

Potential Energy Diagrams and Thermochemical Change

This worksheet asks you to interpret and calculate values from a potential energy diagram of an exothermic reaction, both with and without a catalyst, in line with 30-A2.1k, 30-A2.3k and 30-A2.4k. It also reviews the classification of reactions as exothermic or endothermic (30-A1.10k) and the application of $Q = mc\Delta T$ for heat transfer (30-A1.1k).

Exercises

1. Reading the diagram

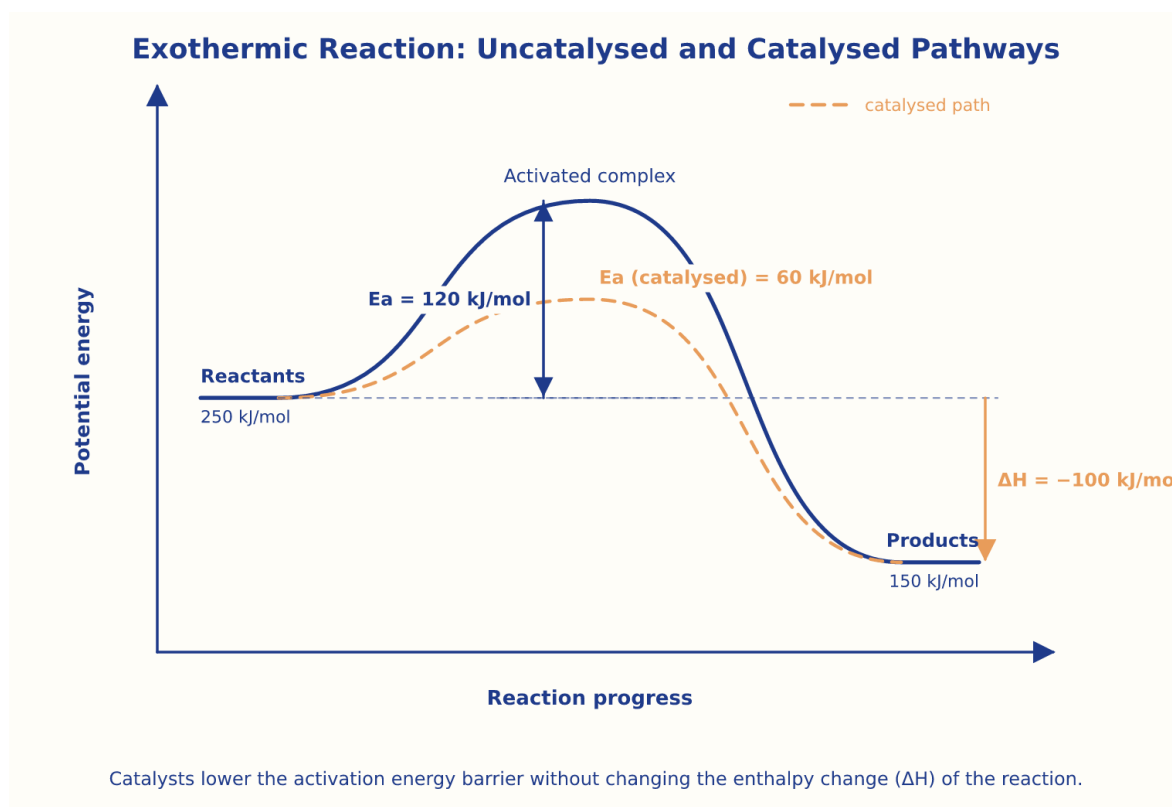


Figure 1: Potential energy diagram of an exothermic reaction: Reactants at 250 kJ/mol, Products at 150 kJ/mol, $E_a = 120$ kJ/mol, E_a (catalysed) = 60 kJ/mol, $\Delta H = -100$ kJ/mol.

Using the labelled potential energy diagram, record the following values.

Potential energy of the reactants: _____ kJ/mol

Potential energy of the products: _____ kJ/mol

Activation energy of the uncatalyzed reaction (E_a): _____ kJ/mol

Enthalpy change of the reaction (ΔH): _____ kJ/mol

2. Calculating enthalpy change

Using the reactant and product energy values from Exercise 1, show the calculation for ΔH to confirm that the reaction is exothermic.

