

The background features a light gray grid of dots. On the right side, there are faint, stylized illustrations of atoms and molecules. One atom is shown with a central nucleus and several elliptical orbits. Below it, a chain of molecules is depicted, each consisting of a central sphere with a faceted surface, connected to other spheres by thin rods.

# Comprehensive Study Notes: Chemical Reactions & Equations

A visual guide to understanding atoms, chemical equations, reaction types, and the laws governing chemical changes.

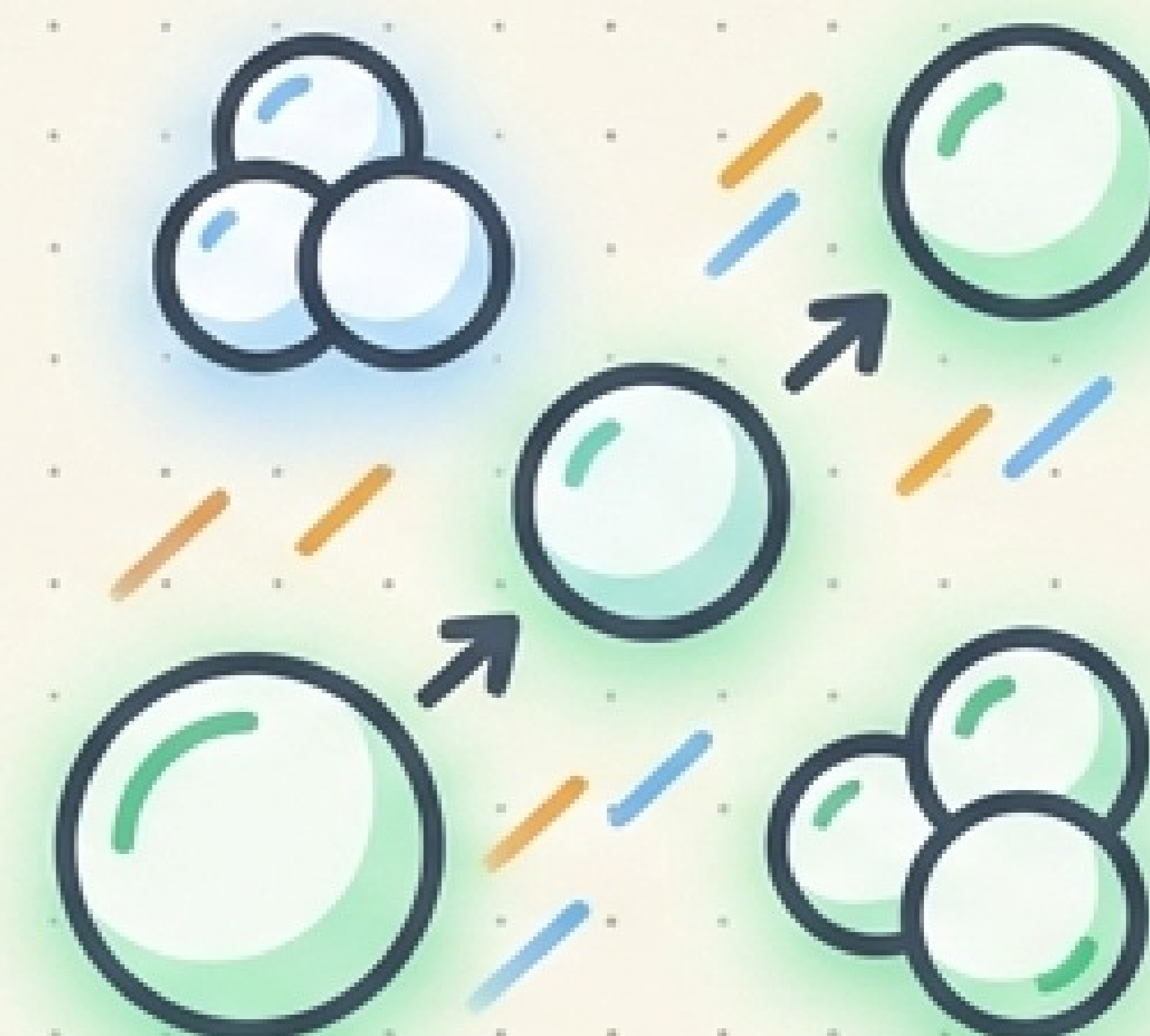
# Atoms are the fundamental building blocks of chemical reactions



Atom



Molecules &  
Compounds



Chemical Reaction

Atoms are the smallest units of elements that participate in chemical reactions. Atoms combine to form molecules and compounds.

Key Concept: During a chemical reaction, atoms rearrange themselves to form entirely new substances.

# The Law of Conservation of Mass dictates that atoms are never lost



**Core Rule:** Atoms are neither created nor destroyed during a chemical reaction.

**Explanation:** Because atoms merely rearrange rather than disappear, the total mass of the substances before the reaction will always equal the total mass after the reaction.

