# Exercise walk-through

## Collision Model ▪ 5.5

eXercise

# You must be able to

- state the two requirements for a successful collision (**energy** and **orientation** 取向)
- define **activation energy** 活化能 $E_a$
- link temperature to the fraction of successful collisions

# Method — Two requirements

For a collision to react, the particles must collide with:

1. at least the **activation energy** $E_a$ (enough energy to break bonds), and
2. the correct **orientation** (the right parts must meet).

Most collisions fail one of these, so only a fraction react.

# Method — Activation energy

$E_a$ is the **minimum energy** needed to start the reaction — the barrier that must be climbed before products form.

# Method — Temperature and successful collisions

Raising temperature gives particles more kinetic energy, so a **larger fraction** exceed $E_a$. This is the main reason a small temperature rise can greatly speed a reaction.

## Method — The Maxwell-Boltzmann link

On the speed distribution, the molecules to the right of $E_a$ can react. Heating shifts the curve right, moving **more** molecules past $E_a$.

## Practice 2.1 ▪ 2 marks

State the two requirements for a successful collision.

# Solution 2.1

Method: Two requirements

**Worked steps**

Enough energy (at least $E_a$); correct orientation B1 B1.

## Practice 2.2 ▪ 1 mark

Define activation energy.

# Solution 2.2

**Worked steps**

The minimum energy needed for a collision to lead to reaction B1.

## Practice 2.3 ▪ 1 mark

Why does raising temperature increase the fraction of successful collisions?

# Solution 2.3

Method: Temperature and successful collisions

**Worked steps**

Particles have more kinetic energy, so more of them exceed $E_a$ B1.

# Exam-style 3.1 ▪ 1 mark

The activation energy is the

**A** energy released by the reaction

**B** minimum energy needed for a collision to react

**C** average energy of the particles

**D** energy of the products

# Solution 3.1

**A** energy released by the reaction

**B** minimum energy needed for a collision to react ✓

**C** average energy of the particles

**D** energy of the products

**Worked steps**

**B** — the minimum energy for a collision to react.

## Exam-style 3.2 ▪ 2 marks

Two gas molecules collide but do not react.
(a) Give two possible reasons.
(b) Explain how heating the gas would increase the reaction rate.

# Solution 3.2

Method: The Maxwell-Boltzmann link

**Worked steps**

(a) Not enough energy (below $E_a$); wrong orientation B1 B1. (b) Heating raises particle energy, so more collisions exceed $E_a$ and collisions are more frequent, increasing the rate M1 A1.

# Exam-style 3.3 ▪ 2 marks

On a Maxwell-Boltzmann distribution, explain what the area to the **right** of $E_a$ represents and how it changes with temperature.

# Solution 3.3

Method: The Maxwell-Boltzmann link

**Worked steps**

It represents the fraction of molecules with energy $\geq E_a$ (able to react); heating shifts the curve right so this area grows **M1** **A1**.