Fourth Grade Companion Document
4-Unit 1: Heat, Electricity, and Magnetism

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Introduction to the K-7 Companion Document
An Instructional Framework

Overview

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

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

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

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

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

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

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

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

Fourth Grade Unit 1:
Heat, Electricity, and Magnetism

Content Statements and Expectations

Unit 4-1: Heat, Electricity, and Magnetism

Big Ideas (Key Concepts)

- Heat and electricity are forms of energy.
- Evidence of energy is change.
- Electrical circuits demonstrate a transfer of energy.
- Magnetism is a physical property of matter.
- Heat can be transferred from one substance or object to another.

Clarification of Content Expectations

Standard: Energy

Statement – P.EN.E.1
Forms of Energy – Heat, electricity, light, and sound are forms of energy.

Content Expectation

P.EN.04.12 Identify heat and electricity as forms of energy.

Instructional Clarifications

1. Identify means to recognize heat and electricity as forms of energy.
2. Energy is an abstract concept. Fourth graders need only to observe forms of energy and describe what they can do.
3. Electricity can produce light, heat, sound, and magnetic effects.
4. Heat can change temperature, change matter from one state to another, and move from one object to another by conduction.
5. Temperature change is measured by using the thermometer (Celsius and Fahrenheit).
6. A common misconception is that energy is a thing.
7. A common misconception is that heat and temperature mean the same thing.
8. A common misconception is that thermometers measure heat.
9. A common misconception is that all thermometers use the same scale. (Count by ones or twos)
10. A common misconception is that when reading thermometers that are below zero, the scale is often misread.
11. A common misconception is that things use up energy.
12. Note: Students identified light and sound as forms of energy in the third grade. At this stage they should identify light, sound, heat, and electricity as forms of energy.

Assessment Clarifications

1. Heat is a form of energy.
2. Electricity is a form of energy.

Statement – P.EN.E.4
Energy and Temperature – Increasing the temperature of any substance requires the addition of energy.

Content Expectations

P.EN.04.41 Demonstrate how temperature can be increased in a substance by adding energy.

Instructional Clarifications

1. Demonstrate is to show through manipulation of materials, drawings, and written and verbal explanations how temperature increases when adding energy.
2. Adding some forms of energy to a substance increases its temperature. This means that the speed of the movement of the molecules within the substance is increased.
3. Heat energy can move from one object to another. It is not necessary for fourth graders to understand how this happens. Rather they need to observe the effects of temperature increasing when energy is added.
4. It is difficult for fourth graders to distinguish between heat and temperature; therefore, investigating heat should just focus on changes in temperature.
5. Adding heat to a substance increases its temperature, and allowing heat to escape (transfer to another substance) decreases its temperature.
6. Temperature is measured in degrees Celsius or degrees Fahrenheit using a thermometer.
7. Fourth graders have multiple experiences reading temperatures on a variety of thermometers with different scales. They discover heat transfer in different substances by observing and reading temperature change.

Assessment Clarifications

1. Adding heat energy to a substance increases its temperature.
2. The temperature of a substance or object is determined using a thermometer and read in degrees Celsius.

P.EN.04.42 Describe heat as the energy produced when substances burn, certain kinds of materials rub against each other, and when electricity flows through wire.

Instructional Clarifications

1. Describe means to tell or depict in spoken or written words how heat is produced.
2. As heat is transferred to an object, the molecules of the object move more rapidly. The motion of the molecules is directly related to the temperature of the object and its state of matter.
3. When a substance burns, heat energy is produced.
3. When two materials rub together (friction), heat energy is produced.
4. When electric current flows through materials, heat energy can be produced.

Assessment Clarifications
1. When a substance burns, heat energy is produced.
2. When two materials rub together (friction), heat energy is produced.
3. When electric current flows through materials, heat energy can be produced.

P.EN.04.43 Describe how heat is produced through electricity, rubbing and burning.

Instructional Clarifications
1. Describe means to tell or depict in spoken or written words how heat is produced through electricity, rubbing and burning.
2. Electric current flows through materials and produces heat. The flow of electrical current meets resistance in the materials and is changed into heat energy. Some materials have greater resistance than others, and produce a greater amount of heat (incandescent light bulb filaments, toaster element, oven and range elements).
3. Friction occurs when one object rubs against another object (two hands rubbing together briskly) and heat is produced.
4. When a substance burns, heat energy is produced through the chemical change in the substance (wood to ash, gases, and smoke).
5. Fourth graders do not need to understand the chemical change that is occurring when substances burn.

Assessment Clarifications
1. Electric current flows through materials and produces heat (light bulb, toaster).
2. Friction occurs when one object rubs against another object (two hands rubbing together briskly) and heat is produced.
3. When a substance burns, heat energy is produced.

Statement – P.EN.E.5
Electrical Circuits – Electrical circuits transfer electrical energy and produce magnetic fields.

Content Expectations

P.EN.04.51 Demonstrate how electrical energy is transferred and changed through the use of a simple circuit.

Instructional Clarifications
1. Demonstrate is to show through manipulation of materials, drawings, and written and verbal explanations how energy is transferred and changed through the use of a simple circuit.
2. The general characteristics of a circuit include a power source (battery or generator), conductor (wire), and a device, which uses electricity (bulb, motor, buzzer, appliance).

3. At this level, students should demonstrate the completion of a simple circuit using batteries, wires, and bulbs accompanied by a diagram using arrows and/or descriptions to show the flow of energy transfer or change.
4. Familiar forms of energy involved in a simple circuit include a battery changes chemical energy to electrical energy that is then transferred to a light bulb that changes the electrical energy to light and heat.
5. When the flow of electricity is interrupted, the circuit is not complete. A closed simple circuit is necessary for the transfer of energy.
6. Stored energy in a battery becomes electrical energy, and electrical energy is transferred to heat and light energy when it encounters resistances. (A wire in a light bulb heats up and glows when electricity travels through it.
7. Observations and demonstrations of energy transfer in an electrical circuit include heating wires, lighting bulbs, ringing bells, and powering small motors.
8. Students recognize that the greater number of batteries will produce a greater amount of energy (if the voltage rating of the bulb is not compatible with total voltage output of the batteries, it will burn out).
9. The observation of a change provides evidence that an energy transfer has taken place.
10. A common misconception is that bulbs store the energy produced by the battery.
11. A common misconception is that if the bulb is far away from the battery, it will be dimmer.

Assessment Clarifications

1. The general characteristics of a circuit include a power source (battery or generator), conductor (wire), and a device, which uses electricity (bulb, motor, buzzer, appliance).
2. Observations of how energy is transferred and changed in an electrical circuit include heating wires, lighting bulbs, ringing bells, and powering small motors.

P.EN.04.52 Demonstrate magnetic effects in a simple electric circuit.

Instructional Clarifications

1. Demonstrate is to show through manipulation of materials, drawings, and written and verbal explanations the magnetic effects in a simple circuit.
2. A wire carrying an electric current creates a weak magnetic field. A magnetic compass will show the effects of the magnetic field.
3. A simple electromagnet has the same general characteristics of a circuit, including a power source (battery or generator), conductor (wire), and a wire wrapped core.
4. An electromagnet is produced by wrapping a wire around a core (nail) and attaching the ends of the wire to a battery.
5. The strength of an electromagnet is increased by wrapping more coils of wire around the nail or increasing the amount of current.
6. An electromagnet is a temporary magnet. The magnetic field usually stops when the current is no longer flowing through the wire.

7. A simple electromagnet provides evidence that electricity flowing through wires produces magnetic effects in the wires.

Assessment Clarification

1. A wire carrying an electric current creates a weak magnetic field. The compass will show the effects of the magnetic field.

Standard: Properties of Matter

Statement – P.PM.E.5
Conductive and Reflective Properties – Objects vary to the extent they absorb and reflect light energy and conduct heat and electricity.

Content Expectation

P.PM.04.53 Identify objects that are good conductors or poor conductors of heat and electricity.

Instructional Clarifications

1. Identify means to recognize good conductors and poor conductors of heat and electricity.
2. An electric charge can flow easily through certain materials. Examples of good conductors of electricity are salt water, copper, aluminum and other metals.
3. An electric charge does not flow easily through certain materials. Examples of poor conductors (insulators) are rubber, cork, wood, cloth, plastic, and air.
4. A good conductor of heat is a material that allows heat to move through it easily. All metals are good conductors of heat (copper, steel, and iron)
5. A poor conductor of heat (insulator) is a material that does not allow heat to move through it easily. Some insulators are wood, paper, wax, and air.
6. Heat can move from one object to another by conduction.

Assessment Clarifications

1. Good conductors of electricity are copper and aluminum.
2. Poor conductors of electricity are rubber, cork, wood, cloth, plastic, and air.
3. All metals are good conductors of heat (copper, steel, and iron).
4. Some poor conductors of heat are wood, paper, wax, and air.

Statement – P.PM.E.3
Magnets – Magnets can repel or attract other magnets. Magnets can also attract certain magnetic objects at a distance.

Content Expectations

P.PM.04.33 Demonstrate magnetic field by observing the patterns formed with iron filings using a variety of magnets.

Instructional Clarifications

1. Demonstrate is to show through manipulation of materials, drawings, and written and verbal explanations of magnetic field patterns made by iron filings using magnets.
2. Magnetism is the force of attraction or repulsion by magnets as well as the force of attraction between magnets and magnetic materials.
3. When iron filings are sprinkled around a magnet, they demonstrate the shape of the magnetic field. Demonstrations on a flat surface do not fully show the three-dimensional magnetic field.
4. Each end of a magnet is called a magnetic pole. Every magnet has two poles – north and south. The opposite poles will attract and like poles will repel.
5. The magnetic lines of force can be seen between two unlike poles and two like poles.
6. A common misconception is that the size of the magnet determines its strength.
7. A common misconception is that all metals are attracted to magnets.
8. A common misconception is that all silver-colored items are attracted to a magnet.
9. A common misconception is that only magnets can produce magnetic fields
10. A common misconception is that a magnetic field is a two-dimensional pattern of lines surrounding a magnet, not a three-dimensional field or force.

Assessment Clarifications

1. When iron filings are sprinkled around a magnet, they demonstrate the shape of the magnetic field.
2. The magnetic lines of force can be seen between two unlike poles and two like poles.

P.PM.04.34 Demonstrate that magnetic objects are affected by the strength of the magnet and the distance from the magnet.

Instructional Clarifications

1. Demonstrate means to show through manipulation of materials, drawings, and written and verbal explanations that magnetic objects are affected by the strength and distance from the magnet.
2. Some magnets have a stronger magnetic field than others.

3. The stronger a magnet, the more magnetic objects (paper clips, nails) can be attracted to the magnet.
4. The closer an object is to a magnet the stronger the attraction. The farther a magnetic object is from a magnet the weaker the attraction.

Assessment Clarifications

1. The stronger a magnet, the more magnetic objects (paper clips, nails) can be attracted to the magnet.
2. The closer an object is to a magnet the stronger the attraction. The farther a magnetic object is from a magnet the weaker the attraction.

Inquiry process, Inquiry analysis and Communication, Reflection and Social Implications

Inquiry Processes
S.IP.03.11 Make purposeful observations of heat, electricity and magnetism.
S.IP.03.12 Generate questions based on observation of heat, electricity and magnetism.
S.IP.03.13 Plan and conduct simple and fair investigations to compare and contrast heat, electricity and magnetism.
S.IP.03.14 Manipulate simple tools (for example thermometer, stop watch/timer) to measure temperature.
S.IP.03.15 Make accurate measurements with appropriate units (degrees, Celsius, Fahrenheit, minutes, seconds) in.
S.IP.03.16 Construct simple charts and graphs from data information collected about fuel types.
Inquiry Analysis and Communication
S.IA.03.11 Summarize information from charts and graphs to answer questions about kinds of fuel that are used to heat buildings.
S.IA.03.12 Share ideas about heat, electricity and magnetism through purposeful conversation in collaborative groups.
S.IA.03.13 Communicate and present findings of investigations that describe the strength of magnets and their uses.
S.IA.03.14 Develop research strategies and skills for information gathering and problem solving about heat energy, electricity sources, global climate changes and uses of electromagnets.
S.IA.03.15 Compare and contrast sets of data from multiple trials of an investigation on magnets and their strengths to explain reasons for differences.
Reflection and Social Implications
S.RS.03.11 Demonstrate similarities and differences in uses of heat, electricity and magnetism through various illustrations, performances or activities.
S.RS.03. 14 Use data/samples as evidence to separate fact from opinion about electricity and magnetism.
S.RS.03.15 Use evidence when communicating, comparing and contrasting the types of heat uses of electricity and uses of magnetism.
S.RS.03.16 Identify technology used in everyday life to measure temperatures.
S.RS.03.17 Identify current problems about heat and electricity sources that may be solved through the use of technology.
S.RS.03.19 Describe how people such as Michael Faraday, Thomas Edison, and Enrico Fermi have contributed to science throughout history and across cultures.

