Solutions-Ions
Topic#13
AMSAT Chem 1H

Student Edition

Solutions
Topic#13

Reaction Review

Naming Compounds Practice Problems

1. Name the following ionic compounds:
    a. RbF
    b. NH_4Br
    c. CaS
    d. Fe_2O_3
    e. Na_3PO_4
    f. $Cr(CrO_4)_3$
    g. $(NH_4)_2SO_4$
2. Write the formula for the following compounds:
    a. magnesium sulfide
    b. ammonium chloride
    c. potassium oxide
    d. chromium (III) telluride
    e. rubidium sulfate
    f. manganese (V) nitride
    g. ammonium phosphate

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Reaction Review

Double Replacement Reactions Practice Problems:

3. Predict the products from the following reactants:

a. sodium carbonate + nickel (II) nitrate →

b. iron (II) chloride + lithium hydroxide →

c. copper (II) sulfate + rubidium phosphate →

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Types of Solutions

Parts of a Solution

- **solvent** - the larger amount and dissolves the solute
- **solute** - dissolves in solvent (changes state or the smaller amount of the two substances)
  - particle size < 1nm and evenly distributed

Types of Solutions

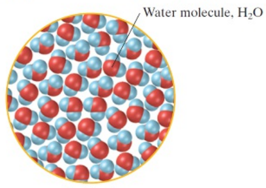
- solid **(alloy)** - steel (iron, nickel, and carbon)
- liquid - antifreeze (ethylene glycol and water)
- gas (air; oxygen in nitrogen)
- **aqueous** - water as solvent
  - ions in solution
    - * $NaCl$, 2 ions per f.u.. $1Na^{+}$ and $1Cl^{-}$
    - * $MgCl_2$, 3 ions per f.u., $1Mg^{2+}$ and $2Cl^{-}$.
  - molecular compounds, individual molecule leaves solid and migrates into solvent
    - * $C_6H_{12}O_6(s) \rightarrow C_6H_{12}O_6(aq)$

24-karat gold is pure gold.

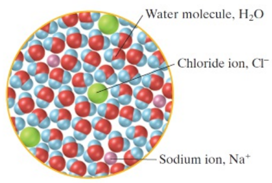
14-karat gold is an alloy of gold with silver and copper. 14-karat gold is 14/24, or 58.3%, gold.

$$NaCl(s) \xrightarrow{H_2O} Na^{1+}(aq) + Cl^{1-}(aq)$$

$$MgCl_2\ (s) \xrightarrow{H_2O} Mg^{2+}(aq) + 2Cl^{1-}(aq)$$



Freshwater



Salt water solution

Non-Solutions

Suspensions

- particles > 1000nm
- must be agitated to keep particles suspended
- will settle out over time after agitation

Colloid

- 1nm <particles<1000nm
- kept in solution by motion of solvent particles
- Tyndall Effect used to identify a colloid
    - glows when a light is shown through it

Property	**Solutions**	**Colloids**	**Suspensions**
Type of mixture	hm	ht	ht
Particle Size	0.1<1nm	1<x<1000nm	>1000nm
	(atoms/ions/molecules)	(aggregates/large molecules)	(large particles/aggregates)
Separates	no	no	yes
Can be Filtered	no	no	yes
Tyndall Effect	no	yes	yes

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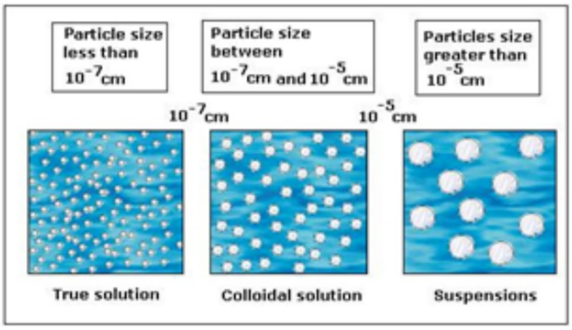
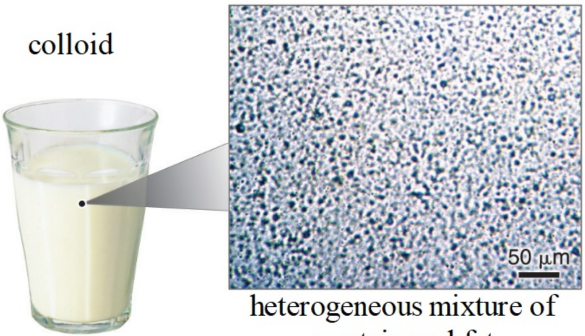
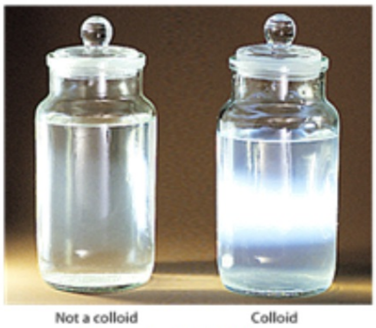
Non-Solutions



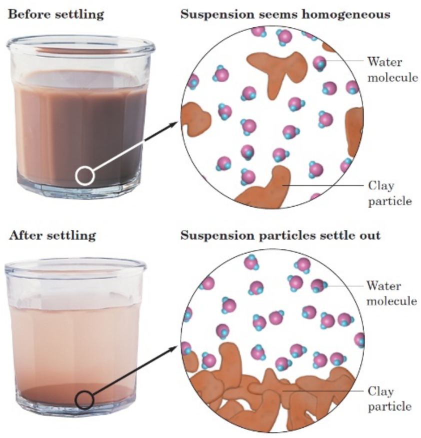
colloid



heterogeneous mixture of protein and fat



Tyndall Effect



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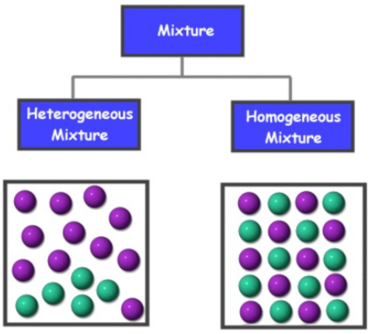
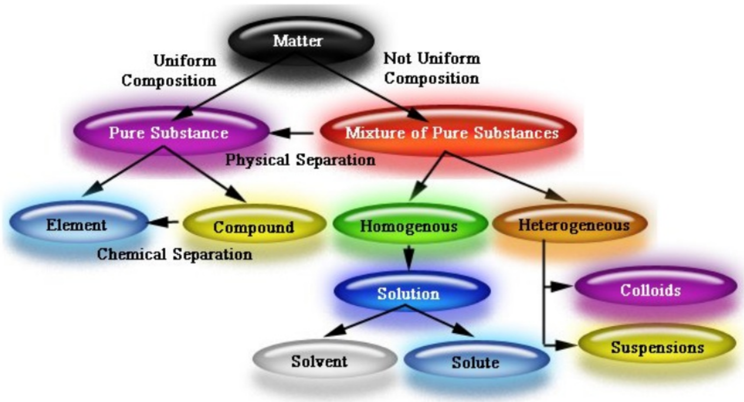
Types of Matter Review





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Electrolytes vs. Nonelectrolytes

Electrolyte

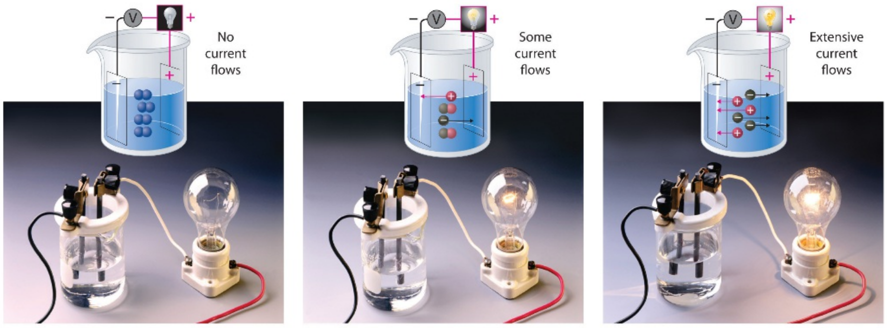
- solution that has ions that conducts electricity (mobile charges)
  - strong electrolyte - conducts well (solution of sodium chloride)
    - soluble ionic compounds (NaCl, KNO_3, etc)
  - weak electrolytes - do not conduct electricity well
    - moderately soluble ionic compounds (ammonia water)

Non-electrolyte

- solution that DOES NOT conduct electricity
- soluble molecular substances - sugars($C_6H_{12}O_6$(glucose))/alcohols (C_2H_5OH(ethanol))
- no ions

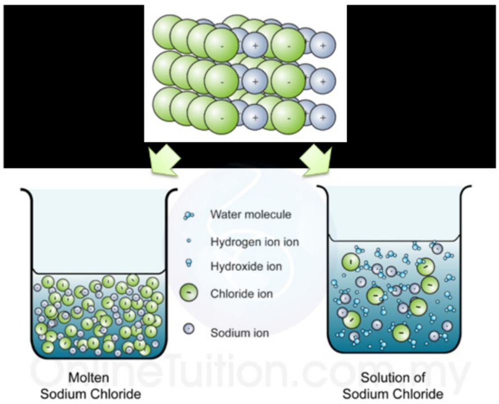
Testing for an electrolyte

- use a conductivity tester



(a) Nonelectrolyte (b) Weak electrolyte (c) Strong electrolyte

Electrolytes vs. Nonelectrolytes



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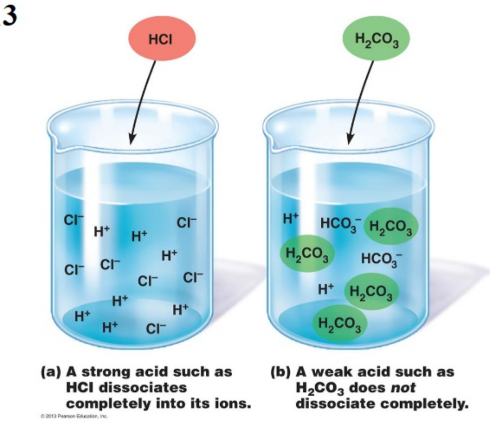

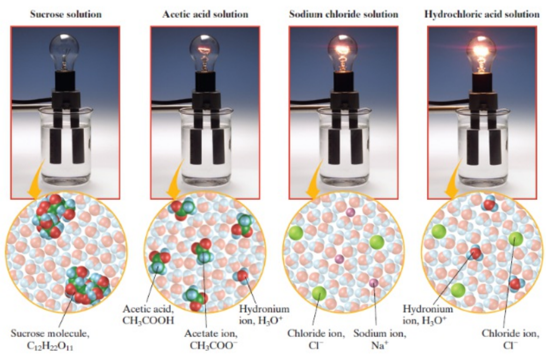

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<u>**Rate of Dissolution**</u>

Factors Affecting the Rate of Dissolution

1) Increasing surface area - the smaller the surface area the faster the solute will dissolve
2) Agitation - stirring, shaking
3) Heating mixture - increases KE of solvent particles, more *E* when colliding with solute
   a) As the temperature of the solvent increases, the amount of dissolved solid solute increases (generally). Exception: Li_2SO_4 actually decreases as temperature increases.
   b) As the temperature of the solvent increases, the amount of dissolved gaseous solute decreases.
      i) Gases above a liquid establish an equilibrium: **gas + solvent ⇔ solution + E**

      ii) Increasing the pressure of the gas above the solution stresses the equilibrium, to re-establish the equilibrium more gas will dissolve inthe solvent.
         a) **Henry's Law**: the solubility of a gas is directly proportional to the partial pressure of the gas above the liquid.
            - Soda: the pressure of CO_2 is about 5atm above the solution so the amount of CO_2 dissolved is about 5 times more than normal.

