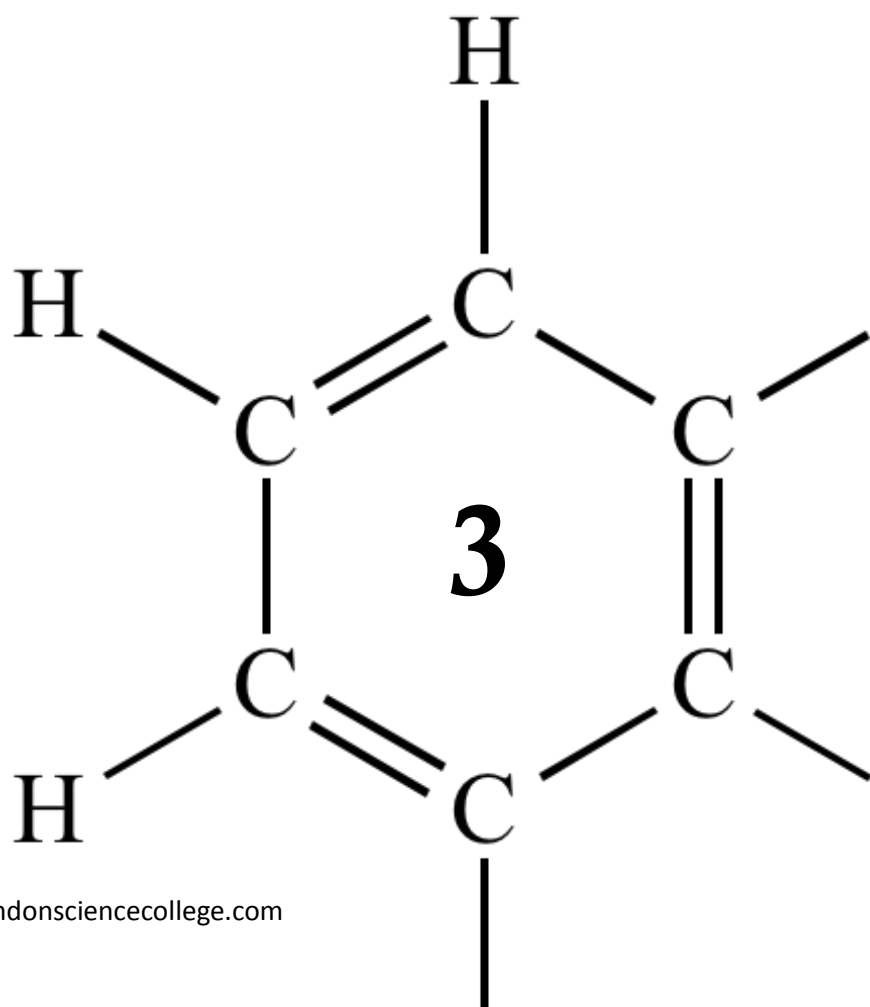


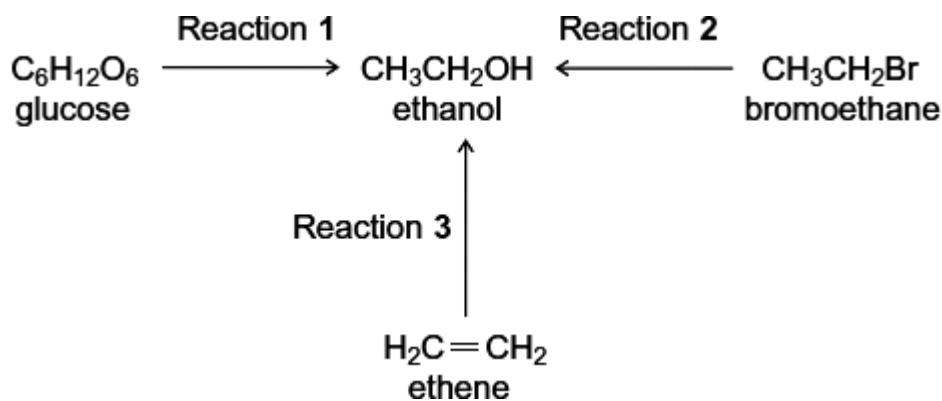
AQA AS CHEMISTRY

# ALKENES



1

Three different ways of producing ethanol are shown below.