Vocabulary

Critically Important – State Assessable	Instructionally Useful
heat electricity energy evident temperature thermometer Celsius Fahrenheit increase decrease substance electric current friction simple circuit open circuit closed circuit battery wire bulb power source energy transfer conductor compass magnet magnetic field magnetic poles lines of force iron filings attract repel generator device appliance	conduct conduction resistance electromagnet three dimensional

Instruments, Measurements, Representations

temperature	thermometer	Fahrenheit, Celsius
Students are not required to convert from Fahrenheit to Celsius or Celsius to Fahrenheit. They do need to be able to read a thermometer using either Fahrenheit or Celsius. Know benchmark temperatures such as freezing (32^0F, 0^0C); boiling (212^0F, 100^0C); room temperature (70^0F, 21^0C); body temperature (98.6^0 F, 37^0 C); and compare temperatures to these, e.g., cooler, warmer.		

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 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

Energy
Forms of Energy: P.EN.04.12**,**
Energy and Temperature: P.EN.04.41, P.EN.04.42, P.EN.04.43

Objectives

- Identify heat and electricity as forms of energy.
- Use a thermometer to measure heat added to a substance and observe the results.
- Describe ways that heat is produced.

Engage and Explore

- Engage students in a variety of activities that use energy, such as running in place, rubbing hands together, feeling heat come out of the blower unit, turning the lights or the fan on and off, etc. In pairs or small groups, students discuss the concept of energy. What is energy? What form of energy was used in each one of these, and where did the energy come from? What change occurred as a result of these actions? Note: Students are not expected to know the answers or understand the concepts presented in this activity. This is intended to introduce the concept of energy to students. (P.EN.04.12, S.IP.04.11)
- Students run in place for 1-3 minutes. Discuss with students that energy is required to perform this activity. As a result, students discuss that they became hot. Their bodies give off heat as they use energy. What sports and games require more energy? Do they give off heat while playing the games? What is the fuel source their bodies use for energy? (P.EN.04.12, S.IP.04.11)
- Discuss the heat given off by the heating system in the classrooms. What kinds of fuels are burned to provide heat for schools and homes? How is

the heat energy controlled in a home or school? Talk to the custodian about the heating/cooling system in the school. (P.EN.04.12, P.EN.04.41, S.IP.04.11, S.IP.04.12, S.IA.04.12)

- If appropriate, build a small campfire to cook marshmallows. The teacher measures the temperature of the air close to the fire and a distance away from the fire. Discuss the difference in temperature. Challenge students to diagram the evidence that heat is produced through burning. (P.EN.04.41, P.EN.04.42, P.EN.04.43, S.IP.04.15, S.IA.04.13, S.RS.04.11)
- Each student is given an ice cube. The goal is to make the ice cube melt as quickly as possible without using any outside heat sources except their bodies. Discuss the methods they used to melt the ice cube. Many students use a form of rubbing motion or friction. A transfer of heat melts the ice cube. Students record findings in a science journal or graphic organizer. (P.EN.04.41, P.EN.04.42, S.IP.04.11, S.IP.04.12)
- Examine various types of thermometers and scales on both Celsius and Fahrenheit thermometers. Practice reading both types of thermometers. Students need to be able to read the temperature, not convert between Celsius and Fahrenheit. Read and compare temperatures in warm and cold water, inside and outside, in different parts of the classroom, etc. (P.EN.04.41, S.IP.04.14, S.IP.04.15)

Explain and Define

- Have students explain their investigations into the melting ice cube to the rest of the class. Ask students what they can conclude from their data and what form of energy was involved in the change from solid water to liquid water.
- Students create classroom definitions for the words energy, fuel, and friction.

Elaborate and Apply

- As a homework assignment, students find out the type of energy used to heat their homes. This information is used to make a classroom data table. The table is used to make a bar graph. Students generate questions and comparisons that can be answered using the bar graph. (P.EN.04.42, S.IP.04.12)
- Students hold a thermometer gently in one hand and record the temperature. Put the thermometer down and create friction by rubbing hands together. Again measure the temperature by holding the thermometer gently. (Students think holding the thermometer tighter will raise the temperature.) Discuss the temperature difference and the cause by using the data. Compare the class results. (P.EN.04.41, P.EN.04.42, S.IP.04.14, S.IP.04.15, S.IA.04.11, S.IA.04.12, S.IA.04.13, S.IA.04.14, S.IA.04.15)

- Students read and compare temperatures using a glass of cold water and adding warm water or using a glass of warm water and adding an ice cube. (P.EN.04.41, S.IP.04.14, S.IP.04.15)
- Bring in a small appliance that uses electricity to produce heat. In collaborative groups, demonstrate and discuss how the heat is generated. It may be necessary to do some initial research before the discussion. Share information with the class. (P.EN.04.41, P.EN.04.42, P.EN.04.43, S.IP.04.11, S.IP.04.12, S.IP.04.16, S.IA.04.12, S.IA.04.13, S.IA.04.14, S.RS.04.11, S.RS.04.14, S.RS.04.15, S.RS.04.16, S.RS.04.17)

Evaluate Student Understanding

Formative Assessment Examples
- Use a data table for temperature readings and compare their data with the class. (P.EN.04.41)
- Use a data table and then use this information to make a line graph. (P.EN.04.41)
- Use student graphs and discussions to assess the students' abilities to describe heat as a form of energy. (P.EN.04.12).
- Use students' ice cube investigation to assess students' ability to explain how heat is produced while performing a simple investigation. (P.EN.04.41, P.EN.042, P.EN.04.43)

Summative Assessment Examples
- Given real world examples, identify heat and electricity as forms of energy. (P.EN.04.12)
- Demonstrate the use of a thermometer to measure the temperature of a variety of substances. (P.EN.04.41)
- Create a simple investigation to give evidence that when heat or electrical energy is added to a substance, the temperature increases. (P.EN.04.41)
- In a quiz, identify burning, rubbing and electricity as ways that heat is produced. Explain through definition or example, how heat is produced by electricity, burning or rubbing. (P.EN.04.42, P.EN.04.43)

Enrichment

- Discuss other types of energy that are used to produce heat for homes. Individually or in small groups, students do research on other types of energy used for homes and businesses. What are the advantages and disadvantages of the different types? What kind of alternative energy is being studied for future use?
- Research how heat is removed from large concrete structures such as dams to allow the concrete to cool and harden more quickly.
- Research and explain why the column of liquid (alcohol, water) rises or falls in a thermometer as it heats or cools.
- Create a solar oven as an alternative way to cook food.

Intervention

- Practice reading thermometers when adding 1 ice cube and then 2 ice cubes to a glass of warm water. Students practice reading a thermometer when adding increments of hot water to a glass of cold water.
- Compare the accuracy of classroom thermometers.
- Practice reading thermometers daily in many different settings.
- Create collages or graphic organizers to demonstrate how heat is produced through electricity, rubbing, or burning.
- Create a school scavenger hunt in which students identify and describe examples of energy produced through burning, rubbing, and electricity.
- Invite the custodian to visit the classroom to discuss how electricity is used in the school and how the school is heated and cooled.

Examples, Observations and Phenomena (Real World Context)

Examples of temperature changes that occur in nature are the temperatures of air, land and water. The changes in temperature of the air that surrounds the Earth, land, and water affect the weather and climate. The students are familiar with the daily changes in temperature and changes within a day, such as day and night. The temperature changes are due to the position of the heat source. The primary heat source for Earth is the sun. A real world application is for students to relate the changes in temperature and the affect humans have on global warming and the melting of the glaciers.

Electricity is used and transformed in everyday experiences (toasters, hair dryer, televisions, video games, ovens, fans, water heaters, dryers, washing machines, etc.). Students make observations of electrical energy from the time the alarm clock sounds in the morning, through the use of electrical devices throughout the day to the turning off of lights at night. A common misconception about electricity in their homes and schools is that the electricity comes from the wall. Students can research the generator or source of electricity for their hometown to their neighborhood and homes.

People control the temperature in their own environments through different heating and cooling sources. The control of temperature has become a major factor on the use of natural resources and carbon emissions. Students make connections between their actions and the effect on the environment. Discuss the impact of global climate issues, the changes that are occurring and human impact on the climate.

Scientists who have contributed to the study and use of energy are Michael Faraday and his work on the generator, Thomas Edison and his development of the light bulb, and Enrico Fermi and his work in nuclear energy.

Literacy Integration

R.CM.04.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.04.02 retell through concise summarization grade-level narrative and informational text.

R.CM.04.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Examples of trade books available for learning about heat and energy:

Exploring Energy by Scholastic Books, 1995
Heat and Energy by Steve Parker, 2004
Turning up the Heat: Energy by Anne Fullick, 2004

Writing

W.PR.04.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.04.02 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., plot, setting, conflicts/resolutions, definition/description, or chronological sequence).

W.PR.04.03 draft focused ideas using a variety of drafting techniques composing coherent and mechanically sound paragraphs when writing compositions.

Mathematics Integration

Measurement

M.UN.04.01 Measure using common tools and select appropriate units of measure.

M.PS.04.02 Give answers to a reasonable degree of precision in the context of a given problem.

M.TE.04.03 Measure and compare integer temperatures in degrees.

Data and Probability

D.RE.04.01 Construct tables and bar graphs from given data.

Instructional Examples

Energy and Properties of Matter
Electrical Circuits: P.EN.04.51, P.EN.04.52
Conductive and Reflective Properties: P.PM.04.53

Objectives

- Build a simple circuit and explain the transfer and change of energy through the circuit.
- Design a working electromagnet to demonstrate the magnetic effects in a simple circuit.
- Identify objects that are good conductors and poor conductors of heat and electricity.

Engage and Explore

- Turn the classroom lights on and off. Where does the energy for the lights come from? What is occurring behind the switch that turns the light on and off? Note: students are not expected to know the answers; they are to generate ideas and questions to explore during the unit. (P.EN.04.51, S.IP.04.11, S.IP.04.12, S.RS.04.11)
- Give students a battery, bulb, and wire and allow them time to explore how to light the bulb. Students record and draw pictures of observations in a journal. Challenge students to find additional ways to light the bulb using a wire, battery and bulb. (P.EN.04.51, S.IP.04.11, S.IP.04.14)
- Use an electrical circuit to demonstrate how energy is transferred and changed from a battery to wire to bulb. Students draw a simple diagram and use arrows to show energy transfer and change. Note: fourth graders describe that energy flows between the two terminals in the battery. The stored energy in the battery transforms into electrical energy in the wire, which is transformed into heat and light energy in the bulb. It is transformed back to electrical before returning to the battery. (P.EN.04.51, S.IP.04.16, S.IA.04.12)

Explain and Define

- As the concepts are introduced throughout the unit, students create an operational definition for the words circuit, transfer of energy, change of energy, electromagnet, and conductors.

Elaborate and Apply

- Using a battery, wires and a light bulb, students demonstrate an open and closed circuit. Students make a labeled diagram that shows the energy source (battery), wires (conductors) and device using the electricity (bulb) with arrows that show the flow of electricity. After students have shown a basic understanding of the electric circuit, the light bulb can be changed to a motor, buzzer, bells, appliance etc. Students write a paragraph explaining how electrical energy is transferred and changed through an electrical circuit. (P.EN.04.51, S.RS.04.11, S.RS.04.15, S.RS.04.16)
- Students explore the magnetic effects in a simple circuit. Using the simple circuit from previous activities, students place a small magnetic compass near the wire. They move the compass closer to and from the wire. Students record their observations in student journals. Students place compasses at intervals around the circuit. They record observations as the circuit is opened and closed. In collaborative groups, students discuss their observations of the magnetic needle's movement and draw conclusions that simple circuits have magnetic effects. (P.EN.04.52, S.IA.04.12, S.IA.04.13, S.RS.04.15)
- Make an electromagnet by wrapping wire around a core (nail) and attaching the ends of the wire to a battery. Use a compass to determine the magnetic effect. What happens when the flow of electricity is reversed? (P.EN.04.52, S.IP.04.13, S.IP.04.13, S.RS.04.12, S.RS.04.13)
- Test the strength of the electromagnet by using paper clips. How can the strength of the electromagnet be increased? Does the number of coils around the core affect the strength of the electromagnet? Make a data chart. Communicate the findings of your group to the class. (P.EN.04.52, S.IP.04.13, S.IP.04.13, S.RS.04.12, S.RS.04.13)
- Students design an investigation to test the electrical conductivity of common materials. They build a circuit tester with three pieces of wires (battery, wire, light bulb, wire, test object, wire to battery). Test objects such as aluminum, cork, penny, plastic, cloth, eraser, rubber band, salt and pencil. Make a chart with a prediction for each object. Test and classify each object as a good conductor or poor conductor. Students record their findings on charts. In collaborative groups, students share ideas and communicate findings. Using class data, as multiple trials, they generate explanations for similarities and differences in their investigations. Groups create an exhibit, diagram, or graphic organizer to present their findings about good and poor conductors. (P.PM.04.53, S.IP.04.11, S.IP.04.16, S.IA.04.11, S.IA.04.12, S.IA.04.13, S.IA.04.14, S.RS.04.11, S.RS.04.14, S.RS.04.15)
- Students touch a series of objects on a table (wood, cloth, paper, metal, and plastic). Rank the materials from coolest to warmest. A thermometer is placed on each material with the bulb touching the surface of the material. Leave the thermometers in place for two minutes and then note the temperatures. Rank the materials again, but this time according to their actual readings. What conclusion about the conductivity of these

materials can be drawn? Note: all materials will be at room temperature. (P.PM.04.53, S.IP.04.11, S.IP.04.16, S.IA.04.11, S.IA.04.12, S.IA.04.13, S.IA.04.14, S.RS.04.11, S.RS.04.14, S.RS.04.15)

