5-7 Science

Grade Level Content Expectations Companion Document

v.1.09

MICHIGAN Department of Education

Fifth Grade
Science Content Expectations
Companion Document

SCIENCE

- **Unit 1: Measuring Changes in Motion**
- **Unit 2: Animal Systems**
- **Unit 3: Evolution and Traits of Organisms**
- **Unit 4: Position and Motion of Objects in the Sky**

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

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

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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 that stretch the thinking beyond the instructional examples and provides ideas for reinforcement of challenging concepts.
g. **Examples, Observations, Phenomena** are included as exemplars of different modes of instruction appropriate to the unit in which they are listed. These examples include reflection, a link to real world application, and elaboration beyond the classroom. These examples are intended for instructional guidance only and are not assessable.
h. **Curricular Connections and Integrations** are offered to assist the teacher and curriculum administrator in aligning the science curriculum with other areas of the school curriculum. Ideas are presented that will assist the classroom instructor in making appropriate connections of science with other aspects of the total curriculum.

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

Fifth Grade GLCE Companion Document

Unit 1: Measuring Changes in Motion

SCIENCE

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

MICHIGAN Department of Education

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Fifth Grade Companion Document

5-Unit 1: Measuring Changes in Motion

Table of Contents Page 1

5th Grade Unit 1:
Measuring Changes in Motion

Content Statements and Expectations

5-Unit 1: Measuring Changes in Motion

Big Ideas (Key Concepts)

- Every force is part of an interaction between two objects.
- Forces are pushes and pulls that can be contact or non-contact forces.
- Motion is described relative to something else (point of reference).
- A change in motion is due to unbalanced forces.
- No change in motion and an object at rest are due to balanced forces.

Clarification of Content Expectations

Standard: Force and Motion

Content Statement – P.FM.M.2
Force Interactions - Some forces between objects act when the objects are in direct contact (touching), such as friction and air resistance, or when they are not in direct contact (not touching), such as magnetic force, electrical force, and gravitational force.

Content Expectations

P.FM.05.21 Distinguish between contact forces and non-contact forces.

Instructional Clarifications

1. Distinguish means to recognize or know the differences between contact forces and non-contact forces.
2. A force is a push or a pull that causes an object to accelerate (change in speed and/or direction) in the direction of force.
3. Contact forces are pushes and pulls that result from direct touching of objects (for example: a foot kicking a soccer ball, a bat striking a baseball, hand pushing on an object, shoes/feet against a floor).
4. Friction is the rubbing of two surfaces. It is the force of two surfaces in contact with each other.
5. Non-contact forces are pushes and pulls that result without direct touching of objects acting at a distance (for example: gravity, magnet attraction and repulsion, and electrical fields).

Assessment Clarifications

1. Contact forces are pushes and pulls that result from direct touching of objects.
2. Non-contact forces are pushes and pulls that result without direct touching of objects. (Gravity, magnets, and electrical fields are examples of non-contact forces.)

3. A force is a push or a pull that causes an object to change its speed and/or direction in the direction of the force.

P.FM.05.22 Demonstrate contact and non-contact forces to change the motion of an object.

Instructional Clarifications

1. Demonstrate is to show through manipulation of materials, drawings, and written and verbal explanations changes in the motion of an object either by contact or non-contact forces.
2. A force is a push or a pull that causes an object to accelerate (change in speed and/or direction) in the direction of the force.
3. Contact forces are pushes and pulls that result from direct touching of objects (for example: a foot kicking a soccer ball, a bat striking a baseball, hand pushing on an object, shoes/feet against a floor).
4. Non-contact forces are pushes and pulls that result without direct touching of objects (for example: a magnet attracting or repelling another magnet or magnetic material through a distance, gravitational pull on objects on earth and/or in space).
5. Change in motion is a change in direction, speed or both.

Assessment Clarifications

1. Show how contact forces change the motion of an object.
2. Show how non-contact forces change the motion of an object.

Content Statement – P.FM.M.3

Force - Forces have a magnitude and direction. Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The speed and/or direction of motion of an object changes when a non-zero net force is applied to it. A balanced force on an object does not change the motion of the object (the object either remains at rest or continues to move at a constant speed in a straight line).

Content Expectations

P.FM.05.31 Describe what happens when two forces act on an object in the same or opposing directions.

Instructional Clarifications

1. Describe means to tell or depict in written or spoken words how two forces act on an object in the same or opposing directions.
2. A force is a push or a pull that causes an object to accelerate (change in speed and/or direction) in the direction of its application.
3. Two forces acting on an object in the same direction cause the object to accelerate (speed up, slow down and/or change direction) in the direction of the forces.

4. Two forces acting on an object in opposing directions can be of equal strength and are, therefore, balanced (zero net force). The result will be that if the object is at rest, it will stay at rest (not move). If the object is moving, it will continue to move a constant speed in a straight line.
5. Two forces acting on an object in opposing directions can be of unequal strength and, therefore, are unbalanced (non-zero net force). The result will be motion (starting or speeding up) in the direction of the stronger force.

Assessment Clarifications

1. A force is a push or a pull that causes an object to change speed and/or direction in the direction of the force.
2. Two forces acting on an object in the same direction cause the object to accelerate (speed up, slow down and/or change direction) in the direction of the forces.
3. Two forces acting on an object in opposing directions can be of equal strength and are, therefore, balanced (zero net force). The result will be that if the object is at rest, it will stay at rest (not move). If the object is moving, it will continue to move a constant speed in a straight line.
4. Two forces acting on an object in opposing directions can be of unequal strength and, therefore, are unbalanced (non-zero net force). The result will be motion in the direction of the stronger force.

P.FM.05.32 Describe how constant motion is the result of balanced (zero net) forces.

Instructional Clarifications

1. Describe means to tell or depict in written or spoken words how constant motion is the result of balanced forces.
2. A force is a push or a pull that causes an object to change speed and/or direction in the direction of the force.
3. Forces acting on an object in opposing directions of equal strength are balanced (zero net force).
4. When all forces are balanced an object that is moving will keep moving in a straight line at a constant speed.
5. If an object is at rest, not moving, it will stay at rest if all of the forces are balanced.

Assessment Clarifications

1. A force is a push or a pull that causes an object to accelerate (change in speed and/or direction) in the direction of its application.
2. Forces acting on an object in opposing directions of equal strength are balanced (zero net force).
3. When all forces are balanced an object that is moving will keep moving in a straight line at a constant speed.
4. If an object is at rest, not moving, it will stay at rest if all of the forces acting on it are balanced.

P.FM.05.33 Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.

Instructional Clarifications

1. Describe means to tell or depict in written or spoken words how changes in motion of objects are caused by a non-zero force.
2. An object experiencing a change in its motion (speeding up, slowing down, or changing direction) is said to be accelerating. A common misconception is that acceleration is limited to an increase in speed.
3. A force is a push or a pull that causes an object to accelerate (change in speed and/or direction) in the direction of the force.
4. Forces acting on an object in opposing directions of unequal strength are unbalanced (non-zero net force).
5. An object at rest will begin to move if a non-zero net force is applied to it. It will move in the direction of the non-zero net force.
6. An object that is in motion will speed up, slow down and/or change direction if a non-zero net force is applied to it. It will speed up, slow down, or change direction in the direction of the non-zero net force.

Assessment Clarifications

1. A force is a push or a pull that causes an object to change speed and/or direction in the direction of the force.
2. Forces acting on an object in opposing directions of unequal strength are unbalanced (non-zero net force).
3. An object at rest will begin to move if a non-zero net force is applied to it. It will move in the direction of the force.
4. An object that is in motion will speed up, slow down, and/or change direction if a non-zero net (unbalanced) force.

P.FM.05.34 Relate the size of change in motion to the strength of unbalanced forces and the mass of the object.

Instructional Clarifications

1. Relate means to establish an association or a connection between size of the change of motion to the strength of unbalanced forces and the mass of the object.
2. Magnitude (size) refers to a force's strength.
3. Forces acting on an object in opposing directions of unequal strength are unbalanced (non-zero net force).
4. A change in motion is change in speed and/or direction.
5. Mass is measured in grams or kilograms using a balance. Mass is related to an object's resistance to changes in motion. The greater the mass of an object the greater force is required to change the motion of the object.
6. The strength of an unbalanced force is the measurement of how strong (greater) or weak (lesser) the push or pull is that causes the change in motion. A weaker or lesser force causes a small change; a strong or greater force causes a larger change in the motion of objects.

Assessment Clarifications

1. Forces acting on an object in opposing directions of unequal strength are unbalanced (non-zero net force).
2. A change in motion is change in speed and/or direction.
3. Mass is measured in grams or kilograms using a balance. Mass is related to an objects resistance to changes in motion. The greater the mass of an object the greater the force is required to change the motion of the object.
4. The strength of an unbalanced force is the measurement of how strong (greater) or weak (lesser) the push or pull is that causes the change in motion. A weaker or lesser force causes a small change; a strong or greater force causes a larger change in the motion of objects.

Content Statement – P.FM.M.4

Speed - Motion can be described by a change in position relative to a point of reference. The motion of an object can be described by its speed and the direction it is moving. The position and speed of an object can be measured and graphed as a function of time.

Content Expectations

P.FM.05.41 Explain the motion of an object relative to a point of reference.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawings), demonstrations, written reports or verbally the motion of an object relative to a point of reference.
2. Motion is relative to something else (point of reference).
3. A point of reference offers all observers a common frame through which to judge motion and its changes. A point of reference is the point from which movement is determined.

Assessment Clarification

1. Describe the motion of an object in relation to a point of reference.

P.FM.05.42 Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.

Instructional Clarifications

1. Describe means to tell or depict in written or spoken words the motion of an object in terms of distance, time, and direction.
2. Speed is the ratio of distance covered per unit of time, S=D/T.
3. The direction of the motion is in relation to a point of reference. Direction can be described as up, down, right, left, north, south, east, west, forward and backward.
4. An object's motion can be described in terms of speed and direction.

5. The term distance describes amount of space between two things or points. Distance is measured in millimeters, centimeters, meters, and kilometers.

Assessment Clarifications

1. Speed is the ratio of distance covered per unit of time, S=D/T.
2. The direction of the motion is in relation to a point of reference. Direction can be described as up, down, right, left, north, south, east, and west.
3. An object's motion can be described in terms of speed and motion.
4. The term distance describes amount of space between two things or points. Distance is measured in millimeters, centimeters, meters, and kilometers.

P.FM.05.43 Demonstrate how motion can be measured and represented on a graph.

Instructional Clarifications

1. Demonstrate means to show through manipulation of materials, drawings, and written or verbal explanation with a graph how motion can be measured and represented.
2. An object's motion can be measured by its position and speed.
3. An object's position can be measured and graphed as a function of time.
4. An object's speed can be measured and graphed as a function of time.
5. Represent motion on a position versus time graph.
6. Represent motion on a speed versus time graph.

Assessment Clarifications

1. An object's motion can be measured by its position and speed.
2. An object's position can be measured and graphed as a function of time.
3. An object's speed can be measured and graphed as a function of time.
4. Represent motion on a position versus time graph.
5. Represent motion on a speed versus time graph.

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

Inquiry Process
S.IP.05.11 Generate scientific questions about motion based on observations, investigations, and research.
S.IP.05.12 Design and conduct scientific investigations on motion and changes in motion.
S.IP.05.13 Use tools and equipment (stop watches, meter sticks and tapes, models, balances) appropriate to scientific investigation of motion.
S.IP.05.14 Use metric measurement devices in the investigation of motion.
S.IP.05.15 Construct charts and graphs from data and observations dealing with motion and changes in motion.
S.IP.05.16 Identify patterns in data regarding motion.
Inquiry Analysis and Communication
S.IA.05.11 Analyze information from data tables and graphs to answer scientific questions on motion.
S.IA.05.12 Evaluate data, claims, and personal knowledge through collaborative science discourse about motion.
S.IA.05.13 Communicate and defend findings of observations and investigations about motion using evidence.
S.IA.05.14 Draw conclusions from sets of data from multiple trials of a scientific investigation on motion and changes in motion.
S.IA.05.15 Use multiple sources of information on motion and changes in motion to evaluate strengths and weaknesses of claims, arguments, or data.
Reflection and Social Implications
S.RS.05.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding motion and changes in motion.
S.RS.05.12 Describe limitations in personal and scientific knowledge regarding motion and changes in motion.
S.RS.05.13 Identify the need for evidence in making scientific decisions about motion.
S.RS.05.15 Demonstrate scientific concepts about motion through various illustrations, performances, models, exhibits, and activities.
S.RS.05.16 Design solutions to problems concerning the motion of objects using technology.
S.RS.05.17 Describe the effect humans and other organisms have on the balance in the natural world when force is applied to an object.
S.RS.05.19 Describe how the science and technology of motion have advanced because of the contribution of many people throughout history and across cultures.

Vocabulary

Critically Important-State Assessable	Instructionally Useful
force	acceleration
balanced force	applied force
change of direction	kinetic energy
change of motion	mechanical motion
change of speed	Newton's laws of motion
force strength	pulley
friction	deceleration
graph	inertia
magnetic attraction	velocity
magnetic repulsion	magnitude
mass	lever
relative position	inclined plane
constant speed	simple machines
direction of motion	spring scale
gravitational force	newtons
speed	
unbalanced force	
zero net force	
non-zero net force	

Instruments, Measurements, Representations

Measurements	Instruments	Representations
mass	balance	kilograms, grams
distance	meter stick, measuring tape	kilometer, meter, centimeter
time	stop watch, timer, clock with second hand	hours, minutes seconds,
speed	meter stick, measuring tape, stop watch, timer, clock with second hand	kilometers /hour, meters/second, centimeters/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

Force Interactions: P.FM.05.21, P.FM.05.22
Forces: P.FM.05.31, P.FM.05.32, P.FM.05.33, P.FM.05.34
Speed: P.FM.05.41, P.FM.05.42, P.FM.05.43

Objectives

- Describe motion as the result of contact and non-contact forces.
- Observe the affects of zero and non-zero net forces acting on an object.
- Given a point of reference describe motion in terms of speed, distance, time, and direction.
- Construct and analyze graphs of motion.

