

# Alkenes

## Question Paper 3

<b>Level</b>	International A Level
<b>Subject</b>	Chemistry
<b>Exam Board</b>	CIE
<b>Topic</b>	Hydrocarbons
<b>Sub-Topic</b>	Alkenes
<b>Paper Type</b>	Theory
<b>Booklet</b>	Question Paper 3

**Time Allowed:** 75 minutes

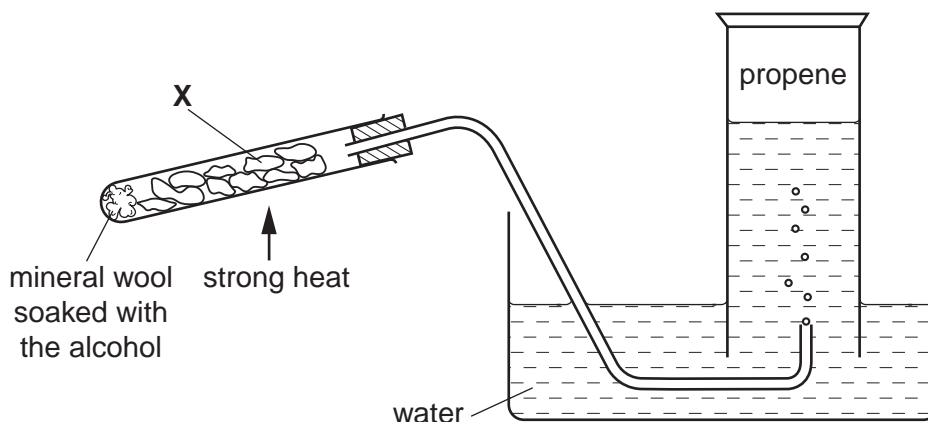
**Score:** /62

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 Alkenes such as propene can be readily prepared from alcohols in a school or college laboratory by using the apparatus below.



- (a) (i) Give the **name** of an alcohol that can be used in this apparatus to prepare propene.

.....

- (ii) Draw the **skeletal** formula of the alcohol you have named in (i).

- (iii) What type of reaction occurs in this case?

.....

[3]

- (b) (i) During the reaction, the material **X** becomes black in colour. Suggest the identity of the black substance and suggest how it is produced during the reaction.

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

- (ii) At the end of the experiment, when no more propene is being produced, the delivery tube is removed from the water before the apparatus is allowed to cool.

Suggest why this done.

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

- (iii) The material labelled **X** can be broken crockery, broken brick or pumice.

Give the chemical formula of a compound that is present in one of these materials.

.....

- (iv) State another reagent that could be used to produce propene from an alcohol.

.....

[5]

- (c) Give the structural formula of the organic product formed when propene reacts separately with **each** of the following substances.

(i) bromine

(ii) cold, dilute manganate(VII) ions

(iii) hot, concentrated manganate(VII) ions

[3]

(d) Propene may be polymerised.

(i) What is the essential condition for such a polymerisation?

.....

(ii) The disposal of waste poly(propene) is very difficult.  
Give **one** important reason for this.

.....

.....

[2]

[Total: 13]

- 2 Astronomers using modern spectroscopic techniques of various types have found evidence of many molecules, ions and free radicals in the dust clouds in Space. Many of the species concerned have also been produced in laboratories on Earth.

Two such species are the dicarbon monoxide molecule,  $C_2O$ , and the amino free radical,  $NH_2$ .

- (a) (i) Dicarbon monoxide can be produced in a laboratory and analysis of it shows that the sequence of atoms in this molecule is carbon-carbon-oxygen and there are no unpaired electrons, but one of the atoms is only surrounded by six electrons.

Draw a 'dot-and-cross' diagram of  $C_2O$  and suggest the shape of the molecule.

shape .....

- (ii) What is meant by the term *free radical*?

.....  
.....

- (iii) Explain why  $NH_2$  is described as a 'free radical'.

.....  
..... [5]

Two derivatives of ethene which have been detected in dust clouds in Space are acrylonitrile (2-propenenitrile),  $CH_2=CHCN$ , and vinyl alcohol (ethenol),  $CH_2=CHOH$ .

- (b) Like ethene, acrylonitrile can be polymerised. The resulting polymer can be used to make carbon fibres.

- (i) Draw the structural formula of the polymer made from acrylonitrile, showing **two** repeat units.

- (ii) What type of polymerisation is this reaction?

