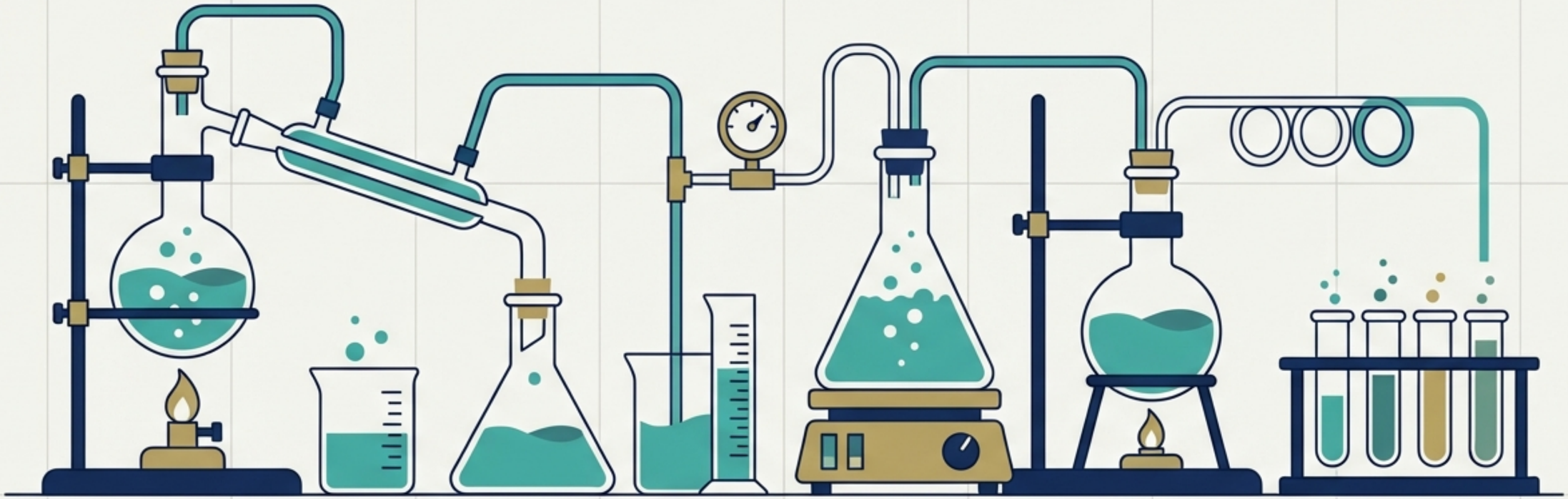
Chemical Reactions and Equations

Decoding the Language of Matter



The universe is rarely still. From the rusting of iron to the digestion of food, matter is constantly rearranging itself. This presentation decodes the shorthand scientists use to describe these changes and categorizes the rules that govern them.

The Nature of Change: Physical vs. Chemical

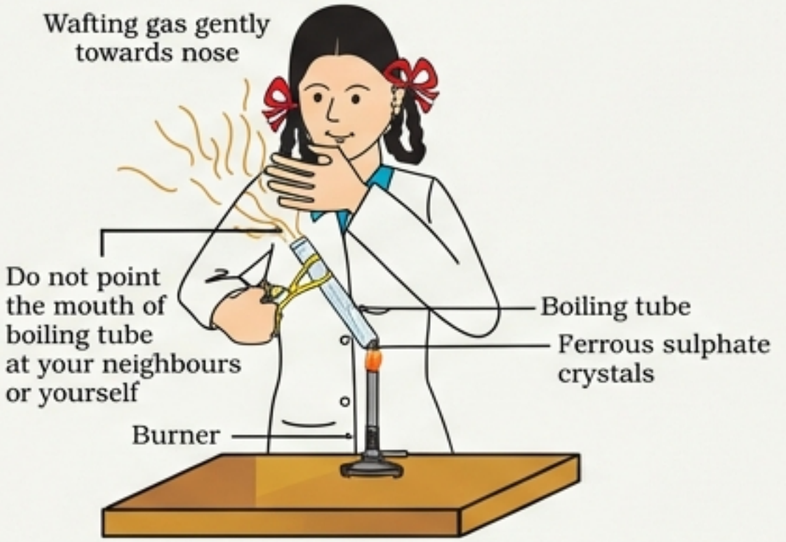
Physical Change

Definition: A temporary change where no new substance is formed. The chemical identity remains the same.

Example: Water boiling to steam; Melting ice.

Key Note: Involves only a change in state.

