

Potential Energy Diagrams: Exothermic Reactions and Catalysts

This worksheet asks you to read and interpret a potential energy diagram for an exothermic reaction, with attention to activation energy, enthalpy change, and the effect of a catalyst on the reaction pathway ([Outcome](#), [Outcome](#)). You will also apply the definitions of enthalpy and catalysis to explain what changes, and what stays the same, when a catalyst is added ([Outcome](#), [Outcome](#)).

Exercises

1. Reading the diagram

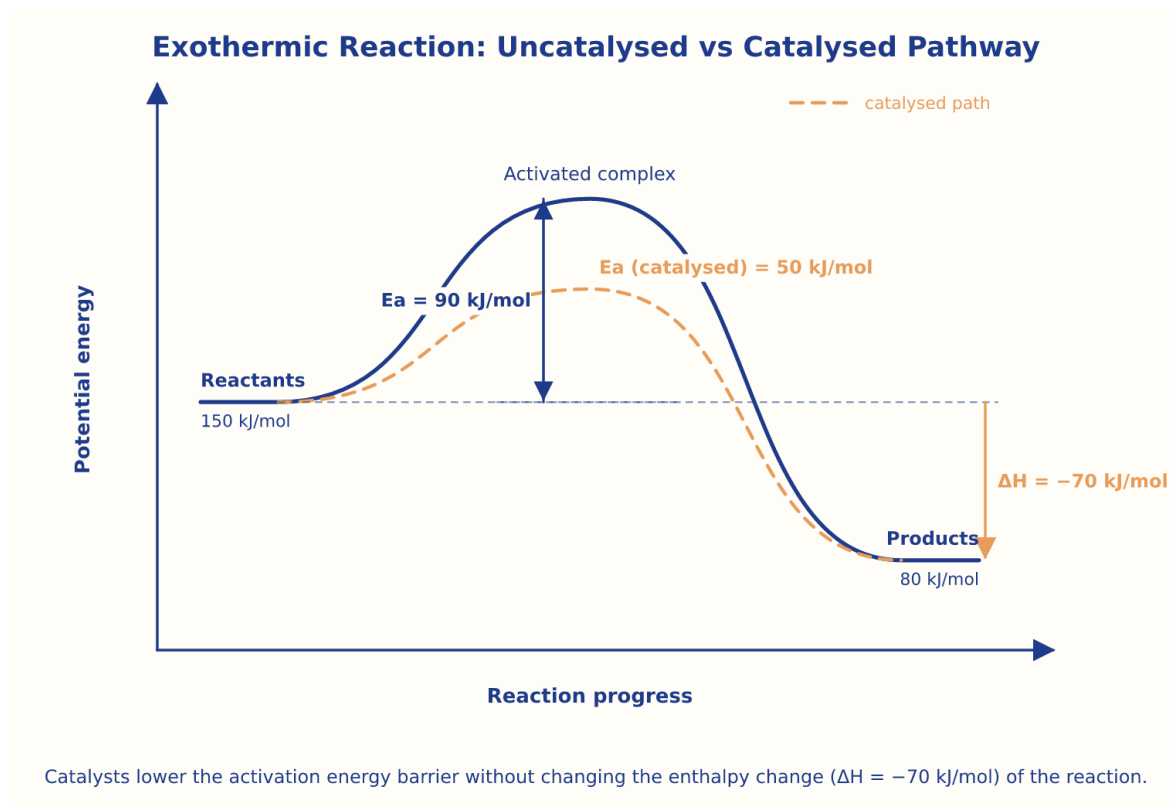


Figure 1: Potential energy diagram of an exothermic reaction: Reactants at 150 kJ/mol, Products at 80 kJ/mol, $E_a = 90 \text{ kJ/mol}$, $E_a (\text{catalysed}) = 50 \text{ kJ/mol}$, $\Delta H = -70 \text{ kJ/mol}$.

Using the potential energy diagram described above, answer the following.