$\Delta H = \text{Potential energy of products} - \text{Potential energy of reactants}$

Work: _____

9D, Ò ðððððððððððððð ò ¢ðÖðÀ

Is the reaction exothermic or endothermic? Explain how the sign of 9D, 7W ÷ ts your answer.

3. Effect of a catalyst on activation energy

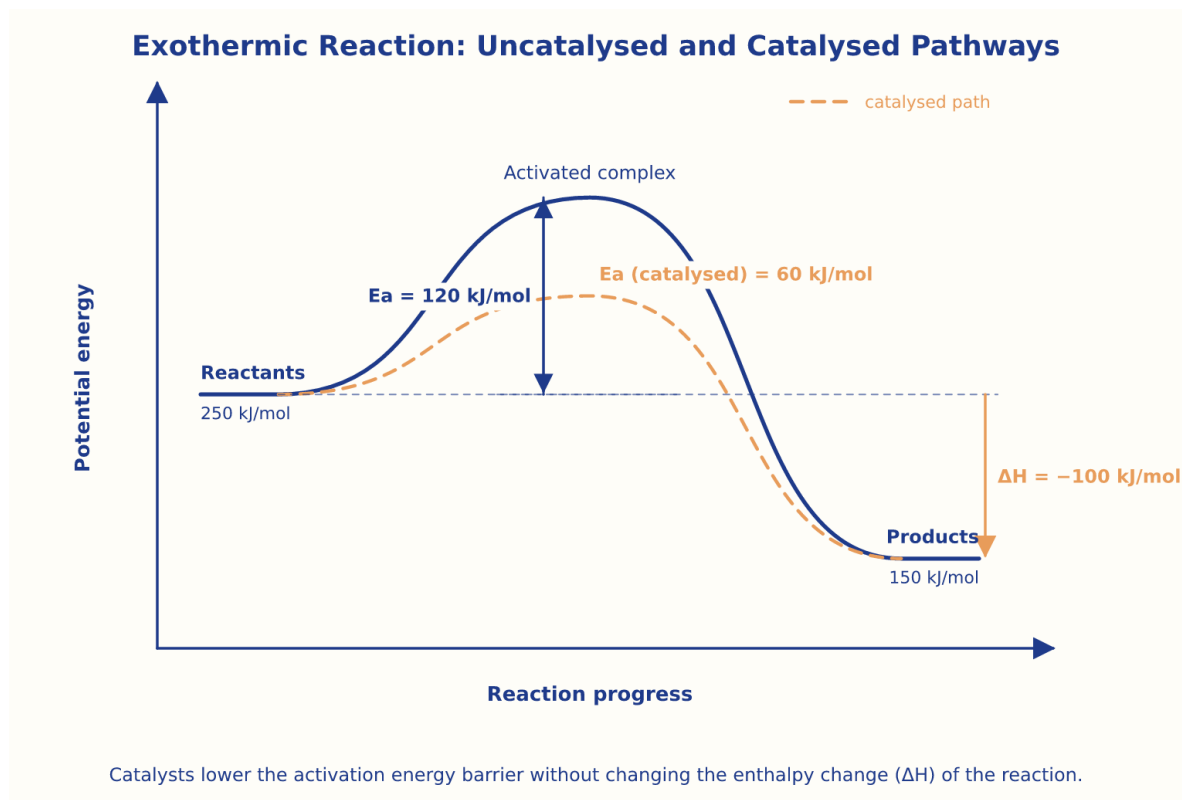


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The diagram shows a second reaction pathway with a lower activation energy.

- State the activation energy of the catalyzed pathway. _____ kJ/mol
- Calculate how much lower the catalyzed E_a is compared to the uncatalyzed E_a .

Work: _____

Difference: _____ kJ/mol

- Does the catalyst change the value of 9Dfò W± Æ —â •our answer in terms of the reactant and product energy levels.

4. Multiple choice

Circle the best answer.

