

# 10<sup>TH</sup> CBSE SCIENCE

## CHEMICAL REACTIONS AND EQUATIONS

- Most of the substance around us undergoes various changes. Some of these changes are temporary with no new substance being formed. They are called physical changes.

**Example:** Water changes to steam on boiling but no new substance is formed (Even though steam and water look different when they are made to react with a piece of Na, they react the same way and give the exact same products). This involves only a change in state (liquid to vapour).

- A substance is said to undergo a chemical change when the chemical properties of a substance alter. As a result, there is either formation or breaking of atomic bonds at the molecular level. Some characteristics of a chemical change are:
  - New substances are produced during a chemical reaction.
  - Changes in energy are involved.
  - During the reaction, there occurs a change in mass.
  - There is a permanent alteration.

**Examples:**

- Cooking of food
- Rusting of iron
- Heating of Lead nitrate
- Souring of milk
- Ripening of fruit.

## Chemical Equation

### Writing Chemical Equations

- In a chemical reaction, the reactants are written on the left hand side and the products on the right hand side of the equation.
- An arrow ( $\rightarrow$ ) pointing towards the products is inserted between the reactants and the products. It also represents the direction of the reaction.
- A single arrow ( $\rightarrow$ ) indicates the direction in which the reaction proceeds.
- A double arrow ( $\rightleftharpoons$ ) indicates a reversible reaction, i.e. the products recombine to form the reactants.

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- A plus sign (+) is inserted between two or more reactants or products formed.
- If reactions are carried out under specific conditions of temperature, pressure, catalyst etc., then these conditions are mentioned on the arrow.
- The chemical equation can be made more informative by mentioning the physical states of the reactants and products.
- If gas is liberated as a product, then it is represented by an arrow pointing upwards ( $\uparrow$ ). If the product formed is in the form of a precipitate, it is represented by an arrow pointing downwards ( $\downarrow$ ).

## Balancing the Chemical Equations

- In a balanced chemical equation, the total number of atoms of each element of the reactants on the left hand side of the equation is equal to the number of atoms of the products formed on the right hand side of the equation.
- The total mass of the reactants is equal to the total mass of the products or the number of atoms of each element before the reaction and after the reaction is equal.

### Steps Involved in Balancing a Chemical Equation

Consider the chemical reaction between magnesium and oxygen to understand the steps involved in balancing a chemical equation.

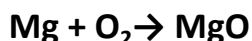
#### Step 1

Let us first write the word equation for this reaction.

**Magnesium + Oxygen  $\rightarrow$  Magnesium oxide**

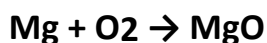
#### Step 2

Write the chemical equation for the reaction between magnesium and oxygen.



#### Step 3

Count the number atoms of an element occurring on both L.H.S. and R.H.S. in this equation.



Component	Reactant	Product
Magnesium	1	1
Oxygen	2	1

This is an unbalanced equation.

#### Step 4

- To balance a chemical equation, first draw boxes around each formula. Do not change anything inside the boxes while balancing the equation.



- Choose a reactant or a product which has the maximum number of atoms in it. In that compound, select the element which has the maximum number of atoms. In this equation we shall select MgO i.e. magnesium oxide and the element oxygen in it.
- To balance the oxygen atoms, let us multiply magnesium oxide molecule by 2 on the right hand side. The equation can now be expressed as,

$$\boxed{\text{Mg}} + \boxed{\text{O}_2} \longrightarrow 2 \boxed{\text{MgO}}$$

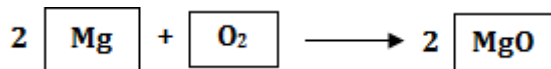
Component	Reactant	Product
Magnesium	1	$1 \times 2 = 2$
Oxygen	2	$1 \times 2 = 2$

#### Step 5

There are two oxygen atoms on either side of the equation but one magnesium atom on the reactant's side and two on the product's side. Therefore, multiply the magnesium atom by 2 on the left hand side.

Component	Reactant	Product
Magnesium	$1 \times 2 = 2$	2
Oxygen	2	2

Balanced equation is,

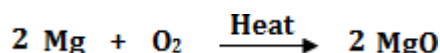


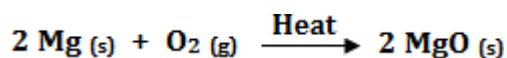
∴ The number of atoms of each element of reactants = The number of atoms of each element of products

#### Step 6

##### Writing Specific Conditions on the Arrow

The reaction is carried out in the presence of 'Heat'. On heating, magnesium combines with oxygen present in air to form magnesium oxide.



**Step 7****Writing Symbols of Physical States**

Using these steps, you can balance any chemical equation.

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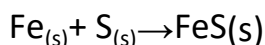
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**Types of Chemical Reactions****1. Combination Reaction**

When two or more substances combine to form a single product, the reaction is known as a combination reaction.

For example:

In the laboratory, iron sulphide is prepared by mixing iron and sulphur.



Formation of slaked lime by the reaction of calcium oxide with water

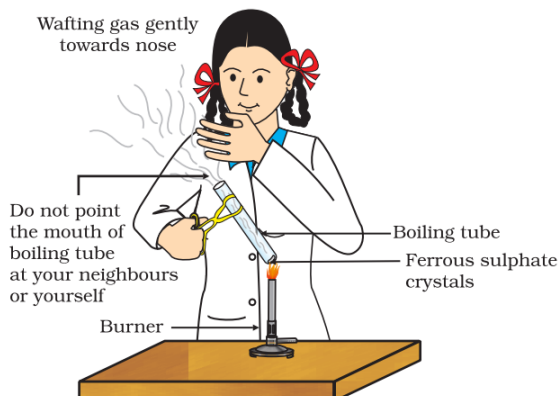
- **Endothermic Reaction:** The reactions accompanied by the absorption of heat are called endothermic reactions.
- **Exothermic Reaction:** The reactions accompanied by the evolution of heat are called endothermic reactions.

