

General Characteristics of Physical Equilibrium

Defining the fundamental rules and measurable properties of phase transformations and dissolution in a dynamic state.



Exam Summary

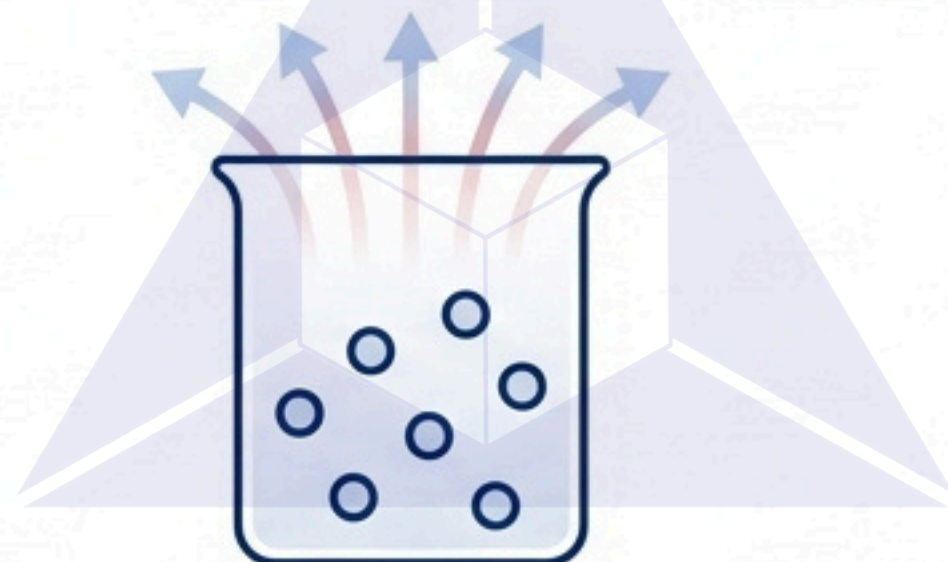
5 Core Principles

The Closed System Requirement

Equilibrium can only be achieved when a system is isolated from its surroundings at a given temperature, preventing the escape of matter.

Open System

Matter Escapes



The rate of the reverse process (condensation/crystallization) can never equal the forward process. Equilibrium is impossible.

Closed System

Matter Retained



Confined molecules build up, allowing the reverse process to accelerate until rates perfectly equalize. Equilibrium is achieved.



Temperature must also remain constant. A change in temperature alters the kinetic energy of the system, shifting the equilibrium.