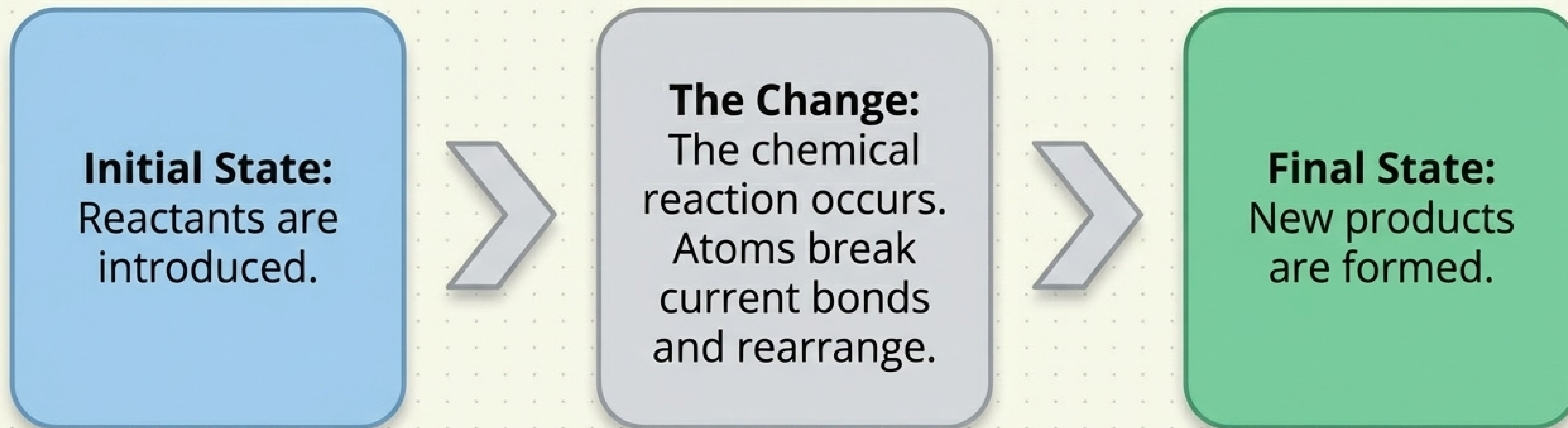
# Chemical reactions transform starting reactants into final products



Reactants: The substances that take part in a chemical reaction.

Products: The substances that are formed as a result of the reaction.

# The basic chemical reaction process follows a clear sequence



A chemical reaction is a process in which one or more substances change into completely new substances with different properties.

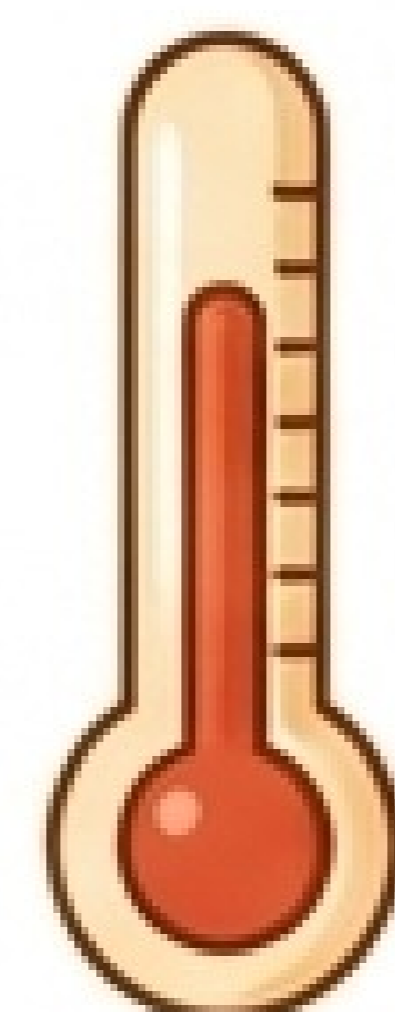
# Four distinct physical signs indicate a chemical reaction has occurred



