

CHEMISTRY Ch. 14 Notes: Mixtures and Solutions

NOTE: Vocabulary terms are in **boldface and underlined**. Supporting details are in *italics*.

14.1 notes

I. Types of mixtures

(**mixture** – *a physical blend of substances*)

A. **heterogeneous mixture**— *physical mix with separate phases (parts)*

1) **suspension**

- heterogeneous mixture that will settle if left alone*
- largest particle sizes of all mixtures*
- can be easily filtered*

2) **thixotropic mixture**

- heterogeneous mixture that settles into a bottom soil phase and top liquid phase*
- when stirred, it flows like liquid*
- when left alone, it sits like a solid*

3) **colloid** (also called **colloidal suspension**)

- heterogeneous mixtures with two phases of intermediate particle sizes*
- cannot be filtered or settled*
- colloids show **Brownian motion** (*random movements*)
- examples: liquid and solid aerosols, emulsions, sols, pastes, gels, foam
- Tyndall effect**—*visible light transmitted by scattering through a colloid or suspension*
 - light will not show a path through a solution*
 - light will show a path through a colloid and a suspension*

f) **emulsions**

- colloidal dispersions of liquid in liquid*
- require an “emulsifier” like soap

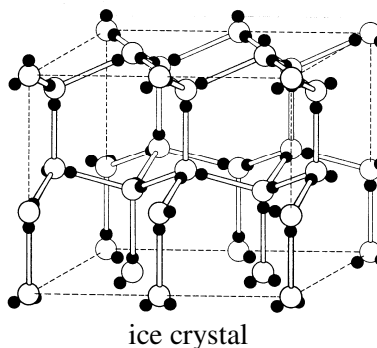
B. **homogeneous mixture (solution)**—“soln”— *physical mix with one phase (part)*

- aqueous solutions** (*aq*)—*water containing dissolved materials*
- true solutions will not precipitate (form solids) or separate into layers
- parts of a solution
 - solute**—*the substance being dissolved*
 - solvent**—*the substance doing the dissolving*
- soluble**—*dissolvable*
insoluble = *not dissolvable*
- miscible**—*liquids that are soluble in each other*
immiscible—*liquids that are not soluble in each other*
- concentration
 - dilute**—*more solvent than solute (weak)*
 - concentrated**—*more solute than solvent (strong)*

PARTICLE SIZE:	<i>solution</i> <	<i>colloid (colloidal suspension)</i> <	<i>suspension</i>
	salt water; acids; “air”	whipped cream; mayo; milk	dirt in water; wax in water

14.2 notes

II. Water Molecule Characteristics



- A) colorless and odorless
- B) neutral pH of 7
- C) *triatomic* (three atoms)
- D) *angular* shape with two unshared electron pairs
- E) *polar* ($\delta+$ and $\delta-$ areas)
- F) **hydrogen bonds**—*an attraction between hydrogen and an unshared pair of an electronegative element on a neighboring molecule*
- G) **surface tension**—*attraction between molecules on the surface of a liquid*
 - 1) surface tension makes water bead
 - 2) **surfactants**—*“wetting agents” which decrease surface tension by breaking hydrogen bonds (soaps)*
- H) **capillarity (capillary action)**—*moving upward, against gravity (up through roots, etc.)*
- I) hexagonal crystals
- J) *high specific heat: 4.184 J/g°C*
- K) *high boiling point: 100 °C*

III. Solution Concentration

- A) **concentration** [] – *amount of solute / amount of solvent*
- B) **molarity (M)**
 - 1) *moles of solute / liters of soln.* **M = mol / L**
 - 2) examples

E1) What is the molarity of a solution of 0.6784 mol NaCl in 4.5 L water?

$$M = \frac{\text{moles}}{L} = \frac{0.6784 \text{ mol NaCl}}{4.5 \text{ L soln.}} = 0.15 \frac{\text{mol}}{L} = \boxed{0.15 \text{ M}}$$

E2) A sugar solution contains 12.5 g of $C_{12}H_{22}O_{11}$ dissolved in 500.00 mL of water. What is the molarity of the solution?

