Announcements – Lecture V – Tuesday, Feb 6th

1. Class Web Site: https://genchem.chem.umass.edu – Under Spring, click on Chem 112 – the click on my picture!

2. Quiz 1: Please place in basket on front bench.

3. iClicker:  Pick any letter a-e

13.1 Quantitative Expressions of Concentration

Units of Concentration – Molarity, Molality, Mole Fraction, Weight %

What is the **molality** of a **chromium(II) nitrate** solution made by dissolving **27.1g** of chromium(II) nitrate (**MM=176.02**) in **513g** of water?

0.?

↳ 0.3

Chromium (II) nitrate = $Cr(NO_3)_2$: MM = 176.02 $g.mol^{-1}$

$$\text{Molality} = \frac{\text{moles of solute}}{\text{kg of solvent}}$$

$$27.1g\ \frac{Cr(NO_3)_2}{} \left| \frac{1\ mol}{176.02g} \right. = 0.154\ mol\ Cr(NO_3)_2 \quad : \text{solute}$$

$$\text{Molality} = \frac{0.154\ mol}{0.513\ kg} = 0.300\ m$$

13.1 Quantitative Expressions of Concentration

Units of Concentration – Molarity, Molality, Mole Fraction, Weight %

An aqueous solution is **6.00 % by mass hydrochloric acid**. What is the **mole fraction** of **hydrochloric acid** in the solution?

$$6.00\%\ HCl = \frac{6.00\,g\ HCl}{100\,g\ solvent}$$

$$\text{Mole fraction} = \frac{\text{moles of solute}}{\text{moles of solute} + \text{moles of solvent}}$$

Assume: 100g of solution
6.00% by mass HCl: 6.00g HCl + 94.00g H_2O

H_2O: MM = 18.02 $g.mol^{-1}$ HCl: MM = 36.5 $g.mol^{-1}$

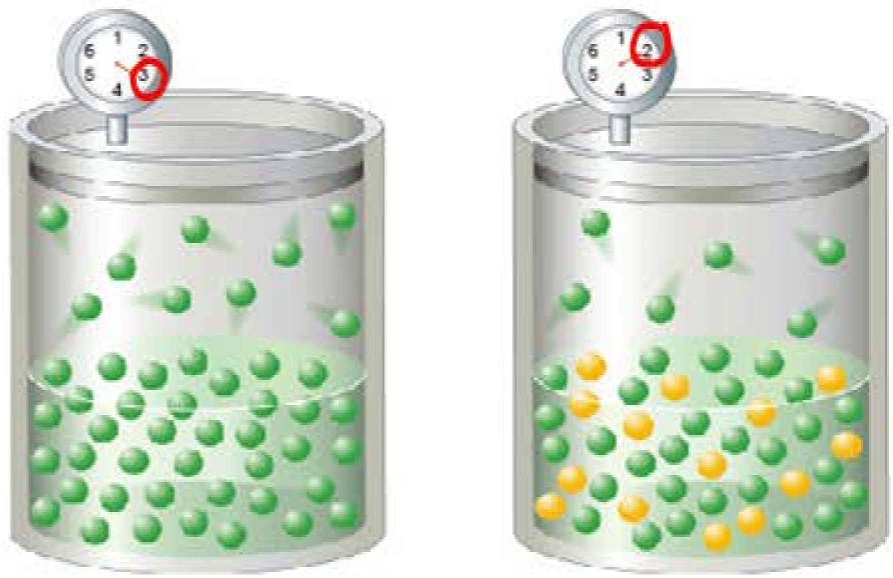
moles of solute: $\frac{6.00\,g\ HCl \mid 1\ mol}{\mid 36.5\,g} = 0.164\ mol\ HCl$

moles of solvent: $\frac{94.00\,g\ H_2O \mid 1\ mol}{\mid 18.02\,g} = 5.22\ mol\ H_2O$

$$\text{Mole fraction} = \frac{0.164}{0.164 + 5.22} = 0.0305$$

13.4 Colligative Properties

Vapor Pressure Lowering – Raoult's Law



Pure solvent

Solution with a nonvolatile solute

Raoult's Law

$$P_{solution} = X_{solvent} \times P^{\circ}_{solvent}$$

$P_{solution}$: Vapor Pressure of the solvent in the solution.

$X_{solvent}$: Mole fraction of the solvent.

$P^{\circ}_{solvent}$: Vapor Pressure of the pure solvent.

When a nonvolatile solute is added to a volatile solvent, the the solute particles block some solvent molecules from escaping ... thus lowering the vapor pressure.

13.4 Colligative Properties

Vapor Pressure Lowering – Raoult's Law

The vapor pressure of **benzene** (C_6H_6) at 25 °C is **73.0 mm Hg**. What is the **vapor pressure of a solution** consisting of **303 g of benzene** and **0.170 mol** of a **solute that is a nonvolatile nonelectrolyte**?