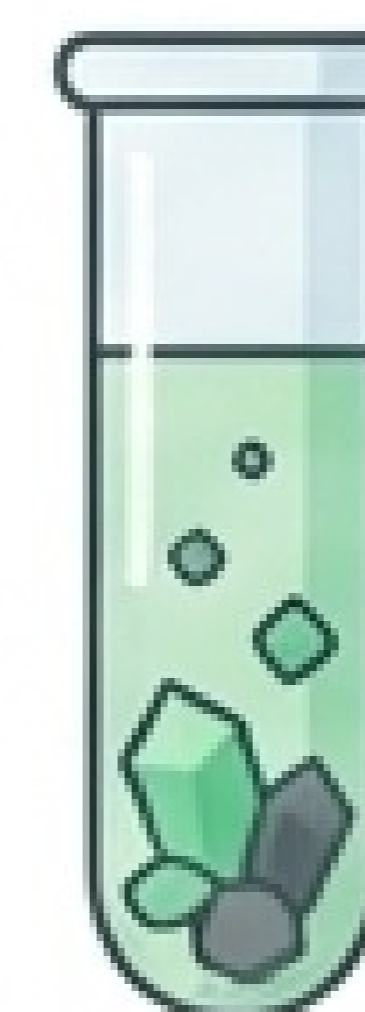
**Color Change**



**Gas Formation**



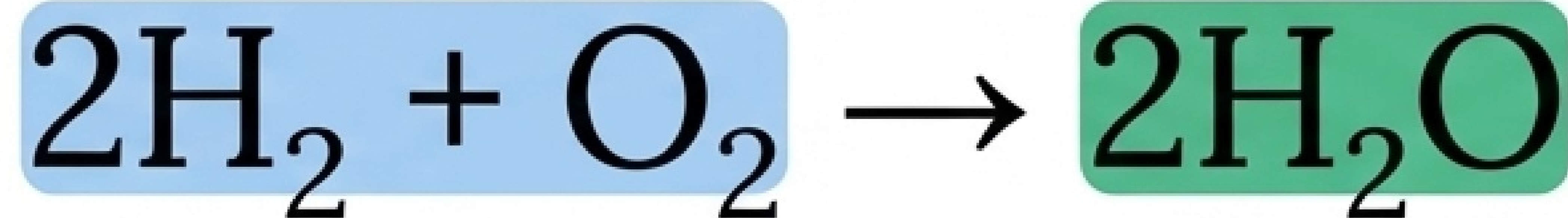
**Temperature Change**



**Formation of a Precipitate**

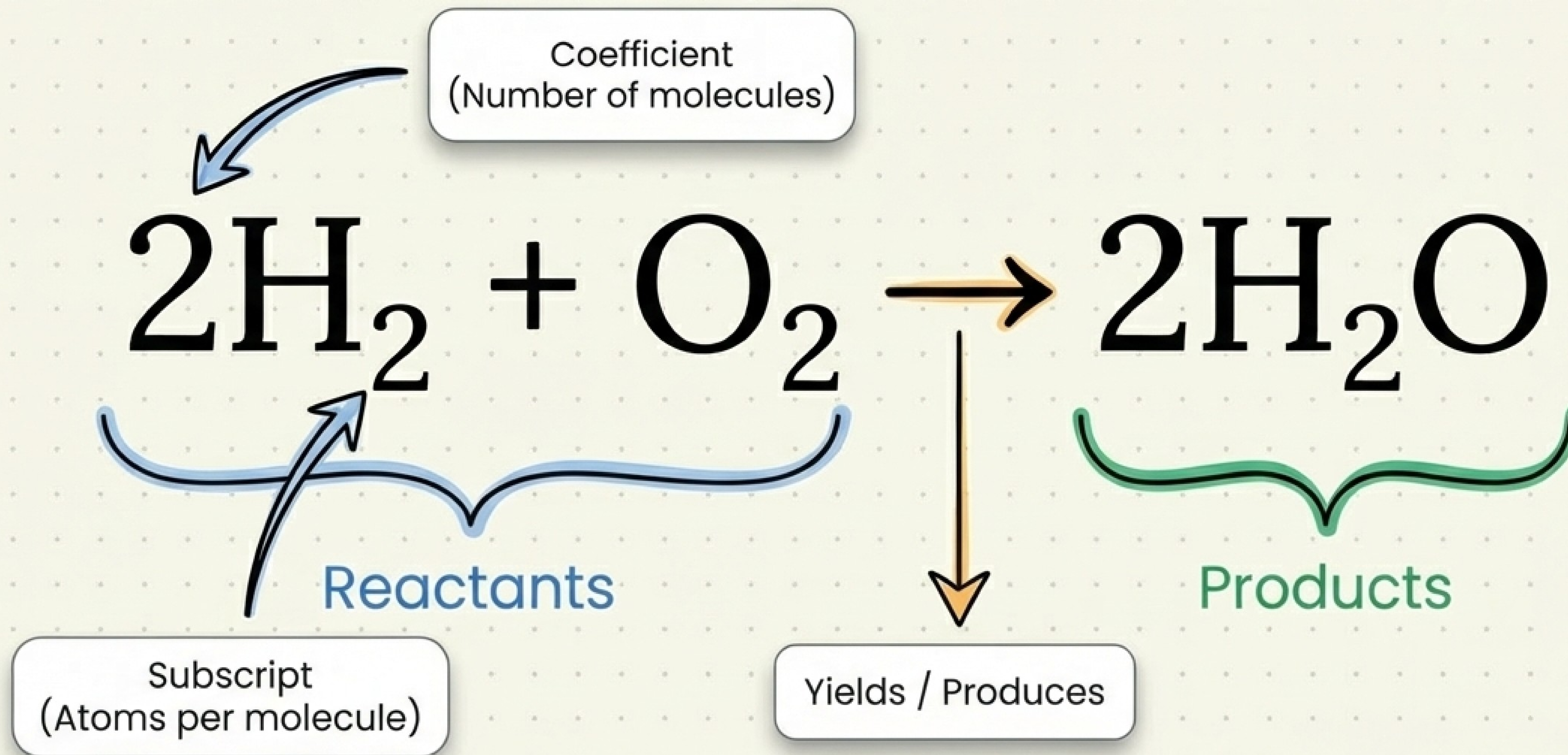
# Chemical equations use formulas to symbolically represent reactions

Two molecules of hydrogen react with one molecule of oxygen to produce two molecules of water.

