1.5 Alkenes

Name: _____ Class: _____ Date: _____ **Total: 19 marks**

KEY WORDS pi bond π • electrophilic addition • carbocation • Markovnikov • repeat unit

Objective

Practise Topic 5: the sigma-pi double bond, E/Z isomerism with CIP priority, electrophilic addition mechanisms, Markovnikov selectivity, and addition polymers.

1 Key knowledge and worked examples

The double bond

One σ bond (head-on overlap) plus one π bond (sideways overlap of p orbitals above and below) – the π cloud is exposed and electron-rich, which is why alkenes attract electrophiles. Rotation is locked by the π bond: hence cis/trans or E/Z isomerism. E/Z needs TWO different groups on EACH double-bond carbon; assign the higher CIP-priority group on each carbon, and if the two high-priority groups are on the same side it is Z (zusammen), opposite sides E (entgegen).

Electrophilic addition mechanism

HBr: the H^+ end is attracted to the π cloud $\rightarrow$ the π bond attacks H, forming a CARBOCATION $\rightarrow$ Br^- captures it. With an asymmetric alkene the major product goes through the MORE STABLE carbocation (secondary > primary): Markovnikov. With Br_2, the electron-rich double bond polarises Br_2 and attacks its positive end. Show electron movement from a bond or lone pair, never from a positive charge. Detailed stereochemical product prediction is not needed for this sheet.

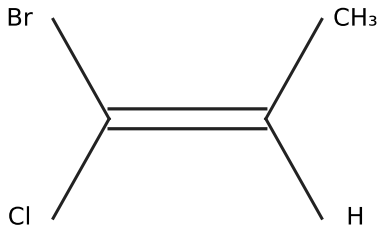
Worked check: predicting the major product

Propene + HBr: H adds to CH_2 (more hydrogens), giving the secondary carbocation CH_3-CH^+-CH_3 $\rightarrow$ 2-bromopropane major.

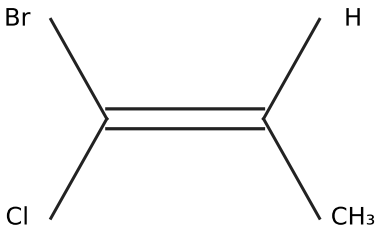
Polymers

n CH_2=CHCl $\rightarrow$ -$(CH_2$-$CHCl)_n$ – draw the repeat unit from the monomer by opening the double bond. Disposal trade-offs: incineration (energy but CO_2), recycling (sorting cost), landfill (persistence).

Assign priority separately on each double-bond carbon.



A: Z (Br and CH_3 together)



B: E (Br and CH_3 apart)

2 Practice

2.1 Explain why ethene does not show geometric isomerism but 1,2-dichloroethene does. [2]

2.2 In isomer A of 1-bromo-1-chloroprop-1-ene, Br and CH_3 are on the same side of the C=C bond. In isomer B they are on opposite sides. Assign E or Z to each. [2]

2.3 Draw the repeat unit of poly(propene). [1]

3 Exam-style questions

3.1 Describe the mechanism for the reaction between HBr and 2-methylbut-2-ene. Include curly arrows, the intermediate, and the structure of the major product. [5]

3.2 An unknown liquid decolourises bromine water. Explain what this observation supports and why it does not identify a unique compound. Write the structural equation for addition of Br_2 to ethene, and name the product. [4]

3.3 An alkene decolourises bromine water and has the molecular formula C_4H_8. Draw the three structural isomers, state which show geometric isomerism, and name each using IUPAC rules. [5]