Why Does the Ice Melt Faster?

Welcome to NSTA's Daily Do

Teachers and families across the country are facing a new reality of providing opportunities for students to ***do*** science through distance and home learning. The **Daily Do** is one of the ways NSTA is supporting teachers and families with this endeavor. Each weekday, NSTA will share a sensemaking task teachers and families can use to engage their students in authentic, relevant science learning. We encourage families to make time for family science learning (science is a social process!) and are dedicated to helping students and their families find balance between learning science and the day-to-day responsibilities they have to stay healthy and safe.

What is Sensemaking?

Sensemaking is actively trying to figure out how the world works (science) or how to design solutions to problems (engineering). Students ***do*** science and engineering through the science and engineering practices. Engaging in these practices necessitates students be part of a learning community to be able to share ideas, evaluate competing ideas, give and receive critique, and reach consensus. Whether this community of learners is made up of classmates or family members, students and adults build and refine science and engineering knowledge together.

Phenomenon Two ice cubes melt at different rates on seemingly similar surfaces		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models • Develop and/or use a model to predict and/or describe phenomena. • Develop a model to describe unobservable mechanisms.	**PS3.A: Definitions of Energy** • The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. • The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. **PS3.B: Conservation of Energy and Energy Transfer** • Energy is spontaneously transferred out of hotter regions or objects and into colder ones.	**Patterns** • Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

This lesson could be in a series of lessons building toward:

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]

Materials (per student or per pair of students)

Investigation 1:

Group A object (one from the following list)

- metal* pot, pan, cookie sheet or mixing bowl (copper, cast iron, aluminum, or steel)
- metal sink
- aluminum foil

**copper, cast iron, aluminum or steel (includes nonstick-coated cookware)*

Group B object (one from the following list)

- glass or ceramic pot, pan, cookie sheet or mixing bowl
- plastic or wood cutting board
- plastic, glass or ceramic plate
- oven mitt
- cardboard (pizza box, cereal box, etc.)
- wax or parchment paper

two ice cubes of similar size and shape

towel or paper towels

thermometer, optional (infrared, [aquarium] liquid crystal strip, or meat thermometer)

Investigation 2:

water

microwave-safe mug

microwave (alternatively, you can heat water on the stove or in an electric tea kettle)

metal spoon

plastic or wooden spoon

Supporting Resources

- Amazing Ice Melting Blocks (video)
- See-Think-Wonder (data table)
- Investigation 1: Melting ice on two different kitchen objects (data table)
- Why does ice melt faster on some surfaces than others? (model scaffold)
- Hot Spoons (formative assessment probe)
- Investigation 2: Temperature of two different kitchen spoons in hot water (data table)
- Thermal Energy Transfer (PBS Learning Media interactive module)

The supporting resources listed above can also be accessed in the *Why does the ice melt faster?* collection of resources: https://bit.ly/DD-04-16-2020. If you are an NSTA member, you can save this collection in your library.

Introduction

We've probably all experienced the phenomenon of stepping from a carpeted floor to a bare floor and noticing our feet feel colder. (If you haven't noticed, give it a try!) Did you ever stop to wonder how two floors in the same home (on the same level or story) could feel like they were at two different temperatures?

In this lesson, *Why does the ice melt faster?*, students and their families notice and wonder about a related phenomenon - ice cubes melting at different rates on two different household objects from the same room in the house. Students engage in science and engineering practices to make sense of science ideas about energy. Namely, energy is spontaneously transferred out of hotter objects to colder ones and when two objects interact, and energy can be transferred from one object to another through collisions (even when those objects are molecules).

Experience the Phenomenon (What am I exploring today?)

Guidance: Students will observe the phenomenon through the Amazing Ice Melting Blocks video (see above). An ice cube is placed on each of two blocks that appear to be similar and students observe what happens throughout the time-lapse video. The goal is for students to generate questions that can be investigated with materials found at home. Using evidence from data collected in those investigations, students develop a model to explain their observations of the ice on each of two blocks.

