2 Matter

NGSS EARLY IMPLEMENTERS

WestEd

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Introduction

The California K–8 NGSS Early Implementation Initiative, developed by the K–12 Alliance at WestEd with close collaborative input on its design and objectives from the State Board of Education, the California Department of Education, and Achieve is a fast-start demonstration project to build local education agency (LEA) capacity to fully implement the Next Generation Science Standards (NGSS) as a core subject in the elementary grades (K–5) and as the SBE's preferred integrated model in grades 6–8. The 4-year Initiative provides teachers and administrators with in-depth, content-rich professional development to build leadership capacity and teacher acumen to deliver high-quality 3-dimensional learning for K-8 students. In addition, through collaborations among the K–12 Alliance, Achieve, and others, the LEAs in the Collaborative have opportunities to pilot test new NGSS-aligned tools, processes, assessment item prototypes, and digital and other instructional materials. The LEAs serve as resources for NGSS implementation across California, and in other NGSS-adopting states as well.

This resource presents the conceptual storyline for a unit of instruction at a specific grade level, then focuses on a portion of the storyline called a learning sequence. The learning sequence uses the 3 dimensions of the NGSS (disciplinary core ideas—DCI; science and engineering practices—SEP; and crosscutting concepts—CCCs) to build and deepen student understanding of natural phenomena and design challenges.

Participants in the CA NGSS K–8 Early Implementation Initiative developed and field-tested the lessons in the learning sequence.

Overview

The anchoring phenomenon for this unit is: Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle. In this unit, students explore, observe patterns, describe, and sort properties of solid and liquid matter by planning and carrying out investigations. Students collect and analyze data to determine that different properties of different materials suit them for different purposes. Students investigate phenomena illustrating reversible and irreversible changes caused by heating or cooling to write claims based upon observable evidence regarding the cause and effect of these changes. Students apply their understanding of changes made to matter by developing a plan that uses a design process. The design process ultimately leads students to understand what can cause a change in the shape of matter. Students also begin to use an engineering design process to solve a problem related to the anchoring phenomenon.

The Performance Expectations that is addressed in this unit are:

2-PS1-1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

2-PS1-4 Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Learning Sequence Narrative

The Learning Sequence Narrative briefly describes what students do in each lesson and helps to establish links between the lessons as a conceptual storyline. At the end of each lesson, students make connections to their understanding of the investigative phenomenon (and to the anchoring phenomenon, if appropriate). The investigative phenomenon for the lessons are: objects, such as a crayon, candle, lip balm, and objects in the classroom, look and feel different from one another (Lesson 1: Properties of Matter); water poured from one container to a different container takes the shape of the new container (Lesson 2: Properties of Liquids); crayon marks are difficult to remove from school surfaces. I wonder what materials would work best to remove them (Lesson 3: Different Properties for Different Purposes); corn kernels changed after they went into the hot air popper (Lesson 4: Reversible and Irreversible Changes); and crayons are made of wax in a shape we can hold with our fingers; birthday candles are made of wax in a shape that we can put on a cake; lip balm is made of wax in a shape that we can apply to our lips (Lesson 5: The Great Wax Disaster).

Students figure out this phenomenon by:

Science and Engineering Practices (SEPs)

Planning and Carrying Out Investigations

- Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.
- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
- Make predictions based on prior experiences.

Analyzing and Interpreting Data

- Record information (observations, thoughts, and ideas).
- Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.

Constructing Explanations and Designing Solutions

- Use information from observations (firsthand or from media) to construct an evidence-based account for natural phenomena.
- Generate and/or compare multiple solutions to a problem.

Engaging in Argument from Evidence

- Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.
- Construct an argument with evidence to support a claim.

Asking Questions and Defining Problems

- Ask questions based on observations to find more information about the natural and/or designed world(s).
- Define a simple problem that can be solved through the development of a new or improved object or tool.

Obtaining, Evaluating, and Communicating Information

- Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.

Disciplinary Core Ideas (DCIs)

PS1.A: Structure and 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.

PS1.B: Chemical Reactions

- Heating or cooling a substance may cause changes that can be observed.
- Some changes are reversible and some are not.

ETS1.A: Defining and Delimiting an Engineering Problem

- Asking questions, making observations, and gathering information are helpful in thinking about problems.

ETS1.C: Optimizing the Design Solution

- Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

Crosscutting Concepts (CCCs)

Patterns

- Patterns in the natural and human-designed world can be observed, used to describe phenomena, and used as evidence.

Cause and Effect

- Events have causes that generate observable patterns.
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s).

Energy and Matter

- Objects may ~~break into smaller pieces and be put together into larger pieces, or~~ change shapes.

Lesson 1: Properties of Matter

Investigative Phenomenon: Objects, such as a crayon, a candle, lip balm, and other objects in the classroom, look and feel different from one another.

This lesson primarily serves as an introduction to properties of matter, with the focus on building an understanding the properties of solids. As students engage in observations of solid matter around them, they have opportunities to connect their language to the corresponding scientific vocabulary. Lesson 1: Properties of Matter introduces students to the anchoring phenomenon: Materials are made of matter; We can observe misshapen objects, including a crayon, lip balm, and a candle. Students are introduced to the development of an engineering problem by posing questions such as: *How did the objects get this way? How can we keep this from happening to the objects?* Students use their prior knowledge of daily interactions with matter as they begin thinking about the everyday objects around them and the properties of the materials from which they are made. Students use prior knowledge of the five senses to make observations and find patterns in their observations to sort solid materials and classify them by their properties. In Lesson 2: Properties of Liquids, students investigate the properties of liquids.

Lesson 2: Properties of Liquids

Investigative Phenomenon: Water poured from one container to a different container takes the shape of the new container.

In Lesson 1: Properties of Matter, students observed, described, and classified the properties of solid materials. Students also began to develop an engineering problem. In this lesson, students plan and conduct investigations to observe and classify patterns of properties of liquids to answer a question generated by the class. Students use their observations to

compare the properties of liquids and solids. The properties of liquids relate to the observable part of the anchoring phenomenon (misshapen objects, including a crayon, lip balm, and a candle) because eventually students are going to understand that when some solids melt, they spread out to take the shape of their container and later return to a solid state, e.g., chocolate bars, chocolate bunnies, etc. This foundational understanding of the properties of matter will help students with the Plan phase of the Engineering Design Process. In Lesson 3: Different Properties for Different Purposes, students explore the idea that materials are used for different purposes depending on their properties.

Lesson 3: Different Properties for Different Purposes

Investigative Phenomenon: Crayon marks are difficult to remove from school surfaces. I wonder what materials would work best to remove them.

This lesson builds on ideas developed in the two prior lessons in which students planned and conducted investigations to explore patterns in the properties of solid and liquid materials. In this lesson, students are presented with a problem and record data as they test the use of materials with different properties to solve the problem. Students collect and analyze more data to determine the materials that can be used to solve the problem and to explain the properties of the materials that made them suited for the solution. Students use what they have learned in this lesson to add to their engineering design plan. In Lesson 4: Reversible and Irreversible Changes, students learn to make a claim based on evidence they gain from exploring the reversible and irreversible changes caused by heating or cooling matter.

Lesson 4: Reversible and Irreversible Changes

Investigative Phenomenon: The corn kernel changed after it went into the hot air popper.

In Lesson 3: Different Properties for Different Purposes, students investigated the use of materials for different purposes depending upon their properties. In this lesson, students learn to construct a claim based on evidence they observe from exploring the reversible and irreversible changes that are caused by heating or cooling different substances. In Lesson 5: The Great Wax Disaster, students build on their new understandings as they return to the anchoring phenomenon of observing misshapen objects in order to develop a plan to change the shape of a piece of chocolate.

Lesson 5: The Great Wax Disaster

Investigative Phenomenon: Crayons are made of wax in a shape we can hold with our fingers. Birthday candles are made of wax in a shape that we can put on a cake. Lip balm is made of wax in a shape that we can apply to our lips.

In Lesson 4: Reversible and Irreversible Changes, students constructed a claim based on evidence as they explored the reversible and irreversible changes that are caused by heating or cooling different substances. In this final lesson, students return to the observable part of the anchoring phenomenon in order to develop a plan to support their understanding from Lesson 4: Reversible and Irreversible Changes that the changes that occurred to the misshapen objects are reversible or irreversible. Students use a design process and the Engineering Planning Sheet to develop a plan, compare plans with others, and collaboratively revise their

plans. After conducting the investigation, students use their data to write a claim of how and if solid objects can be turned into a different shape. From their experiences with properties of materials and whether properties of materials are affected by heating and cooling, the students are now able to explain the phenomena of the misshapen objects.

Learning Sequence 3-Dimensional Progressions

SEP Progression

Only SEPs that have a strong progression are detailed here. While other SEPs are included in the sequence and important to the lesson in which they are used, they are not outlined here if they did not appear in multiple lessons.

SEP PROGRESSION	
Asking Questions and Defining Problems	
Lessons 1 and 2	Students ask questions based on observations to find more information about the natural or designed world. Students collaboratively develop questions and plan investigations to answer questions.
Lesson 3	Students ask questions to define a problem that can be solved.
Lesson 4	Asking questions is a background practice.
Lesson 5	Students apply what they have learned about asking questions about the design process to ask questions about a substance that can be investigated.
Planning and Carrying Out Investigations	
Lesson 1	Students collaboratively plan and carry out investigations. Students make firsthand observations to collect data and use it to make comparisons.
Lesson 2	Students plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
Lesson 3	Students continue to make observations and produce data as evidence in addition to making predictions based on prior experiences.
Lesson 4	Planning and conducting investigations is background practice.
Lesson 5	Students continue to collaboratively plan and carry out investigations, make observations, and produce data as evidence. Students evaluate different ways of observing and/or measuring a phenomenon to determine which method will answer a question.
Analyzing and Interpreting Data	
Lesson 1	Students record information (observations).
Lesson 2	Students use their firsthand observations to describe patterns and/or relationships in the natural and designed world in order to answer scientific questions about the properties of matter.

Learning Sequence 3-Dimensional Progressions (continued)

SEP PROGRESSION (continued)	
Analyzing and Interpreting Data (continued)	
Lesson 3	Students represent data in tables and/or various graphical displays to reveal patterns that indicate relationships.
Lesson 4	Students record information (observations).
Lesson 5	Students record information and use their firsthand observations to describe relationships in the natural and designed worlds in order to answer scientific questions about reversible and irreversible changes in matter.
Engaging in Argument from Evidence	
Lesson 3	Students make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence in order to state which properties of materials are best suited for a purpose.
Lesson 4	Students use evidence to agree or disagree with claims about reversible and irreversible changes.
Constructing Explanations and Designing Solutions	
Lesson 3	Students use information from observations to construct an evidence-based account of the properties that caused a solution to a problem to work and compare multiple solutions to a problem.
Lesson 4	This practice is in the background of the lesson.
Lesson 5	Students use observational evidence to write and support a claim about irreversible and reversible changes.
Obtaining, Evaluating, and Communicating Information	
Lesson 1	Students communicate information about the investigation plans and their data analysis and present information about observed properties.
Lessons 2 and 3	This practice is in the background of the lesson.
Lesson 4	Students communicate the observations and cause-and-effect relationships they determine during an investigation.
Lesson 5	Students write and communicate a claim supported by evidence about reversible and irreversible changes.

DCI PROGRESSION	
Lesson 1	Prior knowledge of everyday interactions with properties of matter. Solid matter can be described and classified by its observable properties. (PS1.A, ETS1.A)
Lesson 2	Liquid matter can be described and classified by its observable properties. Different kinds of matter exist, and many of them can be either solid or liquid. (PS1.A)
Lesson 3	Different properties are suited to different purposes. (PS1.A, ETA1.C)
Lesson 4	Different kinds of matter exist, and many of them can be either solid or liquid, depending upon the temperature. Heating or cooling a substance may cause changes that can be observed. Some changes are reversible and some are not. (PS1.A, PS1.B)
Lesson 5	Heating or cooling a substance may cause changes that can be observed. Some changes are reversible and some are not. (PS1.B, ETA1.A, ETA1.C)

CCC PROGRESSION	
Patterns	
Lessons 1–5	Students use patterns in their observations as evidence to describe phenomena related to the properties of different kinds of matter. Students continue to use observed patterns when matter changes to determine and describe reversible and irreversible changes.
Cause and Effect	
Lesson 3	Students gather evidence to determine that events have causes and to support or refute student ideas about causes.
Lessons 4–5	Students continue to explore the cause-and-effect relationships in reversible and irreversible changes in matter.
Structure and Function	
Lesson 3	Students observe that the shape and stability of structures of natural and designed objects are related to their function.
Energy and Matter	
Lessons 4–5	Students explore matter to determine that objects may change shape.