- (a) Reaction 1 produces a 15% aqueous solution of ethanol. It is claimed that the ethanol produced in this way is a carbon-neutral biofuel.

Write an equation for Reaction 1 and name the process.

Write an equation for the complete combustion of ethanol.

Explain why the ethanol produced by this process may **not** be a *carbon-neutral* biofuel.

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(Extra space) .....

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(5)



Identify a suitable catalyst for Reaction 3.

Identify the type of reaction.

Give **two** conditions, in addition to the presence of a catalyst, necessary for Reaction 3 to produce a high yield of ethanol.

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(Extra space) .....  
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(4)  
(Total 15 marks)

2

(a) Give the **formula** of a Group 2 metal hydroxide used in agriculture.

.....

(1)

(b) Identify a sodium halide that does **not** undergo a redox reaction when added as a solid to concentrated sulfuric acid.

.....

(1)

(c) Chlorine gas reacts with cold dilute sodium hydroxide solution to form sodium chloride and another chlorine-containing compound, **X**.

Give the **formula** of **X**.

.....

(1)

(d) Give the **formula** of the substance responsible for the orange colour when chlorine gas is bubbled through an aqueous solution of sodium bromide.

.....

(1)

(e) Solid sodium iodide undergoes a redox reaction with concentrated sulfuric acid.

Give the **formula** for each of the following in this reaction.

Formula of the solid reduction product .....

Formula of the oxidation product .....

**(2)**

(f) Draw the structure of each of the following organic compounds.

(i) The hydrocarbon that is a chain isomer of methylpropene, but does **not** exhibit E–Z stereoisomerism.

**(1)**

(ii) The alcohol that is a position isomer of butan-2-ol.

**(1)**

(iii) The hydrocarbon that has a peak, due to its molecular ion, at  $m/z = 44$  in its mass spectrum.

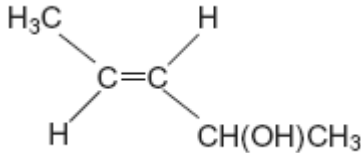
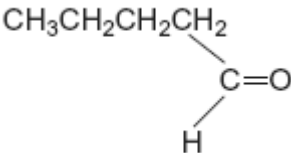
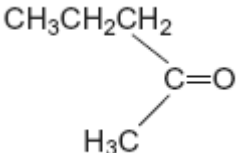
**(1)**

(iv) The bromoalkane that reacts with sodium cyanide to produce propanenitrile.

(1)  
(Total 10 marks)

3

The table below shows the structures of three isomers with the molecular formula  $C_5H_{10}O$

Isomer 1 	(E)-pent-3-en-2-ol
Isomer 2 	pentanal
Isomer 3 	

(a) Complete the table by naming Isomer 3.

(1)

(b) State the type of structural isomerism shown by these three isomers.

.....

(1)

(c) The compound (*Z*)-pent-3-en-2-ol is a stereoisomer of (*E*)-pent-3-en-2-ol.

(i) Draw the structure of (*Z*)-pent-3-en-2-ol.

(1)

(ii) Identify the feature of the double bond in (*E*)-pent-3-en-2-ol and that in (*Z*)-pent-3-en-2-ol that causes these two compounds to be stereoisomers.

.....

(1)

(d) A chemical test can be used to distinguish between separate samples of Isomer **2** and Isomer **3**.

Identify a suitable reagent for the test.

State what you would observe with Isomer **2** and with Isomer **3**.

Test reagent .....

Observation with Isomer **2**.....

