

Exercise walk-through

5.2

Introduction to Rate Law

AP Chemistry

The rate law

Found by experiment

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

The **orders** m, n come from data,
not the equation.

Method of initial rates :
double $[\text{A}]$ – rate $\times 2$ (1st), $\times 4$ (2nd),
unchanged (0th).

0 order: k in $\frac{\text{mol}}{\text{L s}}$

1st order: k in $\frac{1}{\text{s}}$

2nd order: k in $\frac{\text{L}}{\text{mol s}}$

Rate, and the constant in the rate law

Reaction rate

The **reaction rate** is the change in concentration per unit time – and it is divided by the stoichiometric coefficient so every species gives the same number.

Rate constant

The **rate constant** k in $\text{rate} = k[A]^m[B]^n$ depends on temperature and on the catalyst – never on concentration.

Its units

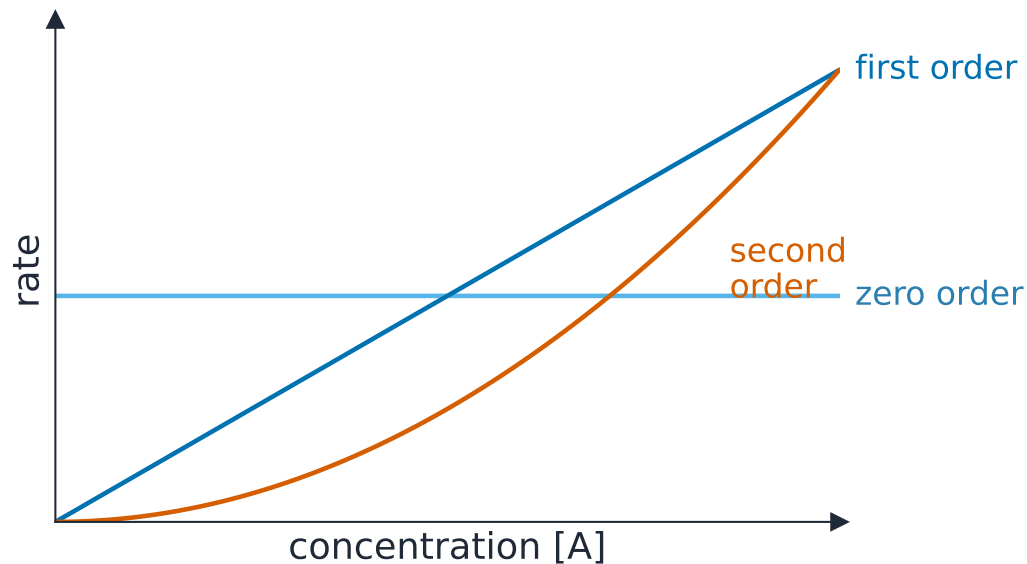
k 's units follow from the overall order, which is a useful check on an experimentally determined rate law.

Where it comes from

The orders come from experiment – initial rates or an integrated plot – never from the balanced equation.

Arrhenius: $k = Ae^{-E_a/RT}$. Temperature acts on k , which is why a rate law with fixed k describes one temperature only.

Rate against concentration for zero-



Rate against concentration for zero-, first-, and second-order reactions

Exercises 2.1-2.3

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

2.2 Doubling $[\text{A}]$ doubles the rate. What is the order in A? [1]

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

Exercises 2.1-2.3

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

2.1

- Second order in A; first order in B
-

2.2 Doubling $[\text{A}]$ doubles the rate. What is the order in A? [1]

2.2

- First order
-

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

2.3

- No – orders are found by experiment

Exercise 3.1

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

☐

A 0

B 1

C 2

D 3

Exercise 3.1

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

☐

A 0

B 1

C 2

D 3

3.1 C

- $2^m = 4 \Rightarrow m = 2$

Exercise 3.2 (a)

3.2 For $A + B \rightarrow C$, 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]

Exercise 3.2 (a)

3.2 For $A + B \rightarrow C$, 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]

(a)

- A: exp 1
- 2 doubles [A], rate doubles
- order 1; B: exp 1
- 3 doubles [B], rate $\times 4$
- order 2

Exercise 3.2 (b)

3.2 For $A + B \rightarrow C$, experiments give:

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

(b) Write the rate law.

[1]

Exercise 3.2 (b)

3.2 For $A + B \rightarrow C$, experiments give:

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

(b) Write the rate law.

[1]

(b)

- $\text{rate} = k[A][B]^2$

Exercise 3.3

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

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

3.3

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