

Freezing and Melting of Water **2**

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.

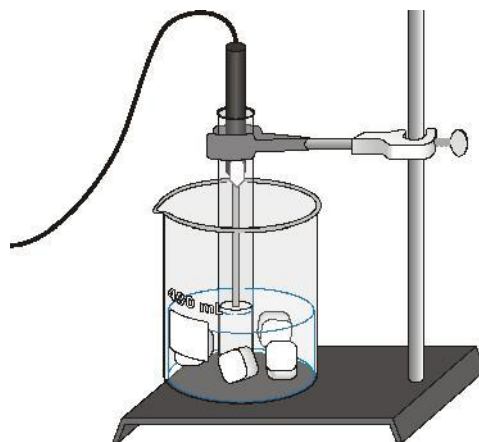


Figure 1


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 tap water.
2. Put 5 mL of distilled water into **your largest** 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*.
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. After 10 minutes have gone by, stop moving the probe and allow the water to freeze. Add more ice **and** salt to the beaker to allow the temperature to go below zero degrees (ideally -2 degrees or lower) before 15 minutes have passed.
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. 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.
10. **VERY IMPORTANT:** Before doing Step 11, **Make sure that the temperature reading is -2.0 degrees or lower and that the water inside the test tube is frozen. If not, add more ice and salt to the beaker until these conditions are met.** Then proceed with Step 11
11. C l i c k  **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 during Part II.
12. Dispose of the ice water as directed by your teacher. 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.
13. When 15 minutes have passed, data collection will stop.

14. On the displayed 2nd 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 2nd 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, . The mean temperature value for the selected data is listed in the statistics box on the graph. Record the value with the same color as this line, as the melting temperature in your data table.
 - c. To remove the statistics box, click on the upper-left corner of the box.
15. To print a graph of temperature vs. time showing both data runs:
 - a. Label both curves by choosing Text Annotation from the Insert menu, and typing "Freezing Curve" (or "Melting Curve") 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.
 - b. Print a copy of the graph. Enter your name(s) and the number of copies of the graph you want.

OBSERVATIONS

DATA TABLE

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

PROCESSING THE DATA

1. According to your data and graph, what is the freezing temperature of water? The melting temperature? Express your answers to the nearest 0.1°C.
2. How does the freezing temperature of water compare to its melting temperature? How **should** the freezing and melting points of water compare to each other?_