CHEMISTRY

IMAT REVIEW COURSE 2024

Imat Alpha
By AlphaMed

STOICHIOMETRY

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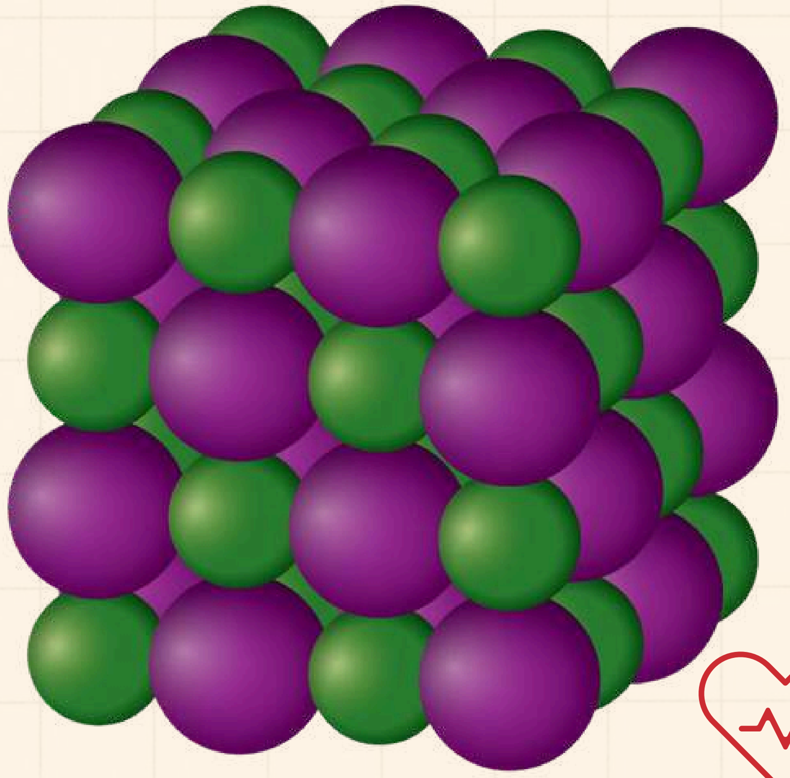
STATES OF MATTER

Solids are characterized by having a definite shape and volume.

- Particle arrangement: Particles are closely packed together.
- Particle movement: Particles primarily exhibit vibrational motion.

Examples of solids: ice, iron, diamond.

solid (s)



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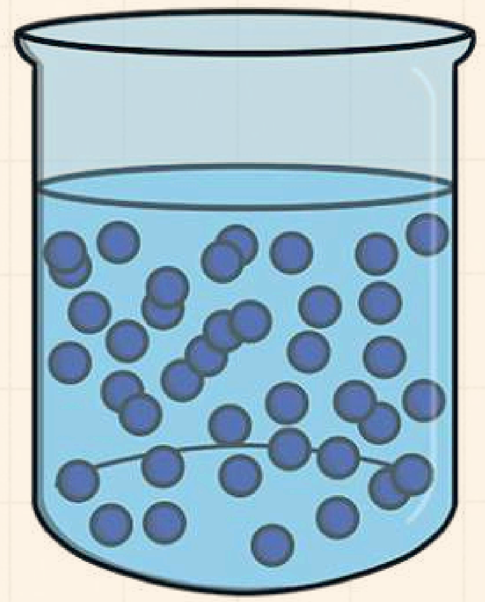
STATES OF MATTER

Liquids have no definite shape but do have a definite volume.

- Particle arrangement: Particles are in contact with each other but can move past one another.
- Particle movement: Particles are free to flow.

Examples of liquids: water (H_2O), mercury (Hg), oil (various compositions).

Liquid (l)

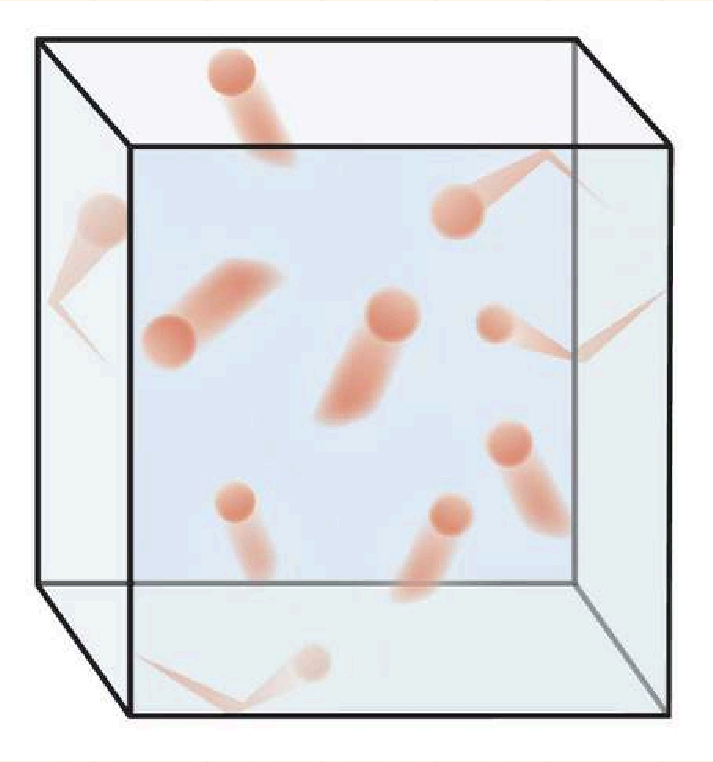


STATES OF MATTER

Gases have no definite shape or volume.

- Particle arrangement: Particles are widely spaced and move freely.
- Particle movement: Particles move rapidly and are compressible.

Examples of gases: oxygen (O_2), helium (He), nitrogen (N_2)



Gas (g)

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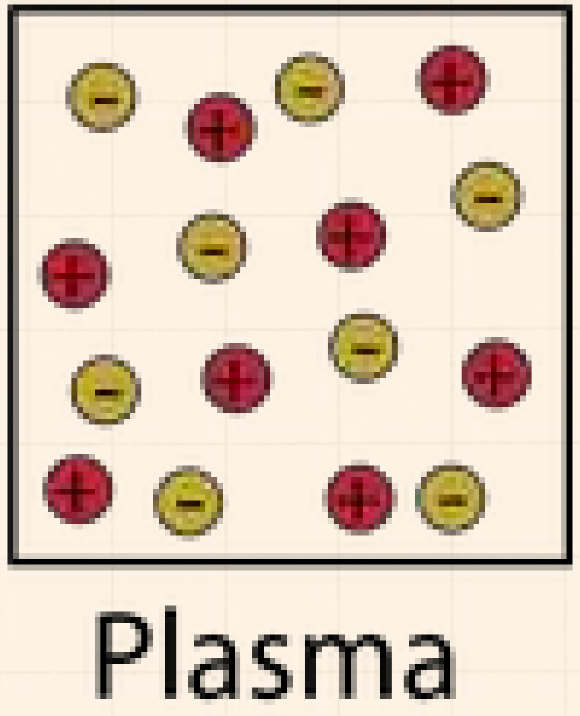
STATES OF MATTER

Plasma is a high-energy state of matter characterized by electrically charged particles.

