16. Observing Phase Changes

*Operation Deep Freeze*

**Driving Question**
What happens to the temperature of ice as it melts?

**Materials and Equipment**

*For each student or group:*
- Data collection system
- Temperature sensor
- Erlenmeyer flask, 250-mL
- Graduated cylinder, 50- or 100-mL
- Balance
- Distilled water, 200 mL
- Ice cubes (at least 5)
- Hot plate
- Measuring spoons
- One-hole stopper
- Table salt ~ 2 g
- Towel

**Safety**

Add these important safety precautions to your normal laboratory procedures:

- Use the heat source with caution
- Wear goggles for the duration of this activity
- Handle glassware carefully

**Thinking about the Question**

Can you describe what happens to ice when it melts into a liquid? Does it melt instantaneously? Discuss with the members of your group the conditions found in a glass of water placed in the sun. What makes the ice turn into water?
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What happens if you place varying amounts of ice in the water? What happens if you place varying amounts of water surrounding the same amount of ice? Does it take the same amount of time to melt? Discuss with the members of your group how the melting of ice cubes differs based on the number of cubes.

What happens if you add salt to the ice water solution? Discuss with the members of your group how the melting of ice cubes differs based on the salt added to the water solution.

Sequencing Challenge

☐ The steps below are part of the Procedure for this lab activity. They are not in the right order. Determine the proper order and write numbers in the circles that put the steps in the correct sequence.

1. Make sure each lab group member is aware of safety rules and procedures for this lab.
2. Adapt equipment to measure temperature in a flask through a one-hole stopper.
3. Begin heating the flask of water and ice.
4. Record the temperature of each sample of water as it cools.
5. Add ice to distilled water in a flask that can be placed on a burner, and close the flask with the 1-hole stopper.
**Investigating the Question**

口 **Note:** When you see the symbol "*" with a superscripted number following a step, refer to the numbered Tech Tips listed in the Tech Tips appendix that corresponds to your PASCO data collection system. There you will find detailed technical instructions for performing that step. Your teacher will provide you with a copy of the instructions for these operations.

**Part 1 – Making predictions**

1. 口 Describe what a temperature versus time graph looks like as ice water melts over time. Explain the graph and the reasoning behind your prediction.

   __________________________________________________
   __________________________________________________
   __________________________________________________

2. 口 In the space below, sketch a temperature versus time graph that reflects your prediction.

3. 口 How would the temperature versus time graph differ when salt is added to the melting ice water? Sketch a temperature versus time graph that reflects your prediction. Explain the graph and the reasoning behind your prediction.

   __________________________________________________
   __________________________________________________
   __________________________________________________
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Part 2 – Testing melting ice in pure water

4. □ Start a new experiment on the data collection system. *(1.2)*

5. □ Using the graduated cylinder, pour 100 mL of distilled water into an Erlenmeyer flask and add five ice cubes.

6. □ Connect the temperature sensor to the data collection system *(2.1)* and insert it through the hole of a one-hole stopper.

7. □ Insert the stopper in the opening of the Erlenmeyer flask that contains the distilled water and ice cubes. Arrange the sensor inside the flask so that it measures the temperature of the solution and not the temperature of the hot plate. Carefully run the cord of the temperature sensor away from the hot plate. How could your results be affected by using tap water rather than distilled water?

8. □ Display Temperature on the y-axis of a graph with Time on the x-axis. *(7.1.1)*

9. □ Turn the hot plate to its highest setting.

10. □ Immediately start recording the temperature of the ice water. *(6.2)* Keep recording until the ice water has completely turned to water.

11. □ Stop recording temperature data. *(6.2)*

Part 3 – Testing melting ice in a salt solution

12. □ Dissolve 2 g teaspoon of salt in 100 mL of distilled water in an Erlenmeyer flask. Add five ice cubes to this solution.

13. □ Why do you think it is important to add the same amount of ice to the flask as you did in Part 2?

14. □ Place the temperature sensor through the hole of a one-hole stopper.
15. □ Insert the stopper, with temperature sensor, in the opening of the flask. Arrange the sensor inside the flask so that it will measure the temperature of the solution and not the temperature of the hot plate. Carefully run the cord of the temperature sensor away from the hot plate.

16. □ Turn the hot plate to its highest setting.

17. □ Immediately start recording the temperature of the ice water. *(6.2)* Keep recording until the icy salt water solution has completely turned to water.

18. □ Stop recording temperature data. *(6.2)*

19. □ Save your experiment. *(11.1)*

**Answering the Question**

**Analysis**

1. Review the temperature graph of the melting ice water. How does your prediction compare to the graph? What was unusual about the melting curve of the ice water?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

2. Analyze your data and determine the melting point for the ice water. *(9.1) (9.4)*

   Melting point for water: _________ °C

3. Review the temperature graph of the melting ice in salt solution. How does your prediction compare to the graph?

________________________________________________________________________

________________________________________________________________________
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4. How did the melting point of the icy salt water compare to the pure ice water? What evidence do you observe in your data to support the use of salt on icy roads and sidewalks in cold winter climates?

   Melting point for icy salt-water: _______ °C

Multiple Choice

☐ Circle the best answer that most nearly defines the given word below.

1. A solution is:
   A. A tool used to determine the temperature of a substance or object
   B. A homogeneous substance formed by dissolving a solid, liquid, or gas into a liquid
   C. The energy of motion of particles in matter
   D. A measure of the average thermal energy of a substance

2. Thermal energy is:
   A. A measure of the average thermal energy of a substance
   B. A mixture in which one substance spreads evenly throughout another
   C. The energy of motion of particles in matter
   D. The temperature at which a liquid becomes a solid

3. Ice is:
   A. A mixture in which one substance spreads evenly throughout another
   B. Glassware with a narrow mouth, used for containing a volume of liquid
   C. Frozen water; that is, the solid form of water
   D. The temperature at which a solid becomes a liquid

4. Freezing point is:
   A. The common name of water in its solid state
   B. A measure of the average thermal energy of a substance
   C. The temperature at which a liquid becomes a solid
   D. The temperature at which a given substance will change from a solid into a liquid

5. Temperature is:
   A. Frozen water, that is the solid form of water
   B. Glassware with a narrow mouth, used for containing a volume of liquid
   C. The energy of motion of particles in matter
   D. A measure of the average thermal energy of a substance
6. Melting point is:
   A. A homogeneous substance formed by dissolving a solid, liquid, or gas into a liquid
   B. The temperature at which a given substance will change from a solid into a liquid
   C. Glassware with a narrow mouth, used for containing a volume of liquid
   D. The common name of water in its solid state

7. A temperature sensor is:
   A. A tool used to determine the temperature of a substance or object
   B. The temperature at which a solid becomes a liquid
   C. Glassware with a narrow mouth, used for containing a volume of liquid
   D. Frozen water; that is, the solid form of water

Key Term Challenge

☐ Fill in the blanks from the randomly ordered words below:

<table>
<thead>
<tr>
<th>freezing point</th>
<th>solution</th>
<th>degrees Celsius</th>
</tr>
</thead>
<tbody>
<tr>
<td>solvent</td>
<td>temperature</td>
<td>solute</td>
</tr>
</tbody>
</table>

1. The SI unit for temperature is ________________.

2. Sugar dissolved in water is an example of a ________________.

3. The ____________________ is the temperature at which a substance changes phase from a liquid to a solid.

4. Water is often called the universal ________________ because it has the ability to dissolve so many substances.

5. Adding salt or sugar to distilled water changes the ________________ at which the solution freezes compared to distilled water alone.