Exercise walk-through

Characteristic organic reactions ▪ 29.2

eXercise

You must be able to

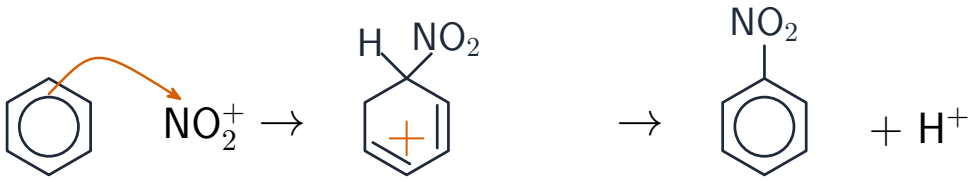
- classify reactions as addition, substitution, elimination, hydrolysis, condensation, oxidation, reduction or polymerisation
- classify reagents as **electrophiles** 亲电试剂, **nucleophiles** 亲核试剂 or **free radicals** 自由基
- describe the two new mechanism types: **electrophilic substitution** and **addition–elimination**

Method — Naming the reaction type

- **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.

Method — Naming the reaction type

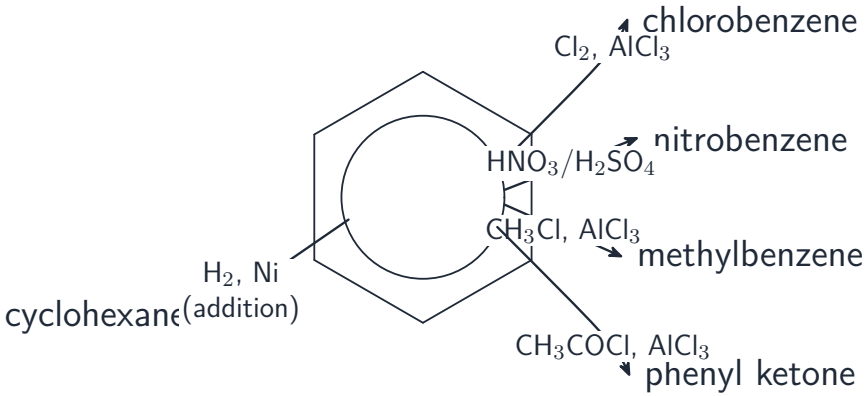


1. ring attacks the electrophile

unstable intermediate

2. lose H^+: ring restored

Method — Naming the reaction type



Characteristic reactions of the benzene ring

Practice 2.1 ▪ 1 mark

State what is meant by an **electrophile**.

Solution 2.1

Worked steps

an electron-pair acceptor / a species that is attracted to a region of high electron density **B1**.

Practice 2.2 ▪ 1 mark

Classify the reaction of bromine with ethene (an alkene).

Solution 2.2

Method: Naming the reaction type

Worked steps

electrophilic addition B1.

Exam-style 3.1 ▪ 1 mark

The reaction of OH^- with bromoethane is best classified as:

A electrophilic addition

B nucleophilic substitution

C electrophilic substitution

D free-radical substitution

Solution 3.1

Method: Naming the reaction type

A electrophilic addition

B nucleophilic substitution ✓

C electrophilic substitution

D free-radical substitution

Worked steps

B. OH^- is a nucleophile and it replaces the bromine — nucleophilic substitution.

Exam-style 3.2 ▪ 1 mark

Which species is a nucleophile?

A NO_2^+

B H^+

C $:NH_3$

D $Cl^\bullet$

Solution 3.2

Method: Naming the reaction type

A NO_2^+

B H^+

C $:NH_3$ ✓

D $Cl^\bullet$

Worked steps

C. $:NH_3$ has a lone pair to donate — a nucleophile.

Exam-style 3.3 ▪ 3 marks

For each reaction, name the **type** and the **reagent class**:

(a) benzene + NO_2^+ → nitrobenzene + H^+

(b) ethene + Br_2 → 1,2-dibromoethane

(c) an ester + water → a carboxylic acid + an alcohol

Solution 3.3

Method: Naming the reaction type

Worked steps

(a) electrophilic substitution; electrophile B1
(b) (electrophilic) addition; electrophile B1
(c) hydrolysis (substitution); water/nucleophile B1.

Exam-style 3.4 ▪ 2 marks

Explain why benzene undergoes **substitution** rather than **addition**, unlike an alkene.

Solution 3.4

Method: Naming the reaction type

Worked steps

benzene's delocalised π system is very stable **M1**; substitution keeps the stable ring intact, whereas addition would destroy the delocalisation, so substitution is favoured **A1**.