Grade 5 Model Science Unit 2: Changes to Matter (1.29.16) **Instructional Days: 15**

Unit Summary
If I have a frozen water bottle that weighs 500 mg, how much will it weigh if the water melts?
In this unit of study, students develop an understanding of the idea that regardless of the type of change that matter undergoes, the total weight of matter is conserved. Students determine whether the mixing of two or more substances results in new substances. The crosscutting concepts of *cause and effect* and *scale, proportion, and quantity* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency in *planning and carrying out investigations* and *using mathematics and computational thinking*. Students are expected to use these practices to demonstrate understanding of the core ideas.
This unit is based on 5-PS1-4 and 5-PS1-2.
Student Learning Objectives
Conduct an investigation to determine whether the mixing of two or more substances results in new substances. (5-PS1-4)
Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. *[Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.]* [Assessment Boundary: Assessment does not include distinguishing mass and weight.]. **(5-PS1-2)**

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Unit Sequence	
Part A: *How can we make slime?*	
Concepts	**Formative Assessment**
• Cause-and-effect relationships are routinely identified, tested, and used to explain change. • When two or more different substances are mixed, a new substance with different properties may be formed.	*Students who understand the concepts are able to:* • Identify, test, and use cause-and-effect relationships to explain change. • Conduct an investigation collaboratively to produce data that can serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials is considered. • Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Unit Sequence	
Part B: *How can baking soda and vinegar burst a zip-lock bag?*	
Concepts	**Formative Assessment**
• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. • No matter what reaction or change in properties occurs, the total weight of the substances does not change. *(Note: Mass and weight are not distinguished at this grade level.)* • Science assumes consistent patterns in natural systems.	*Students who understand the concepts are able to:* • Measure and describe physical quantities such as weight, time, temperature, and volume. • Measure and graph quantities such as weight to address scientific and engineering questions and problems. • Measure and graph quantities to provide evidence that regardless of the type of change that occurs when substances are heated, cooled, or mixed, the total weight is conserved. *(Note: Assessment does not include distinguishing between mass and weight.)* • Examples of reactions or changes could include: ✓ Phase changes ✓ Dissolving ✓ Mixing

What It Looks Like in the Classroom
In this unit of study, students will use mathematical and computational thinking to understand the cause and effect relationship between physical changes in matter and conservation of weight. Throughout the unit, students need multiple opportunities to observe and document changes in matter due to physical changes, and to analyze data to explain changes that do or do not occur in the physical properties of matter. Students begin by planning and conducting investigations to determine whether or not a new substance is made when two or more substances are mixed (see the Sample Open Education Resources). As they work with a variety of substances, they should: ✓ Measure, observe, and document physical properties (e.g., color, mass, volume, size, shape, hardness, reflectivity, conductivity, and response to magnetic forces) of two or three substances. ✓ Mix the original substances. ✓ Measure, observe, and document the physical properties of the substance produced when the original substances are mixed. ✓ Compare data from the original substances to data from the substance produced, and determine what changes, if any, have occurred. ✓ Use observations and data as evidence to explain whether or not a new substance was produced, and to explain any changes that occurred when the original substances were mixed. With each set of substances that students investigate, it is important that they use balances to measure the mass of the original substances and the mass of the substance made when the original substances are mixed. These data should be documented so that students can analyze the data. As they compare the data, they should recognize that when two or more substances are mixed, the mass of the resulting substance equals the sum of the masses of the original substances. In other words, the total mass is conserved. Conservation of mass is a critical concept that is developed over time; therefore, students need multiple opportunities to investigate this phenomenon. Students should measure the mass of each substance, document the data they collect in a table or chart, and use the data as evidence that regardless of the changes that occur when mixing substances, the total weight of matter is conserved. In addition to observing changes that occur when substances are mixed, students should also have opportunities to investigate other types of physical changes. For example, students can observe changes in matter due to heating, cooling, melting, freezing, and/or dissolving. As before, students should measure, observe, and document the physical properties of the substance before and after a physical change, and use the data as evidence to explain any changes that occur. The data should also provide evidence that regardless of the type of change that matter undergoes, the mass is conserved.

Connecting with English Language Arts/Literacy and Mathematics
English Language/Arts Students can conduct short research projects, using both print and digital sources, to build their understanding of physical changes to matter. While reading, they should take notes of relevant information, and summarize that information so that it can be used as evidence to explain the changes that occur as substances are heated, cooled, dissolved, or mixed. When drawing evidence from texts to support analysis, reflection, and research, students should provide a list of sources.

