

Summary of Reactions

The AP Test used to have questions where you had to write various types of complex reactions that required memorizing some categories and patterns. Those questions have been removed from the AP Test in terms of having to just write them from memory, but seeing these categories and examples can be helpful when doing other types of problems. You will not have to memorize these categories and examples like you used to, but familiarizing yourself with them will help you do better in general so it is still a good idea to look at this reference sheet!

Anhydrides

- Metallic hydrides plus water produce hydrogen gas and metallic hydroxides.
- Soluble metallic oxides and water form bases (metallic hydroxides).
- Group IA and IIA 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.
- Nonmetallic hydrides combine with oxygen to form water and nonmetal oxides.
- Nonmetallic sulfides combine with oxygen to form sulfur dioxide and nonmetal sulfides.

Complex Ions

- Complex ion solutions treated with a strong acid solution produce the free metal ion or a metal precipitate and 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

- Binary molecular comp. combined w/ 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 alkane forming a halogenated alkane.
- 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).

Double Replacement (Metathesis)

- 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 any acid will form carbon dioxide gas, water and a salt.
- Metallic sulfites when combined with any 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 w/ *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.
- Nonmetallic hydrides combine with oxygen to form nonmetal oxides and water.
- Nonmetallic sulfides combine with oxygen to form nonmetal sulfides 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 w/ *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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