

# Catalysts

5.6.1.4 · Chemistry · revision notes

What catalysts do, how they speed up reactions by providing a pathway with a lower activation energy, and how to show this on a reaction profile. Questions ask you to identify a catalyst from data, explain catalytic action and draw or use reaction profiles.

## Key facts

- Catalyst: speeds up a reaction, is not used up, same mass at the end
- Enzymes = catalysts in biological systems
- A catalyst provides a different pathway with a lower activation energy
- Reaction profile: activation energy = from the reactants' level up to the peak
- Catalysts are not included in the chemical equation
- Different reactions need different catalysts
- A catalyst does not change the energy change or the amount of product

## Notes

### What a catalyst is

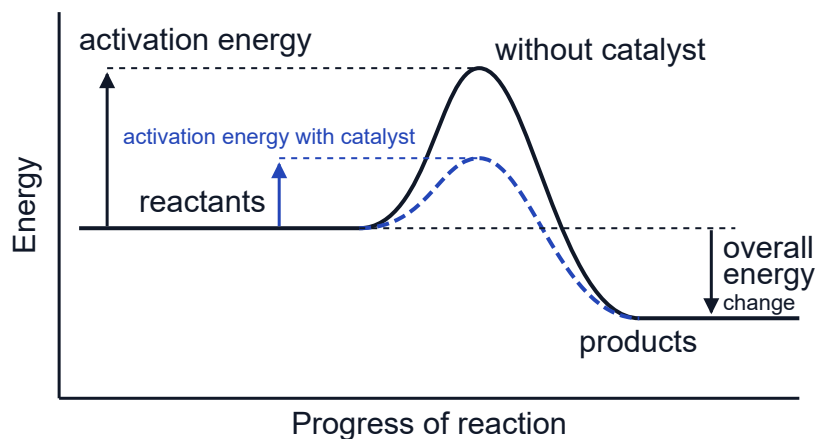
- A **catalyst** changes the rate of a chemical reaction but is **not used up** during the reaction.
- At the end of the reaction the catalyst is chemically unchanged and has the same mass, so it can be used again.
- Catalysts are not included in the chemical equation for the reaction (sometimes the name is written above the arrow).
- Different reactions need different catalysts.
- **Enzymes** act as catalysts in biological systems.
- You can identify a catalyst from data: it makes the reaction faster, its mass is the same at the end, and it is not a reactant or product in the equation.

### How a catalyst works

- A catalyst provides a **different pathway** for the reaction that has a **lower activation energy**.
- So a greater proportion of particles have energy equal to or greater than the activation energy, and successful collisions are more frequent.
- A catalyst does not change the overall energy change of the reaction or the amount of product made.
- With a catalyst, a reaction can be fast enough at a lower temperature, which saves energy.

## Reaction profiles

- A reaction profile shows energy (y-axis) against the progress of the reaction (x-axis).
- Activation energy is the energy difference from the reactants' level up to the peak of the curve.
- With a catalyst, the reactants and products are at the same energy levels, but the peak is lower.



Catalysed path (blue, dashed): lower peak, same reactants, products and overall energy change.

- Draw the catalysed curve starting at the reactants and finishing at the products, with a lower hump. Label its activation energy with an arrow from the reactant level up to the new peak.

## How to answer each type of question

### Identify the catalyst from experimental results

2 to 3 marks

Grade 5

1. Find the substance that makes the reaction faster than with nothing added.
2. Check its mass at the end: a catalyst has the same mass as at the start.
3. Check the equation: a catalyst is not a reactant or a product.

**Example.** A student added 0.50 g of each of three powders, A, B and C, to separate samples of the same hydrogen peroxide solution.

| Powder added | Time to collect 50 cm <sup>3</sup> of oxygen in s | Mass of powder at the end in g |
|--------------|---------------------------------------------------|--------------------------------|
| none         | 400                                               | —                              |
| A            | 400                                               | 0.50                           |
| B            | 35                                                | 0.50                           |
| C            | 90                                                | 0.32                           |

Which powder is a catalyst for this reaction? Give two reasons for your answer.

**Model answer.** B (1). It made the reaction faster than with no powder (1). Its mass did not change, so it was not used up (1).

## Don't lose marks

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- ✗ Writing only 'it lowers the activation energy'. The full answer is that it provides a different pathway with a lower activation energy.
- ✗ Saying a catalyst gives the particles more energy or makes them move faster. It does neither.
- ✗ Saying a catalyst is used up in the reaction.
- ✗ Moving the product level on a catalysed profile, or measuring activation energy from the products.
- ✗ Saying a catalyst increases the amount of product. It only makes the product form faster.

## More tips

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### Memory tricks

- A catalyst is like a tunnel through a hill: same start and finish, but a lower climb.
- Catalyst check: faster? same mass at the end? not in the equation? Then it is a catalyst.
- On a reaction profile, a catalyst only lowers the hump. The start and end levels never move.
- Enzyme = biological catalyst: the same idea you meet in Biology.

### Exam technique

- Learn the key phrase: 'provides a different pathway with a lower activation energy'.
- If asked how you know a substance is a catalyst, use evidence from the data: the rate increased and its mass stayed the same.
- On reaction profiles, draw activation energy arrows from the reactant line up to the peak, with the arrowhead at the peak.
- You do not need to learn the names of particular catalysts for this topic: the question will tell you which one is used.

## What each grade needs

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What you need to be able to do, from the first marks up to the top grade.

### Grade 3

#### State what a catalyst does

It increases the rate of a reaction but is not used up.

### Grade 4

#### Know that enzymes are biological catalysts

Enzymes are the catalysts that speed up reactions in living things.

### Grade 5

#### Identify a catalyst from experimental data

It speeds up the reaction, has the same mass at the end and is not in the equation.

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