- Occurrence: Found in stars and neon lights.

Examples of plasma: the sun, lightning, fluorescent lamps.



Plasma

KINETIC ENERGY OF MATTER

Kinetic Energy (KE) is the energy an object possesses due to its motion.

It relates to:

- Movement of particles: How particles move within an object.
- Speed of particles: The velocity of particles within matter.

Kinetic Energy

Kinetic energy is the energy that objects possess due to their motion.

$$KE = \frac{1}{2}mv^2$$

m = mass (kg)
v = velocity (m/s)
KE = Kinetic energy (J)

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KINETIC ENERGY OF MATTER

STATE OF MATTER	KINETIC ENERGY (KE)	CHARACTERISTICS & MOTION OF PARTICLES
Solid	Lowest	Particles vibrate in fixed positions. Limited movement due to strong intermolecular bonds.
Liquid	Intermediate	Particles slide past each other. More motion than solids but less than gases.
Gas	High	Particles move freely and rapidly in all directions. Minimal intermolecular forces.
Plasma	Extremely high	Electrons stripped from atoms. Charged particles (ions and free electrons) move vigorously.

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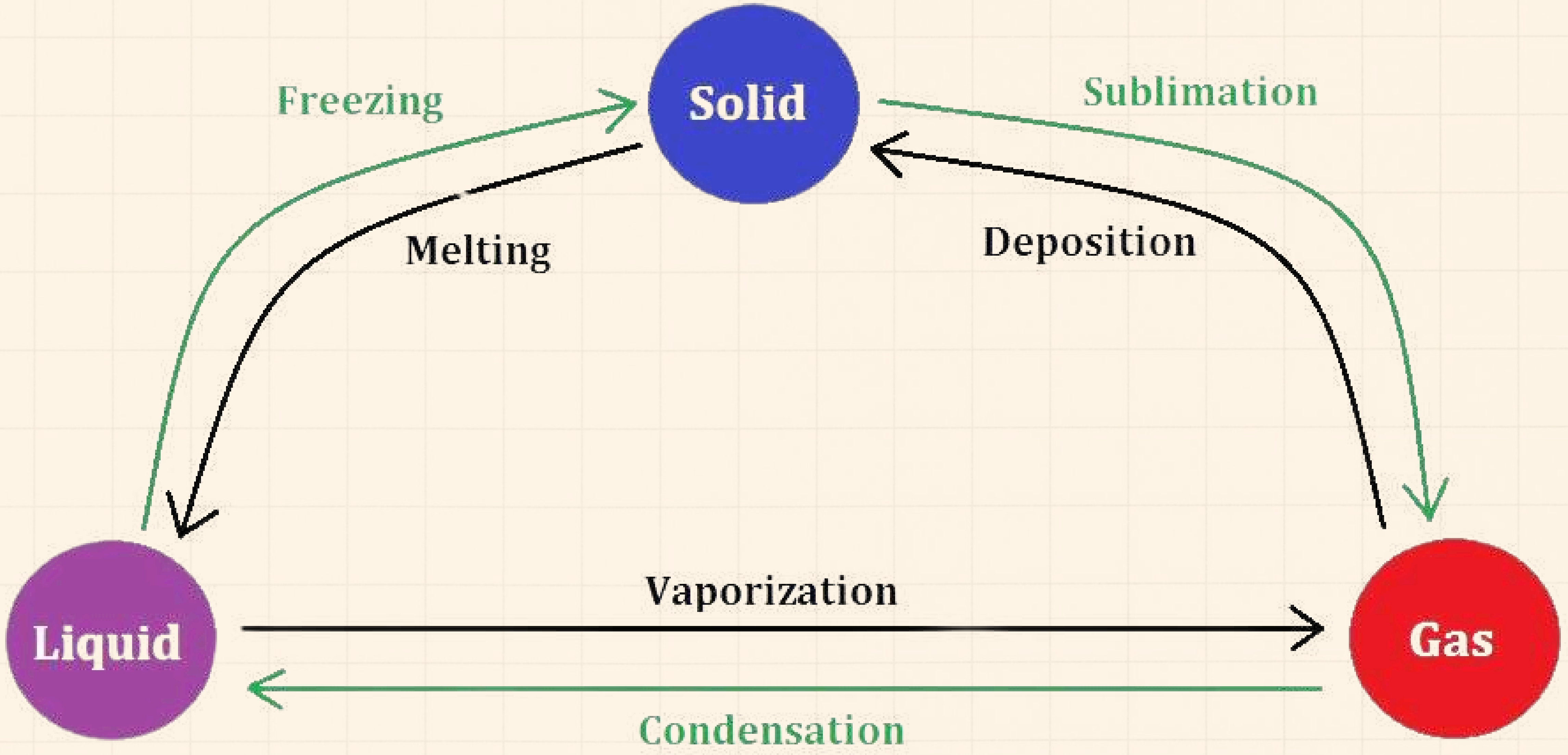
MATTER CHANGES STATE REVERSIBLY

