Fifth Grade Companion Document

5-Unit 1: Measuring Changes in Motion

Table of Contents Page 1

Introduction to the K-7 Companion Document
An Instructional Framework

Overview

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

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

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

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

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

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

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

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

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 Clarification:

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 Clarification:

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 Clarification

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 Clarification

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 Clarification:

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 Clarification

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 Clarification

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 Clarification

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 Clarification

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 or in relation 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 Clarification

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 motion.

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

Assessment Clarification

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 Clarification

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 Clarification

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 Processes
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
balanced force change of direction change of motion change of speed force strength friction graph magnetic attraction magnetic repulsion mass relative position constant speed direction of motion gravitational force speed unbalanced force zero net force non-zero net force	acceleration applied force kinetic energy mechanical motion Newton's laws of motion pulley deceleration inertia velocity magnitude

Instruments, Measurements, Representations

Measurement	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 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 act on an object in the same direction and then in opposite directions. Give students sufficient materials and time to investigate the use of 2 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 use 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 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, 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 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

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

W.PR.05.04 Students will 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 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.06.01 Students will 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 Students will 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 Companion Document

5-Unit 2: Animal Systems

Table of Contents Page 1

Introduction to the K-7 Companion Document
An Instructional Framework

Overview

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

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

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

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

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

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

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

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

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 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 their 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 student's 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 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 student's 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 has affected the health of the nation. The rate of obesity, 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

Reading

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

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

R.CM.05.04 Students will 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 Companion Document
5-Unit 3: Evolution and Traits of Organisms

Table of Contents Page 1

Table of Contents (continued)

Introduction to the K-7 Companion Document
An Instructional Framework

Overview

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

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

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

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

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

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

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

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

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 them 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 Clarification

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 Clarification

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 event.
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

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

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 3 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 it represents. Visually scan the room to determine each students 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 student 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

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 student 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 GLCE's 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 may characteristics have changed over time through analyzing catastrophic events and fossils.

Engage and Explore

- In cooperative learning groups, students can 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 they feel it 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 they have 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

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 GLCE's 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 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. Student colors 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

Reading

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

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 GLCE's when completing writing assignments intended to demonstrate knowledge and learning of the science material.

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.

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

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

Table of Contents Page 1

Introduction to the K-7 Companion Document
An Instructional Framework

Overview

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

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

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

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

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

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

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

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

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. Halfway between summer and

winter are spring and fall; the daylight and nighttime hours are equal in length.
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 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 Clarification

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 it 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 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 it 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

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. Make a class chart, summarizing observations. Using the data, discuss observations. During which season is the nail's shadow 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 story book 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 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). 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. 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.) 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. 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. 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. 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. 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. 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)
- 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)

Explain and Define

- 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? 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. If a student's head blocks the light from the bulb, tell them 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. 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. They 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 (face). This is a solar eclipse when the moon passes directly in front of the sun. 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. Using 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). 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 day light 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

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.