Mathematics

- Use appropriate tools in strategic ways when measuring physical properties of substances, such as weight or volume.
- Model with mathematics when organizing data into tables or charts, and using the data as evidence to explain changes that occur.
- Convert among different-sized standard measurement units within a given measurement system and use these conversions to explain changes that occur.

Modifications

(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide ELL students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.
- Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA).

Research on Student Learning

Student thinking about chemical change tends to be dominated by the obvious features of the change. For example, some students think that when something is burned in a closed container, it will weigh more because they see the smoke that was produced. Further, many students do not view chemical changes as interactions. They do not understand that substances can be formed by the recombination of atoms in the original substances. Rather, they see chemical change as the result of a separate change in the original substance, or changes, each one separate, in several original substances. For example, some students see the smoke formed when wood burns as having been driven out of the wood by the flame (NSDL, 2015).

Prior Learning
Grade 2 Unit 2: Properties of Matter • Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. • Different properties are suited to different purposes. **Grade 2 Unit 3: Changes to Matter** • A great variety of objects can be built up from a small set of pieces. • Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.

Future Learning
Grade 7 Unit 1: Structure and Properties of Matter • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. **Grade 7 Unit 2: Interactions of Matter** • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). • The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. **Grade 7 Unit 3: Chemical Reactions** • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. • The total number of each type of atom is conserved, and thus the mass does not change. • Some chemical reactions release energy, others store energy.

Connections to Other Units
In **Unit 1: Properties of Matter**, students describe that matter is made of particles too small to be seen.

Sample of Open Education Resources
Time for Slime: Students combine water and borax to create slime. Be sure to read and follow all of the cautions on the borax box label. Bubble Burst! How can baking soda and vinegar burst a zip-lock bag? Flame Out: A candle flame is actually a chemical reaction in action! Candle wax is one of the chemicals in the reaction.

Teacher Professional Learning Resources
Using the NGSS Practices in the Elementary Grades The presenters were Heidi Schweingruber from the National Research Council, Deborah Smith from Penn State University, and Jessica Jeffries from State College Area School District. In this seminar the presenters talked about applying the scientific and engineering practices described in A Framework for K–12 Science Education in elementary-level classrooms. Continue the discussion in the community forums. **Teaching *NGSS* in K-5: Constructing Explanations from Evidence** Carla Zembal-Saul, Mary Starr, and Kathy Renfrew, provided an overview of the NGSS for K-5th grade. The web seminar focused on the three dimensional learning of the NGSS, while introducing CLAIMS-EVIDENCE-REASONING (CER) as a framework for introducing explanations from evidence. The presenters highlighted and discussed the importance of engaging learners with phenomena, and included a demonstration on using a KLEWS chart to map the development of scientific explanations of those phenomena. View the resource collection. Continue discussing this topic in the community forums. ***NGSS* Core Ideas: Matter and Its Interactions** The presenter was Joe Krajcik from Michigan State University. The program featured strategies for teaching about physical science concepts that answer questions such as "How do particles combine to form the variety of matter one observes?" and "How do substances combine or change (react) to make new substances?" Dr. Krajcik began the presentation by defining disciplinary core ideas and discussing the value of using core ideas to build understanding across time. He also talked about the way disciplinary core ideas work together with the other components of NGSS: scientific and engineering practices and crosscutting concepts. Dr. Krajcik talked about the disciplinary core ideas for PS1 and shared examples of student work. Participants had the opportunity to ask questions and discuss ideas for classroom application with other participating teachers. Visit the resource collection. Continue discussing this topic in the community forums.

Appendix A: NGSS and Foundations for the Unit

Conduct an investigation to determine whether the mixing of two or more substances results in new substances. (5-PS1-4)

Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. *[Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.]* *[Assessment Boundary: Assessment does not include distinguishing mass and weight.].* **(5-PS1-2)**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations

- Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (5-PS1-4)

Using Mathematics and Computational Thinking

- Measure and graph quantities such as weight to address scientific and engineering questions and problems. (5-PS1-2)

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)

PS1.B: Chemical Reactions

- When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified and used to explain change. (5-PS1-4)

Scale, Proportion, and Quantity

- Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-2)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes consistent patterns in natural systems. (5-PS1-2)

English Language Arts

Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-2),(5-PS1-4) **W.5.7**

Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-PS1-2)(5-PS1-4) **W.5.8**

Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-PS1-2),(5-PS1-4) **W.5.9**

Mathematics

Reason abstractly and quantitatively. (5-PS1-2) **MP.2**

Model with mathematics. (5-PS1-2) **MP.4**

Use appropriate tools strategically. (5-PS1-2) **MP.5**

Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real-world problems. (5-PS1-2) **5.MD.A.1**