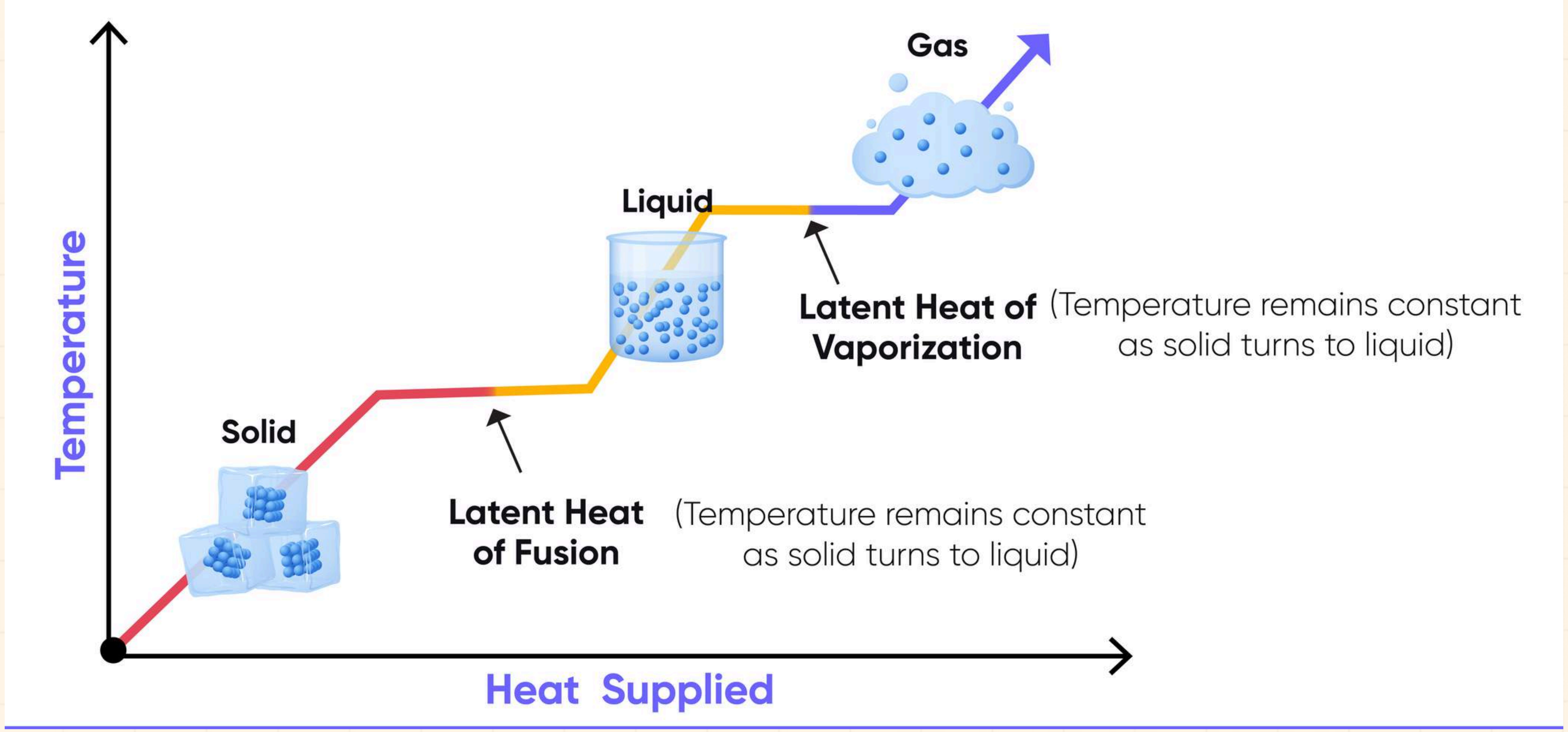
Matter can transition between different states.



MATTER CHANGES STATE REVERSIBLY

STATE CHANGE	DESCRIPTION
Solid to Liquid	Melting: Solid absorbs heat and turns into a liquid. Temperature at which it occurs is the melting point.
Liquid to Solid	Freezing: Liquid loses heat and turns into a solid. Temperature at which it occurs is the freezing point.
Liquid to Gas	Evaporation or Boiling: Liquid absorbs heat and turns into a gas. At boiling point, it's called boiling.
Gas to Liquid	Condensation: Gas loses heat and turns into a liquid. Temperature at which it occurs is the condensation point.
Solid to Gas	Sublimation: Some solids directly turn into gases. Dry ice is an example.
Gas to Solid	Deposition: Gases directly turn into solids. Frost formation is an example.

Latent Heat



Gas
Liquid
Solid
Temperature
Latent Heat of Vaporization
(Temperature remains constant as solid turns to liquid)
Latent Heat of Fusion
(Temperature remains constant as solid turns to liquid)
Heat Supplied

AQUEOUS SOLUTIONS

A substance dissolved in water forms a solution.

Components:

- Solvent: Water (the substance that does the dissolving).
- Solute: The substance being dissolved (e.g., salt, sugar).

Universal Solvent:

- Water: Known as the universal solvent because it can dissolve many substances.
- Reason: Its polar nature and ability to form hydrogen bonds facilitate the dissolution process.

POLAR AND NON-POLAR MOLECULES

The measure of how unevenly electric charge is distributed in a molecule is called polarity.

Polar Molecules:

- Characteristics: Have distinct positive and negative ends, known as dipoles.
- Cause: Arise from an unequal sharing of electrons in a bond.

Non-Polar Molecules:

- Characteristics: Have an even distribution of electric charge.
- Cause: Electrons are shared more equally between atoms.

POLAR AND NON-POLAR MOLECULES

Determining Factors of Polarity:

- Electronegativity: The difference in electronegativity between atoms in a bond. A large difference often leads to polarity.
- Molecular Shape: Even if bonds are polar, a symmetrical shape can make the entire molecule non-polar by balancing out the dipoles.

Importance of Polarity:

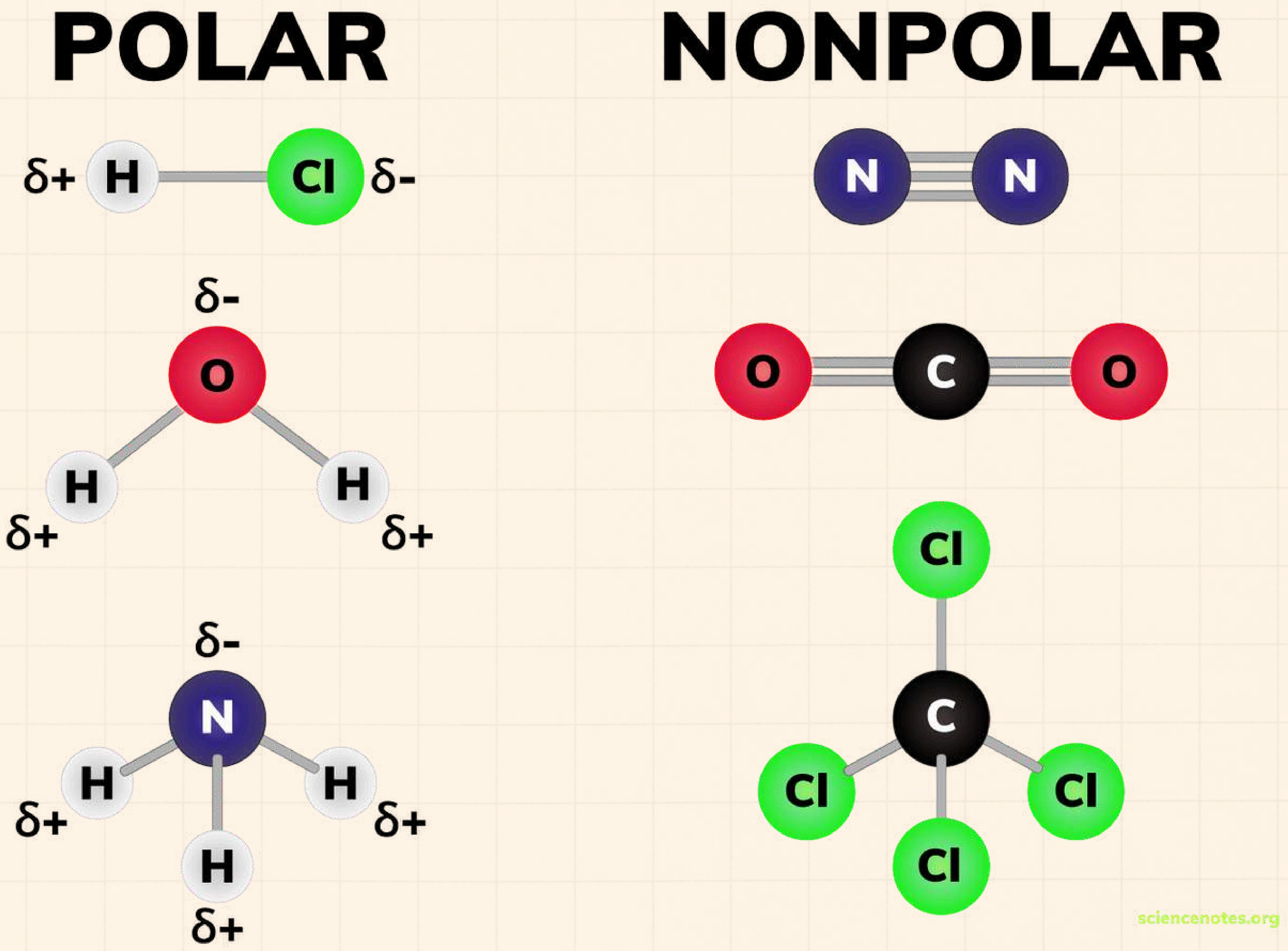
- Influences: Solubility, melting and boiling points, and interactions with other molecules

POLAR AND NON-POLAR MOLECULES

Electronegativity:

- **Definition:** It measures an atom's ability to attract and hold onto electrons.
- **Effect**: The greater the electronegativity, the stronger an atom can pull electrons towards itself.
- **Bond Polarity:** The difference in electronegativity between **two atoms** can indicate whether a **bond is polar or non-polar.**
    - **Large Differences:** Often result in **polar** bonds.
    - **Small Differences:** Typically lead to **non-polar** bonds.

POLAR AND NON-POLAR MOLECULES



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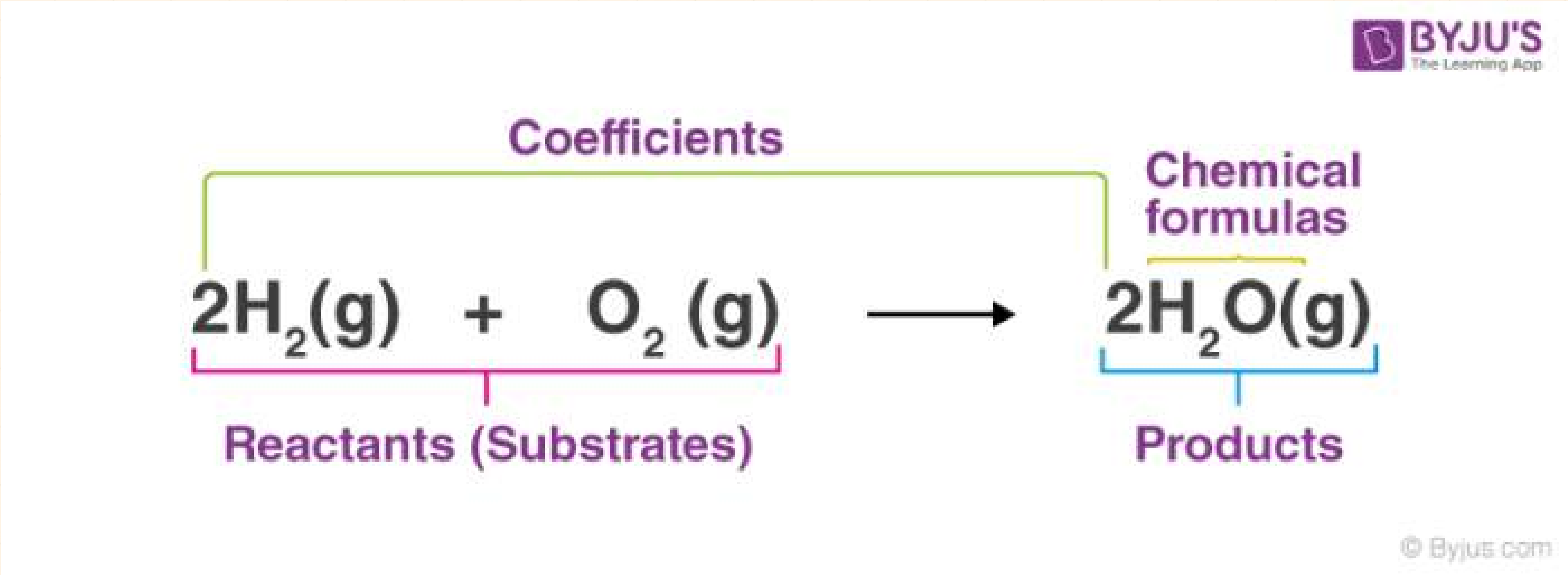
Chemical Equations