..... [2]

Vinyl alcohol cannot be polymerised in the same way as acrylonitrile because it will readily isomerise into another common organic compound, **Z**.

(c) (i) Suggest the structural formula of the organic compound **Z**.

(ii) Suggest the structural formula of another isomer of vinyl alcohol which has a cyclic (ring) structure.

[2]

Acrolein (2-propenal),  $\text{CH}_2=\text{CHCHO}$ , has also been found in Space.

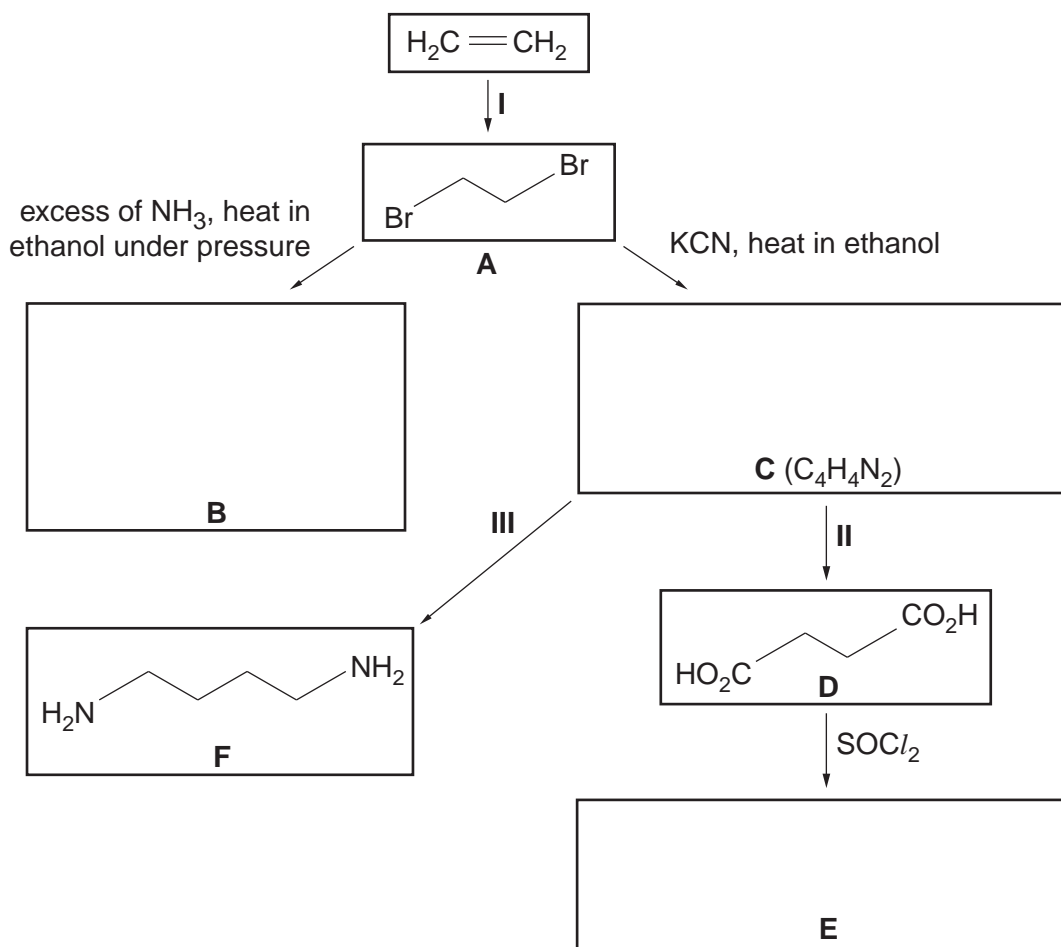
(d) Give the structural formulae of the organic compounds formed when acrolein is reacted separately with **each** of the following reagents.

reagent	product
$\text{Br}_2$ in an inert solvent	
$\text{NaCN} + \text{dilute } \text{H}_2\text{SO}_4$	
Tollens' reagent	
$\text{NaBH}_4$	

[4]

[Total: 13]

- 3 The following scheme outlines the production of some compounds from ethene.



- (a) (i) Suggest the reagent and conditions for reaction I.

.....

- (ii) Describe the mechanism of reaction I by means of a diagram. Include all whole, partial and induced charges, and represent the movements of electron pairs by curly arrows.

(b) Suggest the identities of compounds **B**, **C** and **E**, and draw their structures in the boxes opposite. [3]

(c) Suggest reagents and conditions for

reaction II,

.....

reaction III.

