Chapter 3. Chemical Reactions and Equations

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Science and Technology

Part - 1

Standard 10th

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Observe & Conclude

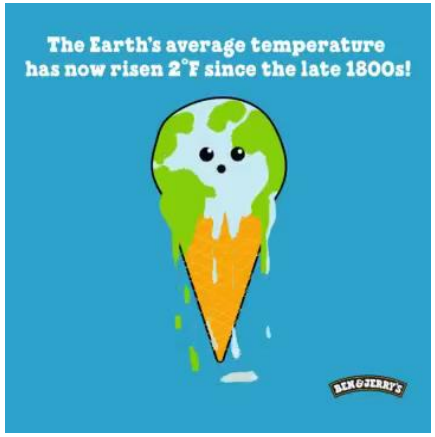
Transformation of ice into water

Cooking of food

Digestion of food

Observe & Conclude

Ripening of fruit



Evaporation of water

Breaking of glass

Size reduction of naptha balls exposed to air

Milk turned into curd

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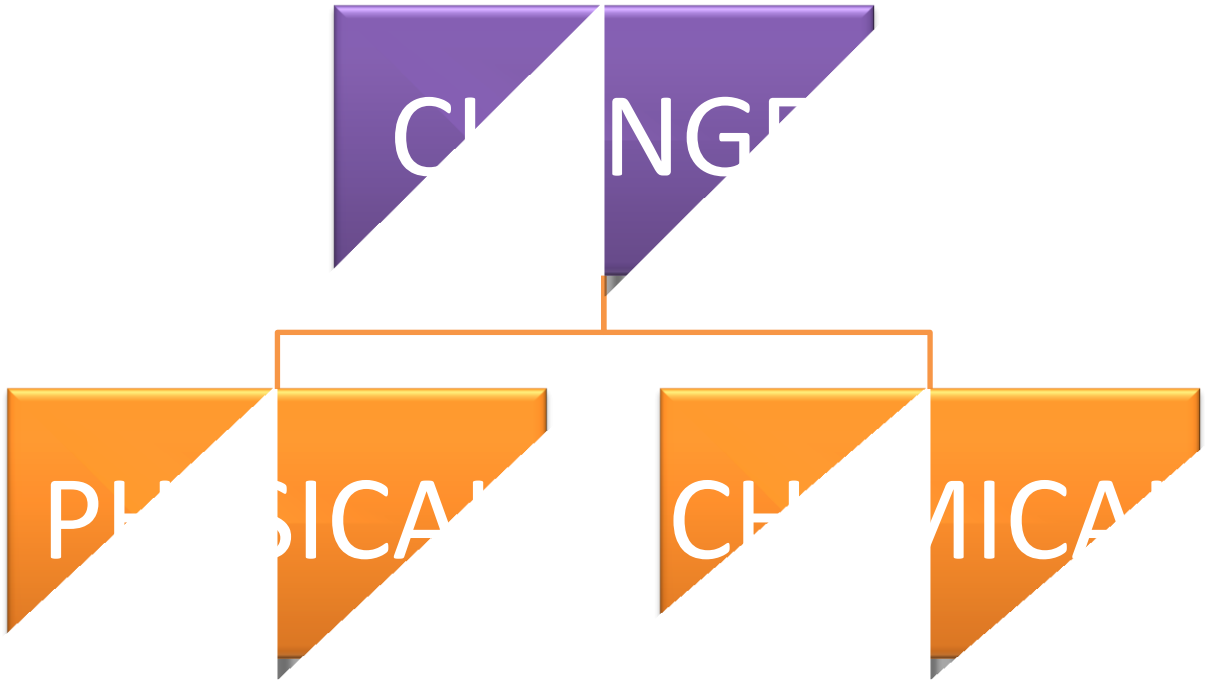
Many physical and Chemical changes occure in our surroundings.

When chemical changes occure, a chemical reaction takes place.



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What is a chemical reaction ?

The transformation of chemical substance into another chemical substance is known as Chemical Reaction.

For example:

Rusting of iron, the setting of milk into curd, digestion of food, respiration, etc.

In a chemical reaction,

a new substance is formed which is completely different in properties from the original substance, so in a chemical reaction, a chemical change takes place.