Chemical Change

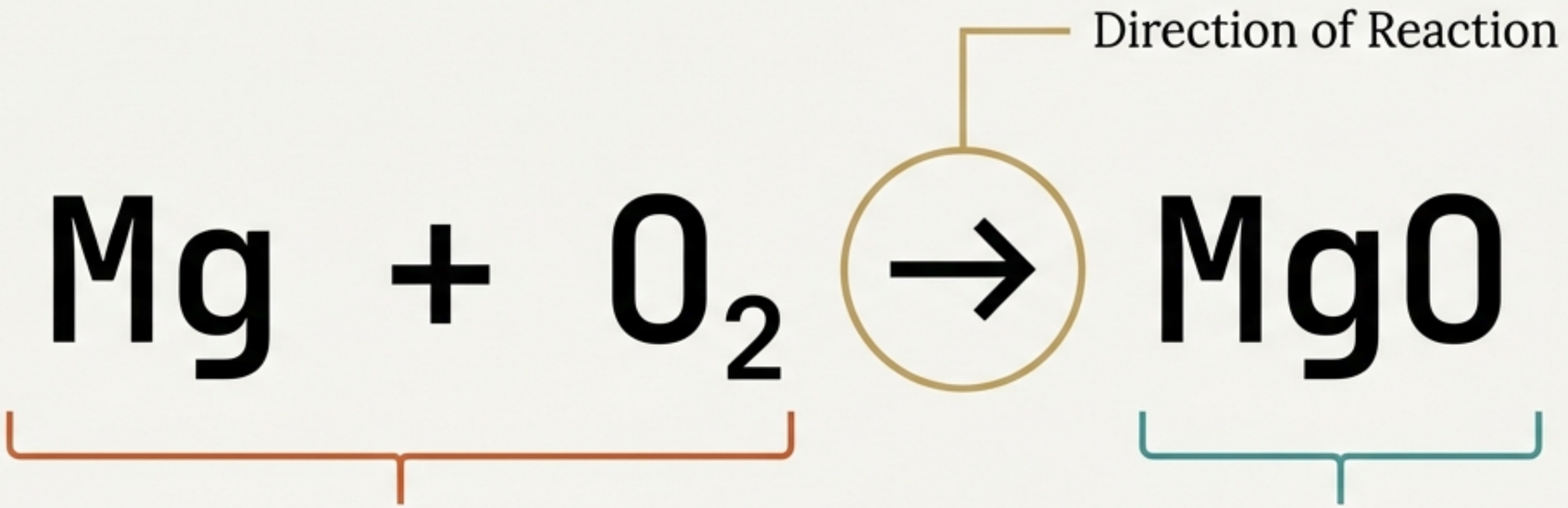


Definition: A permanent alteration where new substances with different properties are produced. Bonds are broken and formed.

Key Indicators: Change in state, color, temperature, or evolution of gas.

Examples: Souring of milk, Rusting of iron, Heating Lead nitrate.

