

## ALKENES QUESTIONS

1. (a) Most of the ethene used by industry is produced when ethane is heated to 900°C in the absence of air. Write an equation for this reaction.

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(1)

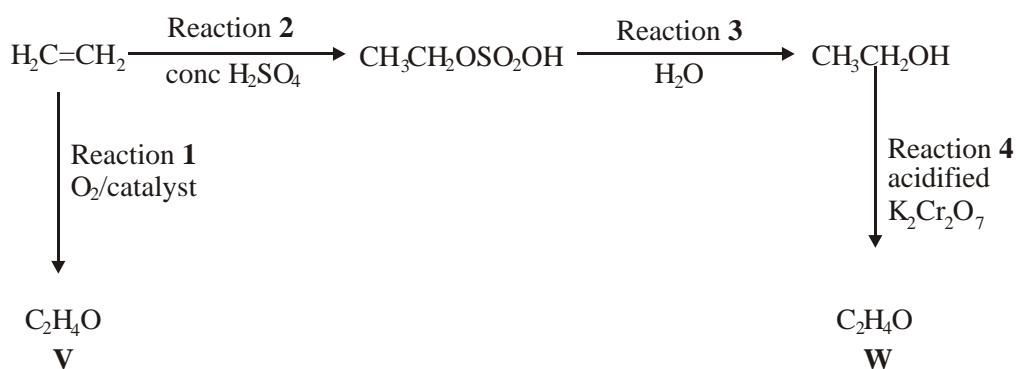
- (b) Name the type of polymerisation which occurs when ethene is converted into poly(ethene).

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(1)

(Total 2 marks)

2. Consider the following reaction scheme, which leads to the formation of two compounds V and W.



Name and outline a mechanism for Reaction 2.

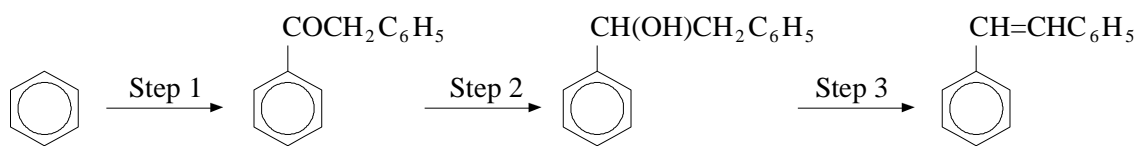
Name of mechanism .....

Mechanism

(5)

(Total 5 marks)

3. Consider the following reaction sequence:



Name the type of isomerism shown by the final product, 1,2-diphenylethene, and explain why this compound can exist in two stereoisomeric forms.

Type of isomerism .....

Explanation .....

.....

(2)

(Total 2 marks)

4. But-2-ene can exist in two isomeric forms. Give the structures of these two isomers and name the type of isomerism.

Structure 1

Structure 2

Type of isomerism .....

(3)

(Total 3 marks)

5. (i) Write an overall equation for the reaction of cyclohexene with hydrogen.

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(ii) By stating a reagent and an observation, give a chemical test which would show that this hydrogenation reaction has gone to completion.

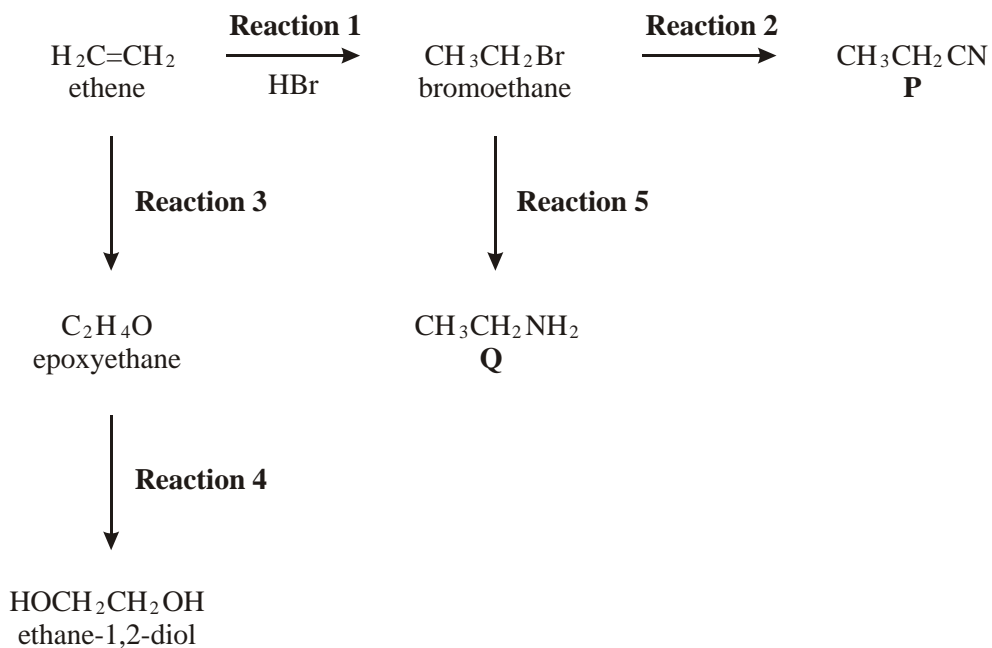
Reagent(s) .....

