

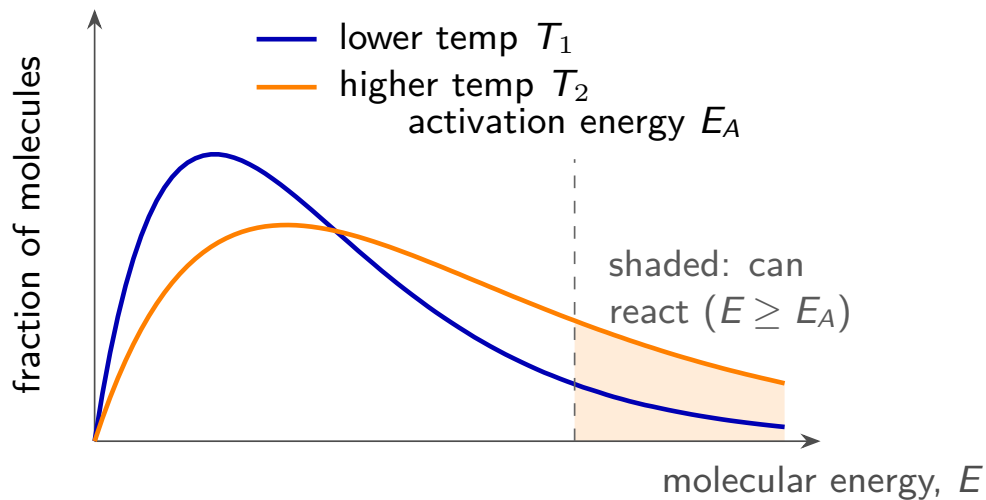
Exercise walk-through

8.3

Homogeneous and heterogeneous catalysts

A-Level Chemistry

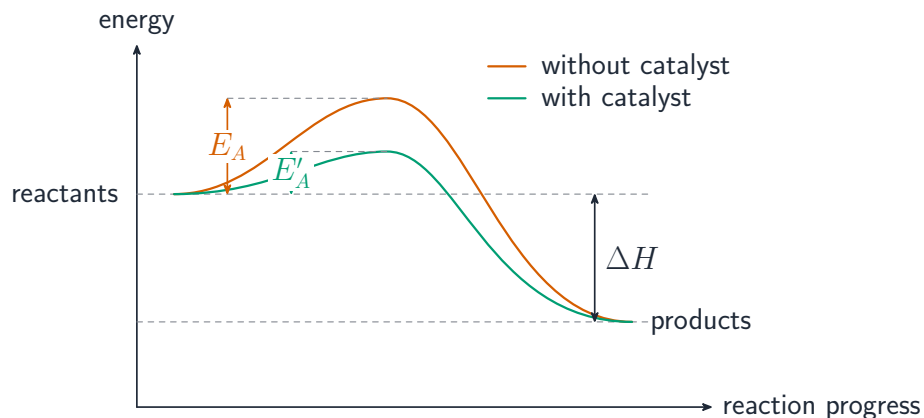
The Boltzmann distribution



Only molecules past the **activation energy** E_A can react.

Raising the temperature spreads the **Boltzmann distribution** to the right, so a **much larger fraction** exceed E_A – a small rise gives a big rate increase.

Catalysts



A **catalyst** speeds a reaction without being used up: it offers a different **reaction mechanism** – a new route with a **lower** E_A . On a **reaction pathway diagram** the catalysed route has a lower hill.

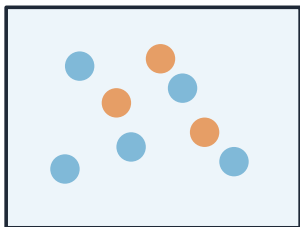
More molecules now exceed E_A , so the rate rises – but the **enthalpy change** ΔH is **unchanged**.

Types of catalyst

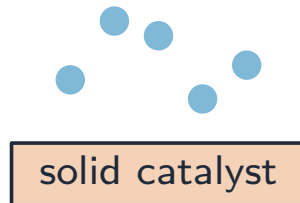
- a **homogeneous catalyst**
- a **heterogeneous catalyst**
(a catalytic converter)

is in the **same** state as the reactants

is in a **different** state (a solid surface, like



homogeneous
(same state,
mixed in)

