MiSP THERMAL CONDUCTION
Teacher Guide, L1 – L3

Introduction

This unit is usually part of a physics/energy unit. In this unit students will study heat transfer by conduction. Conduction is one of three ways that heat is transferred. The other two are convection and radiation. Students will also learn that some materials are better conductors than others. Insulators will be introduced.

Students may be confused by the difference between electrical and heat conductors and insulators. The terms have the same definitions. The difference is the medium being transferred.

Conduction is the transfer of heat by the action of vibrating molecules or atoms. There is no transfer of matter. Convection occurs by movement of fluids (gas or liquid). There is a movement of matter. Radiation does not involve matter. The transfer of energy is by electromagnetic radiation.

An insulator does not allow molecules to conduct heat or electricity efficiently through the material.

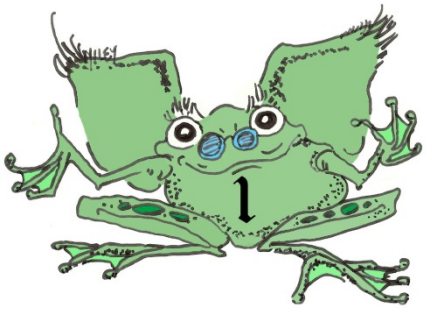
There are many everyday applications to discuss when studying conduction.

Standards

ILST Core Curriculum — Major Understandings:
Standard 4 Physical Setting 4.2a, 4.2b
Physical Setting / Earth Science Core Curriculum — Major Understandings:
Standard 4 Physical Setting 2.2b

Lesson Objectives: After completing this unit, students will be able to

- Define and describe heat transfer by conduction
- Define and describe insulation
- Test materials to see if they are good or poor conductors/insulators
- Explain that heat moves from objects at warmer temperatures to objects at cooler temperatures
- Identify the heat source and the heat sink in an experiment
- Accurately record and graph experimental data



- Apply and generalize how conductors and insulators are used in conserving energy in the home during the winter and the summer
- Quantify the changes in temperature in materials over time by calculating unit rate of change (slope) (L2)
- Compare the unit rates of change (slopes) in temperature changes versus time graphs of selected materials as they are heated or allowed to cool (L2)
- Calculate and apply the formulas for the materials' graphed best-fit lines (L3).

Day 1 — Heat Transfer

Review or introduce the concept of heat transfer by conduction, convection, and radiation.

Include definitions of *heat* and *transfer*. Stress that there is no such thing as cold.

It is recommended that the day 2 lab be introduced and possibly set up during day 1.

The following Internet resources may be used:

http://aspire.cosmic-ray.org/labs/atmosphere/popcorn.html (Note: The demonstration of convection may be a stretch.)

http://www.wisc-online.com/objects/ViewObject.aspx?ID=sce304

http://www.google.com/search?q=conduction%2C+convection%2C+radiation+ppt&sourceid=ie7&rls=com.microsoft:en-us:IE-SearchBox&ie=&oe=

http://www.slideserve.com/presentation/8069/Conduction-Convection-and-Radiation-PPT

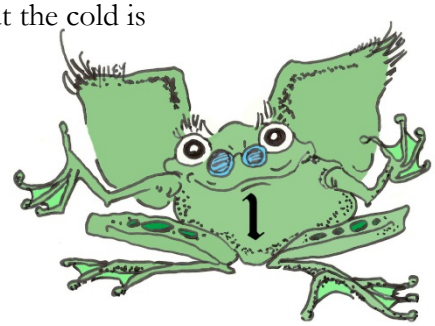
http://www.teachersource.com/Energy/Thermodynamics/AmazingIceMeltingBlocks.aspx

For demonstrations, see:

Liem, Tik L. *Invitations to Science Inquiry*, Second Edition, 1987, Conduction, Convection, Radiation: 7.1 – 7.12, pp. 199–210

Question of the Day

A parent might yell to their child in the winter, "Close the door. You are letting the cold in." Although keeping the door closed would be good practice, the statement about the cold is scientifically incorrect. Why?



What are one or more ways that a parent could make the point they want to make and be scientifically correct? Start with, "Close the door; you are…"

Day 2 — Heat Transfer

The lab activity presented in Thermal Conduction Worksheet #1 should be set up a day in advance so the experiment can be started as soon as possible after the period begins. Teachers who have classes with double periods may want to extend the time for the lab from 15 to 30 minutes and have temperature readings taken every two minutes. If a school has computer probeware, a temperature probe may be used.

The lab uses heat transfer kits available from most science supply vendors. Cheaper versions can be made if you can get aluminum rods and have them bent into a horseshoe shape. Styrofoam cups, lids cut from Styrofoam sheets, and school thermometers work fine.

Students should be cautioned about handling hot water and required to wear safety goggles.

Slope and line equations focus on the second five minutes of the experiment, when the data will be the most linear. Teachers may use longer or shorter times, depending on the data. Best-fit lines may need to be drawn.

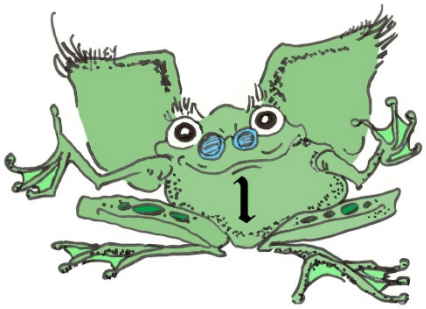
Question of the Day

If you put an aluminum pan and a plastic plate in a freezer at -10°C, each of the two objects would eventually have a temperature of -10°C. If you took the pan and the plate out of the freezer and pressed your hands to them, the aluminum pan would feel colder than the plastic plate. Why?

Days 3 and 4 — Heat Conduction in Different Materials

Students will observe the conduction of heat into and out of various materials.

Sections of pipes/tubes/rods of the following materials may be used: copper, steel, aluminum, wood, PVC, glass, etc. Strips of materials may be used instead. Each group should have three pieces, and the pieces should be at least 10" in length. Of course, the mass of the materials and the thickness are factors, but the data will be usable even if all variables are not controlled.



Stick-on thermometers are used to determine the temperatures. Each thermometer should be fastened at an equal distance from the bottom of the sample. The thermometers may be obtained from Omega (see www.omega.com) or other vendors.
Teachers will determine the depth of the water on the basis of the materials used, including the containers for the water baths.

Depending on the data, it may be best to use best-fit lines. Students may need assistance.

Teachers should experiment to determine the ideal temperatures for the hot and the cool water baths.

Day 5 — Assessment

Administer the appropriate level assessment.