Ice Cream Unit

Grade 2



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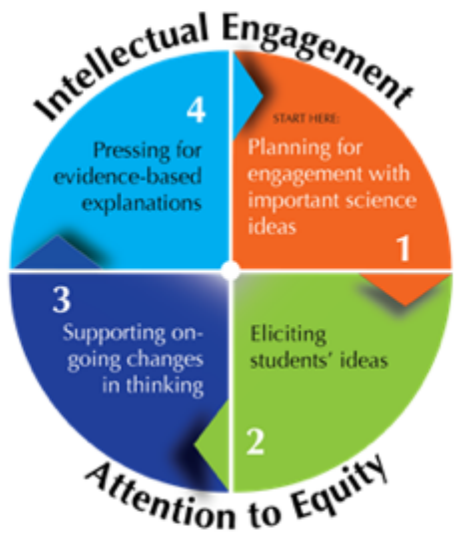
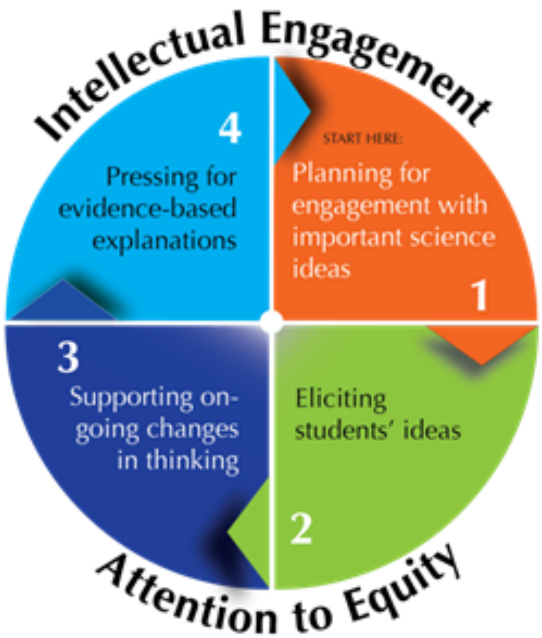


Throughout this unit, students investigate the properties of ice cream as a solid and liquid to help address standards about properties of matter and how that matter can change because of temperature changes. Ultimately, the model and explanation students create is to explain how and why a liquid mixture can turn into solid ice cream, however, knowing the big science ideas behind the system allows students to explain multiple related events, including other changes in matter.

Acknowledgements:
Adapted from a unit taught by Kitten Vaa
Unit Guide written by Colleen LaMotte

Ambitious Science Teaching

We provide here a vision of ambitious teaching - teaching that is effective, rigorous, and equitable. But more than that, we provide a framework or research-based teaching practices that are consistent with this vision and a wide range of tools that can transform how students learn in your classroom. The vision, practice, and tools will furnish a common language about teaching for a group of science educators committed to improvement of teaching. You will be able to identify "what we will get better at" and how to get started.



Ambitious teaching aims to support students of all racial, ethnic, and social class backgrounds in deeply understanding science ideas, participating in the talk of the discipline, and solving authentic problems. This teaching comes to life through four sets of teaching practices that are used together during units of instruction. These practices are powerful for several reasons. They have consistently been shown through research to support student engagement and learning. They can each be used regularly with any kind of science topic. And finally, because there are only four sets of practices, we can develop tools that help both teachers and students participate in them, anyone familiar with the practices can provide feedback to other educators working with the same basic repertoire, teachers can create productive variations of the practices, and everyone in the science education community can share a common language about the continual improvement of teaching.

The four Ambitious and Equitable Science Teaching Practices are summarized in the table below.

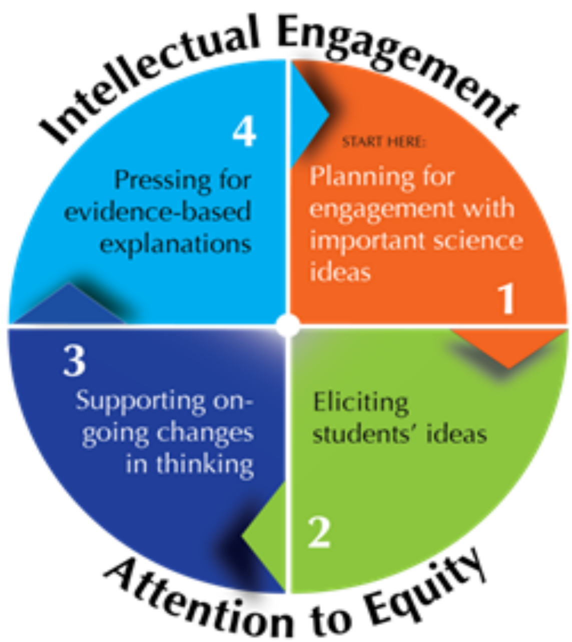
Practices	**What does it LOOK like?**
Planning for engagement with important science ideas.	• Planning a unit that connects a topic to a phenomena that it explains (Chemical Reactions - Bike Rusting, Photosynthesis - Seed Becoming a Tree) • Teaching a topic within real-world context
Eliciting students' ideas	• Asking students to explain HOW and WHY they think a phenomena happens (How did the bike change? Why did it change? What is happening at the unobservable level?
Supporting on-going changes in thinking	• Using ALL activities/lesson to explain the phenomena. • Giving students opportunities to revise their thinking based on what they're learning.
Pressing for evidence-based explanations	• Allowing students to create a final model or explanation about the phenomena. • Pressing students to connect evidence to their explanation

Many teachers want to know what their classrooms should look like and sound like - they want to understand how to interact with their students about science ideas and students' ideas. This is especially true now the *Next Generation Science Standards* are being used in many states. As a result of the last 30 years of classroom research, we know enough about effective instruction to describe in clear terms what kinds of teaching practices have been associated with student engagement and learning. This research tells us that there are many ways that teachers can design and implement effective instruction, but that there are common underlying characteristics to all these examples of teaching that can be analyzed, described, and learned by professionals. These practices embody a new form of "adaptive expertise" that EVERY science educator can work towards. Expert teaching can become the norm, not reserved for a select few. Ambitious teaching is framed in terms of practices that any teacher can learn and get better at over time. What would we see if we entered a classroom of a science educator using ambitious teaching? To give you a sense of what ambitious teaching looks like, we have described below some features common to all science classrooms where ambitious teaching is being implemented (listed on right). These features address everyday problems with learning and engagement that teachers face (listed on left).

Common problems in supporting student engagement and learning	**What you'd see in a science classroom where ambitious teaching is the aim**
The problem: *Students don't see how science ideas fit together.* Each day is perceived by students to be the exploration of ideas that are unconnected with previous concepts and experiences.	At the beginning of the unit, students are focused on developing an evidence-based explanation for a complex event, or process. Students know that throughout the unit, most of the activities, readings, and conversations will contribute to this explanation.
The problem: *An oversimplified view of what it means "to know."* Science ideas perceived to be straightforward and learnable within a lesson - either you get it or you don't.	An idea is never taught once and for all, but revisited multiple times. Students' science explanations are treated as partial understandings that have to be revisited over time to become more refined and coherent.
The problem: *Lack of student engagement.* Students' experiences and interests not elicited or seen as relevant. Student ideas treated as "correct" or "incorrect."	Students' ideas and everyday experiences are elicited and treated as resources for reasoning, students' partial understandings are honored as a place to start. They are made public and built upon.
The problem: *Students reluctant to participate in science conversations.* Teachers dominate the talk, ask primarily for right answers, and get brief responses from students.	Teachers use a varied repertoire of discourse moves to facilitate student talk. Guides and scaffolds for talk help students feel comfortable interacting with peers.
The problem: *Some students have little support for accomplishing tasks that would otherwise be within their grasp.* Little or no guidance for students' intellectual work. Giving "clear directions" is seen as enough to ensure participation in activities.	There is scaffolding that allows students to participate in science-specific forms of talk, in group work, and in science practices.
The problem: *Invisibility of student ideas and reasoning.* Teacher does not know what students think - their heads are a cream box. Cannot then work on students' ideas. Students cannot take advantage of the ideas or ways of reasoning by their peers.	Students' thinking made visible through various public representations (tentative science models, lists of hypotheses, questions they have, etc.). The teacher can see how students think and how that thinking could change over time. Students benefit from seeing and hearing the reasoning of others.
The problem: *Illusion of rigor.* Students reproduce textbook explanations, lean on vocabulary as a substitute for understanding. Talk of evidence and claims are rare.	The teacher presses for complete, gapless explanations for unique real-life events or processes, and press for the use of evidence to support claims.

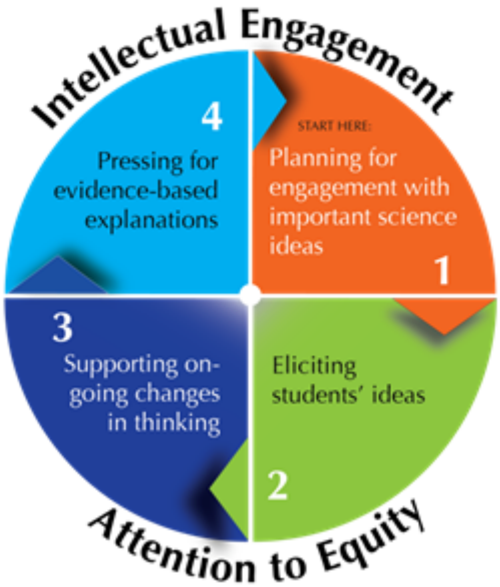
As you will see, ambitious teaching is not a "method," and the teaching practices are not scripts. It is a set of principled practices that must be adapted to your classroom needs. Coaches and other teachers can work with you to do this ambitious work.

Curriculum Guide
Lesson & Activity Guides



This curriculum guides follows the four core teaching practices of the Ambitious Science Teaching Framework. This model-based inquiry approach to science teaching leverages students' existing personal experiences and current understanding about causal mechanisms in their world to revise their own explanations of specific, contextualized scientific phenomena.

Planning for Engagement with Important Ideas



In the Framework for Ambitious Science Teaching, the first phase in any unit of instruction is planning. Only when teachers understand where they are doing in the unit can they begin to design instruction. One goal in this planning practice is to support teachers in moving from topics toward relationships between science ideas which can explain multiple real-world phenomena.

This section provides teachers with some general science background around the content goals for this unit as well as an explanation for a specific phenomenon for this unit - making solid ice cream from a mixture of cream, sugar, and vanilla extract. It also suggests ways teachers can identify related phenomenon that may be more relevant to their specific students and can be explained by the same science ideas.

Unit Goals

This physical science unit focuses on how and why a liquid mixture can turn into solid ice cream. Students will combine some or all of the following ideas to explain one or more real-world phenomena.

- Materials are made of pieces. The same pieces can be used to make different materials.
- Matter can be described and classified by its observable properties.
- Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.

Put another way:

If students understand...	Then, students can explain...
...everything is made up of matter and matter has a structure made up of particles...	...describe the structure of particles based on observable properties of matter.
...temperature is thermal energy (motion of particles)...	… matter changes phase if enough energy is added or removed from the matter.

Next Generation Science Standards

2nd Grade Matter Unit

The performance expectations and related dimensions below are from the Next Generation science standards. For more detailed descriptions of the standards visit http://nextgenscience.org

2.Structure and Properties of Matter

2.Structure and Properties of Matter

Students who demonstrate understanding can:

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.]

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

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. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.]

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

Science and Engineering Practices

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-PS1-1)

Analyzing and Interpreting Data
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.
- Analyze data from tests of an object or tool to determine if it works as intended. (2-PS1-2)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.
- Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (2-PS1-3)

Engaging in Argument from Evidence
Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).
- Construct an argument with evidence to support a claim. (2-PS1-4)

Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Scientists search for cause and effect relationships to explain natural events. (2-PS1-4)

Disciplinary Core Ideas

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. (2-PS1-1)
- Different properties are suited to different purposes. (2-PS1-2),(2-PS1-3)
- A great variety of objects can be built up from a small set of pieces. (2-PS1-3)

PS1.B: Chemical Reactions
- Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)

Crosscutting Concepts

Patterns
- Patterns in the natural and human designed world can be observed. (2-PS1-1)

Cause and Effect
- Events have causes that generate observable patterns. (2-PS1-4)
- Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2)

Energy and Matter
- Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3)

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World
- Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (2-PS1-2)

Connections to other DCIs in second grade: N/A

Articulation of DCIs across grade-levels: **4.ESS2.A** (2-PS1-3); **5.PS1.A** (2-PS1-1),(2-PS1-2),(2-PS1-3); **5.PS1.B** (2-PS1-4); **5.LS2.A** (2-PS1-3)

Common Core State Standards Connections:

ELA/Literacy –

RI.2.1	Ask and answer such questions as *who, what, where, when, why,* and *how* to demonstrate understanding of key details in a text. *(2-PS1-4)*
RI.2.3	Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. (2-PS1-4)
RI.2.8	Describe how reasons support specific points the author makes in a text. *(2-PS1-2)*,(2-PS1-4)
W.2.1	Write opinion pieces in which they introduce the topic or book they are writing about, state an opinion, supply reasons that support the opinion, use linking words (e.g., *because, and, also*) to connect opinion and reasons, and provide a concluding statement or section. (2-PS1-4)
W.2.7	Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-PS1-1),(2-PS1-2),(2-PS1-3)
W.2.8	Recall information from experiences or gather information from provided sources to answer a question. (2-PS1-1),(2-PS1-2),(2-PS1-3)

Mathematics –

MP.2	Reason abstractly and quantitatively. *(2-PS1-2)*
MP.4	Model with mathematics. *(2-PS1-1),(2-PS1-2)*
MP.5	Use appropriate tools strategically. *(2-PS1-2)*
2.MD.D.10	Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. *(2-PS1-1),(2-PS1-2)*

Next Generation Science Standards

Disciplinary Core Idea Progressions K-12 for DCIs featured in this unit

The performance progression for DCI's K-12 are from the Next Generation science standards. For more detailed descriptions of learning progressions and/or Disciplinary Core Ideas, visit http://nextgenscience.org.

DCI	K-2	3-5	6-8	9-12
PS1.A Structure of matter (includes PS1.C Nuclear processes)	Matter exists as different substances that have observable different properties. Different properties are suited to different purposes. Objects can be built up from smaller parts. .	Because matter exists as particles that are too small to see, matter is always conserved even if it seems to disappear. Measurements of a variety of observable properties can be used to identify particular materials.	The fact that matter is composed of atoms and molecules can be used to explain the properties of substances, diversity of materials, states of matter, phase changes, and conservation of matter.	The sub-atomic structural model and interactions between electric charges at the atomic scale can be used to explain the structure and interactions of matter, including chemical reactions and nuclear processes. Repeating patterns of the periodic table reflect patterns of outer electrons. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy to take the molecule apart
PS1.B Chemical reactions	Heating and cooling substances cause changes that are sometimes reversible and sometimes not.	Chemical reactions that occur when substances are mixed can be identified by the emergence of substances with different properties; the total mass remains the same.	Reacting substances rearrange to form different molecules, but the number of atoms is conserved. Some reactions release energy and others absorb energy.	Chemical processes are understood in terms of collisions of molecules, rearrangement of atoms, and changes in energy as determined by properties of elements involved.

Teacher Background Knowledge

This section provides science content knowledge and explanations to explain the general phenomenon of how and why a liquid mixture becomes a solid mixture and explains a specific phenomenon: how cream and sugar can become ice cream. The last part of the section provides information from *A Framework for K-12 Science Education* describing knowledge corresponding to each Disciplinary Core Idea featured in this unit.

1. Puzzling Phenomenon - Making solid ice cream from liquid cream. How and why does the cream change?

The scientific explanation of this phenomenon requires an understanding of the key concepts of this unit identified from the Next Generation Science Standards. Though this phenomenon is contextualized and relates to a specific scenario, the story may or may not seem as relevant to students as something from their own experience or that of a peer. Other phenomena can be substituted as a focal phenomenon for the unit as long as they can be explained with the ideas targeted in the NGSS. If a different phenomenon is selected, be sure to do research and write out a scientific explanation for the phenomenon.

A. What happened?

Anchoring phenomenon

I love ice cream but I don't always have ice cream in my house. Then I discovered I could make my own ice cream whenever I wanted. There are lots of different ways to make ice cream, but the one that intrigued me the most was Ice Cream Magic (https://safeshare.tv/x/mLSJZZilGwk). **What's the science behind the magic?**

I didn't have the ice cream magic, but I did have the materials to make ice cream in a bag. Students experience making cream into ice cream with Ice Cream Shake activity (https://drive.google.com/file/d/0B03hrQRflEWrdEFLSFZRa0NjQ0U/view).

One day I decided to make ice cream in a bag and take it with me to the park. The problem was that the park was 30 minutes away and this happened… (Show the "Ice Cream Melt Time Lapse" video: https://www.youtube.com/watch?v=zzH4BtGcmTs). How and why did it change back from a solid to a liquid?

B. Why did this happen?

The basic components of ice cream are milk or cream, sugar, vanilla or other flavoring. But the main ingredient is water, (which mainly comes from milk). Milk is mostly water and some fat. Fat is a lot like oil because it likes to separate. Cows emulsify the fat and water. That means the fat is so finely dispersed throughout the water that it cannot clump up and float to the top (like oil does). Additional fat in the form of cream is another key ingredient in ice cream.

Ice cream can exist in a solid or liquid depending on the temperature. Ice cream can be classified as a solid or a liquid by its observable properties. At room temperature the cream mixture is a liquid. The cream mixture does not have its own shape; it goes to the bottom of the container and takes on the shape of the container it occupies. The cream pours and flow from a higher point to a lower point. This happens because ice cream is made of a small set of pieces (particles). As a liquids, the particles are close together with no regular arrangement. The particles in the liquid vibrate, move about, and slide past each other making it easy to flow. The particles are subject to intermolecular attraction; however, liquid particles have more space between them, so they are not fixed in position like a solid. The attraction between the particles in a liquid keeps the volume of the liquid constant.

At temperatures below 22 F, the cream mixture will have properties of a solid such as holding its own shape. The cream mixture can be soft and crunchy. It takes up a certain amount of space (volume); the volume does not change if the solid is placed in different containers. This happens because the particles create a more rigid pattern and lock in place. There is little space between the particles so that particles cannot move/slide past one another like in a liquid. Even though the ice cream may feel frozen solid, up to a third of the water stays liquid, all thanks to sugar. Sugar dissolves very well in water but interferes with the water molecules' ability to get near each other and lock into the solid ice crystal structure. At temperatures below freezing, these molecules stay in their liquid state in tiny sugar-filled pockets throughout the ice cream.

Temperature is important to making cream into ice cream. Temperature is a measure of how fast particles are moving around. When the temperature in the system goes down the particles become less excited and active. Ice cream freezes and melts at 21 °F. This is due to the sugar and fats in the mix interfere with the formation of ice crystals, and it takes a colder temperature to get the ice cream to really freeze. In order to freeze the cream, a lot of heat energy must be removed from the cream in order to change the movement of particles so that the cream can change from a liquid to a solid. Ice alone would not make cream into ice cream since water freezes and melts at 32 degrees Fahrenheit. Adding salt into the system with ice, lowers the freezing point which makes the temperature of the ice even colder and the melting point even slower. Therefore a phase change occurs from liquid to solid. The thermal energy from the cream transfers (moves) to the ice and salt which has less thermal energy. Then particles in the cream slow down and allow stronger bonds to form between them to create a solid in the cream.

When the solid ice cream sits out for 30 minutes, the change is reversed. This happens in our ice cream in a bag system, because the plastic allows thermal energy to move between the ice, the plastic, and cream. The plastic also allows thermal energy from the environment to transfer as well. The thermal energy from the environment transfers (moves) to the ice cream which has less thermal energy. The particles become more excited and active, returning the ice cream to a liquid state. This is a reversible change because the particles are brought back to what they once were.

Different materials are suited for different purposes. That's why the ice cream magic and ice cream ball are made up of parts with different materials. Some materials allow thermal energy to transfer, while others do not. A material that would prevent thermal energy from transferring would be an insulator such as Styrofoam, thick cloth and thick plastic. In the ice cream makers the outer material is an insulator in order to keep heat from transferring in or out. In making ice cream, there also needs to be a material that will allow the cream to transfers its energy (conductor). Therefore, in the inside of the ice cream makers both have a metal container to allow thermal energy to move.

C. Finding alternative phenomena

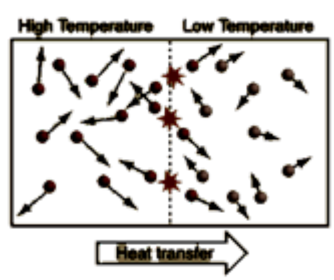
A local phenomenon could anchor the unit instead of the story of making ice cream in a bag and then walking to the park. Or students could simultaneously explain a local phenomenon alongside this particular ice cream story, identifying similarities in underlying causal mechanisms but different in context.

