Freezing and Melting of Water

Freezing temperature is the temperature at which a substance turns from a liquid to a solid. Melting temperature is the temperature at which a substance turns from a solid to a liquid. Freezing temperature and melting temperature are characteristic properties of a pure substance. In this experiment, you will determine and compare the freezing and melting temperatures of water.

OBJECTIVES

In this experiment, you will

- Use a LabQuest and a Temperature Probe to measure temperature.
- Record data.
- Make a graph of the data.
- Analyze your data and graphs to determine the freezing and melting temperatures of water.
- Determine the relationship between the freezing and melting temperatures of water.
- Apply the concepts studied in a new situation.

MATERIALS

LabQuest	600 mL beaker
LabQuest App	5 mL water
Temperature Probe	10 mL graduated cylinder
ring stand	ice
utility clamp	30 g of salt
20 x 150 mm test tube	stirring rod

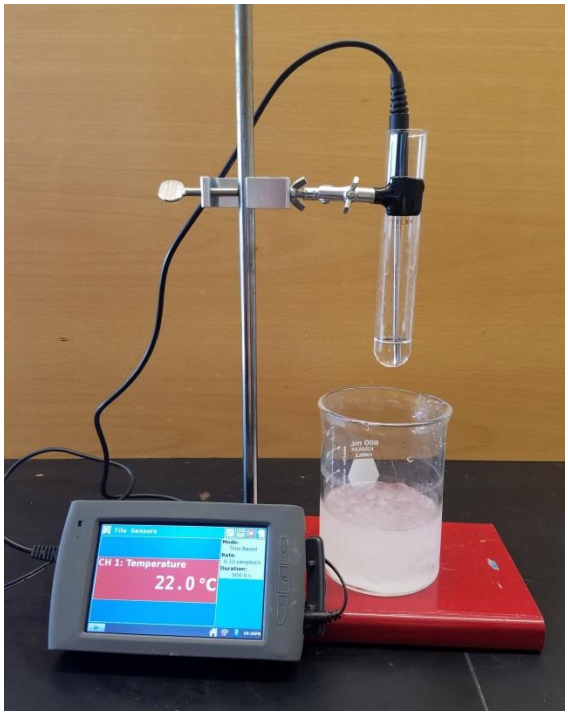

Figure 1. Initial experimental setup.

PROCEDURE

Part I Freezing

1. Fill a 600 mL beaker 1/3 full with ice, and then add 20 g of rock salt.
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 ice bath. Place a Temperature Probe into the water inside the test tube as in Figure 1.
3. Connect the Temperature Probe to LabQuest and choose New from the File menu.
4. On the Meter screen, tap Rate. A new window will appear. In the Rate box enter to 0.2 samples/s and in the Duration box enter 900 s (seconds). Press OK. This will take you back to the Meter Screen.
5. When everything is ready, start data collection pressing on the green triangle button located in the left hand corner of the device. A red square will appear in its place indicating the start of the run.
6. After data have been collected for 30 seconds, lower the test tube into the ice-water bath as in Figure 2.