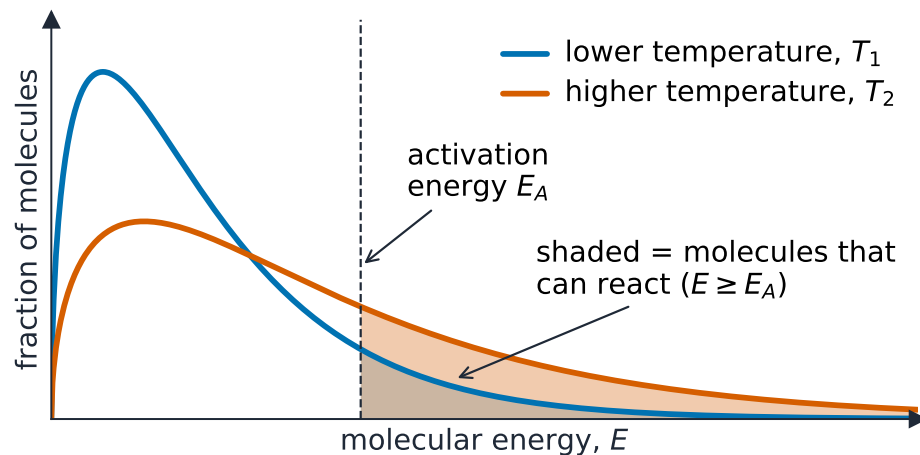


heterogeneous
(different state,
a surface)

Exam tips

- Explain rate changes with **collision theory** – more frequent and/or more energetic **effective collisions**.
- On a **Boltzmann distribution** mark E_A , shade to its right, and show the curve **flatten and shift right** at higher temperature; it starts at the origin and never touches the axis.
- A **catalyst** gives an alternative route with **lower E_A and does not** change ΔH .
- Say why a small temperature rise gives a large rate rise: a **much greater proportion** of molecules now exceed E_A (the main effect).

At higher temperature the curve spreads to the right



higher $T \Rightarrow$ more molecules with $E \geq E_A$

At higher temperature the curve spreads to the right, so a larger fraction of molecules can react

Exercises 2.1·2.2

2.1 State what a catalyst does and what happens to it during the reaction. [2]

2.2 State the difference between a homogeneous and a heterogeneous catalyst. [2]

Exercises 2.1·2.2

2.1 State what a catalyst does and what happens to it during the reaction. [2]

2.1

- it speeds up the reaction; it is not used up / is regenerated
-

2.2 State the difference between a homogeneous and a heterogeneous catalyst. [2]

2.2

- homogeneous – in the same physical state as the reactants; heterogeneous – in a different state

Exercises 3.1-3.2

3.1 A catalyst increases the rate of a reaction by:

[1]

☐

A increasing the activation energy

B providing a route with a lower activation energy

C making the reaction more exothermic

D raising the temperature

3.2 Which property of a reaction is **not** changed by adding a catalyst?

[1]

☐

A the rate

B the activation energy

C the enthalpy change, ΔH

D the mechanism

Exercises 3.1·3.2

3.1 A catalyst increases the rate of a reaction by:

[1]

☐

A increasing the activation energy

B providing a route with a lower activation energy

C making the reaction more exothermic

D raising the temperature

3.1 B

- A catalyst provides a route with lower activation energy

3.2 Which property of a reaction is **not** changed by adding a catalyst?

[1]

☐

A the rate

B the activation energy

C the enthalpy change, ΔH

D the mechanism

3.2 C

- The enthalpy change is unchanged by a catalyst

Exercise 3.3

3.3 (a) Explain, using the Boltzmann distribution, why a catalyst speeds up a reaction. [2]

(b) Sketch a reaction pathway diagram showing the catalysed and uncatalysed routes for an exothermic reaction. [3]

Exercise 3.3

3.3 (a) Explain, using the Boltzmann distribution, why a catalyst speeds up a reaction. [2]

(b) Sketch a reaction pathway diagram showing the catalysed and uncatalysed routes for an exothermic reaction. [3]

3.3

(a)

- the catalyst lowers the activation energy; so a larger fraction of molecules now exceed E_A and can react – more effective collisions per second

(b)

- reactants higher than products (exothermic); two activation-energy humps, the catalysed one lower; same ΔH marked between reactants and products

Exercise 3.4

3.4 Iron is used in the Haber process. State whether it is a homogeneous or heterogeneous catalyst, and explain your answer. [2]

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3.4 Iron is used in the Haber process. State whether it is a homogeneous or heterogeneous catalyst, and explain your answer. [2]

3.4

- heterogeneous; the iron is a solid while the reactants (N_2 and H_2) are gases – a different physical state