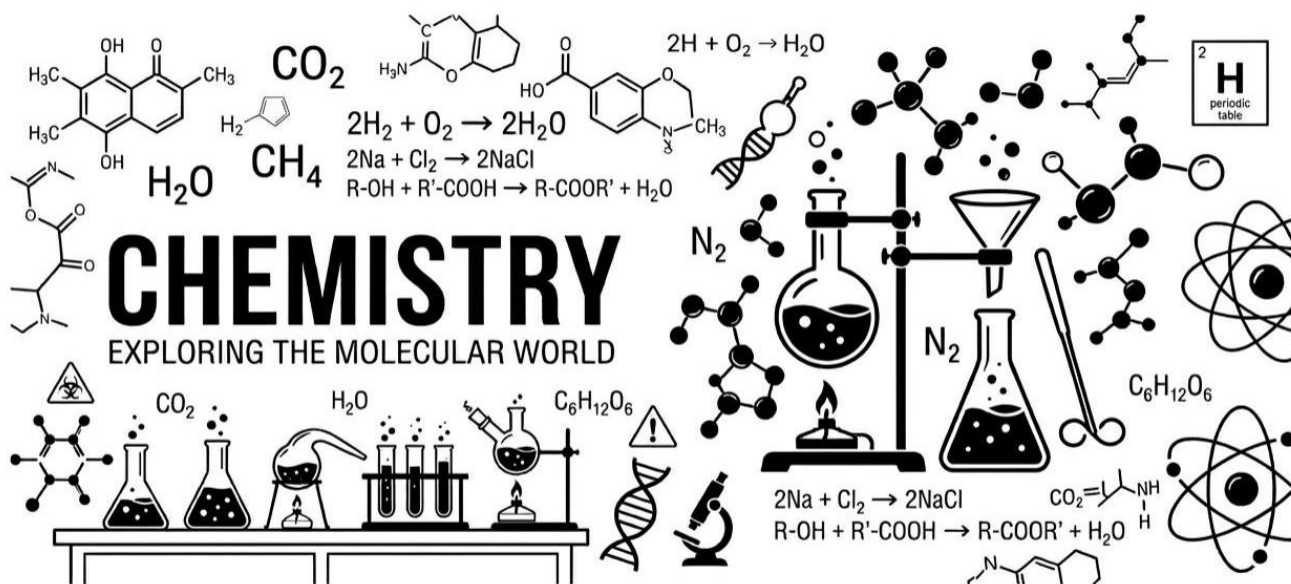


By Navigator Academy (Science)

Chapter 1: Chemical Reactions and Equations



BASIC FUNDAMENTALS

Chemistry is the study of how matter changes. These changes are classified into two categories:

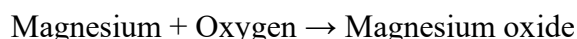
1. **Physical Change:** No new chemical substance is formed; usually reversible. Example: Melting of ice, boiling of water.
2. **Chemical Change:** One or more new substances with different properties are formed. Example: Rusting of iron, burning of paper, digestion of food.

Difference Between Physical Change and Chemical Change

Physical Change	Chemical Change
No new substance is formed.	New substance is formed.
The chemical properties do not change.	The chemical properties change.
The chemical composition does not change.	There is change in the chemical composition.
The old material can be recovered from the newly formed material.	Old matter cannot be retrieved again.

What is a Chemical Reaction?

A **chemical reaction** is a process in which one or more substances (**reactants**) change into new substances (**products**) with different properties. Example:

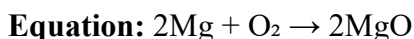


Indicators of a Chemical Reaction:

You can tell a reaction has occurred if you observe:

- **Change in State:** (e.g., formation of water from gases).
- **Change in Colour:** (e.g., iron nail turning brownish in copper sulphate).
- **Evolution of Gas:** (e.g., bubbles of Hydrogen).
- **Change in Temperature:** (e.g., a beaker becoming hot).

Burning of Magnesium Ribbon



When a magnesium ribbon is heated in air:

- It burns with a **very bright white flame**
- After burning, it forms a **white powder (ash)**

This white ash is **magnesium oxide (MgO)**.

Why Does This Reaction Happen?

Magnesium reacts with oxygen present in the air.

- Magnesium (Mg) = metal
- Oxygen (O₂) = gas
- Product formed = Magnesium oxide (MgO)

It is a **combination reaction** (two substances combine to form one product).

Why is Magnesium Ribbon Cleaned Before Burning?