Evaluate Student Understanding

Embedded Assessment Examples

- Observe the student trials and depth of conversation while investigating electrical circuits. (P.EN.04.51)
- Record observations of simple electrical circuits in journals. (P.EN.04.51)
- Make a data chart showing the number of coils around a nail and communicate findings to the group or class. (P.EN.04.52)
- Create a graphic organizer to present findings of a simple investigation of good and poor conductors. (P.PM.04.53)

Summative Assessment Examples

- Diagram energy flow and transfer in an electrical circuit. (P.EN.04.51)
- Design and construct an electromagnet. (P.EN.04.52)
- Students make a chart showing good conductors and poor conductors of heat and electricity. (P.PM.04.53)
- Design and construct a flashlight. (P.EN.04.51, P.PM.04.53)
- Use diagrams of batteries, bulbs and wires illustrating configurations of circuits and non-circuits. Students identify the circuits. (P.EN.04.51)

Enrichment

- Build parallel and series circuits.
- Create a quiz game circuit board. Materials needed are aluminum foil, masking tape, light bulb, wire, battery, and file folder. Punch 6 holes on each side of the file folder. Cut 6 aluminum strips ¼ inch wide that are long enough to connect the holes on opposite sides of the file folder. The holes should be randomly connected. Lay the foil strips, shiny side up, on the sticky side of masking tape that is the same length as the foil. The shiny-sided foil side must connect the holes on opposite sides of the folder. Close the folder. Using a battery, wires and light bulb, test your circuit. If the circuit is complete the light bulb will light. Questions can be used with the correct answer completing the circuit to cause the light bulb to light consequently the board is self-checking.
- Investigate switches. Build circuits containing a variety of switches.
- Investigate light bulbs. Students create an advertisement promoting the use of one bulb over another.
- Design an investigation to explore how common materials are good conductors or poor conductors of heat.

Intervention

- Provide a diagram of a simple circuit with all parts labeled. Students construct the circuit and label the parts.
- Explain and demonstrate open and closed circuits.
- Act out how energy is transferred and changed in an electrical circuit.
- Create a song or poem to explain how energy is transferred and changed in an electrical circuit.
- Use a magnetic compass to show magnetic effects in a variety of circuits. Explain why the magnetic needle moves when the compass is held near the circuit.
- Provide students with a circuit tester to test conductors and insulators. Students predict then test each item. Record observations and results on a chart.
- Provide students with an electromagnet. As students explore the effects of an electromagnetic encourage them to explore the number of coils, different sized batteries, and different wires.

Examples, Observations and Phenomena (Real World Context)

Electrical circuits are an integral part of a students' life. Appliances, electronics, equipment, etc. all use electrical circuits. Different kinds of circuits can be explored such as parallel circuits in home wiring. An investigation into the sources of electrical power has important implications for energy conservation.
Investigate how industry uses electromagnets. Discover practical applications of electromagnets such as in generators and speakers. Electromagnets are used for picking up scrap metal, metal detectors, separating aluminum cans from steel food cans at recycling centers, magnetic resonance imager (MRI), electric guitars and the bullet train in Japan. What is the impact of a power outage on your home and community?

Students are familiar with good and poor conductors of heat and electricity. They understand that a down coat will keep them warmer than a light nylon jacket. They notice the difference between walking barefoot on asphalt and concrete. Cooking utensils have plastic or rubber coated handles. Electricity runs through wires that are insulated with rubber, vinyl or plastic.

As students make observations of everyday activities they discover multiple examples of good and poor conductors.

Literacy Integration

R.CM.04.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.04.02 retell through concise summarization grade-level narrative and informational text.

R.CM.04.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Examples of trade books available for learning about electricity:

All About Electricity by Melvin Berger, 1995
Electricity by Steve Parker and Laura Buller, 2005
Electricity and Magnetism by Peter Adamczyk and Paul-Francis Law, 1994

Writing

W.PR.04.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.04.02 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., plot, setting, conflicts/resolutions, definition/description, or chronological sequence).

W.PR.04.03 draft focused ideas using a variety of drafting techniques composing coherent and mechanically sound paragraphs when writing compositions.

Instructional Examples

Properties of Matter
Magnets: P.PM.04.33, P.PM.04.34

Objectives

- Demonstrate magnetic fields using iron filings.
- Demonstrate that magnetic forces are affected by the strength of the magnet and distance from the magnet.

Engage and Explore

- Magnet Hike: Students list or draw a picture of 10-15 items in the room or on the playground that a magnet will be attracted to. Students test their predictions, record their findings and report to the class. (P.PM.04.33, S.IP.04.11, S.IP.04.16, S.RS.04.14, S.RS.04.15)
- Using a variety of magnets, explore the attraction and repulsion between them. (P.PM.04.33, S.IP.04.11)
- Compare the strength of magnets based on how many paper clips a magnet will pick up. Use a variety of magnets. Make a chart showing a prediction and the actual number of clips picked up for each magnet. Does the kind, shape, size or weight of the magnet determine its strength? (P.PM.04.34, S.IP.04.11, S.IP.04.13, S.IP.04.14, S.IP.04.16)
- In collaborative groups, design a simple investigation to determine the effect distance has on magnetic attraction. Record results and share findings with class. Draw conclusions based on evidence. (P.PM.04.34, S.IP.04.11, S.IP.04.13, S.IP.04.14, S.IP.04.16)

Explain

- Students define attraction and repulsion.
- Explain that magnets with like poles will repel and unlike poles will attract.
- Explain that stronger magnets attract an object from a greater distance. Weaker magnets attract at a much shorter distance.
- Create an operational definition for materials that are attracted to magnets.

Elaborate and Evaluate

- Place two bar magnets inside a large transparent, plastic bag with enough distance between them so they do not attract or repel. Put a piece of paper over the bag. Sprinkle iron filings on the paper over the space between the two magnets and observe the lines of force. Repeat the

activity by repositioning one of the magnets in the opposite direction. Students draw a picture of each observation and label if the magnets are showing attraction or repulsion and whether they are like or unlike poles. (P.PM.04.33, S.IP.04.11, S.RS.04.11)

- Place one bar magnet in a plastic bag. Put a piece of paper over the magnet. Sprinkle iron filings on top of the paper. Observe the magnetic field demonstrated by the iron filings. Students draw a picture showing the magnetic field. Note: Look at the section on misconceptions of the magnetic field. (Do not have the students place the magnet directly on the iron filings as it will be difficult to remove and reuse all the iron filings.) (P.PM.04.33, S.IP.04.11, S.RS.04.11)

Evaluate Student Understanding

Formative Assessment Examples

- Make a chart comparing the number of clips picked up by a magnet. (P.PM.04.34)
- Record results and share findings of a simple investigation exploring the strength and distance of magnets. Draw conclusions based on evidence. (P.PM.04.34)

Summative Assessment Examples

- Draw a diagram of the magnetic effects of two magnets. Diagrams should show like and opposite poles and arrows to indicate how the magnets move toward or away from each other. (P.PM.04.34)
- Draw a picture showing the magnetic field on bar magnets. (P.PM.04.33)
- Design a simple investigation that demonstrates the effect of magnets on materials that are attracted to a magnet. (P.PM.04.34)
- Create a game using magnets. (P.PM.04.34)

Enrichment

- Explore how magnetic fields can be demonstrated using materials other than iron filings.
- Use iron filings to demonstrate the magnetic field of different types of magnets.
- Research the magnetic field of the Earth. How does a magnetic compass interact with the Earth's magnetic field?
- Compare the Earth with a magnet.
- Investigate permanent and temporary magnets. What are their practical uses? Why is one used over the other?
- Research Maglev trains to find out how they use electricity to produce a magnetic field. Would a Maglev train be an asset to the community?

Intervention

- Give students a bag of objects. Sort them as attracted to or not attracted to a magnet. Test the items and record findings on a chart.
- Create a magnet by stroking an iron or steel nail with a magnet. Explore how the number of strokes affects the strength of the magnet.
- Play a game to reinforce the concept that opposite poles attract. Using tape, students mark their hands with N and S. Mark the ends of paper tube or baton with N and S. Form teams. Each team will have a baton. Each team passes the baton down the line and back up the line as quickly as possible but grab it only using the opposite pole hand. After completing the game several times, have students predict what would happen if the baton were grabbed with the same pole hand.

Examples, Observations and Phenomena (Real World Context)

Magnets are used in games, refrigerator magnets, motors, closures, etc.
The use of magnetic properties is used in Magnetic Resonance Imaging (MRI) for medical diagnoses.

Orienteering uses a map and compass. Explore how a magnetic compass works.
What is the advantage of using electromagnets in industry, recycling centers, and scrap metal yards?

Literacy Integration

R.CM.04.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.04.02 retell through concise summarization grade-level narrative and informational text.

R.CM.04.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Examples of trade books available for learning about magnets:

Janice Van Cleave's Magnets by Janice VanCleave, 1993.
Opposites Attract: Magnets by Steve Parker, 2005
The Science of Electricity and Magnetism by Steve Parker, 2005.

Writing

W.PR.04.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.04.02 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., plot, setting, conflicts/resolutions, definition/description, or chronological sequence).

W.PR.04.03 draft focused ideas using a variety of drafting techniques composing coherent and mechanically sound paragraphs when writing compositions.

Fourth Grade Companion Document

4-Unit 2: Properties and Changes of Matter

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.

Fourth Grade Unit 2:
Properties and Changes of Matter

Content Statements and Expectations

4 – 2: Properties and Changes of Matter

Big Ideas (Key Concepts)

- All objects have physical properties that can be measured.
- Matter exists in different states.
- Matter can change from one state to another by heating and cooling.

Clarification of Content Expectations

Standard: Properties of Matter

Content Statement – P.PM.E.1
Physical Properties - All objects and substances have physical properties that can be measured.

Content Expectations

P.PM.04.16 Measure the weight (spring scale) and mass (balances) in grams or kilograms of objects.

Instructional Clarifications

1. Measure means to determine the dimensions, quantity, or capacity of the weight and mass of objects.
2. Mass is defined as the amount of matter in an object. Weight is the force on an object due to gravity.
3. Weight is measured using a spring scale. The metric unit of measure is grams or kilograms. This is not to be confused with measuring force in Newtons using the spring scale.
4. Mass is measured using a balance. The metric unit of measure of mass is also grams or kilograms.
5. Fourth graders should be able to use simple measurement devices to make simple measurements for weight and mass.

Assessment Clarifications

1. Weight is measured using a spring scale. The metric unit of measure is grams or kilograms.
2. Mass is measured using a balance. The metric unit of measure of mass is also grams or kilograms.

P.PM.04.17 Measure the volume of liquids in milliliters and liters.

Instructional Clarifications

1. Measure means to determine the dimensions, quantity, or capacity of volume of liquids in milliliters and liters.
2. Liquid is measured in terms of volume. Volume is how much space matter takes up. The metric units of measure for liquid volume are milliliter and liter.
3. The tools used to measure the volume of liquid are a graduated cylinder or a measuring cup.

Assessment Clarifications

1. Liquid is measured in terms of volume. The metric units of measure for liquid volume are milliliter and liter.
2. The tools used to measure the volume of liquid are a graduated cylinder or a measuring cup.

Content Statement – P.PM.E.2

States of Matter – Matter exists in several different states: solids, liquids, and gases. Each state of matter has unique physical properties. Gases are easily compressed, but liquids and solids do not compress easily. Solids have their own particular shapes, but liquids and gases take the shape of the container.

Content Expectation

P.PM.04.23 Compare and contrast the states (solid, liquid, and gas) of matter.

Instructional Clarifications

1. Compare and contrast means to note similarities and differences between the states of matter.
2. Matter is anything that has mass and takes up space.
3. States of matter are the forms matter can take. The three most familiar forms are solid, liquid, and gas.
4. Solids have a definite shape and size (volume).
5. Liquids have a definite size (volume), but no definite shape. Liquids take the shape of a container, but the volume always stays the same. A liter of milk cannot fit into a half-liter bottle.
6. Gases have no definite shape or size (volume). Gases will also take the shape of the container, but the container is always completely full. Air will take the shape of a basketball, football, balloon, etc.
7. A common misconception is gases are not matter because they are invisible.
8. A common misconception is that air and oxygen are the same things.