Notation: Writing the Chemical Story



REACTANTS (LHS):
Substances undergoing change

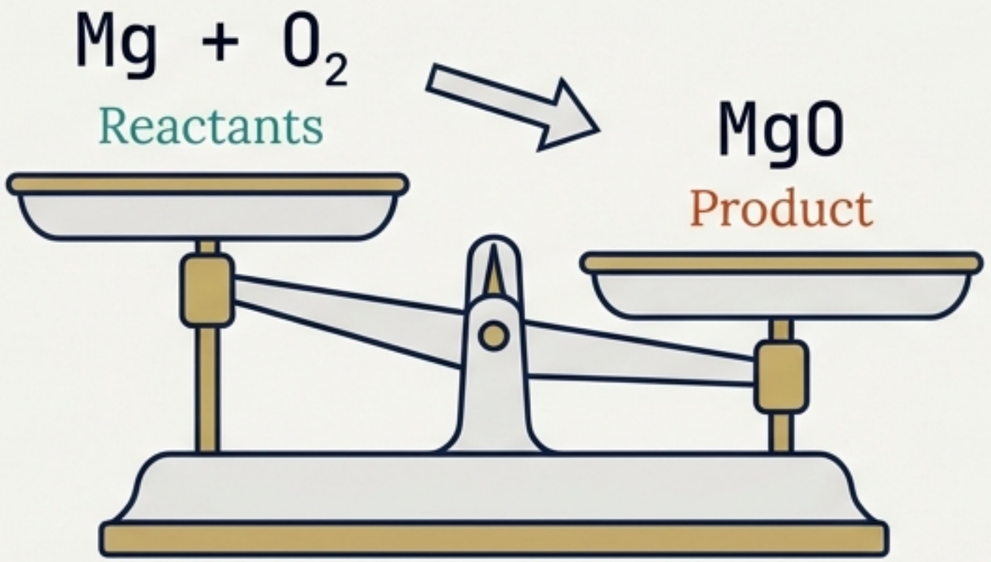
PRODUCTS (RHS):
New substances formed

State Symbols

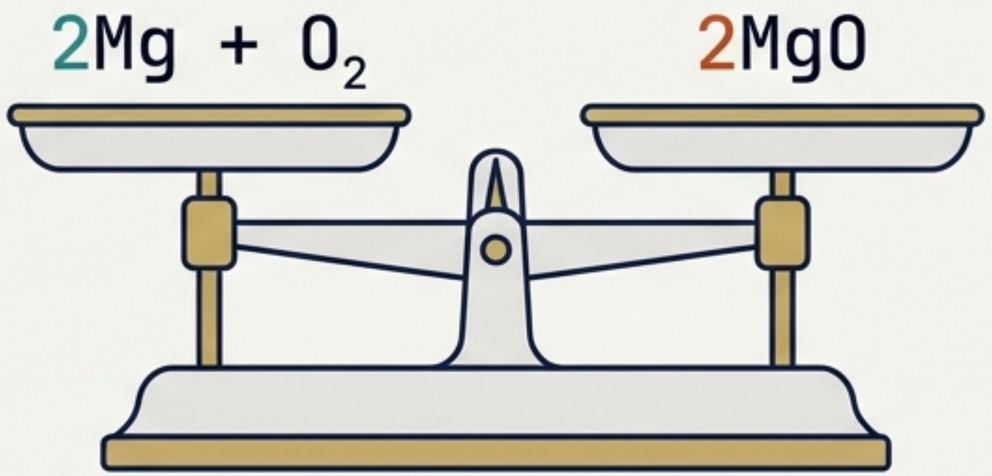
- (s) Solid
- (l) Liquid
- (g) Gas
- (aq) Aqueous Solution
- ↑ Gas Liberated
- ↓ Precipitate Formed

The Law of Conservation of Mass

Matter can neither be created nor destroyed.



Unbalanced (Skeletal Equation) - Mass is missing.



Balanced Equation - Mass is Conserved.

The total mass of the reactants must equal the total mass of the products.
We balance equations to satisfy this law.

Mechanism: Balancing by Hit and Trial

1. Encapsulate

$$\boxed{Fe} + \boxed{H_2O} \rightarrow \boxed{Fe_3O_4} + \boxed{H_2}$$

Do not change anything inside the boxes.

2. Inventory

Element	LHS (Reactants)	RHS (Products)
Fe	1	3
H	2	2
O	1	4

2. Inventory

Element	LHS (Reactants)	RHS (Products)
Fe	1	3
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O	1	4

3. Equalize (The Hit & Trial)

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

Start with the compound holding the most atoms (Fe_3O_4). Adjust coefficients until the inventory matches.

Classification: The 5 Types of Chemical Reactions

Chemical Reactions

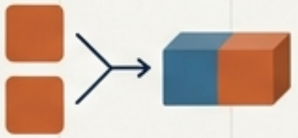
Redox

Oxygen/Hydrogen exchange & Electron transfer (Lora)

Combination

Joining together

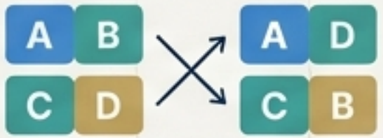
(A + B → AB)



Double Displacement

Swapping partners

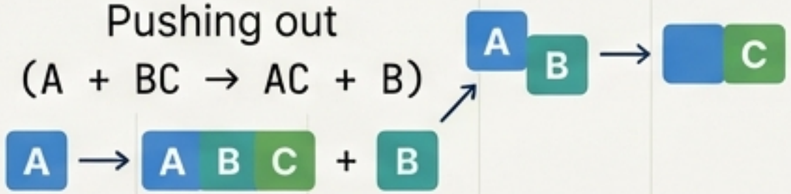
(AB + CD → AD + CB)



Displacement

Pushing out

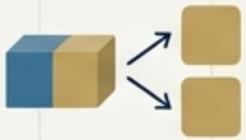
(A + BC → AC + B)



