CHEMICAL REACTION

Chemical reactions are the processes in which new substances with new properties are formed. Chemical reactions involve the breaking of bonds in the atoms of reacting substances and making of new bonds between the atoms of products. During chemical reactions, a large variety of rearrangement of atoms can take place to produce new substances.

TYPES OF CHEMICAL REACTIONS

Chemical reactions can be grouped in to various types on the basis of their nature. Some common types of chemical reactions are

i) Combination reactions
ii) Decomposition reactions
iii) Displacement reactions
iv) Double – displacement reactions
v) Oxidation – reduction reactions
vi) Redox Reactions
vii) Precipitation Reactions

1. Combination Reaction:

A reaction in which two or more substances combine together to form a new substance, is called a combination reaction .The following reactions are combination reactions.

a) Sulphur-dioxide and oxygen combine to form sulphur trioxide.

$SO_2(g) + O_2(g) \longrightarrow SO_3(g)$

sulphur dioxide oxygen sulphur trioxide

b) Calcium oxide and carbon dioxide combine to form calcium carbonate

$CaO(s) + CO_2(g) \longrightarrow CaCO_3(s)$

calcium oxide carbon dioxide calcium carbonate

2. Decomposition Reaction:

A reaction in which a substance is broken down into two or more simpler substances is known as decomposition reaction. Decomposition reactions take place only when some energy in the form of heat, light or electricity is supplied to the substance.

a) Limestone ($CaCO_3$) when heated strongly gives quicklime (CaO) and carbon dioxide (CO_2).

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

limestone quicklime carbon dioxide

b) $2KClO_3 \xrightarrow{heat} 2KCl + 3O_2$

3. Displacement Reaction:

A reaction in which one part (an atom or a group of atoms) of a molecule is replaced by another is called displacement reaction. Displacement reactions are also called substitution reactions. For example, the following reaction

$A + BC \longrightarrow AC + B$

Displacement of copper (cu) from copper sulphate ($CuSO_4$) by active metals like iron, zinc and magnesium is a typical displacement reaction.

$CuSO_4(aq) + Fe(s) \longrightarrow Cu(s) + FeSO_4(aq)$

copper sulphate iron copper metal ferrous sulphate

4. Double Displacement Reaction:

A reaction in which the two reacting ionic compounds exchange their corresponding ions is called a double displacement reaction.

a) Reaction between silver nitrate and sodium chloride in solution.

$AgNO_3(aq) + NaCl(aq) \longrightarrow NaNO_3(aq) + AgCl(s)$

Silver nitrate sodium chloride sodium nitrate silver chloride

b) $NaSo_4(aq) + BaCl_2 \longrightarrow BaSo_4(S) + 2NaCl(aq)$

5. Oxidation Reaction:

The process which involves the addition of oxygen or any electronegative element or a process which involves removal of hydrogen or any other electro positive element is known as oxidation.

$S + O_2 \longrightarrow SO_2$ (Addition of O_2)

$2FeCl_2 + Cl_2 \longrightarrow 2FeCl_3$ (Addition of electronegative element)

$H_2S + Cl_2 \longrightarrow 2Hcl + S$ (Removal of Hydrogen)

$2KI + H_2O_2 \longrightarrow I_2 + KOH$ (Removal of electro positive element)

6. Reduction Reaction:

Reduction may be defined as a process which involves addition of hydrogen or any other electropositive element or a process which involves removal of oxygen or any other electronegative element.

$H_2 + Cl_2 \longrightarrow 2HCl$ (Addition of hydrogen)

$HgCl_2 + SnCl_2 \longrightarrow Hg_2Cl_2 + SuCl_4$ (Addition of electropositive element)

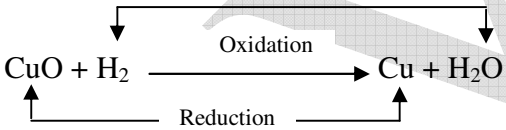
Mercuric Chloride stannous chloride Mercuric chloride Stannic chloride

$ZnO + C \longrightarrow Zn + Co$ (Removal of oxygen)

$2FeCl_3 + H_2 \longrightarrow FeCl_2 + 2HCl$ (Removal of electro negative element)

7. Redox Reaction:

Redox reaction are those reactions in which a reactant gets oxidized while the other gets reduced during a reaction.



$MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$

8. Precipitation Reaction:

Precipitation reactions are those reactions which involve the formation of an insoluble product (solid) either when two solutions are mixed or when a gas is bubbled into a solution.

