

How Equilibrium Responds to Disturbance

Mastering Le Chatelier's Principle

Class 11 Chemistry

JEE High-Yield



Le Chatelier's Principle

A change in any of the factors that determine the equilibrium conditions of a system will cause the system to change in such a manner so as to **reduce** or **counteract** the effect of the change.



Variables that induce stress: [Concentration] [Pressure] [Temperature] [Catalyst]

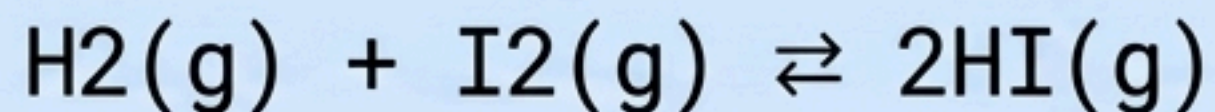
Navy Blue Core Rule: The system shifts to **consume added** substances or **replenish removed** substances.



**Shift
Forward**



Exam Snapshot



Scenario: If H_2 is added, the system shifts right (forward) to consume the excess H_2 .

Formula Bank

$$Q_c = [\text{HI}]^2 / ([\text{H}_2][\text{I}_2])$$

Insight: Adding a reactant makes $Q_c < K_c$. The reaction must move forward until $Q_c = K_c$ again.



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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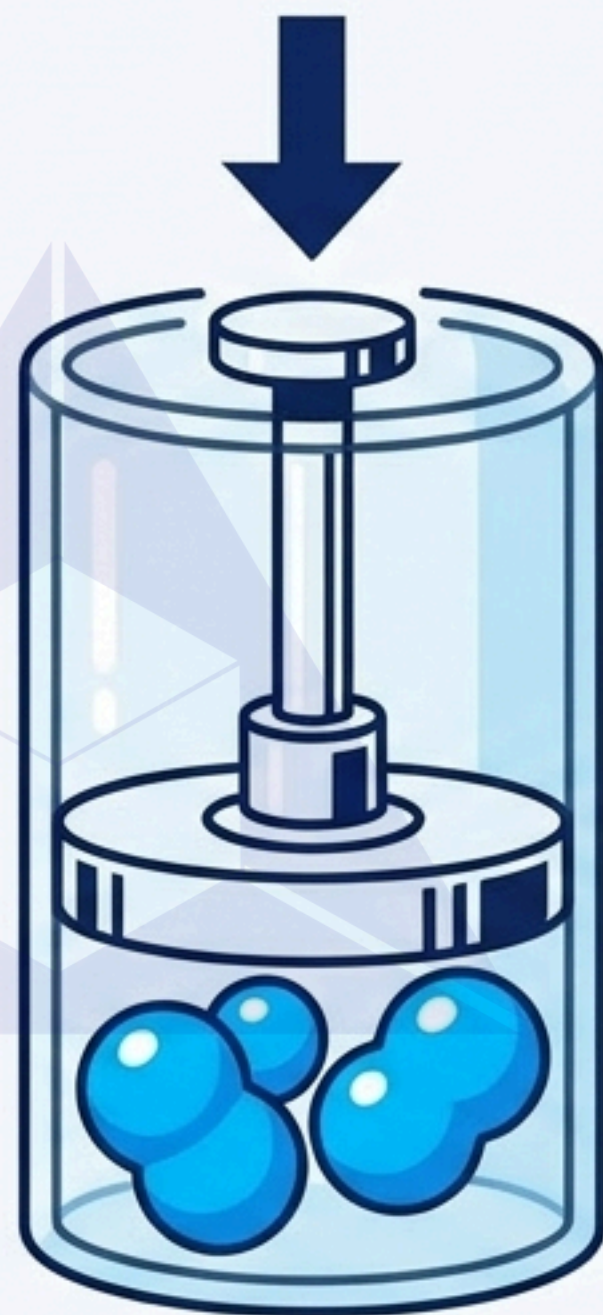


