

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY

Chains and Rings



2812

Wednesday

7 JUNE 2006

Morning

1 hour

Candidates answer on the question paper.

Additional materials:

Data Sheet for Chemistry

Scientific Calculator

Candidate
Name

Centre
Number

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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.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Write your answers, in blue or black ink, in the spaces provided on the question paper.
- Pencil may be used for graphs and diagrams only.
- Do not write in the bar code. Do not write in the grey area between the pages.
- **DO NOT WRITE IN THE AREA OUTSIDE THE BOX BORDERING EACH PAGE. ANY WRITING IN THIS AREA WILL NOT BE MARKED.**

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.

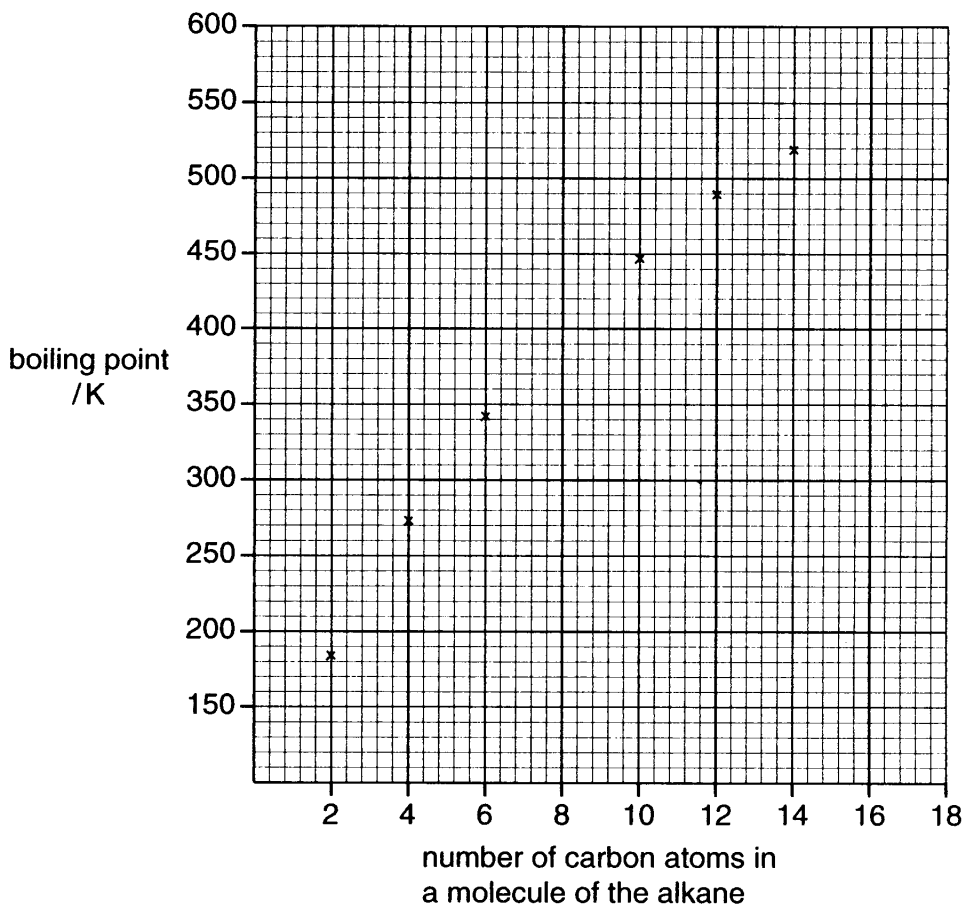
FOR EXAMINER'S USE		
Qu	Max.	Mark
1	16	
2	10	
3	10	
4	15	
5	9	
TOTAL	60	

This question paper consists of 13 printed pages and 3 blank pages.

