Reactions, Types of

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The vast majority of chemical reactions can be classified into one of five major categories: synthesis (or composition), decomposition, single replacement, double replacement, and oxidation-reduction (or redox) reactions.

A synthesis reaction is one in which two elements or two compounds combine with each other to form a new compound. Such reactions can be represented by the general equation:

$A + X \rightarrow AX$

As an example, sodium can combine with chlorine to produce sodium chloride:
$2Na + Cl_2 \rightarrow 2NaCl$

Metalic and nonmetallic oxides often combine with water to form bases or acids, respectively, another example of a synthesis reaction. For example:
$MgO + H_2O \rightarrow Mg(OH)_2$

Decomposition reactions are the opposite of synthesis reactions. In a decomposition reaction, a compound breaks down into two or more simpler compounds and/or elements. The general equation for such reactions is:

$AX \rightarrow A + X$

When an electric current passes through water, it breaks water apart into its constituent elements, hydrogen and oxygen, as shown by the equation
$2H_2O \rightarrow 2H_2 + O_2$

In a single replacement reaction, one element takes the place of another element in a compound, resulting in the formation of a new free element and a new compound. The general equation for a single replacement reaction is

$A + BY \rightarrow B + AY$

In a single replacement reaction, an electropositive element replaces a second electropositive element in the compound, or an electronegative element replaces its electronegative counterpart in the compound. When copper metal is added to a solution

of silver nitrate, copper replaces silver resulting in the formation of free silver metal and copper(II) nitrate:

$Cu + 2AgNO_3 \rightarrow 2Ag + Cu(NO_3)_2$

In a double replacement reaction, the components of both compounds change partners with each other, resulting in the formation of two new compounds, as shown in this general equation:

$AX + BY \rightarrow AY + BX$

An example of a double replacement reaction is that between silver nitrate and hydrogen sulfide:

$2AgNO_3 + H_2S \rightarrow Ag_2S + 2HNO_3$

Double replacement reactions may be reversible or irreversible. An irreversible reaction is one in which one of the products is a gas, a precipitate, or a nonionizable compound that makes it impossible for the products to react with each other and form the original reactants. Such is the case with the reaction shown here. Silver sulfide (Ag_2S) is insoluble, so the two products can not react with each other and the reaction is irreversible. It is said that the reaction "goes to completion". By comparison, the reaction between sodium chloride and potassium nitrate is reversible.

$NaCl + KNO_3 \rightarrow NaNO_3 + KCl$

Sodium nitrate and potassium chloride are both soluble in water, so they can react with each other to form the original reactants, sodium chloride and potassium nitrate.

$NaCl + KNO_3 \leftarrow NaNO_3 + KCl$

This reaction is, therefore, reversible.

An oxidation reaction is one in which one or more of the reactants changes its oxidation number in the reaction. Such reactions typically do not fit into any one of the other four types of reactions. A simple example of a redox reaction is the combustion of carbon to produce carbon dioxide.

$C + O_2 \rightarrow CO_2$

In this reaction, carbon has an oxidation number of 0 to begin with and an oxidation number of +4 in carbon dioxide. Oxygen also has an oxidation number of 0 to begin with and an oxidation number of -2 in carbon dioxide. Since both carbon and oxygen have changed their oxidation numbers in the reaction, it is an example of a redox reaction.

- Sodium Reacting with Chlorine

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