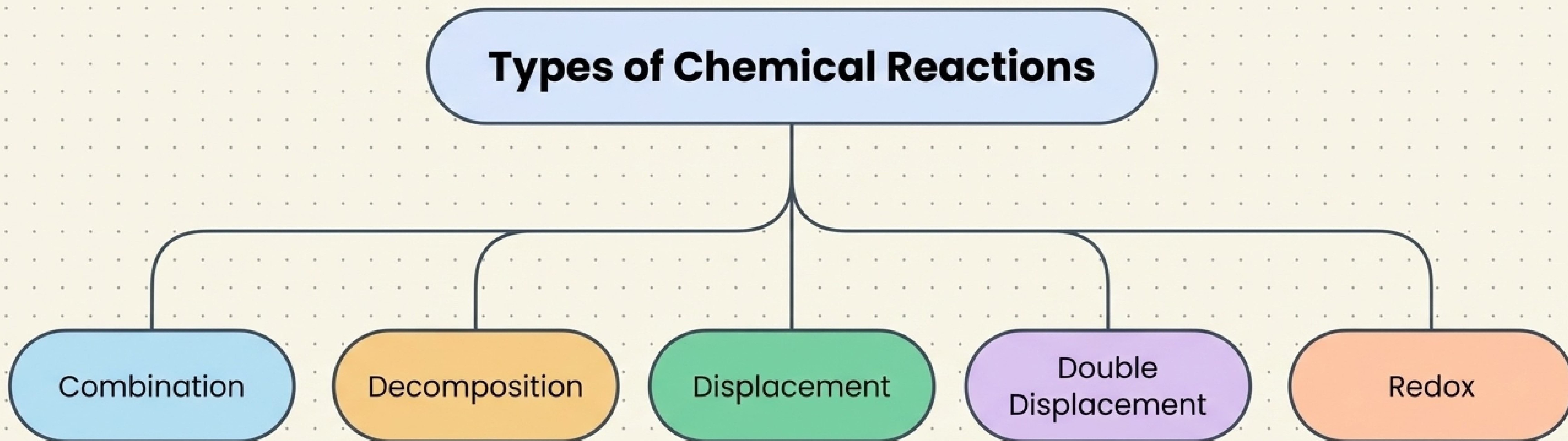


**Key Concept:** A chemical equation is the symbolic representation of a chemical reaction using chemical formulas. It provides a concise, universal way to record chemical changes.

