Heat and temperature - Facilitator guide

Students working on the heat and temperature module.

Learning Objectives

In this activity students will learn:

- Heat flows from hot to cold
- Some materials allow heat to flow better than others (the term *thermal conductivity* may be introduced, depending on the level of the students)
- How warm or cold an object feels depends on its temperature AND how easily heat passes to or from the material

Materials

Students comparing how ice melts on aluminum and plastic plates.

Per group

- 1 plastic plate (PVC)
- 1 aluminum plate
- 1 copper plate (optional)
- 2-3 o-rings

Per class

- 2 mini ice cube trays
- 3-5 “mystery samples” (optional - see “The unknown planet” extension)
- 1 pair of oven mitts (optional - see “The unknown planet” extension)
- Cooler and ice pack to keep ice cold (if no freezer access)
- Paper towels for clean up
- 2-3 infrared thermometer guns

Notes

- Construct mystery samples by coating different plates with the same color of paint. Examples:
    - Plastic (e.g. PVC)
    - Aluminum
    - Copper
    - Cardboard wrapped in aluminum foil
- This activity can also be done using plastic and metal spoons instead of plates.

Tips

- Make typically as many teams as you have test samples if you intend on doing part 4. The maximum size of each team should be 3 students. For large classrooms,
- Parts 1-3 typically take ~1 hour, including filling out the worksheet as they go.
- If time is limited, part 4 can be done as a demo in front of the whole class. For a more interactive but longer activity, have each team analyze one of the mystery samples and collect the results together.
- Do not store the tiles in the cooler with the ice. If you do, when you remove them the metal tiles may become warmer more quickly, and so the two tiles will not have the same temperature.

Preparation

Make sure to prepare the ice ahead of time! If you will not have access to a freezer, you may want to prepare an ice pack to help keep the ice cold as well.

Engage: Introduce the concepts

- Ask what students know about heat and temperature. Suggested questions to ask:
    - Who walks around with slippers at home? In socks? Barefoot? How does it feel?
    - What is the difference between walking on a carpet and tiles?
- Hold up one aluminum and one plastic tile and ask how we can see which one is colder. Write their ideas on the board - they should come up with two possibilities, measure the temperature, or use their hands to see how they feel.
    - How they feel: call on one volunteer to come up and touch each of the plates and tell the class his/her observations. (Aluminium should feel colder.)
    - Measure the temperature: introduce the temperature gun (talk about safety, only senior astronauts can use it, but you can show them the display so they can read off the numbers). Measure each of the two plates, they should have roughly the same temperature.
    - Say, “One plate feels colder yet the temperature is the same? That’s surprising!” Tell them the answer lies in understanding heat transfer, which we will now explore in some experiments.

Explore: Develop Intuition

- Hand out the materials for each group. Each team should have an aluminium and a PVC plate. Tell them not to touch them because this will affect their temperature.

- For each group, measure the temperatures of the plates and the student's hands using the thermometer gun.
- Have them fill out the 2 tables by touching the plates and then their face. Their hand should feel cold after having touched the plates, making them feel that heat has been transferred to the plate. However, they may notice that their hand feels colder after touching the aluminum plate compared to the PVC plate.
- Make 2 drawings of a hand and a plate on the board, one for aluminium and one for PVC. Get a volunteer to fill out with an arrow for the heat transfer. Big one for aluminium, small one for PVC to represent the different amount of heat that's transferred.
- Make them fill out the conclusion (sentence and schematic) Heat flows from hot to cold.

Explore: Ice cube experiment

- Introduce the next experiment as something more quantitative to understand the differences between the two materials.
- Have them guess/measure/write down the temperature of the ice.
- Each team should place one O-ring on the center of each tile to prevent water spillage (no playing around with the O-rings!). At the same time, drop one ice cube on each of the tiles.
- Have them fill out the table summarizing the results
- After the experiment, measure the temperatures of the plates, have them fill out the table and the summarizing text.

Extend: The unknown planet

- Hide the mystery samples around the classroom (do this while the kids are busy with something else, or do it before the kids enter the classroom)
- Tell the students that scientists work on teams - in this experiment, we are going to pretend that an astronaut is going to an unknown planet to collect samples of different materials. We can't send everyone into space, so find/randomly draw a volunteer to be the astronaut. Tell the students that the other scientists will perform experiments and analyze data on the materials the "astronaut" brings back.
- Bring the volunteer to the front and ask the class what gear he will need to go on his mission (a helmet, a suit, etc.)
    - Ask them what material we should make his/her gloves out of, plastic or aluminium?
    - Give him/her the oven mitts.
- Once the volunteer gets to space, the classmates ("mission control") can help him find the plates, but may not leave their seats, he gets them and brings them to the front.
- Back on earth:

- For a shorter activity: Show all the materials at the front with one each of the known materials. Call on volunteers from the class drop an ice cube on each of the plates.
- For a longer activity: Each team gets 1 sample (may need to combine teams). Measure its temperature, fill out the table then perform the experiment, comparing to the known materials.
- In either case, draw a big arrow on the board and have them rank the materials in order from the least to most heat transferred. Perform additional experiments as necessary to finalize ranking.

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