

Curiosity Probe

The Mitten Problem

Teacher notes

The probe

Let's say you are investigating *heat energy*. You think to yourself, "I wonder what would happen to the temperature reading on a thermometer if I put it into a mitten." **[Demonstrate putting the thermometer into a mitten.]** We'll put that on the table. Now, as a real scientist would do, you put *another* thermometer on the table alongside the one in the mitten. **[Demonstrate this.]**

This makes it a *fair test*. Let's say the room temperature *doesn't change* and an hour later you check both temperatures.

Who thinks:

- The thermometer inside the mitten will have a lower temperature reading than the thermometer on the table?
- The thermometer inside the mitten will have a higher temperature reading than the thermometer on the table?
- Both thermometers will have the same temperature reading?

Firstly, gather student choices, then, have a discussion to glean the reasoning behind their choices.

Perform the experiment to find the answer.

Purpose of probe

The purpose of this probe is to elicit students' ideas about sources of heat energy. The probe is designed to find out whether students believe an insulating object, like a mitten, produces its own heat. Their explanations reveal if they can differentiate between heat source and an object affected by a heat source.

Explanation

The best answer is C. The temperature reading inside the mitten and outside the mitten will be the same. Heat describes the energy that is transferred between two interacting systems at different temperatures. A heat source can produce its own heat energy, or it may simply be an object that is at a higher temperature than the surroundings. The mitten in this case does not produce its own heat energy, and it did not have a higher starting temperature to begin with when the thermometer was inserted. The mitten is an insulator that keeps heat, generated by the human body and transferred to the surrounding air, from leaving the mitten as quickly as it leaves a bare hand. The mitten, which is an insulator, slows down the transfer of heat energy to the surrounding environment outside the mitten. If there is no source of additional heat energy inside the mitten, the mitten will have the same temperature as its surroundings.

Temperature is closely related to the measure of kinetic energy of molecules and atoms. During this experiment there is nothing to significantly cause the motion of the molecules and atoms of the mitten or the air inside it to increase. The temperature in the room remained the same throughout the experiment. Therefore the temperature will most likely remain the same inside the mitten as outside the mitten.

At Junior to Mid-Primary Level

Basic ideas at this level are observational. They might include development of the idea of various ways heat is produced, that heat moves from warmer objects to cooler ones, and that there are ways to reduce heat loss. Students at this level are unlikely to distinguish between the words heat and temperature. This probe is useful in determining early ideas about heat transfer and whether students think insulating objects, such as mittens, coats and blankets, generate their own heat.

Mid- to Senior Primary Level

Students at this level become familiar with the ideas that energy is an important property of substances and that many changes involve energy transfer in the form of heat. However, students still have many misconceptions about heat and where it comes from. Confusion between concepts of temperature, heat, energy transfer, and a heat source is common, and focusing on transformations may help to them to address their naïve ideas. The idea that heat results from the motion of molecules is still rather an abstract notion at this level.

High School Students

Heat and temperature ideas can become more complex at this age. Yet, students may still hold onto ideas they had in early primary school as well as fail to distinguish between the use of the words *heat* and *temperature*. High school students can move towards investigating heat more quantitatively by measuring variables such as temperature change, mass and time. Students can experience and analyse a wide variety of actions that give off heat and understand that the mitten prevents some heat given off by the body from dissipating into the environment outside the mitten. However, misconceptions about heat sources may still persist and be uncovered through use of this probe.

Adapted from Keeley, P., Eberle, F. and Farrin, L. (2005) *Uncovering Student Ideas in Science: 25 Formative Assessment Probes*. National Science Teachers Association, David Beacom Publisher, USA.

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