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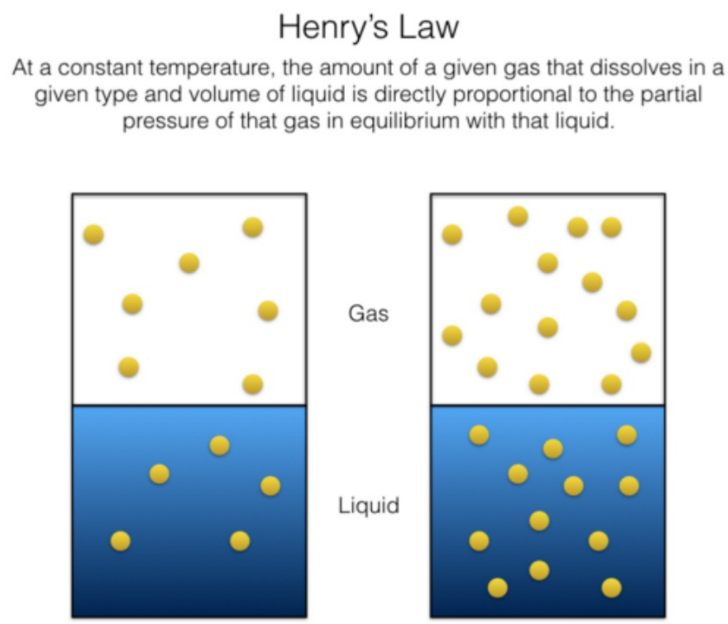
Henry's Law



Saturated Solutions

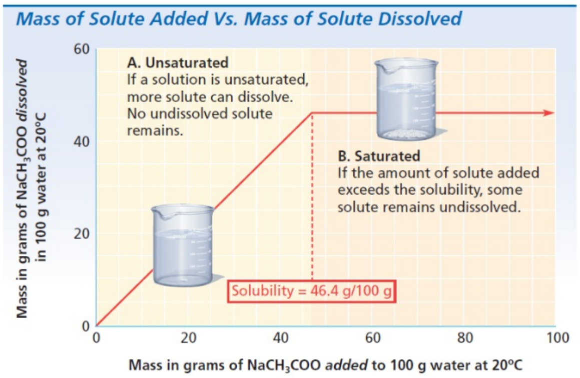
Equilibrium between the formation of the solid and ions

dissolution --------->

solid + *E* <--> solution

<---------- -----crystallization

*Must be a saturated solution

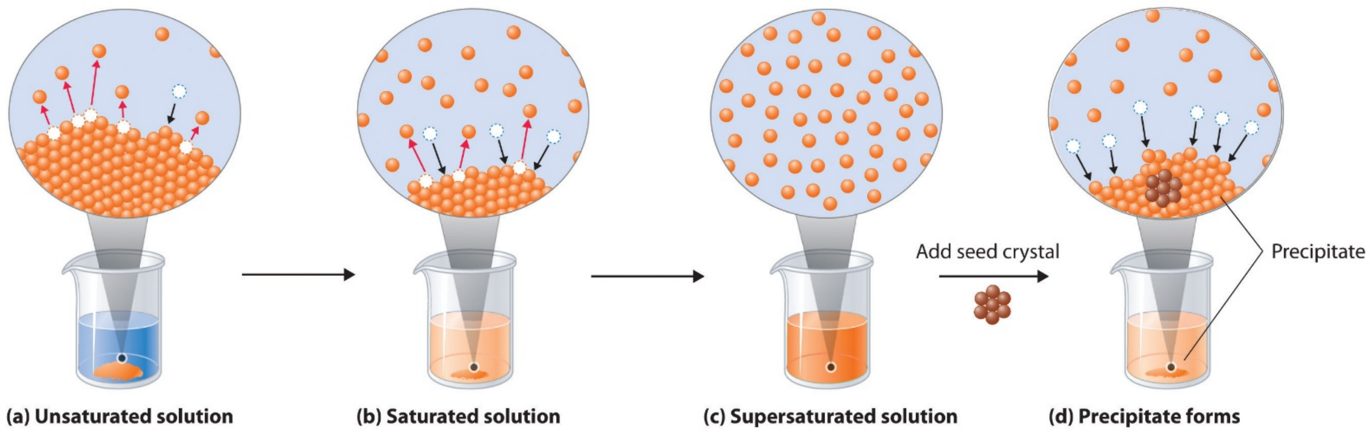


Saturated solution (maximum amount of solute dissolved for a given temperature)
- must have undissolved solid solute at the bottom of the container
- solution equilibrium (dissolution and crystallization occur at the same rate.)

Unsaturated solution (less than maximum amount of solute for a given temperature)
- no undissolved solid

Supersaturated solution - more than the maximum amount of solute at a given temperature
- Process - heat solvent, dissolve solute to saturation, pour off supernatent (liquid above solid) and cool slowly the resulting solution is supersaturated.

Saturated Solutions



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Solubility (Solids/Liquids/Gases)

Solubility values - amount of solute dissolved in 100 g of water at a given temperature

- Soluble: dissolves
- Insoluble: does not dissolve*
- **Solids**
  - solubility (usually) increases as temperature of solvent increases
    - NH_4Cl: 30g/100grams of water at 0°C
    - NH_4Cl: 77g/100grams of water at 100°C
- **Gases**
  - solubility decreases as temperature of solvent increases
    - SO_2: 24g/100g of water at 0°C
    - SO_2: 4g/100g of water at 40°C
  - for a given temperature, solubility increases as pressure above the solution increases

- **Liquids**
  - liquid solvent and solute
    - miscible: dissolves in all quantities
    - immiscible: does not dissolve in ANY quantity

Solutions
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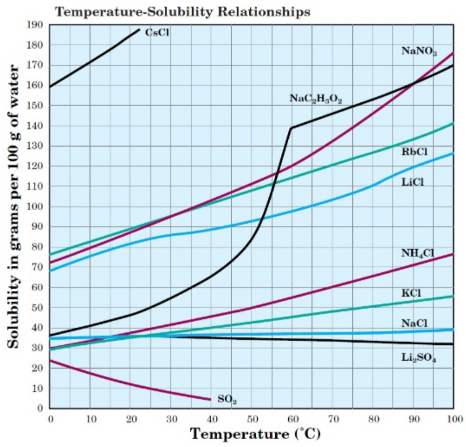
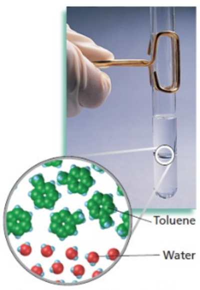
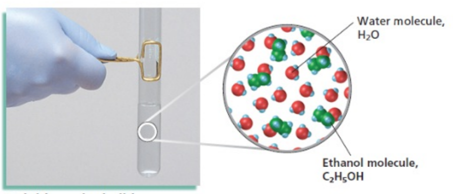
Solubility (Solids/Liquids/Gases)

Solubility of Solutes as a Function of Temperature (in g solute/100.g H_2O)						
	Temperature (°C)					
Substance	0	20	40	60	80	100
$AgNO_3$	122	216	311	440	585	733
$Ba(OH)_2$	1.67	3.89	8.22	20.94	101.4	-
$C_{12}H_{22}O_{11}$	179	204	238	287	362	487
$Ca(OH)_2$	0.189	0.173	0.141	0.121	-	0.07
$Ce_2(SO_4)_3$	20.8	10.1	-	3.87	-	-
KCl	28.0	34.2	40.1	45.8	51.3	56.3
KI	128	144	162	176	192	206
KNO_3	13.9	31.6	61.3	106	167	245
LiCl	69.2	83.5	89.8	98.4	112	128
Li_2CO_3	1.54	1.33	1.17	1.01	0.85	0.72
NaCl	35.7	35.9	36.4	37.1	38	39.2
$NaNO_3$	73	87.6	102	122	148	180
CO_2 (gas @ STP)	0.335	0.169	0.0973	0.058	-	-
O_2 (gas @ STP)	0.00694	0.00537	0.00308	0.00227	0.00138	0.00





Insoluble and immiscible



Soluble and miscible

Temperature-Oxygen Solubility Relationship	
Temperature (°C)	Oxygen Solubility (mg/L)
0	14.6
5	12.8
10	11.3
15	10.2
20	9.2
25	8.6
100	0

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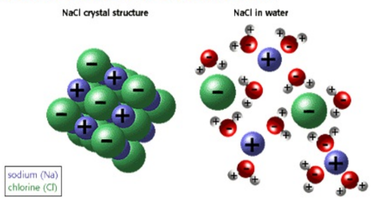
Solution Formation

How a Solution Forms

- process ocurrs at the surface of a solid
- intermolecular forces between solvent and solute, pull solute from surface of a solid.
  - When NaCl dissolves in water, the water molecules have enough attraction to the sodium ions, Na^+, and chloride ions, Cl^-, to separate them from the NaCl crystal lattice. The partial negative charge on oxygen in water attracts the cation, Na+, and the positive partial charge on the hydrogens attracts the anion, Cl^-. After separating from the solid, the ions are surrounded by water molecules which keeps them separated and in solution.
- Ionic compounds **dissociate** when dissolved, separate into ions.
- **Solvation** - interaction between solute and solvent
- **Hydration** - solvation when the solvent is water