Presenting the Phenomenon: Ask students to watch the video and to complete a see-think-wonder chart, as shown below. Students should record observations ("I see…"), possible explanations of the phenomenon ("I think…"), and questions that they would like to investigate ("I wonder…"). It may be helpful to watch the video multiple times and to revisit the see-think-wonder chart. Students can print the See-Think-Wonder table or record their ideas on blank paper using the shared table as a guide.

You can use the following question to prompt students' thinking as they view and process the video.

- What did you see happening in the video?
- What is causing the ice to melt?
- Why do you think the ice melts faster on one block than the other?
- What do you think is the same or different about the blocks?
- What questions do you have?

Investigative Questions (What question do I have about what I just saw?)

Guidance: It is important to allow time for thinking. Many students have ideas and questions but need time to formulate their idea or question into words. Some students may also benefit from writing things down first before they share. As adults we may be tempted to give students the questions we feel might be important to explore, however we need to refrain from this and allow our students to practice asking their own questions.

Investigative questions are common questions kids may ask after they are introduced to the phenomena. Although questions may vary, many students will be curious about the ice melts at different rates on the two blocks even though they appear to made of the same material.

Common questions:

- Are the ice cubes the same?
- Are the ice cubes made out of water?
- Is one of the blocks heated? (Is one block hotter than the other?)
- Are the blocks the same? (Are they made of the same type of material?)

After all the questions have been asked, we want to prompt our students to express their own ideas of how to figure out the answers to their questions. Ask them, "What could we do to figure out some things about why one ice cube melted faster than the other?"

Common responses:

- Google what the blocks and/or ”ice” cubes are made of
- Measure the temperature of the blocks before you put ice on them
- Measure how fast the blocks’ temperatures change
- Measure the temperature of the ice cubes before you put them on the blocks

You might say, “Many of us are wondering what the temperature of the blocks are before you put the ice on them. Does it make sense to investigate this first?”

Investigation 1: Melting Ice in the Kitchen

Share these procedures with your students.

1. Select one object from Group A and one object from Group B.
2. Print the Investigation 1: Melting ice on two different kitchen objects data table or copy the table below onto blank paper. Include the name of the objects you selected from Group A and B.
3. If you have a thermometer, record the room (air) temperature.
4. Touch each object and record how they feel. How do the objects feel temperature-wise compared to each other? How do they feel compared to the temperature of the room?
5. (a) **If you have a thermometer**, record the surface temperature of each object. If you only have a meat thermometer, place the tip in direct contact with the surface of the object and record the temperature. What do you notice about the temperature of the objects compared to how they felt to the touch?

   (b) **If you don’t have a thermometer**, think logically about the temperature of each object. Assuming they have been stored in the open or in a kitchen cabinet, how should their temperatures compare to room temperature? Is there any reason for them to have different temperatures?
6. Make a prediction about what will happen when you place an ice cube on each object (simultaneously).
7. Select two ice cubes as close as possible to the same size and shape.
8. Place one ice cube on each object and start a timer/record your starting time.
9. Observe the ice cubes and record how long it takes each ice cube to melt and anything else you noticed as the ice cubes melted.

Making Sense of the Investigation: Use the following prompts to help students make sense of the investigation.

- What patterns did you observe? (ice seems to melt faster on metal objects than on nonmetal objects, ice seems to melt faster on objects that felt "cooler" to the touch, the starting temperatures of the objects were the same, etc.)
- How did these patterns compare to your predictions?
- How do these patterns help you explain why the ice melts faster on some objects than on others?
- What do you think might be happening at the microscopic level that would help you explain the patterns you observed?

You can find additional prompts in STEM Teaching Tools Practice Brief 41: Prompts for Integrating Crosscutting Concepts Into Assessment and Instruction.

Developing an Initial Model (Why does ice melt faster on some surfaces than others?)

