Chemical Reactions

- The interaction of two or more elements or compounds (the reactants) to form new compound(s) or elements (the products)

Types of Reactions

- Composition/Synthesis
  - Reactions that begin with two or more elements or compounds and produce a single compound
- Group 1 metals react with halogens to form ionic compounds with the formula MX
  - Ex: Na + Cl -> NaCl

- Group 2 metals react with halogens to form ionic compounds with the formula Mx_2
- Ex: Mg + F -> MgF_2

- Decomposition
  - Reactions that begin with a single compound and produce two or more elements or compounds
- Metal carbonates break down upon heating to produce a metal oxide and carbon dioxide gas
  - Ex: $CaCO_3$ -> CaO + CO_2

- Metal hydroxides (except those containing group 1 metals) decompose on heating to form metal oxides and water
  - Ex: $Ca(OH)_2$ -> CaO + H_2O

- Metal Chlorates decompose upon heating to produce a metal chloride and oxygen
  - Ex: $2KClO_3$ -> 2KCl + $3O_2$

- Single Displacement/replacement
  - Reactions that begin with a compound and an element and produce a new compound and a new element

- Replacement of a metal with another metal – occurs according to activity of metals
- Aluminum is more active than lead, so when aluminum is placed in a solution of lead (II) nitrate, solid lead and aluminum nitrate solution result
- $2Al + 3Pb(NO_3)_2 \rightarrow 3Pb + 2Al(NO_3)_3$

- Replacement of hydrogen in water by a metal
- The most active metals (Group 1) react vigorously with water to produce metal hydroxides and hydrogen gas.
  - $2Na + 2H_2O \rightarrow 2NaOH + H_2$
- Less active metals require steam to achieve the same reaction

- Replacement of hydrogen in an acid by a metal
- The more active metals react with certain acids to produce a metal salt and hydrogen gas
  - $Mg + 2HCl \rightarrow H_2 + MgCl_2$

- Double Displacement
  - **Reactions that begin with two compounds and produce two new compounds**
- Combustion
  - **Reactions that use oxygen to decompose a compound into two or more oxides**

Chemical Equations

- Simple shorthand depictions of chemical reactions
- Writing chemical equations
  - **First write correct formulas for the products and the reactants – using subscripts**
    - **Subscripts in ionic compounds depend on charge**
    - **Subscripts in molecular compounds depend on prefixes**
  - **Second balance the products and reactants to exhibit conservation of mass – using coefficients**

Example equations

- Sodium plus chlorine forms sodium chloride
  - Write the formulas for the elements and compounds
  - $Na + Cl_2 \rightarrow NaCl$
  - Balance the elements for conservation of mass
  - $2Na + Cl_2 \rightarrow 2NaCl$

- Aluminum carbonate plus sodium forms sodium carbonate plus aluminum
- Write the formulas for the elements and compounds (remember that the subscripts are dependant on the charge)
- $Al_2(CO_3)_3 + Na \rightarrow Al + Na_2CO_3$
- Balance the elements for conservation of mass
  - $Al_2(CO_3)_3 + 6\ Na \rightarrow 2\ Al + 3\ Na_2CO_3$

Symbols in a chemical equation

- (g) – gas
- (aq) – aqueous – in a water solution
- (s) – solid
- (l) - liquid

Evidence that a chemical reaction has taken place

- Color change
- Production of a gas
  - Smell
  - bubbles
- Precipitation of a solid
- Energy change
  - Hot
  - Cold
  - Light energy given off

Solubility Rules

- Salts of the alkali metals are soluble
- Ammonium salts are soluble
- Salts containing nitrate, chlorate, perchlorate and acetate are soluble
- Chlorides, bromides and iodides are soluble *except* lead II, mercury, and silver

Solubility rules cont.

- Sulfates are soluble except for those of strontium II, barium, mercury and lead II, which are insoluble, and calcium and silver which are moderately soluble
- Hydroxides are insoluble except for those of the alkali metals, which are soluble, and calcium, barium and silver which are moderately soluble

Solubility rules pg 3

- Sulfites, carbonates, chromates and phosphates are insoluble except for those of ammonium and the alkali metals.
- Sulfides are insoluble except for those of ammonium, the alkali metals and the alkaline earth metals

Solubility practice

- Fill in the appropriate states in the products

$BaCl_2(aq) + K_2CrO_4(aq) \rightarrow 2KCl(?) + BaCrO_4(?)$
$BaCl_2(aq) + K_2CrO_4(aq) \rightarrow 2KCl(aq) + BaCrO_4(s)$

$Al_2(SO_4)_3(aq) + 6HCl(aq) \rightarrow 2H_2SO_4(?) + 2AlCl_3(?)$
$Al_2(SO_4)_3(aq) + 6HCl(aq) \rightarrow 2H_2SO_4(aq) + 2AlCl_3(aq)$

$CaCl_2(aq) + H_3PO_4(aq) \rightarrow Ca_3(PO_4)_2(?) + HCl(?)$
$CaCl_2(aq) + H_3PO_4(aq) \rightarrow Ca_3(PO_4)_2(s) + HCl(aq)$