PHASE CHANGE

How is it possible to add heat to a substance without the temperature of the substance increasing?

Objectives

- Determine the effect of phase change on the temperature of a substance.
- Explain the difference between heat and temperature.
- Determine the melting point and boiling point of pure water.

Materials and Equipment

- Data collection system
- Stainless steel temperature sensor
- Hot plate
- Beaker (2), 150-mL or larger
- Graduated cylinder, 10-mL
- Test tube, 10-mm x 100-mm
- Test tube rack
- Ring stand
- Utility clamp
- Stir rod
- Distilled (deionized) water, 103 mL
- Crushed ice to fill the beaker
- Rock salt, 200 g

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- Do not touch the hot plate or hot glassware.
- Allow all glassware and equipment to cool thoroughly before handling.
- Wear safety goggles at all times

Procedure

Part 1 – Freezing Water and Melting Ice

1. Select Sensor Data in SPARKvue.
2. Connect the temperature sensor to your device.
3. Create a graph of Temperature (˚C) versus Time (s).
4. Use a graduated cylinder to measure 3 mL of distilled water and pour the water into the test tube.
5. Place the temperature sensor into the test tube.

Part 2 – Boiling Water

6. Ensure your data collection system is on and that the temperature sensor is connected, and that the graph of Temperature (˚C) versus Time (s) is displayed.
7. Turn on your hot plate to its highest setting and allow it to warm completely.

8. Attach a utility clamp onto a ring stand and securely tighten a temperature sensor to the utility clamp.

9. Fill the beaker with 100 mL of distilled water.

Data Collection

Part 1 - Freezing Water and Melting Ice

1. Collect temperature versus time data as you freeze the water in the test tube using a salt/ice mixture. To do this:

   a. Fill a beaker halfway full of ice.

   b. Add two spoonfuls of rock salt.

   c. Use a stir rod to mix the rock salt and ice together.

   d. Place the test tube containing the temperature sensor into the ice and salt mixture.

   e. Start recording temperature data.

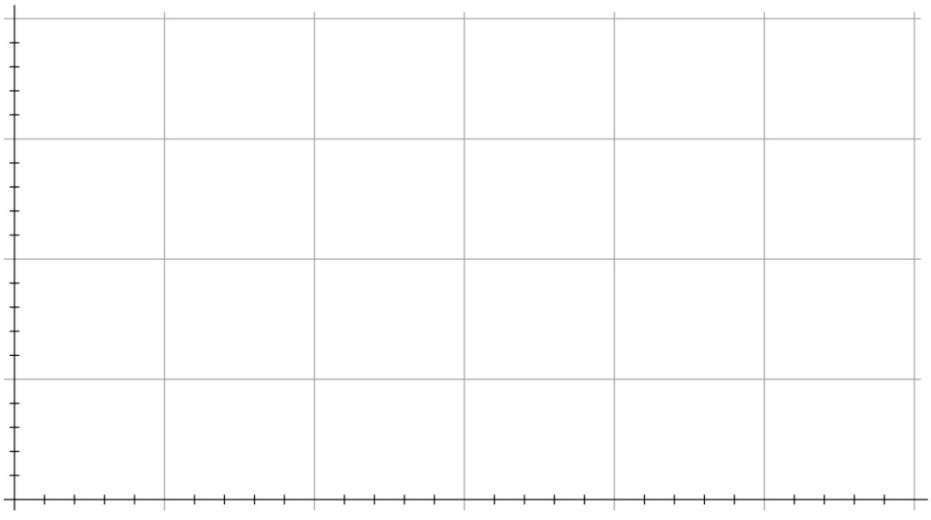
   f. Carefully add more ice around the test tube and two more spoonfuls of salt.

   g. Gently stir the mixture with the test tube. Keep the temperature sensor positioned so the tip freezes in the ice.

   h. Stop recording temperature data when the temperature of the ice falls to -6.0 ˚C or cooler.

2. Name the data run "freezing ice".

3. Sketch a graph of Temperature (˚C) versus Time (s) where heat is removed for freezing water. Label where freezing was occurring. Also label the overall graph, the x-axis, the y-axis, and include units on the axes.



4. Start recording another run of data.

5. Remove the test tube from the salt and ice mixture and place it in a test tube rack.

6. Allow the ice in the test tube to melt. Once the ice has melted enough, twist the temperature sensor so that the ice on the temperature sensor is constantly mixing with the water that has melted.

7. Continue recording data and constantly stirring until all the ice melts and the water temperature rises to between 8 and 10 ˚C.