Assessment System

The Grade 2: Matter unit provides multiple and ongoing strategies for teachers to assess student understanding as they progress toward mastery of Performance Expectations. These include:

- The Student Question Chart is referred to in each lesson. The Student Question Chart allows you to assess the sophistication of students' prior knowledge, student questions, and student-generated responses as they progress through the unit.
- Science notebooks are used in each lesson. Student responses in the science notebook allow you to informally assess student progress. Expected Student Responses (ESRs) are used throughout the unit to guide you in the types of responses students may provide.
- Students' oral language is an opportunity to assess their emerging understanding. You are encouraged to jot down students' oral language and use it to inform instruction.
- The Engage stage of the 5E the instructional model provides an opportunity for you to assess students' prior knowledge. In Lesson 2: Properties of Liquids through Lesson 5: The Great Wax Disaster, a graphic representation of student thinking is used in the Engage stage and will be added to each subsequent learning sequence in this unit.
- The Evaluate stage of the 5E instructional model also provides an opportunity for you to more formally assess student progress. This is the point in instruction where you will make a decision as to whether students are ready to move forward or need additional interventions and accommodations.
- Rubrics for both you and the students are provided when appropriate and serve as an example of how to assess student progress. Throughout the unit, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and emergent sense-making of phenomena.
- The term Expected Student Response (ESR) offers a formative assessment opportunity as well. An ESR is what you can reasonably expect to be the students' response to questions, prompts, activities, etc. The rationale for the inclusion of ESRs is to identify and assist you with the types of responses to expect and accept from students. Student language will be used to build toward scientific explanations as learning progresses. Note: ESRs are not the only possible student responses, and you should not provide the ESRs to the students. ESRs will be italicized.

Scaffolds for Students with Reading and Writing Difficulties

1. Have students speak their answers instead of writing them.

   View the Voice to Text video (https://www.youtube.com/watch?v=Hq6eLFnwzsI) which would allow a student to speak their answer and have it converted to text.

   Student Instructions:

   - Click on Tools and scroll down to Voice Typing. When you are ready to speak, click on the microphone.
   - When you are finished speaking, click on the microphone again.
   - Your teacher will be able to read your ideas!

2. Have students use Screencastify (https://www.screencastify.com/) to record themselves responding to a task.

   Students can create a digital science notebook that can be a combination of images and student recordings. Students can record themselves sharing what they observed/saw, thought/wondered, and learned during or after an experience.

3. Before reading aloud a book, do a picture walk. During a picture walk the text and graphics features of the book are identified and discussed. Special attention is given to the photographs or illustrations since many times the elements of the story can be predicted through the visuals. This preview helps students to understand the content of the text when it is read.

   This support can assist English Learners or students with reading difficulties by allowing time to activate prior knowledge and discuss new vocabulary.

References

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. DOI: https://doi.org/10.17226/13165. National Research Council; Division of Behavioral and Social Sciences and Education; Board on Science Education; Committee on a Conceptual Framework for New K–12 Science Education Standards. National Academies Press, Washington, DC.

Grade 2 Matter Conceptual Flow

Anchoring Phenomenon

Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle.

Matter has properties.
Matter can be changed in many ways.

Investigative Phenomenon

Objects, such as a crayon, a candle, lip balm, and other objects in the classroom, look and feel different from one another.	Water poured from one container to a different container takes the shape of the new container.	Crayon marks are difficult to remove from school surfaces. I wonder what materials would work best to remove them.	The corn kernel changed after it went into the hot air popper.	Crayons are made of wax in a shape we can hold with our fingers. Birthday candles are made of wax in a shape that we can put on a cake. Lip balm is made of wax in a shape that we can apply to our lips.
PS1.A, ETS1.A	PS1.A	PS1.A	PS1.B	PS1.B, ETS1.A,ETS1.C
Matter can be described and classified by its properties and uses. Matter keeps its shape depending upon temperature.	Matter can be liquid, which takes the shape of its container depending upon temparature.	The properties of different types of matter are useful for making things suitable for different purposes.	We know matter has changed because its properties are different. One way to change matter is by changing its shape. Heating and cooling affect matter.	Changes can happen quickly or slowly. Some changes caused by heating or cooiing can be reversed. Some changes caused by heating or cooling are irreversible.
Planning and carrying out investigations	Planning and carrying out investigations	Analyzing and interpreting data	Engaging in argument from evidence	Planning and carrying out investigations
		Constructing explanations and designing solutions	Constructing explanations and designing solutions	Engaging in argument from evidence

Asking questions and defining problems

Patterns

Cause and Effect

Structure and Function

Energy and Matter

A project of CA NGSS K–8 Early Implementation Initiative.

Properties of Matter

2.1

Image via iStock.com/NadinPanina

Anchoring Phenomenon

Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle.

Lesson Concept

Ask questions based on observations to find patterns of properties of different kinds of materials.

Investigative Phenomenon

Objects, such as crayons, birthday candles, lip balm, and other objects in the classroom, look and feel different from each other.

Standards

Refer to Appendix 2.1 for NGSS, CCSS-ELA, and California ELD standards.

Storyline Link

This unit serves as an introduction to the properties of matter, with the focus of building an understanding of properties of solids. As students engage in observations of solid matter around them, they have opportunities to connect their prior knowledge and language to the corresponding scientific vocabulary. This unit introduces students to the anchoring phenomenon: Materials are made from matter. We can observe misshapen objects, including crayons, lip balm, and a candle. (Note: throughout the unit, these three objects will be the focus; however, the properties of matter will be introduced via a variety of solids.) Investigating the properties of matter will help students generate the engineering problem. In addition, students are introduced to the development of an engineering problem by posing student-generated questions, such as, "How did the objects get this way?" or "How can we keep this from happening to the objects?" Students use their prior knowledge of daily interactions with matter as they begin by thinking about the everyday objects around them and the properties of the materials from which they are made. Students use prior knowledge from their five senses to make observations, find patterns in their observations, sort solid materials, and classify them by their properties. In the next lesson, students investigate the properties of liquids.

Throughout the lesson, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and emergent sense-making of phenomena.

Time

120 minutes

Part I	50 minutes	
	15 minutes	Engage
	25 minutes	Explore A
	25 minutes	Explain A
Part II	70 minutes	
	60 minutes	Explore B
	10 minutes	Evaluate

Materials

Whole Class

- ❑ Chart paper
- ❑ 2.1.C1: Student Question Chart
- ❑ 2.1.C2: Engineering Design Process
- ❑ 1 lip balm stick
- ❑ 1 birthday candle
- ❑ 1 misshapen crayon, lip balm stick, and birthday candle (already melted—see Preparation)

Group (Groups of 3)

- ❑ 1 regular crayon, lip balm stick, and birthday candle
- ❑ 1 misshapen crayon, lip balm stick, and birthday candle (already melted)
- ❑ Baggies
- ❑ Materials used to physically change objects; for example, hammers, rolling pins, cans of soup, piles of heavy books, or the leg of a chair, etc.
- ❑ 2 paper plates
- ❑ 8 solid objects (objects should include a variety of textures, colors, hardness, flexibility, shapes, and sizes). Select a variety from the following list:
  - ❑ Sandpaper
  - ❑ Plastic tangram pieces or other math manipulatives
  - ❑ Cotton balls or cotton swabs
  - ❑ Foam sheets and/or yarn
  - ❑ Buttons with and without texture
  - ❑ Metallic objects and/or aluminum foil
  - ❑ Fabrics such as lace, corduroy, velvet, wool, nylon (raincoat), denim, fleece, and/or felt
  - ❑ Sticky/stretchy frogs and/or rubber bands
  - ❑ Seashells with a variety of textures
  - ❑ Rocks of different textures (volcanic rocks)

Individual

- ❑ Goggles (for safety)
- ❑ Science notebook
- ❑ Pencils
- ❑ Sticky notes
- ❑ 2.1.H1: Engineering Planning Sheet

Advance Preparation

1. Melt the crayons, birthday candles, and lip balm stick before beginning the lesson. One effective method for melting is to place the objects on Teflon foil in the oven at 170 degrees until they melt. See How to Melt Crayons (https://www.wikihow.com/Melt-Crayons) for three other possible methods.
2. Assemble the 2 baggies — one with the misshapen crayon, lip balm stick, and birthday candle and one with the regular crayon, lip balm stick, and birthday candle ready to distribute to each group.

3. Gather materials for students to use to physically change the objects: hammers, rolling pins, cans of soup, piles of heavy books, leg of a chair, etc.
4. On chart paper, prepare the **2.1.C1: Student Question Chart**.
5. Prepare the **2.1.C2: Engineering Design Process** chart for classroom viewing.
6. Make copies of **2.1.H1: Engineering Planning Sheet**. Glue the **2.1.H1: Engineering Planning Sheet** into each student's science notebook for use throughout the unit.

Procedure

Part I

Engage (15 minutes)

Ask questions and observe the properties of a material.

TEACHER NOTE

The Engage stage of this learning sequence is intended to 1) generate students' questions about the phenomenon (misshapen objects), 2) help students access their prior knowledge about the five senses and the ways the five senses are used to make observations, and 3) demonstrate that investigating the properties of matter will help students generate the engineering problem. Recalling how we make observations will help students with their investigation plans in the Explore stage of the learning sequence.

1. Display the misshapen objects from one baggie for the whole class. Ask the students to observe the misshapen objects, using prompts such as, "What do you see? What do you think about what you see? What does it make you wonder?" Have students pose questions about what they see and wonder. Expected Students Responses (*ESRs*) may include the following questions from students: *What happened to the objects? Why do they have such a funny shape? How can we keep it from happening again?* Chart student questions on **2.1.C1: Student Question Chart**.

TEACHER NOTE

Do not use the vocabulary *melted* and *unmelted* during the Engage. This lesson helps students to eventually develop an understanding that matter exists as either a solid or a liquid depending upon temperature.

2. Distribute to each group of three students a baggie with the misshapen items and a paper plate. Have them lay the objects on the plate and take a closer look. Ask students to think-pair-share more questions about the misshapen objects, using their senses of touch and smell, such as: "What do you feel when you touch the objects? How do the objects smell? What is the same about the objects? What is different about the objects? What does it make you wonder? "
3. Chart additional student questions about the misshapen objects on **2.1.C1: Student Question Chart**. *ESRs: Why do the objects look different? How did the objects change shape? Can I still use the objects? Can we change the colors? Where were the objects? Do the objects still smell the same? How did they look before they changed? Can the changed objects go back to being the way they were? Why did the objects spread out? Did the objects melt? Was the lip balm left out in the sun?*

TEACHER NOTE

Accept questions about melting. Eventually, the students will discover that the objects changed shape due to a temperature change.

TEACHER NOTE

Retain the **2.1.C1: Student Question Chart**. These questions will drive instruction and help students identify the engineering problem. Subsequent lessons will address some of the student questions from steps 1–3. Throughout the unit, students will collect evidence via experiences with the investigative phenomenon (objects, such as crayons, birthday candles, lip balm, and objects in the classroom, look and feel different from one another). This will help students develop better explanations for the anchoring phenomenon and continue to build on their understanding of the crosscutting concept of patterns from previous grade levels.

4. Referring to the student-generated questions, inform students that scientists ask questions based on observations to find out more information about the world. Let students know that we will be exploring some of their questions in the next several days and that scientists often start investigating questions by observing and recording their observations. Scientists ask questions, and engineers solve problems.

TEACHER NOTE

Refer to **2.1.H1: Engineering Planning Sheet**. In addition to observing the properties of matter, students are beginning to identify the engineering problem, which is the **Ask** phase of the design process.

5. Distribute **2.1.H1: Engineering Planning Sheet** and have student put it in their science notebook. Say to students, "Let's think like engineers." Point out the **2.1.C2: Engineering Design Process** chart and review the steps in a design process. Point to the **Ask** and say, "What's the problem with the three misshapen objects?" *ESRs: The birthday candles won't work. I can't put those candles on a cake. I can't use the lip balm on my lips. I can't color with those crayons.* Have students record their engineering problem in the Ask section of the **2.1.H1: Engineering Planning Sheet** in their science notebooks.

Explore A (25 minutes)

Carry out an investigation to observe properties of different kinds of materials.

