**In-class Activity - Colligative Properties**

Please use the AACT simulation on colligative properties to answer the following questions:

<https://teachchemistry.org/classroom-resources/colligative-properties>

Each of the spheres in the simulation represents a molecule or an ion as given in the following table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Color code | Blue | Red | Yellow | Green | Purple |
| Molecule/ion | H2O | C12H22O11 | Na+ | Cl- | Mg2+ |

Boiling point of pure water = 100◦C Freezing point of pure water = 0◦C

Complete the following table based on your observations from the simulation:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Solution in water | | Sucrose (C12H22O11) | NaCl | MgCl2 |
| Balanced equation for the dissolution:  H2O  Ex: solute 🡪 solute(aq) | |  |  |  |
| Number of ions/particles formed per mole of solute during dissolution: | |  |  |  |
| Boiling point (◦C) of solutions with solute concentration: | 1 mol |  |  |  |
| 2 mol |  |  |  |
| 3 mol |  |  |  |
| Freezing point (◦C) of solutions with solute concentration: | 1 mol |  |  |  |
| 2 mol |  |  |  |
| 3 mol |  |  |  |

**Molecular level observation 1**: As you increase the concentration of the solute, what do you notice about the ability of the water molecules to escape into the vapor phase? Compare the pure solvent vaporization to the 3 mol beaker vaporization. Which of the beakers allow more molecules to escape from the liquid surface?

**Molecular level observation 2**: As you increase the solute concentration, what do you notice about the ability of the water molecules to form the crystal lattice when turning into solid water (ice)? Compare the pure solvent ice formation to the 3 mol solution ice formation. In which solution will it be more difficult to form the hydrogen bonded network required to form the crystalline solid-state structure of ice?

**Explain the following concepts based on the simulations and your answers to the above questions:**

1. How do the boiling point and freezing point of water change by the addition of a solute. Will they increase or decrease?

Boiling point:

Freezing point:

2. The change in boiling point can be calculated by the formula: ΔTb = Kb x *m* x i

If ΔTb is the change in boiling point of a solvent by the addition of a solute and *m* is the molality of the solution, how does the concentration of solute affect ΔTb?

3. The change in freezing point can be calculated by the formula: ΔTf = Kf x *m* x i

If ΔTf is the depression in the freezing point of a solvent by the addition of a solute and *m* is the, molality of the solution, how does the concentration of solute affect ΔTf?

4. If i is the number of ions formed per mole of a salt, how does i affect the ΔTb and ΔTf..(note: be sure to compare between sucrose, NaCl and MgCl2 solutions)?

5. Based on the formulas for calculating ΔTb and ΔTf, shown in #2 and #3 above, calculate the following:

a) if 10.0 g of NaCl is dissolved in 100.0 g of water, what will be the boiling point of the resulting solution (Kb = 0.512 ◦C/m)?

b) if 10.0 g of NaCl is dissolved in 100.0 g of water, what will be the freezing point of the resulting solution (Kf = 1.86 ◦C/m)?

**Final question**: Based on your molecular level observations on page 2, explain the calculated changes in boiling point and freezing point from #5 (why does the boiling point and freezing point increase/decrease)?