A catalyst increases the rate of a reaction by:

- increasing the potential energy of the products
- decreasing the potential energy of the reactants
- providing an alternate reaction pathway with a lower activation energy
- increasing the value of 9D€

5. Matching definitions

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

Term	Answer	Definition
1. Activation energy	_____	A) The energy barrier that must be overcome for a chemical reaction to occur
2. Enthalpy change (ΔH)	_____	B) A substance that increases reaction rate without affecting the net energy change of the reaction
3. Catalyst	_____	C) The difference in potential energy between products and reactants

6. Applying $Q = mc\Delta T$

A student runs an exothermic reaction in a calorimeter containing 200.0 g of water. The water temperature rises from 21.5°C to 38.2°C. The specific heat capacity of water is 4.18 J/(g·°C).

a) Calculate the heat absorbed by the water.

Work: _____

$Q =$ _____ J

b) Convert your answer to kilojoules.

$Q =$ _____ kJ

c) Classify the reaction that took place in the calorimeter as exothermic or endothermic, and justify your classification using the direction of heat flow.

Answer key

1. Reactants = 250 kJ/mol; Products = 150 kJ/mol; E_a (uncatalyzed) = 120 kJ/mol; ΔH = -100 kJ/mol

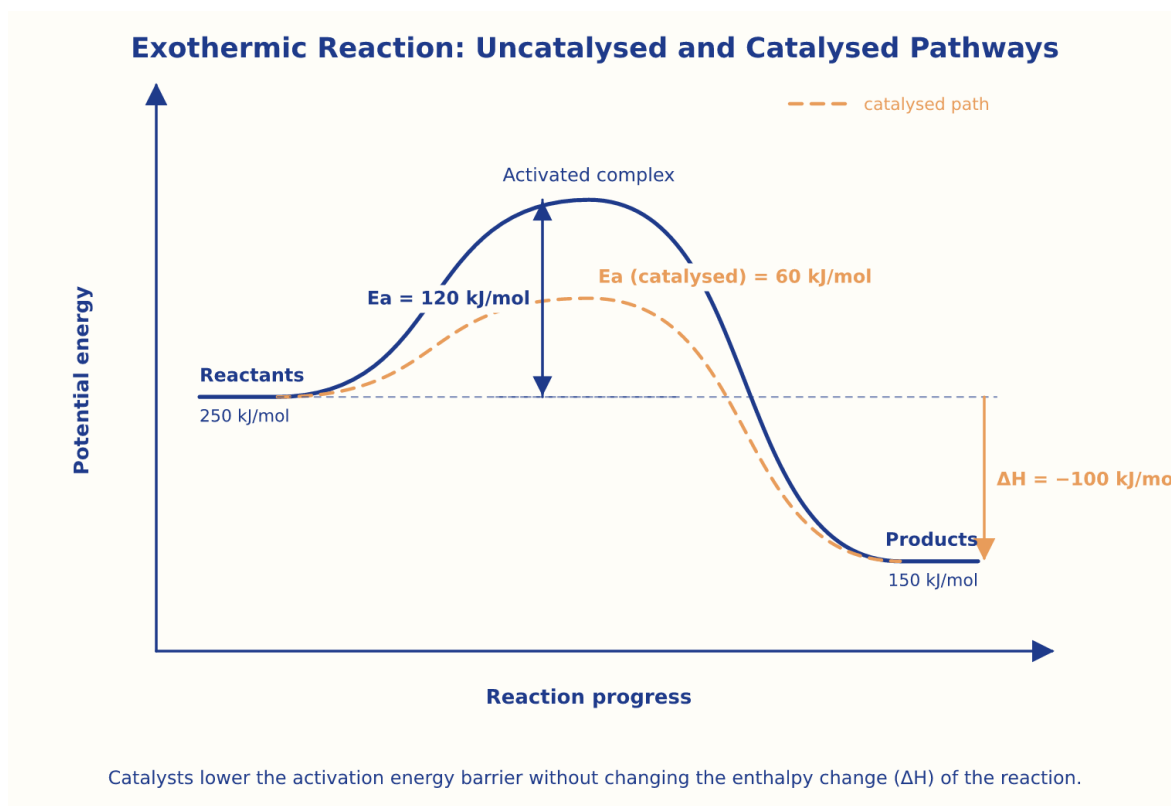


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2. The reaction is exothermic, because the products have less potential energy than the reactants and energy is released to the surroundings.
3. a) E_a (catalysed) = 60 kJ/mol. b) $120 - 60 = 60$ kJ/mol lower. c) No, because the catalyst only lowers the activation energy of the pathway; it does not change the potential energy of the reactants or products.