6. Have students select multiple questions from the **2.1.C1: Student Question Chart** and help them to discuss which questions they might be able to solve with an investigation. Select two questions similar to the following from the **2.1.C1: Student Question Chart**: *How did they look before they changed? How did they change?* or other questions that students want to investigate. Say to students, "Let's find out!"

7. Elicit student suggestions about how we could find out how the misshapen objects looked before and how they changed. *ESRs: We can look at a regular one (crayon, birthday candle, and lip balm to see what they looked like before. We have to try to break them. We have to bend them. We have to smash them.*
8. Distribute the baggie with with the undamaged candle, and lip balm. Allow time for students to decide how to make the regular objects look misshapen (i.e., to physically change the objects). Have a variety of materials available for students to select and use (e.g., hammers, rolling pins, cans of soup, piles of heavy books, leg of a chair, etc.). Have students record their ideas prior to using the materials that are provided. Then, have students work in groups of 3 to investigate their ideas.
9. Allow time for students to carry out their plans. Display the original bag with the misshapen objects. Ask, "With your plan, did you get your objects to look like the misshapen ones?" *ESR: No!*
10. Add the *No!* to the **2.1.C1: Student Question Chart**. Ask students, "What do you think we should do next?" *ESRs: I tried hitting it, now I want to put something heavy on it. I tried something heavy, now I want to try rolling something on it.*
11. Allow time for students to reconsider how to make the regular objects look misshapen (i.e., to physically change the objects). Have students suggest other materials in the classroom they might use in addition to hammers, rolling pins, cans of soup, piles of heavy books, or chair legs. Allow time for students to conduct their investigations.

Explain A (10 minutes)

Observe properties of different kinds of materials.

12. ▶ Have students write or draw their observations of the changed misshapen objects in their science notebook. Encourage students to use their own language related to describing the strength, flexibility, hardness, and texture of the objects. *ESRs: I could not get the regular ones to look like the funny ones. When I hit it, the crayon crumbled. When I rolled it, the birthday candle broke. When I hit it, the lip balm broke and smeared.*

TEACHER NOTE

▶ Use what students have written or drawn in their science notebook as a formative assessment of their emerging understanding of properties of solids (strength, flexibility, hardness, and texture). Accept student language that approximates the language we want students to use when they understand the concept of properties of solids. Explore B has a two-pronged emphasis. If students do not have a thorough understanding of the properties of solids, Explore B may be used to develop an understanding of the properties of solids. If students do have understanding without knowing the vocabulary, Explore B can be used to develop scientific vocabulary.

Part II

Explore B (60 minutes)

Carry out an investigation to observe and classify patterns of properties of different kinds of materials.

13. While reviewing the student-generated observations in step 12, ponder with the students: "I wonder if there are things other than crayons, birthday candles, and lip balm that we can make observations about?" Ask students to brainstorm with their group other things they could observe in the classroom. Circulate to listen to objects students mention.

14. Ask each group to share one object they brainstormed. Chart student responses. *ESRs: markers*, *glue bottles*, *glue sticks*, *balls*, *craft sticks*, *pencils*, etc.

15. Have students work in pairs to investigate objects they brainstormed in the classroom and/or objects provided by you (including, but not limited to sandpaper, math manipulatives, cotton balls, yarn, buttons (with and without texture), aluminum foil, a variety of fabrics, rubber bands, and/or seashells with a variety of textures).

16. Encourage students to explore the objects by asking the following questions:

    - What does the object feel when you touch it?
    - How does the object smell?
    - What is the same about the objects?
    - What is different about the objects?
    - What does it make you wonder?

17. Allow time for students to explore the objects they selected. Have students discuss the similarities and differences in the objects they selected. Circulate among the groups to listen to the different words students use to describe the objects.

> **TEACHER NOTE**
>
> As you circulate among the groups, jot down words you hear the students use related to the properties of matter. Use the students' prior knowledge and language to support the development of student understanding of the properties of objects and the anchoring phenomenon: Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle.

18. Have students sort the objects using the patterns (similarities and differences) they noticed in their observations. Have students explain to their group how they sorted the objects. Then have them record and label their sorts in their science notebook. Encourage students to label their grouped objects with a word or phrase that describes what is similar about the objects in the group. Once students have recorded their first sort, encourage student groups

to find a second way to sort the same objects. Have students record and label this sort in their science notebook as well. Alternatively, students can sort by one similarity, such as "things that are soft" and "things that are not soft." After recording this sort, ask students to choose another similarity to sort by.

19. Ask students to choose one sort to leave on their workspace with their science notebook open. Have student groups walk around the room (gallery walk) to observe other groups' sorts. Encourage student-to-student interaction as student groups stop at each other's workspaces, and have students use their observations to explain the sorts of other student groups. As needed, scaffold student language with the use of sentence frame such as:

    All of the items in this group are/have ___, while all of the objects in this group are not/do not have ___.

20. During the gallery walk, circulate and facilitate conversations that lead student groups to recognize the use of patterns of similarities and differences in the properties of the objects. Select some students to share with the whole class their ideas about the patterns they noticed in their observations.

21. Have students bring their science notebook and one object they explored to the carpet. Have one student share his or her object and describe it. Have another student do the same thing. If it's like the one the student before described, add it to the pile. Go around until every student has had a turn, and all objects are sorted. Now, review the properties of the objects.

TEACHER NOTE

Students often will name an object rather than describe it. Redirect their thinking by saying, "Yes, that's what we call that object. Now think about how you described it to us." A possible exchange between you and your students might go like this:

Teacher: "Explain why you put that object in that pile."

Student: "They are all markers."

Teacher: "Yes, we call them markers. Now think about how you described it to us and use those words to tell us why they belong in that group."

Student: "The case is smooth, hard, and round. I cannot bend it."

22. Distribute sticky notes to students and have each student write one word that describes their object. Select students to come to the board, each with one sticky note. One at a time, have each student read the descriptive word on the sticky note and place it on the board.

23. Encourage students to "clump" similar ideas as the sticky notes are placed on the board, noticing patterns of similarities and differences in the descriptive words.

24. As students group sticky notes using their own words to discuss why they belong together, further develop the idea of *properties* by introducing the property term that describes each "clump." For example, as students say *rough*, *smooth*, *fuzzy*, and *bumpy*, share that the word *texture* can be used to describe this property of materials, and facilitate students grouping all texture property words together. Write the word texture on the board or chart so that it is visible for students to refer to later. Take student words and relate them to the scientific vocabulary of the properties of solids (*texture*, *hardness*, *strength*, *flexibility*).

25. Continue this process with all students and their sticky notes, introducing and recording property terms as they apply. To further develop property categories, have students suggest other descriptive words that could fit each property category.

> **TEACHER NOTE**
>
> As students figure out properties for each clump of sticky notes, facilitate categorizing based on patterns in student observations to include the following properties: color, texture, hardness, flexibility, shape, and other properties.

Evaluate (10 minutes)

Observe and classify patterns of properties of different kinds of materials.

> **TEACHER NOTE**
>
> Throughout the Matter Unit, a 5E model will be employed; however, at the end of Lesson 1: Properties of Matter, there is no Elaborate because this phase of the 5E model will occur later in this Matter Unit.

26. ▶ Remind students of the anchoring phenomenon: Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle. Provide an opportunity for students to add to or revise their observations of the anchoring phenomenon in their science notebook. Encourage students to use the new descriptive words they have just learned.

27. If needed by students, provide the following sentence frames:
    - The texture of the _____ is _____.
    - The strength of the _____ is _____ than the _____.
    - The hardness of the _____ is _____ than the _____.

28. Ask students if anything they just did would help the objects go back to their original shape. Refer to the **2.1.C1: Student Question Chart** and the engineering question, "How can we keep this from happening?" *ESRs: Don't drop them. Don't break them. Don't hit them. Put bubble wrap around them. Keep them safe*. Point to the **Imagine** section of the **2.1.C2: Engineering Design Process** chart and have students add their ideas to the **2.1.H1: Engineering Planning**

TEACHER NOTE

At this point in the lesson, students have been exposed to the anchoring phenomenon; however, they have not explained the anchoring phenomenon. Lesson 1: Properties of Matter builds to an understanding that in order to know if something has changed, one must know what it was like before it changed. Understanding the properties of solids will help students describe changes that resulted in the misshapen objects and formulate an engineering problem.

Sheet in their student notebook.

References

WikiHow. (2020, June 14). How to Melt Crayons. Retrieved June 29, 2020, from https://www.wikihow.com/Melt-Crayons

Toolbox Table of Contents

Student Question Chart

Questions

Engineering Design Process

Engineering Design Process

Ask:	Identify a design problem.
Imagine:	Collaboratively brainstorm multiple ways to generate and solve a design problem.
Plan:	Create a step-by-step solution, on paper, to solve a design problem.
Create and Test:	First attempt to actualize the plan to solve a design problem.
Improve:	Use the data you collected during the test to improve your plan.
Re-create:	Next attempt to improve your solution to a design problem. Repeat until a solution is achieved.

Engineering Planning Sheet

Ask: What is the problem?

Write it:

_____

_____

Imagine: Brainstorm ways to solve the problem.

-
-
-
-
-
-

Plan: What is your step-by-step solution to solve the problem?

Draw a diagram:

Engineering Planning Sheet (continued)

First,

Next,

Last,

Materials you will need:

Create and Test: This is your first attempt to solve the problem:

Follow your plan and make a model. Then test your model to see if it solves the problem.

Engineering Planning Sheet (continued)

Improve: Use the data you collected during the test to improve your plan.

What works?

What doesn't?

How can you make it better?

Re-Create: This is your next attempt to improve your solution to the problem.

Revise your plan and make a model. Then test your model to see if it solves the problem.

Appendix 2.1

Properties of Matter

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
2-PS1-1	Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]
2-PS1-2	Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.* [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [*Assessment Boundary: Assessment of quantitative measurements is limited to length.*]

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)
Asking Questions ~~and Defining Problems~~
• Ask questions based on observations to find more information about the natural and/or designed world(s).
Planning and Carrying Out Investigations
• Make observations (firsthand or from media) ~~and/or measurements~~ to collect data that can be used to make comparisons.
Obtaining, Evaluating, and Communicating Information
• Communicate information ~~or design ideas and/or solutions~~ with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and /or design ideas.
Analyzing and Interpreting Data
• Record information (observations, thoughts, and ideas).
• Use observations (firsthand ~~or from media~~) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.

DISCIPLINARY CORE IDEAS (DCI)
PS1.A: Structure and 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.
ETS1.A: Defining and Delimiting an Engineering Problem
• Asking questions, making observations, and gathering information are helpful in thinking about problems.

Appendix 2.1

CROSSCUTTING CONCEPTS (CCC)
Patterns
• Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Common Core State Standards (CCSS)

CCSS ELA WRITING
CCSS.ELA-LITERACY.W.2.8
Recall information from experiences or gather information from provided sources to answer a question.
CCSS ELA SPEAKING & LISTENING
CCSS.ELA-LITERACY. SL.2.1
Participate in collaborative conversations with diverse partners about *grade 2 topics and texts* with peers and adults in small and larger groups.
CCSS.ELA-LITERACY. SL.2.6
Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification.
CCSS ELA LANGUAGE
CCSS.ELA-LITERACY. L.2.3
Use knowledge of language and its conventions when writing, speaking, reading, or listening.

California English Language Development (ELD) Standards

CA ELD		
Part 1.2.1 Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics		
EMERGING	EXPANDING	BRIDGING
P1.2.1 Contribute to conversations and express ideas by asking and answering *yes-no* and *wh-* questions and responding using gestures, words, and learned phrases.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, and adding relevant information.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, adding pertinent information, building on responses, and providing useful feedback.
In addition to the standard above, you may find that you touch on the following standard in this lesson as well:		
P1.2.5 Listening actively to spoken English in a range of social and academic contexts		

Properties of Liquids

2.2


Image via iStock.com/Doucefleur

Anchoring Phenomenon

Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle.

Lesson Concept

Plan and carry out an investigation to observe and classify patterns of properties of different kinds of materials.

Investigative Phenomenon

Water poured from one container to a different container takes the shape of the new container.

Standards

Refer to Appendix 2.2 for NGSS, CCSS (ELA), and California ELD standards.

Storyline Link

In the prior learning sequence, students observed, described, and classified properties of solid materials. Students also began to develop an engineering problem. In this learning sequence, students plan and conduct investigations to observe and classify patterns of properties of liquids to answer a question generated by the class. Based on their sense-making, students use their observations to compare properties of liquids and solids. The properties of liquids relate to the anchoring phenomenon: "Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle." Eventually students will understand that when some solids melt, they spread out to take the shape of their container. When cooled, some liquids become a solid that doesn't need a container to have that shape, e.g., chocolate bars, chocolate bunnies, etc. This foundational understanding of the properties of matter will help students with the Plan phase of the Engineering Design Process. In the next learning sequence, students will explore the idea that materials are used for different purposes depending upon their properties.

