OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY 2812

Chains and Rings

Friday **18 JANUARY 2002** Morning 1 hour 30 minutes

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

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

FOR EXAMINER'S USE		
Question Number	Mark	Mark
1	8	
2	8	
3	18	
4	22	
5	11	
6	7	
7	16	
TOTAL	90	

This question paper consists of 12 printed pages.

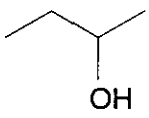
Registered Charity Number:1066969
[Turn over

For Examiner's Use

Answer **all** the questions.

1 **(a)** State the name of

(i) $CH_3CH_2CH_2OH$ .....[1]

(ii) 

.....[1]

(b) What is the molecular formula of $(CH_3)_2CHCH(CH_3)_2$? .....[1]

(c) What is the empirical formula of $(CH_3)_2CHCH(CH_3)_2$? .....[1]

(d) To which homologous series does $(CH_3)_2CHCH(CH_3)_2$ belong? .....[1]

(e) Show the structural formula of a primary, a secondary and a tertiary isomer of C_4H_9Cl.

primary	secondary	tertiary

[3]

[Total : 8]

For Examiner's Use

2 **(a)** When chlorine, Cl_2, reacts with methane or with ethene the C*l*–C*l* bond undergoes fission. The bond fission occurs by a **different** process in each reaction.

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

.....

.....[1]

(ii) State the type of fission of the C*l*–C*l* bond in the reaction between Cl_2 and

methane, ...

ethene. .....[2]

(iii) Write a balanced equation to illustrate **each** type of fission of the C*l*–C*l* bond.

.....

.....[2]

(b) The products formed by fission of the C*l*–C*l* bond can then react with a range of organic chemicals. Identify the product of C*l*–C*l* bond fission that could behave as:

a nucleophile, ...

an electrophile, ...

a free radical. .....[3]

[Total : 8]

[Turn over

For Examiner's Use

3 The table below gives the names and molecular formulae of some alkanes present in crude oil.

name	molecular formula
methane	CH_4
ethane	C_2H_6
propane	C_3H_8
hexane	C_6H_{14}
octane	C_8H_{18}
decane	$C_{10}H_{22}$
octadecane	$C_{18}H_{38}$

(a) (i) What is the general formula of the alkanes? .....[1]

(ii) What is the difference in formulae between successive members of the alkanes?

.....[1]

(iii) Suggest the molecular formula of the alkane *hexadecane*? .....[1]

(b) (i) Explain why the cracking of long-chain alkanes such as octadecane is important.

.....

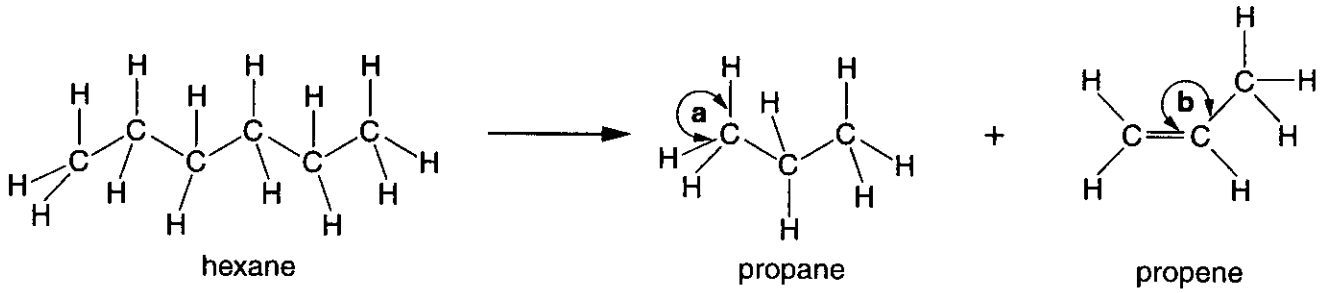
.....

.....[2]

(ii) Under certain conditions octadecane, $C_{18}H_{38}$, can be cracked into hexane and an alkene. What is the molecular formula of the alkene?

.....[1]

(c) Hexane can be cracked further into propane and propene as shown below.



hexane propane propene

(i) Predict the value of

bond angle '**a**' in propane ..... and bond angle '**b**' in propene .....[2]

For Examiner's Use

(ii) Propene is unsaturated and contains a π-bond. Explain, with the aid of a diagram, how p-orbitals are involved in the formation of the π-bond in propene.

.....

.....

.....

.....

.....[2]

(iii) Describe how propane and propene could be distinguished by a simple chemical test.

.....

.....

.....[2]

(d) A major commercial use of propene is the production of the polymer poly(propene).

(i) Draw a section of poly(propene) showing **two** repeat units.

[2]

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

(e) Hydrocarbon polymers such as poly(propene) can be disposed of by using land-fill sites or by burning in an incinerator.

(i) State **one** disadvantage of disposal in a land-fill site.

.....[1]

(ii) State **one** possible advantage and **one** disadvantage if they are disposed of by burning.

advantage .....