9. A common misconception is very tiny things are not matter because they don't weigh enough.
10. A common misconception is all liquids mix.
11. A common misconception is light objects float and heavy ones will not. Larger pieces of ice will sink and a small one will float, for example.
12. A common misconception is objects will float on any liquid.
13. A common misconception is you need the sun for things to evaporate.

Assessment Clarifications

1. States of matter are the forms matter can take. The three most familiar forms are solid, liquid, and gas.
2. Solids have a definite shape and size.
3. Liquids have a definite size, but no definite shape. Liquids take the shape of a container, but the volume always stays the same.
4. Gases have no definite shape or size. Gases will also take the shape of the container, but the container is always completely full (Air will take the shape of a basketball, football, and balloon.).

Content Statement - P.CM.E.1
Changes in State – Matter can be changed from one state (solid, liquid, gas) to another and then back again. Heating and cooling may cause changes in state.

Content Statement

P.CM.04.11 Explain how matter can change from one state (solid, liquid, and gas) to another by heating and cooling.

Instructional Clarifications

1. Explain means to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally how matter can change from one state to another by heating and cooling.
2. Students should be able to identify matter as being the same even after a physical change, such as melting, freezing, or mixing.
3. Heating matter will usually change it from a solid to a liquid or a liquid to a gas or a solid to a gas.
4. Cooling matter will usually change it from a gas to a liquid or a liquid to a solid.
5. Water is the most common type of matter used to show the three states of matter. Other types of matter that change state mostly go from solid to liquid and liquid to solid, such as a candy bar getting soft when sitting in the sun, a popsicle melting on a hot day, or making flavored gelatin. Anything we smell is matter in a gaseous state (gasoline, perfume)
6. Changes in size and shape are not changes in states of matter.

Assessment Clarifications

1. Heating matter will usually change it from a solid to a liquid or a liquid to a gas or a solid to a gas, such as water to water vapor, ice to water.

2. Cooling matter will change it from a gas to a liquid or a liquid to a solid (water vapor to water, water to ice).

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

Inquiry Process
S.IP.04.11 Make purposeful observations concerning properties and changes in matter.
S.IP.04.12 Generate questions based on observations to understand properties and changes in matter.
S.IP.04.13 Plan and conduct simple and fair investigations of properties and changes in matter.
S.IP.04.14 Use metric measurement devices in an investigation of properties and changes in matter.
S.IP.04.15 Make accurate measurements with appropriate units for the measurement tool.
S.IP.04.16 Construct charts and graphs from data and observations dealing with properties and changes in matter.
Inquiry Analysis and Communication
S.IA.04.11 Summarize information from data tables and graphs to answer scientific questions on properties and changes in matter.
S.IA.04.12 Share ideas through discussion in collaborative groups about properties and changes in matter.
S.IA.04.13 Communicate and present findings of observations and investigations about properties and changes in matter using evidence.
Reflection and Social Implications
S.RS.04.11 Use data/samples as evidence to separate fact from opinion regarding properties and changes in matter.
S.RS.04.12 Use evidence in making scientific decisions about properties and changes in matter.
S.RS.04.13 Demonstrate scientific concepts concerning properties and changes in matter through various illustrations, performances, models, exhibits, and activities.
S.RS.04.14 Identify technology associated with properties and changes in matter.
S.RS.04.15.
S.RS.04.16 Design solutions to problems on energy and changes in matter using technology.
S.RS.04.17 Describe how people have contributed to society through the discovery and research into properties and changes in matter.

Vocabulary

Critically Important – State Assessable	Instructionally Useful
weight spring scale grams kilograms balance volume liter (L) milliliter (mL) matter states of matter solid liquid gas definite (as related to shape) compare contrast	metric unit of measure space (related to volume)

Instruments, Measurements, Representations

Measurement	Instruments	Representations
weight	spring scale	grams (g), kilograms (kg)
mass	balance	grams (g), kilograms (kg)
volume	graduated cylinders, metric measuring cups	milliliters (mL), liters (L)
temperature	thermometer	Celsius, Fahrenheit

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

Physical Properties: P.PM.04.16, P.PM.04.17
States of Matter: P.PM.04.23
Changes in State: P.CM.04.11

Objectives

- Measure the weight and mass of objects.
- Measure the volume of liquids.
- Explain the similarities and differences among solids, liquids, and gases.
- Explain how matter can change from one state to another by heating and cooling.

Engage and Explore

- Students have many different experiences finding the weight, mass, and volume of various objects. When using balances, it is best to find the mass of an object three times and find the median, as there will often be discrepancies. (P.PM.04.16, P.PM.04.17, S.IP.04.14, S.IP.04.15)
- Students look around the room and categorize objects by solid, liquid, and gas. In cooperative groups students share their lists to see if they agree on the placement of things. (P.PM.04.16, S.IP.04.11))
- In a whole group discussion share their ideas and then add to the list other things they can think of outside of the classroom setting. If students disagree about the placement of something, have them give support or reasoning for their ideas. Students design activities or investigations that use everyday materials to try to provide evidence their ideas. For example, students design an investigation to find evidence that air is or is not matter, they can use balloons, balls, zip type bags, balances, etc, to prove

that air does have mass and takes up space. (P.PM.04.16, P.PM.04.23, S.IP.04.11, S.IP.04.12, S.IP.04.13, S.IP.04.14, S.IP.04.15, S.IA.04.12, S.IA.04.13, S.IA.04.14, S.RS.04.14)

- Set up a variety of the activities or investigations that students have generated and have them work in cooperative groups to test their ideas. Students revisit their lists to see if they need to make adjustments in any of the items they have included. Most of the discrepancies will involve whether or not gases or very small things are matter. For example, students may not agree on whether a piece of paper is matter. A student comes up and holds out a hand. Lay one sheet of paper on his/her hand, and then keep adding more paper. Even though one sheet of paper doesn't seem to have mass to fourth graders, many sheets of paper do! If it had no mass you could stack paper all day, and they wouldn't feel it. (P.PM.04.16, P.PM.04.23, S.IP.04.11, S.IP.04.12, S.IP.04.13, S.IP.04.14, S.IP.04.15, S.IA.04.12, S.IA.04.13, S.IA.04.14, S.RS.04.11, S.RS.04.14, S.RS.04.15)

Explain and Define

- Students present their findings from their investigations and compare data from similar investigations. (S.IA.04.11, S.IA.04.12, S.IA.04.13, S.RS.04.11)
- Students create definitions of solids, liquids, and gases by the properties that they have observed and measured. (P.PM.04.16, P.PM.04.17, P.PM.04.23)

Elaborate and Apply

- Students compare different liquids and find new properties. What makes them all a liquid even if they are different types of liquids such as dish soap, syrup, water, etc? Use cylinders and measuring cups with metric units to measure volumes. (P.PM.04.16, P.PM.04.17, P.PM.04.23, S.IP.04.14, S.IP.04.15)
- Distribute new tea candles on a metal pie pan to students in cooperative groups. Each group creates a 3-column chart that is labeled, *before/during/after*. Give safety precautions about open flame before lighting the tea candles and specific directions about how to observe a burning candle without putting it out or causing injury. After students have had adequate time to record observations on the *before* portion of the chart, light the candles. Give students approximately 5 minutes to make silent, recorded observations about the candle while it is burning. Instruct students on how to gently blow out the candles and make observations for the next few minutes on the candle after the flame is extinguished. (P.PM.04.23, P.CM.04.11, S.IP.04.11, S.IP.04.12, S.IP.04.13, S.IP.04.16, S.IA.04.11, S.IA.04.12, S.IA.04.13, S.IA.04.14, S.IA.04.15, S.RS.04.11, S.RS.04.14, S.RS.04.15)
- Make ice cream in a zip bag (liquid mixture) inside another zip bag (with ice and rock salt) to show change of state from liquid to solid. Students have an opportunity to use thermometers to measure temperature of the

ice cream before and after, as well as, the ice before and after. (P.CM.04.11)
- Place water in a variety of containers that have different sized openings. Leave the open containers out in the classroom to observe what happens over time. (P.CM.04.11, S.IP.04.16)
- In the winter months, use snow to build a snow person or object and record size and properties. Record temperature of the air and the snow object each day. Predict how long it will take to melt completely. (P.CM.04.11, S.IP.04.16)

Evaluate Student Understanding

Formative Assessment Examples
- Check the results of the weight, mass, and volume measurements. (P.PM.0416, P.PM.04.17)
- Use student investigations and science journals to assess ability to describe properties of matter and changes of state. (P.PM.04.23, P.CM.04.11)
- Observe students during investigations, ask questions to probe student understanding of states of matter while observing cooperative groups. (P.PM.04.23, P.CM.04.11)
- Use student investigations to assess their ability to ask questions based on observations of properties of matter. (P.PM.04.23, P.CM.04.11)

Summative Assessment Examples
- Students will find the weight, mass, and volume of objects not yet measured. (P.PM.0416, P.PM.04.17)
- Create a concept map that shows properties and states of matter. (P.PM.0416, P.PM.04.17, P.PM.04.23, P.CM.04.11)

Enrichment

- Have students look at solids that don't seem like solids and liquids that don't seem like liquids. Some materials like Slime, Goo Yuck, Silly Putty, and gelatin are a few that could be explored.
- Students can plan additional investigations to answer questions that come up during the unit.
- Research glass to see if it is a solid or a liquid.
- Is it possible for matter to change from a solid directly to a gas? What is an example and what is the process called?

Intervention

- Provide students with a set of balls that are different sizes and compositions. First have students put the balls in order from lightest to heaviest. Next, use scales and/or balances to find the actual weight and/or mass.
- Match game: have a set of cards with different objects written on them. Make a large chart with the words "solid", "liquid", and "gas" at the top. Students sort the cards and put them in the correct column.
- Brainstorm a class list of examples of gases changing to liquids and liquids changing to gases, and examples of liquids changing to solids and solids changing to liquids.
- Make finger gelatin. Students measure the ingredients using metric measures and explain changes in states of matter.

Examples, Observations, and Phenomena (Real World Context)

Classifying and measurement are everyday skills. Weight and volume are common measurements for students at this age. Students recognize the volume of liquids from beverage containers, baking and cooking measurements, paint, liquid soaps and detergents. They recognize the measurement of weight from their own measurements and when moving and lifting objects.

Making fudge is an example of watching a change in state of matter. The fudge mixture begins as different solids that are melted to a liquid then stirred and cooled to become a solid again. Baking and cooking activities demonstrate how changes in temperature produce changes in states of matter. Baking and cooking involves making mixtures from solids and liquids and sometimes creating a chemical change for a final product.

The weather provides the opportunity for observations in changes in states through temperature changes and precipitation. Storms may produce rain

and hail due to the difference in the temperature on the ground and up in the air at cloud level. Winter weather can bring a wintry mix that ranges from rain to ice to snow as the temperature decreases.

Literacy Integration

Reading

R.CM.04.01 Connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.04.02 Retell through concise summarization grade-level narrative and informational text.

R.CM.04.04 Apply significant knowledge from grade-level science, social studies, and mathematics texts.

Examples of trade books available for learning about plants and animals:

- *Eyewitness Matter* by C. Cooper, 1999
- *What's the World Made Of? All About Solids, Liquids, and Gases* by Zoehfield and Meisel, 1998
- *It's Science! Solid, Liquid, or Gas?* By Sally Hewitt, 1998

Writing

W.PR.04.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.04.02 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., plot, setting, conflicts/resolutions, definition/description, or chronological sequence).

W.PR.04.03 draft focused ideas using a variety of drafting techniques composing coherent and mechanically sound paragraphs when writing compositions.

Mathematics Integration

Measurement

M.UN.04.01 Measure using common tools and select appropriate units of measure.

M.PS.04.02 Give answers to a reasonable degree of precision in the context of a given problem.

Data and Probability

D.RE.04.01 Construct tables and bar graphs from given data.

Fourth Grade Companion Document
4-Unit 3: Relationships and Requirements of Living Things

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.

Fourth Grade Unit 3:
Relationships and Requirements of Living Things

Content Statements and Expectations

4 – Unit 3: Relationships and Requirements of Living Things

Big Ideas (Key Concepts)

- Plants and animals have basic requirements for maintaining life, which include the need for air, water and a source of energy (food).
- Organisms have observable traits and physical characteristics that help them survive and reproduce in their environments.
- Organisms are a part of a food chain or food web where food/energy is supplied by plants, which need light to produce food/energy.
- Plants and animals can be classified by observable traits and physical characteristics.
- Fossils provide evidence that life forms have changed over time and were influenced by changes in environmental conditions.

Clarification of Content Expectations

Standard: Organization of Living Things

Content Statement – L.OL.E.1

Life Requirements – Organisms have basic needs. Animals and plants need air, water, and food. Plants also require light. Plants and animals use food as a source of energy and as a source of building material for growth and repair.

Content Expectations

L.OL.04.15 Determine that plants require air, water, light, and a source of energy and building material for growth and repair.

