Seventh Grade Companion Document

7-Unit 1: Waves and Energy

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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 the 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.

7th Grade Unit 1:
Waves and Energy

Content Statements and Expectations

7 – Unit 1: Waves and Energy

Big Ideas (Key Concepts)

- Waves are produced through vibrations.
- Waves transfer energy when they interact with matter.
- Nuclear reactions that take place in the sun produce heat and light.
- A fraction of the light energy from the sun provides energy to heat the Earth.

Clarification of Content Expectations

Standard: Energy

Content Statement – P.EN.M.3

Waves and Energy-Waves have energy and transfer energy when they interact with matter. Examples of waves include sound waves, seismic waves, waves on water, and light waves.

Content Expectations

P.EN.07.31 Identify examples of waves, including sound waves, seismic waves, and waves on water.

Instructional Clarifications

1. Identify means to recognize the differences between waves, such as sound waves, seismic waves, and waves on water.
2. A wave is a disturbance that transmits energy through matter and space. The wave is the motion of a vibration.
3. Sound is created when something vibrates. Sound waves are a vibration that spreads away from a vibrating object. Sound waves travel through solids, liquids, and gases.
4. Seismic waves are waves that travel through the Earth.
5. Waves on water are waves that move outward from a disturbance.

Assessment Clarification

1. A wave is a disturbance that transmits energy through matter and space. The wave is the motion of a vibration.
2. Sound is created when something vibrates. Sound waves are a vibration that spreads away from a vibrating object. Sound waves travel through solids, liquids, and gases.
3. Seismic waves are waves that travel through the Earth.
4. Waves on water are waves that move outward from a disturbance.

P.EN.07.32 Describe how waves are produced by vibrations in matter.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words or with drawings how waves are produced by vibrations in matter.
2. A wave is a disturbance that transmits energy through matter and space. The wave is the motion of a vibration.
3. Vibrations are back-and-forth motions.
4. Matter is anything that has mass and volume.
5. When molecules in matter vibrate, they excite other molecules to vibrate and waves travel outward from the center of the vibration.
6. Waves are characterized by wavelength, frequency, and amplitude.

Assessment Clarification

1. A wave is a disturbance that transmits energy through matter and space. The wave is the motion of a vibration.
2. Vibrations are back-and-forth motions.
3. Matter is anything that has mass and takes up space.
4. When molecules in matter vibrate, they excite other molecules to vibrate and waves travel outward from the center of the vibration.

P.EN.07.33 Demonstrate how waves transfer energy when they interact with matter (for example: tuning fork in water, waves hitting a beach, earthquake knocking over buildings).

Instructional Clarifications:

1. Demonstrate is to show through manipulation of materials, drawings, and written and verbal explanations how waves transfer energy.
2. Energy is the ability to do work or cause motion.
3. Matter is anything that has mass and takes up space.
4. A wave is a disturbance that transmits energy through matter and space. The wave is the motion of a vibration.
5. An energy transfer takes place when molecules transfer the energy of motion to other molecules then return to their state of rest.
6. When a tuning fork is place in water, ripples (waves) are seen coming away from the tuning fork in even rings.
7. When waves hit a beach, erosion takes place. Ripples are left in the sand to show the reaction of the wave.
8. Seismic waves are vibrations that travel through the Earth carrying the energy of motion released during an earthquake.
9. When seismic waves from an earthquake travel through the earth, buildings shake and sometimes crumble, the ground trembles, and the vibrations are transferred outward from the origin of the quake.

Assessment Clarifications:

1. Energy is the ability to do work or cause motion.
2. Matter is anything that has mass and takes up space.
3. A wave is a disturbance that transmits energy through matter and space. The wave is the motion of a vibration.

4. An energy transfer takes place when molecules transfer the energy of motion to other molecules then return to their state of rest.
5. When a tuning fork is place in water, ripples (waves) are seen coming away from the tuning fork in even rings.
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Content Statement – P.EN.M.6

Solar Energy Effects - Nuclear reactions take place in the sun producing heat and light. Only a tiny fraction of the light energy from the sun reaches Earth, providing energy to heat the Earth.

Content Expectations

P.EN.07.61 Identify that nuclear reactions take place in the sun, producing heat and light.

Instructional Clarifications:
1. Identify means to recognize that nuclear reactions take place in the sun and produces heat and light.
2. The Sun produces a tremendous amount of light and heat through nuclear reactions.
3. Nuclear reactions occur when atoms change their structure to become new atoms. These reactions release large amounts of energy. The energy from these reactions leaves the sun as light energy.
4. Heat is a form of energy associated with the motion of atoms or molecules and capable of being transferred through solid and fluid media by conduction, through fluid media by convection, and through empty space by radiation.
5. Light is electromagnetic radiation (radiation consisting of electromagnetic waves, including radio waves, infrared, visible light, ultraviolet, x-rays, and gamma rays of any wavelength).

Assessment Clarification:
1. Nuclear reactions that take place in the sun produce heat.
2. Nuclear reactions that take place in the sun produce light.

P.EN.07.62 Explain how only a tiny fraction of light energy from the sun is transformed to heat energy on Earth.

Instructional Clarification:

1. Explain is to clearly describe by means of illustrations (drawings), demonstrations, written reports and/or verbally how only a tiny fraction of light energy from the sun is transformed to heat energy on Earth.
2. The heating of the Earth at any location is related to the angle of the sun in the sky.
3. Only a small percentage of light energy from the sun that hits the Earth produces heat energy on Earth.
4. Light energy from the sun is absorbed by the Earth's surface and changed into heat energy. The heat energy radiates out and heats the air above. Some molecules (e.g., carbon dioxide) in the air absorb this heat energy and radiate some of it back to the Earth's surface, making the Earth warm enough to support life (the greenhouse effect).
5. The color of the Earth's surface affects the amount of heat that the Earth absorbs. Many Earth surfaces reflect light energy away from the Earth. Due to these reflective properties of many Earth surfaces large amounts of light energy are reflected and cannot be used directly as heat energy.

Assessment Clarification

1. The heating of the Earth at any location is related to the angle of the sun in the sky.
2. Only a small percentage of light energy from the sun that hits the Earth produces heat energy on Earth.
3. Light energy from the sun is absorbed by the Earth's surface and changed into heat energy. The heat energy radiates out and heats the air above. Some molecules (e.g., carbon dioxide) in the air absorb this heat energy and radiate some of it back to the Earth's surface, making the Earth warm enough to support life (the greenhouse effect).
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Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications

Inquiry Processes
S.IP.07.11 Generate scientific questions on waves and energy based on observations, investigations, and research.
S.IP.07.12 Design and conduct scientific investigations on waves and energy.
S.IP.07.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes, hot plates, pH meters) appropriate to scientific investigations of waves and energy.
S.IP.07.14 Use metric measurement devices in an investigation dealing with waves and energy.
S.IP.07.15 Construct charts and graphs from data and observations dealing with waves and energy.
S.IP.07.16 Identify patterns in data regarding waves and energy.
Inquiry Analysis and Communication
S.IA.07.11 Analyze information from data tables and graphs to answer scientific questions concerning waves and energy.
S.IA.07.12 Evaluate data, claims, and personal knowledge through collaborative science discourse on waves and energy.
S.IA.17.13 Communicate and defend findings of observations and investigations dealing with waves and energy.
S.IA.07.14 Draw conclusions from sets of data from multiple trials of a scientific investigation to draw conclusions on waves and energy.
S.IA.07.15 Use multiple sources of information on waves and energy to evaluate strengths and weaknesses of claims, arguments, or data.
Reflection and Social Implication
S.RS.07.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding waves and energy.
S.RS.07.12 Describe limitations in personal and scientific knowledge regarding waves and energy.
S.RS.07.13 Identify the need for evidence in making scientific decisions about waves and energy.
S.RS.07.14 Evaluate scientific explanations based on current evidence and scientific principles dealing with waves and energy.
S.RS.07.15 Demonstrate scientific concepts through various illustrations to depict waves and energy.
S.RS.07.16 Design solutions to problems about waves and energy using technology.
S.RS.07.17 Describe the effect humans and other organisms have on the balance of the natural world when the amount of pollution in the air affects the amount of light energy to heat energy the Earth receives.
S.RS.07.18 Describe what science and technology can and cannot reasonably contribute to society when dealing with waves and energy.
S.RS.07.19 Describe how science and technology concerning waves and energy have advanced because of the contributions of many people throughout history and across cultures.

Vocabulary

Critically Important – State Assessable	Instructionally Useful
wavelength sun's radiation seismic wave water wave light energy sound wave energy vibration matter waves energy transfer nuclear reactions	solar energy transform waves transverse waves transfer crest trough amplitude frequency erosion greenhouse effect medium

Instruments, Measurement, Representations

Measurements	Instruments	Representations
length	meter stick, measuring tape	meter, centimeter, millimeter
waves	tuning fork, coils, springs, stop watch	millimeter/second, centimeter/second, meter/second

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

Waves and Energy: P.EN.07.31, P.EN.07.32, P.EN.07.33
Solar Energy Effects: P.EN.07.61, P.EN.07.62

Objectives

- Using sound waves, seismic waves, waves on water, and light waves demonstrate how waves transfer energy.
- Describe how the sun is the major source of light and heat on Earth.
- Demonstrate how only a tiny fraction of the light energy from the sun reaches Earth to heat the Earth.

Engage and Explore

- Have the students demonstrate a “stadium wave.” Explain that the “stadium wave” is a model of how sound waves, seismic waves, and waves on water are produced. (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- Explore waves due to vibrations using a Slinky or coil as a model. Have students work in pairs to first cause a disturbance or in a Slinky at rest and make observations of the movement along the coil of the Slinky. Have the students jerk the slinky forward and make observations. As a class, discuss student initial ideas about waves. (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- What happens when students snap fingers to simulate seismic waves? Try it and observe and record what is happening. (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- Brainstorm ideas of how sounds produced. Construct a simple banjo and use it to find out how sound is produced. (P.EN.07.31, P.EN.07.32, P.EN.07.33)

- Have students make observations of the vibrations of tuning forks through their sense of touch, sight, and hearing. Use a shallow pan of water to demonstrate the transfer of sound waves in the air to waves in water. (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- Go outside and make observations of the effects of the sun's warming on different materials and areas of the schoolyard. Ask students to describe the effects of the sun on different surfaces, living things, and nonliving things, in direct sunlight and in the shade. (P.EN.07.61, P.EN.07.62)
- Pose a "what would happen if…question" to the class: What would happen if there wasn't any sun? Discuss the importance of sunlight on Earth. Take this opportunity to review the safety when making sun observations and explain why it is important not to look directly into the sun. (P.EN.07.61, P.EN.07.62)
- Visit a greenhouse. Why is glass or plastic used to retain the heat from the sun? (P.EN.07.61, P.EN.07.62)

Explain and Define

- Have students share their observations of the waves they produced with the Slinky. Explain that when the Slinky is jerked forward the start moves away from its original position and then returns. The wave motion is called a pulse, producing a longitudinal wave. Explain that energy is transferred along the Slinky through motion and ends up in the same place. Compare the Slinky wave to the "stadium wave." (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- Use the Slinky model to how seismic waves travel through the earth. Seismic waves occur in earthquakes and volcanoes. (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- Explain how sound is created when something vibrates. Sound waves spread away from a vibrating object. (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- The atmosphere of the Earth traps heat energy from the sun. Without the greenhouse effect, the Earth would be too cold to support life. (P.EN.07.61, P.EN.07.62)
- Have students research the properties of the sun and gather information regarding the nuclear reactions that occur on the sun that produces heat and light. Ask students to share their information from their research. (P.EN.07.61, P.EN.07.62)
- Create a model to show the position and size of the Earth in relation to the sun to demonstrate the small fraction of the suns heat and light that reaches the Earth. (P.EN.07.61, P.EN.07.62)

Elaborate and Apply

- When fingers are snapped, imagine that each finger is a big chunk of rock deep inside the earth's surface. Like fingers, one rock mass is forced against another. Think of the increasing amount force placed on the fingers as pressure caused by movements of the Earth's crust. Now, think

of the movement of the fingers to create the snap as the sudden movement of the earth, an earthquake. Think too, that the sound of the snap itself as being the seismic energy traveling from the location of the quake. Using the snapped fingers aids in understanding how earthquakes are formed and the energy is released in huge waves that shake, rattle and roll the earth's surface. (P.EN.07.31, P.PE.07.32, P.EN.07.33)

- Make a pan of gelatin. Drop a marble/block at one end and observe the waves. How is this similar to the seismic waves of an earthquake? Place a structure of cubes at one end and drop the block at the other end of the pan, what happened to the cubes when the waves made contact? How is this similar to the way a building reacts during an earthquake? Vary the distance of impact from building and compare. (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- Stretch a rubber band lengthwise over a ruler. Then insert a pencil under the rubber band at each end of the ruler so that the rubber band is lifted away from the surface of the ruler. Pluck the rubber band at any point between the two pencils. Observe what happens as the rubber band is plucked. Record what is observed and heard. How can the sound be changed? Does instrument make a difference where the rubber band is plucked? Describe the sounds that the “banjo” produces. Hypothesize how the rubber band produces sound. (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- How did the sound change when the rubber band is pressed at different points on the ruler? Demonstrate “real” string instruments, like guitars, fiddles, banjos, and piano. How are these instruments producing sound?
- A greenhouse is usually made of glass. The glass lets in sunlight, which warms the ground and the other surfaces inside the greenhouse. As the surfaces warm, they release heat in the air. The glass (or plastic) keeps the house from escaping. The air inside the greenhouse stays warm enough for plants to grow throughout the year. (P.EN.07.61, P.EN.07.62)
- Inside a closed up car on a hot summer’s day is similar to the heat in a greenhouse. The temperature inside a closed up car can easily reach more that 100 degrees in a short period of time. (P.EN.07.61, P.EN.07.62)

Evaluate Student Understanding

Formative Assessment Examples

- Design different instruments that produce sound. How can the sound be changed; example – use a collection of pop bottles that are all the same – put water in the bottle at different heights – how can sound be produced and changed. Describe.
- How might a hearing-impaired person keep perfect time to music from a piano he or she cannot hear? [Use the video, *Mr. Holland’s Opus*]
- Describe why a motorboat would sound closer when you are under water than if actually is when you come to the surface.

