OCR
RECOGNISING ACHIEVEMENT

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

Candidate Number

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.

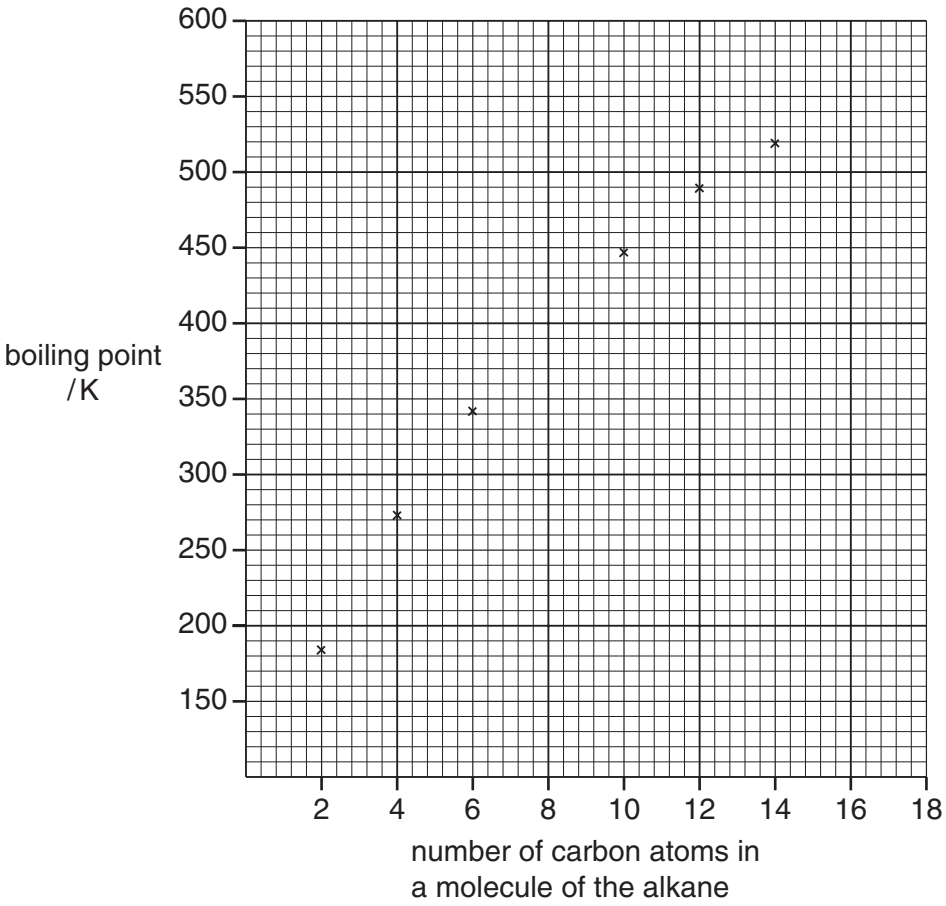
FOR EXAMINER'S USE		
Qu	**Max.**	**Mark**
1	**16**	
2	**10**	
3	**10**	
4	**15**	
5	**9**	
TOTAL	**60**	

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

[Turn over

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

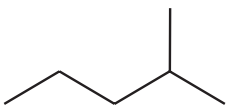
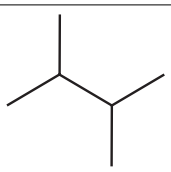
octane C_8H_{18}, …… hexadecane, $C_{16}H_{34}$ …… [2]

(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.

				
isomer **A**	isomer **B**	isomer **C**		

[2]

(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]

(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, $(CH_3)_3COH$. 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 $(CH_3)_3COH$. Give your answer to three significant figures.

answer ..... [2]

(ii) Write a balanced equation for the complete combustion of $(CH_3)_3COH$.