Decomposition

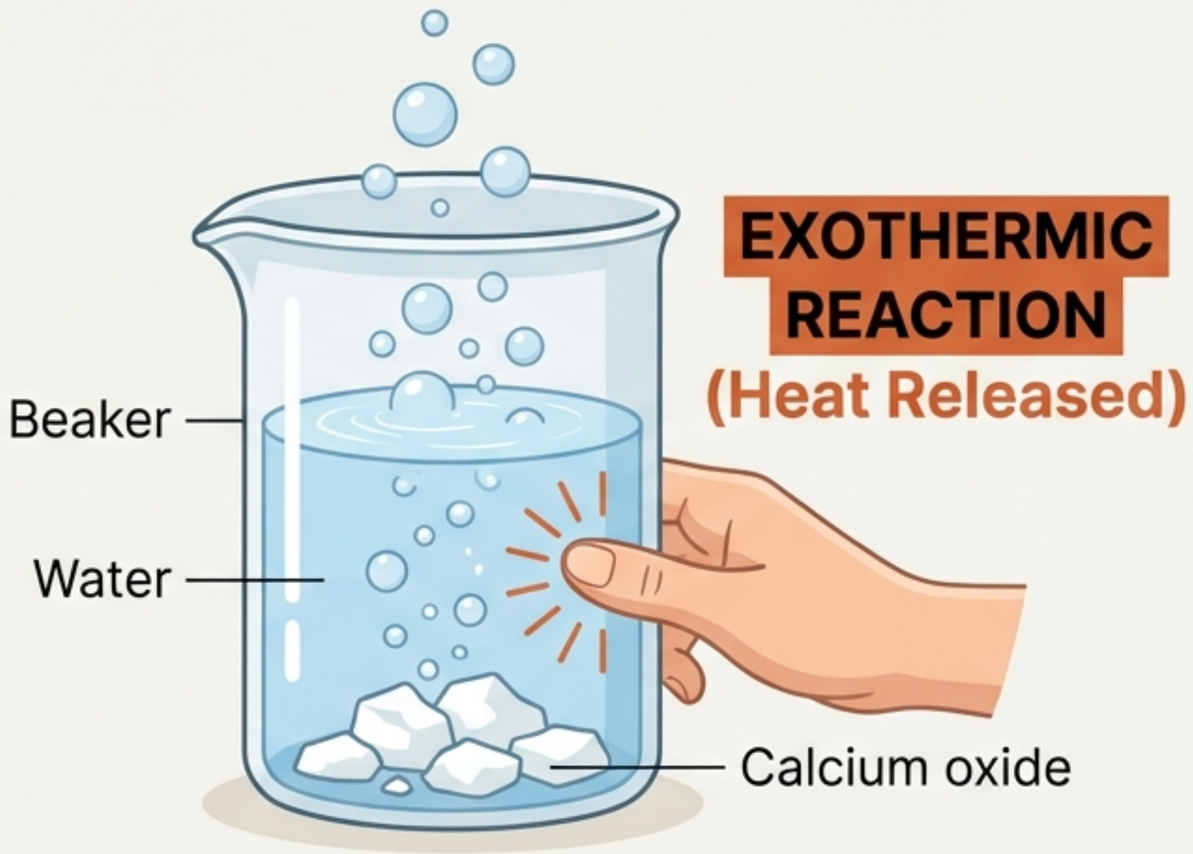
Breaking apart

(AB → A + B)



Type 1: Combination Reaction

- **Logic:** Two or more substances combine to form a single product.
- **General Form:** $A + B \rightarrow AB$
- **Example:** Quick lime (Calcium Oxide) reacting vigorously with water to form Slaked lime (Calcium Hydroxide).
- **Equation:**
  $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + Heat$
- **Real World:** Used for whitewashing walls.



Type 2: Decomposition Reaction

Breaking down requires energy (Endothermic)

Thermal Decomposition (Heat)

Ferrous Sulphate crystals lose water and decompose.

$$2FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2 + SO_3$$

Photolytic Decomposition (Sunlight)