High Volume,
Low Pressure



Before Pressure
Increase
(4 moles gas)

Low Volume,
High Pressure

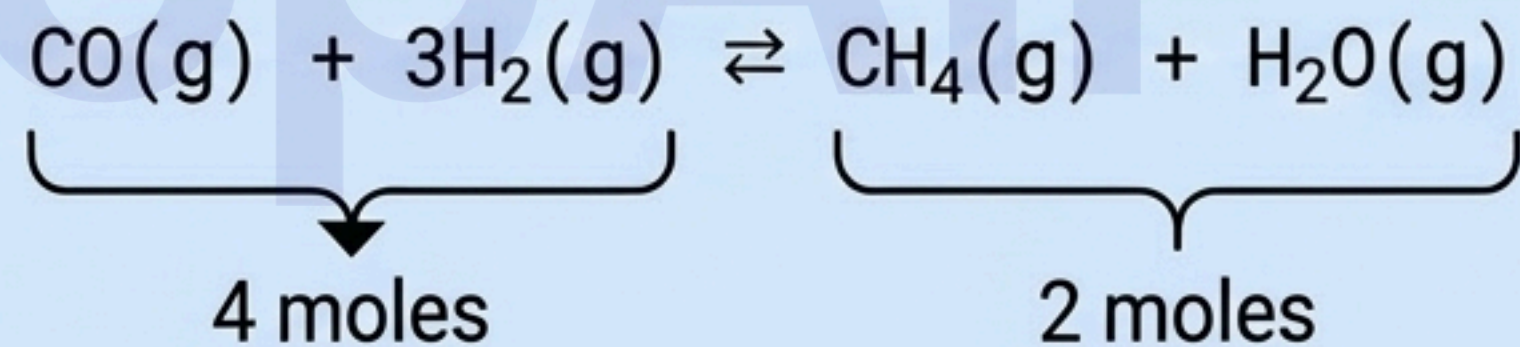


After Pressure
Increase
(2 moles gas)

Increasing pressure (by decreasing volume) shifts equilibrium towards the side with fewer gaseous moles.

Exam Snapshot

The Mole Squeeze



Result: Doubling the pressure forces the reaction forward to reduce total moles and relieve pressure stress.

ALERT: Unlike pressure or concentration, changing temperature actually **CHANGES THE VALUE** of the equilibrium constant (K_c).



Exothermic ($\Delta H < 0$)

Mental Model: Treat Heat as a Product

Action: Raising Temp → Shifts Left.
 K_c decreases.

Haber Process: $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3 + \text{Heat}$

Low temperature favors a high yield of Ammonia.



