Colligative Properties Lab – Freezing Point Depression & Boiling Point Elevation

**Introduction**The physical properties of solutions that depend on the number of dissolved solute particles and not their specific type are known as colligative properties. These include freezing point depression, osmotic pressure, and boiling point elevation. In this lab, freezing point depression and boiling point elevation will be investigated.

**Purpose**: What is the point of completing this lab?

**Materials/Apparatus**: List/draw what you see on the virtual lab bench.

**Procedure**:

1. Go to: <http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/animationsindex.htm>

2. Scroll to the bottom of the page to the section Solutions – click on the Freezing-Point Depression experiment

**Freezing Point:**

For Experiment #1, choose the following options: cold bath (click on the switch), and 100g of distilled H2O, click start. Record your data in the table. For experiment #2, choose cold water bath, 100g H2O, and 2.0g of sucrose (C12H22O11), click start. Record your data. For experiment #3, choose cold water bath, 100 g H2O, and 4.0g of sucrose, click start. Record your data. For experiment #4, add 100 g H2O and 2.0 g of NaCl. Record your data. For experiment #5, add 100 g H2O and 4.0 g NaCl. Record your data.

|  |  |  |
| --- | --- | --- |
| Experiment | Freezing point | Δ T (freezing point of water – freezing point of solution) |
| 1 – pure H2O |  |  |
| 2- H2O & 2.0 g C12H22O11 |  |  |
| 3- H2O & 4.0 g C12H22O11­ |  |  |
| 4- H2O & 2.0 g NaCl |  |  |
| 5- H2O & 4.0 g NaCl |  |  |

Freezing Point Questions:

Questions: Only full sentence answers will be graded.

1. What happened to the freezing point of the pure water when you added a solute?
2. Why did this occur? (look in your notes!)
3. When you doubled the amount of solute, what effect did this have on the change in freezing point?
4. Calculate the number of moles of solute particles added to experiments 2-4. (for experiments 2 & 3, find moles of C12H22O11 because sucrose does not dissociate in water. For experiments 4 & 5, find the moles of Na+ and Cl- because NaCl does dissociate in water.) SHOW YOUR WORK.

Experiment 2 Experiment 3 Experiment 4 Experiment 5

1. Which had a larger impact on the freezing point change: C12H22O11 or NaCl? Why? (hint look at your answers to numbers 4 and 2)
2. Calculate the molality of the solutions in experiments 2, 3, 4, and 5

Experiment 2

Experiment 3

Experiment 4

Experiment 5

1. Using your values for ∆Tf from your data table and your values for molality for each experiment in number 6, calculate the Kf for water for each experiment. Then find the average value for Kf for water.

Experiment 2

Experiment 3

Experiment 4

Experiment 5

Average

1. The accepted value for Kf for water is 1.86 oC/m. Calculate your percent error for Kf.

**Boiling Point**:

For Experiment #1, choose a hot water bath, 100g of distilled H2O. Record the boiling point. For Experiment #2, choose a hot water bath, 100g of H2O, and 2.0g of CaCl2. Record the boiling point. For Experiment #3, choose a hot water bath, 100g of H2O, and 4.0g of CaCl2. Record the temperature. For Experiment #4, choose a hot water bath, 100 g of H2O and 2.0 g of NaCl. For experiment #5, choose a hot water bath, 100 g of H2O and 4.0 g of NaCl.

|  |  |  |
| --- | --- | --- |
| Experiment | Boiling point | Δ T (Boiling point of water – Boiling point of solution) |
| 1 – pure H2O |  |  |
| 2- H2O & 2.0 g CaCl2 |  |  |
| 3- H2O & 4.0 g CaCl2­ |  |  |
| 4- H2O & 2.0 g NaCl |  |  |
| 5- H2O & 4.0 g NaCl |  |  |

Boiling Point Questions:

1. What happened to the boiling point of the pure water when you added a solute?
2. Why did this occur? (look in your notes!)
3. When you doubled the amount of solute, what effect did this have on the change in boiling point?
4. Calculate the number of moles of solute particles added to experiments2-4. (for experiments 2 & 3, find moles of Ca2+ and Cl- because CaCl2 dissociates in water. Remember that there are more ions in CaCl2 than in NaCl. For experiments 4 & 5, find the moles of Na+ and Cl- because NaCl dissociate in water.) SHOW YOUR WORK.

Experiment 2 Experiment 3 Experiment 4 Experiment 5

10. Which had a larger impact on the boiling point change: CaCl2 or NaCl? Why? (hint look at your answers to numbers 9 and 7)

1. Calculate the molality of the solutions in experiments 2, 3, 4, and 5

Experiment 2

Experiment 3

Experiment 4

Experiment 5

1. Using your values for ∆Tb from your data table and your values for molality for each experiment in number 6, calculate the Kf for water for each experiment. Then find the average value for Kf for water.

Experiment 2

Experiment 3

Experiment 4

Experiment 5

Average

1. The accepted value for Kb for water is 0.512oC/m. Calculate your percent error for Kb.