

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY

2812

Chains and Rings

Wednesday **17 JANUARY 2001** Afternoon 1 hour 30 minutes

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

Candidate Name	Centre Number	Candidate Number												
	<table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> </tr> </table>							<table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> </tr> </table>						

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	9	
2	16	
3	19	
4	13	
5	9	
6	7	
7	9	
8	8	
TOTAL	90	

This question paper consists of 14 printed pages and 2 blank pages.

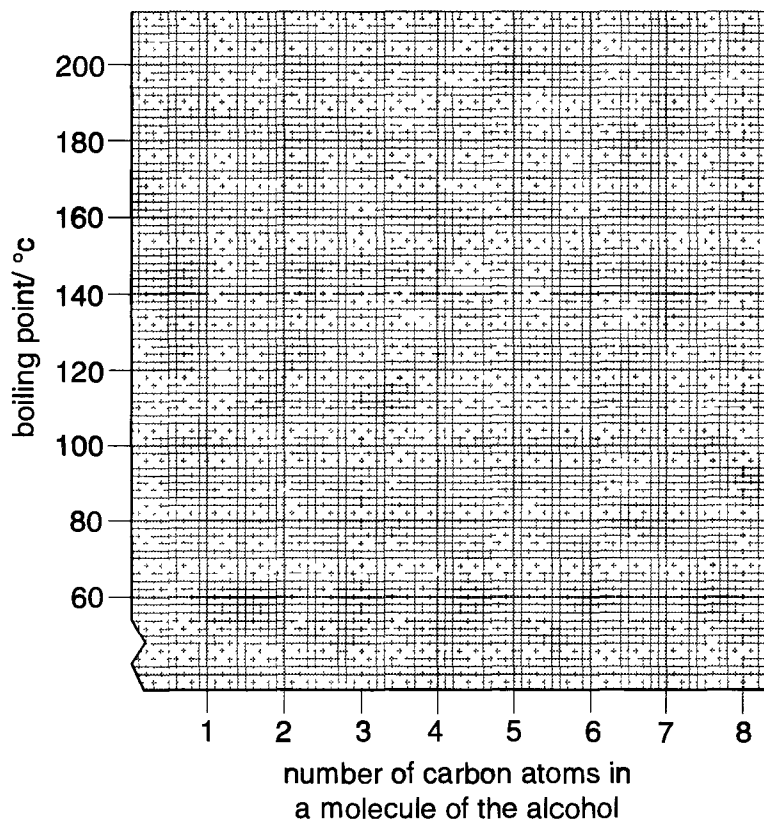
- 1 The table below shows information about some alcohols which form part of an homologous series.

name	formula	boiling point / °C	relative molecular mass
methanol	CH ₃ OH	65	32
ethanol	C ₂ H ₅ OH	78	46
propan-1-ol	C ₃ H ₇ OH	97	60
butan-1-ol	C ₄ H ₉ OH		74
pentan-1-ol	C ₅ H ₁₁ OH	138	
hexan-1-ol	C ₆ H ₁₃ OH	158	102

- (a) (i) Identify the functional group common to all alcohols. [1]
(ii) What is the general formula for these alcohols? [1]
(iii) What is the formula of the next alcohol in the series? [1]
- (b) Calculate the relative molecular mass of pentan-1-ol.

[1]

- (c) (i) Plot a graph of boiling point against number of carbon atoms in a molecule of the alcohol.



[2]

Use the graph to estimate the boiling points of

butan-1-ol, [1]

$C_8H_{17}OH$ [1]

- (ii) State the connection between boiling point and the relative molecular mass of these alcohols.

.....

..... [1]

[Total: 9]

2 The hydrocarbons in crude oil can be separated by fractional distillation.

(a) Explain what is meant by the terms

(i) *hydrocarbons*,

..... [1]

(ii) *fractional distillation*.

.....

..... [1]

(b) Undecane, $C_{11}H_{24}$, can be isolated by fractional distillation.

Calculate the percentage composition by mass of carbon in undecane.

[3]

(c) Undecane can be cracked into nonane and compound **A**. One molecule of nonane contains nine carbon atoms.

(i) Write a balanced equation for this reaction.

..... [2]

(ii) Name compound **A**.

..... [1]

(d) Hydrocarbons of formula C_5H_{12} , can also be isolated from crude oil.

(i) Draw the three structural isomers of C_5H_{12} .

Isomer B	Isomer C	Isomer D

[3]

(ii) Isomers, **B**, **C** and **D** can be separated by fractional distillation. State the order, lowest boiling point first, in which they would distil.

..... [1]

(iii) Justify the order stated in (d)(ii).

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

(iv) Write a balanced equation for the **complete** combustion of pentane, C_5H_{12} .