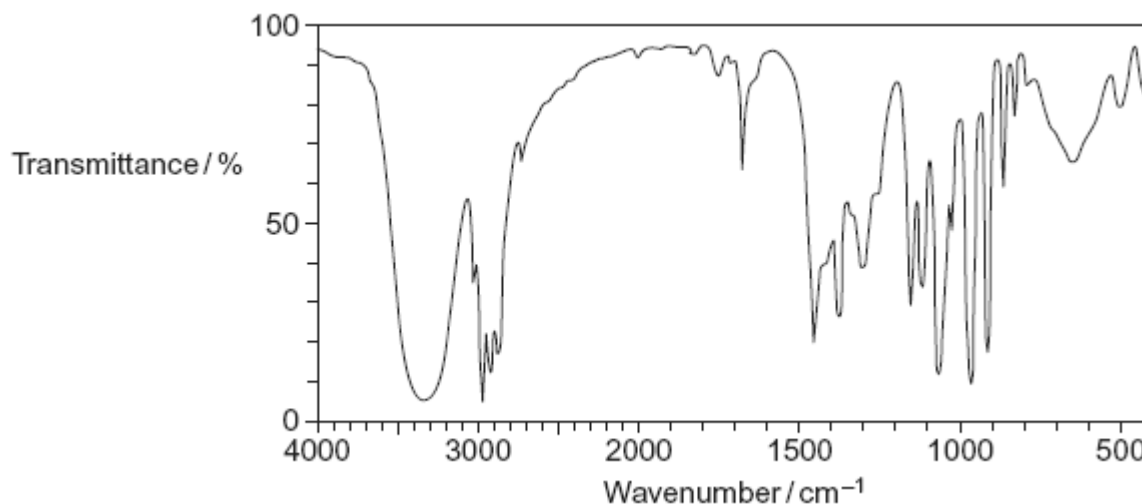
.....

Observation with Isomer **3**.....

.....

(3)

(e) The following is the infrared spectrum of one of the isomers **1**, **2** or **3**.



(i) Deduce which of the isomers (**1**, **2** or **3**) would give this infrared spectrum. You may find it helpful to refer to **Table 1** on the Data Sheet.

.....

**(1)**

(ii) Identify two features of the infrared spectrum that support your deduction. In each case, identify the functional group responsible.

Feature 1 and functional group .....

.....

.....

.....

Feature 2 and functional group .....

.....

.....

.....

**(2)**  
**(Total 10 marks)**



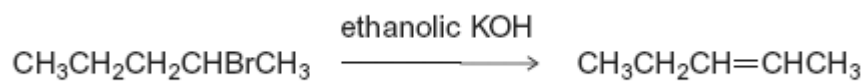
**4**

Organic reaction mechanisms help chemists to understand how the reactions of organic compounds occur.

The following conversions illustrate a number of different types of reaction mechanism.

(a) When 2-bromopentane reacts with ethanolic KOH, two structurally isomeric alkenes are formed.

(i) Name and outline a mechanism for the conversion of 2-bromopentane into pent-2-ene as shown below.



(4)

(ii) Draw the structure of the other structurally isomeric alkene produced when 2-bromopentane reacts with ethanolic KOH.

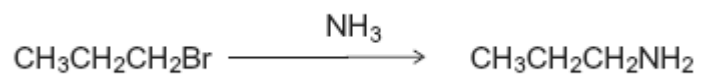
(1)

(b) Name and outline a mechanism for the following conversion.



(5)

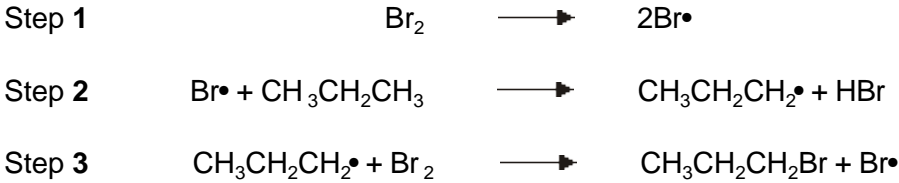
(c) Name and outline a mechanism for the following conversion.



(5)  
(Total 15 marks)

**5**

(a) The reaction of bromine with propane is similar to that of chlorine with methane. Three steps in the mechanism for the bromination of propane to form 1-bromopropane are shown below.



- (i) Name the type of mechanism in this reaction.  
..... (1)
- (ii) Give an essential condition for Step 1 to occur.  
..... (1)
- (iii) Name the type of step illustrated by Steps 2 and 3.  
..... (1)
- (iv) In this mechanism, a different type of step occurs in which free radicals combine. Name this type of step. Write an equation to show how hexane could be formed from two free radicals in the mechanism of this reaction.  
Type of step .....  
Equation ..... (2)
- (v) Write an overall equation for the reaction between bromine and propane by the same mechanism to produce octabromopropane ( $\text{C}_3\text{Br}_8$ ).  
..... (1)

(b) Bromine reacts with alkenes, even though bromine is a non-polar molecule.