- Discuss the sounds that are heard around the school? How does the sound reach the ear? How do students react to the sounds around the school?
- Discuss what is the difference between music and noise? Discuss what the similarities between music and noise are. What sounds/music are around everyday life? [Use the video *August Rush*]
- Students interview people that work at a greenhouse. How are temperatures controlled in a greenhouse? What kind of plants must be grown in a greenhouse? Students write a report to present to the class on the findings.
- Students research the problems of leaving young children in a car on a hot summer's day. What happens to these children? What then could happen to the parents? Students report their findings to the class. (S.RS.07.16)

Summative Assessment Examples

- Unit test covering waves and energy, especially sound waves, water wavers, seismic waves, and nuclear energy from the sun in the form of light and heat. (P.EN.07.31, P.EN.07.32, P.EN.07.33, P.EN.07.61, P.EN.07.62)
- Each student designs a poster, brochure, or power point that shows either movement of sound or water waves or how seismic waves are produced. Students present the project to the class. (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- Each student writes a report on solar energy and how solar energy can be used as a renewable resource. Students present the report to the class. The class takes notes on the different reports. (P.EN.07.61)

Enrichment

- Sound Waves: Have two students go outside the classroom and close the door. Have students inside the classroom tap on the door, then on the wall with various objects. Bring the students back into the room and have the students describe what they heard. Discuss how the sounds were different from what was heard inside the classroom. (S.IP.07.11)

Intervention

- Students work in small groups to create instruments and "band" to share with the class. Each group will present their "band" and then each person in the group will share about his/her instrument. How was sound produced? Discuss the amplitude and wave patterns each instrument produces. (P.EN.07.31, P.EN.07.32, P.EN.07.33)
- Pairs of students measure the distance from one end of the sports field to the other. One student stands at one end of the field holding two wooden blocks, while the other student is at the other end holding a stopwatch. The student with the blocks strikes them together sharply. When the other **sees** the blocks hit, the stopwatch is started. When the sound reaches the student, the stopwatch is stopped and the time recorded to the nearest tenth of a second. Repeat the experiment two or three times and calculate the average. How would this apply to a race when the starter shoots off the starting gun? (S.IA.07.14)

Examples, Observations, and Phenomena (Real World Context)

Waves are everywhere in nature, including sound waves, visible light waves, radio waves, microwaves, water waves, and seismic waves. Sound waves from popular bass tracks can be heard and felt by motorists in automobiles surrounding the stereo system making the sound. Sound travels through the solid automobile and air and transfers sound energy from one car to another. Loud sounds can cause hearing loss through vibrations to the eardrum. Sounds are measured in decibels.

Tsunami and tidal waves are caused by large disturbances in the ocean. Earthquakes on the ocean floor produce tsunami waves. The energy from the earthquake on the floor of the ocean is transferred to the ocean's water and travels in the form of a tsunami wave.

Catastrophic events, such as volcanic eruptions and earthquakes show evidence of how waves travel and can cause great destruction in the path of the waves.

Modern society has developed the use of waves for radio signals, television signals, cellular phones and different communications, wireless Internet, etc. Sometimes disturbances on the sun, such as sunspots and solar flares cause disturbances in the radio, television, and/or communication waves. Sunspots are magnetic regions on the Sun with magnetic field strengths thousands of times stronger than the Earth's magnetic field. Solar flares are tremendous explosions on the surface of the Sun. In a matter of just a few minutes they heat material to many millions of degrees and release as much energy as a billion megatons of TNT. They occur near sunspots, usually along the dividing line (neutral line) between areas of oppositely directed magnetic fields.

Literacy Integration

Reading

R.IT.07.01 Students will analyze the structure, elements, features, style, and purpose of informational genre including persuasive essay, research report, brochure, personal correspondence, autobiography and biography.

R.CM.07.01 Students will connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.07.02 Students will retell through concise summarization grade-level narrative and informational text.

R.CM.07.04 Students will apply significant knowledge from grade-level science, social studies, and mathematics texts.

Read with the class the book, *Volcano: The Eruption and Healing of Mr. St. Helens* by Patricia Lauber, 1993.

- Discuss the effects of the eruption of Mt. St. Helens. Was the eruption predicted? How has the land healed? Is there still seismic activity going on in the area? Have the student research other volcanoes in the United States, be sure to include Alaska and Hawaii.

Writing

W.GN.07.02 Students will write a research report using a wide variety of resources that includes appropriate organizational patterns (e.g., position statement/supporting evidence, problem statement/solution, or compare/contrast), descriptive language, and informational text features.

W.GN.07.03 Students will formulate research questions using multiple resources, perspectives, and arguments/counter-arguments to develop a thesis statement that culminates in a final presented project using the writing process.

W.PR.07.01 Students will set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.07.02 Students will apply a variety of pre-writing strategies for both narrative (e.g., graphically depict roles of antagonist/protagonist, internal/external conflict) and informational writing (e.g., position statement/supporting evidence, problem statement/solution, or compare/ contrast).

W.PR.07.03 Students will revise drafts to reflect different perspectives for multiple purposes and to ensure that content, structure, elements of style and voice, literary devices, and text features are consistent.

W.PS.07.01 Students will exhibit personal style and voice to enhance the written message in both narrative (e.g., personification, humor, element of surprise) and informational writing (e.g., emotional appeal, strong opinion, credible support).

- Research how people in different cultures and parts of the world have used different methods and materials for transmitting sound to send messages. Write a report on one of these methods to present to the class.

Speaking

S.CN.07.01 Students will adjust their use of language to communicate effectively with a variety of audiences and for different purposes by using specialized language related to a topic and selecting words carefully to achieve precise meaning when presenting.

S.DS.07.02 Students will respond to multiple text types in order to anticipate and answer questions, offer opinions and solutions, and to identify personally with a universal theme.

- Choose a method that people in different cultures used to transmit and send messages. Demonstrate by examples or pictorially how the method is used.

Mathematics Integration

N.MR.07.04 Convert ratio quantities between different systems of units.

N.MR.07.02 Solve problems involving derived quantities such as density, velocity, and weighted averages.

A.PA.07.01 Recognize when information given in a table, graph, or formula suggests a directly proportional or linear relationship.

A.PA.07.11 Understand and use basic properties of real numbers.

D.RE.07.01 Represent and interpret data using graphs.

D.AN.07.03 Calculate and interpret relative frequencies and cumulative frequencies for data sets.

Seventh Grade Companion Document
7-Unit 2: Physical and Chemical Properties and Changes in Matter

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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 the 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.

7th Grade Unit 2:
Physical and Chemical Properties and Changes in Matter

Content Statements and Expectations

7 – Unit 2: Physical and Chemical Properties and Changes in Matter

Big Ideas (Key Concepts)

- Matter is made up of atoms and molecules that are represented through models
- Elements are chemical substances that make up all other substances and are composed of one kind of atom.
- Elements are organized on the Periodic Table in families.
- Physical and chemical properties identify substances and determine when a chemical change has occurred.

Clarification of Content Expectations

Standard: Properties of Matter

Content Statement—P.PM.M.1

Chemical Properties-Matter has chemical properties. The understandings of chemical properties helps to explain how new substances are formed.

Content Expectation

P.PM.07.11 Classify substances by their chemical properties (flammability, pH, reactivity).

Instructional Clarification:

1. Classify means to arrange or order substances by their chemical properties (flammability, pH, acid-base indicators, reactivity).
2. Substances can be elements, compounds and mixtures.
3. Distinguish between physical properties (color, size, shape, texture, state of matter, density, boiling point, conductivity) and chemical properties (flammability, pH, reactivity)
4. Classify substances by their chemical properties using a variety of substances.

Assessment Clarification:

1. Classify substances by their chemical properties.
2. Distinguish between physical properties (color, size, shape, texture, state of matter, density, boiling point, conductivity) and chemical properties (flammability, pH, reactivity)

Content Statement—P.PM.M.2

Elements and Compounds-Elements are composed of a single kind of atom that is grouped into families with similar properties on the periodic table. Compounds are composed of two or more different elements. Each element and compound has a unique set of physical and chemical properties such as boiling point, density, color, conductivity, and reactivity.

Content Expectations

P.PM.07.21 Identify the smallest component that makes up an element.

Instructional Clarification:
1. Identify means to recognize that the smallest component that makes up an element is an atom.
2. Composition of matter is a logical introduction to this GLCE.
3. Discussion of elements, and their purpose/significance is implied.
4. Distinguish between an atom, molecule, and an element.

Assessment Clarification:
1. Identify the smallest component that makes up an element as an atom.
2. Distinguish between an atom, molecule, and an element.

P.PM.07.22 Describe how the elements within the Periodic Table are organized by similar properties into families (highly reactive metals, less reactive metals, highly reactive nonmetals, and some almost completely non-reactive gases).

Instructional Clarification:
1. Describe means to tell or depict in spoken or written words how the elements within the Periodic Table are organized by similar properties into families.
2. Elements are chemical substances that make up all other substances.
3. Elements are composed of one kind of atom.
4. Every element that is known to exist is organized on the Periodic Table of the Elements.
5. Memorizing the Periodic Table of the Elements is NOT the purpose of this GLCE.
6. Memorizing protons, etc. is NOT the purpose of this GLCE.

Assessment Clarification:
1. Describe how the elements within the Periodic Table are organized by similar properties into families (highly reactive metals, less reactive metals, highly reactive non metals, and some almost completely non-reactive gases)

P.PM.07.23 Illustrate the structure of molecules using models or drawings (water, carbon dioxide, table salt).

Instructional Clarification:

1. Illustrate means to clarify by way of drawings, diagrams, verbally and/or written examples or comparisons the structures of molecules using models or drawings.
2. Models are representations of things that exist in the real world, and can be larger or smaller than the actual object.
3. Matter is made of molecules, which are made of atoms of the same or different elements.
4. Molecular formulas are diagrams of the make-up of molecules and are used to create models of molecules.
5. Elements on the periodic chart are represented by symbols and organized by families according to its atomic weight & properties.
6. Understanding bonds is NOT the focus of this content expectation.

Assessment Clarification:

1. Illustrate the structure of molecules using models or drawings (water, carbon dioxide, table salt).
2. Models are representations of things that exist in the real world, and can be larger or smaller than the actual object.
3. Matter is made of molecules, which are made of atoms of the same or different elements.

P.PM.07.24 Describe examples of physical and chemical properties of elements and compounds (boiling point, density, color, conductivity, reactivity).

Instructional Clarification:

1. Describe means to tell or depict in spoken or written words examples of physical and chemical properties of elements and compounds.
2. Physical properties are observable properties, such as size, shape, texture, mass, and color.
3. Chemical properties are the properties that are determined by the arrangement of atoms in the molecules making up the object.
4. Students should be able to distinguish between elements and compounds, and understand that they are both made of atoms.
5. Because of their unique composition, elements and compounds have unique properties; by changing even one atom, the properties change.
6. Students should be able to differentiate between physical and chemical properties.
7. Several different examples should be given. One way to explore properties is to have students determine the properties and then attempt to identify the item by using its properties.
8. Students should be able to calculate density. $D = m/v$
9. Memorizing chemical and physical property values is NOT the purpose of this GLCE (i.e. Students do not need to memorize the boiling point of various elements, but they DO need to know that boiling point is a property that distinguishes one element from another, along with other properties)

Assessment Clarification:
1. Describe examples of physical and chemical properties of elements and compounds.
2. Properties that distinguish one element from another include density, boiling point, color, conductivity, and reactivity.

Standard: Changes in Matter

Content Statement: P.CM.M.2

Chemical Changes-Chemical changes occur when elements and/or compounds react or decompose to produce new substances. These new substances have different physical and chemical properties than the original elements and/or compounds. During the chemical change, the number and kind of atoms in the reactants are the same as the number and kind of atoms in the products. Mass is conserved during chemical changes. The mass of the reactants is the same as the mass of the products.

Content Expectations

P.CM.07.21 Identify evidence of chemical change through color, gas formation, solid formation, and temperature change.

Instructional Clarification:
1. Identify means to recognize evidence of chemical change through color, gas formation, solid formation, temperature change, and light.
2. One of the best methods of identifying evidence is through actual experimentation; allow students to complete investigations that enable them to observe evidence of chemical changes.
3. Caution students regarding bubbles in a phase change; boiling water is NOT a chemical change, even though a gas is formed. Remind students that they must look for evidence, and cross check their conclusion with the other factors that must be in place for a chemical change to occur (a new substance was formed with a new molecular formula)
4. Chemical change of a substance is a change in the chemical make-up of the substance and a new substance is created.

Assessment Clarification:
1. Identify evidence of chemical change through color, gas formation, solid formation, and temperature change.
2. Chemical change of a substance occurs when there is a change in the number or kind of atoms that are bonded together.

P.CM.07.22 Compare and contrast the chemical properties of a new substance with the original after a chemical change.

Instructional Clarification:

1. Compare and contrast means to note similarities and differences between the chemical properties of a new substance with the original after a chemical change.
2. An understanding of "properties" would be an appropriate introduction to this GLCE.
3. Distinguish a chemical property from a physical property.
4. An important cross check to determine if a chemical change has occurred is to observe the properties before and after a change. If the properties have changed, then a chemical change has occurred. Other evidence such as color change, gas formation, solid formation, and temperature change, of course, should accompany this.

Assessment Clarification:

1. Compare and contrast the chemical properties of a new substance with the original after a chemical change.

P.CM.07.23 Describe the physical properties and chemical properties of the products and reactants in a chemical change.

Instructional Clarification:

1. Describe means to tell or depict in spoken or written words the physical properties and chemical properties of the products and reactants in a chemical change.
2. Reactants are what react together (what you start with) in a chemical reaction, and Products are what is produced (what you end with) in a chemical reaction.
3. The purpose here is NOT to write chemical formulas and/or balance equations.
4. An understanding of physical and chemical properties is necessary before addressing this GLCE.
5. Students should very clearly understand that if the chemical properties change, then a chemical change has occurred. A deeper understanding of properties, will allow students to quickly identify if a chemical change has occurred.