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## 2. Decomposition Reaction

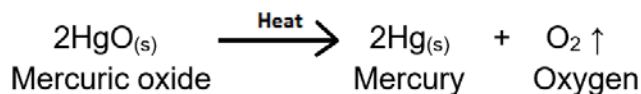
A chemical reaction in which a single compound splits into two or more simple substances is called a decomposition reaction.



Correct way of heating the boiling tube containing crystals of ferrous sulphate and of smelling the odour

For example:

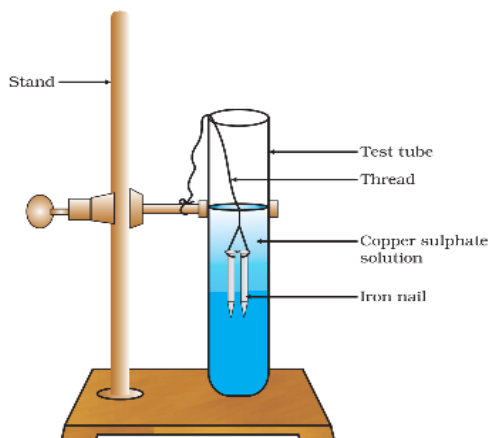
When mercuric oxide is heated in a crucible, the orange-red powder begins to darken and a silver mirror begins to deposit on the cooler parts of the crucible.



- **Thermal Decomposition Reaction:** The decomposition reactions carried out by heating are known as thermal decomposition reactions.
- **Photochemical reaction:** The chemical reactions which proceed with the absorption of light energy are called photochemical reactions.

## 3. Displacement Reaction

Reactions in which the more reactive element displaces the less reactive element from its compound are called displacement reactions.



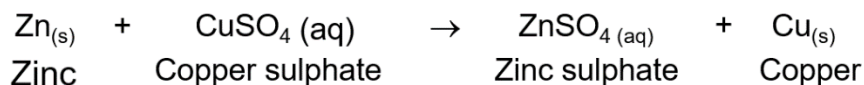
Iron nails dipped in copper sulphate solution

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For example:

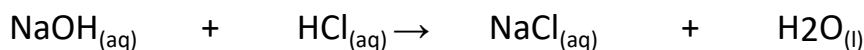
Zinc displaces copper in copper sulphate to form zinc sulphate.



#### 4. Double Displacement Reaction

Reactions in which ions of the reactants exchange places to form two new compounds, are called double displacement reactions.

For example: Sodium hydroxide reacts with hydrochloric acid to form sodium chloride and water.



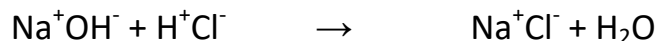
#### Types of Double Displacement Reactions:

##### A. Precipitation

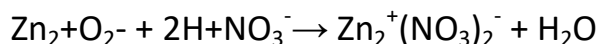
In all of the following processes, a white material is generated that is insoluble in water. A precipitate is the insoluble substance that forms. A precipitation reaction is a reaction that results in the formation of a precipitate.

##### B. Neutralization

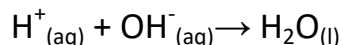
The reactants are a base and an acid, and the products are salt and water. Neutralization is a form of double displacement reaction in which the reactants are a base and an acid, and the products are salt and water. The positive charge of the acid's hydrogen ion and the negative charge of the base's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



Base Acid                      Salt Water



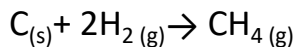
A neutralization reaction is basically a reaction between  $\text{H}^+$  and  $\text{OH}^-$  ions i.e.,



#### 5. Oxidation - Reduction Reactions/Redox Reactions

Oxidation and reduction take place simultaneously.

Reactions which involve the addition of oxygen, or the removal of hydrogen are called **oxidation reactions**. For example:

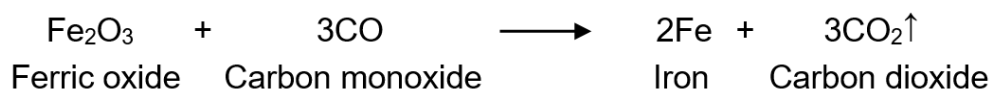


Chemical reactions in which the reactants gain hydrogen are **reduction reactions**. For

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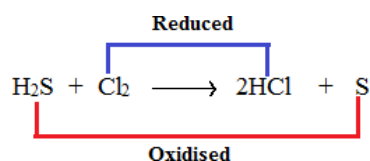
example:



- **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.

## Redox Reaction

The chemical reaction in which oxidation and reduction takes place simultaneously is known as



a redox reaction.

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## Corrosion

The slow process of decay and destruction of metals due to the action of air, moisture or acids is called corrosion.

### For example:

Iron combines with oxygen present in the air, in the presence of water, to form a red-brown flaky substance called **rust**. This process is commonly called the **rusting of iron**.

The chemical formula of rust is  $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ .

### Prevention of Corrosion

- Corrosion damages buildings, bridges, ships, automobiles and other articles made of iron. Hence, prevention of corrosion is necessary. This will not only save money but can also prevent the occurrence of accidents.
- It can be prevented by processes like galvanising and electroplating with other metals.

## Rancidity

- Oils and fats react with oxygen and get oxidised or turn rancid. This process is called rancidity.
- Rancidity can be prevented by keeping food in air tight containers or by using antioxidants.
- Antioxidants are used to prevent oxidation of food containing fats and oils.
- Storage of food in air tight containers also decelerates oxidation.



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