

Potential Energy Diagrams: Exothermic Reactions and Catalysts

Energy diagrams show the path a reaction takes from reactants to products and reveal the energy barrier that must be overcome ([Outcome](#), [Outcome](#)). Catalysts lower this barrier without changing the overall energy released, allowing reactions to proceed faster ([Outcome](#)).

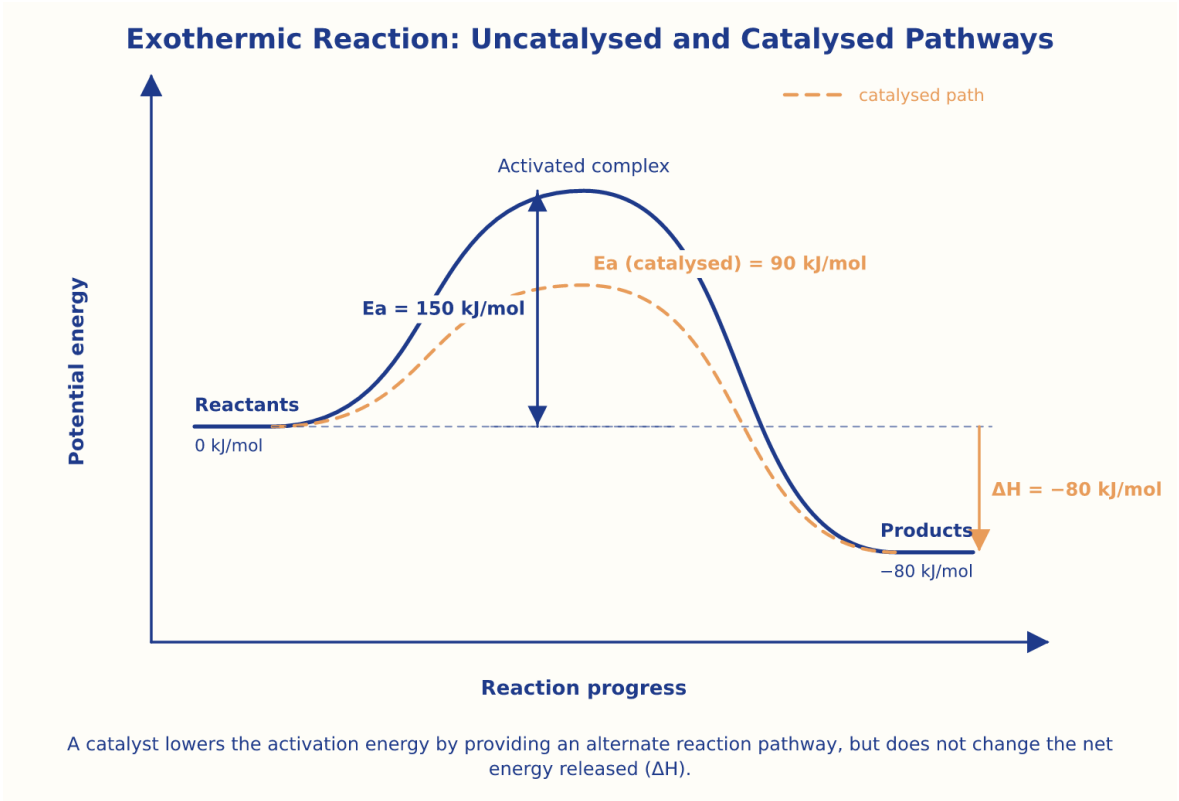


Figure 1: Potential energy diagram of an exothermic reaction: Reactants at 0 kJ/mol, Products at -80 kJ/mol, $E_a = 150 \text{ kJ/mol}$, $E_a (\text{catalysed}) = 90 \text{ kJ/mol}$, $\Delta H = -80 \text{ kJ/mol}$.

Exercises

- Multiple choice.** An exothermic reaction has reactants at 0 kJ/mol and products at -80 kJ/mol. What is E_a for this reaction?
A) -80 kJ/mol
B) +80 kJ/mol
C) 150 kJ/mol
D) 90 kJ/mol
- Short answer.** Using the diagram, identify the activation energy (E_a) of the uncatalysed reaction. Write your answer with units.
- Matching.** Match each term on the left to its definition on the right.