Instructional Clarifications

1. Determine means to conclude or ascertain, as after reasoning, observation, etc. the requirements of plants.
2. Plants and animals have almost the same requirements for growth and repair. The one difference is light. Light is necessary for plants to be able to produce their own food. Sunlight is the initial energy source.
3. Fourth graders do not need to know or understand the process of photosynthesis. They need to know that plants are capable of producing their own food and animals are not. The food that the plant produces is its source of energy and building material.
4. Building materials include the food that the plant makes in its leaves plus the nutrients taken in by the plant's roots.
5. A common misconception is that stronger organisms have more energy.
6. A common misconception is that plants get food from the ground.

7. A common misconception is that plants make food for other organisms and not for themselves.
8. A common misconception is that plants need dirt or soil to grow.

Assessment Clarification

1. Plants need air, water, light, a source of energy, food and nutrients for growth and repair.

L.OL.04.16 Determine that animals require air, water and a source of energy and building material for growth and repair.

Instructional Clarifications

1. Determine means to conclude or ascertain, as after reasoning, observation, etc. that animals have requirements for growth and repair.
2. Animals have similar requirements to plants. The major difference is that animals do not require light because they do not make their own food. Animals have to get their energy and building materials from the food they eat.
3. Animals can only survive in environments in which their needs can be met.

Assessment Clarification

1. Animals need air, water, and food for growth and repair.

Content Statement – L.EV.E.2

Survival – Individuals of the same kind differ in their characteristics, and sometimes the differences give individuals an advantage in surviving and reproducing.

Content Expectations

L.EV.04.21 Identify individual differences (color, leg length, size, wing size, leaf shape) in organisms of the same kind.

Instructional Clarifications

1. Identify means to recognize individual differences in organisms of the same kind (species).
2. Organisms have individual differences within their own kind. Examples of these differences include: color, leg length, size, wing size and leaf shape.

Assessment Clarification

1. Organisms have individual differences within their own kind. Examples of these differences include: color, leg length, size, wing size and leaf shape.

L.EV.04.22 Identify how variations in physical characteristics of individual organisms give them an advantage for survival and reproduction.

Instructional Clarifications

1. Identify means to recognize physical characteristics for survival and reproduction.
2. Plants and animals have a variety of physical characteristics that enable them to survive and reproduce.
3. Some kinds of organisms and individuals have advantages in particular environments.
4. One animal whose coloring is more similar to its environment is better camouflaged and therefore less likely to be eaten. An animal with longer legs may be able to run faster than another and therefore is able to catch more prey or escape being caught. The larger babies in a litter are stronger and can get more food than smaller litter mates and therefore having a stronger chance of survival. The tree that grows the tallest in a crowded forest receives the most sunlight.
5. When the environment changes, variations in physical characteristics allow some organisms to survive and reproduce while others die or move to new locations.

Assessment Clarifications

1. Plants and animals have a variety of observable characteristics that help them survive and reproduce.
2. One animal whose coloring is more similar to its environment is better camouflaged and therefore less likely to be eaten. An animal with longer legs may be able to run faster than another and therefore is able to catch more prey or escape being caught. The larger babies in a litter are stronger and can get more food than smaller litter mates and therefore having a stronger chance of survival. The tree that grows the tallest in a crowded forest receives the most sunlight.

Content Statement – L.EC.E.1

Interactions – Organisms interact in various ways including providing food and shelter to one another. Some interactions are helpful; others are harmful to the organism and other organisms.

Content Expectation

L.EC.04.11 Identify organisms as part of a food chain or food web.

Instructional Clarifications

1. Identify means to recognize that organisms are part of a food chain or food web.
2. All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.

3. The sun's energy is the basis for almost all life on Earth. The producers, or plants, use the sun's energy to make their own food.
4. Some animals eat only plants (herbivores), some eat only animals (carnivores), and some eat both plants and animals (omnivores). All of these animals are called consumers. Consumers cannot make their own food.
5. Dead plants and animals are broken down into materials that are retuned to the soil, air and water. Organisms that break down waste or plant and animal remains are called decomposers.
6. Energy and building materials from food is moved through food chains and food webs.
7. The arrows in a food chain diagrams can be confusing to students. Arrows show the energy flow in the system from producers to consumers.
8. Some animals (predators) hunt other animals (prey).
9. Some interactions between organisms are beneficial and some are detrimental.
10. A common misconception is that there are more herbivores because they have more offspring.
11. A common misconception is that not all animals need plants for survival.
12. A common misconception is that soil is not made from dead plants and animals.
13. A common misconception is that decomposition occurs naturally without the help of other organisms.

Assessment Clarifications

1. The sun's energy is the basis for almost all life on Earth. The producers, or plants, use the sun's energy to make food.
2. All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.
3. Some animals eat only plants, some eat only animals, and some eat both plants and animals. All of these animals are called consumers. Consumers cannot make their own food.
4. Dead plants and animals need to be broken down into materials that are retuned to the soil, air and water. Organisms that break down waste or plant and animal remains are called decomposers.

Content Statement: - L.EC.E.2

Changed Environment Effects – When the environment changes, some plants and animals survive to reproduce; others die or move to new locations.

Content Expectation

L.EC.04.21 Explain how environmental changes can produce a change in the food web.

Instructional Clarifications

1. Explain means to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally that environmental changes can produce a change in the food web.
2. Changes in the environment (temperature, shelter, light, food sources, and water) can affect survival of plants and animals. A forest fire destroys shelter and food for animals but also encourages the reproduction of some plants such as the jack pine.
3. The introduction of a new plant or animal species may become invasive and disrupt the food chain/web, if there is not a natural competitor and/or predator present (zebra mussels, quagga mussels, emerald ash borer, purple loosestrife).
4. Human interaction or interference can have both positive and negative effects on the food chain or web. Human interaction, such as a factory dumping wastes, can raise the temperature of a lake that will affect the amount of oxygen in the water needed by the fish and other animals for survival.
5. When a change is severe a species may become threatened, endangered or extinct.
6. When the environment changes, some plants and survive and reproduce and others die out or move to new locations.

Assessment Clarifications

1. Changes in the environment (temperature, shelter, light, food sources, and water) can affect the survival of plants and animals
2. When the environment changes, some plants and survive and reproduce and others die out or move to new locations.

Content Statement – E.ST.E.3

Fossils – Fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at that time.

Content Expectations

E.ST.04.31 Explain how fossils provide evidence of Earth's past.

Instructional Clarifications

1. Explain means to clearly describe by means of illustrations (drawing), demonstrations, written reports, or verbally that fossils provide evidence of Earth's past.
2. Fossils are important because scientists cannot actually observe the Earth's past. Fossils provide evidence that change has occurred in life forms over a time span of millions of years.
3. Fossils are just a sample of plants and animals that existed long ago.
4. A common misconception is that dinosaurs and cavemen lived at the same time.
5. A common misconception is that humans are responsible for the extinction of dinosaurs.
6. A common misconception is that all fossils were created at the same time in history.

Assessment Clarifications

1. Fossils provide evidence that change has occurred in life forms over a time span of millions of years.
2. Fossils are just a sample of plants and animals that existed long ago.

E.ST.04.32 Compare and contrast life forms found in fossils and organisms that exist today.

Instructional Clarifications

1. Compare and contrast means to note similarities and differences between fossils and present day organisms.
2. Fossils provide evidence that change has taken place over time in organisms.
3. There are many similarities in life forms found in fossils and organisms that exist today (cockroaches, crocodiles, ferns).
4. There are many differences in life forms found in fossils and organisms that exist today (horses, elephants). Some life forms are not alive today (dinosaurs).
5. The fossil record is incomplete and represents only a small sample of life forms that existed.

Assessment Clarifications

1. There are many similarities in life forms found in fossils and organisms that exist today (cockroaches, crocodiles, ferns).
2. There are many differences in life forms found in fossils and organisms that exist today (horses, dinosaurs). Some life forms are not alive today (dinosaurs).

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

Inquiry Processes
S.IP.03.11 Make purposeful observations of plant and animal requirements and relationships.
S.IP.03.12 Generate questions based on observations of living things, their requirements and relationships.
S.IP.03.13 Plan and conduct simple and fair investigations to compare and contrast the needs of plants and animals requirements and their relationships.
S.IP.03.14 Manipulate simple tools (for example ruler, meter stick, balance scales) to determine the growth and change of living things.
S.IP.03.15 Make accurate measurements with appropriate units (centimeters, meters, grams, kilograms) of the growth and change of living things.
S.IP.03.16 Construct simple charts and graphs from data and observations of living things.
Inquiry Analysis and Communication
S.IA.03.11 Summarize information from charts and graphs to answer questions about plants and animal requirements and their relationships.
S.IA.03.12 Share ideas about plants and animals and their relationships through purposeful conversation in collaborative groups.
S.IA.03.13 Communicate and present findings of investigations that describe plants and animal requirements and their relationships.
S.IA.03.14 Develop research strategies and skills for information gathering and problem solving about plants and animal requirements and their relationships.
S.IA.03.15 Compare and contrast sets of data from multiple trials of an investigation about plants and animal requirements and their relationships to explain reasons for differences.
Reflection and Social Implications
S.RS.03.11 Demonstrate similarities and differences of plants and animal requirements and their relationships through various illustrations, performances or activities.
S.RS.03. 14 Use data/samples as evidence to separate fact from opinion about plants and animal requirements and their relationships.
S.RS.03.15 Use evidence when communicating, comparing and contrasting plants and animal requirements and their relationships.
S.RS.03.16 Identify technology used in everyday life to help plant and animal requirements and their relationships.
S.RS.03.17 Identify current problems about changes in plant and animal requirements and their relationships that may be solved through the use of technology.
S.RS.03.19 Describe how people such as Charles Darwin, Rachel Carson, Luther Burbank, George Washington Carver, Ibn Al-Baitar, Charles Turner and others have contributed to science throughout history and across cultures.

Vocabulary

Critically Important – State Assessable	Instructional
plants animals source of energy building material requirements for life repair individual differences organisms observable features enable obtain coloring similarities and differences in organisms camouflage predator prey litter food chain food web producers consumers decomposers populations environment affect survival reproduce fossil evidence variations physical characteristics survival reproduction advantage location compare contrast	produce food nutrients physical characteristics advantages beneficial detrimental mold cast imprint

Instruments, Measurement, Representations

The study of plants and animals in this unit relies closely on observation skills using the hand lens and possibly microscopes. Plants and animals are best observed in their natural environment over a period of time. In the classroom and laboratory setting, models of habitats provide a means to observe the growth, behavioral characteristics and structural or physical characteristics that help them to survive. The controlled environment of the model habitat gives the observer the opportunity to determine the balance in the food web within the environment through manipulation of the needs of organisms.

Representations of the food chain or food web within an environment are made using diagrams that demonstrate the direction of the flow of energy in the environment. For example: plant -> rabbit -> owl

Measurements within an ecosystem include collecting data on population shifts within different species, measurement of food consumption, and growth of organisms.

Instructional Framework

Instructional Examples

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 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.

Organization of Living Things
Life Requirements: L.OL.04.15, L.OL.04.16
Evolution
Survival: L.EV.04.21, L.EV.04.22
Ecosystems
Interactions: L.EC.04.11
Changed Environment Effects: L.EC.04.21

Objectives

- Determine that plants require air, water, light, and a source of energy and building material for growth and repair.
- Determine that animals require air, water, light, and a source of energy and building for growth and repair.
- Identify individual differences in organisms of the same kind.
- Identify variations in physical characteristics that help individual animals survive and reproduce.
- Identify plants and animals as part of a food chain or food web.
- Explain how changes in an environment can produce a change in the food web.

Engage and Explore

- Walk around the playground. Students create a list of living things. (L.OL.04.15, L.OL.04.16, S.IP.04.11, S.IP.04.12)
- Using a plant (real or artificial), an animal (real or artificial) and a book, have students brainstorm how the plant and animal are alike and the book is different. (L.OL.04.15, L.OL.04.16, S.IP.04.11, S.IP.04.12)

- Using the schoolyard, a garden, park or nature area, identify plants and animals living there. How are the plants used? (food and shelter) How do the animals survive? (food and shelter) (L.OL.04.15, L.OL.04.16, S.IP.04.11, S.IP.04.12)
- Using the lists of plants and animals living in the nearby schoolyard, garden, park or nature area, brainstorm reasons why some of these plants and animals might not survive. (loss of habitat, too many predators, pollution, drought, flooding, etc.) Choose one plant or animal and write paragraph explaining what it needs to survive in its environment. (L.EV.04.21, L.EC.04.21, S.IP.04.12, S.IA.04.12, S.RS.04.12)
- Role-play a simple food chain such as a water flea, sunfish and heron. Have 1/2 of the class be water fleas, 3/8 of the class be sunfish and 1/8 of the class be herons. Scatter small pieces of paper on the floor that represent food. Half of the pieces should have an **X** on the back that represents food with toxins. First have the water fleas collect the food in a baggy. Then have the sunfish eat the water fleas (and food pieces) by taking their baggy. Last the herons can eat the sunfish (food pieces and water fleas). Students examine the herons' baggies, which represents their stomachs. The more papers with an **X** the more toxins they have eaten. Have a class discussion about how the toxins were passed through the food chain. What effects could they have on each species? Could humans also be getting toxins through our foods? (L.EC.04.21, S.IP.04.12, S.IA.04.12, S.RS.04.12)

Explain and Define

- Students identify the basic needs of plants and animals: air, water, light and a source of energy. Create a two-column list entitled "Needs of Living Things" with the subheadings: "Plants" and "Animals". Students list the needs of plants and animals.
- Students create a graphic organizer to compare and contrast the needs of plants and animals.

