

NCERT Class 10th Science Notes

Chapter 1 - Chemical Reactions and Equations

- **Chemical change:** A change that results in the formation of one or more new compounds. Chemical changes are also known as chemical reactions.

In a chemical change—

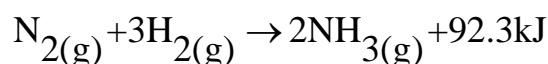
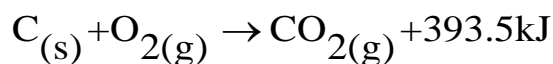
- A. New substances are produced during a chemical reaction.
- B. Changes in energy are involved.
- C. During the reaction, there occurs a change in mass.
- D. There is a permanent alteration.

Examples –

- A. Cooking of food
- B. Rusting of iron
- C. Heating of Lead nitrate
- D. Souring of milk
- E. Ripening of fruit.

- Rusting of iron is a chemical change because
 - A. A new substance, iron oxide, is created as iron rusts, it undergoes a chemical transition.
 - B. The modification is permanent; the article now has a rust layer (which may only peel off).
 - C. When rust forms, the mass of the object increases.
 - D. A shift in energy has occurred (which may not be visible).
- **Exothermic Reaction** - Exothermic reaction is a chemical process that results in the release of heat energy.

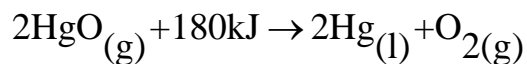
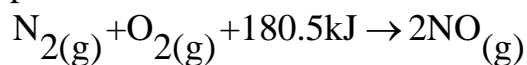
Examples:



Along with the products, the amount of heat (energy) produced is recorded. This means that heat is being emitted.

- **Endothermic Reactions** - Endothermic reaction is a chemical reaction that involves the absorption of heat energy.

Examples:

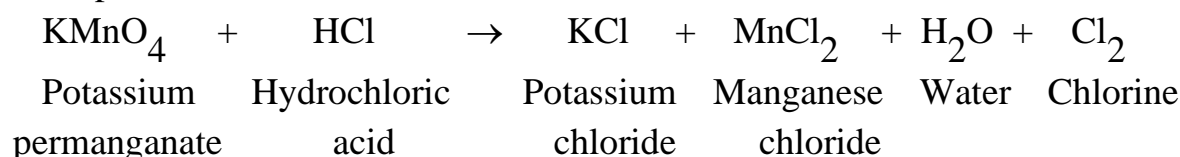


Along with the reactants, the amount of heat (energy) produced is mentioned. This means that heat has been absorbed.

- **Chemical Formulae** - A substance's chemical formula is a symbolic representation of the number of atoms present in a single molecule of that material.
 - a) One water molecule has the formula H_2O . It demonstrates that one molecule of water is made up of two hydrogen atoms and one oxygen atom.
 - b) One molecule of sulphuric acid has the formula H_2SO_4 . It illustrates that one molecule of sulphuric acid has 2 hydrogen atoms, 1 sulphur atom, and 4 oxygen atoms.

- **Chemical Equations** - The chemical equation of the reaction is the representation of a chemical change in terms of symbols and formulae of the reactants and products.

Example:



- **Steps for writing Chemical Equation**

A. Step I: Writing skeletal Equation

A word-equation depicts the transformation of reactants into products by placing an arrow between them (\rightarrow). The arrow indicates the reaction's direction and might be read as "to yield," "to form," or "to give."

The reactants are on the left (LHS) of the arrow, while the products are on the right (RHS). A plus sign (+) links the different reactants and products together.

A balanced account of a chemical transaction is a complete chemical equation, which symbolically depicts the reactants, products, and their physical states.

B. Step II: Balancing of Chemical Equation

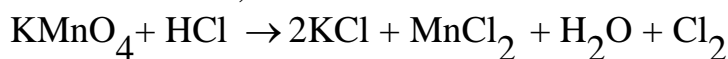
A balanced chemical equation is one in which the number of atoms of each element is equal on both sides of the equation. On the reactant and product sides of the equation, a chemical equation is balanced if the number of atoms of each type involved in the reaction is the same.

Equations must be balanced at all times.

The amount of hydrogens on both sides should be an even number whenever H_2O is present on one side (2 atoms of hydrogen in water). If there are 4 H_2O hydrogen atoms, then $4 \times 2 = 8$ hydrogen atoms are present. If there are 7 H_2O hydrogen atoms, then $7 \times 2 = 14$ hydrogen atoms, indicating that all the numbers are even.

