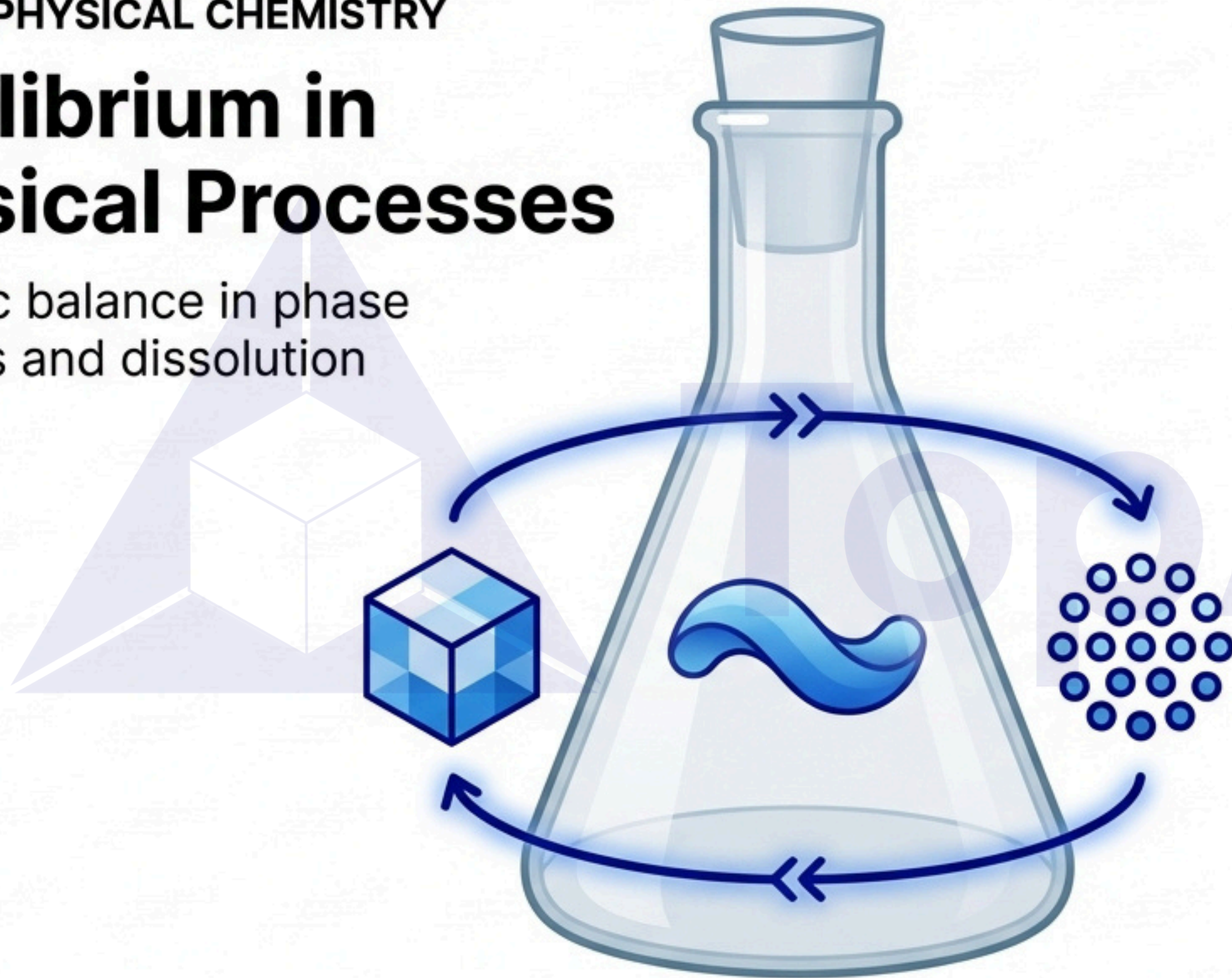


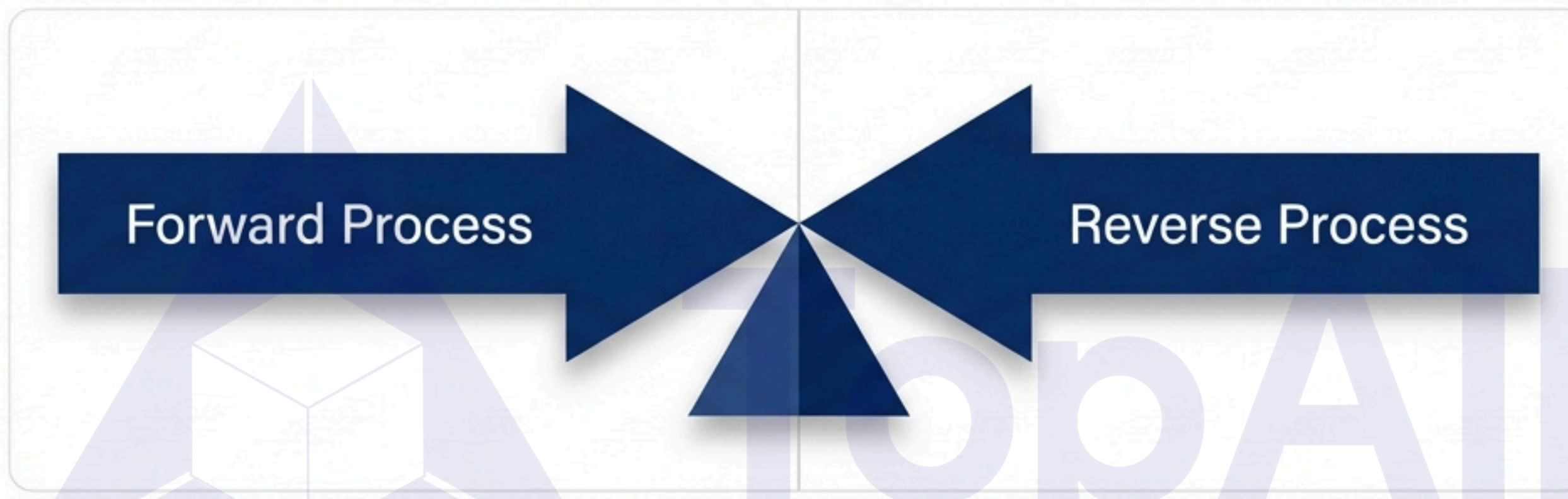
Equilibrium in Physical Processes

Dynamic balance in phase changes and dissolution



CORE CONCEPT

The State Of Balance



Equilibrium is the exact stage in a closed system where opposite processes continue to occur simultaneously.

The system reaches balance when the rate of the forward process becomes exactly equal to the rate of the reverse process.

EQUATION

$$Rate_{\{forward\}} = Rate_{\{reverse\}}$$

CONCEPTUAL DISTINCTION



Physical vs. Chemical Equilibrium

Physical Equilibrium

Phase transformations & dissolution

No breaking or making of chemical bonds. The chemical composition and identity of the substance remain identical.



Chemical Equilibrium

Reactants converting to products

Involves the breaking of old bonds and the formation of new bonds. Entirely new chemical substances are formed.



Remember: Physical equilibrium usually appears as straightforward phase changes (like ice melting to water) or **solute dissolution** (like sugar dissolving in a syrup).



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Main Types Of Physical Equilibrium

Solid $\rightleftharpoons$ Liquid

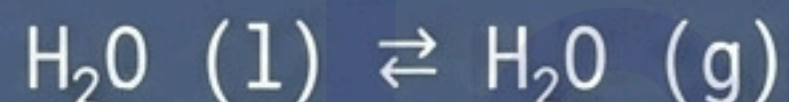
Melting / Freezing



- Occurs at the normal melting point.
- The rate of melting exactly equals the rate of freezing.
- The mass of both phases remains perfectly constant.

Liquid $\rightleftharpoons$ Gas

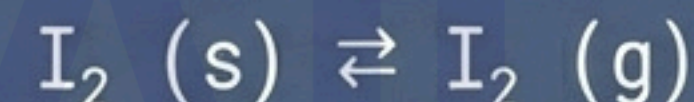
Evaporation / Condensation



- Occurs in a closed vessel.
- The rate of evaporation exactly equals the rate of condensation.
- Achieves a constant equilibrium vapour pressure.

