Types of Chemical Reactions

1. Synthesis

2 or more elements or compounds combine to form a new substance

$A + B \rightarrow AB$

Ex.1 element + element → compound

$2Na + Cl_2 \rightarrow 2NaCl$

Ex. 2 metal oxide + water → base

$MgO + H_2O \rightarrow Mg(OH)_2$

Ex. 3 non-metal oxide + water → acid

$CO_2 + H_2O \rightarrow H_2CO_3$

2. Decomposition

A compound breaks down into elements or simpler compounds

Ex.1 compound → element + element

$2H_2O \rightarrow 2H_2 + O_2$ (by the process of electrolysis)

Ex.2 carbonate → oxide + carbon dioxide

$CaCO_3 \rightarrow CaO + CO_2$

Ex. 3 chlorate → chloride + oxygen

$2KClO_3 \rightarrow 2\ KCl + 3O_2$

3. Combustion

The reaction of a substance with oxygen, producing oxides and energy (light/heat)
Often occurs with hydrocarbons (compounds that contain only hydrogen and carbon such as methane, propane, etc.)

A. Complete Combustion

Occurs when <u>sufficient</u> oxygen is present
Most common oxides are produced
Ex. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

B. Incomplete Combustion

Occurs when <u>insufficient</u> oxygen is present
Less common oxides are produced
Ex. $CH_4 + O_2 \rightarrow CO + C + H_2O$

4. Single Displacement

A single element in a compound is replaced by another element.

A. With a Metal

Will only occur if the metal is more active than the metal ion in the compound (see activity series p. 126)

Ex.1. $Cu + 2AgNO_3 \rightarrow 2Ag + Cu(NO_3)_2$ *copper is more active (higher in the series) than silver

Ex.2. $Au + CuNO3 \rightarrow$ no reaction *gold is less active than copper

B. With a Halogen

Will only occur if the halogen is more active than the halogen in the compound (see activity series p. 127)

Ex.1. $F_2 + 2NaCl \rightarrow 2NaF$

Ex.2. $I_2 + CuF_2 \rightarrow$ no reaction *iodine is less reactive than fluorine

Hint: The less active element wants to be alone

5. Double Displacement

This type of reaction involves the exchange of cations between 2 ionic compounds

Reactants are usually aqueous (dissolved in water, called a solution)

Products can be a precipitate (a solid), a gas, or become neutral.

Look up solubilities on the solubility table p. 137

Ex. 1. **Formation of a precipitate**

$K_2CO_{3\,(aq)} + CuSO_{4\,(aq)} \rightarrow K_2SO_{4(aq)} + CuCO_{3(s)}$

Ex.2. **Formation of a gas**

$Na_2CO_3 + HCl \rightarrow NaCl + H_2CO_3$

Carbonic acid is very unstable and breaks down.

$H_2CO_3 \rightarrow H_2O + CO_2$

Overall : $Na_2CO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

Ex. 3. **Neutralization**

Acid + Base → Salt (any ionic compound) + water

$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$