

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY

Chains and Rings

2812

Wednesday

8 JUNE 2005

Morning

1 hour

Candidates answer on the question paper.

Additional materials:

Data Sheet for Chemistry

Scientific calculator

Candidate Name	Centre Number	Candidate Number														
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TIME 1 hour

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry*.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Question Number	Max.	Mark
1	13	
2	15	
3	13	
4	8	
5	11	
TOTAL	60	

This question paper consists of 11 printed pages and 1 blank page.

Answer **all** the questions.

1 The table below lists the boiling points of some alkanes.

alkane	number of carbon atoms	molecular formula	boiling point / °C
butane	4	C ₄ H ₁₀	0
pentane	5	C ₅ H ₁₂	36
hexane	6		69
heptane	7	C ₇ H ₁₆	99
octane	8	C ₈ H ₁₈	
nonane	9	C ₉ H ₂₀	152
decane	10	C ₁₀ H ₂₂	175

(a) What is the molecular formula of hexane?[1]

(b) (i) State the trend in the boiling points of the alkanes.

.....
[1]

(ii) Explain the trend in the boiling points of the alkanes.

.....
[1]

(iii) Predict the boiling point of octane. °C [1]

(c) Long chain alkanes, such as nonane, can be cracked into shorter chain alkanes and alkenes.

(i) Write a balanced equation for the cracking of nonane into heptane and ethene.

.....[1]

(ii) Much of the ethene is then converted into ethanol.

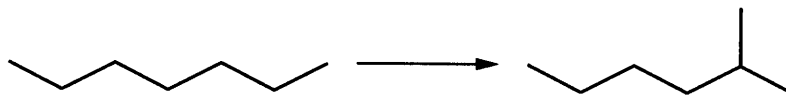
Write a balanced equation for the conversion of ethene into ethanol. State the essential conditions.

equation[1]

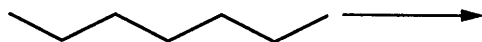
conditions

.....[2]

- (d) Heptane can be isomerised to produce branched chain alkanes such as 2-methylhexane or 2,3-dimethylpentane.
The equation below shows the isomerisation of heptane into 2-methylhexane.



- (i) Using skeletal formulae, complete the balanced equation for the isomerisation of heptane into 2,3-dimethylpentane.



[1]

- (ii) The boiling point of 2,3-dimethylpentane is 84 °C.

Predict the boiling point of 2-methylhexane. °C [1]

- (e) Heptane can be reformed to produce methylcyclohexane which is a cycloalkane.
Write a balanced equation to show the reforming of heptane to obtain methylcyclohexane.

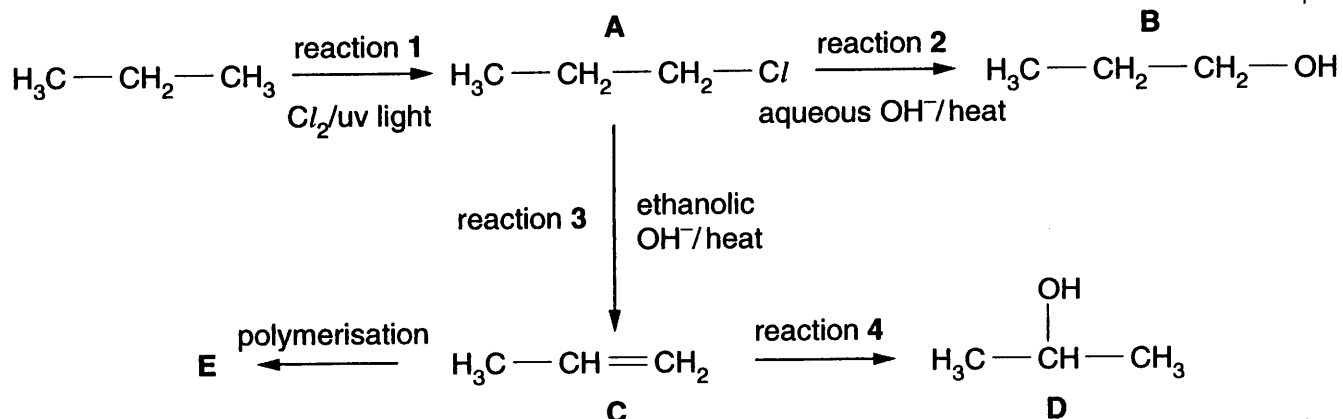
[2]

- (f) State why branched chain alkanes and cycloalkanes are more useful than straight chain alkanes.

