Changes: Heat and States of Matter: Grade 3

Lesson Overview

In this lesson, students will plan and conduct scientific investigations to determine how increases or decreases in heat change matter from one state to another.

Alignment

3.P.2A.3 Plan and conduct scientific investigations to determine how changes in heat (increase or decrease) change matter from one state to another (including melting, freezing, condensing, boiling and evaporating).

Science and Engineering Practices

3.S.1A.3 Plan and conduct scientific investigations to answer questions, test predictions and develop explanations: (1) formulate scientific questions and predict possible outcomes, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

3.S.1A.8 Obtain and evaluate informational texts, observations, data collected, or discussions to (1) generate and answer questions, (2) understand phenomena, (3) develop models, or (4) support explanations, claims, or designs. Communicate observations and explanations using the conventions and expectations of oral and written language.

Crosscutting Concepts (from the SDE instructional unit resources document)

1. Patterns: The National Research Council (2012) states, “observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them” (p. 84). If heat is added to water, the temperature will increase and it will eventually boil. If heat is removed, the water will cool down, but if enough heat is removed the water will eventually freeze.

2. Cause and effect: The National Research Council (2012) states, “mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts” (p. 84). When temperature is increased/decreased, matter changes from one state to another.

7. Stability and change: The National Research Council (2012) states, “for natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study” (p. 84). When temperature is increased/decreased, matter changes from one state to another.

ELA Inquiry Standards

Standard 1: Formulate relevant, self-generated questions based on interests and/or needs that can be investigated. 1.1 Formulate questions to focus thinking on an idea to narrow and direct further inquiry.

Standard 2: Transact with texts to formulate questions, propose explanations, and consider alternative views and multiple perspectives. 2.1 Explore topics of interest to formulate logical questions; build knowledge; generate possible explanations; consider alternative views.

Standard 4: Synthesize integrated information to share learning and/or take action. 4.1 Draw logical conclusions from relationships and patterns discovered during the inquiry process. 4.2 Reflect on findings to build deeper understanding and determine next steps. 4.3 Determine appropriate tools and develop plan to communicate findings and/or take informed action.

ELA Writing

Standard 2: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content

ELA Communication

Standard 1: Interact with others to explore ideas and concepts, communicate meaning, and develop logical interpretations through collaborative conversations; build upon the ideas of others to clearly express one’s own views while respecting diverse perspectives.

Connections

Content Area (2 or more) Connections

- Science
- Math

Content Connections

Elapsed time in math and changes in states of matter in science are connected in this lesson as students plan and conduct investigations to determine how increases and decreases in heat effect changes in states of matter.

Active Learning Strategies (for Purposeful Reading, Meaningful Writing, and Productive Dialogue)

Focused Listing, I Think, We Think, Paint the Picture , Partner Paired Reading

Computational Thinking

During this lesson students, plan and conduct investigations. This requires them to logically organize and analyze data. This is one of the CT characteristics.

Lesson Plan

Time Required – (Three 45 min. classes)

Disciplinary Vocabulary – (melting, freezing, condensing, boiling and evaporating)

Materials Needed:

- Freeze pops
- Rulers
- Materials and equipment for student designed investigations
- It's a Matter of Time handout
- Heat and Changes in States of Matter handout

Formative Assessment Strategies: Teacher feedback, questioning and observations during student engagements in: Focused Listing, I Think, We Think, Paint the Picture , and Partner Paired Reading.

Misconceptions:

1. Heat is a substance (it is something/matter). Heat is not a substance. Heat is energy (students will not learn about energy until fifth grade).
2. Heat and cold are different. Cold is the absence of heat. Heat and cold are at opposite ends of a continuum.
3. Objects that keep things warm (gloves, blankets, sweaters) are sources of heat. Objects like these keep things warm by trapping heat. The warmer the coat, gloves or blanket, the better it is at trapping heat. This is why an Eskimo igloo can be warm in the inside. It will trap heat.

