OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY 2812

Chains and Rings

Tuesday **12 JUNE 2001** Morning 1 hour 30 minutes

Additional materials:
Scientific calculator
Data sheet for Chemistry
Candidates answer on the question paper.

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 30 minutes

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 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 a *Data Sheet for Chemistry*.
- You are advised to show all the steps in any calculations.

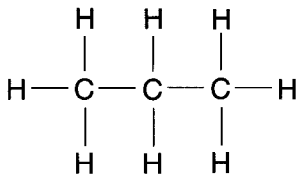
FOR EXAMINER'S USE		
Question Number	Mark	Mark
1	10	
2	17	
3	16	
4	9	
5	9	
6	12	
7	7	
8	10	
TOTAL	90	

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

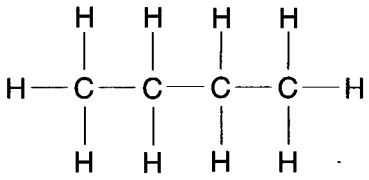
Registered Charity Number:1066969
[Turn over

1 The structures of some saturated hydrocarbon compounds are shown below.

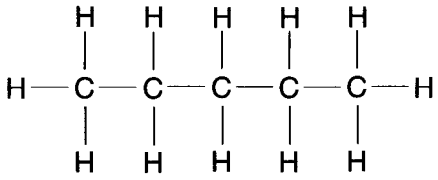
They are labelled **A**, **B**, **C**, **D**, **E** and **F**.



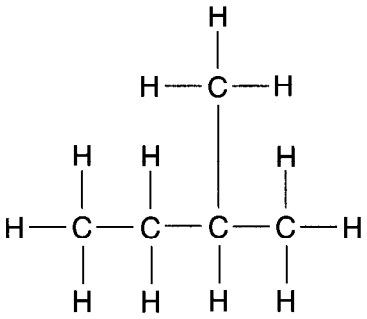
A



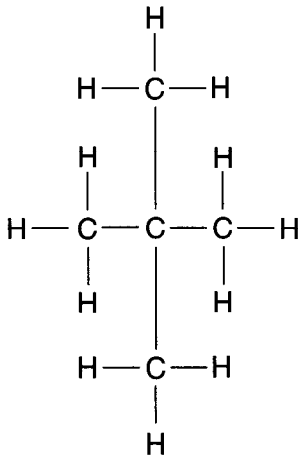
B



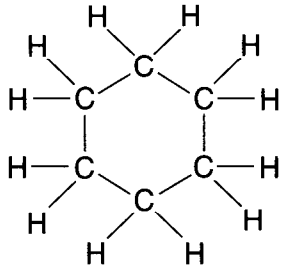
C



D



E



F

(a) The general formula of an alkane is C_nH_{2n+2}.

(i) Which of the compounds, **A** to **F**, has a formula that does **not** fit with this general formula?

..... [1]

(ii) **A**, **B**, and **C** are successive members of the alkane series.

What is the **molecular** formula of the next member in the series?

..... [1]

(iii) What is the **empirical** formula of compound **F**?

..... [1]

(b) Three of compounds **A** to **F** are structural isomers of each other.

(i) Identify, by letter, which of the compounds are the three structural isomers.

....., ..., and ..... . [1]

(ii) Explain what is meant by the term *structural isomer.*

.....

..... [1]

(c) **(i)** Which of the compounds, **A**, **B** or **C**, would you expect to have the highest boiling point?

..... [1]

(ii) Which of the compounds, **C**, **D** or **E**, would you expect to have the highest boiling point?

..... [1]

(iii) Explain your answers to **(c)(i)** and **(c)(ii)** in terms of intermolecular forces.

.....

.....

.....

..... [3]

[Total: 10]

[Turn over

2 An alcohol, **G**, has a relative molecular mass of 74 and has the following composition by mass: C, 64.9%; H, 13.5%; O, 21.6%.

(a) (i) Show that the empirical formula of **G** is $C_4H_{10}O$.

[2]

(ii) Show that the molecular formula of **G** is the same as its empirical formula.

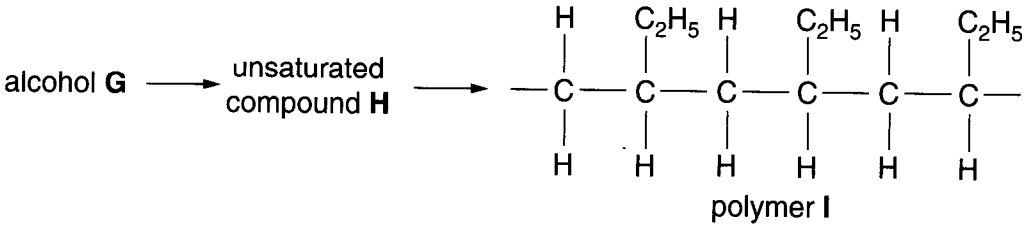
[1]

(b) There are four structural isomers of $C_4H_{10}O$ that are alcohols. Alcohols can be classified as primary, secondary or tertiary. Complete the table below.

structural isomer	formula	name	classification
1	$CH_3—CH_2—CH_2—CH_2—OH$	butan-1-ol	
2			secondary
3	$H_3C—\underset{\displaystyle CH_3}{\underset{\vert}{CH}}—CH_2—OH$		
4		2-methylpropan-2-ol	

[7]

(c) The alcohol **G** can be dehydrated to form an unsaturated compound **H** which can be polymerised to give polymer **I**.



polymer **I**

(i) Explain what is meant by the term *unsaturated*.

