

Unit 3: Changes to Matter

Instructional Days: 15

Unit Summary***How can objects change?******Are all changes reversible?***

In this unit of study, students continue to develop an understanding of observable properties of materials through analysis and classification of different materials. The crosscutting concepts of *cause and effect* and *energy and matter* are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate grade-appropriate proficiency in *constructing explanations*, *designing solutions*, and *engaging in argument from evidence*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on 2-PS1-3 and 2-PS1-4.

Student Learning Objectives

Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object. *[Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.]* [\(2-PS1-3\)](#)

Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot. *[Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.]* [\(2-PS1-4\)](#)

Unit 3: Changes to Matter

Instructional Days: 15

2-PS1-3	Make observations to construct an evidence based account of how an object made of a small set of pieces can be disassembled and made into a new object
2-PS1-4	Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot
PS1.A	Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature
PS1.B	Heating or cooling a substance may cause changes that can be observed

Quick Links[Unit Sequence p. 2](#)[What it Looks Like in the Classroom p. 3](#)[Connecting with ELA/Literacy and Math p. 3](#)[Modifications p. 4](#)[Research on Learning p. 4](#)[Prior Learning p. 5](#)[Future Learning p. 5](#)[Connections to Other Units
p. 5](#)[Sample Open Education Resources
p. 6](#)[Teacher Professional Learning
Resources p. 7](#)[Appendix A: NGSS and Foundations
p. 8](#)

Unit 3: Changes to Matter

Instructional Days: 15

Enduring Understandings

- Different kinds of materials can be compared and classified by color, texture, hardness, and flexibility.
- Not all materials are appropriate for the same purpose because of their properties (strength, flexibility, hardness, texture, and absorbency).
- By observing an object, you are able to see other uses for its pieces.
- Some materials can be changed by heating or cooling, but other changes are irreversible.

Essential Questions

- How can different materials be compared to one another?
- How can we determine if a material is appropriate?
- What makes a material appropriate for multiple objects?
- Why can some materials be changed by heating or cooling and others cannot?

Unit 3: Changes to Matter

Instructional Days: 15

Unit Sequence	
<i>Part A: In what ways can an object made of a small set of pieces be disassembled and made into a new object?</i>	
Concepts	Formative Assessment
<ul style="list-style-type: none"> • Objects may break into smaller pieces and be put together into larger pieces or change shapes. • Different properties are suited to different purposes. • A great variety of objects can be built up from a small set of pieces. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> • Break objects into smaller pieces and put them together into larger pieces or change shapes. • Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. • Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

Unit 3: Changes to Matter

Instructional Days: 15

Unit Sequence	
<i>Part B: Can all changes caused by heating or cooling be reversed?</i>	
Concepts	Formative Assessment
<ul style="list-style-type: none"> • People search for cause-and-effect relationships to explain natural events. • Events have causes that generate observable patterns. • Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. 	<p><i>Students who understand the concepts are able to:</i></p> <ul style="list-style-type: none"> • Observe patterns in events generated due to cause-and-effect relationships. • Construct an argument with evidence to support a claim. • Construct an argument with evidence that some changes caused by heating or cooling can be reversed, and some cannot. <ul style="list-style-type: none"> ✓ Examples of reversible changes could include materials such as water and butter at different temperatures. ✓ Examples of irreversible changes could include <ul style="list-style-type: none"> ➤ Cooking an egg ➤ Freezing a plant leaf ➤ Heating paper

Unit 3: Changes to Matter

Instructional Days: 15

What It Looks Like in the Classroom

In this unit of study, students investigate cause-and-effect relationships between matter and energy as they analyze and classify materials that undergo change. Throughout the unit, students will construct explanations and engage in argument from evidence as they investigate the ways in which matter can change and determine whether or not a change is reversible.

In Unit 2, Properties of Matter, students engaged in the engineering design process in order to understand that different properties are suited to different purposes. Students use this understanding as they construct evidence-based accounts of how an object made of small pieces can be disassembled and made into new objects. In order to do this, they need multiple opportunities to take apart and reassemble objects that are made of small pieces. For example, using blocks, building bricks, and other small objects such as Legos, small groups of students can build an object, and then a second group of students can take the object apart and build another object using those same small blocks or bricks. As students construct and deconstruct objects, then reconstruct the pieces into new objects, they should document the process in their science journals, explaining how they went about reconstructing the pieces into a new object.

