

Potential Energy Diagrams and Catalysts

This worksheet develops your ability to analyze and interpret energy diagrams for chemical reactions ([Outcome](#)) and to explain how catalysts affect activation energy without changing the overall energy released or absorbed ([Outcome](#)).

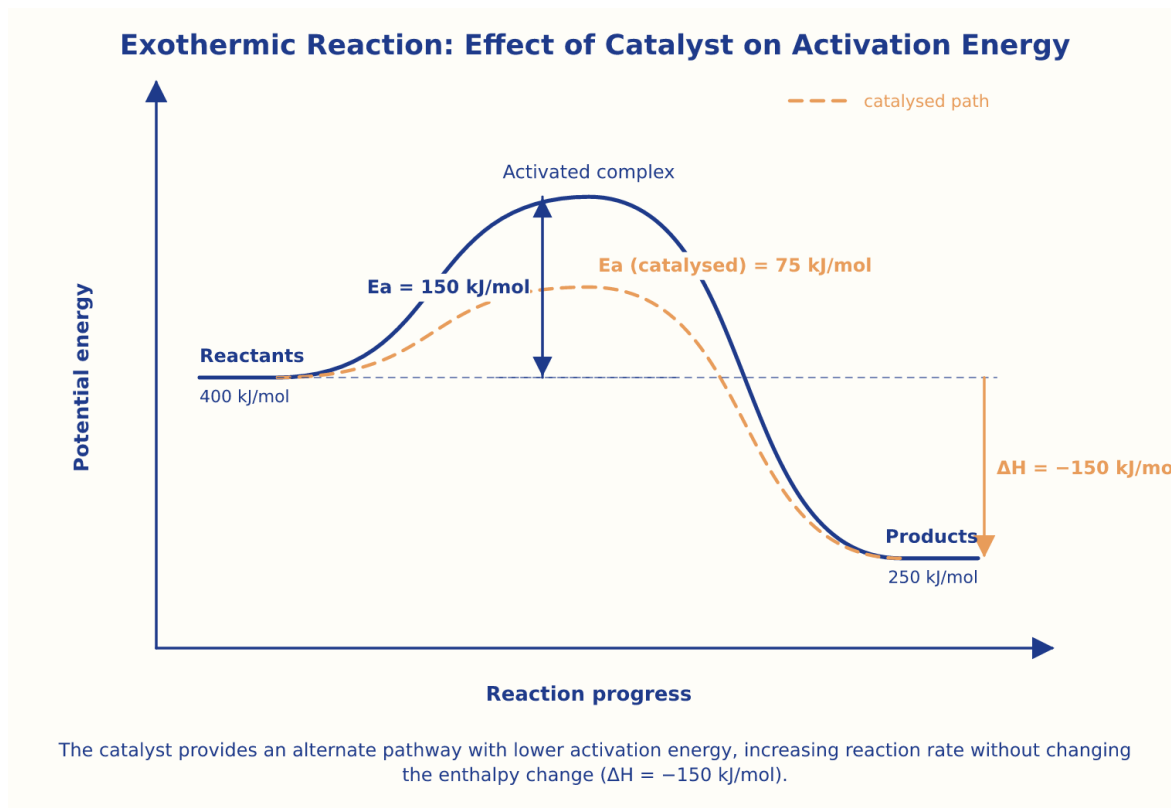


Figure 1: Potential energy diagram of an exothermic reaction: Reactants at 400 kJ/mol, Products at 250 kJ/mol, $E_a = 150 \text{ kJ/mol}$, $\Delta H = -150 \text{ kJ/mol}$.

Exercises

- Use the diagram to identify the potential energy of the reactants and products. What is the enthalpy change for this reaction? Show your calculation.

Reactants: _____ kJ/mol

Products: _____ kJ/mol

$\Delta H =$ _____ kJ/mol

- Classify this reaction as endothermic or exothermic. Explain your answer using evidence from the diagram.

- The activation energy for the uncatalyzed pathway is 150 kJ/mol. When a catalyst is added, the activation energy becomes 75 kJ/mol. Calculate the reduction in activation energy.

Reduction in $E_a =$ _____ kJ/mol

Does the catalyst change the value of ΔH for this reaction? Circle one: **Yes / No**

Explain:

4. On the diagram, the catalyzed pathway shows a lower activation energy. Which of the following best explains why a catalyst lowers the activation energy?
 - A) The catalyst provides an alternate reaction pathway with a lower energy barrier.
 - B) The catalyst increases the potential energy of the reactants.
 - C) The catalyst decreases the potential energy of the products.
 - D) The catalyst increases the kinetic energy of all molecules in the reaction mixture.
 5. A student claims that because the catalyzed reaction has a lower activation energy, it must release more energy than the uncatalyzed reaction. Is this claim correct? Explain your reasoning.
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6. For the uncatalyzed reaction, compare the activation energy to the enthalpy change. What does this relationship tell you about the energy required to break bonds versus the energy released when bonds form?
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Answer Key

1. Reactants: 400 kJ/mol; Products: 250 kJ/mol; 9D, 0 # S ' ¢öÖöÀ
2. Exothermic. The products have lower potential energy than the reactants, so energy is released to the surroundings.
3. Reduction in $E_a = 75$ kJ/mol; No. The catalyst provides an alternate pathway but does not change the overall energy difference between reactants and products.
4. A
5. No. The enthalpy change (9D, 0 # S ' ¢öÖöÀ' FW VæG2 öæÇ' öâ F†R F–f' erence in potential energy between reactants and products, not on the activation energy. Both pathways release the same amount of energy.
6. In this particular diagram, the activation energy happens to equal the magnitude of 9D,Â ut this is a numerical coincidence. Activation energy is the energy needed to reach the transition state, which is independent of the total energy of bonds broken in the reactants.