Unit 10: Solutions Name: ________________________

Solution Definitions

solution: a homogeneous mixture

--

-- e.g.,

alloy: a solid solution of metals

-- e.g.,

solvent: the substance that dissolves the solute

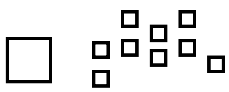
soluble: "will dissolve in"

miscible: refers to two liquids that mix evenly in all proportions

-- e.g., food coloring and water

Factors Affecting the Rate of Dissolution

1. temperature 

2. particle size 

3. mixing 

4. nature of solvent or solute

Classes of Solutions

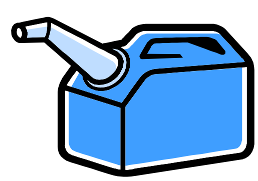
aqueous solution: solvent =

amalgam: solvent =

e.g., dental amalgam

tincture: solvent =

e.g., tincture of iodine (for cuts)



organic solution: solvent contains ___________

e.g., gasoline, benzene, toluene, hexane

Non-Solution Definitions

<u>insoluble</u>: "will NOT dissolve in"

e.g.,

<u>immiscible</u>: refers to two liquids that will NOT form a solution

e.g.,

<u>suspension</u>: appears uniform while being stirred, but settles over time

Molecular Polarity

<u>nonpolar</u> molecules: -- e^- are shared equally

-- tend to be symmetric

e.g.,

<u>polar</u> molecules: -- e^- NOT shared equally

e.g.,

"Like dissolves like."

Using Solubility Principles

Chemicals used by body obey solubility principles.

-- <u>water-soluble vitamins</u>: e.g.,

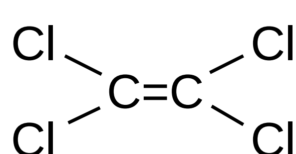
-- <u>fat-soluble vitamins</u>: e.g.,

<u>Dry cleaning</u> employs nonpolar liquids.

-- polar liquids damage wool, silk

-- also, dry clean for stubborn stains (ink, rust, grease)

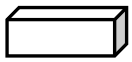
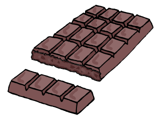
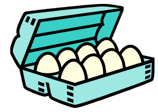
-- *tetrachloroethylene* is in common use



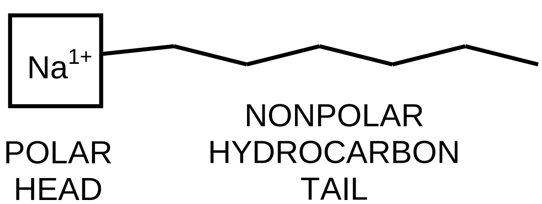
emulsifying agent (emulsifier): --

--

e.g., soap detergent lecithin eggs

MODEL OF A SOAP MOLECULE



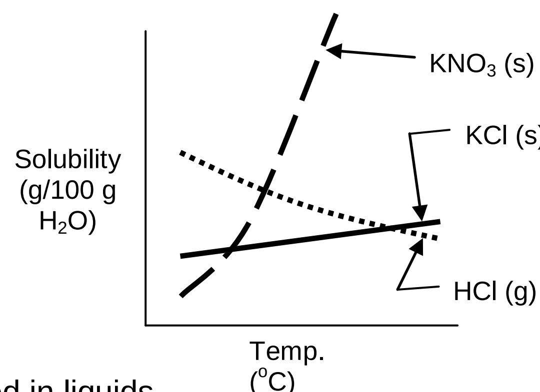
soap	vs.	detergent
--		--

Hard water contains minerals ^{w}/ions like Ca^{2+}, Mg^{2+}, and Fe^{3+} that replace Na^{1+} at polar end of soap molecule. Soap is changed into an insoluble precipitate (i.e., soap scum).

micelle: a liquid droplet covered ^{w}/soap or detergent molecules

Solubility →

SOLUBILITY CURVE

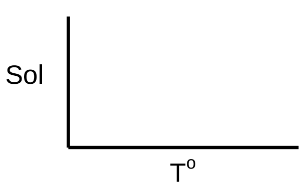


unsaturated: sol'n could hold more solute;

saturated: sol'n has "just right" amt. of solute;

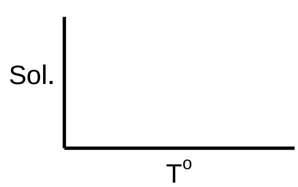
supersaturated: sol'n has "too much" solute dissolved in it;

Solids dissolved in liquids



As T^o ↑, solubility ___

Gases dissolved in liquids



As T^o ↑, solubility ___

Using an available solubility curve, classify as unsaturated, saturated, or supersaturated.

per 100 g H_2O:

- 80 g $NaNO_3$ @ 30^oC
- 45 g KCl @ 60^oC
- 50 g NH_3 @ 10^oC
- 70 g NH_4Cl @ 70^oC

Per 500 g H_2O, 120 g KNO_3 @ 40^oC

Describe each situation below.

(A) Per 100 g H_2O, 100 g $NaNO_3$ @ 50^oC. →

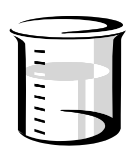
(B) Cool sol'n (A) very slowly to 10^oC. →

(C) Quench sol'n (A) in an ice bath to 10^oC. →

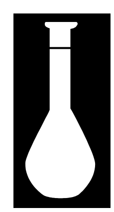
Glassware – Precision and Cost

	beaker	vs.	volumetric flask
	1000 mL $\pm$ 5%		1000 mL $\pm$ 0.30 mL

When filled to 1000 mL line, how much liquid is present?