\therefore There must be an even number in front of HCl on the reactant side. (We'll figure out what that number is later.) As a result, there will be an even amount of chlorine atoms (i.e., $\text{KCl}=1$, $\text{MnCl}_2 = 2$, $\text{Cl}_2 = 2$.i.e., $1 + 2 + 2 = 5$

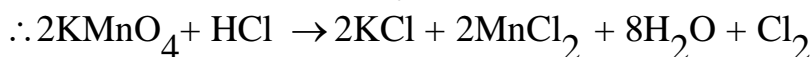
However, the quantity of chlorine atoms in the product is unusual. KCl has the only odd number of chlorine atoms. Let's alter it to the simplest even number we can think of, which is 2.



Since the number of K atoms in $2 \text{KCl}=2$, we have to put 2 in front of KMnO_4 for balancing K atoms.



In 2KMnO_4 , there are 2 K, 2 Mn, and 8 O. So, add these numbers in front of K, Mn and O, (K is already done).



If there are 8 H_2O on the product side, there should be 16 H (8×2) on the reactants side as well.



Now the only unbalanced one is Chlorine. On the left-hand side, there are 16 Cl. On the right-hand side, firstly, there are 2 Cl in $2 \text{KCl} + 4 \text{Cl}$ in MnCl_2 , 2

making a total of $6(2 + 4)$. So, 10 more Cl atoms are to be accounted for. So, place 5 in front of Cl_2 to make it 10 (5×2).

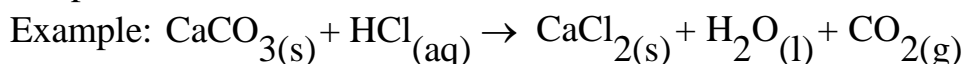


The Hit and Trial approach is a technique for balancing chemical equations.

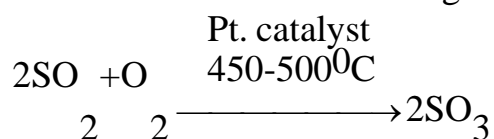
- From a chemical equation we can conclude:
 - A. Various reactants and products' names
 - B. Reactant and product formulae
 - C. The number of moles of the reactants and products in relation to each other
 - D. Masses of reactants and products relative to each other
 - E. Volumes of gaseous reactants and products in relation to each other

- **Limitation of a Chemical Equation**

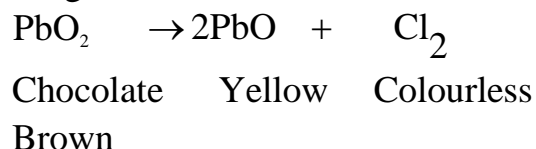
The condition of the chemicals is not mentioned. As a result, the symbols below should be added to make it more informative: (s) denotes a solid, (l) a liquid, (aq) if the reactant or product is dissolved in water, (g) a gas, and (vap) a vapour.



- It's possible that the reaction isn't finished. This is not revealed by an equation.
- It does not provide any information on the reaction time or the reaction speed.
- It does not provide the substance concentrations. Terms like diluted (dil) and concentrated (conc) may be used in specific instances.
- It does not specify the temperature, humidity, pressure, catalyst, or other environmental factors. This can be avoided by mentioning these items either above or below the arrow. e.g.

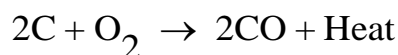


- The changes in colour have to be mentioned separately.



- The production or absorption of heat have to be mentioned separately.





- Some reactions are reversible. They are represented by \rightleftharpoons or \longleftrightarrow
- $$3\text{Fe} + 4\text{H}_2\text{O} \rightleftharpoons \text{Fe}_3\text{O}_4 + 4\text{H}_2$$

In short – the steps involved in balancing a Chemical Equation can be listed as:

Step 1: Write the skeleton equation correctly.

Step 2: Start with the compound that has the maximum atoms or maximum types of atoms and the atoms present in it are balanced first.

Step 3: Start by balancing elements that only appear once on each side of the arrow. Then, on each side, balance elements that appear more than once.

Step 4: The Elementary substances are balanced last.

Step 5: To make all the coefficients whole numbers, the entire equation is multiplied by a suitable number if necessary.

