

Potential Energy Diagrams: Exothermic Reactions and Catalysts

This worksheet develops your ability to analyze and interpret potential energy diagrams for exothermic reactions ([Outcome](#)) and to explain how catalysts affect activation energy without changing the overall enthalpy change ([Outcome](#)).

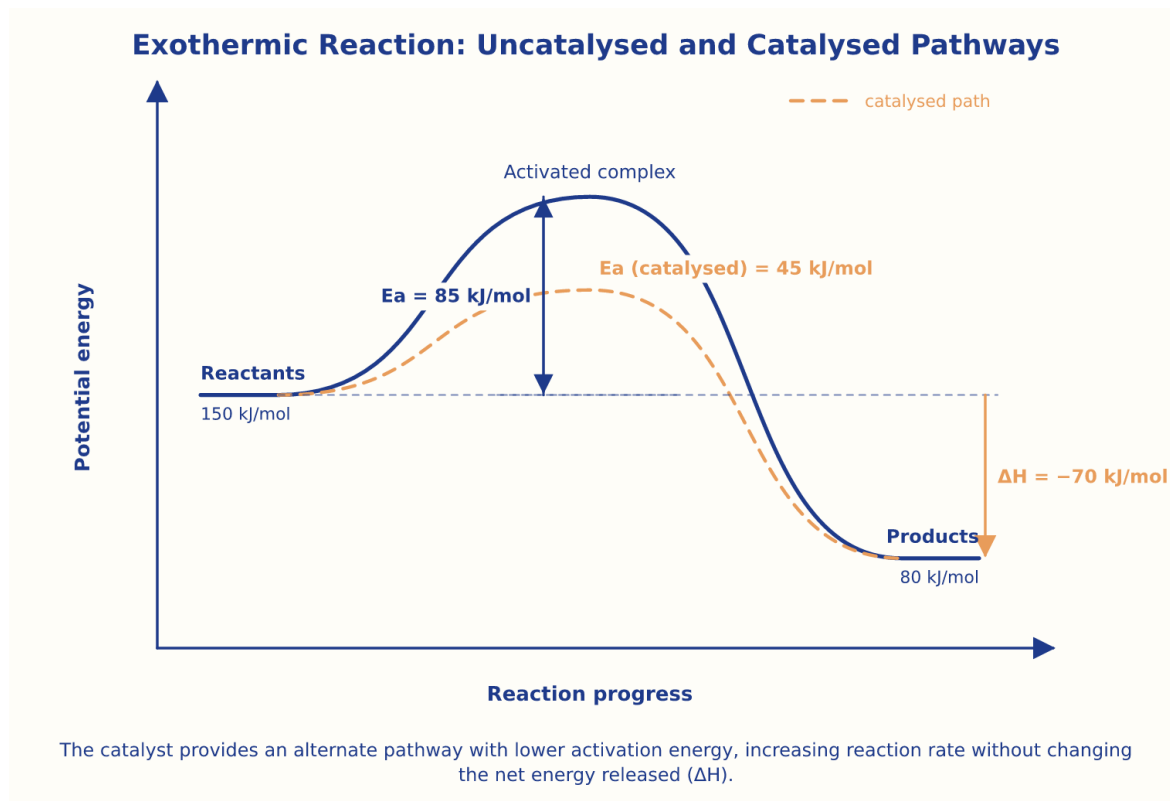


Figure 1: Potential energy diagram of an exothermic reaction: Reactants at 150 kJ/mol, Products at 80 kJ/mol, $E_a = 85$ kJ/mol, E_a (catalysed) = 45 kJ/mol, $\Delta H = -70$ kJ/mol.

Exercises

- Using the diagram, calculate the enthalpy change (ΔH) for this reaction. Show your work and include the sign and units.
- The activation energy for the uncatalyzed pathway is _____ kJ/mol. The activation energy for the catalyzed pathway is _____ kJ/mol. The catalyst lowers the activation energy by _____ kJ/mol.
- Which statement correctly describes the role of the catalyst in this reaction?
 - The catalyst lowers the energy of the products, making the reaction more exothermic.
 - The catalyst provides an alternate pathway that requires less energy to reach the transition state, without changing ΔH .
 - The catalyst increases the energy released when reactants form products.
 - The catalyst changes the enthalpy change from exothermic to endothermic.
- A student claims that because the catalyst lowers the activation energy, the products must have lower potential energy than they do in the uncatalyzed reaction. Explain why this claim is incorrect.