Throughout the lesson, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and making sense of phenomena.

Time

140 minutes

Part I	45 minutes	
	30 minutes	Engage
	15 minutes	Explore
Part II	50 minutes	
	30 minutes	Explore
	20 minutes	Explain
Part III	45 minutes	
	15 minutes	Elaborate
	30 minutes	Evaluate

Materials

Whole Class

- ❑ Chart paper
- ❑ Different-sized containers for student investigations
- ❑ 8 solid objects (from Lesson 1)
- ❑ Bottle of water
- ❑ 2.1.C1: Student Question Chart (from Lesson 1: Properties of Matter)

Groups (Groups of 2)

- ❑ 2.2.G1: Investigation Planner
- ❑ 1 500-mL bottle of water
- ❑ 2 9-oz clear plastic cups
- ❑ 1 clear bowl (of a different width than the cups)
- ❑ One ice cube in a cup
- ❑ Paper towels
- ❑ Small disposable cup with water

Each station (Assemble various liquid containers)

- ❑ Plastic cups for pouring liquids
- ❑ Plastic storage containers of various sizes
- ❑ Various-sized containers with lids (e.g., 500 mL empty water bottles)
- ❑ One bottle of each of the following liquids:
  - ❑ Tap water with food coloring
  - ❑ Baby oil
  - ❑ Dish soap
  - ❑ Pancake syrup
  - ❑ Bottle of juice

Individual

- ❑ Science notebook
- ❑ Pencils
- ❑ Funnels (optional)
- ❑ Measuring cups (optional)

Advance Preparation

1. Have **2.1.C1: Student Question Chart** (from Lesson 1: Properties of Matter) available for this and subsequent lessons. This will help students develop better explanations for the anchoring phenomenon: Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle and continue to build on their understanding of the crosscutting concept of patterns from previous grade levels.
2. Make a copy of **2.2.G1: Investigation Planner** for every pair of students.
3. Gather the liquids for the Explore (preferably based on student wonderings).

Procedure

Part I

Engage (30 minutes)

Carry out an investigation to observe and classify patterns of properties of different kinds of materials.

1. Bring students to a central area and have them guide you in drawing a picture on chart paper of what they recall doing to the solid objects in Lesson 1: Properties of Matter. Be sure to label and clarify students' current thinking and wonderings.
2. As a whole group, students can view the eight solid objects from Lesson 1: Properties of Matter, a variety of containers, and a water bottle. Have students connect their thinking about properties from the previous lesson by asking, "What do you wonder about the items?" Encourage students to explore the objects by asking the following questions:
   - What do you feel when you touch the objects?
   - How do the objects smell?
   - What is the same about the objects?
   - What is different about the objects? What does it make you wonder?

   ESRs: I wonder if I can hit the water bottle with a hammer. I wonder if I can smash the water bottle.

TEACHER NOTE

To increase student-driven learning, connect to the student ideas and wonderings about the bottle of water while introducing the activity. If all student wonderings are about changing the water bottle, redirect student wonderings to the contents of the water bottle. A possible exchange between you and your students might be:

Student: "What happens if we hit the water bottle with a hammer?"

Teacher: "Remember what happened when we hit the crayons and other objects with the hammer?"

Students: "They were smashed."

Teacher: "So we know what's going to happen if we hit it with a hammer. Let's focus on the water inside. What do you wonder about the water?"

Students: "I wonder if we can take it out. I wonder if we can put it in those containers. I wonder if it will spill. I wonder if it will get things wet. I wonder if it will dry up. I wonder if we can put it back in the water bottle."

3. Invite pairs of students to select a bottle of water and a variety of containers to investigate their wonderings. Have students work in pairs to explore the materials by pouring water into different containers, then think-pair-share observations of how the water behaves. Ask students to write—in words or pictures—in their science notebook what they observed and questions that they have about water based on the investigative phenomenon, "Water poured from one container to a different container takes the shape of the new container." *ESRs: The water is wet. It spreads out. It looks like there is more or less in different containers. It is wider or taller. It changed shape. What happened to the water? What happens if I pour it back into the bottle? Why did it change shape? Is there more water now? Is there less? Do other things change shape also?* Add their questions to the **2.1.C1: Student Question Chart**.
4. Ask students to name other substances/items that behave like water when they are poured. *ESRs: I can pour milk. I can pour pancake syrup. I can pour juice. Rain pours. I can pour glue. I can pour oil.*

> **TEACHER NOTE**
>
> In the materials, it was suggested that you provide certain liquids for the Explore. However, if you are able, it is best to provide the liquids the students identified.

Explore (15 minutes)

Plan and conduct an investigation to observe and classify patterns of properties of different kinds of materials.

> **TEACHER NOTE**
>
> Set boundaries for this investigation to ensure student safety.

5. If students used the word *liquids* in the Engage stage, affirm that the substances/items they listed that act like water when they are poured are called liquids. If the word *liquid* was not mentioned by students, introduce the term.
6. Show students the liquids they can choose to investigate and the different materials and containers they can use in their investigation. Provide each pair with **2.2.G1: Investigation Planner.** Have students work in pairs to create a plan about how they will investigate the different liquids. Prompt students to think about how much liquid is in the bottle/container and the shape of the liquid in the container. Allow five to ten minutes for students to work on their plan.

Part II

Explore (30 minutes)

Plan and conduct an investigation to observe and classify patterns of properties of different kinds of materials.

7. Circulate among the students; as needed, encourage students to create ways in their investigation plan to answer questions from **2.1.C1: Student Question Chart** or other questions they might have about the properties of liquids.
8. Have students share their plans with the whole class. Allow time for them to ask questions about each other's plans. Then allow time for students to revise based on the ideas they heard from other students.
9. Explain to students that they will be choosing the liquids described in their plan from the materials table to carry out their investigations. Students will record their observations in their science notebook using **2.2.G1: Investigation Planner**. Remind students of the safety boundaries for this investigation.
10. Allow time for students to conduct their investigations and record data. Ask students to note any patterns they notice in their observations (similarities, differences, things that happen repeatedly, etc.).
11. Refer to the question in **2.2.G1: Investigation Planner**: "What patterns did you see when you observed the liquids?" Have students think-pair-share the similarities and differences they observed about the different liquids. Then select some students to share their own or their partner's observations, facilitating a student-to-student conversation about how some of the observable properties are similar to each other, and some are different.
12. As students share ideas using their own words, help students discuss why certain properties belong together. *ESRs: The liquids spread out in their new container. Some liquids poured fast. When we poured two liquids into the same container, one liquid was on top of the other. The liquids didn't mix. The liquids looked like the shape of the new container. The liquids looked taller or shorter depending on the container's shape. The liquids looked fatter or skinnier depending on the container's shape.*

> **TEACHER NOTE**
>
> The properties of liquids relate to the anchoring phenomenon. Eventually students will understand that when some solids melt, they spread out to take the shape of their container. When cooled, the liquids become a solid that doesn't need a container to keep that shape, e.g., chocolate bars, chocolate bunnies, etc.

13. Have students refer to the **2.1.C1: Student Question Chart**. Ask students to think-pair-share which of the questions have been answered. Record answers on the chart. *ESR: Liquids spread out and take the shape of their new container.*

Explain (20 minutes)

Plan and conduct an investigation to observe and classify patterns of properties of different kinds of materials.

14. ▶ Have students write or draw their observations of the liquids in their science notebook. Remind students to use examples from their investigations in their explanation. *ESRs: Liquids pour, but I observed that the water poured easier than the syrup. Liquids spread out in their containers. The water and the dish soap spread out when they were poured into a container. When I poured two liquids into the same container, they didn't mix. The syrup spread out, but it was slow. Some liquids are bubbly, and some liquids are clear.*
15. Have students review the **2.1.C1: Student Question Chart** to recall the properties they observed about the solid objects. Have students answer the question, "How are liquids similar to or different from the solid objects?" in their science notebook. *ESRs: The liquids are wet, and the solid objects are dry. The liquids are soft, and the solid objects are hard. The misshapen objects spread out like the liquids. They are similar because both are smooth.*

Part III

Elaborate (15 minutes)

Plan and conduct an investigation to observe and classify patterns of properties of different kinds of materials.

16. Distribute an ice cube in a cup and a cup of water to each student pair. Have students make observations of the ice and the water as it changes from a solid to a liquid.
17. Encourage students to explore the materials. Allow students to decide how to explore the cup with ice and the cup with water. Have students think-pair-share observations. *ESRs: The ice cube is hard. The ice cube doesn't spread out. The water spread out. Water is wet, and the ice cube is wet. When we put the ice in the water, it floated. It was solid and then it was a liquid. The ice cube melted in my hand.*
18. Ask students to think-pair-share how the ice cube and water are like the misshapen and regular solid objects. *ESRs: The ice cube is hard like the solid objects. The ice cube doesn't spread out when it is frozen. The regular objects don't spread out. The water is like the misshapen objects because it spreads out.*

TEACHER NOTE

Students are beginning to explain the anchoring phenomenon: "Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle" by noticing when the ice cube (a solid) gets heated, it becomes liquid water.

19. Ask students to think-pair-share how the ice cube and water are like the misshapen and regular solid objects. *ESRs: The ice cube is hard like the solid objects. The ice cube doesn't spread out when it is frozen. It spreads out in my hand as it melts. When the ice becomes water in my hand, it is like (the crayon, lip balm, or candle) because it spreads out.*
19. Ask students if anything they just did with the liquids would help the objects go back to their original shape. Refer to the **2.1.C1: Student Question Chart** and the engineering question from Lesson 1: Properties of Matter, "How can we keep this from happening?" *ESR: Don't warm them up!*
21. ▶ Provide a block and a glass of milk and two different-sized containers for students to observe. Have students think-pair-share to describe how they would plan and conduct an investigation to find evidence to describe the patterns of the properties of each. Encourage students to recall what they know about the properties of solids and liquids.

Evaluate (30 minutes)

Observe and classify properties of solids and liquids.

22. Have students refer to the **2.2.G1: Investigation Planner** they completed in the Explore. Have students write their own investigation plan.

TEACHER NOTE

You can provide your students with scaffolds to write their investigation plans. For example:

First, I would…

Next, I would...

Then, I would...

Last, I would...

Finally, I would…

23. ▶ Based on the investigation plan, have students write in their science notebook about the differences between solids and liquids. They should base the differences on the evidence they found in patterns of observation, including classifying each as a solid or liquid and identifying at least three properties. *ESRs: I know that the block is a solid. I know because I observed it is hard, brown, wooden, and square. I know the milk is a liquid. I know this because it is white, runny, cold, foamy, flowing, spreads, and takes the shape of the glass.*

TEACHER NOTE

▶ Review your student's responses. Use the following rubric for evaluating student understanding of solids and liquids in step 23.

3	2	1
The student identifies the state (solid or liquid), provides 3 or more properties, and fully explains how he or she found out or used evidence to find out about those properties.	The student identifies the state (solid or liquid) and provides 2–3 properties but does not fully explain how he or she used evidence to find out about those properties.	The student demonstrates minimal understanding. Can identify solid or liquid and 1–2 properties but does not explain how he or she used evidence to find out about those properties.

Toolbox Table of Contents

Investigation Planner

Name the Liquid	What do you want to find out about the liquid?	What are you going to do to find out?	What did you find out?	What patterns did you see when you observed the liquids?
	We want to find out	We are going to	We found out	The patterns we saw are
	We want to find out	We are going to	We found out	
	We want to find out	We are going to	We found out	

Appendix 2.2

Properties of Liquids

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
2-PS1-1	Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]
2-PS1-2	Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.* [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [*Assessment Boundary: Assessment of quantitative measurements is limited to length.*]

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)
Planning and Carrying Out Investigations
• Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. • Make observations (firsthand or from media) ~~and/or measurements~~ to collect data that can be used to make comparisons.
ASKING QUESTIONS ~~AND DEFINING PROBLEMS~~
• Ask questions based on observations to find more information about the natural and/or designed world(s).
ANALYZING AND INTERPRETING DATA
• Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. • Record information (observations, thoughts, and ideas).

DISCIPLINARY CORE IDEAS (DCI)
PS1.A Structure and 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.