Elaborate and Apply

- In collaborative groups, students conduct a simple plant investigation. Each group is given four plants of the same kind. For each plant take away one requirement: light, water, soil and one plant that has all 3 taken away. Make a chart showing each plant and daily record observations. Compare and contrast the plants. Generate questions about the plants needs and other ways to meet these needs. How could students prove a plant's need for air? (L.OL.04.15, S.IP.04.13, S.IP.04.15, S.IP.04.16, S.IA.04.11, S.IA.04.12, S.IA.04.13, S.RS.04.12, S.RS.04.14, S.RS.04.15.)
- Students review the needs of a plant (air, water, light and materials for growth and repair). Each group is given a picture a different mammal. Discuss and present how this animal has these same needs and how they

take care of these needs. Use animals from other groups such as reptile, amphibian, insect, bird etc. Do these animals have the same needs? (L.OL.04.16, S.IP.04.11, S.IP.04.12)

- Make observations of the students in the classroom. List observable traits or physical characteristics that all fourth grade students have in common. Create a list of individual differences in traits and characteristics such as height, arm length, hand size, finger length, foot size, etc. Discuss that every species of animal has individual traits. Which student would be better at reaching the top shelf in the closet? Which student would be better at holding a large ball? Discuss the how individual differences may give an animal an advantage in its environment. (L.EV.04.21, L.EV.04.22, S.IP.04.11, S.IA.04.13)
- Teacher prep: Create die-cut butterflies from newspaper, wrapping paper, construction paper, and lined paper. The majority will be cut from newspaper. Tape sheets of newspaper to the board. Tape the butterflies to the newspaper. Cover the newspaper before students enter the room. Instruct students that they will have five seconds to count the number of butterflies hidden under the paper. Uncover the butterfly-covered newspaper for five seconds. Students record the number and color of the butterflies they observed. Discuss their findings as a group. Create a chart, then a graph, of the number and color of observed butterflies. As a class, uncover the butterflies and count how many and the color of butterflies present. Discuss the variations in observations. Relate the activity to a bird preying on butterflies. How does coloration give the butterflies an advantage or disadvantage? Conclude that individual differences or variations in physical characteristics give organisms an advantage for survival. (L.EV.04.21, L.EV.04.22, S.IP.04.11, S.IP.04.22, S.IP.04.16, S.IA.04.11, S.IA.04.13)
- Students understand a plant's needs. Next, they discuss that a plant makes its own food in its leave so is called a producer. Plants produce or make their own food. Animals depend on plants and other animals for food and are called consumers. Students use pictures or word cards of common plants and animals to construct food chains first and show the interconnections through food webs, using arrows to show the flow of energy. (seeds, grasses, trees, mice, rabbits, moles, raccoons, deer, coyotes, house cat, owls, etc.) Most food chains have 3-4 links. Draw pictures or develop an exhibit to show the food chain or food web. Note: the arrows show the direction that the energy flows through a food chain. (L.EC.04.11, S.IA.04.13, S.RS.04.13)
- Research different kinds of animals using books and Internet sources to find out the foods they eat. Determine from the foods if the animal is an herbivore, omnivore or carnivore. Make a poster showing the animal, its foods and a food chain or web that it is part of. (L.EC.04.11, S.IA.04.14, S.RS.04.12, S.RS.04.13, S.RS.04.14)
- In a cooperative group, research Michigan plants and animals that are on the threatened and endangered list. Using a chart, list the plant or animal and the reason or reasons it is on this list. What are the most common reasons? What is the human role in this plant or animal's reason

for being on this list? Rank the list in order of importance to save. Have a class discussion to compare the rankings and the reasons. (L.EC.04.21, S.IA.04.12, S.IA.04.13, S.IA.04.14, S.RS.04.12)

- Using information on invasive species of Michigan (zebra mussels, quagga mussels, round goby, ruffe, purple loosestrife, emerald ash borer, spiny water flea, sea lamprey, etc.) write and act out a simple play that shows the cause that brought these species and the effect on food chains. (L.EC.04.21, S.IA.04.14, S.RS.04.12)

Evaluate Student Understanding

Formative Assessment Examples

- Chart of results from an investigation of plants and their requirements. (L.OL.04.15)
- Draw a picture of an animal and plant comparing their basic needs. (L.OL.04.15, L.OL.04.16)
- Choose one plant or animal and write paragraph explaining how it is adapted to survive in its environment. (L.EV.04.21, L.EV.04.22)
- Create a food chain and a food web that includes water flea, sunfish and heron. (L.EC.04.11)
- Paragraph explaining the affects of a change in a food chain. (L.EC.04.21)

Summative Assessment Examples

- Draw or construct an environment for an imaginary plant or animal that meets all of its needs. Identify and describe how the organism's needs are met. (L.OL.04.15, L.OL.04.16)
- Draw food chains that include all levels (producers, consumers and decomposers) and indicate energy flow using arrows. Describe and draw the results of a flood, drought, fire, subdivision, etc. (L.EC.04.11)
- Write a paragraph explaining how individual differences among organisms give them an advantage for survival. (L.EV.04.21, L.EV.04.22)

Enrichment

- Research scientists such as Charles Darwin, Luther Burbank, Charles Turner and George Washington Carver to understand their contributions to scientific knowledge.
- Research Rachel Carson to understand how she discovered disruptions in our food chains and their effects.
- Visit the zoo or a botanical garden. Observe and describe how the animals/plants needs are met within the constructed environment. How is this different and the same as their natural environment? What are the advantages and disadvantages of each?
- Research the work of Dr. Robert Ballard and his investigations of ecosystems at the bottom of the ocean that do not use the sun as a source of energy.
- Study other ecosystems (rain forest, desert, mountain, prairie, tundra) and make a poster or diorama that shows the food chains or food web of that ecosystem.
- Investigate color phases among some animal species (squirrels, fox, etc.) to determine the advantages or disadvantages of coloration.
- Research the effects that global climate change, urban sprawl, deforestation, off shore drilling, etc. have on plant and animal populations.

Intervention

- Give students pictures of one plant and one animal. Students research their organisms on the Internet or media. Students draw a picture of one environment that meets the needs of both the plant and the animal.
- Observe a tank of different colored goldfish. Discuss the variation in color. Discuss how the color variations would affect their survival in certain environments, i.e. muddy pond, white pool, etc.
- Sort pictures of organisms into herbivores, omnivores, carnivores, producers, consumers, and decomposers. Create a match game.
- Make food chains and food webs with animals in the area or with pictures cut from magazines.
- Students look at different ecosystems and make simple food chains and food webs based on the ecosystem.

Examples, Observations, and Phenomena (Real World Context)

The National Wildlife Foundation and Environmental Protection Agency work together to keep track of populations and changes in populations of plants and animals. Organisms that become threatened by changes in the environment, hunting or poaching, disease, and other outside factors are placed on *threatened* or *endangered species* list. For example, the polar bear is an endangered species. The habitat of the polar bear is threatened by global warming. The main food source, the seal is more difficult for the polar bear to hunt due to the shifting and melting ice. There are dozens of endangered species. Some animals and plants have become extinct due to the destruction of habitat and interruption of the food web.

Human activities, such as land development, pollution, hunting and poaching, and careless use of natural resources are the main threat to habitats and environments that support diverse species on Earth.

The term “survival of the fittest” is a real world application of the survival of animals and plants in their environment. Organisms with the strongest features that help them to get food, maintain body temperature, escape danger, build homes or nests, and reproduce survive at a greater rate in their environment. Organisms that display weakness in their physical characteristics that help them to survive become prey to other animals or die from lack of nutrition.

Scientists who have contributed to the study of plants and animals are Luther Burbank, Ibn Al-Baitar, Charles Turner and George Washington Carver.

Literacy Integration

Reading

R.CM.04.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.04.02 retell through concise summarization grade-level narrative and informational text.

R.CM.04.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Examples of trade books available for learning about plants and animals:

Woods Walk, Henry W. Art and Michael W. Robbins, 2003
Food Chains and Webs: What are They and How Do They Work?, Andrew Solway, 2007.
Forest Food Chains, Bobbie Kalman, 2004
Food Chains, Peter Riley, 1999
How Animals Live, Bernard Stonehouse and Esther Bertram, 2004
Can We Save Them?, David Dobson, 1997

Writing

W.PR.04.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.04.02 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., plot, setting, conflicts/resolutions, definition/description, or chronological sequence).

W.PR.04.03 draft focused ideas using a variety of drafting techniques composing coherent and mechanically sound paragraphs when writing compositions.

Mathematics Integration

Measurement

M.UN.04.01 Measure using common tools and select appropriate units of measure.

M.PS.04.02 Give answers to a reasonable degree of precision in the context of a given problem.

Data and Probability

D.RE.04.01 Construct tables and bar graphs from given data.

Instructional Examples

Earth in Space and Time

Fossils: E.ST.04.31, E.ST.04.32

Objectives

- Explain how fossils provide evidence of Earth's past.
- Compare and contrast life forms found in fossils and organisms that exist today.

Engage and Explore

- Draw sets of tracks on the board, such as dog, cat, a bicycle, two children, an adult. The tracks cross each other and go in different directions. Students make up scenarios to fit the tracks and defend their versions. (S.IP.04 11, S.IP.04.12)
- Students look at two different rocks. One of the rocks has clear fossil evidence and the other rock has no fossil evidence. Students make observations and generate questions about the pictures of the fossils in the rock. (E.ST.04.31, E.ST.04.32, S.IP.04 11, S.IP.04.12)
- Students make their own fossil by using plaster of Paris or drywall plaster. First flatten a circle of clay of 3-4 inch diameter. Cover the clay with a light coat of petroleum jelly and press shells into the clay leaving the print. Remove the shell and put a ring of poster board around the clay. Fill the clay with the plaster mix to about 1-1 ½ inch thickness. Mix the plaster in small amounts as it will solidify quickly and be difficult to pour into the mold. Let the plaster set for at least a day. Remove the clay and ring and see the shell prints left in the plaster. Which is the mold and which is the cast? Discuss how the print of the shell is left, not the real shell. Discuss how finding shell fossils tell us that at one time water covered that area. (E.ST.04.31, E.ST.04.32, S.IP.04 11, S.IP.04.12, S.RS.04.12)
- Find a spot where students are able to dig in the ground. Look for examples of dead leaves, twigs and insects. Remove them carefully and clean up with a toothbrush. Did the things leave an imprint in the soil? Discuss how this is similar to what a paleontologist does as he/she studies fossils in rocks. (E.ST.04.31, E.ST.04.32, S.IP.04 11, S.IP.04.12)

Explain and Define

- Students develop a definition that a fossil is evidence of what lived in the past. Students develop an understanding that some animals are similar to what exists today such as shellfish; and other animals, such as dinosaurs, no longer exist. Evidence of their existence is shown in fossils.

