative print material (with diagrams, photographs, illustrations or appropriate to the students' literacy level).
- Create a concept map with linking words to use throughout teaching cycle

Examples, Observations, and Phenomena (Real World Context)

Students are a part of their surrounding ecosystem. They interact with their natural environment everyday. Students who have taken vacations "up north" or to Michigan's many lakes have observed that Michigan has a variety of distinct ecosystems. Students observe seasonal populations of animals such as the American Robin during the spring and summer months. Students are able to observe man's impact on the environment on a regular basis such as by seeing what used to be a farmer's field being developed into a new subdivision. Students think about the choices they make in their own lives in order to lessen their negative impacts on the environment such as by recycling or riding bikes rather than in automobiles.

Literacy Integration

Students will...

Reading

R.NT.06.04 analyze how authors use literary devices including dialogue, imagery, mood, and understatement to develop the plot, characters, point of view, and theme.

R.CM.06.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

Books:

Sand County Almanac, Aldo Leopold

Silent Spring, Rachel Carson

The Woods Scientist, Stephen R. Swinburne, 2002

- Students read *Sand County Almanac* by Aldo Leopold or *Silent Spring* by Rachel Carson to learn about the beginning of modern environmental ethics and conservation. (S.RS.06.29)

Writing

W.PR.06.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PS.06.01 exhibit personal style and voice to enhance the written message in both narrative (e.g., personification, humor, and element of surprise) and informational writing (e.g., emotional appeal, strong opinion, and credible support).

- Students write a natural history story of a select organism describing its interactions and life cycle within the selected ecosystem or tell its story along with the components of the ecosystem from the organism's point-of-view.

Speaking and Listening

S.CN.06.01 adjust their use of language to communicate effectively with a variety of audiences and for different purposes by asking and responding to questions and remarks to engage the audience when presenting.

S.DS.06.03 discuss written narratives that include a variety of literary and plot devices (e.g., established context plot, point of view, sensory details, dialogue, and suspense).

L.CN.06.01 respond to, evaluate, and analyze the speaker's effectiveness and content when listening to or viewing a variety of speeches and presentations.

- Students prepare and present in first person information about the life and contribution of influential people in the field of environmental education and natural history, such as Rachel Carson. Students listen to others doing the same and engage in discourse for peer review of presentations. (S.RS.06.29)

Mathematics Integration

N.FL.06.10 Add, subtract, multiply and divide positive rational numbers fluently.

- Students chart population fluctuations as a result of studying deer populations in Michigan. (S.IP.06.15, S.IA.06.11)
- Students chart population fluctuations of the moose and wolf on Isle Royal. (S.IP.06.15, S.IA.06.11)

Sixth Grade GLCE Companion Document

Unit 3: Composition, Properties, and Changes of the Earth

SCIENCE

- Big Ideas
- Clarifications
- Inquiry
- Vocabulary
- Instruments
- Measurements
- Instructional Framework
- Enrichment
- Intervention
- Real World Context
- Literacy Integration
- Mathematics Integration

Sixth Grade Companion Document

6-Unit 3: Composition, Properties, and Changes of the Earth

Table of Contents	Page 1
Curriculum Cross Reference Guide	Page 2
Unit 3: Composition, Properties, and Changes of the Earth	Page 3
Big Ideas (Key Concepts)	Page 3
Clarification of Content Expectations	Page 3
Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications	Page 8
Vocabulary	Page 9
Instruments, Measurements, and Representations	Page 9
Instructional Framework	Page 10
Enrichment	Page 13
Intervention	Page 13
Examples, Observations and Phenomena (Real World Context)	Page 14
Literacy Integration	Page 15

**6th Grade Unit 3:
Composition, Properties, and Changes of the Earth**

Content Statements and Expectations

Code	Statements & Expectations	Page
E.SE.M.4	Rock Formation – Rocks and rock formations bear evidence of the minerals, materials, temperature/pressure conditions and forces that created them.	3
E.SE.06.41	Compare and contrast the formation of rock types (igneous, metamorphic, and sedimentary) and demonstrate the similarities and differences using the rock cycle model.	3
E.SE.M.1	Soil – Soils consist of weathered rocks and decomposed organic materials from dead plants, animals, and bacteria. Soils are often found in layers with each having a different chemical composition and texture.	4
E.SE.06.11	Explain how physical and chemical weathering lead to erosion and the formation of soils and sediments.	4
E.SE.06.12	Explain how waves, wind, water, and glacier movement shape and reshape the land surface of the Earth by eroding rock in some areas and depositing sediments in other areas.	5
E.SE.06.13	Describe how soil is a mixture, made up of weather-eroded rock and decomposed organic material, water, and air.	5
E.SE.06.14	Compare and contrast different soil samples based on particle size.	6
E.SE.M.6	Magnetic Field of Earth – Earth as a whole has a magnetic field that is detectable at the surface with a compass.	6
E.SE.06.61	Describe the Earth as a magnet and compare and contrast the magnetic properties of the Earth to that of a natural or manufactured magnet.	6
E.SE.06.62	Explain how a compass works using the magnetic field of the Earth, and how a compass is used for navigation on land and sea.	7

6-Unit 3: Composition, Properties, and Changes of the Earth

Big Ideas (Key Concepts)

- Earth materials have properties that make the materials useful.
- Earth materials and the surface of the Earth change gradually and rapidly.
- The Earth has magnetic properties.

Clarification of Content Expectations

Standard: Solid Earth

Content Statement – E.SE.M.4

Rock Formation – Rocks and rock formations bear evidence of the minerals, materials, temperature/pressure conditions and forces that created them.