# How to accurately read and interpret a chemical equation

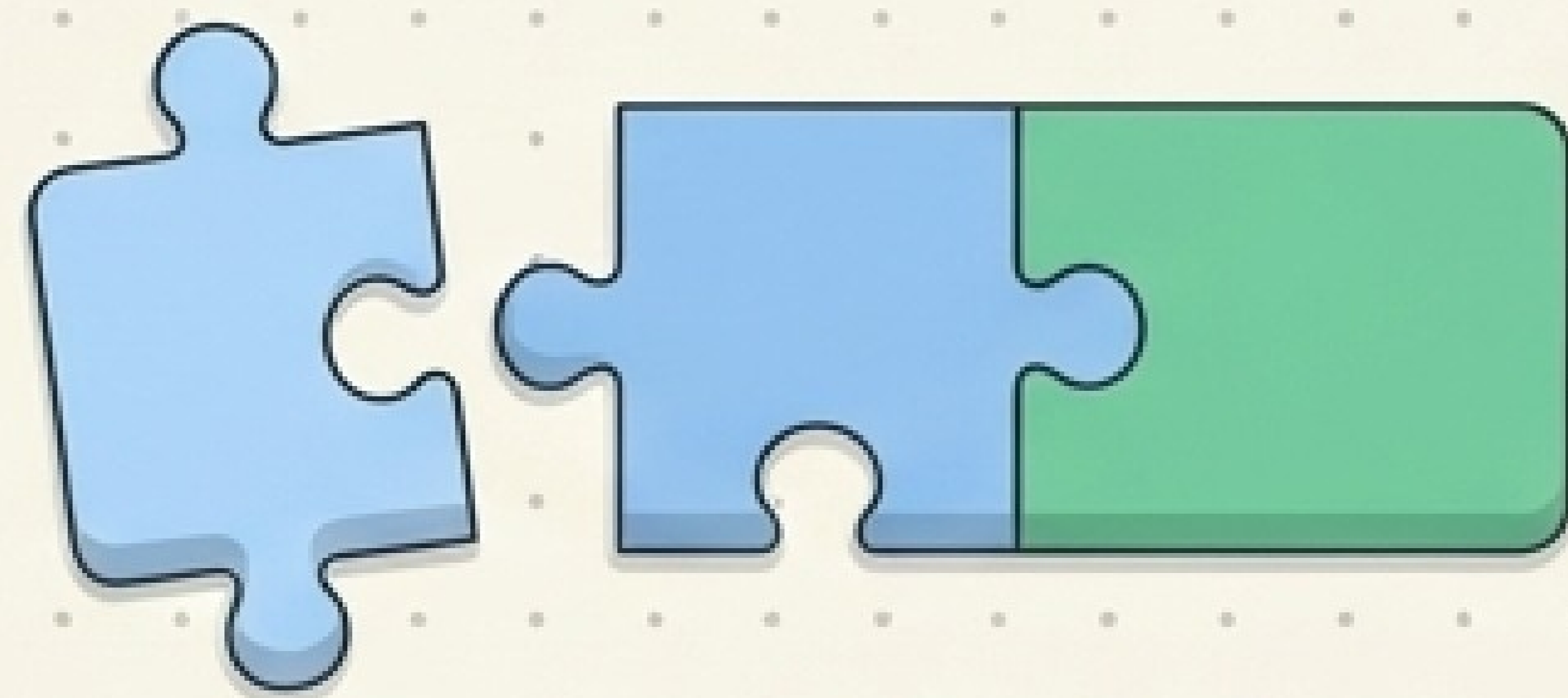


# The hierarchy of chemical reaction types categorizes how atoms interact



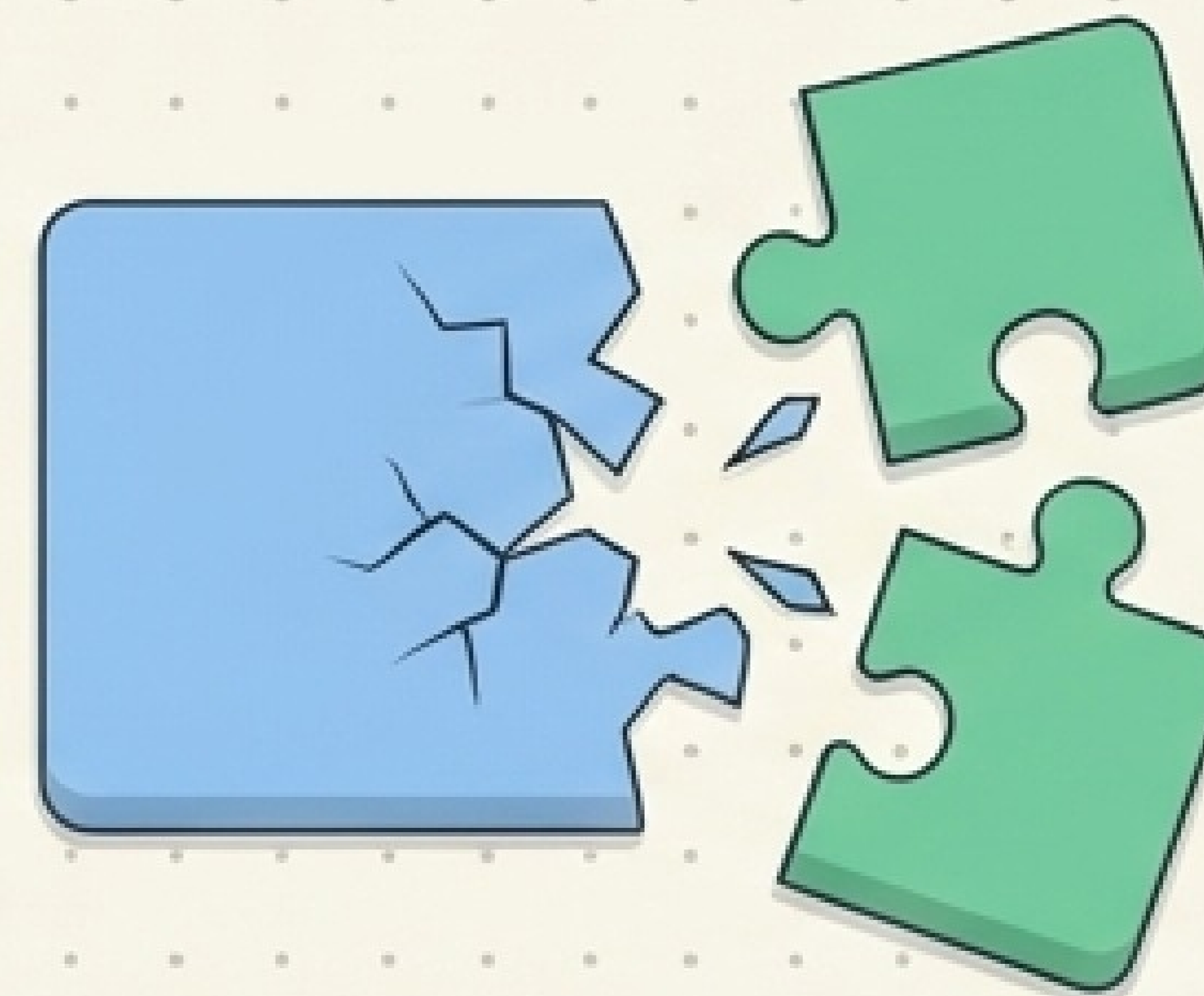
Reactions are classified based on how the reactants interact and rearrange to form products.

# Combination and Decomposition reactions are functional opposites



## Combination Reaction

Two or more substances combine to form a single product.