Assessment Clarification:

1. Describe the physical properties and chemical properties of the products and reactants in a chemical change.

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

Inquiry Processes
S.IP.07.11 Generate scientific questions on physical and chemical properties and changes in matter based on observations, investigations, and research.
S.IP.07.12 Design and conduct scientific investigations on physical and chemical properties and changes in matter.
S.IP.07.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes, hot plates, pH meters) appropriate to scientific investigations on physical and chemical properties and changes in matter.
S.IP.07.14 Use metric measurement devices in an investigation dealing with physical and chemical properties and changes in matter.
S.IP.07.15 Construct charts and graphs from data and observations dealing with physical and chemical properties and changes in matter.
S.IP.07.16 Identify patterns in data regarding physical and chemical properties and changes in matter
Inquiry Analysis and Communication
S.IA.07.11 Analyze information from data tables and graphs to answer scientific questions concerning physical and chemical properties and changes in matter
S.IA.07.12 Evaluate data, claims, and personal knowledge through collaborative science discourse on physical and chemical properties and changes in matter
S.IA.17.13 Communicate and defend findings of observations and investigations about physical and chemical properties and changes in matter
S.IA.07.14 Draw conclusions from sets of data from multiple trials of a scientific investigation to draw conclusions on physical and chemical properties and changes in matter
S.IA.07.15 Use multiple sources of information on physical and chemical properties and changes in matter to evaluate strengths and weaknesses of claims, arguments, or data.
Reflection and Social Implication
S.RS.07.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding physical and chemical properties and changes in matter
S.RS.07.12 Describe limitations in personal and scientific knowledge regarding physical and chemical properties and changes in matter.
S.RS.07.13 Identify the need for evidence in making scientific decisions about physical and chemical properties and changes in matter.
S.RS.07.14 Evaluate scientific explanations based on current evidence and scientific principles dealing with physical and chemical properties and changes in matter
S.RS.07.15 Demonstrate scientific concepts through various illustrations to depict physical and chemical properties and changes in matter.
S.RS.07.16 Design solutions to problems to physical and chemical properties and changes in matter using technology.
S.RS.07.17 Describe the effect humans and other organisms have on the balance of the natural world through chemical reactions, and choices humans make as far as using elements for various purposes.
S.RS.07.18 Describe what science and technology can and cannot reasonably contribute to society when dealing with physical and chemical properties and changes in matter.
S.RS.07.19 Describe how science and technology concerning physical and chemical properties and changes in matter have advanced because of the contributions of many people throughout history and across cultures.

Vocabulary

Critically Important – State Assessable	Instructionally Useful
atom atomic arrangement chemical change chemical properties of compounds chemical reaction closed system molecule nonmetal reactive gases chemical properties of elements products reactants density boiling point conductivity pH paper/meter	classification of substances conservation of Mass graduated cylinder physical properties of elements physical properties of compounds

Common Misconceptions (Naïve Understandings)

- Atoms and Elements are the same
- Atoms change in number, size, or composition in a chemical change
- Mass changes in a chemical change
- A phase change is a chemical change (when students see bubbles (gas) in boiling they can attribute that as evidence of a chemical change, which is incorrect).

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 Example

Elements and Compounds: P.PM.07.21, P.PM.07.22, P.PM.07.23, P.PM.07.24

Objectives

- Identify elements as the chemical substances that make up all other substances and are composed of one kind of atom.
- Elements are organized on the Periodic Table in families.
- Describe examples of physical and chemical properties of elements and compounds

Engage and Explore

- Show students a copy of the Periodic Table of the elements. Have students create a T chart with one side labeled “Everyday Elements” and the other side “Never Used Elements” and give them a few minutes to fill out the T Chart using the Periodic Table. Have students “stand up/pair up” with another student and share their list. (P.PM.07.22)
- Create a matchbook of an element. On the outside of the matchbook students should write the symbol of the element and the name of the element. On the inside, there should be a picture of where the element would be found in the world (either from a magazine, the internet, or a drawing) Extension can be to use these matchbook and create a classroom Periodic Table of the Elements that covers one wall of the classroom (P.PM.07.22)

Explain and Define

- Define *elements* as chemical substances that make up all other substances and are composed of one kind of atom. (P.PM.07.21)

- Use a literacy strategy such as an anticipatory set, (questions before teacher choice reading and then return to the questions after reading) KWL, or semantic features analysis to explore facts about elements. (P.PM.07.21)
- Use a particular family (for example, highly reactive metals), to illustrate how the Periodic Table is organized; focus on how the classification is determined. (P.PM.07.22)

Elaborate and Apply

- Create models of elements to emphasize that elements are composed of one type of atom. (P.PM.07.23)
- Give molecular formulas for various compounds, and have students create or simply identify the number/type of elements. (P.PM.07.23)
- Have students make a list of 5 items that surround them in the classroom (desk, pencil, chalkboard, people, book, fish tank, etc.). Once this list is created, have students determine/research what elements are in each item and share their results with the class. (S.IA.07.13)
- Have students discover what elements make up the human body, and then create a graphical representation. (S.IA.07.12, S.IA.07.13, S.IP.07.15)

Evaluate Student Understanding

Formative Assessment Examples
- Stand Up, Pair Up
- Matchbook of the elements (See Engage and Explore)
- Literacy strategies (KWL, anticipatory set)
- Models- Illustrate the structure of molecules using models or drawings (water, carbon dioxide, salt)
- "Book of Elements"

Summative Assessment Examples
- Write a scientific explanation: Does an element's position on the Periodic Table of the Elements give us important information? (Must include claim, and at least 3 pieces of evidence)
- Create a T chart with physical and chemical properties of elements and compounds (boiling point, density, color, conductivity, reactivity)
- Students create an "Alphabook of the Elements" for a younger audience, that
  a. Explains the importance of elements in our lives, and gives an explanation of how the Periodic Table of the Elements is organized, and features 1 or more elements, or
  b. Details one element in detail (perhaps by turning it into a cartoon character), or
  c. Has one page for each element

Enrichment

- Students complete a research report on one of the elements by focusing on the year of discovery, the person credited with discovery, the common uses of the element, and their opinion of the significance of the element in their life.
- Creative Writing: Pretend that you are Dmitri Mendeleev, the father of the periodic table. Write a 1 page or longer (typed, double-spaced) autobiography of your life and your work in researching the patterns of the elements.

Intervention

- Use various internet sites that are designed to teach about elements and the Periodic Table of the Elements
- Video about Elements and the Periodic Table of the Elements from various suppliers, youtube.com, or teachertube.com.
- "The Most Common Elements Project" Have students complete research on only the most common elements which includes what makes them the most common, its symbol, where it sits on the Periodic Table and why.
- Students can create a song about an element or the Periodic Table of the Elements or the teacher can find one and play it (there are several available on the internet)

Examples, Observations, and Phenomena (Real World Context)

Elements are the building blocks of our world. Everything around us is made of elements. Mostly our everyday observations involve unseen elements that are combined to create objects we can see. However there are some elements that we can observe in their pure form such as Gold, Neon, Iron, Aluminum, and Copper.

Instructional Example

Chemical Properties: P.PM.07.11
Chemical Changes: P.CM.07.21, P.CM.07.22, P.CM.07.23

Objectives

- Identify evidence of a chemical change through color, gas formation, solid formation, and temperature change.
  - Compare and contrast the properties of reactants and products in a chemical change, using those properties as evidence of the chemical change. *(implied: define chemical properties)*
  - Illustrate the structure of molecules using models or drawings.
  - Demonstrate that in a chemical change mass is conserved.

Engage and Explore

- Show students some common and some less common examples of chemical changes, (rusting on a bike, Alka Seltzer and water, road salt + *phenopthalein*, flash paper) pictures of fireworks, the sun, and/or hair treatments. Compare and contrast the chemical properties of a new substance with the original after a chemical change. (P.CM.07.22)
- Have students Think-Pair-Share their explanation of what happened (write an explanation, pair up with a neighbor, and each person shares their thoughts) (S.IA.07.12, S.IA.07.13)
- Give students several different materials and have them explore different combinations and make a determination as a team if they believe a chemical reaction has occurred (this is BEFORE an official definition is given). Materials to explore with could include drink mix, water, baking soda, etc. (S.IP.07.11, S.IP.07.12, S.IA.07.11, S.IA.07.13, S.RS.07.13)
- Create a T-chart that is labeled, “properties before” and “properties after”. Have students complete their T chart as they investigate the various combinations. (P.CM.07.22)
- Give students several mystery substances and have them classify them by their chemical properties (P.PM.07.11)

Explain and Define

- Define Reactants as the “before” items, and Products as the “after”. (P.CM.07.22, P.CM.07.23)
- Students brainstorm the term chemical change and what makes it different than a phase change (something new/different; various signs/indicators) (P.CM.07.21, P.CM.07.22, P.CM.07.23)
- Students present their ideas to the class and collectively the class makes sense of chemical changes and their indicators, as evidenced in reactants and products. (P.CM.07.21, P.CM.07.22, P.CM.07.23)

- Identify evidence of a chemical change through color, gas formation, solid formation, and temperature change. (P.CM.07.21)
- Define chemical properties (flammability, pH, acid-base indicators, reactivity) (P.PM.07.11, P.CM.07.21)
- Students should brainstorm situations where chemical properties would have significance both for safety, and for classification. (P.PM.07.11)

Elaborate and Apply

- Students generate questions regarding chemical change, and then design and conduct investigations to prove that a chemical change occurred. (P.CM.07.21, P.CM.07.22, P.CM.07.23, S.IP.07.11, S.IP.07.12, S.IP.07.13, S.IA.07.13)
- Show some examples of phase changes that may give the illusion of being a chemical change because they "produce" gas (bubbles are seen), etc. (P.CM.07.21, P.CM.07.22, P.CM.07.23)
- Use molecular models to demonstrate the atoms rearranging in a chemical change, which allows something "new" to be created, while the atoms themselves are not new*. (Chemical formulas of reactants and products would need to be provided.)* (P.CM.07.22, P.CM.07.23)
- Emphasize the number and types of atoms involved, and have students discuss the question, "How does anything new come into existence?" (P.CM.07.22, P.CM.07.23)
- Students complete research on various "new" substances, and share with the class either through oral, visual, or written presentations. (P.CM.07.21, P.CM.07.22, P.CM.07.23, S.IA.07.13)
- Ask students about the mass in a chemical change; is there a change? Students discuss their thoughts, and then design and conduct investigations to determine if mass is conserved. (P.CM.07.21, P.CM.07.22, P.CM.07.23, S.IA.07.11, S.IA.07.13)
- Students do a presentation to share their findings. Teacher would introduce the concept of "open" and "closed" systems, and allow students to re-design their experiment to prove Conservation of Mass. (P.CM.07.21, P.CM.07.22, P.CM.07.23, S.IA.07.11, S.IA.07.13, S.IP.07.11, S.IP.07.12)
- Students once again should create and examine molecular models as a piece of evidence for Conservation of Mass (in a chemical change, the atoms rearrange, but do not increase or transform, so the mass is conserved). (P.CM.07.22, P.CM.07.23)
- Students set up a museum tour with stations containing either chemical changes or phase changes, with molecular models. The "visitors" must determine what change has occurred, and cite at least 3 pieces of evidence. (P.CM.07.21, P.CM.07.22, P.CM.07.23, S.IA.07.13, S.RS.07.11, S.RS.07.13, S.RS.07.15)
- Students should be able to classify substances by their chemical properties either by determining the properties themselves, and then referencing a key, or using data (P.PM.07.11, S.IA.07.11, S.IA.07.13, S.RS.07.11, S.RS.07.13)

Evaluate Student Understanding

- Have students classify substances by their chemical properties (flammability, pH, acid-base indicators, reactivity) (P.PM.07.11)
- Give students the molecular formula for some "mystery" reactants and have them create models of some possible products. Students should be able to identify the type and number of elements in the reactants and the products, as well as proving conservation of mass in their equation. In addition, students should be able to use the information from the Periodic Table of the Elements to make some inferences about how the elements behave based on their family. Students should also be able to communicate this model to the class, and provide examples of what to look for to determine if a chemical change had occurred. (P.PM.07.22, P.PM.07.22, P.PM.07.23, P.PM.07.24, P.CM.07.21, P.CM.07.22, P.CM.07.23, S.IA.07.12, S.IA.07.13, S.RS.07.11, S.RS.07.13, S.RS.07.15)

Formative Assessment Examples

- Use the student discussions (Think-Pair-Share, etc.) to assess the students' ability to describe chemical changes and indicators of chemical change.
- T-Chart
- Molecular models
- Experiment design and conclusions
- Museum Tour and the "visitor" reports

Summative Assessment Examples

- Write a scientific explanation: Are bubbles always an indicator of a chemical change? (Must include a claim and at least 3 pieces of evidence to support your claim)
- Choose the possible product/s for the molecular model shown here. (There would be a molecular model of at least 2 reactants)
- Create a chart with "properties before" and "properties after" and have students determine if a chemical change has taken place by examining the data.

Enrichment

- Students may be given a more complex chemical formula and construct a molecular model or give a molecular model and asked to break it down into its formula and identify.

- Students are given different examples of substances that are classified as one substance, but behaves as another, i.e. salt is a solid, but behaves like a liquid, and have them explain to a peer why

Intervention

- Give students different colored circles of paper to “talk their way” through the chemical change. (i.e. as the Alka Seltzer bubbles – move the atom to its new bond – this leads to the E & D step of reactants and products.
- Use everyday common examples, have students list what they did to get ready for school and then list, which were chemical or physical changes and how they know.

Examples, Observations, and Phenomena (Real World Context)

Chemical changes are around us everyday, from baking a cake, to rusting of a bicycle, to fireworks. Some chemical changes are beneficial such as digestion in our stomachs. Some chemical changes can be harmful such as bombs or explosions. Some chemical changes can be both beneficial and harmful such as the combustion of fossil fuels (allows humans to travel and create heat; can be detrimental to the environment). Some evidence of chemical changes such as color, gas formation, solid formation, and temperature change are easily observable, while changes to the chemical properties of a new substance may be more complex to discover, but are still valid.

Literacy Integration

Reading

R.WS.07.01 explain and use word structure, sentence structure, and prediction to aid in decoding and understanding the meanings of words encountered in context.

