

Exercise walk-through

4.1.1

Measured orders, rate constants and half-lives

Pearson Edexcel · International A-Level · Chemistry

Infer an unfamiliar rate law

Your turn

Doubling A quadruples rate; tripling B triples rate. Which law fits?

- A. $r = k[A][B]$
- B. $r = k[A]^2[B]$
- C. $r = k[A][B]^3$
- D. $r = k[A]^2$

Find the temperature boundary

Your turn

$\Delta H = +36.0 \text{ kJ mol}^{-1}$; $\Delta S(\text{system}) = +120 \text{ J mol}^{-1} \text{ K}^{-1}$. Which condition gives positive total entropy?

- A. T below 300 K
- B. T above 300 K
- C. Every temperature
- D. No temperature

Independent structural identification

Your turn

$\text{C}_3\text{H}_6\text{O}$ has two carbon-13 signals, gives iodoform and no Tollens' silver. Which structure fits?

- A. Propanal
- B. Propanone
- C. Propan-1-ol
- D. Ethanoic acid

Exercises 2.1·2.3

2.1 At fixed $[B]$, doubling $[A]$ leaves rate unchanged. State the order in A and what happens when $[A]$ is tripled. [2]

2.2 For $r = k[A]^2$, rate is $0.0120 \text{ mol dm}^{-3} \text{ s}^{-1}$ at $[A] = 0.200 \text{ mol dm}^{-3}$. Calculate k

2.3 A reactant falls from 0.160 to 0.080 to 0.040 to $0.020 \text{ mol dm}^{-3}$ at $0, 40, 80$ and 120

3 Exam-style questions

Exercises 2.1·2.3

2.1 At fixed $[B]$, doubling $[A]$ leaves rate unchanged. State the order in A and what happens when $[A]$ is tripled. [2]

2.1 Zero order; rate remains unchanged at fixed other conditions.

2.2 For $r = k[A]^2$, rate is $0.0120 \text{ mol dm}^{-3} \text{ s}^{-1}$ at $[A] = 0.200 \text{ mol dm}^{-3}$. Calculate k

2.2 $k = r/[A]^2 = 0.0120/(0.200)^2 = 0.300 \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$.

2.3 A reactant falls from 0.160 to 0.080 to 0.040 to 0.020 mol dm^{-3} at 0, 40, 80 and 120

3 Exam-style questions

2.3 40 s; first order under the stated fixed conditions, because successive half-lives are constant.

Exercises 3.1·3.2

3.1 Three trials have ([A], [B], rate): (0.10, 0.10, 0.0020), (0.20, 0.10, 0.0080), (0.20, 0.30, 0.0240), in mol dm^{-3} and $\text{mol dm}^{-3} \text{ s}^{-1}$. Find the rate equation, overall order and k with units. [6]

3.2 A student uses the slope from 0 to 60 s as the rate at 60 s on a curved concentration–time trace. Explain the error and the correct graphical method. Explain why $1/\text{time}$ can be a rate proxy only in a controlled endpoint method. [3]

Exercises 3.1·3.2

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3.1 First pair: doubling A quadruples rate, order 2. Last pair: tripling B triples rate, order 1. $r = k[A]^2[B]$, overall order 3. $k = 0.0020/(0.10^2 \times 0.10) = 2.0 \text{ dm}^6 \text{ mol}^{-2} \text{ s}^{-1}$.

3.2 A student uses the slope from 0 to 60 s as the rate at 60 s on a curved concentration–time trace. Explain the error and the correct graphical method. Explain why $1/\text{time}$ can be a rate proxy only in a controlled endpoint method. [3]

3.2 The chord gives an interval average; a tangent at 60 s gives instantaneous concentration gradient, and the positive disappearance rate is the negative of that gradient. Reciprocal time compares rates only when the same small conversion/endpoint and relevant conditions are controlled.