D. Sources

- Science Xplained - Ice Cream Chemistry: https://www.youtube.com/watch?v=k1pel10ufmk
- Everyday Reactions - Chemistry of Ice Cream: https://www.youtube.com/watch?v=-rlapUkWCSM
- The Science of Ice Cream: http://www.icecreamnation.org/science-of-ice-cream/
- Physics Buzz - The Science of Ice Cream: http://physicsbuzz.physicscentral.com/2014/06/the-science-of-ice-cream.html
- Ice Cream and Chemistry: https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/past-issues/archive-2013-2014/ice-cream-chemistry.html
- How Does Salt Melt Ice: https://www.youtube.com/watch?v=JkhWV2uaHaA

2. General Science Background - Properties of Matter

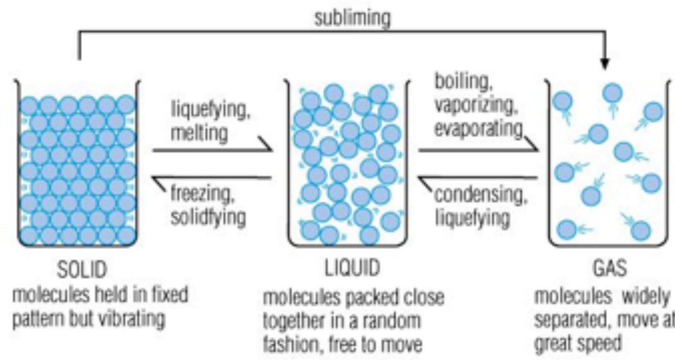
A. *Temperature and Heat*



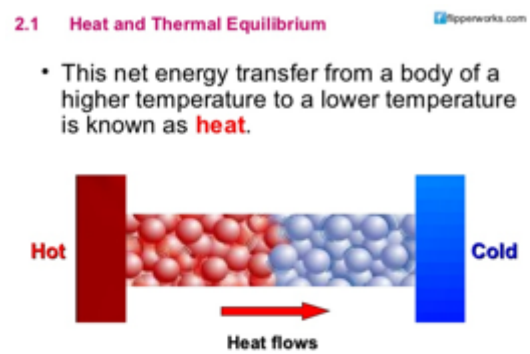
Temperature is important to making ice cream. Temperature is a measure of the average kinetic energy of the particles of a substance. Kinetic energy is a type of energy associated with motion, or how fast atoms or molecules are moving around. The higher the temperature of an object, the higher is its kinetic energy (the faster the molecules are moving). Conversely, the lower the temperature of an object, the lower its kinetic energy (the slower the molecules are moving).

B. *States of Matter*

A substance can exist in three different states: solid, liquid, and gas. The state of a substance is determined by the arrangement of the substance's molecules and the amount of kinetic energy in its molecules at a given time. When a substance is in the solid state, its molecules are arranged in a fixed pattern with little kinetic energy (vibrating) and a low temperature. When a substance is in a liquid state, the molecules are packed close together in a random fashion but free to move. Therefore, molecules in the liquid state have more kinetic energy and a higher temperature than in the solid state. When a substance is in a gaseous state, the molecules are widely separated and move freely (high kinetic energy) and the substance has a high temperature relative to the other states.



In order for the liquid cream mixture to freeze, the molecular movement must slow down (decrease kinetic energy). This allows strong bonds to form between the molecules so that they can be held in a fixed pattern. In order to decrease kinetic energy, thermal energy must be removed from the substance. Thermal energy always flows from a high concentration to a low concentration. In other words, heat energy moves from warm to cold. Therefore, in order to freeze, the liquid cream must transfer thermal energy to a colder substance. In this case, the cream transfers heat to the salted ice.



Water freezes at 32 °F. At this temperature, the water molecules have a low enough kinetic energy to be held in a fixed position. Ice cream freezes at 21 °F. This is due to the sugar and fats in the mixture. They interfere with the molecules ability to hold together to form ice crystals so it takes a colder temperature to get the ice cream to really freeze. The outer bag is used to hold the ice. So the thermal energy from the environment transfers (moves) to the ice which has less thermal energy. Salt is added to the ice because it helps ice absorb more heat energy than it would without salt. The salt therefore lowers the freezing point of water which makes the ice even colder and the melting point even lower. This means the ice needs to absorb more thermal energy in order to melt and can therefore absorb more thermal energy from the surrounding environment (the cream). The cream needs to lose a lot of heat energy to freeze. Salt is added to make sure the ice would draw enough heat energy out of the cream to freeze it.

3. Levels of Explanation: What-How-Why

What are what-how-why levels? These levels indicate a depth of explanation that students are expected to make progress on during the unit (i.e. moving from a 'what' level to a 'how'/'why' level).

- WHAT - student describes what happened. Describes, summarizes, restates or describes an observation or pattern in data without making connections to unobservable components.
- HOW - Student describes how or partial why something happened. Addresses unobservable components but not deeply.
- WHY - Student explains why something happened and can trace a causal story for why a phenomenon occurred or ask questions at this level. Uses important science ideas that have unobservable components to explain observable events. Students may have a blend of what-how-why depending on which concepts they best understand. Ultimately, students are pressed to develop a 'why' level explanation. However, 'why' level is the most challenging to achieve because it requires wrestling with unobservable mechanisms.

	Level 1 - WHAT "What happened" account	Level 2 - HOW Partial "causal" explanation	Level 3 - WHY "Causal" explanation
Description of each level of explanation (What, How, Why)	Student describes what is observable or measureable in a phenomenon.	Student tells a one-step "cause and effect" story. Student describes but does not explain relationships between variables, or differences between experimental groups, or trends over time or qualitative observations. Student predicts the way some natural systems will behave, based on previously collected data, but without talking about unobservable events, processes.	Student can trace a full causal story for why a phenomenon unfolded the way it did. Students uses powerful science ideas that have unobservable / theoretical components that link to observable events. Explanation is about a system of events and processes that are linked.
For this Unit	WHAT WOULD YOU EXPECT FROM STUDENTS? **Matter:** In the beginning, I think the cream was a liquid because the cream could flow, it took the shape of the bag. In the middle, the cream was a solid. I know this because the cream held its shape and was thicker. At the end, the cream was back to a liquid because the cream was flowing and took the shape of the bag again. **Temperature:** In the beginning, the cream was warm and a liquid. In the middle, the cream was a solid and was cold. In the end, the cream was a liquid because it got warmer.	WHAT WOULD YOU EXPECT FROM STUDENTS AT THE "HOW" LEVEL? **Matter:** I think there is a connection between the particle structures and the state of matter. I think the particles in the cream at the beginning were not as close because the cream was able to flow. I think the cream changed to a solid because the particles came closer together, making the ice cream more solid/thicker. **Temperature:** **I think there is a connection between** the cream and the temperature. When the cream changes to a solid the temperature decreases. I know this because the cream became thicker and harder. **If ____ changes, then ...**	WHAT WOULD YOU EXPECT FROM STUDENTS AT THE "WHY" LEVEL? **Matter and Temperature:** **I think there is a relationship between** the cream's particles and the energy of the particles. **In the beginning**, the cream was a liquid. The particles were moving more and were farther apart. I know this because the liquid was flowing. **When the temperature decreased** the particles in the cream began to move less and moved closer together. I know this because the cream was harder (chunkier). **At the end**, the cream was removed from the ice and salt.

4. Additional General Physical Science Background

General physical science background for teachers corresponding to the Disciplinary Core Ideas taken directly from National Acadamies Press *A Framework for K-12 Science Education* available in its entirety for free: http://www.nap.edu/download.php?record_id=13165

PS1.A: STRUCTURE OF MATTER
Source: National Academies Press
How do particles combine to form the variety of matter one observes?

While too small to be seen with visible light, atoms have substructures of their own. They have a small central region or nucleus—containing protons and neutrons—surrounded by a larger region containing electrons. The number of protons in the atomic nucleus (atomic number) is the defining characteristic of each element; different isotopes of the same element differ in the number of neutrons only. Despite the immense variation and number of substances, there are only some 100 different stable elements. Each element has characteristic chemical properties. The periodic table, a systematic representation of known elements, is organized horizontally by increasing atomic number and vertically by families of elements with related chemical properties. The development of the periodic table (which occurred well before atomic substructure was understood) was a major advance, as its patterns suggested and led to the identification of additional elements with particular properties. Moreover, the table's patterns are now recognized as related to the atom's outermost electron patterns, which play an important role in explaining chemical reactivity and bond formation, and the periodic table continues to be a useful way to organize this information.

The substructure of atoms determines how they combine and rearrange to form all of the world's substances. Electrical attractions and repulsions between charged particles (i.e., atomic nuclei and electrons) in matter explain the structure of atoms and the forces between atoms that cause them to form molecules (via chemical bonds), which range in size from two to thousands of atoms (e.g., in biological molecules such as proteins). Atoms also combine due to these forces to form extended structures, such as crystals or metals. The varied properties (e.g., hardness, conductivity) of the materials one encounters, both natural and manufactured, can be understood in terms of the atomic and molecular constituents present and the forces within and between them.

Within matter, atoms and their constituents are constantly in motion. The arrangement and motion of atoms vary in characteristic ways, depending on the substance and its current state (e.g., solid, liquid). Chemical composition, temperature, and pressure affect such arrangements and motions of atoms, as well as the ways in which they interact. Under a given set of conditions, the state and some properties (e.g., density, elasticity, viscosity) are the same for different bulk quantities of a substance, whereas other properties (e.g., volume, mass) provide measures of the size of the sample at hand.

Materials can be characterized by their intensive measureable properties. Different materials with different properties are suited to different uses. The ability to image and manipulate placement of individual atoms in tiny structures allows for the design of new types of materials with particular desired functionality (e.g., plastics, nanoparticles). Moreover, the modern explanation of how particular atoms influence the properties of materials or molecules is critical to understanding the physical and chemical functioning of biological systems.

Grade Band Endpoints for PS1.A

By the end of grade 2. Different kinds of matter exist (e.g., wood, metal, water), and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties (e.g., visual, aural, textural), by its uses, and by whether it occurs naturally or is manufactured. Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces (e.g., blocks, construction sets). Objects or samples of a substance can be weighed, and their size can be described and measured. (Boundary: volume is introduced only for liquid measure.)

By the end of grade 5. Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means (e.g., by weighing or by its effects on other objects). For example, a model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects (e.g., leaves in wind, dust suspended in air); and the appearance of visible scale water droplets in condensation, fog, and, by extension, also in clouds or the contrails of a jet. The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish (e.g., sugar in solution, evaporation in a closed container). Measurements of a variety of properties (e.g., hardness, reflectivity) can be used to identify particular materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.)

PS1.B: CHEMICAL REACTIONS

Source: National Academies Press

How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?

Many substances react chemically with other substances to form new substances with different properties. This change in properties results from the ways in which atoms from the original substances are combined and rearranged in the new substances. However, the total number of each type of atom is conserved (does not change) in any chemical process, and thus mass does not change either. The property of conservation can be used, along with knowledge of the chemical properties of particular elements, to describe and predict the outcomes of reactions. Changes in matter in which the molecules do not change, but their positions and their motion relative to each other do change also occur (e.g., the forming of a solution, a change of state). Such changes are generally easier to reverse (return to original conditions) than chemical changes.

"Collision theory" provides a qualitative model for explaining the rates of chemical reactions. Higher rates occur at higher temperatures because atoms are typically moving faster and thus collisions are more frequent; also, a larger fraction of the collisions have sufficient energy to initiate the process. Although a solution or a gas may have constant chemical composition—that is, be in a steady state—chemical reactions may be occurring within it that are dynamically balanced with reactions in opposite directions proceeding at equal rates.

Any chemical process involves a change in chemical bonds and the related bond energies and thus in the total chemical binding energy. This change is matched by a difference between the total kinetic energy of the set of reactant molecules before the collision and that of the set of product molecules after the collision (conservation of energy). Some reactions release energy (e.g., burning fuel in the presence of oxygen), and others require energy input (e.g., synthesis of sugars from carbon dioxide and water).

Understanding chemical reactions and the properties of elements is essential not only to the physical sciences but also is foundational knowledge for the life sciences and the earth and space sciences. The cycling of matter and associated transfers of energy in systems, of any scale, depend on physical and chemical processes. The reactivity of hydrogen ions gives rise to many biological and geophysical phenomena. The capacity of carbon atoms to form the backbone of extended molecular structures is essential to the chemistry of life. The carbon cycle involves transfers between carbon in the atmosphere—in the form of carbon dioxide—and carbon in living matter or formerly living matter (including fossil fuels). The proportion of oxygen molecules (i.e., oxygen in the form O2) in the atmosphere also changes in this cycle.

Grade Band Endpoints for PS1.B

By the end of grade 2. Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible (e.g., melting and freezing), and sometimes they are not (e.g., baking a cake, burning fuel).

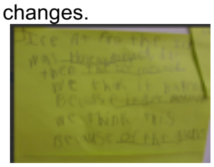
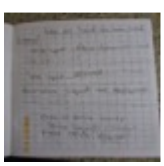
By the end of grade 5. When two or more different substances are mixed, a new substance with different properties may be formed; such occurrences depend on the substances and the temperature. No matter what reaction or A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas Copyright National Academy of Sciences. All rights reserved. Dimension 3: Disciplinary Core Ideas—Physical Sciences 111 change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.)

Unit Overview: 2nd Grade Liquids & Solids Unit

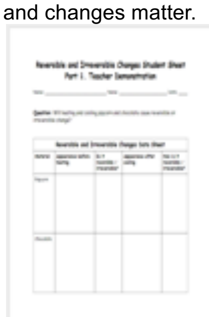
How and why does the cream change?

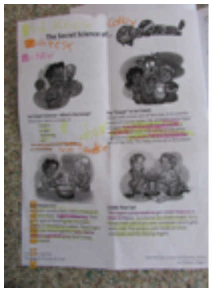
This guide is designed to be completed in 18 forty-five minute sessions (approximate times indicated below). Based on students' questions, experiences, and ideas, teachers may change lesson order or add in activities. To clarify, track lessons 2-10 on the classroom summary chart. Some of the lesson entries could be combined if time constraints apply (for example, entries from lesson 2 and 3 could be combined on the classroom summary chart).

****Please note, the summary chart below is intended for teachers. The classroom summary chart entries should use more age-appropriate language. For ideas of what to include in the classroom summary chart, refer to the sample summary charts embedded in the lessons as a guide.*

AST Practice	Activity Name and Suggested Time	Learning Targets	What students learn	Connections to why the cream changed to ice cream	Standards: NGSS
Eliciting students' ideas	**Lesson 1** **Ice Cream Shake** *Day 1: 45 min* *Day 2: 45 min*	Based on observations and students' personal experiences, students develop their initial models on how and why the cream changes. 	The bag of ice got really cold. Our hands felt really cold, too. The sloshy cream got harder and changed to ice cream. The ice cubes in the bag melted into water.	Student's possible initial ideas: - The shaking created evaporation of water in the cream. - The cream has water in it which freezes and makes "ice" cream - The ice made the cream cold and made the cream "clumped" together.	**SEP:** Asking questions **SEP:** Developing and Using Models **CCC:** Patterns
Supporting on-going changes in thinking	**Lesson 2** **What is a Solid?** *Day 1: 45 min* *"What makes a solid a solid?"*	Students observe properties of solids and look for patterns to understand the properties that are in common with all solids.	Solids can be sorted by their properties (color, texture, hardness, flexibility) Solid materials keep their shape	The ice begins as a solid. I know this because the ice is hard and it holds its shape. The cream changes into a solid. I know this because the cream holds its shape on a spoon. It is also soft and crunchy. It does not flow.	**SEP:** Plan and conduct investigation (make observations) **CCC:** Patterns
Supporting on-going changes in thinking	**Lesson 3** **What is a Liquid?** *Day 1: 45 min* *"What makes a liquid a liquid?"*	Students observe properties of liquids and look for patterns to understand the properties that are in common with all liquids. 	*Liquids have many properties (bubbly, viscosity, color) *Liquids have a definite volume *Liquids take the shape of its container *Liquids pours, flows, spreads *Liquids allow things to go through it.	The cream begins as a liquid. I know this because cream fills the container, it pours, and flows. The ice turns into liquid water. I know this because the ice no longer has a shape and fills the shape of bag.	**SEP:** Plan and conduct investigation (make observations) **CCC:** Patterns
	Lesson 4 **Freezing and Melting Changes Matter** *Day 1: 45 min* *Day 2: 45 min*	Students observe frozen juice concentrate melt into a liquid as it is stirred and added to water. They then see the juice freeze into a solid after it is added to the freezer.	An increase in temperature will cause a solid to melt into a liquid. A decrease in temperature will cause a liquid to freeze into a solid.	The cream started out as a liquid with a higher temperature (___°F). The ice started out as a solid with a lower temperature (____°F). When the cream turned to solid ice cream, the temperature of the cream must have gone down. When the ice melted into water, the temperature of the ice must have gone up. The change in temperature caused the cream to turn to ice cream.	**SEP:** Plan and conduct investigation (make observations) **CCC:** Cause and Effect **CCC:** Energy and matter

Supporting on-going changes in thinking	**Lesson 5** **What's the Matter?** *Day 1: 45 min* *Day 2: 45 min* *"How can Legos model liquids and solids?"* Solids and Liquid Particle Model - http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/particle_model/activity/	Students learn that matter is made of tiny pieces called particles or molecules (reading/acting/video) Students develop a model with Legos to demonstrate how a small set of pieces can model solids and liquids. 	Legos can model a liquid when they are disconnected because they fill up a container, they pour, and you can put your hand through a liquid. Legos can model a solid when Legos are connected. Can't put your hand through a solid brick made of Legos without a lot more force.	When the ice cream was a liquid the particles flowed and they were loosely connected. When the ice cream was a solid the particles has a stronger connection and held together.	**SEP:** Developing and using models **CCC:** Energy and matter
Supporting on-going changes in thinking	**Lesson 6** **Hot and Cold Water** *Day 1: 45 min* *"What happens to the particles in water when it is heated or cooled?"* **Video example: https://www.youtube.com/watch?v=YbhwXSv9rk4&feature=youtu.be**	Students observe the effect of cold and hot water on a drop of food coloring. 	Temperature affects how fast or slow the particles are moving in liquids. When water is hotter the particles are more active. I know this because I observed… The colder the water the less active the particles. I know this because...	At the beginning the particles in the cream were more active. But as the temperature begins to cool then the particles in the cream became less active. I know this because the temperature started at 68° F then changed to 22° F.	**SEP:** Plan and conduct investigations (make observations) **CCC:** Patterns **CCC:** Cause and effect
Supporting on-going changes in thinking	**Lesson 7** **Energy Matters** *Day 1: 45 min* *"How might heat energy be part of the ice cream story?"* **Heat Energy Video: https://www.turtlediary.com/video/heat-energy.html**	Students gain information about the effects of heat energy on temperature and particle movement.	Energy is the movement of particles that make up matter. If particles are moving slow there is less energy. Particles in a hot pot have lots of energy and move a lot. Heat energy transfers from hotter substances to colder substances. Temperature tells us how hot or cold something is.	Energy is part of the ice cream story. Heat or "thermal energy" is part of the ice cream story which causes the ice to melt. The heat source in our system is from the cream.	**SEP:** Constructing explanations and designing solutions **CCC:** Energy and Matter **CCC:** Cause and Effect

Supporting on-going changes in thinking	**Lesson 8** **Melting Ice in my Hand** *Day 1: 45 min* *"How might heat energy transfer be part of the ice cream story?"* Melting Ice Particle Model Video: **https://www.youtube.com/watch?v=CDTZoFGmZoc**	Students observe the causes of change with ice in their hand. Students develop a model to explain the flow of heat energy. 	The ice makes my hand feel cold. The heat from my hand made the ice melt. This happens because the "heat" energy moves from my hand to the ice.	The ice in the bag made the cream feel colder because heat from the cream moved to the ice.	**CCC:3-5** Energy can be transferred in various ways and between objects **SEP:** Construct an argument with evidence to support a claim.
Supporting on-going changes in thinking	**Lesson 9** **Reversible and Irreversible Changes** *Day 1: 45 min* *Day 2: 45 min* *Day 3: 45 min* *Day 4: 45 min* *"What are examples of reversible and irreversible changes?"* Irreversible Changes Reversible Change: **http://www.bbc.co.uk/bitesize/ks2/science/materials/reversible_irreversible_changes/read/2/**	Students plan and conduct an investigation by heating and cooling a variety of materials. Students observe changes caused by heating or cooling. Students observe how heat energy moves and changes matter. 	Chocolate is a reversible change. I know this because… Popcorn is an irreversible change. I know this because…	Ice cream changes are reversible because…. I know this because... This happens because the thermal energy from the environment transfers (move) to the ice cream which has less thermal energy. The particles become more excited and active, returning the ice cream to a liquid state. This is a reversible change because the particles are brought back to what they once were.	**SEP:** Planning and carrying out investigations **SEP:** Constructing explanations and designing solutions **CCC:** Cause and Effect **CCC:** Energy and Matter

Supporting on-going changes in thinking	**Lesson 10** **The Secrets of Ice Cream** *Day 1: 45 min* **Secrets of Ice Cream:** **https://www.acs.org/content/dam/acsorg/education/whatischemistry/adventuresinchemistry/secretscience/icecream/sss-icecream.pdf**	Students use the article to identify information they know, new information, and testable information. 	There are air pockets in ice cream. All three states of matter exist in ice cream. When ice cream melts, the liquid ice cream fills the air pockets. When it refreezes it is less because there are fewer air pockets. Planning and carrying out investigations - possible tests: What happens if there is no shaking? What happens if you use different fatty creams? Do all ice creams float?	Our ice cream has three states of matter. When we shake our ice cream we are adding air pockets. The water forms ice crystals making a solid. Not all the syrup freezes.	**SEP:** Constructing explanations and designing solutions **CCC:** Patterns **CCC:** Energy and Matter
Pressing for evidence-based explanations	**Lesson 11** **Generating Evidence-based explanations** *Day 1: 45 min* *Day 2: 45 min*	Students have been revising their thinking about the unit phenomenon over time in light of new experiences, observations, and sense making talk that they have had throughout the unit activities. In this lesson, students will pull together what they have learned thus far in the unit by answering questions related to why the cream changed to ice cream and revising their original responses to questions on their initial model.			**SEP:** Developing and using models (making observations) **SEP:** Constructing explanations **CCC:** Cause and Effect **CCC:** Energy and Matter
Supporting on-going changes in thinking	**Lesson 12** **Feel the Heat Mystery Activity** *Day 1: 45 min* *"What materials are 'heat stoppers'? How can we prevent heat from melting our ice cream?"*	Students investigate how different materials affect the transfer of thermal energy. Students construct an argument with evidence that supports a claim that a material is a heat stopper.	The material that stopped the heat from moving through the most was the Styrofoam. I know this because I could not feel the heat. *The material that allowed the heat to travel the most was the aluminum. I know this because…	A material(s) that would be best suited to keep thermal energy from changing the ice cream to a liquid would be …. I think this because…	SEP: Analyzing and Interpreting Data CCC:

Lesson 1: Ice Cream Shake

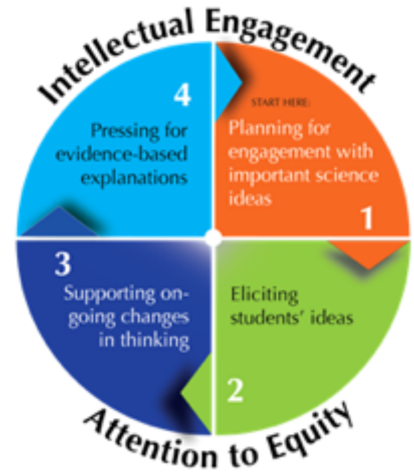
OBJECTIVES & OVERVIEW

Students will develop and use their models to explain the cause-and-effect relationship between changes in temperature and changes in matter to explain the real-world experience of ice cream freezing and melting.

