Reactions in Aqueous Solution

Chapter 4

Outline

Precipitation Reactions
Acid-Base Reactions
Oxidation-Reduction Reactions
Solute Concentrations; Molarity
Solution Stoichiometry
Solution Reactions in Quantitative Analysis

Precipitation Reactions

Electrolytes - materials that are conductors when dissolved in a water solution.
Strong electrolytes - ionic compounds which dissociate into ions in water and are therefore good conductors.
Precipitate - an insoluble compound that forms and separates out in a solution.

Precipitate of AgI

$$Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$$

Solubility Rules

Know: All Alkali Metals, Nitrates, and Ammonium compounds are soluble in water. Other soluble compounds are will be given to you on the AP test.

An x-ray photo of the gastrointestinal tract after a person drank a barium sulfate "cocktail"

Net Ionic Equations

Net Ionic Equations - chemical equations which involve ions and exclude any species that do not take part in the reaction.

Acid-Base Reactions

Acid - a species that produces H^+ ions in water solution.

Base - a species that produces OH^- ions in water solution.

Common Strong Acids and Bases

Acids
HCl, HBr, HI, HNO_3, $HClO_4$, H_2SO_4
Bases
LiOH, NaOH, KOH, RbOH, CsOH, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$

Reaction of Strong Acid with Strong Base

$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O$$

Reaction of Weak Acid with Strong Base

$$HB_{(aq)} + OH^-_{(aq)} \rightarrow H_2O + B^-_{(aq)}$$

Reaction of Strong Acid with Weak Base

$$H^+_{(aq)} + NH_{3\,(aq)} \rightarrow NH_4^+{}_{(aq)}$$

Oxidation-Reduction Reactions

Oxidation-Reduction reactions are also called redox reactions.
Oxidation and reduction occur together.
There is no net change in the number of electrons in a redox reaction.

Redox Reactions

$Zn_{(s)} + 2H^+_{(aq)} \rightarrow Zn^{2+}_{(aq)} + H_{2(g)}$

Oxidation: a loss of electrons

(increase in ox #)

ox: $Zn_{(s)} \rightarrow Zn^{2+}{}_{(aq)} + 2e^-$

Reduction: a gain of electrons

(decrease in ox #)

red: $2H^+_{(aq)} + 2e^- \rightarrow H_{2(g)}$

Rules for Assigning Oxidation Numbers

The ox # of a free element is zero.
The ox # of a monatomic ion is equal to its charge.

The ox # of certain elements is almost always the same. (Group I, II & VII, and H^{1+}, O^{2-})
The sum of the ox # is equal to the charge on that species.

Balancing Redox Equations

Separate the equation into oxidation and reduction half reactions.
Balance each half equation first for atoms then for charge by adding electrons where needed.
Balance total charge by adding H^+ in acidic solution or adding OH^- in basic solution.
Balance hydrogen by adding H_2O where needed.
Combine two half equations so that electrons cancel.

Silver metal forming on the surface of a copper wire

Balancing Redox Equations
Alternate Method

Separate the equation into oxidation and reduction half reactions.
Balance each half equation first for atoms then for charge by indicating electrons lost and electrons gained.
Add H_2O to a side requiring oxygen and add H^+ to a side requiring hydrogen.
Then if in basic solution:
Add OH^- to get rid of H^+
Combine two half equations so that electrons cancel.

A redox reaction of
Fe^{2+} with MnO_4^-

Solute Concentrations; Molarity

Concentration - how much solute is present in a given volume of solution.

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

Solution Stoichiometry

Identify reaction type
Write balanced equation
Calculate moles of reactant
Determine limiting reactant

Calculate moles of product
Calculate mass,volume, or molarity

Acid/Base Tritration

Solution Reactions in Volumetric Analysis