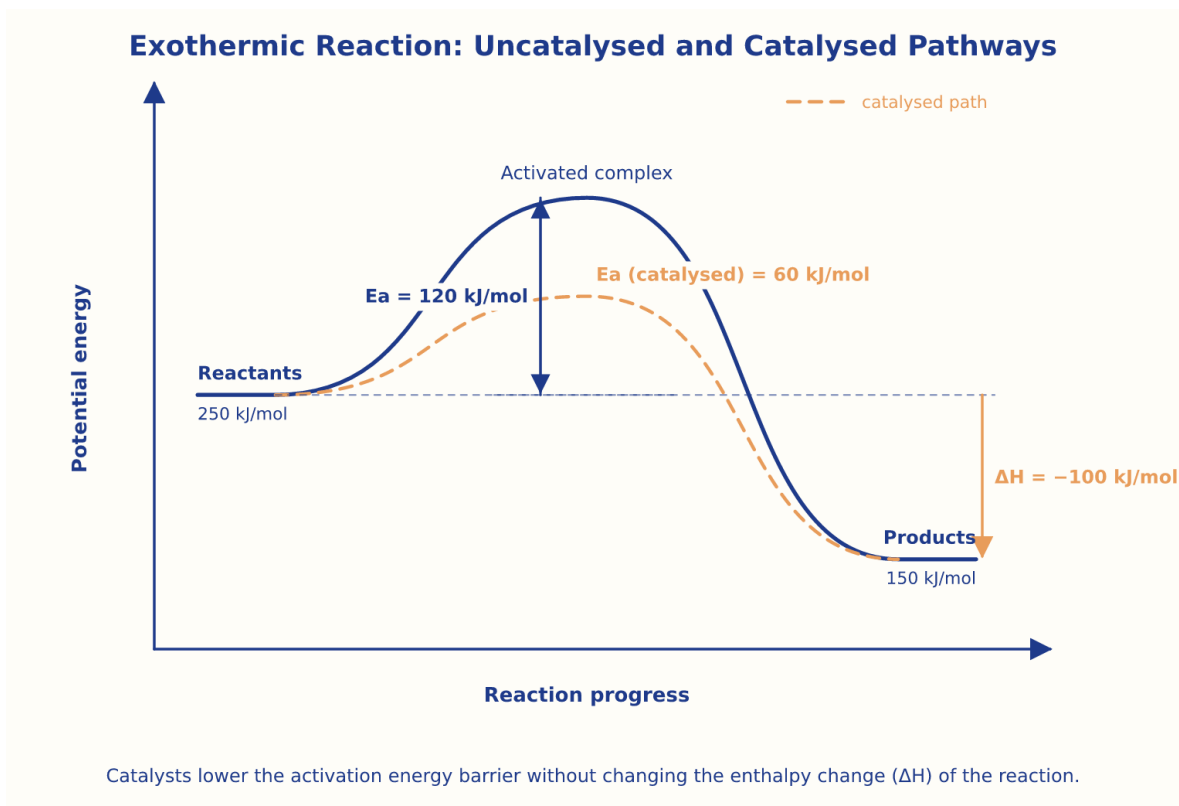


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4. C
5. 1-A, 2-C, 3-B
6. a) $Q = mc\Delta T$ where $m = 100$ g, $c = 4.18$ J/g°C, $\Delta T = 14.0$ °C. b) $Q = 5780$ J. c) Exothermic, because heat flows from the reaction into the water, raising its temperature.