AP CHEMISTRY • EXERCISE SHEET

# 5.2 Writing the Rate Law

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

## Objective

Build the skills to answer exam questions on the **rate law** —how rate depends on concentration.

**You must be able to:**

- write a **rate law** 速率定律 rate $= k[\mathrm{A}]^m[\mathrm{B}]^n$
- find the **order** 级数 with respect to each reactant from data
- calculate the **rate constant** $k$

## 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.

### The rate law

$$\text{rate} = k[\mathrm{A}]^m[\mathrm{B}]^n,$$

where $m$ and $n$ are the **orders** (found by experiment, not from coefficients) and $k$ is the rate constant.

### Finding order by comparing experiments

Change one reactant's concentration and see how the rate responds:

- rate unchanged when [A] doubles → order 0 in A;
- rate doubles → order 1;
- rate quadruples (×4) → order 2.

### A worked order

If doubling [A] (with [B] fixed) makes the rate 4× larger, then $2^m = 4$, so $m = 2$ (second order in A).

### Finding k

Substitute one experiment's rate and concentrations into the rate law and solve for $k$. Its units depend on the overall order.

## 2 Practice

Now apply the methods above.

**2.1** In rate $= k[\mathrm{A}]^2[\mathrm{B}]$, state the order in A and in B. [2]

**2.2** Doubling [A] doubles the rate. What is the order in A? [1]

**2.3** Are reaction orders taken from the balanced equation? [1]

## 3 Exam-style questions

**3.1** If doubling a reactant's concentration quadruples the rate, the order is [1]

- **A** 0
- **B** 1
- **C** 2
- **D** 3

**3.2** For $\mathrm{A} + \mathrm{B} \rightarrow \mathrm{C}$, experiments give:

| exp | [A] | [B] | rate |
|---|---|---|---|
| 1 | 0.1 | 0.1 | 2 |
| 2 | 0.2 | 0.1 | 4 |
| 3 | 0.1 | 0.2 | 8 |

(a) Find the order in A and in B. [3]

(b) Write the rate law. [1]

**3.3** Using experiment 1 above (rate = 2, [A] = [B] = 0.1) and your rate law, find $k$. [3]

## 4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **5.2 Writing the Rate Law** lesson on the **Learn** page;
- read the **Writing the Rate Law** section of the AP Chemistry handout on the **Know** page.

## Solutions

**2.1** Second order in A; first order in B.

**2.2** First order.

**2.3** No —orders are found by experiment.

**3.1 C** —$2^m = 4 \Rightarrow m = 2$.

**3.2** (a) A: exp 1→2 doubles [A], rate doubles → order 1; B: exp 1→3 doubles [B], rate ×4 → order 2. (b) rate = $k[\text{A}][\text{B}]^2$.

**3.3** $2 = k(0.1)(0.1)^2 = k(0.001)$; $k = 2000\ \text{L}^2\text{mol}^{-2}\text{s}^{-1}$.