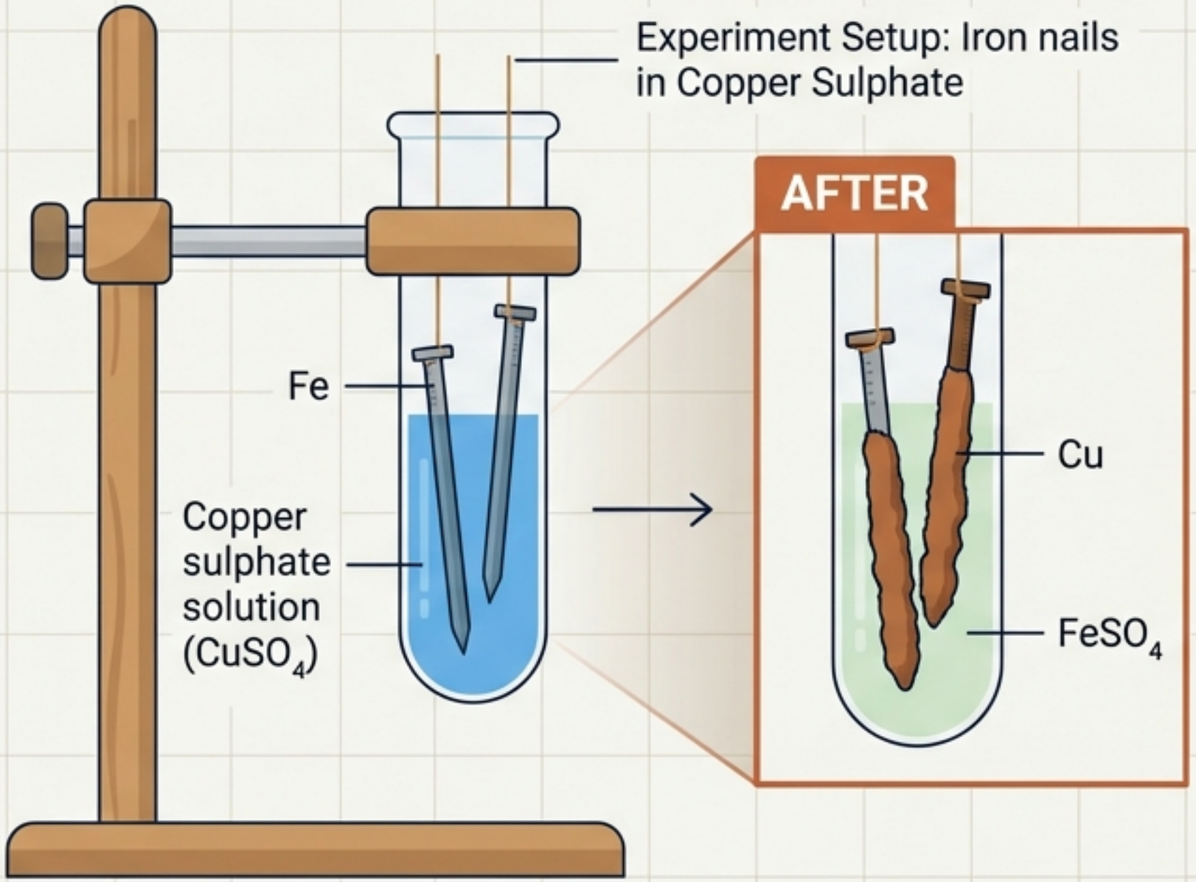
Silver Chloride turns grey in sunlight to form Silver metal.

$$2AgCl(s) \xrightarrow{Sunlight} 2Ag(s) + Cl_2(g)$$

Used in Black & White photography.

Type 3: Displacement Reaction

The high reactivity element displaces the lower reactivity element.



- **Experiment:** Iron nails dipped in Copper Sulphate.
- **Equation:**

  $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$
- **Observation:** Blue solution turns light green; Iron nail gets a brown coating.
- **Rule:** Iron is more reactive than Copper.

Type 4: Double Displacement Reaction

Exchange of ions between reactants.

- **Example:** Sodium Sulphate + Barium Chloride.

$$Na_2SO_{4(aq)} + BaCl_{2(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$$