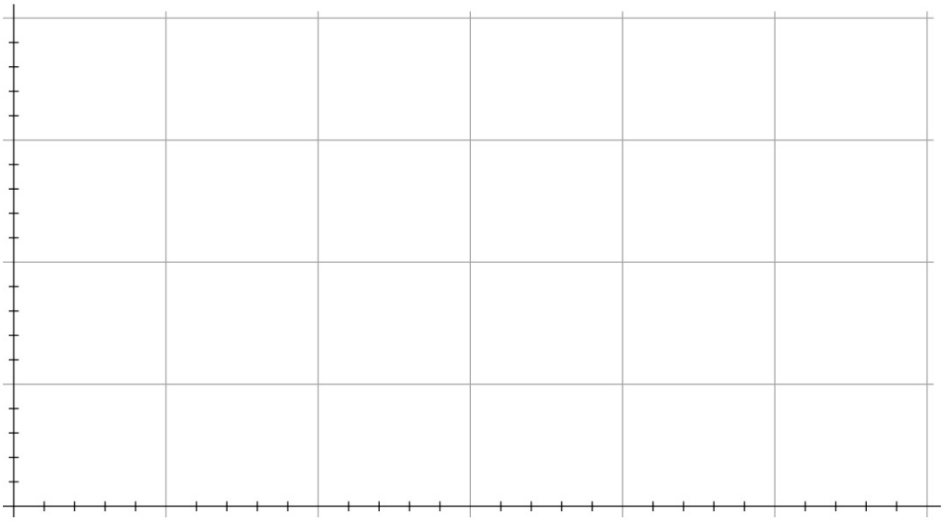
8. Record the temperature at which the water freezes and the ice melts.

9. From where does the heat causing the ice to melt come?

10. Stop recording data when the temperature of the water is between 8 and 10 ˚C.

11. Name the data run "melting ice".

12. Sketch a graph of Temperature (˚C) versus Time (s) where heat is added for melting ice. Label where melting was occurring. Also label the overall graph, the x-axis, the y-axis, and include units on the axes.



Part 2 – Boiling Water

13. Place the beaker with water on the warmed hot plate.

14. Lower the temperature sensor into the water, positioning the sensor in the center of the water. Make sure the sensor does not touch the bottom or the side of the beaker.

15. Start recording data.

16. Continue recording data until the water has boiled for 8 to 10 minutes.

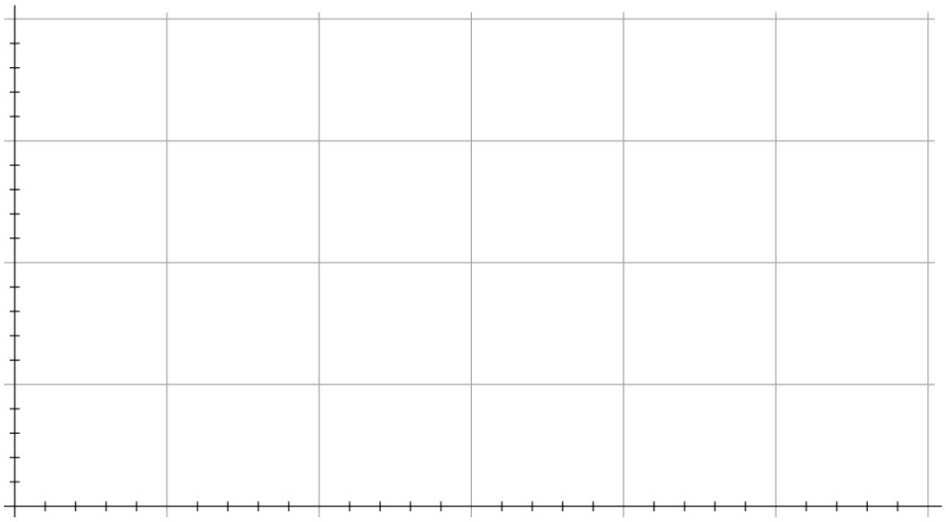
17. Stop recording data when the water has been at a boil for 8 to 10 minutes.

18. Name the data run "boiling water".

19. Turn off the hot plate and allow the equipment to cool for at least 20 minutes.

20. Save your experiment and clean up your lab station according to teacher directions.

21. Sketch a graph of Temperature (˚C) versus Time (s) where heat is added for boiling water. Label where boiling was occurring. Also label the overall graph, the x-axis, the y-axis, and include units on the axes.



Questions and Analysis

1. Relate the shape of your graphs above to the behavior of the water molecules. Hint: Explain whether the heat added caused the molecules to move faster or break attractions.

2. Explain how it is possible to add heat to a substance without the temperature of the substance increasing.

3. According to your lab results, what is the melting point and boiling point of distilled water? How do your results compare to your classmates?

4. Explain how heat and temperature are different.