Engage and Explore

- Introduce observations of motion using a variety of balls and other rolling objects (marbles, tennis balls, golf balls, toy cars, dowels, cylinders, etc.) and ramps. Give students sufficient time to explore motion of a variety of objects, raise questions, conduct trial and error investigations, and describe their observations in their own terms and current understandings. (P.FM.05.41, P.FM.05.42, S.IP.05.11)
- Encourage students to ask *what would happen if…* questions to explore the relationship between the size of the force and the change in motion and the mass of the object and the change in motion. Have students conduct investigations to determine the size of forces needed to change the motion of objects. (P.FM.05.34, S.IP.05.11, S.IA.05.12, S.IA.05.13, S.IA.05.14, S.IA.05.15, S.IA.05.16)
- Make a class chart that classifies the descriptions of motion into motion words, speed words, and direction words. Ask students if any of the descriptions of motion are measurable. (P.FM.05.41, P.FM.05.42, S.IP.05.15)

- Further develop student experiences with describing motion by measuring distance and time of different types of motion that they can generate by themselves, (hop, skip, walk, run, hop on one foot, walk backwards, crawl, etc.) and compare the distances traveled over time. (P.FM.05.41, P.FM.05.42, S.IP.05.11, S.IP.05.12, S.IA.05.13, P.FM.05.43)
- Distribute metric measuring tapes and stop watches and give students the opportunity to explore the measurement of distance and time as related to the motion of different objects and themselves. (P.FM.05.41, P.FM.05.42, S.IP.05.11, S.IP.05.12, S.IA.05.13, P.FM.05.43)
- Ask students to describe what started the objects in motion. Review the term force from their experiences in the third grade or introduce the term force if students are not yet familiar with the term. (P.FM.05.21)
- Students explore forces and their affect on motion by setting up low friction cars with and without fans attached to them. They observe a car at rest with out any fans attached. They observe the motion of a car with two fans attached in opposing directions, one fan attached, and three fans attached (two oriented in the same direction, and one in the opposite direction. They are asked to predict how the cars will move after the fan or fans are turned on. They record their results. (P.FM.05.31, P.FM.05.32, P.FM.05.33, P.FM.05.34)
- Students explore the motion of an object relative to a reference point by moving their bodies in front of a sensor to recreate distance-time graphs. (P.FM.05.41, P.FM.05.42, P.FM.05.43)

Explain and Define

- Explain the terms balanced and unbalanced forces. Ask students to define the terms in their own words and give examples of when the forces were balanced and unbalanced in the balloon rocket demonstration. (P.FM.05.31, P.FM.05.32, P.FM.05.33, S.IA.05.12)
- Students experience balanced and unbalanced forces through the game of tug-of-war. As a class, discuss the forces acting on objects at rest and explain that objects at rest have balanced forces acting on them. Relate balanced forces to tug-of-war when the pull is equal from each team and unbalanced when one team pulls harder than another. The students understand that the balanced and unbalanced forces are the forces exerted on the rope by each team. (P.FM.05.31, P.FM.05.32, P.FM.05.33)
- Introduce the spring scale, as a tool to measure the net force, in Newtons, that cause various changes in the motion of objects. Spring scales can be attached to a variety of material as it is pulled across a variety of surfaces and up and down ramps. Students collect data and compare the forces and variables that affect the forces of motion. (P.FM.05.31, P.FM.05.32, P.FM.05.33, S.IP.05.13)
- Introduce the balance as a tool to measure the mass of different objects they are using for investigations into forces and motion. (P.FM.05.34, S.IP.05.13)
- Students move a bowling ball using only a rubber mallet. Tapping the ball with the mallet can only move the ball, and the mallet cannot be kept in constant contact with the ball. This forces to the students to observe the

direction of the taps that are necessary to start the ball moving, keep the ball moving in a given direction, and to stop the ball and bring it to rest. The students identify the use of the mallet as a contact force and compare it to the use of magnetism, gravity or electrical forces to move objects. (P.FM.05.21, P.FM.05.22)

- Students discuss the effect of the force of the fan or fans on the cars. When did the cars go faster? Were the forces ever balanced? When were the forces unbalanced? (P.FM.05.31, P.FM.05.32, P.FM.05.33, P.FM.05.34)
- Students explain what they had to do to recreate the different parts of the graphs. For example, what did they have to do make the line slope up or down for a certain amount of time. What happened to the graph when they moved away from the sensor? What did they have to do make the line flat? What happened when they were moving the fastest or slowest? (P.FM.05.41, P.FM.05.42, P.FM.05.43)

Elaborate and Apply

- Challenge student to use the balloon rocket to design a demonstration that shows motion with two forces acting on an object in the same direction and then in opposite directions. Give students sufficient materials and time to investigate the use of two or more balloons. (P.FM.05.31, P.FM.05.32, P.FM.05.33, S.RS.05.11, S.RS.05.12, S.RS.05.13, S.RS.05.15)
- Elaborate on balanced and unbalanced forces by introducing non-contact forces. The forces students are most likely to have explored are pushes and pulls that come in contact with the moving object. Once students understand that net forces change the motion of objects, introduce the force of gravity, magnets, and electricity. Have students move objects using the different polarity of the object and magnets. (P.FM.05.21, P.FM.05.22)
- Have students design an investigation that demonstrates the least amount of force needed to move an object, using their knowledge of friction, gravity, magnitude of force, and mass of an object. (P.FM.05.21, P.FM.05.22, S.IP.05.11, S.IP.05.12, S.IP.05.13, S.IP.05.14, S.IP.05.15, S.IP.05.16, S.IA.05.13)
- Demonstrations of gravity should include the following kinds of investigations, dropping objects and observing the path of falling objects, observing the path of baseballs, volleyballs, footballs, basketballs, ping pong balls, marbles after being launched. (P.FM.05.21, P.FM.05.22)
- Demonstrations of magnetic forces include moving magnetic marbles/ball bearings of various sizes and weights. (P.FM.05.21, P.FM.05.22)
- Design a paper airplane that will stay aloft for x number of minutes. Have students measure the distance and time for multiple trials of their airplane and calculate and graph the speed. Encourage students to analyze their plane design and make modifications to increase the distance and/or speed of the plane. Discuss the force of friction as air resistance (contact force) and how friction is considered in designs of vehicles of flight.

(P.FM.05.21, P.FM.05.22, P.FM.05.43, S.IA.05.11, S.IA.05.12, S.IA.05.13, S.IA.05.14, S.RS.05.15)

- Demonstrate static electricity changing the direction of a stream of water as it comes out of a faucet or is poured from a container into another container. The use of static electricity can also be used to move or stop the motion of a hanging object suspended from a string. An inflated balloon rubbed on a fabric can be used to pick up tiny bits of paper to show static electricity. (P.FM.05.21, P.FM.05.22)
- The students draw diagrams, pictures or concept maps to indicate how they are thinking about force and its relationship to motion. (P.FM.05.31, P.FM.05.32, P.FM.05.33, P.FM.05.34)
- Students discuss speeding up and slowing down as represented on the graphs that they created moving in front of the sensor. (P.FM.05.41, P.FM.05.42, P.FM.05.43)

Evaluate Student Understanding

Formative Assessment Examples

- Demonstrations and explorations using magnets to change motion which would include moving a magnetic object that is at rest, repelling or attracting another magnet from a distance. (P.FM.05.21, P.FM.05.22)
- Provide students with examples of graphs created in the activity from P.FM.05.41, P.FM.05.42, and P.FM.05.43. The students determine if the cars could match any of the distance-time graphs. (P.FM.05.31, P.FM.05.32, P.FM.05.33, P.FM.05.34)
- Students illustrate via graphs or number lines what it means to move regarding distance, time and direction. (P.FM.05.41, P.FM.05.42, P.FM.05.43)
- Students write in science journals, quick writes, and poetry to reflect knowledge of forces and motion.
- Use classroom discussion following an inquiry activity to assess understanding of motion and forces.
- Design inquiry experiments using contact and non-contact forces to assess understanding of the forces from a distance and forces that make contact with the object.

Summative Assessment Examples

- End of unit test
- Poster, brochure, or Power Point presentation on energy transfer
- Written report on uses/benefits of alternative power

Enrichment

- Students explore speed, distance, and direction building and programming robots using Lego Mindstorm kits. For example, Lego robots can be programmed to speed up and/or slow down, go forward, reverse and go backward, etc. Students can use stopwatches to time a robot traveling over a course taking marking the times at regular intervals of distance. Afterwards, the students create distance-time graphs using the data.
- Students build and use weather instruments such as wind vanes and anemometers to make observations of the motion of the air.
- Students build air popper devices using various cylinders such as gift-wrap paper tubes, coffee cans, Pringles cans, balloons, wax paper or other kinds of material. The students attach the balloon to one of the open ends of the tube, and poke a hole the center of the other end of the cylinder in the case of Pringles and coffee cans. In the case of gift-wrap paper or paper towel cylinders the other end is covered with wax paper or newspaper. A hole is poked in the center of the paper at this end. The air popper devices are then used to propel an object across a length of table or other surface. A feather works very well, and can be used to conduct "feather races". Pointing the end of the device with the hole at the feather and plucking or tapping the end with the balloon moves the feather or other object. Students can make observations of speed, direction, mass, and contact forces.
- Students research the Maglev train to learn more about how non-contact forces are used to reduce the use of natural resources.

Intervention

- Students further explore forces and their affect on motion by observing the motion of cars as they move across a table. The students will attach fishing line or some other string to one end of a car and attach a baggy to the other end. The baggy is for adding weights, which will exert a force on the car when hung over the end of the table. The students should attach enough line so that the car can travel one meter when they release the car. In the first set of trials, the baggy will contain 10 grams and the car will have 0 grams on top of it. The students observe the motion of the car after it is released. They can time the car stopping it when it reaches the end of a meter. They should repeat this several times to see if the results are consistent. Next, the students add 10 grams to the top of the car, and observe the motion of car when they release it. The baggy still contains the original 10 grams. Finally, the students place 20 grams on the top of the car while keeping the baggy at 10 grams, and record the results.
- After completing the above trials the students will conduct three new trials. In the first trial, the car will not have any additional grams added

as in the first trial above, but the weight in the baggy will now be increased to 20 grams. The students repeat the procedure above. For the second trial 10 grams is added and for the third trial 20 grams is added.

- The third set of trials will be conducted with 30 grams in the baggy. Once again, the car will have 0 grams, then 10 grams, and finally 20 grams for each of the subsequent trials. There will be a total of nine trials in all. Students record their observations and discuss the results. Do they observe a pattern or patterns? What are the forces acting on the car? Is or are the forces contact or non-contact forces?
- Center an index card over the top of a glass, and place a coin in the center of the index card. Flick the card from the side with one or two fingers. Observe the motion of the card and the coin. Place the coin on a table or other level surface. Observe it for a while. Note that the card flew off in the direction of the force of applied to it by the finger. The coin stayed in place and dropped due the force of gravity.

Examples, Observations, and Phenomena (Real World Context)

Examples of contact forces causing motion include wind-propelling a sailboat across water, a horse pulling a wagon or a car pulling a trailer, a person pushing a cart of books, etc.

Examples of a contact force and a non-contact force causing motion or changes in motion would be throwing a rock or ball. You and your hand provide the contact force that gets it going. Gravity acting on the rock or ball causes it to start falling and speeding up in the direction of the ground. When it hits the ground it stops which is another change in motion.

A person riding in a car with groceries or other objects not restrained by a seat belt provides another real life scenario. When the driver steps on the brake, friction between the road and the tires changes the motion of the car as it comes to a stop. The seat belt applies a force to the driver and other passengers and changes the motion of the people in the car from moving to not moving. The groceries or other objects not restrained keep doing what they are doing which is moving, and change position in the car that is probably to wind up on the floor.

Two students push with equal force on a chair or cart on opposite sides and the result is that the chair or cart does not move. Because the forces are the same and in opposite directions, they cancel each other out. The net force acting on the chair or cart is zero. The net force is what is left over when you figure in all the effects of different forces acting on something. Next add another student to one of the sides so that there are now two students pushing against one. The chair or cart will move in the direction of the greater force. The additional student causes the forces to be unbalanced for a non-zero net force.

Automobiles start moving and stop moving faster than trucks. Automobiles have smaller masses than trucks. In general, it is easier to change the speed and/or direction of an automobile than a truck. This is also true of motorcycles and automobiles. The motorcycle may have a smaller engine (smaller force), but it also has a smaller mass.

Literacy Integration

Students will…

Reading

R.IT.05.01 analyze the structure, elements, features, style, and purpose of informational genre, including research reports, "how-to" articles, and essays.

R.CM.05.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.05.02 retell through concise summarizations grade-level narrative and informational text.

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

Read the book - *THE MAGIC SCHOOL BUS PLAYS BALL: A Book About Forces* by Joanna Cole.

Writing

W.PR.05.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.05.04 revise drafts based on constructive and specific oral and written responses to writing by identifying sections of the piece to improve organization and flow of ideas (e.g., position/evidence organizational pattern, craft such as titles, leads, endings, and powerful verbs).

W.PS.05.01 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.06.01 adjust their use of language to communicate effectively with a variety of audiences and for different purposes by asking and responding to questions and remarks to engage the audience when presenting.

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

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

Mathematics Integration

N.ME.05.08 Understand the relative magnitude of ones, tenths, and hundredths and the relationship of each place value to the place to its right.

N.MR.05.15 Multiply a whole number by powers of 10: 0.01, 0.1, 1, 10, 100, 1000, and identify patterns.

N.FL.05.16 Divide numbers by 10's, 100's, 1000's using mental strategies.

M.UN.05.03 Compare the relative sizes of one cubic inch to one cubic foot, and one cubic centimeter to one cubic meter.

M.UN.05.04 Convert measurements of length and weight within a given system using easily manipulated numbers.

D.RE.05.01 Read and interpret line graphs, e.g., distance-time graphs.

Fifth Grade GLCE Companion Document

Unit 2: Animal Systems

SCIENCE

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

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v.1.09

Fifth Grade Companion Document

5-Unit 2: Animal Systems

Table of Contents Page 1

5th Grade Unit 2:
Animal Systems

Content Statements and Expectations

5-Unit 2: Animal Systems

Big Ideas (Key Concepts)

- Animals' bodies are made up of various body systems that perform specific functions.
- These body systems function together and contribute to the animal's survival and well being.

Clarification of Content Expectations

Standard: Organization of Living Things

Content Statement – L.OL.M.4
Animal Systems – Multicellular organisms may have specialized systems that perform functions that serve the needs of the organism.

Content Expectations

L.OL.05.41 Identify the general purpose of selected animal systems (digestive, circulatory, respiratory, skeletal, muscular, nervous, excretory, and reproductive).

Instructional Clarifications

1. Identify means to recognize the general purpose of selected animal systems.
2. A description of what "system" refers to is logical as introduction to this expectation.
3. Human systems are used as representative of all vertebrate systems. This is particularly important if human systems are not taught in other parts of a district's K-7 curriculum.
4. Comparing animal systems of organisms from different animal Phyla is not the purpose or intent of this expectation.
5. Identification of the general purpose of each animal system is the focus of instruction, not a detailed understanding of the anatomy and physiology of all parts of each system.
6. Identify those organs in selected systems that relate to the general purpose of each system.
7. The purpose of the circulatory system is to carry food and oxygen to all parts of the body and to remove waste products from all parts of the body.

8. The purpose of the digestive system is to break down food into small particles that can be carried in the blood to all parts. A common misconception is that we eat because our stomachs need food.
9. The purpose of the respiratory system is to bring oxygen into the blood and to remove waste products (or carbon dioxide) from the blood.
10. The purpose of the skeletal system is to provide support and structure for the animal.
11. The purpose of the muscular system is to provide movement and form for the animal.
12. The purpose of the nervous system is an internal communication system between the brain and all other parts of the body.
13. The purpose of the excretory system is to remove wastes from the body.
14. The purpose of the reproductive system is to create offspring for the continuation of species.

Assessment Clarification

1. Identification of the general purpose of each animal system is the focus of instruction, not a detailed understanding of the anatomy and physiology of all parts of each system.

L.OL.05.42 Explain how animal systems (digestive, circulatory, respiratory, skeletal, muscular, nervous, excretory, and reproductive) work together to perform selected activities.

Instructional Clarifications

1. Two or more systems can be linked in performing selected activities.
2. Example of systems working together: as muscles work, the circulatory system carries oxygen from the respiratory system and food from the digestive system to muscles to provide energy. Then the circulatory system carries away waste from the muscles to the urinary system and respiratory system.
3. A common misconception is that not all systems are working all the time.

Assessment Clarifications

1. Students explain how two or more systems are linked in performing selected sports activities.
2. Students explain how all animal systems are functioning all the time, even when the animal is at rest.

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

Inquiry Process
S.IP.05.11 Generate scientific questions about animal systems (digestive, circulatory, respiratory, skeletal, muscular, nervous, excretory and reproductive) based on observations, investigations, and research.
S.IP.05.12 Design and conduct scientific investigations that demonstrate how selected systems work together (for example: how changes in muscular activity cause changes in circulatory and respiratory activity).
S.IP.05.13 Use tools and equipment appropriate to scientific investigations of systems working together (stop watches, meter sticks).
S.IP.05.14 Use metric measuring devices in investigations of how animal systems work together.
S.IP.05.15 Construct charts and graphs comparing changes in muscular activity with changes in pulse rate and breathing rate.
S.IP.05.16 Identify patterns in data from investigations of changes in muscular activity, pulse rate and breathing rate.
Inquiry Analysis and Communication
S.IA.05.11 Analyze information from data tables and graphs comparing changes in muscular activity with changes in pulse rate and breathing rate to answer scientific questions.
S.IA.05.12 Evaluate data, claims, and personal knowledge through collaborative discourse about animal systems working together.
S.IA.05.13 Communicate and defend findings of observations and investigations using evidence about muscular activity, heart rate and breathing rate.
S.IA.05.14 Draw conclusions from sets of data from multiple trials (data from all student groups) of a scientific investigation.
S.IA.05.15 Use multiple sources of information to evaluate strengths and weaknesses about the claims, arguments, or data regarding the relationship between muscular activity and breathing rate and pulse rate.
Reflection and Social Implication
S.RS.05.21 Evaluate the strengths and weaknesses of claims, arguments, and data about the work performed by selected animal systems.
S.RS.05.22 Describe limitations in personal and scientific knowledge about the ways in which animal systems work together.
S.RS.05.24 Demonstrate scientific concepts through various illustrations, performances, models, exhibits or activities of how animal systems work together.
S.RS.05.27 Describe how science and technology related to animal systems have advanced because of the contributions of Ibn Nafis, Daniel Hale Williams and other people throughout history and across cultures.