- The potential energy of the reactants is 150 kJ/mol. Using the diagram and the enthalpy change you calculated in Exercise 1, verify that the potential energy of the products is 80 kJ/mol.
- This reaction is classified as exothermic ([Outcome](#)). Explain how the diagram supports this classification, and state what would be different if the reaction were endothermic instead.

Answer Key

- 9D, $\Delta H = -70 \text{ kJ/mol}$. The negative sign indicates the reaction is exothermic (energy is released).
- 85 kJ/mol; 45 kJ/mol; 40 kJ/mol.
- B
- The catalyst does not change the potential energy of the reactants or products. It only provides an alternate pathway with a lower activation energy. The products have the same potential energy (80 kJ/mol) whether the reaction proceeds through the catalyzed or uncatalyzed route.
- Figure 1 9D, $\Delta H = -70 \text{ kJ/mol}$. $150 - 70 = 80 \text{ kJ/mol}$, which matches the product energy shown in the diagram.

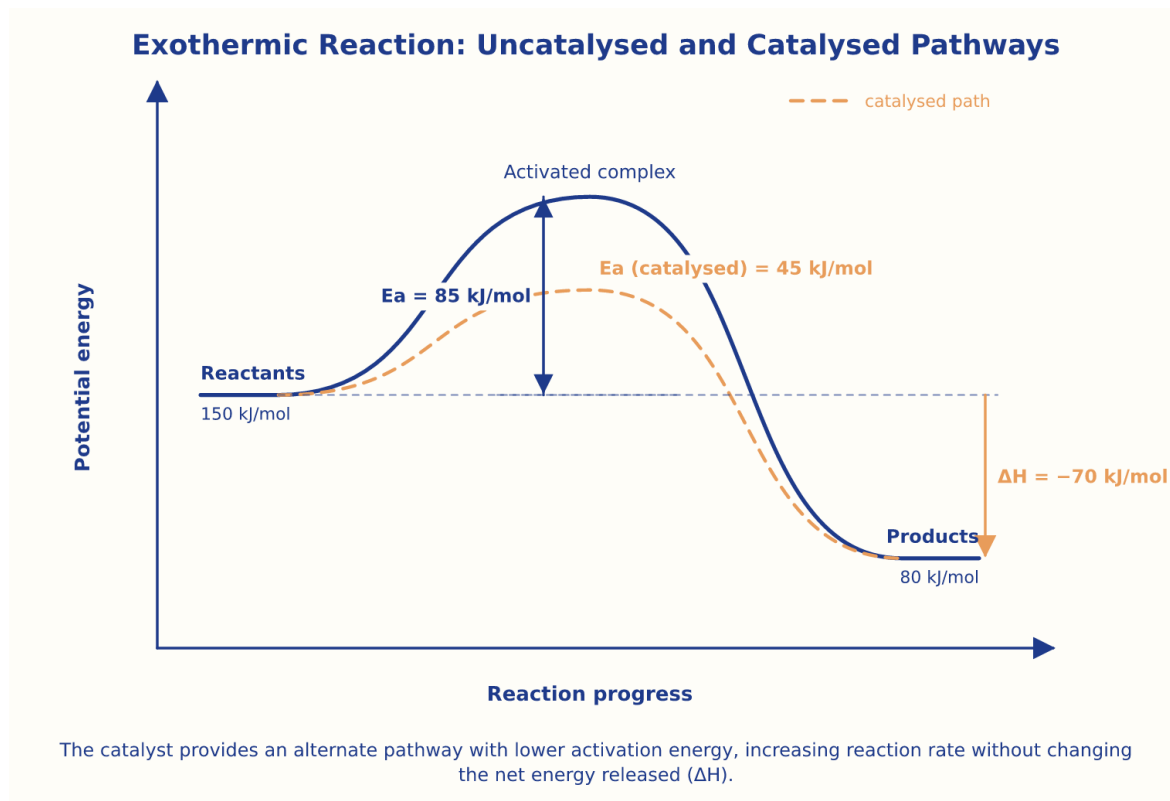


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- The diagram shows products at lower potential energy than reactants, which means energy is released to the surroundings; this defines an exothermic reaction. In an endothermic reaction, the products would be at higher potential energy than the reactants, and the ΔH could be positive.