(i) Explain why bromine molecules react with the double bonds in alkenes.

.....  
.....  
.....  
.....  
.....  
.....

(2)

(ii) Name the type of mechanism involved in this reaction.

.....

(1)

(iii) Draw the structure of the compound with  $M_r = 387.6$  formed when penta-1,4-diene ( $H_2C=CHCH_2CH=CH_2$ ) reacts with an excess of bromine.

(1)

(c) Two products are formed when propene reacts with hydrogen bromide.  
Draw the structure of the intermediate that leads to the formation of the major product in the reaction of propene with hydrogen bromide.  
Give the name of this type of intermediate.

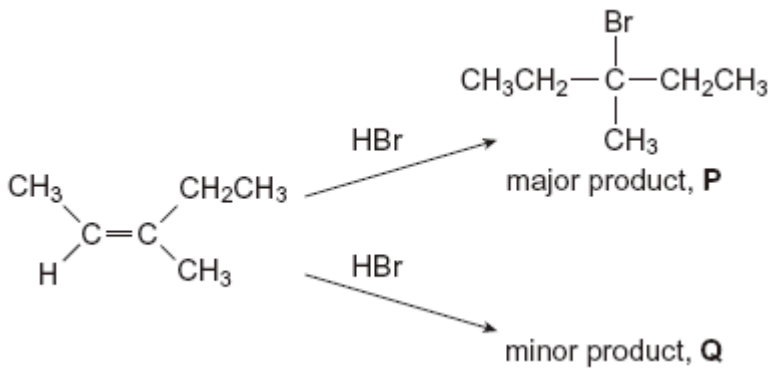
Structure of intermediate

Type of intermediate .....

(2)  
(Total 12 marks)

6

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



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

.....

(1)

(ii) Name the mechanism for these reactions.

.....

(1)

(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 .....

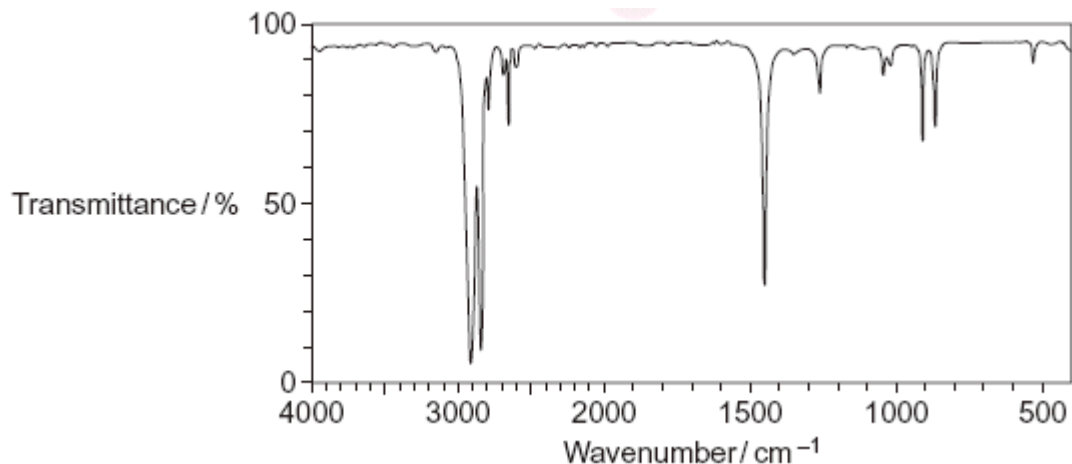
(2)

