AP CHEMISTRY • EXERCISE SHEET

5.2 Writing the Rate Law

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

KEY WORDS order 级数 • rate law 速率定律 • rate constant 速率常数

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]

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