Cambridge (CIE) A Level Chemistry

Your notes

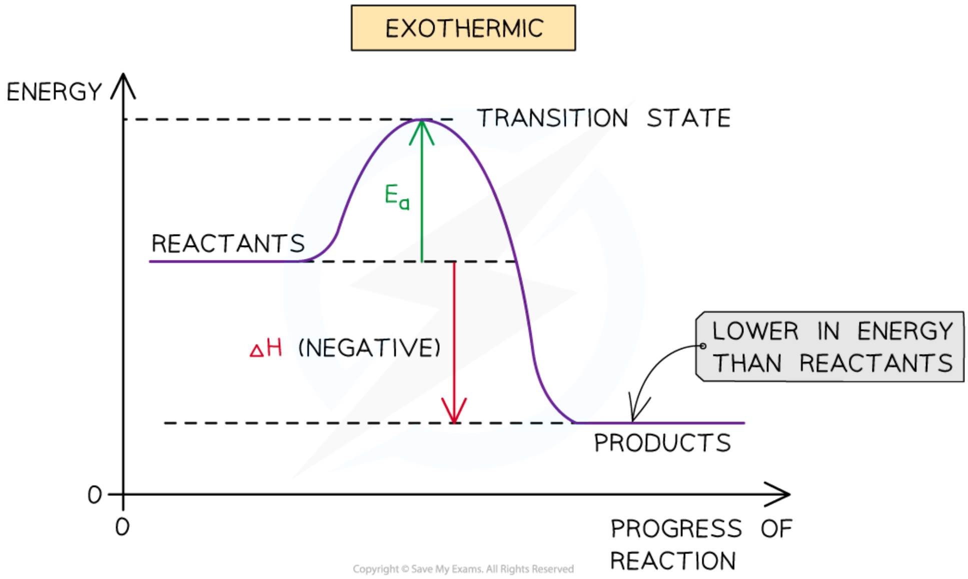
Effect of Temperature on Reaction Rates & the Concept of Activation Energy

Contents

Activation Energy

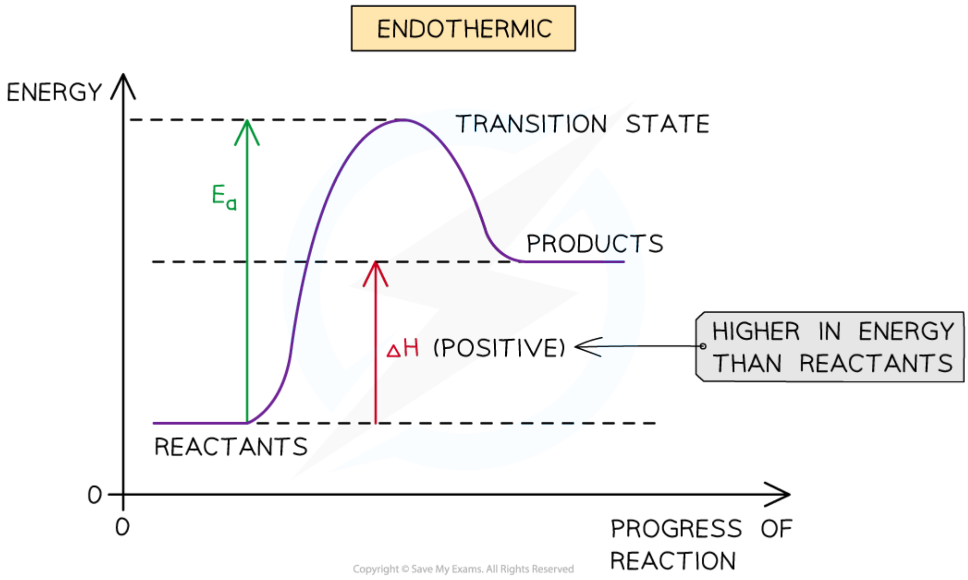
- For a reaction to take place, the reactant particles need to overcome a minimum amount of energy
- This energy is called the **activation energy (E_a)**
- In **exothermic reactions,** the reactants are higher in energy than the products
- In **endothermic reactions,** the reactants are lower in energy than the products
- Therefore, the E_a in **endothermic reactions** is relatively larger than in exothermic reaction

Exothermic reaction pathway diagram



The reactants are higher in energy than the products in an exothermic reaction, so the energy needed for the reactants to go over the energy barrier is relatively small

Endothermic reaction pathway diagram



The reactants are lower in energy than the products in an endothermic reaction, so the energy needed for the reactants to go over the energy barrier is relatively large

- Even though particles collide with each other in the same orientation, if they don't possess a minimum energy that corresponds to the E_a of that reaction, the reaction will **not** take place
- Therefore, for a collision to be **effective** the reactant particles must collide in the correct orientation **AND** possess a minimum energy equal to the E_a of that reaction

