

Grade 5 Science, Unit 2

Changes to Matter

Overview

Unit abstract

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. In the fifth-grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in planning and carrying out investigations and using mathematics and computational thinking, and to use these practices to demonstrate understanding of the core ideas.

Essential questions

- When matter changes, does its weight change?
- Can new substances be created by combining other substances?

Written Curriculum

Next Generation Science Standards

5. Structure and Properties of Matter		
Students who demonstrate understanding can: 5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.		
The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i> :		
<p style="text-align: center;">Science and Engineering Practices</p> <p>Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.</p> <ul style="list-style-type: none"> ▪ 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) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>PS1.B: Chemical Reactions</p> <ul style="list-style-type: none"> ▪ When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Cause and Effect</p> <ul style="list-style-type: none"> ▪ Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4)
<i>Connections to other DCIs in fifth grade:</i> N/A		
<i>Articulation of DCIs across grade-levels:</i> 2.PS1.B (5-PS1-4); MS.PS1.A (5-PS1-4); MS.PS1.B (5-PS1-4)		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy –</i>		
W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-4)		
W.5.8 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-PS1-4)		
W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-PS1-4)		

<p>5. Structure and Properties of Matter</p> <p>Students who demonstrate understanding can:</p> <p>5-PS1-2. 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.]</p>		
<p>The performance expectations above were developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i>:</p>		
<p style="text-align: center;">Science and Engineering Practices</p> <p>Using Mathematics and Computational Thinking</p> <p>Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.</p> <ul style="list-style-type: none"> Measure and graph quantities such as weight to address scientific and engineering questions and problems. (5-PS1-2) 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>PS1.A: Structure and Properties of Matter</p> <ul style="list-style-type: none"> The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) <p>PS1.B: Chemical Reactions</p> <ul style="list-style-type: none"> No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) (5-PS1-2) 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Scale, Proportion, and Quantity</p> <ul style="list-style-type: none"> Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-2) <p style="text-align: center;">-----</p> <p style="text-align: center;">Connections to Nature of Science</p> <p>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</p> <ul style="list-style-type: none"> Science assumes consistent patterns in natural systems. (5-PS1-2)
<p><i>Connections to other DCIs in fifth grade:</i> N/A</p>		
<p><i>Articulation of DCIs across grade-levels:</i> 2.PS1.A (5-PS1-2); 2.PS1.B (5-PS1-2); MS.PS1.A (5-PS1-2); MS.PS1.B (5-PS1-2)</p>		
<p><i>Common Core State Standards Connections:</i></p> <p><i>ELA/Literacy –</i></p> <p>W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-2)</p> <p>W.5.8 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)</p> <p>W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-PS1-2)</p> <p><i>Mathematics –</i></p> <p>MP.2 Reason abstractly and quantitatively. (5-PS1-2)</p> <p>MP.4 Model with mathematics. (5-PS1-2)</p> <p>MP.5 Use appropriate tools strategically. (5-PS1-2)</p> <p>5.MD.A.1 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)</p>		

Clarifying the standards

Prior learning

The following disciplinary core ideas are prior learning for the concepts in this unit of study. By the end of grade 2, students know that:

- 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.
- A great variety of objects can be built up from a small set of pieces.
- Heating and cooling a substance may cause changes in the substance that can be observed. Sometimes these changes are reversible, and sometimes they are not.

Progression of current learning

Driving question 1

How can we determine whether the mixing of two or more substances results in new substances?

Concepts

- 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.

Practices

- 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.

Driving question 2

What evidence would support the claim that regardless of the type of change that occurs when substances are heated, cooled, or mixed, the total weight of matter is conserved?

Concepts

- 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. (Mass and weight are not distinguished at this grade level.)
- Science assumes consistent patterns in natural systems.

Practices

- 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. (Assessment does not include distinguishing between mass and weight.) Examples of reactions or changes could include:
 - Phase changes
 - Dissolving
 - Mixing

Integration of content, practices, and crosscutting concepts

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 first plan and conduct investigations to determine whether or not a new substance is made when two or more substances are mixed. 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.

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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.

Integration of DCI from prior units within this grade level

Students measured and documented physical properties of a variety of substances in Unit 1, Properties of Matter. Students apply their understanding of properties of matter during this unit in order to identify whether or not a new substance is formed when two or more substances are mixed, and to understand that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight is conserved.

Integration of English language arts and mathematics

Mathematics

There are a number of ways in which the CCSS-Mathematics standards are integrated into this unit. Students

- Use appropriate tools in strategic ways when measuring physical properties of substances, such as mass 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.

English language arts

In order to integrate the CCSS-ELA into this unit, 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.

Future learning

By the end of middle school, students know that:

- 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.
- 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.
- 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.

Number of Instructional Days

Recommended number of instructional days: 15 (1 day = approximately 45–60 minutes)

Note—The recommended number of days is an estimate based on the information available at this time. Teachers are strongly encouraged to review the entire unit of study carefully and collaboratively to determine whether adjustments to this estimate need to be made.

