Heat Transfer Labs and Demonstrations

Hear Transfer by Conduction Demonstration

Adapted from a lab from Western Oregon University.

Learning objective:

Students will be able to explain heat transfer by conduction and describe typical materials that are thermal conductors and thermal insulators.

Overview:

As a teacher demonstration or in small groups, students will place the three spoons in a bowl of hot water and observe the difference in temperatures between the three spoons.

Materials:

- A bowl or pot of water
- A way to heat the water
- 3 spoons: plastic, metal, and wood

Procedure:

Bring the water to boil and then place the three spoons in the water. Let the students touch the handles of the spoons and note the difference in temperature.

Explanation:

All materials conduct heat with different abilities. A material that conducts heat well is a “good thermal conductor”. In our spoons-in-hot-water example, given each spoon is in the hot water for the same amount of time, the temperature of a good thermal conductor will be higher than that of a poor one.

Discussion questions:

- Can you tell a difference in their temperatures?
- Which feels the hottest?

- Which feels the coolest?
- List the spoons in the order from best conductor to worst.
- Now you've seen that some materials conduct heat better than others. If you were frying yourself an omelet or tofu scramble for breakfast, would you rather use a skillet with a metal or a plastic handle? Why?
- You are building a new house and are given the choice of building the walls out of plywood or sheet metal. Which material should you use if your goal is to lose heat from the house as slowly as possible? Explain your reasoning.

Heat Transfer by Conduction: Insulating Materials Lab

Learning objective:

Students will be able to explain heat transfer by conduction and describe typical materials that are thermal conducts and the thermal insulators.

Overview:

In this lab activity, students will determine which materials are better insulators. We'll relate this to heat transfer in buildings.

Materials:

- One hand warmer per team of 3-4 students
- One thermal imaging camera per team
- A variety of materials, such as:
    - Fleece
    - Wool
    - Bubble wrap
    - Styrofoam
    - Aluminum foil
    - Procedures
    - Activate the hand warmer.

Procedure:

1. Activate the hand warmer
2. Measure the temperature of the hand warmer using the thermal imaging camera
3. Gently wrap the hand warmer in the insulating materials, one at a time. Wait at least 30 seconds for the heat to "transfer" to the material.
4. Using the thermal imaging camera, record the temperature for each material in the data table.

Material	Temperature reading/color
Baseline: Hand warmer	
Material 1	
Material 2	
Material 3	
Material 4	
Material 5, etc.	

Discussion questions:

1. How did the heat energy move during the experiment? Be specific.
2. Which materials were the best insulators?
3. Which materials were the worst insulators?
4. Which materials would have a higher U-value?
5. Which materials would have a higher R-value?

Heat Transfer by Radiation Lab

Adapted from a lab from Western Oregon University

Learning objective:

Students will be able to explain heat transfer by radiation and describe what kinds of materials can absorb radiation.

Overview:

As a teacher demonstration or in small groups, students will explore heat transfer by radiation using a lamp and different kinds of paper.

Materials needed:

- Lamp
- Black, dull piece of paper
- Shiny piece of paper or tin foil
- White piece of paper

Procedure:

Shine a light on each of the three pieces of paper. Place your hand on the black piece of paper. Note what you feel. Next, place your hand on the shiny piece. Ask yourself, "Do you feel anything different from the black piece?" Do the same for the white piece of paper and compare what you feel to the previous two.

Explanation:

You just investigated radiation. Radiation occurs when energy is transferred in the form of infrared waves. These waves can either be absorbed or emitted. If a material absorbs these waves, the temperature of the material rises.

Discussion questions:

1. Consider the pieces under the light. List these pieces, from the warmest (first) to the coolest.
2. Given this result, which is the best absorber? Which is the worst absorber?

3. Would you rather wear black or white on a hot summer day? Explain your answer.
4. Explain how this lab relates to buildings. What kinds of roofs or walls are more likely to absorb heat? How about windows?