Examiner Tips and Tricks

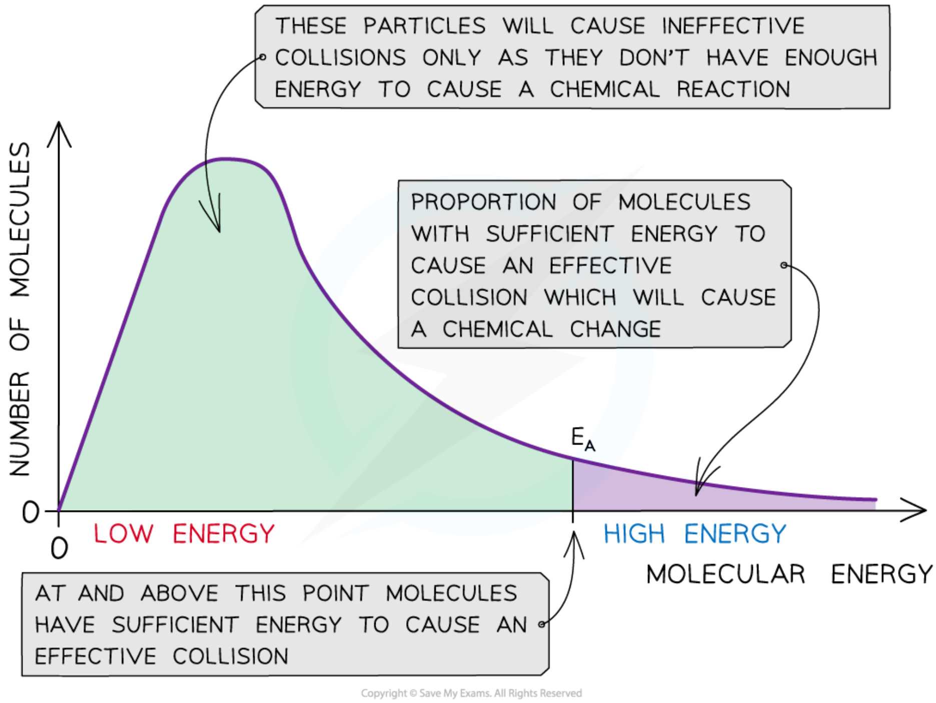
The activation energy is the energy needed to 'activate' the reactant particles in order for them to collide effectively and cause a chemical reaction.

Boltzmann Distribution Curves

Boltzmann distribution curve

- The **Boltzmann distribution curve** is a graph that shows the distribution of **energies** at a certain **temperature**
- In a sample of a substance, a few particles will have very low energy, a few particles will have very high energy, and many particles will have energy in between

A Boltzmann distribution curve



The Boltzmann distribution curve shows the distribution of the energies and the activation energy

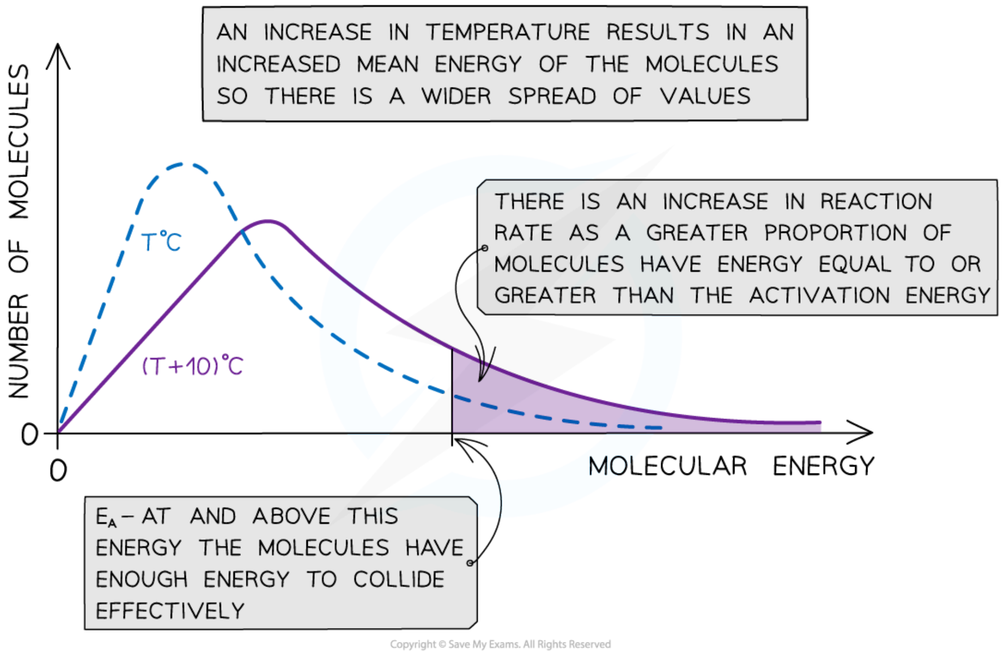
- The graph shows that only a small proportion of molecules in the sample have enough energy for an **effective collision** and for a **chemical reaction** to take place

Changes in temperature

- When the temperature of a reaction mixture is increased, the particles gain more kinetic energy
- This causes the particles to move around faster resulting in more **frequent collisions**
- Furthermore, the proportion of **successful collisions** increases, meaning a higher **proportion** of the particles possess the minimum amount of energy (activation energy) to cause a chemical reaction
- With higher temperatures, the Boltzmann distribution curve **flattens** and the peak **shifts** to the right

How temperature affects a Boltzmann distribution curve

Your notes



The Boltzmann distribution curve at T oC and when the temperature is increased by 10 oC

- Therefore, an increase in temperature causes an increased rate of reaction due to:
  - There being **more effective collisions** as the particles have **more kinetic energy**, making them move around faster
  - A **greater proportion** of the molecules having **kinetic energy** greater than the **activation energy**

Examiner Tips and Tricks

The increase in proportion of molecules having kinetic energy greater than the activation has a greater effect on the rate of reaction than the increase in effective collisions