I. Combination reaction

In a combination reaction, two elements or one element and one compound or two compounds combine to give one single product.

$H_2 + Cl_2 \rightarrow 2HCl$

element + element → compound

$2CO + O_2 \rightarrow 2CO_2$

compound + element → compound

$NH_3 + HCl \rightarrow NH_4Cl$

compound + compound → compound

Combination reactions are also called synthesis reactions as a new compound is formed from its constituents .

When magnesium is burnt in the air (oxygen), magnesium oxide is formed. In this reaction, magnesium is combined with oxygen.

$Mg(s) + O_2(g) \rightarrow 2MgO(s)$

Magnesium + Oxygen → Magnesium Oxide

II. Decomposition reaction

A single reactant decomposes on the application of heat or light or electricity to give two or more products.

Types of decomposition reactions:

a.) Thermal Decomposition reactions: which require heat are called thermolytic decomposition or thermolysis.

Examples:

When calcium carbonate is heated, it decomposes into calcium oxide and carbon dioxide.

$CaCO_3(s) \xrightarrow{heat} CaO(s) + CO_2(g)$

Calcium carbonate → Calcium oxide + Carbon dioxide

When ferric hydroxide is heated, it decomposes into ferric oxide and water

$2Fe(OH)_3(s) \xrightarrow{\triangle} Fe_2O_3(s) + 3H_2O(l)$

Thermal Decomposition of HgO

2HgO--------- 2Hg + O2

$2Pb(NO_3)_2(s) \xrightarrow{heat} 2PbO(s) + 4NO_2(g) + O_2(g)$

Thermal decomposition of HgO

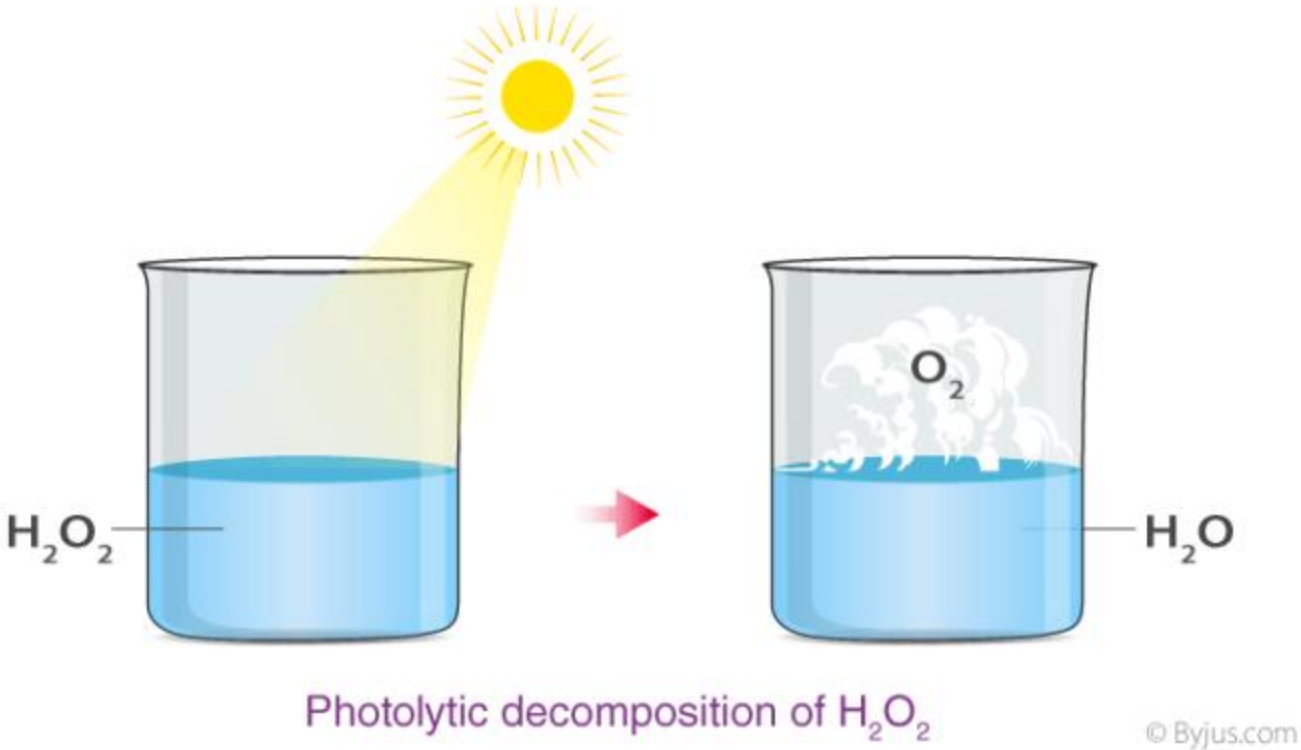
b.) **Photolysis or Photo Decomposition Reaction:** Reactions in which a compound decomposes because of sunlight are known as Photolysis or Photo Decomposition Reaction.