Solute-Solvent Interactions

- Like dissolves Like
  - polar solute dissolved by polar solvent (ethanol dissolved in water)
    - polar solvent has a positive and negative area within its structure; water
  - nonpolar solute dissolved by nonpolar solvent (octane dissolved in gasoline)
    - nonpolar solvent does not have a positive and negative region; benzene
- Examples:
  - NaCl (polar) DOES NOT dissolve in cooking oil (nonpolar)
  - cooking oil (nonpolar) does not dissolve in water (polar)

Solutions
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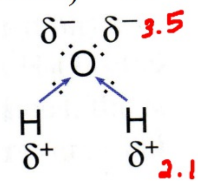
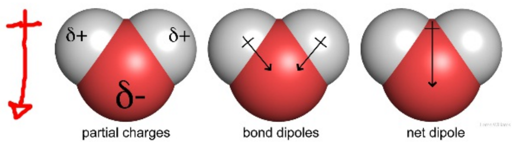
Polar vs. Nonpolar Solvents/Solutes

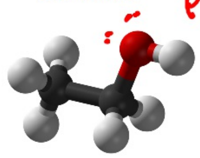
EN_{diff} (O and H) = 1.4



water



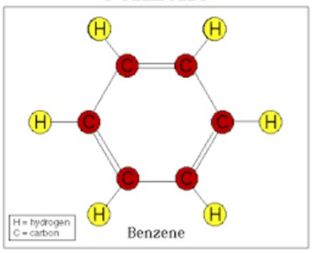
ethanol polar



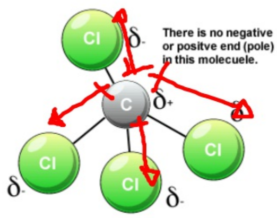
$H - Cl$ polar

EN_{diff} (C and H) = 0.4

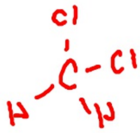
benzene



carbon tetrachloride



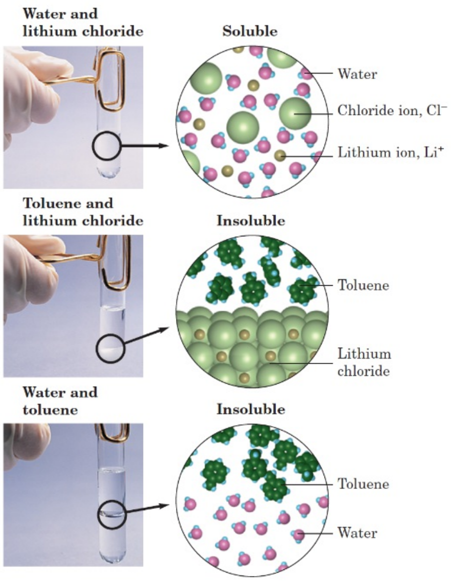
CCl_4

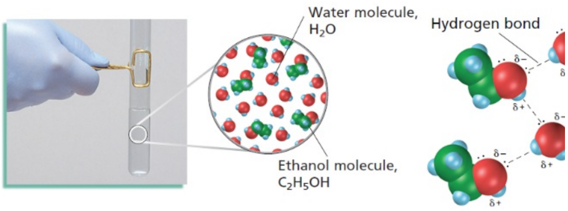


CH_2Cl_2

Polar vs. Nonpolar Solvents

Particle Model for Soluble and Insoluble Substances 106





Hydrogen bonding between the solute and solvent enhances the solubility of ethanol in water.

Solutions
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Topic#13 WS#1: Nature of Solutions

1. f
2. c
3. g
4. h
5. e
6. b
7. d
8. a
9. two or more metals dissolved in one another. 14K Au, Steel, stainless steel, etc
10. solid solute dissolved in a liquid or liquid solute in a liquid solvent or a gaseous solute in a liquid solvent: kool-aide, alcoholic beverage, soda, etc.
11. gaseous solute in a gaseous solvent: air
12. a homogeneous mixture of two or more substances whose particles are small (<1nm), evenly distributed, and will not separate out.
13. If a change in physical state occurs, this is the solute. If no change in state occurs, than the substance in greatest amount is the solvent.
14. Desirable because they have different properties than the pure iron beam. Stronger and resist corrosion better.
15. Miscible substances can mix in any amount while immiscible substances cannot mix in any amount.
16. It can dissolve a lot of substances.
17. Dissolve it in water and use a conductivity tester. If the light illuminates, the substance is an electrolyte
18. pond water - dissolved minerals and oxygen; blood - dissolved ions, sugars, and etc.

Topic#13: WS#2 Solubility Curve

1. C, A
2. 52g, 208g
3. B
4. increases
5. increases
6. decreases
7. A and B
8. C
9. saturated
10. unsaurated
11. saturated (excess solid would fall to the bottom)
12. Dissolve 52 grams of B at 60ºC then cool slowly without disturbance. This would create a supersaturated solutino of B at 50ºC.

Solutions
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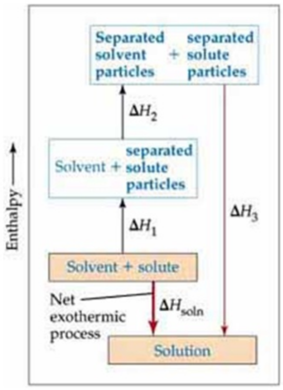
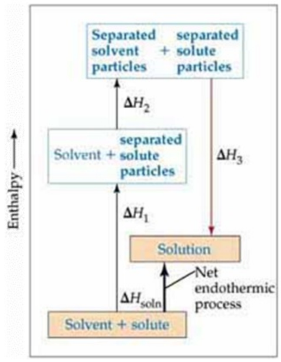
Enthalpy of Solution, ΔH_{soln}

Demo: **lithium chloride vs potassium chloride**

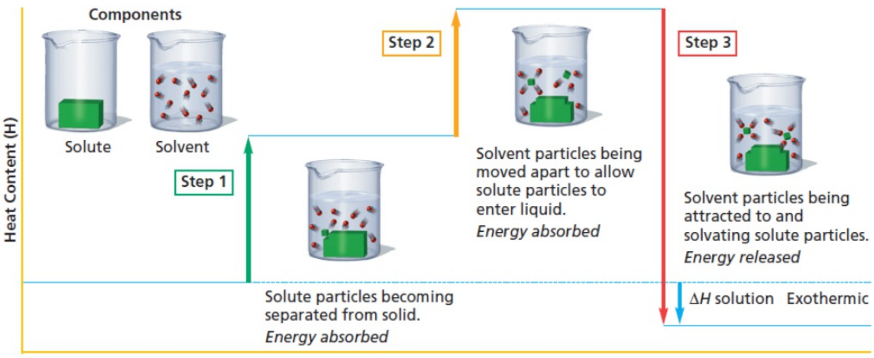
Energies Associated with Solution Formation

- 3 steps in the formation of a solution
  1) Separation of solute particles, energy added (+E)
  2) Separation of solvent particles, energy added (+E)
  3) attraction between solute and solvent particles, energy released (-E)
- Enthalpy of solution (ΔH_{soln}) - the energy gained or lost during the formation of a solution. $\Delta H_{soln} = (\Delta H_1 + \Delta H_2) + \Delta H_3$
- ΔH_1 is the energy needed to separate the solute particles (break the intermolecular forces between the solute particles)
  ΔH_2 is the energy needed to separate the solvent particles (break the intermolecular forces between the solvent particles)
- ΔH_3 is the enery release from attractive intermolecular force between solute and solvent particles.
  - If (3) > (1+2) then ΔH_{soln} is negative (exothermic)
  - If (3) < (1+2) then ΔH_{soln} is positive (endothermic)
    - KI is $+\Delta H_{soln}$ (endo)
    - LiCl is $-\Delta H_{soln}$ (exo)





Enthalpy of Solution, ΔH_{soln}



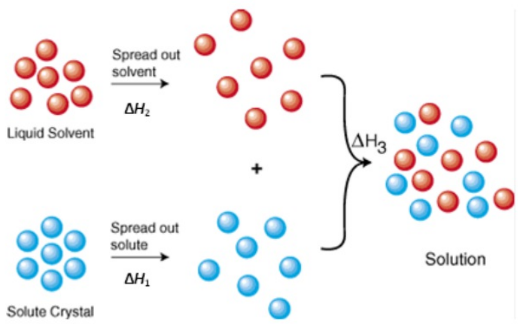


TABLE 11.2 Some Enthalpies and Entropies of Solution in Water at 25°C

Substance	ΔH_{soln} (kJ/mol)	ΔS_{soln} [J/(K · mol)]
LiCl	−37.0	10.5
NaCl	3.9	43.4
KCl	17.2	75.0
LiBr	−48.8	21.5
NaBr	−0.6	54.6
KBr	19.9	89.0
KOH	−57.6	12.9

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Concentrations

Concentration

- similar to density (mass/volume vs. moles/volume)
- unlike the density of a solid or liquid, concentration can change by adding more solvent or solute.
- the amount of solute per solution is constant for a given concentration.
- for a given amout of solution, the ratio of solute to solvent remains the same.

