

8.2 Effect of temperature on reaction rates and activation energy

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS activation energy 活化能 • boltzmann distribution 玻尔兹曼分布
 • rate of reaction 反应速率 • effective collision 有效碰撞 • collide 碰撞

Objective

Build the skills to answer exam questions on **temperature and activation energy** — **activation energy** 活化能, the **Boltzmann distribution** 玻尔兹曼分布, and why temperature has a large effect on rate.

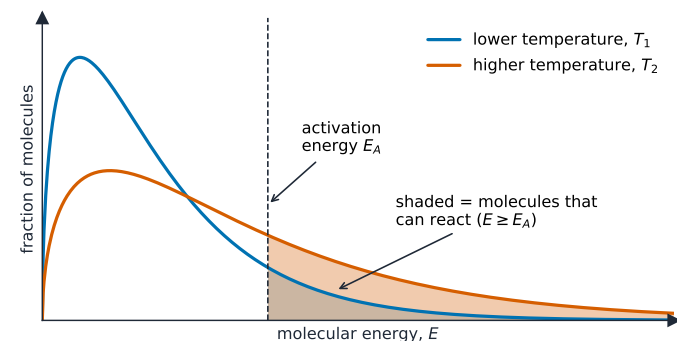
You must be able to:

- define activation energy and sketch the Boltzmann distribution
- use the Boltzmann distribution to explain the significance of E_A
- explain the effect of temperature in terms of the distribution and effective collisions

1 Worked examples

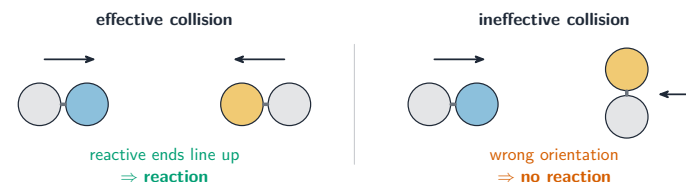
■ Activation energy and the Boltzmann distribution

The **activation energy** E_A is the minimum energy a collision needs to be effective.



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

The curve starts at the origin, peaks, then tails off; only molecules to the right of E_A can react. At higher T the curve spreads right, so a larger fraction can react



Higher temperature gives more effective collisions

■ Why temperature has a big effect

Raising the temperature:

- spreads the curve to the right, so a **much larger fraction** of molecules exceed E_A (the bigger effect);
- makes molecules move faster, so they collide more often.

So a small temperature rise gives a large rate rise.

2 Practice

2.1 Define activation energy.

[1]

2.2 On a Boltzmann distribution, state which molecules are able to react. [1]

3 Exam-style questions

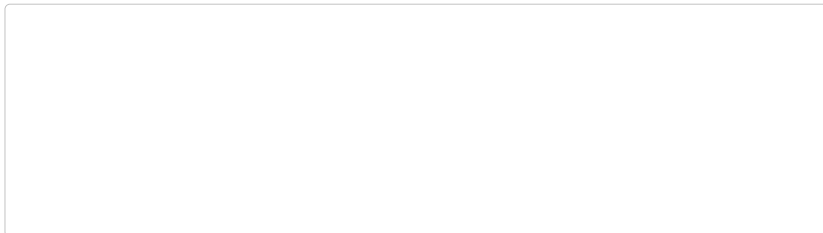
3.1 When the temperature is increased, the main reason the rate rises is: [1]

- | | |
|---|---|
| A | B |
| C | D |
- A the activation energy falls
B a much larger fraction of molecules have energy $\geq E_A$
C the molecules get bigger
D the enthalpy change increases

3.2 The total area under a Boltzmann distribution curve represents: [1]

- | | |
|---|---|
| A | B |
| C | D |
- A the activation energy
B the total number of molecules
C the rate of reaction
D the temperature

3.3 Sketch a Boltzmann distribution curve. Mark the activation energy E_A and shade the molecules that can react. [3]



3.4 Explain, using the Boltzmann distribution, why a 10 °C rise in temperature can roughly double the rate of a reaction. [3]
