

Exploring Boiling Points and Freezing Points of Solutions

Name: _____

Date: _____ Per: _____

Testable Questions

How does the amount of solute in a solution affect its freezing point? How does the amount of solute in a solution affect its boiling point?

Materials

For Freezing Point: ice, distilled water, thermometer, balance, salt, 250mL beaker

For Boiling Point: distilled water, thermometer, balance, salt, 250mL beakers (4) hot plate, beaker tongs, wire gauze

Procedure

For Freezing Point:

1. Place approximately 100mL of an ice and water mixture into a 250mL beaker. Use a thermometer to measure the lowest temperature reached by this mixture. Record this temperature.
2. Add 2.5g of salt. Stir carefully until the salt dissolves. Record the new temperature.
3. Add 2.5 more grams of salt (for a total of 5.0g). Stir carefully until the salt dissolves. Record the new temperature.
4. Add 2.5 more grams of salt (for a total of 7.5g). Stir carefully until the salt dissolves. Record the new temperature.
5. Pour out the contents of the beaker and rinse with water.

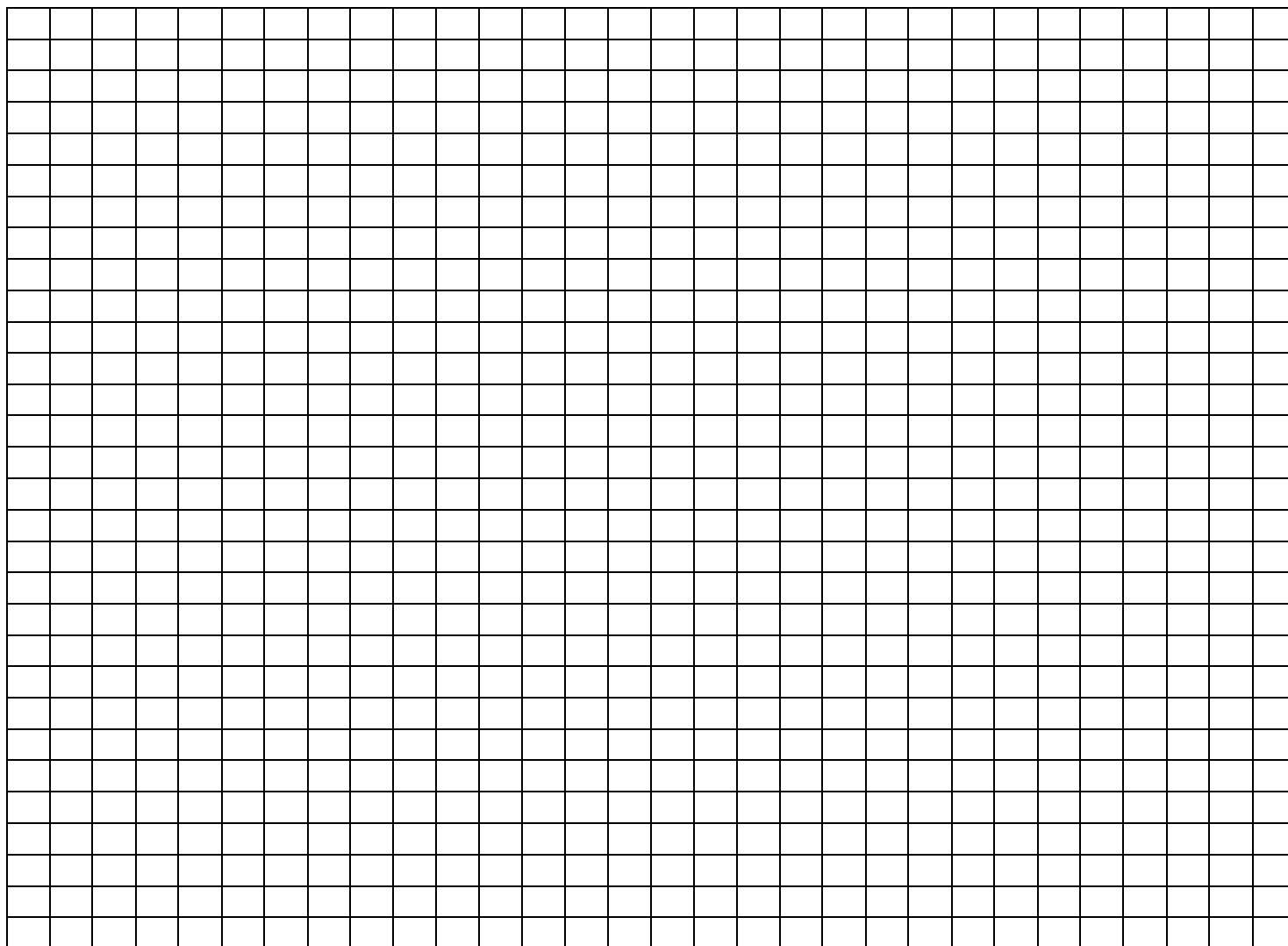
For Boiling Point:

