Experiment 2

Freezing and Melting of Water

Freezing temperature, the temperature at which a substance turns from liquid to solid, and melting temperature, the temperature at which a substance turns from a solid to a liquid, are characteristic physical properties. In this experiment, the cooling and warming behavior of a familiar substance, water, will be investigated. By examining graphs of the data, the freezing and melting temperatures of water will be determined and compared.

OBJECTIVES

In this experiment, you will

- Collect temperature data during the freezing and melting of water.
- Analyze graphs to determine the freezing and melting temperatures of water.
- Determine the relationship between the freezing and melting temperatures of water.

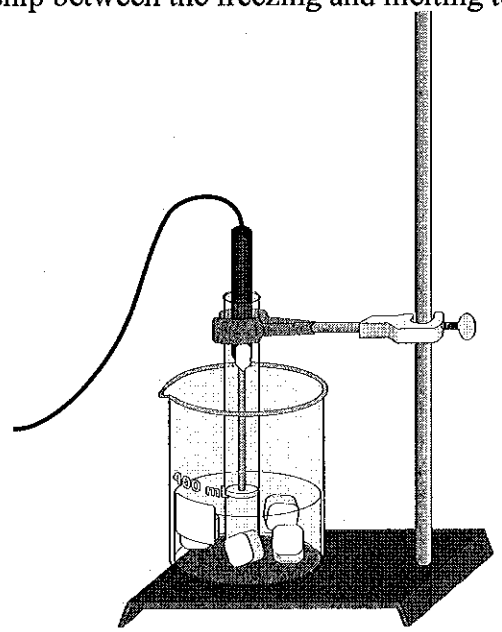

Figure 1

MATERIALS

computer
Vernier computer interface
Logger*Pro*
Temperature Probe
ring stand
utility clamp
test tube
400 mL beaker
water
10 mL graduated cylinder
ice
salt
stirring rod

PROCEDURE

Part I: Freezing

1. Fill a 400 mL beaker 1/3 full with ice, then add 100 mL of water.
2. Put 5 mL of water into a test tube and use a utility clamp to fasten the test tube to a ring stand. The test tube should be clamped above the water bath. Place a Temperature Probe into the water inside the test tube.
3. Connect the probe to the computer interface. Prepare the computer for data collection by opening the file "02 Freeze Melt Water" from the *Chemistry with Computers* folder of Logger*Pro*. You may also have to choose the correct sensor.
4. When everything is ready, click [Collect] to begin data collection. Then lower the test tube into the ice-water bath.
5. Soon after lowering the test tube, add 5 spoons of salt to the beaker and stir with a stirring rod. Continue to stir the ice-water bath during Part I. **Important:** Stir enough to dissolve the salt.
6. **Slightly, but continuously, move the probe during the first 10 minutes of Part I.** Be careful to keep the probe in, and not above, the ice as it forms. When 10 minutes have gone by, stop moving the probe and allow it to freeze into the ice. Add more ice cubes to the beaker as the original ice cubes get smaller.
7. When 15 minutes have passed, data collection will stop. Keep the test tube *submerged* in the ice-water bath until Step 10.
8. On the displayed graph, analyze the flat part of the curve to determine the freezing temperature of water:
   a. Move the mouse pointer to the beginning of the graph's flat part. Press the mouse button and hold it down as you drag across the flat part to *select* it.
   b. Click on the Statistics button, [STAT]. The mean temperature value for the selected data is listed in the statistics box on the graph. Record this value as the freezing temperature.
   c. To remove the statistics box, click on the upper-left corner of the box.
9. PRINT A COPY OF THE GRAPH
10. Answer the questions on the back of your graph sheet.

PROCESSING THE DATA

1. What happened to the water temperature during freezing?

2. According to your data and graph, what is the freezing temperature of water? Is this the same as the theoretical freezing point of water? If not, what may have caused error?

3. Use your graph to record the highest and lowest temperatures measured.

4. Calculate the heat lost by the water, in Joules, from the highest temperature recorded to the theoretical freezing point.

   Use: $q = C_p m \Delta t$ where C_p for water is 4.18 J/g°C

5. Calculate the heat lost by the water, in Joules, at the theoretical freezing point.

   Use: $q = H_f m$ where H_f is 334 J/g

6. Calculate the heat lost by the ice, in Joules, from the theoretical freezing point to the lowest temperature recored.

   Use: $q = C_p m \Delta t$ where C_p for ice is 2.09 J/g°C

7. What was the total heat lost by H_2O in your 15 minute lab experiment?