
Chapter 14

Summary of Reactions

Anhydrides

- Metallic hydrides plus water produce hydrogen gas and metallic hydroxides.
- Soluble metallic oxides and water form bases (metallic hydroxides).
- Group 1 and 2 metallic nitrides react with water to produce metallic hydroxides and ammonia.
- Soluble nonmetallic oxides and water form acids. *Note:* The nonmetal retains its oxidation number.

Combustion

- Hydrocarbons and other organic compounds combine with excess oxygen to form carbon dioxide and water.
- Metals combine with oxygen to form metallic oxides.
- Binary compounds of nonmetals with hydrogen combine with oxygen to form water and nonmetal oxides.
- Nonmetallic sulfides combine with oxygen to form sulfur dioxide and nonmetal oxides.

Complex Ions

- Complex ion solutions treated with a strong acid solution produce the free metal ion or a precipitate of the metal salt with the ligand ion.
- An electron pair acceptor is combined with an electron pair donor to form a coordinate covalent compound.
- Metal ion solutions react with an excess of concentrated ammonia to form ammine complex ions.

- Metal ion solutions react with an excess of cyanide solution to form cyano complex ions.
- Metal ion solutions react with an excess of hydroxide solution to form hydroxo complex ions.
- Metal ion solutions react with thiocyanate solution to form thiocyanato complex ions.
- Solid metallic hydroxides when combined with concentrated ammonia solution produce soluble ammine complex ions and hydroxide ions.
- Solid metallic hydroxides when added to hydroxide solution produce hydroxo complex ions.

Decomposition

- Ammonium carbonate decomposes into ammonia, water, and carbon dioxide.
- Ammonium hydroxide decomposes into ammonia and water.
- Binary ionic compounds (molten) can be electrolyzed into their metal and nonmetal components.
- Carbonic acid decomposes into water and carbon dioxide.
- Hydrogen peroxide decomposes into water and oxygen.
- Metallic carbonates decompose into metallic oxides and carbon dioxide.
- Metallic chlorates decompose into metallic chlorides and oxygen.
- Oxyacids decompose into water and a nonmetallic oxide.
- Sulfurous acid decomposes into water and sulfur dioxide.

Synthesis

- A binary molecular compound combined with a nonmetal (contained in the compound) forms a single compound.
- An electron pair acceptor is combined with an electron pair donor to form a coordinate covalent compound.
- A halogen is added to an alkene forming a halogenated alkane.
- Hydrogen is added to an alkene forming an alkane.
- Metals and nonmetals combine to form binary ionic compounds.
- Metal ion solutions react with an excess of concentrated ammonia to form ammine complex ions.
- Metal ion solutions react with an excess of cyanide solution to form cyano complex ions.
- Metal ion solutions react with an excess of hydroxide solution to form hydroxo complex ions.
- Metal oxides combine with carbon dioxide to form metallic carbonates.
- Metal oxides combine with sulfur dioxide to form metallic sulfites.
- Nonmetallic oxides and water form acids. *Note:* The nonmetal retains its oxidation number.
- Soluble metallic oxides and water form bases (metallic hydroxides).

Metathesis (Double Replacement)

- Two soluble ions in aqueous solution may form an insoluble precipitate.
- Metal sulfides when combined with any acid will form hydrogen sulfide gas and a salt.
- Metallic carbonates when combined with an acid will form carbon dioxide gas, water, and a salt.
- Metallic sulfites when combined with an acid will form sulfur dioxide gas, water, and a salt.
- Ammonium salts when heated with a soluble strong hydroxide will form ammonia gas, water, and a salt.
- An acid and a base will form a salt and water.
- A salt formed from a strong acid and a weak base will hydrolyze in water to form a strong acid and a weak base.
- A salt formed from a weak acid and a strong base will hydrolyze in water to form a weak acid and a strong base.

Redox

- Binary ionic compounds (molten) can be electrolyzed into their metal and nonmetal components.
- Chlorine gas reacts with *dilute* sodium hydroxide to produce sodium hypochlorite, sodium chloride, and water.
- Copper reacts with *concentrated* nitric acid to produce copper(II) nitrate, nitrogen dioxide, and water.
- Copper reacts with *dilute* nitric acid to produce copper(II) nitrate, nitrogen monoxide, and water.
- Copper reacts with *concentrated* sulfuric acid to produce copper(II) sulfate, sulfur dioxide, and water.

- A halogen is added to an alkane forming a halogenated alkane.
- A halogen is added to an alkene forming a halogenated alkane.
- Active free halogens replace less active halide ions from their compounds in aqueous solution to form a halogen and halide ion in solution.
- Hydrocarbons and other organic compounds combine with excess oxygen to form carbon dioxide and water.
- Hydrogen gas is added to an alkene forming an alkane.
- Hydrogen gas reacts with a hot metallic oxide to produce the elemental metal and water.
- Metals and nonmetals can combine to form binary ionic compounds.
- Active free metals replace hydrogen in acids to form metallic ions and hydrogen gas.
- Active free metals replace hydrogen in water to form metallic hydroxides and hydrogen gas.
- Active free metals replace less active metals from their compounds in aqueous solution to form a metal and metal ion in solution.
- Metal sulfides react with oxygen to produce metallic oxides and sulfur dioxide.
- Binary compounds of nonmetals with hydrogen combine with oxygen to form nonmetal oxides and water.
- Nonmetallic sulfides combine with oxygen to form nonmetal oxides and sulfur dioxide.

Single Replacement

- Active free halogens replace less active halide ions from their compounds in aqueous solution to form a halogen and halide ion in solution.
- Active free metals replace hydrogen in acids to form metallic ions and hydrogen gas.
- Active free metals replace hydrogen in water to form metallic hydroxides and hydrogen gas.
- Active free metals replace less active metals from their compounds in aqueous solution to form a metal and metal ion in solution.

Atypical Redox Reactions

Note: The following reactions look like single replacements from their reactants but are actually tricky redox reactions.

- Hydrogen reacts with a hot metallic oxide to produce the elemental metal and water.
- Metal sulfides react with oxygen to produce metallic oxides and sulfur dioxide.
- Chlorine gas reacts with *dilute* sodium hydroxide to produce sodium hypochlorite, sodium chloride, and water.
- Copper reacts with *concentrated* sulfuric acid to produce copper(II) sulfate, sulfur dioxide, and water.
- Copper reacts with *dilute* nitric acid to produce copper(II) nitrate, nitrogen monoxide, and water.
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