COOL IT! (1 Hour)

Addresses NGSS
Level of Difficulty: 1
Grade Range: 6-8

OVERVIEW

In this activity, students will observe how ice melts on wood and metal blocks, and they will draw conclusions about how heat conducts through different materials.

Topic: **Heat transfer**

Real-World Science Topics

- An exploration of the thermal conductivity of different substances
- An exploration of heat and phase changes

Objective

Students will gain an understanding of how heat is conducted through different materials, and they will explore how materials can be modified to alter their conductive properties.

Materials Needed for Teacher Demonstration

- beaker
- hot plate
- ice cubes (enough to fill the beaker)
- plastic straw
- metal spoon

Materials Needed for Student Teams

- block of wood, painted
- block of metal, painted
- ice cubes
- stopwatch or clock with second hand
- various insulating and conducting materials, such as plastic wrap, aluminum foil, paper bags, wax paper
- tape

Teacher Preparation

You will need to prepare the wood and metal blocks ahead of time. If possible, use blocks that are the same size and shape, and use a lightweight metal (such as aluminum) so that they are similar in mass. Paint the blocks the same color so that they look reasonably similar.

COOL IT!

STEPS FOR *COOL IT!*

1. **Warm-Up Activity:** Place the beaker on the hot plate, set on low, and fill the beaker with the ice cubes. Ask students what they think will happen to the ice cubes and prompt them to explain their reasoning. (Students should conclude that the ice will melt.) While the ice is melting, have students brainstorm instances when they have seen ice melting before. Have students think about what factors might affect the process of ice melting. (For example, would ice melt faster in a glass of cold water or a glass of hot chocolate?) Briefly review the definition of temperature. Explain to students that the temperature of an object can be changed when heat energy is added or removed from the object. Point to the hot plate and explain that the hot plate adds heat energy to the beaker. When the heat energy is transferred to the ice cubes, it increases their temperature. This causes them to melt. (If students are unfamiliar with the phases of matter, briefly review the concepts of solids and liquids.)

2. Ask students if they think heat moves the same way through all materials. Be sure to have students provide examples to defend their reasoning. Prompt students by having them think about the ways that different objects heat up in hot liquid. By this point, the ice cubes in the beaker should have melted into water, and the water should be heating up. Show a plastic straw and metal spoon to students. Pass the objects around the classroom and have students observe the temperature of the objects. Ask students what will happen to each object when you place a plastic straw and metal spoon in the hot liquid. Will the objects heat up? Will they both be the same temperature or different temperatures? Place the objects in the liquid for at least two minutes. Then remove the objects from the liquid and have a few student volunteers observe and report the new temperature of the objects. Have students think about why the objects might not be the same temperature. Then explain that in this activity students will explore how heat moves through different objects.

3. Divide students into groups and distribute the wooden and metal blocks as well as the Student Handouts. The blocks should be painted beforehand so that they look similar to each other. (This also ensures that one block will not absorb more ambient heat energy than the other due to its color.) Tell the students to each take turns placing their hands on top of the blocks. Which feels warmer? Ask the students to make predictions about what they think will happen when each block has an ice cube on it. Which ice cube will melt more quickly? Have students record their observations and predictions on the Student Handouts.

4. Give each team a pair of ice cubes and a stopwatch or a clock with a second hand. Have each team place one cube on the wooden block and one cube on the metal block. You may want to place paper towels beneath each block to minimize water spills. Have the students work together to time how long it takes each ice cube to melt completely. They should record all observations on their Student Handouts.

5. Challenge students to modify the blocks so that they observe the opposite results. (For example, if the ice melted more quickly on the metal block, they should try to modify the blocks so that the ice melts more quickly on the wooden block.) Have students modify the blocks by wrapping them with any of the items listed on the materials list.

   If students need more guidance, explain that they want to find a material that slows down the rate at which heat is transferred from the blocks to the ice. If they can find a material that does this, they can then wrap the block on which the ice melted faster with that material so that it won't cause the ice to melt so quickly. Suggest that they first wrap both blocks with wax paper and then repeat the ice-melting investigation. Then have them wrap the blocks with aluminum foil and repeat the investigation again. Have them observe if either material increased or decreased the rate at which the ice melted on the wooden or metal block. (They should observe that the wax paper reduced the rate at which the ice cube melted.) Then have students observe what happens when they wrap the block on which the ice melted more quickly with the material that reduces the melting rate. Have them leave the second block untreated and repeat the investigation. Allow students to modify the investigation as necessary until they observe the desired results.

6. **Wrap-up Activity:** Bring the class together and have groups share their results. Prompt discussion by asking some of the following questions: Which block caused the ice cube to melt the fastest? Did these results match their predictions? Why did the ice cube melt quicker on the metal surface than on the wooden surface, despite the fact that the metal block initially felt cooler than the wooden one? How did wrapping the blocks with materials change the melting rate? After students have shared their results, explain to them that heat energy is transferred at different rates through different materials. Some materials allow heat to pass through them easily, while others do not. Objects that allow heat to pass through easily are called conductors, while objects that do not allow heat transfer are called insulators. Emphasize that conductors not only gain heat easily, but they also lose heat easily. This is why the ice cube melts faster on the metal block. Even though the metal block is colder than the wooden block, it transfers the heat it has to the ice cube more easily than the wooden block, and this makes the ice cube melt faster.