- Potential energy of the reactants: _____ kJ/mol
- Potential energy of the products: _____ kJ/mol
- Activation energy (uncatalyzed pathway), E_a : _____ kJ/mol
- Activation energy (catalyzed pathway): _____ kJ/mol
- Enthalpy change, ΔH : _____ kJ/mol

2. Calculations from the diagram

Show your work for each calculation.

- Calculate the potential energy of the activated complex (transition state) for the uncatalyzed pathway.

b) Calculate the potential energy of the activated complex for the catalyzed pathway.

c) Confirm that $\Delta H_{\text{activation}}$ is the value shown on the diagram. Show the subtraction.

3. Classifying the reaction

Circle the correct classification, then justify your answer in one sentence using the enthalpy change ([Outcome](#)).

Endothermic / Exothermic

Justification: _____

4. Matching terms to definitions

Match each term on the left to its correct definition on the right by writing the matching letter in the blank.

Term	Match	Definition
1. Activation energy	_____	A) The energy barrier that must be overcome for reactants to convert to products
2. Enthalpy change (ΔH)	_____	B) A substance that provides an alternate reaction pathway with a lower activation energy
3. Catalyst	_____	C) The difference in potential energy between products and reactants
4. Activated complex	_____	D) The unstable, high-energy arrangement of atoms at the peak of the reaction pathway

5. Explaining the catalyst's effect

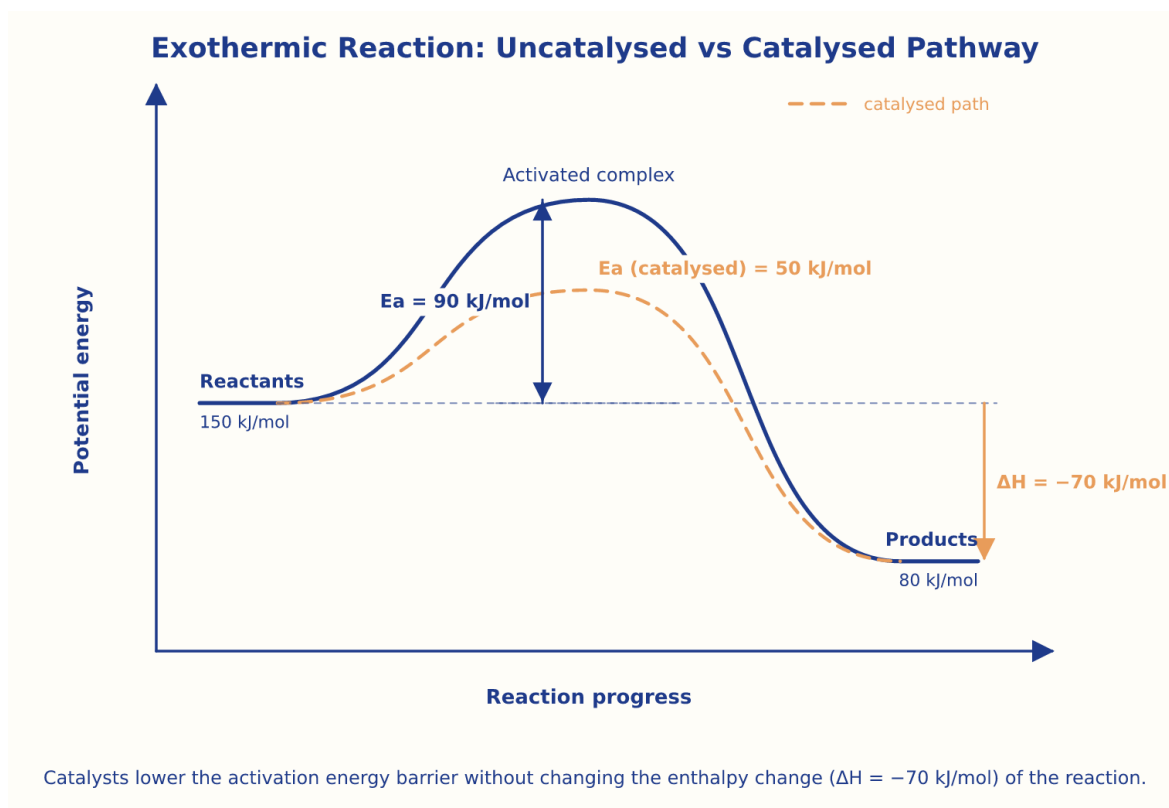


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A student claims that adding a catalyst to this reaction changes the value of ΔH to a smaller negative number. Explain, in two to three sentences, why this claim is incorrect, referring to what a catalyst does and does not change ([Outcome](#)).