Content Expectation

E.SE.06.41 Compare and contrast the formation of rock types (igneous, metamorphic, and sedimentary) and demonstrate the similarities and differences using the rock cycle model.

Instructional Clarifications

1. Compare and contrast means to show similarities and differences between the formation of rock types (igneous, metamorphic, and sedimentary) and demonstrate the similarities and differences using the rock cycle model.
2. All rocks are similar because they are composed of minerals.
3. Rocks, over time, can be transformed into other types of rocks.
4. There are three different types of rocks—igneous, metamorphic, and sedimentary.
5. The three rock types are different in the way in which they are formed. Igneous rocks are formed from melted minerals that have cooled and hardened. Metamorphic rocks are formed by intense heat pressure and chemical reactions. Sedimentary rocks are formed either from the compaction and cementation of sediment (pressure) or chemical precipitation in water.
6. The rock cycle is a conceptual model that depicts rock changing and rock forming processes.

Assessment Clarifications

1. All rocks are similar because they are composed of minerals.

2. There are three different types of rocks—igneous, metamorphic, and sedimentary.
3. The three rock types are different in the way in which they are formed. Igneous rocks were formed from melted minerals that have cooled and hardened. Metamorphic rocks were formed by intense heat pressure and chemical reactions. Sedimentary rocks were formed from rocks and soil that have been pressed together and cemented together.
4. The rock cycle is a process of natural changes that cause one type of rock to become another type of rock.

Content Statement – E.SE.M.1

Soil – Soils consist of weathered rocks and decomposed organic materials from dead plants, animals, and bacteria. Soils are often found in layers with each having a different chemical composition and texture.

Content Expectations

E.SE.06.11 Explain how physical and chemical weathering lead to erosion and the formation of soils and sediments.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally how physical and chemical weathering lead to erosion and the formation of soils and sediments.
2. Weathering breaks down rock.
3. Abrasion, freeze-thaw, thermal expansion/contraction, pressure unloading, and plants and organisms cause physical weathering. Abrasion occurs when water or wind carrying debris acts with a scouring action on rock surfaces. Freeze/thaw occurs when water is trapped in the spaces of rock and repeatedly frozen and thawed. Thermal expansion/contraction occurs when solar radiation causes minerals to heat and cool at various speeds producing stresses in rock over time.
4. Plant roots and the actions of organisms can also physically break down rocks.
5. Chemical processes cause chemical weathering. Water is the main agent at work in this process and causes the composition of the mineral or rock to change. Primary minerals in rock are broken down to secondary minerals and this material can be carried away in solution.
6. As soon as a rock particle is loosened by weathering and moves it is called erosion.
7. Eroded rock is one of the main components of soil.

Assessment Clarifications

1. Weathering breaks down rock.
2. Abrasion, freeze-thaw, thermal expansion/contraction, pressure unloading, and plants and organisms cause physical weathering. Abrasion occurs when water or wind carrying debris acts with a scouring action on

rock surfaces. Freeze/thaw occurs when water is trapped in the spaces of rock and repeatedly frozen and thawed. Thermal expansion/contraction occurs when solar radiation causes minerals to heat and cool at various speeds producing stresses in rock over time.

3. Chemical processes cause chemical weathering. Water is the main agent at work in this process and causes the composition of the mineral or rock to change. Primary minerals in rock are broken down to secondary minerals and this material can be carried away in solution.
4. As soon as a rock particle is loosened by weathering and moves it is called erosion.
5. Eroded rock is one of the main components of soil.

E.SE.06.12 Explain how waves, wind, water, and glacier movement shape and reshape the land surface of the Earth by eroding rock in some areas and depositing sediments in other areas.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally how waves, wind, water, and glacier movement, shape and reshape the land surface of the Earth by eroding rock in some areas and depositing sediments in other areas.
2. Rock can be eroded by wind, water (including waves), and glacial movement.
3. Processes of erosion in part determine the shapes of landforms.
4. Fragments of rock that are produced by erosion and transported are called sediment.
5. Sediment that is transported by the energy of wind or water is deposited when that energy level decreases.

Assessment Clarifications

1. Rock can be eroded by wind, water (including waves), and glacial movement.
2. Processes of erosion in part determine the shapes of landforms.
3. Fragments of rock that are produced by erosion and transported are called sediment.
4. Sediment that is transported by the energy of wind or water is deposited when that energy level decreases.

E.SE.06.13 Describe how soil is a mixture, made up of weather-eroded rock and decomposed organic material, water, and air.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words how soil is a mixture, made up of weathered eroded rock, decomposed organic material, water and air.
2. One of the components in soil is mineral, which is made from many tiny pieces of eroded rock.
3. Another component in the soil is the organic material that comes from decaying plants and animals.

4. Minerals and organic material make up approximately half of soil. In addition there is air and water.

Assessment Clarifications

1. One of the components in soil is mineral, which is made from many tiny pieces of eroded rock.
2. Another component in the soil is the organic material that comes from decaying plants and animals.
3. Minerals and organic material make up approximately half of soil. In addition there is air and water.

E.SE.06.14 Compare and contrast different soil samples based on particle size.

Instructional Clarifications

1. Compare and contrast means to show similarities and differences between different soil samples based on particle size.
2. The main particle sizes of soil from largest to smallest are: sand, silt, and clay.

Assessment Clarifications

1. Compare and contrast means to show similarities and differences between different soil samples based on particle size.
2. The main particle sizes of soil from largest to smallest are: sand, silt, and clay.

Content Statement – E.SE.M.6

Magnetic Field of Earth – Earth as a whole has a magnetic field that is detectable at the surface with a compass.

