

CHAPTER 14 ALKENES

1 The table below gives the names and structures of three isomeric alkenes.

Name	Structure
but-1-ene	$\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$
but-2-ene	$\text{CH}_3\text{CH}=\text{CHCH}_3$
methylpropene	$\begin{array}{c} \text{CH}_3 \\ \\ \text{H}_3\text{C}-\text{C}=\text{CH}_2 \end{array}$

(a) Give the molecular formula and the empirical formula of but-2-ene.

Molecular formula

Empirical formula

(2 marks)

(b) Methylpropene reacts with hydrogen bromide to produce 2-bromo-2-methylpropane as the major product.

(i) Name and outline the mechanism for this reaction.

Name of mechanism

Mechanism

(ii) Draw the structure of another product of this reaction and explain why it is formed in smaller amounts.

Structure

Explanation

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(8 marks)

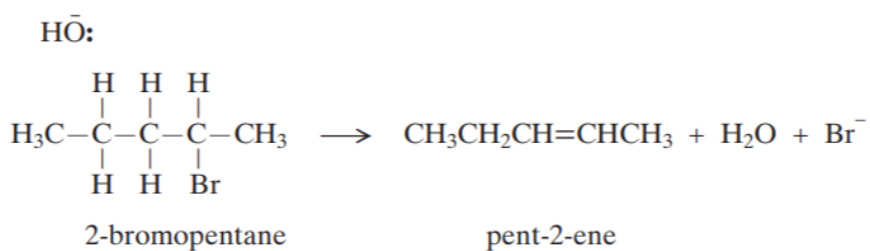
(c) Draw the structures and give the names of the two geometrical isomers of but-2-ene.

Isomer 1

Isomer 2

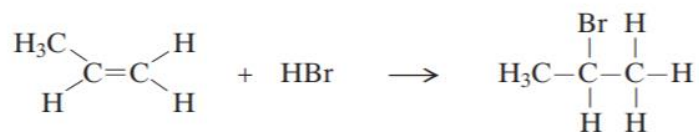
Name Name
(2 marks)

2 (a) Complete the mechanism below by drawing appropriate curly arrows.



(3 marks)

3 (a) Propene reacts with hydrogen bromide by an electrophilic addition mechanism forming 2-bromopropane as the major product.
The equation for this reaction is shown below.

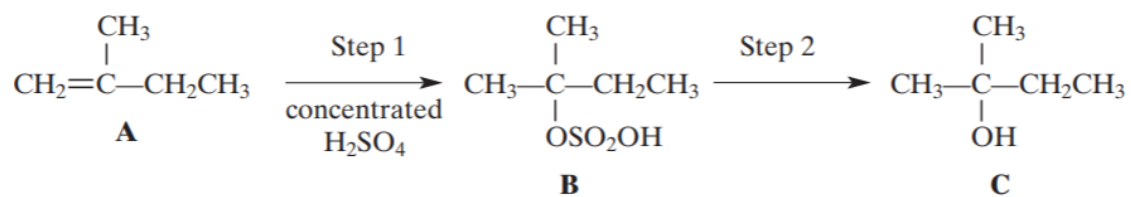


(i) Outline the mechanism for this reaction, showing the structure of the intermediate carbocation formed.

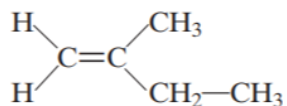
- (ii) Give the structure of the alternative carbocation which could be formed in the reaction between propene and hydrogen bromide.

(5 marks)

- 4 The reaction scheme below shows the conversion of compound **A**, 2-methylbut-1-ene, into compound **B** and then into compound **C**.



- (a) The structure of **A** is shown below. Circle those carbon atoms which must lie in the same plane.



(1 mark)

- (b) Outline a mechanism for the reaction in Step 1.

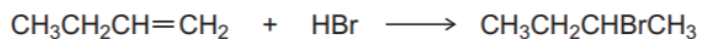
(4 marks)

5 It is possible to convert but-1-ene into its structural isomer but-2-ene.

(a) State the type of structural isomerism shown by but-1-ene and but-2-ene.

