Exercise walk-through

Alkenes ▪ 14.2

eXercise

You must be able to

- recall how alkenes are made and describe their addition reactions
- describe the electrophilic addition mechanism and use the bromine test
- explain carbocation stability and Markovnikov addition

Method — Reactions of alkenes

The C=C bond reacts by **electrophilic addition**: with H (Pt/Ni) → alkane; steam (H PO) → alcohol; HX → halogenoalkane; X → dihalide. Cold dilute KMnO → diol; hot conc. KMnO breaks the C=C.

Method — Reactions of alkenes

shake with orange bromine water

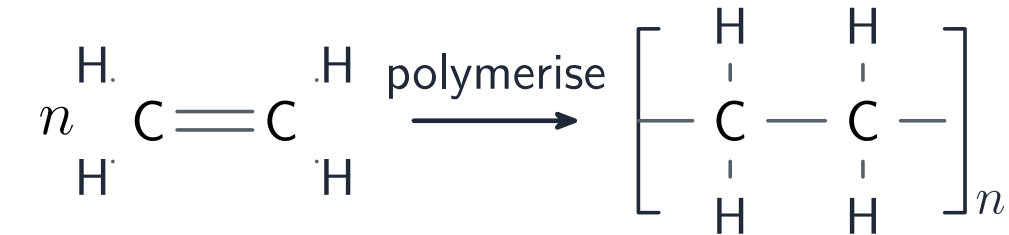
with an **alkene**

turns colourless
(decolourised)

with an **alkane**

stays orange
(no reaction)

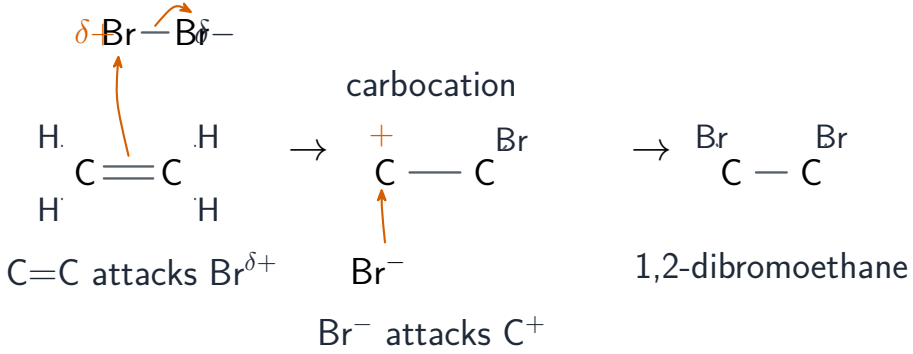
Method — Reactions of alkenes



n ethene molecules opening their double bonds to form the long chain of poly(ethene)

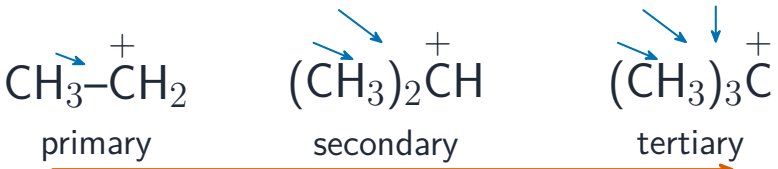
Method — Mechanism and Markovnikov

Electrophilic addition: the electron-rich C=C attacks the electrophile, forming a carbocation, then the nucleophile attacks



Bromine adding to ethene: the C=C attacks Br$\delta+$, a carbocation forms, then Br$^-$ attacks

Method — Mechanism and Markovnikov



more alkyl groups push more electrons in $\Rightarrow$ more stable

Markovnikov: HBr adds so the *more stable* carbocation forms

Primary, secondary and tertiary carbocations; stability rises with more alkyl groups

Practice 2.1 ▪ 2 marks

State the reagent and condition for making an alcohol from an alkene.

Solution 2.1

Method: Reactions of alkenes

Worked steps

steam (H O gas) with a phosphoric acid (H PO) catalyst B1 B1.

Practice 2.2 ▪ 2 marks

Describe the test for a C=C double bond and the positive result.

Solution 2.2

Method: Reactions of alkenes

Worked steps

shake with (orange) bromine water **B1**; an alkene decolourises it / turns it colourless **B1**.

Exam-style 3.1 ▪ 1 mark

Which reagent converts ethene into a halogenoalkane?

A H / Ni

B steam / H PO

C HBr at room temperature

D hot KMnO

Solution 3.1

Method: Reactions of alkenes

A H / Ni

B steam / H PO

C HBr at room temperature ✓

D hot KMnO

Worked steps

C. HBr at room temperature gives a halogenoalkane.

Exam-style 3.2 ▪ 1 mark

During electrophilic addition, the positive intermediate formed is a:

A free radical

B carbocation

C nucleophile

D diol

Solution 3.2

A free radical

B carbocation ✓

C nucleophile

D diol

Worked steps

B. The intermediate is a carbocation.

Exam-style 3.3 ▪ 3 marks

(a) Describe the mechanism of the electrophilic addition of bromine to ethene (use curly arrows or words).
(b) Write the equation for the addition polymerisation of ethene to poly(ethene).

Solution 3.3

Method: Reactions of alkenes

Worked steps

(a) the C=C double bond attacks the $\delta+$ bromine, with a curly arrow from the double bond **M1**; the Br–Br bond breaks heterolytically, forming a carbocation and a Br **M1**; the Br then attacks the carbocation to give 1,2-dibromoethane **A1**.
(b) $n\,CH_2{=}CH_2 \rightarrow -(CH_2CH_2)_n-$ **B1**.

Exam-style 3.4 ▪ 3 marks

When HBr adds to propene, 2-bromopropane is the major product. Explain why, using carbocation stability.

Solution 3.4

Method: Mechanism and Markovnikov

Worked steps

adding H to propene can form a secondary or a primary carbocation M1; the secondary carbocation is more stable, because two alkyl groups push electrons towards the positive carbon M1; the more stable (secondary) carbocation forms preferentially, giving 2-bromopropane A1.