Vocabulary

Critically Important–State Assessable	Instructionally Useful
digestive system circulatory system skeletal system muscular system nervous system excretory system reproductive system respiratory system	energy movement & support breathe digestion absorption elimination transport stimulus response sperm egg urine feces mouth esophagus stomach small intestine large intestine (colon) liver pancreas heart arteries veins skeletal: (bones, tendons, ligaments, skull, ribs, sternum) muscles tendons brain spinal cord sensory nerves motor nerves kidneys urinary bladder urethra ovaries oviducts uterus vagina testes vas deferens penis

Instruments, Measurements, Representations

stop watches	use to determine pulse rate
representations	create and utilize data tables
representations	graphic results of pulse rate investigation
model	symbolic representation of linking sports and body systems

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

Animal Systems: L.OL.05.41, L.OL.05.42

Objective

- Animal body systems work together in order for activities to be performed.

Engage and Explore

- Engage students in an activity that supplies each student with a card containing one of the following 1) a body system 2) a major organ or part 3) general purpose/function. Students work collaboratively to match a body system with the appropriate organ/part and function. Each group will explain to the class the reasons for its choices. (L.OL.05.41, S.RS.05.21, S.RS.05.24)
- Pairs of students measure changes in pulse rate and breathing rate before and after mild exercise such as jumping jacks. One student exercises, the other student monitors the pre- and post-exercise pulse rate. Each pair of students list the systems they feel were most important in this activity and explain how these systems worked together. (L.OL.05.42, S.IP.05.12, S.IP.05.13, S.IP.05.15)

Explain and Define

- Students investigate individual organ systems separately and report on each of their functions as a means of communicating the specific job of each system. It is important to understand that no organ systems are

independent and the work of each system is related to the work of one or more other systems. (L.OL.05.42)

Elaborate and Apply

- Elaborate on the student questions generated during the activities and class discussion. (L.OL.05.41, L.OL.05.42, S.IA.05.12)
- Students pool class data on pulse-rate activity and create a graph to represent class results. Determine mean and mode for class results and compare their individual results to class results. (L.OL.05.42, S.IP.05.15, S.IP.05.16, S.IA.05.11, S.IA.05.12, S.IA.05.13, S.IA.05.14, S.RS.05.11, S.RS.05.12)
- Students choose a sports or leisure activity to describe the body systems used and how these body systems are used together to perform the activity of the chosen sport or leisure activity. Students design symbolic representation from the sport of their choice upon which they will write each system and how it is used in that activity. (L.OL.05.42, S.RS.05.22, S.RS.05.24)
- Elaborate on the health of the human body and maintenance of body systems through discussion and research of a healthy diet and exercise. (L.OL.05.42, S.IA.05.12, S.RS.05.11)
- Pose *what would happen if… questions* regarding the consequences of one body system shutting down or becoming injured. (L.OL.05.42, S.RS.05.11, S.RS.05.12)

Evaluate Student Understanding

Formative assessment

- Evaluate the appropriateness of students' selection of body system and related leisure activity. (L.OL.05.42)
- Evaluate the accuracy of students' matching of body systems with appropriate organ/part and function. (L.OL.05.41)
- Explain which body systems, during exercise, are most involved and how they work together. (L.OL.05.42)

Summative assessment

- Complete a fill-in-the-blank chart with three columns: body system, parts (organs), and general purpose. One column for each system will contain clue information. Clue examples for the organ column could be heart, or stomach; for function, transports nutrients throughout organism; for body system, digestive or reproductive, etc. Students will add to that column and complete other blank columns with appropriate information. (L.OL.05.41)
- Explain what body systems work together as you do your homework. (L.OL.05.42)

Enrichment

- After conducting independent research about a selected system or organ, students create an artifact that represents their deepened knowledge. Possible artifacts could be a poster, digital presentation, model, song, diorama, or other appropriate possibilities.
- Dissection of chicken wings, fish or specific organs such as beef heart, kidneys.
- After conducting independent research about a specific disease that affects organs or organ systems, students create an artifact that represents their deepened knowledge. Possible artifacts could be a poster, digital presentation, model, song, diorama, or other appropriate possibilities.
- Museums or science centers with appropriate displays.

Intervention

- Provide students with a short video relevant to the above content expectations, from United Streaming, Annenberg or other sources.
- Provide alternative print material that may be more appropriate to the students' literacy level.

Examples, Observations, and Phenomena (Real World Context)

Students are generally aware that breathing rate and pulse rate increase during exercise. The activities in this unit build an understanding of the quantitative proportionality between amount of exercise and rate of breathing and pulse.

Digestive, muscular and circulatory systems are interdependent in the act of eating, digesting and distributing nutrients.

Skeletal, muscular and nervous systems are interdependent in physical activity.

Poor diet and lack of exercise have affected the health of the nation. The rate of obesity, and other health issues are on the rise in the United States.

Organic foods are becoming a more popular choice for the health conscious population. Additives, preservatives, and other artificial ingredients are becoming a health risk to consumers. Some consumers are concerned that food additives, such as preservatives and dyes may pose health risks.

Smoking affects the respiratory system and can lead to cancer and respiratory and heart diseases.

Literacy Integration

Students will…

Reading

R.CM.05.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.05.02 retell through concise summarization grade-level narrative and informational text.

R.CM.05.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Writing

W.PR.05.02 apply a variety of pre-writing strategies for both narrative and informational writing (e.g., graphic organizers such as maps, webs, Venn diagrams) in order to generate, sequence, and structure ideas (e.g., role and relationships of characters, settings, ideas, relationship of theory/evidence, or compare/contrast).

- Students work in teams to perform investigations, including the recording of observations, discussion of results and presentation of results and conclusions.

Speaking

S.CN.05.02 adjust their use of language to communicate effectively with a variety of audiences and for different purposes including research, explanation, and persuasion.

S.DS.05.01 engage in interactive, extended discourse to socially construct meaning in book clubs, literature circles, partnerships, or other conversation protocols.

S.DS.02.01 engage in substantive conversations, remaining focused on subject matter, with interchanges building on prior responses in book discussions, peer conferencing, or other interactions.

Mathematics Integration

D.RE.05.02 Construct line graphs from tables of data; include axis labels and scale.

D.AN.05.03 Given a set of data, find and interpret the mean (using the concept of fair share) and mode.

D.AN.05.04 Solve multi-step problems involving means.

- Students determine individual pulse rates by counting pulse rate for 15 or 30 seconds and multiplying to determine the pulse per minute. Students then calculate their mean pulse rate based on three trial measurements. Students will pool class data on pulse-rate activity and create a graph to represent class results. Determine mean and mode for class results and compare their individual results to class results.

Fifth Grade GLCE Companion Document

Unit 3: Evolution and Traits of Organisms

SCIENCE

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

MICHIGAN Department of Education

v.1.09

Fifth Grade Companion Document
5-Unit 3: Evolution and Traits of Organisms

Table of Contents Page 1

Fifth Grade Companion Document
5-Unit 3: Evolution and Traits of Organisms

Table of Contents (continued)

5th Grade Unit 3:
Evolution and Traits of Organisms

Content Statements and Expectations

5 – Unit 3: Evolution and Traits of Organisms

Big Ideas (Key Concepts)

- Traits are influenced by both genetics of the individual and the environment.
- Traits can be classified as either inherited or acquired.
- Each organism (plants and animals) has specific behavioral and physical characteristics allowing it to better survive in a given environment.
- As environments change over time, these characteristics may change (adaptations) to allow them to continue to survive or flourish in their environment.
- Fossils provide evidence that life forms have changed over time and were influenced by changes in environmental conditions including catastrophic events.
- Organisms that are similar in anatomical structures are more likely to be more closely related than those whose structures are less similar to one another.

Clarification of Content Expectations

Standard: Heredity

Content Statement – L.HE.M.1

Inherited and Acquired Traits – The characteristics of organisms are influenced by heredity and environment. For some characteristics, inheritance is more important; for other characteristics, interactions with the environment are more important.

Content Expectations

L.HE.05.11 Explain that both the environment and the genetics of the individual influence the traits of an individual.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally how traits are influenced by the environment and genetics.
2. The similarity of genetic (inherited) traits between parents and their young is easily recognized.

3. Differences in soil minerals, exposure to sun, availability of water or other environmental factors are conditions that may cause variation in growth among offspring of the same parent plants or plants of the same species. Differences in growth among these plants are also influenced by the genetic traits of each plant.
4. Differences in nutrition, disease exposure, or other environmental factors are conditions that may cause variation in growth among offspring of the same animal parents or animals of the same species. Differences in growth among these animals are also influenced by the genetic traits of each animal.
5. A common misconception is that organisms can develop adaptations to a changing environment. Organisms may adapt behaviorally during their lifetime but these changes are not heritable. The term "adaptation" refers to genetically based traits that develop at the population level due to genetic variation and subsequent natural selection. These adaptations are heritable.

Assessment Clarifications

1. Environmental effects on inherited traits include disease and nutrition levels.
2. The environment may alter inherited traits.

L.HE.05.12 Distinguish between inherited and acquired traits.

Instructional Clarifications

1. Distinguish means to recognize or know the difference between inherited and acquired traits.
2. Inherited traits develop from the genetic "instructions" passed along from parents to offspring. Plant examples: Shape of leaves or shape of flowers. Animal examples: Body shape, body covering.
3. Acquired traits are a consequence of an organism's experiences and are not part of their genetic makeup. For example, amputation of a limb, scars, learned knowledge, small size due to lack of food (animals) or sunlight (plants).
4. Inherited traits may be modified by disease, nutrition or other environmental factors and represent acquired traits. Example: One twin of a genetically identical pair may acquire a disease that retards growth in comparison to his/her twin.
5. A common misconception is that daughters inherit most of their characteristics from their mothers while boys inherit most of their characteristics from their fathers.
6. Another common misconception is that traits are either inherited or acquired. In fact, some can be a combination of both, such as athletic ability.

Assessment Clarifications

1. Identify common inherited traits of plants and animals. Plant examples: shape of leaves or shape of flowers. Animal examples: body shape, body covering.

2. Identify acquired traits of plants and animals that may result from environmental conditions. Examples include: amputation of a limb, scars, learned knowledge, small size due to lack of food (animals) or sunlight (plants).

Standard: Evolution

Content Statement - L.EV.M.1

Species Adaptation and Survival - Species with certain traits are more likely than others to survive and have offspring in particular environments. When an environment changes, the advantage or disadvantage of the species' characteristics can change. Extinction of a species occurs when the environment changes and the characteristics of a species are insufficient to allow survival.

Content Expectations

L.EV.05.11 Explain how behavioral characteristics (adaptation, instinct, learning, habit) of animals help them to survive in their environment.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally how behavioral characteristics help animals survive in their environment.
2. Learned behavior may become a habit. Example of a learned behavior: birds coming to a bird feeder, raccoons getting into garbage cans to look for food.
3. Example of habit: some animals have the habit of being active at night (nocturnal) and may be protected from predators that are active during the day.
4. Example of instinct: a bird building a nest is an instinctive (unlearned) behavior. All birds of the same species build the same type of nest.

Assessment Clarifications

1. Some behavioral characteristics such as birds coming to a bird feeder, raccoons getting into garbage cans to look for food, nocturnal activity and nest building help animals survive in their environment.
2. Give examples of behaviors due to adaptation, instinct, learned, and habit.

L.EV.05.12 Describe the physical characteristics (traits) of organisms that help them survive in their environment.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words how physical traits allow organisms to survive in their environment.

2. Observe and relate physical characteristics of plants and animals to the ways in which these traits may improve their survival. Examples: thorns or spines discourage plant eaters, webbed feet improve the swimming ability of animals making it possible for them to better avoid predators or get food, shapes of bird beaks/bills adapt them to using certain types of foods, mammals have specialized teeth adapted for eating certain types of foods.

Assessment Clarification

1. Specific physical characteristics such as thorns or spines, webbed feet, shape of beaks or bills, specialized teeth help improve the organisms' chances for survival.

L.EV.05.13 Describe how fossils provide evidence about how living things and environmental conditions have changed.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words how fossil evidence shows how living things and environmental conditions have changed over time.
2. Plant and animal types that live today and somewhat resemble fossil plants and animals indicate that living things have changed as the environment has changed. For example: whales once being land animals.
3. Some plants and animals exist only as fossils and not as living things, today.

Assessment Clarification

1. Fossils indicate that environmental factors have led to changes of particular organisms. For example: whales as land animals.

L.EV.05.14 Analyze the relationship of environmental change and catastrophic events (for example: volcanic eruption, floods, asteroid impact, tsunami) to species extinction.

Instructional Clarifications

1. Analyze means to carefully examine by identifying key factors in the relationship between species extinction and either environmental change or other catastrophic events.
2. Catastrophic events may change widespread environmental conditions such as world temperatures (volcanic eruption dust and gases) or destroy habitat (tsunamis) leading to species extinction.
3. Records of mass extinctions follow evidence of catastrophic events such as asteroid impacts.
4. Localized catastrophic events such as tsunamis and volcanic eruptions may eliminate species with limited ranges and/or numbers, such as those existing only on one or a few ocean islands.

Assessment Clarifications

1. Link catastrophic events (volcanic eruption, floods, asteroid impact, tsunami) to specific changes in environmental conditions.

2. Link specific environmental changes due to catastrophic events to species extinction.

Content Statement - L.EV.M.2

Relationships Among Organisms - Similarities among organisms are found in anatomical features, which can be used to infer the degree of relatedness among organisms. In classifying organism, biologists consider details of internal and external structures to be more important that behavior or general appearance.

Content Expectation

L.EV.05.21 Relate degree of similarity in anatomical features to the classification of contemporary organisms.

Instructional Clarifications

1. Relate means to establish an association or connection between the degrees of similarity in anatomical features to the classification of organisms.
2. Organisms with substantial similarities in anatomical structure are more closely related genetically than those organisms with fewer similarities. All vertebrate animals have a backbone; they can be further classified by body covering (fur, feather, scales) into groups showing greater degree of similarity and closer relatedness.
3. Similarities of behavior among organisms of different types is not a reliable indicator of genetic relatedness. Example: all animals that are active at night (nocturnal) are not necessarily genetically related.

Assessment Clarifications

1. Compare and contrast species appearance based on anatomical features. For example vertebrates can be further classified by body covering.
2. Infer degree of relationship between species based on anatomical features.

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

Inquiry Process
S.IP.05.11 Generate scientific questions about heredity, traits that allow organisms to survive and evolution based on observations, investigations, and research.
S.IP.05.12 Design and conduct scientific investigations showing traits/characteristics and how they are influenced by the environment and genetics.
S.IP.05.13 Use tools and equipment appropriate to scientific investigations of environmental influence on characteristics and traits and characteristics improving survival rate (research materials, plants, soil of varying nutrient levels).
S.IP.05.14 Use metric measurement devices in an investigation of environmental factors on plant growth (height in centimeters, volume of water in milliliters, etc.).
S.IP.05.15 Construct charts and graphs from data and observations found while investigating heredity and factors affecting populations and traits.
S.IP.05.16 Identify patterns in data from investigations of behavioral, physical and environmental factors affecting traits and changes in populations.
Inquiry Analysis and Communication
S.IA.05.11 Analyze information on behavioral and physical characteristics and environmental influences on traits from data tables and graphs to answer scientific questions.
S.IA.05.12 Evaluate data, claims, and personal knowledge of traits, changes in traits/characteristics over time and degree of organism similarity through collaborative science discourse.
S.IA.05.13 Communicate and defend findings of observations and investigations using evidence of students traits and factors influencing traits.
S.IA.05.14 Draw conclusions from sets of data from multiple trials of a scientific investigation on environmental influence on traits.
S.IA.05.15 Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments or data while conducting research on environmental factors causing change in species/organisms over time.
Reflection and Social Implications
S.RS.05.11 Evaluate the strengths and weaknesses of claims, arguments, and data recorded investigating influences on traits.
S.RS.05.12 Describe limitations in personal and scientific knowledge on heredity and traits as well as how the environment influences these traits.
S.RS.05.13 Identify the need for evidence in making scientific decisions while investigating factors influencing traits.
S.RS.05.15 Demonstrate scientific concepts of heredity, traits and characteristics through various illustrations, performances, models, exhibits, and activities.