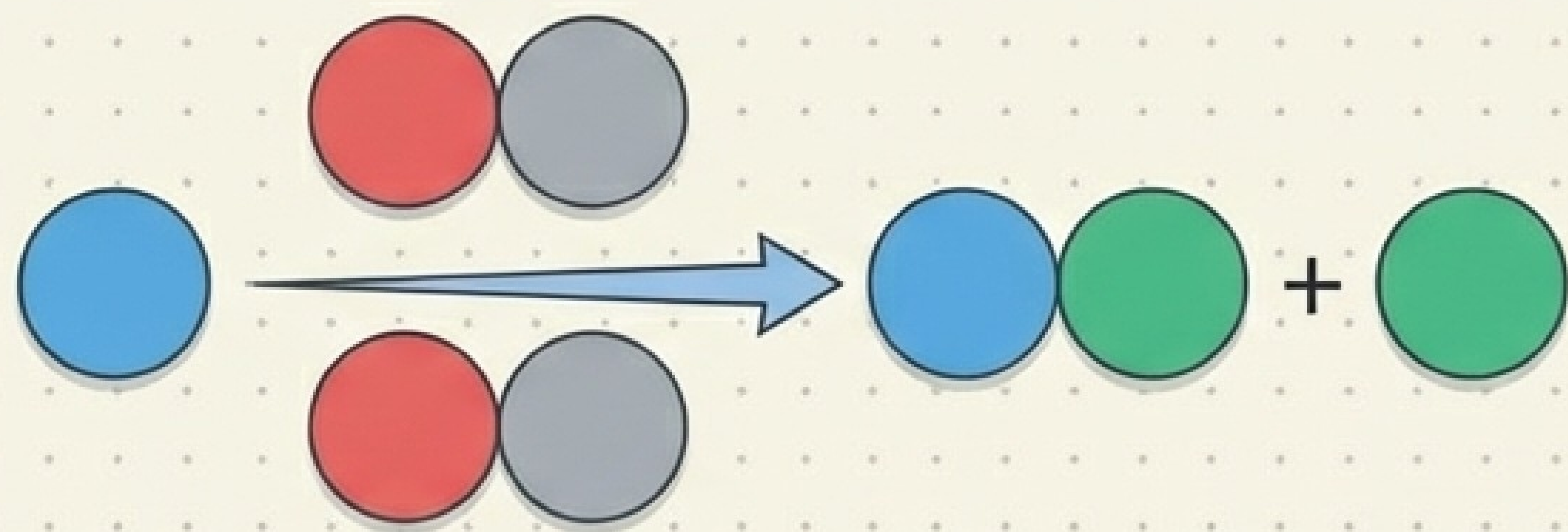


## Decomposition Reaction

A single compound breaks down into simpler substances.