Elaborate and Evaluate

- Use the chart to complete the activity. Footprint size gives a good idea of overall size and height. Scientists have determined that the length of a footprint is generally equal to one-quarter the length of the hind-leg bone of the animal that made it. The length of the bone gives a good idea of the animal's overall size. In this activity, use numbers to determine the approximate lengths of dinosaur leg bones. (E.ST.04.31, E.ST.04.32, S.IA.04.11, S.IA.04.12, S.IA.04.13, S.RS.04.12)

Name of Dinosaur	Length of footprint	Probable length Of Hind-leg Bone (4 X footprint)	Probable Rank in Probable Size
Triceratops	15 inches (1 1/2 feet)		
Tyrannosaurus	30 inches (2 ½ feet)		
Stegosaurus	18 inches (1 ½ feet)		
Velociraptor	6 inches (1/2 foot)		
Compsognathus	3 inches (1/4 foot)		
Ultrasaurus	78 inches (6 ½ feet)		

- Fossil teeth are evidence of the animal's size and diet. Using pictures of different sizes and kinds of teeth, students identify whether the teeth belonged to an herbivore, omnivore, or carnivore and whether the animal was small, medium, or large. Write a paragraph supporting each decision. (E.ST.04.31, E.ST.04.32, S.IP.04.11, S.IP.04.12, S.RS.04.12)
- Use fossil prints or pictures of plants that show different types of ecosystems (ferns-wetland, pine cone-coniferous forest, maple leaves-deciduous forest, coral-ocean, etc.). Match the picture with the kind of ecosystem. (E.ST.04.31, E.ST.04.32, S.IP.04.11, S.IP.04.12, S.RS.04.12)
- Students draw an underground picture showing what might be found in the schoolyard by a future paleontologist. Plants, animals and humans would leave what items? What could they tell about the environment? (E.ST.04.31, E.ST.04.32, S.IP.04.11, S.IP.04.12, S.RS.04.12)

Evaluate Student Understanding

Formative Assessment Examples

- Discuss the scenario based on animal interaction evidenced through tracks. (E.ST.04.31)
- Discuss the difference between mold and cast fossils. (E.ST.04.31)

- Review the numbers on the table from the dinosaur size activity; and review the dinosaur ranking by size. (E.ST.04.31)
- Match plant fossil print and the kind of ecosystem in which it would be found. (E.ST.04.32)

Summative Assessment Examples

- Paragraph using supporting evidence about teeth to determine the size and type of consumer. (E.ST.04.31)
- Picture and a paragraph that has supporting details describing future evidence of today's environment. (E.ST.04.31, E.ST.04.32)

Enrichment

- Using animal footprints, students create their own story on a slab of clay. Have another student or group of students interpret the picture.
- Take a field trip to a Natural History Museum that has displays of dinosaurs.
- Research the Michigan state fossil, the mastodon, and the Michigan state stone, the Petosky stone.
- Research the dinosaur fossil, Sue, at the Chicago Field Museum. Write a report telling about the finding and restoration of this dinosaur.
- A paleontologist studies fossils. Find out the kind of tools needed to recover fossils from rocks.
- A baby mammoth was found preserved in ice in Siberia. Find current information on this type of fossil.
- The Tuatara Lizard is a living fossil. Research this lizard.
- Research crocodiles, cockroaches and ferns to discover the similarities and differences between ancient and present life forms.

Intervention

- Make a handprint or footprint in plaster. Discuss how this is similar to finding a footprint fossil of an animal. This fossil can be used to identify the kind of animal that lived in that area.
- Bury artifacts, bones, etc. in sand. Students act as paleontologists to uncover evidence. Students create a story based on the evidence.
- Using a fossil collection, students determine whether the fossil originated from a plant or animal. Support ideas with evidence.

Examples, Observations and Phenomena (Real World Context)

Fossils are evidence that dinosaurs existed. Natural History Museums preserve and display dinosaur skeletons. The information archeologists and paleontologists learn from fossils gives evidence of once living organisms and the changes in climate over long periods of time.

Fossils of similar species of animals were found on different continents. Scientists use this evidence to show the continents were once connected.

Literacy Integration

Reading

R.CM.04.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.04.02 retell through concise summarization grade-level narrative and informational text.

R.CM.04.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Examples of trade books available for learning about fossils:

A Dinosaur Named Sue by Fay Robinson, 1999
My Life as an Explorer (Hunt for the Past), Sue Hendrickson, 2001
New Dinos, Shelley Tanaka, 2003
Fossils, Melissa Stewart, 2002
Evolution, Linda Gamlin, 2000

Writing

W.PR.04.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

W.PR.04.02 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., plot, setting, conflicts/resolutions, definition/description, or chronological sequence).

W.PR.04.03 draft focused ideas using a variety of drafting techniques composing coherent and mechanically sound paragraphs when writing compositions.

Mathematics Integration

Data and Probability

D.RE.04.01 Construct tables and bar graphs from given data.

Number and Operations

N.MR.04.14 Solve contextual problems involving whole number multiplication and division.

Fourth Grade Companion Document

4-Unit 4: Sun, Moon, and Earth

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.

Fourth Grade Unit 4:
Sun, Moon, and Earth

Content Statements and Expectations

4 – Unit 4: Sun, Moon, and Earth

Big Ideas (Key Concepts)

- The moon and the Earth move in a predictable pattern around the sun.
- The predictable patterns of the Earth and moon define a day, year, and moon phases.
- The sun appears to move in a predictable pattern across the sky.

Clarification of Content Expectations

Standard: Earth in Space and Time

Content Statement – E.ST.E.1

Characteristics of Objects in the Sky – Common objects in the sky have observable characteristics.

Content Expectations

E.ST.04.11 Identify the sun and moon as common objects in the sky.

Instructional Clarifications

1. Identify means to recognize the differences between the sun and moon and other objects in the sky.
2. The moon is the closest object to Earth, and while many other objects are larger, the moon appears prominent in the sky because it is so close to Earth.
3. The sun is the closest star to Earth, and while many other stars are larger, the sun appears prominent in the sky because it is so close to Earth.

Assessment Clarification

1. The moon is the closest object to Earth, and while many other objects are larger, the moon appears prominent in the sky because it is so close to Earth.
2. The sun is the closest star to Earth, and while many other stars are larger, the sun appears prominent in the sky because it is so close to Earth.

E.ST.04.12 Compare and contrast the characteristics of the sun, moon, and Earth, including relative distances and abilities to support life.

Instructional Clarifications

1. Compare and contrast means to note the similarities and differences of the sun, moon, and Earth.
2. The moon is the closest object in the sky to the Earth.
3. The sun is the closest star to the Earth.
4. The moon is a natural satellite of the Earth, and the Earth is a natural satellite of the sun.
5. The sun is capable of producing its own light, but the Earth and the moon reflect the sun's light.
6. The Earth is capable of supporting life, as we know it, because Earth has water, a breathable atmosphere, and light from the sun.
7. The moon is not capable of supporting life, as we know it, because it does not have breathable atmosphere.
8. The sun, moon, and Earth are nearly spherical.
9. Although the sun is much larger than the moon, they appear to be the same size because the sun is much farther away.
10. The Earth and moon are solid spheres and the sun is gaseous.
11. A common misconception is the sun and moon are the same size.
12. A common misconception is the sun is not a star.
13. A common misconception is the sun orbits the Earth.
14. A common misconception is the stars go away during the day, and the sun goes away at night.
15. A common misconception is the moon is not a satellite.
16. A common misconception is the moon can only be seen at night.
17. A common misconception is the moon has no gravity.
18. A common misconception is wind blows on the moon.

Assessment Clarifications

1. The moon is the closest object in the sky to the Earth.
2. The sun is the closest star to the Earth.
3. The moon is a natural satellite of the Earth and the Earth is a natural satellite of the sun.
4. The sun is capable of producing its own light, but the Earth and the moon reflect the sun's light.
5. The Earth is capable of supporting life, as we know it, because Earth has water, a breathable atmosphere, and light from the sun.
6. The moon is not capable of supporting life, as we know it, because it does not have breathable atmosphere.
7. The sun, moon, and Earth are spheres.
8. Although the sun is much larger than the moon, they appear to be the same size because the sun is much farther away.

Content Statement – E.ST.E.2

Patterns of Objects in the Sky – Common objects in the sky have observable characteristics and predictable patterns of movement.

Content Expectations

E.ST.04.21 Describe the orbit of the Earth around the sun as it defines a year.

Instructional Clarifications

1. Describe means to tell or depict in spoken or written words how the orbit of the Earth around the sun defines a year.
2. It takes the Earth approximately 365.25 days or one year to make a complete revolution around the sun. Leap year occurs every fourth year to accommodate the extra 0.25 day per year.
3. Revolution is the movement of one object on a path (orbit) around another object.
4. The path the Earth follows is called an orbit. The Earth follows the same imaginary path every year.

Assessment Clarification

1. It takes the Earth approximately 365 days or one year to make a complete revolution around the sun.
2. The path the Earth follows is called an orbit. The Earth follows the same imaginary path every year.

E.ST.04.22 Explain that the spin of the Earth creates day and night.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally tell how the spin of the Earth creates day and night.
2. The Earth spins on its axis. It takes the Earth approximately 24 hours or one day to make one complete rotation.
3. Rotation is the turning of an object on its axis.
4. Axis is an imaginary line through the center of an object around which that object turns.
5. The side of the Earth facing the sun is experiencing daytime and the side not facing the sun is experiencing night.

Assessment Clarifications

1. The Earth spins on its axis. It takes the Earth approximately 24 hours or one day to make one complete rotation.
2. The side of the Earth facing the sun is experiencing daytime and the side not facing the sun is experiencing night.

E.ST.04.23 Describe the motion of the moon around the Earth.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words the path the moon travels around the Earth.
2. The moon travels on a path around the Earth called a revolution.
3. The moon rotates on its axis.
4. The moon takes approximately 28 days to both rotate and revolve thus causing the same side of the moon to always face the Earth.
5. A common misconception is the moon does not rotate on its axis as it revolves around the Earth.

Assessment Clarification

1. The moon travels on a path around the Earth called a revolution.

E.ST.04.24 Explain how the visible shape of the moon follows a predictable cycle, which takes approximately a month.

Instructional Clarifications

1. Explain is to clearly describe by means of illustrations (drawing), demonstrations, and/or verbally tell how the visible shape of the moon follows a predictable cycle that takes approximately a month.
2. The moon shines by reflecting light from the sun.
3. The observable shape of the moon changes from day to day in a cycle that lasts about a month. The different shapes of the moon are called phases.
4. No matter where the moon is in space, half is lighted and half is dark. As the moon revolves around the Earth, we see different amounts of the moon's lighted side. So, the moon seems to change shape.
5. The cycle of phases is new moon, waxing crescent, first quarter, waxing gibbous, full moon, waning gibbous, last quarter, and waning crescent. Note: Although the quarter moon looks like a "half moon," the word quarter refers to the moon being one fourth of its way through its cycle.
6. A common misconception is the moon gets bigger and smaller.
7. A common misconception is the phases of the moon are caused by shadows cast on its surface by other objects in the solar system.
8. A common misconception is the phases of the moon are caused by the shadow of the Earth on the moon.
9. A common misconception is the moon moving into the sun's shadow cause the phases of the moon.
10. A common misconception is clouds cause the phases of the moon.
11. A common misconception is the same side of the moon is always dark.

Assessment Clarifications

1. The moon is visible because it reflects light from the sun.
2. The moon seems to change shape from day to day in a cycle that lasts about a month.
3. The different shapes of the moon are called phases.

E.ST.04.25 Describe the apparent movement of the sun and moon across the sky through day/night and the seasons.

Instructional Clarifications

1. Describe is to tell or depict in spoken or written words the apparent movement of the sun and moon across the sky through day/night and the seasons.
2. The sun appears to move across the sky every day from the eastern part of the sky to the western part of the sky. The apparent motion of the sun across the sky is due to the Earth's rotation.
3. The path of the sun changes slowly with the seasons getting higher in the summer and lower in the winter.
4. The moon also appears to move across the sky from east to west on a daily basis due to the Earth's rotation, however the time of the rising and setting varies throughout its cycle.
5. A common misconception is the sun rises exactly due east and sets exactly due west every day.
6. A common misconception is the sun is directly overhead at 12:00 noon everyday.

Assessment Clarifications

1. The sun appears to move across the sky in the same way from east to west every day.
2. The path of the sun changes slowly with the seasons getting higher in the summer and lower in the winter.
3. When visible, the moon also moves across the sky from east to west on a daily basis.

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

Inquiry Processes
S.IP.04.11 Make purposeful observations of the sun and the moon using the appropriate senses.
S.IP.04.12 Generate questions based on observations of the sun and the moon
S.IP.04.14 Manipulate simple tools that aid observation and data collection (ruler, thermometer).
S.IP.04.15 Make accurate measurements with appropriate units (centimeters, Celsius).
S.IP.04.16 Construct simple charts and graphs from data and observations of the movements of the sun and the moon.
Inquiry Analysis and Communication
S.IA.04.11 Summarize information from charts the Earth, sun, and moon
S.IA.04.12 Share ideas about the Earth, sun, and moon through purposeful conversation in collaborative groups.
S.IA.04.13 Communicate and present findings of observations and investigations.
S.IA.04.14 Develop research strategies and skills for information gathering about the sun and the moon.
Reflection and Social Implications
S.RS.04.11 Demonstrate understanding of the relationship of the Earth, sun, and moon through illustrations and models.
S.RS.04.14 Use samples as evidence to separate fact from opinion when classifying the Earth, sun, and moon.
S.RS.04.15 Use evidence when communicating about the Earth, sun, and moon.
S.RS.04.16 Identify technology used in everyday life when taking shadow readings of the sun's movement in the sky.
S.RS.04.18 Describe the effect the sun has on the balance of the natural world.
S.RS.04.19 Describe how people such as Ptolemy, Copernicus, Galileo, Hubble, and Hawking have contributed to science throughout history and across cultures.

