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?

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

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

$\Delta T_f = 5.455^{\circ}C - 4.880^{\circ}C = 0.575^{\circ}C$

* We can calculate the MOLAL concentration of the solution based on the FREEZING POINT DEPRESSION

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

$0.113524186\,6\ m = C_m = \frac{\text{mol unknown}}{\text{kg benzene}}$

unknown

benzene

Find moles unknown using mass of benzene and the molal concentration

$0.1000\ \text{kg benzene} \times \frac{0.113524186\,6\ \text{mol unknown}}{\text{kg benzene}} = 0.011352418\,56\ \text{mol unknown}$

Molecular weight is mass per mole, so ...

$MW = \frac{\text{mass unknown}}{\text{mol unknown}} = \frac{2.500\ g}{0.011352418\,56\ mol} = \boxed{220\ g/mol}$