Focus Question:

- Students will make observations about cream in a liquid and solid state.
- Students will explain their science ideas about how the cream changed from liquid to solid using words and pictures.

Ambitious Science Teaching: ELICITING STUDENTS' IDEAS



Information gathered by eliciting all students' initial ideas about a scientific idea and making a public record of these can inform instructional decisions for upcoming lessons. For more information about these practices please visit: http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

Standards Note: Because this lesson is intended to elicit students' initial ideas and experiences, students will not entirely demonstrate the performance expectations (PE) listed here. Students will have additional opportunities in this unit to fully engage in the dimensions of the PEs below. However, students will use their prior experiences and their casual observations of how traits are passed to construct explanations (SEP) that can explain patterns (CCC) to begin to explain how traits are passed. Students are engaged in a three-dimensional performance.

PE 2-PS1: Matter and Its Interactions

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Develop and use models Develop and/or use models to describe and/or predict phenomena	**PS1.A Structure and property 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. (2-PS1-1) **PS1.B Chemical reactions** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	**Cause-and-Effect** Events have causes that generate observable patterns. (2-PS1-4) **Patterns** Patterns in the natural and human designed world can be observed. (2-PS1-1)

MATERIALS

For the class:

- Ice Cream Magic Video: https://safeshare.tv/x/mLSJZZilGwk
- Ice Cream Shake Activity: http://www-tc.pbskids.org/fetch/parentsteachers/activities/pdf/FETCH_IceCreamShake_AG.pdf
- Ice Cream Melting Video: https://www.youtube.com/watch?v=zzH4BtGcmTs
- Chart paper and markers
- Paper towels and/or hand wipes
- Large bag of ice cubes (10 lb. bag)
- Small cooler
- 3 gallon bags
- 3 quart bags
- 1 ½ cups half-and-half (referred to as 'cream')
- 3 tablespoons sugar
- 3 tablespoons vanilla
- 2 bath or beach towels (not provided in kit)
- Thermometer

(These materials make 3 bags of ice cream- enough for students to have a small sample. If you want each table group to make a bag, plan accordingly. See recipe after lesson 1, part 1 directions).

SAFETY ALERT!

Check with the school nurse about food allergies in the event that students would like to taste the vanilla ice cream.

Per student (or pair of students):

- Model scaffold sheet and pencil

PREPARATION

30 minutes

➢ Before the lesson, make ice-cream in a bag to troubleshoot any issues and to use in the lesson introduction. It needs to be mixed for 10-15 minutes to start hardening up. You will need this example in your lesson introduction.

➢ Materials tip: Bring in a cooler to keep the ice frozen before it is used in making ice cream.

➢ Materials tip: Prepare 2 quart size bags by adding in ½ cup half-and-half, 1 tablespoon sugar, and 1 teaspoon vanilla. Keep these bags in the refrigerator or iced-down cooler until ready to begin the lesson. You can refer to this mixture as 'cream' (or a 'cream mixture').

➢ View the Ice Cream Magic and Melting Ice Cream videos

➢ Explore the Ice Cream Shake Website

PROCEDURE

Turn and Talk

Tell a short story about a time you ate ice cream or a popsicle.

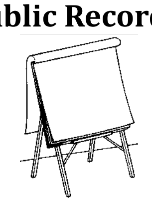
PART 1: Making Ice Cream & Sharing Observations (45 minutes)

Get the cream-mixture bags out of the refrigerator and keep them in a cooler.

1. **Activate prior knowledge and experiences (whole group)**
   a. Gather students in the carpet area and have your pre-made sample of ice-cream-in-a-bag and quart-sized bag of cream mixture in the cooler near you.
   b. Tell students the story about ice cream below:

> I love ice cream but I don't always have ice cream in my house. Then I discovered I could make my own ice cream whenever I wanted. There are lots of different ways to make ice cream, but the one that intrigued me the most was Ice Cream Magic. **What's the science behind the magic?**
>
> I didn't have the ice cream magic, but I did have the materials to make ice cream in a bag.
>
> One day I decided to make ice cream in a bag and take it with me to the park. The problem was that the park was 30 minutes away and this happened... (Show students the Ice Cream Melt Time Lapse video). How and why did it change back from a solid to a liquid?

Public Record



Our Observations

   c. Think-Pair-Share: Have students think for a second about a time they ate ice cream or a Popsicle and what happened as they ate it. Have students turn-and-talk to a partner about their experience.

2. **Introduce the phenomenon (whole class)**
   a. Hold up the bag of ice cream you made. Tell students that you made this ice cream and that they will make ice cream in science class today.

3. **Record observations about the phenomenon (whole class)**
   a. Have students verbally share their observations about the ice cream. Ask them:
      i. What color is it?
      ii. What does it look like?
      iii. How does it feel? (Have 2 students feel and report out)
   b. Repeat this for the bag of cream.

NOTE: Keep this part short to allow time for making ice cream! You could make a written list of observations on a chart, which would be useful to students later; however, this takes more time than sharing verbally.

SAFETY ALERT!

The added salt makes the ice incredibly cold and uncomfortable to hold. Have students use a towel to protect their hands.

See the chart below for an example of possible observations. It is generated with input from 2nd grade students so the lists may vary.

Our Observations	
Cream ● Sloshy ● Looks wet ● Cool ● Yellowish white ● Looks like yellow milk ● It moves a lot when you touch it	**Ice Cream** ● Hard, solid ● Firm, chunky ● Super cold ● Lighter color ● Harder to move, can poke holes

4. **Sharing hypothesis about ice cream (whole class)**
    a. Show the students the quart-sized bag of ice cream that you made before class. Tell students that the ice cream started out like this (hold up cream mixture bag and slosh it around) but then it turned into this (hold up the ice-cream bag). What do you think happened to make this (hold liquid bag up) turn into this (hold solid bag up)?
    b. After the turn-and-talk, have a few students share out ideas and start a list. Tell students that we can keep adding to the list later but now is time to work together to make some ice cream!

    NOTE: Put your ice-cream back in the cooler with ice to keep it solid. This can be extra ice cream if needed it when students get to sample the ice cream in step 17.

    See the chart below for an example. It is generated with input from 2nd grade students so the lists may vary.

> **<u>How can this cream change into ice cream?</u>**
>
> **Our Ideas**
> - It has to get super cold
> - Put it in the freezer
> - Like when we make ice cubes and put water to make it hard
> - Don't touch it when it is cold because it will melt

SAFETY ALERT!

Don't share germs! No sharing spoons and no double dipping.

5. **Setting up activity (whole class)**
    a. Tell students that they will be working together to make ice cream using this idea about making the cream super cold. Use the thermometer to take the temperature of the cream.
    b. Put the sealed quart-sized bag with cream (which you prepared prior to the lesson) inside the gallon bag and add ice and salt. Repeat. (You will have 2 set-ups and towels to pass around in the circle). Make sure the bags are well sealed.
    c. Have students move to sit in a big circle.

d. Tell students to use the towel to protect their hands as they begin to move the bags around to make sure the cold ice gets contact with the cream.
e. Tell students they will take turns shaking and mixing the bag. Also, the bag gets cold so make sure they have towel.

6. **Making Ice Cream**
   a. Have students shake their bags and move them around inside the towel. The 'shakers' can stand up if it's easier.
   b. Have all students do one of the ice creams songs* as a timer. At the end of the song, pass the bag.
   c. After a few minutes, have students sit down and pause to look at the progress so far. Remove the towel and ask the back-pocket questions listed below. Use the thermometer to measure the temperature of the cream (or ice cream, as it changes).

<u>Back-Pocket Questions:</u>

- What's happening to the ice cubes?
- Where do you think the ice cube went?
- What's happening to the cream?
- Why is the cream getting chunks?
- Why is the cream changing?

Turn and Talk

What did we do to make ice cream?

   d. After a pause for observations, wrap the bag back in the towel, resume the chant and passing/shaking until the ice cream is firm.

***NOTE:** Several songs and a suggestion for reading are available at the end of this lesson for students to chant or sing while waiting for the ice cream to become firm. While you can choose a different task, 10-15 minutes is a long time, so do consider a task during this time to avoid management issues and allow all students to participate.

7. **Tasting ice cream and clean-up**
   a. When the ice cream in each bag is firm, pass out spoons to each student.
   b. Have students make 2 lines, each in front of a bag. They can get one spoonful and go back to their desks. (If you run out, take out the bag of ice-cream you made before class, and let students try a spoonful of that.)
   c. Clean-up and if time permits revisit the questions in the box above as a whole class.
   d. Tell students that tomorrow they will talk, write, and draw about the ideas related to how the sloshy cream changed into ice cream.

OPTIONAL: Send copies of the activity sheet home with students if they want to try this at home. http://www-tc.pbskids.org/fetch/parentsteachers/activities/pdf/FETCH_IceCreamShake_AG.pdf

PART 2: DEVELOPING EXPLANATORY MODELS (45 minutes)

1. **Activate prior knowledge and experiences (whole group)**
   a. Introduce this lesson by revisiting what happened in the previous activity. Ask students to turn-and-talk about what they did to make ice cream.
   b. Re-explore student observations about the sloshy cream turning into ice cream as well as their ideas about where the ice cubes went and why the cream changed.

2. **Develop Initial Models (individual)**
    a. Show students the different sections of the model - places to draw and write about the cream (top) and ice cream (bottom) and tell the story of why the cream changed.
    b. Explain to students that the circles are zoom-ins, as if they had microscope eyes and could look and see super tiny things inside the cream and ice cream. What's going on that we can't see to explain why the ice cubes change?
    c. Point to the drawing area and writing area on the model and direct students to use the spaces to draw and write to show all their ideas and questions about how cream turned into ice cream.
    d. Tell students they are encouraged to talk during this time. Because we are figuring this out together, we will probably have different ideas and different ways of showing and explaining our ideas. This is great! So as you work, you might talk to a partner or a teacher about your thinking.
3. **Continue to develop models (individual)**
    a. Circulate as students are working. Interact with students asking them about their ideas. Look for similarities and differences in ways students are representing ideas about liquids, solids, and temperature. Some possible questions are listed here:

Back-Pocket Questions

Questions to Ask:

Don't ask them all. Rather pick a question that aligns with an idea the student is currently talking, writing, or drawing about.

Opening talk move: *Tell me what you're drawing (or writing) about.*

Follow-up back-pocket question:
- *Why do you think that happened?*
- *Have you seen that happen before?*

General questions that all student should be attending to in their models:
- *Where did the ice cubes go?*
- *Why did the cream change?*
- *What's going on that we can't see? If we had microscope eyes how does cream look different than ice cream?*
- *What is the temperature story?*

Questions to prompt modelling: Insert student ideas:
- *I see you drew ____. Let's write a sentence together about it on the lines. How can you start?*
- *Can you read me your sentence you wrote? That's interesting. Do you have that in the picture part of your model? (If so: Looks good! Would you label that? / If not: How or where would you add that?)*
- *I heard you say ___. We can't see ___, so how could you represent it in your model?*
  Specific student examples:
    - *You keep saying it is super cold. We can't see cold. How can you show cold in a picture?*
    - *You said that the heat from our hands is melting the ice cubes. We can't see heat, how can you show heat from our hands in our picture?*
    - *I heard you say the ice cubes shrank because they got warmer, how can you show how they shrank in your drawing?*

Whole Class Discussion

4. **Summarize and select ideas to make public (whole class)**
As students work on their models, circulate and observe the kinds of ideas students talk, draw, and write about. Look for ideas about the role of temperature and how they are talking about how liquids change to solids (cream to ice cream) or how solids change to liquids (what happens to ice cubes). Select 2 or 3 students (or pairs) to share parts of their model about these ideas. Select students who have different ideas.

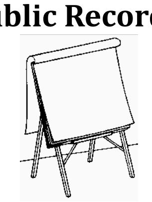
Have these students show their model under the document camera and explain their idea(s) to the class.

Encourage students to have a short discussion about their initial ideas to make sure we all understand each other's' ideas. This is a time for clarifying and elaborating about ideas, not for debating or argumentation (this can come later when students have more evidence from the activities).

Students can use prompts like:
- Why do you think that (asking for evidence/experience)
- Your idea makes me wonder if (posing a question)
- I agree but I said/showed that idea by...(comparing models)

Allow students to continue to work on their models answering the questions for a few more minutes. They can incorporate some ideas they just heard if they agree. You may also decide to include specific directions around something you notice your students are not doing. This might be something like:
- What is the temperature story?
- Have you shown cool or super cold?
- What makes it change temperature?

Public Record



Hypothesis chart

5. **Pressing for possible explanations: Create a hypothesis list (whole class)**

Have students share out their ideas with each other before writing a list to allow students to hear the different ideas. Then generate a list with students by having them write ideas on sticky notes. If helpful, students could use this sentence starter:

I think the cream turned to ice cream because...

6. **Students continue working on models (individual)**

Give students more time to add to their models. As you circulate make sure students are including pictures and words about their ideas. Ask questions listed above to press and probe their thinking. The purpose of this lesson is to elicit ideas and experiences students are using to explain this phenomenon. Take notes if needed as you listen and watch students work.

7. **Summarizing ideas and Closing**
Collect student models - make sure they have names.

Close the lesson by referring to the list of hypothesis and thanking students for their hard work on their models. Tell students: "*Over the next few lessons, we will think more about our ideas and add to or change this information based on some experiments and learning.*"

EXAMINING STUDENT WORK

For this lesson, the teacher should use student discussions and examine what *experiences or stories* the students shared and drew upon to explain why ice cream melts. This task is intended to help you notice what concepts students are already thinking about and which ones are new to most students. As well, the teacher should reflect on what *language* students used as they shared their ideas. For example, what phrases or words - maybe things like "it gets squishy and soft and then gets all runny" or "my hands make ice cream turn into a mess." Lastly, the teacher should reflect on what *ideas* students have about matter and temperature.

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of hypothesizing about a phenomenon helped students to/with…*
- *The task about _______ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed _____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The model scaffold tool allowed students to…*
- *Creating a list of initial ideas allowed students to...*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to...*

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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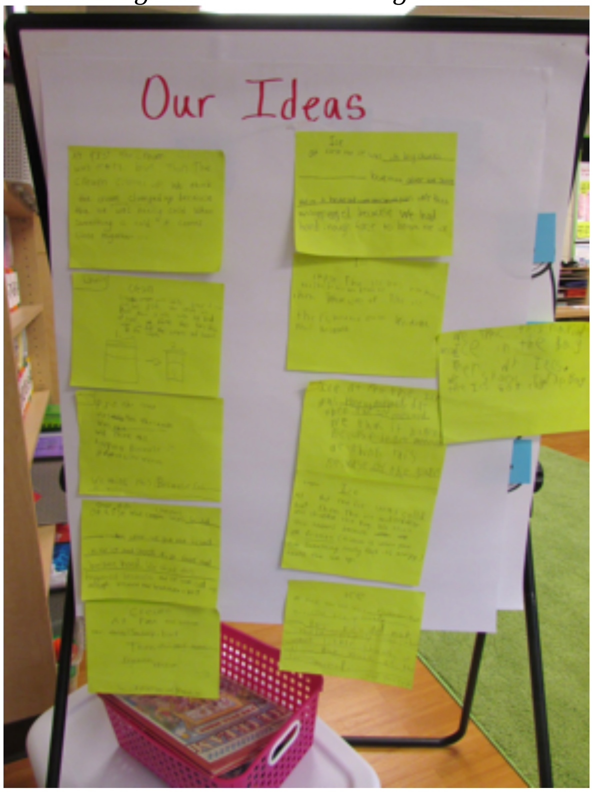
Below is a list of initial ideas generated in the 2nd grade classroom of K. Vaa:



Helpful Resources:

- Ice Cream Instructions: http://www-tc.pbskids.org/fetch/parentsteachers/activities/pdf/FETCH_IceCreamShake_AG.pdf
- Suggested reading: Should I Share My Ice Cream by Mo Willems

- Ice Cream Shake: https://www-tc.pbskids.org/fetch/parentsteachers/activities/pdf/FETCH_IceCreamShake.pdf

Ice Cream Song

To the tune of "Farmer in the Dell"

By Cara Caroll

Ice cream in a bowl.
Ice cream in a cone.
Ice cream any way I want
As long as it's my own.
Ice cream can be sticky.
Ice cream can be sweet.
Ice cream is delicious it's my very favorite treat!

Take Me Out for Some Ice Cream

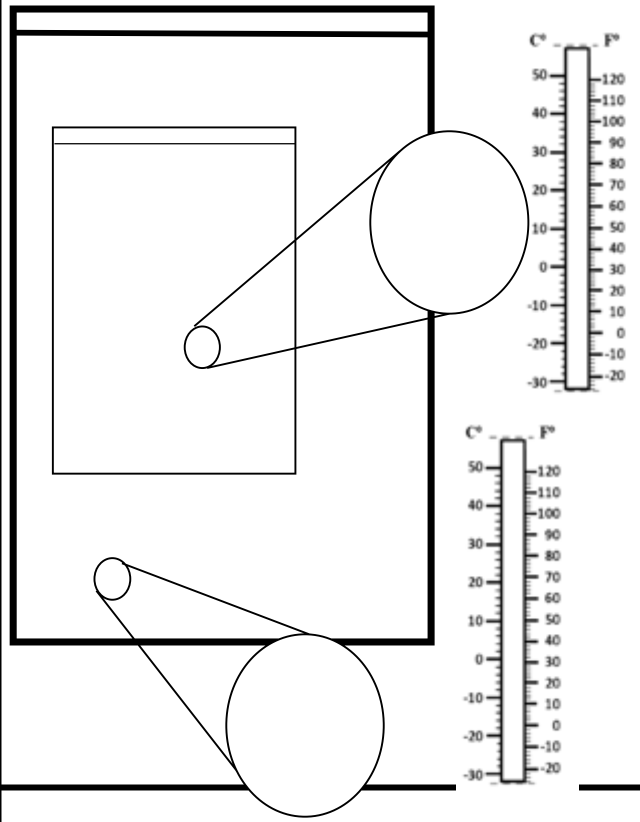
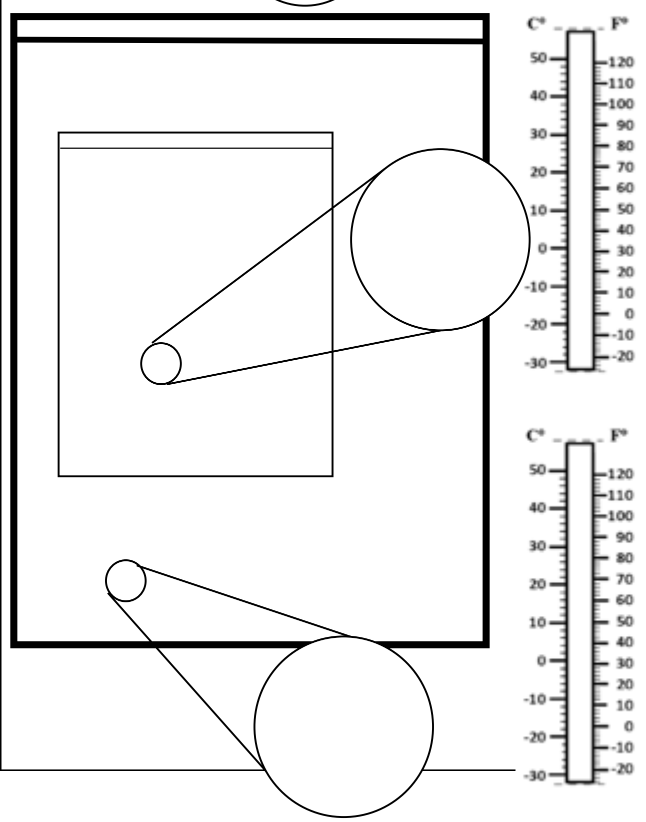
To the tune of "Take Me Out to the Ballgame"

By Leah Carpenter

Take me out for some ice cream
Take me out to the store
Buy me a triple scoop jumbo cone
I won't share, I will eat it alone!
For its scoop, scoop, scoop, up the ice cream -
Give me three kinds I adore!
For it's one, two, three scoops to go
At the ice cream store!