.....

..... [1]

(ii) Describe a simple chemical test to show unsaturation.

test .....

observation ..... [2]

(iii) Circle the repeat unit of polymer **I** in the diagram above. [1]

(iv) Identify the unsaturated compound **H** and draw its structure.

[1]

(v) Suggest an identity of alcohol **G**.

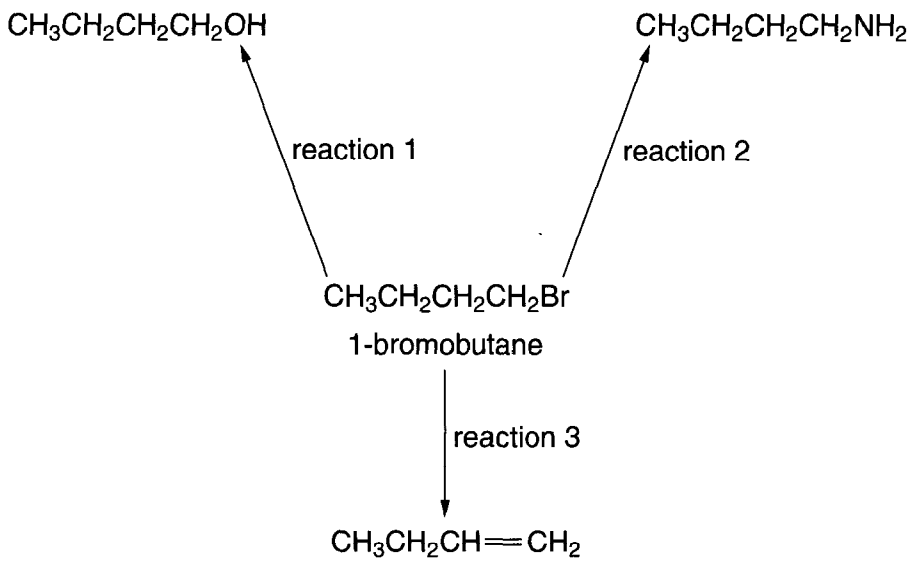
[1]

(vi) Draw the **skeletal** formula of the alcohol **G**.

[1]

[Total: 17]

3 Some reactions of 1-bromobutane, $CH_3CH_2CH_2CH_2Br$, are shown below.



(a) For each of the reactions shown, name the reagent and the solvent used.

reaction 1

reagent .....

solvent .....

reaction 2

reagent .....

solvent .....

reaction 3

reagent .....

solvent .....[6]

(b) Under the same conditions, 1-chlorobutane was used in reaction 1 in place of 1-bromobutane.

What difference (if any) would you expect in the rate of reaction? Explain your answer.

.....

.....

..... [2]

(c) Dichlorodifluoromethane, CCl_2F_2, is an example of a chlorofluorocarbon, CFC, that was commonly used as a propellant in aerosols. Nowadays CFCs have limited use because of the damage caused to the ozone layer.

(i) Draw a diagram to show the shape of a molecule of CCl_2F_2.

[1]

(ii) Predict an approximate value for the bond angles in a molecule of CCl_2F_2.

..... [1]

(iii) Suggest a property that makes CCl_2F_2 suitable as a propellant in an aerosol.

..... [1]

(iv) When CFCs are exposed to strong ultraviolet radiation in the upper atmosphere, homolytic fission takes place to produce free radicals.

Explain what is meant by the term *homolytic fission*.

..... [1]

(v) Suggest which bond is most likely to be broken when CCl_2F_2 is exposed to ultraviolet light. Explain your answer.

bond .....

reason .....

..... [2]

(vi) Identify **two** free radicals most likely to be formed when CCl_2F_2 is exposed to ultraviolet light.

