AP CHEMISTRY • EXERCISE SHEET

5.5 Why Collisions Do or Do Not React

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS activation energy 活化能 • orientation 取向 • collision theory 碰撞理论 • reaction rate 反应速率

Objective

Build the skills to answer exam questions on **collision theory** — why some collisions react and others do not.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ 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.

■ Activation energy

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

■ 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.

■ 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.

2 Practice

Now apply the methods above.

2.1 State the two requirements for a successful collision. [2]

2.2 Define activation energy. [1]

2.3 Why does raising temperature increase the fraction of successful collisions? [1]

3 Exam-style questions

3.1 The activation energy is the [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

3.2 Two gas molecules collide but do not react.

(a) Give two possible reasons. [2]

(b) Explain how heating the gas would increase the reaction rate. [2]

3.3 On a Maxwell-Boltzmann distribution, explain what the area to the **right** of E_a represents and how it changes with temperature. [2]

Solutions

2.1 Enough energy (at least E_a); correct orientation.

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

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

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

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

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