Fourth Grade Companion Document

4-Unit 2: Properties and Changes of Matter

Table of Contents Page 1

Introduction Page 2

Curriculum Cross Reference Guide Page 4

Unit 2: Properties and Changes of Matter Page 5

- Big Ideas (Key Concepts) Page 5
- Clarification of Content Expectations Page 5
- Inquiry Process, Inquiry Analysis and Communication, Reflection and Social Implications Page 9
- Vocabulary Page 10
- Instruments, Measurements, and Representations Page 10
- Instructional Framework Page 11
- Enrichment Page 14
- Intervention Page 14
- Examples, Observations and Phenomena (Real World Context) Page 14
- Literacy Integration Page 15
- Mathematics Integration Page 16

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

Code	Statements & Expectations	Page
P.PM.E.1	**Physical Properties - All objects and substances have physical properties that can be measured.**	1
P.PM.04.16	Measure the weight (spring scale) and mass (balances) in grams or kilograms of objects.	1
P.PM.04.17	Measure the volume of liquids in milliliters and liters.	2
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.**	2
P.PM.04.23	Compare and contrast the states (solid, liquid, and gas) of matter.	2
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.**	3
P.CM.04.11	Explain how matter can change from one state (solid, liquid, and gas) to another by heating and cooling.	3

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.