The substances which take part in a chemical reaction are called reactants.

The new substances produced as a result of a chemical reaction are called products.

Example:

The burning of magnesium in the air to form magnesium oxide is an example of a chemical reaction.

$$2Mg(s) + O_2(g) \xrightarrow{\Delta} 2MgO(s)$$

What is a chemical Equation ?

Chemical Equation:

Representation of chemical reaction using symbols and formulae of the substances is called Chemical Equation.

Example: $A + B \rightarrow C + D$

In this equation,
A and B are called reactants and C and D are called the products. The arrow shows the direction of the chemical reaction.

Example:
When hydrogen reacts with oxygen, it gives water. This reaction can be represented by the following chemical equation:

Hydrogen + Oxygen $\rightarrow$ Water

$H_2 + O_2 \rightarrow H_2O$

reactants product

A chemical equation can be divided into **two types:**

Balanced Chemical Equation and Unbalanced Chemical Equation.

(a) Balanced Chemical Equation :

A balanced chemical equation has the number of atoms of each element equal on both sides.

Example: **$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$**

In this equation, numbers of zinc, hydrogen and sulphate are equal on both sides, so it is a Balanced Chemical Equation.

(b) Unbalanced Chemical Equation :

If the number of atoms of each element in reactants is not equal to the number of atoms of each element present in the product, then the chemical equation is called Unbalanced Chemical Equation.

Example: **$Fe + H_2O \rightarrow Fe_3O_4 + H_2$**

Balancing a Chemical Equation:

To balance the given or any chemical equation, follow these steps:

$Fe + H_2O \rightarrow Fe_3O_4 + H_2$

Write the number of atoms of elements present in reactants and in products in a table as shown here.

$$Fe + H2O \rightarrow Fe3O4 + H2$$

Name of atom	No. of atoms in the reactant	No. of atoms in the product
Iron	1	3
Hydrogen	2	2
Oxygen	1	4

Balance the atom which is maximum in number on either side of a chemical equation.
In this equation, the number of oxygen atom is the maximum on the RHS.
To balance the oxygen, one needs to multiply the oxygen on the LHS by 4, so that, the number of oxygen atoms becomes equal on both sides.

$$Fe + 4 \times H_2O \rightarrow Fe_3O_4 + H_2$$

Now, the number of hydrogen atoms becomes 8 on the LHS, which is more than that on the RHS. To balance it, one needs to multiply the hydrogen on the RHS by 4.

$$Fe + 4 \times H_2O \rightarrow Fe_3O_4 + 4 \times H_2$$

After that, the number of oxygen and hydrogen atoms becomes equal on both sides. The number of iron is one on the LHS, while it is three on the RHS. To balance it, multiply the iron on the LHS by 3.

$$3 \times Fe + 4 \times H_2O \rightarrow Fe_3O_4 + 4 \times H_2$$

After balancing, the above equation can be written as follows:

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2.$$

To Make Equations More Informative:
By writing the physical states of substances, a chemical equation becomes more informative.

Gaseous state is represented by symbol (g).

Liquid state is represented by symbol (l).

Solid state is written by symbol (s).

Aqueous solution is written by symbol (aq).