Content Expectations

E.SE.06.61 Describe the Earth as a magnet and compare and contrast the magnetic properties of the Earth to that of a natural or manufactured magnet.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words how the Earth acts as a magnet and compare and contrast means to show similarities and differences between the magnetic properties of the Earth and those of a natural or manufactured magnet.
2. The Earth acts as a giant magnet.
3. The Earth, like any natural or manufactured magnet, exhibits a north and south magnetic pole.
4. The Earth's liquid outer core spins as the Earth rotates creating a magnetic field.

Assessment Clarifications

1. The Earth acts as a giant magnet.

2. The Earth like any natural or manufactured magnet exhibits a north and south magnetic pole.

E.SE.06.62 Explain how a compass works using the magnetic field of the Earth, and how a compass is used for navigation on land and sea.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally how a compass works using the magnetic field of the Earth, and how a compass is used for navigation on land and sea.
2. A compass is composed of a small, light-weight magnet, called a needle, that is balanced on a point.
3. The Earth acts like a giant magnet and exhibits a north and south magnetic pole. One pole of the magnet will be attracted and point toward the North Pole. By convention this is called the north pole of the magnet.
4. Compasses can be used for navigation from any point on the Earth due to the Earth's magnetic field.

Assessment Clarifications

1. A compass is composed of a small, lightweight magnet, called a needle that is balanced on a point.
2. The Earth acts like a giant magnet and exhibits a north and south magnetic pole. One pole of the magnet will be attracted and point toward the North Pole. By convention this is called the north pole of the magnet.
3. Compasses can be used for navigation from any point on the Earth due to the Earth's magnetic field.

Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications

Inquiry Process
S.IP.06.11 Generate scientific questions based on observations, investigations, and research concerning rock samples.
S.IP.06.12 Design and conduct scientific investigations to understand rock formation.
S.IP.06.13 Use tools and equipment (models, thermometers) appropriate to scientific investigations of the rock cycle.
S.IP.06.14 Use metric measurement devices in an investigation of rock formation and weathering.
S.IP.06.15 Construct charts and graphs from data and observations dealing with erosion and soil formation.
S.IP.06.16 Identify patterns in data dealing with erosion and soil formation.
Inquiry Analysis and Communication
S.IA.06.11 Analyze information from data tables and graphs to answer scientific questions on rock formation, erosion, and soil formation.
S.IA.06.12 Evaluate data, claims, and personal knowledge through collaborative science discourse about erosion and the rock cycle.
S.IA.06.13 Communicate and defend findings of observations and investigations about the rock cycle using evidence.
S.IA.06.14 Draw conclusions from sets of data from multiple trials about Earth's magnetic properties using scientific investigation.
S.IA.06.15 Use multiple sources of information on Earth's magnetic properties to evaluate strengths and weaknesses of claims, arguments, or data.
Reflection and Social Implications
S.RS.06.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding the magnetic properties of Earth.
S.RS.06.12 Describe limitations in personal and scientific knowledge regarding the magnetic properties of Earth.
S.RS.06.13 Identify the need for evidence in making scientific decisions.
S.RS.06.14 Evaluate scientific explanations based on current evidence and scientific principles.
S.RS.06.15 Demonstrate scientific concepts concerning the rock cycle through various illustrations, performances, models, exhibits, and activities.
S.RS.06.16 Design solutions to problems on Earth's magnetic properties using technology.
S.RS.06.18 Describe what science and technology, in regards to erosion and Earth's magnetic properties, can and cannot reasonably contribute to society.
S.RS.06.19 Describe how science and technology of Earth's magnetic properties have advanced because of the contributions of many people throughout history and across cultures.

Vocabulary

Critically Important – State Assessable	Instructionally Useful
igneous metamorphic sedimentary rock cycle erosion minerals weathering soils sediments abrasion thermal expansion/contraction glaciers gravel sand silt clay organic material particle size magnetic field poles navigation	gradual formation

Instruments, Measurements, Representations

Magnets, compass

Instructional Framework

The following Instructional Framework is an effort to clarify possible units within the K-7 Science Grade Level Content Expectations. The Instructional Framework provides descriptions of instructional activities that are appropriate for inquiry science in the classroom and meet the instructional goals. Included are brief descriptions of multiple activities that provide the learner with opportunities for exploration and observation, planning and conducting investigations, presenting findings, and expanding thinking beyond the classroom. The Instructional Framework is NOT a step-by-step instructional manual, but a guide intended to help teachers and curriculum developers design their own lesson plans, select useful and appropriate resources and create assessments that are aligned with the grade level science curriculum for the State of Michigan.

Instructional Examples

Rock Formation: E.SE.06.41, E.SE.06.11, E.SE.06.12, E.SE.06.13, E.SE.06.14, E.SE.06.61, E.SE.06.62

Objectives

- Describe formation of rock types (igneous, metamorphic, and sedimentary) and differences between the types - using the rock cycle model.
- Describe how physical and chemical weathering lead to erosion and the formation of soils and sediments.
- Explain how waves, wind, water, and glacier movement shape and reshape the land surface of the Earth by eroding rock in some areas and depositing sediments in other areas.
- Explain that soil is a mixture, made up of weather-eroded rock and decomposed organic material.
- Describe how soil samples can be characterized based on particle size and texture.
- Describe the Earth as a magnet and tell how the magnetic properties of the Earth are similar/different to natural or man-made magnets.
- Explain how a compass works using the magnetic field of the Earth, and how a compass is used for navigation on land and sea.