Name ______________________________ Name _________________________ Date _____________

The Ice Cream Story: *How and why does the cream change?*

The cream mixture at the beginning *What do the ice cubes look like at the beginning?*		The cream mixture… ________________________ ________________________ The ice mixture… ________________________ ________________________
After 10-15 minutes, the cream changes and the ice cubes change. *Where are changes happening? How do you know? What caused that change?*		The cream mixture… ________________________ ________________________ The ice mixture… ________________________ ________________________

Lesson 2: Properties of Solids

OBJECTIVES & OVERVIEW

Students will learn about the properties of solids and identify patterns to understand properties in common with all solids. They will observe and classify a variety of different solid objects according to their observable properties.

Focus Question: What are some properties of solids that we can see?

- Students will generate a list of observable properties of solids.
- Students will sort solid objects based on their observable properties.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING

This practice supports on-going changes in student thinking by (1) introducing ideas to reason with, (2) engaging with data or observations, and (3) using knowledge to revise models or explanations. For more, visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

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

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions: Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (2-PS1-3)	**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. (2-PS1-1)	**Patterns** Patterns in the natural and human designed world can be observed. (2-PS1-1)

Common Core Connections:
CCSS.ELA-LITERACY.RL.1.1: Ask and answer questions about key details in a text.

MATERIALS

For the class:

- Copy of book: “Change It! Solids, Liquids, Gases, and You”
- Chart paper and markers
- Class set of varying solid objects

Per student group:

- Container for solid objects (i.e. plastic tub)
- Properties of Solids student worksheet

- 20 different solid objects with different properties - a possible list is included below:
    - Cube
    - Button
    - Pipe cleaner
    - Bouncy ball
    - Sandpaper
    - Feather
    - Cork
    - Cardboard
    - Golf tee
    - Cup
    - Cotton ball
    - Marble
    - Plastic
    - Popsicle stick
    - Yarn
    - Penny
    - Ping pong ball
    - Playdoh
    - Lego
    - Steel Nut

Per Student (*OPTIONAL)*

- Comparing and Contrasting Properties of Solids Worksheet

Teacher Decision Point

Decide if student groups will describe all of the objects or half of the objects.

All of the objects:

- *Students can begin to see patterns in the objects*
- *More practice describing solids*

Half of the objects:

- *Students are less overwhelmed by the task but still get experience describing solids*
- *Students can spend more time describing their assigned objects*

PREPARATION

15 minutes

- ➢ Print student recording sheets
- ➢ Read through “Change It – Solids, Liquids, Gases, and You” and decide where to ask students to make connections between the reading and the activity.

PROCEDURE

Turn and Talk

How would you describe these two different objects?

1. **Activate prior knowledge and experiences (whole group)**

   Introduce this lesson by telling students they will be learning about solids and their properties. Show the students two solid objects: a unifix cube and a cotton ball (any two objects can be used as long as they are distinctly different in some of their properties). Ask the students to turn-and-talk about how to describe these objects.

   Have students share out a few of their ideas and introduce the idea of categories. You could say, “Cotton balls are soft and unifix cubes are hard. We also noticed that cotton balls are round and cubes are square. These are categories: hard, soft, round, square. We will be looking at more solids and deciding on even more categories to describe them.”

   Focus question: How can we describe different solids?

Teacher Decision Point

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Decide if student groups will describe each of the objects or just some of the objects

2. **Getting the activity started (whole class)**
   Ask students to work as a team to describe their items. They should label their ideas on the “Describing Solids Student Worksheet.”

   Note: You can have the students describe all of the objects or just half. The “Describing Solids Student Worksheet” is divided into two papers. The teacher can choose to have students work in pairs where one pair at a table group identifies half and the other pair identifies the other half. Conversely, the teacher can opt to have student pairs describe all of the objects and simply complete both sheets.

See the chart below for an example of possible descriptive words. It is generated with input from students so lists of observations will vary.

Possible Descriptions
Hard
Soft
Squishy
Bumpy
Bendy
Not Bendy
Pointy
Round
Heavy
Light
Dark
See-through

Back-Pocket Questions

3. Make observations and uncover patterns using questions (small groups)

a. Circulate as students make observations and talk about how to describe the solids.

b. As the students make observations, circulate and ask questions about observations and patterns.

Back-Pocket Questions:

- *What is a solid?*
- *How do we know if something is a solid?*
- *What is something that is the same with all of the solids?*
- *What are the solids in our ice cream story?*

Whole-class discussion

Compare Worksheets

4. **Select ideas to make public (whole class)**

   As students work on their descriptions, circulate and observe the kinds of ideas students have. Select 2 or 3 students (or pairs) to share out the descriptions they chose. Select students who have different ideas.

   Have these students show their worksheet in front of the class and describe their idea(s) to the class. As the students are sharing their ideas, the teacher can write them on a poster in the front of the class.

   Encourage students to have a short discussion about their descriptions to ensure that all understand each other's ideas. This is a time for clarifying and elaborating about ideas, not for debating or argumentation.

   Students can use prompts like:
   - *Why do you think that?* (asking for experience/evidence)
   - *Your idea makes me wonder if…* (posing a question)
   - *I agree but I thought of the categories this way…* (comparing charts)

   Allow students to continue working on their worksheets for a few more minutes. They can incorporate some ideas they just heard if they agree.

Reading Integration

Read about solids

5. **Reading about solids (whole class)**

   Read the section of the text about solids to the class.

   As you read, have students make connections to what they observed in the activity.

6. **Writing about solids (individual)**

*****OPTIONAL ELA CONNECTION***

   Ask students to complete the optional writing and classification activity included at the end of this lesson.
   - *Comparing and Contrasting Properties of Solids*

Public Record

Summary Table

7. **Connections to the phenomena (whole class)**

   Take out a piece of ice and ask them to describe it. Ask students if the ice is a solid. How do they know? (*It can be described by its physical properties - cold and hard - and it has a definite shape).*

   Use information from the activity and reading to complete the information from the 'observations' and 'learning' columns. Have students think about how this could help explain why the cream turned to ice cream.

Activity	What did we observe?	What did we learn?	How does this help us understand why the cream turned to ice cream?
Properties of Solids	Solids can be soft, hard, round, square, etc. Some solids are more similar than others.	Solids can be described and sorted by their physical properties. Solids can look and feel different but all solids have a definite shape.	When the cream turned to ice cream, it became a solid. I know this because it was hard and cold and had a definite shape. The ice was also a solid because it had a definite shape

EXAMINING STUDENT WORK

For this lesson, the teacher should use student discussions and student worksheets to track students' understanding of solids and their properties. This task is intended to help you notice what concepts students are already thinking about and which ones are new to most students.

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of describing solids helped students to/with…*
- *The task about _______ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed _____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The model scaffold tool allowed students to…*
- *Creating a list of initial ideas allowed students to...*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to...*

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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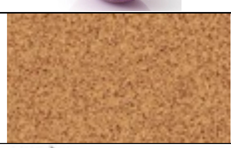
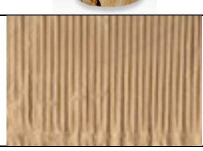
Properties of Solids Student Worksheet

Names: ____

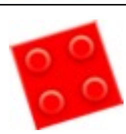
Directions: Look and touch each solid object and decide as a group how to describe it. Write your ideas in the chart below.

Picture	Solid	Description
	Cube	
	Pipe cleaner	
	Button	
	Ball	
	Sandpaper	
	Feather	
	Cork	
	Cardboard	
	Golf tee	
	Cup	

Properties of Solids Student Worksheet

Names: ____

Directions: Look and touch each solid object and decide as a group how to describe it. Write your ideas in the chart below.

Picture	Solid	Description
	Cotton ball	
	Marble	
	Plastic	
	Popsicle stick	
	Yarn	
	Penny	
	Ping pong ball	
	Playdoh	
	Lego	
	Steel Nut	

Lesson 3: Properties of Liquids

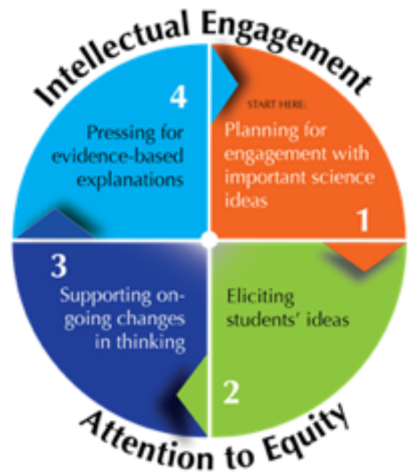
OBJECTIVES & OVERVIEW

Students will learn about the properties of liquids and identify patterns to understand properties in common with all liquids. They will observe liquids with different viscosity to determine both that liquids have no definite shape and can flow at different rates. Understanding properties of liquids is a foundational concept to understanding that particles make up matter and temperature changes the state of matter.

Focus Question: What are some properties of liquids that we can see?

- Students will discover that liquids have no definite shape.
- Students will observe that different liquids can flow at different rates.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING



This practice supports on-going changes in student thinking by (1) introducing ideas to reason with, (2) engaging with data or observations, and (3) using knowledge to revise models or explanations. For more, visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

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

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions: Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (2-PS1-3)	**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. (2-PS1-1)	**Patterns** Patterns in the natural and human designed world can be observed. (2-PS1-1)

Common Core Connections:
CCSS.ELA-LITERACY.RL.1.1: Ask and answer questions about key details in a text.

MATERIALS

Teacher Decision Point

Decide if each student pair or table group will get a set of materials.

For the class:

- Summary Chart
- Copy of book: “Change It! Solids, Liquids, Gases, and You”

Each student

- Properties of liquids student worksheet

Per student group / table group:

- 3 oz dixie cup with 15 ml water (½ ounce)
- 3 oz dixie cup with 15 ml white glue (½ ounce)
- 3 oz dixie cup with 15 ml corn syrup (½ ounce)
- 3 oz dixie cup with 15 ml oil (½ ounce)
- 4 empty clear plastic cups
- Tray (to contain materials)

PREPARATION

15 Minutes

➢ For each group, prepare four 3 oz dixie cups with approximately 15 ml (½ ounce) of each different liquid. Also, add 4 empty plastic cups (large enough to hold 15 ml of liquid).

➢ Print student recording sheets

➢ Read through “What is Matter” and decide where to ask students to make connections between the reading and the activity.

PROCEDURE

1. **Activate prior knowledge and experiences (whole group)**

Turn and Talk

What do you notice about these different liquids?

Introduce this lesson by revisiting the student generated descriptions of solids from lesson 2. Show the students the 4 liquids (under the document camera or at each table group). Name each of the liquids for the students. Then, have students turn-and-talk about what they notice about the liquids.

Focus question: How are the liquids similar and different?

Have students share out a few of their observations.

2. **Getting the activity started (whole class)**
Quickly go through the directions for students so each group knows what to do with the materials and what to record on their worksheet.

Demonstrate with one sample if needed. Students will:
   1. Hold up the liquid and write observations about color and texture.
   2. Pour the liquid into the cup. Write observations about the shape of the water and ease of pouring.
   3. Repeat with the other liquids into new cups.

Back-Pocket Questions

3. **Make observations and uncover patterns using questions (small groups)**
   a. Circulate as students set up materials and make observations. Re-direct and help students with set-up as needed.
   b. As the students make observations, circulate and ask questions about observations and patterns.

Back-Pocket Questions:

- *How do we know if something is a liquid?*
- *In our ice cream story, what are the liquids?*
- *Which liquid is the hardest to pour? WHY?*

   c. Make sure students are recording observations in their data tables.

See the chart below for an example of possible observations. It is generated with input from students so lists of observations will vary.

Liquid Observations	
Color and Texture	**Shape and "Pourability"**
Clear	Runny
Thick	Slow
Thin	Fast
Yellow	Free-Flowing
White	Same shape as the cup
Sticky	Shape of the container
Slick	Quick

Public Record

Summary Table - Observations

4. **Publicly sharing ideas on summary table (whole group)**
Record observations about each type of liquid on the summary table under "observations."

Reading Integration

Read about liquids

5. **Reading about liquids (whole class)**
Read aloud from "Change It!" the section about liquids.

As the selection is read, have students make connections to what they observed in the activity.

Public Record

Summary Table

6. **Connections to the anchoring event (whole class)**
Take out the liquid cream and ask them to describe it. Ask students if the cream is a liquid or a solid. How do they know? (*It can be described by its physical properties - white, runny - and it takes the shape of its container).*

Use information from the activity and reading to complete the information from the 'observations' and 'learning' columns. Have students think about how this could help explain why the cream turned to ice cream.

Activity	What did we observe?	What did we learn?	How does this help us understand why the cream turned to ice cream?
Properties of Liquids	Water - clear, runny, fast, thin Glue - white, thick, slow Oil - yellow, slimy, free-flowing Corn Syrup - yellow, thick, sticky, slow	Liquids take the shape of their container. Liquids can pour, spread, and flow	The cream begins as a liquid. I know this because cream fills the container, it pours, and flows. The ice turns into liquid water. I know this because the ice no longer has a shape and fills the shape of bag.

EXAMINING STUDENT WORK

Most of the student work today is at an observation level. Pay attention to the kinds of questions students ask today about liquids - these questions can frame future lessons. Also, listen in on student talk as they make connections between the activity, the reading, and the ice cream story. Are they able to identify the liquids in the ice cream story? Can they tell you how they know?

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

LESSON REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of describing liquids helped students to/with...*
- *The task about ______ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to...*
- *During turn-and-talks, I observed ____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The summary table allowed students to...*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because...*
- *Overall, this combination of talk, task, and tools, allowed most/all students to...*

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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Properties of Liquids Student Worksheet

Names: ____

Liquid	Color and Texture	Shape and Pourability
 Water		
 Glue		
 Oil		
 Corn Syrup		

Lesson 4: Freezing and Melting Changes Matter

OBJECTIVES & OVERVIEW

Students will observe and describe what causes matter to change forms from liquid to solid and back again using an everyday example of making juice popsicles. Focusing students around temperature changes (using a thermometer) during the steps to make popsicles support students in telling the temperature story in explaining the ice cream phenomenon.

Focus Question: How does temperature affect solids and liquids?

- Students will make observations about how temperature changes matter.
- Students will collect data related to temperature and states of matter.

Ambitious Science Teaching:
SUPPORTING ON-GOING CHANGES IN STUDENT THINKING

This practice supports on-going changes in student thinking by (1) introducing ideas to reason with, (2) engaging with data or observations, and (3) using knowledge to revise models or explanations. For more, visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

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

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Engaging in Argument from Evidence Construct an argument with evidence to support a claim. (2-PS1-4)	**PS1.B: Chemical Reactions** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	**Cause and Effect** Events have causes that generate observable patterns. (2-PS1-4)

MATERIALS

For the class:

- Can of frozen orange juice concentrate (or another flavor of juice)
- Pitcher
- Large spoon
- Water
- Thermometer
- Tray (to carry the student popsicle cups)
- Chart paper and markers

For each student:

- Small paper cup
- Popsicle stick
- *Optional: Student Data Sheet*

SAFETY ALERT!

Check with the school nurse about food allergies to ensure the safety of the students wanting to eat their popsicle.

PREPARATION

45 minutes

➢ Create a chart template on poster paper for student observations
➢ Assign students different roles in the process. Possible roles could include:
  - Observer of concentrate - 2 students
  - Temperature reader / reporter - 3 students
  - Recorder - 3 - 6 students
  - Assembly worker (pouring, putting stick in cup, and putting on tray)
➢ Identify a location where the juice can be frozen to make popsicles.
➢ Materials tip: Bring in a cooler to keep the juice concentrate frozen before it is used in making juice
➢ Materials tip: Pull out one can of concentrate about 10 minutes before it is needed so that it can soften enough to insert the thermometer but still remain a solid.
➢ Materials tip: Have the cold water pre-measured according to package instructions and placed in the pitcher.

PROCEDURE - PART 1. Making Observations

1. **Activate prior knowledge and experiences (whole class)**

   Have students look at their worksheets from the solids and liquids lessons (and/or refer to the class summary chart).

   Remind students what they did, something like: “*Remember when we made observations about different solids, we noticed that solids have a specific shape and can be identified by their properties. When we made observations about liquids, we noticed that liquids can pour at different speeds, they have different “thickness” and they take the shape of their container. Remind students also that they figured out that the ice and the ice cream are the solids, and the water and the cream are the liquids in our ice cream story."*

Turn-and-Talk

How do liquids change to solids? How do solids change to liquids?

Have students turn-and-talk about the questions: **How do liquids change to solids? How do solids change to liquids?**

Tell students that today they will be investigating how liquids and solids change and how temperature affects the change. Introduce the **Focus Question: How does temperature affect solids and liquids?**

Just-in-time Instruction

2. **Provide information to leverage during the activity (whole class)**

   Introduce two new terms for today's lesson that students can use to describe the changes between solids and liquids: freezing and melting. Use the box below to introduce the terms.

Solids can turn into liquids. This is called **melting**. Solid ice turning into liquid water is an example of **melting**.

Liquids can turn into solids. This is called **freezing**. Liquid water turning into solid ice is an example of **freezing**.

When water **freezes** into ice and ice **melts** into water, this is called a **change of state**.

3. **Getting the activity started (whole class)**

   Have the students sit in a circle. Tell them that today they will be making observations about the temperature of solid juice concentrate and liquid juice and watching as it changes from a solid to a liquid.

4. Making observations and uncovering patterns (whole class)

Show students the open can of frozen juice concentrate. Have students verbally share their observations about the frozen juice. Ask them:

- What color is it?
- What does it look like?
- How does it feel? (have two students feel and report out)
- What is the temperature? (carefully insert the thermometer into the juice concentrate and ask for a student to read the temperature aloud)
- Is it a solid or a liquid? How do we know?

Next, show the students the pitcher of cold water. Have students verbally share their observations about the water. Ask them:

- What color is it?
- What does it look like?
- What is the temperature? (Insert the thermometer and ask another student to read the temperature aloud).
- Is it a solid or a liquid? How do we know?

Add the concentrate to the pitcher of cold water and stir (have two or 3 students take turns carefully stirring until the concentrate is dissolved).
While waiting for the juice to be ready, ask students to think about and turn-and-talk to their neighbor about the following questions:

Back-Pocket Questions

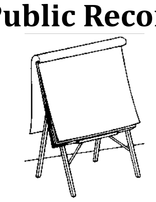
Back-Pocket Questions:
• How do liquids change to solids? • How do solids turn to liquids?

Once the juice is ready, have students verbally share their observations about the juice. Ask them:

- What color is it?
- What does it look like?
- What is the temperature? (Insert the thermometer and ask a student to read the temperature aloud).
- Is it a solid or a liquid? How do we know?

As the students are sharing observations, make a written list of student observations on a classroom chart.

Public Record



Our Observations

Note: If you would like to increase student involvement, you can select several students to record information on the classroom chart. You may want to prepare the students ahead of time that they will be assigned this task to ensure they are comfortable.

Our Observations					
	What does it look like?	What does it feel like?	Temperature	Solid or Liquid	How do we know?
Frozen Juice					
Water					
Juice					
Popsicle					

5. **Have students clean up materials**

Part 2. Making Connections

Turn-and-Talk

How did the solid juice concentrate turn into liquid juice?

