

Potential Energy Diagrams: Exothermic Reactions and Catalysts

This worksheet develops your ability to analyze and interpret potential energy diagrams for exothermic chemical reactions ([Outcome](#)). You will examine how catalysts affect activation energy while leaving the overall energy change of the reaction unchanged ([Outcome](#)).

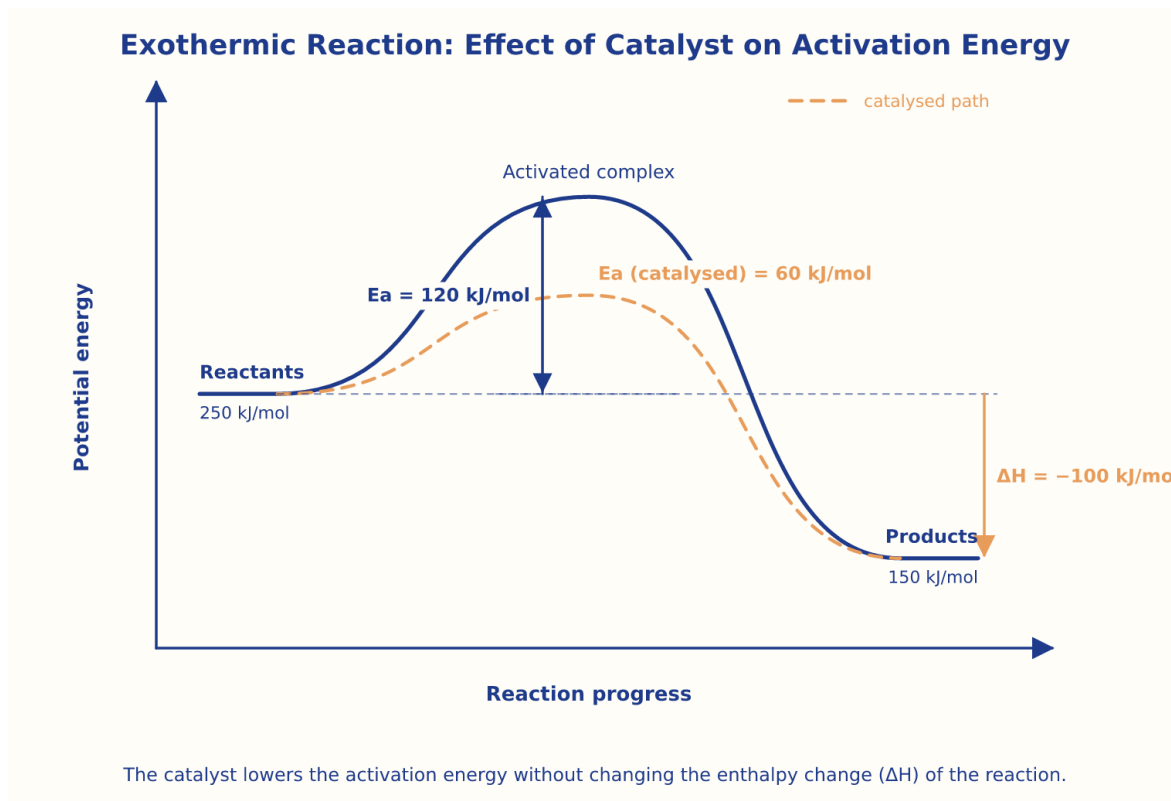


Figure 1: Potential energy diagram of an exothermic reaction: Reactants at 250 kJ/mol, Products at 150 kJ/mol, $E_a = 120$ kJ/mol, $\Delta H = -100$ kJ/mol.

Exercises

- Using the diagram, identify the enthalpy change (ΔH) for this reaction and classify it as endothermic or exothermic. Show your calculation.

$\Delta H =$ _____

This reaction is _____ because _____.

- The activation energy for the uncatalyzed reaction is shown on the diagram. Calculate the activation energy for the catalyzed pathway and explain why a catalyst lowers this barrier.

E_a (uncatalyzed) = _____ kJ/mol

E_a (catalyzed) = _____ kJ/mol

A catalyst lowers activation energy by _____.

- On the diagram, the reactants are at 250 kJ/mol and the products are at 150 kJ/mol. If a different exothermic reaction had reactants at 300 kJ/mol and products at 200 kJ/mol, what would be its enthalpy change?

9D, Ò ðððððððððððððððð ò ¢ðÖðÀ

4. Which statement correctly describes the effect of a catalyst on an exothermic reaction?

- A) A catalyst increases the enthalpy change, making the reaction more exothermic.
- B) A catalyst lowers the activation energy without changing the enthalpy change of the reaction.
- C) A catalyst raises the energy of the products, making them more stable.
- D) A catalyst changes the reactants into different substances with lower potential energy.

