Chapter 4. The Major Classes of Chemical Reactions

Note: You are not responsible for sections 4.5 and 4.6, which cover Oxidation-Reduction reactions. This class of reactions is very important, and it will be covered next semester in Chemistry 1442.

Be sure to review:
1. Names, formulas and charges of all ions.
2. These terms: solution, solvent, solute, aqueous solutions

1. Electrolytes

1. Light bulb demonstration. (figure 4.3, p. 111)
   • In the light bulb demonstration, what happens in solution to cause some solutions to conduct electricity?
   • Before answering that question, a more fundamental question is:
     What is electric current?

   • Based on that definition, substances that _______ _______ in aqueous solutions will conduct electricity.

2. Principle: When ___________ compounds dissolve in water, they ____________________ into ions.
   NaCl(aq) →
   NaNO3(aq) →

3. Principle: Some ______________ compounds form ions when they dissolve in water, called _________.
   HCl(aq) →
   HNO3(aq) →
   CH3COOH(aq) ⇋
   NH3(aq) + H2O(l) ⇋

4. Definition of electrolyte:

5. Strong electrolytes
   definition:
   in practice:
   how to identify:

6. Weak electrolytes
   definition:
   in practice:
   how to identify:
7. Nonelectrolytes
examples:

8. Memorize the seven strong acids:

9. Memorize the strong bases:

10. Two ways to define “salt”:

2. Precipitation Reactions.

1. \( \text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \)

This is a ______________________, or double displacement reaction:
Precipitation reaction:
What is the driving force of this reaction?

2. To analyze reactions such as this, it helps to write the equation in 3 different ways:
   
   (1) molecular eqn:
   (2) total ionic eqn:
   (3) net ionic eqn:

3. A net ionic equation is very important because:
   
   (1)
   (2)

4. The driving force of a precipitation reaction is:

5. A very important learning objective: Know (i.e., memorize) the solubility rules, and use them to predict if an ionic compound is soluble or insoluble. Also, use them to predict if a precipitation reaction will occur.
**Solubility Rules: A Summary**

<table>
<thead>
<tr>
<th>Soluble Ionic Compounds</th>
<th>Insoluble Ionic Compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>• column 1 cations (Li⁺, Na⁺, K⁺, Rb⁺, Cs⁺)</td>
<td>• metal hydroxides (except column 1, Ca²⁺, Sr²⁺, Ba²⁺)</td>
</tr>
<tr>
<td>• NH₄⁺</td>
<td>• CO₃²⁻, PO₄³⁻ (except column 1 and NH₄⁺)</td>
</tr>
<tr>
<td>• NO₃⁻, CH₃COO⁻, ClO₄⁻</td>
<td>• S²⁻ (except column 1, 2, and NH₄⁺)</td>
</tr>
<tr>
<td>• Cl⁻, Br⁻, I⁻ (except Ag⁺, Pb²⁺, Hg²⁺, Cu⁺)</td>
<td></td>
</tr>
<tr>
<td>• SO₄²⁻ (except Ca²⁺, Sr²⁺, Ba²⁺, Ag⁺, Pb²⁺)</td>
<td></td>
</tr>
</tbody>
</table>

**Examples:** Determine if the compounds below are soluble or “insoluble” in water.

\[
\begin{align*}
\text{AgCl} & \quad \text{Al(OH)}_3 \\
\text{Na}_3\text{PO}_4 & \quad \text{Sr(OH)}_2 \\
\text{CuSO}_4 & \quad \text{Zn(NO}_3)_2 \\
\text{Cu(OH)}_2 & \quad \text{Ba(ClO}_4)_2 \\
\end{align*}
\]

6. Be able to predict if a precipitation reaction will occur.

a) What happens when aqueous solutions of barium nitrate and potassium sulfate are mixed?
   
   molecular eqn:
   total ionic eqn:
   net ionic eqn:

b) What happens when aqueous solutions of sodium chloride and potassium carbonate are mixed?
   
   molecular eqn:
   total ionic eqn:
   net ionic eqn:

c) What happens when aqueous solutions of ammonium carbonate and silver acetate are mixed?
   
   molecular eqn:
   total ionic eqn:
   net ionic eqn:

d) What happens when aqueous solutions of copper(II) sulfate and ammonium sulfide are mixed?
   
   molecular eqn:
   total ionic eqn:
   net ionic eqn:

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3. **Acid-Base Reactions**

1. Metathesis reactions:
2. Two important types of metathesis reactions:
   1) 
   2) 

3. An acid is:

4. A base is:

5. Strong acids and bases ___________________________________________________________________

6. Weak acids and bases _____________________________________________________________________

7. Be able to write and balance acid/base reactions.

   a) hydrochloric acid + sodium hydroxide
      
      molecular eqn:
      total ionic eqn:
      net ionic eqn:

   b) perchloric acid + strontium hydroxide
      
      molecular eqn:
      total ionic eqn:
      net ionic eqn:

   c) hydrofluoric acid + potassium hydroxide
      
      molecular eqn:
      total ionic eqn:
      net ionic eqn:

4. **Solution Stoichiometry**

1. What volume of 0.100 M NaCl solution is required to precipitate all of the silver from 10.0 mL of 0.0500 M AgNO₃?

2. What mass of calcium carbonate is formed when 25.0 mL of 0.120 M calcium nitrate is mixed with 30.0 mL of 0.110 M potassium carbonate?

3. If 28.5 mL of 0.100 M nitric acid is required to completely neutralize 21.0 mL of a solution of potassium hydroxide, what is the concentration of the potassium hydroxide solution?

4. What volume of 0.125 M hydrobromic acid is required to completely neutralize 25.0 mL of 0.0500 M calcium hydroxide?