Example: When silver chloride is put in sunlight, it decomposes into silver metal and chlorine gas.

$2AgCl(s)\ (white) \xrightarrow{Sunlight} 2Ag(s)\ (grey) + Cl_2(g)$

Photographic paper has a coat of silver chloride, which turns into grey when exposed to sunlight. It happens because silver chloride is colourless while silver is a grey metal

$2AgBr(s)\ (white) \xrightarrow{Sunlight} 2Ag(s)\ (grey) + Br_2(g)$



Photolytic decomposition of H_2O_2

c) . **Electrolytic Decomposition:** Reactions in which compounds decompose into simpler compounds because of passing of electricity, are known as Electrolytic Decomposition. This is also known as Electrolysis.
Example: When electricity is passed in water, it decomposes into hydrogen and oxygen.

$$2H_2O(l) \xrightarrow[Electrolysis]{Electric\ \ Current} 2H_2(g) + O_2(g)$$

III. **Displacement Reaction:** The chemical reactions in which a more reactive element displaces a less reactive element from a compound is known as Displacement Reactions. Displacement reactions are also known as Substitution Reaction or Single Displacement/ replacement reactions.
A general displacement reaction can be represented by using a chemical equation as follows :
$A + BC \rightarrow AC + B$
Displacement reaction takes place only when 'A' is more reactive than B. If 'B' is more reactive than 'A', then 'A' will not displace 'C' from 'BC' and reaction will not be taking place.
Examples:
When zinc reacts with hydrochloric acid, it gives hydrogen gas and zinc chloride.
$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

More reactive element displaces a less reactive element from its compound or solution.

i) $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

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

IV. **Double Displacement Reaction:** Reactions in which ions are exchanged between two reactants forming new compounds are called Double Displacement Reactions.
AB + CD → AC + BD
Examples:
When the solution of barium chloride reacts with the solution of sodium sulphate, white precipitate of barium sulphate is formed along with sodium chloride.
$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s)$ (Precipitate) + 2NaCl(aq)

When sodium hydroxide (a base) reacts with hydrochloric acid, sodium chloride and water are formed.
$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

Note: Double Displacement Reaction, in which precipitate is formed, is also known as precipitation reaction. Neutralisation reactions are also examples of double displacement reaction.

Precipitation Reaction: The reaction in which precipitate is formed by the mixing of the aqueous solution of two salts is called Precipitation Reaction.
Example:

$$\underset{\text{Silver Nitrate}}{AgNO_3(aq)} + \underset{\text{Sodium Chloride}}{NaCl(aq)} \longrightarrow \underset{\text{Silver Chloride (Precipitate)}}{AgCl(s)} + \underset{\text{Sodium Nitrate}}{NaNO_3(aq)}$$

An insoluble compound called precipitate forms when two solutions containing soluble salts are combined.

For example, $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow 2KNO_3(aq) + PbI_2(\downarrow)(s)(yellow)$

Neutralization Reaction: The reaction in which an acid reacts with a base to form salt and water by an exchange of ions is called Neutralization Reaction.

Example:

$$\underset{\text{Sodium hydroxide}}{NaOH(aq)} + \underset{\text{Hydrochloric Acid}}{HCl(aq)} \longrightarrow \underset{\text{Sodium Chloride}}{NaCl(aq)} + \underset{\text{Water}}{H_2O(l)}$$

When zinc reacts with copper sulphate, it forms zinc sulphate and copper metal.
$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

V. Redox reaction

Oxidation and reduction take place simultaneously.
Oxidation: Substance loses electrons or gains oxygen or loses hydrogen.
Reduction: Substance gains electrons or loses oxygen or gains hydrogen.
Oxidising agent – a substance that oxidises another substance and self-gets reduced.
Reducing agent – a substance that reduces another substance and self-gets oxidised.