6. Multiple choice

Which of the following correctly describes the effect of the catalyst on this reaction, based on the diagram?

- A) The catalyst lowers the potential energy of the products from 80 kJ/mol to a new, lower value.
- B) The catalyst raises the potential energy of the reactants from 150 kJ/mol to a new, higher value.
- C) The catalyst provides an alternate pathway that lowers the activation energy from 90 kJ/mol to 50 kJ/mol, without changing ΔH .
- D) The catalyst increases the value of ΔH , by consuming some of the released energy.

Answer: _____

Answer key

1. a) 150 kJ/mol b) 80 kJ/mol c) 90 kJ/mol d) 50 kJ/mol e) -70 kJ/mol

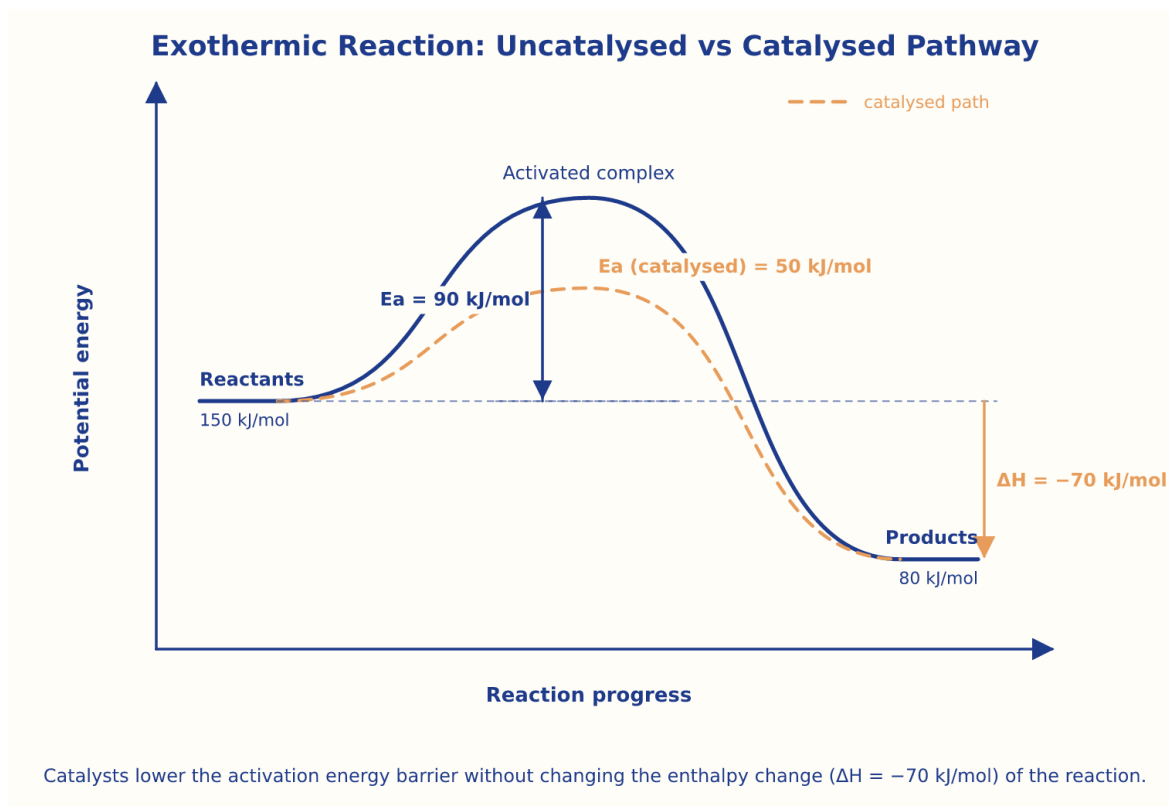


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2. a) $150 + 90 = 240 \text{ kJ/mol}$