Before burning, the magnesium ribbon is rubbed with sandpaper.

Reason:

- Magnesium reacts slowly with oxygen in air even at room temperature
- This forms a thin layer of magnesium oxide (MgO) on its surface
- This layer blocks the actual magnesium from reacting properly

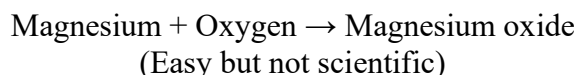
So, we clean it to:

- Remove the oxide layer
- Expose fresh magnesium metal
- Ensure the reaction happens properly and quickly

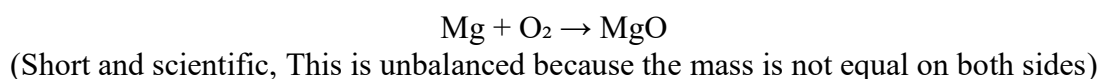
CHEMICAL EQUATIONS

A chemical equation is the symbolic representation of a chemical reaction. There are three types of chemical equation

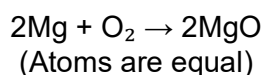
Word Equation:



Skeletal equation:



Balanced Equation:



BALANCED CHEMICAL EQUATION

Why do we balance equations?

According to the **Law of Conservation of Mass**, mass can neither be created nor destroyed in a chemical reaction. Therefore, the number of atoms of each element must remain the same on both sides.

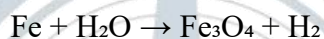
How to balance a chemical equation?

Balancing a chemical equation means making sure the **number of atoms of each element is equal on both sides**.

Here we will discuss the simplest way to do this—just adjust numbers step by step until everything matches.

Step 1: Write the Skeletal Equation

Start with the unbalanced equation:



Step 2: Count Atoms on Both Sides

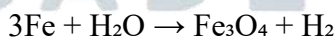
Element	Left Side	Right Side
Fe	1	3
H	2	2
O	1	4

Here we see atoms are not equal yet.

Step 3: Balance One Element at a Time

(a) Balance Iron (Fe):

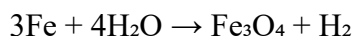
Right side has 3 Fe → put 3 before Fe



(b) Balance Oxygen (O):

Right side has 4 O → we need 4 O on left

Each H₂O has 1 O → put 4 before H₂O

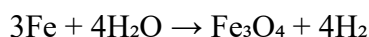


(c) Balance Hydrogen (H):

Left side: 4H₂O = 8 H

Right side: H₂ = 2 H

To make 8 H on right, put 4 before H₂

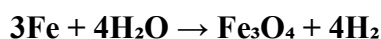


Step 4: Check Final Equation

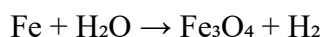
Element	Left Side	Right Side
Fe	3	3
O	4	4
H	8	8

Now All atoms are equal. So, the equation is balanced

Final Balanced Equation



Now try yourself:



Golden Rules

- Change **coefficients**, not formulas
- Balance **Oxygen last**
- Check again

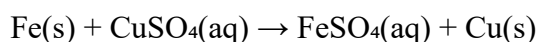
State Symbols

Equations often include notation to indicate the physical state of chemicals:

The diagram illustrates five physical states of matter using test tubes:

- Solid (s):** A test tube containing white granules. $\text{NaCl (s)} \rightarrow \text{Solid}$ is shown with a dashed arrow pointing to a green box labeled "Solid (s)".
- Liquid (l):** A test tube containing blue liquid. $\text{H}_2\text{O (l)} \rightarrow \text{Liquid}$ is shown with a dashed arrow pointing to a blue box labeled "Liquid (l)".
- Gas (g):** A test tube containing a gas with bubbles and an upward arrow. $\text{CO}_2 \text{ (g)}$ or $\text{CO}_2 \uparrow$ is shown with a dashed arrow pointing to a yellow box labeled "Gas (g)" with "(or an upward arrow)" below it.
- Aqueous (aq):** A test tube containing blue liquid. $\text{NaCl (aq)} \rightarrow \text{Aqueous (soluble in water)}$ is shown with a dashed arrow pointing to a blue box labeled "Aqueous (aq)".
- Precipitate (ppt):** A test tube containing a yellow solid at the bottom. $\text{PbI}_2 \text{ (ppt)}$ is shown with a dashed arrow pointing to a yellow box labeled "(ppt) ↓".

Example:



They make the chemical equation more clear and informative by showing the physical state of reactants and products.

