

Unit 1 Chemical Substances: Nature & Behaviour



Chapter 1:

Chemical Reactions And Equations

→ **Chemical Reaction** - It is a process where substances combine to create a new substance with unique properties.

★ These are the following changes to determine that the chemical reaction has taken place

(i) Change in state

(ii) change in colour

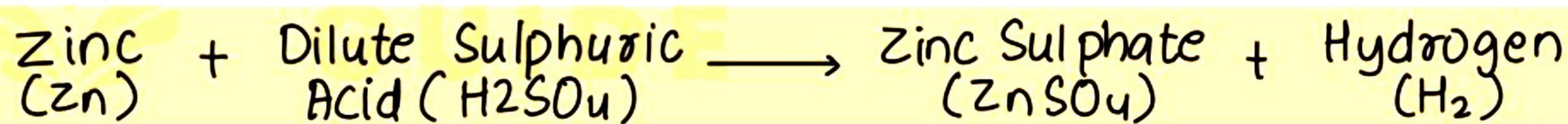
(iii) change in temperature

(iv) Evolution of gas

→ **Reactant** - Substances which take part in a chemical reaction are called **reactants**. Ex - Mg and O_2

→ **Product** - New substance formed after a chemical reaction is called a **product**. Ex - MgO.

→ **Chemical Equation** - A chemical equation symbolically represents a chemical reaction, using formulas of reactants and products. For instance



→ **Balanced chemical Reaction** - A reaction where the number of atoms of each element is equal on both sides of the equation. Ex - $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$. This represents the balanced combustion of hydrogen gas with oxygen to form water vapor.

→ **Unbalanced chemical Equation** - If the atoms of each element in reactants is not equal to the numbers of atoms of each element present in the product, then the chemical equation is called **unbalanced chemical equation**. Ex - $\text{Fe} + \text{H}_2\text{O} \rightarrow \text{Fe}_3\text{O}_4 + \text{H}_2$. In this example, a number of atoms

of elements are not equal on two sides of the reaction.

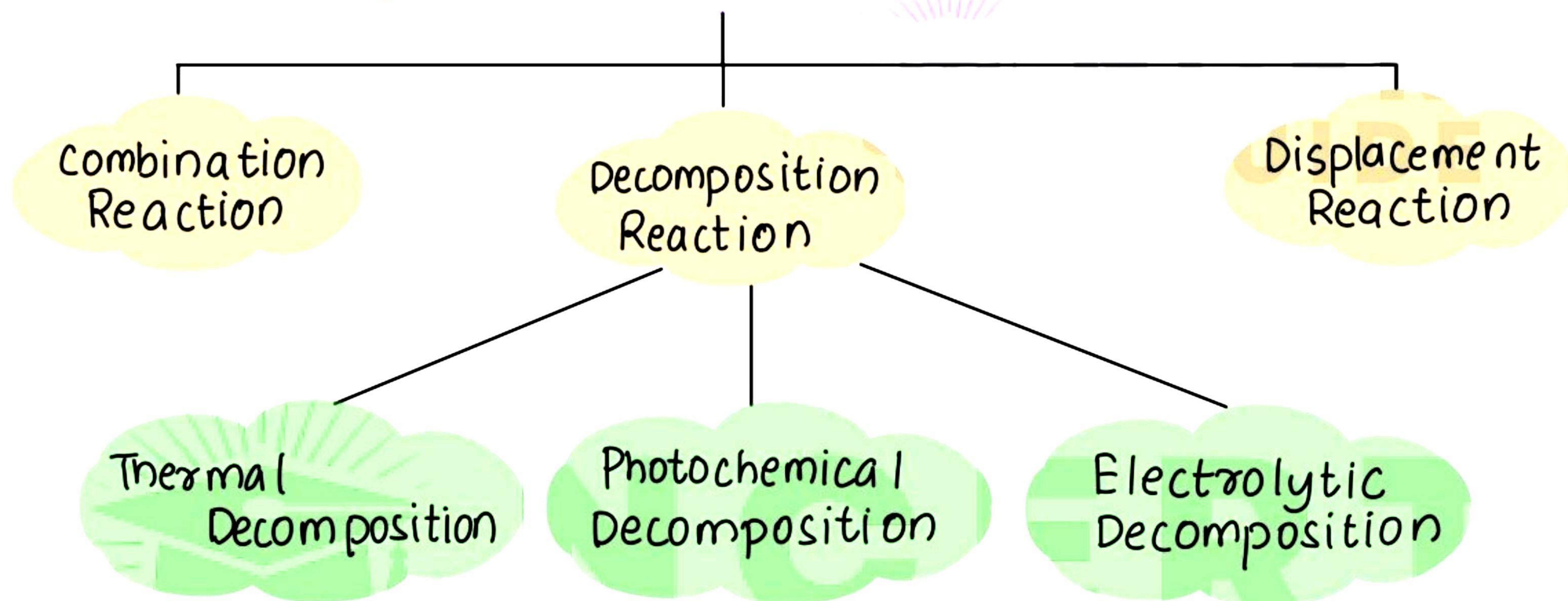
Ex - On the left-hand side only one iron atom is present, while three iron atoms are present on the right-hand side. Therefore, it is an unbalanced chemical equation.

