A-LEVEL CHEMISTRY • EXERCISE SHEET

14.2 Alkenes

Name: _____ Class: _____ Date: _____ **Total: 13 marks**

Objective

Build the skills to answer exam questions on **alkenes** 烯烃—making them, **electrophilic addition** 亲电加成, the **bromine** 溴 test, **addition polymerisation** 加成聚合, and **Markovnikov's rule** 马氏规则.

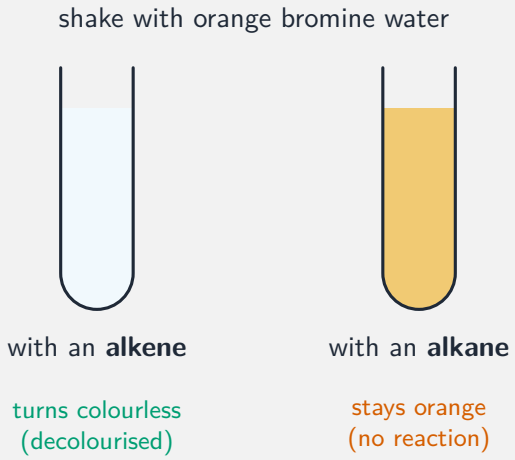
You must be able to:

- 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

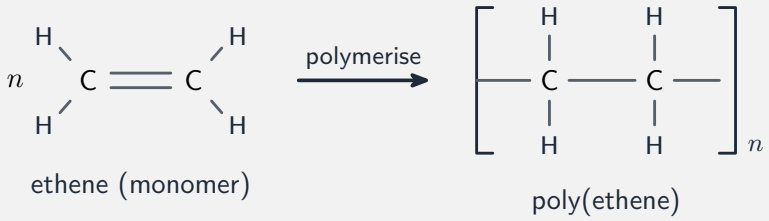
1 Worked examples

Reactions of alkenes

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

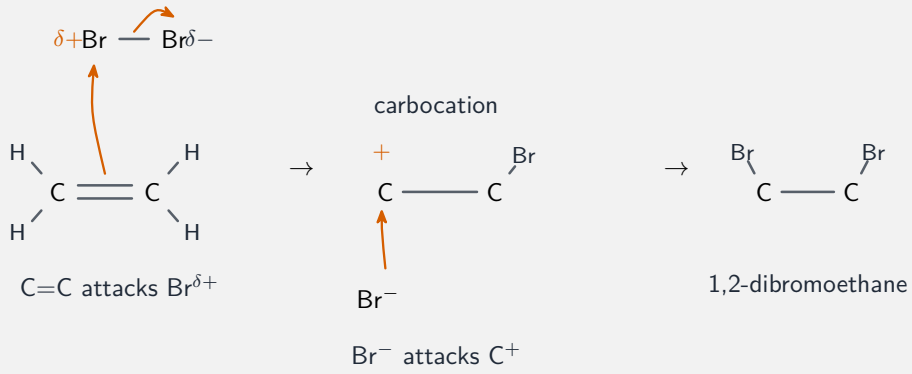


Test for C=C: an alkene decolourises orange bromine water; an alkane does not

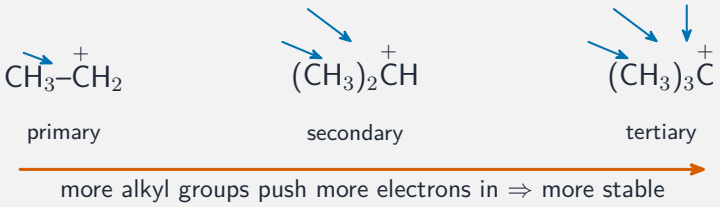


Addition polymerisation: many ethene molecules join into poly(ethene), with no other product

Mechanism and Markovnikov



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



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

Alkyl groups push electrons in (inductive effect), so tertiary > secondary > primary —the basis of Markovnikov's rule

2 Practice

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 Exam-style questions

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

- **A** H / Ni
- **B** steam / H PO
- **C** HBr at room temperature
- **D** hot KMnO

3.2 During electrophilic addition, the positive intermediate formed is a: [1]

- **A** free radical
- **B** carbocation
- **C** nucleophile
- **D** diol

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]

3.4 When HBr adds to propene, 2-bromopropane is the major product. Explain why, using carbocation stability. [3]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **14.2 Alkenes** past-paper sheet in the Library, or try these in **Practice mode**:

- 9701/11 N25 —Q27 (alkenes)
- 9701/12 N25 —Q28 (electrophilic addition)
- 9701/14 N25 —Q29 (polymerisation)

Solutions

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

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

3.1 C. HBr at room temperature gives a halogenoalkane.

3.2 B. The intermediate is a carbocation.

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) $n\,CH_2{=}CH_2 \rightarrow -(CH_2CH_2)_n-$.

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.