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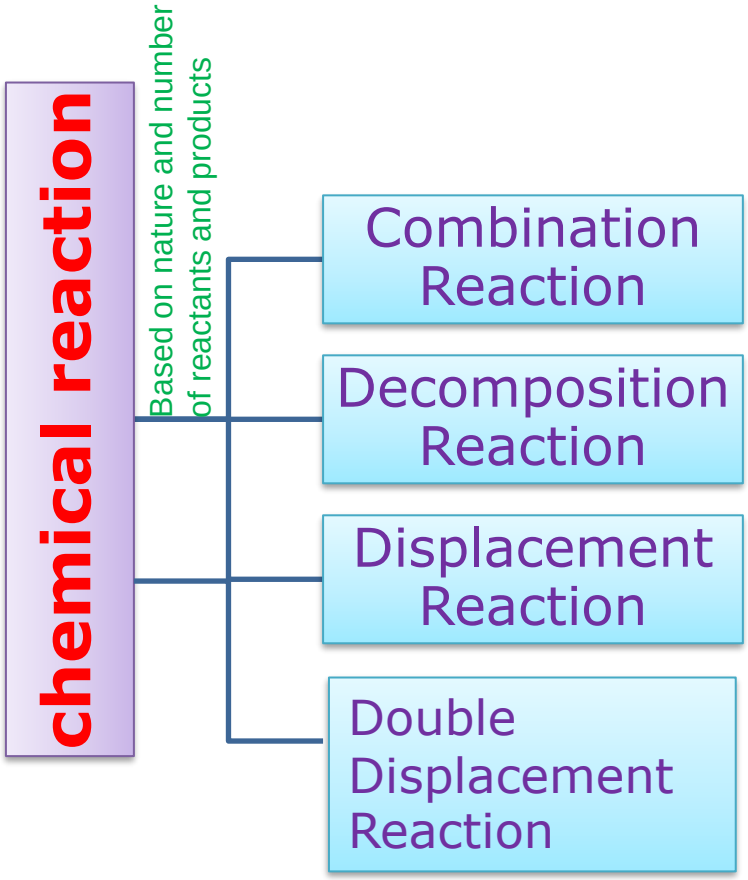
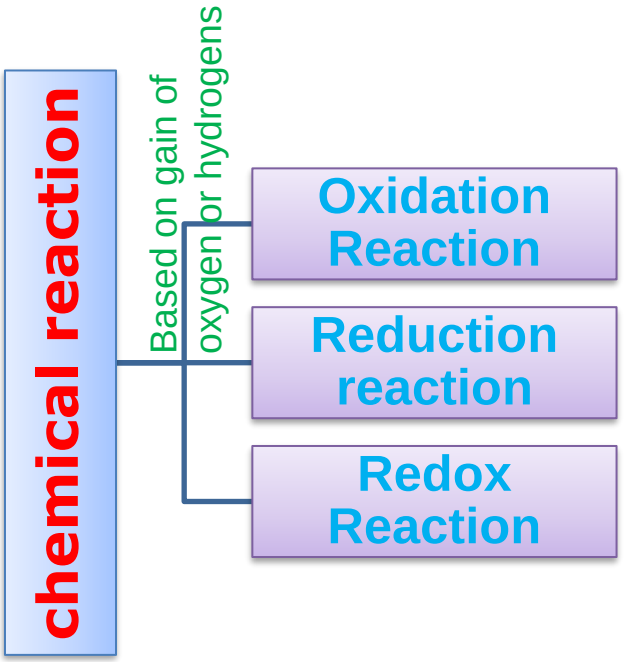
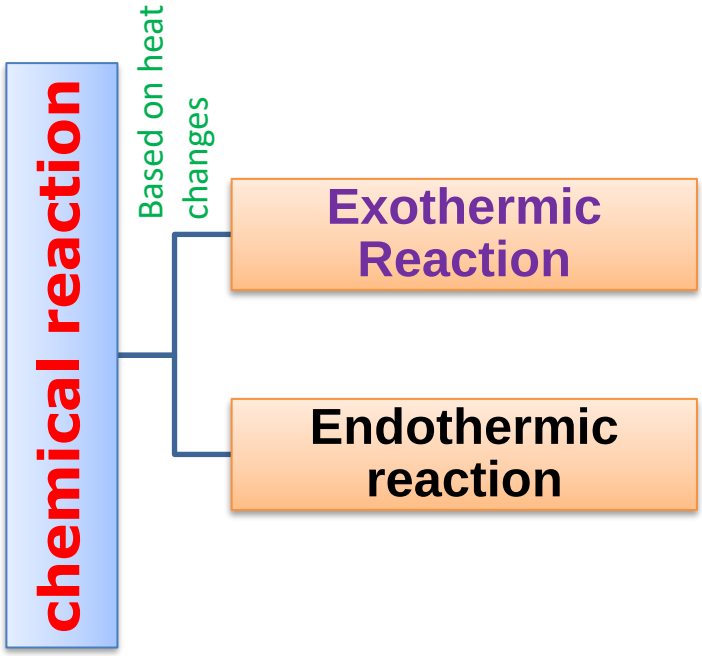
Types of Chemical Reactions:







(i) Combination Reaction :

Reactions in which two or more reactants combine to form single product are called Combination Reactions.