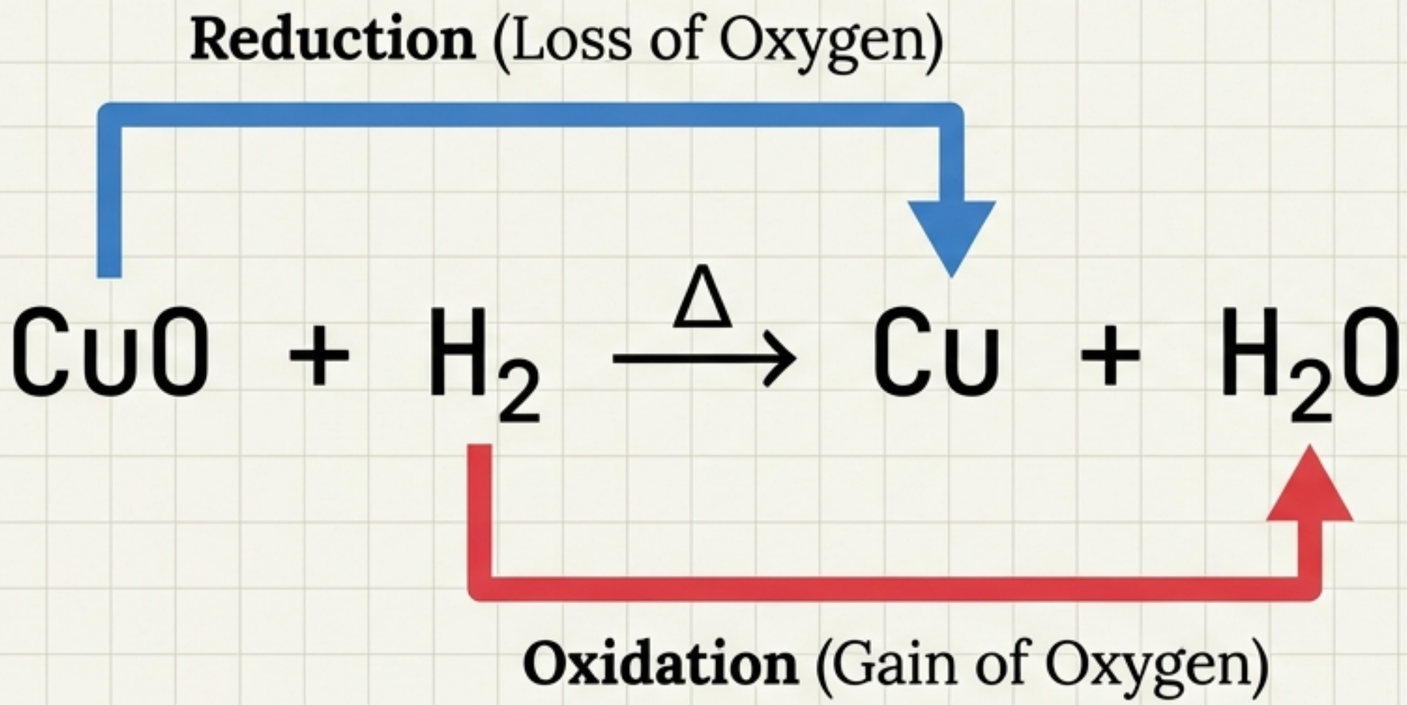
Sodium sulphate	Barium chloride	Barium sulphate	Sodium chloride

- **Observation:** A white precipitate of Barium Sulphate ($BaSO_4$) is formed immediately.

- **Neutralization:** A specific type of double displacement where Acid + Base → Salt + Water.

Type 5: Oxidation and Reduction (Redox)

These reactions always occur simultaneously.