1. **Activate prior knowledge (whole class)**

   Refer to the chart of observations from the last lesson. Remind students what they did. Say something like: *Remember when we made observations and measured the temperature of juice as a solid and a liquid? We noticed that the frozen juice was a solid because it was hard and had a shape, but the water was a liquid because we could pour it and it took the shape of the container. We also noticed that juice concentrate was colder than both liquid water and liquid juice.*

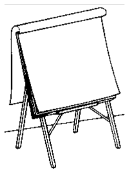
   Have students turn-and-talk about the questions: **How did the solid juice concentrate turn into liquid juice?**

   Tell students that today they will be thinking about the relationship between temperature and whether something is a solid or liquid. Introduce the **Focus Question: How does temperature change matter?**

2. **Getting the activity started (whole class)**

   Tell students that today they will be observing, measuring the temperature, and eating the juice in their cup from the previous lesson.

Public Record



Our Observations

3. **Making observations and uncovering patterns (whole class)**

   Show students one cup with the frozen juice. Have students verbally share their observations about the frozen juice. Ask them:
   - What color is it?
   - What does it look like?
   - How does it feel? (have two students feel and report out)
   - What is the temperature? (Carefully insert the thermometer into the frozen juice and ask for a student to read the temperature aloud.)
   - Is it a solid or a liquid? How do we know?

   Ask another student to record the observations on the class chart.

Materials note: you may want to take one popsicle out of the freezer about 10 minutes before the rest so that it can begin to soften enough to insert the thermometer.

Once observations are completed, pass out the popsicles and allow the students to eat them. They can simply peel off the paper cup and enjoy!

Optional: you can have one extra popsicle that you allow to melt while the students are eating and answering questions. You can allow them to observe the process of melting.

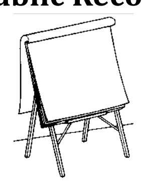
As they are eating, ask students to think about and turn-and-talk to their neighbor about the following questions:

Back-Pocket Questions

Back-Pocket Questions:
• How does temperature change matter? • How do these ideas about hot and cold help us understand our ice cream story?

4. **Have students clean up materials**

Public Record



Summary Table Row

5. **Connections to the anchoring event (whole class)**

   Observations: Take a few observations from the students that includes numeric data about the relationship between temperature and state of matter.
   Learning: Help students craft generalizable statements about what they learned from the investigation. They could also put questions or wonderings here.
   Connections: Ask students to think about how the investigation can help us understand how the cream turned into ice cream.

Activity	What did we observe?	What did we learn?	How can this help us understand why the cream turned to ice cream?
Freezing and melting changes matter	Frozen juice concentrate was hard and had a definite shape. The temperature of the frozen juice was ______°F The water took the shape of the container. The temperature of the water was _____°F The juice took the shape of the container. The temperature of the juice was _____°F The frozen juice had a definite shape. The temperature of the frozen juice was _____°F	Solids have a lower temperature than liquids. Liquids have a higher temperature than solids. Solids change to liquids when the temperature rises. Liquids turn to solids when the temperature lowers.	The cream started out as a liquid with a higher temperature (___°F). The ice started out as a solid with a lower temperature (____°F). When the cream turned to solid ice cream, the temperature of the cream must have gone down. When the ice melted into water, the temperature of the ice must have gone up. The change in temperature caused the cream to turn to ice cream.

EXAMINING STUDENT WORK

For this lesson, the teacher should use student discussions and to track students' understanding of the relationship between temperature and state of matter. This task is intended to help you notice what concepts students are already thinking about and which ones are new to most students.

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

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TEACHER REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of making observations and collecting temperature data helped students to/with…*
- *The task about ______ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed ____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The summary chart allowed students to…*
- *Creating a list of initial ideas allowed students to...*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to...*

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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Classroom Data and Observation Chart

Note: You can print this chart and display under the document camera, or you can make a wall poster.

Data and Observations					
	What does it look like?	What does it feel like?	Temperature °F	Solid or Liquid	How do we know?
Frozen Juice 					
Water 					
Juice 					
Popsicle 					

These are pictures that can be printed and displayed on the classroom chart. Alternatively, pictures of the actual materials used in class can be taken, printed, and displayed on the classroom poster.

Lesson 5: What's the Matter?

OBJECTIVES AND OVERVIEW

Students will receive just-in-time instruction, where the teacher provides content knowledge that students cannot discover on their own, on the idea that particles make up matter. The instruction will also address how the arrangement of particles changes depending on temperature. This may be considered slightly above grade level; however, it can be presented in an age-appropriate level and is critical to explaining how liquids and solids are different.

Focus Question: What is matter made of?

- Students will explain how liquids and solids are different based on their particles.
- Students will act like particles with their bodies to help them understand how the motion of particles predicts the observable properties of liquids and solids.

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NEXT GENERATION SCIENCE STANDARDS

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

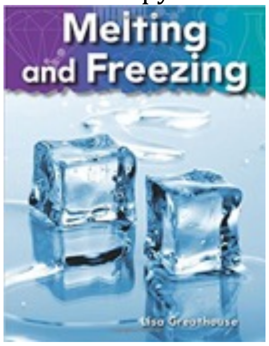
Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Engaging in Argument from Evidence Construct an argument with evidence to support a claim. (2-PS1-4)	**PS1.B: Chemical Reactions** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	**Cause and Effect** Events have causes that generate observable patterns. (2-PS1-4)

Common Core Connections:
CCSS.ELA-LITERACY.RL.1.1: Ask and answer questions about key details in a text.

MATERIALS

For the class:

- Interactive Presentation: BBC Bitesize (Click through the steps/pages and focus on liquids and solids) http://www.bbc.co.uk/bitesize/ks3/science/chemical_material_behaviour/particle_model/revision/1/
- Teacher Copy of "Melting and Freezing (Science Readers: A Closer Look)"



- Summary Table

Per student group:

- Empty container
- Instruction sheet
- Particle note sheet
- 15 Legos of the same size in a container

PREPARATION

30 minutes

➢ Review the interactive presentation
➢ Read through "Melting and Freezing" and decide where to ask students to make connections between the reading and the activity. (If using another reading, select the reading and decide where to ask students to make connections).
➢ Determine a space appropriate to allow students to act out the particles in liquids and solids.

PROCEDURE - PART 1

Turn-and-Talk

How do liquids change to solids?
How do solids change to liquids?

1. **Activate prior knowledge and experiences (whole class)**

   Have students look at the summary chart from lesson 4.

   Remind students what they did, something like: *Remember when we made juice using solid juice concentrate and liquid water? We noticed the solid was cold and hard but the liquid had the shape of the pitcher. We then froze the juice and made solid popsicles. We observed that solids have lower temperatures than liquids and to make a liquid into a solid, we had to lower the temperature by putting it in the freezer.*

   Tell students that today they will be investigating what liquids and solids are made of and how temperature affects matter. Introduce the **Focus Question: What is matter made of?**

Just-in-time Instruction

Reading Integration

Read about liquids

2. **Provide information to leverage during the activity (whole class)**

   Read "Melting and Freezing" with special emphasis on the information that particles make up matter.

   Possible reading comprehension questions:
   - What is matter made of?
   - How are the particles in solids and liquids different?

   Explain to students that now that they know what matter is made of, they will be acting out the particles in liquids and solids.

Turn-and-Talk

How are the particles in solids moving and how are they arranged?

Turn-and-Talk

How are the particles in liquids moving and how are they arranged?

3. **Getting the activity started (whole class)**

   Have students gather in an open space where they will be able to act out the particles. Tell students that they will each act as one of the many particles found in a solid.

   Turn-and-talk with a partner about the question: How are the particles in solids moving and how are they arranged? Ask for student volunteers to share their responses.

   Have students act out solid particles by standing close together and vibrating slowly in place.

   Next, tell students they will be acting like the particles in liquids. Turn-and-talk with a partner about the question: How are the particles in liquids moving and how are they arranged? Ask for student volunteers to share their responses.

   Have students act out liquid particles by moving farther apart and moving faster.

Back-Pocket Questions

4. **Summarizing (whole class)**

Ask students to turn and talk about the following back-pocket questions:
- How are the particles different in solids and liquids?
- How are the particles the same in solids and liquids?

Note: You may want to record some of the students' ideas to refer back to on the next lesson.

PART 2. - Lego Models

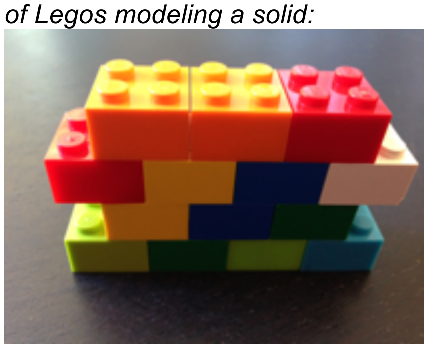
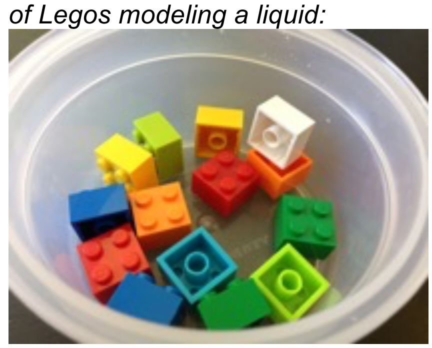
1. **Activate prior knowledge and experiences (whole class)**

Introduce the lesson by revisiting observations made about the particles in solids and liquids. You can say something like, "*During our last lesson we acted like the particles in a solid and noticed that we were all standing close together and not moving very much. We also acted like the particles in a liquid and noticed that we had to stand farther apart and could move more. Some of you also noticed that being a particle in liquid required more energy.*

2. **Getting the activity started (whole class)**

Explain to students that they will continue to model the particles in solids and liquids. Quickly go through the directions so each student group knows what to do with the materials.

Students will:
1. Imagine that each Lego is a tiny particle of matter.
2. Organize the Legos so they are arranged like the particles in a solid.
3. Draw the Lego formation.
4. Put the "solid" Legos into a container. What happens to the shape of the "solid"?
5. Try to pour the "solid" Legos. Does it pour?
6. Next, organize the Legos so they are arranged like the particles in a liquid.
7. Draw the Lego formation.
8. Put the "liquid" Legos into a container. What happens to the shape of the "liquid?"
9. Try to pour the "liquid" Lego pour?

Below is a picture of one example of Legos modeling a solid: 	*Below is a picture of one example of Legos modeling a liquid:* 

Back-Pocket Questions

3. Make observations and uncover patterns using questions (small groups)

Circulate as students set up the materials and make observations. Redirect students and help with the set up as needed.

As students complete the activity, circulate and ask them questions about observations and patterns.

Make sure students are recording observations in their data table.

Back-pocket Questions:

- How are the particles different in solids and liquids?
- How are the particles the same in solids and liquids?
- What happens to the energy when the particles became a liquid? How do you know?

Public Record

Summary Table

4. Connections to anchoring event (whole class)

Use information from the reading and activities to complete the observations and learning columns of the summary table. Have students think about how this could help them understand how the cream changed to ice cream.

Activity	*What did we observe?*	*What did we learn?*	***How does this help us understand why the cream changed to ice cream?***
What's the Matter?	*From the reading:* All matter is made of tiny pieces called particles (or atoms). These tiny particles are always moving. Legos can model the particles in matter.	When Legos are connected in a block they are like the particles in a solid because they are close together, they have a definite shape, and you can't put your hand through them. Legos can model a liquid when they are disconnected because they fill up a container, they pour, and you can put your hand through a liquid.	When the ice cream was a liquid the particles were farther apart and loosely connected. When the ice cream was a solid the particles were closer together and had a stronger connection.

EXAMINING STUDENT WORK

Pay attention to student conversations as they build their Lego models. Do they understand that the Legos represent the invisible particles that make up matter? Can they distinguish between the arrangement of particles in a solid and a liquid? Do they conceptualize that the particles themselves don't change between solids and liquids - rather the interactions between the particles change?

LESSON REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

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- *The task about ______ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed _____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The summary table tool allowed students to…*
- *Creating a list of initial ideas allowed students to...*

Overall, reflecting on task, talk, and tools together:

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Group Directions
Modeling Particles with Legos

1. Imagine that each Lego is a tiny particle of matter.
2. Organize the Legos so they are arranged like the particles in a solid.
3. Put the "solid" Legos into a container. What happens to the shape of the "solid".
4. Try to pour the "solid" Legos. Do they pour?
5. Can you put your hand through the Lego particles?
6. Record observations.
7. Repeat for organizing Legos like the particles in a liquid.

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5. Can you put your hand through the Lego particles?
6. Record observations.
7. Repeat for organizing Legos like the particles in a liquid.

Modeling with Legos Student Data Sheet

Name: _________________________ **Name:** _______________________ **Date:** ____

	Particles in a Solid	**Particles in a Liquid**
Drawing of Lego particles		
Definite shape or shape of the container?	Definite shape / Shape of the container	Definite shape / Shape of the container
Does it pour?	Yes / No	Yes / No
Can your hand pass through easily?	Yes / No	Yes / No

Lesson 6: Hot and Cold Water

OBJECTIVES AND OVERVIEW

Students will observe the effect of hot and cold water on a drop of food coloring and make connections between the movement of the food coloring and the movement of the particles in the water. Students will determine the effects of temperature on the particle movement in water.

Focus Question: What happens to the water particles when water is heated or cooled?

- Students will observe that food coloring spreads more quickly in warm water than cool water.
- Students will make connections between the spreading of food coloring and the movement of water particles.

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MATERIALS

For the class:

- Video example: https://www.youtube.com/watch?v=YbhwXSv9rk4&feature=youtu.be
- Summary Table

For the Teacher Demonstration:

- Thermometer
- Food coloring
- Hot plate
- Heat proof bowl
- 100 mL cold water (about 65°F)
- 100 mL hot water (about 100°F)
- 2 clear containers
- Timer

Per student:

- Data sheet

Hot and Cold Water Data Sheet

Name: ____________

	Hot Water	Cold Water
Temperature	_____°F	_____°F
[illegible]		
[illegible]		
Observations	The food coloring spread...	The food coloring spread...

SAFETY ALERT!

The hot water temperature should not exceed 100°F in order to prevent any serious injury. Remind students that the water is hot and to be cautious when using it to avoid spilling the hot liquid.

PREPARATION

30 minutes

- ➢ Preview the video example and decide when to ask students to record their observations. It may be easiest to ask students to record their observations from a video clip that can be paused.
- ➢ Decide if/how the teacher demonstration will be video recorded.
- ➢ Review the demonstration procedure and identify tasks that can be assigned to students.
- ➢ Determine the source of hot and cold water. A hot pot can be used to warm the water (be sure to keep the temperature at or below 100), and ice can be added to the cold water (be sure all of the ice has melted before food coloring is added).
- ➢ Assemble the materials needed to conduct the activity.

PROCEDURE - PART 1

1. **Activate prior knowledge and experiences (whole class)**

   Have students look at the summary chart from lesson 5.

   Remind students what they did, something like: *Remember when we learned that everything is made up of little particles that we can't see? You acted like the particles in a solid by standing close together and not moving much. You then acted like the particles in a liquid by standing farther apart and moving more. You also used Legos to model particles and arranged them into a solid and then a liquid.*

   Tell students that today they will be investigating how temperature affects the movement of the particles.

   Introduce the **Focus Question: What happens to the water particles when water is heated or cooled?**

2. **Provide information to leverage during the activity (whole class)**

   Explain that students cannot see the particles in water, but they can observe their motion by observing the movement of food coloring in the water. When the particles in water are moving faster, the food dye will spread through the water faster. When the particles in water are moving more slowly, the food dye will take longer to color the water.

Turn-and-Talk

What will happen to the food coloring in the hot water? What will happen to the food coloring in cold water?

Teacher Decision Point

Decide if students will record their observations during the demonstration, after the demonstration, or when watching the video example.

NOTE: It may be easier for students to draw their observations if a picture is taken for students to use as a reference.

3. **Getting the activity started (whole class)**

   Explain to students that you will be adding a drop of food coloring to a container of hot water and to a container of cold water. Have students turn-and-talk about their predictions for what will happen when the food coloring is added to each container of water.

   Teacher will:
   1. Measure 100 mL of hot water and pour it into a clear cup.
   2. Use a thermometer to measure the temperature of the hot water.
   3. Measure 100 mL of cold water and pour it into a clear cup.
   4. Use a thermometer to find the temperature of the cold water.
   5. Write down the temperature on the data sheet.
   6. Add one drop of food coloring to the hot water.
   7. Add one drop of food coloring to the cold water.
   8. Start the timer.
   9. Draw the food coloring in the hot water and cold water at 15 seconds.
   10. Draw the food coloring in the hot water and cold water at 2 minutes.

Back-Pocket Questions

4. **Make observations and uncover patterns using questions (small groups)**

   Circulate as students draw their observations. Redirect students and help with the set up as needed.

   As students complete the activity, circulate and ask them questions about observations and patterns.

Back-pocket Questions:
- What does the spreading of the food coloring tell us about what is happening in the water that we cannot see?
- How does the temperature of the water affect the movement of the particles in the water?

Public Record

Summary Table

5. **Connections to anchoring event (whole class)**

   Use information from the demonstration, student data sheets, and discussions to complete the observations and learning columns of the summary table. Have students think about how this could help them understand how the cream changed to ice cream.

Activity	*What did we observe?*	*What did we learn?*	*How does this help us understand why the cream changed to ice cream?*
Hot and Cold Water 	When food coloring was added to hot and cold water, it spread through the water.	Temperature affects how fast or slow the particles are moving in liquids. When water is hotter the particles are more active. I know this because I observed… The colder the water the less active the particles. I know this because...	At the beginning the particles in the cream were more active. But as the temperature begins to cool then the particles in the cream became less active. I know this because the temperature started at 68 F then changed to 22 F.

EXAMINING STUDENT WORK

Pay attention to student conversations as they build their Lego models. Do they understand that the Legos represent the invisible particles that make up matter? Can they distinguish between the arrangement of particles in a solid and a liquid? Do they conceptualize that the particles themselves don't change between solids and liquids - rather the interactions between the particles change?

LESSON REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**
   Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?
   - *The task of observing the demonstration and recording data helped students to/with…*
   - *The task about _______ relates to students' and/or their families' lives because...*

   Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?
   - *The students talked to each other during (name particular parts of lesson) which allowed students to…*
   - *During turn-and-talks, I observed _____ which makes me wonder if/how...*

   Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?
   - *The summary table tool allowed students to…*

   Overall, reflecting on task, talk, and tools together:
   - *Talk, task, and tools supported students to share their thinking because…*
   - *Overall, this combination of talk, task, and tools, allowed most/all students to...*

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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Hot and Cold Water Data Sheet

Name: ________________________ Name: ______________________ Date: ____

	Hot Water	Cold Water
Temperature	________°F	________°F
Drawing at 15 seconds		
Drawing at 2 minutes		
Observations	The food coloring spread... ______________________ ______________________ ______________________	The food coloring spread... ______________________ ______________________ ______________________

Lesson 7: Energy Matters

OBJECTIVES AND OVERVIEW

Students will receive just-in-time instruction about the effects of heat energy on temperature and particle movement. They will make the connection that particles move faster in warmer water and slower in cooler water and thus the particles in warmer water have more energy than the particles in colder water.

Focus Question: How might heat energy be part of the ice cream story?

- Students will use a video to gather information about energy and particle motion.
- Students will reason that when particles move slowly they have less energy and when they move quickly they have more energy.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING

This practice supports on-going changes in student thinking by (1) introducing ideas to reason with, (2) engaging with data or observations, and (3) using knowledge to revise models or explanations. For more, visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

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

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Obtaining, Evaluating, and Communicating Information Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).	**PS1.B: Chemical Reactions** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	**Cause and Effect** Events have causes that generate observable patterns. (2-PS1-4)

Common Core Connections:
CCSS.ELA-LITERACY.RL.1.1: Ask and answer questions about key details in a text.

MATERIALS

For the class:

- [**Heat Energy Video**](https://www.turtlediary.com/video/heat-energy.html): https://www.turtlediary.com/video/heat-energy.html

  

- Summary Chart

PREPARATION

15 minutes

➢ Watch “Heat Energy Video for Kids” and decide where to ask students to make connections between the video and the ice cream story.

PROCEDURE

1. **Activate prior knowledge and experiences (whole class)**

   Have students look at the summary chart from lesson 6.

   Remind students what they did, something like: *Remember when we added food coloring to hot and cold water and watched the food coloring spread? We observed that the food coloring spread more quickly in the hot water than the cold water. We reasoned that the particles in hot water are moving faster than the particles in cold water.*

   Tell students that today they will watch a video and learn about energy. Introduce the **Focus Question: How might heat energy be part of the ice cream story?**

Just-in-time Instruction

2. **Provide information to leverage during the activity (whole class)**

   Have students watch “Heat Energy Video for Kids.” Review the key content with students, pausing to ask students to make connections between the content and the phenomenon.

   Possible video comprehension questions:
   - What is heat?
   - If particles are moving slowly, do they have more or less energy than particles moving quickly?
   - How does heat energy travel?
   - What is the difference between temperature and energy?