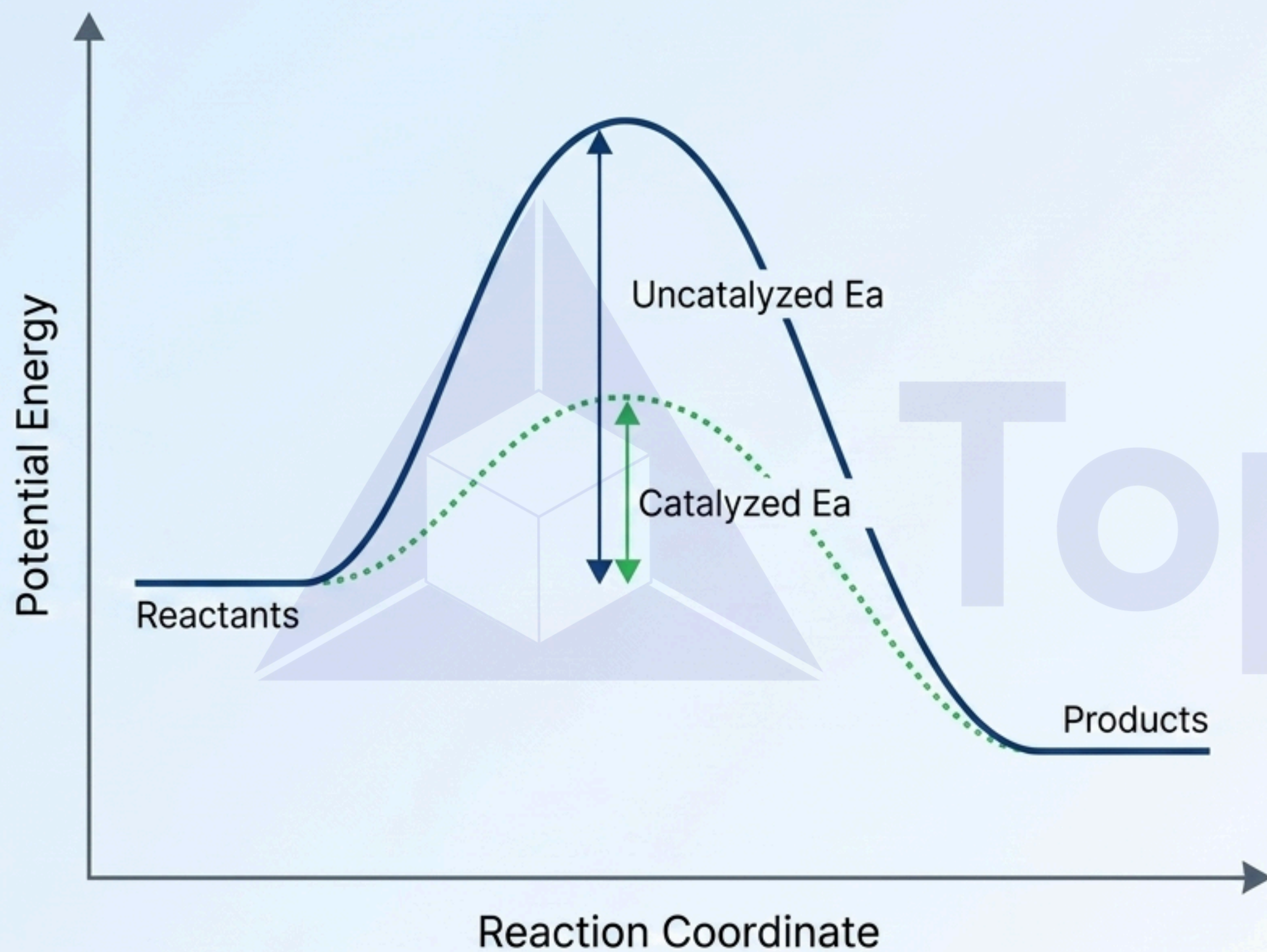
Endothermic ($\Delta H > 0$)

Mental Model: Treat Heat as a Reactant

Action: Raising Temp → Shifts Right.
 K_c increases.

$\text{Heat} + \text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$

High temperature favors product formation.



Core Rule: A catalyst lowers activation energy for both forward and reverse reactions equally.

- ✓ Helps the system reach equilibrium faster.
- ✓ Yields the exact same equilibrium composition.
- ✓ Does not appear in the K_c expression.
- ✓ It is a shortcut, not a destination changer.



JEE TRAP ALERT

~~Adding an iron catalyst to Haber's process will increase the final yield of Ammonia at equilibrium.~~



FALSE! A catalyst does NOT shift the equilibrium position.

- It does NOT change the value of K_c .
- It only alters the time taken to reach the equilibrium state. High yields require pressure/temperature optimization, not just a catalyst.

Equilibrium Shift Quick-Reference

Synthesis Map

	Concentration	Shifts to consume additions or replenish removals.
	Pressure	Increasing Pressure shifts to the side with fewer gaseous moles.
	Temperature	Raising Temp shifts Left for Exothermic ($\Delta H < 0$), Right for Endothermic ($\Delta H > 0$). Only factor that changes K_c value.
	Catalyst	NO SHIFT. Only increases the speed of reaching equilibrium.
	Inert Gas (Constant Volume)	NO SHIFT. Does not alter partial pressures of reacting gases.



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