Bay Area Scientists in Schools Presentation Plan

Lesson Name Melting, Freezing, and More!: Phase Transitions
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Grade Level 3rd

California Standards Connection(s)

3-PS-Matter has three states which can change when energy is added or removed.

Next Generation Science Standards:

2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. [
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	Disciplinary Core Ideas	Crosscutting Concepts
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) 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)	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)	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)

Common Core Standards:

ELA/Literacy:

W.2.8 Recall information from experiences or gather information from provided sources to answer a question.

SL.2.2 Recount or describe key ideas or details from a text read aloud or information presented orally or through other media.

Mathematics:

MP.2 Reason abstractly and quantitatively.

MP.5 Use appropriate tools strategically.

FOSS Connections:

Grade 3 Module: Matter and Energy

Investigation 3: Matter

Abstract: All matter in the universe is composed of atoms, which are very tiny particles. For example, water air, and people are all made up of atoms. Atoms move at different speeds depending on how much energy they have. Our presentation will demonstrate how heat and cold change the energy of atoms and how this affects properties of matter that we can observe. We will perform some experiments on common materials, such as water, to illustrate the importance of phase transitions in everday life. We will also bring in less familiar materials from the laboratory that will demonstrate the relevance of these processes in scientific experiments.

Vocabulary/Definitions: *3 – 6 important (new) words*

- Solid
- Liquid
- Gas
- Phase Changes

Materials:

What will you bring with you?

-Centrifuge tubes
-Liquid nitrogen
-Dewar
-Balloons
-Dry ice
-Cold gloves
-Empty soda bottles
-Candles and matches
-Worksheets
-Computer with presentation
-Projector

What should students have ready (pencils, paper, scissors)?

-Water
-Rulers
-Pens
-Markers

Classroom Set-up:

The students should be arranged in 3 groups of equal size for the experimental portion of the presentation. We will need approximately 10 minutes on either end for setting and cleaning up. The talk consists partially of a Power point presentation, so we will need access to a projection screen or white wall surface.

Classroom Visit

1. Personal Introduction: **5 Minutes**

We are graduate students in chemistry and bioengineering at UC Berkeley. All of our research interests focus on using state-of-the-art science to solve real-world problems. Similarly, in the classroom we like to introduce students to fundamental scientific principles that have great relevance to their everyday lives. The phases of matter and the principles of phase transitions are central to many areas of science. For example, meteorology (the study of weather) requires knowledge about the phases of water.

We are also aware of the importance of scientific exploration at a young age and the role this had in shaping our own interests in science. Many interesting experiments on the phases of matter can be performed in the classroom or at home. We hope that our presentation will provide a good starting point for further scientific exploration in the area of phases and phase transition.

Topic Introduction: **15 Minutes**

We anticipate that students will be familiar with the phases of matter (solid, liquid, gas) that we will use as the starting point of our presentation. We will ask students for examples of these different phase and the important properties of each phase. Some knowledge of the atomic theory of matter will be important to our presentation. We will consult with the teacher beforehand to gauge the students' familiarity with this concept and adjust our presentation to encompass either a short introduction or provide a brief review.

We will introduce the concept of phase transitions and ask students if they are familiar with any common phase transitions and their names (e.g. ice melts to water). We will present other examples of common phase transitions. We will also challenge students to consider less familiar phase transitions (sublimation). We will show how all phases of matter can interconvert depending on the amount of energy we add or remove and discuss with students the ways we add or remove the energy associated with phase transitions. Finally, we will introduce students to the atomic theory behind phase transitions.

2. Learning Experience(s): **25 Minutes**

The experimental portion of our presentation will build on the concepts that we have introduced in our presentation and provide opportunities for hands-on learning. We will give students worksheets with visual themes and vocabulary that should be familiar from our talk. Students can fill in the missing information on these worksheets as they move between the three demonstration stations we will set up. This information will include: 1) the name of the phase transition being demonstrated; 2) the relevant phases and direction of the transition; and 3) a drawing of the

atomic basis for the phase transition. These worksheets will hopefully enrich the experiments by reinforcing what has been introduced in the opening presentation.