1. Place 100mL of water into a 250mL beaker. Heat the water using the hot plate until it boils. Carefully take and record the temperature of the boiling water. Carefully remove the hot beaker and set it on a wire gauze on the table.
2. To a second beaker, add 100mL of water and 2.5 g of salt. Stir carefully until the salt dissolves. Heat the salt water solution until it reaches a boil. Carefully take and record the temperature of the boiling water. Carefully remove the hot beaker and set it on a wire gauze on the table.
3. To a third beaker, add 100mL of water and 5.0g of salt. Stir carefully until the salt dissolves. Heat the salt water solution until it reaches a boil. Carefully take and record the temperature of the boiling water. Carefully remove the hot beaker and set it on a wire gauze on the table.
4. To a fourth beaker, add 100mL of water and 7.5g of salt. Stir carefully until the salt dissolves. Heat the salt water solution until it reaches a boil. Carefully take and record the temperature of the boiling water. Carefully remove the hot beaker and set it on a wire gauze on the table.

Data and Results

Freezing Points and Boiling Points of Solutions		
Mass of Salt Added to Solution	Freezing Point (°C)	Boiling Point (°C)
0.0g		
2.5g		
5.0g		
7.5g		

In the space provided, create a graph to display your results. Be sure to place each of the variables in the appropriate place and give your graph a title and a key. Use blue to represent freezing points and red to represent boiling points.



Analysis Questions

1. What was/were the independent variable(s) in this experiment?
2. On what axis of a graph should the independent variable be plotted?
3. What was/were the dependent variable(s) in the experiment?
4. On what axis of a graph should the dependent variable be plotted?
5. What happen to the freezing points and boiling points as solute was added to each solution?

Extension Questions

1. What are colligative properties?
2. Give two examples of colligative properties.
3. In the lab, you explored the effect of NaCl on the freezing point and boiling points of solutions. Write an equation for the dissociation of NaCl in water.
4. How many ions are produced in solution per mole of NaCl?
5. Write an equation for the dissociation of another salt, CaCl₂ in water.
6. How many ions are produced in solution per mole of CaCl₂?
7. Based on the definition of the term colligative properties, which salt, sodium chloride or calcium chloride would you predict to create the highest boiling point when dissolved in water? Assume that equal amounts of the salts are dissolved in equal amounts of water. Explain your answer.

8. Earlier you learned that sugar is not an electrolyte. How would the data collected in your exploration of boiling point and freezing point be different if sugar had been used rather than NaCl? Explain your answer.
9. The boiling point and freezing points of solutions can be calculated. Write the equation that can be used for each calculation. Label the variables and constants in the equation.

10. Write an equation to calculate molality.

11. Calculate the moles of each amount of NaCl used in the laboratory investigation.

a. 2.5g NaCl

b. 5.0g NaCl

c. 7.5g NaCl

12. The amount of water used in the laboratory was 100g (1mL=1g).

a. Solution with 2.5g of NaCl

b. Solution with 5.0g of NaCl

c. Solution with 7.5g of NaCl

13. Calculate the actual boiling point elevation for each of the solutions. (The actual difference between the boiling point of the distilled water, and the boiling point of each solution)

a. Solution with 2.5g of NaCl

b. Solution with 5.0g of NaCl

c. Solution with 7.5g of NaCl

14. Calculate the actual freezing point depression for each of the solutions. (The actual difference between the freezing point of the distilled water and the freezing point of each solution)
- Solution with 2.5g of NaCl
 - Solution with 5.0g of NaCl
 - Solution with 7.5g of NaCl
15. Calculate the boiling point elevation for each of the solutions. The normal boiling point of water is 100°C value for K_b of water is $0.512^{\circ}\text{C}/\text{m}$.
- Solution with 2.5g of NaCl
 - Solution with 5.0g of NaCl
 - Solution with 7.5g of NaCl
16. Calculate the freezing point depression for each of the solutions. The normal freezing point of water is 0.0°C and the K_f value for water is $1.86^{\circ}\text{C}/\text{m}$.
- Solution with 2.5g of NaCl
 - Solution with 5.0g of NaCl
 - Solution with 7.5g of NaCl
17. Compare the values calculated in questions 15 and 16 with your experimental values. Explain any discrepancies based on possible experimental error.

HW5: Colligative Properties

Directions: Finish any calculations not completed on the lab in class. Then answer the questions that follow.

1. Calculate the molar mass of glucose, $C_6H_{12}O_6$.
2. Calculate the number of moles contained in 12g of glucose, $C_6H_{12}O_6$.
3. Convert 50.0g of water to kilograms.
4. Calculate the molality of a glucose solution that contains 12g of glucose in 50.0g of water.
5. Calculate the freezing point depression of the solution in number 3. The normal freezing point of water is 0.0°C and the K_f value for water is $1.86^\circ\text{C}/\text{m}$.
6. Calculate the boiling point elevation of the solution in number 3. The normal boiling point of water is 100°C value for K_b of water is $0.512^\circ\text{C}/\text{m}$.
7. Calculate the boiling point elevation and freezing point depression of a solution that contains 50.0g of glucose, $C_6H_{12}O_6$ in 500.0g of water.