[2]

[Total: 16]

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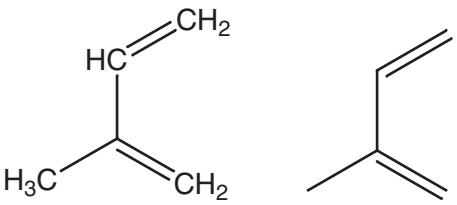
2 Isoprene is an alkene that can be tapped from some trees. It is the monomer in natural rubber.

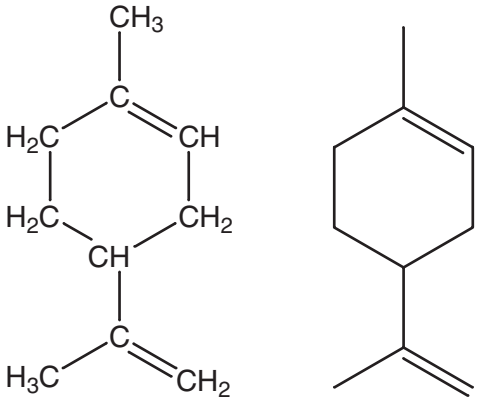
Limonene is a natural oil found in the rind of oranges and lemons.

Both isoprene and limonene contain two double bonds.

Their structural and skeletal formulae are shown below.



isoprene



limonene

(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.

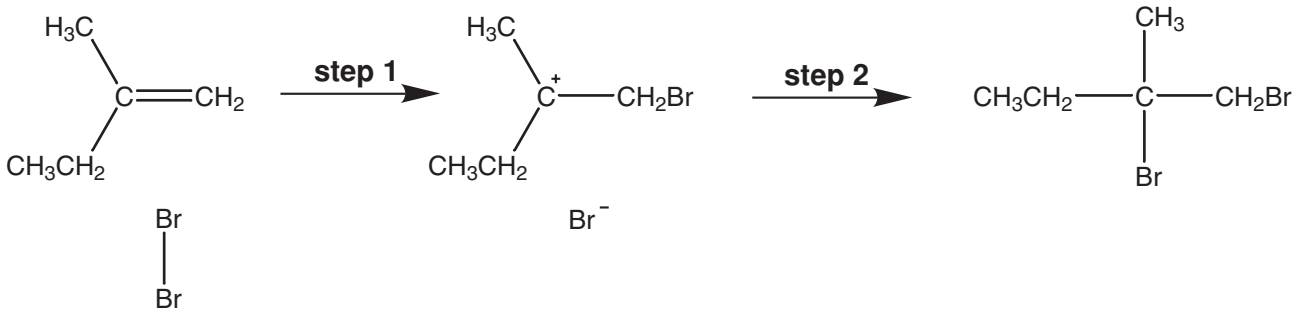
[2]

(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]

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.

$$(CH_3)_2CHCH_2OH + HBr \longrightarrow (CH_3)_2CHCH_2Br + H_2O$$

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 $(CH_3)_2CHCH_2OH$ used.

answer ..... mol [2]

(ii) Calculate the number of moles of $(CH_3)_2CHCH_2Br$ collected.
$(CH_3)_2CHCH_2Br$, 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*.

.....

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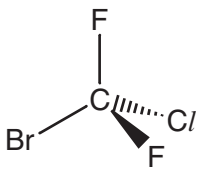
..... [2]

(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]

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

$$C_6H_{12} + Cl_2 \longrightarrow C_6H_{11}Cl + HCl$$

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.