Molarity

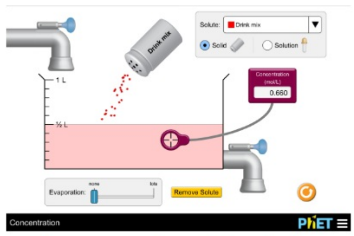
- moles of solute per liters of solution
    - M = mol/L = g/MM/L

Molality

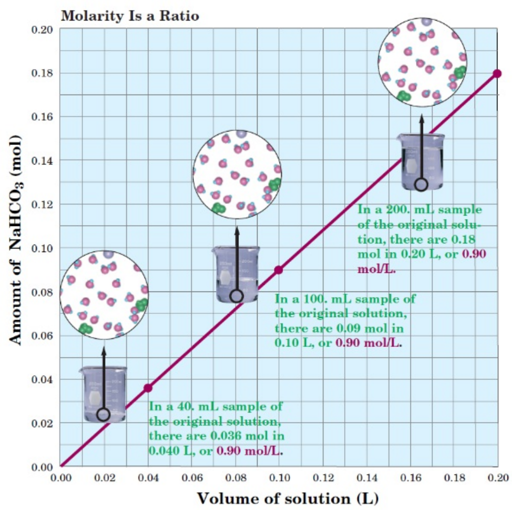
- moles of solute per kilogram of solvent
    - m = mol/kg = g/MM/kg

Mole Fraction

- moles of one component divided by the total number of moles in the system.
    - $X_a = n_a/n_T$
    - $n_a = g_a/MM_a$ and n_T = sum of the moles in a system



Concentration Simulation



Solutions
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Concentrations

1L

0.10 M NaOH
1L × 0.10 mol/L = 0.10 mol

0.10 mol × 40g/mol
= 4.0g NaOH

22.99
16.00
1.01
40.00

Name	Symbol	Units	Areas of application
Molarity	M	$\frac{\text{mol solute}}{\text{L solution}}$	in solution stoichiometry calculations
Molality	*m*	$\frac{\text{mol solute}}{\text{kg solvent}}$	boiling-point elevation and freezing-point depression calculations
Mole fraction	*X*	$\frac{\text{mol solute}}{\text{total mol solution}}$	in solution thermodynamics
Volume percent	% *V*/*V*	$\frac{\text{volume solute}}{\text{volume solution}} \times 100$	with liquid-liquid mixtures
Mass or weight percent	% or %w/w	$\frac{\text{g solute}}{\text{g solution}} \times 100$	in biological research
Parts per million	ppm	$\frac{\text{g solute}}{1\,000\,000 \text{ g solution}}$	to express small concentrations
Parts per billion	ppb	$\frac{\text{g solute}}{1\,000\,000\,000 \text{ g solution}}$	to express very small concentrations, as in pollutants or contaminants

Molarity (*M*)

$$M = \frac{\text{moles solute}}{\text{Liters of solution}}$$

Molality (*m*)

$$\frac{mol_{\text{solute}}}{kg_{\text{solvent}}} = m$$

Mole Fraction (X_a)

$$X_A = \frac{n_A}{n_A + n_B}$$

$$X_A = \frac{n_A}{n_{TOT}}$$

Dilution

$$M_1V_1 = M_2V_2$$

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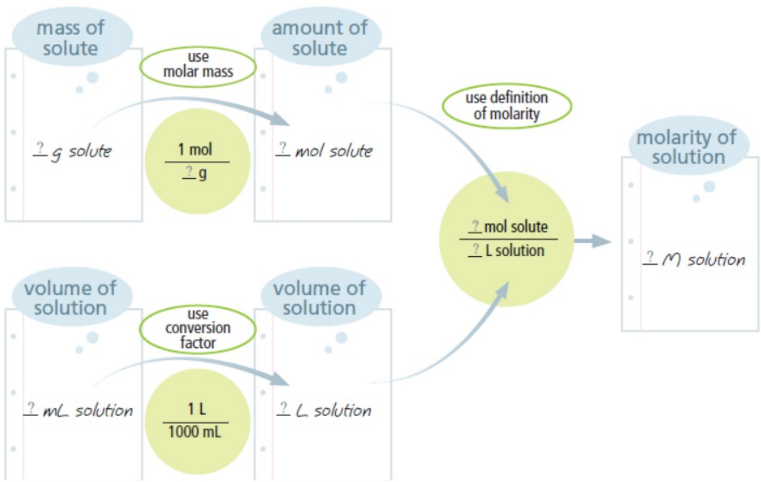
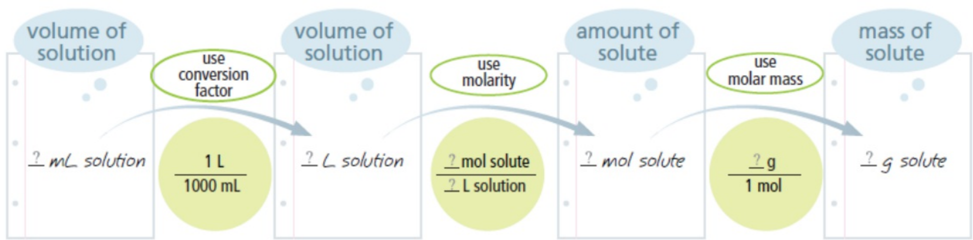
Concentrations





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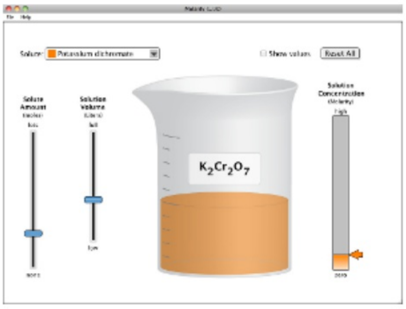
Topic#13

Concentrations

$$M = \frac{\text{moles solute}}{\text{Liters of solution}} = \text{grams}/MM/\text{L}$$



Molarity Simulation

Solutions
Topic#13

Concentrations

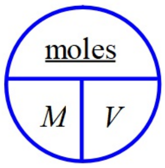
Molarity Problems

Molarity = moles/volume IN LITERS of solution

If asked for molarity: M = n/V

If asked for volume: V = n/M

If asked for moles: n = MV



$$M = \frac{\textbf{moles solute}}{\textbf{Liters of solution}}$$

Topic#13 Sample WS#2 - Molarity Practice Problems

1. You have 3.50L of solution that contains 90.0g of sodium chloride, NaCl. What is the molarity of the solution? Ans: 0.440*M* NaCl

GUN
V = 3.50 L
90.0g NaCl
MM_{NaCl} = 58.44 g/mol

NTK
$M = \frac{mol}{V} = \frac{g/MM}{L}$

UNK
M = 0.440 mol/L

SOLVE:
$M = \frac{90.0g / 58.44 g/mol}{3.50} = \boxed{0.440 M}$

Concentrations

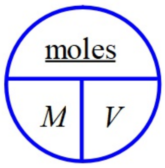
Molarity Problems

Molarity = moles/volume IN LITERS of solution

If asked for molarity: M = n/V

If asked for volume: V = n/M

If asked for moles: n = MV



$$M = \frac{\text{moles solute}}{\text{Liters of solution}}$$

2. You have 0.8L of a 0.5*M* HCl solution. How many moles of HCl does the solution contain?

Ans: 0.4 mol HCl

GVN
0.8 L
0.5 M HCl

NTK
$M = \frac{mol}{L}$

UNK
moles = 0.4 mol

SOLVE
mol = M * L
mol = 0.5 * 0.8 = 0.4 moles HCl

Concentrations

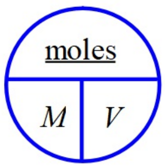
Molarity Problems

Molarity = moles/volume IN LITERS of solution

If asked for molarity: M = n/V

If asked for volume: V = n/M

If asked for moles: n = MV



$$M = \frac{\text{moles solute}}{\text{Liters of solution}}$$

3. How many grams of sodium chloride are needed to make 250.mL of a 0.250*M* solution?

Ans: 3.65g

GVN

V: 250mL = 0.250L

M = 0.250 M

MM_{NaCl} = 58.44g/mol

NTK

$M = \frac{mol}{L} = \frac{g/MM}{L}$

UNK

$g = \frac{3.65}{}$ g

SOLVE

$g = (MM)(L)(M)$

$= \left(58.44 \frac{g}{mol}\right)(0.250 L)\left(0.250 \frac{mol}{L}\right)$

$= \boxed{3.65 g}$

Concentrations

Molarity Problems

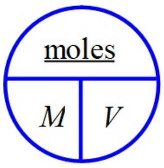
Molarity = moles/volume IN LITERS of solution

If asked for molarity: M = n/V

If asked for volume: V = n/M

If asked for moles: n = MV

$$M = \frac{\text{moles solute}}{\text{Liters of solution}}$$



4. To produce 40.0g of silver chromate, you will need at least 23.4g of potassium chromate in solution as a reactant. All you have on hand in the stock room is 5L of 6.0*M* K_2CrO_4 solution. What volume of the solution is needed to give you the 23.4g K_2CrO_4 needed for the reaction? (Ans: 0.020 L K_2CrO_4)

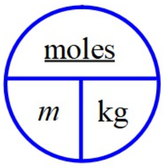
GVN
40.0g Ag_2CrO_4
23.4g K_2CrO_4
5 L
6.0 M K_2CrO_4
$MM_{K_2CrO_4}$ = 194.2g/mol

NTK
$M = \frac{g/MM}{L}$

UNK
V = 0.02 L

SOLVE:
$$L = \frac{g/MM}{M} = \frac{23.4\text{g}/194.2\text{ g/mol}}{6.0\ \frac{\text{mol}}{\text{L}}} = \boxed{0.02\ \text{L}}$$

Concentrations



$$\frac{mol_{solute}}{kg_{solvent}} = m$$

Molality Problems

5. A solution was prepared by dissolving 17.1g of sucrose (table sugar, $C_{12}H_{22}O_{11}$) in 125g of water. Find the molal concentration of this solution. (Ans: 0.400*m*)

GVN

17.1 g sucrose (solute)

125 g H_2O (solvent) = 0.125 Kg

MM_{suc} = 342.34

NTK

$m = \frac{mol}{Kg} = \frac{g/MM}{Kg}$

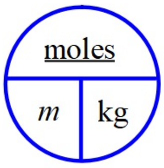
UNK

m = 0.400 m

SOLVE:

$$m = \frac{\frac{17.1\,g}{342.34\,g/mol}}{0.125\,Kg} = 0.400\ mol/Kg$$

Concentrations



$$\frac{mol_{\text{solute}}}{kg_{\text{solvent}}} = m$$

6. A solution of iodine, I_2, in carbon tetrachloride, CCl_4, is used when iodine is needed for certain chemical tests. How much iodine must be added to prepare a 0.480*m* solution of iodine in CCl_4 if 100.0g of CCl_4 is used? (Ans: 12.2 g I_2)

Gvn

I_2 (solute)

100g CCl_4 (solvent) = 0.100Kg

m = 0.480m

MM_{I_2} = 253.8 g/mol

NTK

$m = \frac{g/MM}{kg}$

UNK

grams_{I_2} = 12.2 g

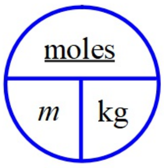
SOLVE:

$g = (m)(MM)(Kg)$

$= \left(0.480\frac{mol}{Kg}\right)\left(253.8\frac{g}{mol}\right)(0.100\,Kg)$

= **12.2g I_2**

Concentrations

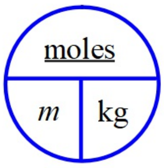


$$\frac{mol_{\text{solute}}}{kg_{\text{solvent}}} = m$$

7. (OYO) What is the mass of water needed to make a 0.680*m* solution containing 61.3g of glucose?

Ans: 0.500kg (500 mL)

Concentrations



$$\frac{mol_{solute}}{kg_{solvent}} = m$$

7. (OYO) What is the mass of water needed to make a 0.680*m* solution containing 61.3g of glucose?