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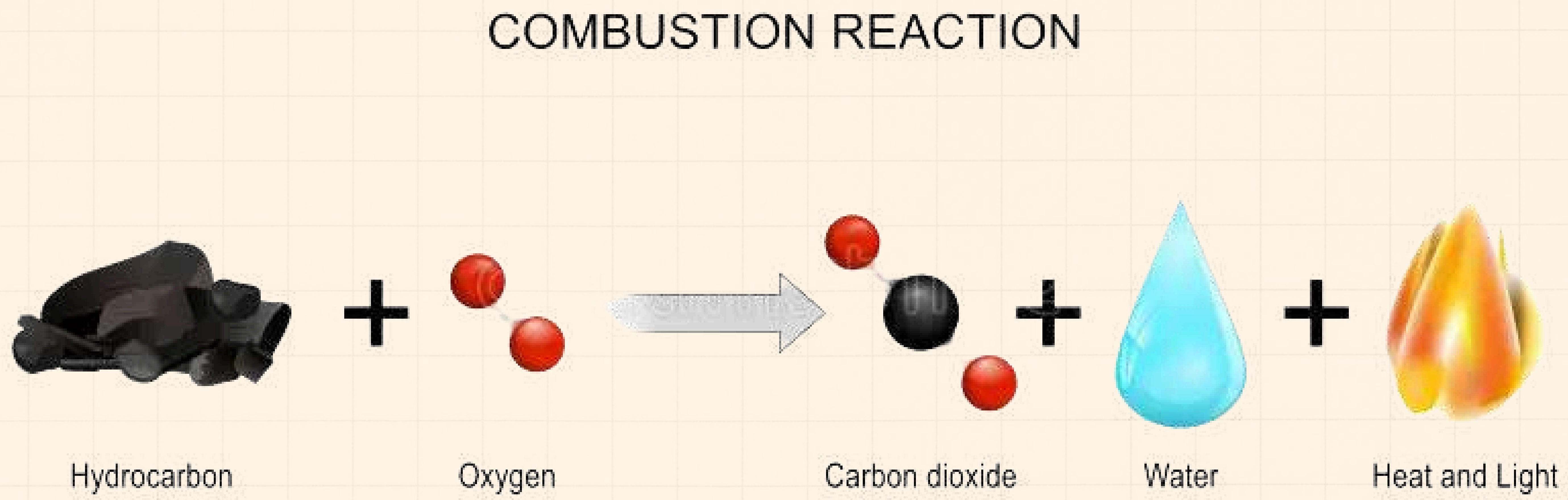
TYPES OF CHEMICAL REACTIONS



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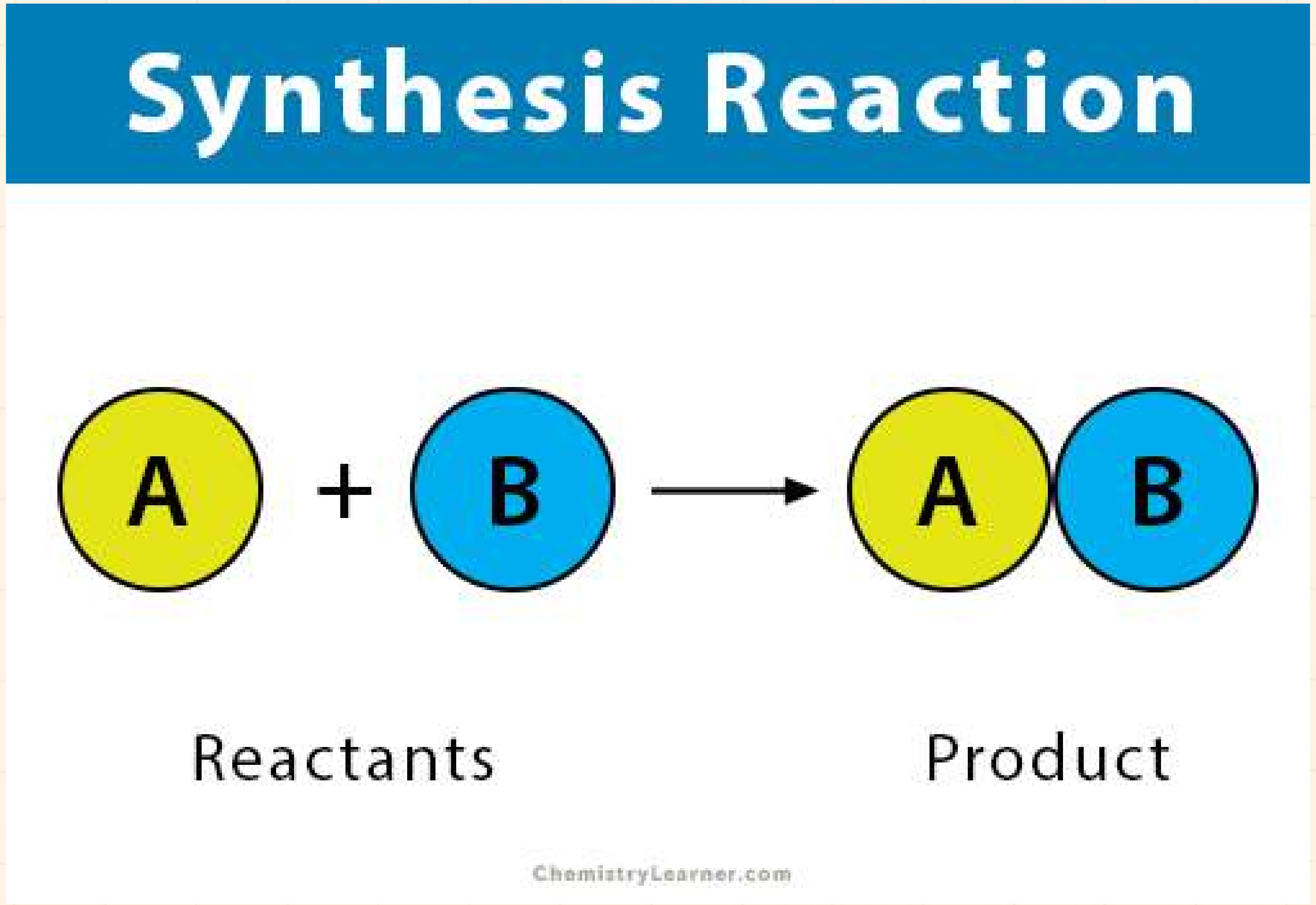