Appendix 2.2

CROSSCUTTING CONCEPTS (CCC)
Patterns
• Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Common Core State Standards (CCSS)

CCSS ELA WRITING
CCSS.ELA LITERACY.W.2.8
Recall information from experiences or gather information from provided sources to answer a question.
CCSS ELA SPEAKING & LISTENING
CCSS.ELA LITERACY. SL.2.1
Participate in collaborative conversations with diverse partners about *grade 2 topics and texts* with peers and adults in small and larger groups.
CCSS.ELA LITERACY. SL.2.6
Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification.
CCSS ELA LANGUAGE
CCSS.ELA LITERACY. L.2.3
Use knowledge of language and its conventions when writing, speaking, reading, or listening.

California English Language Development (ELD) Standards

CA ELD		
Part 1.2.1 Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics		
EMERGING	EXPANDING	BRIDGING
P1.2.1 Contribute to conversations and express ideas by asking and answering *yes-no* and *wh-* questions and responding using gestures, words, and learned phrases.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, and adding relevant information.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, adding pertinent information, building on responses, and providing useful feedback.
In addition to the standard above, you may find that you touch on the following standard in this lesson as well: **P1.2.5** Listening actively to spoken English in a range of social and academic contexts.		

Different Properties for Different Purposes

2.3


Image via iStock.com/Anze Furlan/psgtproductions

Anchoring Phenomenon

Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle.

Lesson Concept

Analyze and interpret data to determine which properties of materials are best suited for a specific purpose.

Investigative Phenomenon

Crayon marks are difficult to remove from school surfaces. I wonder what materials would work best to remove them?

Standards

Refer to Appendix 2.3 for NGSS, CCSS (ELA and Math), and California ELD standards.

Storyline Link

This lesson builds on ideas developed in the two prior lessons in which students planned and conducted investigations that helped them explore patterns of properties of solid and liquid materials. In this lesson, students are presented with a problem and record data as they test the use of materials with different properties to solve the problem. Students collect and analyze more data in order to determine the materials that can be used to solve the problem and to explain the properties of the materials that made them well suited for the solution. Students apply what they have learned in this lesson to add to their engineering design plan. In the next lesson, students will learn to make a claim based on evidence they gain from exploring the reversible and irreversible changes caused by heating or cooling matter.

Throughout the lesson, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and making sense of phenomena.

Time

145 minutes

Part I	35 minutes		
		35 minutes	Engage
Part II	45 minutes		
		30 minutes	Explore A
		15 minutes	Explain A
Part III	65 minutes		
		15 minutes	Explain B
		20 minutes	Elaborate
		30 minutes	Evaluate

Materials

Whole Class

- ❑ Book: *Rosie Revere, Engineer* by Andrea Beaty
- ❑ Book: *Iggy Peck, Architect* by Andrea Beaty
- ❑ Chart paper
- ❑ Markers
- ❑ 2.1.C1: Student Question Chart (from Lesson 1: Properties of Matter)

Group (Groups of 4)

- ❑ Tray
- ❑ Sponge (divided into four equal parts)

- ❑ Sandpaper (2 in. x 2 in. piece)
- ❑ Paper towels
- ❑ Sock or felt (2 in. x 2 in. pieces)
- ❑ Cotton balls
- ❑ Paper
- ❑ Wooden block
- ❑ Straws
- ❑ Aluminum foil
- ❑ Wax paper
- ❑ Crayon
- ❑ Two crayon-marked cups (See Advanced Preparation)
- ❑ 2.3.G1: Crayon-marked Cup Rubric

Individual

- ❑ Science notebook
- ❑ Pencils
- ❑ 2.1.H1: Engineering Planning Sheet (from Lesson 1: Properties of Matter)

Advance Preparation

1. Obtain a copy of *Rosie Revere, Engineer and Iggy Peck, Architect* by Andrea Beaty. You can either purchase or check out from the library.
2. Gather materials for the Explore stage for each group and put them on the tray.
3. Prepare two crayon cups for each group. Use a black crayon to cover at least 4 sections of the side of one of the plastic cup. This will enable students to try different materials on different sections of the cup. Use a black crayon to completely cover the bottom of another cup to be used as a control to compare the "cleaned" cups.
4. Either make one copy per group of **2.3.G1: Crayon-marked Cup Rubric** or display it on a chart where everyone can view it.

Procedure

Part I

Engage (35 minutes)

Analyze and interpret data to determine via cause and effect which properties of materials are best suited for a specific purpose.

1. Bring the students to a central area. Prompt students to guide you in drawing on chart paper a picture of what the students recall doing to the liquids in Lesson 2: Properties of Liquids. Be sure to label and clarify students' current thinking and wonderings. Any student questions should be added to the **2.1.C1: Student Question Chart**.
2. Refer to the **2.1.C1: Student Question Chart** and engage students in a conversation about what they have learned about solids and liquids that helps them to explain what might have caused the objects to become misshapen. *ESRs: I tried different things from my investigation plan. I made a plan, and I tried out my ideas. I had lots of questions, and I got answers after I tried out my plan.*
3. Have a class discussion about how people might solve problems. *ESRs: I ask for help. I don't give up. I make a plan. I think about it. I think about how I could fix it. I try and try again.*

> **TEACHER NOTE**
>
> To facilitate this discussion, it may be helpful to refer to a recent problem that the class has solved or that a group has solved.

4. Read aloud *Rosie Revere, Engineer* by Andrea Beaty. Ask, "How does Rosie solve problems? Does Rosie's solution always work the first time?" *ESRs: Rosie tries different materials. Rosie keeps trying different ways. Rosie tests materials to see if they will help her solve a problem. Her solutions don't always work the first time.*
5. Ask students to think-pair-share as they compare how they solve problems with how Rosie solves problems. Prompt students to notice what is the same and what is different about how Rosie solves problems and how they solve problems.

Part II

Explore A (30 minutes)

Analyze and interpret data to determine via cause and effect which properties of materials are best suited for a specific purpose.

6. Say to students, "Just as Rosie had a problem to solve, we have a problem to solve at our school. We have had crayon marks show up around our school on different surfaces. How can we clean the crayon marks from our school surfaces?"

TEACHER NOTE

The problem students are trying to solve is how to remove crayon marks from school surfaces. If there has been a recent episode of crayon marks on desks or other surfaces at the school, use that incident as a setting for the problem. Alternatively, the problem can be set in the context of wanting to recycle the cups for a different purpose in order to establish the need to remove the crayon marks from the cups.

7. Ask students, "What do you think will clean crayon marks from our school surfaces? Why? How?" *ESRs: I can try rubbing it off. I can use a napkin. I can use my shirt. I can use an eraser. I can use water. I can use soap. I think it will work because rubbing takes marks off, and I've done it before.*
8. Distribute the tray of materials to each group of four. Allow students time to explore and observe the materials and consider how they could be used to remove the crayon marks from the cups. Have them think-pair-share and then record their observations in a student-designed table (chart) in their science notebook. Observations could include: *the sandpaper is rough*, *the cotton ball is fluffy and white*, *or the sponge is dry and has holes*, etc. Remind students to record their data with the name of the item and its properties.

TEACHER NOTE

Student data tables should reflect student thinking; therefore, it is not necessary to have them organized in the same way. Select a few data tables for students to display later to the class and have a conversation about which features of the data table make it easier to look at the data and understand the data, e.g., labels and one-to-one correspondence between the item and its properties.

9. ▶ Ask students to use the properties they've listed in their table to make a prediction about which of the items might work best to remove the crayon from the cup. Have students write their predictions in their science notebook. Encourage students to back up their claim with what they observed about the properties of the object(s) and how those properties will help clean the crayon marks.

TEACHER NOTE

▶ As you walk around, assess students' responses using this rubric.

TEACHER NOTE (continued)

3	2	1
Identifies the object, states a property of the object, and explains how that property will help.	Identifies the object and states a property of the object	Identifies the object.
The _____ (sandpaper) will work the best because it is _____ (rough), and it will rub the crayon mark off the cup completely.	*The _____ (sandpaper) will work the best because it is _____ (rough).*	*I will use the ___ (sandpaper)*

10. Allow time for students to test their predictions. Have students record their findings in their science notebooks.
11. ▶ Have the class compare their results to the control cup. Allow students to self-assess their results by using **2.3.G1: Crayon-marked Cup Rubric** or the chart on the wall. Construct a class chart to determine the overall best material for cleaning the crayon marks.

Explain A (15 minutes)

Analyze and interpret data to determine via cause and effect which properties of materials are best suited for a specific purpose.

12. Have students refer to their data tables and the class data table. Ask students, "What properties of these materials were best suited for cleaning the crayon marks from our school surfaces? Why? What patterns did you notice?" Chart student responses.

Part III

Explain B (15 minutes)

Analyze and interpret data to determine via cause and effect which properties of materials are best suited for a specific purpose.

13. Engage students in a conversation about the crayon problem and the different properties of the materials that helped to clean the crayon off the cup. Facilitate the conversation so that students clarify that there were several different properties that served the same purpose: cleaning. Have students review the way the problem was solved and the way the data were used to determine success in solving the problem.
14. Ask students to think about other objects used in the classroom and share with a partner the object's use. Ask, "What are the properties of your object that makes it useful for that purpose?" For example, a student might say that a pencil is used to write, and it's made of wood to hold it in your hand. Have students think-pair-share about the different properties

of the pencil that make it useful for writing. Ask a few students to share an object that was talked about, its purpose, and the properties that made it useful for that purpose. Ask if the object could be made of different materials and still be useful for its purpose.

15. Refer to the **2.1.C1: Student Question Chart** with the questions generated in Lesson 1: Properties of Matter about crayons. Ask students to identify any questions that may have been answered or partially answered or addressed during the investigations. Direct student thinking toward how the misshapen objects were formed and how to prevent it from happening. The student responses will depend on the questions your students generated.

Elaborate (20 minutes)

Analyze and interpret data to determine via cause and effect which properties of materials are best suited for a specific purpose.

16. Read aloud, *Iggy Peck, Architect* by Andrea Beaty. Ask students: "How does Iggy solve problems? Does Iggy's solution always work the first time?" *ESRs: Iggy was using materials for different purposes. Iggy writes a plan on paper. Iggy keeps trying different ways. Iggy doesn't give up. Iggy uses evidence from his tests to revise his designs. Iggy teaches his classmates how to solve problems. Iggy's solutions don't always work the first time.*

Evaluate (30 minutes)

Analyze and interpret data to determine via cause and effect which properties of materials are best suited for a specific purpose.

17. Turn to the page in *Iggy Peck, Architect* that begins: "The class was amazed. They stood there uncertain of what they should do." Display the page. (You may be able to display the book page from a video on the Internet.)
18. Ask students to evaluate how well the solids that the second-grade students in the story have chosen will work (based on the solid's properties) for the purpose of building a bridge.
19. Have students record responses in their science notebook using statements of evidence to represent cause and effect. *ESRs: Because sticks are strong and hard and will hold up (or support) a bridge, they are a good choice for building a bridge.*
20. Turn to the page in the book that begins. "And when she came to, Miss Lila Greer knew." Display the page.
21. Have students evaluate how well each solid in the bridge would work based on where the solid is in the bridge. Invite students to compare the properties of each part to its function in the bridge, i.e., certain materials are used based on the ability to hold up the bridge. *ESRs: The sticks made the bridge strong. The kids in the story needed a strong bridge so they can cross back. The sticks were used to hold up the shoelaces in the bridge because it is their job. I think that that is a good use of the sticks because they are hard (structure) and strong and will hold up the shoelaces.*
22. Have students give an alternative solid that could be used to support the bridge based on the properties (structure) and function of the solid. *ESRs: The little boy could have also used a piece of metal in place of the stick because it is also strong and hard (structure) and could help with the job (function) of holding up the shoelaces in the bridge.*

23. Return to the **2.1.C1: Student Question Chart**. Have students add responses to any of the questions they have that can now be answered.
24. Have students reflect on how the children in the stories solved problems. Ask students to think about how some of the children's ideas may be incorporated into their engineering plans.
25. Refer to **2.1.H1: Engineering Planning Sheet,** which students should have a copy in their science notebooks. Have students begin the Create Phase by attempting to actualize the plan to solve their design problem, which is "How can we keep our three regular objects from becoming misshapen?"

Toolbox Table of Contents

Crayon-marked Cup Rubric

3	2	1
The cup is free of crayon marks and not damaged.	The cup is free of crayon marks but is damaged.	The cup still has crayon marks or is destroyed.