Observation(s) .....

(3)

(Total 3 marks)

6. Consider the following scheme of reactions.



In **Reaction 1**, ethene undergoes electrophilic addition with hydrogen bromide.

- (i) State what is meant by the term *electrophile*.

.....  
 .....

- (ii) Outline a mechanism for this reaction.

(5)  
(Total 5 marks)

7. (a) Draw and name the geometrical isomers of pent-2-ene.

*Isomer 1*

*Isomer 2*

Name ..... Name .....

(2)

(b) Pent-1-ene reacts with hydrogen bromide to produce 2-bromopentane as the major product.

(i) Outline the mechanism for this reaction.

(ii) Identify the minor product formed in this reaction.

.....

(iii) Explain why 2-bromopentane is the major product of this reaction.

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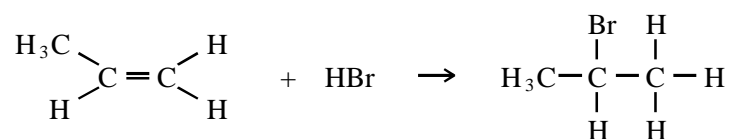
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(7)  
(Total 9 marks)

8. 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.

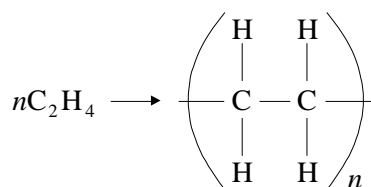
(5)  
(Total 12 marks)

9. (a) How do the physical properties of the alkene homologous series change as the chain length increases?

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

(2)

- (b) For the reaction shown in the equation:



give the name of this process:

.....

(2)

- (c) Most ethanol used in the chemical industry is manufactured by reacting together water and ethene.

- (i) Write a balanced equation for this reaction.

- ..... (1)
- (ii) Outline the reaction conditions for this reaction.
- .....
- ..... (3)
- (iii) Classify this reaction, indicating the type of initial attack on the ethene.
- ..... (2)
- (Total 10 marks)**

**10.** Compounds with double bonds between carbon atoms can exhibit geometrical isomerism.

- (i) Draw structures for the two geometrical isomers of 1,2-dichloroethene.

*Isomer 1*

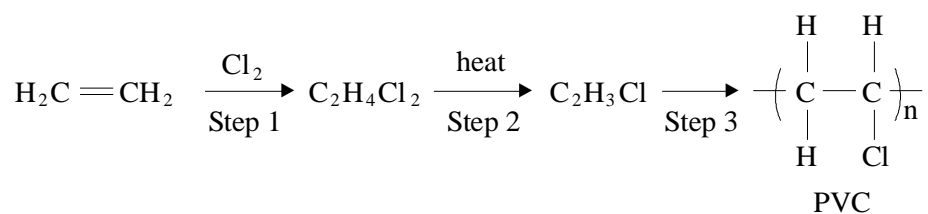
*Isomer 2*

- (ii) What feature of the double bond prevents isomer 1 from changing into isomer 2?

..... (3)

**(Total 3 marks)**

11. The polymer poly(chloroethene), commonly known as poly(vinyl chloride) or PVC, can be produced as follows:



- (a) Using your knowledge of the reaction between bromine and ethene, name and outline a mechanism for Step 1.

*Name of mechanism* .....

*Mechanism*

(5)

- (b) Write an equation for Step 2 showing clearly the structure of the organic product.

.....

(1)

- (c) Plasticisers are often incorporated into polymers such as PVC. Name a type of compound used as a plasticiser.

.....

(1)

- (d) (i) Draw the structure of the organic product of the reaction of  $\text{C}_2\text{H}_4\text{Cl}_2$  with an excess of warm aqueous sodium hydroxide.