⚠ **NOTE**

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A solid substance that has been separated from a liquid in a chemical process. { Denoted as (↓) in reactions }.

Types of Chemical Reactions



To Make Equation More Informative

Writing the symbols of physical state of substances in a chemical equation:

By writing the physical states of substances, a chemical equation becomes more informative.

- Gaseous state is represented by symbol (g).
- Liquid state is written by symbol (l).
- Solid state is written by symbol (s).
- Aqueous state is written by symbol (aq).
- Writing the condition in which reaction takes place. The condition is generally written above and/or below the arrow of a chemical equation.



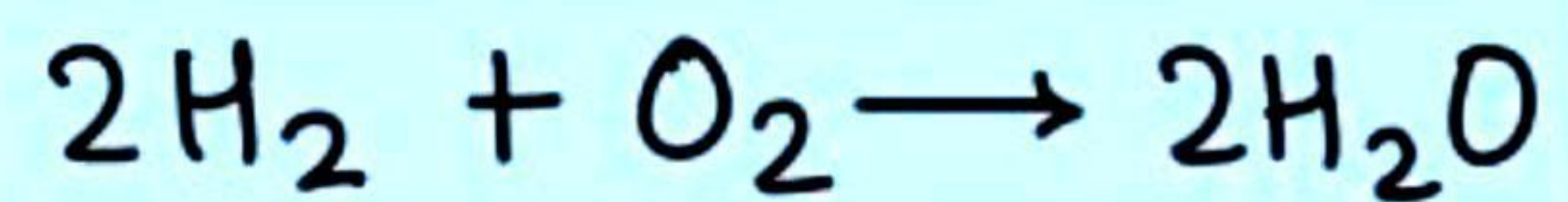
➔ **Combination Reaction** - A combination reaction, also called a **synthesis** or **addition reaction** occurs when two or more reactants combine to produce a single product.

• General form: $A + B \rightarrow AB$

Examples

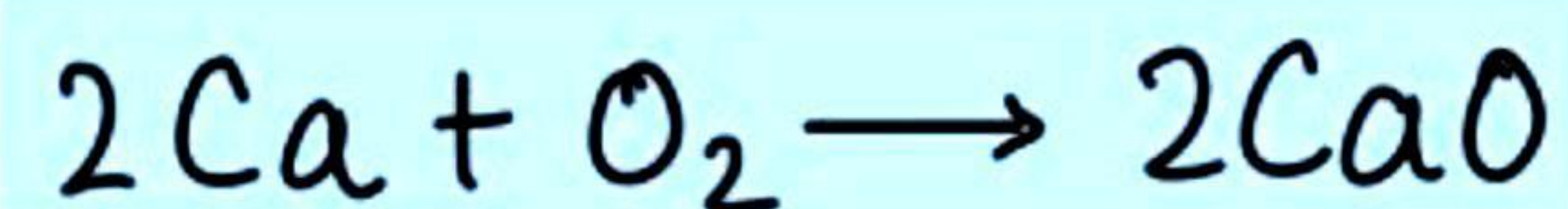
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📌 **FORMATION OF WATER (HYDROGEN AND OXYGEN)**