R.WS.07.07 in context, determine the meaning of words and phrases including regional idioms, literary and technical terms, and content vocabulary using strategies including connotation, denotation, and authentic content-related resources.

R.CM.07.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.07.03 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.07.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Writing

W.GN.07.02 write a research report using a wide variety of resources that includes appropriate organizational patterns (e.g., position statement/supporting evidence, problem statement/solution, or compare/contrast), descriptive language, and informational text features.

W.GN.07.03 formulate research questions using multiple resources, perspectives, and arguments/counter-arguments to develop a thesis statement that culminates in a final presented project using the writing process.

W.PR.07.02 apply a variety of pre-writing strategies for both narrative (e.g., graphically depict roles of antagonist/protagonist, internal/external conflict) and informational writing (e.g., position statement/supporting evidence, problem statement/solution, or compare/contrast).

Speaking

S.CN.07.01 adjust their use of language to communicate effectively with a variety of audiences and for different purposes by using specialized language related to a topic and selecting words carefully to achieve precise meaning when presenting.

S.DS.07.04 plan a focused and coherent informational presentation using an informational organizational pattern (e.g., problem/solution, sequence); select a focus question to address and organize the message to ensure that it matches the intent and the audience to which it will be delivered.

Mathematics Integration

A.PA.07.01 Recognize when information given in a table, graph, or formula suggests a directly proportional or linear relationship.

A.RP.07.02 Represent directly proportional and linear relationships using verbal descriptions, tables, graphs, and formulas, and translate among these representations.

Seventh Grade Companion Document
7-Unit 3: Structures and Processes of Living Things

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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 the 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.

7th Grade Unit 3:
Structures and Processes of Living Things

Content Statements and Expectations

7 – Unit 3: Structures and Processes of Living Things

Big Ideas (Key Concepts)

- All living organisms are composed of cells, from one cell to many cells and they exhibit cell growth and division.
- Specialized cells within multi-cellular organisms form different kinds of tissues and organs and organ systems that function together.
- Photosynthesis transforms light energy to chemical energy making possible the building of key chemical building blocks of living organisms.
- All organisms have a life span and must reproduce in order to continue the species. Reproduction may be asexual or sexual.

Clarification of Content Expectations

Standard: Organization of Living Things

Content Statement – L.OL.M.2

Cell Functions- All organisms are composed of cells, from one cell to many cells. In multicellular organisms, specialized cells perform specialized functions. Organs and organ systems are composed of cells, and function to serve the needs of cells for food, air, and waste removal. The way in which cells function is similar in all living organisms.

Content Expectations

L.OL.07.21 Recognize that all organisms are composed of cells (single cell organisms, multicellular organisms).

Instructional Clarifications

1. All living organisms are composed of cells. Organisms may be composed of just one cell others may consist of many cells.
2. Protists can be observed as examples of single-celled organisms.
3. Plants can be used to observe multicellular structure.

Assessment Clarifications

1. Recognize is to be able to distinguish between organisms that are one-celled and those that are multicellular based on observable characteristics.

L.OL.07.22 Explain how cells make up different body tissues, organs, and organ systems.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally, that:
    a. Tissue consists of cells of similar structure.
    b. Organs are made up of tissues of different types.
    c. Organ systems serve the needs of cells for food, air, and waste removal.
2. The intent is to relate organ systems to their basic cell structure and function (tissues and individual specialized cells). The intent is NOT to address human body systems that are included in fifth grade content expectations (L.OL.05.41, L.OL.05.42). Plants are a practical choice to examine tissues, organs and organ systems.
3. In multicellular organism:
    a. Tissues are composed of groups of similar specialized cells, for example, in animals, muscle, nerve, bone and others. In plants, epidermis, conductive tissue, and distinct photosynthetic layers in leaves.
    b. Organs are composed of different types of tissues. For example, in animals, the heart contains nerve tissue, muscle tissue, and other tissues. In plants, leaves contain conductive tissue, epidermal tissue and layers of photosynthetic tissue.
    c. Organ systems are composed of different organs. For example, the digestive system is composed of esophagus, stomach, small intestine, etc.
    d. Organs and organ systems are composed of cells and function to serve the needs of cells for food, air, water, and waste removal.
4. Excluded: Structure and function of specific tissues and cells within organs (e.g., different types of blood cells or muscle cells.)

Assessment Clarification:

1. The intent is to relate organ systems to their basic cell structure and function (tissues and individual specialized cells). The intent is NOT to address human body systems that are included in fifth grade content expectations (L.OL.05.41, L.OL.05.42). Plants are a practical choice to examine tissues, organs and organ systems.

L.OL.07.23 Describe how cells in all multicellular organisms are specialized to take in nutrients, which are used to make the materials that a cell or organism needs.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words how nutrients pass through cell membranes by diffusion.
2. Cells in all multicellular organisms have cell membranes that allow some nutrients to pass through to the interior of the cell by diffusion.

3. Nutrients that cannot pass through the membrane by diffusion can be taken into the cell through active transport (uses cell energy).
4. Nutrients taken in by the cell also provide materials to build cell structures and specialized molecules used by the organisms.
5. Exclusion: endocytosis, exocytosis and cell organelles.

Assessment Clarification

1. Student will describe how nutrients pass through cell membranes by and are used to provide energy for work of the cell and materials that the cell needs.

L.OL.07.24 Recognize that cells function in a similar way in all organisms.

Instructional Clarifications

1. Recognize is to be aware that cells function in a similar way in all organisms.
2. Organisms need food, oxygen, and removal of wastes. These needs are actually at the cellular level. Cells perform the same basic life functions in all organisms (take in food, oxygen, and removal of waste).
3. The cells of all organisms require nutrients to provide energy and building materials.
4. Cell functions include general and specialized jobs performed by cells.

Assessment Clarifications

1. Describe basic life functions performed by cells.
2. Recognize that cells function in a similar way in all organisms.

Content Statement - L.OL.M.3

Growth and Development- Following fertilization, cell division produces a small cluster of cells that then differentiate by appearance and function to form the basic tissues of multicellular organisms.

Content Expectations

L.OL.07.31 Describe growth and development in terms of increase of cell number and or cell size.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words
    a. how division of cells and their subsequent growth leads to an increase in cell number and an increase in the size of multicellular organisms.
    b. how growth in one-celled organisms is due to an increase in cell size.
2. Growth of one-celled organisms is limited to increase in cell size.
3. Growth of multicellular organisms is due to both increase in cell size and increase in cell number.

4. Cells in multicellular organisms increase in cell number by cell reproduction (cell division). A larger multicellular organism has more cells than a smaller organism of the same species.

Assessment Clarifications

1. Describe how division of cells leads to an increase in cell number and an increase in the size of multicellular organisms.
2. Exclusion: The phases of mitosis are excluded at this grade level.
3. Describe how growth in one-celled organisms is due to an increase in cell size.

L.OL.07.32 Examine how through cell division, cells can become specialized for specific functions.

Instructional Clarifications

1. Examine is to investigate how cell division in multicellular organisms leads to the development of specialized tissues, organs and organ systems.
2. Sexually reproducing multicellular organisms begin as a fertilized egg and develop into complex organisms with specialized systems, organs, tissues and cells. As cell division and growth occur, differentiation into specialized cells also occurs.
3. Some cells produced by cell division develop specialized structure and are able to perform particular functions.
4. A variety of specialized cells formed through cell division make up different tissues, performing different functions.
5. Students have difficulty discriminating between cell division, enlargement, and differentiation. They may believe that living things grow because their cells get larger. Students poorly understand the roll of cell differentiation in growth.

Assessment Clarifications

1. Investigate how continued cell division in multicellular organisms leads to the development of specialized tissues, organs and organ systems.
2. Infer that the large number of cells in a multicellular organism, make possible the development of tissues, organs, and organ systems.

Content Statement - L.OL.M.6

Photosynthesis - Plants are producers; they use the energy from light to make sugar molecules from the atoms of carbon dioxide and water. Plants use these sugars along with minerals from the soil to form fats, proteins and carbohydrates. These products can be used immediately, incorporated into the cells of a plant as the plant grows, or stored for later use.

Content Expectations

L.OL.07.61 Recognize the need for light to provide energy for the production of carbohydrates, proteins and fats.

Instructional Clarifications

1. Recognize is to know that sugars produced directly by photosynthesis are used to provide the energy to produce other carbohydrates, proteins and fats.
2. The process of photosynthesis uses light energy to produce simple carbohydrates.
3. Some students mistakenly think:
    a. plants obtain their energy directly from the sun rather than using light energy to produce food.
    b. Plants use heat from the sun as a source of energy for photosynthesis
    c. Sunlight is a food.
    d. Sunlight is composed of molecules.
    e. Sunlight is "consumed" in photosynthesis.
4. Carbohydrates, proteins, and fats need not be described in terms of chemical structure, but students should be familiar with common examples.
    a. Carbohydrates (sugars and starches): potato, corn, wheat bread, maple syrup, beet sugar
    b. Proteins: beans
    c. Fats and oils: olive, sunflower, corn

Assessment Clarification

1. Recognize that light provides the energy for plants to combine materials from air, water, and soil to produce carbohydrates, proteins, and fats.

L.OL.07.62 Explain that carbon dioxide and water are used to produce carbohydrates, proteins, and fats.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, an/or verbally that carbon dioxide and water are used in the process of photosynthesis to make simple carbohydrates.
2. Examples of structural formulae of carbohydrates, proteins, and fats may be used mainly to point out the presence of carbon, hydrogen and oxygen in each. J
3. Plants take energy from light to form higher energy molecules contain carbon, hydrogen, and oxygen (carbohydrates) from lower energy molecules (carbon dioxide and water).
4. Students sometimes think that plants make food for use by animals rather than plants making their own food for use in growth and reproduction.
5. The process of photosynthesis in land plants uses light energy to produce simple carbohydrates from carbon dioxide in the air and water from the soil. Aquatic plants obtain both substances from water.
6. Plants use the sugar made in photosynthesis as the building block to make bigger carbohydrates and fats. With the addition of the minerals from the soil they are bale to make proteins.

Assessment Clarification

1. Explain that the source of carbon, hydrogen, and oxygen found in carbohydrates, proteins and fats produced by plants is carbon dioxide and water.

L.OL.07.63 Describe evidence that plants make, use, and store food.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words the evidence that plants make, use and store food.
    a. A germinating seed shrivels as the growing seedling uses its stored food.
    b. Plant parts rich in food value are nuts, seeds, roots (carrots, beets) and fruits.
    c. Animals can obtain energy and useful materials by consuming plants or plant parts.
2. Plants grow using light as a source of energy. Plants have specialized food storage structures such as the potato or onion.
3. Plants produce carbohydrates, proteins and fats that serve their own purposes and as food for other organisms.
4. Stored food, such as that in a seed, is used as the seed germinates and begins to grow. Some plants such as carrots store food in a root to support the next season's growth.
5. Plant structures such as roots, tubers, fruits and seeds have high caloric value.

Assessment Clarification

1. Describe evidence that plants make, use and store food. Examples:
    a. A germinating seed shrivels as the growing seedling uses its stored food.
    b. Plant parts rich in food value are nuts, seeds, roots (carrots, beets) and fruits.
    c. Animals can obtain energy and useful materials by consuming plants or plant parts.

Content Statement – P.EN.M.4

Energy Transfer – Energy is transferred from a source to a receiver by radiation, conduction, and convection. When energy is transferred from a source to a receiver, the quantity of energy before the transfer is equal to the quantity of energy after the transfer.

P.EN.07.43 Explain how light energy is transferred to chemical energy through the process of photosynthesis.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing, demonstrations, and/or verbally that light energy is stored as chemical energy in sugar molecules in the process of photosynthesis.
2. Plants use light energy to build high-energy sugar molecules (chemical energy) from lower energy molecules (carbon dioxide and water).
3. Some students mistakenly believe that plants feed by absorbing food through their roots.
4. Some students mistakenly believe that energy from sunlight is necessary for photosynthesis and that artificial light cannot drove photosynthetic processes.
5. Details of the photosynthetic process such as the light dependent and light independent reactions are excluded.

Assessment Clarification

1. Explain the energy that plants use to combine materials from air, water, and soil to produce carbohydrates, proteins, and fats is provided by light.

Content Statement - L.HE.M.2

Reproduction- Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually.

Content Expectations

L.HE.07.21 Compare how characteristics of living things are passed on through generations, both asexually and sexually.

Instructional Clarifications

1. Compare is to distinguish between the characteristics and sources of genetic material of young produced by sexual and asexual reproduction.
2. Reproduction, whether sexual or asexual is a requirement for the survival of a species. The genetic material that produces characteristics of living things is passed from generation to generation.
3. Sexually reproduced organisms become adults that closely resemble their parents. Both parents contribute genetic material equally to the offspring.
4. Some students mistakenly believe that daughters inherit most of their characteristics from their mothers and that boys inherit most of their characteristics from their fathers.
5. Organisms produced through asexual reproduction receive genetic material from only one organism and are, therefore, genetically identical to that organism. Cloning, whether natural or artificial, is an example of asexual reproduction.

6. Plants can produce sexually through pollination →fertilization or asexually by a variety of means, e.g., runners, underground stems.

Assessment Clarifications

1. Compare the characteristics of young produced by sexual and asexual reproduction.
2. Compare the sources of genetic material of young produced by sexual and asexual reproduction, i.e., respectively, genetic material from two sources (organisms) and genetic material from one organism.
3. Exclusion: The phases of mitosis and meiosis are excluded at this grade level.

L.HE.07.22 Compare and contrast the advantages and disadvantages of sexual vs. asexual reproduction.

Instructional Clarifications

1. Compare and contrast is to tell or depict in spoken or written words, the advantages of sexual vs. asexual reproduction.
2. Some students mistakenly believe that sexual reproductions occurs in animals and not plants.
3. Sexual reproduction produces variation among offspring. These variations may provide combinations of characteristics helpful to species survival. This variation may also produce combinations of characteristics that are a disadvantage to survival of some species.
4. Students often do not distinguish between sexual and asexual reproduction.
5. Asexual reproduction can produce large numbers of offspring that are identical to the previous generation. These organisms may be at a disadvantage for survival if the environment changes.
6. Asexual reproduction can produce large numbers of offspring that are identical to the previous generation. This can produce a situation where many organisms to take advantage of available resources.
7. Asexual reproduction can be accomplished without the need to find a mate.
8. Some students mistakenly believe that asexual reproduction produces weak offspring and that sexual reproduction produces superior offspring.

