

15.1 Halogenoalkanes

Name: _____ Class: _____ Date: _____

Total: 12 marks

KEY WORDS secondary 仲 • elimination 消去 • tertiary 叔 • nucleophilic substitution 亲核取代
• primary 伯

Objective

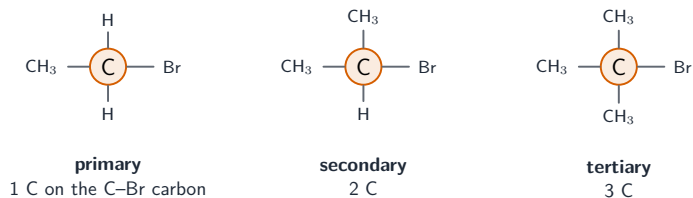
Build the skills to answer exam questions on **halogenoalkanes** 卤代烷 — **nucleophilic substitution** 亲核取代, **elimination** 消去, the S_N1/S_N2 mechanisms, and the trend in reactivity.

You must be able to:

- classify halogenoalkanes and describe their nucleophilic substitution reactions
- describe the elimination reaction and the S_N1 and S_N2 mechanisms
- explain the different reactivities in terms of C–X bond strength

1 Worked examples

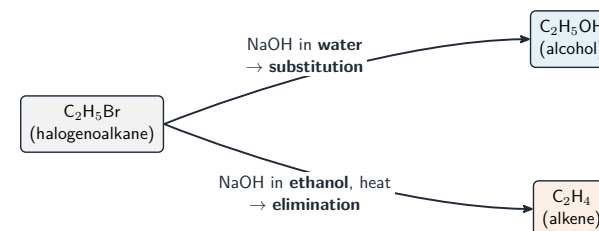
Classes and nucleophilic substitution



Primary/secondary/tertiary = 1/2/3 carbons joined to the carbon bearing the halogen

The polar C–X carbon is attacked by **nucleophiles**: NaOH(aq) → alcohol; KCN/ethanol → nitrile (+1 C); NH₃/ethanol/pressure → amine. **Test the halogen** with AgNO₃ in ethanol (white AgCl, cream AgBr, yellow AgI).

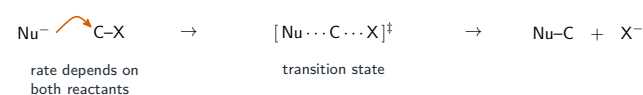
Substitution vs elimination



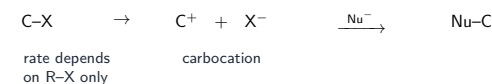
$NaOH(aq) \rightarrow$ substitution (alcohol); $NaOH$ in ethanol + heat $\rightarrow$ elimination (alkene)

S_N1 and S_N2

S_N2 : one step



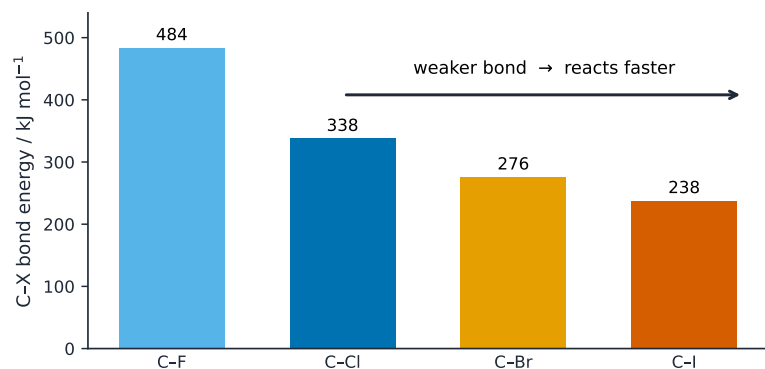
S_N1 : two steps



S_N2 : one step (rate depends on both). S_N1 : via a carbocation (rate depends only on the halogenoalkane)

Primary → mostly S_N2 ; tertiary → mostly S_N1 (stable carbocation).

Reactivity



rate: RI > RBr > RCl (weaker C-X ⇒ faster)

The weaker the C-X bond, the faster — iodoalkanes react fastest, chloroalkanes slowest

2 Practice

2.1 State the reagent and condition to convert a halogenoalkane into an alcohol. [2]

2.2 Name the organic product when a halogenoalkane reacts with KCN in ethanol. [1]

3 Exam-style questions

3.1 Which conditions favour **elimination** of a halogenoalkane to an alkene? [1]

- | | |
|---|---|
| A | B |
| C | D |
- A NaOH in water, warm
 B NaOH in ethanol, heat
 C aqueous silver nitrate
 D KCN in ethanol

3.2 Which halogenoalkane reacts **fastest** with aqueous silver nitrate? [1]

- | | |
|---|---|
| A | B |
| C | D |
- A 1-chlorobutane
 B 1-bromobutane
 C 1-iodobutane
 D they react at the same rate

3.3 (a) Describe the S_N2 mechanism for the reaction of bromoethane with hydroxide ions. [3]

(b) Explain why tertiary halogenoalkanes tend to react by the S_N1 mechanism. [2]

3.4 Explain why iodoalkanes are more reactive than chloroalkanes in substitution reactions. [2]