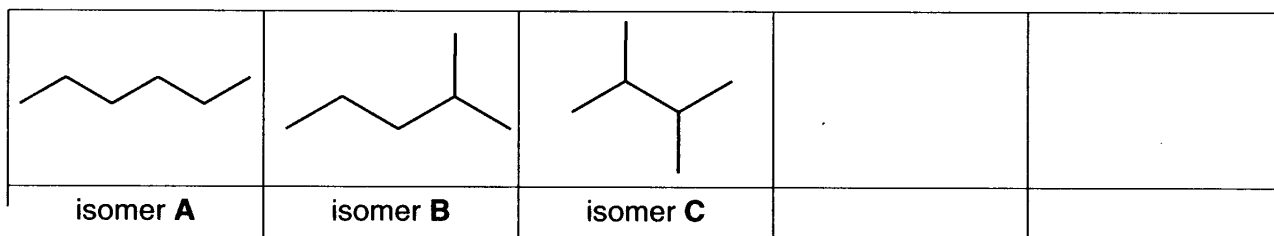


Answer **all** the questions.

- 1 The graph below shows the boiling points of some alkanes.



- (a) Draw a smooth curve through the points on the graph and estimate the boiling points of octane C_8H_{18} , hexadecane, $C_{16}H_{34}$ [2]
- (b) State how decane, $C_{10}H_{22}$, can be separated from a mixture of the alkanes. [1]
- (c) Isomerisation of hexane, C_6H_{14} , produces a mixture of structural isomers, three of which are shown in the boxes below.
- (i) Draw, using skeletal formulae, **two** other structural isomers of hexane.



- (ii) Name isomer B. [1]



- (iii) Isomers **A**, **B** and **C** have different boiling points. In the boxes below, list the isomers **A**, **B** and **C** in order of their boiling points.

lowest boiling point

--	--	--

highest boiling point

[1]

- (iv) Explain the order given in (c) (iii).

.....

.....

..... [2]

- (d) Hexane can be reformed to produce cyclohexane as one of the products.

- (i) Draw the structural formula of cyclohexane.

[1]

- (ii) Write a balanced equation for the reforming of hexane into cyclohexane.

[1]

- (iii) Suggest **one** reason why oil companies reform alkanes such as hexane.

.....

..... [1]

[Turn over



- (e) Oxygen-containing compounds can be added to improve the efficiency and performance of fuels.

In Formula One racing cars, it is common practice to add oxygen-containing compounds, such as 2-methylpropan-2-ol, $(\text{CH}_3)_3\text{COH}$. The amount of oxygen-containing compounds added is strictly controlled by the Federation Internationale de l'Automobile, FIA.

- (i) Calculate the percentage by mass of oxygen in $(\text{CH}_3)_3\text{COH}$. Give your answer to three significant figures.

answer [2]

- (ii) Write a balanced equation for the complete combustion of $(\text{CH}_3)_3\text{COH}$.

[2]

[Total: 16]