.....[1]

[Total: 13]

2 Propane, C_3H_8 , is used in the reaction sequence shown below.



(a) The reaction sequence shows several important reaction mechanisms. Select from reactions 1 to 4, the reaction that shows

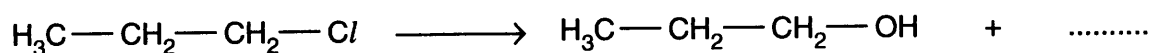
- | | | |
|--------------------------------|----------------|-----|
| (i) free radical substitution, | reaction | [1] |
| (ii) electrophilic addition, | reaction | [1] |
| (iii) elimination. | reaction | [1] |

(b) In reaction 2, the aqueous OH^- acts as a nucleophile.

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

.....[1]

(ii) Complete, with the aid of curly arrows, the mechanism involved in reaction 2. Show any relevant dipoles.



[4]

(c) Compounds **B** and **D** are structural isomers of each other.

(i) State what is meant by the term *structural isomers*.

.....
[2]

(ii) Draw the skeletal formulae of compounds **B** and **D**.

Compound B	Compound D

[2]

(d) Compound **C** can be polymerised to form compound **E**.

(i) State the type of polymerisation.[1]

(ii) Name compound **E**.[1]

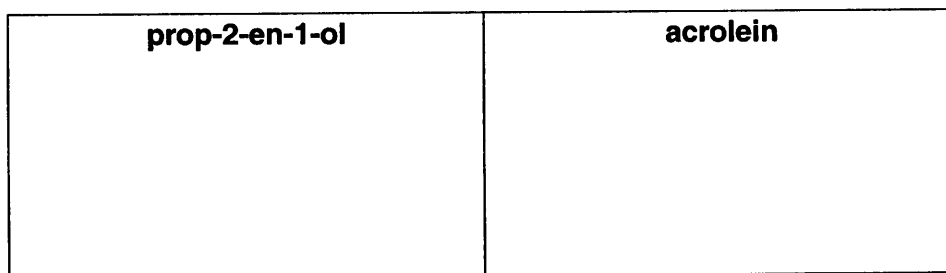
(iii) Draw a section of compound **E**. Show **two** repeat units.

[1]

[Total: 15]

- 3 Acrolein, $\text{CH}_2=\text{CHCHO}$, and acrylic acid, $\text{CH}_2=\text{CHCOOH}$, are both used in industry for the manufacture of plastic resins and polymers. Both acrolein and acrylic acid can be made from prop-2-en-1-ol, $\text{CH}_2=\text{CHCH}_2\text{OH}$.

- (a) (i) Draw the structures of prop-2-en-1-ol and acrolein. Clearly display the functional groups in each compound.



[2]

- (ii) Name the functional group common to **both** prop-2-en-1-ol and acrolein.

.....[1]

- (b) Prop-2-en-1-ol can be oxidised to form either acrolein or acrylic acid.