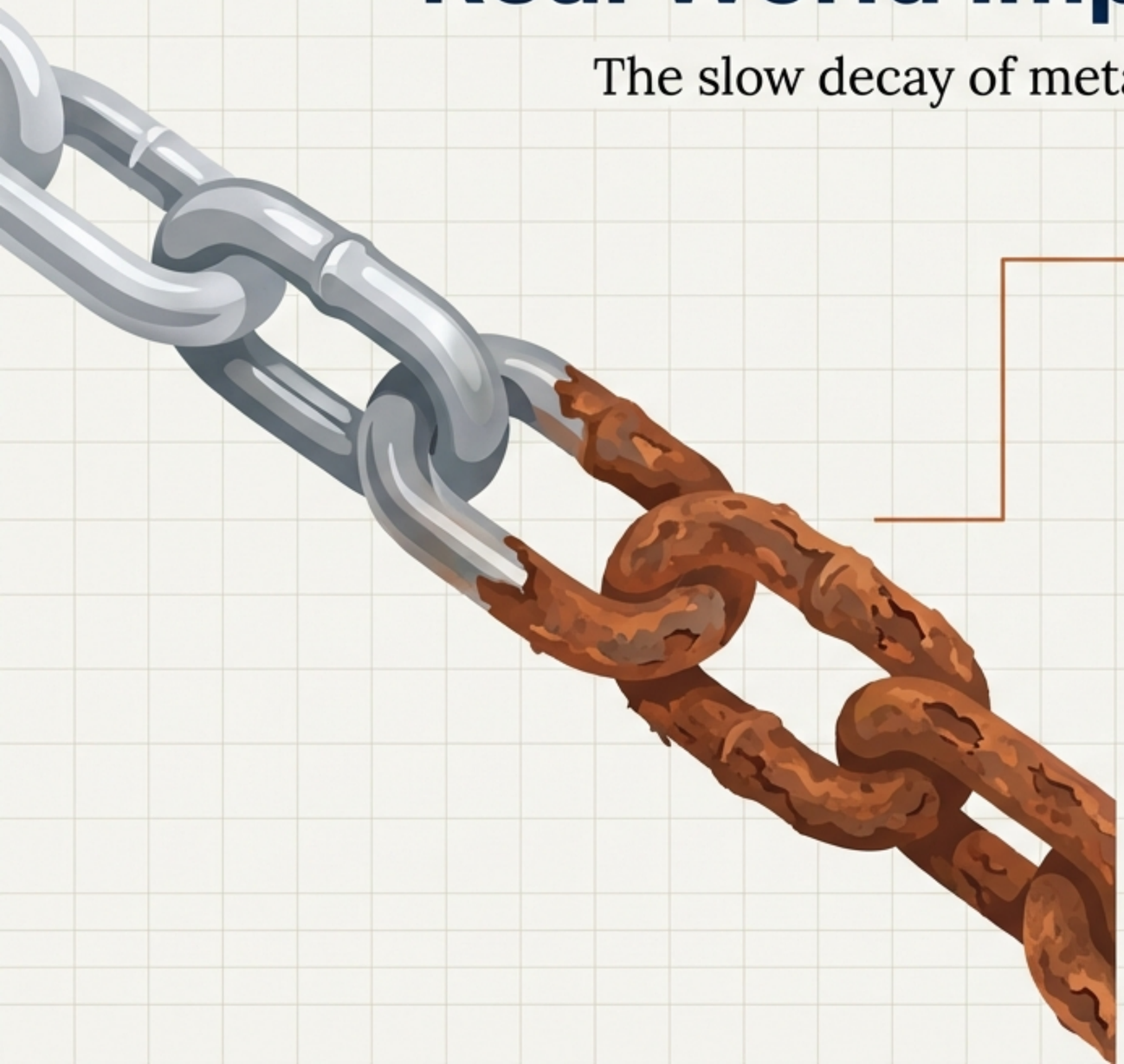


Oxidation: Gain of Oxygen / Loss of Hydrogen.

Reduction: Loss of Oxygen / Gain of Hydrogen.

Real World Impact: Corrosion

The slow decay of metals by air and moisture.



- **Rusting of Iron:** Iron combines with oxygen and moisture to form hydrated ferric oxide.

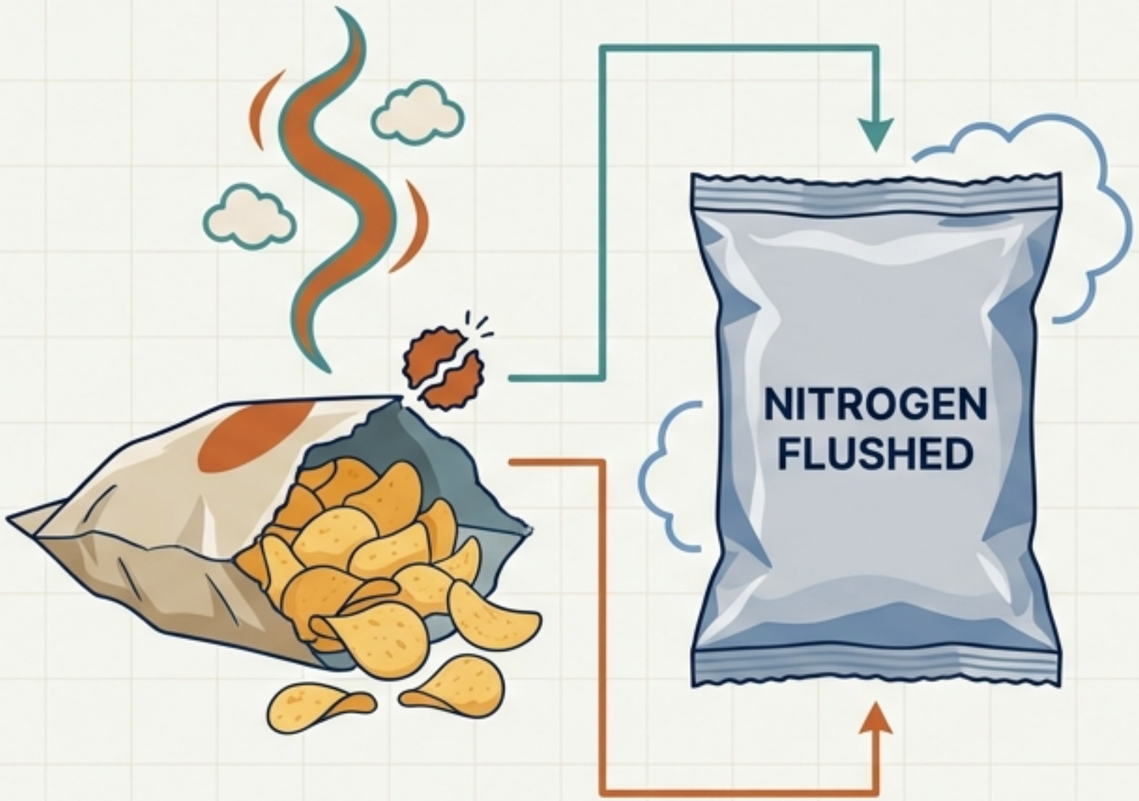
$$Fe_2O_3 \cdot xH_2O$$

- **Other Examples:**
  - Black coating on silver (Ag_2S)
  - Green coating on copper

- **Prevention:**
  - Galvanization
  - Electroplating
  - Painting

Real World Impact: Rancidity

The oxidation of fats and oils.