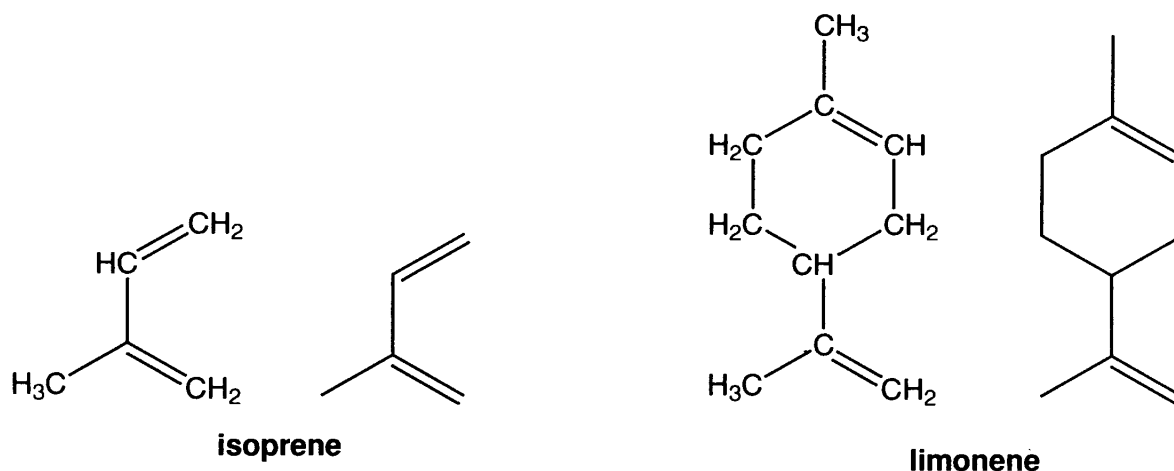


2 Isoprene is an alkene that can be tapped from some trees. It is the monomer in natural rubber.

Limonene is a natural oil found in the rind of oranges and lemons.

Both isoprene and limonene contain two double bonds.

Their structural and skeletal formulae are shown below.



- (a) (i) What is the molecular formula of **isoprene**? [1]
- (ii) What is the empirical formula of **limonene**? [1]
- (b) In the presence of a suitable catalyst, isoprene and limonene both react with hydrogen.
- (i) State a suitable catalyst for this reaction. [1]
- (ii) Write an equation for the reaction when **isoprene** reacts **completely** with hydrogen.

[2]

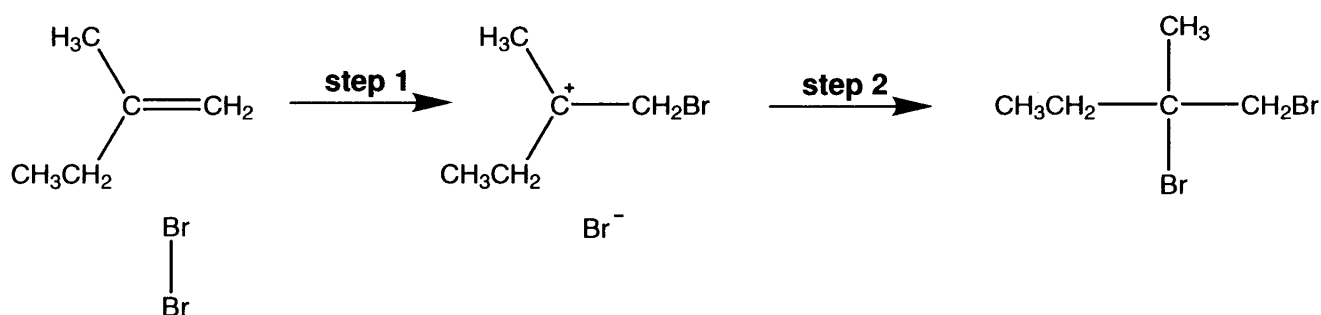


- (iii) Draw the skeletal formula of a product formed when **limonene** reacts **partially** with hydrogen.

[1]

- (c) 2-Methylbut-1-ene can be formed by the partial hydrogenation of isoprene.

2-Methylbut-1-ene reacts with Br_2 to produce 1,2-dibromo-2-methylbutane by an electrophilic addition mechanism. The mechanism for the reaction is shown below.



- (i) In **step 1**, Br_2 behaves as an electrophile. Explain what is meant by the term *electrophile*.

..... [1]

- (ii) Label any relevant dipoles and add 'curly arrows' to the mechanism to show the movement of electron pairs in **step 1** and in **step 2**. [3]

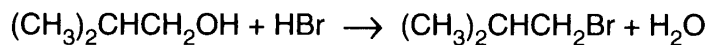
[Total: 10]

[Turn over]



3 Halogenoalkanes are used in the production of pharmaceuticals, polymers and flame retardants.

- (a) 1-Bromo-2-methylpropane is used in the production of ibuprofen and can be prepared from the reaction between 2-methylpropan-1-ol and HBr.



A student reacted 4.44 g of 2-methylpropan-1-ol with an excess of HBr. The student produced 5.48 g of 1-bromo-2-methylpropane.