Assessment Clarifications

1. Compare and contrast the advantages and disadvantages of sexual vs. asexual reproduction.

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

Inquiry Processes
S.IP.07.11 Generate scientific questions about cells or plant growth based on observations, investigations, and research.
S.IP.07.12 Design and conduct scientific investigations to study the relationship between cells and tissues (look at different types of plants, examining leaf tissue, root tissue, stem tissue, and compare the structure of specialized cells
S.IP.07.13 Use tools and equipment (hand lens, microscopes, thermometer) appropriate to the scientific investigation.
S.IP.07.14 Use metric measurements in an investigation of plant growth.
S.IP.07.15 Construct charts and graphs from data and observations such as growth in leaf size or height of plants growing under different environmental conditions.
S.IP.07.16 Identify patterns in data collected from plant growth experiments conducted by student groups.
Inquiry Analysis and Communication
S.IA.07.11 Analyze information from data tables and graphs to answer scientific questions on the patterns of relationships between light and or carbon dioxide concentrations in the environment and plant growth.
S.IA.07.12 Evaluate data, claims, and personal knowledge of photosynthesis through collaborative scientific discourse.
S.IA.07.12 Evaluate data, claims, and personal knowledge in distinguishing one celled and multicellular organisms through collaborative scientific discourse (or, about photosynthesis investigation results).
S.IA.07.13 Communicate and defend findings about characteristics passed on through sexual reproduction and asexual reproduction using evidence from observations and investigations.
S.IA.07.14 Draw conclusions from sets of data from multiple trials in a scientific investigation of plant growth under varied environmental conditions.
Reflection and Social Implication
S.RS.07.11 Evaluate the strengths and weaknesses of claims, arguments, and data from plant growth investigations.
S.RS.07.12 Describe limitations in personal and scientific knowledge regarding the ability to study how plants get solar energy.
S.RS.07.13 Identify the need for evidence in making scientific decisions about optimal conditions of light and carbon dioxide for plant growth to provide energy for the production of carbohydrates, proteins and fats.
S.RS.07.14 Evaluate scientific explanations about the process of photosynthesis based on current evidence and scientific principles.
S.RS.07.15 Demonstrate the process of cell division through various illustrations, performances, models, exhibits, and activities.
S.RS.07.16 Design solutions to problems of growing plants in the classroom using technology.
S.RS.07.18 Describe what science and technology can and cannot reasonably contributes to society to address food production for increasing world population.
S.RS.07.19Describe 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
cell cell division cell growth specialized cell tissues organs organ systems photosynthesis sexual reproduction asexual reproduction specialized cell unicellular organism multicellular organism carbon dioxide water carbohydrate protein fat	specialized tissue cell membrane cell function differentiation diffusion osmosis active transport chemical building blocks fertilization heart muscle nerve systems: circulatory, digestive, nervous, skeletal, excretory, muscular genetic material atoms molecules

Instruments, Measurements, Representations

microscopes	Use to examine plant tissues and one-celled organisms, animal tissue slides if available.
representations	Labeled drawings comparing specialized cells in plants
metric ruler	Measure plant growth
representations	Graphic results of plant growth Concept maps relating experimental results to the simplified equation of photosynthesis.

Instructional Framework

The following Instructional Frameworks are an effort to clarify possible units within the K-7 Science Grade Level Content Expectations. The Instructional Frameworks provide 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 Frameworks are ***NOT*** *step-by-step instructional manuals, 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

Cell Functions - L.OL.07.21, L.OL.07.22, L.OL.07.23, L.OL.07.24, L.OL.07.31, L.OL.07.32

Objectives

- Make microscopic observations of cells in a variety of organisms, distinguishing one-celled from multicellular organisms.
- Focus on variety of cell organization and structure (specialization) in different tissues of a plant.
- Relate the growth of organisms to increase in cell size and/or number.

Note: In the study of cells, cell structures and function, and cell division and growth, it is necessary to provide multiple resources for students to view diagrams, models, photos, text information, and virtual demonstrations. Students should also have the opportunity to gain skills in using the microscope to view actual cells within their exploration of cell structure and function.

Engage and Explore

- Prepare multiple slides at microscope station of different cells for students to observe. Slides may include, onion skin (plant), cheek cells (animal), pond water with amoeba or paramecia, and aquatic plants such as elodea.(L.OL.07.21, S.IP.07.11, S.IP.07.12, S.IP.07.13)
- After students have had the opportunity to observe the slides under the microscope, conduct a whole class brainstorming session to gain an understanding of student's ideas about cells. Ask: Can anyone explain what a cell is or does? (S.IA.07.12, S.IA.07.13)

- Make a list of student questions based on their initial observations of the cell slides. (S.IP.07.11)
- Make microscopic examinations of pond water samples observing one-celled protists, algae such a diatoms, and multicellular organisms. Also observe tissue samples from plants (multicellular organisms). Develop criteria for distinguishing between one celled and multicellular organisms. (L.OL.07.21, S.IP.07.11, S.IP.07.12, S.IP.07.13)
- Observe tissues from different parts of a plant comparing the structure of cells from roots, stems, and leaves and/or compare the structure of cells from different regions of a leaf of a flowering plant, e.g., epidermis, photosynthetic layers within the leaf). (L.OL.07.22, L.OL.07.32, S.IP.07.11, S.IP.07.12, S.IP.07.13)

Explain and Define

- Using criteria from student teams, develop consensus criteria to distinguish single-celled organisms from multicellular organisms. (S.IA.07.12, L.OL.07.21)
- Use multiple references sources for students to use to evaluate their initial ideas about cells and cell functions. (S.IA.07.15, L.OL.07.21)
- Use a Venn diagram to compare plant and animal cells. (L.OL.07.24,
- Have students compare and contrast cells of different body tissues, organs, and organ systems. (L.OL.07.22, L.OL.07.23, L.OL.07.24)
- As a class, determine how specialized cells carry out different functions. Divide the class into research teams and assign teams different cells types to research and present findings to the rest of the class. Develop a rubric for information gathering on the team's particular cell type. Include how cells are specialized yet continue to function in a similar way. (S.IA.70.15, L.OL.07.23, L.OL.07.24)
- Explain and define the terms growth and development, and differentiation and specialization. Have student apply the key terms to cells and the specialized cells in their research. (L.OL.07.31, L.OL.07.32)
- Provide Internet sites and reference textbooks that give students a visual representation of cell division, cell growth, and diffusion.

Elaborate and Apply

- Students apply the consensus criteria to the observation of additional organisms.
- Research about and relate specialized cells to general functions such as epidermal cells preventing dehydration, green (chlorophyll containing) cells performing photosynthesis, conductive tissue providing transport.
- Calculate the number of cells produced in one day by cell division of a fertilized egg if cell division occurs every 10 minutes.
- Perform activities that demonstrate diffusion of a substance in water and diffusion and osmosis through a semi-permeable membrane (similar to a cell membrane). (L.OL.07.23, L.OL.07.24, S.IP.07.12)

- Explain the similarities and differences between diffusion and osmosis. Infer the structure of semi-permeable membranes.
- Students perform a series of investigations with chicken eggs whose shells have been dissolved by immersion in vinegar. Eggs are placed in solutions of different salt concentrations. Change in the egg's circumference is used to measure movement of water into and out of the egg. Reference: http://www.sciencespot.net/Pages/classbio.html#Anchor-eggs

Evaluate Student Understanding

Formative Assessment
- Identify microscopic images of organisms as one celled or multicellular and give supporting evidence.
- Relate images of plant cells to their general function.
- Relate growth in multicellular organisms to increase in cell number.
- Make predictions regarding the net diffusion of water given different scenarios of solutions of different types on either side of a semi-permeable membrane.

Summative Assessment
- Compare and resolve differences in classification of organisms among student groups. (L.OL.07.21, S.IA.07.12)
- List criteria for distinguishing one-celled from multicellular organisms. (L.OL.07.21)
- Describe how one-celled and multicellular organisms increase in size. (L.OL.07.21)
- Explain how multicellular organisms can develop more specialized parts and functions than one-celled organisms. (L.OL.07.21)
- Write a paragraph describing how multicellular organisms grow and form specialized cells observed in the investigation, relating the structure of these cells to their function.
- Distinguish between diffusion and osmosis.
- Describe how materials enter and leave cells. Use diagrams with varied concentrations of solutions to predict the movement of water into or out of eggs whose shells have been dissolved.
- Infer and describe the nature of cell membranes and predict the movement of water into and out of cells given different concentrations of internal and external solutions.

Enrichment

- Students use varying concentrations of salt water to perform plasmolysis investigations with fresh onion epidermis in order to estimate the "normal" concentration of dissolved substances within the onion cells.

Intervention

- Students use a graphic organizer similar to a Venn diagram to model movement of substances from a higher concentration to a lower concentration. The intersect portion of the diagram reflects the properties of a semi-permeable membrane (water easily passes through, sugar does not pass through). One side of the diagram "contains" water and the other side "contains" a sugar solution. Students use blank replicates of the diagram to indicate changes of concentration over time, including the change in the amount of water and sugar concentration in the sugar solution side.

Examples, Observations, and Phenomena (Real World Context)

Macroscopic observation of cell growth and specialization is most obvious in germinating seeds and plant seedlings which grow rapidly through cell division and show development of organs such as leaves stems and roots. Combined with microscopic examination of plant tissues, students can infer that growth and development are the result of cell reproduction and specialization.

Healing of minor scrapes and cuts also provides the opportunity to observe cell growth and reproduction and specialization that lead to tissue repair.

Crisping of celery soaked in tap water is a common example of osmosis moving water into plant cells.

Literacy Integration

Reading

R.WS.07.07 in context, determine the meaning of words and phrases including cross cultural expressions, mathematical expressions, scientific procedures, and literary terms using strategies and authentic content-related resources.
R.IT.07.01 analyze the structure, elements, features, style, and purpose of informational genre including persuasive essay, research report, brochure, personal correspondence, autobiography and biography.
R.CM.07.02 retell through concise summarization grade-level narrative and informational text.
R.CM.07.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.
Speaking
S.CN.07.03 present in standard American English if it is their first language. (Students whose first language is not English will present in their developing version of standard American English.)
Select a scientist to read about and give a brief oral report in class.
Reference: *100 Most Popular Scientists for Young Adults: Biographical Sketches and Professional Paths* by Kendall Haven , Donna Clark

Mathematics Integration

N.FL.07.03 Calculate rates of change including speed.
Determine growth over a 24-hour period in the number of cells from a fertilized egg if cell division occurs once every hour.

Instructional Examples

Photosynthesis - L.OL.07.61, PEN.07.43, L.OL.07.62, L.OL.07.63

Objectives

- Explain how the sun supplies living things with the energy they need.
- Describe how plants use light to provide energy for the production of food.
- Describe what happens during the process of photosynthesis.
- Design an investigation to grow plants under different conditions and draw conclusions on plant health, growth, and food production.

Engage and Explore

- Review the students' previous knowledge regarding the plant cell and the difference between a plant and animal cell. Begin the study of photosynthesis by asking the questions, "What would happen if there weren't any plants?" and "What do plants need to grow and survive?" Accept all reasonable ideas at the onset of the unit. To encourage deeper thinking, ask students how plants survive through the winter or through the night. Ask students to predict what would happen to plants if there weren't any sunlight.
- Check for student ideas that relate to the plant's need for sunlight, water, food, and space. Ask the class where plants get their food.
- Through whole class and small group discussion, have students' plan an investigation that will help to answer the class questions about what plants need to survive and how they get their food.
- Have students read about the experiment of scientist Van Helmont and how he discovered that plants do not use soil the same way people use food. (S.RS.07.19,L.OL.07.63)
- Have students explore stations to discover where sugar and starch are stored in different parts of different plants. (use glucose test strips and iodine for indicators) (L.OL.07.62)
- Set up a demonstration in a closed system to show how plants give off oxygen.
- Student groups test the ability of an Elodea plant to photosynthesize with and without light. This familiar activity requires students to seal part of an Elodea plant in a test tube filled with a weak bromthymol blue solution that as been acidified with CO_2 from a student's breath and observe color changes in plants exposed to light and those shielded from light as CO_2 is consumed in the process of photosynthesis. (L.OL.07.61, PEN.07.43, L.OL.07.62, S.IA.07.12, S.IA.07.14)

Explain and Define

- Explain the process of photosynthesis and how plants use CO_2 , water, and light energy to produce glucose (sugar) and oxygen.
- Provide multiple resources for students to evaluate informational text, diagrams, and virtual representations of the process of photosynthesis.
- Use BTB color change to infer the use of CO_2 by plants exposed to light.
- Relate investigation results to the simplified equation of photosynthesis. (L.OL.07.61, PEN.07.43, L.OL.07.62, S.RS.07.13, S.RS.07.14)

Elaborate and Apply

- Design investigations that block light from different parts of the plant (leaves and stems). (L.OL.07.61, L.OL.07.63, S.IP.07.11, S.IP.07.12, S.IP.07.13, S.IP.07.14, S.IP.07.15, S.IP.07.16)
- Students design and perform plant growth investigations that use light as a variable. (L.OL.07.63, PEN.07.43, SIP.07.16, S.IA.07.12, SRS.07.16)
- Students design investigations into food storage in plants and how plants survive through the winter and overnight. Students recognize that plants make, use, and store their own food. (L.OL.07.63, S.IP.07.11, S.IP.07.12, S.IP.07.13, S.IP.07.14, S.IP.07.15, S.IP.07.16)
- Return to the model of plant cells from their previous unit and have students identify the chloroplasts and chlorophyll in the cell. (L.OL.07.21, L.OL.07.61)
- Discuss how plants take in carbon dioxide. Use the underside of a variety of leaves under the microscope to identify the stomata cells of the plant where carbon dioxide enters the plant and oxygen exits the plant. (The stomata cells of the *zebrina* plant (Wandering Jew) are easily recognized under the microscope.) (L.OL.07.61, L.OL.07.62, S.IP.07.13, S.IA.07.12, S.IA.07.13)

Evaluate Student Understanding

Formative Assessment

- Identify the variable in the BTB investigation and create a control for the experiment.
- Explain why starch is tested for in the leaves, though photosynthesis in the leaf produces sugar. . (L.OL.07.63)

Summative Assessment

- Relate all investigation results to the simplified equation of photosynthesis by explaining and defending each team's concept map. (L.OL.07.61, L.OL.07.62)
- In teams of three, create a concept map that relates each component of the simplified equation of photosynthesis to the Elodea plant and the "LIGHTS OUT" investigations. Present the map and defend its representations. (L.OL.07.61, L.OL.07.62, S.IA.07.13)

Enrichment

- Students design and perform plant growth investigations that use carbon dioxide as a variable. The effect of carbon dioxide enrichment on the growth of plants can be investigated in a closed system such as a two-liter soda bottle. Reacting Alka Seltzer or similar products with water can supply carbon dioxide. (L.OL.07.61, , L.OL.07.62, S.IP.07.11, S.IP.07.15, S.IA.07.11, S.RS.07.16, S.RS.07.18)

Intervention

- *Illuminating Photosynthesis* at http://www.pbs.org/wgbh/nova/methuselah/photosynthesis.html#
- This NOVA website produced by WGBH provides both background reading and interactive learning through "puzzlers."

