Solution Chemistry: Ch 8, 9 and 10

Solution, solute, solvent, solubility, soluble, insoluble, aqueous, miscible, immiscible, alloys, amalgam, saturated, unsaturated, supersaturated, concentration, homogenous, electrolyte, polar, non polar, acids, bases, neutral, mixture,

Dec 8-12:02 PM

Explaining Solutions - WHY?

Dissolving - physical change

the solvent and solute must be able to mix in order for a solution to form

Page 288 - polar and nonpolar

polar + polar = dissolve
polar + ionic = dissolve
non polar + polar or ionic = does not dissolve

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Factors that affect dissolving and solubility

Page 290 - 299
General trends
-agitation
-temperature (solids and liquids)
-particle size
-type of particle
-polar vs non polar
-pressure

page 330 - 331
Ionic compounds
-charge
-ion size

TERMS-dipole, dipole-dipole attraction, hydrogen bonding, ion-dipole attraction, hydrated, electrolyte, non-electrolytes,

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So...What did you learn?

Temp? Agitation? Particle size? Pressure?

Ionic Compounds? ion charge
particle size

Molecular Compounds?

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Quantitative Descriptions of Solutions
(Section 8.3)

Overall Description

$$\text{Concentration} = \frac{\text{Solute}}{\text{Solution}}$$

Three Specific Ways

1. Percentages
2. PPM
3. Molar concentration

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1. Percentage Concentration

- questions on 305,308, 310

$$\%\text{Concentration} = \frac{\text{solute}}{\text{solution}} \times 100$$

**equivalent amounts: g and ml kg and L

m/v - mass per volume (g/100ml)

ex. Saline solution - $NaCl_{(s)}$ in $H_2O_{(l)}$

v/v - volume per volume (ml/100ml)

ex. Vinegar - $CH_3COOH_{(l)}$ in $H_2O_{(l)}$

m/m - mass per mass (g/100g)

ex. alloys - stainless steel

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m/v - mass per volume (g/100ml)

v/v - volume per volume (ml/100ml)

m/m - mass per mass (g/100g)

Ex. 20g of NaCl are dissolved in H_2O to make a final solution of 375 ml. What is the percent concentration (m/v)?

$$\frac{20\text{ g}}{375\text{ ml}} \times 100 = 5.3\%$$

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Ex. Yogurt is 4% m/v. If you buy and eat a tub of yogurt (500 ml) How much fat did you consume?

$$4\% \rightarrow \frac{4\text{ g}}{100\text{ ml}}$$

$$\frac{4\text{ g}}{100\text{ ml}} = \frac{x\text{ g}}{500\text{ ml}} \quad 20\text{ g}$$

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2. ppm - part per million - pg 312

$\frac{mg}{L}$ $\frac{mg}{1000g}$ $\frac{mg}{1Kg}$ $\frac{g}{1000000g}$

ex. 71 ppm of Ca in H_2O sample

$= \frac{71\,mg}{1\,L} = \frac{71\,mg}{1000\,g} = \frac{71\,g}{1000\,kg}$

ppb - part per billion

Density of H_2O $1g/cm^3 = 1g/ml$

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Solution has 4 g in 2×10^6 L of water what is the concentration in ppm?

$\frac{4g}{2000000L} = \frac{\cancel{4000}\,mg}{\cancel{2000000}L} = \frac{4mg}{2000L} = \frac{?\ mg}{1\,L}$ 0.002 mg

0.002 ppm

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3. Molar concentration - pg 313

$C = \frac{n}{V}$ n ← moles, V ← litres

"concentration of" → [ ]

∴ [NaOH] means concentration of NaOH

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unit is : mol/L or M

molar concentration = molarity

ex. [NaOH] = 0.5 M

the concentration of NaOH is 0.5 mol/L

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Ex. If 40 grams of MgF_2 is added to water to make a final solution of 250 ml → L, then what is its molar concentration?

Step 1: mass → moles $\frac{40\,g}{62.3\,g/mol}$ $= 0.642\,mol$

Step 2: $C = \frac{n}{V} = \frac{0.642\,mol}{0.25\,L} = 2.6\,M$

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Concerns?