Vocabulary

Critically Important- State Assessable	Instructionally Useful
anatomical features genetic relatedness adaptation inherited traits acquired traits learned behavior nocturnal heredity environmental factors fossil catastrophic events (volcanic eruptions, tsunamis, asteroid impacts, floods) natural selection instinct habit behavioral characteristics physical characteristics (traits) survival	internal structures external structures vertebrate invertebrate flowering non-flowering aquatic terrestrial cold-blooded warm-blooded

Instruments, Measurements, and Representations

meter stick	to measure plant growth
graduated cylinder	to measure water level
research resources	computers, encyclopedias or other media center resources
representations	T-chart, bar graphs, model ecosystems

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

Heredity: L.HE.05.11, L.HE.05.12

Objective

- Demonstrate understanding of the influence of traits by genetics and the environment.

Engage and Explore

- Using a T-chart, have students list traits they believe were passed on from their parents on one side and list traits they have obtained from other sources on the other side. Allow students to share their ideas in pairs before discussing as a class. (L.HE.05.11, L.HE.05.12, S.IP.05.11, S.IP.05.12, S.IP.05.15, S.IA.05.12, S.IA.05.13, S.IA.05.11)
- Students explore their own traits and consider where they may have originated. This can help students explore genetic (inherited) traits as well as acquired traits. Traits may include widow's peak, eye color, scars, tongue rolling, etc. There is no intent to trace inherited patterns but to identify traits that have been genetically passed down from parents and grandparents. Students discuss and compare personal traits with classmates. (L.HE.05.11, L.HE.05.12, S.IP.05.11, S.IP.05.12, S.IA.05.12, S.IA.05.13, S.RS.05.12, S.RS.05.15)
- Have students research the inherited traits of the ability to roll one's tongue and the ability to do the "Vulcan hello" (separate the middle finger and ring finger to form a "V"). Have students find out if their grandparents or parents have these inherited traits and how many siblings. Students realize that they cannot learn to roll the tongue or

make the “Vulcan hello”. They are inherited traits. (L.HE.05.11, L.HE.05.12)

Explain and Define

- Discuss with students the difference between acquired and inherited traits in the context that they can inherit a family member’s wealth but could also acquire wealth themselves throughout their lifetime. Give students time to define the terms inherited traits and acquired traits. In pairs share definitions and change them if they desire. As a class, with teacher directions, define the terms. (L.HE.05.11, L.HE.05.12, S.IA.05.12)

Elaborate and Apply

- Students design an experiment by altering environmental factors of plants to determine the influence these factors have on the traits of the plants. For example, vary soil nutrients, amounts of water, exposure to sunlight, etc. In small groups students choose which aspect of the environment to alter then design the experiment. Students collect data over a given period of time. This data will then be interpreted and analyzed and presented to the entire class. Presentations should include how the traits were influenced by the environmental factor tested. (L.HE.05.11, S.IP.05.12, S.IP.05.13, S.IP.05.14, S.IP.05.15, S.IP.05.16, S.IA.05.11, S.IA.05.12, S.IA.05.13, S.IA.05.14, S.RS.05.11, S.RS.05.12, S.RS.05.13, S.RS.05.15)

Evaluate Student Understanding

Formative Assessment Examples
- Evaluate student presentation of information on environmental influences affecting plants traits. (L.HE.05.11)
- Evaluate student design and investigations of the classroom habitat and presentations. (L.EV.05.11 and L.EV.05.12)

Summative Assessment Examples
- Give each student three separate index cards and label the first with an A (Acquired), the second with an I (Inherited) and the third with a B (Both). Read different traits aloud and have each student independently choose which type of trait each represents. Visually scan the room to determine each student’s understanding (or misunderstanding) of the Content Expectation. (L.HE.05.12)
- Design matching type questions for inherited and acquired traits. (L.HE.05.12)
- Describe situations in which the environment would affect a trait of a plant or animal and have student describe how the trait would be affected in the given situation. (L.HE.05.11)

Enrichment

- Allow students to trace a particular trait prominent in their family back a few generations.
- Student independently researches a particular environmental factor (teacher or student chosen) and how it would affect plant or animal traits. The student would gather data, interpret results and design a presentation to share information to the class.
- Students research the types of traits or differences in traits found regionally or within particular ethnic groups
- Student visits a place that researches genetic diseases (or interviews an adult that has had an experience with genetic diseases or disorders) and compiles a presentation to share with the class.

Intervention

- Show two parents with their offspring and together discuss similarities with traits. Give student two additional parents to demonstrate similarities of genetic traits.
- Provide student with a short video or video clips depicting how variation among species occur.

Examples, Observations, and Phenomena (Real World Context)

Students both biological and adopted are generally interested in investigating the traits that they possess. Students are easily engaged in discussions regarding these traits.

Most students relate well to professional sports. Athletes in these sports may have inherited genes allowing them to be better at a particular sport. However, if they do not practice and acquire the traits, they may not be as good.

The comparisons between the characteristics humans have to help them survive in their environments and other animals lead to an understanding of evolution and connections between animals. The opposable thumbs of humans separates humans from all other animals.

Literacy Integration

Students will…

Reading

R.WS.05.04 know the meaning of words encountered frequently in grade-level reading and oral language contexts.

R.CM.05.02 retell through concise summarization grade-level narrative and informational text.

R.CM.05.03 analyze global themes, universal truths, and principles within and across text to create a deeper understanding by drawing conclusions, making inferences, and synthesizing.

R.CM.05.04 apply significant knowledge from grade-level science, social studies and mathematics texts.

- After students complete their designed plant experiment and compile results, students research (textbooks or computer technology) similar studies to compare results.

Writing

W.PR.05.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.05.02 apply a variety of pre-writing strategies for both narrative and informational writing (e.g., graphic organizers such as maps, webs, Venn diagrams) in order to generate sequence, and structure ideas (e.g., role and relationships of characters, settings, ideas, relationship of theory/evidence, or compare/contrast).

W.PR.05.03 draft focused ideas using linguistic structures and textual features needed to clearly communicate information composing coherent, mechanically sound paragraphs when writing compositions.

W.PR.05.04 revise drafts based on constructive and specific oral and written response to writing by identifying sections of the piece to improve organization and flow of ideas (e.g., position/evidence organizational pattern, craft such as titles, leads, endings and powerful verbs).

W.PR.05.05 proofread and edit writing using grade-level checklists and other appropriate resources both individually and in groups.

W.SP.05.01 in the context of writing, correctly spell frequently encountered words (e.g., roots, inflections, prefixes, suffixes, multi-syllabic); for less frequently encountered words, use structural clues (e.g., letter/sound, rime, morphemic) and environmental sources (e.g., word walls, word lists, dictionaries, spell checkers).

- It is reasonable for students to use all these GLCEs when completing writing assignments intended to demonstrate knowledge and learning of the science material.

- Students concisely write a conclusion using their results and researched information of similar plant experiments from the one they designed. It may be beneficial to provide students with a simple rubric to follow when writing a conclusion.

Speaking

S.CN.05.01 use common grammatical structures correctly when speaking including irregular verbs to express more complex ideas.

S.CN.05.02 adjust their use of language to communicate effectively with a variety of audiences and for different purposes including research, explanation and persuasion.

S.CN.05.03 speak effectively using varying modulation, volume, and pace of speech to indicate emotions, create excitement, and emphasize meaning in narrative and informational presentations.

S.CN.05.04 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).

S.DS.05.01 engage in interactive, extended discourse to socially construct meaning in book clubs, literature circles, partnerships, or other conversations protocols.

- Students are expected to engage in cooperative or social learning during activities that are directed in pairs or small groups.

- Students need to appropriately and effectively present information orally to classmates.

Instructional Examples

Evolution - Species Adaptation and Survival: L.EV.05.11, L.EV.05.12, L.EV.05.13, L.EV.05.14

Objectives

- To identify behavioral and physical traits allowing organisms to survive better in particular environments.
- To determine how these characteristics have changed over time through analyzing catastrophic events and fossils.

Engage and Explore

- In cooperative learning groups, students identify unique physical and behavioral characteristics they have that allow them to survive. They create a visual representation of their ideas. For example, they may draw a person and label characteristics while giving an explanation of how the characteristic allows them to survive. (L.EV.05.11, L.EV.05.12, S.IP.05.11)
- Explore how organisms better suited for a specific environment survive better. For example, camouflage is a characteristic that allows some organisms to survive better in some environments. Place students in groups of 3-4. Set up containers for each group containing 25 squares of one color construction paper and 25 squares of another color. The container should be lined with one of the colors, allowing one set of 25 to be camouflaged. The students will act as predators and have a limited amount of time (10-15 seconds) to find prey. The container should be located at least an arms length distance away from each student so he has to move to obtain the prey. The students will take turns until 6-8 trials are completed. (Upon completion of the trials, they should be able to determine that animals possessing camouflage have a better chance of survival). Students can then integrate math by making graphical representations and interpreting the mean of the class data (see math integrations below). Be sure to ask students to extend their thinking to include other factors (behavioral and physical characteristics and environmental) that would allow some organisms to survive better. (L.EV.05.11, L.EV.05.12, S.IP.05.12, S.IP.05.13, S.IP.05.15, S.IP.05.16, S.IA.05.11, S.IA.05.14, S.RS.05.11, S.RS.05.13, S.RS.05.15)
- Set up a classroom habitat with plants and animals for students to observe over a period of time. Students make purposeful observations of the behavioral and physical traits and how they help the organisms to survive in the model habitat. Students do further research on the classroom habitats to make connections between what they are observing

in the model habitat and how the animals and plants survive in their natural habitats. (L.EV.05.11, L.EV.05.12, S.IP.05.11, S.IP.05.12, S.IP.05.15, S.IA.05.11, S.IA.05.12, S.IA.05.12, S.IA.05.15)
- Design an investigation to try to teach the animals a "learned" behavior, such as ringing a bell, making a noise, or changing the lighting, before placing food in the habitat. (L.EV.05.11, L.EV.05.12, S.IP.05.12, S.IP.05.13, S.IA.05.12, S.IA.05.13)

Explain and Define

- Students work collaboratively, with a variety of animals (pictures/images or plastic pieces) to identify their unique behavioral and physical characteristics that allow them to survive in their particular environment. (L.EV.05.11, L.EV.05.12, S.IP.05.13)
- Students choose an animal to research and gather information about the behavioral characteristics and physical characteristics of the animal that helps it to survive in its environment. Students use multiple sources of information, organize and present the information to others. (L.EV.05.11, L.EV.05.12,

Elaborate and Apply

- Students design an imaginary organism with specific behavioral and physical characteristics allowing it to survive in a chosen environment. A written description of the characteristics must be included in the diagram or illustration. (L.EV.05.11, L.EV.05.12, S.RS.05.15)
- Students (individually, in pairs or small groups) research a particular organism, chosen by student or by teacher, and the organisms' history to explain characteristic changes over time. Directions lead students to investigate changes in the organism's fossils over time and other catastrophic events that may have caused these characteristics to change. Students then give short oral presentations while others take notes. Teacher should provide a rubric to help evaluate student research. (L.EV.05.11, L.EV.05.12, L.EV.05.13, L.EV.05.14, S.IP.05.13, S.IP.05.16, S.IA.05.12, S.IA.05.15)

Evaluate Student Understanding

Formative Assessment Examples
- Evaluate student diagrams/illustrations depicting characteristics allowing survival in particular environments. (L.EV.05.11, L.EV.05.12)
- Evaluate student research and presentations of organisms' changes over time. (L.EV.05.11, L.EV.05.12, L.EV.05.13, L.EV.05.14)
- Evaluate students' ability to identify characteristics allowing organisms to survive in their environment. (L.EV.05.11, L.EV.05.12)

Summative Assessment Examples

- Choose an organism to have students identify the behavioral and physical characteristics that allow it to survive in its particular environment. (L.EV.05.11, L.EV.05.12)
- Students analyze fossil evidence to determine how environmental conditions changed over time. (L.EV.05.13, L.EV.05.14)

Enrichment

- Allow student to research environmental factors that affect populations. The student can choose to investigate a particular environmental factor (change in temperature, deforestation, etc.) or a catastrophic event (volcanic eruption, tsunami, etc). The student or teacher can choose the method of completion for the activity (essay, poster, etc.).

Intervention

- Give students a short article with information (or computer information) on two different organisms. They read the article or information (you may choose to read aloud) then together list the features the organisms have. After, discuss how the features may be helpful for the organisms in their particular environment. Allow students to practice more with two different organisms.

Examples, Observations, and Phenomena (Real World Context)

Variation in the appearance of plants and animals of the same species may be caused by both differences in nutrition, disease, or other environmental factors and by differences in inherited genetic traits. Students generally recognize variations very easily within their own species but cannot always distinguish environmental from genetically influenced traits. In situations where genetically identical twins were raised in environments with different nutrition and exposure to diseases and other environmental factors, they displayed greater differences in appearances as adults than twins raised in the same environment.

Students can observe variations in nature. Some plants receive more sunlight, due to either competition or an object obstructing the light, than others therefore growing taller. Some may become infested with parasites limiting their growth and survival. After discussing human variation, it may be easier for students to understand variation among plants of the same species.

The case of the peppered moth shows how pollution caused by the industrial revolution caused population changes. The darker moths were able to survive better and pass on their traits living in the more polluted forest while the lighter colored moths survived better in the unpolluted forests.

Evolution at this grade level refers to behavioral and physical characteristics that allow animals to survive better in a particular environment as well as how these characteristics may have changed over time.

Students may observe characteristics of animals as they view them in different habitats in a zoo. For example, zookeepers provide specific conditions for penguins, such as cool temperatures, clean air, a large swimming area and fish for food. Penguins have characteristics that require these conditions for their healthy survival.

Literacy Integration

Students will…

Reading

R.WS.05.04 know the meaning of words encountered frequently in grade-level reading and oral language contexts.

R.CM.05.02 retell through concise summarization grade-level narrative and informational text.

R.CM.05.03 analyze global themes, universal truths, and principles within and across text to create a deeper understanding by drawing conclusions, making inferences, and synthesizing.

R.CM.05.04 apply significant knowledge from grade-level science, social studies and mathematics texts.

- In addition to instructional examples given, students need to read concepts in textbooks and other appropriate texts. They are expected to know vocabulary pertinent to the unit.
- Students should incorporate information read in texts with that learned while engaged in activities.

Writing

W.GN.05.04 use the writing process to produce and present a research project; use a variety of resources to gather and organize relevant information into central ideas and supporting details for a teacher-approved narrowed focus question and hypothesis.

W.PR.05.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.05.02 apply a variety of pre-writing strategies for both narrative and informational writing (e.g., graphic organizers such as maps, webs, Venn diagrams) in order to generate sequence, and structure ideas (e.g., role and relationships of characters, settings, ideas, relationship of theory/evidence, or compare/contrast).

W.PR.05.03 draft focused ideas using linguistic structures and textual features needed to clearly communicate information composing coherent, mechanically sound paragraphs when writing compositions.

W.PR.05.04 revise drafts based on constructive and specific oral and written response to writing by identifying sections of the piece to improve organization and flow of ideas (e.g., position/evidence organizational pattern, craft such as titles, leads, endings and powerful verbs).

W.PR.05.05 proofread and edit writing using grade-level checklists and other appropriate resources both individually and in groups.