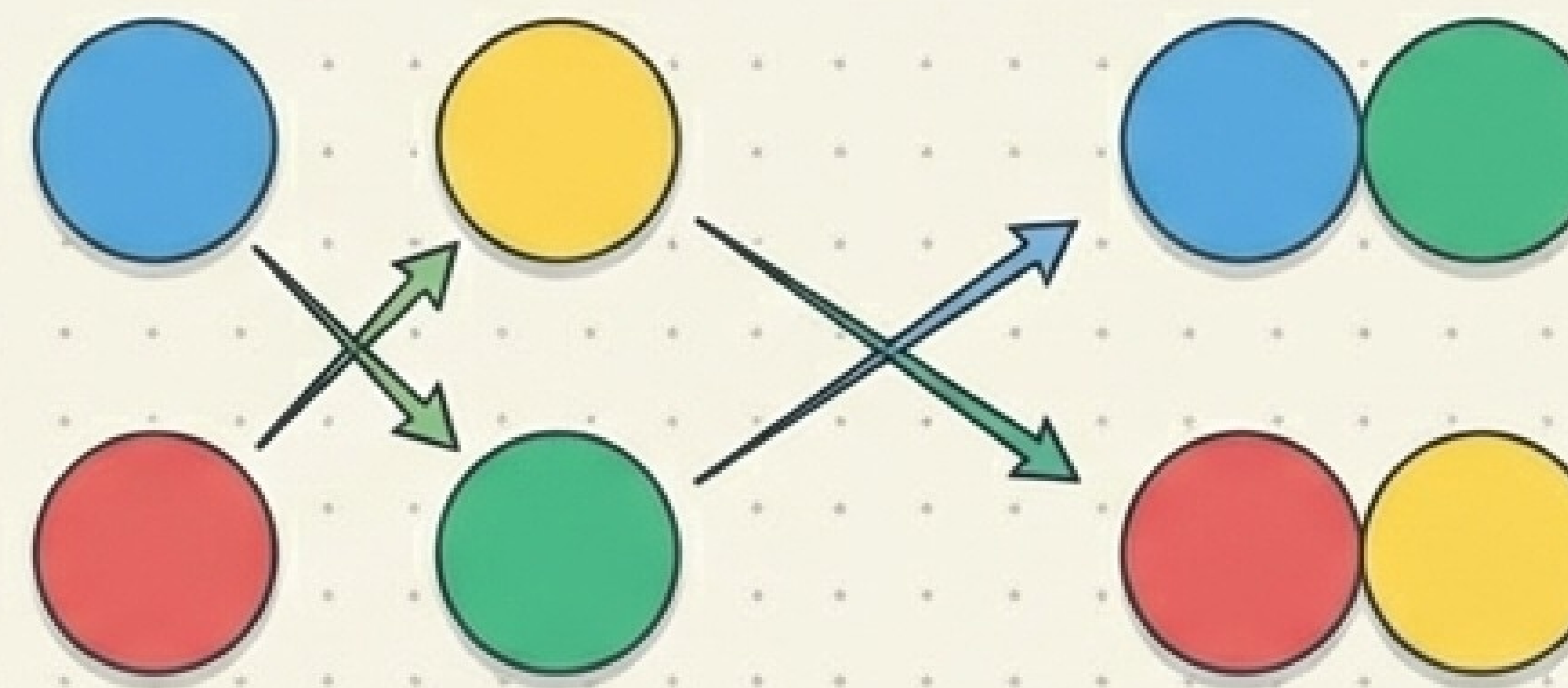


# Displacement reactions involve elements swapping positions



## Displacement Reaction

A more reactive element replaces a less reactive element.

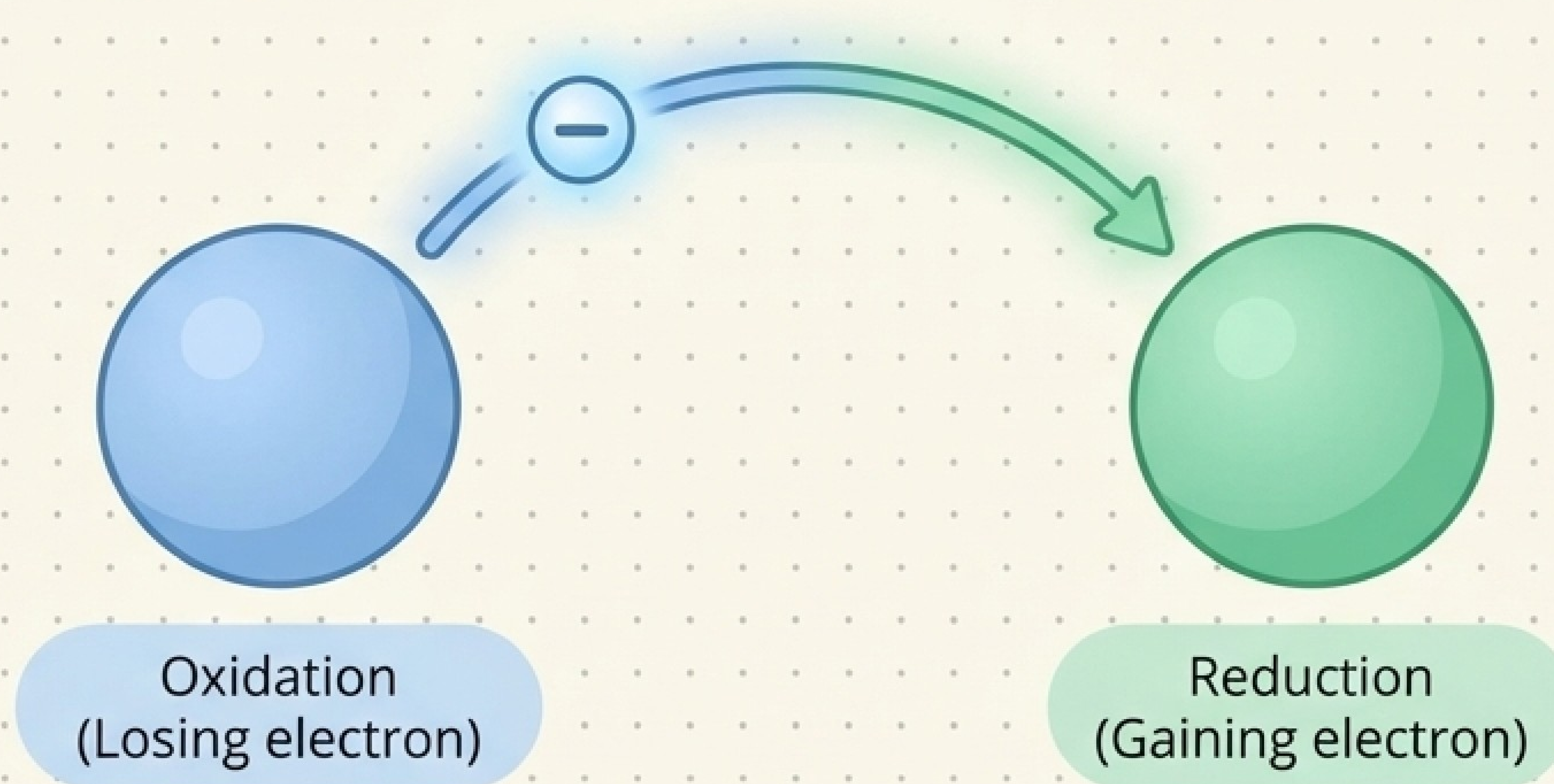


## Double Displacement Reaction

Exchange of ions between two compounds.

