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.

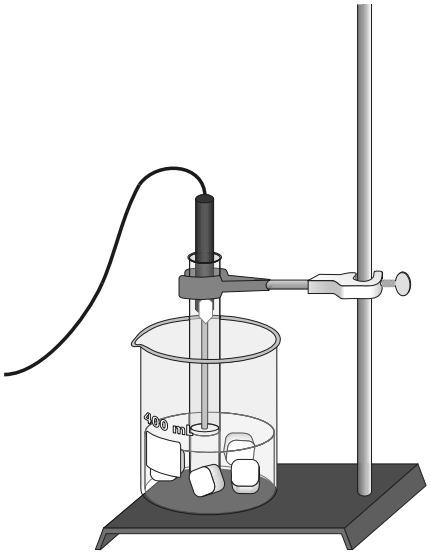

Figure 1

MATERIALS

TI-Nspire handheld **or**
  computer and TI-Nspire software
EasyTemp **or** Go!Temp **or**
  Temperature Probe and data-collection interface
ring stand with utility clamp
stirring rod
400 mL beaker
10 mL graduated cylinder
test tube (25 x 150 mm)
salt
ice
water

PROCEDURE

Part I Freezing

1. Put about 100 mL of water and 6 ice cubes into a 400 mL beaker.

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 situated above the water bath. Place the Temperature Probe into the water inside the test tube.

3. Connect the Temperature Probe to the data-collection interface. Connect the interface to the TI-Nspire handheld or computer. (If you are using an EasyTemp or Go!Temp, you do not need a data-collection interface.)

4. Choose New Experiment from the Experiment menu. Choose Collection Setup from the Experiment menu. Enter **0.2** as the rate (samples/second) and **900** as the experiment duration in seconds (15 minutes). The number of points collected should be 181. Select OK.

5. When everything is ready, start data collection ( ). Lower the test tube into the ice-water bath.

6. 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 throughout the remainder of Part I.

7. Slightly, but continuously, move the Temperature 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.

8. Data collection will stop after 900 seconds. Keep the test tube *submerged* in the ice-water bath until Step 11.

9. Analyze the flat part of the graph to determine the freezing temperature of water.
   a. Identify the flat portion of the graph that represents freezing. Select the data in the flat portion of the graph.
   b. Choose Statistics from the Analyze menu.
   c. Record the mean (average) temperature. This is your value for the freezing temperature of water.

Part II Melting

10. Click the Store Latest Data Set button ( ) to store data from the first run.

11. Start 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. Data collection will stop after 900 seconds. Analyze the flat part of the graph to determine the melting temperature of water.
    a. Identify a flat portion of the graph that represents melting. Select a region of data in the flat potion of the graph.
    b. Choose Statistics from the Analyze menu.
    c. Record the mean (average) temperature. This is your value for the melting temperature of ice.
14. A good way to compare the freezing and melting curves is to view both sets of data on one graph. Click **run2** and select All. Both runs will now be displayed on the same graph. Sketch or print this graph.

DATA

Freezing temperature of water (°C)	
Melting temperature of ice (°C)	

QUESTIONS

1. What happened to the water temperature during freezing? During melting?
2. 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.
3. How does the freezing temperature of water compare to the melting temperature of ice?
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 when:
    a. the temperature is changing before and after the water reaches its freezing point in Part I.
    b. the temperature remains constant in Part I.
    c. the temperature is changing before and after the ice reaches its melting point in Part II.
    d. 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.