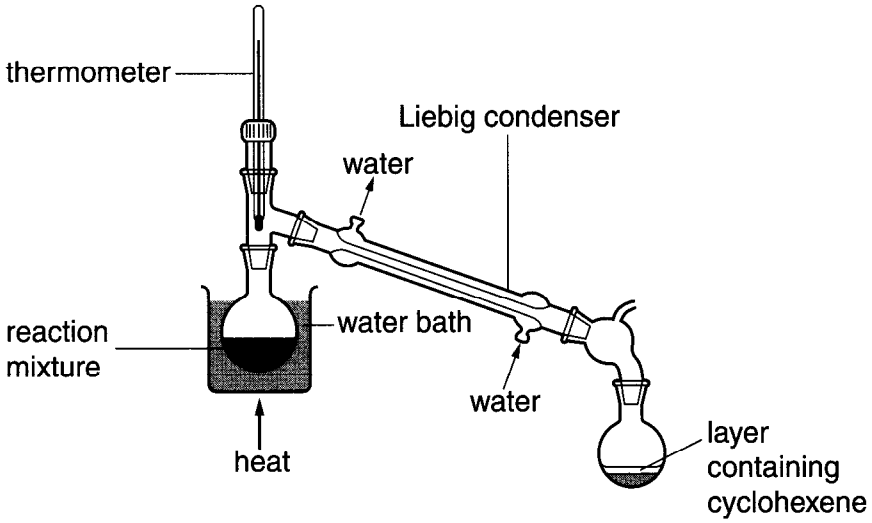
..... and ..... [2]

[Total :16]

[Turn over

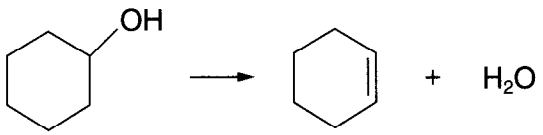
4 Cyclohexene, C_6H_{10}, can be prepared from cyclohexanol, $C_6H_{11}OH$, by the dehydration method described below.

A reaction mixture of 10.0 g cyclohexanol and 4 cm^3 of phosphoric acid, H_3PO_4, was placed in a round-bottomed flask and the apparatus arranged as shown below. An impure liquid, consisting of two immiscible layers, was collected after distillation.



The upper organic layer was separated and dried. Finally it was re-distilled to yield 3.69 g of cyclohexene.

The equation for the preparation can be represented as either



or

$$C_6H_{11}OH \longrightarrow C_6H_{10} + H_2O$$

Use the information above to answer the questions that follow.

(a) Suggest an impurity that could have been in the mixture after the first distillation.

..... [1]

(b) **(i)** What is the relative molecular mass of cyclohexanol?

..... [1]

(ii) How many moles of cyclohexanol were used in the experiment?

[1]

(iii) How many moles of cyclohexene were produced in the experiment?

[2]

(iv) Calculate the percentage yield of cyclohexene in the experiment.

[2]

(c) Suggest how infra-red spectroscopy could be used to show that the product was not contaminated with any unreacted cyclohexanol. Refer to the *Data Sheet* in your answer.

.....

.....

.....

.....

..... [2]

[Total: 9]

[Turn over

5 Reagents used in organic chemistry may contain electrophiles, nucleophiles or free radicals.

In the spaces below:
explain what is meant by each term;
give an example of each type of species;
write a balanced equation for a reaction that involves each species.

(a) (i) *electrophile* .....

..... [1]

(ii) *example* ..... [1]

(iii) Write a balanced equation to illustrate electrophilic addition.

..... [1]

(b) (i) *nucleophile* .....

..... [1]

(ii) *example* ..... [1]

(iii) Write a balanced equation to illustrate nucleophilic substitution.

..... [1]

(c) (i) *free radical* .....

..... [1]

(ii) *example* ..... [1]

(iii) Write a balanced equation to illustrate free-radical substitution.

..... [1]

[Total: 9]

6 Many drinks have a characteristic smell. 2-Ethyl-3-methylbutanoic acid, $C_7H_{14}O_2$, gives rum its characteristic aroma.

(a) 2-Ethyl-3-methylbutanoic acid can be prepared in the laboratory by oxidation of 2-ethyl-3-methylbutan-1-ol, $(CH_3)_2CHCH(C_2H_5)CH_2OH$.

(i) State the reagents and conditions that could be used for this oxidation. Describe what colour change you would see.

reagents .....

conditions .....

colour change *from* ..... *to* ..... . [4]

(ii) State, with a reason, whether a reflux apparatus or a distillation apparatus should be used to produce the correct oxidation product.

.....

.....

..... [2]

(iii) What is the molecular formula of 2-ethyl-3-methylbutan-1-ol? ..... [1]

(iv) Using [O] to represent the oxidising agent, write a balanced equation for this oxidation.

..... [2]

(v) Identify a likely organic impurity which could be formed in this oxidation.

..... [1]

(b) If 2-ethyl-3-methylbutan-1-ol were replaced by 2-ethyl-3-methylbutan-2-ol, oxidation would **not** occur in this experiment. Explain why not.

.....

..... [2]

[Total: 12]

[Turn over

(In this question, 1 mark is available for the quality of written communication.)

7 Describe and explain how ethene reacts with bromine. You should include in your answer:

- any observations,
- the name of the organic product,
- a full description of the mechanism.

[Total: 7]

(In this question, 1 mark is available for the quality of written communication.)

8 The fractions from crude oil can be processed further by either cracking, reforming or isomerisation.

Outline, with the aid of suitable examples and equations, each of these processes.

State clearly the industrial importance of each process.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[Total: 10]