Appendix 2.3

Different Properties for Different Purposes

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
2-PS1-1	Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.]
2-PS1-2	Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.* [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [*Assessment Boundary: Assessment of quantitative measurements is limited to length.*]

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)
Analyzing and Interpreting Data
• Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.
Planning and Carrying Out Investigations
• Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons • Make predictions based on prior experiences.
Engaging in Argument from Evidence
• Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.
Constructing Explanations and Designing Solutions
• Use information from observations (firsthand or from media) to construct an evidence-based account for natural phenomena. • Generate and/or compare multiple solutions to a problem.

DISCIPLINARY CORE IDEAS (DCI)
PS1.A Structure and Properties of Matter
• Different properties are suited to different purposes.
ETS1.C Optimizing the Design Solution
• Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

Appendix 2.3

CROSSCUTTING CONCEPTS (CCC)
Cause and Effect
• Simple tests can be designed to gather evidence to support or refute student ideas about causes. • Events have causes ~~that generate observable patterns~~.
Structure and Function
• Students observe that the shape and stability of structures of natural and designed objects are related to their function(s). • The shape and stability of structures of natural and designed objects are related to their function(s).
Patterns
• Patterns in the natural and human designed world can be observed.

Common Core State Standards (CCSS)

CCSS ELA SPEAKING & LISTENING
CCSS.ELA-LITERACY. SL.2.1 Participate in collaborative conversations with diverse partners about *grade 2 topics and texts* with peers and adults in small and larger groups.
CCSS.ELA-LITERACY. SL.2.6 Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification.
CCSS ELA LANGUAGE
CCSS.ELA-LITERACY. L.2.3 Use knowledge of language and its conventions when writing, speaking, reading, or listening.
CCSS MATHEMATICAL PRACTICES
MP.2 Bring up Reason Reason abstractly and quantitatively.
MP.5 Bring up Use Use appropriate tools strategically.

Appendix 2.3

California English Language Development (ELD) Standards

CA ELD		
Part 1.2.1 Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics		
EMERGING	EXPANDING	BRIDGING
P1.2.1 Contribute to conversations and express ideas by asking and answering yes-no and wh- questions and responding using gestures, words, and learned phrases.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, and adding relevant information.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, adding pertinent information, building on responses, and providing useful feedback.
In addition to the standard above, you may find that you touch on the following standard in this lesson as well: **P1.2.5** Listening actively to spoken English in a range of social and academic contexts		

Reversible and Irreversible Changes

2.4


Image via iStock.com/GiuseppeSchiros

Anchoring Phenomenon

Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle.

Lesson Concept

Construct an argument using collected evidence to support the claim that some changes caused by heating or cooling can be reversed and some cannot.

Investigative Phenomenon

The corn kernel changed after it went into the hot air popper.

Standards

Refer to Appendix 2.4 for NGSS, CCSS (ELA), and California ELD Standards.

Storyline Link

In Lesson 3: Different Properties for Different Purposes, students investigated the use of materials for different purposes. The properties of the materials determine if they are best suited for a specific purpose. In this lesson, students continue to learn to construct a claim based on evidence. To facilitate this, students observe reversible and irreversible changes that are caused by heating or cooling different substances. In the next lesson, students will build on the ideas they explore in this lesson. As they return to the anchoring phenomenon of misshapen objects, students develop a plan to change the shape of a piece of chocolate. Their plan addresses the idea that materials are made of matter that may undergo a reversible or irreversible change.

Throughout the unit, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and making sense of phenomena.

Time

155 minutes

Part I	45 minutes	
	30 minutes	Engage
	15 minutes	Explore A
Part II	40 minutes	
	30 minutes	Explore B
	15 minutes	Explain B
Part III	45 minutes	
	25 minutes	Explore C
	20 minutes	Explain C
Part IV	25 minutes	
	15 minutes	Elaborate
	10 minutes	Evaluate

Materials

Whole class

- ❑ Unpopped corn kernel (one per student)
- ❑ Air popper or brown paper bag
- ❑ Pancake mix
- ❑ A raw egg
- ❑ Two clear containers for demonstration of egg and pancake mix
- ❑ Access to a microwave

- ❑ Craft sticks for mixing
- ❑ 4 chocolate bars
- ❑ Snack-sized bags (one per student)
- ❑ Molds for melting
- ❑ 2.1.C1: Student Question Chart (from Lesson 1: Properties of Matter)
- ❑ Toaster
- ❑ Loaf of Bread
- ❑ 2.4.R1: Bread and Toast (optional)

Group (Groups of 4)

- ❑ 2.4.G1: Student Claims
- ❑ 1 Envelope

Individual

- ❑ Science notebook
- ❑ Pencils

Teacher

- ❑ 2.4.R2: T-Chart

Advance Preparation

1. Gather all needed materials and heat sources.
2. If you're modeling with a real pancake and egg, cook them in advance.
3. Prepare chocolate bars by breaking them into pieces and putting one piece into each bag.
4. Make copies of **2.4.G1: Student Claims** and cut the claims apart. For each group of four, prepare one envelope with a set of claims.
5. For Part IV, use the toaster and make a piece of toast or be prepared to project the image on **2.4.R1: Bread and Toast**.

Procedure

Part I

Engage (30 minutes)

Observations combined with prior knowledge are used to explain the causes of changes to matter.

1. Bring the students to a central area and have them guide you in drawing a picture on chart paper what the students recall doing to remove the crayon markings in Lesson 4: Different Properties for Different Purposes. Be sure to label and clarify students' current thinking and wonderings. Any student questions should be added to the **2.1.C1: Student Question Chart**.
2. Show students the anchoring phenomenon: Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle. Ask students to think-pair-share a response to this question: "Thinking about what you learned about solids and liquids, what can you now say about the properties of these misshapen objects?" *ESRs: The crayon and the birthday candles are solids, and somehow they got spread out. The lip balm is also a solid, and when it got spread out it became squishy, but it's not a liquid. None of them are liquids because I can't pour them like the other liquids.*
3. Ask students to think-pair-share a response to this question: "What else have you learned about the properties of liquids and solids?" *ESRs: Last time, we used different solid materials to get the crayon marks off the cup. The kids in the stories used different solid materials to build things like a bridge. Maybe the crayon, the birthday candle, and the lip balm were once liquids.*
4. Ask students to think-pair-share a response to this question: "We learned about the purpose of some materials. What is the purpose of the crayon, candle, and lip balm?" *ESRs: The crayons are used to draw and color; the candle is used for a birthday cake; and the lip balm is used for our chapped lips.*
5. Ask students to think-pair-share a response to this question: "Will the objects still work as they're supposed to even though they're misshapen?" *ESRs: The crayons will kind of draw and color; the candle can probably be lit on a birthday cake but it won't look nice; and the lip balm will be hard to put on because it will smear on my face. They work better when they're just the regular way.*
6. Ask students, "Have we figured out how these objects got misshapen?" *ESRs: We already hit them, rolled over them, smashed, and nothing worked to make them look like they do now. I think they melted!*
7. Ask students to think about how the misshapen objects changed and how this is similar or different from other changes we see around us. Tell students that now we will explore some other types of matter that we can change in different ways.

Explore A (15 minutes)

Collect evidence that some changes caused by heating or cooling can be reversed and some cannot.

8. Distribute an unpopped corn kernel to each student. Have students make observations of the properties of the unpopped corn kernels. Have students share their observations. Chart student responses. *ESRs: It is a solid. It is hard, smooth, "pointy" and brown. It is not a liquid.*
9. Ask students to place the unpopped kernels in the air popper. Pop the kernels. Have students carefully observe what is happening to the kernels when heat is added.
10. Distribute a popped corn kernel to each student. Have students make observations of the properties of the popped corn kernel, and chart their responses. Students compare kernels before and after being heated. Have students think-pair-share observations. *ESRs: It is hot. It got spread out. It is fluffy and white. It feels softer and crunchy. The kernel changed from hard and smooth to white and fluffy.*
11. Have students compare the properties of the unpopped corn kernels with the popped kernels. Then engage in a collaborative discussion about what they think caused the unpopped corn kernel to change and questions they have. Chart student questions on the **2.1.C1: Student Question Chart**. Use student questions to drive student learning. *ESRs: Why did the kernel change? Did the heat cause it to change? Will it change back? Can we eat it?*

Part II

Explore B (30 minutes)

Collect evidence that some changes caused by heating or cooling can be reversed and some cannot.

12. To find out the answer to these questions, think about your kitchen at home. "Let's name some other things that change when we heat them." *ESRs: a cake, brownies, cookies, pancakes, eggs, etc.* Chart student responses.
13. Have students create a T-chart (see a model in **2.4.R2: T-Chart**) to track what happens before and after heating each substance suggested by the students.

> **TEACHER NOTE**
>
> You can substitute similar foods based on your students' ideas, such as brownie mix or cake mix, for steps 14–20.

14. Show students a package of pancake mix and some water. Pour pancake mix into a clear container. Have students observe the properties of the pancake mix. Have students share and record observations of the properties of the pancake mix on the Before side of the T-chart in their science notebook. Next, add water to the pancake mix and make a batter. Ask, "What do you notice about the pancake mix now?" *ESRs: It is a liquid. It can be poured. It flows. It has bubbles.*

15. Ask students, "What do you have to do to the batter to make it a pancake?" *ESRs: You have to cook it. You have to heat it. My mom puts it on a griddle.*
16. Show students a cooked pancake or display an image of a cooked pancake. Ask, "What do you notice about the cooked pancake?" Have students add in their science notebook the properties of the cooked pancake on the After side of the T-chart. Now, have them compare the properties of the cooked pancake with the properties of the raw batter. Ask, "Are the properties the same or different?" Chart student responses. Have students tell the story of the changing pancake mix, from a dry powder to a wet batter to something light, fluffy, and edible.

TEACHER NOTE

If appropriate for your class, provide the following sequence frame:

First,

Next,

Last,

For example: First, the pancake mix was dry and a solid. Next, we mixed it with water and it became a liquid. Last, it became a solid again once it was cooked.

17. Say to your students, "Let's try something else!" Show students a raw egg. Crack the egg and pour it into a clear container. Have students observe the properties of the raw egg. Have students share and record observations of the properties of the raw egg on the before side of the T-chart in their science notebook. *ESRs: It is a liquid. It is clear. It flows. It has bubbles. It has a yellow yolk.*
18. Ask students, "What do you have to do to make it an egg we can eat? *ESRs: You have to cook it. You have to heat it. My mom puts it in the microwave.*
19. Show students a fried egg or display an image of a fried egg. Ask, "What do you notice about the cooked egg?" Have students add in their science notebook the properties of the cooked egg on the After side of the T-chart in their science notebook. Now, compare the properties of the cooked egg with the properties of the raw egg. Ask, "Are the properties the same or different?" Chart student responses underneath the responses in step 16.
20. Have students identify and discuss cause-and-effect relationships in the pancake and egg investigation. *ESRs: Because it was heated, the raw egg (which was a liquid) is now a solid. It was flowy and now it is squishy because it was heated. The heat caused the egg to change.*

TEACHER NOTE

If appropriate for your class, provide the following sentence frame:

_____ was _____, now _____ is _____ because _____.

Explain B (10 minutes)

Begin to construct a claim using collected evidence that some changes caused by heating or cooling can be reversed and some cannot.

21. Ask students to think about the three cooked foods: popcorn kernels, pancakes, and eggs. Ask students, "What is the same about how they changed?" Refer students to what they wrote in their science notebook (evidence) and the chart on the board. *ESRs: They all spread out. They are all cooked. We can eat them. They can't change back to the way they were before.*
22. Explain that when we cannot change something back, it is an irreversible change. When we can change something back, it is a reversible change.
23. Have students add new understandings from this investigation and record in their science notebook whether the change in the cooked egg, pancake, and popcorn are reversible or irreversible changes. Encourage students to think about the pattern emerging from the three cause-and-effect relationships they have recorded in their science notebook.
24. Ask, "Have we answered our questions?" *ESR: Yes, heat changes the things we eat, and we can't change them back.*

Part III

Explore C (25 minutes)

Collect evidence that some changes caused by heating or cooling can be reversed and some cannot.