Examples:

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

Magnesium + Oxygen → Magnesium Oxide

Mg(s) + O2(g) → 2MgO(s)

When carbon is burnt in oxygen (air), carbon dioxide is formed. In this reaction, carbon is combined with oxygen.

Carbon + Oxygen → Carbon dioxide

C (s) + O2(g) → CO2(g)

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(ii) Decomposition Reaction :

Reactions in which one compound decomposes in two or more compounds or elements are known as Decomposition Reaction.

A decomposition reaction is just the opposite of combination reaction.

Examples:

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

Calcium carbonate → Calcium oxide + Carbon dioxide

$CaCO_3(s)$ heat → $CaO(s)$ + $CO_2(g)$

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

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

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(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.

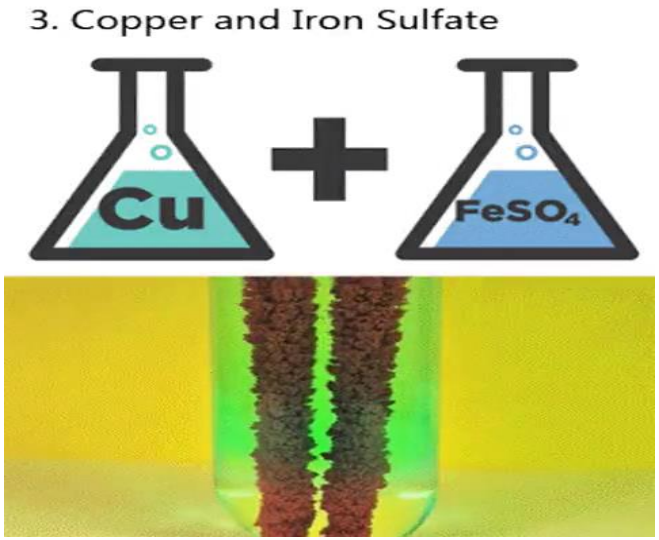
Examples:

When zinc reacts with hydrochloric acid, it gives hydrogen gas and zinc chloride.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl2(aq) + H2(g)$$

When zinc reacts with copper sulphate, it forms zinc sulphate and copper metal.

$$Zn(s) + CuSO4(aq) \rightarrow ZnSO4(aq) + Cu(s)$$



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(iv) Double Displacement Reaction :

Reactions in which ions are exchanged between two reactants forming new compounds are called Double Displacement Reactions.

Examples:

1) 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) + $2NaCl(aq)$

2) 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.

(v) 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.

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

Example: 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.

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

(vi) Oxidation and Reduction Reactions :

Oxidation :

Addition of oxygen or removal of hydrogen from a compound is known as Oxidation.

Reduction :

Addition of hydrogen or removal of oxygen from a compound is called Reduction.

Oxidizing agent:

The substance which gives oxygen for oxidation is called an Oxidizing agent.

The substance which removes hydrogen is also called an Oxidizing agent.

Reducing agent:

The substance which gives hydrogen for reduction is called a Reducing agent.

The substance which removes oxygen is also called a Reducing agent.

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vii) Redox reaction :

The reaction in which oxidation and reduction both take place simultaneously is called Redox reaction.

Example :

When copper oxide is heated with hydrogen, then copper metal and hydrogen are formed.

$$CuO + H_2 \rightarrow Cu + H_2O$$

(i) In this reaction, CuO is changing into Cu. Oxygen is being removed from copper oxide. Removal of oxygen from a substance is called Reduction, so copper oxide is being reduced to copper.

(ii) In this reaction, H_2 is changing to H_2O. Oxygen is being added to hydrogen. Addition of oxygen to a substance is called Oxidation, so hydrogen is being oxidised to water.

Effects of Oxidation Reactions in Everyday life :

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 which is called Rust.

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

(Hydrated ferric oxide)

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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

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.

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

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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.

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

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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:

By adding anti-oxidant.
Vacuum packing.
Replacing air by nitrogen.
Refrigeration of foodstuff.

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