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Preparing Standard Solutions (8.4)

- solutions of known concentration

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1. Glassware

beaker - hold + pour low quality measuring ±5% error
Erlenmeyer flask - designed for mixing

$ graduated cylinders - multiple measurements
graduated pipettes - fairly accurate
buret - designed ~~to~~ to allow leftover solutions in tip of pipette

$$$ volumetric flask
volumetric pipettes only 1 measurement
High degree of accuracy

meniscus

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2. Using a solid

Pros - Storage of dry chemicals easy
Cons - slow, many compounds don't dissolve in water very quickly

determine the mass - calculation $C = \frac{n}{V}$ n? $m = n M$

obtain the sample - scale, beaker or weigh boat

begin dissolving in a beaker - don't use total amount of water needed

transfer into a volumetric flask - rinse to avoid loss of sample

add additional water to the meniscus

mix

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3. Using stock solutions

Pros - very quick,fewer steps
Cons - storage of containers

Next slide

determine the volume of stock solution needed - calculation

obtain the sample - volumetric pipette / graduated pipette

transfer into a volumetric flask - no rinsing required - designed to transfer

add additional water to the meniscus

mix

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4. Dilution Formula

used for calculating the amount of stock solution required to make a diluted standard solution

Stock solution - Solutions with very high concentrations

Formula

$$C_1 V_1 = C_2 V_2$$

[Stock] amount to transfer [Standard] total volume of standard

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Example of using dilution formula:

Need to make 500 ml (V_2) of 0.4 M (C_2) NaOH. The stock solution of NaOH is 14.6 M (C_1). How much stock do you need (V_1)?

$$V_1 = \frac{C_2 V_2}{C_1} = 13.7\text{ ml}$$

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Pg 321 + 324

CONCERNS???

Dec 14-1:10 PM

SOLUBILITY (9.1-9.2)

1. Terms
   precipitate, almost nothing, aqueous
   little low solubility, insoluble, high solubility, sparingly soluble, soluble
   small, lots
2. Solubility table (Unit 2)
3. Solubility graph - page 301, website
4. Net Ionic Equations

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2. Solubility table (Unit 2)

Table F
Solubility Guidelines for Aqueous Solutions

Ions That Form *Soluble* Compounds	Exceptions
Group 1 ions (Li^+, Na^+, etc.)	
ammonium (NH_4^+)	
nitrate (NO_3^-)	
acetate ($C_2H_3O_2^-$ or CH_3COO^-)	
hydrogen carbonate (HCO_3^-)	
chlorate (ClO_3^-)	
perchlorate (ClO_4^-)	
halides (Cl^-, Br^-, I^-)	when combined with Ag^+, Pb^{2+}, and Hg_2^{2+}
sulfates (SO_4^{2-})	when combined with Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, and Pb^{2+}

Ions That Form *Insoluble* Compounds	Exceptions
carbonate (CO_3^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
chromate (CrO_4^{2-})	when combined with Group 1 ions, Ca^{2+}, Mg^{2+}, or ammonium (NH_4^+)
phosphate (PO_4^{3-})	when combined with Group 1 ions or ammonium (NH_4^+)
sulfide (S^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
hydroxide (OH^-)	when combined with Group 1 ions, Ca^{2+}, Ba^{2+}, Sr^{2+}, or ammonium (NH_4^+)

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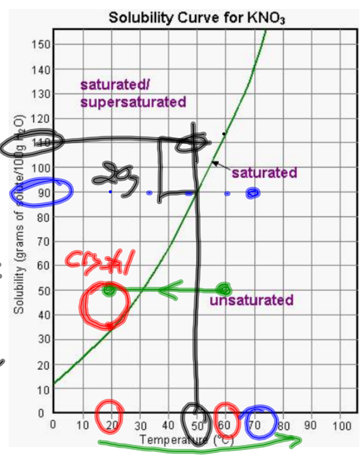
3. Solubility graph - page 301, website

