Chemistry Lecture #46: Types of Reactions

Chemical reactions fall into categories based on what you start with (reactants) and what you end up with (products). There are five types of reactions: synthesis, combustion, decomposition, single-replacement, and double-replacement.

Synthesis: Two or more substances react to form one substance.

Examples:

$2Fe + 3Cl_2 \rightarrow 2FeCl_3$

In the above example, two elements (iron and chlorine) combine to form the ionic compound iron (III) chloride.

$CaO + H_2O \rightarrow Ca(OH)_2$

In above example, two compounds (CaO and H_2O) combine to form the compound $Ca(OH)_2$.

$2SO_2 + O_2 \rightarrow 2SO_3$

In the above example a compound (SO_2) combines with an element (O_2) to form the compound SO_3.

The standard pattern in all the above examples is

$A + B \rightarrow C$

Combustion: A substance combines with oxygen.

A combustion reaction occurs anytime an element or compound combines with oxygen. In the previous example of

$2SO_2 + O_2 \rightarrow 2SO_3$

we labeled it as a synthesis reaction because two substances combined to form one substance. But it is also a combustion reaction since the SO_2 is combining with the O_2.

Here's another example:

$2H_2 + O_2 \rightarrow 2H_2O$

This is another example of a combustion reaction that is also a synthesis reaction.

However, not all combustion reactions are synthesis reactions. For example,

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

In the above example, a substance (CH4) reacts with oxygen to produce two substances that contain oxygen, CO_2 and H_2O.

The general pattern in combustion reactions is

substance + oxygen → compound(s) that contain oxygen

Decomposition: One substance decomposes into two or more substances.

Synthesis means things are being put together. Decomposition is the opposite: things are falling apart.

Examples:

$NH_4NO_3 \rightarrow N_2O + 2H_2O$

In the above example, one compound (NH_4NO_3) is breaking apart into two compounds (N_2O and H_2O).

$2H_2O_2 \rightarrow 2H_2O + O_2$

In the above example, a compound (H_2O_2) is breaking apart into a compound (H_2O) and an element (O_2).

$2NaN_3 \rightarrow 2Na + 3N_2$

In the above example, a compound (NaN_3) is breaking apart into elements (Na and N_2).

The general pattern we see in decomposition is

$A \rightarrow B + C$

Single-replacement: One element replaces the atoms of another element in a compound.

Example:

Cl_2 + 2KBr → 2KCl + Br_2

element compound compound element

In the above example, Cl is replacing the Br in KBr. KBr has been turned into KCl.

2Li + $2H_2O$ → 2LiOH + H_2

element compound compound element

In the above example, Li is replacing one of the H's in H_2O. H_2O is now LiOH.

The pattern we see in all single-replacement reactions is

Element + compound → compound + element

If there is an element and a compound on one side of the arrow, and an element and a compound on the other side, you have a single-replacement reaction.

Double-replacement: Two compounds exchange ions

In a double-replacement reaction, the positive and negative ions of two compounds switch places.

$NaCl$ + $AgNO_3$ → $NaNO_3$ + $AgCl$
compound compound compound compound

In the above example, Na and Ag switch partners. NaCl becomes $NaNO_3$. $AgNO_3$ becomes AgCl. Two replacements have occurred.

H_2O is often a common product of a double replacement reaction. For example,

HCl + $NaOH$ → $NaCl$ + H_2O
compound compound compound compound

In the above example, H and Na switch partners. HCl becomes HOH or H_2O. NaOH becomes NaCl.

The basic pattern for double replacement reactions is

compound + compound → compound + compound

Summary of Reactions

Synthesis

A + B  C

Combustion

substance + oxygen  compound(s) that contain oxygen

Decomposition

A  B + C

Single-replacement

element + compound  element + compound

Double-replacement

compound + compound  compound + compound