Ans: 0.500kg (500 mL)

GVN

m = 0.680 m

61.3g $C_6H_{12}O_6$ (solute)

H_2O (solvent)

$MM_{C_6H_{12}O_6}$ = 180.18g/mol

NTK

$m = \frac{mol}{Kg} = \frac{g/MM}{Kg}$

UNK

Kg_{H_2O} = 0.500 Kg

SOLVE

$$Kg = \frac{g/MM}{m}$$

$$= \frac{61.3g / 180.18\,g/mol}{0.680\,\frac{mol}{Kg}} = \boxed{0.500\ Kg}$$

Concentrations

$$X_A = \frac{n_A}{n_A + n_B}$$
$$X_A = \frac{n_A}{n_{TOT}}$$

Mole Fraction Practice Problem

8. What is the mole fraction for each part of a solution containing 2.4mol N_2, 0.34mole O_2, 9.8mol NH_3, 0.65mol CO_2, and 15.3mol CH_4. (Ans: 0.084 N_2/0.012 O_2/0.34 NH_3/0.023 CO_2/0.54 CH_4)

GVN

2.4 mol N_2
0.34 mol O_2
9.8 mol NH_3
0.65 mol CO_2
15.3 mol CH_4

NTK

$X_a = \frac{n_a}{n_T}$

$n_T = 2.4 + 0.34 + 9.8 + 0.65 + 15.3$
$= 28.49$

SOLVE

$X_{N_2} = \frac{2.4}{28.49} = 0.084$

$X_{O_2} = \frac{0.34}{28.49} = 0.012$

$X_{NH_3} = \frac{9.8}{28.49} = 0.344$

$X_{CO_2} = \frac{0.65}{28.49} = 0.0228$

$X_{CH_4} = \frac{15.3}{28.49} = 0.537$

Dilution:
$M_1V_1 = M_2V_2$

Dilution Practice Problems

9. Concentrated HCl(*aq*) (12*M*) is delivered in a shatter proof bottle. A lab requires 250 mL of 0.100*M* HCl(*aq*). How much HCl must be used for the creation of this solution? How much water must be added? Ans: 2.1mL HCl, 247.9mL H_2O

GVN
$M_1 = 12M$
$V_2 = 250\ mL$
$M_2 = 0.100M$

NTK
$M_1V_1 = M_2V_2$
$V_1 = \frac{M_2V_2}{M_1}$

UNK
$V_1 =$ 2.1 mL
$V_{H_2O} =$ 247.9 mL

SOLVE:
$V_1 = \frac{(0.1)(250)}{12} = 2.1\ mL$
$V_T = V_1 + V_{H_2O}$
$250 = 2.1 + V_{H_2O} \rightarrow V_{H_2O} = 250 - 2.1 = 247.9\ mL$ H_2O added

Solutions
Topic#13

Concentrations

Quiz#1 Starter: Molarity, Molality, Mole Fraction, and Dilutior

1) What is the molar mass of 6.3g of a substance with a volume of 250mL and a molarity of 0.125?
2) How many grams of $W(NO_3)_3$ are needed to prepare a 750.mL of a 0.220*M* solution?
3) What is the mole fraction for each substance in the following mixture: 2.3g of H_2, 9.5g CO_2 and 6.4g of CH_4?
4. How many grams of $W(NO_3)_3$ are needed to prepare 450mL of a 0.220*m* solution?
5. A 0.2500*M* NaOH solution is prepared from 6.000*M* NaOH. You need 150.0mL of the 0.2500*M* solution. What is the volume of 6.000*M* solution needed and how much water is added to make the dilute solution?

APRIL FOOLS!!!!!!

Answers:
1. $2.0x10^2$g
2. 61g
3. 0.65/0.12/0.23
4. 37g
5. 6.25mL and 143.8mL

Concentrations

Molarity, Molality, Mole Fraction, and Dilution Starter

1) What is the molar mass of 6.3g of a substance with a volume of 250mL and a molarityof 0.125?
2) How many grams of $W(NO_3)_3$ are needed to prepare a 750.mL of a 0.220*M* solution?
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(1) $M = \frac{g/mm}{L}$ solve for mm

(2) $M = \frac{g/MM}{L}$ solve for g

(3) convert to moles, total, divide total into each mol

(4) $m = \frac{g/mm}{Kg}$ solve for grams, convert grams of solvent into Kg.

(5) $M_1V_1 = M_2V_2$

$V_T = V_2 + V_{H_2O}$

Answers:

1. 2.0×10^2g
2. 61g
3. 0.65/0.12/0.23
4. 37g
5. 6.25mL and 143.8mL

Concentrations - Preparing a Solution

Preparing 1.000 L of a 0.5000 M Solution 110

Copper(II) sulfate, $CuSO_4$, is one of the compounds used to produce the chemiluminescence in light sticks. To make a 0.5000 M $CuSO_4$ solution, you need 0.5000 mol of the hydrate, $CuSO_4 \bullet 5H_2O$, for each liter of solution. To convert this amount of $CuSO_4 \bullet 5H_2O$ to a mass, multiply by the molar mass of $CuSO_4 \bullet 5H_2O$ (mass of $CuSO_4 \bullet 5H_2O$ = 0.5000 mol × 249.68 g/mol = 124.8 g).

Add some solvent (water) to the calculated mass in the beaker to dissolve it, and then pour the solution into a 1.000 L volumetric flask.

Rinse the beaker with more water several times, and each time pour the rinse water into the flask until the solution almost reaches the neck of the flask.

Stopper the flask, and swirl thoroughly until all of the solid is dissolved.

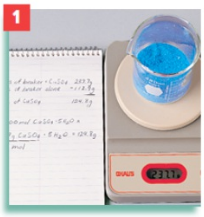
Carefully fill the flask with water to the 1.000 L mark.

Restopper the flask, and invert the flask at least 10 more times to ensure complete mixing.

The solution that results has 0.5000 mol of $CuSO_4$ dissolved in 1.000 L of solution—a 0.5000 M concentration.

Concentrations - Preparing a Solution

Making a Molal Solution



Calculate the mass of $CuSO_4 \cdot 5H_2O$ needed. To make this solution, each kilogram of solvent (1000 g) will require 0.5000 mol of $CuSO_4 \cdot 5H_2O$. This mass is calculated to be 124.8 g.

Add exactly 1 kg of solvent to the solute in the beaker. Because the solvent is water, 1 kg will equal 1000 mL.

Mix thoroughly.

The resulting solution has 0.5000 mol of solute dissolved in 1 kg of solvent.

Topic#13: WS#3 Concentrations

Part A
1. molarity
2. saturated
3. concentration
4. supersaturated
5. mole fraction
6. molality
7. unsaturated
8. using a balance, measure out the mass (moles) of the solute, add to the correct volumetric flask, then add solvent to the flask until the correct volume is reached.
9. molality refers to the mass of solvent while molarity is defined by the liters of solution.
10. Chemical reactions depend on a known concentration. Not knowing the concentration leads to bad reactions with uncalculateable results. For consulmers, knowing the concentration is useful when comparing products.

Part B (2019-2020)

11. endothermic
12. polar solvent
13. solubility
14. solvation
15. endothermic
16. nonpolar solvent
17. Henry's law
18. decreases
19. increases
20. increases

Solutions
Topic#13

WS Questions

What questions do you have regarding the worksheets?

22. Calculate the molarity of each ion after 12.54g of iron (III) sulfate are dissolved in 250.0mL of distilled water. (Ans: 0.250*M* Fe^{3+} and 0.375*M* SO_4^{2-})

$$M = \frac{g/mm}{L} = \frac{12.54g / 399.91}{0.250} = 0.125 M$$

$Fe_2(SO_4)_3$
399.91

$[Fe_2(SO_4)_3] = 0.125$

$[Fe^{3+}] = 2(0.125) = 0.250 M\ Fe^{3+}$

$[SO_4^{2-}] = 3(0.125) = 0.375 M\ SO_4^{2-}$

1. 14.35g of barium nitrate were added to 350.0mL of distilled water. After the barium nitrate was fully dissolved 50.0mL of the solution was removed and diluted with 200.0mL of distilled water. Calculate the molarity of the final solution. (Ans: 0.1569*M* for initial solution and 0.03138*M* for the dilution)

WS Questions

What questions do you have regarding the worksheets?

$Ba(NO_3)_2$

23. 14.35g of barium nitrate were added to 350.0mL of distilled water. After the barium nitrate was fully dissolved 50.0mL of the solution was removed and diluted with 200.0mL of distilled water. Calculate the molarity of the final solution. (Ans: 0.1569*M* for initial solution and 0.03138*M* for the dilution)

$$M = \frac{\frac{14.35g}{261.35}}{0.350} = 0.1569M$$

$$M_1V_1 = M_2V_2$$

$$(0.1569)(50) = M_2(250)$$

$$M_2 = 0.03138M$$

Concentrations

Quiz#1 Review - Molarity, Molality, and Mole Fraction

1. What is the molar mass of 6.6g of a substance with a volume of 750mL and a molarity of 0.550?
2. How many grams of $Cr(NO_3)_3$ are needed to prepare a 350.mL of a 0.520*M* solution?
3. How many grams of $Cr(NO_3)_3$ are needed to prepare 450 grams of a 0.220*m* solution?
4. A 0.5200*M* NaOH solution is prepared from 4.500*M* NaOH. You need 250.0mL of the 0.5200*M* solution. What is the volume of 4.500*M* solution needed and how much water is added to make the dilute solution?

Answers:

1. 16g/mol
2. 43g
3. 24g
4. 28.89mL and 221.1mL

Concentrations

Quiz#1 Review - Molarity, Molality, and Mole Fraction

1. What is the molar mass of 6.6g of a substance with a volume of 750mL and a molarity of 0.550?
2. How many grams of $Cr(NO_3)_3$ are needed to prepare a 350.mL of a 0.520*M* solution?
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4. A 0.5200*M* NaOH solution is prepared from 4.500*M* NaOH. You need 250.0mL of the 0.5200*M* solution. What is the volume of 4.500*M* solution needed and how much water is added to make the dilute solution?