The Problem:

When fats and oils oxidize, they create unpleasant smells and tastes.

The Solutions:

1. **Nitrogen Flushing:** Inert gas prevents contact with oxygen (why chip bags are puffy).
2. **Antioxidants:** Added chemical defenders.
3. **Airtight Containers:** Slowing down the process.

Laboratory Checkpoint

Test your understanding.

Q: Why is magnesium ribbon cleaned before burning?

A: To remove the interfering layer of Magnesium Carbonate/Oxide.

Q: What defines a 'Precipitation' reaction?

A: The formation of an insoluble solid substance.

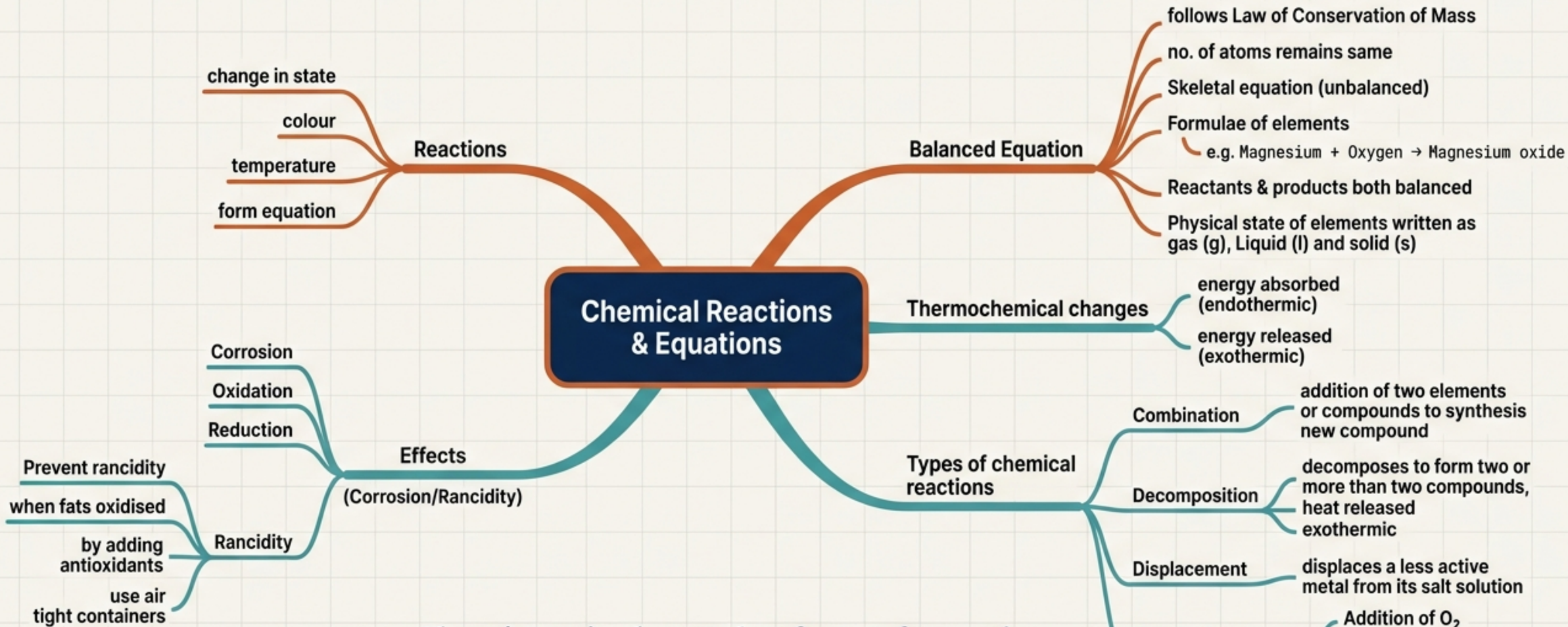
Q: Is the digestion of food Exothermic or Endothermic?

A: Exothermic. The decomposition of food releases energy for the body.

Q: Heating Lead Nitrate produces a brown gas. What is it?

A: Nitrogen Dioxide (NO_2).

Summary: The Cycle of Chemical Change



Chemistry is the study of transformation. Look closely, and you will see it happening everywhere around you.