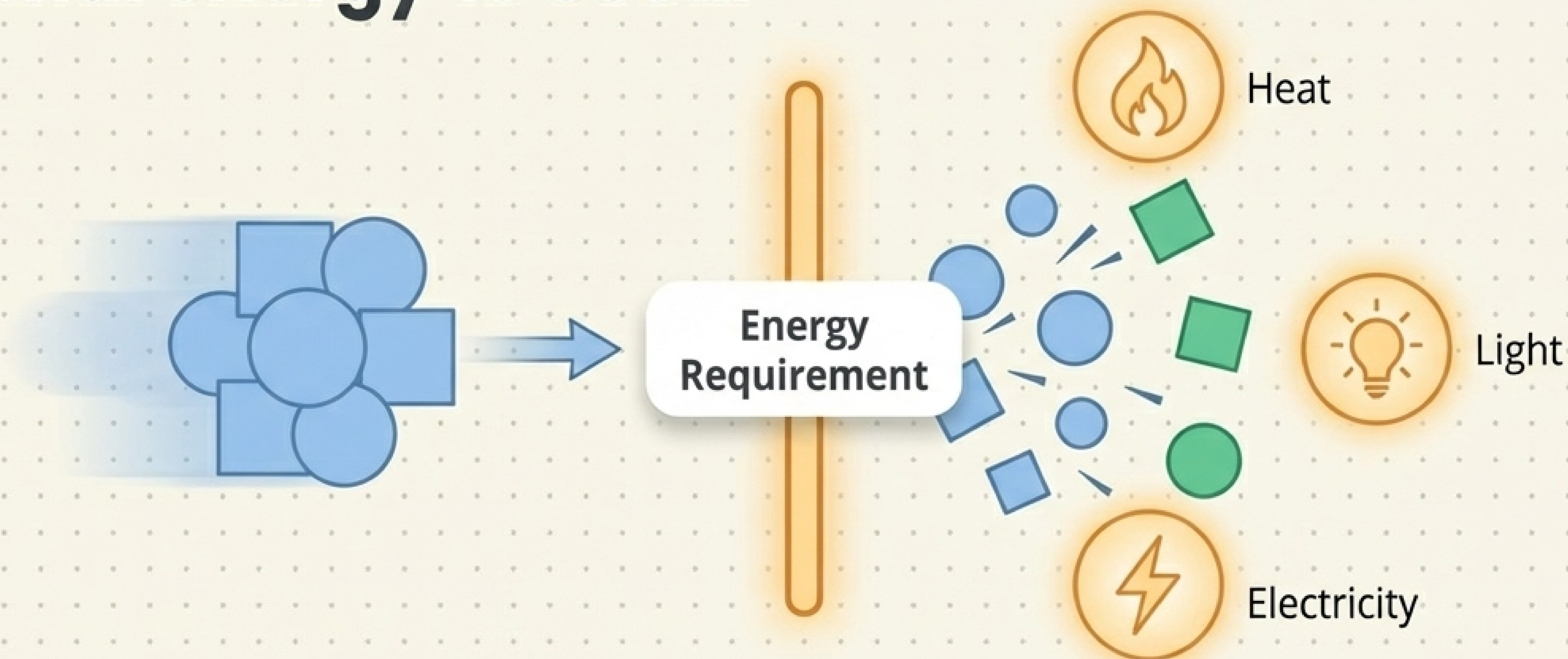


# Redox reactions involve simultaneous oxidation and reduction



**Redox Reaction:** A reaction where oxidation and reduction occur simultaneously.

# Deep Dive: Decomposition reactions require external energy to occur



- **Mechanism:** In a decomposition reaction, one compound splits into two or more simpler substances.
- **The Catalyst:** Because breaking chemical bonds requires effort, this process usually requires energy in the form of heat, light, or electricity.

# Thermal decomposition utilizes heat, while electrolysis utilizes electricity



**Thermal Decomposition:** Occurs when heat energy is applied to break down the compound. Example: Calcium Carbonate breaking down into Calcium Oxide and Carbon Dioxide.



**Electrolysis:** Occurs when an electric current is passed through a substance. Example: Water splitting into Hydrogen and Oxygen gas.

# Knowledge Check: Question 1

**Question:** What is the smallest unit of an element?

**Answer:** Atom

Study Note: Atoms are the baseline units that participate in chemical reactions and combine to form **molecules**.

## Knowledge Check: Question 2

**Question: Substances that take part in a chemical reaction are called?**

**Answer: Reactants**

Study Note: Remember the color coding: **Reactants** transform into **Products**.

## Knowledge Check: Question 3

**Question:**  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$  is which type of reaction?

**Answer:** Decomposition reaction

Study Note: We can tell because a single compound ( $\text{CaCO}_3$ ) breaks down into simpler substances. Specifically, this is an example of thermal decomposition.

## Knowledge Check: Question 4

**Question: Which law states atoms are neither created nor destroyed in reactions?**

**Answer: Law of Conservation of Mass**

Study Note: This law explains why chemical equations must be perfectly balanced.

## Knowledge Check: Question 5

**Question:**  $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$   
is what type of reaction?

**Answer: Displacement reaction**

**Study Note:** Here, the more reactive **Zinc (Zn)** swaps places with the less reactive **Copper (Cu)**, proving displacement has occurred.