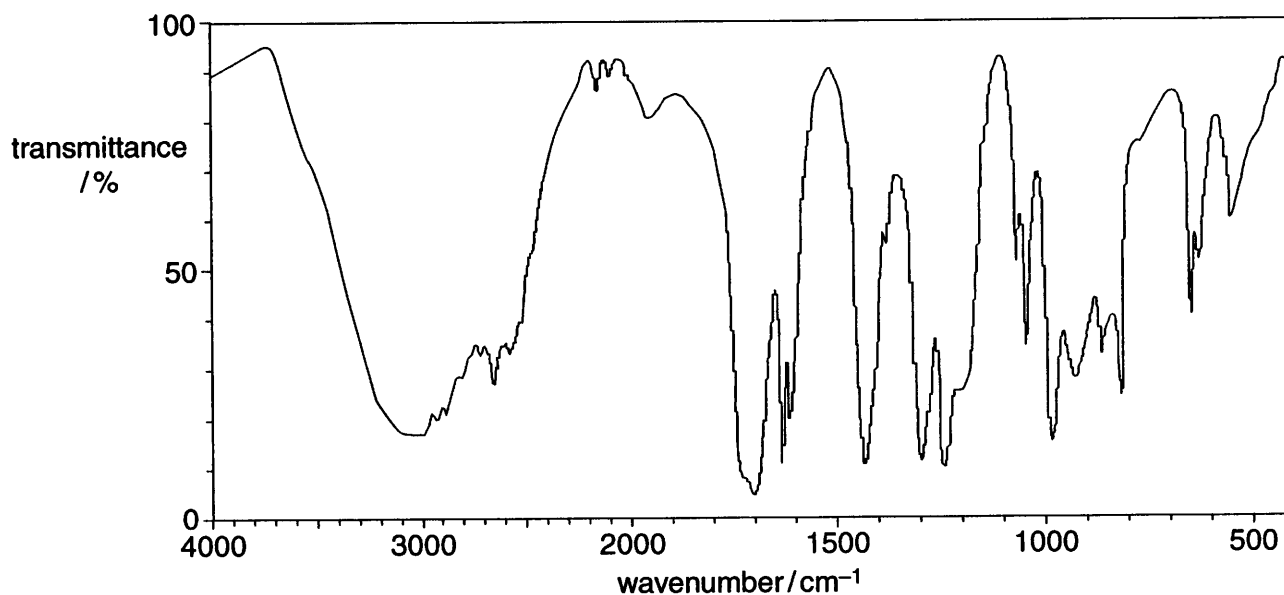
- (i) Identify a suitable oxidising mixture.

.....[2]

- (ii) Write a balanced equation for the oxidation of prop-2-en-1-ol into acrolein. Use [O] to represent the oxidising agent.

.....[1]

- (c) A sample of prop-2-en-1-ol was oxidised and an infra-red spectrum of the organic product was obtained.



By referring to your *Data Sheet*, decide whether acrolein, $\text{CH}_2=\text{CHCHO}$, or acrylic acid, $\text{CH}_2=\text{CHCOOH}$, was formed.

The infra-red spectrum above is of

because

.....

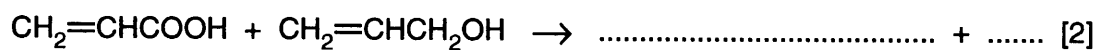
.....

.....

.....[3]

(d) Acrylic acid reacts with prop-2-en-1-ol to produce an ester.

(i) Complete the balanced equation for this reaction.



(ii) Draw the structure of the ester. Clearly display **all** of the functional groups.

[2]

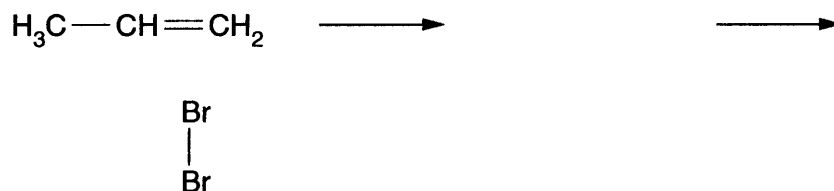
[Total: 13]

4 Propene, $\text{CH}_3\text{CH}=\text{CH}_2$, is an alkene and undergoes an addition reaction with bromine.

(a) (i) State what you would see when propene reacts with bromine.

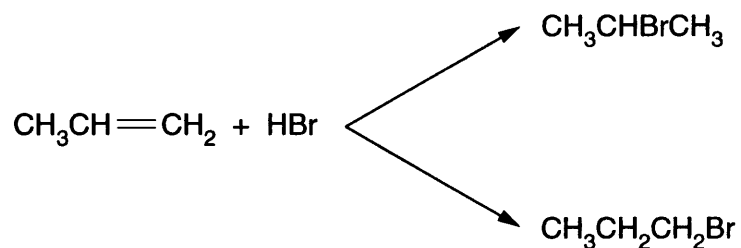
.....[1]

(ii) Complete, with the aid of curly arrows, the mechanism involved in the reaction between propene and bromine. Show any relevant dipoles and charges.



[4]

(b) Propene, $\text{CH}_3\text{CH}=\text{CH}_2$, also reacts with HBr to produce two bromoalkanes that are structural isomers.



Propyne, $\text{CH}_3\text{C}\equiv\text{CH}$, reacts like propene. It reacts with HBr to give three isomers with molecular formula $\text{C}_3\text{H}_6\text{Br}_2$.

Draw the three isomers with molecular formula $\text{C}_3\text{H}_6\text{Br}_2$.

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[3]

[Total: 8]