Cool It! Extension Activities

1. Have students investigate how other factors might affect the rate at which ice cubes melt on the blocks used in this experiment. They could vary the following: initial temperature of the blocks, initial temperature of the air around the blocks, or the composition of liquid in the ice (adding salt or sugar).
2. Have students research and model the relationship between temperature and the distance between particles in a substance. For example, they might perform a brief skit to model the particles in water at different temperatures.

What is the difference between temperature and heat energy?

The average kinetic energy, or movement energy, of the particles in a substance is commonly referred to as heat energy or thermal energy. Temperature is a measure of the heat energy in a substance. When the particles in a substance move faster, the temperature increases, and vice versa. When you rub your hands together, you momentarily cause particles in your skin to move more quickly, and this increases the temperature of your skin.

What is heat?

Heat is a generally misunderstood concept in physics due to its misuse in common language. Heat is the *movement* of thermal energy from a high temperature region to a low temperature region. When something is "heated," you can say that an object with a high temperature is transferring heat energy to an object at a lower temperature. However, it is incorrect to use the term "heat" to refer to a substance (such as hot air traveling from a vent).

What role does heat play in phase changes?

When substances, such as ice, are "heated," they are put in contact with another substance that is at a higher temperature. The second substance, such as hot air, has particles that are moving rapidly and bouncing off of each other at high speeds. When the high energy particles from the hotter substance come in contact with the ice particles, they collide with the ice particles and cause them to move faster. In this process, the particles in the ice bounce farther away from each other. This causes the ice to begin to spread out, or melt. Thus, the ice turns from a solid into a liquid. If this process continues, the particles in the liquid will continue to gain thermal energy and spread out even farther. If they spread out far enough, the particles of liquid will evaporate and turn into a gas.

Why does the metal block cause the ice cube to melt faster, despite the fact that it is initially cooler than the wooden block?

Metal is a conductor. This means it transfers heat energy much more readily than other materials. Whenever a conductor is put in contact with a substance at a different temperature, it will either transfer heat energy or absorb heat energy rather quickly so that it comes to the same temperature as the second substance. For example, if a metal spoon is resting at 65˚F and it is placed in a beverage that is 95˚F, the metal spoon will absorb heat energy until it is at thermal equilibrium (the same temperature) as the beverage. Alternatively, if the metal spoon is placed in a colder beverage with a temperature of 45˚F, the spoon will *release* heat energy into the beverage until it is at equilibrium with the beverage.

It can be estimated that the ice cube in this activity is at a temperature around 30˚F, and the metal block is at room temperature, around 75˚F. The wooden block conducts heat energy less readily than the metal. It may be initially at 80˚F. When the ice cube is placed on the metal block, the metal block, despite being colder than the wooden block, transfers its heat energy much faster to the ice cube than the wooden block. This causes the ice cube to melt more quickly on the metal block than on the wooden block.

Key Vocabulary

particle: a tiny piece of matter

conductor: a material that transfers heat energy easily

insulator: a material that does not easily transfer heat energy

temperature: a measure of how much heat energy is in a substance

heat energy: the average amount of motion energy in the particles of a substance

heat: the transfer of heat energy from a hot substance to a cold substance

1. Observe the temperature of the metal and wooden blocks. Which one is hotter and which one is colder?

[Sample answer: The metal block is colder than the wooden block.]

2. What do you think will happen to the ice cube that is placed on the metal block? What will happen to the ice cube on the wooden block? Explain your reasoning.

[Sample answer: I think the ice will melt faster on the wooden block than on the metal block because the wooden block is warmer.]

3. Record your observations of the ice changes on the metal and wooden blocks in the chart below.

[Sample answers included in the chart.]

Type of block	Time for ice to melt	Material added to the block/New melt time	Second material added to the block/New melt time	Third material added to the block/New melt time
Metal	[2 minutes]	[Wax paper/ 3 minutes 20 seconds]	[Aluminum foil/ 1 minute 45 seconds]	[Wax paper/ 3 minutes 10 seconds]
Wooden	[3 minutes and 20 seconds]	[Wax paper/ 4 minutes and 30 seconds]	[Aluminum foil/ 3 minutes]	[Aluminum foil/ 2 minutes and 40 seconds]

4. Which block caused the ice to melt faster? Why do you think this was the case? Were you predictions correct?

[Sample answer: The metal block caused the ice to melt faster. I think this was because the metal conducts heat energy better than the wooden block. My prediction was incorrect.]

5. Were you able to change the blocks so that the results from Question 4 were reversed? If so, what did you do?

[Sample answer: Yes. I wrapped the metal block with insulating paper and the wooden block with conducting material. This reversed the results.]

6. If you were going to build a snowman inside, which material would you choose to build the snowman on: a wooden board or a metal sheet? Explain your reasoning.

[Sample answer: I would build the snowman on a wooden board so that the snow does not melt as quickly. This is because the wooden board does not conduct heat energy as well as the metal board.]

Name:

Date:

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