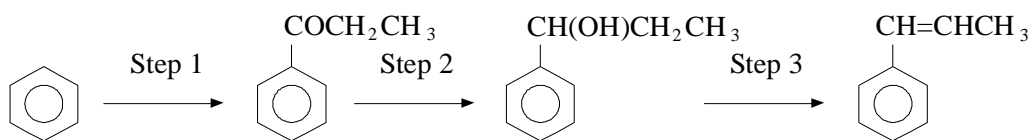
- (ii) Suggest why  $\text{C}_2\text{H}_3\text{Cl}$ , the organic product of Step 2, does not react with warm aqueous sodium hydroxide.

.....  
.....

(3)

(Total 10 marks)

12. Consider the following reaction sequence:



- (a) Explain why the final product, 1-phenylpropene, is formed as a mixture of two isomers.

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

(2)

- (b) When 1-phenylpropene is treated with hydrogen bromide, two compounds are formed which are structural isomers.

- (i) Give the structures of the two isomers.

*Isomer 1*

*Isomer 2*

- (ii) Name the type of mechanism involved.

.....

- (iii) By reference to the structures of the two carbonium ion intermediates formed, suggest why the two isomers are obtained in unequal amounts.

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

(6)  
 (Total 8 marks)

13. Four members of the homologous series of alkenes are ethene, propene, but-1-ene and pent-1-ene.

- (i) Give **one** structural feature of the compounds that makes them members of the homologous series of alkenes.



.....  
.....

(1)

(ii) State the trend in the boiling points from ethene to pent-1-ene.

.....

(1)

(iii) Give the name and draw the graphical formula of an alkene that is an isomer of but-1-ene **and** that has a different carbon skeleton.

*Name* .....

*Graphical formula*

(2)

(Total 4 marks)

**14.** Ethanol is produced industrially from ethene. Name the catalyst and state the conditions used in the industrial process and write an equation for the reaction.

*Catalyst*.....

*Conditions*.....

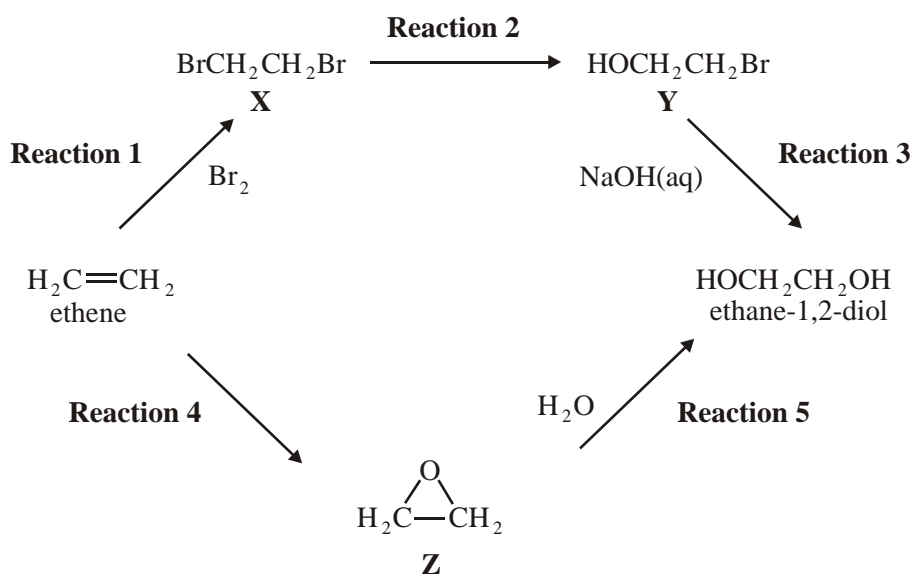
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*Equation*.....

(4)

(Total 4 marks)

15. Consider the following scheme of reactions for making ethane-1,2-diol from ethene by two different routes.



Name compound **X** and name a mechanism for **Reaction 1**. Explain why ethene is able to react with bromine in this reaction, given that bromine molecules are non-polar.

(4)  
(Total 4 marks)