In this reaction, hydrogen gas (H_2) combines with oxygen gas (O_2) to form water (H_2O)

📌 **FORMATION OF CALCIUM OXIDE (CALCIUM AND OXYGEN)**



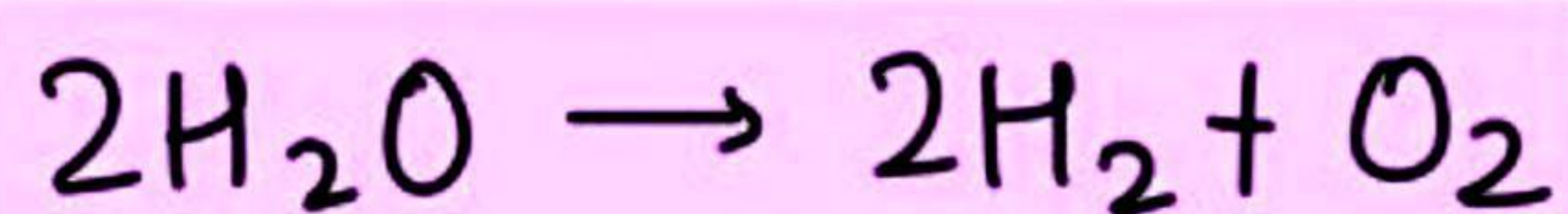
Calcium (Ca) combines with oxygen gas O_2 to form calcium oxide CaO

➔ **Decomposition Reaction** - A decomposition reaction is a chemical reaction in which a single reactant breaks down into two or more products.

• General form $AB \rightarrow A + B$

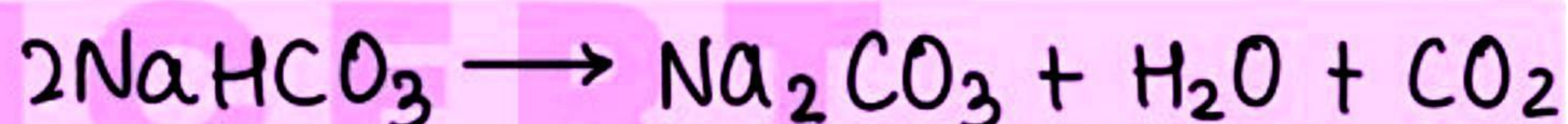
Examples

📌 **DECOMPOSITION OF WATER (ELECTROLYSIS):**



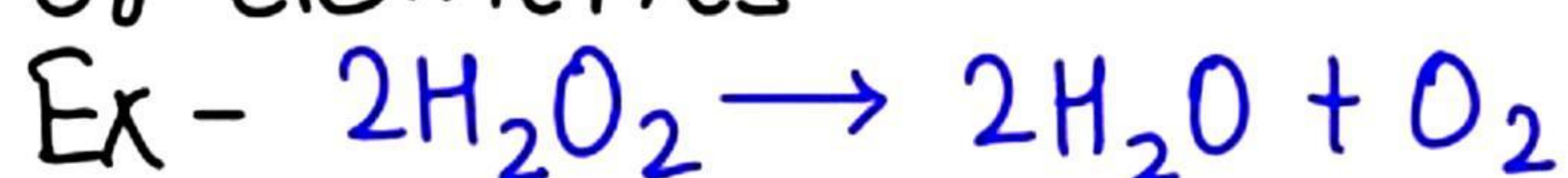
In this process of electrolysis, water H_2O decomposes into hydrogen gas H_2 and oxygen gas O_2

📌 **DECOMPOSITION OF SODIUM BICARBONATE (BAKING SODA)**



Baking soda $NaHCO_3$ decomposes when heated to form sodium carbonate Na_2CO_3 water H_2O and carbon dioxide gas CO_2

🌸 **Thermal Decomposition** - Thermal decomposition is a chemical reaction in which a substance breaks down into simpler substances when heated. The process involves the breakdown due to the absorption of heat, leading to the formation of new compounds or elements.