After students have worked through and documented this process, ask them, “Are the changes you made to each of the original objects reversible? Can we disassemble the new objects and use the pieces to reconstruct the original object? After class discussion, ask students, “Are all changes reversible?” This should lead to opportunities for students to observe changes caused by heating or cooling. With close supervision and guidance by teachers, students can investigate such changes as heating or cooling butter, chocolate chips, or pieces of crayon, freezing water, and melting ice. They can observe an egg before and after cooking or a small piece of paper or cardboard before and after burning. As they attempt to reverse changes, they will also notice that all events have causes that generate patterns of change that can be observed and predicted. Through these types of experiences, students will recognize that some changes caused by heating or cooling can be reversed and some cannot, and they can use evidence from their investigations to support their thinking.

Unit 3: Changes to Matter

Instructional Days: 15

Connecting with English Language Arts/Literacy and Mathematics*English Language Arts*

Students need opportunities to read texts that give information about matter and the changes that can happen to matter. With adult support, students can identify the main idea and details in informational text in order to answer questions about matter. With teacher support and modeling, students can ask and answer who, what, where, when, why, and how questions to demonstrate their understanding of key details in informational text.

As students investigate reversible and irreversible changes to matter, they should record observations in science journals, using drawings or other visual displays, when appropriate, to help clarify their thinking. To further support their learning, students can conduct shared research using trade books and online resources in order to learn more about physical changes to matter.

After reading informational texts and conducting investigations, students should be able to write opinion pieces in which they state an opinion, supply evidence to support their opinion, use linking words to connect opinion to evidence (reasons), and provide a concluding statement. For example, students can be presented with an example of matter that has been changed in some way, then asked to write an opinion piece in which they state whether or not they think the change is reversible or irreversible, and supply evidence to support their thinking. Evidence can include information recalled from experiences or information gathered from informational texts or other resources. Some possible changes that can be used are:

- ✓ Tearing paper
- ✓ Bending a spoon
- ✓ Baking a cake
- ✓ Hammering a nail into a piece of wood
- ✓ Getting grass stains on a pair of jeans
- ✓ Cutting your hair.

Mathematics

N/A

Unit 3: Changes to Matter

Instructional Days: 15

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).

Unit 3: Changes to Matter

Instructional Days: 15

Research on Student Learning

N/A

Prior Learning

In **Unit 2, Properties of Matter**, students described and classified different kinds of materials based on their observable properties. They also tested different materials to determine which have properties that are best suited for an intended purpose.

Unit 3: Changes to Matter

Instructional Days: 15

Future Learning**Grade 4 Unit 1: Weathering and Erosion**

- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

Grade 5 Unit 1: Properties of Matter

- Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)
- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.

Grade 5 Unit 2: Changes to Matter

- When two or more different substances are mixed, a new substance with different properties may be formed.
- 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.*)
- The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.

Grade 5 Unit 3: Matter and Energy in Ecosystems

- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.

Unit 3: Changes to Matter

Instructional Days: 15

Connections to Other Units

In **Unit 2, Properties of Matter**, students described and classified different kinds of materials based on their observable properties. They also tested different materials to determine which have properties that are best suited for an intended purpose.

Sample of Open Education Resources

[STEM in a BOX - Shakin' Up the Classroom: K-3EarthScienceSTEMintheboxprint.docx](#): In this engaging lesson, the students examine and describe materials and their properties in order to assemble these materials into a strong building that could withstand the earth shaking. The physical science core ideas in the Performance Expectation are met through a larger earth science/earthquake unit that is part of the unit level resource.

Go to the resource listed under K-3: [k-3EarthScienceSTEMintheboxprint.docx](#)

[Thousands of tiny pieces can create something big](#): In this resource which is based on enactment in a second grade classroom and includes videos and examples of student work, the teacher introduces students to Watt's tower, a tower made of many pieces of junk in the neighborhood. Students make their own objects out of many pieces or materials that the teacher provides and the students think about and discuss whether they could use the same set of materials to make something different.

[Take it apart, put it together](#): This is a wonderfully supported and creative lesson that involves students taking apart an old appliance and making a new object using the appliance parts. The teacher guides students using a variety of teacher prompts and individual journaling to track their idea development, questions, changing plans, and evidence-based explanations.

[Exploring Reversible Changes of State and Exploring Irreversible Changes of State](#)

These two lessons work together to explore reversible and irreversible changes of state through guided investigations. The PDF is a set of activities focusing on materials followed by some optional post-activity lessons. Two of these post activity lessons deal with reversible and irreversible changes to materials. The first lesson involves teachers showing students phenomena and then asking the students to generate questions about their observations of the phenomena. The second lesson involves students engaging in investigating, explaining and asking questions about two irreversible changes and using observations to identify what about the changes make them irreversible.

