

CHEMICAL KINETICS • 3.4.1

Effect of Catalyst.

Lowering the barrier, not changing the destination.

A reaction coordinate diagram illustrating the effect of a catalyst. The vertical axis represents potential energy, and the horizontal axis represents the reaction progress. A dashed grey curve represents the uncatalyzed reaction path, which has a high activation energy barrier. A solid blue curve represents the catalyzed reaction path, which has a lower activation energy barrier. Both curves start at the same energy level on the left and end at the same lower energy level on the right, indicating that the catalyst lowers the energy barrier without changing the overall free energy change of the reaction. The background features a faint watermark of a chemical structure and the word 'TopAll'.



Catalyst

A substance that increases the rate of a chemical reaction without undergoing any permanent chemical change itself.



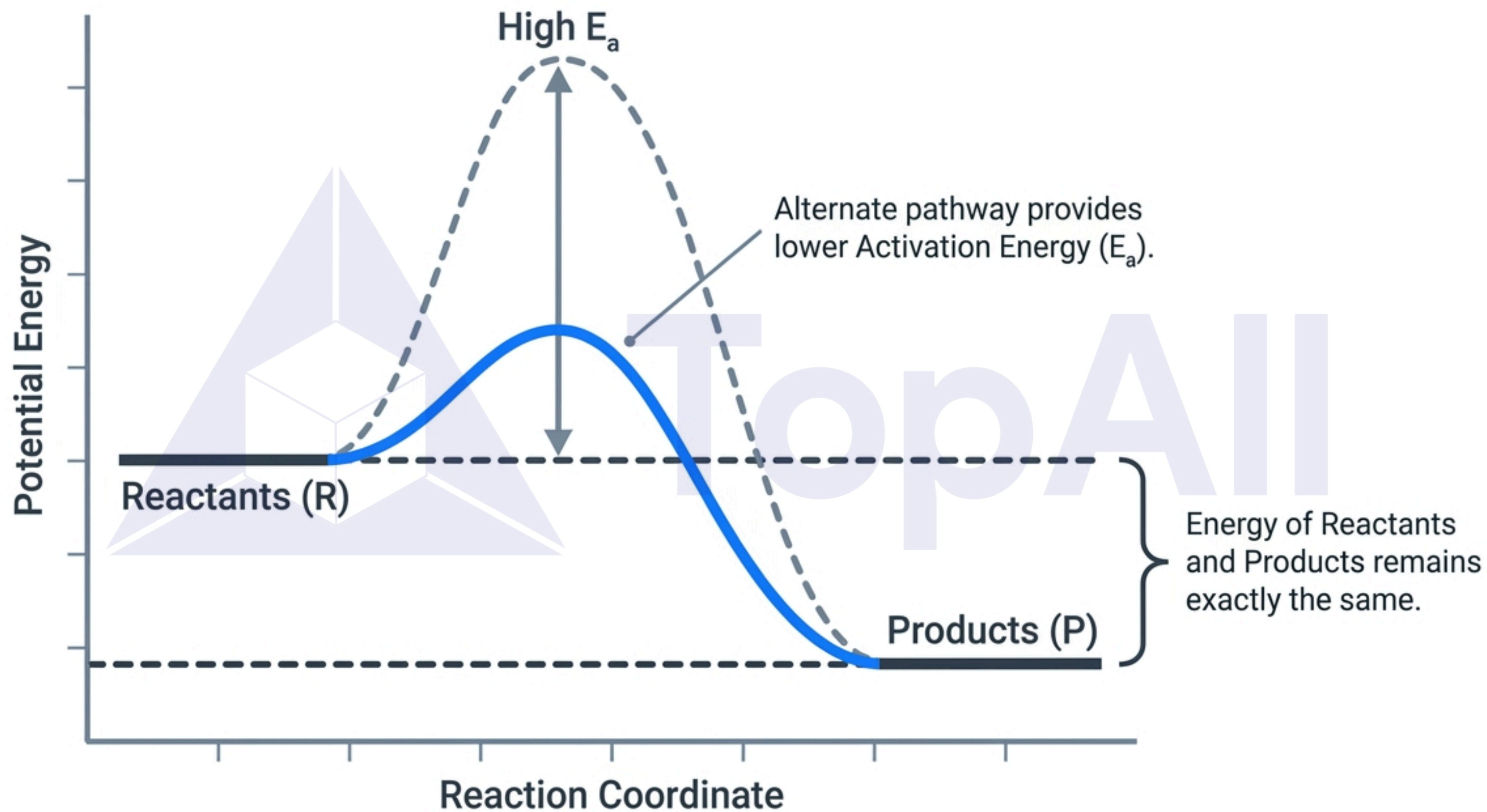
Inhibitor

A substance that reduces the rate of a reaction (sometimes referred to as a negative catalyst).



Intermediate Complex Theory

The catalyst participates by forming temporary bonds with reactants, creating a transitory intermediate complex that quickly decomposes into products.





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$$E=mc^2$$



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A very small amount of MnO_2 can catalyze the decomposition of a massive quantity of KClO_3 .

Does a catalyst alter Gibbs Energy (ΔG)?

NO

Does a catalyst change the Equilibrium Constant (K_{eq})?

NO

Does it speed up both forward and backward directions equally?

YES

Does it help the reaction reach equilibrium faster?

YES



Rule of thumb: Catalysts accelerate spontaneous reactions, but they can NEVER force a non-spontaneous reaction to occur.



JEE / NEET TRAP ALERT

A catalyst NEVER shifts the position of equilibrium.

It only reaches it faster. Because a catalyst lowers the activation energy for both the forward and backward reactions by the exact same amount, the rates of both directions are boosted to the same extent.

The final equilibrium state remains completely untouched.

The Bottom Line

- ✓ Catalysts provide an alternate mechanism/pathway with a lower activation energy (E_a).
- ✓ They are not consumed in the reaction (small amounts catalyze large quantities).
- ✓ They have zero effect on thermodynamic endpoints: ΔG and K_{eq} remain completely unchanged.
- ✓ Equilibrium is reached faster because forward and backward reaction rates increase equally.



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