Examples, Observations, and Phenomena (Real World Context)

Today's concern about global climate change generally focuses on the addition of carbon dioxide to the atmosphere but mentions little about how plants trap carbon dioxide and sequester it in the carbon compounds that they synthesize. Global deforestation has reduced the consumption of carbon dioxide by photosynthetic processes.

Literacy Integration

Reading

R.IT.07.01 analyze the structure, elements, features, style, and purpose of informational genre including persuasive essay, research report, brochure, personal correspondence, autobiography and biography.

R.IT.07.02 analyze organizational text patterns including sequential, compare/contrast, and cause/effect.

R.CM.07.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Reference: *Illuminating Photosynthesis* at
http://www.pbs.org/wgbh/nova/methuselah/photosynthesis.html#

Writing

W.GN.07.03 formulate research questions using multiple resources, perspectives, and arguments/counter-arguments to develop a thesis statement that culminates in a final presented project using the writing process.

Speaking

S.DS.07.04 plan and deliver a focused, coherent informational presentation using an informational organizational pattern (e.g., theory/evidence, persuasion, sequence) that incorporates persuasive, non-verbal techniques, and provides explanations and descriptions supportive of the presentation's focus and the backgrounds and interests of the audience.

- Present data and conclusions from the investigation of plant growth related to conditions of light.

Mathematics Integration

N.FL.07.07 Solve problems involving operations with integers.

D.RE.07.01 Represent and interpret data using circle graphs, stem and leaf plots, histograms, and box-and-whisker plots, and select appropriate representation to address specific questions.

D.AN.07.02 Create and interpret scatter plots and find line of best fit; use an estimated line of best fit to answer questions about the data.

- Metric measurement of plant growth will be recorded over an extended period. Total and average growth per day will be calculated. Growth over time will be represented with a line graph.

N.FL.07.05 Solve proportion problems using such methods as unit rate, scaling, finding equivalent, fractions, and solving the proportion equation a/b = c/d; know how to see patterns about proportional situations in tables.

- If an average sized tree can produce enough oxygen to support two to three humans, how many average size trees are necessary to provide oxygen for today's estimated world population?

Instructional Examples

Heredity - L.HE.07.21, L.HE.07.22

Objectives

- Observe and distinguish between patterns of inheritance of characteristics of asexually and sexually reproducing organisms.
- Understand that most plants usually reproduce sexually.
- Recognize that organisms produced through asexual reproduction are generally genetically identical.
- Recognize that sexual reproduction introduces genetic variety into the offspring produced.

Engage and Explore

- Ask students if they know how humans and other animals pass on their traits to their offspring. The point of the discussion is not to have students discuss the mechanisms of genes and DNA in detail, but to make sure that students understand that in animals, traits are inherited from both parents. (L.HE.07.21)
- Student teams examine four or five large plants of the same type. Each plant should be slightly different from the others. Ask students to describe how each one is similar and different in terms of height, color, and shape. (L.HE.07.21) Ask students:
  1. Why do the plants not look exactly alike?
  2. Do you think the plants look like their parents?
  3. Do plants even have parents?
- After library or web research on vegetative propagation, students will attempt the propagation at home with cuttings taken from one of the classroom plants. They must write and follow directions for the propagation, and keep a journal that tracks the progress of the plant for approximately six weeks. Comparisons will be made with the classroom plant that is the source of each student's cutting. Driving question: Do asexually produced plants have the same characteristic as the plant from which they are produced by vegetative propagation? (Adapted from Science NetLinks) (L.HE.07.21, L.HE.07.22, S.IP.07.11, S.IP.07.12, S.IP.07.13, S.IP.07.14, S.IP.07.15, S.IP.07.16, S.IA.07.11, S.IA.07.12)

Explain and Define

- Explain and define the distinctions between asexual and sexual reproductions. Include the advantages and disadvantages of each.
- A video of asexual lizard reproduction provides deeper understanding of the distinctions between sexual and asexual reproduction as well as the evolutionary advantage of each. http://www.teachersdomain.org/resources/tdc02/sci/life/repro/asexual/index.html (L.HE.07.22)

Elaborate and Apply

- Have the class discuss and explain the different traits of organisms that are influenced by genetics (reproduction) and environmental influence. Have students identify traits that are passed on through reproduction that enhance the organism's chances to survive. (L.HE.07.21, S.RS.07.11, S.RS.07.12, S.RS.07.13, S.RS.07.14)
- Visit a greenhouse or research facility that is using asexual reproduction in plants to increase food supply and genetically engineer superior plants. Have students conduct research into current science and technology that is being used to alter food crops. (S.RS.07.18)

Evaluate Student Understanding

Formative Assessment

- Distinguish between asexual and sexual reproduction. (L.HE.07.21, L.HE.07.22)
- Distinguish between the variability of characteristics in organisms produced by asexual reproduction and those produced by sexual reproduction. (L.HE.07.21, L.HE.07.22)

Summative Assessment

- Create a Venn diagram of sexual versus asexual reproduction that displays similarities and differences in the types of reproduction, characteristics of offspring compared to parents and advantages and disadvantages of each type of reproduction. (L.HE.07.21, L.HE.07.22)
- Justify that fraternal twins are the result of sexual reproduction and that identical twins are the result of asexual reproduction. (L.HE.07.21, L.HE.07.22)

Enrichment

- Teams of two students read two chapters of *Cloning* by Daniel Cohen. One of the chapters is "History and Hoax." The teacher assigns the other chapter. Teams make presentations to the class providing a "jigsaw" oral book report to the entire class that covers the entire book.

Intervention

- Have students research the characteristics that were passed down from their family members. Have them find out if they have inherited the ability to tongue roll, Vulcan hello, wiggle ears, eye color, hair color, etc. Have students distinguish between the traits that were passed down through genetics and the traits that they have learned.

Examples, Observations, and Phenomena (Real World Context)

A comparison of fraternal (two egg/two sperm) twins and identical (one egg/one sperm) twins is a comparison of characteristics produced by sexual reproduction (fraternal twins) and asexual reproduction (identical twins). Apples are available in a greater variety of types than most other fruits. This is due to the asexual (vegetative propagation) of apple trees on which these apple varieties are produced. This technique consistently produces apple varieties with very similar characteristics of color, taste and texture.

Literacy Integration

Reading

R.CM.07.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.
R.IT.07.01 analyze the structure, elements, features, style, and purpose of informational genre including persuasive essay, research report, brochure, personal correspondence, autobiography and biography.

Writing

W.GN.07.03 formulate research questions using multiple resources, perspectives, and arguments/counter-arguments to develop a thesis statement that culminates in a final presented project using the writing process.

Read write think of science fiction related to cloning is described at: http://www.readwritethink.org/lessons/lesson_view.asp?id=927 A lesson plan asks students to explore the science behind science fiction.
Cloning by Don Nardo (2003)

Mathematics Integration

N.FL.07.07 Solve problems involving operations with integers.

Students calculate and compare the population growth in sexually reproducing and asexually reproducing organism when given the generation time of each.

Seventh Grade Companion Document

7-Unit 4: Fluid Earth Systems and Human Activities

Table of Contents Page 1

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 the 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.

7th Grade Unit 4:
Fluid Earth Systems and Human Activities

Content Statements and Expectations

Code	Statements and Expectations (Continued)	Page
E.ES.07.74	Describe weather conditions associated with frontal boundaries (cold, warm, stationary, and occluded) and the movement of major air masses and the jet stream across North America using a weather map.	6
E.ES.M.8	**Human consequence – Water circulates through the four spheres of the Earth in what is known as the "water cycle."**	8
E.ES.07.81	Explain the water cycle and describe how evaporation, transpiration, condensation, cloud formation, precipitation, infiltration, surface runoff and ground water occur within the cycle.	8
E.ES.07.82	Analyze the flow of water between the components of a watershed, including surface features (lakes streams, rivers, wetlands) and groundwater.	10
E.FE.M.1	**Atmosphere – The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different physical and chemical composition at different elevations.**	11
E.FE.07.11	Describe the atmosphere as a mixture of gases.	11
E.FE.07.12	Compare and contrast the atmosphere at different elevations.	11

7 – Unit 4: Fluid Earth Systems and Human Activities

Big Ideas (Key Concepts)

- The Sun is the major source of energy for phenomenon on Earth.
- The Sun's warming relates to weather, climate and the water cycle.
- Human interaction and use of natural resources affects the environment.
- The Earth's atmosphere is a mixture of gases and water vapor.

Clarification of Content Expectations

Standard: Earth Systems

Content Statement – E.ES.M.1
Solar Energy – The sun is the major source of energy for phenomena on the surface of the Earth.

Content Expectations

E.ES.07.11 Demonstrate, using a model or drawing, the relationship between the warming by the sun of the Earth and the water cycle as it applies to the atmosphere (evaporation, water vapor, warm air rising, cooling, condensation, clouds).

Instructional Clarifications

1. Demonstrate is to show through manipulation of materials, drawings, and written and verbal explanations the relationship between the warming of the Earth by the sun and the water cycle.
2. The water cycle describes the continuous movement of water from the ocean and other bodies of water to the atmosphere, precipitation to the Earth's surface, through runoff and groundwater to streams, and back into the oceans, lakes, rivers, and streams.
3. The Sun send energy to the Earth in the form of light/radiation, and this energy is transformed into thermal energy after it arrives at Earth.
4. Heat causes water to evaporate. Evaporation is the process by which liquid water changes into a gas called water vapor and enters the atmosphere.
5. Warm air in the atmosphere rises. Surrounding cooler air pushes it up.
6. The cooling temperatures in the upper atmosphere cause water vapor to change state and condense as a liquid.
7. The cooled water in the atmosphere forms clouds. The water droplets in the cloud collide and form larger droplets until they are pulled to the ground by gravity in the form of precipitation.

Assessment Clarifications

1. The water cycle describes the continuous movement of water from the ocean and other bodies of water to the atmosphere, precipitation to the Earth's surface, through runoff and groundwater to streams, and back into the oceans, lakes, rivers, and streams.
2. The Sun send energy to the Earth in the form of light/radiation, and this energy is transformed into thermal energy after it arrives at Earth.
3. Heat causes water to evaporate. Evaporation is the process by which liquid water changes into a gas called water vapor and enters the atmosphere.
4. Warm air in the atmosphere rises.
5. The cooling temperatures in the upper atmosphere cause water vapor to change state and condense as a liquid.
6. The cooled water in the atmosphere forms clouds. The water droplets in the cloud collide and form larger droplets until they are pulled to the ground by gravity in the form of precipitation.

E.ES.07.12 Describe the relationship between the warming of the atmosphere of the Earth by the sun and convection within the atmosphere and oceans.

Instructional Clarifications:

1. Describe means to tell or depict in written or spoken words how the sun's warming of the atmosphere is related to convection in the atmosphere and oceans.
2. The atmosphere is the envelope of gases that surrounds Earth.
3. Convection is the transfer of heat energy through liquids and gases by moving particles. Convection currents move warmer air through the atmosphere and warmer water through the oceans.
4. Air will rise if it is warmer than the surrounding air.
5. If cool air is present, warm air will rise to great heights.
6. Eventually the rising air will cool.
7. Cool air holds less water vapor than warm air. Water vapor in a cooling air mass will condense into liquid water at a certain temperature and pressure.
8. The water vapor may produce clouds and precipitation.

Assessment Clarifications

1. Convection is the transfer of heat energy though liquids and gases by moving particles. Convection currents move warm air through the atmosphere and warm water through the oceans.
2. The atmosphere is the envelop of gases that surrounds Earth.
3. Air will rise if it is warmer than the surrounding air.
4. If cool air is present, warm air will rise to great heights.
5. Eventually the rising air will cool.
6. Cool air holds less water vapor than warm air. Water vapor in a cooling air mass will condense into liquid water at a certain temperature and pressure.
7. The water vapor may produce clouds and precipitation.

E.ES.07.13 Describe how the warming of the Earth by the sun produces winds and ocean currents.

Instructional Clarifications

1. Describe means to tell or depict in written or spoken words how the warming of the Earth by the sun produces winds and ocean currents.
2. Wind is the movement of air from areas of high pressure to areas of low pressure.
3. Areas of high or low pressure are caused by differences in the Earth's temperature. Differences in Earth's temperature are due to the sun's uneven heating of the Earth's surface.
4. The air that moves is affected by the rotation of the Earth.
5. An ocean current is the movement of ocean water.
6. The uneven heating and density of the ocean waters cause Ocean currents. On a global scale ocean currents can be classified as cold or warm resulting from the latitude of origin. In some places cold currents result when deep water ascends to the surface.

