

29.2 Characteristic organic reactions

Name: _____ Class: _____ Date: _____

Total: 21 marks

KEY WORDS electrophilic substitution 亲电取代 • addition-elimination 加成消去

• characteristic organic reactions 有机反应类型 • free radicals 自由基 • electrophiles 亲电试剂

Objective

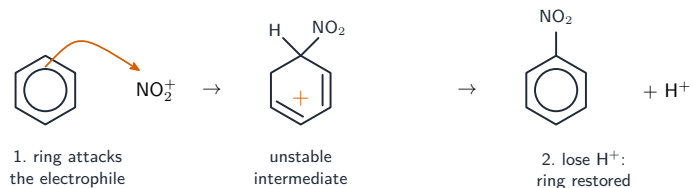
Build the skills to answer exam questions on **characteristic organic reactions** 有机反应类型 — classifying a reaction by its type and the kind of reagent involved.

You must be able to:

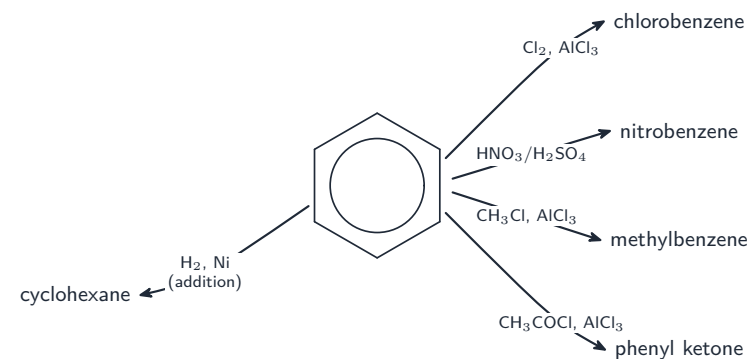
- classify reactions as addition, substitution, elimination, hydrolysis, condensation, oxidation, reduction or polymerisation
- classify reagents as **electrophiles** 亲电试剂, **nucleophiles** 亲核试剂 or **free radicals** 自由基
- describe the two new mechanism types: **electrophilic substitution** and **addition-elimination**

1 Worked examples

■ Naming the reaction type



Electrophilic substitution: an electrophile replaces a ring hydrogen — the characteristic reaction of benzene



Characteristic reactions of the benzene ring

- **electrophilic substitution** — an electrophile replaces an H on a benzene ring (e.g. nitration).
- **nucleophilic substitution** — a nucleophile replaces a leaving group (e.g. OH^- + halogenoalkane).
- **addition** — a π bond opens and two groups add on (e.g. Br_2 + alkene).
- **addition-elimination** — a group adds, then a small molecule leaves (e.g. 2,4-DNPH, acyl chlorides).

Reagent types: electrophile = electron-pair **acceptor**; nucleophile = electron-pair **donor**; radical = species with an unpaired electron.

2 Practice

2.1 State what is meant by an **electrophile**. [1]

2.2 Classify the reaction of bromine with ethene (an alkene). [1]

3 Exam-style questions

3.1 The reaction of OH^- with bromoethane is best classified as: [1]

- | | |
|---|---|
| A | B |
| C | D |
- A** electrophilic addition
B nucleophilic substitution
C electrophilic substitution
D free-radical substitution

3.2 Which species is a nucleophile? [1]

- | | |
|---|---|
| A | B |
| C | D |
- A** NO_2^+
B H^+
C $:\text{NH}_3$
D $\text{Cl}^\bullet$

3.3 For each reaction, name the **type** and the **reagent class**: [3]

- (a) $\text{benzene} + \text{NO}_2^+ \rightarrow \text{nitrobenzene} + \text{H}^+$
(b) $\text{ethene} + \text{Br}_2 \rightarrow 1,2\text{-dibromoethane}$
(c) $\text{an ester} + \text{water} \rightarrow \text{a carboxylic acid} + \text{an alcohol}$

3.4 Explain why benzene undergoes **substitution** rather than **addition**, unlike an alkene. [2]

3.5 Four reactions of propene and its derivatives are shown.

- I** $\text{CH}_3\text{CH}=\text{CH}_2 + \text{Br}_2 \rightarrow \text{CH}_3\text{CHBrCH}_2\text{Br}$
- II** $\text{CH}_3\text{CHBrCH}_3 + \text{KOH}(\text{aq}) \rightarrow \text{CH}_3\text{CH}(\text{OH})\text{CH}_3 + \text{KBr}$
- III** $\text{CH}_3\text{CHBrCH}_3 + \text{KOH}$ in ethanol $\rightarrow \text{CH}_3\text{CH}=\text{CH}_2 + \text{KBr} + \text{H}_2\text{O}$
- IV** $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3 + [\text{O}] \rightarrow \text{CH}_3\text{COCH}_3 + \text{H}_2\text{O}$

(a) Classify each reaction by type. [4]

(b) For **I**, name the attacking species and explain how a non-polar bromine molecule comes to attack an alkene. [3]

(c) Reactions **II** and **III** use the same reagent on the same compound but give different products. Explain what decides which happens. [2]

(d) Name a suitable oxidising agent for **IV**, and state what you would see. Explain why the product cannot be oxidised further. [3]