Engage and Explore

- Give each student a piece of bubble gum, and tell him or her it represents a sedimentary rock. Have them put it in their mouth and begin chewing it. Ask the students to think scientifically about what they are doing to the gum (Leading questions: Is it cold inside their mouth? NO! Are they applying heat? YES! What is happening when their teeth come down on

the gum? Are they applying pressure? So is the gum being changed? Yes!) Have students pull the gum out of their mouth and place it somewhere clean. (E.SE.06.41)

- Now open up a packet of Nerds or similar candy and pour some onto the gum. Then kind of squeeze or fold them into the gum. Hold up the gum and say this represents an igneous rock. Now have students place the gum (igneous rock) into their mouth and chew. Ask the students: What they are doing? Hopefully they will answer, applying heat and pressure. Here pressure is enough to crush the candy (crystals). Pull out the gum and say what this represents (metamorphic rock). Explain to the students that they have just modeled the rock cycle! (E.SE.06.41)
- Students can take sandstone and place it in a glass jar of water to model physical weathering. By shaking the jar vigorously for one minute they will find that sediment is created and that the rock has changed. Many other earth models can be used to show these concepts. Sand can be blown with straws, water can be dripped through cups with holes in them, ice blocks can be used to model glaciers, etc. (E.SE.06.11, E.SE.06.12)
- Have students use particle size charts (can be made or found online) to compare the particle sizes of various earth materials. Magnifiers and microscopes are helpful here. Texture of soil samples can also be explored at this time. (E.SE.06.14)
- Have students explore the Earth as a magnet using compasses. This can be done as a scavenger hunt activity outdoors. They can also make a temporary magnet and compass. (E.SE.06.61, E.SE.06.62)

Explain and Define

- The students can now define the characteristics of each rock type. (E.SE.06.41)
- Types of physical and chemical weathering should be discussed and defined here. (E.SE.06.11, E.SE.06.12)
- After testing various samples of soil, the term soil should be properly defined by the students. (E.SE.06.13)
- Students should be able to describe how they used magnets on their scavenger hunt to find certain objects and then discuss how they could use them to navigate on the sea. This is also a good time to discuss how the Earth compares to other magnets. (E.SE.06.61, E.SE.06.62)

Elaborate and Apply

- Many examples of each rock type can now be explored and identified by the students. (E.SE.06.41)
- Students can be given various pictures of earth features and asked to determine which earth process caused the earth to look this way and to describe the process. (E.SE.06.11, E.SE.06.12)
- Students could be taken to various outdoor sites and asked to determine the soil properties at each site. (E.SE.06.13)

- Students could write a paper on the importance of using magnets for sea navigation throughout history. (E.SE.06.61, E.SE.06.62)

Evaluate Student Understanding

Formative Assessment Examples

- Check on students' understanding as they classify rock types themselves.
- Check student understandings on earth feature description work from pictures.
- Check for student understandings as students perform their own soil properties tests.
- Check for student understandings in their papers on sea navigation.

Summative Assessment Examples

- Give students real rock samples for them to classify as igneous, metamorphic or sedimentary.
- Students are shown various geological formations and asked to pick which kind of earth process is responsible for this formation.
- Various soils could be described and students could identify the type of soil being described.
- Students could be asked to explain how the Earth is similar to a natural magnet. Students could also be asked to identify some useful properties of magnets.

Enrichment

- Take the students to a rock quarry or site of geological interest and have them create their own rock and mineral collection. At least three of each type should be included to complete their collection. E.SE.06.41
- Take the students to various sites and ask them to work in groups and try to explain the weathering forces at work to sculpt the land to look like it does. E.SE.06.11, E.SE.06.12
- Students could be given sand samples from various sites and asked to compare/contrast them with each other using particle size charts. E.SE.06.14
- The Earth's magnetic field can be shown using a galvanometer and a 50-foot extension cord. Connect the galvanometer to the extension cord and swing in large arcs like a jump rope. Determine what is happening and why. E.SE.06.61, E.SE.06.62

Intervention

- For the rock cycle it may be important to show the model of the rock cycle more than one time. Gum and different candies should be used again. Also another good model would be using cookies to show the component parts of rock – chocolate chip cookies are often used for this. Taking trips and looking at real rocks outside will make this more authentic and repeating this many times makes it easier to do.
- There are many land changes around us. Taking walking trips to look at these changes and writing a list of what is observed is very powerful proof that these changes are real and occurring around us.
- Have students bring in samples of soil from around their house. By comparing these samples with other student samples in groups of four, students can start to see the differences and similarities between samples taken at different locations. Then students can look at the samples from other groups over the course of a few days and start to write down the observable properties. The teacher can guide and help build strategies to find these differences and define them.
- Some students need to have extended real experiences with magnets to determine their properties and start to understand non-contact forces. Once these properties are seen as consistent and useful they can be expanded upon and defined more easily by the student.

Examples, Observations, and Phenomena (Real World Context)

Rock formation can provide us with glimpses into the way our world was formed. It can also provide us more locally with information on how our area was shaped.

Changes in rock usually take thousands of years to happen; it is therefore important to show students the shorter-term changes we can see (like potholes in a road or the wearing down of their sled hill by the school). Soil quality is important for agriculture and therefore, for all people. By looking at the properties of soil we can begin to learn the properties that are most useful to growing various types of crops with the highest yields possible.

Magnets were very important to the history of navigation by people on Earth. Without this tool many were lost at sea or did not attempt open sea voyages. They are still widely used today even with the increasing use of GPS systems for navigation. Magnets are also used in many electrical circuits, generators, and motors. Magnets are used in the generation of electricity at municipal power plants.

Literacy Integration

Students will...

Reading

R.IT.06.01 analyze the structure, elements, features, style, and purpose of informational genre, including research reports, "how-to" articles, and essays.

R.IT.06.03 explain how authors use text features including footnotes, bibliographies, introductions, summaries, conclusions, and appendices to enhance the understanding of central, key, and supporting ideas.