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(1 mark)

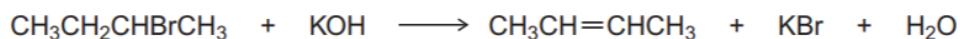
(b) The first stage in this conversion involves the reaction of hydrogen bromide with but-1-ene.



Outline a mechanism for this reaction.

(4 marks)

(c) The second stage is to convert 2-bromobutane into but-2-ene.



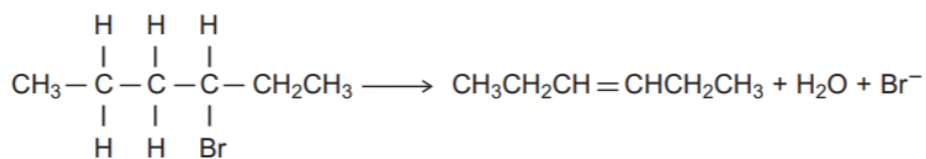
Outline a mechanism for this reaction.

(3 marks)

6 Alkenes are useful intermediates in the synthesis of organic compounds.

(a) (i) Complete the elimination mechanism by drawing appropriate curly arrows.

HO^- :



3-bromohexane

hex-3-ene

(3 marks)

(ii) Draw structures for the E and Z stereoisomers of hex-3-ene.

E isomer of hex-3-ene

Z isomer of hex-3-ene

(2 marks)

(iii) State the meaning of the term *stereoisomers*.

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(2 marks)

- (b) The equation for the first reaction in the conversion of hex-3-ene into hexan-3-ol is shown below.



Outline a mechanism for this reaction.

(4 marks)

7 Propene reacts with bromine by a mechanism known as electrophilic addition.

- (a) Explain what is meant by the term *electrophile* and by the term *addition*.

Electrophile

.....

Addition

.....

(2 marks)

- (b) Outline the mechanism for the electrophilic addition of bromine to propene. Give the name of the product formed.

Mechanism

Name of product
(5 marks)

- 8 (a) (i) Name the alkene $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$

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- (ii) Explain why $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ does not show stereoisomerism.

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- (iii) Draw an isomer of $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ which does show *E-Z* isomerism.

(iv) Draw another isomer of $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ which does not show *E-Z* isomerism.

(4 marks)

(b) (i) Name the type of mechanism for the reaction shown by alkenes with concentrated sulfuric acid.

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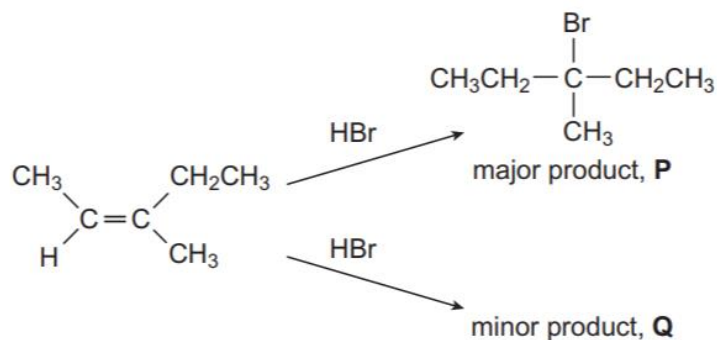
(ii) Write a mechanism showing the formation of the major product in the reaction of concentrated sulfuric acid with $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$.

(iii) Explain why this compound is the major product.

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(6 marks)

9 The alkene (Z)-3-methylpent-2-ene reacts with hydrogen bromide as shown below.



(a) (i) Name the major product **P**.

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(1 mark)

(ii) Name the mechanism for these reactions.

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(1 mark)

(iii) Draw the displayed formula for the minor product **Q** and state the type of structural isomerism shown by **P** and **Q**.

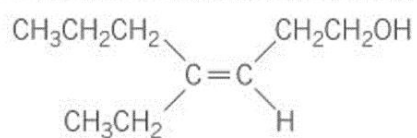
Displayed formula for **Q**

Type of structural isomerism
(2 marks)

(iv) Draw the structure of the (E)-stereoisomer of 3-methylpent-2-ene.

(1 mark)

10 An organic compound A is shown below.



Explain how the Cahn–Ingold–Prelog (CIP) priority rules can be used to deduce the full IUPAC name of this compound.

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