

Halogen Compounds

A-Level Chemistry ■ Topic 15

A-Level Chemistry



Halogen Compounds

What we will cover

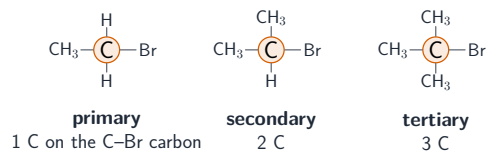
- 1 Three classes
- 2 Nucleophilic substitution
- 3 Substitution vs elimination
- 4 S_N1 & S_N2
- 5 Different reactivities



volatile halogenoalkanes

1 Halogenoalkanes

Three classes



A **halogenoalkane** 卤代烷 has a C-X bond.

- **primary** 伯 – 1 carbon on the C-X carbon
- **secondary** 仲 – 2
- **tertiary** 叔 – 3

Nucleophilic substitution

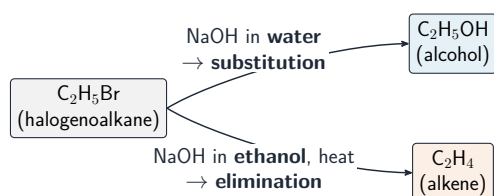


The polar carbon is attacked by a **nucleophile** 亲核试剂:

- $\text{NaOH(aq)} \rightarrow$ an **alcohol** 醇
- $\text{KCN} \rightarrow$ a **nitrile** 腈 (adds a carbon)
- $\text{NH}_3 \rightarrow$ an **amine** 胺

Warm with **silver nitrate** 硝酸银 to identify the halogen.

Substitution vs elimination



The conditions decide:

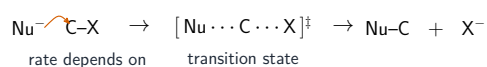
- NaOH in **water** → substitution (alcohol)
- NaOH in **ethanol**, heat → **elimination** 消去 (alkene)

2 Mechanism and rate

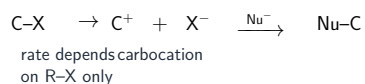
Halogen Compounds
Mechanism and rate

S_N1 and S_N2

S_N2: one step



S_N1: two steps

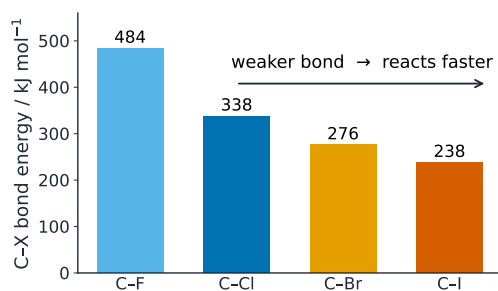


- **S_N2** 双分子 – one step, a crowded **transition state** 过渡态; primary
- **S_N1** 单分子 – two steps via a **carbocation** 碳正离子; tertiary

The inductive effect stabilises the tertiary carbocation.

Halogen Compounds
Mechanism and rate

Different reactivities



Reactivity depends on the C-X **bond energy** 键能.

The weaker the bond, the faster it reacts – so **iodoalkanes** react fastest, **chloroalkanes** slowest.

3

Recap

Halogen Compounds

└ Recap

Worked example – S_N1 or S_N2?

Predict the mechanism for hydrolysis of (a) 1-bromobutane and (b) 2-bromo-2-methylpropane.

- (a) **Primary**: little steric hindrance, and a primary cation is too unstable to form.
 - ⇒ S_N2: one step, OH⁻ attacks as Br leaves; rate = $k[\text{RBr}][\text{OH}^-]$.
- (b) **Tertiary**: bulky groups block attack, but the tertiary cation is stable.
 - ⇒ S_N1: two steps via the cation; rate = $k[\text{RBr}]$ only.

Primary → S_N2, tertiary → S_N1, secondary → both. The **rate equation** is the exam's proof of which one ran.

Halogen Compounds

└ Recap

Topic 15 – key takeaways

1 Classes

primary, secondary, tertiary

2 Substitution

NaOH(aq), KCN, NH₃ replace the halogen

3 Mechanism

S_N2 (primary) vs S_N1 (tertiary)

4 Reactivity

weaker C–X → faster; iodo fastest

Check yourself

- 1 NaOH in water gives which product?
- 2 NaOH in ethanol gives which product?
- 3 Which mechanism do tertiary halogenoalkanes favour?
- 4 Which halogenoalkane reacts fastest?



Answers 1. an alcohol 2. an alkene 3. S_N1 4. the iodoalkane