Examples:

1. $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$
   (Blue) (Green)

$Fe \rightarrow Fe^{+2} + 2e-$ $(oxidation)$; Fe - reducing agent.

$Cu^{+2} + 2e- \rightarrow Cu(s)$ $(reduction)$; Cu - oxidising agent.

2. $ZnO + C \rightarrow Zn + CO$

ZnO reduces to Zn → reduction

C oxidises to CO → oxidation

ZnO - Oxidising agent

C - Reducing agent

$$CuO + H_2 \xrightarrow{\Delta} Cu + H_2O$$

Cuo reduces to Cu

H2 oxidises to H2O

CuO – oxidizing agent

H2 – reducing agent

(vi) Exothermic and Endothermic Reactions:

Exothermic Reaction: Reaction which produces energy is called Exothermic Reaction. Most of the decomposition reactions are exothermic.

Example:

Respiration is a decomposition reaction in which energy is released.

$$\underset{\text{glucose}}{C_6H_{12}O_6(aq)} + \underset{\text{oxygen}}{6O_2(g)} \longrightarrow \underset{\text{carbondioxide}}{6CO_2(g)} + \underset{\text{water}}{6H_2O(l)} + \text{Energy}$$

When quick lime (CaO) is added to water, it releases energy.

$$\underset{\substack{\text{Quick lime}\\ \text{(Calcium oxide)}}}{CaO(s)} + \underset{\text{Water}}{H_2O(l)} \longrightarrow \underset{\substack{\text{Calcium}\\ \text{hydroxide}\\ \text{(Slaked lime)}}}{Ca(OH)_2(aq)} + \text{Energy}$$

Endothermic Reaction: A chemical reaction in which heat energy is absorbed is called Endothermic Reaction.

Example: Decomposition of calcium carbonate.

$$\underset{\substack{\text{Calcium}\\ \text{carbonate}}}{CaCO_3(s)} \xrightarrow{\text{heat}} \underset{\substack{\text{Calcium}\\ \text{oxide}}}{CaO(s)} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{CO_2(g)}$$

Corrosion: The process of slow conversion of metals into their undesirable compounds due to their reaction with oxygen, water, acids, gases etc. present in the atmosphere is called Corrosion.

Example: Rusting of iron.

Rusting: Iron when reacts with oxygen and moisture forms red substance hydrated iron oxide which is called Rust.

$$4Fe(s) + 3O_2(g) + H_2O(l) \longrightarrow \underset{\substack{\text{Rust}\\ \text{(Hydrated ferric oxide)}}}{2Fe_2O_3 \cdot xH_2O\ (s)}$$

The rusting of iron is a redox reaction.

Corrosion (rusting) weakens the iron and steel objects and structures such as railings, car bodies, bridges and ships etc. and cuts short their life.

Methods to Prevent Rusting

- By painting.
- By greasing and oiling.
- By galvanisation.

- By anodizing
- By alloying

Corrosion of Copper: Copper objects lose their lustre and shine after some time because the surface of these objects acquires a green coating of basic copper carbonate, $CuCO_3.Cu(OH)_2$ when exposed to air.

$$\underset{\text{Copper}}{2Cu(s)} + \underset{\text{Moist Air}}{CO_2(g) + O_2(g) + H_2O(l)} \longrightarrow \underset{\text{Basic Copper Carbonate (Green)}}{CuCO_3.Cu(OH)_2}$$

Corrosion of Silver Metal: The surface of silver metal gets tarnished (becomes dull) on exposure to air, due to the formation of a coating of black silver sulphide(Ag_2S) on its surface by the action of H_2S gas present in the air.

$$\underset{\text{Silver}}{2Cu(s)} + \underset{\text{Hydrogen sulphide}}{H_2S(g)} \longrightarrow \underset{\text{Silver Sulphide (Black)}}{Ag_2S(g)} + H_2(g)$$

Rancidity: The taste and odour of food materials containing fat and oil changes when they are left exposed to air for a long time. This is called Rancidity. It is caused due to the oxidation of fat and oil present in food materials.

Methods to prevent rancidity:

- Store cooking oils from direct sunlight.
- Food should be placed at low temperature in air tight containers.
- By adding antioxidants such as BHT and BHA, food can be protected from rancidity.
- Packing material should replace the air with nitrogen.
- Minimize the use of salts in fried foods.

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