We will use the following three experiments as demonstration of the principles of phase transitions:

1) Sublimation of solid carbon dioxide and gas expansion. Students can use the cold gloves to place dry ice in a soda bottle. Add water and cover the top of the bottle with a balloon and the balloon will inflate as the dry ice sublimes. This experiment illustrates a rare process (sublimation) and utilizes a cryogenic material (dry ice) that should be interesting to students.

2) Freezing of water and ice expansion. The volunteers will use cold gloves to place tubes of water in liquid nitrogen. As the water freezes it will expand and this expansion may be measured. This experiment demonstrate an important property of a very common phase transition and utilizes liquid nitrogen, a material rarely available outside of the laboratory.

3) Melting candle wax. Students will be familiar with melting candle wax, which provides a good opportunity for hands-on play and also illustrate both melting and freezing.

3. Wrap-up: Sharing Experiences **____5____ Minutes**

For our wrap-up, we would like to ask the students to consider some new questions about phase transitions that they can think about after we leave. They could think about the "phase transition" associated with cooking an egg, or we might ask them what the phase of Jello is. These are the kinds of question and experiments that they can discuss among themselves and work on with their teacher or at home with their parents. We will emphasize that kids can think about science and apply their knowledge every day and that this is a fun and educational process.

4. Connections & Close: **____5____ Minutes**

What else might kids relate this to from their real-life experience? How can they learn more? Thanks and good-bye! Clean-up.

We have a fun final demonstration that should provide a good close to the talk. When air-filled balloons are place in liquid nitrogen, they dramatically contract. This allows us to place several balloons in a small liquid nitrogen container. Upon emptying the container of liquid nitrogen and the balloons, the balloons re-expand. This demonstration should provide some "fireworks".

Total 50 – 60 Minutes

Differentiated Instruction:

English Learners: Repeat directions, if necessary, and physically model how to perform activities at each station. Write vocabulary, e.g. solid, liquid, on the board and read words aloud. Vocabulary words can also be visually demonstrated using an illustration or action and redefined in very simplistic terms.

Advanced Learners: At each station, have students think of other materials that would behave in a similar manner, i.e. have similar properties, as the matter they are manipulating.

Follow-up Possibilities

ELA Activity:
Students answer the following prompt:
"Write a letter to a friend explaining what you learned about changing states of matter."

Reading Connections:
- Matter: See It, Touch It, Taste It, Smell It by Darlene Stille – The states of matter (solids, liquids, and gases) are explained and demonstrated. Includes an experiment to try. http://books.google.com/books/about/Matter.html?id=JxLYKx9ul2EC

Mathematics Activity:
Have students measure and record the temperature at which certain matter changes states.

Other:

Meltdown (Children's Museum of Houston) – In this activity, learners heat ice and water of the same temperature to get a hands-on look at phase changes. This is an easy and inexpensive way to introduce states of matter and thermodynamics. The activity page includes a fun how-to video for learners and educators.

http://www.cmhoustonblog.org/2010/07/23/meltdown/

What to Do:
1. Cool some water down to about 32° F (0°C) using your freezer or extra ice.
2. Measure around a cup of water and find the weight (you'll see why in a moment).
3. Pour it into a pot on the stove and turn the temperature to high.
4. Time how long it takes to boil.
5. Take the pot off, pour out the water, and let the pot cool down to room temperature.
6. Raise the temperature of some ice to 32° F (0°C) by placing it out at room temperature. Note that some will melt, so you will need to make sure you only use unmelted ice.
7. Measure out equal weight of ice as the water you used earlier. This way, when the ice melts, you have the same amount of water being heated.
8. Pour the ice into the pot on the stove, turn the temperature to high, and time how long it takes for the ice to melt and reach boiling.

What's Happening?
Even though the ice and water are at the same temperature, ice has bonds that hold its molecules in a crystal pattern. In order to break the bonds and melt the ice, extra heat energy is needed. So, even though the temperature doesn't rise, heat is absorbed to melt the ice which is why it will take longer for the ice to first melt and then boil.