**Colligative Properties: The Influence of a Solute**

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: the properties that deal with the \_\_\_\_\_\_\_\_\_\_\_ of particles dissolved in a given mass of solvent

The physical properties of a solution differ from the properties of the solvent

* + Vapor Pressure \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Boiling Point \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Point Depression

*i = the Van’t Hoff factor,*

* *i =* the number of particles into which the added solute \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* for ALL molecular compounds, the Van’t Hoff factor is equal to \_\_\_\_\_\_\_
* for ionic compounds (that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ dissolve in the solvent), the Van’t Hoff factor is dependent upon the \_\_\_\_\_\_\_\_\_\_\_ of particles dissociated once dissolved

Examples

* NaCl →
* Van’t Hoff factor = \_\_\_\_\_
* Na3PO4→
* Van’t Hoff factor = \_\_\_\_\_
* For colligative properties, the \_\_\_\_\_\_\_\_\_\_\_\_\_ of the particles IS NOT IMPORTANT.
* Size and molar mass do NOT matter – the number of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ particles is what is important here!

Vapor Pressure Lowering

* Vapor Pressure: the pressure exerted by a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ that is in dynamic equilibrium with its \_\_\_\_\_\_\_\_\_\_\_\_ in a closed system
* When solutes are added to a pure solvent, the vapor pressure is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_ molecules escape liquid phase
  + The decrease is proportional to the number of solute \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ dissolved
* Vapor Pressure decreases when a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ solute is added to a solvent

SKETCH

* Vapor Pressure increases when a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ solute is added to a solvent

Effect on Boiling Point

* **Boiling Point \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**: When a nonvolatile solute is added to a solution the boiling point of the solution will \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Boiling Point: the temperature where the vapor pressure of the liquid \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ atmospheric pressure
* When solute is added, the vapor pressure is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ so the boiling temperature is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Additional \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ is required to break apart solute/solvent interactions
* <http://www.chem.purdue.edu/gchelp/solutions/eboil.html>

Sketch/Summarize

Boiling Point Elevation

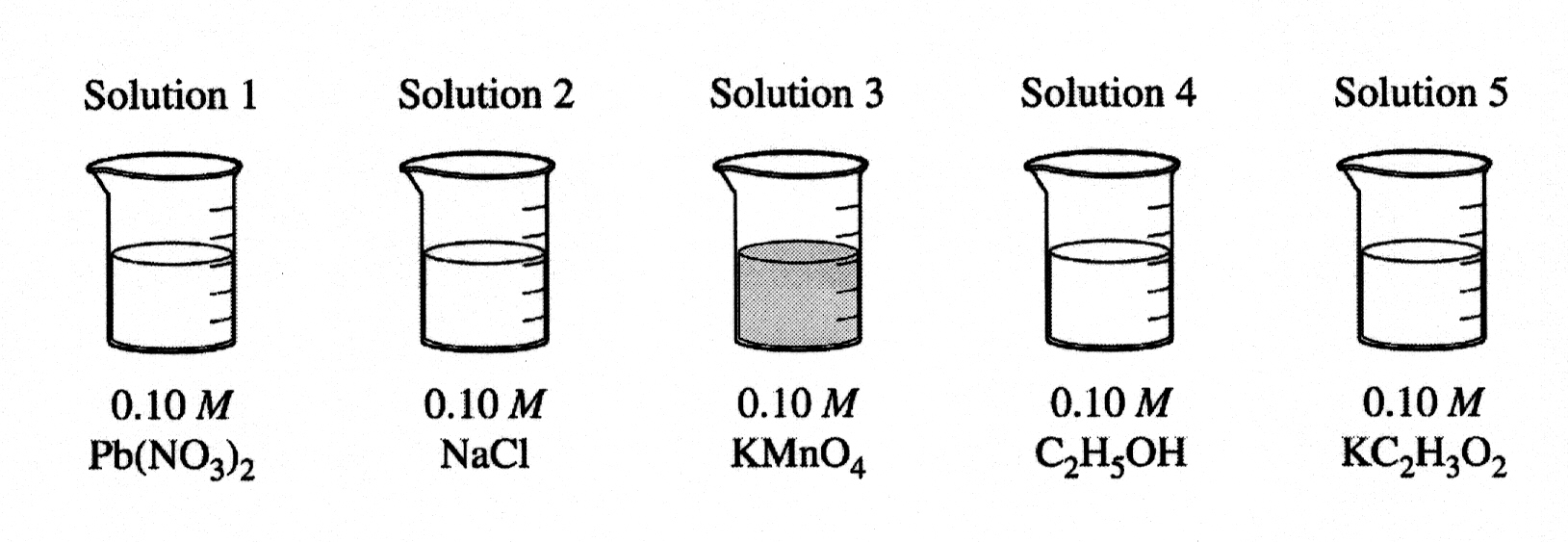
* Occurs because additional solute particles \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ vapor pressure so more pressure is needed to boil
* More energy is needed to break \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ between neighboring molecules and exert additional vapor pressure

Freezing Point Depression: Temperature difference between the freezing point of \_\_\_\_\_\_\_\_\_\_\_\_\_ and pure \_\_\_\_\_\_\_\_\_\_\_\_\_

* Solutes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the normal geometric pattern of a pure frozen solvent in a solution
* Additional \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy must be lost for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to occur

SKETCH

**Practice Problems**



a. Which solution has the highest boiling point? Explain.

b. Which solution has the lowest vapor pressure? Explain.

c. Identify a pair of the solutions that would produce a precipitate when mixed together. Write the formula of the precipitate.

d. When KMnO4 is used to oxidize hydrogen peroxide, what is the oxidation state of the Mn in KMnO4 and in the product, Mn2+?

e. Which solution would be the least effective conductor of electricity due to its lack of charged particles? Explain.