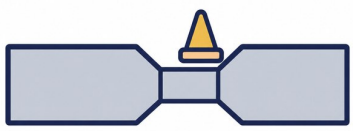
Rate Equations and Mechanisms Map

Edexcel A Level Chemistry (9CH0) · Topic 16B Rate Equations and Mechanisms

1 The slow step

16.1 vii, 16.9

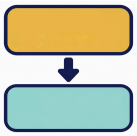
- Slowest step: **rate-determining**
- Its species: in the rate equation
- Later steps: not counted
- **Intermediate**: made, then used



2 Mechanism → rate equation

16.9

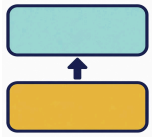
- List the slow step's species
- Intermediate? Use what made it
- Order = number of particles
- up to and including the slow step

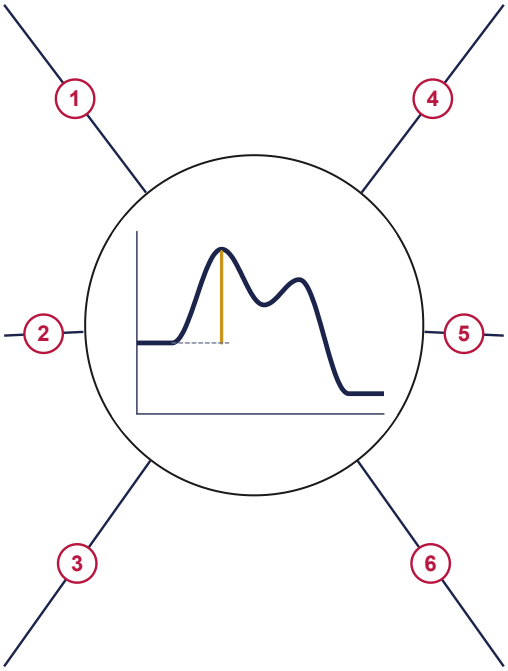


3 Rate equation → mechanism

16.10

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





4 Iodine and propanone

16.8

- rate = **k[CH_3COCH_3][H^+]**
- Zero order in I_2
- I_2 reacts after the slow step
- H^+: catalyst in the equation



5 Titration method

CP 13a

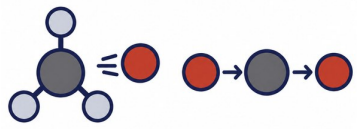
- Propanone, acid in **excess**
- Samples **quenched** in $NaHCO_3$
- Titrate I_2: thiosulfate, starch
- [I_2]–time: straight line



6 SN1 and SN2

16.11

- Primary: rate = k[RX][OH^-]: **SN2**
- Tertiary: rate = k[RX]: **SN1**
- SN1: slow C–X break, **carbocation**
- Number = species in the slow step



Rate equation to mechanism

the species in the rate equation are the species up to 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
$CH_3COCH_3 + I_2$ (H^+)	rate = k[CH_3COCH_3][H^+]	propanone, H^+	I_2 in a fast step
$CH_3CH_2Br + OH^-$	rate = k[RBr][OH^-]	RBr and OH^-	SN2, one step
$(CH_3)_3CBr + OH^-$	rate = k[RBr]	RBr only	SN1, carbocation

Worked examples

Mechanism to rate

- fast: $2NO \rightleftharpoons N_2O_2$
- slow: $N_2O_2 + O_2$
- rate = **k[NO]^2[O_2]**

Rate to mechanism

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

SN1 or SN2?

- double [OH^-]: rate × 1
- zero order in OH^-
- **SN1**: tertiary

Activation energy, the Arrhenius equation and catalysts follow in Topic 16C.

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