Reaction Types (Hints on Reaction Prediction)

There are 5 main types of reactions. Each type has several representative categories ("subtypes").

I. Synthesis reactions - 2 or more elements are joined together A. General Form:

$$A + X \longrightarrow AX$$

B. Subtypes:

1. Reaction of elements with oxygen to form oxides

a. $Mg(s) + O_2(g) \longrightarrow MgO(s)$

- 2. Reactions of 2 nonmetals to form a covalent compound
 - a. $2 H_2(g) + O_2(g) \longrightarrow 2 H_2O(g)$
 - b. $S(s) + O_2(g) \longrightarrow$
 - c. C(s) + $H_2(g)$ \longrightarrow
- 3. Metals react with nonmetals (other than oxygen) to form salts
 - a. Halogens + alkali metals, alkaline earth metals, transition metals b. 2 Na(s) + $Cl_2(g) \longrightarrow 2 NaCl(s)$
- 4. Metallic oxides react with water to produce metal hydroxides a. CaO(s) + $H_2O(l)$ \longrightarrow Ca(OH)_{2(s)}
- 5. Nonmetallic oxides react with water to form oxyacids a. $SO_3(g) + H_2O(l) \longrightarrow H_2SO4(aq)$
- 6. Some metal oxides react with some nonmetallic oxides to form salts a. $CaO(s) + SO_2(g) \longrightarrow CaSO_3(s)$
- II. Decomposition opposite of synthesis compound is broken into elements or simpler compounds.
 - A. General form:

$$AX \longrightarrow A + X$$

- B. Subtypes:
 - 1. Binary compounds, when heated, decompose into their elemental forms a. 2 HgO(s) \longrightarrow 2 Hg(l) + O₂(g)
 - 2. Some binary compounds decompose when an electric current passes through them.

a. $2 H_2O(l) \longrightarrow 2 H_2(g) + O_2(g)$

3. Metal carbonates, when heated, break down into metal oxides and CO2.

a.CaCO₃(s) \longrightarrow^{Δ} CaO(s) + CO₂(g)

4. Metal hydroxides when heated decompose to give metal oxides + water.

a. $Ca(OH)_2(s)$ \longrightarrow $CaO(s) + H_2O(g)$

- 5. Metallic chlorates when heated decompose to give a metal chloride +O2.
 - a. 2 KClO₃(s) $\xrightarrow{MnO2(s)\Delta}$ 2 KCl(s) + 3 O₂(g)
- 6. Some acids decompose to nonmetallic oxides and water.

a. $H_2CO_3(aq) \longrightarrow CO_2(g) + H_2O(l)$

- III. Single Replacement one element replaces a similar element in a compound. Usually take place in an aqueous solution.
 - A. General Form:

	$A + BX \longrightarrow AX + B$
	or $Y + BX \longrightarrow BY + X$
В.	Subtypes:
	1. Replacement of a metal by a more active metal
	a. $2 \operatorname{Al}(s) + 3 \operatorname{Fe}(\operatorname{NO}_3)_2(aq) \longrightarrow 3 \operatorname{Fe}(s) + 2 \operatorname{Al}(\operatorname{NO}_3)_3(aq)$
	 2. Replacement of hydrogen in water by a metal a. 2 Na(s) + 2 H₂O(l)> 2NaOH(aq) + H₂(g) More active metals react with water. Less active metals (Fe) react with steam.
	 3. Replacement of hydrogen in an acid by a metal a. Mg(s) + 2 HCl(aq) -> H₂(g) + MgCl₂(aq)
	4. Replacement of halogens

IV. Double Replacement Reactions (Ionic reactions) - ions of 2 compounds change places. Usually take place in water, where one compound is generally soluble and the other forms a precipitate.

a. $Cl_2(g) + 2 KBr(aq) \longrightarrow 2 KCl(aq) + Br_2(l)$

A. General form:

$$AX + BY \longrightarrow AY + BX$$

- B. Subtypes:
 - 1. Formation of a precipitate a. $Pb(NO_3)_2(aq) + 2 KI(aq) \longrightarrow PbI_2(s) + 2 KNO_3(aq)$
 - 2. Formation of a gas a. $FeS(s) + 2 HCl(aq) \longrightarrow H_2S(g) + FeCl_2(aq)$
 - 3. Formation of water a. $HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O(l)$
- IV. Combustion Reactions a substance combines with oxygen, releasing a large amount of energy as light and heat.
 - A. Hydrocarbons react with oxygen to give carbon dioxide and water.

 $C_{3}H_{8(g)} + 5 O_{2(g)} \longrightarrow 3 CO_{2(g)} + 4 H_{2}O_{(g)}$