Ask student to think about what causes ice to melt and why it might melt faster on some materials than others. Then ask them to develop an initial model to explain why the ice melted faster one object than another object. Share the model scaffold with students or ask them to refer to the model scaffold and draw their initial models on blank paper.

Consider using the following guidance to support students in developing an initial model to explain their observations in Investigation 1.

- Your model should show all the parts of the system. The template shows the object and the ice cube. Are there any other components that you need to include?
- Your model should also show how the parts of the system interact. Think about these questions.
  - What is changing?
  - How is energy moving?
  - How is each part of the system affecting other parts of the system?
- Your model also needs to show what is happening at the microscopic level that helps you explain your observations. Use the "zoom-in circles" to show what you would see at the microscopic level if you had a special tool that allowed you to do so.

You might choose to put students into small groups and share their models. Ask students to note similarities and differences between their models. Give students an opportunity to revise or add to their models. Then tell them to save their models/put them away until later. Remind students their models don't need to be perfect - they will have a chance to revise them after collecting additional evidence.

Say to students, "We noticed the blocks' temperatures were the same at the start of the investigation. Based on our models, most of us are wondering why the blocks' temperatures changed at different rates. Does it make sense to investigate this question next?"

Investigation 2: Hot Spoons

Guidance: Investigation 1 allowed students to experience and explore the ice melting phenomenon first-hand. Investigation 2 engages students with an investigative phenomenon that will help them make sense of the transfer of thermal energy (heat). Students will investigate the phenomenon of placing two spoons, one metal and one nonmetal, into a mug of hot water. You can prompt students' thinking about heat by using the "Hot Spoons" formative assessment probe. This probe is based on the "Cold Spoons" probe from *Uncovering Student Ideas in Physical Science, Volume 3* and on the "Hot Spoons" task from *Predict, Observe, Explain: Activities Enhancing Scientific Understanding*. You can learn more about using formative assessment probes by reading the "Why is my shadow always changing?" Daily Do.

Share the "Hot Spoons" probe with your students. Read through the probe with students or give them time to read through it. Ask students to choose the student whose answer they think best explains why the metal spoon gets hot when placed in hot chocolate. Ask students to record their answer and explain their thinking. Students might use words, pictures, and/or symbols. Prompt students to clarify their thinking, but be careful not to give away the explanation at this point. You might ask students to turn to a partner and share their ideas.

Tell students, "We are going to try this out, but with a twist. We are going to observe what happens when both a metal and nonmetal spoon are placed in hot water. What do you think will happen to the spoons when they are placed in the hot water?" Have students share their predictions with a partner.

Procedure

1. Gather the materials and share the Investigation 2: Temperature of two different kitchen spoons in hot water data table with students.
2. As students make their initial observations, you will need to call their attention to one of the surprising aspects of this phenomenon. Students should have noticed that metal objects consistently feel "cooler" than nonmetal objects like the plastic/wooden spoon. If you are using a thermometer, then now is a good time to call students' attention to the fact that the room temperature and the temperature of both spoons are all the same. Prompt students to think about why the metal spoon feels cooler if it actually is the same temperature as the plastic/wooden spoon. If you do not have a thermometer, then you will need to guide students to think through the scenario logically. You might use the following script. *Let's think about the temperature of the spoons. What is the temperature in this room? Let's look at our thermostat. It says the room is 72 degrees. Where have the spoons been? Has either of the spoons been heated or cooled? So, what must be the temperature of both spoons?*
3. Ask students to record their initial observations and predictions.
4. If you have a microwave available, then microwave 6 ounces of water in a microwave-safe mug for 90 seconds. Use extreme caution in handling the mug of hot water.
5. Have students place the two spoons into the hot water and let them sit for 5 minutes.
6. Tell students to record their final observations after 5 minutes.