Public Record

Summary Table

3. Connections to anchoring event (whole class)

Use information from the video to complete the observations and learning columns of the summary table. Have students think about how this could help them understand how the cream changed to ice cream.

Activity	***What did we observe?***	***What did we learn?***	***How does this help us understand why the cream changed to ice cream?***
Energy Matters 	*From the video:* Energy is the movement of particles that make up matter. Temperature is a measurement of heat energy.	If particles are moving slowly there is less energy. Particles in a hot pot have lots of energy and move a lot. Heat energy transfers from hotter substances to colder substances. Temperature tells us how hot or cold something is.	Energy is part of the ice cream story. Heat or "thermal energy" is part of the ice cream story which causes the ice to melt. The heat source in our system is from the cream

EXAMINING STUDENT WORK

Pay attention to student connections between the information in the video and the ice cream story. Do they understand that heat is a measurement of particle movement? Do they conceptualize that the particles in matter move due to heat energy? Can they describe the transfer of heat energy?

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

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LESSON REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of watching a video to gather critical information helped students to/with…*
- *The task about _______ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed _____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The summary table tool allowed students to…*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to...*

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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Lesson 8: Melting Ice in my Hand

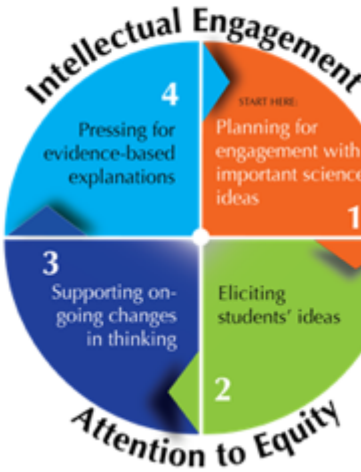
OBJECTIVES AND OVERVIEW

Students will hold ice in their hand and make observations as the ice cube melts. Students will then use their observations and what they've learned to create a model of the flow of heat energy between their hand and the ice cubes.

Focus Question: How might heat energy transfer be part of the ice cream story?

- Students will make and record observations about the process of an ice cube melting in their hand.
- Students will create a model of the flow of heat energy between their hand and an ice cube.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING



This practice supports on-going changes in student thinking by (1) introducing ideas to reason with, (2) engaging with data or observations, and (3) using knowledge to revise models or explanations. For more, visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

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

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Obtaining, Evaluating, and Communicating Information Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).	**PS1.B: Chemical Reactions** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	**Cause and Effect** Events have causes that generate observable patterns. (2-PS1-4)

MATERIALS

For the class:

- Melting Ice Particle Model Video: https://drive.google.com/file/d/0B03hrQRfIEWrV1VaRGxTRzk1V3M/view
- Summary Chart

Per student pair:

- Ice Melting Observation sheet


- Two ice cubes
- Paper towels

Note: *There are two versions of the Ice Melting Observation Sheet - one with more scaffolding and one with less. Decide which version will be most appropriate for your students.*

PREPARATION

15 minutes

➢ Prepare ice cubes for each student.
➢ Determine an accessible location to store the ice until it is ready to be used by the students.
➢ View Ice Melting Particle Model video: https://drive.google.com/file/d/0B03hrQRfIEWrV1VaRGxTRzk1V3M/view

PROCEDURE

1. **Activate prior knowledge and experiences (whole class)**

   Have students look at the summary chart from lesson 7.

   Remind students what they did, something like: "*Remember when we watched the video about heat energy? We learned that energy is the movement of particles. This means that when particles are moving faster, they have more energy. We also learned that heat energy moves, or transfers, in one direction."*

   Tell students that today they will make observations as they hold an ice cube in their hand. Introduce the **Focus Question: How might heat energy transfer be part of the ice cream story?**

2. Getting the activity started (whole class)

Explain to students that they will hold the ice cube in their hand, make observations, and then create a model to explain the flow of heat energy.. Quickly go through the directions so each student group knows what to do with the materials.

Students will:
1. Hold an ice cube in their hand for a few minutes.
2. Make observations and record them on the data sheet.
3. Use the paper towels to clean up after the activity.
4. Complete the model showing the flow of heat energy.

3. Provide information to leverage during the activity (whole class)

As the students are completing the ice melting activity, gather their attention to view the Melting Ice Particle Model Video. As the video is playing, explain that students are watching a model of particle movement as ice is melting.

Ask for volunteers to make observations about the particle movement during the process of ice melting.

Explain to students that they will now be recording their observations and creating their model to show the flow of heat energy when the ice cube melted in their hand.

Back-Pocket Questions

4. Make observations and uncover patterns using questions (small groups)

Circulate as students set up the materials and make observations. Redirect students and help with the set up as needed.

As students complete the activity, circulate and ask them questions about observations and patterns.

Make sure students are recording observations in their data table.

Back-pocket Questions:
- What are the particles in the ice doing?
- What are the particles in your hand doing?
- Where is the energy in this design?
- How is the energy moving?
- How is this similar to the ice cream story?

Public Record

Summary Table

5. Connections to anchoring event (whole class)

Use information from the activity to complete the observations and learning columns of the summary table. Have students think about how this could help them understand how the cream changed to ice cream.

Activity	*What did we observe?*	*What did we learn?*	*How does this help us understand why the cream changed to ice cream?*
Melting Ice in my Hand 	The ice felt cold. The ice melted in my hand.	The heat from my hand made the ice melt. The heat energy traveled from my hand to the ice.	The ice in the bag made the cream feel colder because heat from the cream moved to the ice.

EXAMINING STUDENT WORK

Pay attention to student conversations as they make observations and create their heat flow models.. Do they understand that their hand is the source of heat energy that causes the ice to melt? Can they apply that information to the ice cream story?

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

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LESSON REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

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Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed _____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The modeling tool allowed students to...*
- *The summary table tool allowed students to…*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to...*

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- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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Melting Ice in my Hand

Name: ______________________ **Name:** ______________________ **Date:** ___

Observations:

At first, the ice cube was in my hand.

It looked like: ________________

____

It felt like: __________________

____

After a few minutes:

It looked like:_________________

____

It felt like: ___________________

______________________________.

I showed heat energy in my drawing by:

____

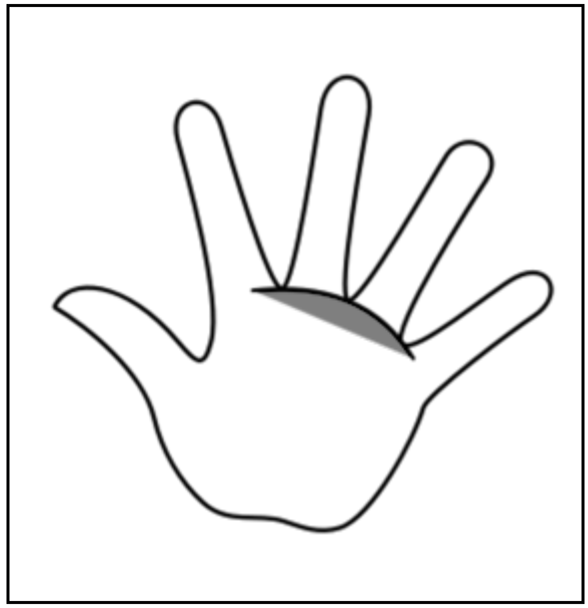
____

The heat energy transferred from:

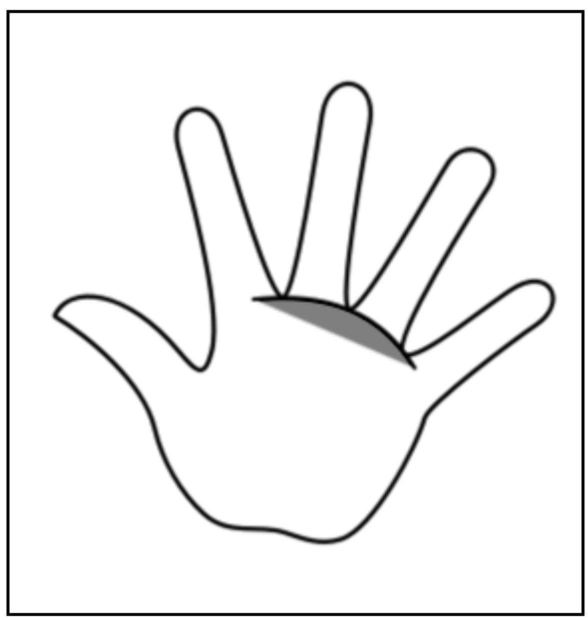
____________________________ to

______________________________.

Before:



After:



Melting Ice in my Hand

Name: ______________________ Name: _____________________ Date: ___

Observations:	Before:
	After:

Lesson 9: Reversible and Irreversible Changes

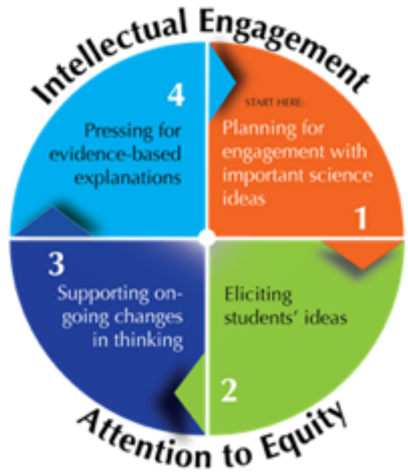
OBJECTIVES AND OVERVIEW

Students will plan and conduct an investigation by heating and cooling a variety of materials. They will observe changes caused by heating and cooling and observe how heat energy moves and changes matter. Finally, students will construct an argument with evidence that some changes caused by heating or cooling can be reversed while others cannot.

Focus Question: What are some examples of reversible and irreversible changes caused by heating and cooling?

- Students will observe changes caused by heating and cooling.
- Students will use evidence to determine examples of reversible and irreversible changes caused by heating or cooling.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING



This practice supports on-going changes in student thinking by (1) introducing ideas to reason with, (2) engaging with data or observations, and (3) using knowledge to revise models or explanations. For more, visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

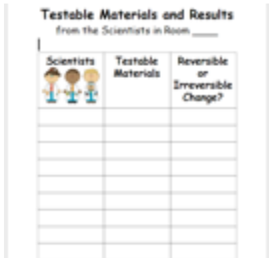
PE 2-PS1-4: Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
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.(2-PS1-1)	**PS1.B: Chemical Reactions** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	**Cause and Effect** Events have causes that generate observable patterns. (2-PS1-4) Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2) **Energy and Matter** Objects may break into smaller pieces and be put together into larger pieces, or change shapes. (2-PS1-3)

MATERIALS

For the class:

- Class Poster of Testable Materials and Results



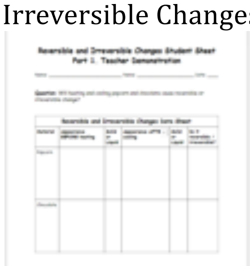
- Summary Chart

For the demonstration:

- Popcorn kernels
- Air popcorn popper
- Chocolate Chips
- Hot Plate
- Heat Proof Bowl with water
- Plastic Bag
- Tongs

For student groups:

- "Reversible and Irreversible Changes Student Sheet"



Note: You will need to determine the amount of materials needed based on the selections by student groups. Try to ensure that each substance is tested by at least one group.

- Gummy worms
- Sugar cubes
- Wax
- Butter
- Bread
- Toaster (*not provided in a kit*)
- Hot plate
- Heat proof bowl
- Plastic bag
- Plate

SAFETY ALERT!

Heating equipment can cause burn injuries. Be sure to warn students of the dangers. As well, only adults should operate the heating devices.

SAFETY ALERT!

Check with the school nurse about food allergies in the event that students would like to the popcorn, chocolate chips, or their testable substance.

PREPARATION

30 minutes

- ➢ Assemble the materials needed to conduct the lab.

Note: You will not know the exact amounts of materials until after Day 1 when the students plan their investigation.

- ➢ Determine a safety plan for the use of heating equipment, including speaking with the school nurse about what to do in case of an injury.
- ➢ Designate an adult-only heating station.

PROCEDURE - DAY 1

1. Activate prior knowledge and experiences (whole class)

Have students look at the summary chart from lesson 8.

Remind students what they did, something like: *Remember when we made observations as an ice cube melted in our hand? We learned about how heat energy moves from warmer to cold. The heat energy caused the ice cube to melt and change from a solid to a liquid. We also know that if we put water in the freezer it will become solid ice again. This is an example of a reversible change.*

Tell students that today they will be investigating a few materials to find out if heating and cooling them causes a change that is reversible or irreversible. Introduce the **Focus Question: What are some examples of reversible or irreversible changes caused by heating and cooling?**

Just-in-time Instruction

2. Provide information to leverage during the activity (whole class)

Introduce two new terms for today's lesson that students can use to describe changes caused by heating and cooling: reversible and irreversible. Use the box below to introduce the terms.

REVERSIBLE and IRREVERSIBLE

CHANGES

In a **reversible change** a material turns into something that looks and feels different. But then it **CAN** be changed back to its original form.

In an **irreversible change** the material **CANNOT** be changed back to its original form. The material looks and feels different and this change is permanent.

3. **Getting the activity started (whole class)**

   Tell students that today they will be making observations about changes caused by heating and cooling two different substances: chocolate and popcorn. Explain that you will first do a demonstration with the two substances.

4. Making observations and uncovering patterns (whole class)

Show students the popcorn kernels. Ask them:

- What color is it?
- What does it look like?
- How does it feel? (have two students feel and report out)
- Is it a solid or a liquid? How do we know?

Turn-and-Talk

What will happen when the kernels are heated? What will happen with the chocolate chips are heated?

Pass out “Reversible and Irreversible Changes Student Sheet” Day 1. Ask students to complete their observations for popcorn before heating.

Next, show students the chocolate chips. Ask them:

- What color is it?
- What does it look like?
- How does it feel? (have two students feel and report out)
- Is it a solid or a liquid? How do we know?

Ask students to complete their observations for chocolate before heating.

Explain to students that you will be heating the popcorn kernels in the popcorn popper and heating the chocolate chips by putting them in a plastic bag and submerging that bag in the crock pots hot water.

Ask students to turn-and-talk to their neighbor and make predictions about what they think will happen after the kernels and chips are heated.

Heat the popcorn kernels in the air popper and heat the chocolate chips by putting them in a plastic bag and submerging that plastic bag in the hot water in the crock pot. Wait until the popcorn kernels pop to popcorn and the chocolate chips melt.

Turn-and-Talk

What will happen when the kernels are cooled? What will happen with the chocolate chips are cooled? Do you think the changes will be reversible or irreversible?

Hold up the popcorn and ask for students to make observations.

- What color is it?
- What does it look like?
- How does it feel? (have two students feel and report out)
- Is it a solid or a liquid? How do we know?

Hold up the melted chocolate and ask for students to make observations.

- What color is it?
- What does it look like?
- How does it feel? (have two students feel and report out)
- Is it a solid or a liquid? How do we know?

Next, explain that you will be putting the materials in the freezer to cool. They will be able to make their observations during the next class lesson. Ask students to turn-and-talk to their neighbor and make predictions about what they think will happen after the kernels and chips are cooled. Do they think the changes will be reversible or irreversible? Ask students to share out their predictions with the class.

Optional: Allow students to eat the popcorn and chocolate chips. Only 1 or 2 pieces of popcorn need to be frozen and only 1 or 2 chocolate chips need to be melted. The rest can be distributed for student consumption.

5. Closure and preparation for day 2

Explain to students that for the next lesson they will be choosing a substance to test and then planning and conducting their investigation.

PROCEDURE - DAY 2

Turn-and-Talk

Do you think the popcorn and chocolate chip had a reversible or irreversible change? Why do you think this?

1. **Activate prior knowledge (whole class)**

   Remind students what they did. Say something like: *Remember when we made observations about a popcorn kernel and chocolate chips? Then we heated the two substances and noticed how they changed. Finally, we cooled the two substances in the freezer to find out if their changes from heating are reversible or irreversible.*

   Have students turn-and-talk about the question: **Do you think the popcorn and chocolate chip had a reversible or irreversible change? Why do you think this?**

   Tell students that today they will be observing the cooled popcorn and chocolate chip.

2. **Making observations and uncovering patterns from the previous lesson (whole class)**

   Show students the cooled popcorn. Have students verbally share their observations about popcorn. Ask them:
   - What color is it?
   - What does it look like?
   - How does it feel? (have two students feel and report out)
   - Is it a solid or a liquid? How do we know?
   - Was the change reversible or irreversible? How do we know?

   Ask students to complete their observations for popcorn after cooling.

   Show students the cooled chocolate chip. Have students verbally share their observations about the chocolate chip. Ask them:
   - What color is it?
   - What does it look like?
   - How does it feel? (have two students feel and report out)
   - Is it a solid or a liquid? How do we know?
   - Was the change reversible or irreversible? How do we know?

   Ask students to complete their observations for popcorn after cooling.

3. **Getting the activity started (whole class)**

   For the next part of the lesson, explain that students will be choosing a substance to test and planning their own investigation. Introduce the **Focus Question: How can I plan and set up an investigation to answer a question?**

   Hold up the possible items that students can choose to test:
   - Sugar cube
   - Gummy worm
   - Bread
   - Butter
   - Wax

   Explain that student groups will get to choose one of these substances to test. They will be heating and cooling their substance and making observations to find out if the change is reversible or irreversible.

4. **Guiding the investigation planning (whole class)**

Turn-and-Talk

What will be the best heating tool to test our substance?

Pass out the "Reversible and Irreversible Changes Student Worksheet" Day 2.

Ask student pairs to decide on a substance to test and to record their decision on their planning sheet. *NOTE: Students will not be operating the heating devices – this is only appropriate for an adult.*

Guide the students through the first page of the worksheet including the question and prediction.

Turn-and-Talk

What are the steps we need to complete in order to answer our question?

For the materials section, show students the heating station in the classroom:

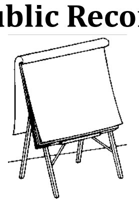
- Toaster
- Hot plate

Explain that scientists choose the best materials to complete their specific investigation. Have student groups turn-and-talk about which heating device would be best suited for their investigation. Next, show students the different containers and have them chose the most appropriate. Students should circle one material from each section on their student worksheet.

For the procedure section, have students turn-and-talk with their partners to complete the information that is specific to their investigation. Explain that each group may be testing a different material in a different manner but it is important that the procedure clearly outline the steps to complete the investigation.

5. **Wrapping up (whole class)**

Public Record



Class Tests

Circulate as students are completing their planning worksheet and redirect as necessary. As well, make note of what each group is planning to test.

Record the information on a poster displayed in a visible location.

Scientists	***Testable Material***	***Reversible or Irreversible Change?***

PROCEDURE - DAY 3

1. **Activate prior knowledge (whole class)**

   Remind students what they did. Say something like: *During our last class you worked with a partner to plan an investigation. Today you will get to conduct your investigation.*

   FOCUS QUESTION: Will our substance have a reversible or irreversible change after it is heated and cooled?

2. **Getting the activity started (whole class)**

   Explain to students that they will use their planning sheet from day 2 to guide their investigation. Remind students to wait until an adult can heat their substance.

Back-Pocket Questions

3. **Make observations and uncover patterns using questions (small groups)**

   Circulate as students set up the materials and make observations. Redirect students and help with the set up as needed.

   As students complete the activity, circulate (or while at the heating station) and ask them questions about observations and patterns.

   Make sure students are recording observations in their data table.

   Back-pocket Questions:
   - How is the heat energy flowing in your investigation?
   - What are the particles doing in your testable material before heating?
   - What will the particles in your testable material be doing after it is heated?

4. **Clean-up**

   Have students cool their substance in the freezer until the next lesson.

   Ask students to clean-up all of their materials.

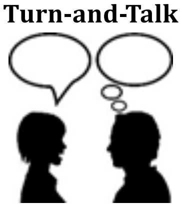
PROCEDURE - DAY 4

1. **Activate prior knowledge (whole class)**

   Remind students what they did in the last meeting. Say something like:
   During our last class you worked with a partner to conduct your investigation. You made and recorded observations and then heated your substance. Finally, you allowed it to cool in the freezer. Today, you will complete your data, and then create a model to show the transfer of heat energy in your investigation.

   FOCUS QUESTION: When our substance was heated and cooled, how did the heat energy move? Was the change reversible or irreversible?

Turn-and-Talk



Is our substance a solid or liquid? What the change reversible or irreversible? How can we tell?

2. **Getting the activity started (small groups)**

   Pass out the student materials from the freezer and ask students to complete their data chart from the last lesson. Have them turn-and-talk about the appearance of their material, is it a solid or liquid, and was the change reversible or irreversible?

Back-Pocket Questions

3. Make observations and uncover patterns using questions (small groups)

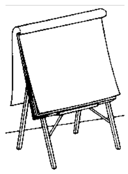
Instruct students to work with their partner to complete the conclusion section of the student worksheet.

As students complete the activity, circulate and ask them questions about observations and patterns.