$Pb(NO_3)_2 + 2KI \longrightarrow PbI_2 + 2KNO_3$

$CO_2 + Ca(OH)_2 \longrightarrow CaCO_3 + H_2O$

EXOTHERMIC REACTION

The term exothermic means giving out heat, (exo-out, and thermic - heat). So, the reaction in which heat is liberated (given out) are known as exothermic reactions.

Following are some typical exothermic reactions.

i) **Burning of carbon**:- Carbon (C) burns in oxygen (or in air) to form carbon dioxide (CO_2) gas, and liberating a large amount of heat.

$C(s) + O_2(g) \longrightarrow CO_2(g) + Heat$

carbon oxygen carbon dioxide 393.3kj

When 12g of pure carbon is burnt in excess of air 393.3kj of heat is liberated.

ENDOTHERMIC REACTION

A reaction which proceeds with the absorption of heat is called an endothermic reaction (endo-means in, and thermic means heat). Some typical endothermic reactions are,

i) **Reaction between nitrogen and oxygen**:- Nitrogen reacts with oxygen at about 3000^0C to form nitric oxide (NO)

$$N_2(g) + O_2(g) + \text{Heat} \xrightarrow{3000^0C} 2NO(g)$$

nitrogen oxygen nitric oxide

This is one of the major reactions which takes place in the atmosphere when lightening strikes.

CHEMICAL EQUATION

The method of representing a chemical reaction with the help of symbols and formulae of the substances involved in it is known as a chemical equation.

For example, the chemical reaction during the burning of carbon (or coal) may be described by the statement, "carbon is burnt in excess of air (or oxygen) to produce carbon dioxide." This reaction may also be described by a word equation, viz.,

Carbon + Oxygen (excess) ⟶ Carbon dioxide

The substances which combine or react are known as reactants.

The new substances produced in a reaction are known as products.

HOW IS A CHEMICAL EQUATION WRITTEN

Chemical equation for a chemical reaction is written as follows.

Step 1 : Identify the reactants and the products of the chemical reaction.

Step 2 : Write down the formulae or symbols of the reactants on the left hand side with a sign of plus (+) between them.

The formulae or symbols of the products formed in the reaction are written on the right hand side with a sign of plus (+) between them.

Such a chemical equation is called the skeleton equation.

Step 3 : Count the number of atoms of each element on both the sides. If the numbers of atoms of each element on both the sides are equal, then the equation is called a balanced chemical equation. If the number of atoms of any one or more of the elements on both the sides are not equal, then these are made equal by adjusting the coefficients before the symbols and formulae of the reactants and element on both sides are sides are made equal, is called balancing of chemical equation.

Step 4 : In the end, the chemical equation is made molecular, if required.

WHAT INFORMATION DOES A BALANCED CHEMICAL EQUATION CONVEY?

A chemical equation gives the following two types of information.

1. Qualitative information: A chemical equation provides the following qualitative information about the reaction. It tells us the,

i) Names of the reactants which take part in the reaction.

ii) Names of the products formed in the reaction.

2. Quantitative information.A chemical equation gives the following quantitative information. It tells us about,

i) The number of molecules or atoms of reactants and products taking part in the reaction.

ii) The number of moles of each substance involved in the reaction.

iii) The mass of each substance involved in the reaction.

iv) Mass-mass, mass-volume, volume-volume relationships between the reactants and products.

BALANCING OF CHEMICAL EQUATIONS

The method by which the number of atoms of each element on both sides of the arrow (⟶) in a chemical reaction are made equal, is called balancing of chemical equation.,

WHY IS IT NECESSARY TO BALANCE A CHEMICAL EQUATION?

In a balanced chemical equation, the number of atoms of each element on both the sides should be equal. This is because; no matter is lost or gained during a chemical reaction, (law of conservation of matter). Therefore, balancing of a chemical equation is necessary because no matter. Hence, no atom is lost or gained during a chemical reaction.

HOW ARE CHEMICAL EQUATIONS BALANCED?

Chemical equations are balanced by adjusting the coefficients placed before the symbols or formulae of the reactants and products. There are a few methods which can be used for the balancing of chemical equations.

i) Hit and trial method ii) Partial equation method.

ii)

HIT AND TRIAL METHOD

This method is also called trial and error method, or inspection method. In this method, coefficients before the formulae or symbols of the reactants and products are adjusted in such a way that the total number of atoms of each element on both sides become equal .This is called material balance, or mass balance. In this method first of all, atoms of the element which appears least in the chemical equation should be balanced. Then, the next one, and so on.