50g @ 60°C ↓ 20°C



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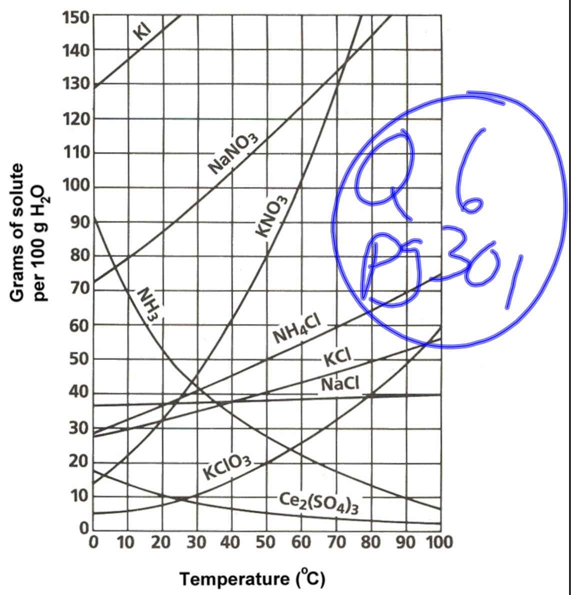

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4. Net Ionic Equations

- Identifying the real players in chemical reactions

Ex. Aqueous aluminum chloride reacts with aqueous potassium sulphide to form a precipitate.

$$AlCl_{3(aq)} \xrightarrow{\text{dissociation}} Al^{+3}_{(aq)} + 3\,Cl^{-1}_{(aq)}$$

$$K_2S_{(aq)} \longrightarrow 2\,K^{+}_{(aq)} + S^{-2}_{(aq)}$$

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$$2AlCl_{3(aq)} + 3K_2S_{(aq)} \rightarrow Al_2S_{3(s)} + 6KCl_{(aq)}$$

(Total Ionic Equation)

$$2Al^{+3}_{(aq)} + \cancel{6Cl^{-}_{(aq)}} + \cancel{6K^{+}_{(aq)}} + 3S^{-2}_{(aq)} \rightarrow Al_2S_{3(s)} + \cancel{6K^{+}_{(aq)}} + \cancel{6Cl^{-}_{(aq)}}$$

Net ionic equation

$$2Al^{+3}_{(aq)} + 3S^{-2}_{(aq)} \rightarrow Al_2S_{3(s)}$$

K^{+}, Cl^{-} → spectator ions

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Qualitative Analysis of Solutions (9.2)

1. Colour
   - -copper, iron, permanganate,
   - -affected by ion charge

2. Flame Tests
   - colourless solutions
   - metal ions make colours when heated

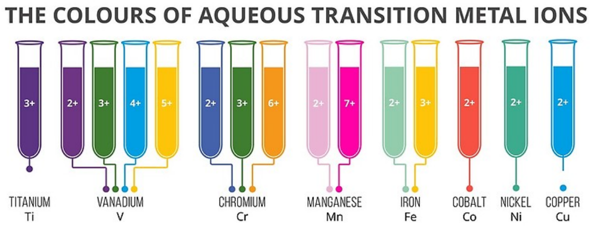
3. Ions that form precipitates
   - -sequential analysis

Dec 17-11:32 PM

1. Colour
-copper, iron, permanganate,
-affected by ion charge

Dec 18-10:51 AM

1. Colour
-copper, iron, permanganate,
-affected by ion charge

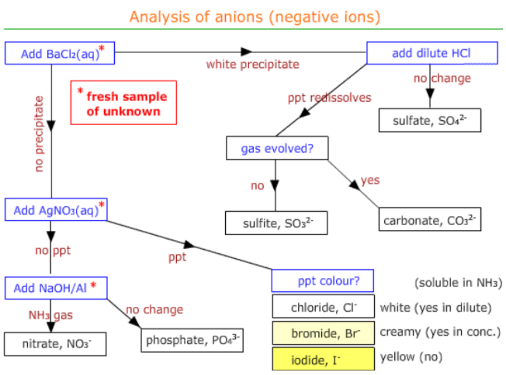


Dec 18-11:04 AM

2. Flame Tests
- colourless solutions
- metal ions make colours when heated

Dec 18-10:51 AM

3. Ions that form precipitates
-sequential analysis



Dec 18-11:02 AM

page 339 + 343
- try some net ionic equations

$C_6H_{12}O_{6(s)} \rightarrow C_6H_{12}O_{6(aq)}$

molecular compounds stay together

(weak acids stay together) not worried

precipitates (low solubility) stays together

Dec 18-11:06 AM

4 f. pg ~~3~~ 339

ammonium iodide + silver nitrate

$NH_4I_{(aq)} + AgNO_{3(aq)} \rightarrow$

$NH_4NO_{3(aq)} + AgI_{(s)}$

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$NH_4I_{(aq)} + AgNO_{3(aq)} \rightarrow NH_4NO_{3(aq)} + AgI_{(s)}$