..... [2]

(d) During reaction II the nitrogen atoms are lost from the organic molecule. Suggest the identity of the nitrogen-containing ion produced during this reaction.

..... [1]

(e) Compounds **E** and **F** react together to give a polymer and an inorganic product.

(i) Draw **one** repeat unit of this polymer.

(ii) Identify the inorganic product.

..... [2]

(f) A  $0.100 \text{ mol dm}^{-3}$  solution of compound **D** has a pH of 2.60.

(i) Calculate the  $[\text{H}^+]$  in this solution.

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.....

(ii) Hence calculate the value of  $K_a$  of compound **D**.

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.....

[2]

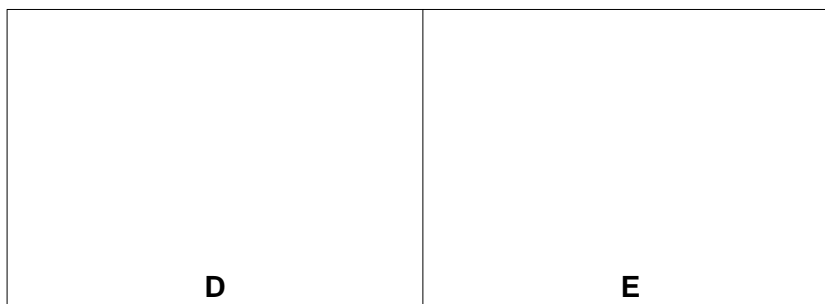
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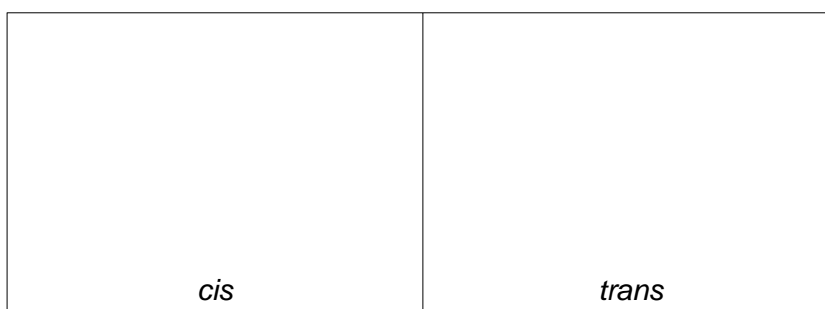
- 4 Two types of isomerism found in organic compounds are structural isomerism and *cis-trans* isomerism.

(a) Draw displayed formulae for

- (i) **two** structural isomers of  $C_2H_4Br_2$ ,



- (ii) the *cis*- and the *trans*- isomers of  $C_2H_2Br_2$ .



[4]

- (b) (i) The *cis*- isomer of  $C_2H_2Br_2$  can be converted into **one** of the structural isomers of  $C_2H_4Br_2$ . State the reagent(s) and conditions you would use to do this.

.....  
 .....

- (ii) Which of your structural isomers, **D** or **E**, would be formed? Explain your answer.

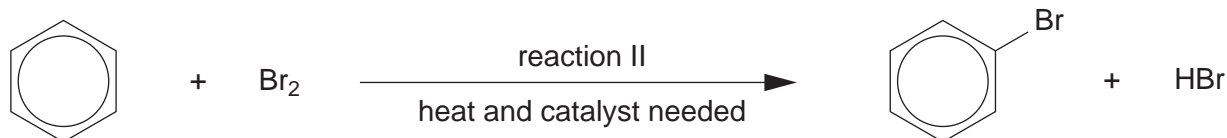
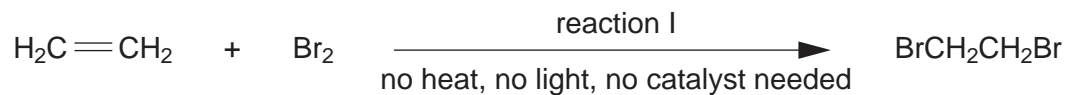
isomer formed is .....

reason .....

[3]

[Total: 7]

- 5 Both ethene and benzene react with bromine, but the mechanisms and the types of products of the two reactions are different.



