Exercise walk-through

Characteristic organic reactions ▪ 13.2

eXercise

You must be able to

- use the terms homologous series, saturated/unsaturated, and homolytic/heterolytic fission
- define nucleophile, electrophile, and the reaction types (addition, substitution, etc.)
- describe the free-radical steps and name the main mechanisms

Method — Breaking bonds

*Homolytic: one electron to each atom (two **free radicals** 自由基). Heterolytic: both electrons to one atom (two ions)*

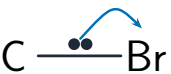
homolytic fission

$Cl\bullet \quad + \quad \bullet Cl$

one electron each

$\Rightarrow$ two **radicals**

heterolytic fission



$C^{+} \quad + \quad :Br^{-}$

both electrons to one

$\Rightarrow$ two **ions**

Method — Nucleophiles and electrophiles

nucleophile

a lone pair attacks the electron-poor ($\delta+$) carbon

electrophile

it is drawn to the electron-rich C=C double bond

Method — Reaction and mechanism types

addition (two → one), **substitution** (swap), **elimination** (lose a small molecule → double bond), **hydrolysis** (split by water), **condensation** (join + lose a small molecule). Free-radical reactions go by **initiation → propagation → termination**. Main mechanisms: free-radical substitution, electrophilic addition, nucleophilic substitution, nucleophilic addition. A **curly arrow** shows a pair of electrons moving.

Practice 2.1 ▪ 1 mark

Define a **nucleophile**.

Solution 2.1

Worked steps

a species with a lone pair that is attracted to (attacks) an electron-poor / positive centre **B1**.

Practice 2.2 ▪ 1 mark

Name the type of bond fission that produces two free radicals.

Solution 2.2

Method: Breaking bonds

Worked steps

homolytic fission B1.

Exam-style 3.1 ▪ 1 mark

Heterolytic fission of a covalent bond produces:

A two free radicals

B two ions

C two atoms

D a double bond

Solution 3.1

Method: Breaking bonds

A two free radicals

B two ions ✓

C two atoms

D a double bond

Worked steps

B. Heterolytic fission gives both electrons to one atom, producing two ions.

Exam-style 3.2 ▪ 1 mark

A reaction in which a small molecule is removed to form a C=C double bond is:

A addition

B substitution

C elimination

D hydrolysis

Solution 3.2

Method: Reaction and mechanism types

A addition

B substitution

C elimination ✓

D hydrolysis

Worked steps

C. Removing a small molecule to form a double bond is elimination.

Exam-style 3.3 ▪ 2 marks

(a) State the difference between homolytic and heterolytic fission.
(b) Name the three steps of a free-radical mechanism.

Solution 3.3

Method: Breaking bonds

Worked steps

(a) homolytic — the bond splits evenly, one electron to each atom (two radicals) B1; heterolytic — both electrons go to one atom (two ions) B1.
(b) initiation; propagation; termination B1 *each*.

Exam-style 3.4 ▪ 2 marks

Explain why a C=C double bond is attacked by electrophiles.

Solution 3.4

Worked steps

the C=C bond is an electron-rich region (high electron density) M1; electrophiles are electron-deficient and are attracted to it A1.