

Heat: An Agent of Change

Thermometers and Thermostats

TEACHER GUIDE

BACKGROUND INFORMATION

Metals expand at differing rates with the same input of heat. The **thermal expansion coefficient** value assigned to each material expresses these differences. The coefficient for a given material is a measure of the fractional change in length per degree change in temperature. The coefficient itself slightly changes with ambient temperature, and is most commonly reported as an average value for the temperature range of interest, typically room temperature to 100° C.

If two metals are bonded together, and they both try to expand but at different rates, the welded strip will bend. Novelty "jumping discs," commonly available from science supply companies, demonstrate this in an entertaining manner. Regular bimetal strips are the standard science equipment used to show the effect of heated and cooled metals bending back and forth. This activity makes a model of a bimetal strip out of two types of tape.

STANDARDS ADDRESSED

Grades 5–8: [Abilities necessary to do scientific inquiry](#)

Grades 9–12: [Abilities necessary to do scientific inquiry](#)

MATERIALS NEEDED

Thermometers

Various kinds of tape, including paper masking, plastic transparent, adhesive, duct, bookbinding, strapping, and so on
Heat source (blow dryer or light bulb works well).

PROCEDURE

Teachers (and students) often assume that, by middle school, children have used and understand thermometers. Often this is not totally true. Begin this activity by reviewing the basics of how to read a thermometer. (Perhaps the math teacher can collaborate with you on this one.)

Typical rules for using a thermometer include:

- Handle the thermometer carefully from the top of the stem (so body heat is not transferred to the bulb).
- Leave the thermometer in the liquid being measured (the measured temperature will change when the bulb is exposed to room temperature air).
- Read the temperature with your eye at the level of the column in the thermometer stem (to increase accuracy).
- Never use the thermometer to stir (it could break).
- Never read the temperature with the thermometer resting against the bottom or side of the container (you are not really measuring the temperature of the liquid).



After reviewing correct procedures for measuring temperatures in liquids with a thermometer, continue with building the model thermostat.

Disassembling a real thermostat is a connection to real-life, as is locating a thermostat under the hood of a car.

After finishing the experiments with various combinations of bi-tape strips, students may discuss which worked best. Did the strip always bend in the same direction? Some lab groups may not have noticed this, which may necessitate additional experimentation.

ADDITIONAL LEARNING OPPORTUNITIES

1. Design a simple breadboard circuit that incorporates a thermostat.
2. Investigate the use of thermostats in industrial situations, such as incubators or ovens. How do these tools work?
3. Invent a way to calibrate an unmarked thermometer. Test your proposed process.

RESOURCES

<http://www.pr.erau.edu/~metro/cwx/notes/chap03/thermometer.html>

This site gives advantages and disadvantages of various types of thermometers, including mercury, alcohol, and bimetallic.

<http://acs1.bu.edu:8001/~connw/physics.html>

Despite misspellings, this site offers valuable information about how a thermometer works.

<http://esf.uvm.edu/envhazwaste/thermswap.html>

An offer to trade your mercury thermometers for environmentally safe models, at no cost.

<http://www.beakman.com/interact/pole.html>

Beakman answers the question "How do thermometers work?" The site includes an interactive simulation of the sun's heat expanding power lines.

http://www.pd.sk.k12.ri.us/GEMS_NET/Weather/Thermometer.html

This site contains a lesson on how to read a thermometer.

<http://www.galaxy.net/~k12/weather/makether.shtml>

Directions for making a bottle thermometer.

<http://www.avstc.org/sthtml/solar/hottherm.htm>

Photo and description of a student project to make a bottle thermometer.

<http://server2.greatlakes.k12.mi.us/explorerer/desc/7837499615-447DED81.html>

A blank thermometer graphic for downloading to use for recording of elementary weather data.