- (i) Calculate the number of moles of $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$ used.

answer mol [2]

- (ii) Calculate the number of moles of $(\text{CH}_3)_2\text{CHCH}_2\text{Br}$ collected.
 $(\text{CH}_3)_2\text{CHCH}_2\text{Br}$, $M_r = 137$

answer mol [1]

- (iii) Calculate the percentage yield. Quote your answer to three significant figures.

answer [1]



(b) Chloroethene, CH_2CHCl , is polymerised to form poly(chloroethene) commonly known as *pvc*.

(i) Draw a section of *pvc* showing **three** repeat units. Put a bracket round one repeat unit.

[2]

(ii) Polymers such as *pvc* are difficult to dispose of because they are non-biodegradable. Increasingly, they are disposed of by combustion.

State the problem associated with the combustion of polymers such as *pvc*.

.....

..... [1]

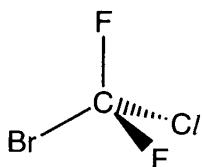
(iii) State **two** ways in which chemists are trying to minimise the damage to the environment caused by the disposal of halogenated plastics such as *pvc*.

.....

.....

..... [2]

(c)



Bromochlorodifluoromethane has been used as a flame retardant.

When exposed to high temperatures, one of the C–halogen bonds undergoes homolytic fission to produce free radicals.

Suggest, with a reason, which C–halogen bond is most likely to be broken.

The C–halogen bond most likely to be broken is because

.....

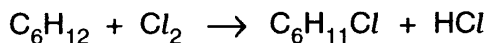
..... [1]

[Total: 10]

[Turn over



- 4 (a) Cyclohexane, C_6H_{12} , reacts with chlorine to produce chlorocyclohexane, $C_6H_{11}Cl$.



The mechanism for this reaction is a free radical substitution.

- (i) Write an equation to show the initiation step.

..... [1]

- (ii) State the conditions necessary for the initiation step.

..... [1]

- (iii) The reaction continues by **two** propagation steps resulting in the formation of chlorocyclohexane, $C_6H_{11}Cl$.

Write equations for these **two** propagation steps.

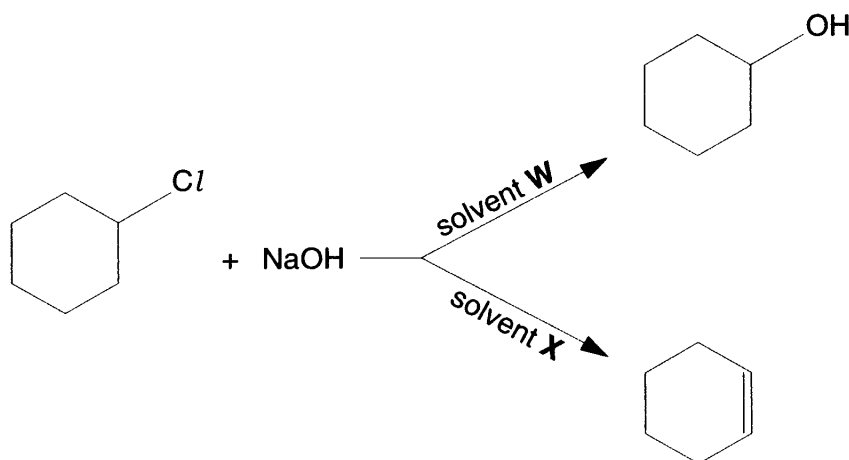
step 1

step 2 [2]

- (iv) State what happens to the free radicals in the termination steps.

..... [1]

- (b) Chlorocyclohexane reacts with NaOH to produce either cyclohexanol or cyclohexene.