W.SP.05.01 in the context of writing, correctly spell frequently encountered words (e.g., roots, inflections, prefixes, suffixes, multi-syllabic); for less frequently encountered words, use structural clues (e.g., letter/sound, rime, morphemic) and environmental sources (e.g., word walls, word lists, dictionaries, spell checkers).

- It is reasonable for students to use these GLCEs when completing all writing assignments provided in the instructional examples.

Speaking

S.CN.05.01 use common grammatical structures correctly when speaking including irregular verbs to express more complex ideas.

S.CN.05.02 adjust their use of language to communicate effectively with a variety of audiences and for different purposes including research, explanation and persuasion.

S.CN.05.03 speak effectively using varying modulation, volume, and pace of speech to indicate emotions, create excitement, and emphasize meaning in narrative and informational presentations.

S.CN.05.04 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.)

S.DS.05.01 engage in interactive, extended discourse to socially construct meaning in book clubs, literature circles, partnerships, or other conversations protocols.

- Students are expected to engage in cooperative or social learning during activities that are directed in pairs or small groups.
- Students need to appropriately and effectively present information orally to classmates.

Mathematics Integration

D.AN.05.03 Given a set of data, find and interpret the mean and mode.

D.RE.05.01 Read and interpret line graphs, and solve problems based on line graphs, e.g., distance –time graphs, and problems with two or three line graphs on same axes, comparing different data

- Students will interpret the data from the engage and explore activity associated with species adaptation and survival.
- Students analyze line graphs representing population changes among species over time. They can compare this graph to one depicting catastrophic events or other environmental changes to interpret any connection.

Instructional Examples

Evolution - Relationships Among Organisms: L.EV.05.21

Objective

- Relate anatomical features to classification of organisms.

Engage and Explore

- In pairs, students place a variety of vertebrates (pictures or plastic pieces) into groups based on similar characteristics. They should be able to give a title to each group and defend their choice. (L.EV.05.21, S.IP.05.11)

Explain and Define

- Discuss with students how these characteristics (from above) have to be universally recognized. For example, students may place organisms into groups based on color. This would not be a good characteristic to use, as species may vary in color. Instead, other characteristics like body covering or if they have a backbone are used. Students devise a list of appropriate characteristics to use by scientists when discussing anatomical features when classifying organisms. (L.EV.05.21, S.IA.05.12, S.RS.05.12)
- Research the work of Charles Linne and the early work of other scientists that began to classify organisms on the basis of physical characteristics. (L.EV.05.21, S.RS.05.19, S.IA.05.15)

Elaborate and Apply

- Students create Venn diagrams comparing and contrasting features of two different organisms. After completing the diagram, students infer the degree of relatedness of the two organisms. Students will follow the think, pair, and share model for discussion. (L.EV.05.21, S.IP.05.15, S.IP.05.16, S.IA.05.12, S.RS.05.11)
- Discuss and explore the advantages of classification of organisms by physical structures compared to behavioral characteristics. (L.EV.05.21)

Evaluate Student Understanding

Formative Assessment Examples

- Evaluate the list of appropriate characteristics to help scientists classify organisms. (L.EV.05.21)

- Evaluate students' completed Venn diagrams. (L.EV.05.21)

Summative Assessment Examples

- List organisms that would be placed into a similar group based on characteristics and have students determine the similarity. (L.EV.05.21)
- Give students different organisms to determine the degree of relatedness. (L.EV.05.21)

Enrichment

- Give students several animal skeletal pictures, such as a bat, whale, human, fish, cat, duck, etc. Students color the bones they believe to be similar in the pictures (some may not have any similarities). From there they can determine/infer the degree of relatedness based on similar skeletal structures.

Intervention

- Use a different type of organizer than a Venn diagram. For example, allow students to use a T-chart to compare organisms then infer relatedness.

Examples, Observations, and Phenomena (Real World Context)

Students may have noticed that the zoo animals are organized based on similar characteristics or relatedness. Such as primates are usually together as well as birds.

Students recognize similarities between themselves and primates.

Literacy Integration

Students will…

Reading

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Mathematics Integration

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D.RE.05.01 Read and interpret line graphs, and solve problems based on line graphs, e.g., distance –time graphs, and problems with two or three line graphs on same axes, comparing different data.

Fifth Grade GLCE Companion Document

Unit 4: Position and Motion of Objects in the Sky

SCIENCE

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

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Fifth Grade Companion Document
5-Unit 4: Position and Motion of Objects in the Sky

Table of Contents Page 1

5th Grade Unit 4:
Position and Motion of Objects in the Sky

Content Statements and Expectations

5 – Unit 4: Position and Motion of Objects in the Sky

Big Ideas (Key Concepts)

- The sun is the central and largest body in the solar system.
- The sun's warming of the Earth and tilt of the Earth on its axis has an important connection to the seasons.
- Earth's motion is the basis for measuring time.
- Objects in the sky move in regular and predictable patterns around the sun.
- The sun, stars and constellations appear to move in predictable patterns across the sky.
- Gravity is the force that keeps the planets in orbit around the sun and without it, planets would continue in a straight path.

Clarification of Content Expectations

Standard: Earth Systems

Content Statement – E.ES.M.6
Seasons – Seasons result from annual variations in the intensity of sunlight and length of day due to the tilt of the axis of the Earth relative to the plane of its yearly orbit around the sun.

Content Expectations

E.ES.05.61 Demonstrate and explain seasons using a model.

Instructional Clarifications

1. Demonstrate is to describe, explain, or illustrate by experiments, examples, or practical application the causes of the seasons on Earth.
2. The Earth has a 23.5 degree tilt to its axis.
3. The Earth revolves or orbits around the sun in an elliptical (but nearly circular) pattern.
4. The Earth's axis always points toward the North Star causing the North Pole to tilt toward the sun during a portion of its revolution around the sun and away from the sun during the rest of its revolution around the sun. When the northern hemisphere is tilted toward the sun, it receives more direct sunlight. When the southern hemisphere is pointed toward the sun, the northern hemisphere receives less direct sunlight. This causes winter in the northern hemisphere. Between summer and winter

are spring and fall; the daylight and nighttime hours are equal in length on the spring and fall equinox.
5. The intensity of sunlight on the Earth is related to the tilt of the axis of the Earth.
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 is experiencing fall and winter.
7. A common misconception is that the distance between the Earth and the sun causes the seasons.

Assessment Clarifications

1. The Earth is tilted on its axis.
2. The Earth revolves or orbits around the sun.
3. The Earth's axis always points toward the North Star causing the North Pole to tilt toward the sun during a portion of its revolution around the sun and away during a portion. When the northern hemisphere is tilted toward the sun, it receives longer periods of daylight and experiences summer. When the southern hemisphere is pointed toward the sun, the northern hemisphere receives shorter periods of daylight and experiences winter.
4. As the Earth moves along its flat orbit around the sun part of the Earth is more directly exposed to the sun due to the tilt. The angle at which the sun's rays strike each part of the Earth changes as the Earth moves through its orbit. When the North Pole is tilted toward the sun, the sun's rays strike the Northern Hemisphere more directly so it receives a higher concentration of solar energy and is warmer. This would be the summer season. The opposite would be true for winter.
5. Spring and fall occur between summer and winter when the day and nighttime hours of sunlight are nearly equal and the angle at which the sun's rays strike the Earth are in between summer and winter.

E.ES.05.62 Explain how the revolution of the Earth around the sun defines a year.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally how the revolution of the Earth around the sun defines a year.
2. The Earth revolves around the sun.
3. It takes 365.25 days or one year for the Earth to complete one revolution of the sun.
4. Every four years an extra day is added to the calendar to keep the calendar the same as Earth's movements. This is defined as leap year.

Assessment Clarification

1. It takes one year for the Earth to complete one revolution of the sun.

Standard: Earth in Space and Time

Content Statement – E.ST.M.1
Solar system – The sun is the central and largest body in our solar system. Earth is the third planet from the sun in a system that includes other planets and their moons, as well as smaller objects, such as asteroids and comets.

Content Expectation

E.ST.05.11 Design a model of the solar system that shows the relative distances and positions of the planets, dwarf planets, comets and asteroids to the sun.

Instructional Clarifications

1. Design means to make drawings, preliminary sketches, or plans of a model to describe the positions and distances of planets and other objects to the sun.
2. The sun is the largest body in our solar system.
3. The sun is at the center of our solar system.
4. Our solar system is made up of planets, dwarf planets, moons, asteroids and comets.
5. Planets, dwarf planets, plutoids, comets and asteroids orbit the sun. Moons orbit the planets.
6. There are currently eight planets and three or four* (depending on the source) identified plutoids and dwarf planets in our solar system. Dwarf planets and plutoids are smaller, orbit the sun, have enough mass and gravity to maintain their spherical shape, but do not have a clear/clean orbit, as do planets. Plutoids are located beyond Neptune. Dwarf planets are located within the asteroid belt between Mars and Jupiter. This demonstrates how science knowledge is changing and the information from scores of years ago is changed through further research and evidence.
7. The Earth is the third planet from the sun in our solar system. The planets have a specific location and path within the solar system. From the sun, the order of the planets is Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. All planets orbit the sun in a counterclockwise and elliptical (but nearly circular) path.
8. Asteroids are small rocky bodies that orbit the sun. Most asteroids orbit the sun in a belt located between Mars and Jupiter.
9. Comets are objects, which contain ice and dust. As they get closer to the sun, they develop a tail. Comets have highly elliptical orbits around the sun.
10. Students' models will be limited to comparing the position and motion of the different planets and other objects in our solar system with the sun being the largest and at the center.

Assessment Clarifications

1. Students' models will be limited to comparing the position and distances of the planets, dwarf planets, comets and asteroids with the sun being the largest and at the center.
2. There are currently eight planets and three* dwarf planets in our solar system. Pluto is located beyond Neptune. Eris, discovered in 2005 is located on the outer edge of the solar system. Ceres is a large asteroid located within the asteroid belt between Mars and Jupiter. (*This number will change, as more information is available.)
3. The Earth is the third planet from the sun in our solar system. The planets have a specific location and path within the solar system. From the sun, the order of the planets is Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. All planets orbit the sun in a counterclockwise and elliptical (but nearly circular) path.
4. Asteroids are small rocky bodies that orbit the sun. More than 100,000 asteroids orbit the sun in a belt located between Mars and Jupiter.
5. Comets are objects, which contain ice and dust. As they get closer to the sun, they develop a tail. Comets have highly elliptical orbits around the sun.

Standard: E.ST.M.2

Solar System Motion – Gravity is the force that keeps most objects in the solar system in regular and predictable motion.

Content Expectations

E.ST.05.21 Describe the motion of planets and moons in terms of rotation on axis and orbits due to gravity.

Instructional Clarifications

1. Describe means to tell or depict in spoken or written words the motion of planets and moons.
2. Planets in our solar system orbit the sun. Each planet has its own orbital period, which defines a year on each planet.
3. Planets rotate on their axes. Each planet has its own rotational period, which defines a day on each planet.
4. All objects exert a gravitational force on other objects. The strength of the force is related to the mass of the object and the distance between the objects.
5. Planets move in an elliptical (but nearly circular) orbit around the sun due to gravity between the sun and the planet.
6. Planets stay in their orbit and do not go out into space because gravity pulls the object into a curved path instead of flying off in a straight line.

7. Planets stay in a circular orbit and do not crash into the sun because they do not have enough speed to escape the sun's gravity but have enough speed to not be pulled in by the sun's gravity.
8. A moon is a natural satellite.
9. A natural satellite is a celestial body that orbits a larger body.
10. Six of the planets in our solar system have smaller bodies or moons that orbit them. All moons rotate on their axes but have different patterns of rotation.
11. Our moon is a natural satellite that orbits the Earth.
12. Technically, the Earth could be considered to be a moon of the sun.
13. The Earth's gravity keeps the moon in orbit and the sun's gravity keeps the planets orbiting around it.

Assessment Clarifications

1. Planets in our solar system orbit the sun. Each planet has its own orbital period, which defines a year on each planet.
2. Planets rotate on their axes. Each planet has its own rotational period, which defines a day on each planet.
3. Planets move in an orbit around the sun due to gravity between the sun and the planet.
4. Planets stay in an orbit and do not go out into space because gravity pulls the object into a curved path instead of flying off in a straight line.
5. A moon is a natural satellite.
6. A natural satellite is a celestial body that orbits a larger body.
7. Six of the planets in our solar system have smaller bodies or moons that orbit them. All moons rotate on their axes.
8. Our moon is a natural satellite that orbits the Earth.

E.ST.05.22 Explain the phases of the moon.

Instructional Clarifications

1. Explain means to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally how moon phases relate to the position of the moon in its orbit around the Earth.
2. The moon revolves around the Earth.
3. The moon rotates on its axis.
4. The moon only completes one rotation during each orbit around the Earth. The moon revolves once around the Earth in about 27.3 days or about one month. The moon's rotation and revolution equal approximately one month.
5. Because the rotation and revolution of the moon take the same amount of time, observers on Earth always see the same side of the moon.
6. The moon reflects light from the sun and that amount is constant. The sun always lights half of the moon.
7. The light we see when we look at the moon depends on the moon's location in its orbit. From Earth, people see only the portions lit by the sun that are facing Earth.
8. The different portions of the lit half facing the Earth as the moon revolves around the Earth cause the apparent change in the moon's shape.

9. Moon phases follow a predictable pattern each month: new moon, waxing crescent, first quarter, waxing gibbous, full moon, waning gibbous, third-quarter, and waning crescent.
10. A common misconception is that the moon is only visible at night. The moon's rise has an approximate one-hour difference each day. The moon rises in the daytime and appears to move across the daytime sky.

Assessment Clarifications

1. The moon revolves around the Earth.
2. The moon rotates on its axis.
3. The moon only completes one rotation during each orbit around the Earth. The moon revolves once around the Earth in about one month. Thus, the moon's rotation and revolution equal approximately one month.
4. Because the rotation and revolution of the moon take the same amount of time, observers on Earth always see the same side of the moon.
5. The moon reflects light from the sun. The sun always lights half of the moon.
6. The revolution of the moon around the Earth makes the moon appear as if it is changing shape in the sky.
7. The different portions of the lit half facing the Earth as the moon revolves around the Earth cause this apparent change in the moon's shape.

E.ST.05.23 Explain the apparent motion of the stars (constellations) and the sun across the sky.

Instructional Clarifications

1. Recognize is to identify or perceive that nighttime objects and the sun appear to move across the sky.
2. The Earth rotates in a counterclockwise direction (west to east).
3. Because of the Earth's rotation, the moon and the sun appear to move across the sky in a regular pattern. They seem to rise in the east, move across the sky and set in the west.
4. Constellations are composed of stars.
5. The movement of the Earth as it turns on its axis makes the constellations appear to move through the sky. In the northern hemisphere all of the constellations seem to move around a point that is directly above the Earth's North Pole. A star located directly above the North Pole (Polaris) does not seem to move. In the southern hemisphere, all constellations appear to move around a point directly above the South Pole.
6. Because the Earth is in different positions as it revolves around the sun, different constellations are seen at different times of the year and in different positions. People living in the northern or southern hemisphere see different constellations.

Assessment Clarifications

1. The Earth rotates in a counterclockwise direction (west to east).
2. Because of the Earth's rotation, the moon and the sun appear to move across the sky in a regular pattern. They seem to rise in the east, move across the sky and set in the west.

3. The movement of the Earth as it turns on its axis makes the constellations appear to move through the sky. In the northern hemisphere all of the constellations seem to move around a point that is directly above the Earth's North Pole. A star located directly above the North Pole (Polaris) would not seem to move. In the southern hemisphere, all constellations appear to move around a point directly above the South Pole.
4. Because the Earth is in different positions as it revolves around the sun, different constellations are seen at different times of the year and in different positions. People living in the northern or southern hemisphere see different constellations.

E.ST.05.24 Explain lunar and solar eclipses.