- Ionic Equation Balancing:** A balanced ionic equation must fulfil both mass and charge balance.

- Chemical Equations-Based Calculations:** A chemical reaction can provide a wealth of quantitative data. A chemical reaction can be used to calculate the number of moles of reactants and products.

- Types of Reactions**

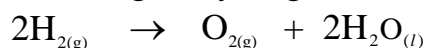
- A. Combination or Synthesis Reactions:**

The reactions in which two or more chemicals combine to generate a single new compound.

Types of Combination reactions:

I. Combination of two elements to form a compound

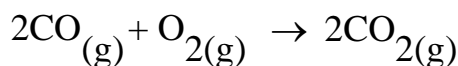
- Burning of hydrogen in air or oxygen to produce water.



Hydrdogen Oxygen Water

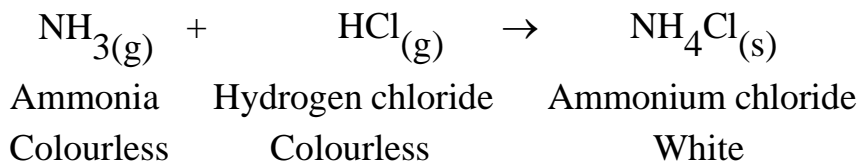
II. Combination Reactions involving an Element and a Compound

- Burning of carbon monoxide in oxygen to form carbon dioxide.



III. Combination Reactions involving Two Compounds

- Combination of ammonia and hydrogen chloride to produce ammonium chloride.



B. Decomposition reactions:

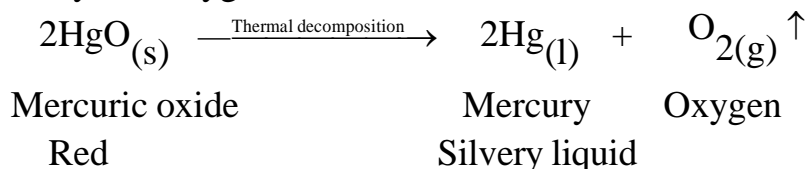
Decomposition reactions, on the other hand, are the polar opposite of combination reactions. A decomposition reaction occurs when a complex is broken down into two or more simple components using heat or electricity.

Thermal decomposition occurs when a substance decomposes owing to heat, whereas **electrolytic decomposition** occurs when a substance decomposes due to electricity.

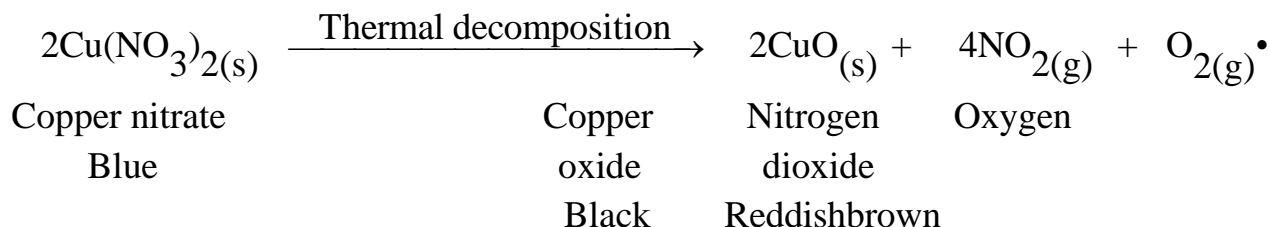
Electrolysis is the process of decomposing a substance by putting an electric current through it.

Photolysis: The decomposition of a compound with light is called photolysis.