Total Ionic Equation

$\cancel{NH_4^+}_{(aq)} + I^-_{(aq)} + Ag^+_{(aq)} + \cancel{NO_3^-}_{(aq)} \rightarrow \cancel{NH_4^+}_{(aq)} + \cancel{NO_3^-}_{(aq)} + AgI_{(s)}$

Net Ionic

$Ag^+_{(aq)} + I^-_{(aq)} \rightarrow AgI_{(s)}$

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Ex. Calcium metal placed in a solution of iron (III) chloride. Write the net ionic equation.

$3Ca_{(s)} + 2FeCl_{3(aq)} \rightarrow 2Fe_{(s)} + 3CaCl_{2(aq)}$

$3Ca_{(s)} + 2Fe^{+3}_{(aq)} + \cancel{6Cl^-_{(aq)}} \rightarrow 2Fe_{(s)} + 3Ca^{+2}_{(aq)} + \cancel{6Cl^-_{(aq)}}$

$3Ca_{(s)} + 2Fe^{+3}_{(aq)} \rightarrow 2Fe_{(s)} + 3Ca^{+2}_{(aq)}$

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Review some of the predictable reactions that occur in solutions

Page 340

Pg. 339, 343

Net Ionic

Dec 18-11:06 AM

Quantitative Analysis

$c = \frac{n}{V}$

Concentrations of ions in mixtures - pg 348 - dissociation ratio

0.04L V c 1 mol/L

40 ml of 0.5M NaCl mixed with 30 ml of 0.6M $CaCl_2$....
What is the concentration of Cl^- ions?

$n_{NaCl} = C \times V = 0.02\,mol$ $n_{CaCl_2} = C \times V = 0.018\,mol$

Mass percent of ions - 350 - ion ratio

40 grams of $Al(NO_3)_3$......% of nitrate ions

$40\,g \times \%NO_3^- = g\ NO_3^-$

$\frac{NO_3}{Al(NO_3)_3} \times 100 = \%$

Precipitate amounts - 351

Determining Concentrations

Stoichiometry

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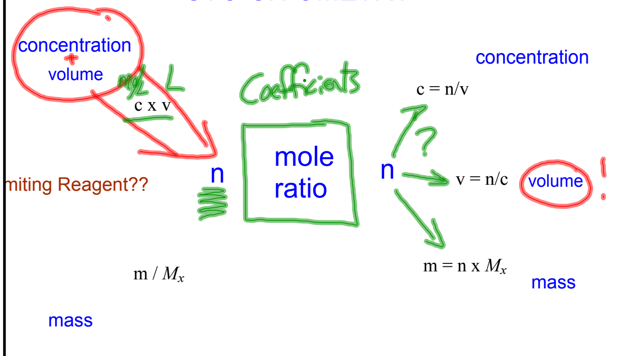
Quantitative Analysis

STOICHIOMETRY



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40 ml of 0.4 NaOH is reacted with 0.7 M HCl. What volume of HCl is needed to neutralize all of the NaOH?

$1\,NaOH + 1\,HCl \rightarrow NaCl + H_2O$

$c = 0.4$ $c = 0.7$

$V = 0.04\,L$ $V = \frac{n}{c} = \frac{0.016\,mol}{0.7}$

$n = 0.016\,mol$ $n = 0.016\,mol$

$0.023\,L$

$\frac{NaOH}{HCl} = \frac{1}{1} = \frac{0.016}{x}$

$x = 0.016$

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$2Al(NO_3)_3 + 3BaSO_4 \rightarrow 3Ba(NO_3)_2 + Al_2(SO_4)_3$

$V = 13\ ml$ $\quad$ $V = 23\ ml$

$C = 0.8\ M$ $\quad$ $C = ?$

$n = 0.8 \times 0.013$

$= 0.0104$

$C = \frac{n}{V}$

$= \frac{x}{0.023L}$ $\quad$ 0.0156

$0.678\ mol/L$

$\frac{Al(NO_3)_3}{BaSO_4} = \frac{2}{3} = \frac{0.0104}{x}$ $\quad$ $x = 0.0156$

Dec 19-2:10 PM