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.
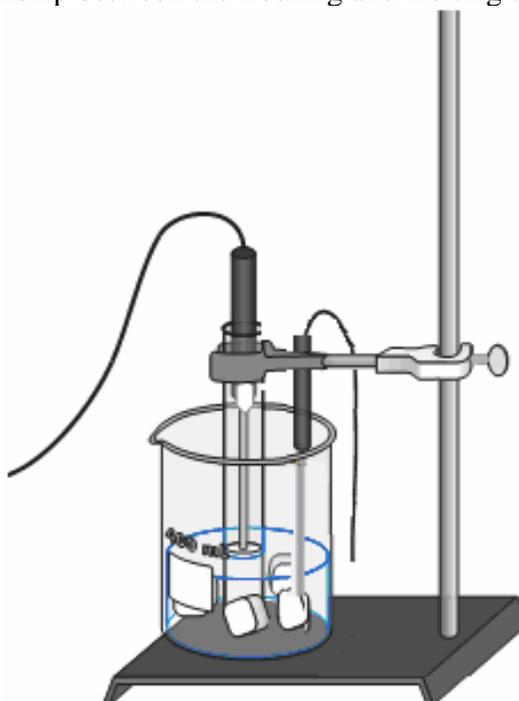

Figure 1

MATERIALS

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

PROCEDURE

Part I: Freezing

1. Fill a 400 mL beaker 1/2 full with ice, then add 100 mL of water.

2. Put 5 mL of distilled 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. Place another Temperature Probe into the ice water bath.

3. Connect the probes 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*. Be sure the program has a data column for each temperature probe.

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 inside the test tube 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 in your data table.

    c. To remove the statistics box, click on the upper-left corner of the box.

Part II: Melting

9. Prepare the computer for data collection. From the Experiment menu, choose **Store Latest Run**. This stores the data so it can be used later. To hide the curve of your first data run, click the Temperature vertical-axis label of the graph, click More, and uncheck the Run 1 Temperature box. Click [OK].

10. Click [▶ Collect] to begin data collection. Then raise the test tube and fasten it in a position above the ice-water bath. Do not move the Temperature Probe inside the test tube during Part II. Position the other temperature probe so that it is hanging in the air nearby the test tube.

11. Dispose of the ice water by dumping it into your sink. Obtain 250 mL of warm tap water in the beaker. When 12 minutes have passed, lower the test tube and its contents into this warm-water bath. AT THE SAME TIME, place the second temperature probe into the warm water.

12. When 15 minutes have passed, data collection will stop.

13. On the displayed graph, analyze the flat part of the curve to determine the melting 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 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 melting temperature in your data table.

    c. To remove the statistics box, click on the upper-left corner of the box.

14. To print a graph of temperature *vs.* time showing both data runs:

    a. Click the Temperature vertical-axis label of the graph. To display both temperature runs, click More, and check the Run 1 Temperature and Latest Temperature boxes. Click [OK].

    b. Label all the curves by choosing Text Annotation from the Insert menu, and typing "Freezing Curve" or "Melting Curve" or "Surroundings" in the edit box. Then drag each box to a position near its respective curve. Adjust the orientation of the arrowhead by clicking and dragging to the desired position.

    c. Print a copy of the graph. Enter your name(s) and the number of copies of the graph you want.

REPORT SHEET
Freezing and Melting of Water

NAME_____**DATE**_____

OBSERVATIONS:

DATA TABLE

Freezing temperature of water	°C
Melting temperature of water	°C

PROCESSING THE DATA

1. What happened to the water temperature during freezing?

2. What happened to the water temperature during melting?

3. According to your data and graph, what is the freezing temperature of water? Express your answer to the nearest 0.1°C.

4. According to your data and graph, what is the melting temperature of water? Express your answer to the nearest 0.1°C.

3. How does the freezing temperature of water compare to its melting temperature?

4. Tell if the ***kinetic energy*** of the water in the test tube increases, decreases, or remains the same in each of these time segments during the experiment.

    a. when the temperature is changing at the beginning and end of Part I

    b. when the temperature remains constant in Part I

    c. when the temperature is changing at the beginning and end of Part II

    d. when the temperature remains constant in Part II

5. In those parts of Question 4 in which there was no kinetic energy change, tell if ***potential energy*** increased or decreased.