Back-pocket Questions:

- How did the heat energy move when our substance was heated?
- How did the heat energy move when our substance was cooled?
- How does knowing about energy help us understand the particle movement?
- What is the connection between the energy and the state of matter?
- Are there any patterns between changes in state and reversibility of change?

Public Record



Class Test Results

Once students have determined if the change in their substance was reversible or irreversible, have them record their findings on the class chart.

Public Record

Summary Table

4. Connections to anchoring event (whole class)

Use information from the activity to complete the observations and learning columns of the summary table. Have students think about how this could help them understand how the cream changed to ice cream.

Activity	*What did we observe?*	*What did we learn?*	*How does this help us understand why the cream changed to ice cream?*
Reversible and Irreversible Changes 	The popcorn kernel was a solid after heating and ended as a solid after cooling. The chocolate chip was a liquid after heating and ended as a solid after cooling. My substance was a ____ after heating and ended as a____ after cooling.	Popcorn was an irreversible change. I know this because… Chocolate was a reversible change. I know this because… My substance had a ________ change. I know this because…	Ice cream changes are reversible because…. I know this because... This happens because the thermal energy from the environment transfers (move) to the ice cream which has less thermal energy. The particles become more excited and active, returning the ice cream to a liquid state. This is a reversible change because the particles are brought back to what they once were.

EXAMINING STUDENT WORK

Pay attention to student conversations as they make observations and create their heat flow models. Do they understand that heat energy flows from warmer to colder? Can they complete a model that illustrates heat energy flowing from the heating tool to their substance and then from their substance to the cold environment of the freezer? Can they apply that information to the ice cream story?

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

LESSON REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

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Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of planning and conducting an investigation helped students to/with…*
- *The task about _______ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed _____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The modeling tool allowed students to...*
- *The summary table tool allowed students to…*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to...*

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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Testable Materials and Results

from the Scientists in Room ____

Scientists 	Testable Materials	Reversible or Irreversible Change?

Reversible and Irreversible Changes Student Sheet
Part 1. Teacher Demonstration

Name: ____________________________ Name: ______________________ Date: ____

Question: Will heating and cooling popcorn and chocolate cause reversible or irreversible change?

Reversible and Irreversible Changes Data Sheet					
Material	**Appearance BEFORE heating**	**Solid or Liquid**	**Appearance AFTER cooling**	**Solid or Liquid**	**Is it reversible / irreversible?**
Popcorn					
Chocolate					

Reversible and Irreversible Changes Student Sheet
Part 2. Student Investigation Design

Name: ___________________________ Name: _____________________ Date: ____

Directions: Choose a substance to test with your partner to find out if heating and cooling causes a reversible or irreversible change.

Possible Substances:	Our substance to test:
• Sugar Cube • Gummy Worm • Bread • Butter • Wax	____

Question: Will heating and cooling _______________________________________ cause a

reversible or irreversible change?

Prediction: I think heating and cooling _________________________________ will cause a

_____________________________________ change. I think this because

____

____.

Materials: (Circle the materials you will need for your substance. Be sure to circle one material for each process).

Process	Material	Picture
Cooling	• Freezer	
Heating	• Hot Plate	
	• Toaster	
Container	• Bowl	
	• Plate	
	• Plastic Bag	
Safety	• Hot pad	

Procedure:

1. Heat the ______________________ using ___________________________.

2. Observe the changes.

3. Record the changes on the data sheet.

4. Cool the _______________________ using ___________________________.

5. Wait ________________________ for the ___________________________ to cool completely.

6. Observe the changes.

7. Record the changes on the data sheet.

Reversible and Irreversible Changes Student Sheet
Part 3. Student Observations and Models

Name: ______________________________ Name: _________________________ Date: ______

Data:

Reversible and Irreversible Changes Data Sheet					
Material	**Appearance BEFORE heating**	**Solid or Liquid**	**Appearance AFTER cooling**	**Solid or Liquid**	**Is it reversible / irreversible?**

<table>
<tr><th><u>Observations and Conclusions</u></th><th><u>Model of Heat Transfer</u></th></tr>
<tr><td rowspan="2">When the _______________________ was

heated and cooled, the change was

________________________________.

I know this because _______________

________________________________.

When the ___________________ was heated,

heat energy moved from the

__________________________ to the

________________________________.

When the ___________________ was cooled,

heat energy moved from the ______________

to the ________________________________.</td><td>Heating</td></tr>
<tr><td>Cooling</td></tr>
</table>

Reversible and Irreversible Changes Summary Chart
Sentence Starters

- Ice cream changes are reversible because….
- I know this because...
- This happens because the thermal energy (heat) from ______________________ transfers (moves) to the ______________________________ which has less thermal energy (heat).
- The particles become more excited and ____________________, returning the ice cream to a liquid state.

Lesson 10: The Secrets of Ice Cream

OBJECTIVES AND OVERVIEW

Students will read an article about the science of ice cream posted by the American Chemical Society. Students will use the article to identify information they know, new information, and testable information.

Focus Question: What have I learned, what could I test, and what new information can I learn to understand the ice cream story?

- Students will read an article about ice cream.
- Students will use the text to gather evidence to support or refute their initial ideas about the ice cream story.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING

This practice supports on-going changes in student thinking by (1) introducing ideas to reason with, (2) engaging with data or observations, and (3) using knowledge to revise models or explanations. For more, visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

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

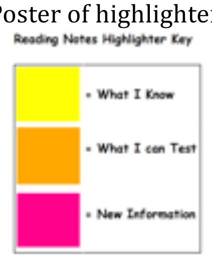
Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Obtaining, Evaluating, and Communicating Information Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).	**PS1.B: Chemical Reactions** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	**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. (2-PS1-3)

MATERIALS

For the class:

- Teacher copy of article: **https://www.acs.org/content/dam/acsorg/education/whatischemistry/adventuresinchemistry/secretscience/icecream/sss-icecream.pdf**

- Poster of highlighter key



- Whiteboard highlighters in 3 colors: yellow, orange, and pink

PREPARATION

15 minutes

- ➢ Read through "The Secrets of Ice Cream" and decide where to ask students to make connections between the reading and the activity.
- ➢ Decide how students will have access to the article (projected as a shared reading or read on individual student computers).

PROCEDURE

1. **Activate prior knowledge and experiences (whole class)**

   Have students look at the summary chart.

   Remind students what they've learned, something like: *As we've tried to understand the ice cream story, we have learned many things. We've learned about solids and liquids, how temperature affects melting and freezing, that matter is made of particles, and that these particles move and have energy.*

   Tell students that today they will be reading a science article about ice cream. Introduce the **Focus Question: What have I learned, what could I test, and what new information can I learn to understand the ice cream story?**

2. **Getting the activity started (whole class)**

   Explain to students that they will be using a highlighting reading strategy to identify 3 things when they are reading:
   - What they know
   - Testable questions
   - New information

   Show the "Reading Notes Highlighter Key" and pass out the 3 different colored highlighters to each student or student pair.

3. **Provide information to leverage during the final model (whole class)**

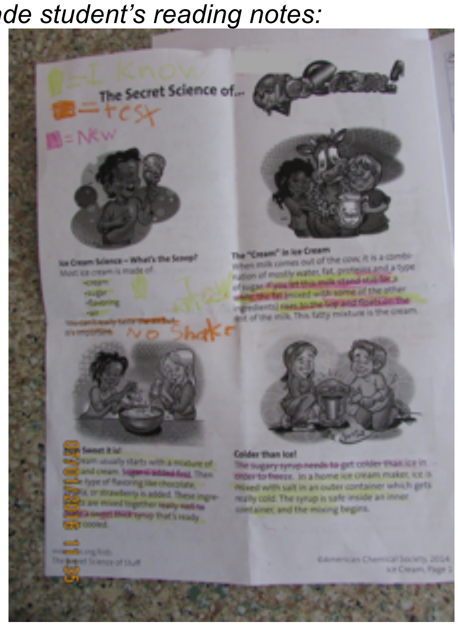
   Read "The Secrets of Ice Cream."

Reading Integration

Read about ice cream

Ask for student input as you read to add highlighting to the class document projected on the whiteboard.

Below is one example from K. Vaa of a 2nd grade student's reading notes:



Turn-and-Talk

What new information did you learn?
What ideas do you have for testing?

4. **Share observations and connections (small groups)**

   As students complete the reading activity, have them turn-and-talk with their partner about the information they highlighted. Ask them to focus specifically on new information they learned and any ideas for testing.

   Ask for student volunteers to come and present their note sheet under the document camera. Allow other students to comment and ask probing questions of each other.

Public Record

   Complete the observations portion of the summary table using student contributions.

Turn-and-Talk

How does the new information help us understand the ice cream story?

Public Record

Summary Table

5. Connections to anchoring event (whole class)

Ask students to turn-and-talk about how the new information can help us understand the ice cream story.

Use student responses to complete the final column in the summary table.

Activity	*What did we observe?*	*What did we learn?*	*How does this help us understand why the cream changed to ice cream?*
The Secrets of Ice Cream		There are air pockets in ice cream. All three states of matter exist in ice cream. When ice cream melts, the liquid ice cream fills the air pockets. When it refreezes it is less because there are fewer air pockets. Planning and carrying out investigations - possible tests: • What happens if there is no shaking? • What happens if you use different fatty creams? • Do all ice creams float?	Our ice cream has three states of matter. When we shake our ice cream we are adding air pockets. The water forms ice crystals making a solid.

EXAMINING STUDENT WORK

Pay attention to what students are highlighting. Is a significant amount of the content information they already knew? Can they identify testable questions? Are they able to label new information and can they relate that information to the ice cream story?

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

LESSON REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of highlighting different kinds of information helped students to/with…*
- *The task about ______ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed ____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The summary table tool allowed students to…*

Overall, reflecting on task, talk, and tools together:

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EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

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- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

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Reading Notes Highlighter Key

= What I Know

= What I can Test

= New Information

Lesson 11: Generating Evidence-Based Explanations

OBJECTIVES AND OVERVIEW

Students have been revising their thinking about the unit phenomenon over time in light of new experiences, observations, and sense making talk that they have had throughout the unit activities. In this lesson, students will pull together what they have learned in this unit and identify how their thinking has changed by revising their models and supporting changes with evidence.

Focus Question: How and why does the cream change?

- Students review and revise their models in light of new learning from unit activities to explain the phenomenon.
- Students write and draw a short evidence-based explanation for the phenomenon.

***Ambitious Science Teaching Framework:* PRESSING FOR EVIDENCE-BASED EXPLANATIONS**

This practice happens is the last third of the unit, but parts can be introduced at other times when students talk about evidence. This requires that several tools be available to students: 1.) their original models, 2.) an explanation checklist, 3.) the summary table, and 4.) a scaffolded guide to help students create, in writing and drawing, their final model. If you would like more information about these practices please visit: http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

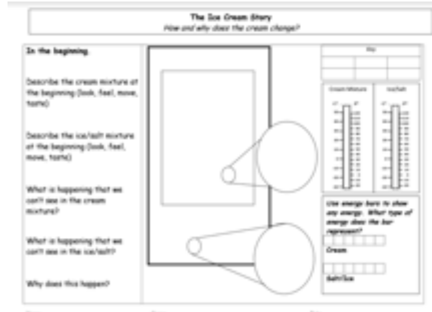
2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Constructing Explanations and Designing Solutions Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (2-PS1-3) **Engaging in Argument from Evidence** Construct an argument with evidence to support a claim. (2-PS1-4)	**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. (2-PS1-1) A great variety of objects can be built up from a small set of pieces. (2-PS1-3) **PS1.B: Chemical Reactions** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	**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. (2-PS1-3)

MATERIALS

For the class:
- Summary Table
- Chart Paper
- Markers
- Ice Cream Pictures
  - In the beginning
  - 5 minutes later
  - 30 minutes later

For each student pair:
- 1 blank Ice Cream Model



- Original model scaffolds (completed in pairs in lesson 1)
- Colored pens or pencils
- Previous student work from the unit

PROCEDURE: PART 1. Revising Models with Evidence

Present Visuals
Summary Chart

Turn-and-Talk

What ideas do we need to include in an explanation of the phenomenon?

Public Record

Explanation checklist

1. **GENERATE EXPLANATION CHECKLIST (WHOLE GROUP) - 10 mins**

   a. Remind students of the unit phenomenon using any charts and public records. **How and why did the cream change?**

   a. Ask students to think about what they have learned in this unit (encourage them to look at the summary table) and identify: What are the key pieces that we have to know in order to explain the phenomenon. Give private think time. Have students turn-and-talk.

   a. Share out some ideas and generate an explanation checklist on a chart paper with markers. This list might have items on it such as:

   Explanation checklist:

   We should…

   - Use our observations about the relationship between temperature and state of matter
   - Include knowledge of particles
   - Explain how energy moves

2. **STUDENTS UPDATE EXPLANATORY MODELS (Individual) - 25 min**

   a. Leave the explanation checklist on the board for student reference. Tell students they will have a chance to show all the new ideas they have about how and why the cream changed by completing a final model. They have acquired these new ideas because they have had so many experiences in this unit (point to the summary table).

   b. Show students the final model and explain what you expect to see in each part of it. Also, remind students that both students in the pair should be talking, drawing, and writing on the sheet.

   c. Point out the pictures of the ice cream at the 3 different stages (before, after 5 minutes, after 30 minutes). Explain to students that these pictures can be used as they complete each section of the model.

   d. *OPTIONAL: Select three areas in the classroom to represent the three ideas on the model. Ask students to go stand in the person's area they agree with. Students can talk in the groups about their thinking. Each group can share out their thinking to the class before groups begin working on the model.*

   e. Give students time to work in pairs to complete the model. Redirect students as needed to the explanation checklist, the summary table, or their prior work to help them make progress on their models.

Back Pocket Questions

As students work in pairs, prompt reasoning about gaps and contradictions in their models. These prompts or questions could help you do this:

- *"Can you tell me what role [Insert idea or concept] has in your explanation?"*
- *"How does this part about ________ fit with the rest of the model?"*
- *"How have you included this idea about ________ from the explanation checklist?"*
- *"I see you have drawn and labeled ________. How do you know it works like that? Have we done something in class on the summary table?"*

3. **PREPARE STUDENTS TO USE EVIDENCE**

   a. Have a pair share one claim they have made on their model so far. It should be a claim that we have evidence for so far from an activity or reading from the unit.

   b. Ask the class: What evidence do we have of this idea? Where can we look to remember what evidence we have?

   c. Demonstrate how to write evidence on a sticky note and put it on the model next to the claim.

   d. Give students 10 minutes to identify 1 claim on their model and write sticky notes about evidence. Each student in the pair should write one sticky note and share their evidence with their partner.

   e. As students work, circulate and look at how students are selecting evidence. If they are stuck, refer them to the summary table or their activity worksheets. If students only name the activity, put some sentence stems on the board to help get more about why this activity provided us with evidence for a certain idea or claim.

PART 2. Comparing Models & Adding Evidence

Talk Norms

Remind students about talk norms

1. **PUBLIC COMPARISON OF MODELS (whole group) - 20 mins**
   a. *Physically orient students toward each other.* Have students bring their model sheets to the gathering area and sit so students can see and hear each other easily and see the screen when students share work under the document camera.
   b. *Set the purpose of today's discussion:* Say something like: *We are coming together to see ways to represent ideas in models and how we use evidence to support our ideas. Give each other feedback by agreeing or disagreeing and saying why you think the evidence they picked supports their idea or if you think another piece of evidence from our summary table would be stronger. After the discussion you will have time to add more evidence or to clarify your ideas on your models.*

Whole Class Discussion

Collaboratively revise a model based on evidence

   c. *Allow students to use talk norms and lead and manage the talk:* Remind students of talk norms and encourage them to call on each other and not look to the teacher.
   d. Choose one pair to start the conversation and have them share one claim and the evidence they selected to support it. Encourage students to agree or disagree, in either case saying what evidence they used or would use and how it supports their idea. Students should be sharing work under the document cameras as they have a discussion. Peers could suggest changes to either their ideas or the evidence they selected.

NGSS Note: In Appendix F: Science and Engineering Practices, one performance of developing and using models for grades K-2 students is to develop a model based on evidence and then compare models to identify common features and differences. Students are mostly doing this in pairs for this lesson but this whole group discussion is another way to compare models.

2. **MAKE ADAPTATIONS TO MODELS (pairs/individuals) - 10 mins**
   a. Have students go back to working in their pair (or individually) and make changes to their models to clarify their ideas, add new ideas they heard during the discussion they agreed with, and to add or change the evidence they selected to support some of their claims.
   b. By the end of the lesson students should have drawn and written about their ideas to explain the phenomenon and have at least one sticky note with evidence to support one of their claims.

Quick Write

How has my thinking changed?

3. **HOW HAS MY THINKING CHANGED (individually) - 10 mins**
   a. Pass back the original models and let students look over them. As an exit ticket, have students write about how their thinking has changed in this unit.

      At first I thought… Now, I think…
      I used to think… Now, I know…
      Before I didn't know how… But, now, I learned that...

EXAMINING STUDENT WORK

Examine students' model revisions and see how their thinking has changed over the unit. Track changes in thinking on the What-How-Why rubric.

PLANNING NEXT STEPS

Using the ideas and questions you have heard from students during class decide what lesson(s) should come next. These lessons give students more information about ideas they shared to deepen their understanding or the lessons can help answer questions students posed. Additional lesson could be added or substituted based on the ideas and questions students have.

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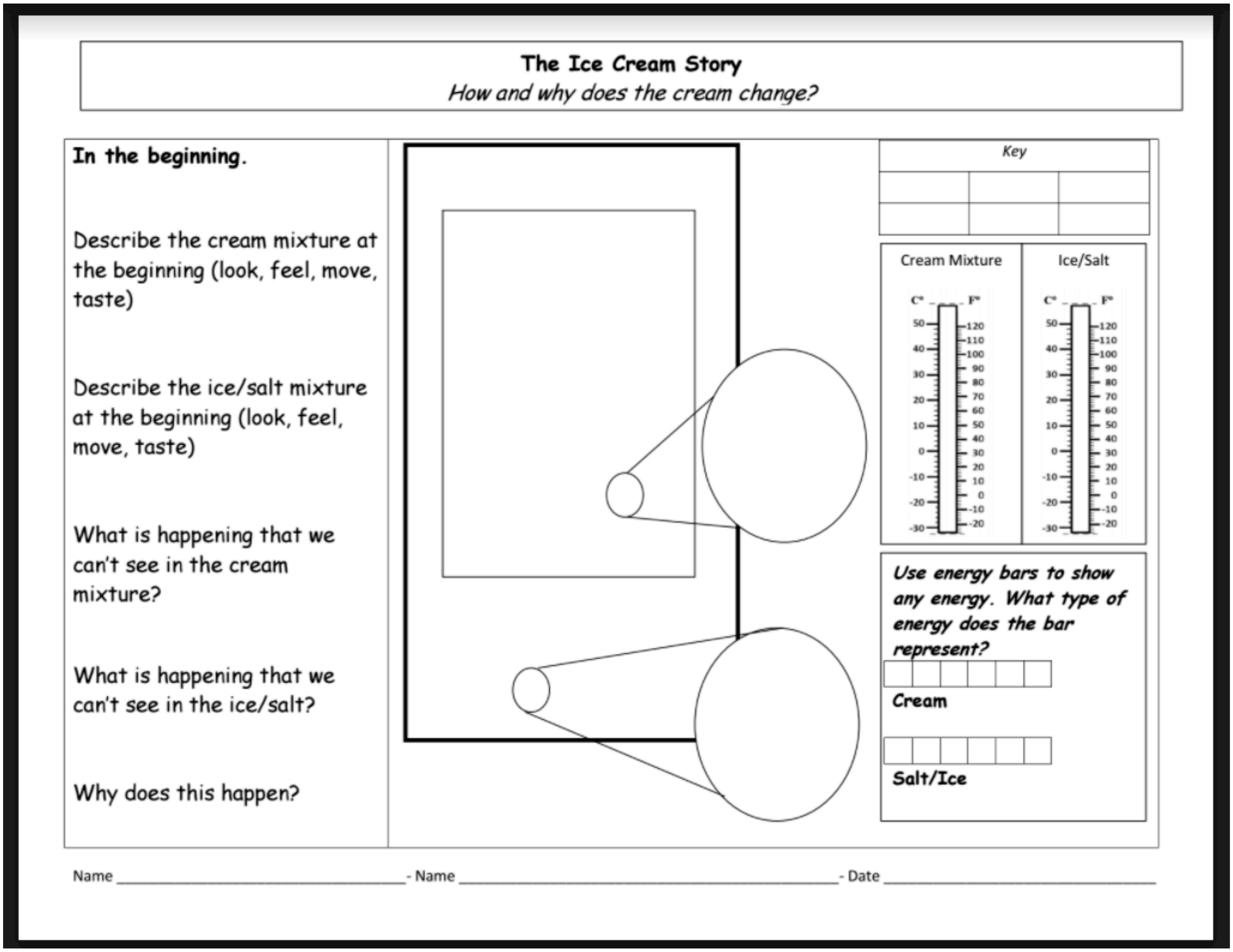
Ice Cream Final Model:



The Ice Cream Story

How and why does the cream change?

