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Teacher Notes

Hot and Cold Cups Introduction

In this activity, children will use a temperature probe to investigate how different types of containers affect the warming and cooling of water. Using the temperature probe will afford them the opportunity to watch the temperature change continuously over a period of time. They will then be able to compare heating and cooling graphs for various types of containers.

Students will investigate and observe substances at different temperatures eventually reach the same temperature while:

1. identifying variables that can affect the outcome of an experiment. In addition they will learn to identify other variables in an experimental design that must be controlled in order to isolate the affect of one variable.

2. gaining skills and confidence in using a scientific measurement tool, the temperature probe, as well as the spreadsheet and graphing capacity of a computer to represent and analyze data.

3. learning to value accuracy and precision in scientific investigation.

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Discussion Guide

Begin a discussion with the class by having the students in each group look around the room and describe items or substances in terms of their temperature in relationship to a cup of hot liquid sitting on your desk. This is hotter---this is cooler. After compiling their lists make a master list for the class. Ask the class to make a list of objects that are the same temperature. Many of the students will be surprised that most things in the room are at the same temperature. Even more revealing is that often students will not place the air inside a room on the list because air does not seem to have any temperature at all.

Hand out the temperature probes to the class. Have the students hold their temperature probes in the air for a short period (2 to 3 minutes) of time. Ask them to refer to this temperature as the room temperature. To help convince them that the temperature probe is measuring the temperature of the air, ask the students to either hold onto or blow on the probe for the same amount of time.

The idea of room temperature is important to establish in discussing variables that will affect the cooling or warming of solutions in containers. Ask the students to recall situations when they left hot or cold drinks sitting for a period of time. Ask the class to discuss what variables might affect how quickly the drinks cooled off or warmed up. (They might suggest variables such as room temperature, the size of the container, or the material of the container.)

Challenge the class to predict which type of container would do the best job of keeping cold drinks cold and hot drinks hot. Ask them to discuss the question for a few minutes in their group and present their reasons for their prediction.

Within their groups, have the students design an experiment to test their predictions. Direct the class to "Thinking About the Question".

While selecting the varying types of cups for this activity, try to choose cups of different materials of approximately the same shape and size. This will limit the number of variables that the students will encounter during the activity by concentrating on the differences in the types of materials.

Place a sample set of all types of cups at the front of the room. Ask each group to record the noticeable differences among the cups by using this set. While distributing the cups for the activity, mix the type of cup in the groups throughout the room, by placing a different type of cup in as many groups as possible.

During the "Analysis", students from each group will be asked to share their data with students in other groups with different types of cups. If you do not want students sharing computer disks, the teacher can transfer the data by computer disk to one computer for student observation. This data could then be shared on a computer in an easily accessible part of the room or by using a projection system. Once a graph is obtained of data from the entire class, focus the students on the differing rate of time between one type of material and another.

Determine a place in the room where students will be able to leave their cups overnight. Help the students focus on the other factors (location of the cups, room temperature, etc.) besides of the type of container that may have affected the temperature of the water in the morning.

Direct the students to "Investigation I".

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Additional Teacher Background

If some part of the room is hotter than another area, heat will flow from the hotter area to the colder area until both areas are the same temperature. So why does it feel warmer in certain parts of the room? For example, if the area around the heating vent is warm, it must always be supplied with new heat as quickly as it gives up heat to the room. Turn the thermostat down or off, and the area around the heater soon reaches room temperature. Where there is heating, heat must be flowing in and where there is cooling, heat must be flowing out.

If you mix two liquids, they become the same temperature almost at once because the two are in direct contact. But what happens when you place an insulator (a poor conductor) between the two liquids? Put cold water in an insulated cup and it stays colder longer because the insulator slows heat flow. Put hot chocolate in an insulated cup and it stays hot for a longer period of time because it is a poor conductor of heat. So good insulators keep things hot or cold by stopping the flow of heat, while good conductors help make things the same as the room temperature by not blocking the flow of heat. Think about wrapping a cold soda pop in aluminum foil. It is commonly thought that this will help the drink stay cold. Unfortunately, aluminum foil is an excellent conductor and will not prevent the soda pop from reaching room temperature.

Students at this age are just beginning to understand the phenomenon we call heat energy and energy transfer. We do not expect them to understand the molecular model of matter. The goal is to build a repertoire of experiences with the phenomenon of energy transfer. The main idea is that when cooler things and warmer things come in contact, the cooler things get warmer and the warmer things get cooler. Introducing insulators, cups of varying materials, and comparing the air temperature with that of the liquids brings an awareness of this process to the students. They begin to question the role of the cup material as both a barrier to and transmitter of heat.

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Hot and Cold Cups Suggested Timeline

The amount of time you spend on introductory discussions, data collection, and analysis, will determine your overall timeline. The following represents a possible timeline.

- One class period - Introductory Discussion
- One class period - Investigation I: Warming chilled water
- One class period - Investigation II: Cooling warm water
- One class period - Investigation III: Observing overnight results
- One class period - Analysis

Additional days can be used for further investigations.

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