🌸 **Electrolytic Decomposition (Electrolysis)** - Electrolysis is the process where an electric current is passed through an electrolyte, causing it to decompose.

PROCESS

- Ions move towards electrodes.
- Oxidation takes place at the anode.
- Reduction occurs at the cathode.
- The electrolyte decomposes into its components
- Ex - Electrolysis of water yields hydrogen and oxygen. $2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$

Applications: Extensively utilized in industrial settings for extracting metals and manufacturing chemicals.

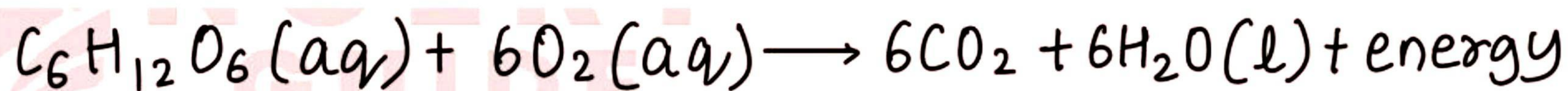
🌸 **PHOTOCHEMICAL DECOMPOSITION (PHOTOSYNTHESIS):** Photosynthesis is a process in which plants use light energy to convert carbon dioxide and water into glucose and oxygen.

PROCESS

- Chlorophyll absorbs light, facilitating the conversion of CO_2 and H_2O .
- Results in the production of glucose and oxygen.
- Equation - $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$

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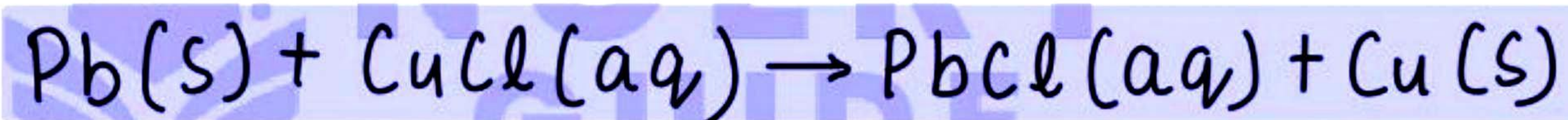
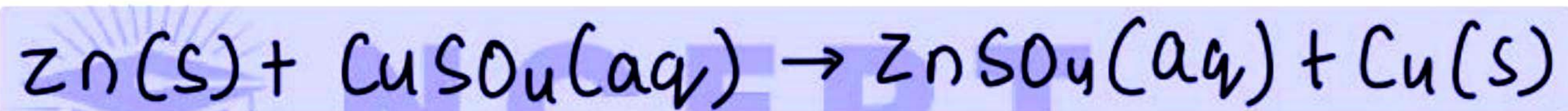
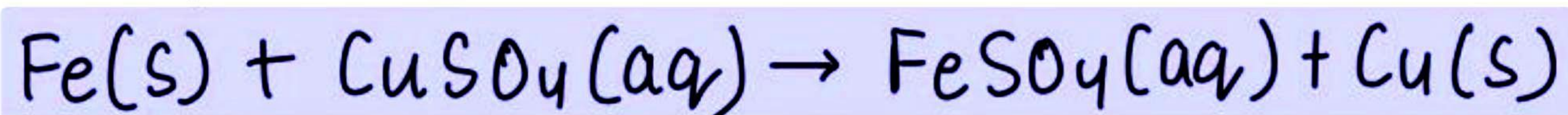
➔ **Exothermic Reaction** - An exothermic process releases heat, and cause the temperature of the immediate surroundings to rise. The rice, potatoes and bread we eat contain carbohydrates. These carbohydrates are broken down to form glucose. This glucose combine with oxygen in the cells of our body and provides energy. The special name of this reaction is respiration in an **exothermic reaction**.



➔ **Endothermic Reaction** - An endothermic process absorbs heat and cools the surroundings. The decomposition of vegetable matter into compost is also an example of an **endothermic Reaction**.


➔ **Displacement Reaction** - A displacement reaction is a chemical reaction in which a more reactive element displaces a less reactive element from its compound.