Example: Balance the equation, $Mg + HCl \longrightarrow MgCl_2 + H_2$

Solution: (i) Each type of atom is counted on each side of the equation. Then we decide which atoms are unbalanced.

	Left side	*Right side*
Mg	1	1
Cl	1	2
H	1	2

We see that Cl and H atoms are unbalanced. In case all the atoms are balanced, there is no need to proceed further, as we already have a balanced equation.

(ii) The most complicated formula of the equation is used to balance atoms other than H and O. In this equation, $MgCl_2$ is the most complicated formula. The equation is already balanced with respect to Mg. So, we can balanced Cl by setting 2 just before HCl.

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

By doing so hydrogen is also balanced

(iii) Each type of atom is now counted on both sides of the arrow to check whether or not the equation is balanced.

	Left side	*Right side*
Mg	1	1
Cl	2	2
H	2	2

Since all types of atoms are equal in number, the equation is balanced. The balanced equation is

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

CORROSION:

Corrosion may be defined as the chemical process of slow eating up of the surfaces of certain metals when kept in open for a long time. Black coating on the surface of silver and green layer on the surface of copper are the examples of corrosion. Corrosion is very harmful and cause damage to the buildings, railway tracks, automobiles and other objects/materials where metals are used.

CORROSION OF METALS

When a metal is exposed to air containing water vapour, its upper surface gets peeled off as a result of corrosion and the metal is gradually eaten up. This process of slow destruction of metals as a result of oxidation reaction with the air and moisture of the atmosphere is referred to as corrosion of metals. The corrosion of metals involves

transfer of electrons from the metal to the oxygen through water, due to which the metallic surface forms a mixture of metallic oxide and metallic hydroxide leading to the corrosion of the metals as explained under:
When a metallic surface comes in contact with air and moisture, the metals (say iron) loses electrons and get oxidized to iron III ions, as shown under:

$$\underset{\text{Iron atom}}{Fe} \xrightarrow{\text{Oxidation}} \underset{\text{iron III ion}}{Fe^{3+}} + 3e^-$$

The oxygen gas takes these electrons and gets reduced to oxide ion, as shown under:

$$\underset{\text{Oxygen}}{O_2} + 2e^- \xrightarrow{\text{Reduction}} \underset{\text{oxide ion}}{2O^{2-}}$$

When the iron III ion and oxide ion combine together, iron III oxide is formed, as shown under:

$$\underset{\text{iron III ion}}{2Fe^{3+}} + 3O^{2-} \longrightarrow \underset{\text{iron III oxide}}{Fe_2O_3}$$

However, the iron III ion also reacts with hydroxide ions of the moisture (water) of the air and forms iron III hydroxide.

$$\underset{\text{Iron III ion}}{Fe^{3+}} + \underset{\text{hydroxide ion}}{3OH^-} \longrightarrow \underset{\text{iron III hydroxide}}{Fe(OH)_3}$$

CONDITIONS NECESSARY FOR CORROSION

The corrosion of metals is an oxidation process and requires following two conditions:

1. Presence of oxygen in the air. 2. Presence of moisture or water in the air.

However, the rate of corrosion increases if two metals are in contact with each other and the air presence in the atmosphere of these metals is polluted with acidic gases like sulphur dioxide, nitrogen dioxide and carbon dioxide.

Prevention of Corrosion: The process of corrosion can be prevented by the following precautionary measures:

1. By coating the surface of a metal with a protective layer of paint, varnish or grease.
2. By coating a thick layer of corrosion resistant metals like Zinc, tin or chromium.
3. By applying a thin layer of oil over the surface of the metal.
4. By alloying the metal with other metals like chromium and nickel.

RANCIDITY

It may be defined as the slow oxidation of oils and fats present in food material resulting in some bad smelling compounds.

Example:

When food containing fat and oil is left as such for a long time, it becomes stale. The stale food often develops bad taste and smell. This is very common in case of curd or cheese particularly in summer. Actually, the oils and fats are slowly oxidized to certain bad smelling compounds. These are of volatile nature and release foul smell.

METHODS TO CHECK RANCIDITY

Following measures can be adopted to prevent or slow down rancidity.

- Manufactures sometimes add certain food additives to the food materials. These are known antioxidants and check their oxidation.
- Food materials are often packed in air tight containers. Oxygen has no access to them and oxidation resulting in rancidity is prevented.
- Refrigeration of food also slows down rancidity because the temperature inside refrigerator is very low and direct contact with air or oxygen is avoided.
- In bags containing potato chips and other similar stuff, the air is quite often replaced by nitrogen. This checks their oxidation as well as rancidity.

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