

Heat Flow in Snow and Ice – Change in temperature and mass

Dr. Delena Norris-Tull (d_norris@umwestern.edu)
University of Montana Western, Department of Education

Adapted with permission from an activity developed by
Marjorie A. Porter (marjorie.a.porter@snet.net)
Somers High School
Somers, Connecticut

Objective – Students will:

1. Measure and create graphs of changes in temperature and mass as water cools
2. Demonstrate understanding of the relationship between temperature change and heat loss in lakes in winter

Equipment for each group of two students

Two insulated cups with covers for each group of students (Mark the cups “Open” and “Covered”)

Two thermometers (Celcius) long enough to protrude from top of cup

A balance and weights (or digital scale)

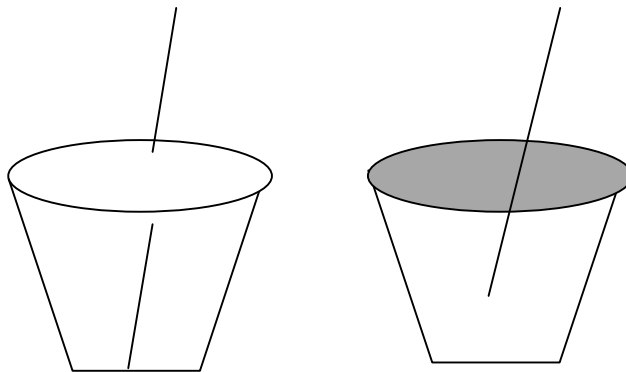
Hot water

Safety glasses

Activity: (See diagram below)

1. Heat water (does not need to be boiling)
2. Quickly pour approximately equal amounts of water in each of two cups (at least 100 ml) (1 ml water = 1 gram water)
3. Immediately cover both cups with lids
4. Use the balance to determine the mass of each cup of water (do this quickly) – record the mass.
5. Remove the lid from one cup.

6. Immediately take the water temperature (Celcius) in each cup and record it. (Put the thermometer through a small hole in the covered cup and leave it there).
7. Write down what you predict will happen to the water in each cup over the next 30 minutes. What factors will affect what happens to the water?
8. Record the temperature in each cup once every minute until the temperatures level off (equilibrate, reach equilibrium).
9. Put the lid back on the open cup.
10. Record the mass of both cups.



Cup with lid

Open cup

Results:

1. Create graphs showing what happens to the temperature and the mass in each cup.
2. Describe the lines you produced for the graphs – explain what the lines tell you about any changes in the water in the two cups.

3. In your groups, write responses to the following questions, which we will discuss with the whole class later:
- How long did it take the water temperature in the each cup to level off (reach equilibrium)?
 - What might have caused the difference between the two cups in the time it took for the temperature to level off?
 - Did the mass of water in each cup stay the same or change over time?
 - What might have caused any changes in mass that you noticed?
 - Imagine that the cups of water were actually lakes or oceans and the lids represent layers of ice and snow. How might the presence or absence of ice and snow affect what happens to a lake or ocean over the course of the winter?

Teacher's key:

- The students should observe that the cup that remains open cools more rapidly. The open cup will also lose a small amount of mass (you need at least 100ml of hot water to observe a measurable change in mass).
- The covered cup will take longer to equilibrate. And it will not lose a measurable amount of mass.
- The cups simulate a lake that has no ice and snow on it (open cup), and a lake that is covered with ice and snow. The ice and snow slows down the loss of heat from the lake, and dramatically slows down the evaporation of water (mass) from the lake.
- Heat escapes from the cups by *conduction* and/or *convection*.
- Conduction - heat escapes by direct contact of the water with the sides of the cup. This occurs in both cups.
- Convection - Water holds heat. As the water vapor escapes from the surface of the water, and floats away, it carries both heat and mass (water) with it. The open cup allows the water vapor to escape.

Change in Temperature: Covered and Uncovered Cups

Time (Minutes)

Change in Mass: Covered and Uncovered Cups

Time (Minutes)