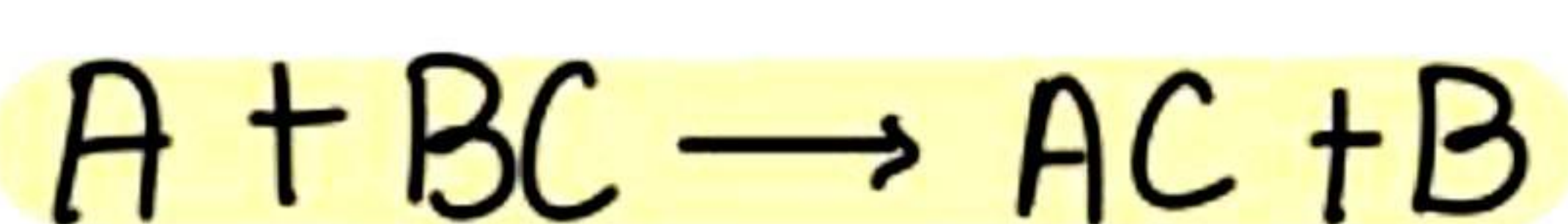
Examples




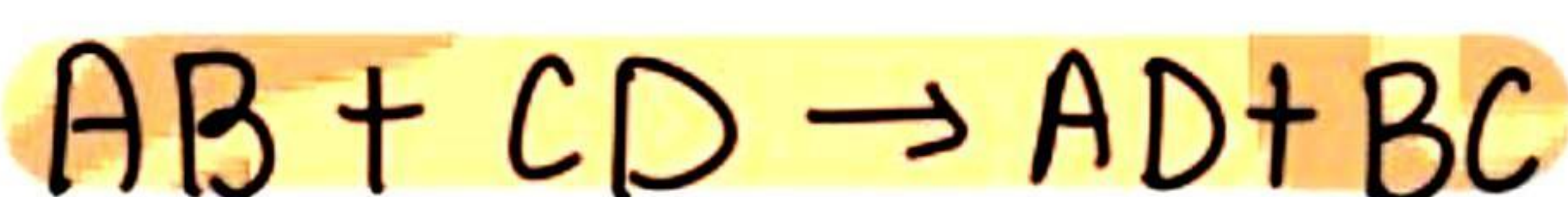
FeSO_4 (Brownish Green)

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 **Single Displacement** - A single displacement reaction is a chemical reaction in which an element replaces another element in a compound, resulting in the formation of a new compound and a different element.



 **Double Displacement** - A double displacement reaction is a chemical reaction in which two compounds exchange ions to form two new compounds. This typically involves the exchange of positively charged ions (cations) or negatively charged ions (anions) between the reactants, resulting in the formation of two different compounds.



→ Oxidation Reaction

Understanding Oxidation

Oxidation is a fundamental chemical process where in a substance undergoes electron loss, an increase in its oxidation state, or a rise in the number of oxygen atoms associated with it.

Key points about Oxidation

- **Electron Loss** - Oxidation involves the loss of electrons by a substance.
- **Oxidation state** - The oxidation state of the substance increases during oxidation.
- **Combination with oxygen** - Oxidation may entail the addition of oxygen to a substance.

Example

An illustration of oxidation is the reaction $2\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$

where iron combines with oxygen to produce iron (III) oxide.

💡 Importance of Oxidation

Oxidation is a vital process in various chemical reactions, playing crucial roles in phenomena like combustion and corrosion.

➔ Reduction Reaction

💡 Definition of Reduction

Reduction is a chemical process wherein a substance gains electrons, reduces its oxidation state or experiences a decrease in the number of oxygen atoms.

💡 Key points about Reduction

- **Electron Gain** - Reduction involves the gaining of electrons by a substance.
- **Oxidation State** - The oxidation state of the substance decreases during reduction.
- **Removal of oxygen** - Reduction can entail the removal of oxygen from a substance.