Instructional Clarifications

1. Explain means to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally how lunar and solar eclipses are based on the relative positions of the Earth, moon and sun, and the orbit of the moon.
2. A lunar eclipse occurs when the sun, Earth and moon are aligned with the Earth in the middle. The moon then passes through the Earth's shadow. The moon is not able to reflect the sun's light because the light is blocked. The Earth's shadow falls on the moon. An eclipse of the moon occurs only when there is a full moon, when the Earth is between the moon and the sun.
3. A total lunar eclipse is rare because the tilt of the moon's orbit reduces the chance that the sun, Earth and moon will align in the same plane.
4. A solar eclipse occurs when the moon passes between the sun and the Earth so that the sun's light is blocked. A solar eclipse happens only when there is a new moon. The moon's shadow falls on the Earth.
5. A solar eclipse does **not** happen every month because the moon's orbit is tilted about 5 degrees. The moon usually passes between the Earth and the sun either too high or too low for its shadow to fall on the Earth.

Assessment Clarifications

1. A lunar eclipse occurs when the sun, Earth and moon are aligned with the Earth in the middle. The moon then passes through the Earth's shadow. The moon is not able to reflect the sun's light because the light is blocked. The Earth's shadow falls on the moon. An eclipse of the moon occurs only when there is a full moon, when the Earth is between the moon and the sun.
2. A solar eclipse occurs when the moon passes between the sun and the Earth so that the sun's light is blocked. A solar eclipse happens only when there is a new moon. The moon's shadow falls on the Earth.
3. An eclipse does not happen each month because the moon's orbit is tilted a little above or below the Earth's orbit.

E.ST.05.25 Explain the tides of the oceans as they relate to the gravitational pull and orbit of the moon.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally how tides are related to gravitational pull and the orbit of the moon.
2. A tide is the rise and fall of the ocean's surface caused mainly by the moon's gravitational pull on Earth.
3. The Earth has a gravitational pull on the moon and the moon has a gravitational pull on the Earth. Because the Earth is more massive, it has a greater pull of gravity that keeps the moon revolving around the Earth. The moon's weaker gravitational pull affects the Earth by causing tides.
4. The moon's pull of gravity on the side of the Earth facing the moon makes the easily movable waters of the oceans on that side bulge out toward the moon. This bulge is called a high tide. At the same time, another high tide is formed on the opposite side because this is the furthest point from the moon where gravitational pull is the weakest on the Earth. The water that is drawn in to make the bulge at these two points comes from the remaining water at the opposite points on Earth. These lower levels are called low tides.
5. Because of the Earth's rotation every 24 hours, the Earth has two high tides and two low tides every 24 hours at different points on Earth. Every point on Earth experiences two high tides and two low tides every 24 hours.
6. Because the moon rises about 50 minutes later each day, high tide and low tide change times each day.

Assessment Clarifications

1. A tide is the rise and fall of the ocean's surface caused mainly by the moon's gravitational pull on Earth.
2. The Earth has a gravitational pull on the moon and the moon has a gravitational pull on the Earth. Because the Earth is more massive, it has a greater pull of gravity that keeps the moon revolving around the Earth. The moon's weaker gravitational pull affects the Earth by causing tides.
3. The moon's pull of gravity on the side of the Earth facing the moon makes the easily movable waters of the oceans on that side bulge out toward the moon. This bulge is called a high tide. At the same time, another high tide is formed on the opposite side because this is the furthest point from the moon where gravitational pull is the weakest on the Earth. The water that is drawn in to make the bulge at these two points comes from the remaining water at the opposite points on Earth. These lower levels are called low tides.
4. Because of the Earth's rotation every 24 hours, the Earth has two high tides and two low tides every 24 hours at different points on Earth.
5. Because the moon rises about 50 minutes later each day, the high tide and low tide times change each day.

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

Inquiry Process
S.IP.05.11 Generate scientific questions based on observations, investigations, and research concerning the position and motion of objects in the sky.
S.IP.05.13 Use tools and equipment (models) appropriate to scientific investigations for the position and motion of objects in the sky.
S.IP.05.15 Construct charts and graphs from data and observations dealing with the position and motion of objects in the sky.
S.IP.05.16 Identify patterns in data dealing with the position and motion of objects in the sky.
Inquiry Analysis and Communication
S.IA.05.12 Evaluate data, claims, and personal knowledge through collaborative science discourse about the position and motion of objects in the sky.
S.IA.05.13 Communicate and defend findings of observations and investigations about the position and motion of objects in the sky using evidence.
S.IA.05.15 Use multiple sources of information on the position and motion of objects in the sky to evaluate strengths and weaknesses of claims, arguments, or data.
Reflection and Social Implications
S.RS.05.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding the reasons for the position and motion of objects in the sky.
S.RS.05.13 Identify the need for evidence in making scientific decisions about the position and motion of objects in the sky.
S.RS.05.15 Demonstrate scientific concepts concerning the position and motion of objects in the sky through various illustrations, performances, models, exhibits, and activities.

Vocabulary

Critically Important – State Assessable	Instructionally Useful
seasons tilt axis revolution rotation solar system planet dwarf planet asteroids comets gravity gravitational pull phases stars constellations lunar solar eclipse tides	latitude model circular elliptical apparent motion satellite celestial North Star Mars Venus Earth Neptune Uranus Saturn Mercury Jupiter

Instruments, Measurements, Representations

models		
thermometers	temperature	degrees Celsius
rulers, meter sticks	distance	centimeters, meters

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

Earth Systems

Seasons: E.ES.05.61, E.ES.05.62

Objectives

- Demonstrate how seasons are caused by variations in the intensity of sunlight due to the tilt of the Earth on its axis and its revolution around the sun.
- Understand how the angle at which sunlight hits the Earth's surface produces a variation in temperatures or concentration of solar energy.
- Illustrate how the Earth's axis is tilted toward the North Star (Polaris) as it revolves around the sun.
- Explain that a year is defined as one complete revolution (orbit) around the sun.

Engage and Explore

- Display pictures of the four seasons. Discuss the characteristics of each season. What is the students' favorite season? Have any students lived in a location with fewer than four seasons? As a pre-assessment, individually or in collaborative groups, instruct students to draw a picture to explain the cause of the seasons in their journals. Share ideas. Record questions that may have been generated during the class discussion. (E.ES.05.61, S.IP.05.11)
- Demonstrate the seasons using activities and discussions. Materials needed: a globe that rotates around a tilted axis, small table lamp, small nail with a large head, and tape. Place a sign on the floor labeled north. Identify north using a compass for accuracy. Place the lamp (without its shade) in the middle of the floor. The lamp represents the sun. Find the

location of the school on the globe and tape the nail, head side down, on the location. Place the globe on the ground, about 1.5 m away from the lamp, on the side opposite north. The light bulb should be the same height as the middle of the globe. Darken the room. The globe should tilt toward north. This is summer position for the northern hemisphere. Center the nail in the light from the lamp. As a class, discuss the appearance of the nail's shadow. Measure and record the length of the shadow. Rotate the globe; one rotation represents one day (24 hours). Notice during part of the rotation the nail is in the light (daylight hours) and during part of the rotation it is in the dark (night). Move the globe counter clockwise a quarter "revolution" around the lamp. This is fall. Make sure the globe is tilted toward north. Repeat observations as the globe continues in its orbit around the lamp (winter and spring). Record observations and data of the length of the nail's shadow and the amount of daylight during each season in student journals. (E.ES.05.61, E.ES.05.62, S.IP.05.11, S.IP.05.15, S.IA.05.12, S.RS.05.15)

- Make a class chart, summarizing observations. Using the data, discuss observations. During which season is the shadow of the nail the shortest? The longest? Explain that a short shadow indicates strong, direct sunlight. A long shadow indicates weaker sunlight at an angle. During which season is the nail in the sunlight the longest when you rotate the globe? During which season(s) do you get about the same amount of sunlight and darkness? In general, the more sunlight at a direct angle creates a warmer day. Identify one complete revolution of the globe (Earth) around the lamp (sun) as a year. Record questions generated during class discussions. Hint: If four globes are available, all four can be set up and used at the same time with four groups of students making observations and rotating after a few minutes. The best place to observe the amount of daylight and darkness is just above the globe's North Pole. (E.ES.05.61, E.ES.05.62, S.IP.05.11, S.IP.05.15, S.IA.05.12, S.RS.05.15)
- As students explore the concepts of direct sunlight and sunlight at an angle, they construct charts and share in discussions to defend their observations. (Using the term "indirect" instead of slanted may create misconceptions.) Give each group of students a flashlight with a length of cardboard tube taped to the end. On a piece of paper, shine the flashlight tube at a 90-degree angle (perpendicular) to the paper. Trace the lighted shape. Tilt the flashlight tube to a 45-degree angle. Observe and trace the lighted shape. Continue to explore different angles and the shapes of the lighted area. The amount of light coming through the tube is constant, just as the light coming from the sun is constant. What happens to the amount of light at different angles on the paper? Which condition is closest to summertime? Winter? Discuss and draw conclusions in groups. Record ideas in student journals. (E.ES.05.61, S.IA.05.12)
- Students explore the differences in the temperature of direct and slanted sunlight and draw conclusions from multiple sets of data. Give each group of students, two matched thermometers, (be sure to check that they are the same at room temperature) and two pieces of the same

sized pieces of cardboard. Cover each piece of cardboard with black paper. Staple a pocket from black paper for the thermometer on each piece of cardboard so that the top of the thermometer is near the end of the cardboard and the bulb is inside the pocket. On a sunny day, lay one thermometer flat in the sun (i.e., on a windowsill). It will receive sunlight at an angle. Prop the other thermometer on some books next to the first thermometer so that the sun strikes it directly. Hint: Students can tape a nail head on the cardboard and lift the cardboard to an angle until the nail no longer makes a shadow. This indicates direct rays of the sun. Students record the temperatures on each thermometer every minute. Which thermometer has the higher temperatures? What does this indicate about direct sunlight and slanted sunlight (sunlight at an angle)? Record observations and conclusions in student journals. Caution: do not allow the temperature in the thermometer to rise too high. Note: If a sunny day is not available, a 100-watt or higher bulb can be used. (E.ES.05.61, S.IP.05.11, S.IP.05.13, S.IA.05.14)

Explain and Define

- Students share and discuss their findings from their investigations into temperature from direct and indirect light.
- The difference between rotation and revolution is reviewed and clarified.
- Students create classroom definitions and illustrations for rotation, revolution, axis, orbit, direct sunlight, slanted sunlight or sunlight at an angle.
- Students develop charts and illustrations to describe the causes of seasons.

Elaborate and Apply

- In cooperative groups, students develop a model to show that the seasons are the result of variations in the intensity of sunlight caused by the tilt of the Earth on its axis. They further develop their model to include how the Earth's yearly revolution around the sun affects seasonal changes. (E.ES.05.61, E.ES.05.62, S.RS.05.15)
- Using their models, challenge students to explain questions such as: "During June in the Northern Hemisphere, the days are long and the nights are short. Why do the days become longer as you move north? Is there a place where the sun does not set at all? Using your model, demonstrate your answer." (E.ES.05.61, E.ES.05.62)
- Throughout the school year, record sunrise and sunset weekly and make observations of the angle of sunlight based on a reference point. At the end of the school year, consolidate data and draw conclusions about the hours of sunlight within the different seasons. Relate conclusions to the intensity of sunlight, hours of sunlight and time of year and what they have learned about the seasons. (E.ES.05.61)

Evaluate Student Understanding

Formative Assessment Examples

- Write vocabulary words and illustrations on cards with definitions on the back. (E.ES.05.61, E.ES.05.61)
- Record observations, data and conclusions in student journals. (E.ES.05.61)
- Participate in cooperative group activities and discussions. (E.ES.05.61)

Summative Assessment Examples

- Draw conclusions to the reason for seasons based on evidence obtained during activities and research. Write an essay to explain the reason for seasons based on evidence. (E.ES.05.61, E.ES.05.62)
- Create a model that explains the reason for seasons. (E.ES.05.61, E.ES.05.62)
- Create a storybook for fourth grade students that explains the seasons. (E.ES.05.61, E.ES.05.62)

Enrichment

- Explore how various cultures celebrate the seasons.
- Explore how early Native Americans explained day and nighttime observations.
- Introduce students to real-life females and minority scientists who are involved in aerospace or astronomy.
- Visit a planetarium to further students' understanding of the seasons.
- Respond to the statement, "The northern hemisphere tilts toward the sun in the summer and tilts away from the sun in the winter."
- Investigate Daylight Savings Time.
- Investigate how the Earth's movements define time.
- Make a sundial and place it outside and compare the length and position of the shadow through the seasons and during the time change from and to Daylight Savings Time.

Intervention

- Pair students with responsible partners to assist with activities, explanations, and conclusions.
- Repeat the globe/light activity several times.
- View video clips to reinforce concepts.
- Act out the concepts taught regarding the seasons through skits and songs.
- Read non-fiction books to support concepts.

Examples, Observations, Phenomena (Real World Context)

Many naïve ideas are perpetuated through observations and assumptions about the day and night sky. It is important that students become aware of misinformation in their everyday lives. Find examples to share with the class. Discuss why pictures or models can be incorrect or misleading. For example, in many of the illustrations regarding the seasons, the sun is nearly the same size as the Earth and its distance is very close to the Earth. It isn't possible to draw the sun and Earth in their correct relative sizes and distances. It is important to point these examples out to students.

Students are familiar with the seasons and seasonal changes. They observe the daylight hours getting longer or shorter, the temperature changes associated with the seasons, the height of the sun in the sky during summer and winter, and animal and foliage behavior during the seasons.

Seasons can be related to the need for alternative energy sources and the impact that the seasons have on our natural resources.

Relate global warming concerns and issues to evidence of climate and seasonal changes.

Literacy Integration

Reading

R.WS.05.04 know the meanings of words encountered frequently in grade-level reading and oral language contexts.

R.IT.05.02 identify and describe informational text patterns including compare/contrast, cause/effect, and problem/solution.

R.CM.05.02 retell through concise summarization grade-level narrative and informational text.

R.CM.05.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Examples of trade books available for learning about seasons are:

Weather and Climate by Barbara Taylor, 2002
The Four Seasons by Annie Jones, 2006
The Complete Book of Seasons by Sally Tagholm, 2002

Writing

W.GN.05.03 write a position piece that demonstrates understanding of central ideas and supporting details (e.g., position/evidence organizational pattern) using multiple headings and subheadings.

- Write a paper regarding the causes of seasons using supporting details gained from activities and investigation.

Speaking

WS.DS.05.01 engage in interactive, extended discourse to socially construct meaning in book clubs, literature circles, partnerships, or other conversation protocols.

Instructional Examples

Earth in Space and Time

Solar System: E.ST.05.11, E.ST.05.21, E.ST.05.22, E.ST.05.23, E.ST.05.24, E.ST.05.25

Objectives

- Describe the position and motion of planets, dwarf planets, comets, and asteroids as they orbit the sun.
- Describe the motion of planets and moons within the solar system.
- Explain moon phases.
- Explain the apparent motion of the stars (constellations) and the sun across the sky.
- Explain lunar and solar eclipses.
- Explain how the gravitational pull and the orbit of the moon affect ocean tides.

Engage and Explore

Note: Students have difficulty comprehending how vast space really is, and how large the planets and our moon are compared with everyday objects. In order for students to gain an understanding of visible objects in the sky, it helps to begin with activities that introduce scale. The first exploration is a review and extension of concepts (sun, moon, Earth model) introduced in fourth grade but provides an important foundation for learning new concepts.

- Divide students into groups of three or four. Give each group a ball of clay (each group receives a different amount of clay). Instruct students to divide the ball into fifty equal-sized balls. Students will then choose one average-sized ball. Tell them to combine the other 49 pieces into one large ball. Challenge them to determine what their model represents. Explain that although each group's model contains different-sized objects, each model is to scale (49:1). (E.ST.05.11, S.IP.05.13, S.IP.05.16, S.RS.05.15)
- The students have constructed a model of the Earth and its moon. Our moon is closest object in the sky. Next, ask students to predict the ratio of the Earth's diameter to that of the moon. Through collaboration, students discover that the Earth's diameter is roughly four times that of the moon. (3.7:1). Each group should calculate the same ratio. (E.ST.05.11, S.IP.05.13, S.IP.05.16, S.RS.05.15)
- Finally, challenge students to estimate how far apart the moon and Earth should be in their scale model system. Each group should arrive at consensus, set up their Earth-moon system and measure the distances.

