

Exercise walk-through

14.2

Alkenes

A-Level Chemistry

Alkenes and their reactions



Alkenes (C_nH_{2n}) have a reactive $C=C$, attacked by **electrophilic addition** :

- $H_2/Ni \rightarrow$ alkane; steam $\rightarrow$ alcohol
- $HX \rightarrow$ halogenoalkane; $X_2 \rightarrow$ dihalide

The bromine test

shake with orange bromine water



with an **alkene**

turns colourless
(decolourised)



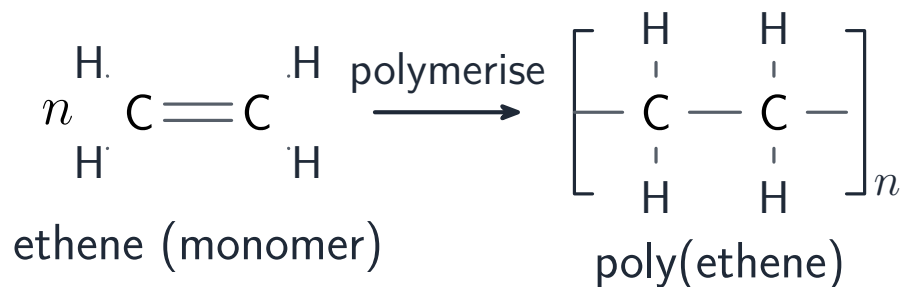
with an **alkane**

stays orange
(no reaction)

Shake with orange **bromine water** :

An alkene **decolourises** it (electrophilic addition); an alkane leaves it orange.

Addition polymerisation

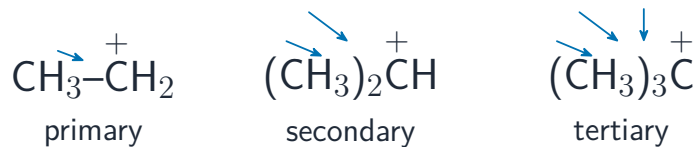


In **addition**

polymerisation

, many alkene molecules open their C=C and join into one long chain – with **no other product**. Ethene → poly(ethene), a **polymer**.

Mechanism and Markovnikov's rule



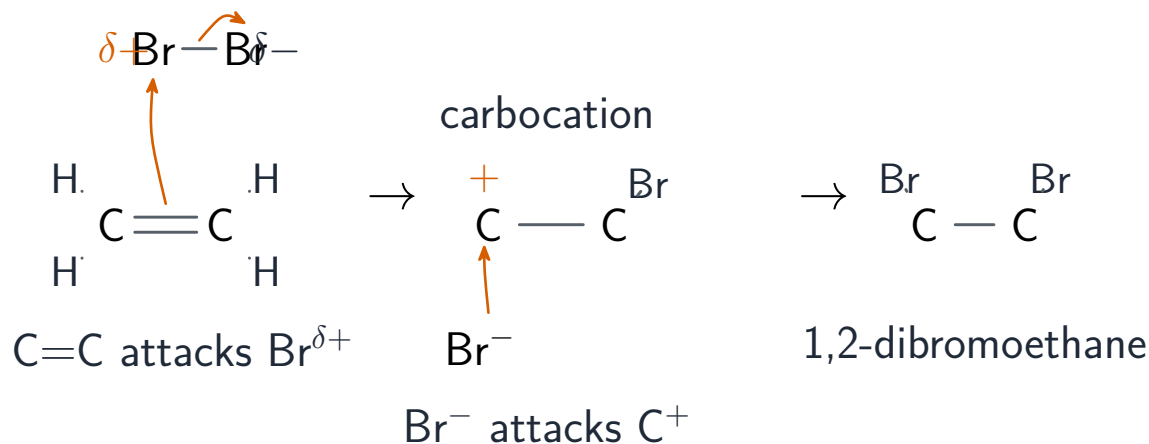
more alkyl groups push more electrons in $\Rightarrow$ more stable

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

A **carbocation** forms in electrophilic addition.

Alkyl groups push electrons in (the **inductive effect**), so tertiary > secondary > primary – the more stable one forms (**Markovnikov's rule**).

The mechanism and Markovnikov's rule



Electrophilic addition of bromine to ethene: the $\text{C}=\text{C}$ attacks $\text{Br}^{\delta+}$, a carbocation forms, then Br^- attacks it

Exercises 2.1·3.1

2.1 State the reagent and condition for making an alcohol from an alkene. [2]

2.2 Describe the test for a C=C double bond and the positive result. [2]

3.1 Which reagent converts ethene into a halogenoalkane? [1]

☐

A H_2 / Ni

B steam / H_3PO_4

C HBr at room temperature

D hot KMnO_4

Exercises 2.1·3.1

2.1 State the reagent and condition for making an alcohol from an alkene. [2]

2.1

- steam (H_2O gas) with a phosphoric acid (H_3PO_4) catalyst
-

2.2 Describe the test for a $\text{C}=\text{C}$ double bond and the positive result. [2]

2.2

- shake with (orange) bromine water; an alkene decolourises it / turns it colourless
-

3.1 Which reagent converts ethene into a halogenoalkane? [1]

☐

A H_2 / Ni

B steam / H_3PO_4

C HBr at room temperature

D hot KMnO_4

3.1 C

- HBr at room temperature gives a halogenoalkane

Exercise 3.2

3.2 During electrophilic addition, the positive intermediate formed is a:

[1]

☐

A free radical

B carbocation

C nucleophile

D diol

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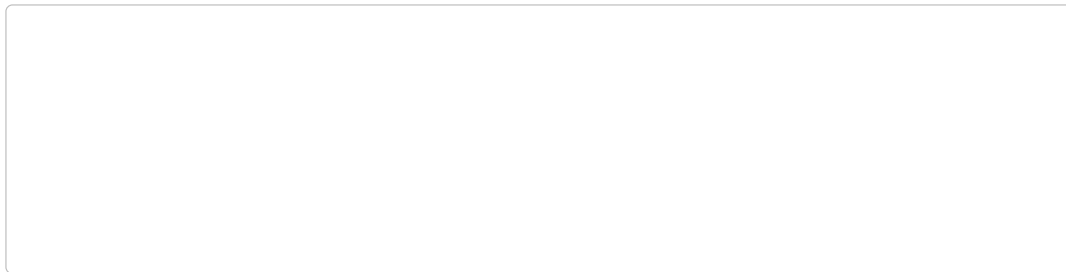
D diol

3.2 B

- The intermediate is a carbocation

Exercise 3.3

3.3 (a) Describe the mechanism of the electrophilic addition of bromine to ethene (use curly arrows or words). [3]



(b) Write the equation for the addition polymerisation of ethene to poly(ethene). [1]

Exercise 3.3

3.3 (a) Describe the mechanism of the electrophilic addition of bromine to ethene (use curly arrows or words). [3]

(b) Write the equation for the addition polymerisation of ethene to poly(ethene). [1]

3.3

(a)

- the C=C double bond attacks the $\delta+$ bromine, with a curly arrow from the double bond; the Br-Br bond breaks heterolytically, forming a carbocation and a Br^- ; the Br^- then attacks the carbocation to give 1,2-dibromoethane

(b)

- $n \text{CH}_2=\text{CH}_2 \rightarrow -(\text{CH}_2\text{CH}_2)_n-$

Exercise 3.4

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3.4

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