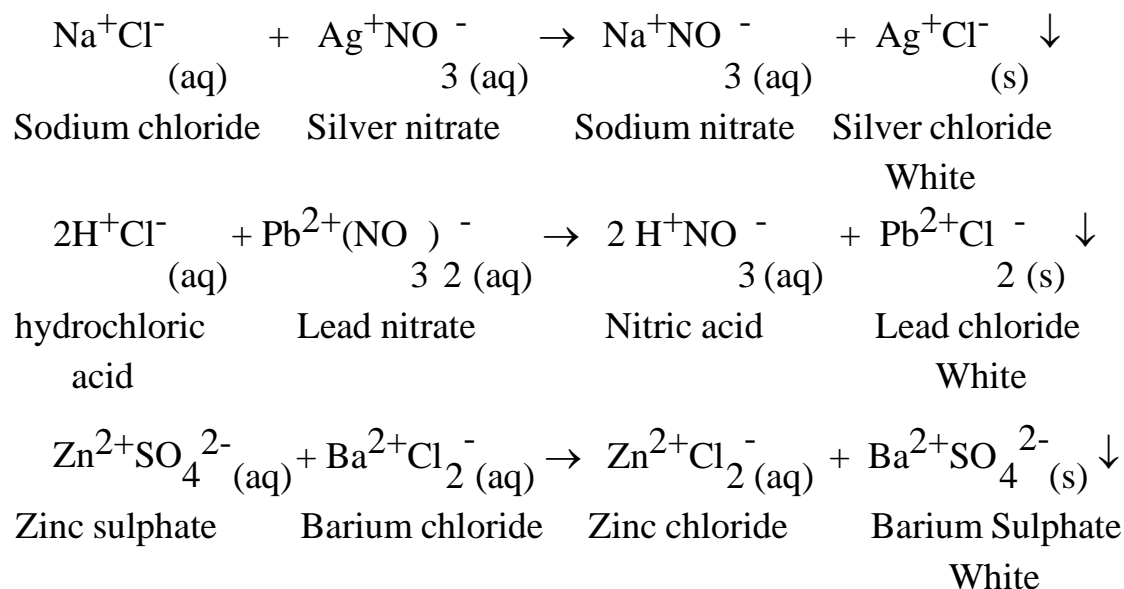
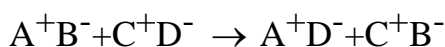
1. Mercuric oxide, when heated, undergoes thermal decomposition, to give mercury and oxygen.



2. Similarly, heating blue copper nitrate crystals causes thermal breakdown, resulting in black copper oxide, reddish brown nitrogen dioxide fumes, and a colourless oxygen gas.



- **Double Displacement Reactions / Metathesis reactions:** The mutual exchange of ions in which two chemicals react to generate two distinct molecules.



Types of Double displacement reactions:

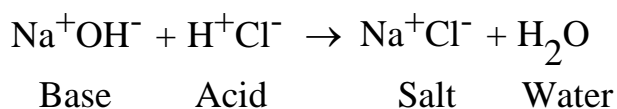
1. Precipitation Reaction
2. Neutralization Reactions

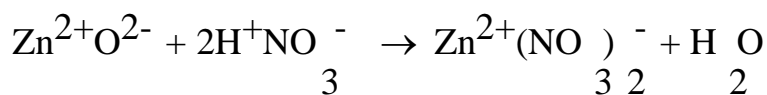
1. Precipitation

In all of the following processes, a white material is generated that is insoluble in water. A precipitate is the insoluble substance that forms. A precipitation reaction is a reaction that results in the formation of a precipitate.

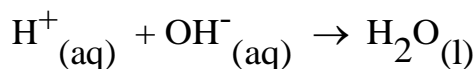
2. Neutralization

The reactants are a base and an acid, and the products are salt and water. Neutralization is a form of double displacement reaction in which the reactants are a base and an acid, and the products are salt and water. The positive charge of the acid's hydrogen ion and the negative charge of the base's hydroxyl ions or oxide ions lose their electrical charge and form covalent water molecules.





A neutralization reaction is basically a reaction between H^+ and OH^- ions i.e.,

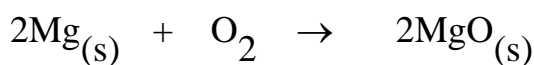


● Oxidation - Reduction Reactions/Redox Reactions

Classical Concept of Oxidation and Reduction

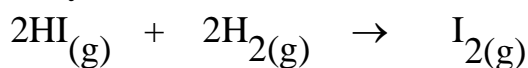
"Oxidation is a reaction in which oxygen is added or hydrogen is removed from a substance."