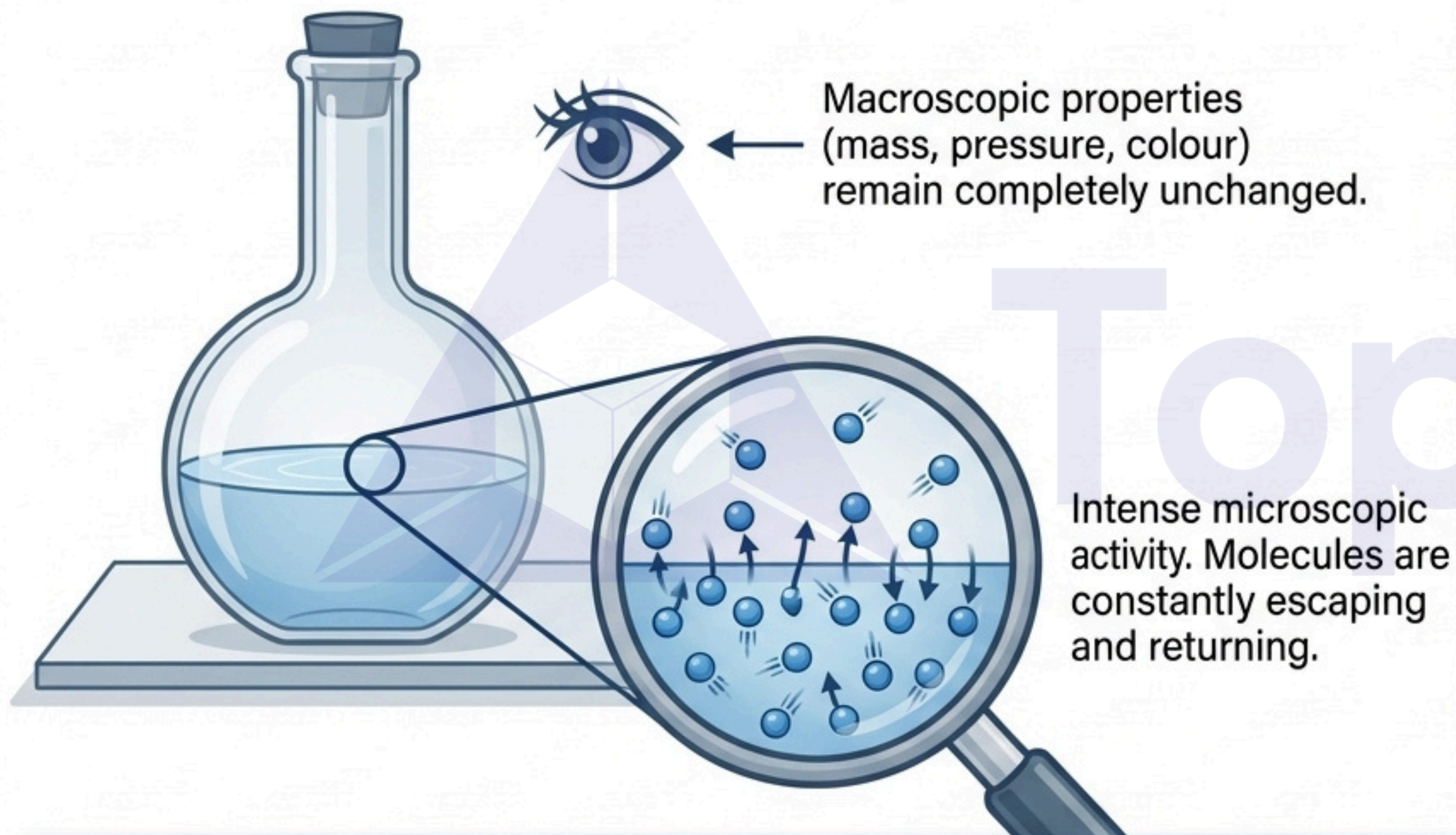
Solid $\rightleftharpoons$ Gas

Sublimation



- Direct phase change without a liquid state.
- Example: Solid iodine subliming into violet vapour until the colour intensity becomes constant.

Equilibrium Is Dynamic, Not Static



The Illusion

To the naked eye, it looks like all chemical and physical activity has completely stopped.

The Reality

Both opposing processes are still happening. Because they happen at the exact same rate, **the net macroscopic change is zero.**

Remember: The system hasn't stopped working; it's just working equally in both directions!

The 3 Pillars Of Physical Equilibrium

1

Environment

Closed System

Equilibrium can only be achieved in a closed system at a given temperature. If the system is open, matter escapes into the surroundings and balance becomes impossible.

2

Mechanism

Equal Opposing Rates

Both the forward process and the reverse process occur simultaneously at the exact same rate. This is what makes the system dynamic rather than static.

3

Observation

Constant Measurable Properties

At equilibrium, one or more macroscopic parameters—such as vapour pressure, melting point, colour intensity, or concentration—reach a stable, constant value.



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