(1) $M = \frac{g/mm}{L}$ $mm = \frac{g}{M \cdot L} = \frac{6.6}{(0.55)(0.750)} = 16$

(2) $g = M \cdot L \cdot mm = (0.520)(0.350)(238.03)$

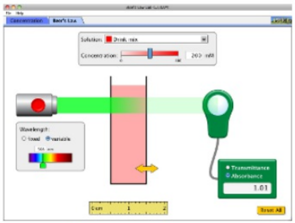
(3) $m = \frac{g/mm}{Kg}$ $(m)(Kg)(mm) = g = (0.22)(0.45)(238.03)$

(4) $M_1V_1 = M_2V_2$
$(0.52)(250) = (4.5)(V_2)$
28.89mL
$V_{H_2O} = V_T - V_2 = 250 - 28.89$
$= 221.1mL\ H_2O$

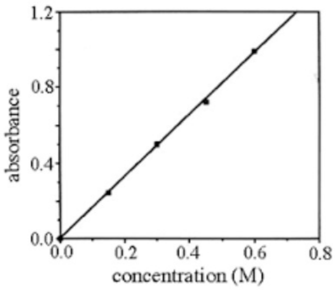
Answers:
1. 16g/mol
2. 43g
3. 24g
4. 28.89mL and 221.1mL

Solutions
Topic#13

Concentrations



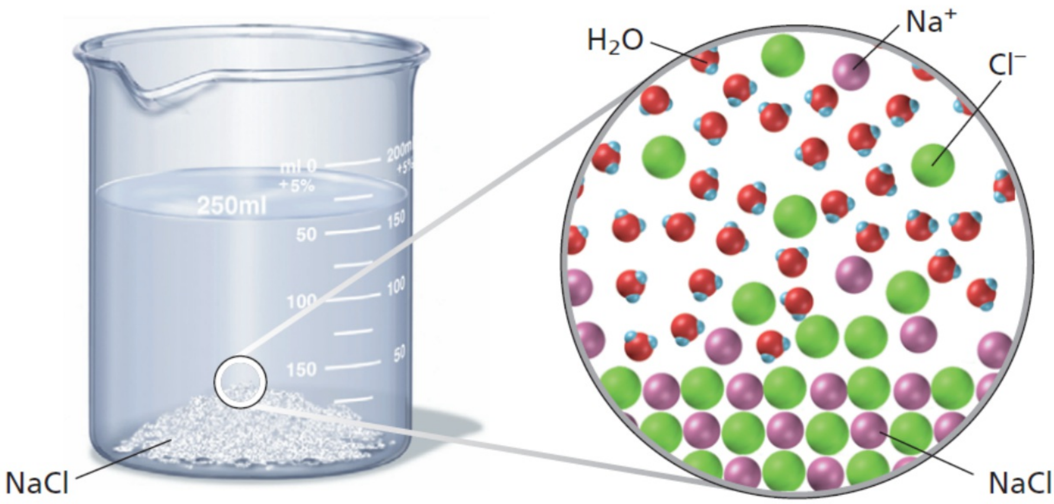
Beers Law Simulation



Dissociation Reactions

Dissociation of NaCl

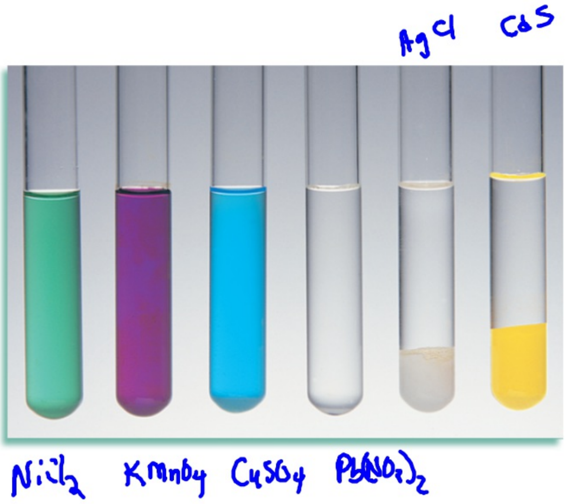
$NaCl(s) \rightleftharpoons Na^+(aq) + Cl^-(aq)$



Solutions
Topic#13

Soluble vs. Insoluble Ionic Compounds

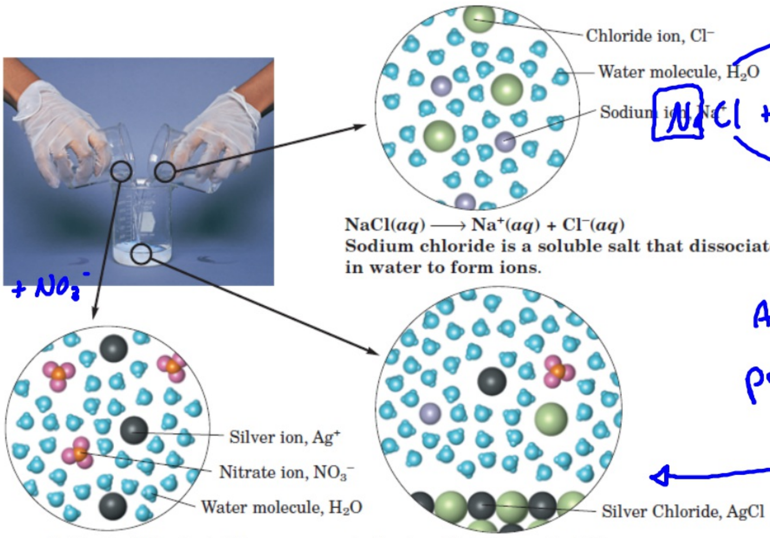
Soluble and Insoluble Ionic Compounds



Ionic compounds can be soluble or insoluble in water. $NiCl_2$, $KMnO_4$, $CuSO_4$, and $Pb(NO_3)_2$ are soluble in water. AgCl and CdS are insoluble in water.

Precipitate Formation

Particle Model for the Formation of a Precipitate



$NaCl(aq) \longrightarrow Na^+(aq) + Cl^-(aq)$ **Sodium chloride is a soluble salt that dissociates in water to form ions.**

$AgNO_3(aq) \longrightarrow Ag^+(aq) + NO_3^-(aq)$ **Silver nitrate is a soluble salt that dissociates in water to form ions.**

$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$ **Silver chloride is an insoluble salt that forms when Ag^+ ions can react with Cl^- ions.**

$AgNO_3(s) \rightarrow Ag^+ + NO_3^-$

spectator ions

$NaCl + AgNO_3 \rightarrow AgCl_{(s)} + NaNO_3{}_{(aq)}$

participatory ions

$Ag^+ + Cl^- \rightarrow AgCl(s)$

participatory ions

Na^+ & NO_3^-

spectator ions

Solutions
Topic#13

Using Solubility Rules

General Solubility Guidelines

	Compounds containing these ions are soluble in water:
1.	**Acetates,** $CH_3CO_2^-$, except that of Fe^{3+}
2.	**Alkali metals** (Group 1), except LiF
3.	**Ammonium,** NH_4^+
4.	**Bromides,** Br^-, except those of Ag^+, Pb^{2+}, and Hg_2^{2+}
5.	**Chlorides,** Cl^-, except those of Ag^+, Pb^{2+}, and Hg_2^{2+}
6.	**Nitrates,** NO_3^-
7.	**Sulfates,** SO_4^{2-}, except those of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}, and Hg_2^{2+}
	Compounds containing these ions are insoluble in water:
8.	**Carbonates,** CO_3^{2-}, except those of Group 1 and NH_4^+
9.	**Chromates,** CrO_4^{2-}, except those of Group 1 and NH_4^+
10.	**Hydroxides,** OH^-, except those of Group 1 and Ca^{2+}, Sr^{2+}, + Ba^{2+}
11.	**Oxides,** O^{2-}, except those of Group 1, Ca^{2+}, Sr^{2+}, and Ba^{2+} (which form hydroxides) *
12.	**Phosphates,** PO_4^{3-}, except those of Group 1 and NH_4^+
13.	**Sulfides,** S^{2-}, except those of Group 1, Mg^{2+}, Ca^{2+}, Ba^{2+}, and NH_4^+

Dirty Three
Most all Ag^+, Pb^{2+}, and Hg_2^{2+} compounds are insoluble

$Na_2O + H_2O \rightarrow NaOH$

$CaO + H_2O \rightarrow Ca(OH)_2$

Using Solubility Rules

Topic#13 Sample WS#3 - Solubility of Compounds Practice Problems

Use the solubility rules to determine solubility of the following compounds. If the compound is soluble, write the dissociation equation for the compound.

	Soluble (Y/N)	Equation for Soluble Compound
1. $Sr_3(PO_4)_2$	____	______________________
2. Na_2CrO_4	____	______________________
3. LiOH	____	______________________
4. $Fe(C_2H_3O_2)_3$	____	______________________
5. $Sr(OH)_2$	____	______________________
6. $CaCO_3$	____	______________________
7. FeS	____	______________________
8. CuO	____	______________________
9. Na_2O	____	______________________
10. Ag_2SO_4	____	______________________

WS#4: Dissociation of Water Soluble Compounds

1. $Cd(NO_3)_2(s)$ _____ Rule _______ Equation: ______________________________

2. CdS(*s*) _____ Rule _______ Equation: ______________________________

Using Solubility Rules

Topic#13 W S#4: Dissociation of Ionic Compounds Key

3. $Rb_2CO_3(s)$	yes	#2	$Rb_2CO_3(s)$ --> $2Rb^+(aq) + CO_3^{2-}(aq)$
4. $Sr_3(PO_4)_2(s)$	No	#12	
5. $AgCl(s)$	No	#5	(Dirty three)
6. $KOH(s)$	Yes	#2/10	$KOH(s)$ --> $K^{1+}(aq) + OH^{1-}(aq)$
7. $NH_4Cl(s)$	Yes	#3	$NH_4Cl(s)$ --> $NH_4^{1+}(aq) + Cl^{1-}(aq)$
8. $NaBr(s)$	Yes	#2/4	$NaBr(s)$ --> $Na^{1+}(aq) + Br^{1-}(aq)$
9. FeS	No	#13	
10. $CuC_2H_3O_2(s)$	Yes	#1	$CuC_2H_3O_2(s)$ --> $Cu^{1+}(aq) + C_2H_3O_2^{1-}(aq)$
11. $Ca(OH)_2(s)$	No	#10	
12. $Na_2SO_4(s)$	Yes	#2/7	$Na_2SO_4(s)$ --> $2Na^{1+}(aq) + SO_4^{2-}(aq)$
13. $BaSO_4(s)$	No	#7	
14. $LiI(s)$	Yes	#2	$LiI(s)$ --> $Li^{1+}(aq) + I^{1-}(aq)$
15. $(NH_4)_3PO_4(s)$	Yes	#3	$(NH_4)_3PO_4(s)$ --> $3NH_4^{1+}(aq) + PO_4^{3-}(aq)$
16. $Cu(NO_3)_2(s)$	Yes	#6	$Cu(NO_3)_2(s)$ --> $Cu^{2+}(aq)$ --> $2NO_3^{1-}(aq)$
17. $AlPO_4(s)$	No	#12	
18. $CaCO_3(s)$	No	#8	
19. $Fe(OH)_2(s)$	No	#10	
20. $Cs_2SO_4(s)$	Yes	#2/7	$Cs_2SO_4(s)$ --> $2Cs^{1+}(aq) + SO_4^{2-}(aq)$
21. $NaClO(s)$	Yes	#2	$NaClO(s)$ --> $Na^{1+}(aq) + ClO^{1-}(aq)$
22. $NaF(s)$	Yes	#2	$NaF(s)$ --> $Na^{1+}(aq) + F^{1-(aq)}$
23. $Na_2S(s)$	Yes	#2	$Na_2S(s)$ --> $2Na^{1+}(aq) + S^{2-}(aq)$
24. $AgNO_3(s)$	Yes	#6	$AgNO_3(s)$ --> $Ag^{1+}(aq) + NO_3^{1-}(aq)$
25. $Al(OH)_3(s)$	No	#10	