5. For the catalyzed pathway shown in the diagram, calculate the difference in activation energy between the uncatalyzed and catalyzed routes. Express this as a percentage reduction.

Difference in E_a = _____ kJ/mol

Percentage reduction = _____ %

6. A student claims that because the catalyzed reaction has a lower activation energy, it must release more energy overall than the uncatalyzed reaction. Use the diagram to explain why this claim is incorrect.

Answer Key

1. 9D, Ò !# ¢ðÖðÀ° exothermic because the products have lower potential energy than the reactants (or because energy is released).
2. E_a (uncatalyzed) = 120 kJ/mol; E_a (catalyzed) = 60 kJ/mol; a catalyst provides an alternate reaction pathway that requires less energy to reach the transition state.
3. 9D, Ò !# ¢ðÖðÀ
4. B
5. Difference in E_a = 60 kJ/mol; Percentage reduction = 50% (or $60 \div 120 \times 100$).
6. Figure 1 Both pathways start at the same reactant energy (250 kJ/mol) and end at the same product energy (150 kJ/mol), so both release the same amount of energy (" 100 kJ/mol). The catalyst only affects how fast the reaction occurs, not how much energy is released overall.

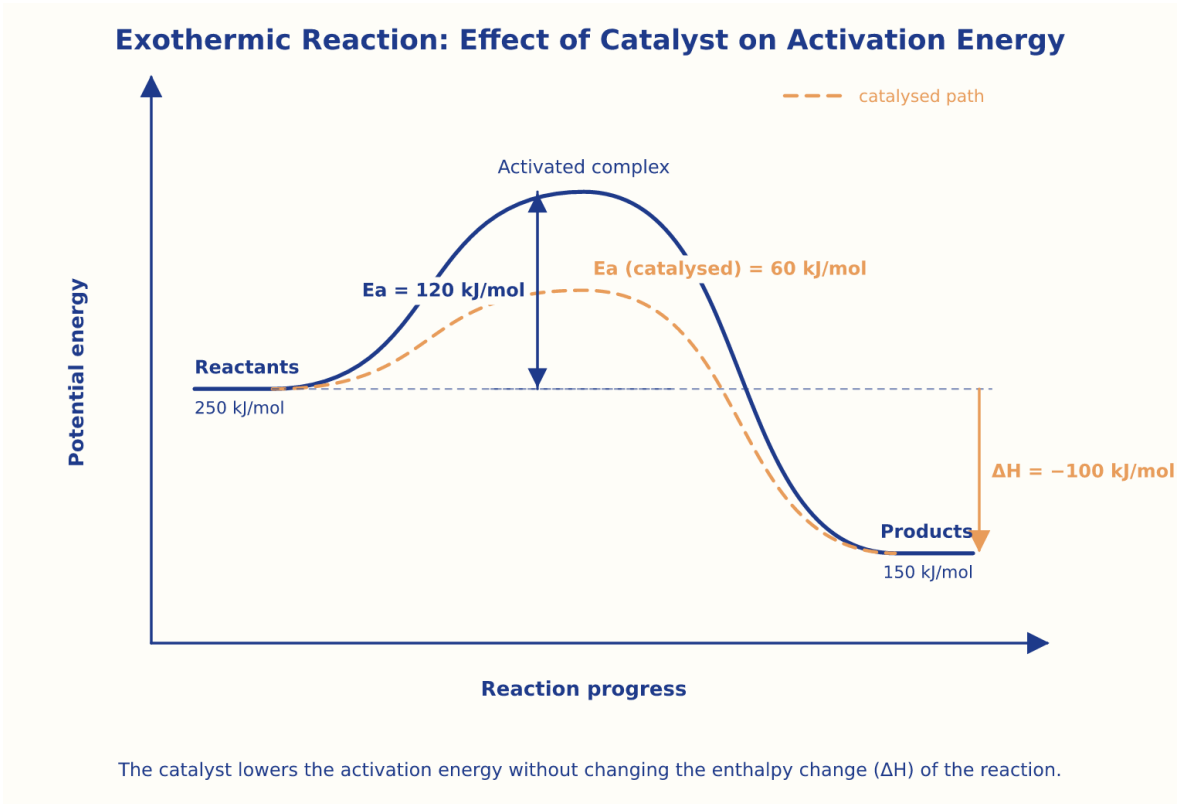


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