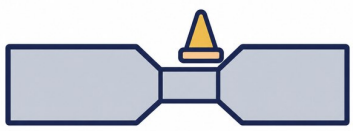
Mechanisms and Temperature Map

OCR A Level Chemistry A (H432) · 5.1.1 How fast? · Mechanisms and temperature

1 The slow step

5.1.1(i)(i)

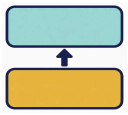
- Slowest step: **rate-determining**
- Its species: in the rate equation
- Later steps: not counted
- **Intermediate**: made, then used



2 Rate equation → mechanism

5.1.1(i)(ii)

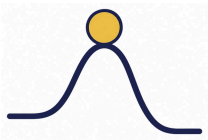
- Slow step: the rate-equation species
- Other reactants: **fast** steps after
- Steps **add up** to the equation
- Intermediates cancel

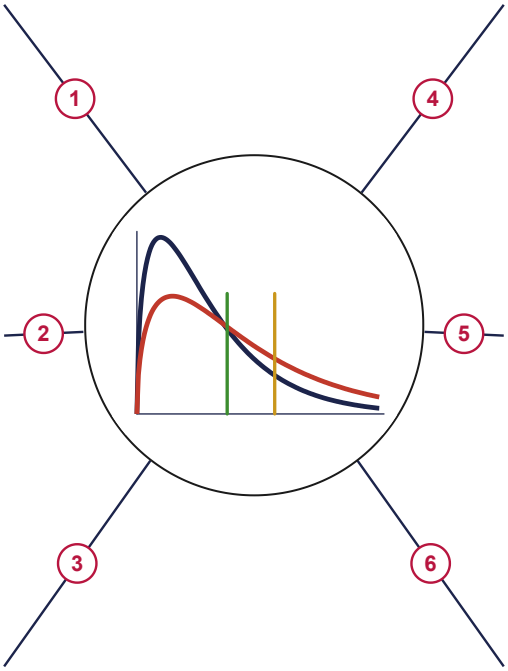


3 E_a and temperature

5.1.1(j), 3.2.2

- **E_a**: minimum energy to react
- Higher T: curve flatter, to the right
- More molecules with E ≥ E_a
- k rises; rate equation unchanged





4 The Arrhenius equation

5.1.1(k)(i)

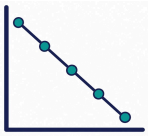
- **k = Ae^(−E_a/RT)**
- E_a in J mol^{-1}, T in K
- R = 8.31 J K^{-1} mol^{-1}
- ln k = −E_a/RT + ln A



5 Arrhenius plot

5.1.1(k)(ii)

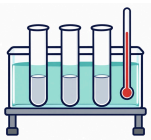
- ln k against **1/T**
- Gradient = **−E_a/R**
- Intercept = **ln A**
- Line of best fit, T in kelvin



6 The E_a practical

5.1.1(k), PAG 10

- Clock run at several T
- Same concentrations: **1/t ∝ k**
- Plot ln(1/t) against 1/T
- Errors: end point, T drifting



Rate equation to mechanism

the species in the rate equation are the species up to and including the slow step

Reaction	Rate equation	Slow step holds	Mechanism
$NO_2 + CO \rightarrow NO + CO_2$	rate = k$[NO_2]^2$	2 NO_2, no CO	two steps, NO_3 intermediate
$2NO + O_2 \rightarrow 2NO_2$	rate = k$[NO]^2[O_2]$	2 NO and O_2	fast $2NO \rightleftharpoons N_2O_2$ first
$H_2 + 2ICl \rightarrow I_2 + 2HCl$	rate = k$[H_2][ICl]$	H_2 and one ICl	two steps, HI intermediate
$2N_2O_5 \rightarrow 4NO_2 + O_2$	rate = k$[N_2O_5]$	one N_2O_5	slow $N_2O_5 \rightarrow NO_2 + NO_3$

Worked examples

Rate to mechanism

- $2NO_2 + O_3$, rate = k$[NO_2][O_3]$
- slow: $NO_2 + O_3 \rightarrow NO_3 + O_2$
- fast: $NO_3 + NO_2 \rightarrow N_2O_5$

k from E_a

- E_a 50 kJ, A 4.0 × 10^{10} s^{-1}
- E_a/RT at 300 K = 20.06
- **k = 78 s^{-1}**

E_a from a gradient

- gradient −7.22 × 10^3 K
- × 8.31
- **E_a = 60.0 kJ mol^{-1}**

Catalysts and the Boltzmann distribution: 3.2.2. Rates lead on to equilibrium constants (5.1.2 How far?).

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