Record all measured distances. Assure students that each group will have its own correct answer based on the scale used. The correct answer is that the distance between the Earth and moon is approximately thirty times the Earth's diameter. Students will calculate how close their prediction was to the actual distance. (The next closest object in space is Venus, which is 3000 Earth diameters away.) (E.ST.05.11, S.IP.05.13, S.IP.05.16, S.RS.05.15)

- Students use tools and equipment (models) to investigate the position and motion of objects in the sky. As students begin to formulate ideas about the enormous distances and sizes of objects in space, they investigate a scale of the solar system. It is difficult to place both the planetary sizes and distances within one scale model because of the enormity of distances compared to miniscule size of the planets. One model, however, "The Thousand Yard Model" or "Earth as a Peppercorn" is one that can be easily introduced to students. (Remember that most scale models still contain Pluto as a planet, so the activity will need adjustment.) (E.ST.05.11, S.IP.05.13, S.IP.05.16, S.IA.05.12)
- Gather necessary "planets;" Sun (any ball 8" in diameter), Mercury (a pinhead through a piece of paper), Venus (a peppercorn), Earth (a peppercorn 0.08 inch diameter), Mars (a second pinhead), Jupiter (a chestnut or pecan 0.90 inch diameter), Saturn (a hazelnut or acorn, 0.70 inch diameter), Uranus (peanut or coffee bean, 0.30 inch diameter), Neptune (second peanut or coffee bean). Using common objects helps students remember. (E.ST.05.11, S.IP.05.13, S.IP.05.16, S.IA.05.12)
- Challenge students to predict which object represents which planet/sun and the order from the sun. After sharing the correct order and size, ask "How much space will be needed to create the solar system to scale?" Accept and record all answers. Give a clue: The Earth is eight thousand miles wide and the peppercorn is 0.08 of an inch. The sun is 800,000 miles wide. In this model, one inch equals a hundred thousand miles. That means that one-yard equals 3,600,000 miles! The distance between the sun and the Earth is 93 million miles or 26 yards in this model. Through discussion and initial research of planetary distances, students develop a solar system model. They construct charts from data and identify patterns of solar system objects. Students will evaluate their claims and models through collaborative discourse. (E.ST.05.11, S.IP.05.13, S.IP.05.16, S.IA.05.12)
- After determining their best model, students share their solar system models outside. After the group presentations, the teacher presents the "peppercorn" scale. (Approximately a thousand yards is needed to complete the model.) Practice pacing so that one pace (two steps) equals one yard. Give "planets" to students. Place the sun down and march away as follows: 10 paces for Mercury, another 9 paces for Venus, another 7 paces for Earth, (26 paces total), another 9 paces to Mars, another 95 paces to Jupiter, another 112 paces to Saturn, another 249 paces to Uranus, another 281 paces to Neptune (Pluto would be another 242 paces beyond Neptune). Students will have marched more than one half mile. The total distance is 1,019 paces. A mile is 1760 yards. (This

scale is accurate in size and distance.) (E.ST.05.11, S.IP.05.13, S.IP.05.16, S.IA.05.12)

- Distribute cards with sun and the names of the planets written on them to nine students. Give additional students cards with planetary objects written on them: Pluto (dwarf planet), Ceres (dwarf planet), Eris (dwarf planet), 5-6 students receive asteroid cards and 4-5 students receive comet cards. Go outside. Planets line up in order from the sun. Students estimate the distances based on prior knowledge. (The distances used in this activity are smaller but to scale. This activity does not compare size and distance.) The teacher provides the following distances: Mercury is 4 paces from the sun, Venus is 7 paces from the sun, Earth is 10 paces from the sun, Mars is 15 paces, Jupiter is 52 paces, Saturn is 95 paces, Uranus is 191 paces, Neptune is 301 paces. Using sticks, mark each planet's position. Students with dwarf planet cards and asteroid cards take their position within the solar system. Students with comet cards can take a position anywhere within or outside the solar system. Several students will run at a constant speed from the sun to Eris. (E.ST.05.11, S.IP.05.11, S.IP.05.16, S.IA.05.13, S.RS.05.15)
- Discuss the distances between planets and the time it takes to travel between the planets. Notice how close the inner planets are to one another. (E.ST.05.11, S.IP.05.11, S.IP.05.16, S.IA.05.13, S.RS.05.15)
- Instruct all students to begin orbiting the sun in a counter clockwise direction at the same pace. They may also rotate on their axis. (Real orbits aren't exactly circular.) The comets will orbit in a highly elliptical pattern. Why do some orbits take longer? Additional students can participate as moons. Moons orbit their planets (only Mercury and Venus do not have moons) and spin on their axis. Adjustments can be made to regulate the speed of the planets' revolution (i.e., Jupiter should take 12 times as long to revolve as the Earth – Jupiter year vs. Earth year) but observing the effect of distances and position is the purpose of this activity. (E.ST.05.11, S.IP.05.11, S.IP.05.16, S.IA.05.13, S.RS.05.15)
- They should realize, however, that planets do not orbit at the same speed. Students summarize their learning by creating illustrations to demonstrate the position and motion of space objects around the sun. (E.ST.05.11, S.IP.05.11, S.IP.05.16, S.IA.05.13, S.RS.05.15)
- Students identify patterns in information and data regarding the motion of planets and moons in terms of rotation and orbits. Students create charts of the planetary days (rotation) and years (revolution). They compare data and evaluate the strengths and weaknesses of data and previous activities regarding position and motion of solar system objects. (E.ST.05.21, S.IP.05.16, S.IP.05.15, S.IA.05.15)

Explain and Define

- After completing preliminary activities, challenge the students to consider, "How do planets and moons stay up there?" Allow students time to research and conclude that there is connection between gravitational force and orbital motion. Students participate in an activity to

demonstrate the gravitational force that makes objects go in a circular path. Thread a string through a rubber ball; tie a knot on the outside of the ball. Thread the other end of the string through a straw and tie a roll of tape to that end. Hold the straw and swing the ball at a constant speed in a circle so that it orbits the straw. The string represents the force preventing the ball from flying off. Pull on the roll of tape to simulate a shorter orbit. Discuss what would happen if gravity did not exist or if the string is cut. Students develop and test a hypothesis about the relationship between the length of a planet's year and its distance from the sun using different ball/string combinations. (E.ST.05.21, S.RS.05.13)

- Students demonstrate their understanding of the position of the planets, dwarf planets, asteroids and comets through illustrations and written explanations. (E.ST.05.11, S.RS.05.15)
- Students create operational definitions of the gravitational force that keeps planets and moons in an orbital path. (E.ST.05.21)

Elaborate and Apply

- In fourth grade, students investigated the predictable cycle of the moon. In fifth grade, students build on their understanding of moon phases. They explore the position and motion of objects in the sky and study how they relate to moon phases. Students generate questions about moon phases based on nightly observations of the moon over several months. A moon calendar can be started in the fall so data is available during the solar system unit. (E.ST.05.22, S.IP.05.11, S.IP.05.15)
- Students use tools and equipment to create a model to visualize, demonstrate and explain moon phases. Equipment: Styrofoam ball on a craft stick painted half black (vertical) per student to represent the moon, a bright light bulb to represent the sun, and students' heads to represent the Earth. Hold the moon ball in the left hand with an outstretched arm. The white side of the ball is always facing the student. (The black side is the side of the moon that we never view from Earth.) Ask, "How much of the ball do you see at one time?" (Half) Darken the room. Turn on the bright light and look at the ball from several angles. Is any part of the ball illuminated? (E.ST.05.22, S.IP.05.13, S.IP.05.15, S.IA.05.12, S.IA.05.13, S.RS.05.15)
- Describe the location of the lit part in relation to the bright light. Instruct that the moon orbits the Earth each month. Stand facing the light. Hold the moon ball outstretched in front so it appears a little left of the light. Is a lit area visible on the moon? Students should see a small crescent on the right side of the moon. Slowly turn to the left (counterclockwise), keeping the ball outstretched. (E.ST.05.22, S.IP.05.13, S.IP.05.15, S.IA.05.12, S.IA.05.13, S.RS.05.15)
- If a student's head blocks the light from the bulb, tell him/her to raise the ball slightly so the light can reach it. Observe how the illuminated part of the ball varies as its position changes. Move the ball around its orbit

several times to observe patterns. (E.ST.05.22, S.IP.05.13, S.IP.05.15, S.IA.05.12, S.IA.05.13, S.RS.05.15)

- Discuss and draw conclusions from observations. The moon reflects light from the sun, half of the moon is illuminated at all times; we see half of the moon at all times, but we can only observe the part of the moon that is illuminated. Students illustrate or create a model to explain the apparent phases when the moon is in various positions in its orbit around the Earth. (E.ST.05.22, S.IP.05.13, S.IP.05.15, S.IA.05.12, S.IA.05.13, S.RS.05.15)
- Elaborate on position and motion of objects in the sky by investigating the apparent motion of the stars and the sun. Challenge the students to think about objects in the sky. Which objects are moving? Which objects are stationary? How do we know? Over a period of a week, students make hourly observations of the sun's location in the sky and the moon's location in the sky (with reference to a stationary object such as a rooftop). Students can use their fists to measure distance above the horizon. Students collect and organize data into charts. Based on their observations, students generate questions and develop a claim or hypothesis about the movement or apparent movement of the sun and stars in the sky. (E.ST.05.23, S.IP.05.11, S.IP05.13, S.IP.05.15, S.IP.05.16, S.IA.05.12, S.IA.05.13, S.IA.05.15, S.RS.05.11, S.RS.05.13, S.RS.05.15)
- Students conduct a simple investigation to test their claims. Students will use reference materials, activities, interviews, online research, etc., to test and provide evidence of the strengths and weaknesses of their claims. They present their findings to the class. The class will evaluate the strengths and weaknesses of the groups' claims, arguments and data regarding the reasons that the sun and stars appear to move across the sky. (E.ST.05.23, S.IP.05.11, S.IP05.13, S.IP.05.15, S.IP.05.16, S.IA.05.12, S.IA.05.13, S.IA.05.15, S.RS.05.11, S.RS.05.13, S.RS.05.15)
- To elaborate on their understanding of Earth, moon, sun systems, students explore eclipses. Repeat the moon phases activity with the moon ball directly in the sight line from the eye to the light. Close one eye so the view is only from one location on Earth. Students observe the illuminated portion of the moon ball as it passes directly in front of the sun. Record observations. In which phase is the moon? (New) The moon blocks the light from the sun. The shadow of the moon falls on the Earth. This is a solar eclipse when the moon passes directly in front of the sun. (E.ST.05.24, S.RS.05.15)
- Move the moon model until the moon falls into the shadow of the student's head. What phase should the moon show? (Full) This is a lunar eclipse when the moon passes through the shadow of the Earth. Continue moving the moon ball until it makes one revolution (one month). Using this model, how often would we experience a lunar eclipse or solar eclipse? (once per month during a full moon and once during a new moon) Eclipses are rare events. (E.ST.05.24, S.RS.05.15)
- Use a hula-hoop to represent the path of the moon's orbit, hold it parallel at eye level. In this position, Earth would experience an eclipse twice a

month. The moon's orbit is at a slight angle. Tilt the hula-hoop at a slight angle (5 degree) to show that path of the moon above and below eye level (the ecliptic). (E.ST.05.24, S.RS.05.15)

- Repeat the activity with the moon ball passing above and below eye level when in the new and full moon phases. They only time that an eclipse occurs is when the sun, moon and Earth are in a straight line. This is when the moon is crossing the point at which it moves above or below the ecliptic. Remind students, also, that the moon and the Earth are very far apart (30 Earth diameters) compared to the model in the classroom. Give students flashlights and different sized balls to create their own models of lunar and solar eclipses. (E.ST.05.24, S.RS.05.15)
- Elaborate on the position and gravitational pull of the Earth–moon system by investigating the cause and effects of tides. Conduct research and create models, diagrams or activities to demonstrate ocean tides. (E.ST.05.25, S.IA.05.13, S.RS.05.15)

Evaluate Student Understanding

Formative Assessment Examples

- Apply concepts of scale to an Earth-moon model. (E.ST.05.11)
- Demonstrate understanding through illustrations and models of the position of objects in the solar system. (E.ST.05.11, E.ST.05.21)
- Create moon journals and illustrations of phases of the moon. (E.ST.05.22)
- Share results of simple investigations to demonstrate the apparent motion of the sun and stars across the sky. (E.ST.05.23)
- Display models or demonstrations of eclipses and tides. (E.ST.05.24, E.ST.05.25)
- Monitor learning through observations of student discussions and participation. (E.ST.05.11, E.ST.05.21, E.ST.05.22, E.ST.05.23, E.ST.05.24, E.ST.05.25)

Summative Assessment Examples

- Draw a diagram of the solar system that includes the correct position of planets, dwarf planets, comets, and asteroids. (E.ST.05.11)
- Explain and illustrate rotation and revolution of planet and moons. (E.ST.05.21)
- Write a paragraph explaining how moon phases occur. (E.ST.05.22)
- Explain the difference between the apparent and the actual motion of the sun and stars across the sky. (E.ST.05.23)
- Demonstrate a lunar and a solar eclipse with illustrations or models. (E.ST.05.24)
- Draw a diagram and explain how the gravitational pull of the moon causes ocean tides. (E.ST.05.25)

Enrichment

- Investigate daylight savings.
- Research planets, moons, and other solar system objects. Create travel brochures for space travel in the solar system.
- Research space missions. Plan a mission to Mars.
- Research the possibility of life on other planets.
- Visit a planetarium.
- Create constellations and stories.
- Investigate galaxies and the possibility of life within other solar systems.
- Investigate the appearance of the Earth from the moon. Does the Earth have phases like the moon?
- Further investigate the different kinds of eclipses and the historical and cultural perspectives of eclipses.
- Investigate tides and their effect on ocean communities.
- Create a web quest that includes information from the space unit.
- Research the technology used by scientists to obtain information from space.
- Research contributions of scientists throughout history and across cultures. Examples include Ptolemy, Copernicus, Galileo, Steven Hawking, Neil deGrasse Tyson, Henrietta Leavitt, and Maria Mitchell.

Intervention

- Pair students during reading and writing activities.
- Use student journals to record ideas, questions, and daily notes.
- Provide extra practice during activities and demonstrations.
- Create vocabulary and concept cards that include definitions, illustrations, and everyday examples.
- Create graphic organizers to define and review concepts.
- Use a variety of visual diagrams and pictures to supplement activities.

Examples, Observations, and Phenomena (Real World Context)

Students are aware of objects in the sky that can be seen in the day and nighttime sky. Because they have been making observations since they were young children, they may have developed their own ideas to explain natural phenomena. It is important that students become aware of their naïve ideas and begin to resolve them through the activities and research while they study the motion and position of objects in the solar system. An interesting phenomenon for students to reason through and demonstrate is why we have approximately the same hours of daylight on April 21st as we do on August 21st. Early November (fall) also has approximately the same hours of daylight as early February (winter).

Students cannot directly observe the planets and their moons. They do, however, have a natural curiosity about space. Movies, books, newspaper articles, and games enhance student understanding and interest.

It is common to find misinformation in movies, stories and other media regarding space, space travel, and distant galaxies. Students should be aware of how this misinformation can cause misconceptions. Share news articles regarding space research and technological advances. NASA websites are full of information for students who are interested in space and space travel.

Literacy Integration

Students will…

Reading

R.WS.05.04 know the meanings of words encountered frequently in grade-level reading and oral language contexts.

R.IT.05.02 identify and describe informational text patterns including compare/contrast, cause/effect, and problem/solution.

R.CM.05.02 retell through concise summarization grade-level narrative and informational text.

R.CM.05.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Examples of trade books available for learning about the position and motion of objects in the sky are:

America in Space by Steven Dick et al, 2007
Our Solar System by Seymour Simon, 2007
Don't Know Much About the Solar System, by Kenneth C. Davis and Pedro Martin, 2004
Earth, Moon, Sun by Peter Riley, 2006
Will the Sun Ever Burn Out? by Rosalind Mist, 2006

Writing

W.GN.05.03 write a position piece that demonstrates understanding of central ideas and supporting details (e.g., position/evidence organizational pattern) using multiple headings and subheadings.