25. Ask students, "Can you think of other things that change when they are heated?" *ESRs: Yes, I remember that happened with the ice cube. It melted in my cup, and then when I put the water back in the freezer, I got ice cubes again. Solid to liquid to solid! Oh, that happens with popsicles too!*
26. Ask students, "What about chocolate?" *ESRs: When I have hot chocolate, you can't change it back. My Easter bunny melted, and I couldn't get it to look like a bunny again. No, we can't get it back just the same.*
27. Have students observe the properties of a piece of chocolate in a snack-sized baggie. Have students think-pair-share their observations. Have students record their observations of the properties of the chocolate in their science notebook. *ESRs: It is brown. It is hard. It is crunchy. It is a solid. It smells sweet.*
28. Have students observe what changes occur to the chocolate when it is held in their hands (Note: They must keep the chocolate in the bag). If the chocolate doesn't melt, ask students to think about what they might do to change the chocolate. *ESRs: place it in the sun outside, rub my hands together, place it in hot water, heat it, microwave it, etc.*
29. Have students take an action to heat their chocolate and then think-pair-share their observations. Have students record their observations of the properties of the chocolate in their science notebook. Have students identify and discuss possible cause-and-effect relationships.

TEACHER NOTE

If appropriate for your class, provide the following sentence frame:

_____ was _____, now _____ is _____ because _____.

For example, *The chocolate was hard and solid, now it is soft and squishy because I put it in the sun on the windowsill.*

30. Ask students, "Is the chocolate still solid? How do you know?" *ESRs: It's not a solid because it's not hard. It's not a solid because it spread out in the bag (like the liquids). I think we can pour it, so it's not a solid (like the liquids).*

31. Ask students, "Can we get the chocolate to be a solid again? What can we try?" *ESRs: If we put it in the freezer, it can change. If we heat it more, it can change. It will be solid again if we keep it out of the sun.*

32. Explore student responses and try out student ideas to determine if the change is reversible or irreversible, e.g., put the chocolate in the freezer, heat the chocolate more, put the chocolate in the blender, etc. Have the students observe the chocolate and answer their questions.

TEACHER NOTE

One way to carry out student ideas is to put the solid chocolate squares into a mold and melt the chocolate in the microwave. Then either leave it to cool and set or freeze it to cool and set.

33. Have students add new understandings from this investigation and record whether the change in the melted chocolate is a reversible or irreversible change in their science notebook.

Explain C (20 minutes)

Begin to construct a claim using collected evidence that some changes caused by heating or cooling can be reversed and some cannot.

34. Ask students what patterns they noticed about what happened to the chocolate when it was heated or cooled. *ESRs: The sun caused the chocolate to melt and become a liquid. The microwave caused the chocolate to melt and become a liquid. The freezer caused the chocolate to become a solid again.*

TEACHER NOTE

Help students relate the changed or melted chocolate to the anchoring phenomenon of the misshapen objects.

35. Distribute envelopes with the cut apart **2.4.G1: Student Claims** to each group of four students. Have students read the student claims and select the one with which they mostly strongly agree or disagree.

36. Have the students in each group discuss their reasons for agreeing with the student claim they selected using evidence they have collected in their science notebook.

37. Students write a claim in their science notebook that some changes by heating or cooling can be reversed and some cannot. Students support their claim with evidence from what they gathered in Explore A, B, and C.

38. ▶ Have students cite specific evidence from their observations. Students may use drawings as part of their explanation. *ESRs: The pancakes and eggs changed from a liquid to a solid and could not be changed back. This is an irreversible change. The popcorn kernel changed shape after it was heated, and it can't change back either. That's an irreversible change. The chocolate changed from a solid to a liquid and it became a solid again. This is a reversible change.*

Part IV

Elaborate (15 minutes)

Make predictions based on prior experiences that some changes caused by heating or cooling can be reversed and some cannot.

39. Refer students to the anchoring phenomenon: Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle. Have students refer to their observations of the regular objects and misshapen objects in Lesson 1: Properties of Matter.

40. Have students think-pair-share about whether the change in the misshapen objects is reversible or irreversible. Be sure to have students apply evidence from the investigations Explore A, B, and C in this lesson to make their predictions.

41. Have students respond in their science notebook. *ESRs: They are like chocolate. I can heat them, and they change from a solid to a liquid. When I cool them they can get their shape back and be used for their purpose. I predict the misshapen crayon is a reversible change. I predict the misshapen lip balm is an irreversible change. I predict the misshapen candle is a reversible change.*

Evaluate (10 minutes)

Construct a claim using collected evidence that some changes caused by heating or cooling can be reversed and some cannot.

42. Show students a slice of bread and a slice of toasted bread or show them **2.4.R1: Bread and Toast**.

43. ▶ Ask students to make a claim (using words or pictures) about what caused the changes to the bread in the second picture and whether the change can be reversed using evidence from prior investigations. *ESRs: The soft bread was heated and that caused it to become brown and hard. The change cannot be reversed. The evidence is that the changes weren't reversed when the pancake batter, popcorn, and eggs were cooked. They couldn't be changed back. Cooking seems to cause irreversible changes.*

Toolbox Table of Contents

Student Claims

Monica's claim is that when we heat a solid like ice, it turns to liquid water.

I agree or disagree with Monica's claim because _____.

My evidence is _____.

Josue's claim is that when we heat pancake batter, it turns to a solid. Josue thinks it will be easy to get the solid pancake back into a liquid.

I agree or disagree with Josue' claim because _____.

My evidence is _____.

Demond's claim is that when we heat chocolate candy, it becomes a liquid. Demond thinks it is easy to get the melted candy back into a solid shape.

I agree or disagree with Demond's claim because _____.

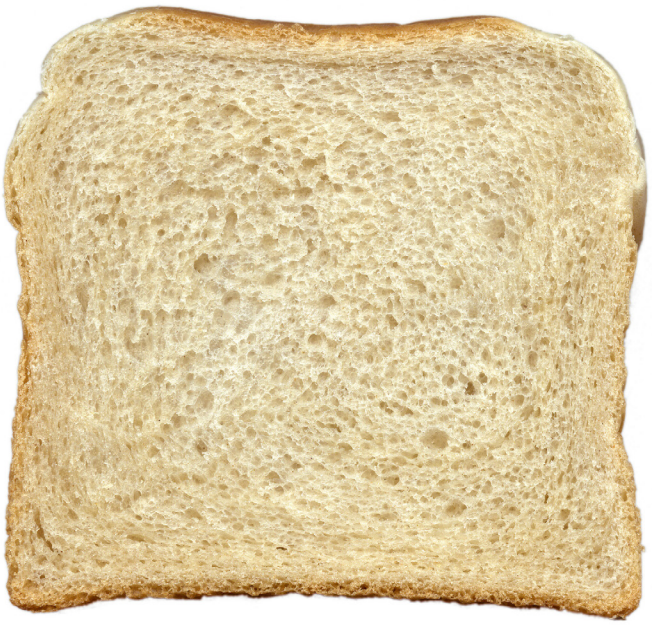
My evidence is _____.

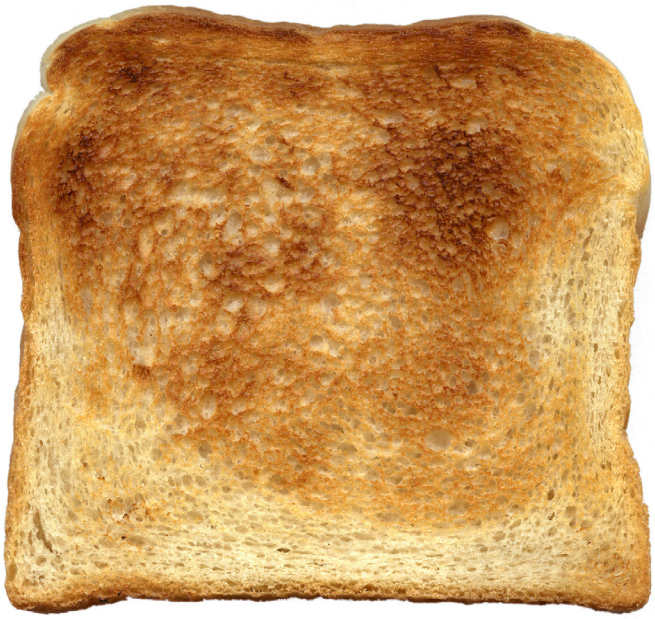
Landon's claim is that when we pop a popcorn kernel, it can never go back to an unpopped kernel. Landon thinks his claim is accurate.

I agree or disagree with Landon's claim because _____.

My evidence is _____.

Bread and Toast





Images by Rainer Z via Wikimedia Commons [GNU Free Documentation License]

T-Chart

Name: _____

Before	After

Appendix 2.4

Reversible and Irreversible Changes

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
2-PS1-4	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.]
2-PS1-2	Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.* [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [*Assessment Boundary: Assessment of quantitative measurements is limited to length.*]

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)
Engaging in Argument from Evidence
• Construct an argument with evidence to support a claim (2-PS1-4).
Planning and Carrying Out Investigations
• Make observations (firsthand or from media) and/or measurements to collect data. • Make predictions based on prior experiences.
Analyzing and Interpreting Data
• Record information (observations, thoughts, and ideas).
Constructing Explanations and Designing Solutions
• Use information from observations (firsthand or from media) to construct an evidence-based account for natural phenomena.
Obtaining, Evaluating, and Communicating Information
• Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.

Appendix 2.4

DISCIPLINARY CORE IDEAS (DCI)
PS1.A: Structure and 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.
PS1.B: Chemical Reactions
• Heating or cooling a substance may cause changes that can be observed. • Some changes are reversible and some are not.

CROSSCUTTING CONCEPTS (CCC)
Cause and Effect
• Events have causes that generate observable patterns (2-PS1-4).
Energy and Matter
• Objects may break into smaller pieces and be put together into larger pieces, or change shapes.

Common Core State Standards (CCSS)

CCSS ELA WRITING
CCSS.ELA-LITERACY.W.2.8 Recall information from experiences or gather information from provided sources to answer a question.
CCSS ELA SPEAKING & LISTENING
CCSS.ELA-LITERACY. SL.2.1 Participate in collaborative conversations with diverse partners about *grade 2 topics and texts* with peers and adults in small and larger groups.
CCSS.ELA-LITERACY. SL.2.6 Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification.
CCSS ELA LANGUAGE
CCSS.ELA-LITERACY. L.2.3 Use knowledge of language and its conventions when writing, speaking, reading, or listening.

Appendix 2.4

California English Language Development (ELD) Standards

CA ELD		
Part 1.2.1 Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics.		
EMERGING	EXPANDING	BRIDGING
P1.2.1 Contribute to conversations and express ideas by asking and answering *yes-no* and *wh-* questions and responding using gestures, words, and learned phrases.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, and adding relevant information.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, adding pertinent information, building on responses, and providing useful feedback.
In addition to the standard above, you may find that you touch on the following standard in this lesson as well: **P1.2.5** Listening actively to spoken English in a range of social and academic contexts.		

The Great Wax Disaster

2.5

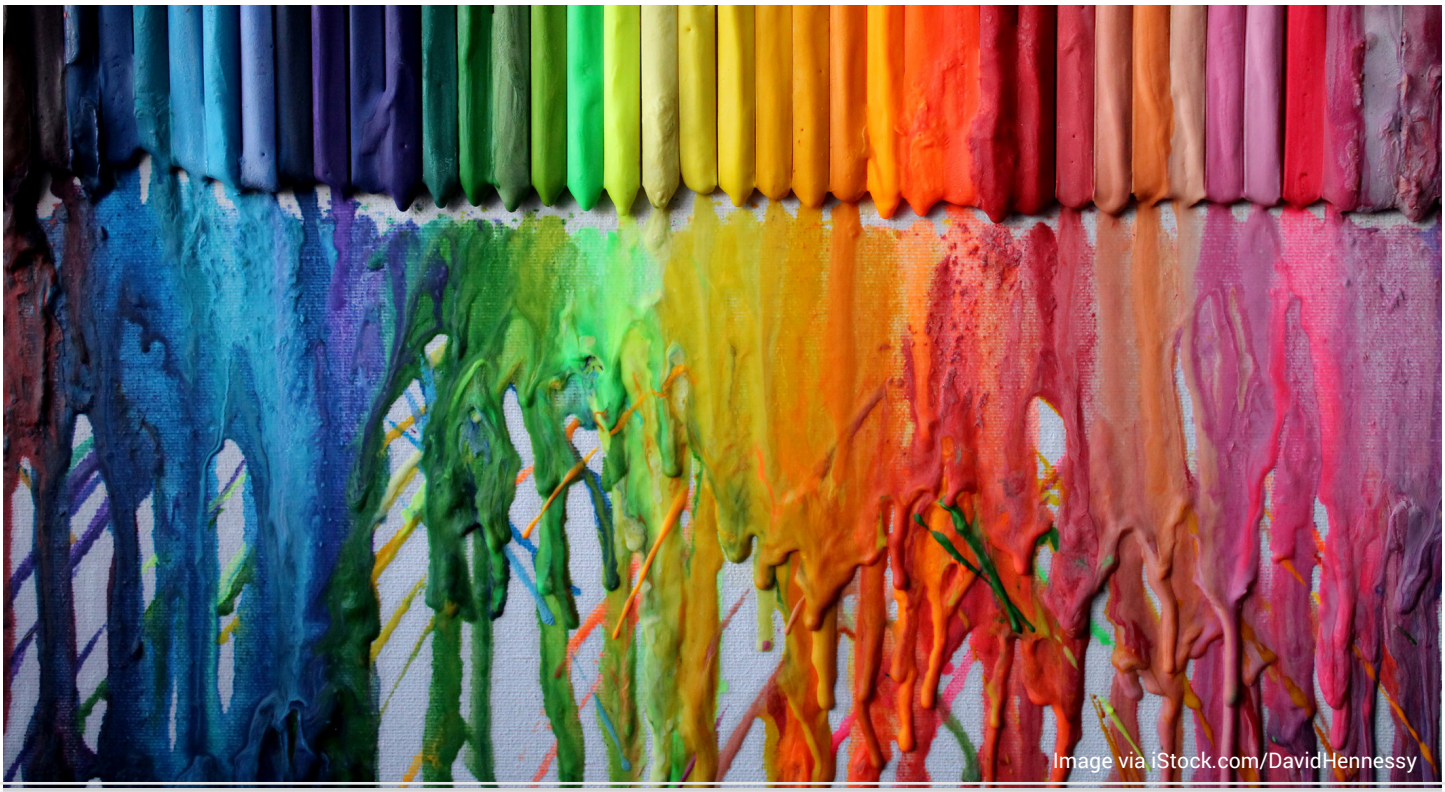


Image via iStock.com/DavidHennessy

Anchoring Phenomenon

Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle.

