

## Solutions; Colloids

### Key Words

<b>Solute</b>	<b>Solvent</b>	<b>Solubility</b>	<b>effervescence</b>
<b>Miscible</b>	<b>saturated</b>		

Supersaturated (metastable system)- a cooled solution contains more solute than it would at equilibrium, desolvation= solvation.

It is an unstable system, but can exist.

Electrolytes- salt solutions and acids and bases; can conduct electricity. Strong .1 M HCl

Weak- acetic acid .1 M HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>

Nonelectrolytes- sugar and alcohol and DI H<sub>2</sub>O

**Solubility Rules** - They help you predict precipitation reactions.

### **Expressing Concentrations**

Deals with the methods of describing concentrations of solutions

#### **A. % by mass (like % composition)**

% of solute =  $\frac{\text{g of solute}}{100 \text{ g of water}}$  (really solution)

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% of solute (m/v) = You must be given the specific gravity; Example: HCl has a S.G.= 1.19  
 $\frac{(1.19 \text{ g solution})}{1 \text{ ml}}$

Only difference is S.G. may be given. You must calculate the g of solution first by using the S.G.

#### **B. Molarity – mol/L**

**C. Molality –**  $m = \frac{\text{mole of solute}}{\text{Kg of solvent}}$

#### **D. Mole Fraction (X):** really, they will be expressed as decimals

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

### **Colligative Properties of Solutions**

#### **1. Lowering VP of solvent- (Ideal Behavior)**

VP determined by how many molecules escape from surface. Also it depends on the concentration of solute molecules

- Raoult's Law :  $P_{\text{soln}} = X_{\text{soln}} * P_{\text{soln}}^{\text{pure}}$
- VP of ideal sol. (solvent)
- Mole fraction of solvent
- VP of pure solvent

- This law says that when you increase the # of solute molecules, it will lower the VP of solutions.
- The solute must be nonvolatile, and ideal behavior results.

## 2. Elevation of BP of solvent:

- a liquid boils when VP equals external pressure
- when solute is added, VP will drop.
- elevation of BP of solvent is proportional to mole fraction of solute (like Raoult's Law)
- **1 mol of any nonelectrolyte will raise the BP by .512° C (in 1 Kg of water)**

$$\Delta T = K_b \cdot m$$

$\Delta T$  - change in BP  
 $K_b$  - molal BP elevation constant  
 $m$  - m- molal conc.

Ex: 1 mol of NaCl – 2 ions –  $6.02 \cdot 10^{23} \times 2$  (ions)  
 1 mol of sugar –  $C_6H_{12}O_6$  –  $6.02 \cdot 10^{23}$  molecules

\*\*\*So, NaCl causes twice the elevation in BP as sugar does  
 Which of the above is a nonelectrolyte?

So, when calculating molality of an ionic compound, multiple by however many IONS are in solution. This is called the Van Hoff factor. For example,  $NaCl \rightarrow Na^+ + Cl^-$  so, 2 ions.

## 3. Fractional Distillation: Distillation speeds up the rate of evaporation and raises the VP and condensation of vapor occurs.

Each part (fraction) raises in the less volatile (higher boiling) component. Ex: Crude Oil

## 4. Depression of FP of solvent:

Solutions freeze at lower temperature than pure liquids (ex: antifreeze in cars)

The depression of FP of solvent is a reflection of a decrease VP caused by solute. (ex:  $CaCl_2$  melts on highways)

$$\Delta T = K_f \cdot m$$

$K_f$  = molal FP depression constant

ex. ICE CREAM :]

## 5. Phase Change Diagram of nonelectrolytes

## 6. Osmosis and Osmotic P of Solutions

Like diffusion, but it takes place in a solution with a pure solvent separated by a semi-permeable membrane. The pure solvent will pass through and dilute the solution.

Osmotic Pressure is the P required to stop the mixing of solution and solvent - (osmotic P)

$$\pi = MRT$$

M= moles of molarity

R= .0821 (L\* atm/ K\* mole)

T= Kelvin                      K = C + 273

$\pi$ =osmotic pressure (usually in torr or atm)    remember: 760 mm = 760 torr = 1 atm

Reverse Osmosis- If a solution in contact with a pure solvent across a semipermeable membrane is subjected to a high external pressure, the pressure will cause a net flow of solvent from the solution to the solvent.