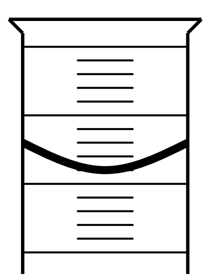


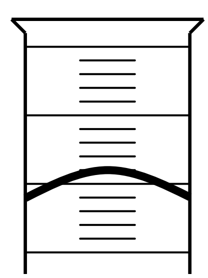
beaker



volumetric flask

water in grad. cyl.





mercury in grad. cyl.

Concentration…a measure of solute-to-solvent ratio

concentrated dilute

Add water to dilute a sol'n; boil water off to concentrate it.

Selected units

A. mass % = $\frac{\text{mass of solute}}{\text{mass of sol'n}} \times 100$

B. parts per million (ppm) = $\frac{\text{mass of solute}}{\text{mass of sol'n}} \times 10^6$

→ also, ppb and ppt

-- commonly used for minerals or contaminants in water supplies

C. molarity (M) = $\frac{\text{moles of solute}}{\text{L of sol'n}}$

-- used most often in this class

1: How many mol solute are req'd to make 1.35 L of 2.50 M sol'n?

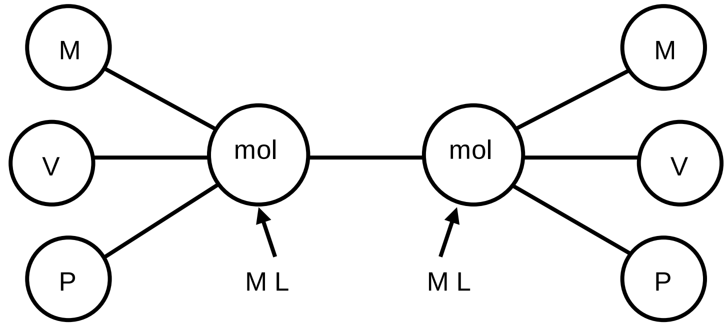
A. What mass sodium hydroxide is this?

B. What mass magnesium phosphate is this?

2: Find molarity if 58.6 g barium hydroxide are in 5.65 L sol'n.

3: You have 10.8 g potassium nitrate. How many mL of sol'n will make this a 0.14 M sol'n?

Molarity and Stoichiometry



EX. __$Pb(NO_3)_2$(aq) + __KI (aq) → __PbI_2(s) + __KNO_3(aq)

What volume of 4.0 M KI sol'n is req'd to yield 89 g PbI_2?

Strategy: (1)

(2)

How many mL of a 0.500 M $CuSO_4$ sol'n will react w/excess Al to produce 11.0 g Cu?

Dilutions of Solutions → Acids (and sometimes bases) are purchased in concentrated form ("<u>concentrate</u>") and are easily diluted to any desired concentration.

**Safety Tip:

Dilution Equation:

EX. Conc. H_3PO_4 is 14.8 M. What volume of concentrate is req'd to make 25.00 L of 0.500 M H_3PO_4?

How would you mix the above sol'n?

1. Measure out ________ L of conc. H_3PO_4.
2. In separate container, obtain ~20 L of cold H_2O.
3. In fume hood, slowly pour H_3PO_4 into cold H_2O.
4. Add enough H_2O until 25.00 L of sol'n is obtained.

EX. You have 75 mL of conc. HF (28.9 M); you need 15.0 L of 0.100 M HF. Do you have enough to do the experiment?

<u>Dissociation</u> occurs when neutral combinations of particles separate into ions while in aqueous solution.

sodium chloride	$NaCl$ →
sodium hydroxide	$NaOH$ →
hydrochloric acid	HCl →
sulfuric acid	H_2SO_4 →
acetic acid	CH_3COOH →

In general, ________ yield hydrogen (H^{1+}) ions in aqueous solution; ________ yield hydroxide (OH^{1-}) ions.

Strong electrolytes exhibit nearly 100% dissociation.

$$NaCl \rightleftharpoons Na^{1+} + Cl^{1-}$$

NOT in water:

in aq. sol'n:

Weak electrolytes exhibit little dissociation.

$$CH_3COOH \rightleftharpoons CH_3COO^{1-} + H^{1+}$$

NOT in water:

in aq. sol'n:

electrolytes: solutes that dissociate in sol'n

-- conduct elec. current because of free-moving ions

-- e.g.,

-- are crucial for many cellular processes

-- obtained in a healthy diet

--

nonelectrolytes: solutes that DO NOT dissociate

--

-- e.g., any type of sugar

Colligative Properties →

Compared to solvent's…	a sol'n w/that solvent has a…
…normal freezing point (NFP)	
…normal boiling point (NBP)	

Applications (NOTE: Data are fictitious.)

1. salting roads in winter

	FP	**BP**
water		
water + a little salt		
water + more salt		

2. antifreeze (AF) / coolant

	FP	**BP**
water		
water + a little AF		
50% water + 50% AF		

3. law enforcement

white powder	starts melting at…	finishes melting at…	penalty, if convicted
A			
B			
C			