TYPES OF CHEMICAL REACTIONS

1. Combination Reaction

A reaction in which two or more substances combine to form a single product.

General Form: $A + B \rightarrow AB$

Example: $CaO + H_2O \rightarrow Ca(OH)_2 + \text{Heat}$

Observation: The container becomes hot because heat is released (Exothermic).

2. Decomposition Reaction

A reaction where one substance breaks into two or more simpler substances.

General Form: $AB \rightarrow A + B$

Types:

- Thermal (heat)
- Electrolytic (electricity)
- Photolytic (light)

Example: $CaCO_3 \rightarrow CaO + CO_2$
 $2AgCl \rightarrow 2Ag + Cl_2$ (sunlight)

3. Displacement Reaction

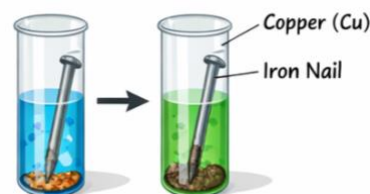
A reaction where a more reactive element replaces a less reactive element from its compound.

General Form: $A + BC \rightarrow AC + B$

Example: $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$
 $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

Observation:

- Blue \rightarrow Green solution
- Brown copper deposit



4. Double Displacement Reaction

A reaction where **exchange of ions** occurs between two compounds.

General Form: $AB + CD \rightarrow AD + CB$

Example: $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$

Special Type: Precipitation Reaction

- Formation of insoluble solid (ppt) Yellow precipitate forms

5. Oxidation & Reduction (Redox Reaction)

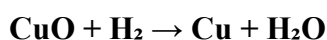
▲ Oxidation

- Gain of oxygen
- Loss of hydrogen
- Loss of electrons

▼ Reduction

- Loss of oxygen
- Gain of hydrogen
- Gain of electrons

Example:



- CuO → Reduced
- H₂ → Oxidised

Important Rule: Oxidation + Reduction always together

6. Exothermic & Endothermic Reactions

Exothermic Reaction: Reaction in which heat is released

Example:



- Respiration
- Combustion

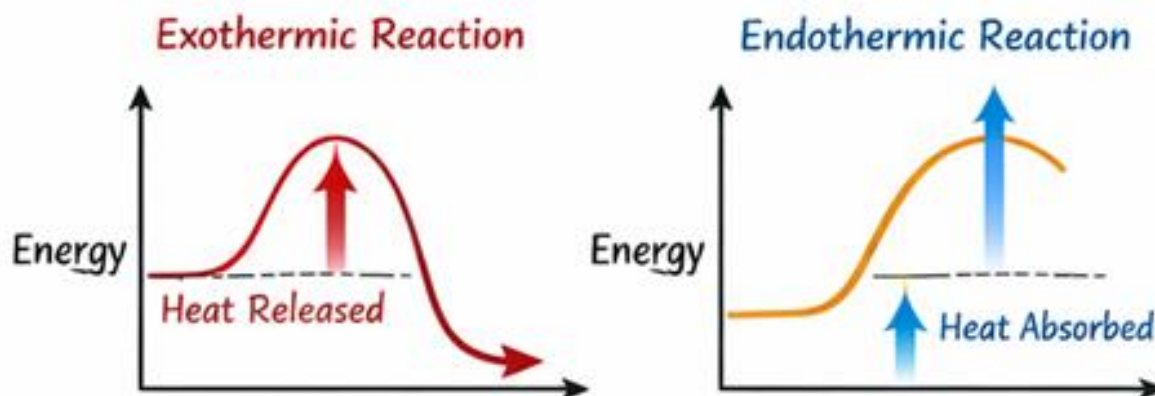
Endothermic Reaction: Reaction in which heat is absorbed

Example:



- Photosynthesis

Exothermic vs Endothermic Reaction



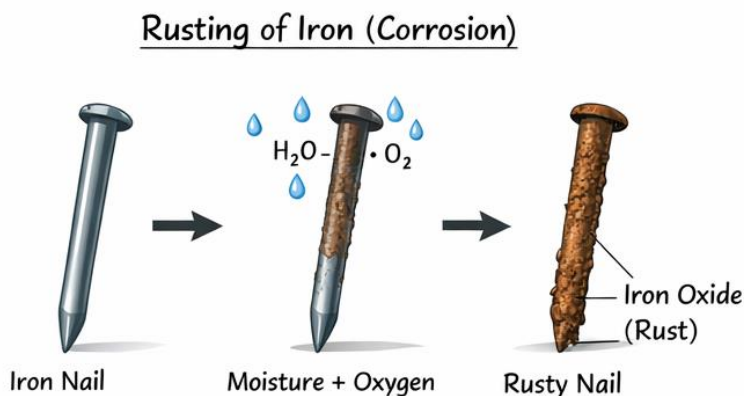
Effects of Oxidation in Daily Life:-

(1) Corrosion: Slow destruction of metals due to reaction with environment

Example:

- Rusting of iron

Reaction:



Prevention:

- Painting
- Oiling
- Galvanization

(2) Rancidity: Oxidation of fats/oils → bad smell & taste

Example:

- Chips smell bad after long time

Prevention:

- Airtight containers
- Nitrogen gas packing



Rancid

Chips smell bad after long time

IMPORTANT REACTIONS

- $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$
- $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$
- $\text{Fe} + \text{CuSO}_4 \rightarrow \text{FeSO}_4 + \text{Cu}$
- $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
- $\text{Pb}(\text{NO}_3)_2 + 2\text{KI} \rightarrow \text{PbI}_2 + 2\text{KNO}_3$
- $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$

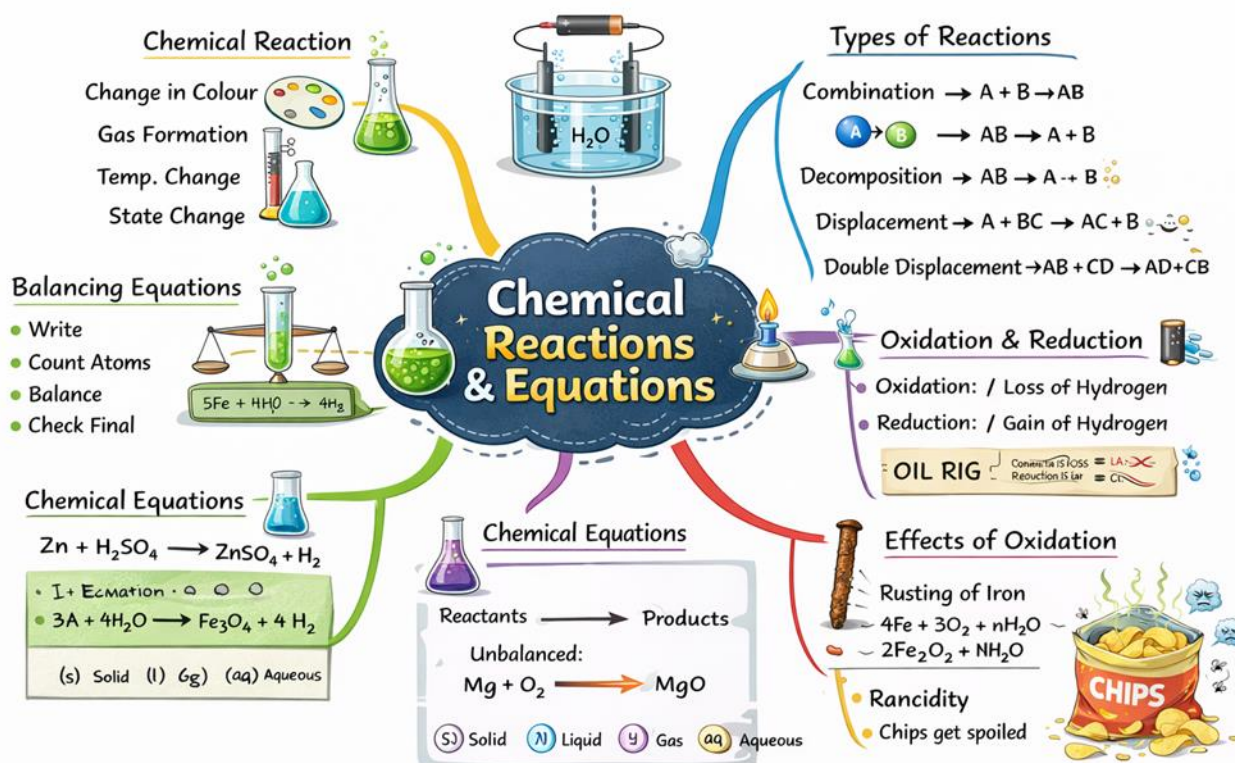
FINAL EXAM STRATEGY

Remember each reaction like this:

Equation + Type + Observation

Best Way to Learn Fast: **Concept → Example → Practice → Revision**

Mindmap of Chemical Reactions and Equations



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Prefer for all offline study students.**