Ex: desalination of sea H<sub>2</sub>O

### **Osmotic Systems**

1. Carrots celery- become limp because of loss of H<sub>2</sub>O (put into water to become crisp)
2. Cucumbers- put into salt solution will lose H<sub>2</sub>O and become a pickle
3. Isotonic- solutions that have the same osmotic P; Blood injections
4. Hypotonic- less concentration solution; can cause cells to burst
5. Hypertonic- more concentrated solution; can cause loss of H<sub>2</sub>O and cells, die by shriveling up.

## **COLLOID CHEMISTRY**

Collodial Dispersions- solutions with large molecules, but not visible with the eyes

### **2 parts:**

dispersed phase- divided system

dispersed medium- the fluid in the system is dispersed in.

**COLLOID:** “glue”; amorphous

Example: virus, proteins, mayonaise, gels, foam (shaving cream), even pumice (igneous rock)

### **PREPARATIONS:**

1. dispersion methods- grinding large particles to smaller subdivisions. Ex. paint
2. condensation methods- “growth” of small molecules into larger ones. Ex. formation of clouds  
(H<sub>2</sub>O condenses and forms very small droplets)
3. Peptizations- Ex. Gelatin, starch; solid particles already colloidal size and mixed with H<sub>2</sub>O.

Emulsion-shaking two immiscible liquids together; agitation breaks one liquid into large colloidal size droplets that disperse by coalescing forming large drops from the other substance and liquids separate.

Emulsifying agent: stabilize the emulsion (ex. Soap –oil and water)

Soap- made by boiling fats/oils with SB.

## 2 kinds result:

Sodium stearate –  $C_{17}H_{35}CO_2Na$  (Sodium Salt)

Sodium lauryl sulfate-  $C_{12}H_{25}OSO_3Na$

(Hydrocarbon chain and an ionic group)

*(the formulas above in italics) - This end attracts dirt and ionic end is attracted by water. Dirt becomes suspended as colloidal particles and washed away.*

Brownian Movement- Explains why some particles don't move in a colloid even though their density is high.

Tyndall Effect - known as Willis–**Tyndall**scattering, is light scattering by particles in a colloid or else particles in a very fine suspension. It is named after the 19th-century physicist John **Tyndall**.

<https://www.youtube.com/watch?v=qxIR7ZdgV7w>

GEL- Viscous body which takes up  $H_2O$  or some other solvent and is hydrated. It makes up a three dimensional network; (ex. Living tissue and pectin)

## What are a colloid and a suspension?

Colloid – a suspension in that it has intermediate-sized particles that settle out of solution.

The dispersed phase – particles are large enough to be suspended while solvent's particles are in constant motion.

Types of colloids: emulsion or foams

Mayonnaise – an emulsion where the egg yolk is the emulsifying agent (helps to keep oil droplets dispersed)

## More Information about Colligative Properties

Raoult's Law – used to correct the vapor pressure of the pure solvent in the presence of a solute.

- Solute particles take up space that was occupied by the liquid solvent.
  - The solute decreases the possibility of solvent particles from escaping by evaporation.
  - Fewer solvent particles thus escape into a vapor, causing a decrease in VP.
- VP of a solution is less than the vapor pressure of a pure solvent (at the same temperature)
- Calcium chloride is more effect at melting the ice than NaCl because it produces 3 ions.
  - As solutions become more concentrated, each ion becomes less effective through increased interaction with its neighboring ions.
  - The attractive forces between ions that dissociate are greater in conc. Solutions than dilute solutions, so the FP depression and BP elevation in conc. solutions are not as great as would be expected for an ideal solution.

IDEAL BEHAVIOR – Ionic compounds will completely dissociated in a solution with water.  
Intermolecular attractions are the same.

Solute – solute

**Solvent- solvent**

Solute-solvent

ATTRACTIONS ARE THE SAME

OSMOSIS: solvent molecules pass rapidly into the solution than in the opposite direction.  
Soon after, the pressure inside the membrane = the outside (dynamic equilibrium)

Solvent molecules move in and out through the membrane and no net change in conc.

**Osmotic pressure** – a colligative property

A living cell takes in water. A cell is an aqueous solution in a semipermeable membrane (cell membrane). The fluid that surrounds the cell = inside the cell.