Assessment Clarifications

1. Wind is the movement of air from areas of high pressure to areas of low pressure.
2. Areas of high or low pressure are caused by differences in the Earth's temperature. Differences in Earth's temperature are due to the sun's warming.
3. The air that moves is affected by the rotation of the Earth.
4. An ocean current is the movement of ocean water.
5. Ocean currents are made up of hot or cold water.
6. The movement of ocean water is similar to the movement of warm and cold air in the atmosphere.

Content Statement – E.ES.M.4
Human Consequence – Human activities have changed the land, oceans, and atmosphere of the Earth resulting in the reduction of the number and variety of wild plants and animals sometimes causing extinction of species.

Content Expectations

E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival or organisms.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawings), demonstrations, written reports or verbally how human activities change the surface of the Earth and survival of organisms.

2. Examples of human activities that affect habitats and the survival of organisms include surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas.
3. Human activities change animal habitat.
4. Change in animal habitat affects the survival rate of organisms.
5. The strongest force in rapid habitat loss is human activity.

Assessment Clarifications

1. Human activities change animal habitat.
2. Habitat destruction is due to surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas.
3. Change in animal habitat affects the survival rate of organisms.
4. The strongest force in rapid habitat loss is human activity.

E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

Instructional Clarifications

1. Describe means to tell or depict in written or spoken words the origins of pollution in the atmosphere, geosphere, and hydrosphere.
2. Pollution is the presence of harmful substances in the air, water, and land.
3. The atmosphere is the envelope of gases that surround the Earth.
4. The geosphere is the land that makes up the Earth.
5. The hydrosphere is the bodies of water that make up the Earth.
6. The major causes of air pollution come from automobiles, fuel consumption in buildings, and coal-burning power plants.
7. Air pollution damages plants and causes health problems in animals. Most air pollution is the result of burning fossil fuels (such as coal, oil, gasoline, and diesel fuel) due to the release of particles and gases when burned.
8. Damage to plants causes a loss of habitat.
9. Loss of habitat threatens or endangers species.
10. Fossil fuels, aerosols, pollution, and land use influence climate change.
11. Burning fossil fuels releases carbon dioxide into the air.

Assessment Clarifications

1. Pollution is the presence of harmful substances in the air, water, and land.
2. The atmosphere is the envelope of gases that surround the Earth.
3. The geosphere is the land that makes up the Earth.
4. The hydrosphere is the bodies of water that make up the Earth.
5. The major causes of air pollution come from automobiles, fuel consumption in industry and buildings, and coal-burning power plants.
6. Air pollution damages plants and causes health problems in animals. Most air pollution is the result of burning fossil fuels, such as coal, oil, gasoline, and diesel fuel due to the release of particles and gases when burned.
7. Damage to plants causes a loss of habitat.

8. Loss of habitat threatens or endangers species.
9. Fossil fuels, aerosols, pollution, and land use can influence climate change.
10. Burning fossil fuels releases carbon dioxide into the air.

Content Statement – E.ES.M.7
Weather and Climate – Global patterns of atmospheric and oceanic movement influence weather and climate.

Content Expectations

E.ES.07.71 Compare and contrast the difference and relationship between climate and weather.

Instructional Clarifications
1. Compare and contrast is to tell in written form the similarities and differences between climate and weather.
2. Weather is the mix of events that happen each day in the atmosphere including temperature, rainfall and humidity.
3. Climate is the average weather pattern in a place over many years.
4. Climate is useful for weather forecasting.

Assessment Clarifications
1. Weather is the mix of events that happen each day in the atmosphere including temperature, rainfall and humidity.
2. Climate is the average weather pattern in a place over many years.
3. Climate is useful for weather forecasting.

E.ST.07.72 Describe how different weather occurs due to the constant motion of the atmosphere from the energy of the sun reaching the surface of the Earth.

Instructional Clarifications
1. Describe means to tell or depict in written or spoken words how weather is due to the motion of the atmosphere from the sun's warming of the Earth.
2. Most weather occurs at the lower portion of the atmosphere.
3. An air mass is a huge body of air that has similar temperature, humidity, and air pressure at any given height in the atmosphere.
4. Temperature changes in air masses and upper air currents cause air masses to move in the atmosphere.
5. The sun is the major cause of the heating of our atmosphere.
6. The Earth gets the same amount of light each day, but since the Earth is tilted on its axis, the light is unevenly divided into two hemispheres. The hemisphere that is tilted toward the sun and is receiving more of the direct light is experiencing spring and summer. The hemisphere that is tilted away from the sun is receiving less direct light and is experiencing fall and winter.
7. Rising warm air eventually cools.

8. Cool air is eventually warmed.

Assessment Clarification

1. Most weather occurs at the lower portion of the atmosphere and is due to changes in the temperature of air masses.
2. An air mass is a huge body of air that has similar temperature, humidity, and air pressure at any given height in the atmosphere.
3. Temperature changes in air masses cause them to move in the atmosphere.
4. The sun is the major cause of the heating and cooling of our atmosphere.
5. The Earth gets the same amount of light each day, but since the Earth is tilted on its axis, the light is unevenly divided into two hemispheres. The hemisphere that is tilted toward the sun and is receiving more of the direct light is experiencing spring and summer. The hemisphere that is tilted away from the sun is receiving less direct light and is experiencing fall and winter.
6. Rising warm air eventually cools.
7. Cool air is eventually warmed.
8. The more hours of sunlight mean more solar heating.

E.ES.07.73 Explain how the temperature of the oceans affects the different climates on Earth because water in the oceans holds a large amount of heat.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawings), demonstrations, written reports or verbally how the temperature of the oceans affects climates.
2. The Sun is the main source of the Earth's energy.
3. Both oceans and land absorb solar energy.
4. Oceans make up 70% of the Earth's surface.
5. Oceans absorb more energy from the Sun than land.
6. Oceans store a lot of heat energy.
7. The oceans store and transport heat energy that is related to climate.

Assessment Clarifications

1. The Sun is the main source of the Earth's energy.
2. Both oceans and land absorb solar energy.
3. Oceans make up 70% of the Earth's surface.
4. Oceans absorb more energy from the Sun than land.
5. Oceans store a lot of heat energy.
6. The oceans store and transport heat energy that is related to climate.

E.ES.07.74 Describe weather conditions associated with frontal boundaries (cold, warm, stationary, and occluded) and the movement of major air masses and the jet stream across North America using a weather map.

Instructional Clarification

1. Describe means to tell or depict in written or spoken words.

2. Frontal boundaries refer to the boundary that forms between warm and cold air masses.
3. Air masses are huge bodies of air that have similar temperature, humidity, and air pressure at any given height in the atmosphere. Warm and Cold air masses do not mix readily.
4. Warm air masses are forced to rise and expand over and above cold air masses, and cold air masses wedge underneath warmer air masses. Cool air is more dense and tends to sink. Warm air is less dense and tends to rise.
5. As the warm air cools, the moisture condenses to form clouds. Rain or snow may form if the warm air continues to rise and expand.
6. A cold front is a situation where a cold air mass is advancing upon a warm air mass.
7. A warm front is a situation where a warm air mass is advancing upon a cold air mass.
8. A stationary front is a situation where a cold air mass and warm air mass meet and neither mass is displacing the other.
9. An occluded front occurs when warm, cool, and cold air masses come together. They are not as common as cold, warm, or stationary fronts.
10. The jet stream is the concentrated, high-altitude streams of fast moving wind that blow from west to east across the northern and southern Hemispheres. It is responsible for the movement of major weather features from west to east across North America and the Earth as a whole.
11. Big thunderstorms in the summer and snowfalls in the winter are the weather conditions associated with cold fronts.
12. Steady, long-lasting rains in the summer and steady snowfalls in the winter are weather conditions associated warm fronts.
13. Weather conditions associated with an occluded front can be divided into three categories, before passing, while passing, and after passing.
14. Stationary fronts occur when neither warm nor cold air advances. The two air masses reach a stalemate. Neither front is moving. These types of conditions can last for days, producing nothing but Altocumulus clouds. Temperatures remain stagnant and winds are gentle to nil.

Assessment Clarifications

1. Frontal boundaries refer to the boundary that forms between warm and cold air masses.
2. Air masses are huge bodies of air that have similar temperature, humidity, and air pressure at any given height in the atmosphere. Warm and Cold air masses do not mix readily.
3. Warm air masses are forced to rise and expand over and above cold air masses, and cold air masses wedge underneath warmer air masses. Cool air is more dense and tends to sink. Warm air is less dense and tends to rise.
4. As the warm air cools, the moisture condenses to form clouds. Rain or snow may form if the warm air continues to rise and expand.
5. A cold front is a situation where a cold air mass is advancing upon a warm air mass.

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12. Weather conditions associated with an occluded front can be divided into three categories, before passing, while passing, and after passing.
13. Stationary fronts occur when neither warm nor cold air advances. The two air masses reach a stalemate.

Content Statement – E.ES.M.8
Human consequence – Water circulates through the four spheres of the Earth in what is known as the "water cycle."

Content Expectations

E.ES.07.81 Explain the water cycle and describe how evaporation, transpiration, condensation, cloud formation, precipitation, infiltration, surface runoff and ground water occur within the cycle.

Instructional Clarifications
1. Explain is to clearly describe by means of illustrations (drawings), demonstrations, written reports or verbally the water cycle.
2. The water cycle describes the continuous movement of water from the ocean and other bodies of water to the atmosphere, precipitation back to the Earth's surface, through runoff and groundwater to streams, transpiration from plants, and returning into the oceans, lakes, rivers, and streams.
3. Earth's water is always in motion, and the water cycle, also known as the hydrologic cycle, describes the continuous movement of water on, above, and below the surface of the Earth.
4. Evaporation is when the sun heats up water in rivers or lakes or the ocean and turns from liquid water to water in a gaseous state (water vapor). The water vapor or steam leaves the river, lake or ocean and goes into the air.
5. Plants absorb water from the soil and move it through the plant to all parts of the plant. Excess water leaves the plant through openings in the leaves, which is called transpiration.

6. Condensation takes place high in the atmosphere and at ground level. Water vapor rises and cools collecting around particles of dust, smoke, or salt to form water droplets. The process happens close to the ground. Fog develops when air having a relatively high humidity content (i.e., moist) comes in contact with a colder surface, often the Earth's surface, and cools to the dew point. Additional cooling leads to condensation and the growth of low-level clouds. (USGS)
7. Clouds form in the atmosphere because air containing water vapor rises and cools. Condensation takes place to complete the process. See Item 6 above for details.
8. For precipitation to occur, cloud droplets or ice crystals must grow heavy enough to fall through the air. One way that cloud droplets grow is by colliding and combining with other droplets and particulate matter in the atmosphere. As the droplets grow larger, they move faster and collect more small droplets. Finally, the droplets become heavy enough to fall out of the cloud as raindrops.
9. Infiltration occurs when precipitation remains in the shallow soil layer, then move through the soil and subsurface. Eventually the water enters a stream by seepage or filters down to become ground water.
10. Runoff is when rain falls on saturated or impervious ground and flows downhill as runoff.
11. Large amounts of water are stored beneath the surface of the Earth as groundwater. Rain soaks into the ground until it reaches layers of rock or clay that has tiny particles that are packed closely together. The water travels and fills the spaces between soil, rocks, and sand. The ground water stays within the aquifers withing the ground until it seeps out as a spring, connects to rivers or lakes, or people use it by digging wells.
12. A common misconception is that ground water is in the form of rivers and lakes beneath the surface of the Earth.

Assessment Clarifications

1. The water cycle describes the continuous movement of water from the ocean and other bodies of water to the atmosphere, precipitation back to the Earth’s surface, through runoff and groundwater to streams, and returning into the oceans, lakes, rivers, and streams.
2. Earth's water is always in motion, and the water cycle, also known as the hydrologic cycle, describes the continuous movement of water on, above, and below the surface of the Earth.
3. Evaporation is when the sun heats up water in rivers or lakes or the ocean and turns it into vapor or steam. The water vapor or steam leaves the river, lake or ocean and goes into the air.
4. Plants absorb water from the soil and move it through the plant to all parts of the plant. Excess water leaves the plant through openings in the leaves, which is called transpiration.
5. Condensation takes place high in the atmosphere and at ground level. Water vapor rises and cools collecting around particles of dust, smoke, or salt to form water droplets. The process happens close to the ground. Fog develops when air having a relatively high humidity content (i.e., moist) comes in contact with a colder surface, often the Earth's surface, and

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E.ES.07.82 Analyze the flow of water between the components of a watershed, including surface features (lakes streams, rivers, wetlands) and groundwater.

Instructional Clarifications
1. Analyze is to examine methodically by separating into parts and studying their interrelations the flow of water between the components of a watershed.
2. A watershed is the land area that is drained by a river.
3. Streams and rivers that join another river become a larger watershed.
4. One watershed is divided or separated from another by a ridge or rise in the land.
5. Some of the precipitation that falls onto the land infiltrates into the ground to become ground water. Once in the ground, some of this water travels close to the land surface and emerges very quickly as discharge into streambeds, but, because of gravity, much of it continues to sink deeper into the ground. If the water meets the water table (below which the soil is saturated), it can move both vertically and horizontally. Water moving downward can also meet more dense and water-resistant non-porous rock and soil, which causes it to flow in a more horizontal fashion, generally towards streams, the ocean, or deeper into the ground. (From USGS)

Assessment Clarifications
1. A watershed is the land area that is drained by a river.
2. Streams and rivers that join another river become a larger watershed.

3. One watershed is divided or separated from another by a ridge or rise in the land.

Content Statement – E.FE.M.1
Atmosphere – The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different physical and chemical composition at different elevations.

Content Expectations

E.FE.07.11 Describe the atmosphere as a mixture of gases.

Instructional Clarifications
1. Describe means to tell or depict in written or spoken words the atmosphere as a mixture of gases.
2. The atmosphere is the envelope of gases that surrounds Earth.
3. The atmosphere is primarily composed of nitrogen and oxygen. The atmosphere is 78% nitrogen and 21% oxygen and 1% trace gases.
4. Trace gases include argon, carbon dioxide, neon, helium, methane, krypton, and hydrogen.
5. The combination of gases in Earth's atmosphere makes conditions on Earth suitable for living things.