Lesson Concept

Planning and conducting an investigation to determine evidence that can be used to construct a claim that some changes caused by heating or cooling can be reversed and some cannot.

Investigative Phenomenon

Crayons are made of wax in a shape that we can hold with our fingers. Birthday candles are made of wax in a shape that we can put on a cake. Lip balm is made of wax in a shape that we can apply to our lips.

Standards

Refer to Appendix 2.5 for NGSS, CCSS (ELA), and California ELD standards.

Storyline Link

In Lesson 4: Reversible and Irreversible Changes, students constructed a claim based on evidence as they explored reversible and irreversible changes that are caused by heating or cooling different substances. In this final lesson, students return to the anchoring phenomenon of materials being made of matter and misshapen objects in order to develop an engineering plan that utilizes their thinking from Lesson 4: Reversible and Irreversible Changes, i.e., the changes that occurred to the misshapen objects are reversible or irreversible. The engineering plan ultimately solves problems generated by the students, i.e., how to keep the objects from becoming misshapen or how to return the objects to their original and useful shape. Students use a design process and 2.1.H1: Engineering Planning Sheet to develop a plan, compare plans with others, and collaboratively revise their plans. After conducting the investigation, students use their data to write a claim of how and if solid objects can be turned into a different shape. From their experiences with properties of materials and how properties of materials are or are not affected by heating and cooling, the students are able to explain the phenomena of the misshapen objects.

Throughout the unit, a flag (▶) denotes formative assessment opportunities where you may change instruction in response to students' level of understanding and making sense of phenomena.

Time

105 minutes

Part I	30–60 minutes	
	30–60 minutes	Engage
Part II	60 minutes	
	30 minutes	Explore
	15 minutes	Explain/Evaluate
	15 minutes	Elaborate

Materials

Whole class

- ❑ 2.1.C1: Student Question Chart (from Lesson 1: Properties of Matter)
- ❑ 2.1.C2: Engineering Design Process (from Lesson 1: Properties of Matter)

Individual

- ❑ Science notebook
- ❑ Pencils
- ❑ 2.1.H1: Engineering Planning Sheet (from Lesson 1: Properties of Matter)

Procedure

Part I

Engage (30–60 minutes)

Observations combined with prior knowledge are used to infer the causes of changes to properties of matter.

1. Bring the students to a central area and have them guide you in drawing a picture on chart paper of what the students recall doing to explore reversible and irreversible changes in the last lesson. Be sure to label and clarify students' current thinking and wonderings. Any student questions should be added to the **2.1.C1: Student Question Chart**.
2. Review with students the **2.1.C1: Student Question Chart** and ask them, "Which of these questions have we answered?" Add student responses to the chart. *ESRs: responses will vary depending on the students' questions.*
3. Ask students: "Which questions are you still curious about?" Support student curiosity and autonomy by providing opportunities and materials for students to explore their as yet unanswered questions. Encourage students to elaborate on what evidence will be necessary to answer their questions.

Part II

Explore (30 minutes)

Collaboratively plan and carry out an investigation to gather evidence to support or refute ideas about causes of changes to matter due to heating and cooling.

> **TEACHER NOTE**
>
> This Explore helps students make the connection to the anchoring phenomenon via their learning in Lessons 2.1: Properties of Matter through 2.4: Reversible and Irreversible Changes.

4. Ask students to recall their ideas from Lessons 2.1: Properties of Matter through 2.4: Reversible and Irreversible Changes and think-pair-share about whether the changes to the misshapen objects are reversible or irreversible. Display the anchoring phenomenon: Materials are made of matter. We can observe misshapen objects, including a crayon, lip balm, and a candle. Chart student ideas. *ESRs: I think the misshapen candles and crayons are reversible changes because they're like the chocolate bar. I disagree; I think the candles and crayons are irreversible because we'll never get them back to their real shape so they can do their job. I disagree because sometimes it changes shape, but when it is a solid, it can still do its job.*

5. Brainstorm with the students: "What does it mean to undergo a reversible change?" *ESRs: We can get it back to its regular shape. We can get it back so it can do its job. The object has to be a solid. The properties are the same as the regular one. A property like shape helps it do its job.* Chart student responses.
6. Brainstorm with the students: "What does it mean to undergo an irreversible change?" *ESRs: We cannot get it back to its regular shape. We cannot get it back so it can do its job. The object can be a liquid or a solid so the properties may not be the same. Chart student responses.*
7. Explain to students that they will be developing a plan to conduct an investigation. However, before we begin, we need to agree: "Will we be planning for a reversible or irreversible change? Why?" *ESRs: A reversible change because we want the objects to get back to a shape so they can do their jobs.*
8. Guide students to write a plan that results in a reversible change, i.e., getting the misshapen objects to return to their original and useful state or a plan that stops the change from happening altogether. Advise students that they can later write a plan that results in an irreversible change.
9. Help students craft a question they can use to develop a plan to collaboratively conduct an investigation. *ESRs: How can we keep the change from happening? How can we get the misshapen crayon back to a shape so it can do its job? How can we get the misshapen birthday candle back to a shape so it can do its job? How can we get the misshapen lip balm stick back to a shape so it can do its job?*
10. Refer students to the path of learning you have created on chart paper from Lessons 1: Properties of Matter through 4: Reversible and Irreversible Changes. Have students discuss all the different things we did to matter to change it. Now, allow time for them to think-pair-share about any of those ideas they may want to include in their plan.
11. To create a blueprint to guide students' thinking, use your chart from Lesson 1: Properties of Matter (refer to **2.1.C2: Engineering Design Process** for a sample design process: Imagine, Plan, Create, Test, Improve, Re-create) You can choose to allow students to go through the entire cycle or not. Ask students to identify what materials they will need to carry out their plans.

TEACHER NOTE

Have students choose one misshapen object they want to focus on to plan an investigation. Be aware of safety concerns in the planning, e.g., you can't put a metal lip balm stick case in a microwave. Here is a sample student plan that only includes the *Imagine and Plan* phase:

Imagine: *I can change the shape of the misshapen crayon.*

TEACHER NOTE (continued)

Plan: *First, I would stick the crayon in a microwave to make it a liquid. Then, I would put it in a mold in the shape of a real crayon. Next, I would put it in the freezer to cool. Last, I would use the crayon to color my picture.*

12. Have students compare their plans with a partner and improve their plans.

Explain/Evaluate (15 minutes)

Gather evidence to support or refute ideas about the causes of changes to matter.

13. ▶ Have students refer to their science notebook entries regarding reversible and irreversible changes. Have students use the evidence in their notebook entries from previous lessons to discuss whether their design plan will work.

TEACHER NOTE

Provide the following sentence frame if your students would benefit:

I think my plan for ___ will work because ___.

For example, *I think my plan for the crayon will work because it is just like what we did with the chocolate. The chocolate melted and turned to a liquid. Then when we put it in a mold, it became hard again after it cooled. I think the crayon will do the same thing. It will have the same shape and hardness (properties) as the regular one.*

14. Revisit the anchoring phenomenon of misshapen objects. Have students collaboratively discuss: How can you turn an ordinary object into a different shape?

TEACHER NOTE

▶ Throughout the Matter Unit, a 5E the word model was employed; however, at the end of Lesson 5: The Great Wax Disaster, the final Explain is used to Evaluate student understanding of the anchoring phenomenon. Use this rubric to evaluate students' plans.

TEACHER NOTE (Continued)

3	2	1
The plan includes a logical sequence of steps that involve heating/melting and then cooling the misshapen crayon, candle, or lip balm. The plan includes the idea that a solid such as wax, once liquefied, can be put into an appropriate mold, cooled, and then will function as intended.	The plan includes a somewhat logical sequence of steps that involve some part of heating/melting and cooling the misshapen crayon, candle, or lip balm. May refer to the object being returned to its intended shape for its intended purpose.	Plan is illogical. Vague reference to heating/ melting and cooling the misshapen crayon, candle, or lip balm. Limited to no mention of the object being returned to its original shape for intended purpose.

Elaborate (15 minutes)

Defining and delimiting an engineering problem means generating more than one possible solution to a problem.

15. Have students complete the **2.1.H1: Engineering Planning Sheet** with their plans for how to prevent the objects from becoming misshapen again.

Appendix 2.5

The Great Wax Disaster

Next Generation Science Standards (NGSS)

This lesson is building toward:

PERFORMANCE EXPECTATIONS (PE)	
2-PS1-4	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.]
2-PS1-2	Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.* [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [*Assessment Boundary: Assessment of quantitative measurements is limited to length.*]

NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press.

SCIENCE AND ENGINEERING PRACTICES (SEP)
Planning and Carrying Out Investigations
• Plan ~~and conduct~~ an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
Asking Questions and Defining Problems
• Define a simple problem that can be solved through the development of a new or improved object or tool.
Analyzing and Interpreting Data
• Use observations (firsthand or from media) to describe patterns and or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. • Record information (observations, thoughts, and ideas).
Obtaining, Evaluating, and Communicating Information.
• Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.

DISCIPLINARY CORE IDEAS (DCI)
S1.B: Chemical Reactions
• Heating or cooling a substance may cause changes that can be observed. • Some changes are reversible and some are not.
ETS1.A Defining and delimiting an engineering problem
• Asking questions, making observations, and gathering information are helpful in thinking about problems.
ETS1.C More than one possible solution to a problem
• Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

Appendix 2.5

CROSSCUTTING CONCEPTS (CCC)
Cause and Effect
• Events have causes that generate observable patterns.

Common Core State Standards (CCSS)

CCSS ELA WRITING
CCSS.ELA-LITERACY.W.2.8
Recall information from experiences or gather information from provided sources to answer a question.
CCSS ELA SPEAKING & LISTENING
CCSS.ELA-LITERACY. SL.2.1
Participate in collaborative conversations with diverse partners about *grade 2 topics* and texts with peers and adults in small and larger groups.
CCSS.ELA-LITERACY. SL.2.6
Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification.
CCSS ELA LANGUAGE
CCSS.ELA-LITERACY. L.2.3
Use knowledge of language and its conventions when writing, speaking, reading, or listening.

California English Language Development (ELD) Standards

CA ELD		
Part 1.2.1 Exchanging information and ideas with others through oral collaborative conversations on a range of social and academic topics.		
EMERGING	EXPANDING	BRIDGING
P1.2.1 Contribute to conversations and express ideas by asking and answering *yes-no* and *wh-* questions and responding using gestures, words, and learned phrases.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, and adding relevant information.	**P1.2.1** Contribute to class, group, and partner discussions, including sustained dialogue, by listening attentively, following turn-taking rules, asking relevant questions, affirming others, adding pertinent information, building on responses, and providing useful feedback.
In addition to the standard above, you may find that you touch on the following standard in this lesson as well: **P1.2.5** Listening actively to spoken English in a range of social and academic contexts.		