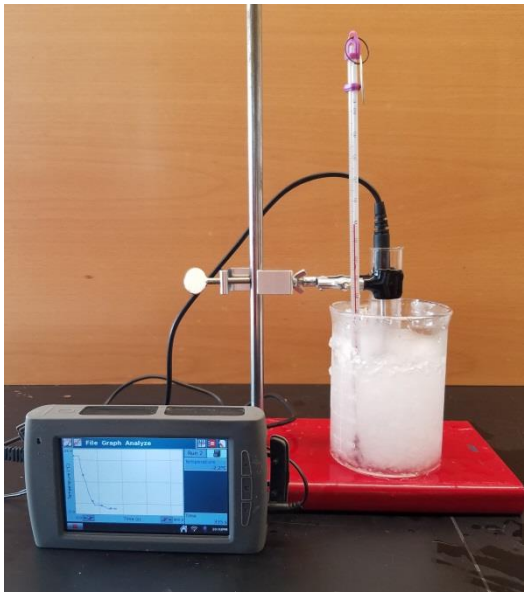

Figure 2. Experimental Sample in an ice bath

7. Soon after lowering the test tube, start stirring the mixture of salt and ice. Make sure that one of you is CONITNOUSLY STIRRING the ice bath during remaining time (about 15 minutes).
8. Another student must slightly, but continuously, move the probe during the first 5 minutes (or until you have reached 330 seconds). Be careful to keep the probe in, and not above, the ice as it forms. When 5 minutes (300 seconds) have gone by, stop moving the probe and allow it to freeze into the ice. Add more ice to the beaker if some of the ice has dissolved and add another 10 g of rock salt. Keep adding ice as needed but no more salt.
9. Data collection will stop after 15 minutes (900 seconds). **IMPORTANT:** Keep the test tube *submerged* in the ice-water bath until Step 12 below.
10. When data collection is complete, a graph of temperature *vs*. time will be displayed. To examine the data pairs on the displayed graph, tap any data point. As you tap each data point,

the temperature and time values are displayed to the right of the graph. Record the temperature values in your data table (round to the nearest 0.1°C).

Part II Melting

11. Press the icon that looks like a file cabinet beside the box that says Run 1. Run 2 should appear in that box now.
12. Start data collection for Run 2 by pressing on the green triangle in the bottom left hand corner. Once again a red square will appear in its place to indicate that the data run has started.
13. Raise the test tube and fasten it in a position above the ice-water bath as shown in Figure 3. Do not move the Temperature Probe during the entirety of Part II.

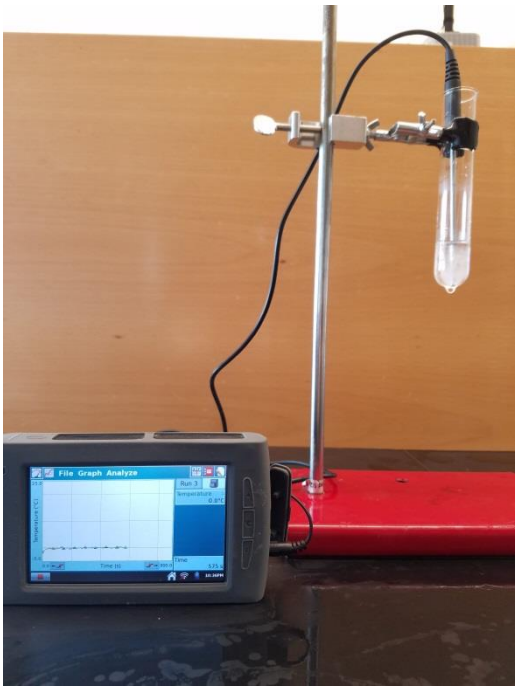

Figure 3.

14. Dispose of the ice bath down the sink. When 12 minutes (720 seconds) have passed, obtain about 300 mL of warm tap water and submerge the test tube and its contents into warm-water bath.
15. When data collection is complete, a graph of temperature *vs*. time will be displayed. To examine the data pairs on the displayed graph, tap any data point. As you tap each data point, the temperature values of the point are displayed to the right of the graph. Record the temperature values in your data table (round to the nearest 0.1°C).

DATA

Part I Freezing

Time (s)	Temp (°C)	Time (s)	Temp (°C)	Time (s)	Temp (°C)	Time (s)	Temp (°C)
0		240		480		720	
30		270		510		750	
60		300		540		780	
90		330		570		810	
120		360		600		840	
150		390		630		870	
180		420		660		900	
210		450		690			

Part II Melting

Time (s)	Temp (°C)	Time (s)	Temp (°C)	Time (s)	Temp (°C)	Time (s)	Temp (°C)
0		240		480		720	
30		270		510		750	
60		300		540		780	
90		330		570		810	
120		360		600		840	
150		390		630		870	
180		420		660		900	
210		450		690			

OBSERVATIONS

PROCESSING THE DATA

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?

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

4. Phenyl salicylate has a freezing temperature of 41.5°C. In the space to the right, sketch and label a freezing curve for phenyl salicylate. Be sure to indicate the freezing temperature on the graph.

5. Using another color, draw a melting curve for phenyl salicylate on the same graph. Indicate the melting temperature on the curve.