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1. The atmosphere is the envelope of gases that surrounds Earth.
2. The atmosphere is primarily composed of nitrogen and oxygen. The atmosphere is 78% nitrogen and 21% oxygen and 1% trace gases.
3. The combination of gases in Earth's atmosphere makes conditions on Earth suitable for living things.

E.FE.07.12 Compare and contrast the atmosphere at different elevations.

Instructional Clarifications
1. Compare and contrast is to tell in written form or verbally the similarities and differences of the atmosphere at different elevations.
2. The atmosphere has different properties at different elevations.
3. At higher elevations the temperature of the air is generally colder (there are some exceptions) the air pressure is lower, and the density is lower.
4. The concentration of oxygen at sea level is about 21% and the barometric pressure averages 760 mmHg. As altitude increases, the concentration remains the same but the number of oxygen molecules per breath is reduced. At 12,000 feet (3,658 meters) the barometric pressure is only 483 mmHg, so there are roughly 40% fewer oxygen molecules per breath.
5. The atmosphere stretches high above the Earth and gets thinner at higher elevations. At an elevation of 80 kilometers (50 miles) there is very little air at all.

Assessment Clarifications

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

Inquiry Processes
S.IP.07.11 Generate scientific questions about fluid earth systems and human activities based on observations, investigations, and research.
S.IP.07.12 Design and conduct scientific investigations on fluid earth systems and human activities
S.IP.07.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes, hot plates, pH meters) appropriate to scientific investigations of fluid earth systems and human activities.
S.IP.07.14 Use metric measurement devices in an investigation dealing with fluid earth systems and human activities.
S.IP.07.15 Construct charts and graphs from data and observations dealing with fluid earth systems and human activities.
S.IP.07.16 Identify patterns in data regarding fluid earth systems and human activities.
Inquiry Analysis and Communication
S.IA.07.11 Analyze information from data tables and graphs to answer scientific questions concerning fluid earth systems and human activities.
S.IA.07.12 Evaluate data, claims, and personal knowledge through collaborative science discourse on fluid earth systems and human activities.
S.IA.17.13 Communicate and defend findings of observations and investigations dealing with fluid earth systems and human activities.
S.IA.07.14 Draw conclusions from sets of data from multiple trials of a scientific investigation to draw conclusions on fluid earth systems and human activities.
S.IA.07.15 Use multiple sources of information on fluid earth systems and human activities to evaluate strengths and weaknesses of claims, arguments, or data.
Reflection and Social Implication
S.RS.07.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding fluid earth systems and human activities.
S.RS.07.12 Describe limitations in personal and scientific knowledge regarding fluid earth systems and human activities.
S.RS.07.13 Identify the need for evidence in making scientific decisions about fluid earth systems and human activities.
S.RS.07.14 Evaluate scientific explanations based on current evidence and scientific principles dealing with fluid earth systems and human activities.
S.RS.07.15 Demonstrate scientific concepts through various illustrations to depict fluid earth systems and human activities.
S.RS.07.16 Design solutions to problems about fluid earth systems and human activities using technology.
S.RS.07.17 Describe the effect humans and other organisms have on the balance of the natural world in terms of the water cycle and the sun's warming of the Earth.
S.RS.07.18 Describe what science and technology can and cannot reasonably contribute to society when dealing with fluid earth systems.
S.RS.07.19 Describe how science and technology concerning fluid earth systems have advanced because of the contributions of many people throughout history and across cultures.

Vocabulary

Critically important-State Assessable	Instructionally Useful
water cycle	pollutant
atmosphere	oxygen
evaporation	nitrogen
water vapor	trace gases
condensation	altitude
clouds	particle size
convection	hold water
ocean currents	solar energy
wind	habitat destruction
weather	endangered species
climate	extinct species
frontal boundaries	potable
cold front	non-potable
warm front	
stationary front	
occluded front	
air mass	
jet stream	
transpiration	
cloud formation	
precipitation	
infiltration	
surface runoff	
groundwater	
absorption	
watershed	
elevations	
surface mining	
deforestation	
overpopulation	
construction and urban development	
farming	
dams	
landfills	
air pressure	
barometric pressure	
acid rain	
fog	
dew	
radiation	
conduction	
energy	
sun	
pollution	

Instruments, Measurements, Representations

Measurements	Instruments	Units
temperature	thermometers	Celsius, Fahrenheit
wind velocity	wind vane or sock	north, south, east, west, kilometers/hour
barometric pressure	barometer	in/Hg

Representations of the water cycle are made through models and drawings of how the water in the atmosphere moves in a cycle.

A model of the water movement in a watershed demonstrates how smaller streams and rivers feed the largest river in a given landmass. The addition of ridges and elevations demonstrates the boundaries between watersheds.

Weather maps are representations of different weather conditions and demonstrate the movement of frontal boundaries.

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

Solar Energy: E.ES.07.11, E.ES.07.12, E.ES.07.13
Human Consequences: E.ES.07.41, E.ES.07.42
Weather and Climate: E.ES.07.71, E.ES.07.72, E.ES.07.73, E.ES.07.74
Water Cycle: E.S.07.81, E.ES.07.82
Atmosphere: E.FE.07.11, E.FE.07.12

Objectives

- Explain how the sun's warming of the Earth creates movement of air and water and affects weather and climate.
- Describe the affects of human activity on the atmosphere, hydrosphere, and geosphere.
- Describe the atmosphere as a mixture of gases.

Engage and Explore

- Conduct a brainstorming session to determine students' initial ideas about the water cycle. Write the following statement on the board or chart paper: *Earth's water is moving all the time.* Ask students to discuss their ideas in small groups and make diagrams of how they think the water on Earth is moving all the time and circulates through the atmosphere, on land, and in the oceans. Have students share their ideas of how a raindrop is made and where it goes after it falls to the ground. (E.ES.07.11, E.ES.07.12, E.ES.07.81, S.IP.07.11, S.IP.07.12, S.IA.07.13, S.IA.07.14, S.RS.07.15)
- To test student ideas about the water cycle make a model that demonstrates how water can circulate on land, water, and air. Use a container that is clear and can be a closed system. Place sand or soil in the bottom of the container and moisten the soil. Place a container or tub

of water in the model to represent a body of water. Close the system with a lid or plastic wrap to keep air from going into the model or coming out of the model. Place a clamp lamp or light bulb over the model. Position or direct the lamp over the body of water. Place a baggie of ice on one side of the lid so that it is positioned over the land (sand or soil) and have students make observations and record their findings. (E.ES.07.11, E.ES.07.12, E.ES.07.81, S.IP.07.11, S.IA.07.13, S.IA.07.14, S.RS.07.15)

- Demonstrate ocean currents using blue food coloring and hot water and icy cold water. Fill a container with hot tap water and place a few drops of dark blue food coloring in the hot water. Have the students make observations of the water and describe what they think is happening. Repeat the procedure with a container of icy cold water. Have students compare their observations between the two containers. Give students the opportunity to ask some what would happen if… questions and mess about with mixing hot and cold water and ice cubes to the containers and observe. (E.ES.07.11, E.ES.07.12, E.ES.07.13, S.IP.07.11, S.IA.07.13, S.IA.07.14, S.RS.07.15)
- Investigate the role of evaporation on pure water and salt water. Have students make a solar still by placing a small cup of water into a closable bag and place in the sunlight. Have students make one still with salt water and one still with pure water and make observations over a period of time. (E.ES.07.11)

Explain and Define

- Provide posters or other resources that illustrate the water cycle for students to use to compare their observations of the model of the water cycle and solar stills. Ask students to describe how the model demonstrates what happens in the atmosphere. (E.ES.07.11, E.ES.07.12, E.ES.07.13, E.ES.07.81)
- As a class determine a working definition of the water cycle and then introduce the terms evaporation, condensation, precipitation, and transpiration. Only after students have determined a meaning on their own, have them refer to a resource that helps to explain the definition of the terms. (E.ES.07.11, E.ES.07.81)
- Relate the model of the solar still to the water cycle and ask students the part of the water cycle where evaporation is key. Explain the role of the sun's warming of the Earth in the water cycle. (E.ES.07.11, E.ES.07.81)
- Discuss the sun's warming of the oceans. Explain that the oceans are vast bodies of salt water and represent 3/4ths of the Earth's surface.
- Explain that the sun's warming of the atmosphere also causes movement or currents in the air (wind) similar to the currents in the ocean. (E.ES.07.11, E.ES.07.12, E.ES.07.13)
- Compare weather and climate and explain how movement of water in the oceans and atmosphere affect weather and climate. Explain that weather is the daily conditions of temperature, precipitation, wind, and humidity and climate is the long term, year-to-year conditions of temperature,

precipitation, wind, and humidity. (E.ES.07.71, E.ES.07.72, E.ES.07.73, E.ES.07.74)

Elaborate and Apply

- Elaborate on the concept of the sun's warming of the Earth, the water cycle, and ocean currents to weather and climate. Have students study weather maps and weather reports to make connections between weather fronts and boundaries. Have students determine how the sun's warming of the Earth's land, water, and air affect the make-up of the different climates on Earth and daily weather changes. (E.ES.07.81, E.ES.07.74)
- Make real world connections to students' lives by relating the effect of human activity on the environment and how it affects plant and animal life. Have students do research on green house gases and global warming. Make connections to pollution in the atmosphere, hydrosphere, and geosphere. (E.ES.07.41, E.ES.07.42)
- The movement of water in the water cycle can be elaborated on by following the flow of water after it falls to the ground. Students investigate and make models of ground water and the movement of water in local watersheds. Have students identify different habitats that exist in the watersheds and how pollution and human activity has affected populations and quality of life. (E.ES.07.81, E.ES.07.82)
- Challenge the class to design and carry out a procedure that would clean polluted water. Encourage students to use what they have learned about the water cycle and evaporation through the solar still to clean the polluted water sample. (E.ES.07.41, E.ES.07.42)

Evaluate Student Understanding

Formative Assessment Examples
- Demonstrations and explorations
- Experiment design and conclusion
- Classroom discussion
- Student journal entries
- Quick Writes

Summative Assessment Examples
- End of unit test
- Poster, brochure, or Power Point presentation on the water cycle and how the sun's warming of the Earth causes ocean and air currents.
- Written report on the effect of human activities and action steps that can be taken.
- Models of water cycle, solar still, design for cleaning a sample of polluted water.

Enrichment

- Students take local soil and water samples to determine the level of pollution.
- Keep a long-term log of precipitation and compare it to records of 25 years and 50 years ago.
- Make a solar still to capture and clean rainwater.
- Research and report on acid rain and other environmental issues.
- Have students follow a drop from a cloud to the ocean.
- Research the role the Great Lakes play in the supply of fresh water on Earth.

Intervention

- Students design investigations to rank the particle size of different Earth materials, soil, sand, silt, clay, and pebbles. Students layer the water from largest to smallest particle size (top to bottom) and make observations of the flow of water underground and around different material.
- Use a sponge to demonstrate how water moves between the particles of soil.
- Watch daily weather reports and determine where the cold and warm fronts are located in the United States and the resulting weather from the fronts.
- Ask a local meteorologist to talk to the students and explain Doppler radar and how it is used to track different weather fronts.

Examples, Observations, and Phenomena (Real World Context)

The usual path of air masses in the northern hemisphere is from west to east. As air moves up a mountain range, it cools, and is less able to hold water. Precipitation often occurs and most of the water contained in the clouds falls to the ground on the west side of the mountain range. The land on the east side of the mountain range is dryer than the land on the west side. The east side of some mountain ranges is where some deserts are located.

Dew, fog, and clouds form when water vapor condenses on surfaces such as dust, smoke particles, and sea salt crystals. These small particles in the air are a necessary part of the water cycle for condensation to occur in the atmosphere.

Global warming and the effect of carbon emissions is a real world issue for students to study and make connections between the cycles and conditions that are necessary for life on Earth and how the activities of humans have threatened the survival of the planet.

Literacy Integration

Reading

R.IT.07.01 Students will analyze the structure, elements, features, style, and purpose of informational genre including persuasive essay, research report, brochure, personal correspondence, autobiography and biography.

R.CM.07.01 Students will connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.07.02 Students will retell through concise summarization grade-level narrative and informational text.

R.CM.07.04 Students will apply significant knowledge from grade-level science, social studies, and mathematics texts.

Books:
The Inside Story of Earth, Tam O'Shaughnassey, 2007
Living Green, John Johnson, Jr., 2008
A River Ran Wild, Lynne Cherry

Writing

W.GN.07.02 Students will write a research report using a wide variety of resources that includes appropriate organizational patterns (e.g., position statement/supporting evidence, problem statement/solution, or compare/contrast), descriptive language, and informational text features.

W.GN.07.03 Students will formulate research questions using multiple resources, perspectives, and arguments/counter-arguments to develop a thesis statement that culminates in a final presented project using the writing process.

W.PR.07.01 Students will set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.07.02 Students will apply a variety of pre-writing strategies for both narrative (e.g., graphically depict roles of antagonist/protagonist, internal/external conflict) and informational writing (e.g., position statement/supporting evidence, problem statement/solution, or compare/ contrast).

W.PR.07.03 Students will revise drafts to reflect different perspectives for multiple purposes and to ensure that content, structure, elements of style

and voice, literary devices, and text features are consistent.
Students will...

W.PS.07.01 Students will exhibit personal style and voice to enhance the written message in both narrative (e.g., personification, humor, element of surprise) and informational writing (e.g., emotional appeal, strong opinion, credible support).

Speaking

S.CN.07.01 Students will adjust their use of language to communicate effectively with a variety of audiences and for different purposes by using specialized language related to a topic and selecting words carefully to achieve precise meaning when presenting.

S.DS.07.02 Students will respond to multiple text types in order to anticipate and answer questions, offer opinions and solutions, and to identify personally with a universal theme.

Mathematics Integration

N.MR.07.04 Convert ratio quantities between different systems of units.

N.MR.07.02 Solve problems involving derived quantities such as density, velocity, and weighted averages.

A.PA.07.01 Recognize when information given in a table, graph, or formula suggests a directly proportional or linear relationship.

A.PA.07.11 Understand and use basic properties of real numbers.

D.RE.07.01 Represent and interpret data using graphs.

D.AN.07.03 Calculate and interpret relative frequencies and cumulative frequencies for data sets.