Safety Note(s):

1. Do not taste any chemicals unless told to do so (In this module they will NOT be instructed to taste.)
2. Wash hands after lessons
3. Keep hands away from the mouth and nose when you are touching chemicals

Engage.

- Show students a picture of freeze pops
- Have students to think like Ada Twist, Scientist and write down all of their observations and questions from the picture using the strategy Focused Listing.
- Ask students, "What states of matter appear to be present in the picture?"
- Ask students, "How might you plan and conduct an investigation to get some of the answers to your questions?" Students answer with the strategy, I Think, We Think.
- Tell students that in this lesson we will plan and conduct investigations to determine how increases and decreases in heat change matter from one state to another.

Explore

- Give each student a freeze pop. Tell them that before they eat it that they must write down all of their observations about it. (measurement, color, temperature, condensation, taste, smell, state(s) of matter)
- Next, have them to think like Ada Twist, Scientist and write down all of their questions about the freeze pop. Sample question – what causes the condensation to form?
- Have students use terms from the class' word wall in their observations and questions.
- Ask students, "In what ways are the 3 states of matter we learned about in the last unit represented in the freeze pop?" In addition to learning about 3 states of matter during the first lesson of this unit, in 2nd grade addressed these indicators: 2.P.3A.3 Conduct structured investigations to test how adding or removing heat can cause changes in solids and liquids; as well as 2.P.3A.4 Construct scientific arguments using evidence from investigations to support claims that some changes in solids or liquids are reversible and some are not when heat is added or removed.
- Ask students to identify the order in which the states of matter occurred. Sample answer – it started as a liquid, then a solid, the air on the outside was a gas and then condensation formed which is a liquid, and then the frozen fruit punch melted and became a liquid again.
- Allow students to eat the freeze pop.
- Ask students, "What is happening to the freeze pop as you are eating it?" "What might be some causes for the changes in the states of matter of the freeze pop as you eat it?" Expect to hear: The warmth of my body, the room, etc.

Explain

- Students read and discuss informational text on Changes in States of Matter using strategy, Partner Paired Reading.
- Conduct class discussion emphasizing concepts.
- Students complete task "It's About Time"
- Ask students, "Are Josh's investigations scientific?
- In Josh's investigation, the ice cube melted in 38 minutes in the kitchen at room temperature. What if the ice cube were placed in another room in the house or on the stove top as his mom baked cookies in the oven? What if the ice cube were placed outside in the winter? In the summer? What questions do you have about the ice?
- Plan and conduct a scientific investigation to determine how increases or decreases in heat change the ice from one state to another. Design your investigation to:
    - Answer questions, test predictions and develop explanations: (1) formulate scientific questions and predict possible outcomes, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.
    - Keep a journal during the investigation and prepare a graphic using the strategy Paint the Picture to share with the class.

It's a Matter of Time

Josh is learning about states of matter in science and time in math. His homework over the weekend was to plan and conduct investigations to determine how increases or decreases in heat change matter from one state to another. During his investigations he collected data including the changes in states of matter that he observed, and a time estimate for the change process to complete. He kept a chart of his observations. He left some information blank, help him fill in the blanks.

Investigation During the investigations, Josh:	**State of Matter at the Beginning**	**State of Matter at the End**	**Cause of Change**	**Start Time**	**Elapsed Time**	**End Time**
Puts an ice cube in a paper cup inside the kitchen at room temperature until the ice becomes water	solid	liquid		11:42 p.m.	38 min.	
Heats tap water until bubbles and vapor form		gas	boiling		25 min.	2:18 p.m.
Fills a glass with iced tea and places it in kitchen until water forms on the outside of the glass	gas	liquid		11:52 a.m.		12:06 p.m.
Pours a glass of water on sidewalk and observes until the water disappears	liquid			11:08 a.m.	56 min.	
Observes a birthday candle that his mom lights until wax drips					8 min.	7:06 p.m.
Places cold fruit juice in the freezer to make a popsicle	liquid		freezing	10:46 a.m.		12:56 p.m.