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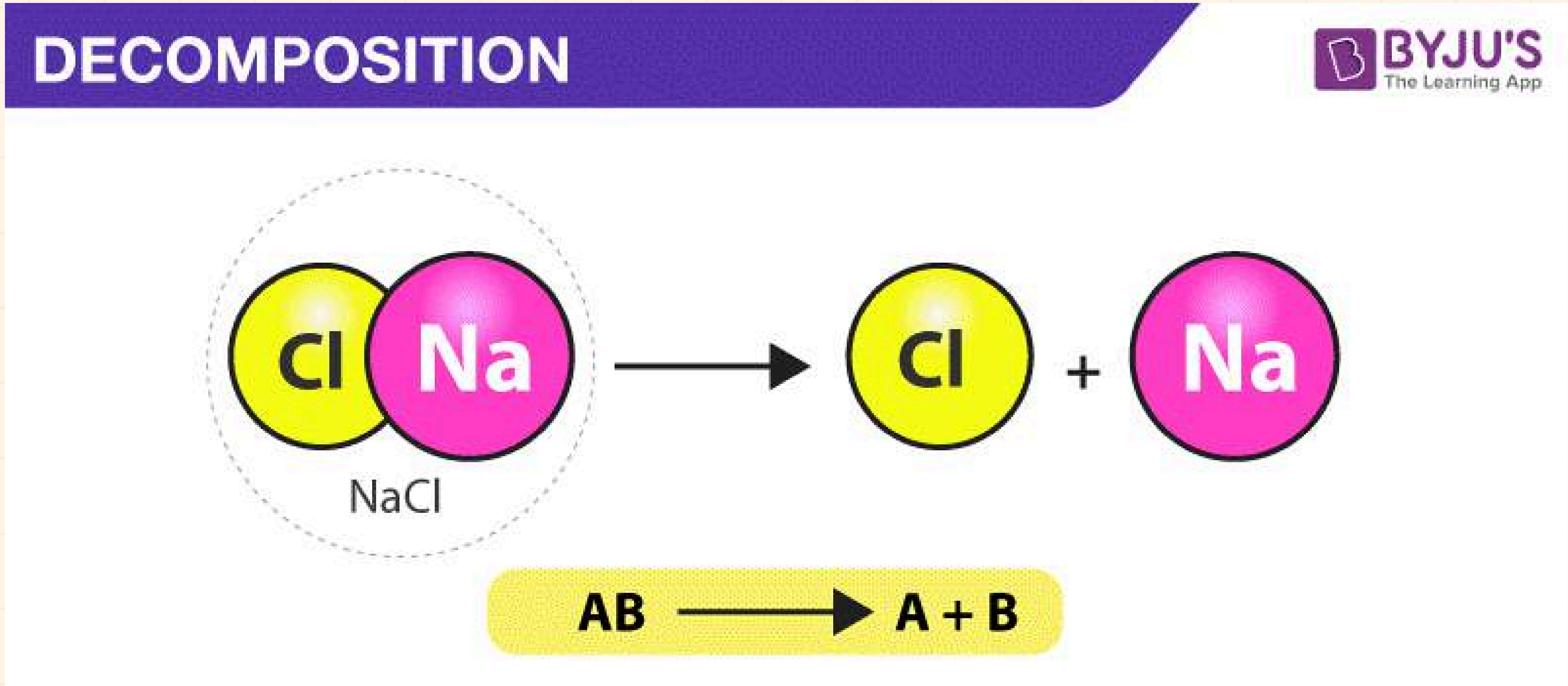

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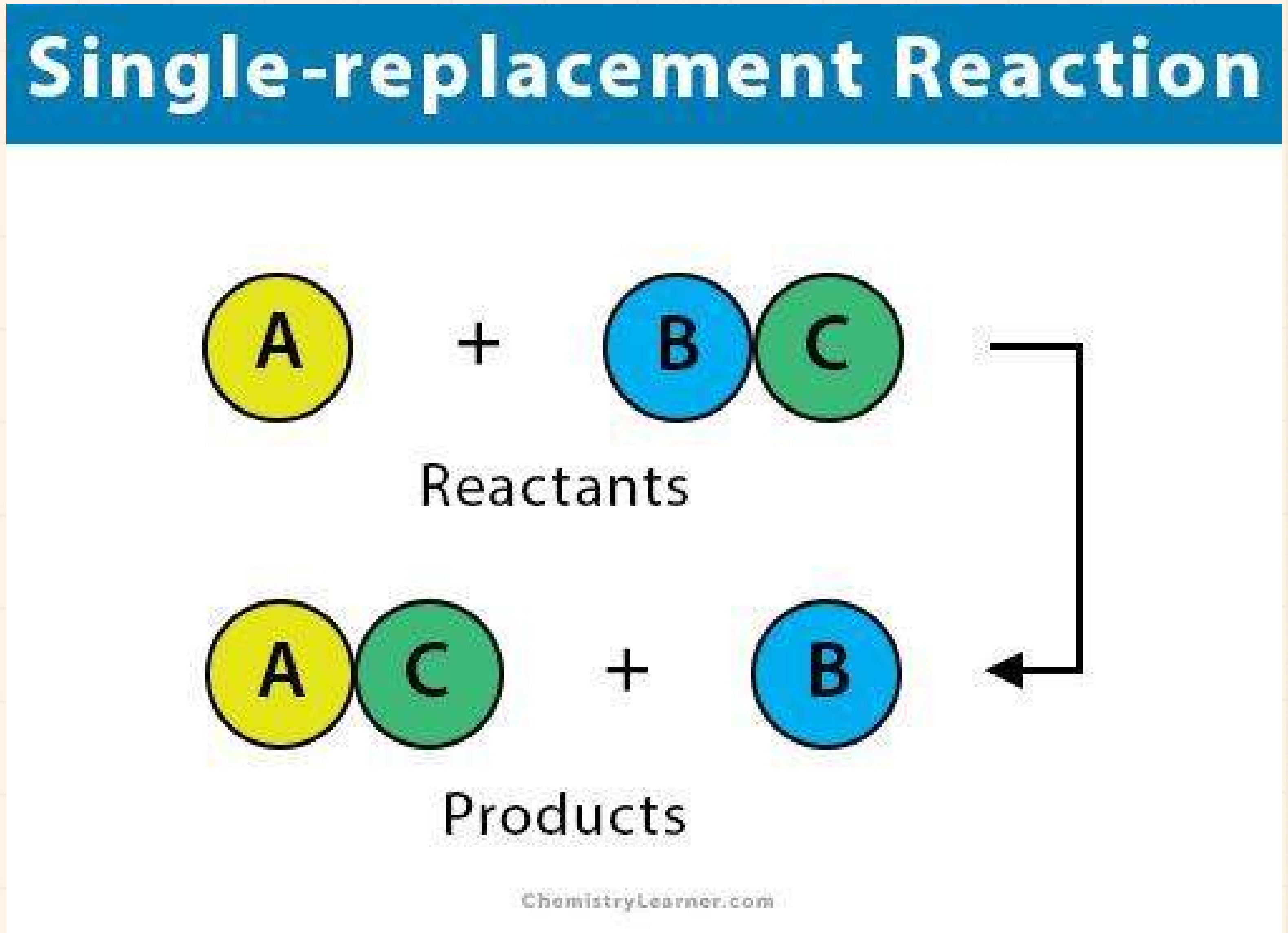