Precipitation Reactions Lab#1

Topic#13 Lab#1 Predicting Precipitation

Instructions:

1. Using your solubility rules, construct 5 precipitation reactions using the following chemicals as reactants.
   $AgNO_3$, $Al(NO_3)_3$, $CuCl_2$, $Ba(NO_3)_2$, $FeCl_3$, Na_3PO_4, Na_2CO_3, Na_2SO_4, NaOH, K_2CrO_4
2. Write these chemicals in their respective places on your lab sheet.
3. Carry out your reactions using 5-10 drops from each reactant in a reaction well on your spot plate.
4. Do one reaction at a time!
4. Write the balanced molecular equation on the provided lab form. Identify the product that is the solid with a (*s*).
5. Your grade will be based on how many of your reactants produce precipitates.

5/5	20pts
4/5	17pts
3/5	15pts
<3/5	14pts

Lab#1: Precipitation Lab

Reactions

1. ____ ____________ + ____ ____________ → ____ ____________ + ____ ____________
2. ____ ____________ + ____ ____________ → ____ ____________ + ____ ____________
3. ____ ____________ + ____ ____________ → ____ ____________ + ____ ____________
4. ____ ____________ + ____ ____________ → ____ ____________ + ____ ____________
5. ____ ____________ + ____ ____________ → ____ ____________ + ____ ____________

Solutions
Topic#13

Precipitation Reactions

Spectator ions - do not react, stay in solution
Participatory ions - make the solid, gas, or molecule in a DR reaction
Molecular equation - balanced equation with full formulas
Ionic equation - Reactants: ions or solid for carbonates.
Products: solid, gas, or molecules and the spectator ions.
- spectator ions are in (*aq*) form on BOTH sides of equation

Net Ionic Equation - Reactants: Ions involved in product
Product(s): The solid, gas, or molecule produced.

Molecular Formula Equation (Balanced Formula Equation)

$$2\ KI_{(aq)} + Pb(NO_3)_{2(aq)} \rightarrow PbI_{2(s)} + 2\ KNO_{3(aq)}$$

Total ionic equation. Rewrite the equation so that all dissolved compounds (*aq*) (see solubility chart) are separated into their constituent ions:

$$2\ K^+_{(aq)} + 2\ I^-_{(aq)} + Pb^{2+}_{(aq)} + 2\ NO_3^-{}_{(aq)} \rightarrow PbI_{2(s)} + 2\ K^+_{(aq)} + 2\ NO_3^-{}_{(aq)}$$

Spectator ions are those that appear on both sides of the equation and as such do not participate in the reaction. In the above example, the spectator ions are $2\ K^+_{(aq)}$ and $2\ NO_3^-{}_{(aq)}$.

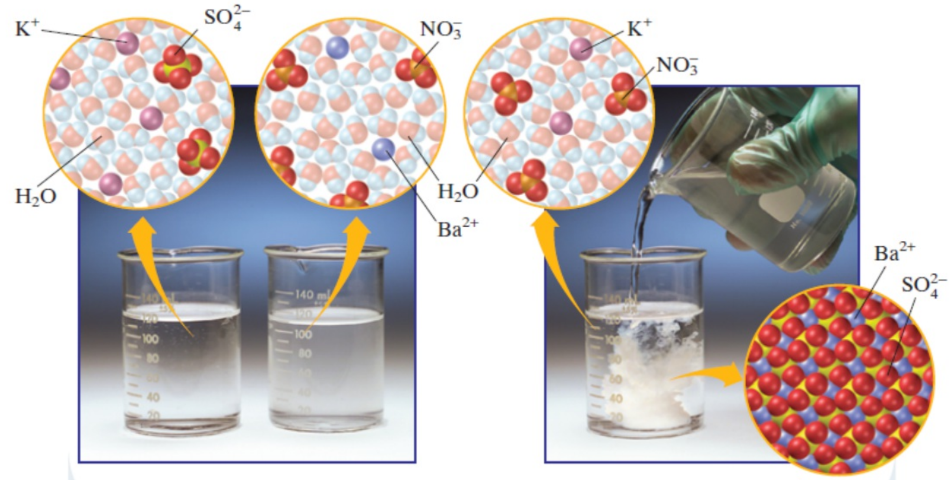
Net ionic equation:

Spectator ions cancel, and are ***not*** included in the net ionic equation:

$$Pb^{2+}_{(aq)} + 2\ I^-_{(aq)} \rightarrow PbI_{2(s)}$$

Net Ionic Equations

Writing a Net Ionic Equation



molecular equation →

Chemical equation:

$K_2SO_4(aq) + Ba(NO_3)_2(aq) \longrightarrow 2KNO_3(aq) + BaSO_4(s)$

Total ionic equation:

$2K^+(aq) + SO_4^{2-}(aq) + Ba^{2+}(aq) + 2NO_3^-(aq) \longrightarrow 2K^+(aq) + 2NO_3^-(aq) + BaSO_4(s)$

Net ionic equation:

$SO_4^{2-}(aq) + Ba^{2+}(aq) \longrightarrow BaSO_4(s)$

Net Ionic Equations

Process

(1) Are the reactants soluble?
(2) Predict the products
(3) Is a solid formed? Products are both soluble - no reaction (NR). STOP HERE
(4) If a solid, gas, or molecule is formed write the ionic equation for the reaction.
(5) For the net ionic equation, write ONLY the ions involved with the production of the solid, gas, or molecule as reactants and the product formed.
(6) Balance net ionic equation.

Writing Molecular, Ionic, and Net Ionic Equations Problems

2a. potassium chloride + sodium nitrate → potassium nitrate + sodium chloride

Molecular Equation: $KCl(aq) + NaNO_3(aq) \rightarrow KNO_3(aq) + NaCl(aq)$

Ionic Equation: $K^+(aq) + Cl^-(aq) + Na^+(aq) + NO_3^-(aq) \rightarrow K^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq)$

Net Ionic Equation: NR

Net Ionic Equations

Process

(1) Are the reactants soluble?
(2) Predict the products
(3) Is a solid formed? Products are both soluble - no reaction (NR). STOP HERE
(4) If a solid, gas, or molecule is formed write the ionic equation for the reaction.
(5) For the net ionic equation, write ONLY the ions involved with the production of the solid, gas, or molecule as reactants and the product formed.
(6) Balance net ionic equation.

b. calcium chloride + sodium carbonate → calcium carbonate + sodium chloride

Molecular Equation: $CaCl_2(aq) + Na_2CO_3(aq) \rightarrow CaCO_3(s) + 2NaCl(aq)$

Ionic Equation: $Ca^{2+}(aq) + 2Cl^-(aq) + 2Na^+(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3(s) + 2Na^+(aq) + 2Cl^-(aq)$

Net Ionic Equation: $Ca^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3(s)$

Solutions
Topic#13

Net Ionic Equations

Process

(1) Are the reactants soluble?
(2) Predict the products
(3) Is a solid formed? Products are both soluble - no reaction (NR). STOP HERE
(4) If a solid, gas, or molecule is formed write the ionic equation for the reaction.
(5) For the net ionic equation, write ONLY the ions involved with the production of the solid, gas, or molecule as reactants and the product formed.
(6) Balance net ionic equation.

c. silver (I) nitrate + cesium phosphate → silver(I) phosphate (s) + cesium nitrate

Molecular equation: $3AgNO_3(aq) + Cs_3PO_4(aq) \rightarrow Ag_3PO_4(s) + 3CsNO_3$

Ionic Equation: $3Ag^+(aq) + 3NO_3^-(aq) + 3Cs^{+1}(aq) + PO_4^{3-}(aq) \rightarrow Ag_3PO_4(s) + 3Cs^{+1}(aq) + 3NO_3^{-1}(aq)$

Net Ionic Equation:

$3Ag^+(aq) + PO_4^{3-}(aq) \rightarrow Ag_3PO_4(s)$

Net Ionic Equations

d. calcium hydroxide + cadmium (II) nitrate → Calcium nitrate + Cadmium(II) hydroxide

Molecular eq: $Ca(OH)_2(aq) + Cd(NO_3)_2(aq) \rightarrow Ca(NO_3)_2(aq) + Cd(OH)_2(s)$

Net: $2OH^-(aq) + Cd^{2+}(aq) \rightarrow Cd(OH)_2(s)$

e. iron (III) sulfate + lead (II) nitrate →

$Fe_2(SO_4)_3(aq) + 3Pb(NO_3)_2 \rightarrow 2Fe(NO_3)_3(aq) + 3PbSO_4(s)$

Net: $Pb^{2+}(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s)$

Solutions
Topic#13

Net Ionic Equations

Starter: Solubility and Net Ionic Equations

Soluble (Y or N)

1. $BaCrO_4$ — N
2. $(NH_4)_2CO_3$ — Y
3. $Zn_3(PO_4)_2$ — N
4. $RhCl_6$ — Y
5. Ag_2CO_3 — N
6. $SrSO_4$ — N
7. $Ir(NO_3)_4$ — Y

Molecular equation and net ionic. No product, NR.

