

Make Your Own Thermometer

Grade 5

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References:

- CPS curriculum guide
- www.harcourtschool.com/activity/states_of_matter/index.html

Benchmarks & Objectives:

PS-1: Define temperature as the measure of thermal energy and describe the way it is measured.

PS-2 Trace how thermal energy can be transferred from one object to another by conduction.

Materials:

- Plastic pop bottles (1 per group)
- Small amount of clay, enough to close top of bottle (1 per group)
- Straw- preferably thin, long and clear (1 per group)
- Food coloring
- Dihydrogen monoxide (water), preferably *cold*, from the faucet
- Thermometers (3)
- Hot, cold, and room temperature cups of water
- Liquid Nitrogen (optional)
- Balloon (optional)

Initial Demonstration:

Visit this website on an overhead projector or in small groups around computers (www.harcourtschool.com/activity/states_of_matter/index.html). This website briefly compares the atomic/molecular motion of solids, liquids and gases. It does so with words as well as images. The key message from this is that when materials are heated to a higher temperature, their atoms/molecules vibrate more and push apart, taking up more space. However, be weary, an important exception to this is water, when it cools from a liquid phase to a solid phase (ice) it actually expands. (Aren't we lucky.)

[Optional] Do a demonstration with liquid nitrogen to elaborate on this idea that materials expand as their temperature increases and contract as their temperature decreases.

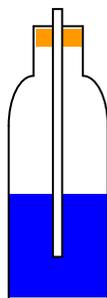
Half fill a balloon with air and tie the end. Talk about the air that is inside and that the molecules are pushing each other as well as the sides of the balloon and this is what gives the balloon its shape. Next, dip the balloon (using proper safety equipment) into the liquid nitrogen. When the balloon is removed it will look completely deflated. Discuss how the particles in the balloon are now very cold, and not vibrating very much at all. As a result they aren't pushing on each other or the balloon walls as much and they don't take up as much space. The air didn't

disappear, the volume just contracted. You can convince them of this by allowing the balloon to slowly warm up in room temperature again, returning to its original size.

Liquid nitrogen is the same nitrogen we breath in our atmosphere, except it is so cold that it is in a liquid phase. To demonstrate this, 'soak' a small plastic film canister in the liquid nitrogen. With appropriate safety equipment remove the canister and fill the bottom 1/5 with liquid nitrogen. Quickly cap the film canister, set on the table and **stand back**. As the liquid nitrogen's temperature increases, the molecules/atoms start vibrating more, pushing on each other and the sides of the canister more (the pressure increases). Eventually the pressure is too great and the canister 'pops'.

Procedure:

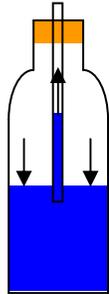
1. Fill the plastic pop bottle halfway with water (preferably cold water, this ensures that the air above the water is also cold).
2. Add a small amount of food coloring. This allows the water level in the straw to be seen more easily.
3. Use a small amount of clay at the mouth of the bottle to hold the straw in the water. (See diagram below, blue = water, yellow = clay) The seal around the straw and around the rim of the bottle needs to be airtight. The straw should not be clogged.



4. Place a hand on the outside of the bottle near the top (to warm the air inside). It is important not to squeeze the bottle! The gas in the bottle should warm and expand. As a result the air pushes down on the water. This causes the water level inside the straw to rise! The warmer the gas, the higher the water level! It's a thermometer!
5. Place three beakers of water at the front of the room. One with hot water, one with cold water, and one with room temperature water. Put an alcohol thermometer in each one.

Discussion:

1. How do humans tell temperature? (Touch- nerves, thermometers- expanding mercury or alcohol, thermostats- two strips of metal back to back and coiled, sight- glowing red is hot!)
2. (Explain) What happened to the level of water in the straw? (When the hand was on the outside, the water level went up. When the hand was removed, the water level slowly dropped.)
3. (Explain) Please explain in words and/or draw a diagram that shows how our thermometer works. (The gas in the bottle warms and expands. The air has no place to go so it pushes down on the water. This causes the water level inside the straw to rise. As the gas cools, the air does not push as much and the water level drops.)



4. (Expand) How might we improve this thermometer? (Mark the straw at certain intervals so the thermometer can tell us what the actual temperature is.)
5. (Expand) What are the limitations of this microscope? (Thermometer will not work below 32 degrees Fahrenheit or 0 degrees Celsius because the water would freeze.)
6. (Expand) Measure the temperature of the three cups in the front of the room. This will allow the students to connect what was done in class to a real thermometer. Allow them to measure the temperatures to practice using a thermometer and to get a qualitative feel for how a thermometer behaves.

[Lab Notebook Structure]

Lab # 15- How to make a thermometer!

Feb. 2, 2007

Purpose- To learn how most thermometers work by making our own!

Materials- Plastic bottle, clay, straw, food coloring, water

Question (Engage)- How do humans tell temperature? (Touch, thermometers, thermostats, sight)

Procedure (Explore)

1. Fill bottle halfway with water.
Amount of Water: _____
2. Add food coloring to the water.
Number of Drops: _____
3. Place straw in bottle and seal the top with clay.
4. Place hands gently around the top part of the bottle to warm up the 'thermometer'. Do not squeeze bottle!

Questions

1. (Explain) What happened to the level of water in the straw?
2. (Expalin) Please explain in words and/or draw a diagram that shows how our thermometer works.
3. (Expand) How might we improve this thermometer?
4. (Expand) What are the limitations of this thermometer?
5. (Expand) Measure the temperature of the three cups in the front of the room. (Both Fahrenheit and Celcius)

Hot _____

Room Temperature _____

Cold _____