Vocabulary

Critically Important – State Assessable	Instructionally Useful
Earth	seasonal change
sun	sun's position
moon	planet
star observe	relative position
reflect	solar system
ability to support life	compare
produce light	contrast
breathable atmosphere	approximately
revolution	
orbit	
rotation	
Earth's axis	
phases of the moon	
day	
night	
cycle	
seasons	
year	
natural satellite	
relative distance	
capable	
visible shape	
predictable cycle	
apparent movement	

Instruments, Measurements, Representations

temperature	thermometer	Celsius

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 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

Characteristics of Objects in the Sky: E.ST.04.11, E.ST.04.12
Patterns of Objects in the Sky: E.ST.04.21, E.ST.04.22, E.ST.04.23, E.ST.04.24, E.ST.04.25

Objectives

- Make observations and describe the apparent movement of the sun and moon across the sky.
- Determine why there is day and night and a year.
- Observe the phases of the moon.

Engage and Explore

- Students are fascinated with the skies but often have misconceptions and a difficult time understanding the concept of size and distance. In the hallway, outside, or in the gym, a student stands and holds a baseball about 10 feet away from the class. Another student stands about 40 feet away and holds a basketball. Discuss the relative sizes of the balls and the distances between them. Students measure the relative sizes of the two balls by fully extending their arm and aligning their thumb between their eye and each ball. Note: the distances may need to be adjusted. Repeat the activity with the sun and a full moon. Each object will be about the size of your thumbnail. (E.ST.04.11, E.ST.04.12, S.IP.04.11, S.IP.04.14, S.IA.04.14, S.RS.04.11, S.RS.04.15)
- Students predict the sizes of the Earth and moon relative to the sun. Using play clay, the students create Earth and moon models based on an eight-inch diameter ball representing the sun. After comparing their models, discuss the sizes the clay balls should be relative to the eight-inch diameter ball. (The actual size of the Earth should be about the size of a peppercorn and the moon 1/4th of the Earth.) (E.ST.04.12, S.RS.04.11)

- Relative sizes and distances between the sun, moon, and Earth are shown outside. Use an eight-inch diameter ball to represent the sun, a peppercorn to represent the Earth, and a very small pinhead to represent the moon. It helps to attach the moon and Earth to cards so they don't get lost. Place the sun at one end of the playground. Use a yardstick and count out 26 lengths from the sun to the Earth. The moon is 2 ½ inches from the Earth. This model is accurate both in size and distance. Pluto would be another 974 yardstick lengths away. Have the students reflect on the fact that the moon is the farthest man has been in space. Other fun facts are 109 Earths lined up equal the diameter of the sun and a million Earths can fit into the sun. (E.ST.04.11, E.ST.04.12, S.IP.04.11, S.IA.04.14, S.RS.04.12, S.RS.04.15)
- Time needs to be spent outside making observations of the sun. On a sunny day put out a piece of chart paper with a stick standing up vertically in the center. Record the shadow the stick makes by tracing it. Repeat this every half hour for five hours. Allow the students time to measure the lengths of the shadows and have substantive conversation about the data they recorded. (E.ST.04.22, E.ST.04.25, S.IP.04.11, S.IP.04.14, S.IP.04.15, S.IP.04.11, S.IP.04.12, S.IP.04.14, S.RS.04.16)
- The sun produces heat and light that is reflected by the Earth and moon. Take the temperatures of two cups of cold water. Cover one with aluminum foil and leave the other uncovered. Put them in the sun for 15 minutes and take the temperatures again. The foil reflects the radiation while the water absorbs it. (E.ST.04.12, S.IP.04.14, S.IP.04.15, S.IP.04.14, S.RS.04.14, S.RS.04.16)
- The moon is more difficult to track but the students can create an observation chart and keep track of the shape of the moon for a month. (E.ST.04.23, E.ST.04.24, E.ST.04.25, S.IP.04.11, S.IP.04.12, S.IP.04.16, S.IP.04.11, S.IP.04.14, S.RS.04.11)
- Demonstrating the spinning of the Earth on its axis needs to be reinforced many times. Students put their index finger on top of their heads and spin counterclockwise showing the Earth's rotation on its axis. A flashlight shining at them can simulate the sun. When they are facing the "sun", it is day for them; and when they aren't facing the "sun", it is night for them. The moon also rotates on its axis, but it is very slow compared to the Earth. A helpful way for students to remember the concept of rotation and day and night is that the words "rotation", "day", and "axis" all have the letter "A". In pairs students can have substantive conversation about the words day and night. (E.ST.04.22, S.IP.04.14, S.RS.04.15)
- Demonstrating the Earth or moon traveling on an imaginary path also needs to be reinforced many times. Students walk around another object or use balls and flashlights to simulate revolution. A helpful way for students to remember revolution is that the words "revolution" and "orbit" have the letter "O" in them, and the letter O looks like an orbit. In pairs students can have substantive conversation about the definition of a year. (E.ST.04.21, S.IP.04.14, S.RS.04.15)

Explain and Define

- The difference between revolution and rotation can be clarified with many class discussions and demonstrations. The definitions for axis, orbit, day, night, and year are a natural fit while discussing rotation and revolution. Pictures should be made along with the definitions. Differences in sizes of the sun and moon and the phases of the moon also can be discussed. (E.ST.04.11, E.ST.04.21, E.ST.04.22, E.ST.04.23, E.ST.04.24, S.IP.04.12, S.IP.04.12)

Elaborate and Apply

- The Earth, sun, and moon can be compared and contrasted on a chart. While in cooperative groups, students use reference books to find various characteristics about the Earth, sun, and moon. (E.ST.04.12, S.IP.04.16, S.IP.04.11, S.RS.04.14)

	Size (diameter)	Distance from sun	Length for 1 rotation	Length for 1 revolution	Can support life	Fun facts
Sun		---	---	---		
Moon						
Earth						

- Students make a two or three-dimensional model of the Earth, sun, and moon. The model should show the rotations and revolutions of the Earth and moon, give the length of time it takes for these movements, and demonstrate day and night. (E.ST.04.11, E.ST.04.12, E.ST.04.21, E.ST.04.22, E.ST.04.23, S.IP.04.13, S.RS.04.11, S.RS.04.15)
- Using hands can easily recognize the different phases of the moon. The start of the moon cycle is the new moon when no moon is observed. By cupping the right hand into a backwards “C” shape, the moon phase that fits into the curve is the first quarter or the time when the moon appears to be getting bigger (waxing). When the left hand is cupped and the moon phase fits into the curve, it is the last quarter or time when the moon appears to be getting smaller (waning). A full moon is halfway through the cycle. Understanding what causes the phases is very difficult for fourth grade students and is not something they are required to learn.
- Show the phases using chocolate sandwich cookies. When they are carefully pulled apart, the frosting stays on one cookie and looks like a full moon. Using a toothpick, the frosting is scraped off to show the phases. The cookie without frosting looks like a new moon. Students can lay out the cookies, and then draw pictures of the phases of the moon while looking at the cookies and using their hands in the “C” shapes to help. (E.ST.04.24, S.IP.04.13, S.RS.04.11)
- A long-term project can be used to note how high the sun is in the sky through different seasons. At the start of each month, students measure the height of the sun at noon using fists. Students clench both hands into

fists, and put their arms out straight in front. Starting at the horizon, they continuously put one fist on top of the other until they get to the height of the sun. Count how many fists it takes. Each fist represents approximately 10 degrees. (Three fingers equal five degrees and the pinky finger is one degree if a fractional part is needed.) Record the data on a graph. Note: the time. *Warning: Do not look directly at the sun.* (E.ST.04.25, S.IP.04.16, S.IP.04.11, S.RS.04.11)

- To determine that the moon rises in the eastern part of the sky like the sun, the students need to make observations of the moon. If the moon is seen in the east, it is rising; and if it is seen in the west, it is setting. The time of day the moon is observed can be recorded on a chart. Unfortunately the moon does not always rise or set at approximately the same time like the sun does due to the fact that it's revolving around the Earth. It does, however, always rise in the east and set in the west. Fourth graders only need to know that it does rise in the east and set in the west. The best time to see the moonrise is during the full moon. (E.ST.04.25, S.IP.04.16, S.IP.04.11, S.RS.04.15)

Evaluate Student Understanding

Formative Assessment Examples

- Organize facts about the sun, moon, and Earth on a chart. (E.ST.04.11, E.ST.04.12)
- Draw diagrams and pictures to show understanding of the terms rotation, revolution, day, night, year, orbit, and phases of the moon. (E.ST.04.21, E.ST.04.22, E.ST.04.23, E.ST.04.24)
- Keep ongoing graphs and/or charts showing the data collected about the sun and the moon. (E.ST.04.24, E.ST.04.25)

Summative Assessment Examples

- Explain the difference between the words rotation and revolution. (E.ST.04.21, E.ST.04.22)
- Explain the difference between the time it take the Earth to rotate and revolve and the moon to rotate and revolve. (E.ST.04.21, E.ST.04.22, E.ST.04.23)
- Put pictures of phases of the moon in the correct order. (E.ST.04.24)
- Create a model of the Earth, sun, and moon that has labels showing: rotation and revolution of the Earth and moon, day and night, a year, and the relative sizes of the Earth, sun, and moon. (E.ST.04.21, E.ST.04.22, E.ST.04.23, E.ST.04.24)

Enrichment

- Research about craters on the moon and what causes them. Set up an investigation making craters by dropping clay balls into flour and observing the patterns and sizes of the craters. Try different heights to see if the size of the crater changes. A toothpick inserted into the clay ball makes it easier to drop the ball and remove it from the flour without disturbing the crater.
- Do research about the missions to the moon and what it was like for the astronauts. Students plan a make-believe mission to the moon. What would be the 10 most important items they would need to take and why?
- Research about possible missions to the sun.
- Take a field trip to a planetarium.
- Answer the question, “Why does it look like the American flag the astronauts planted is waving on the moon?” (Answer: there is a bar across the top to hold it out. Remember there is gravity on the moon and there is no atmosphere so no wind.)
- Research other moons around other planets.
- Contributions of scientists throughout history and across cultures have contributed significantly to current scientific thought. Knowledge about space is constantly changing. Scientists such as Ptolemy, Copernicus, Galileo, Steven Hawking, Neil deGrasse Tyson, Henrietta Leavitt, and Maria Mitchell can be studied.

Intervention

- Several times per day students get up and demonstrate rotation and revolution.
- Have students in groups of three-play act the sun, moon, and Earth. Repeat all the vocabulary words while acting them out.
- Use many flashlights and Styrofoam balls to demonstrate day and night and a year.
- Find examples of rotation and revolution in everyday life.
- Make a flipbook showing the phases of the moon.
- Use a calendar that shows the phases of the moon. Put up a phase once a week on the class calendar.
- In art class do a lesson on perspective and draw pictures with things in the foreground and things in the background.

Examples, Observations, and Phenomena (Real World Context)

Many misconceptions are found when observing objects in the sky. Our knowledge of space is constantly changing, however, our understanding of the phenomena discussed in this unit is and has been stable for a very long time. Scientists have understood the rotation of the Earth on its axis and the revolution of the Earth around the sun and moon around the Earth for centuries.

Discuss why pictures are drawn or models are made either incorrectly or are misleading. For example, the sun is always represented as a small object in a picture of the solar system simply because it isn't possible to draw its accurate size and distance relative to the Earth and moon. The paper would have to be the size of the classroom. If a model shows the correct relative sizes of the Sun, moon, and Earth, then the relative distances are often shown incorrectly or vice versa because the model has to be a useful size. The news sometimes has reporters giving incorrect information or updates on new findings by astronomers. Cartoon pictures or even pictures in textbooks can be incorrect or misleading. What was true 10 years ago may no longer be correct. Students need to be aware of misinformation and new information in their everyday lives.

NASA is once again planning a mission to the moon. Encourage students to visit the NASA website to view current information about space and simulations of the movement of the Earth and moon.

The sun is often in the news from solar power to causing skin cancer to solar flares disrupting computers.

Literacy Integration

Reading

R.CM.04.01 connect personal knowledge, experiences, and understanding of the world to themes and perspectives in text through oral and written responses.

R.CM.04.02 retell through concise summarization grade-level narrative and informational text.

R.CM.04.04 apply significant knowledge from grade-level science, social studies, and mathematics texts.

Examples of the trade books available for learning about the sun, moon, and Earth are:

Postcards From Pluto: A Tour of the Solar System by Loreen Leedy, 1996
The Moon by Seymour Simon, 2003
The Sun by Seymour Simon, 2003
Earth: Our Planet in Space by Seymour Simon, 2003
George's Secret Key to the Universe by Steven and Lucy Hawking, 2007

Writing

W.PR.04.01 set a purpose, consider audience, and replicate authors' styles and patterns when writing a narrative or informational piece.

- Using the same format as the book *Postcards from Pluto* and the chart that was made comparing and contrasting the Earth, sun, and moon, write postcards from the moon and the sun that include facts.

W.PR.04.02 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., plot, setting, conflicts/resolutions, definition/description, or chronological sequence).

W.PR.04.03 draft focused ideas using a variety of drafting techniques composing coherent and mechanically sound paragraphs when writing compositions.

Mathematics Integration

M.UN.04.01 measure using common tools and select appropriate units of measure.

M.PS.04.02 give answers to a reasonable degree of precision in the context of a given problem.

D.RE.04.01 construct tables and bar graphs from given data.