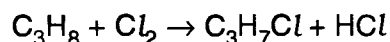
..... [2]

(v) Why do oil companies isomerise alkanes such as pentane?

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

[Total: 16]

- 3 Propane, C_3H_8 , reacts with Cl_2 in the presence of sunlight to form a mixture of chlorinated products. One possible product is C_3H_7Cl , formed as shown in the following equation.



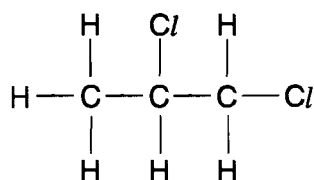
- (a) Describe, with the aid of equations, the mechanism of this reaction.

initiation

propagation

termination [4]

- (b) One other possible product of the reaction between propane and chlorine is compound H, shown below.



compound H

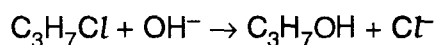
- (i) Name compound H. [1]

- (ii) Draw **two other** structural isomers of $C_3H_6Cl_2$.

--	--

[2]

- (c) 1-Chloropropane can react with a solution of sodium hydroxide as shown in the equation below.



- (i) State the solvent in which the sodium hydroxide is dissolved.

..... [1]

- (ii) State and explain the role of the hydroxide ion, OH^- , in this reaction.

.....

..... [2]

(d) Propan-1-ol, C_3H_7OH , is refluxed with an acidified solution of potassium dichromate(VI) to produce propanoic acid. The acidified potassium dichromate(VI) acts as an oxidising agent.

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

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

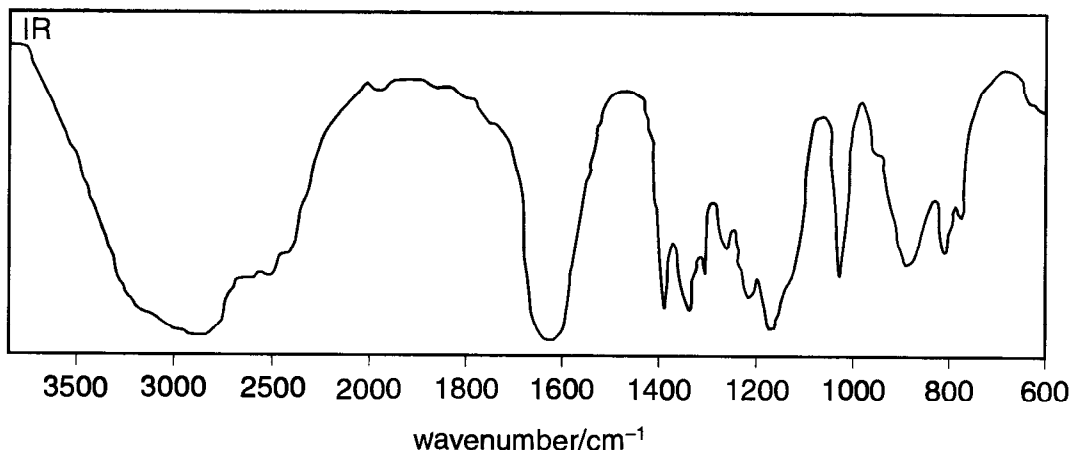
(ii) State what colour change takes place in the reaction mixture.

from to [2]

(iii) Write a balanced equation for the oxidation of propan-1-ol to propanoic acid. The oxidising agent can be represented as [O] in your equation.

..... [2]

(e) An infra-red spectrum of propanoic acid was obtained. By referring to your *Data Sheet*, identify two peaks in the infra-red spectrum that confirm the presence of the carboxylic acid functional group.



Peak 1 wavenumber/ cm^{-1}

bond

Peak 2 wavenumber/ cm^{-1}

bond

[4]

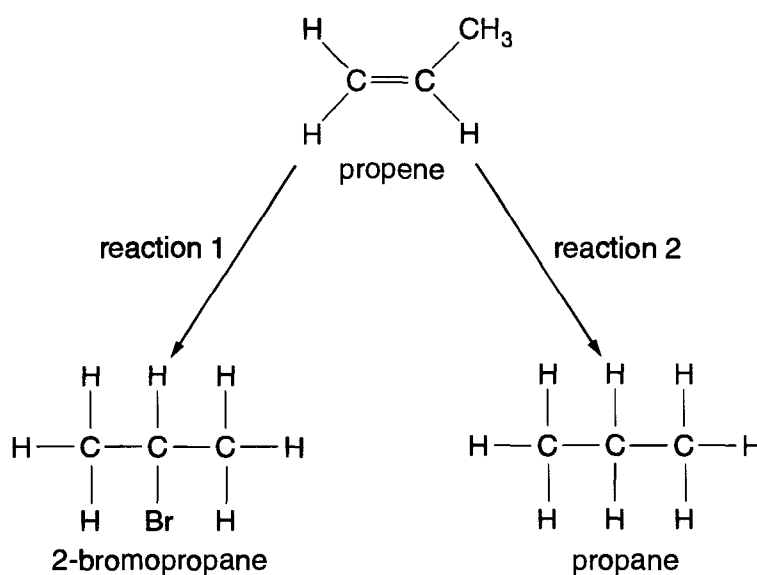
[Total: 19]