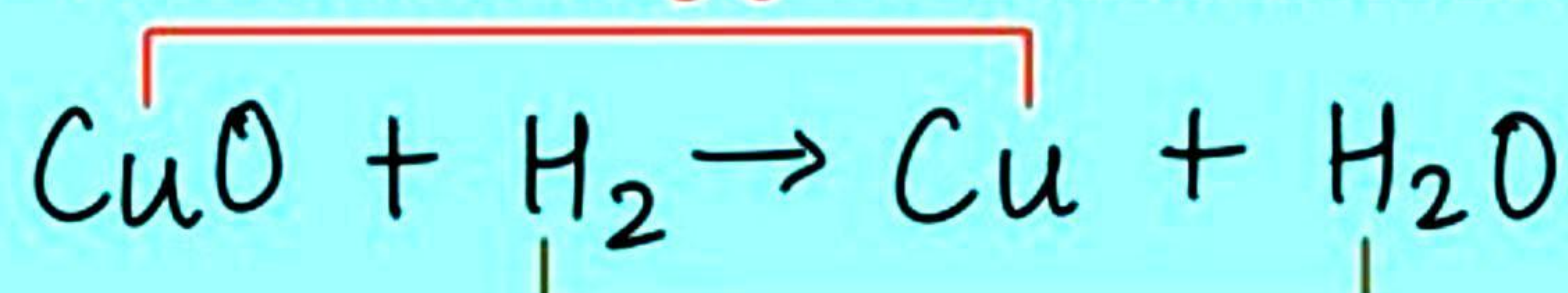
💡 Example

In the reaction $\text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O}$, copper oxide is reduced by gaining hydrogen to form copper and undergoes water.

Examples

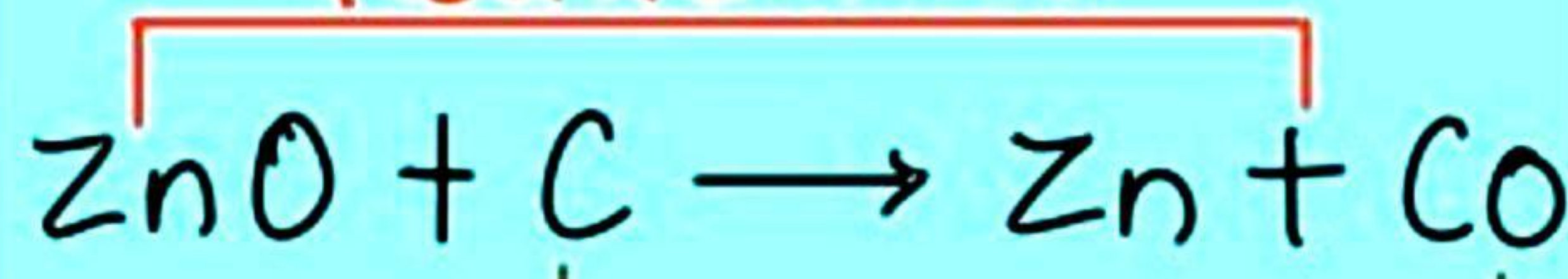
- Substance oxidised - H
- Substance reduced - CuO
- Oxidising agent - CuO
- Reducing agent - H
- Substance oxidised - C
- Substance reduced - ZnO
- Oxidising agent - ZnO
- Reducing agent - C

Removal of oxygen (Reduction)



Addition of oxygen (Oxidation)

Reduction



Oxidation

➔ **Redox Reaction** - In a redox reaction, one substance gains electrons (reduction) while another loses electrons (oxidation). This exchange involves electron transfer between the reactants. For instance, in the reaction $\text{Zn} + \text{Cu}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$, zinc loses electrons (oxidation) and copper ions gain electrons (reduction).

Examples

- Substance Oxidised - HCl
- Substance reduced - MnO₂
- Oxidising agent - MnO
- Reducing agent - HCl

less of oxygen Reduced



less of hydrogen oxidation

→ **Corrosion** - The process of slow conversion of metals into their undesirable compounds due to their reaction with oxygen, water, acids, gases etc present in the atmosphere is called **corrosion**.

Rusting - Iron when reacts with oxygen and moisture forms red substance called rust.

→ **Rancidity** - The taste and odour of food material containing fat materials and oil changes when they are left exposed to air for long time. This is called **rancidity**. It is caused due to oxidation of fat and oil present in food material. It can be prevented by using various method such as by adding antioxidants to the food materials, storing food in air tight container and by flushing out air with nitrogen.