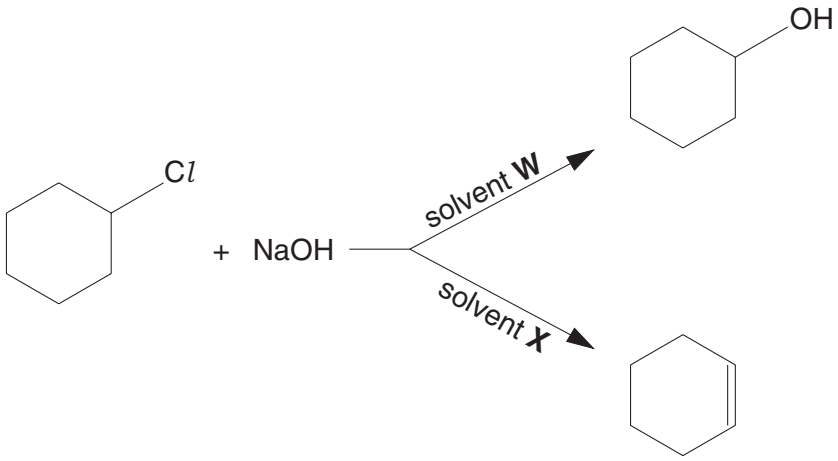
step 1 .....

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.

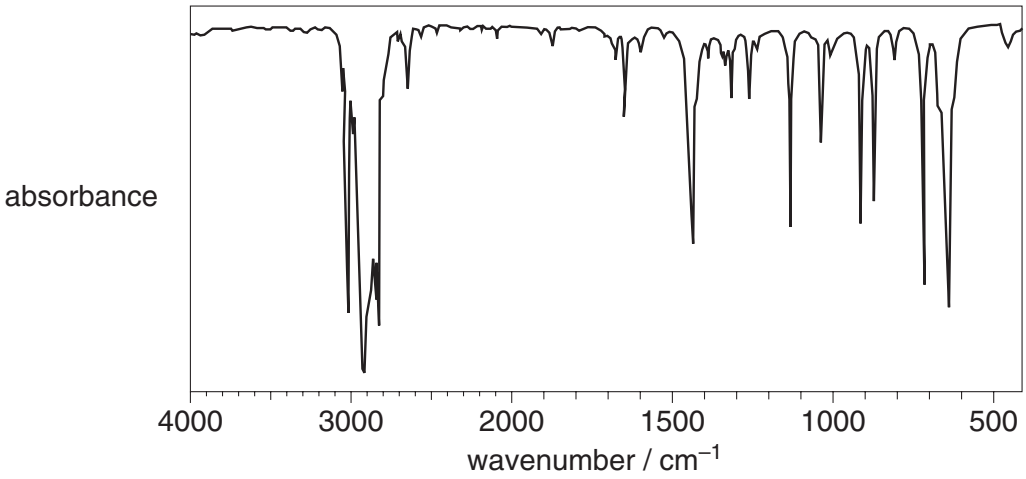


The organic product depends on the solvent used.

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.

.....

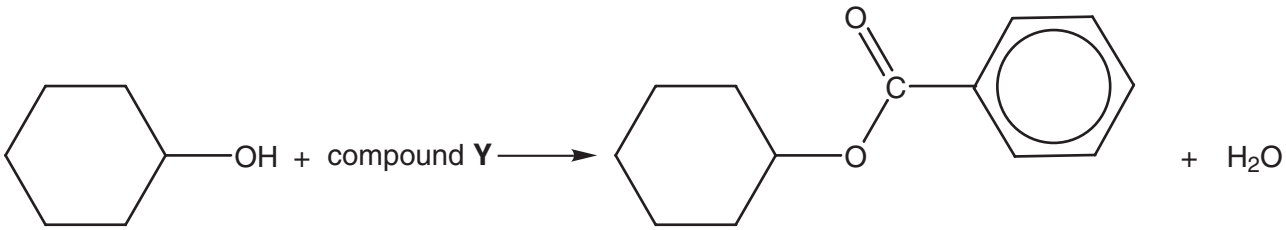
test and observation .....

equation

[2]

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

The organic product is shown in the equation below.



organic product

(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]

5 In this question, one mark is available for the quality of use and organisation of scientific terms.

Name and give examples of the types of isomerism in compounds with formula C_4H_8. Explain how each type of isomerism arises.

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Quality of Written Communication [1]

[Total: 9]

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