- 4 (a) Propene, C_3H_6 , readily undergoes electrophilic addition reactions. Show, with the aid of curly arrows, the mechanism of the electrophilic addition reaction of propene with bromine.



[4]

- (b) Propene also reacts as shown below.



- (i) State a suitable reagent for reaction 1.

..... [1]

- (ii) State a suitable reagent and conditions for reaction 2.

.....
 [2]

- (iii) In the presence of an acid catalyst, propene can react with steam to form a mixture of two alcohols. Draw the structures of the two alcohols.

--	--

[2]

- (c) The scientists Ziegler and Natta were awarded a Nobel Prize for chemistry in 1963 for their work on polymerisation. Part of this work involved the polymerisation of propene into poly(propene).

- (i) What type of polymerisation forms poly(propene)?

..... [1]

- (ii) Draw a section of poly(propene) to show **two** repeat units.

[1]

- (iii) State **two** difficulties in the disposal of poly(propene).

.....

.....

..... [2]

[Total: 13]

- 5 Alcohols can be converted into chloroalkanes by reaction with hydrochloric acid, HCl.

2-Chloro-2-methylpropane can be prepared by shaking together 5.1 cm³ (4.0 g) of 2-methylpropan-2-ol with 20 cm³ of concentrated HCl. After 10 minutes two separate layers begin to form.

- (a) (i) What is the molecular formula of 2-methylpropan-2-ol, (CH₃)₃COH?

..... [1]

- (ii) Write a balanced equation for the reaction between 2-methylpropan-2-ol and HCl.

..... [1]

Use the data in the table below to answer the questions that follow.

compound	relative molecular mass	density / g cm ⁻³	boiling point / °C
2-methylpropan-2-ol	74	0.78	83
2-chloro-2-methylpropane	92.5	0.84	51
water	18	1.00	100

One of the layers is aqueous and the other contains the organic product.

- (b) Suggest whether the upper or lower layer is likely to contain the organic product.

Explain your reasoning.

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

- (c) *The organic layer was shaken with a dilute solution of sodium hydrogencarbonate, NaHCO₃. A gas was given off.*

Identify the gas that was given off. [1]

Suggest the chemical that could have reacted with the NaHCO₃ to form the gas.

..... [1]

(d) *The resulting impure organic liquid was dried with anhydrous calcium chloride and then distilled. 3.75g of pure 2-chloro-2-methylpropane was produced.*

(i) At what temperature would you expect the **pure** organic product to distil?

..... [1]

(ii) Calculate how many moles of 2-methylpropan-2-ol were used in the experiment.

[1]

(iii) Calculate how many moles of pure 2-chloro-2-methylpropane were produced.

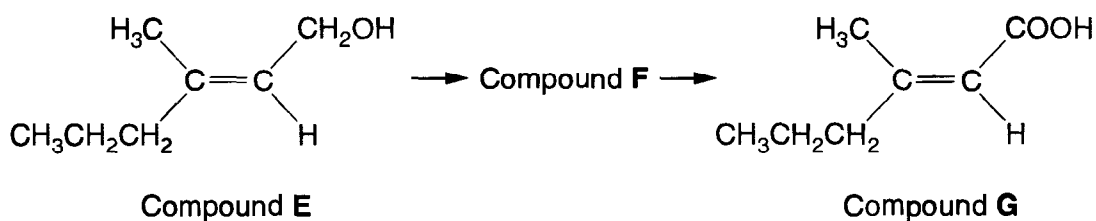
[1]

(iv) Calculate the percentage yield of 2-chloro-2-methylpropane in this experiment.

[1]

[Total: 9]

- 6 The production of body odour often begins with secretions from glands called apocrine glands which are most numerous in the armpits. Skin bacteria, which live in the armpits, use these secretions to produce energy and many different waste products. Scientists have isolated one of these products, compound **E**, which is shown below. Compound **E** can be oxidised to form compounds **F** and **G**.



- (a) Compound **E** contains two functional groups. Identify both functional groups and state how you could test for each.

functional group 1

test

observation

functional group 2

test

observation

[6]

- (b) Suggest the structural formula of compound **F**.

[1]

[Total: 7]

