**Colligative Properties:**

**Freezing Point Depression & Boiling Point Elevation**

**YOYO:**

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| 1. What are the units for molarity | 1. How many moles of NaCl are there in 1L of a 2M solution? |

Molecules vs. Ionic Compounds in Aqueous Solutions

* Some molecular compounds dissolve but do not dissociate into ions.
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - 1 mole of sugar gives 1 mole of sugar when dissolved in water
* Many ionic compounds dissociate into independent ions when dissolved in water
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - 1 mole of NaCl solid gives 1 mole of sodium ions and 1 mole of chloride ions when dissolves (total of 2 moles of dissolved particles).
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - Total of 3 moles of dissolved particles

Colligative Properties

* Colligative properties refer to properties of a solution that depend on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Vapor Pressure Lowering

* The presence of any solute (salt or sugar) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the vapor pressure of the solvent.
* The more moles of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (greater concentration of solute), the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the vapor pressure.

Boiling Point Elevation

* The presence of a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (salt or sugar) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the boiling point of the solvent.
  + Nonvolatile: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the concentration (more moles of dissolved particles) of the solute, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ it raises the boiling point.

Freezing Point Depression

* The presence of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (salt or sugar) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the freezing point of the solvent.
* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (greater concentration of solute), the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the freezing point.

Other Things to Remember

* Low vapor pressure = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* High vapor pressure = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The stronger the intermolecular forces the lower the vapor pressure/higher the boiling point.

Increasing strength of intermolecular forces of attraction

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| London Forces | Dipole-Dipole Interactions | Ion-Dipole Interactions | Hydrogen Bonding |

Summary

* The addition of solutes in water:
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Practice Questions

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| 1. How are the boiling and freezing point of a sample of water affected when a salt is dissolved in the water? 2. BP decreases/FP decreases 3. BP decreases/FP increase 4. BP increase/FP decreases 5. BP increase/FP increases | 1. Which solution containing 1 mole of solute dissolved in 100 grams of water has the lowest freezing point? 2. KOH (aq) 3. C6H12O6 (aq) 4. C2H5OH (aq) 5. C12H12O11 (aq) |
| 1. Which sample, when dissolved in 1.0 liter of water, produces a solution with the highest boiling point? 2. 0.1 mole KI 3. 0.2 mole KI 4. 0.1 mole MgCl2 5. 0.2 mole MgCl2 | 1. Which solution has the highest boing point at standard pressure? 2. 0.10M KCl (aq) 3. 0.10M K2SO4 (aq) 4. 0.10M K3PO4 (aq) 5. 0.10M KNO3 (aq) |
| 1. Which aqueous solution of KI freezes at the lowest temperature? 2. 1 mol of KI in 500 g of water 3. 2 mol of KI in 500 g of water 4. 1 mol of KI in 1000 g of water 5. 2 mole of KI in 1000 g of water | 1. Which solution has the lowest freezing point? 2. 10 g of KI dissolved in 100 g of water 3. 20 g of KI dissolved in 200 g of water 4. 30 g of KI dissolved in 100 g of water 5. 40 g of KI dissolved in 200 g of water |