8. sodium carbonate + manganese (III) chloride → sodium chloride + manganese (III) carbonate

$3Na_2CO_3 + 2MnCl_3 \rightarrow 6NaCl + Mn_2(CO_3)_3(s)$ Net: $3CO_3^{2-} + 2Mn^{3+} \rightarrow Mn_2(CO_3)_3(s)$

9. barium chloride + titanium (II) nitrate → barium nitrate + titanium chloride

$BaCl_2 + Ti(NO_3)_2 \rightarrow Ba(NO_3)_2(aq) + TiCl_2(aq)$ Net: NR

10. cesium hydroxide + niobium (V) acetate → cesium acetate + niobium hydroxide

$5CsOH + Nb(C_2H_3O_2)_5 \rightarrow 5CsC_2H_3O_2 + Nb(OH)_5(s)$ Net: $5OH^- + Nb^{5+} \rightarrow Nb(OH)_5(s)$

Solutions
Topic#13

Net Ionic Equations

Starter: Solubility and Net Ionic Equations

Soluble (Y or N)

1. $BaCrO_4$ N
2. $(NH_4)_2CO_3$ Y
3. $Zn_3(PO_4)_2$ N
4. $RhCl_6$ Y
5. Ag_2CO_3 N
6. $SrSO_4$ N
7. $Ir(NO_3)_4$ Y

Molecular equation and net ionic. Now product, NR.

8. sodium carbonate + manganese (III) chloride → sodium chloride + manganese$_2$ carbonate$_3$

$3Na_2CO_3 + 2MnCl_3 \rightarrow 6NaCl + Mn_2(CO_3)_3(s)$ Net: $3CO_3^{2-} + 2Mn^{3+} \rightarrow Mn_2(CO_3)_3(s)$

9. barium chloride$_2$ + titanium (II) (nitrate)$_2$ → barium^{2+} (nitrate)$_2^{1-}$ + titanium^{2+} (II) chloride NR

10. cesium hydroxide + niobium (V) (acetate)$_5$ → cesium^{1+} acetate^{1-} + niobium^{5+} (hydroxide)$_5$

$5CsOH + Nb(C_2H_3O_2)_5 \rightarrow 5CsC_2H_3O_2 + Nb(OH)_5(s)$ Net: $5OH^- + Nb^{5+} \rightarrow Nb(OH)_5(s)$

Net Ionic Equations

Solutions
Topic#13

1. copper (II) chloride + ammonium sulfate →

ME: $CuCl_2 + (NH_4)_2SO_4 \rightarrow CuSO_4 + 2NH_4Cl$

Net: NR

2. strontium chloride + potassium sulfate →

ME: $SrCl_2 + K_2SO_4 \rightarrow SrSO_4(s) + 2KCl$

Net: $Sr^{2+} + SO_4^{2-} \rightarrow SrSO_4(s)$

3. mercury (I) nitrate + nickel (II) sulfate →

ME: $Hg_2(NO_3)_2 + NiSO_4 \rightarrow Hg_2SO_4(s) + Ni(NO_3)_2$

NET: $Hg_2^{2+}(aq) + SO_4^{2-}(aq) \rightarrow Hg_2SO_4(s)$

4. iron (II) nitrate + ammonium chromate →

ME: $Fe(NO_3)_2 + (NH_4)_2CrO_4 \rightarrow FeCrO_4(s) + 2NH_4NO_3$

NET: $Fe^{2+} + CrO_4^{2-} \rightarrow FeCrO_4(s)$

Solutions
Topic#13

Net Ionic Equations

5. tin (II) acetate + iron (III) chloride → $3Sn(C_2H_3O_2)_2(aq) + 2FeCl_3(aq) \rightarrow 3SnCl_2(aq) + 2Fe(C_2H_3O_2)_3(s)$

ME: $3Sn(C_2H_3O_2)_2(aq) + 2FeCl_3(aq) \rightarrow 3SnCl_2(aq) + 2Fe(C_2H_3O_2)_3(s)$

Net: $2Fe^{3+}(aq) + 2(C_2H_3O_2)^-(aq) \rightarrow 2Fe(C_2H_3O_2)_3(s)$

6. nickel (II) bromide + barium hydroxide →

ME: $NiBr_2 + Ba(OH)_2 \rightarrow Ni(OH)_2 + BaBr_2$

Net: $Ni^{2+} + 2OH^- \rightarrow Ni(OH)_2$

7. calcium^{2+} (nitrate^{1-})$_2$ + potassium^{1+} chloride^{1-} → calcium^{2+} chloride$^{1-}_2$ + potassium^{1+} nitrate^{-}

ME: $Ca(NO_3)_2 + 2KCl \rightarrow CaCl_2 + 2KNO_3$

Net: NR

8. chromium (III) chloride + sodium sulfide → Chromium$^{3+}_2$ sulfide$^{2-}_3$ + sodium^{1+} chloride^{1-}

ME: $2CrCl_3 + 3Na_2S \rightarrow Cr_2S_3 + 6NaCl$

Net: $2Cr^{3+}(aq) + 3S^{2-}(aq) \rightarrow Cr_2S_3(s)$

Solutions
Topic#13

Net Ionic Equations

9. manganese (II) acetate + potassium phosphate → manganese (II) phosphate + potassium acetate

ME: $3Mn(C_2H_3O_2)_2 + 2K_3PO_4 \rightarrow Mn_3(PO_4)_2 + 6KC_2H_3O_2$

Net: $3Mn^{2+} + 2PO_4^{3-} \rightarrow Mn_3(PO_4)_2$

10. ammonium sulfate + magnesium nitrate → ammonium nitrate + magnesium sulfate

ME: $(NH_4)_2SO_4 + Mg(NO_3)_2 \rightarrow 2NH_4NO_3 + MgSO_4$

Net: NR

11. nickel (II) chloride + sodium carbonate → nickel (II) carbonate + sodium chloride

ME: $NiCl_2 + Na_2CO_3 \rightarrow NiCO_3(s) + 2NaCl$

Net: $Ni^{2+}(aq) + CO_3^{2-}(aq) \rightarrow NiCO_3(s)$

12. zinc (II) chloride + sodium phosphate → zinc (II) phosphate + sodium chloride

ME: $3ZnCl_2 + 2Na_3PO_4 \rightarrow Zn_3(PO_4)_2(s) + 6NaCl$

Net: $3Zn^{2+}(aq) + 2PO_4^{3-}(aq) \rightarrow Zn_3(PO_4)_2(s)$

Solubility and Net Ionic Equation Quiz Review

Soluble (Y or N)

1. $Ni(OH)_2$
2. $(NH_4)_3PO_4$
3. $ZnCO_3$
4. $CuCl_2$
5. Na_2CO_3
6. $BaSO_4$
7. $W(NO_3)_4$

Molecular equation and net ionic. Now product, NR.

8. lithium phosphate + iron (III) chloride -->

9. barium nitrate + manganese (II) chloride -->

10. potassium hydroxide + cobalt (II) acetate

Net Ionic Equations

Solubility and Net Ionic Equation Quiz Review

Soluble (Y or N)

1. $Ni(OH)_2$ N
2. $(NH_4)_3PO_4$ Y
3. $ZnCO_3$ N
4. $CuCl_2$ Y
5. Na_2CO_3 Y
6. $BaSO_4$ N
7. $W(NO_3)_4$ Y

Molecular equation and net ionic. Now product, NR.

8. lithium phosphate + iron (III) chloride -->

$Li_3PO_4 + FeCl_3 \rightarrow 3LiCl + FePO_4(s)$

Net: $PO_4^{3-} + Fe^{3+} \rightarrow FePO_4(s)$

9. barium nitrate + manganese (II) chloride -->

$Ba(NO_3)_2 + MnCl_2 \rightarrow BaCl_2 + Mn(NO_3)_2$

Net: NR

10. potassium hydroxide + cobalt (II) acetate

$2KOH + Co(C_2H_3O_2)_2 \rightarrow 2KC_2H_3O_2 + Co(OH)_2(s)$

Net: $2OH^- + Co^{2+} \rightarrow Co(OH)_2(s)$

POGIL Saturation vs. Unsaturation Solutions

Assessment Questions

1. You are given a small beaker of solution at room temperature. You add a bit of solute to the solution and it dissolves. The solution was:

   a. saturated b. unsturated c. concentrated d. warm

2. Crystals of alum, sugar, or copper (II) sulfate are made be hanging a string in a solution of the substance. Is this solution saturated or unsaturated? Explain.

3. Sketch a beaker with a volume of solvent.

   a. Draw ten total solute particles in the beaker to represent a saturated solution.

   b. If five additional solute particles are stirred in, and the temperature is kept constant, sketch the appearance of the resulting mixture in the beaker.

POGIL Solubility
Assessment Questions

1. What ratio below correctly describes the solubility of X.

   a. $\frac{54.0gX}{100mL\ H_2O}$

   b. $\frac{54.0gX}{1.0L\ H_2O}$

   c. $\frac{100gH_2O}{54.0gX}$

   d. $\frac{54.0gX}{100.0g\ H_2O}$

2. A saturated solution of copper (II) nitrate is allowed to sit on a countertop for several days. The volume of the solution decreases as water evaporates from the beaker. Describe the changes (if any) that would be observed in the beaker, and the changes (if any) to the solubility of copper (II) nitrate in the beaker.

3. Substance Y has a reported solubility of 52g/100g H_2O. What mass of water would be needed to dissolve 130g of Substance Y? Show your calculation.

POGIL Molarity

Assessment Questions

1. A solution that is more concentrated

a. is always darker than a dilute solution.

b. has a lower density

c. contains more dissolved particles

d. has a greater volume.

2. Two solutions of NaCl both contain 0.2 moles of NaCl, but they have different molarities. Explain how this is possible.

3. Calculate the molarity of a KCl solution containing 0.75 moles of KCl in 250mL of solution. Show all work, including units.

Lab#2: Solubility (Precipitation Reactions)

Caution: VERY DANGEROU

- cobalt solutions
- nickel solutions
- chromate solution

Supplies:

- 6-well plate (plastic, square)
- 0.10*M* solutions: Na_3PO_4 / $CuCl_2$ / Na_2CO_3 / $CoCl_2$ / $Ni(NO_3)_2$ / $FeCl_3$ / $Fe(NO_3)_3$ / K_2CrO_4 / $Ca(NO_3)_3$
- ruler
- solubility chart

Procedure

1. Using a ruler, draw a 4(columns) x 6(rows) data table.
2. Headings for your data table are cation, anion, and solid product (correct formula).
3. Study the provided solutions and your solubility rules.
4. Identify 6 combinations that will make an insoluble solid.
5. Test your combinations in the square, plastic, 6 well plate.
6. For testing, use three drops of each solution (from your combinations).
7. Write the cations, anions, and correct formula in your data table.

Conclusion.

1. Write 6 balanced equations based on your data.
2. Write 6 balanced net ionic equations from your balanced equations in conclusion question (1).