R.CM.06.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.06.02 retell through concise summarization grade-level narrative and informational text.

R.CM.06.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Writing

W.GN.06.03 formulate research questions using multiple resources and perspectives that allow them to organize, analyze, and explore problems and pose solutions that culminate in a final presented project using the writing process.

W.PR.06.02 apply a variety of pre-writing strategies for both narrative and informational writing.

Sixth Grade GLCE Companion Document

Unit 4: Plate Tectonics and Fossils

SCIENCE

- Big Ideas
- Clarifications
- Inquiry
- Vocabulary
- Instruments
- Measurements
- Instructional Framework
- Enrichment
- Intervention
- Real World Context
- Literacy Integration
- Mathematics Integration

Sixth Grade Companion Document

6-Unit 4: Plate Tectonics and Fossils

Table of Contents	Page 1
Curriculum Cross Reference Guide	Page 2
Unit 4: Plate Tectonics and Fossils	Page 3
Big Ideas (Key Concepts)	Page 3
Clarification of Content Expectations	Page 3
Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications	Page 8
Vocabulary	Page 9
Instruments, Measurements, and Representations	Page 9
Instructional Framework	Page 10
Enrichment	Page 13
Intervention	Page 13
Examples, Observations and Phenomena (Real World Context)	Page 13
Literacy Integration	Page 14

6th Grade Unit 4: Plate Tectonics and Fossils

Content Statements and Expectations

Code	Statements & Expectations	Page
E.SE.M.5	Plate Tectonics – The lithospheric plates of the Earth constantly move, resulting in major geological events, such as earthquakes, volcanic eruptions, and mountain building.	5
E.SE.06.51	Explain plate tectonic movement and that the lithospheric plates move centimeters each year.	5
E.SE.06.52	Demonstrate how major geological events (earthquakes, volcanic eruptions, mountain building) result from these plate motions.	6
E.SE.06.53	Describe layers of the Earth as lithosphere (crust and upper mantle) convecting mantle, and a dense metallic core.	7
E.ST.M.3	Fossils – Fossils provide important evidence of how life and environmental conditions have changed in a given location.	7
E.ST.06.31	Explain how rocks and fossils are used to understand the age and geological history of the Earth (timelines and relative dating, rock layers).	7
E.ST.M.4	Geologic Time – Earth processes seen today (erosion, mountain building, and glacier movement) make possible the measurement of geologic time through methods such as observing rock sequences and using fossils to correlate the sequences at various locations.	8
E.ST.06.41	Explain how Earth processes (erosion, mountain building, and glacier movement) are used for the measurement of geologic time through observing rock layers.	8
E.ST.06.42	Describe how fossils provide important evidence of how life and environmental conditions have changed.	9

6 – Unit 4: Plate Tectonics and Fossils

Big Ideas (Key Concepts)

- The surface of the Earth undergoes gradual and rapid changes.
- Plate tectonics is the central organizing theory of the field of geology and explains major landforms and geological events.

Clarification of Content Expectations

Standard: Solid Earth

Content Statement – E.SE.M.5

Plate Tectonics – The lithospheric plates of the Earth constantly move, resulting in major geological events, such as earthquakes, volcanic eruptions, and mountain building.

Content Expectations

E.SE.06.51 Explain plate tectonic movement and that the lithospheric plates move centimeters each year.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally the movement of lithospheric plates.
2. The Earth's crust is composed of seven major semi-rigid plates that slowly move in various directions. The plates are referred to as lithospheric plates.
3. These plates only move centimeters per year.
4. One theory for the movement of the plates is that the mantle pushes the plates by a process called convection. When a gas or a liquid is heated unevenly, the part that is heated rises (convection current).
5. Another theory is that gravity pulls the old heavier ocean floor with more force than the newer lighter sea floor.
6. As the plates move they interact with one another at their boundaries, where they are separating, converging, or sliding past each other.

Assessment Clarifications

1. The Earth's crust is composed of seven major semi-rigid plates that move in various directions. The plates are referred to as lithospheric plates.
2. These plates only move centimeters per year.
3. As the plates move they interact with one another at their boundaries, where they are separating, converging, or sliding past each other.

4. One theory for the movement of the plates is that the mantle pushes the plates by a process called convection. When a gas or a liquid is heated unevenly, the part that is heated rises (convection current).
5. Another theory is that gravity pulls the old heavier ocean floor with more force than the newer lighter sea floor.
6. As the plates move they interact with one another at their boundaries, where they are separating, converging, or sliding past each other.

E.SE.06.52 Demonstrate how major geological events (earthquakes, volcanic eruptions, mountain building) result from these plate motions.

Instructional Clarifications

1. Demonstrate is to show major geological events through manipulation of materials, drawings, and written and verbal explanations.
2. Earthquakes are formed when the boundaries of the lithospheric plates move against each other, building up pressure, then cause a sudden and often violent shift. This movement causes an earthquake.
3. Volcanoes are formed when plates move apart or collide.
4. When two plates collide, one plate is pushed up and the other slides under. Part of the crust that slides under is melted, and forms magma and can be forced through vents to form volcanic mountains.
5. Volcanoes can also be formed when a plate moves over a hot spot in the mantle and exposes a vent. Fountains of magma or hot rock punch through the crust.
6. When plates beneath the ocean move apart a vent is exposed and magma slowly rises to the surface, which forms a new ocean floor.
7. Mountains form when two plates collide. The two plates crush together causing land to be pushed up, resulting in the folding and breaking of the Earth's crust.