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

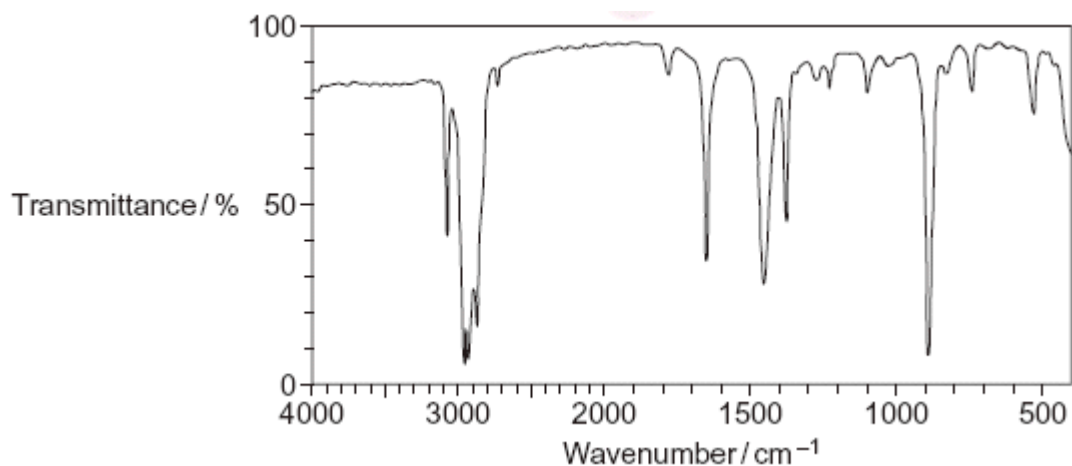
(1)

- (b) The infrared spectra of two compounds **R** and **S** are shown below. **R** and **S** have the molecular formula  $C_6H_{12}$  and are structural isomers of 3-methylpent-2-ene. **R** is an unsaturated hydrocarbon and **S** is a saturated hydrocarbon.

Spectrum 1



Spectrum 2



- (i) Identify the infrared Spectrum 1 or 2 that represents compound **R**.  
Use information from the infrared spectra to give **one** reason for your answer.  
You may find it helpful to refer to **Table 1** on the Data Sheet.

**R** is represented by Spectrum .....

Reason .....

.....

(2)

- (ii) State the type of structural isomerism shown by **R** and **S**.

.....

(1)

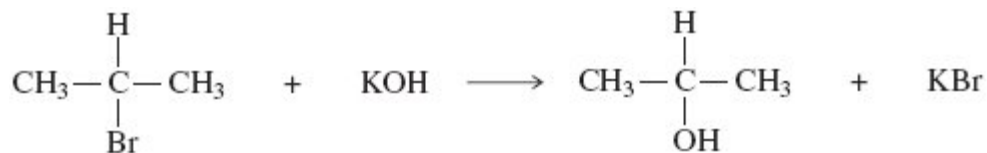
(iii) Name **one** possible compound which could be **S**.

.....

(1)  
(Total 9 marks)

7

(a) Consider the following reaction.



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

Name of mechanism .....

Mechanism

(3)

(ii) Name the haloalkane in this reaction.

.....

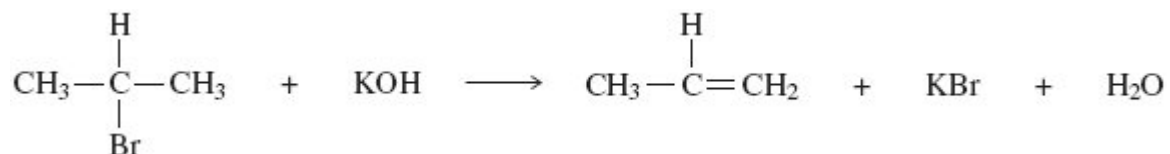
(1)

(iii) Identify the characteristic of the haloalkane molecule that enables it to undergo this type of reaction.

.....

(1)

- (b) An alternative reaction can occur between this haloalkane and potassium hydroxide as shown by the following equation.



Name and outline a mechanism for this reaction.

Name of mechanism .....

Mechanism

(4)

- (c) Give **one** condition needed to favour the reaction shown in part (b) rather than that shown in part (a).

.....

(1)

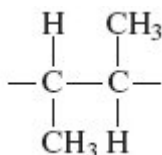
- (d) Alkenes can be polymerised to produce poly(alkenes).

- (i) State the type of polymerisation that alkenes undergo.

.....

(1)

- (ii) Name the alkene that gives a polymer with the repeating unit shown below.



Name of alkene .....

(1)

(Total 12 marks)