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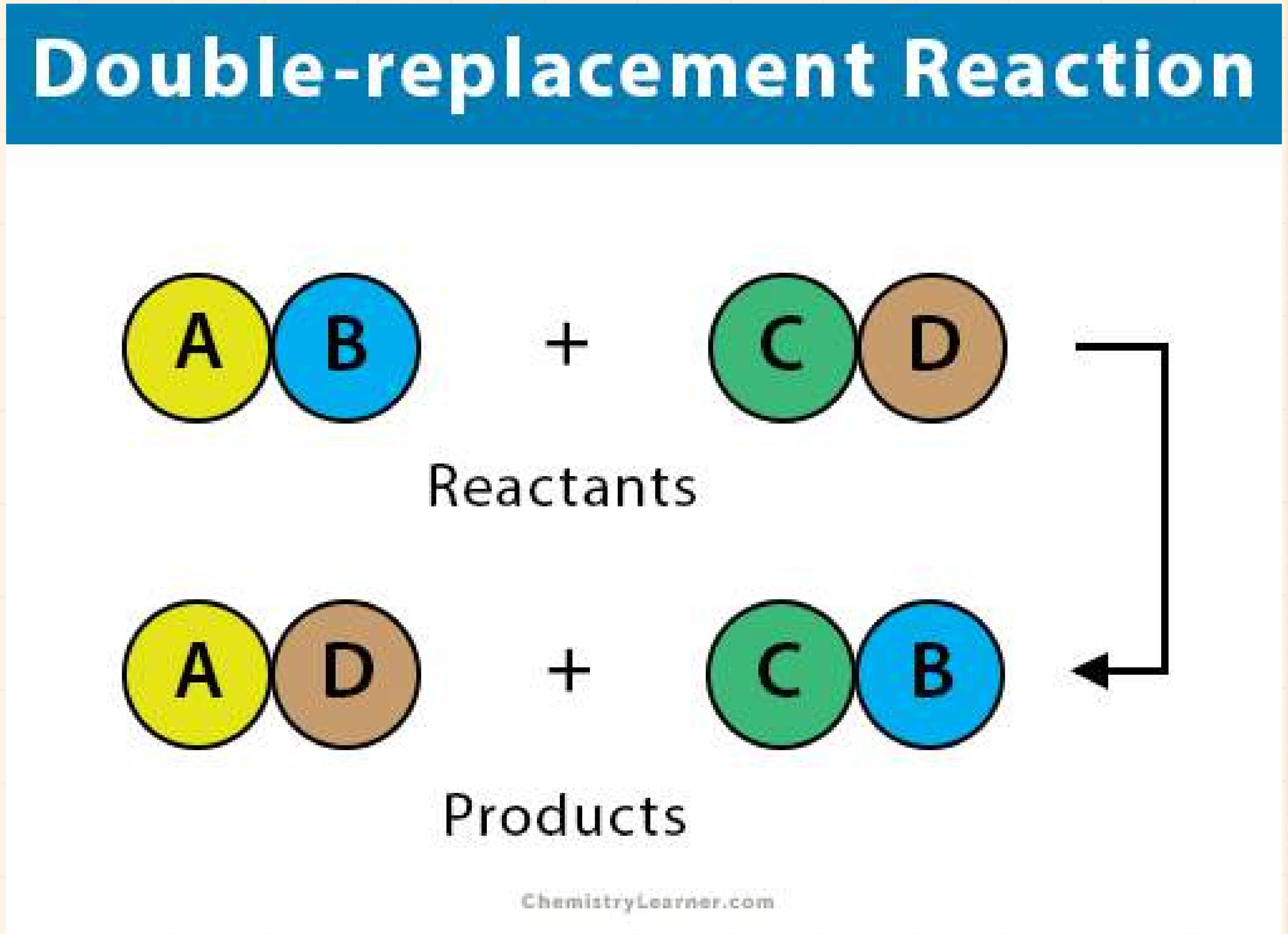

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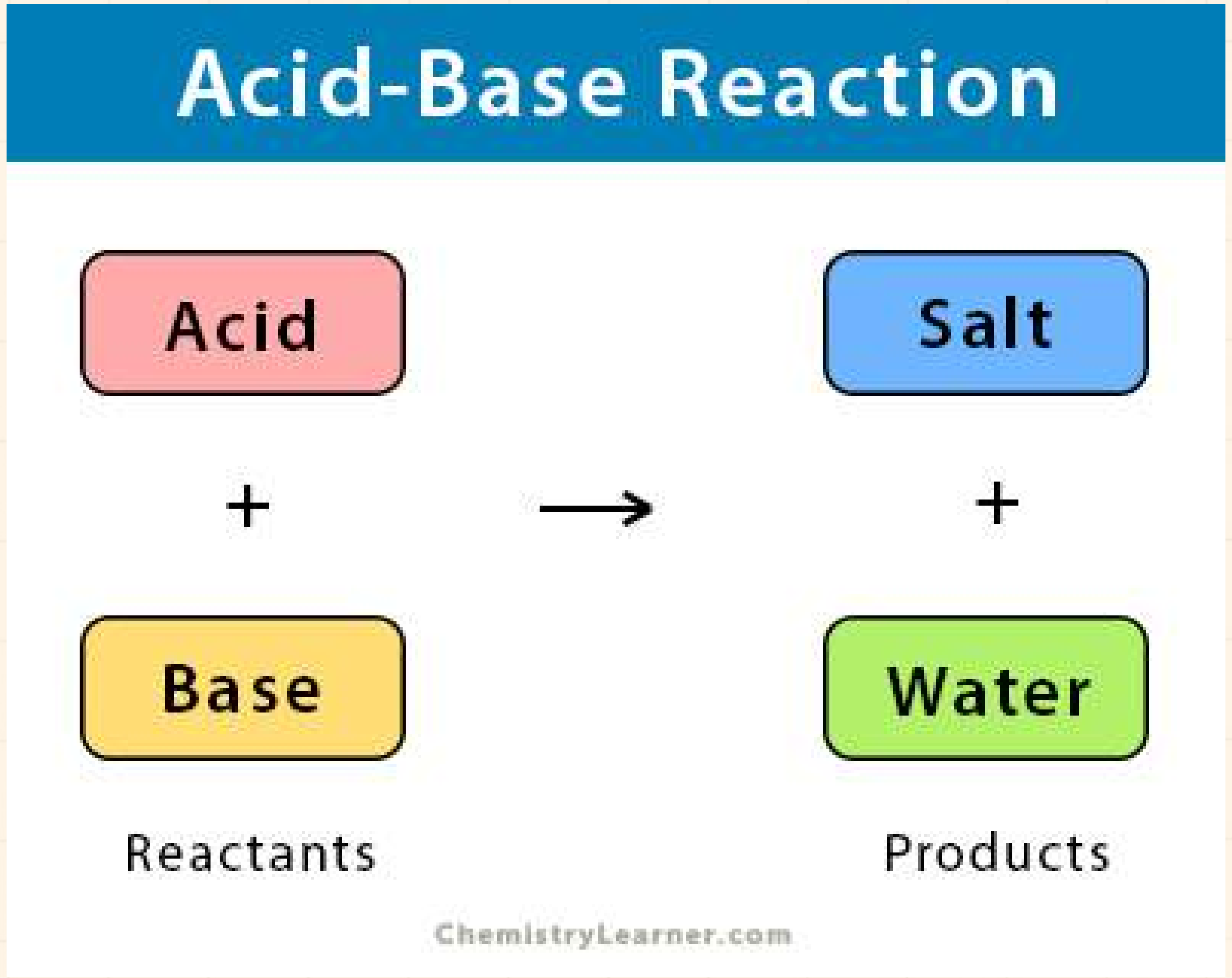