$$M = \frac{\text{moles}}{L} = \frac{12.5 \text{ g } C_{12}H_{22}O_{11} \times \frac{1 \text{ mol } C_{12}H_{22}O_{11}}{342.0 \text{ g } C_{12}H_{22}O_{11}}}{0.50000 \text{ L}} = 0.0365 \text{ mol } C_{12}H_{22}O_{11} / L$$

$$500.00 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.50000 \text{ L} \qquad \frac{0.0365 \text{ mol}}{0.50000 \text{ L}} = \boxed{0.0730 \text{ M}}$$

E3) How many grams of KBr should be added to 977.6 mL of water to make a 3.0 M solution?

$$977.6 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.9776 \text{ L}$$

$$3.0 \frac{\text{mol KBr}}{\text{L}} \times 0.9776 \text{ L} \times \frac{119.0 \text{ g KBr}}{1 \text{ mol KBr}} = \boxed{350 \text{ g KBr}}$$

OTHER CALCULATIONS...

C) percent by mass = $\frac{\text{mass of solute}}{\text{mass of solution}} \times 100$

D) percent by volume = $\frac{\text{volume of solute}}{\text{volume of solution}} \times 100$

E) molality (m) = $\frac{\text{moles of solute}}{\text{kg of solvent}}$

F) dilution $M_1V_1 = M_2V_2$ (M = molarity, V = volume)

G) other calculations: mole fraction, normality, etc.

IV. Heat Capacity of Water

A) **heat capacity**—amount of heat required to change a substance's temperature by exactly 1 °C

B) **specific heat capacity** (*specific heat*) (C or c_p)—amount of heat required to raise the temperature of 1 g of a substance by exactly 1 °C

C) *water has a high specific heat (4.184 J/g°C) as compared to other substances:*

air: 1.01	stainless steel: 0.51	aluminum: 0.90	gold: 0.13	wood: 1.76
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D) *high requirements and retention = heat up slowly and cool down slowly*

V. Phase changes of evaporation and freezing

A) evaporation

- 1) water absorbs a large amount of heat before it changes phase from a liquid to a vapor
- 2) many hydrogen bonds must be broken
- 3) liquid has a lower K.E.; vapor has a higher K.E.

B) freezing

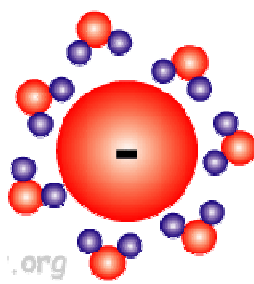
- 1) *solid water is less dense than liquid water (ice floats)*
 - 2) *at 4 °C, water is densest*
 - 3) *below 4 °C, it expands to form hexagonal crystals*
 - 4) density comparisons
 - a) pure water before boiling: 0.9584 g/cm³
 - b) pure water at 4 °C: 1.00 g/cm³
 - c) density of pure ice: 0.9168 g/cm³
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14.3 notes

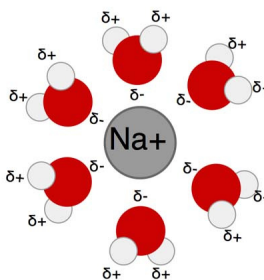
VI. **Solvation**—*the dissolving of a solute into a solvent*

- A) **hydration**—*a specific kind of solvation, when water is the solvent*
- B) water hydrating an anion: water's partially positive ($\delta+$) end points inward, surrounding the anion
- o water hydrating a cation: water's partially negative ($\delta-$) end points inward, surrounding the cation

(diagrams from MCAT-review.org and humboldt.edu)



water hydrating an anion



water hydrating a cation

VII. Electrolytes and Nonelectrolytes

- A) **electrolytes**—*conductors in aqueous solution* (usually ionic compounds and acids)
- 1) **weak electrolyte**—*a small fraction of the solute is as free ions*
 - 2) **strong electrolyte**—*almost all of the solute is as free ions*
- B) **nonelectrolytes**—*nonconductors in aqueous solution* (usually molecular and organic compounds)