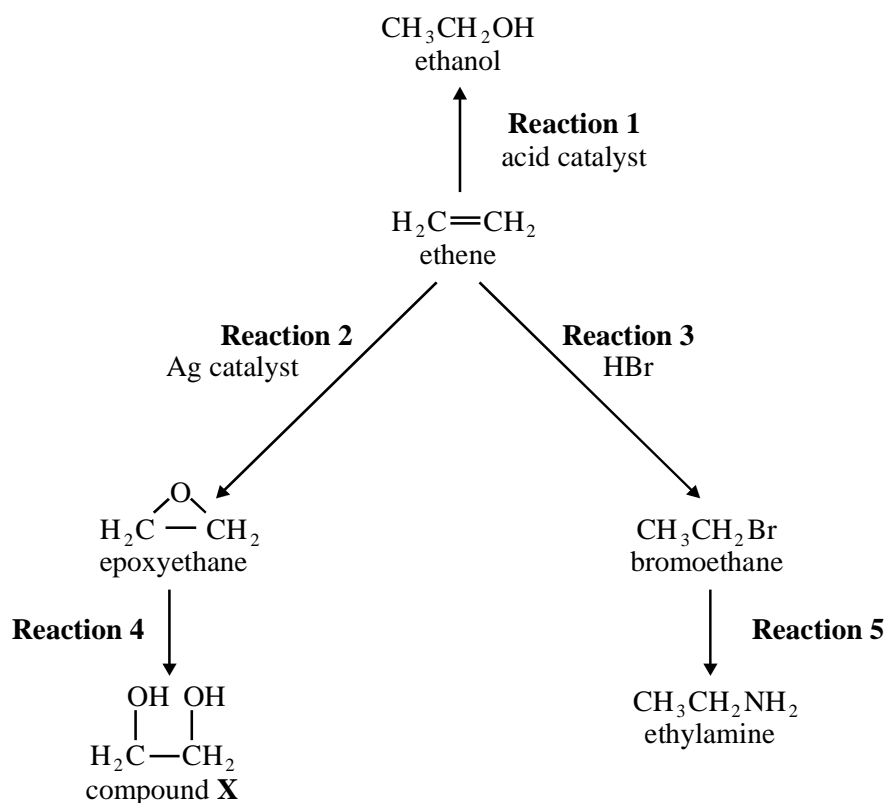
16. Addition reactions to alkenes can result in the formation of isomeric compounds.

Choose an alkene with molecular formula  $\text{C}_4\text{H}_8$  which reacts with  $\text{HBr}$  to form two structural isomers. Give the structures of these two isomers and name the type of structural isomerism shown.

Outline a mechanism for the formation of the major product.

(7)  
(Total 7 marks)

17. Ethene can be converted into a variety of useful products as illustrated below.



- (a) Give a reagent for **Reaction 1** (1)
- (b) Outline a mechanism for **Reaction 3**. (4)
- (Total 5 marks)

18. Describe the arrangement of bonds around the carbon atoms in ethane and in ethene, and state the bond angle in each compound. Compare the relative lengths of the carbon-carbon bonds in the two molecules and explain why they are different. (6)

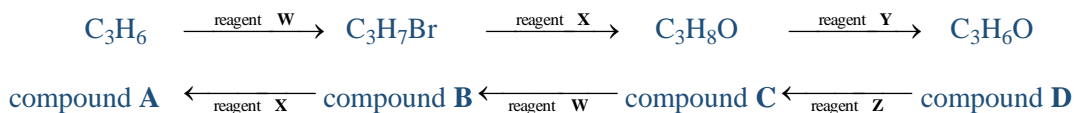
(Total 6 marks)

19. There are several non-cyclic structural isomers with the molecular formula  $\text{C}_6\text{H}_{12}$ .
- (a) One of these isomers, 2-methylpent-2-ene,  $(\text{CH}_3)_2\text{C}=\text{CHCH}_2\text{CH}_3$ , reacts with hydrogen bromide. Name the major product and account for its formation by reference to the mechanism of the reaction. (7)
- (b) Identify one linear alkene of formula  $\text{C}_6\text{H}_{12}$  which can exist as a pair of stereoisomers. State the type of stereoisomerism shown, name the alkene and draw the structures of the two isomers. (4)
- (Total 11 marks)

20. When 2-methylpent-2-ene reacts with hydrogen bromide two products are formed, one major and one minor, each with molecular formula  $C_6H_{13}Br$ . Name these two products and account for their formation by reference to the mechanism of the reaction.

(Total 15 marks)

21. This question is concerned with the six reactions shown in the following scheme. The four compounds involved are represented by their molecular formulae and labelled using the letters **A**, **B**, **C** and **D**.



- (a) State the names of the three homologous series to which compounds **A**, **B** and **C** belong. (3)
- (b) Give the name of the type of reaction occurring in each of the following conversions:
- (i) compound **A** to compound **B**; (1)
- (ii) compound **B** to compound **C**; (1)
- (c) Give the name **or** formula of reagent **X** and state the different conditions under which it would be used in the conversions of compound **B** to compound **C**, and of compound **B** to compound **A**. (3)
- (f) Write an equation for each of the following reactions:
- (i) the conversion of compound **B** to compound **A**; (1)
- (ii) the conversion of compound **B** to compound **C**. (1)
- (g) Outline a possible mechanism for the conversion of compound **B** to compound **C**. (3)

(Total 13 marks)

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