

Exercise walk-through

4.1.3

Rate measurements, iodine evidence and activation energy

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 Select a suitable measurement for each: a coloured iodine reactant disappearing; CO_2 leaving a reaction mixture; a dissolved acid changing with time. Give one limitation of each choice. [6]

2.2 A quenched 5.00 cm^3 aliquot uses 8.00 cm^3 of $0.00500 \text{ mol dm}^{-3}$ thiosulfate. Calculate

2.3 A controlled clock takes 20 s in trial A and 40 s in trial B. Compare their initial rates and state two conditions needed for that comparison. [3]

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2.1 Calibrated colorimetry for iodine, with suitable wavelength/path length and no interfering colour/turbidity. Mass loss or collected gas volume for escaping CO₂, limited by leaks or CO₂ remaining dissolved. Timed quenched aliquots followed by titration for acid, requiring justified effective quenching and allowance for sampling delay. Accept another suitable explained technique.

2.2 A quenched 5.00 cm³ aliquot uses 8.00 cm³ of 0.00500 mol dm⁻³ thiosulfate. Calculate

2.2 $n(S_2O_3^{2-}) = 0.00500 \times 0.00800 = 4.00 \times 10^{-5}$ mol. Iodine is half this, 2.00×10^{-5} mol. Original $[I_2] = 2.00 \times 10^{-5} / 0.00500 = 0.00400$ mol dm⁻³.

2.3 A controlled clock takes 20 s in trial A and 40 s in trial B. Compare their initial rates and state two conditions needed for that comparison. [3]

2.3 A has twice B's initial rate, since inverse time compares the same endpoint extent. Keep the endpoint amount small and identical and temperature/total volume and other reactant conditions controlled. Only the intentionally varied concentration should differ.

Exercises 3.1·3.2

3.1 Equal quenched 5.00 cm^3 aliquots from one reaction require 10.00, 8.00, 6.00 and

3.2 Separate trials give: doubling propanone doubles rate; doubling H^+ doubles rate;

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3.1 Initial iodine concentration $0.00500 \text{ mol dm}^{-3}$, final $0.00200 \text{ mol dm}^{-3}$. Disappearance rate $= (0.00500 - 0.00200)/60 = 5.00 \times 10^{-5} \text{ mol dm}^{-3} \text{ s}^{-1}$. Constant iodine loss in equal time intervals supports zero order in iodine over this measured range, provided the other kinetic factors stay sufficiently constant. Separate controlled variations of propanone and H^+ are needed to determine their individual orders.

3.2 Separate trials give: doubling propanone doubles rate; doubling H^+ doubles rate;

3.2 $r = k[\text{propanone}][\text{H}^+]$. Factor $2 \times \frac{1}{2} = 1$, unchanged. Iodine can react after the rate-determining sequence; zero order is not absence from the overall reaction or a unique mechanism proof.

Exercise 3.3

3.3 A student plots $\ln(1/t)$ against $1/T$ for clock data at several temperatures. State two assumptions needed to infer activation energy from the gradient. If the gradient is -5000 K and $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$, calculate the activation energy. [4]

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3.3 The fixed small endpoint makes $1/t$ proportional to the initial rate with a comparable proportionality factor across temperatures; reactant concentrations/other conditions are controlled so the change reflects k , with actual mixture temperatures measured in kelvin.
 $E_a = -R \times \text{gradient} = 8.31 \times 5000 = 41550 \text{ J mol}^{-1}$, or 41.6 kJ mol^{-1} .