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$$E=mc^2$$



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Key Highlights

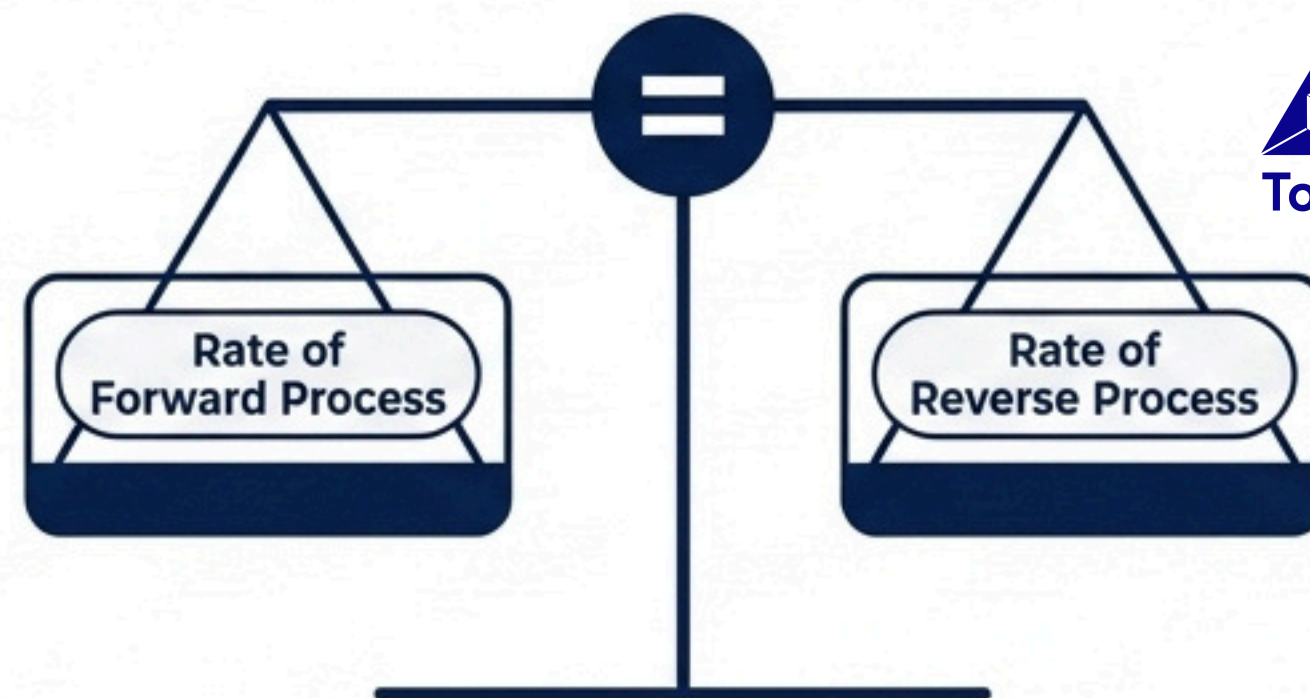
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ESSENTIAL CONDITION 02

Dynamic Stability: Equal Opposing Rates

Physical equilibrium is never static. It is a highly active state where two opposing processes occur simultaneously and at the exact same velocity.



Macroscopic View (What we see)

Stable and unchanging. The total measurable amount of reactants and products (e.g., ice and water) remains perfectly constant.



Microscopic View (What is happening)

Intensely dynamic. Molecules continuously and actively cross the phase boundary back and forth.

$$\text{Rate}(\text{forward}) = \text{Rate}(\text{reverse})$$

Constant Measurable Properties

When equilibrium is attained, all macroscopic properties stabilize. The system is characterized by a specific, constant parameter at a given temperature.

Process Type	Equation Pill	Constant Parameter
Phase Change Liquid $\rightleftharpoons$ Vapour	$\text{H}_2\text{O}(l) \rightleftharpoons \text{H}_2\text{O}(g)$	Vapour Pressure ($p_{\text{H}_2\text{O}}$) is constant at a given temperature.
Phase Change Solid $\rightleftharpoons$ Liquid	$\text{H}_2\text{O}(s) \rightleftharpoons \text{H}_2\text{O}(l)$	Melting point is fixed at constant pressure.
Dissolution Solute(s) $\rightleftharpoons$ Solute(aq)	$\text{Sugar}(s) \rightleftharpoons \text{Sugar}(aq)$	Concentration of solute in saturated solution is constant at a given temperature.
Dissolution Gas(g) $\rightleftharpoons$ Gas(aq)	$\text{CO}_2(g) \rightleftharpoons \text{CO}_2(aq)$	Ratio of $[\text{gas}(aq)] / [\text{gas}(g)]$ is constant at a given temperature.

CHAPTER RECAP

The 5 Features of Physical Equilibrium



Master these five universal characteristics to accurately predict and define physical equilibria.

1

Closed System

Equilibrium is only possible in a closed system at a specific, given temperature.

2

Dynamic Rates

Both opposing processes occur simultaneously at the exact same rate.

3

Constant Properties

All macroscopic, measurable properties of the system remain unchanged.

4

Signature Parameters

The system is defined by a constant value of one specific parameter (e.g., vapour pressure, solubility).

5

Indicative Magnitude

The magnitude of these constant quantities indicates the extent to which the process proceeded before reaching equilibrium.

Exam Smart

Always verify the existence of a closed boundary and constant temperature before assuming equilibrium can exist.



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