Assessment Clarifications

1. Earthquakes are formed when the boundaries of the lithospheric plates move against each other, building up pressure, and then causing a sudden and often violent shift. This movement causes an earthquake.
2. Volcanoes are formed when plates move apart or collide.
3. When two plates collide, one plate is pushed up and the other slides under. Part of the crust that slides under is melted, and forms magma and can be forced through vents to form volcanic mountains.
4. Volcanoes can also be formed when a plate moves over a hot spot in the mantle and exposes a vent. Fountains of magma or hot rock punch through the crust.
5. When plates beneath the ocean move apart a vent is exposed and magma slowly rises to the surface, which forms a new ocean floor.
6. Mountains form when two plates collide. The two plates crush together causing land to be pushed up, resulting in the folding and breaking of the Earth's crust.

E.SE.06.53 Describe layers of the Earth as lithosphere (crust and upper mantle), convecting mantle, and a dense metallic core.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words the layers of the Earth.
2. Lithosphere is the solid, most outer part of the Earth; the part of the Earth's surface that is made up of land, including the ocean's floor.
3. The Earth's crust is the outside (exterior) of the Earth.
4. Mantle is the layer of the Earth between the crust and the core.
5. The core of the Earth is found below the mantle.
6. The core of the Earth is made up of iron and nickel.
7. There is a liquid outer core and a solid inner core.
8. The core of the Earth heats the mantle. This transfer of energy through the layers of the Earth is convection.

Assessment Clarifications

1. Lithosphere is the solid most outer part of the Earth; the part of the Earth's surface that is made up of land, including the ocean's floor.
2. The earth's crust is the outside (exterior) of the Earth.
3. Mantle is the layer of the Earth between the crust and the core.
4. The core of the Earth is found below the mantle.
5. The core of the Earth is made up of iron and nickel.
6. There is a liquid outer core and a solid inner core.

Content Statement – E.ST.M.3

Fossils – Fossils provide important evidence of how life and environmental conditions have changed in a given location.

Content Expectation

E.ST.06.31 Explain how rocks and fossils are used to understand the age and geological history of the Earth (timelines and relative dating, rock layers).

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawings), demonstrations, written reports, or verbally how rocks and fossils are used to understand the age and geological history of the Earth.
2. The Earth has distinct layers of rock.
3. Sedimentary rocks most often contain fossils.
4. The rock layers show a progression of organisms from layer to layer.
5. Relative dating can be used to estimate the order of prehistoric and geological events.
6. This happens by observing where fossils are found in layers of rock.
7. Timelines describe the timing and relationships between events in the Earth's history.
8. The Earth is estimated to be about 4.5 billion years old.

Assessment Clarifications

1. The Earth has distinct layers of rock.
2. Sedimentary rocks most often contain fossils.
3. The rock layers show a progression of organisms from layer to layer.
4. Relative dating can be used to estimate the order of prehistoric and geological events.
5. This happens by observing where fossils are found in layers of rock.
6. Timelines describe the timing and relationships between events in the Earth's history.

Content Statement – E.ST.M.4

Geologic Time – Earth processes seen today (erosion, mountain building, and glacier movement) make possible the measurement of geologic time through methods such as observing rock sequences and using fossils to correlate the sequences at various locations.

Content Expectations

E.ST.06.41 Explain how earth processes (erosion, mountain building, and glacier movement) are used for the measurement of geologic time through observing rock layers.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally how erosion, mountain building and glacier movement are used for the measurement of geologic time through observing rock layers.
2. Erosion is the wearing away of material through wind and water. The process of erosion can expose layers of rock.
3. Mountain building is when two plates collide. The two plates crush together causing land to be pushed up, resulting in the folding and breaking of Earth's crust. Mountain building changes the shape of the Earth.
4. Over time all mountains will crumble through erosion.
5. Mountain peaks eventually become rounded hills.
6. The observation and study of rock layers is used for the measurement of geologic time.
7. Glaciers are slow moving masses of ice formed from compacted layers of snow. Glaciers move and change with temperature change, gravity, and high pressure.
8. Glaciers carve out mountains.
9. Glaciers move rocks out of mountains.
10. Erosion, mountain building, and glacier movement change the surface of the Earth and earth materials to form layers. Rock layers are used to show the geologic time and history of the Earth.

Assessment Clarifications

1. Erosion is the wearing away of material through wind and water. The process of erosion can expose layers of rock.
2. Mountain building is when two plates collide. The two plates crush together causing land to be pushed up, resulting in the folding and breaking of Earth's crust. Mountain building changes the shape of the Earth.
3. Glaciers are slow moving masses of ice formed from compacted layers of snow. Glaciers move and change with temperature change, gravity, and high pressure.
4. Erosion, mountain building, and glacier movement change the surface of the Earth and earth materials to form layers. Rock layers are used to show the geologic time and history of the Earth.

E.ST.06.42 Describe how fossils provide important evidence of how life and environmental conditions have changed.

Instructional Clarifications

1. A fossil is an imprint, replacement, or remains of an organism from ancient times.
2. Fossils provide a historical perspective on change of the Earth.
3. Fossils provide a biological record of life on Earth.
4. Fossils provide a record of how organisms have changed over time.
5. The fossil record can be aligned to the major environmental changes that have occurred on Earth.
6. The fossil record provides evidence from a "living laboratory."
7. The fossil record illustrates how organisms responded to environmental change.
8. Some fossils provide a continuous record of environmental change.

Assessment Clarifications

1. A fossil is an imprint, replacement, or remains of an organism from ancient times.
2. Fossils provide a historical perspective on change of the Earth.
3. Fossils provide a biological record of life on Earth.
4. Fossils provide a record of how organisms have changed over time.
5. The fossil record can be aligned to the major environmental changes that have occurred on Earth.
6. The fossil record illustrates how organisms responded to environmental change.
7. Some fossils provide a continuous record of environmental change.

