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,

Explaining Solutions

Dissolving - physical change

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

Page 288 - polar and nonpolar

\[
\text{polar} + \text{polar} = \text{dissolve}
\]

\[
\text{polar} + \text{ionic} = \text{dissolve}
\]

\[
\text{non polar} + \text{polar or ionic} = \text{no diss}
\]

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

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

So...What did you learn?

Temp? Agitation? Particle size? Pressure?

Ionic Compounds? Molecular Compounds?
Quantitative Descriptions of Solutions

(Section 8.3)

Overall Description

Concentration = \frac{Solute}{Solution} \times 100

Three Specific Ways

1. Percentages
2. PPM
3. Molar concentration

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)

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

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

ex. Saline solution - NaCl in H_{2}O

ex. Vinegar - CH_{3}COOH in H_{2}O

ex. Alloys - Stainless Steel

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

\text{\% Concentration} = \frac{20 \text{ g}}{375 \text{ ml}} \times 100 = 5.3\%
2. ppm - part per million - pg 312

\[
\text{mg L}^{-\text{1}} = \text{mg 1000g}^{-\text{1}} = \text{mg 1Kg}^{-\text{1}} = \frac{\text{g}}{1000000\text{g}}
\]

ex. 71 ppm of Ca in H_2O sample

\[
\frac{71 \text{mg}}{1 \text{L}} = \frac{71 \text{mg}}{1000 \text{g}} = \frac{71 \text{g}}{1000 \text{kg}}
\]

Density of H_2O \quad 1\text{g/cm}^3 = 1\text{g/mL}

ppb - part per billion

Dec 12-10:47 AM

Dec 19-1:25 PM

3. Molar concentration - pg 313

\[
C = \frac{n}{V} \quad \text{moles}
\]

\[
\text{litres}
\]

“Concentration of” \rightarrow [ ]

\[
\therefore [\text{NaOH}] \text{ means concentration of NaOH}
\]

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

\[
\frac{4 \text{g}}{2000000 \text{g}} = \frac{4 \text{mg}}{2000000 \text{mg}} = \frac{4 \text{mg}}{2000000 \text{mg}} \times \frac{1 \text{L}}{1}
\]

0.002 ppm

Unit is: \text{mol/L} \quad \text{molar concentration}

\[
M
\]

= \text{molarity}

ex. [\text{NaOH}] = 0.5 \text{ M}

the concentration of NaOH is 0.5 \text{ mol/L}

Dec 12-10:47 AM

Dec 13-1:53 PM
Preparing Standard Solutions
- solutions of known concentration

Ex. If 40 grams of MgF₂ is added to water to make a final solution of 250 mL, then what is its molar concentration?

Step 1: mass \rightarrow moles \quad \frac{40 \text{ g}}{62.35 \text{ g/mol}} = 0.642 \text{ mol}

Step 2: \quad C = \frac{n}{V} = \frac{0.642 \text{ mol}}{0.250 \text{ L}} = 2.6 \text{ M}

Concerns?
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

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

3. Using stock solutions

**Pros** - very quick, fewer steps

**Cons** - storage of containers

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

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**

\[ C_1 V_1 = C_2 V_2 \]

Example of using dilution formula:

Need to make 500 ml of 0.4 M NaOH. The stock solution of NaOH is 14.6 M. How much stock do you need?

\[ V_1 = \frac{C_2 V_2}{C_1} = \frac{14.6 \text{ M} \times 500 \text{ ml}}{0.4 \text{ M}} = 18.7 \text{ ml} \]
CONCERNS???

2. Solubility table (Unit 2)

<table>
<thead>
<tr>
<th>Ion That Form Soluble Compound</th>
<th>Exception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I ions (Li⁺, Na⁺, etc.)</td>
<td></td>
</tr>
<tr>
<td>carbonates (CO₃²⁻)</td>
<td></td>
</tr>
<tr>
<td>oxalate (C₂O₄²⁻)</td>
<td></td>
</tr>
<tr>
<td>sulfate (SO₄²⁻) or sulfate (SO₃²⁻)</td>
<td></td>
</tr>
<tr>
<td>silicate (SiO₃²⁻)</td>
<td></td>
</tr>
<tr>
<td>borate (BO₄³⁻)</td>
<td></td>
</tr>
<tr>
<td>chromate (CrO₄²⁻)</td>
<td></td>
</tr>
<tr>
<td>phosphate (PO₄³⁻)</td>
<td></td>
</tr>
<tr>
<td>thiocyanate (SCN⁻)</td>
<td></td>
</tr>
</tbody>
</table>

3. Solubility graph - page 301, website

4. Net Ionic Equations
4. Net Ionic Equations
- Identifying the real players in chemical reactions

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

\[ \text{AlCl}_3(aq) \rightarrow \text{Al}^{3+} + 3\text{Cl}^-(aq) \]

\[ \text{K}_2\text{S}(aq) \rightarrow 2\text{K}^+ + \text{S}^{2-}(aq) \]

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

2. Flame Tests
- colourless solutions
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THE COLOURS OF AQUEOUS TRANSITION METAL IONS

3. Ions that form precipitates
- sequential analysis

Analysis of anions (negative ions)
page 339 + 343
- try some net ionic equations

molecular compounds stay together

weak acids stay together

precipitates (low solubility) stays together

\[
\text{NH}_4\text{I}(aq) + \text{AgNO}_3(aq) \rightarrow \text{NH}_4\text{NO}_3(aq) + \text{AgI}(s)
\]

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

\[
3\text{Ca}(s) + 2\text{FeCl}_3(aq) \rightarrow 2\text{Fe}(s) + 3\text{CaCl}_2(aq)
\]
Review some of the predictable reactions that occur in solutions

Page 340

**Quantitative Analysis**

Concentrations of ions in mixtures - pg 348

- Dissociation ratio

40 ml of 0.5M NaCl mixed with 30 ml of 0.6M CaCl₂...

What is the concentration of Cl⁻ ions?

- Mass percent of ions - 350 - ion ratio

40 grams of Al(NO₃)₃...% of nitrate ions

- Precipitate amounts - 351

Determining Concentrations

**Stoichiometry**

- Mole ratio

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?

\[
\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}
\]

\[
c = 0.4, c = 0.7
\]

\[
v = \frac{n \times M}{c} = \frac{0.04 \times 1}{0.7} = \frac{0.016}{x}
\]

\[
x = 0.016
\]
2Al(N\textsubscript{3})\textsubscript{3} + 3Ba\textsubscript{2}SO\textsubscript{4} \rightarrow 3Ba(N\textsubscript{3})\textsubscript{2} + Al\textsubscript{2}(SO\textsubscript{4})\textsubscript{3}

V = 13 ml
C = 0.8 M
C = ?

n = 0.3 \times 0.013
C = \frac{V}{n}
= \frac{0.03}{0.0104}
= 0.0287 L

\frac{2}{3} = \frac{0.0104}{0.0056}

\text{Dec 19-2:10 PM}