- In Josh's investigation, the ice cube melted in 38 minutes in the kitchen at room temperature. What if the ice cube were placed in another room or on the stove top as his mom baked cookies in the oven? What if the ice cube were placed outside in the winter? In the summer? What questions do you have about the ice?
- Plan and conduct a scientific investigation to determine how increases or decreases in heat change the ice from one state to another. Design your investigation to:
    - Answer questions, test predictions and develop explanations: (1) formulate scientific questions and predict possible outcomes, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

- Keep a journal during the investigation and prepare a graphic to share with the class.

Key:

Investigation During the investigations, Josh:	**State of Matter at the Beginning**	**State of Matter at the End**	**Cause of Change**	**Start Time**	**Elapsed Time**	**End Time**
Puts an ice cube in a paper cup inside the kitchen at room temperature until the ice becomes water	solid	liquid	*melting*	11:42 p.m.	38 min.	*12:20 a.m.*
Heats tap water until bubbles and vapor form	*liquid*	gas	boiling	*1:53 p.m.*	25 min.	2:18 p.m.
Fills a glass with iced tea and places it in kitchen until water forms on the outside of the glass	gas	liquid	*condensing*	11:52 a.m.	*14 min.*	12:06 p.m.
Pours a glass of water on sidewalk and observes until the water disappears	liquid	gas	*evaporating*	11:08 a.m.	56 min.	*12:04 p.m.*
Lights a birthday candle until wax drips	*solid*	*liquid*	*melting*	*6:58 p.m.*	8 min.	7:06 p.m.
Places cold fruit juice in the freezer to make a popsicle	Liquid	*solid*	freezing	10:46 a.m.	*2 hrs. 10 min.*	12:56 p.m.

Heat and Changes in States of Matter

In third grade we learn about 3 states of matter – liquids, solids, and gas. We also plan and conduct scientific investigations to determine how increases or decreases in heat change matter from one state to another. We focus on melting, freezing, condensing, boiling and evaporating. We likely see these processes in our daily lives.

Melting

Melting occurs when sufficient heat energy is added to change the solid to a liquid. Ice starts to melt at 0°C or 32°F. Examples of solids that can be easily melted include ice, chocolate, and wax.

Freezing

Freezing occurs when sufficient heat energy is removed to change the liquid to a solid. Water starts to freeze at 0°C or 32°F. Water will expand when it freezes; most other substances contract. A yummy frozen treat can be made by freezing fruit punch.

Condensing

Condensing is a change in state from a gas to a liquid. Condensing occurs when sufficient heat energy is removed to change air, which is a gas to a liquid. Examples of condensing include the formation of water droplets on the outside of a glass of cold liquid, or the formation of water droplets on the cool surface of a mirror during a warm shower. The water droplets that form during condensing are called condensation.

Boiling

Boiling is a change in state from a liquid to a gas. Boiling occurs when sufficient heat is added to a liquid causing bubbles of gas to form within the liquid and rise to the surface. Boiling causes liquids to change to a gas more quickly than evaporation. Water starts to boil at 100°C or 212°F. When most substances are heated, they will expand and take up more space.

Evaporation

Evaporation is a change in state from a liquid to a gas. Evaporation occurs at the surface of the liquid as heat is added from the surroundings. Evaporation causes liquids to change to a gas more slowly than boiling. Water evaporates more quickly at warmer temperatures, but can evaporate at any temperature. One example of evaporation is the decrease in the level of water in a glass that has been sitting on the counter for a while. Another example is the water that disappears from the pavement after the rain.

When planning and conducting scientific investigations to determine how changes in heat impacts changes in states of matter, one must think like a scientist. It is important to: 1) formulate scientific questions and predict possible outcomes, (2) identify materials, procedures, and variables, (3) select and use appropriate tools or instruments to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.