Making Sense of the Investigation:
Use the following prompts to help students make sense of the investigation:

- Did your prediction match your results?
- What patterns do you observe in the data from both investigations? (both objects were the same starting temperature but one felt colder than the other, the objects that felt cold had/caused the biggest changes - fast melting ice cube/highest temperature change)
- Why do you think the metal spoon warmed up faster than the plastic/wooden spoon? What might be happening at the microscopic level that helps us explain this?
- How does this help us understand the ice melting investigation? How does the energy flow in this investigation compare to the energy flow in Investigation 1?

Revisit the "Hot Spoons" probe. Give students time to reread and respond to the probe. Then have students share their responses and thinking. At this point, you want to press students to use evidence from the investigation to justify their explanations. If a student is committed to an explanation other than Jamal's, then press them to revisit the evidence from the investigation.

Teacher background: The best answer is Jamal's: "I think heat from the hot chocolate moves through the spoon to my hand." The second law of thermodynamics puts constraints on how energy flows in a system. Warmer objects transfer energy to cooler objects, not the other way around. Thermal energy from the hot chocolate heats the metal spoon, which is a good conductor, and the energy is then transferred from the spoon to Jamal's hand. The energy gained from the hot chocolate caused the particles in the spoon to move faster. This energy is then transferred from the spoon to Jamal's hand as these faster-moving particles collide with the slower-moving particles in his hand. The other answers express common misconceptions about heat and its movement.

Obtaining and Making Sense of Scientific Information (What is heat?)

Guidance: Now that students have built some direct experiences and begun to wrestle with ideas about heat and temperature, you will want to support them in obtaining and making sense of some scientific information. In order to fully model and explain the ice melting phenomenon, students need to be able to answer the following questions:

- What makes something hot or cold?
- How do things get warmer or cooler?

To help them answer these questions, engage students in the PBS Learning Media Thermal Energy Transfer interactive module.

You can use the discussion questions from the lesson to help students summarize the new information they obtain from the lesson.

- Can you explain why you feel warm when you are standing near a campfire?
- Why does a carpeted floor feel warmer to bare feet than tile or wood even though all surfaces are the same temperature?
- What information would you need in order to predict whether transfer of thermal energy would occur when two objects or materials interact?

- What would happen if a person who is wearing a heavy winter jacket were to place a thermometer inside the jacket next to his or her skin? What would happen if we took the same jacket, after it had been hanging in a closet, and placed a thermometer inside?

Students can learn more by exploring the animations and student reading from the Middle School Chemistry Lesson 2.1 on Heat, Temperature, and Conduction. Students who want to dive deeper into these concepts can conduct online research on the thermal conductivity of common materials.

Revising and Applying the Model (Why does ice melt faster on some surfaces than others?)

Guidance: Now, you will want to help students transfer their learning from the investigations and interactive lesson to revise their model of the ice melting phenomenon. You might have students use the following questions to organize their ideas from the investigations and interactive lesson.

- What did we do?
- What did we learn?
- How does this help us explain why ice melts faster on some surfaces than others?

Now, prompt students to revisit their models for the ice melting phenomenon. Say, "Think about what causes ice to melt and why it might melt faster on some materials than others. For each object you tested in Investigation 1, revise your initial model to explain why the ice melted faster or slower on that object. Use the zoom-in circles to show what might be happening at the microscopic level that can help you explain your observations. Be sure that you are incorporating ideas from Investigation 2 and from the interactive lesson. You can make changes on your original model or begin a new model."

Revisit the original phenomenon by watching this extended Ice Melting Blocks video. In addition to the original phenomenon, this video shows the initial temperature of the blocks and shows how the blocks interact with heat-sensitive liquid crystal sheets. Students can use this additional evidence to support their explanations. Have students use their models to explain why the ice melts faster on one block than the other, and have them infer the type of material for each block. Y

Teacher background: You can find an explanation of the ice melting blocks in the Flinn ChemFax Lesson Plan: Ice Melting Blocks.