COLLIGATIVE PROPERTIES

- properties unique to solutions.

- depend only on the CONCENTRATION of a solution and not the IDENTITY of the solute**

**ionic solutes: Remember that they dissociate into MULTIPLE IONS!

1. Freezing point depression

   - The freezing temperature of a SOLUTION gets lower as the CONCENTRATION of a solution increases.

2. Vapor pressure lowering

   - The vapor pressure of a solution (pressure of sovent vapor over a liquid surface) goes DOWN as solution concentration goes UP

3. Boiling point elevation

   - The boiling temperature of a solution increases as the concentration of the solution increases.

4. Osmotic pressure

   - The pressure required to PREVENT the process of osmosis

FREEZING POINT DEPRESSION

$$\Delta T_f = K_f \times C_m$$

- C_m: concentration of solute (molality)
- K_f: Freezing point depression constant (for SOLVENT)
- ΔT_f: Freezing point depression: The amount the freezing temperature is LOWERED by the solute.

- Applications: In chemistry, this effect is often used to determine the molecular weight of an unknown molecule.

A solution of 2.500g of unknown dissolved in 100.0 g of benzene has a freezing point of 4.880 C. What is the molecular weight of the unknown?

$K_{f,\,benzene} = 5.065\ ^{\circ}C/m$, $T_{f,\,benzene} = 5.455^{\circ}C$

$\Delta T_f = K_f \times C_m = \frac{\text{moles unknown}}{\text{kg solvent}}$ ← 0.1000 kg solvent

$\Delta T_f = 5.455^{\circ}C - 4.680^{\circ}C = 0.575^{\circ}C$

* We can easily calculate the freezing point depression (0.575 C).
* Knowing this, we can calculate cm (the molal concentration of the unknown).
* From cm, we can calculate the number of moles of unknown in the solution!

$(0.575^{\circ}C) = (5.065\ ^{\circ}C/m) \times C_m$

$0.113524\,m = C_m$

$0.1000\ kg\ solvent \times \frac{0.113524\ mol\ U}{kg\ solvent} = 0.0113524\ mol\ U$

$MW = \frac{mass}{moles} = \frac{2.500\ g}{0.0113524\ mol\ U} = \boxed{220\ g/mol}$