**Inquiry Process, Inquiry Analysis and Communication,
Reflection and Social Implications**

Inquiry Process
S.IP.06.11 Generate scientific questions based on observations, investigations, and research about the plate tectonic movement.
S.IP.06.12 Design and conduct scientific investigations into erosion, mountain building, and glacier movement.
S.IP.06.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, sieves, microscopes) appropriate for observations and scientific investigations into earthquakes, volcanoes, and mountain building.
S.IP.06.14 Use metric measurement devices in model building for investigations into major geological events.
S.IP.06.15 Construct charts and graphs from data and observations of models of geological events, fossils, and erosion.
S.IP.06.16 Identify patterns in data.
Inquiry Analysis and Communication
S.IA.06.11 Analyze information from data tables and graphs to answer questions about the formation of volcanoes, mountains, and earth processes.
S.IA.06.12 Evaluate data, claims, and personal knowledge through collaborative science discourse about the theory of tectonic plates and the importance of evidence through fossils.
S.IA.06.13 Communicate and defend findings of observations and investigations into major geological events and earth processes using evidence.
S.IA.06.14 Draw conclusions from sets of data from multiple trials of scientific investigation of major geological events and earth processes.
S.IA.06.15 Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data regarding plate tectonics and the evidence provided by fossils.
Reflection and Social Implications
S.RS.06.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding plate tectonics and the evidence provided by fossils.
S.RS.06.12 Describe limitations in personal and scientific knowledge regarding plate tectonics and the history of the Earth.
S.RS.06.13 Identify the need for evidence in making scientific decisions.
S.RS.06.14 Evaluate scientific explanations based on current evidence and plate tectonics and evidence from fossils.
S.RS.06.15 Demonstrate plate movement, formation of mountains and volcanoes, and the occurrence of earthquakes through various illustrations, models, exhibits, and activities.
S.RS.06.16 Design solutions to problems using technology.
S.RS.06.18 Describe what science and technology can and cannot reasonably contribute to the study of major geological events and determining the history of the Earth.
S.RS.06.19 Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures.

Vocabulary

Critically Important – State Assessable	Instructionally Useful
plate tectonic lithospheric plates geological events earthquakes volcanic eruptions mountain building lithosphere crust upper mantle convecting mantle metallic core fossils rocks geological history timelines relative dating rock layers earth processes erosion glacier movement environmental conditions	Pangea Richtor scale lava magma tremor vibrations weathering wind water movement Seizmograph Magnitude

Instruments, Measurements, Representations

The study of plate tectonics, fossils, and rock layers presents the opportunity for students to learn about the use of evidence, inference, and making models to explain phenomena that cannot be observed in the present or on Earth. The use of models for representation of plate movement, rock layers, and how fossils are made provide a glimpse of the past.

Fossil identification and comparison to modern life forms requires the use of the hand lens, measurement in millimeters, and representations through drawing and models.

Research and analysis of data, theories, and representations made by other scientists is an important form of information gathering when trying to uncover Earth's history and relate modern life forms, climate, and the shape of the Earth to cycles that take millions of years to complete.

Instructional Framework

The following Instructional Framework is an effort to clarify possible units within the K-7 Science Grade Level Content Expectations. The Instructional Framework provides descriptions of instructional activities that are appropriate for inquiry science in the classroom and meet the instructional goals. Included are brief descriptions of multiple activities that provide the learner with opportunities for exploration and observation, planning and conducting investigations, presenting findings, and expanding thinking beyond the classroom. The Instructional Framework is NOT a step-by-step instructional manual, but a guide intended to help teachers and curriculum developers design their own lesson plans, select useful and appropriate resources and create assessments that are aligned with the grade level science curriculum for the State of Michigan.

Instructional Examples

Plate Tectonics: E.SE.06.51, E.SE.06.52, E.SE.06.53

Fossils: E.ST.06.31,

Geologic Time: E.ST.06.41, E.ST.06.42

Objectives

- Use models to explain major geological events, plate tectonics, and layers of the Earth.
- Make observations of rock layers and fossils and compare them to modern life forms to demonstrate environmental change over time.

Engage and Explore

- Use a classroom globe and have students find the oceans and continents that make up Earth today. (E.SE.06.51)
- Display a map of the Earth that shows the oceans and continents. Explain how the map represents Earth as a sphere. Divide the class into teams of two and have the students distribute one map of Earth and have them cut out the continents and oceans, mix them up and try to put the world back together again. (E.SE.06.51, S.IP.06.11, S.RS.06.12, S.RS.06.15)
- Ask the students to closely examine the coastline of the continents. Bring their attention to the eastern coastline of South America and the western coastline of Africa. Explain that some scientists believe that the continents once were joined in a single landmass. (E.SE.06.51, S.IP.06.11, S.RS.06.12, S.RS.06.15)
- Provide research material for students to read about the scientists Alfred Wegener and Sir Francis Bacon and the theory of continental drift. In their research, ask students to look for the evidence each scientist used to explain his theory and some of the skepticism from other scientists. Compare Wegener's and Bacon's theories with what scientists believe today. (E.SE.06.51, S.IP.06.11, S.RS.06.12, S.RS.06.15, S.RS.06.19)