VIII. Water of Hydration (review)

- A) **water of hydration**—*water molecules chemically integrated into a crystalline structure*
- B) **hydrate**—*a compound with water in its structure*
- 1) *general formula:* [compound] · H₂O
 - 2) *naming:* [compound name] (prefix)hydrate
 $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ copper(II) sulfate pentahydrate
- C) **anhydrous**—*a hydrate without its water of hydration*
- $$\text{Na}_2\text{SO}_4 \cdot 2\text{H}_2\text{O} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$$
- sodium sulfate dihydrate anhydrous sodium sulfate + water
- D) **efflorescence**—*the release of water by a hydrate (heating not needed)*
- E) **hygroscopic**—*remove water from the atmosphere*
- F) **deliquescence**—*absorbing excess water from the atmosphere to form a liquid substance*
- G) **desiccant**
- 1) *a drying agent* which is hygroscopic
 - 2) examples: Damp Rid; packets of silica powder in shoe boxes

IX. Solution Formation (abbreviation for solution = *soln.*)

- A) **SOLUTE + SOLVENT = SOLUTION**
- B) “**Like dissolves like**”

<u>SOLUTE</u>		<u>SOLVENT</u>	<u>SOLUTION?</u>
Polar	+	Polar	Yes
Polar	+	Nonpolar	No
Nonpolar	+	Polar	No
Nonpolar	+	Nonpolar	Yes

<u>POLAR / IONIC examples:</u>		
All BI	Salts	Water
All TI	Sugars	Non-symmetrical molecules
All crisscrossed formulas	Acids (vinegar, etc.)	

<u>NONPOLAR EXAMPLES:</u>		
Oil	Wax/Parrafin	Symmetrical molecules
Hydrocarbons: methane, propane, butane, octane...		

C) Factors which increase solution (dissolving) rate:

- 1) crush up solids (increase surface area [S.A.]
- 2) stirring
- 3) heating

D. examples of different types of solutions

solute-solvent:

- 1) liquid-liquid: alcohol in water
- 2) solid-liquid: sugar in water
- 3) solid-solid: metal alloys such as brass
- 4) gas-gas: atmospheric air

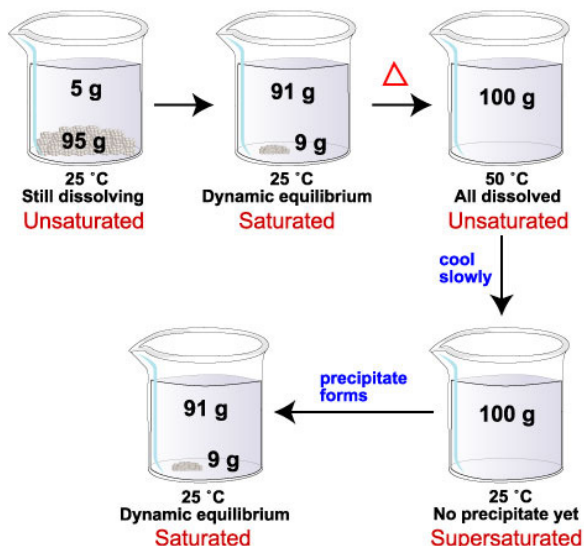
X. Solubility

A) *the maximum amount of a solute (substance being dissolved) which will dissolve in a given amount of solvent (substance doing the dissolving)*

B) **miscible**—*the ability of liquids to mix* (opposite = **immiscible**)

C) solution descriptions

- 1) **unsaturated**—small amount of solute; completely dissolved; room for more
- 2) **saturated**—too much solute; not all dissolved; excess settles on the bottom
- 3) **supersaturated**—an unstable solution formed from heating a saturated solution until all the solid dissolves; can recrystallize when cooled



14.4 notes

XI. **Colligative Properties** of Solutions

A) *these properties relate to the number of solute particles*

B) examples

- 1) **vapor pressure lowering** (volatile solute \propto v.p.)
- 2) **boiling point elevation** (BPE \propto solute concentration)
- 3) **freezing point depression** (FPD \propto solute concentration)

C) osmosis

- 1) **osmosis**—*diffusion of a solvent through a semipermeable membrane, from dilute to concentrated*
- 2) **osmotic pressure**—*amount of additional pressure from the water molecules that moved into the concentrated solution*