- Write a paper regarding the causes of seasons using supporting details gained from activities and investigation.

Speaking

WS.DS.05.01 engage in interactive, extended discourse to socially construct meaning in book clubs, literature circles, partnerships, or other conversation protocols.

Mathematics Integration

Numbers and Operations

N.FL.05.05 Solve applied problems involving multiplication and division of whole numbers.

N.ME.05.09 Understand percentages as parts out of 100, use % notation, and express a part of the whole as a percentage.

Measurement

M.UN.05.04 Convert measurement of length, weight, area, volume, and time within a given system using easily manipulated numbers.

Data and Probability

D.RE.05.02 Construct line graphs from tables of data; include axis labels and scale.

D.AN.05.03 Given a set of data, find and interpret the mean (using the concept of fair share) and mode.

Sixth Grade
Science Content Expectations
Companion Document

SCIENCE

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

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

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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 that stretch the thinking beyond the instructional examples and provides ideas for reinforcement of challenging concepts.
g. **Examples, Observations, Phenomena** are included as exemplars of different modes of instruction appropriate to the unit in which they are listed. These examples include reflection, a link to real world application, and elaboration beyond the classroom. These examples are intended for instructional guidance only and are not assessable.
h. **Curricular Connections and Integrations** are offered to assist the teacher and curriculum administrator in aligning the science curriculum with other areas of the school curriculum. Ideas are presented that will assist the classroom instructor in making appropriate connections of science with other aspects of the total curriculum.

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

Sixth Grade GLCE Companion Document

Unit 1: Matter and Energy

SCIENCE

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

MICHIGAN Department of Education

v.1.09

Sixth Grade Companion Document

6-Unit 1: Matter and Energy

Table of Contents

6th Grade Unit 1:
Matter and Energy

Content Statements and Expectations

6 – Unit 1: Matter and Energy

Big Ideas (Key Concepts)

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

Clarification of Content Expectations

Standard: Energy

Content Statement – P.EN.M.1

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

Content Expectations

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

Instructional Clarifications

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

c. Large molecules such as sugar have greater potential energy than smaller molecules such as carbon dioxide and water.

5. Potential energy can be converted to kinetic energy. For example, potential energy of a battery can be converted to kinetic energy in an electric motor.
6. Kinetic energy can be converted to potential energy. For example, a windmill's kinetic energy can be converted to potential energy as it charges storage batteries.
7. Energy may be changed from one form to another, but the amount of energy stays the same.

Assessment Clarifications

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

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

Instructional Clarifications

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

Assessment Clarifications

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

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

Content Statement – P.EN.M.4

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

Content Expectations

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

Instructional Clarifications

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

Assessment Clarifications

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

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

Instructional Clarifications

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

Assessment Clarifications

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

Standard: Changes in Matter

Content Statement – P.CM.M.1

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

Content Expectations

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

Instructional Clarifications

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

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

Assessment Clarifications

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

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

Instructional Clarifications

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

Assessment Clarifications

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

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

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

Vocabulary

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

Instruments, Measurements, Representations

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

Instructional Framework

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

Instructional Examples

Kinetic and Potential Energy: P.EN.06.11, P.EN.06.12
Energy Transfer: P.EN.06.41, P.EN.06.42
Changes in State: P.CM.06.11, P.CM.06.12

Objectives

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

Engage and Explore

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

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

Explain and Define

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

Elaborate and Apply

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

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

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

Evaluate Student Understanding

Formative Assessment Examples

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

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

Summative Assessment Examples

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

Enrichment

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

Intervention

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

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

Examples, Observations, and Phenomena (Real World Context)

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

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

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

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

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

Literacy Integration

Students will…

Reading

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

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

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

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

Books:
Energy (Eye-Witness), Jack Challoner, 1993
Energy (See for Yourself), DK Publishing, Chris Woodford, 2007

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

Writing

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

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

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

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

Speaking

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

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

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

Mathematics Integration

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

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

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

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

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

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

Sixth Grade GLCE Companion Document

Unit 2: Ecosystems

SCIENCE

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

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Sixth Grade Companion Document

6-Unit 2: Ecosystems

Table of Contents Page 1

6th Grade Unit 2:
Ecosystems

Content Statements and Expectations

6 - Unit 2: Ecosystems

Big Ideas (Key Concepts)

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

Clarification of Content Expectations

Standard: Organization of Living Things

Content Statement – L.OL.M.5

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

Content Expectations

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

Instructional Clarifications

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

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

Assessment Clarification

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

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

Instructional Clarifications

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

Assessment Clarifications

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

Standard: Ecosystems

Content Statement: LEC.M.1

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

Content Expectations

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

Instructional Clarifications

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

Assessment Clarifications

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

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

Content Statement – L.EC.M.2

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

Content Expectations

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

Instructional Clarifications

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

squirrels and fox squirrels competing for acorns and forest trees competing for light.
   b. Parasitism is beneficial to the parasite and has a harmful effect on the host.
   c. Predator populations benefit and prey populations are harmed.

Assessment Clarifications

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

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

Instructional Clarifications

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

Assessment Clarifications

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

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

Instructional Clarifications

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

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

Assessment Clarifications

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

Content Statement – L.EC.M.3

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

Content Expectations

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

Instructional Clarifications

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

Assessment Clarification

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

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

Instructional Clarifications

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

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

Assessment Clarifications

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

Content Statement – L.EC.M.4

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

Content Expectations

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

Instructional Clarifications

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

Assessment Clarifications

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

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

Instructional Clarifications

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

Assessment Clarifications

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

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

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

Vocabulary

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

Instruments, Measurements, Representations

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

Instructional Examples

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

Objectives

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

Engage and Explore

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

Explain and Define

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

Elaborate and Apply

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

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

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

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

Evaluate Student Understanding

Formative Assessment Examples

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

Summative Assessment Examples

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

Enrichment

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

Intervention

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

Examples, Observations, and Phenomena (Real World Context)

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

Literacy Integration

Students will…

Reading

R.NT.06.04 analyze how authors use literary devices including dialogue, imagery, mood, and understatement to develop the plot, characters, point of view, and theme.
R.CM.06.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

Books:
Sand County Almanac, Aldo Leopold
Silent Spring, Rachel Carson
The Woods Scientist, Stephen R. Swinburne, 2002

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

Writing

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

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

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

Speaking and Listening

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

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

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

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

Mathematics Integration

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

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

Sixth Grade GLCE Companion Document

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

SCIENCE

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

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Sixth Grade Companion Document

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

Table of Contents

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

Content Statements and Expectations

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

Big Ideas (Key Concepts)

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

Clarification of Content Expectations

Standard: Solid Earth

Content Statement – E.SE.M.4

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

Content Expectation

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

Instructional Clarifications

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

Assessment Clarifications

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

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

Content Statement – E.SE.M.1

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

Content Expectations

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

Instructional Clarifications

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

Assessment Clarifications

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

rock surfaces. Freeze/thaw occurs when water is trapped in the spaces of rock and repeatedly frozen and thawed. Thermal expansion/contraction occurs when solar radiation causes minerals to heat and cool at various speeds producing stresses in rock over time.
3. Chemical processes cause chemical weathering. Water is the main agent at work in this process and causes the composition of the mineral or rock to change. Primary minerals in rock are broken down to secondary minerals and this material can be carried away in solution.
4. As soon as a rock particle is loosened by weathering and moves it is called erosion.
5. Eroded rock is one of the main components of soil.

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

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

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

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

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

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

Assessment Clarifications

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

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

Instructional Clarifications

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

Assessment Clarifications

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

Content Statement – E.SE.M.6

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

Content Expectations

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

Instructional Clarifications

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

Assessment Clarifications

1. The Earth acts as a giant magnet.

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

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

Instructional Clarifications

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

Assessment Clarifications

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

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

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

Vocabulary

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

Instruments, Measurements, Representations

Magnets, compass

Instructional Framework

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

Instructional Examples

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

Objectives

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

Engage and Explore

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

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

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

Explain and Define

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

Elaborate and Apply

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

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

Evaluate Student Understanding

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

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

Enrichment

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

Intervention

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

Examples, Observations, and Phenomena (Real World Context)

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

Changes in rock usually take thousands of years to happen; it is therefore important to show students the shorter-term changes we can see (like potholes in a road or the wearing down of their sled hill by the school).
Soil quality is important for agriculture and therefore, for all people. By looking at the properties of soil we can begin to learn the properties that are most useful to growing various types of crops with the highest yields possible.
Magnets were very important to the history of navigation by people on Earth. Without this tool many were lost at sea or did not attempt open sea voyages. They are still widely used today even with the increasing use of GPS systems for navigation. Magnets are also used in many electrical circuits, generators, and motors. Magnets are used in the generation of electricity at municipal power plants.

Literacy Integration

Students will…

Reading

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

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

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

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

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

Writing

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

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

Sixth Grade GLCE Companion Document

Unit 4: Plate Tectonics and Fossils

SCIENCE

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

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Sixth Grade Companion Document

6-Unit 4: Plate Tectonics and Fossils

Table of Contents Page 1

6th Grade Unit 4:
Plate Tectonics and Fossils

Content Statements and Expectations

6 – Unit 4: Plate Tectonics and Fossils

Big Ideas (Key Concepts)

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

Clarification of Content Expectations

Standard: Solid Earth

Content Statement – E.SE.M.5

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

Content Expectations

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

Instructional Clarifications

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

Assessment Clarifications

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

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5. Another theory is that gravity pulls the old heavier ocean floor with more force then the newer lighter sea floor.
6. As the plates move they interact with one another at their boundaries, where they are separating, converging, or sliding past each other.

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

Instructional Clarifications

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

Assessment Clarifications

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

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

Instructional Clarifications

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

Assessment Clarifications

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

Content Statement – E.ST.M.3

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

Content Expectation

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

Instructional Clarifications

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

Assessment Clarifications

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

Content Statement – E.ST.M.4

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

Content Expectations

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

Instructional Clarifications

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

Assessment Clarifications

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

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

Instructional Clarifications

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

Assessment Clarifications

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

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

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

Vocabulary

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

Instruments, Measurements, Representations

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

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

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

Instructional Framework

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

Instructional Examples

Plate Tectonics: E.SE.06.51, E.SE.06.52, E.SE.06.53
Fossils: E.ST.06.31,
Geologic Time: E.ST.06.41, E.ST.06.42

Objectives

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

Engage and Explore

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

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

Explain and Define

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

Elaborate and Apply

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

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

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

Evaluate Student Understanding

Formative assessment

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

Summative Assessment

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

Enrichment

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

Intervention

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

Examples, Observations, and Phenomena (Real World Context)

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

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

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

Literacy Integration

Students will…

Reading

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

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

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

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

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

Writing

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

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

Mathematics Integration

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

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

Seventh Grade
Science Content Expectations
Companion Document

SCIENCE

- **Unit 1: Waves and Energy**
- **Unit 2: Physical and Chemical Properties and Changes in Matter**
- **Unit 3: Structures and Processes of Living Things**
- **Unit 4: Fluid Earth Systems and Human Activities**

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

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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 that stretch the thinking beyond the instructional examples and provides ideas for reinforcement of challenging concepts.
g. **Examples, Observations, Phenomena** are included as exemplars of different modes of instruction appropriate to the unit in which they are listed. These examples include reflection, a link to real world application, and elaboration beyond the classroom. These examples are intended for instructional guidance only and are not assessable.
h. **Curricular Connections and Integrations** are offered to assist the teacher and curriculum administrator in aligning the science curriculum with other areas of the school curriculum. Ideas are presented that will assist the classroom instructor in making appropriate connections of science with other aspects of the total curriculum.

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

Seventh Grade GLCE Companion Document

Unit 1: Waves and Energy

SCIENCE

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

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Seventh Grade Companion Document

7-Unit 1: Waves and Energy

Table of Contents Page 1

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 Clarifications

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 Clarifications

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.
6. When waves hit a beach, erosion takes place. Ripples are left in the sand to show the reaction of the wave.
7. Seismic waves are vibrations that travel through the Earth carrying the energy of motion released during an earthquake.
8. 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.

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 Clarifications

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 Clarifications

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 Clarifications

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).
4. 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.

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

Inquiry Process
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 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, Measurements, 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 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 demonstrate 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 sun's 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 it 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 waves, 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 its "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

Students will…

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.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.07.02 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.

Read with the class the book, *Volcano: The Eruption and Healing of Mount 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 students research other volcanoes in the United States, be sure to include Alaska and Hawaii.

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

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).

W.PR.07.03 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 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 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 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 GLCE Companion Document

Unit 2: Physical and Chemical Properties and Changes in Matter

SCIENCE

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

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

Table of Contents Page1

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 Clarifications

1. Classify means to arrange or order substances by their chemical properties (flammability, pH, 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 Clarifications

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 Clarifications

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 Clarifications

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 Clarifications

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 Clarifications

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 and properties.
6. Understanding bonds is NOT the focus of this content expectation.

Assessment Clarifications

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 Clarifications

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 Clarifications

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, temperature change, and light.

Instructional Clarifications

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 Clarifications

1. Identify evidence of chemical change through color, gas formation, solid formation, temperature change, and light.
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 Clarifications

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 Clarifications

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 Process
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 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 Implications
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 elements periodic table of the elements physical change compound	classification of substances conservation of mass graduated cylinder physical properties of elements physical properties of compounds phase change

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 five 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 three 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 one 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 one-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, their symbols, where they sit 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 his/her 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 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 substances, and products as the after substances. (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 three 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 three 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 two 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 given 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 behave 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

Students will…

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 GLCE Companion Document

Unit 3: Structures and Processes of Living Things

SCIENCE

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

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

Table of Contents Page 1

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 multicellular 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. Recognize is to be able to distinguish between organisms that are one-celled and those that are multicellular based on observable characteristics.
2. All living organisms are composed of cells. Organisms may be composed of just one cell others may consist of many cells.
3. Protists can be observed as examples of single-celled organisms.
4. Plants can be used to observe multicellular structure.

Assessment Clarification

1. All living organisms are composed of cells. Organisms may be composed of just one cell others may consist of many cells.

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 a 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.
2. In a 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.

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 diffusion 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 performed 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 (take in food, oxygen, and waste removal).
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.
3. Plants take energy from light to form higher energy molecules that 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 able 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 root, tuber (potato), or bulb (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 drive photosynthetic processes.
5. Details of the photosynthetic process such as the light dependent and light independent reactions are excluded.

Assessment Clarification

1. Explain that 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 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 Clarification

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

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

Inquiry Process
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 Implications
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.07.19 Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures.

Vocabulary

Critically Important- State Assessable	Instructionally Useful
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 as 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 cell 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 students 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 ten 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

Students will…

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

Students will…

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) reproduction 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

Students will…

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 GLCE Companion Document

Unit 4: Fluid Earth Systems and Human Activities

SCIENCE

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

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v.1.09

Seventh Grade Companion Document

7-Unit 4: Fluid Earth Systems and Human Activities

Table of Contents Page 1

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

Content Statements and Expectations

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 sends 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 sends 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 through 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 Consequences – 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, and 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.ES.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 Clarifications

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 weather conditions associated with frontal boundaries and the movement of major

air masses and the jet stream across North America, using a weather map.

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.
6. A warm front is a situation where a warm air mass is advancing upon a cold air mass.
7. A stationary front is a situation where a cold air mass and warm air mass meet and neither mass is displacing the other.
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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
Water Cycle – 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 moves 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 within 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 groundwater 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 cools to the dew point. Additional cooling leads to condensation and the growth of low-level clouds. (USGS)

6. 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.
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8. 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 groundwater.
9. Runoff is when rain falls on saturated or impervious ground and flows downhill as runoff.
10. 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 groundwater 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.

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 groundwater. 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.

Assessment Clarifications

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

1. The atmosphere has different properties at different elevations.
2. At higher elevations the temperature of the air is generally colder.
3. 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.

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

Inquiry Process
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 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 Implications
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 three-fourths 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 groundwater 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

Students will…

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.

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.