

Which Cools Faster?

Subject Area(s): Physical Science
Associated Unit: Unit 3 – Properties of water
Associated Lesson: N/A
Activity Title : Which cools faster?



Image 1

ADA Description: The image shows a glass container of steaming water in air

Caption: A glass container of steaming water in air

Image file name: BoilingWater.bmp

Source/Rights: whatscookinginamerica.net

Grade Level: 4 (3-4)

Activity Dependency: None

Time Required: 45 mins

Group Size: 3

Expendable Cost per Group: US \$5

Summary

Students observe and record the cooling of water in two conditions – in water and in air. They construct a very simple heat exchanger using cups, with water and air being the heat transfer fluids. They learn that water has better heat transferring properties than air.

Engineering Connection

Heat exchange is an essential process in many chemical engineering applications. Chemical engineers exploit the heat transferring properties of materials in order to use the most appropriate one in a particular setting. For example, in nuclear plants, using water as a coolant may not be the best choice because disposing warm water may have a negative effect on the

eco-systems at the disposal site. As another example, cooling supercomputers with cold air may not be sufficient; liquid nitrogen may be the best choice for a coolant in this case.

Engineering Category

(#1) relates science concept to engineering

Keywords

air, conduction, energy, heat transfer, temperature, water

Educational Standards choose from <http://www.jesandco.org/asn/viewer/default.aspx>

State science: PS 2.1c; PS 3.2b,c; PS 4.1d

State math: none

Learning Objectives

After this activity, students should be able to:

- **Describe the requirement for conduction, understand that different materials conduct heat at different rates**

Materials List

Each group needs:

- Two small cups, two large cups (such that the small cups fit into the larger ones), hot water, water at room temperature, temperature sensors, stop-watch

Introduction / Motivation

Who knows what heat is? Heat is *energy* that is caused by an increase in temperature. For example, when water in a pot boils and its temperature goes up, it starts bubbling, and moving around. The fire that changes the temperature of water makes the water *heat* up. Now heat can travel from one material to another, as in from fire to water. How many of you have ever had hot chocolate? Did any of you ever burn your tongue? You've experienced *heat transfer*! The heat from the hot chocolate traveled to your tongue! Similar to this, other materials may transfer heat from one to another. Can anyone think of other examples? (ice cubes in lemonade) But different materials may transfer heat faster than others. How many of you have eaten soup? Have you used a metal spoon? A plastic spoon? Which one was hotter in your hand? This is because the metal spoons transfer heat from the soup faster than plastics spoons. This form of heat transfer is called *conduction*. Conduction requires only that the two materials touch each other. Who can think of another requirement for conduction? But of course! The two materials have to be at different temperatures!

Heat transfer is a very important in chemical engineering. Selecting the right material to cool a hot material is very important. A hot water stream is very bad for the environment – it will be bad for the fishes, and other living things. So before it comes out of the factory, it may need to be cooled down. Usually, engineers try to come up with the cheapest materials to do that. So one option would be to do it with air – we all know its free, a second option would be water, it's the second cheapest thing. So today we will become chemical engineers and try to cool down some hot water in a cup using cheapest materials – air and water.

So, which material, air or water at room temperature, will cool down the cup of hot water faster? Does anyone think that the water and air will cool down the hot water at the same rate? (count the number of students who answer air, water, or same and make a table and then see who was right)

In air	In water	Same

Vocabulary / Definitions

Word	Definition
heat transfer	Movement of energy from one object to another
Conduction	One of the forms of heat transfer that requires only that (1) the objects are in contact with one another and (2) are at different temperatures

Procedure

Before the Activity

- Have some water at room temperature (in the same room where the experiment will be conducted such that the air and water will be at the same temperature)

With the Students

- **Divide the students into groups of 3—Each group should have two temperature sensors, 2 smaller cups and 2 larger cups**
- **Put some hot water (from the faucet) into two smaller cups**
- **Place the smaller cups inside the larger cups**
- **Pour the water at room temperature into one of the larger cups (such that it doesn't go into the smaller cup with hot water)**
- **Measure the temperature of the hot water at time 0**
- **Ask the students which one of the cups with hot water will cool faster**
- **One of the students with a stop watch should count off 1 minute intervals. Have another student read out the temperature after the 1 minute time interval. The third student records the temperature and a time interval in a note book.**
- **Possibly ask the students why the heat transfer in water is faster than in air??**

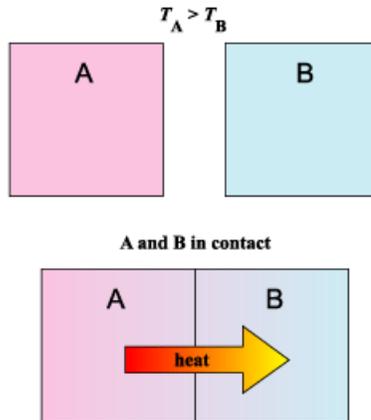


Figure 1

ADA Description: A picture illustrating two blocks representing different temperature materials, and showing how by placing the different materials in contact temperature transfers between the materials

Caption: Figure 1: Heat Transfer Illustration

Image file name: heat_transfer.gif

Source/Rights: <http://yuyingandstuff.blogspot.com/>

Safety Issues

- Handling hot water

Troubleshooting Tips

- If temperature change is not observed quickly enough, increase time intervals of temperature data collection

Investigating Questions

- Which cup of water will cool faster?

Assessment

Pre-Activity Assessment

See introduction/motivation section

Activity Embedded Assessment

See introduction/motivation section

Post-Activity Assessment

Students complete a worksheet with fill-in-the-blank questions

1. Increasing temperature of an object causes its _____ (energy/heat) to increase.
2. One form of movement of heat from one object that is touching the other object is called _____ (conduction)
3. General movement of heat from one object to another is called _____ (heat transfer)

4. Different materials _____(transfer heat) faster than others

5. Water transfers heat _____(faster) than air.

Supporting Program

Project AMPS under GK12 grant 0807286 from the NSF

Version: April 2010