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TYPES OF CHEMICAL REACTIONS

Reaction Type	Description
Combustion	Combustion is the formation of CO_2 and H_2O from the reaction of a chemical and O_2.
Combination (synthesis)	Combination is the addition of 2 or more simple reactants to form a complex product.
Decomposition	Decomposition is when complex reactants are broken down into simpler products.
Double Displacement	Double displacement is when two elements from one reactant switch with two elements of the other to form two new reactants.
Single Displacement	Single displacement is when an element from one reactant switches with an element of the other to form two new reactants.
Acid-Base	Acid-base reactions are when two reactants form salts and water.

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INTRODUCTION TO STOICHIOMETRY

- Derived from Greek words:
- "Stoikhein" meaning "element"
- "Metron" meaning "measure"
- Importance: Essential for determining quantitative data in chemical reactions

IMPORTANCE OF BALANCING REACTIONS

- Foundation: Based on the Law of Conservation of Mass.
- Principle: Matter is neither created nor destroyed.
- Application: The number of elements in reactants **equals** the number of elements in products.
- Importance: Crucial for converting **between different amounts of elements** in chemical reactions.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

C=1		C=1
H=4	=	H=4
O=4		O=4

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IMPORTANCE OF BALANCING REACTIONS

- Representation: Chemical reactions are depicted as equations.
- **Aim**: To ensure that the number of atoms for each element is **equal** on both sides of the equation.
- Method: Achieved by adjusting the coefficients of the reactants and products.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

C=1		C=1
H=4	=	H=4
O=4		O=4

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COEFFICIENTS OF STOICHIOMETRY

- Definition: Numbers placed **in front** of atoms or molecules in a chemical equation.
- Purpose: To ensure that the number of atoms of each element is **balanced on both sides of the equation.**
- Types: Can be fractions, but **whole numbers** are preferred for simplicity.
- Function: Establish the **mole ratio between reactants and products**.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

C=1		C=1
H=4	=	H=4
O=4		O=4

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COEFFICIENTS OF STOICHIOMETRY

- Determining the Quantity of Products: Calculating how much product is formed from a **given amount of reactants.**
- Conversion Between Reactants and Products: Converting amounts of **reactants to products and vice versa.**
- Solving Stoichiometric Problems: Solving problems related to the **quantities** of substances involved in chemical reactions.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

C=1		C=1
H=4	=	H=4
O=4		O=4

BASICS OF BALANCING REACTIONS

Key Principle in Balancing Equations:

- Least Common Multiples: Use the least common multiples for the elements involved to find the correct coefficients.

Applying Coefficients:

- Approach: Focus on balancing molecules or paired elements first, and adjust unpaired elements or molecules last.

Balance:

- Atoms: Ensure that there are equal numbers of each element on both sides of the equation.
- Charge: Verify that the total charge is balanced on both sides of the equation.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

C=1		C=1
H=4	=	H=4
O=4		O=4

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MOLE

The mole concept is fundamental in chemistry for understanding the quantity of particles in substances.

- **Mole:** Represents 6.022×10^{23} entities (atoms, molecules, ions), known as Avogadro's number, linking macroscopic and microscopic scales.
- **Molar Mass:** The mass of one mole of a substance, expressed in grams per mole (g/mol).
- **Calculation:** The number of moles is calculated using the formula:

$$\text{Moles} = \frac{\text{Mass (g)}}{\text{Molar Mass (g/mol)}}$$

MOLE

- **Stoichiometric Calculations:** Facilitates calculations based on balanced chemical equations to determine reactant and product quantities.
- **Molarity (M):** Expresses the concentration of a solute in a solution, calculated as moles of solute per liter of solution ($M = \frac{\text{moles of solute}}{\text{liters of solution}}$).

Overall, the mole concept is essential for understanding chemical reactions, performing stoichiometric calculations, and achieving accurate quantification in chemistry.

UNDERSTANDING MOLAR MASS

To find the molar mass:

- For Atoms or Ions: Use the atomic mass listed on the periodic table.
- For Compounds or Molecules:
    - Sum of Atomic Masses: Add up the atomic masses of all atoms in the compound.
    - Multiply: Multiply each atomic mass by the number of each type of atom present.

This process determines the compound's molar mass.

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UNDERSTANDING MOLAR MASS

Density (ρ):

$$\rho = \frac{\text{Mass}}{\text{Volume}}$$

Calculations using Density:

- To Find Mass:

$$\text{Mass} = \text{Volume} \times \rho$$

- To Find Volume:

$$\text{Volume} = \frac{\text{Mass}}{\rho}$$

UNDERSTANDING MOLARITY

Molarity (M):

$$\text{Molarity} = \frac{\text{Moles}}{\text{Liters}}$$

Represents: The concentration of a solute in a solution.

Calculations using Molarity:

- **To Determine Moles:**

$$\text{Moles} = \text{Molarity} \times \text{Volume (Liters)}$$

- **To Ascertain Volume:**

$$\text{Volume (Liters)} = \frac{\text{Moles}}{\text{Molarity}}$$

DETERMINING EMPIRICAL FORMULAS

To determine the empirical formula of a molecule:

1. Identify Elements: Determine which elements are present in the molecule.
2. Determine Ratio: Calculate the ratio of these elements based on the number of moles of each element present.
3. Simplify Ratio: Express this ratio as the simplest whole number.

This process provides the empirical formula, which represents the smallest whole-number ratio of elements in the compound.

DETERMINING MOLECULAR FORMULAS

To determine the molecular formula from the empirical formula:

1. **Start with the Empirical Formula:** Determine it using the method outlined previously.
2. **Find Molecular Mass:** This is typically determined experimentally.
3. **Divide & Calculate:**

$$\text{Factor} = \frac{\text{Molecular Mass}}{\text{Molar Mass of Empirical Formula}}$$

4. **Determine Molecular Formula:**
   - Multiply the subscripts in the empirical formula by the factor obtained in step 3 to get the molecular formula.

ANY QUESTIONS?

MESSAGE ON WHATSAP

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