- (a) State the *type of reaction* undergone in each of reactions I and II.

reaction I

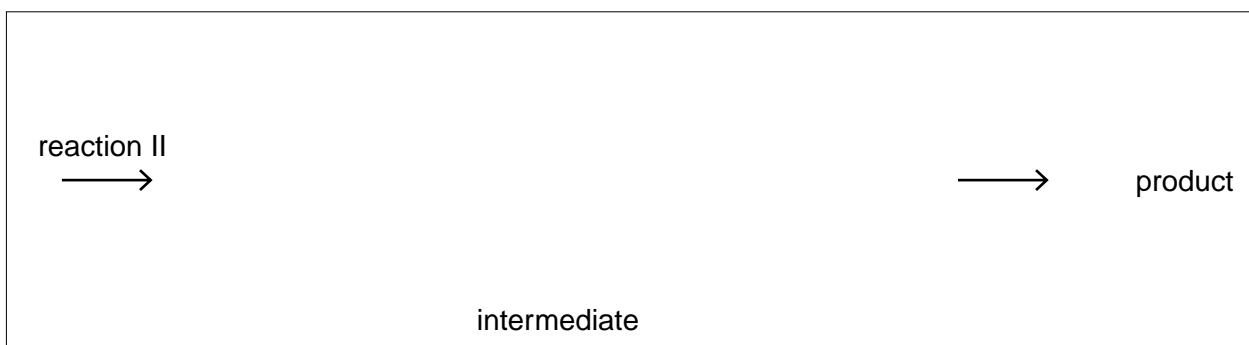
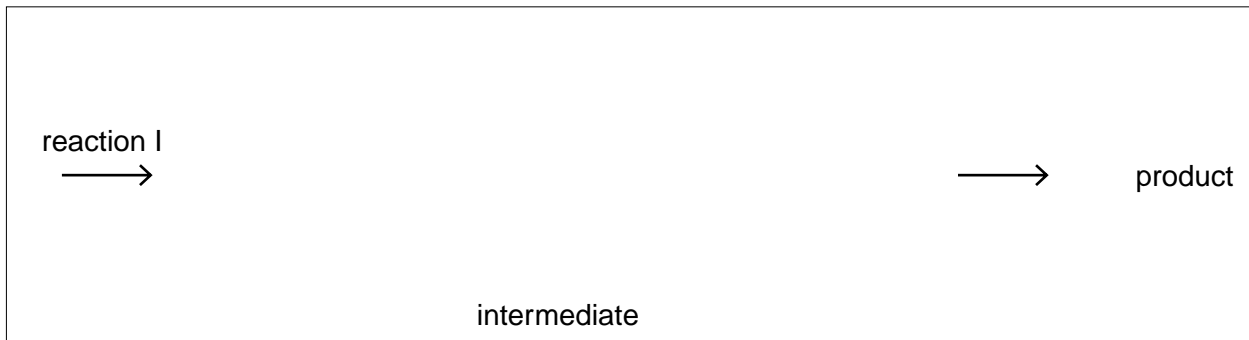
.....

reaction II

.....

[2]

- (b) In each of reactions I and II, the intermediate is a bromine-containing cation. In each of the following boxes, draw the intermediate and use curly arrows to show how it is converted into the product.



[4]

- (c) Why do ethene and benzene differ in their reaction with bromine?

.....  
..... [1]

[Total: 7]

- 6 The molecular formula of a compound states the number of atoms of each element that are present in one molecule. It contains no information about the structure of the molecule. Hydrocarbons with the molecular formula  $C_5H_{10}$  may be branched chain, straight chain or cyclic.

(a) Draw a displayed formula of  $C_5H_{10}$  as a branched chain hydrocarbon.

[1]

Pent-2-ene is one straight chain hydrocarbon with formula  $C_5H_{10}$ .

(b) Pent-2-ene exhibits *cis-trans* isomerism. Draw and label the structural formulae of the two *cis-trans* isomers of pent-2-ene.

[2]

(c) In the spaces below draw the structural formulae of **two** alcohols which would **each** produce pent-2-ene on dehydration.

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[2]

- (d) One of these alcohols exhibits optical isomerism. Draw the structural formulae of the two isomers of this alcohol. Your structures should clearly indicate the three-dimensional nature of the structures.

[2]

- (e) Pent-2-ene decolourises aqueous bromine. Suggest the structural formula of an isomer of  $C_5H_{10}$  which does **not** decolourise aqueous bromine.

[1]

- (f) Pent-2-ene can be polymerised. Draw a section of the polymer chain produced showing **two** repeat units.

[1]

[Total: 9]