Unit 3: Changes to Matter

Instructional Days: 15

[The Magic School Bus Bakes in a Cake lesson and video, "Ready Set Dough" !](#): This is a lesson plan that accompanies the reading or watching of The Magic School Bus Bakes a Cake, or Ready Set Dough. The lesson is a short activity with guided questions that accompany making pretzel dough. In the book and video, which are not included in the resource, The Magic School Bus shrinks down to molecule size to observe and discuss chemical and physical changes while baking. The resource contains a link to purchase the book. The video can be found at <https://www.youtube.com/watch?v=dTw-ok3KkuU>.

[The Science of Macaroni Salad \(and 2. Dig Deeper\)](#): This three minute video is great for teachers who need a short and deeper understanding of what is entailed in the Performance Expectations for Properties of Matter and what is involved when a physical and chemical change occurs. It would be over the heads of younger children, but perfect for elementary teachers who can either view the video themselves and translate the most pertinent ideas in it, or watch the video with the students and narrate in kid language. If the teacher watched the video first, they would be ensured that they had the understanding necessary for tough questions.

Unit 3: Changes to Matter

Instructional Days: 15

Teacher Professional Learning Resources**Connections Between Practices in NGSS, Common Core Math, and Common Core ELA**

The presenter was Sarah Michaels from Clark University. In this seminar Dr. Michaels talked about connecting the scientific and engineering practices described in A Framework for K–12 Science Education with the Common Core State Standards in Mathematics and English Language Arts.

Engineering Design as a Core Idea

The presenter was Cary Sneider, Associate Research Professor at Portland State University in Portland, Oregon. The seminar focused on the Core Idea of Engineering, led by Cary Sneider, Associate Research Professor at Portland State University. Cary explained the overall NGSS engineering components for K-2, MS and HS, and went through a number of practical examples of how teachers could develop modules and investigations for their students to learn them. Cary also spoke about the ways in which teachers could include cross-cutting engineering concepts to a number of classroom subjects. The seminar concluded with an overview of NSTA resources about NGSS available to teachers by Ted, and a Q & A session with Cary.

Visit 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.

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Unit 3: Changes to Matter

Instructional Days: 15

Appendix A: NGSS and Foundations for the Unit		
<p>Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object. [Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.] (2-PS1-3)</p>		
<p>Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot. [Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.] (2-PS1-4)</p>		
<p>The performance expectations above were developed using the following elements from the NRC document A Framework for K-12 Science Education:</p>		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Analyzing and Interpreting Data</p> <ul style="list-style-type: none"> Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS3-1) <p>Constructing Explanations and Designing Solutions</p> <ul style="list-style-type: none"> Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (2-PS1-3) <p>Engaging in Argument from Evidence</p> <ul style="list-style-type: none"> Construct an argument with evidence to support a claim. (2-PS1-4) 	<p>PS1.A: Structure and Properties of Matter</p> <ul style="list-style-type: none"> Different properties are suited to different purposes. (2-PS1-3) A great variety of objects can be built up from a small set of pieces. (2-PS1-3) <p>PS1.B: Chemical Reactions</p> <ul style="list-style-type: none"> Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4) 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Events have causes that generate observable patterns. (2-PS1-4) <p>Energy and Matter</p> <ul style="list-style-type: none"> Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3)

Unit 3: Changes to Matter

Instructional Days: 15

		<p>Connections to Nature of Science</p> <p>Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena</p> <ul style="list-style-type: none"> Science searches for cause and effect relationships to explain natural events. (2-PS1-4)
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English Language Arts	Mathematics
<p>Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. (2-PS1-4) RI.2.1</p> <p>Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. (2-PS1-4) RI.2.3</p> <p>Describe how reasons support specific points the author makes in a text. (2-PS1-4) RI.2.8</p> <p>Write opinion pieces in which they introduce the topic or book they are writing about, state an opinion, supply reasons that support the opinion, use linking words (e.g., because, and, also) to connect opinion and reasons, and provide a concluding statement or section. (2-PS1-4) W.2.1</p> <p>Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-3) W.2.7</p> <p>Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-3) W.2.8</p>	<p style="text-align: center;">N/A</p>

Unit 3: Changes to Matter

Instructional Days: 15

Common Vocabulary	
Temperature	Flexible
Exist	Hardness
Gas	Magnetic
Human made	Powder
Liquid	Texture
Mixture	Unit
Solid	Weight
Space	
Flexibility	