

Orders, rate constants and activation energy

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test covers rate equations, orders, units of k , half-life, activation energy, catalysts and mechanisms. Show your working, keep units, and use the marks as a guide to the detail needed.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB R2.2

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Units of k (2 marks)

A reaction has rate = $k[A][B]$.

- State the overall order. (1 mark)
- Deduce the units of k . (1 mark)

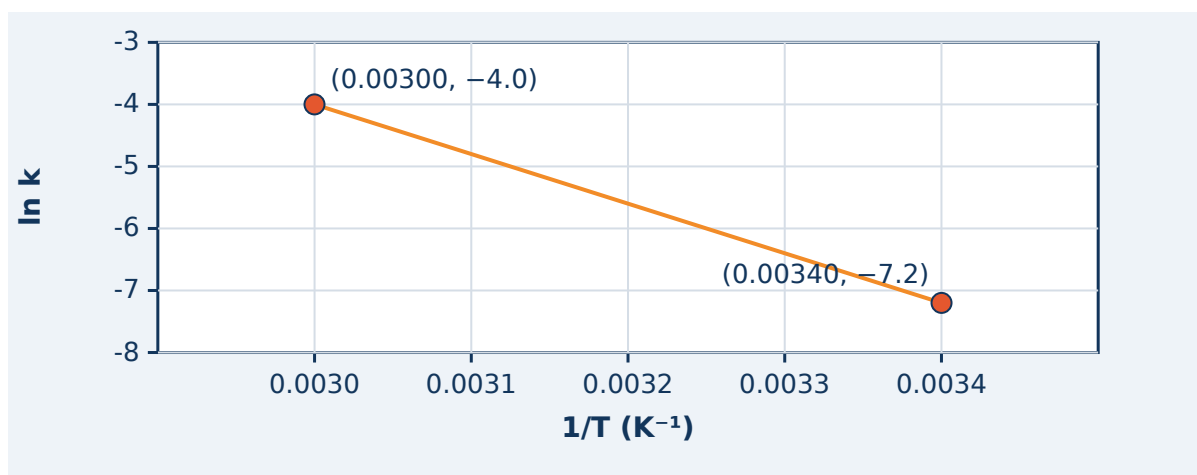
Question 2 Initial rates (3 marks)

Initial rates for $P + Q \rightarrow \text{products}$: (1) $[P] = 0.10$, $[Q] = 0.20$, rate 3.0×10^{-4} ; (2) $[P] = 0.30$, $[Q] = 0.20$, rate 9.0×10^{-4} ; (3) $[P] = 0.10$, $[Q] = 0.40$, rate 3.0×10^{-4} (mol/dm^3 and $\text{mol dm}^{-3} \text{s}^{-1}$). Deduce the orders, write the rate equation and calculate k with units.

Question 3 Mechanism (3 marks)

A two-step mechanism is: step 1 (slow) $\text{H}_2\text{O}_2 + \text{I}^- \rightarrow \text{IO}^- + \text{H}_2\text{O}$; step 2 (fast) $\text{IO}^- + \text{H}_2\text{O}_2 \rightarrow \text{I}^- + \text{H}_2\text{O} + \text{O}_2$. Write the rate equation, give the overall equation and identify the catalyst and the intermediate.

Question 4 Arrhenius graph (3 marks)



Arrhenius plot for a reaction.

Use the graph to calculate the gradient and the activation energy in kJ/mol.

Question 5 Half-life (2 marks)

A first order reaction has $k = 2.31 \times 10^{-2} \text{ min}^{-1}$. Calculate the half-life.

Question 6 Temperature and rate (3 marks)

Explain, using the idea of activation energy, why the rate of a reaction increases greatly with a small rise in temperature.

Question 7 Catalysts (2 marks)

Explain how a catalyst increases the rate of a reaction without being used up.

Question 8 Changing two concentrations (2 marks)

The rate equation is $\text{rate} = k[\text{A}][\text{B}]^2$. Calculate the factor by which the rate changes when $[\text{A}]$ is doubled and $[\text{B}]$ is halved. Show your working.