A. Addition of Oxygen - Magnesium oxide is formed when oxygen reacts with magnesium.



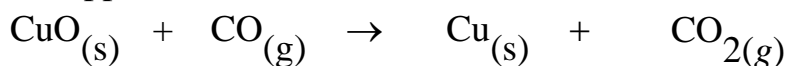
Magnesium Oxygen Magnesium oxide

B. Removal of Hydrogen - To liberate free iodine, hydrogen is removed from hydroiodic acid.



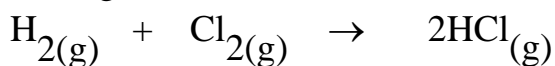
Hydroiodic Hydrogen Iodine
acid

C. Removal of Oxygen - Copper metal is formed by removing oxygen from copper oxide.



Copper oxide Carbon Copper Carbondioxide
Black monoxide Reddish
Brown

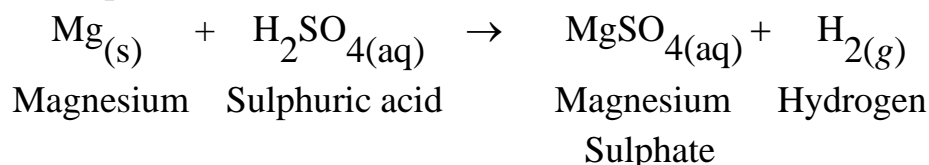
D. Addition of Hydrogen - When hydrogen reacts with chlorine, hydrogen chloride gas is formed.



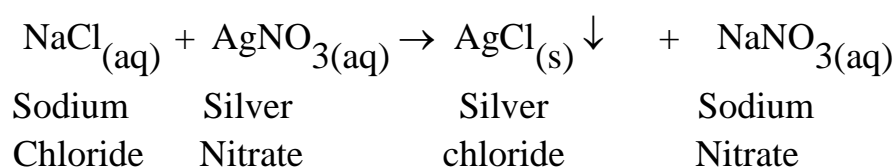
Hydrogen Chlorine Hydrogen chloride

- A **reduction** reaction is one in which oxygen is removed from a material and hydrogen is added.
- Redox reactions occur when **oxidation** and **reduction** reactions occur at the same time.

Example of **Redox Reaction**:



Example of Non-redox Reaction



Redox reactions are those in which oxidation and reduction occur at the same time.

- **Oxidizing and Reducing Agents**

- Oxidizing Agent:** A substance that brings about oxidation.
- Reducing Agents:** A substance that brings about reduction.

- **Another definition of Oxidation and Reduction**

- Addition of an electronegative element or radical, or removal of an electropositive element or radical, is referred to as **oxidation**.
- Addition of an electropositive element or radical, or removal of an electronegative element or radical, is known as **reduction**.

- **Electronic Concept of Oxidation and Reduction**

- Oxidation:** The process in which there is loss of electrons.
- Reduction:** The process in which there is gain of electrons.

- **The Effects of Oxidation Reactions in Everyday Life**
Corrosion

Many metals are chemically active elements that are easily affected by moisture, oxygen, acids, and other things. When iron products are new, they are shiny, but after some time, they become coated with a reddish-brown powder. The rusting of iron is the common name for this phenomenon.

The difficulty with iron (and many other metals) is that it oxidises, and the resulting oxide does not attach firmly to the metal's surface, leading it to flake off readily. This eventually leads to structural weakening and metal breakdown.

As a result, when metal is attacked by substances in its environment, it is said to corrode, and the process is known as corrosion.

When copper vessels or artefacts are exposed to air and water, what happens? They gradually tarnish as a thin layer of green oxide forms on them. Silver, too, quickly develops a thin black oxide covering when exposed to damp air. In wet weather, even the heaviest metal lead tarnishes. The black coating on silver and the green coating on copper are instances of corrosion in which the oxides generated create a strong connection to the metal's surface, blocking further oxygen exposure and thereby reducing corrosion.

- **Rancidity**

Have you ever tasted or smelled fat/oil-containing food materials that have been left out for an extended period of time? Rancidity refers to an undesirable change in a food's flavour and odour. The oxidation process causes fats and fatty foods to deteriorate, which is the most common cause of rancidity. When an oxygen atom replaces a hydrogen atom in a fatty acid molecule, the molecule becomes destabilised. Factors which accelerate fat oxidation include, salt, light, water, bacteria, moulds, trace metals (iron, zinc, etc.).

Antioxidants are chemicals that prevent fat from oxidising or becoming rancid (such as BHT, BHA, vitamin E, and vitamin C, and spices such as sage and rosemary). To avoid spoilage, they are added to foods containing fats and oils. Keeping food in air tight containers or airtight wrapping also helps to slow down oxidation.

Some high fat meals such as potato chips are wrapped in materials that shield them from light and oxygen and the containers are flooded with nitrogen to further exclude oxygen. Vacuum packaging is sometimes employed in processed goods to completely eliminate the presence of oxygen.