?0.0 mmHg
↳ ~7

$P_{solution} = X_{benzene} P^{\circ}_{benzene}$

C_6H_6 : MM = 78.12 $g.mol^{-1}$

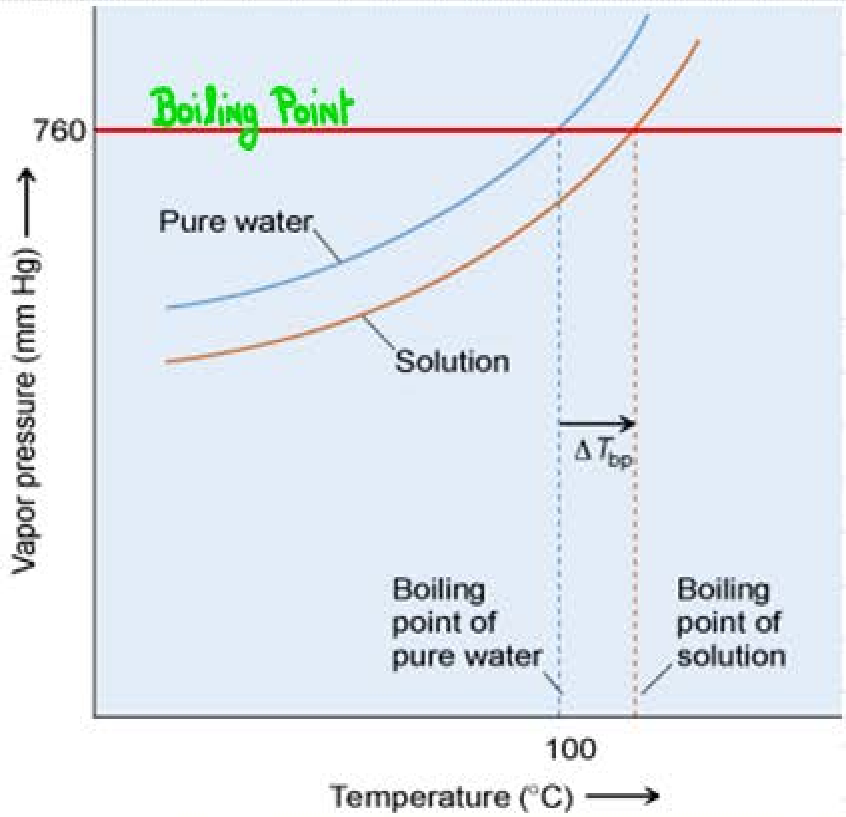
$\frac{303 g\ C_6H_6 \mid 1\ mol}{\mid 78.12 g} = 3.88\ mol\ C_6H_6$

$X_{C_6H_6} = \frac{3.88}{3.88 + 0.17} = 0.958$

$P_{solution} = 0.958 (73.0) = 69.9\ mm\ Hg$

13.4 Colligative Properties

Vapor Pressure Lowering – Boiling Point Elevation



$$\Delta T_{BP} = i \times K_{BP} \times m_{solute}$$

ΔT_{BP} : Change in Boiling Point

K_{BP} : Boiling Point elevation constant for the solute.

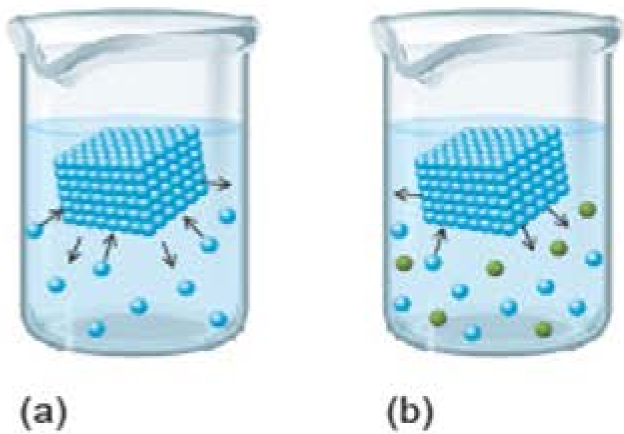
m_{solute} : Molality of the solute.

i : van't Hoff Factor.
For a nonelectrolyte, $i = 1$

13.4 Colligative Properties

Vapor Pressure Lowering – Freezing Point Depression

$$\Delta T_{fp} = i \times K_{fp} \times m_{solute}$$



ΔT_{fp} : Change in freezing point.

K_{fp} : Freezing point depression constant for the solute.

m_{solute} : Molality of the solute.

i : van't Hoff factor.
For a nonelectrolyte, $i = 1$