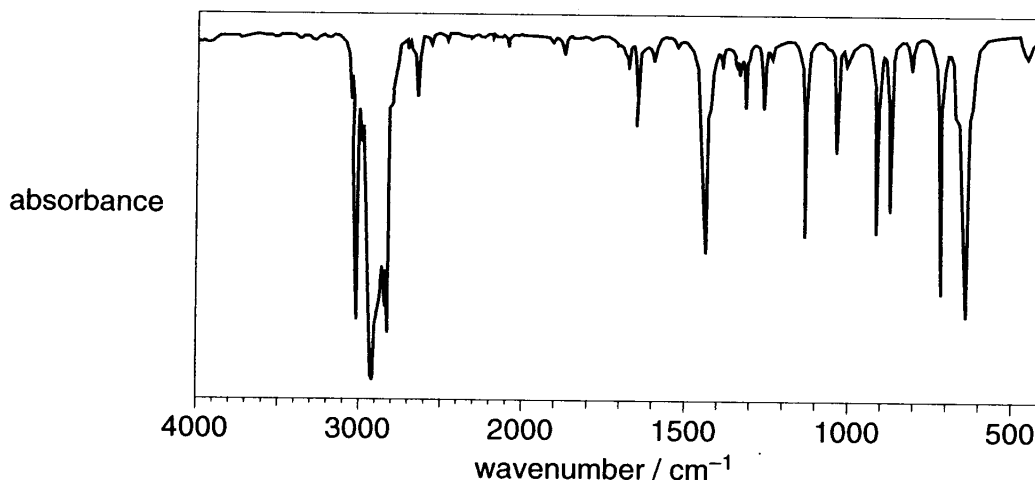
The organic product depends on the solvent used.

Identify solvent **W**, and solvent **X**..... [2]



- (c) A student refluxed a solution of chlorocyclohexane and NaOH.
The organic product was separated and analysed by infra-red spectroscopy.

The infra-red spectrum of the organic product is shown below.



The student used the infra-red spectrum to conclude that cyclohexene had been produced.

- (i) Explain what is meant by *refluxed*.

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

- (ii) Use your *Data Sheet* to explain why the student was justified in ruling out cyclohexanol as the organic product.

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

- (iii) A simple chemical test can be used to confirm that the alkene, cyclohexene, had been produced.

Clearly state what you would see and write a balanced equation for the reaction.

.....

test and observation

equation

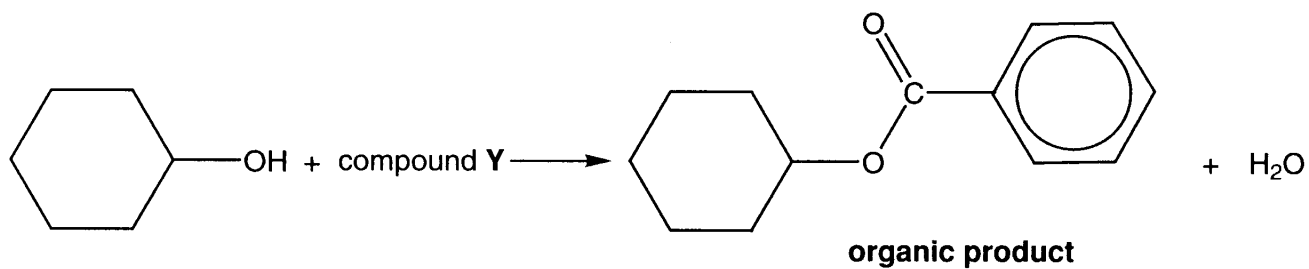
[2]

[Turn over



(d) In the presence of a suitable catalyst, cyclohexanol reacts with compound Y.

The organic product is shown in the equation below.



- (i) State a suitable catalyst. [1]
 (ii) Identify compound Y.

[1]

(e) Cyclohexanol can also be oxidised to form cyclohexanone.

- (i) State a suitable oxidising agent for this reaction.

..... [1]

- (ii) Write a balanced equation for the oxidation of cyclohexanol to cyclohexanone. Use [O] to represent the oxidising agent.

[1]

[Total: 15]