Term	Definition
Activation energy	The energy difference between reactants and products

Enthalpy change (9D,•	The minimum energy needed for reactants to form products
Catalyst	A substance that speeds up a reaction by lowering the activation energy

- Short answer.** The diagram shows two pathways: one uncatalysed ($E_a = 150 \text{ kJ/mol}$) and one catalysed ($E_a = 90 \text{ kJ/mol}$). By how many kilojoules does the catalyst lower the activation energy?
- Analysis.** A student claims that adding a catalyst to this reaction will make the products have more energy than they do in the uncatalysed reaction. Is this claim correct? Explain your reasoning using the diagram.
- Calculation.** In the uncatalysed pathway, reactants must gain 150 kJ/mol to reach the transition state. In the catalysed pathway, reactants must gain 90 kJ/mol to reach the transition state. Express the ratio of the catalysed activation energy to the uncatalysed activation energy as a fraction in lowest terms.

Answer Key

- A) " 80 kJ/mol
- 150 kJ/mol
- Activation energy !' The minimum energy needed for reactants to form products; Enthalpy change (9D,' " The energy difference between reactants and products; Catalyst !' A substance that speeds up a reaction by lowering the activation energy
- 60 kJ/mol ($150 - 90 = 60$)
- No, the claim is incorrect. Figure 1 shows that both pathways end at the same product energy level (" 80 kJ/mol). The catalyst provides an alternate pathway with lower activation energy but does not change the final energy of the products ([Outcome](#)).

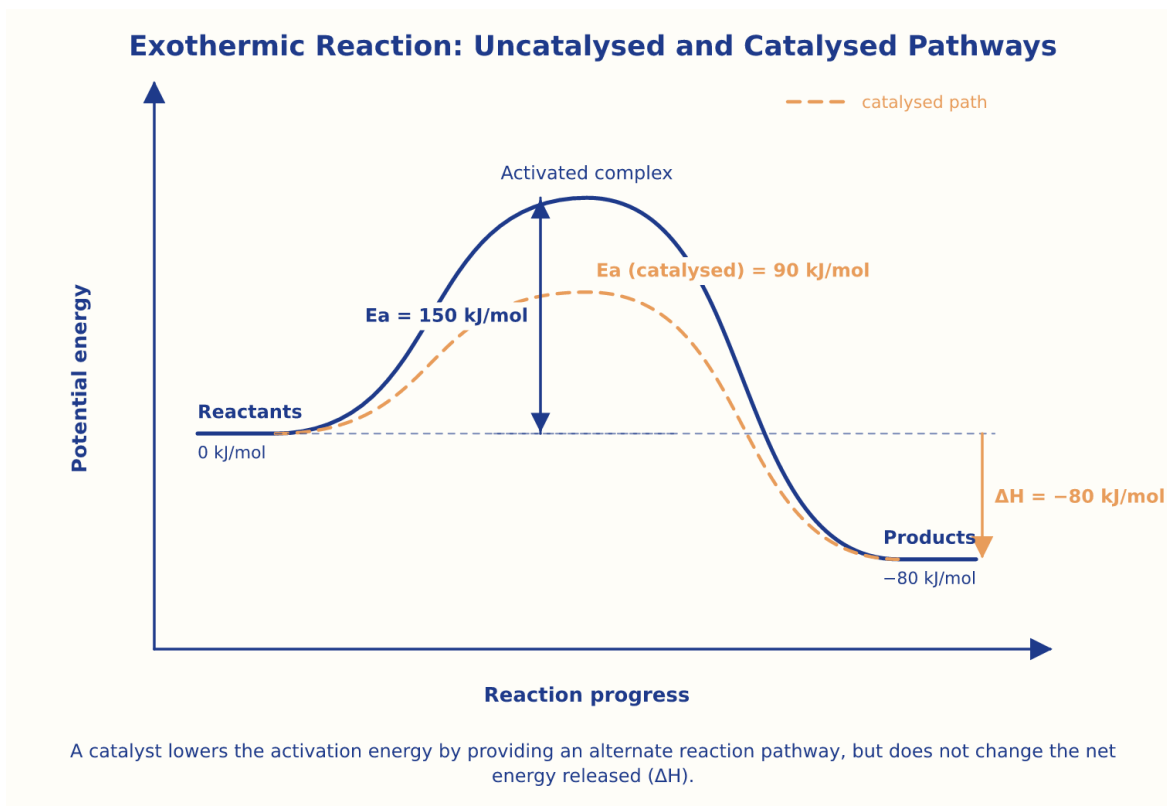


Figure 1: Potential energy diagram of an exothermic reaction: Reactants at 0 kJ/mol, Products at -80 kJ/mol, $E_a = 150$ kJ/mol, $E_a(\text{catalysed}) = 90$ kJ/mol, $\Delta H = -80$ kJ/mol.

6. $\frac{3}{5}$ ($90 \div 150 = 90/150 = 3/5$)