Freezing and Melting

Introduction

A large ice cube takes longer to melt than a small one, as does a large pile of snow compared to a small one. On a cold evening a puddle will freeze while the lake next to it does not. You should keep these events in mind while you are working on this activity. How does the amount of a substance affect its change from liquid to solid or from solid to liquid? What is happening as the substance changes phase? Try to explain what is happening in terms of molecules as you are working your way through this investigation.

Objectives:

Construct and interpret tables and graphs to analyze data.

Form an inference from a set of related observations.

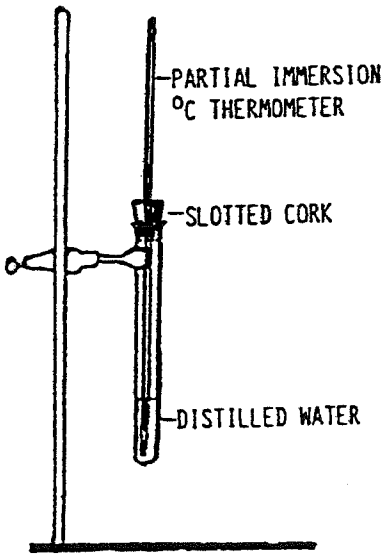
Relate changes in temperature to changes in the motion of molecules.

Equipment and Materials:

styrofoam cup or a 400 ml (or larger) beaker
plastic spoon
ring stand
test tube clamp
paper towels
2 thermometers
distilled water
test tube with slotted cork to fit thermometer
crushed ice or snow
30 ml of calcium chloride or rock salt per lab group

Procedure:

Part 1: Observations of Water Freezing



1. Set up the apparatus as shown in Figure 1. Put water in the test tube to a depth of about 3 cm. Be certain the thermometer bulb is centered in the water. It should not touch the sides or bottom of the test tube.

2. Put about 2 cm. of ice or snow in the bottom of a styrofoam cup.

3. Lower the test tube containing the thermometer into the cup by loosening the clamp.

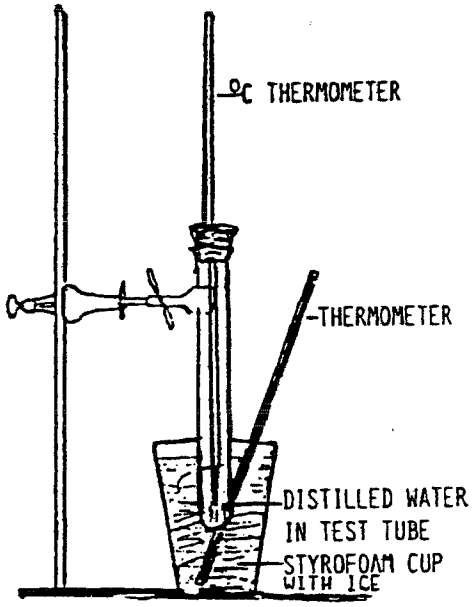
4. Layer ice and salt around the test tube so the water level in the tube is below the surface of the ice.

5. Insert the second thermometer into the salt-ice brine.

6. Take the initial temperatures of:

   a. the water in the test tube.
   b. the ice-salt mixture in the styrofoam cup.

   After each reading, momentarily raise the tube and observe the water in the tube. Record these observations in the Data Table on page 8.3. Continue taking readings and observations every 30 seconds until the water in the test tube reaches at least -5°C.



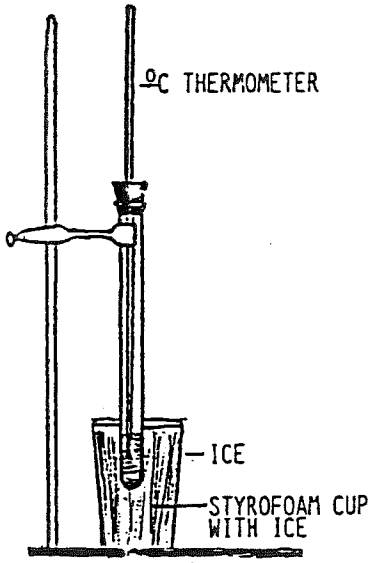
7. Upon reaching -5°C or lower, begin Part 2.

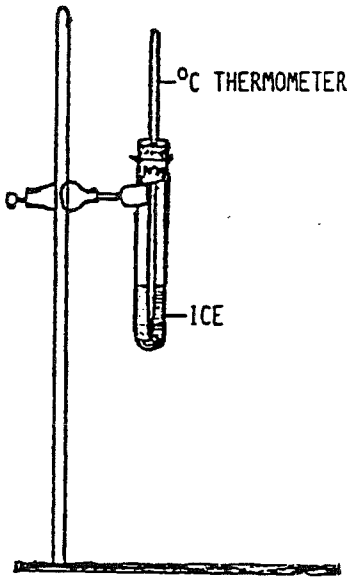
Procedure: (continued)

Part 2: Observations of Melting Ice

8. At the end of Part I (freezing) the apparatus looked like Figure 1. Raise the tube from the ice brine as shown in Figure 2. Record the temperature and observations of the ice in the tube every 30 seconds until the temperature reaches 10 degrees C.

9. On a sheet of graph paper, construct a line graph of temperature vs. time for each set of data. Use a different color for each graph.





Data Table - Part 2 - Melting

Time (min.)	Temperature of water	Observations
0.0		
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		
4.5		
5.0		
5.5		
6.0		
6.5		
7.0		
7.5		
8.0		
8.5		
9.0		
9.5		
10.0		
10.5		
11.0		
11.5		
12.0		
12.5		
13.0		
13.5		
14.0		
14.5		
15.0		
15.5		
16.0		
16.5		
17.0		
17.5		
18.0		
18.5		
19.0		
19.5		
20.0		

Name _____

Section _____

Data Table - Part 1 Freezing

Time (min.)	Temperature of water	Temperature of salt brine	Observations
0.0			
0.5			
1.0			
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0			
5.5			
6.0			
6.5			
7.0			
7.5			
8.0			
8.5			
9.0			
9.5			
10.0			
10.5			
11.0			
11.5			
12.0			
12.5			
13.0			
13.5			
14.0			
14.5			
15.0			
15.5			
16.0			
16.5			
17.0			
17.5			
18.0			
18.5			
19.0			
19.5			
20.0			

Name _____ 8.5

Section _____

Questions:

1. At what temperature does water freeze?

2. Notice that the ice in the cup is melting, but the temperature is below the freezing point of the water in the test tube. How does this compare to your answer in question 1? Explain why this happens?

3. When looking at a graph, important things to make note of are when something changes. On a graph, changes are represented by a different slope. With this in mind, look at your graph for melting and describe the shape of your graph.

4. Describe the section of the graph corresponding to times when the water was changing from liquid to solid. Explain what was happening in terms of molecules.

5. How does the graph of the melting of ice compare to the one you made for freezing of water?

Questions (continued)

6. Complete the temperature-time graph showing what happens when ice is heated from -10°C to water vapor. Indicate the temperatures at which the ice melts and the water boils. Recall what happens to the temperature of water as it boils. (HINT: If you were to draw the melting and boiling curves on one graph, what would it look like?)