In the beginning.

Describe the cream mixture at the beginning (look, feel, move, taste)

Describe the ice/salt mixture at the beginning (look, feel, move, taste)

What is happening that we can't see in the cream mixture?

What is happening that we can't see in the ice/salt?

Why does this happen?

Key

Cream Mixture	Ice/Salt
C° F°	C° F°

Use energy bars to show any energy. What type of energy does the bar represent?

Cream

Salt/Ice

Name ______________________ - Name ______________________ - Date ______________________

5 minutes later.
The bag of cream is placed inside the gallon bag with salt and ice for 5 minutes.

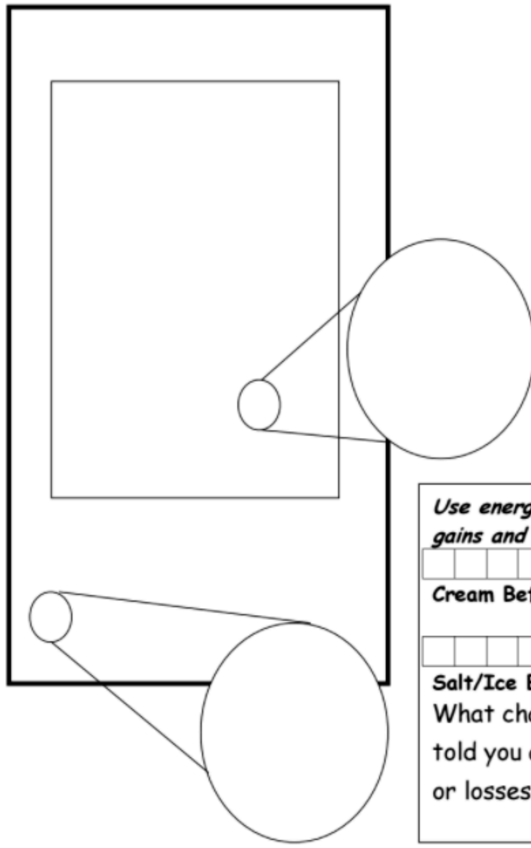
Describe the cream mixture now.

Describe the ice/salt now.

Where are changes happening? How do you know?

What do you think caused those changes?

Why does this happen?



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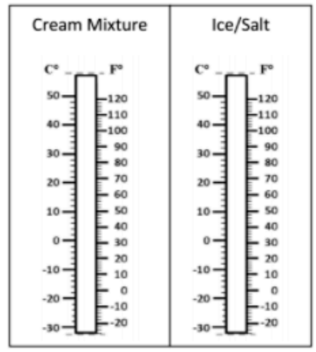


Use energy bars to show any energy gains and losses

Cream Before → Cream After

Salt/Ice Before → Salt/Ice After

What changes did you observe that told you about thermal energy gains or losses?

Name ______________________________ - Name ____ - Date ____________________________

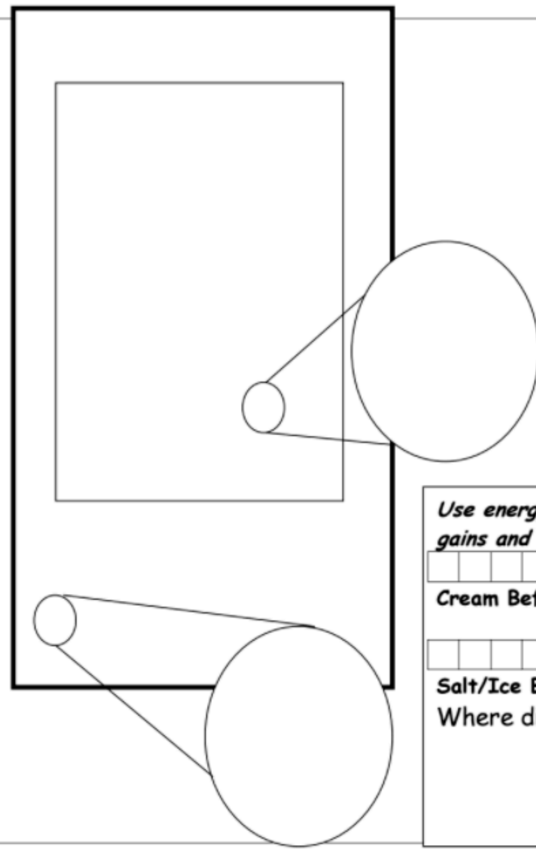
The cream mixture 30 minutes later

Describe the cream mixture now.

Describe the ice/salt now.

What happened?

What caused those changes?



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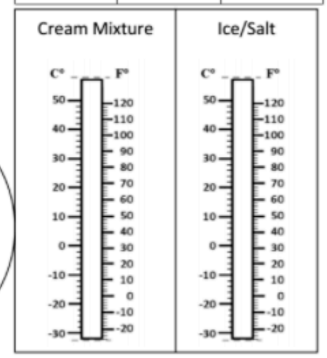


Use energy bars to show any energy gains and losses

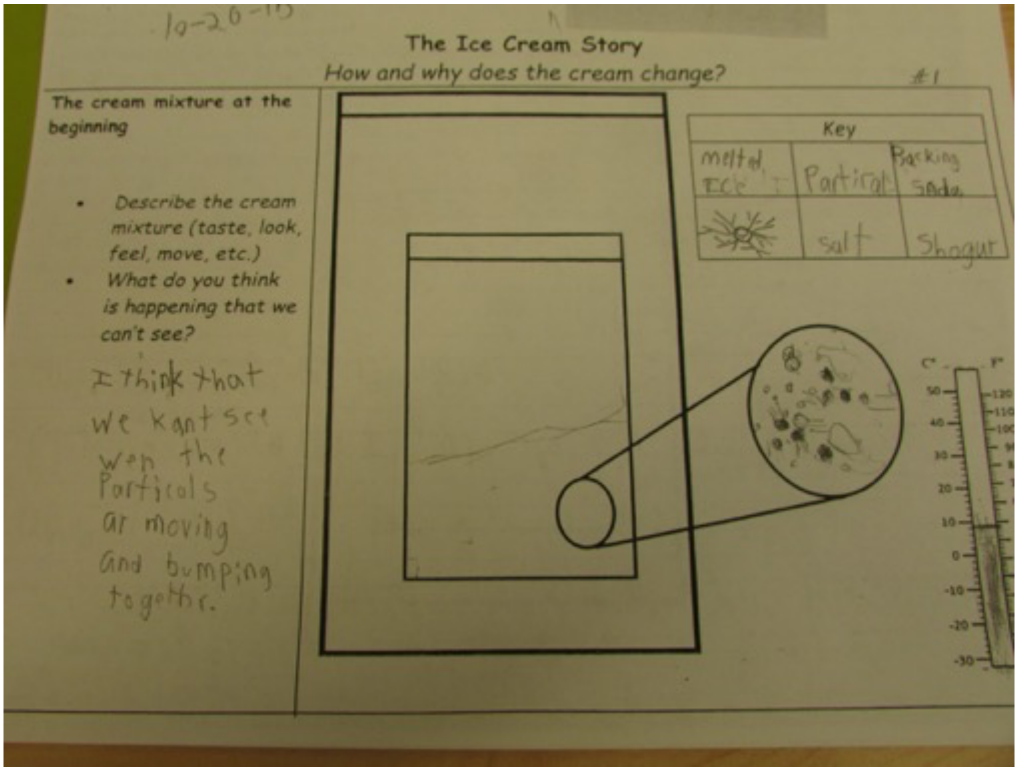
Cream Before → Cream After

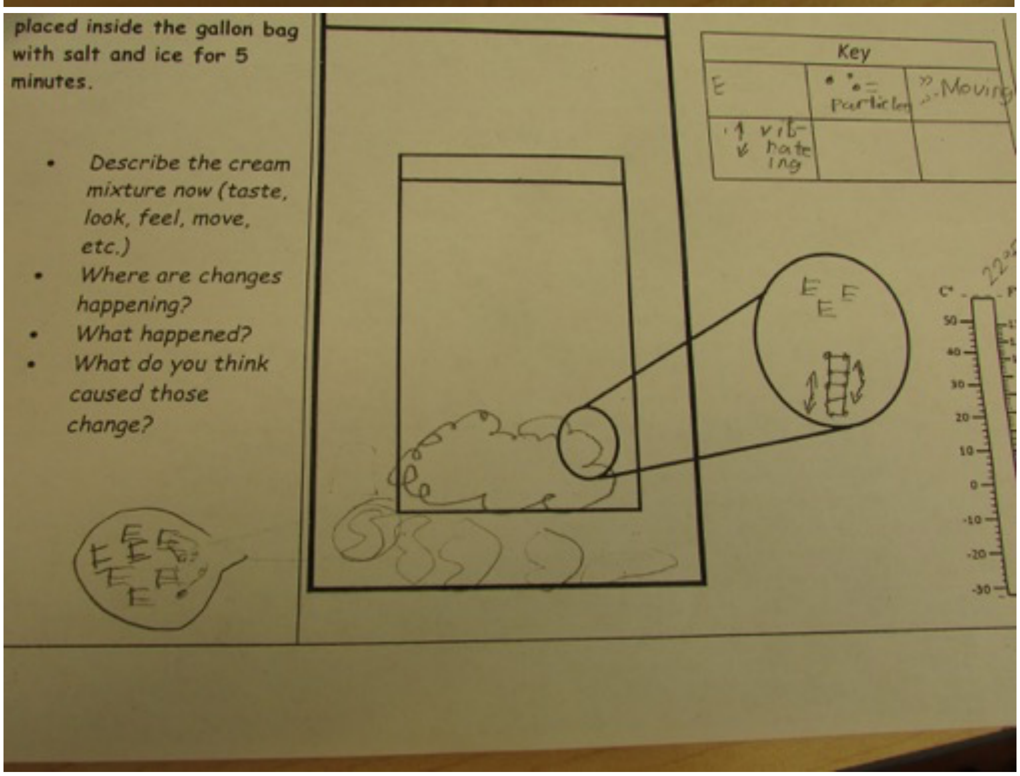
Salt/Ice Before → Salt/Ice After

Where did the thermal energy go?

Name ______________________ - Name ______________________ - Date ______________________

Below are examples of final models from K. Vaa's 2nd grade classroom:





Lesson 12: Feel the Heat

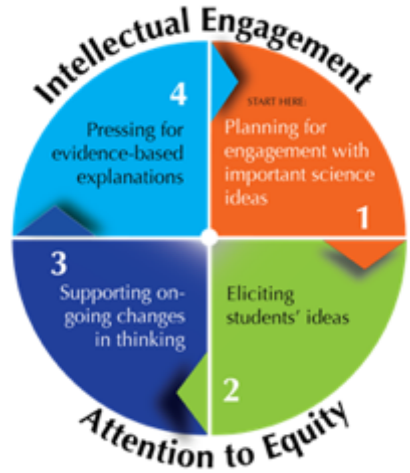
OBJECTIVES AND OVERVIEW

Students will investigate how different materials, aluminum foil, cotton socks, and Styrofoam, affect the transfer of thermal energy. They will then construct an argument with evidence that supports a claim that a material is a heat stopper. Finally, they will suggest a material that would be effective in slowing thermal energy transfer between the environment and their ice cream. *(This activity was modified from a similar Mystery Science activity).*

Focus Question: What materials are 'heat stoppers'? How can we prevent heat from melting our ice cream?

- Students will investigate a variety of materials to determine how they affect the transfer of thermal energy.
- Students will make a claim that a particular material is a heat stopper using evidence gained from the activity.

Ambitious Science Teaching: SUPPORTING ON-GOING CHANGES IN STUDENT THINKING



This practice supports on-going changes in student thinking by (1) introducing ideas to reason with, (2) engaging with data or observations, and (3) using knowledge to revise models or explanations. For more, visit http://AmbitiousScienceTeaching.org

NEXT GENERATION SCIENCE STANDARDS

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

Science & Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Cross-Cutting Concepts (CCC)
Analyzing and Interpreting Data Analyze data from tests of an object or tool to determine if it works as intended. (2-PS1-2)	**PS1.A: Structure and Properties of Matter** Different properties are suited to different purposes.	Simple tests can be designed to gather evidence to support or refute student ideas about causes. (2-PS1-2)

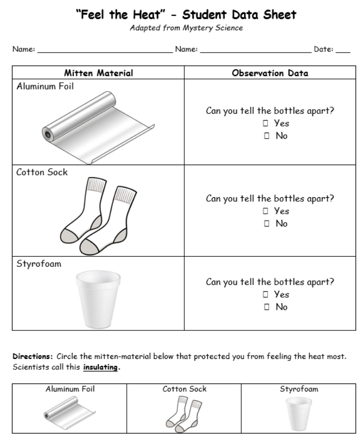
MATERIALS

For the class:

- Ice Cream Melting Video: https://www.youtube.com/watch?v=zzH4BtGcmTs
- Observations and Connections Sentence Starters
- Funnel

Per student group:

- A pair of socks
- Two 12 inch aluminum foil squares
- 2 Styrofoam cups
- 2 plastic bottles - one filled with hot water and one filled with cold water
- 2 "Feel the Heat" student worksheets



"Feel the Heat" - Student Data Sheet

Adapted from Mystery Science

Name: ______________ Name: ______________ Date: ___

Mitten Material	Observation Data
Aluminum Foil	Can you tell the bottles apart? ☐ Yes ☐ No
Cotton Sock	Can you tell the bottles apart? ☐ Yes ☐ No
Styrofoam	Can you tell the bottles apart? ☐ Yes ☐ No

Directions: Circle the mitten-material below that protected you from feeling the heat most. Scientists call this **insulating**.

Aluminum Foil	Cotton Sock	Styrofoam

PREPARATION

15 minutes

- Find a source of hot water.
  Materials Note: You can fill bottles an hour or two ahead of class if you have a cooler (or a cardboard box and a bath towel) to keep the water bottles hot.
  Materials Note: The difference in temperature between the hot water and the cold water has to be enough to feel easily with bare hands. You can use ice water and warm water or you can use very hot water and cool water. You just need to make sure there is a definite difference.

PROCEDURE

1. **Activate prior knowledge and experiences (whole class)**

Remind students about all that they have learned about how cream can change into ice cream and then back into cream. You could say something like: "*We have learned so much about the ice cream story! We have learned that all matter is made of particles, and that they particles are always moving. Particles with more movement have more energy and also a higher temperature. Energy can move between substances from objects with more energy (warmer) to objects with less energy (colder). Now we are going to apply all that amazing science knowledge we have to coming up with a solution to my melting ice cream.*

Revisit the original ice cream story below:

> I love ice cream but I don't always have ice cream in my house. Then I discovered I could make my own ice cream whenever I wanted. There are lots of different ways to make ice cream, but the one that intrigued me the most was Ice Cream Magic **What's the science behind the magic?**
>
> I didn't have the ice cream magic, but I did have the materials to make ice cream in a bag.
>
> One day I decided to make ice cream in a bag and take it with me to the park. The problem was that the park was 30 minutes away and this happened...Students begin with observing a video, Ice Cream Melt Time Lapse . How and why did it change back from a solid to a liquid?

Today we are going to explore **Focus Question: What materials are 'heat stoppers'? How can we prevent heat from melting our ice cream?**

2. **Getting the activity started (whole class)**

Turn and Talk

How will the heat energy move when we hold a bottle of hot water? How will the heat energy move when we hold a bottle of cold water?

Explain to students that they will test three different materials to determine how they each affect the transfer of heat energy (from warm to cold). The three materials will be: aluminum foil, cotton socks, and Styrofoam. Explain that they will use these materials to cover their hands to investigate how well they stop the heat when holding a hot water bottle and a cold water bottle.

Ask students to turn-and-talk about the questions: how will the heat energy move when we hold a bottle of hot water? How will the heat energy move when we hold a bottle of cold water?

Explain to students that they will test three different materials to find out how well they stop the heat. Quickly go through the directions so each student group knows what to do with the materials.

Students will:

1. Make two foil mittens.
2. Get your two bottles of water - one hot and one cold from the teacher.
3. Have one partner put on the aluminum foil mittens and close their eyes.
4. Hand the partner a bottle of hot water and a bottle of cold water, one by one. Can they tell the bottles apart?
5. Have the second partner put on the aluminum foil mittens and repeat steps 3 and 4.
6. Record your response on the worksheet.
7. Repeat steps 3-6 with the socks and then with the Styrofoam.

Reading Integration

Read about insulating materials

3. Provide information to leverage during the activity (whole class)

As the students are completing investigation, gather their attention to the explanation at the end of the procedure. As well, have students read the “Heat Stoppers” reading.

Back-Pocket Questions

4. Make observations and uncover patterns using questions (whole group)

Ask students to turn-and-talk about the following back-pocket questions:

Back-Pocket Questions:

- How did the heat energy move between your hand and the hot water bottle?
- How did the heat energy move between your hand and the cold water bottle?
- What do you think the particles look like in the aluminum vs the Styrofoam?
- What is happening in the Styrofoam that helps stop the heat?
- How can we apply what we have learned to our ice cream story?

After students have had a chance to talk to each other, ask for student volunteers to share their thinking.

5. Connections to anchoring event (small group)

Use information from the activity to complete the sentence starters relating to observations and connections to the anchoring event.

EXAMINING STUDENT WORK

Review student writing samples about their observations and connections. Do they understand that certain materials are better insulators than others? Can they apply that information to preventing the ice cream from melting?

LESSON REFLECTION

Teacher Reflection

Task, Talk, Tools, & Equity

Use the prompts to reflect on the lesson in order to track student thinking and make changes to improve future lessons. Keep a record of these reflections for your professional portfolio.

Keep a record of these reflections for your professional portfolio.

1. **TASK, TALK, & TOOLS**

Task. What was the nature of the task in this lesson? Overall, what was the cognitive load? How does the task relate to the students' lived experiences or funds of knowledge?

- *The task of making observations helped students to/with…*
- *The task about ______ relates to students' and/or their families' lives because...*

Talk. What was the nature of talk in this lesson? What structures and routines supported student participation in talk?

- *The students talked to each other during (name particular parts of lesson) which allowed students to…*
- *During turn-and-talks, I observed ____ which makes me wonder if/how...*

Tools. Tools scaffold student thinking and can house student ideas. Tools in this lesson included the model scaffold and public records/charts. How did tools support students to communicate their ideas?

- *The back-pocket questions tool allowed students to…*

Overall, reflecting on task, talk, and tools together:

- *Talk, task, and tools supported students to share their thinking because…*
- *Overall, this combination of talk, task, and tools, allowed most/all students to...*

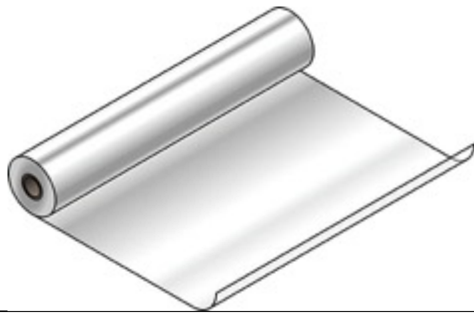
EQUITY. Describe one issue around equity that arose during this lesson. Consider change(s) to the next lesson to help address the issue. Here are some categories to help you name a specific issue of equity:

- *Developing relationships and forming an inclusive, trusting community*
- *Scaffolding for full participation in the culture and language of science*
- *Recognizing our own and others' worldviews and developing critical consciousness about our own assumptions and beliefs*
- *Addressing power dynamics (how a person is seem and responded to by others) to disrupt stereotypes and privilege*

"Feel the Heat" - Student Data Sheet

Adapted from Mystery Science

Name: ______________________________ Name: _________________________ Date: ___

Mitten Material	Observation Data
Aluminum Foil 	Can you tell the bottles apart? ☐ Yes ☐ No
Cotton Sock 	Can you tell the bottles apart? ☐ Yes ☐ No
Styrofoam 	Can you tell the bottles apart? ☐ Yes ☐ No

Directions: Circle the mitten-material below that protected you from feeling the heat most. Scientists call this **insulating**.

Aluminum Foil	Cotton Sock	Styrofoam
		

"Feel the Heat"
Observations and Connections

Name: ________________________ **Name:** _____________________ **Date:** ________

1. The material that stopped the heat from moving through the most was

   _________________________. I know this because ______________________

   ____.

2. The material that allowed the heat to travel the most was______________.

I know this because ____

____.

3. A material(s) that would be best suited to keep thermal energy from chang-

ing the ice cream to a liquid would be ___________________________________.

I think this because ____

____.

Group Directions
Testing Materials for Heat Transfer

1. Make two foil mittens.
2. Get your two bottles of water - one hot and one cold from the teacher.
3. Have one partner put on the aluminum foil mittens and close their eyes.
4. Hand the partner a bottle of hot water and a bottle of cold water, one by one. Can they tell the bottles apart?
5. Have the second partner put on the aluminum foil mittens and repeat steps 3 and 4.
6. Record your response on the worksheet.
7. Repeat steps 3-6 with the socks and then with the Styrofoam.