- Have the students recreate the evidence used by the scientists to support their theories. Create game cards that give examples of fossils of plants and animals that were discovered on continents now separated by oceans. For example, the fossils of fresh water reptiles Mesosaurus and Lystrosaurus were discovered on South America and Africa. These animals are not capable of swimming an ocean. The imprint fossil of the plant Glossopteris have been found in rocks in Africa, South America, Australia, India, and Antarctica. Have the students match the fossil to the different continents where they had been discovered. (E.SE.06.51, S.IP.06.11, S.RS.06.12, S.RS.06.15)
- Simulate rock layers and fossils that are found within rock layers using a model. Place three different colors of aquarium gravel in separate baggies. Mix 1/4 cup sand and 1/4 cup soil into each bag. Shake the gravel/soil mixtures to thoroughly mix the materials. Fill a clear container 1/2 full with water. Use a spoon to slowly sprinkle the gravel/soil mixture from one of the baggies into the water. Wait 10 minutes and observe. Repeat the process with the two remaining baggies every 10 minutes. To simulate fossils, add a small plastic animal or plant. Discuss the age of the bottom layer compared to the top layer. Ask students how major events affect rock layers. Explain that each 10 minutes represents thousands to millions of years. Discuss what might happen if plant or animal remains were trapped between the layers. (E.ST.06.31, S.IP.06.11, S.IA.06.12, S.IA.06.13, S.RS.06.11, S.RS.06.12, S.RS.06.14)

Explain and Define

- Using maps, textbooks, and the Internet, have students find the seven major semi-rigid sections or plates called the lithospheric plates that move in various directions. (E.SE.06.51, S.IA.06.15)
- Have students make models of the plates and demonstrate the different types of movements of the plates as they collide, pull apart, or grind past each other, producing changes in Earth's surface. Have students include plate boundaries in their models (divergent boundaries, convergent boundaries, and transform boundaries). (E.SE.06.51, E.SE.06.52, S.IP.06.13, S.IA.06.12, S.IA.06.13, S.IA.06.15, S.RS.06.11, S.RS.06.14)
- Explain that Earth material mixture in the rock layer models represent Earth deposits from erosion over long periods of time. Great pressure and heat over long periods of time eventually turn the layers to rock. Discuss how fossils found in the different layers give evidence of organisms and climate from long ago. (E.ST.06.31, E.ST.06.41, E.ST.06.42)

Elaborate and Apply

- Using their models, students explain how the plate motion results in earthquakes, volcanic eruptions, and mountain building. (E.SE.06.52, S.IP.06.13, S.IA.06.11, S.RS.06.14, S.RS.06.15)
- Elaborate further on the history of the Earth by researching Earth's different layers (crust and upper mantle, convecting mantle and dense

metallic core). (E.SE.06.53, S.IA.06.15, S.RS.06.11, S.RS.06.14, S.RS.06.15)

- Make an edible model of rock layers that simulates the movement and folding and faulting of rock strata like sandstone, siltstone, limestone, and shale. (Different food layers represent the different rock strata - graham cracker crumbs, gelatin, pudding, and Oreo cookie crumbs. Pieces of fruit represent fossils found in different layers.) (E.ST.06.31, S.RS.06.15)
- Conduct a mock fossil dig by planting different items to represent fossils between different layers of gravel, sand, soil, etc. Have students explain how the organism lived a very long time ago and the fossils found in the layers far below the Earth's surface lived the longest time ago. (E.ST.06.13, E.ST.06.42, S.RS.06.15, S.RS.06.13)

Evaluate Student Understanding

Formative assessment

- Use the student presentations, models and discussion to assess the students' ability to describe plate tectonics and the theory of moving plates.
- Use the class discussions and student presentations to assess their ability to identify the need for evidence.
- Use student research and presentations to assess their ability to use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data.

Summative Assessment

- Students describe how scientists use rock layers and fossils found within the layers to describe the geological history of the Earth.
- Models are used to assess students on their ability to explain mountain building, earthquakes, and volcanic eruptions.
- Student research papers and presentations are used to assess their understanding of plate tectonics and how scientists use evidence to establish theories.

Enrichment

- Students can further explore fossils by researching plants and animals that lived long ago and comparing them to modern plants and animals.
- Students research the most recent volcanic eruptions and earthquakes and make models of structures that can withstand catastrophic events.

Intervention

- Students make models of earthquakes and demonstrate the destruction of earthquakes and other catastrophic events.
- Students explore different materials that are used to make strong structures that will withstand an earthquake.

Examples, Observations, and Phenomena (Real World Context)

The evidence of the history of the Earth is ongoing. Geological digs are providing fossils that give evidence of once living things and ancient climates. The continued study of the Earth provides students with real world news and articles that explain how the history of the Earth relates to problems faced on Earth today.

The digging out of hillsides and mountainsides to clear the way for highways and other excavation projects, provides a glimpse at rock layers that were formed thousands and millions of years ago.

The comparison of ancient life forms through fossils and modern life forms gives evidence of cycles and patterns in climate, terrain, and living things.

Literacy Integration

Students will...

Reading

R.IT.06.01 analyze the structure, elements, features, style, and purpose of information genre, including research reports, “how-to” articles, and essays.

R.IT.06.03 explain how authors use text features including footnotes, bibliographies, introductions, summaries, conclusions, and appendices to enhance the understanding of central, key and supporting ideas.

R.CM.06.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.06.03 analyze global themes, universal truths and principles within and across texts to create a deeper understanding by drawing conclusions, making inferences, and synthesizing.

R.CM.06.04 apply significant knowledge from grade-level science, social studies, and mathematical texts.

Writing

W.GN.06.03 formulate research questions using multiple resources and perspectives that allow them to organize, analyze, and explore problems and pose solutions that culminate in a final presented project using the writing process.

W.PR.06.02 apply a variety of pre-writing strategies for both narrative and informational writing.

Mathematics Integration

N.FL.06.10 Add, subtract, multiply and divide positive rational numbers fluently.

- The exploration and research into the history of the Earth provides the opportunity for students to mathematically investigate millions of years and determine the period as compared to the present.