 b) $150 + 50 = 200 \text{ kJ/mol}$
 c) $80 - 150 = -70 \text{ kJ/mol}$, matching the diagram
3. Exothermic; $\Delta H = -70 \text{ kJ/mol}$, meaning the products have less potential energy than the reactants, so energy is released to the surroundings ([Outcome](#)).
4. 1-A, 2-C, 3-B, 4-D
5. The claim is incorrect. A catalyst provides an alternate reaction pathway with a lower activation energy (90 kJ/mol drops to 50 kJ/mol), which increases reaction rate, but it does not change the potential energy of the reactants or products. Since $\Delta H = -70 \text{ kJ/mol}$, the difference between reactant and product energy, $\Delta H = -70 \text{ kJ/mol}$, is the same ([Outcome](#)).

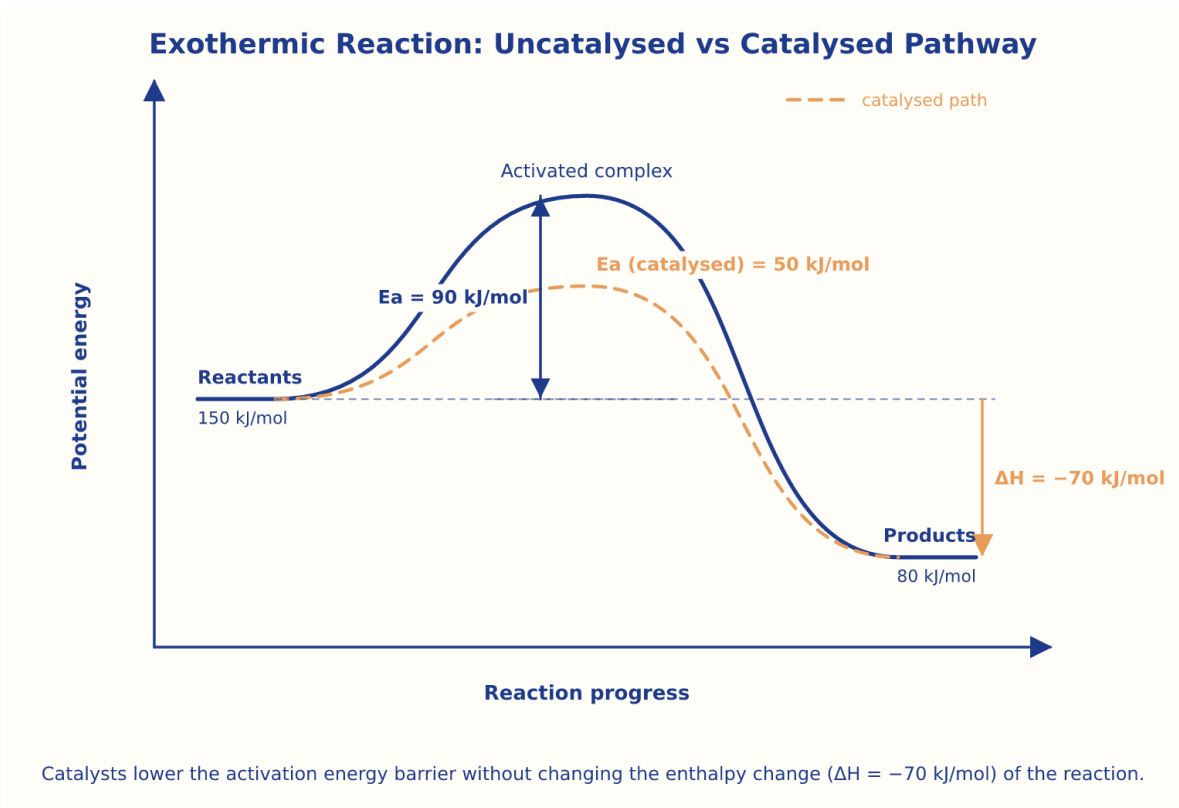


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6. C