Precipitation, Neutralization and Redox Reactions

**Precipitation reaction** - exchange reaction between two soluble ionic substances that yields an **insoluble solid**.

\[
\begin{align*}
\text{Ca}^{+2}(aq) + \text{CO}_3^{-2}(aq) & \rightarrow \text{CaCO}_3(s) \\
\text{Pb}^{+2}(aq) + 2 \text{Cl}^{-1}(aq) & \rightarrow \text{PbCl}_2(s)
\end{align*}
\]

**Acids** in aqueous solution ionize to give hydrogen ions (hydrogen ions react with water to give hydronium ions).

\[
\text{H}_2\text{SO}_4 \rightarrow \text{H}^+ + \text{HSO}_4^-
\]

**Oxides of non-metals** react with water to form acids.

\[
\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3
\]

**Bases** in aqueous solution ionize to give hydroxide ions (oxide ions react with water to give hydroxide ions).

\[
\text{NaOH} \rightarrow \text{Na}^+ + \text{OH}^-
\]

**Oxides of metals** react with water to form bases.

\[
\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2 \text{Na}^+ + 2 \text{OH}^-
\]

**Weak acids** and **weak bases** are ionized much less than 100% but still produce hydronium ion or hydroxide ion.

\[
\begin{align*}
\text{CH}_3\text{CO}_2\text{H} + \text{H}_2\text{O} & \rightleftharpoons \text{H}_3\text{O}^+ + \text{CH}_3\text{CO}_2^- \\
\text{CH}_3\text{NH}_2 + \text{H}_2\text{O} & \rightleftharpoons \text{CH}_3\text{NH}_3^+ + \text{OH}^-
\end{align*}
\]

**Neutralization reaction** - acid and a base react to yield a salt and water.

\[
\begin{align*}
\text{HNO}_3 + \text{KOH} & \rightarrow \text{KNO}_3 + \text{H}_2\text{O} \\
\text{HCl} + \text{CH}_3\text{NH}_2 & \rightarrow \text{CH}_3\text{NH}_3\text{Cl} + \text{H}_2\text{O}
\end{align*}
\]

**Redox reaction** - reaction where electrons are transferred, yielding different **oxidation numbers** for elements in products and reactants.

A substance is **oxidized** when its oxidation number increases (it **loses electrons**).

A substance is **reduced** when its oxidation number decreases (it **gains electrons**).

Moles electrons lost must equal moles electrons gained.

\[
\begin{align*}
2 \text{ Ag}^+ + \text{Cu} & \rightarrow 2 \text{ Ag} + \text{Cu}^{+2} \\
\text{CH}_4 + 2 \text{ O}_2 & \rightarrow \text{CO}_2 + 2 \text{ H}_2\text{O}
\end{align*}
\]

**Assigning Oxidation Numbers**

1) **Elements** ON = 0

2) **Monatomic ions** ON = ion charge

3) **Hydrogen** ON = +1 with non-metals

4) **Oxygen** ON = -2 (peroxides (ROOR), ON = -1)

5) **Sum of all ONs** of atoms in a molecule or ion equals **charge** on molecule or ion.