.....

disadvantage .....

.....[2]

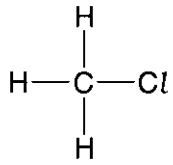
[Total : 18]

[Turn over

For Examiner's Use

4 Halogenoalkanes are polar molecules and react with nucleophiles.

(a) The displayed formula of chloromethane is shown below. Label the dipole on the C–C*l* bond.



[1]

(b) Chloromethane is hydrolysed by aqueous sodium hydroxide in a nucleophilic substitution reaction. An equation for this reaction is shown below.

$$CH_3Cl + OH^- \longrightarrow CH_3OH + Cl^-$$

(i) What is meant by the term *nucleophile*?

.....

.....[1]

(ii) Show, with the aid of curly arrows, the mechanism of this hydrolysis.

[2]

(c) **(i)** What would happen to the rate of hydrolysis if chloromethane were replaced by iodomethane? Explain your answer.

.....

.....

.....[2]

(ii) Suggest a reagent that could be used to compare the rate of the hydrolysis of both halogenoalkanes. State what you would see in each case.

reagent .....

observation(s) with chloromethane .....

.....

observation(s) with iodomethane .....

.....[5]

For Examiner's Use

(d) Compound **D** has the following composition by mass: C, 12.76%; H, 2.13%; Br, 85.11%.

(i) Calculate the empirical formula of **D**. Show your working.

[2]

(ii) Compound **D** has a relative molecular mass of 187.8.

What is the molecular formula of **D**? Show your working.

[2]

(iii) Identify **two** possible structural isomers of **D**.

[2]

(e) Complete hydrolysis of **D** forms ethane-1,2-diol, which is used as anti-freeze in cars.

(i) Draw the displayed formula of ethane-1,2-diol.

[1]

(ii) Which of the isomers in **(d)(iii)** is **D**. Explain your answer.

[1]

(iii) Write a balanced equation for the complete hydrolysis of **D**.

.....[2]

(iv) Suggest why ethane-1,2-diol is suitable for use as *anti-freeze*.

.....

.....[1]

[Total : 22]

[Turn over

5 Alcohols can react with carboxylic acids to produce esters. Esters are often described as having 'fruity smells'.

The following experiment was carried out to produce the ester, $CH_3COOCH_2CH_2CH(CH_3)_2$, which contributes to the flavour of ripe pears.

An 8.8 g sample of 3-methylbutan-1-ol, $(CH_3)_2CHCH_2CH_2OH$, and 6.0 g of ethanoic acid, CH_3COOH, were mixed in a flask and 2.0 g of concentrated sulphuric acid were added. The mixture was refluxed for four hours and then fractionally distilled to give the crude ester. The ester was washed repeatedly with aqueous sodium carbonate, to remove any acid present, until there was no more effervescence. The mixture was distilled and 7.8 g of ***pure*** *ester were obtained.*

(a) By referring to the experimental procedure above,

(i) state the role of the concentrated sulphuric acid,

.....[1]

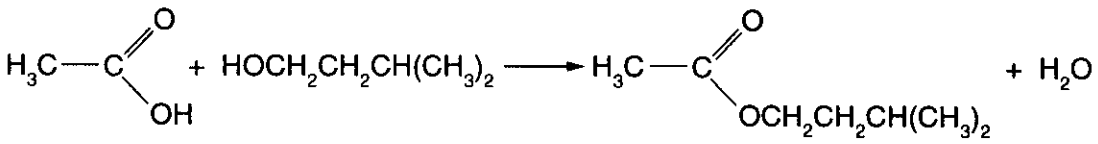
(ii) explain the meaning of *refluxed*, ...

.....[1]

(iii) suggest which gas was responsible for the *effervescence*.

.....[1]

(b) The equation for the esterification is given below.



(i) Calculate the relative molecular mass of CH_3COOH.

Answer .....[1]

(ii) Calculate how many moles of CH_3COOH were used.

Answer .....[1]

For Examiner's Use

(iii) Deduce the theoretical yield, in moles, of the ester $CH_3COOCH_2CH_2CH(CH_3)_2$.

Answer .....[1]

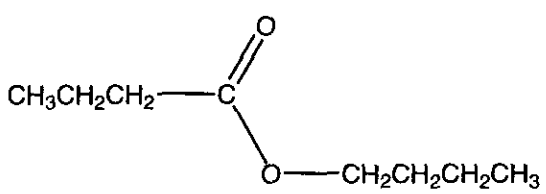
(iv) The student produced 7.8 g of the **pure** ester, $CH_3COOCH_2CH_2CH(CH_3)_2$ (M_r = 130). Calculate how many moles of **pure** ester were produced in this experiment.

Answer .....[1]

(v) Calculate the percentage yield of **pure** ester obtained in this experiment.

Answer .....[1]

(c) Butan-1-ol, $CH_3CH_2CH_2CH_2OH$, reacts with a carboxylic acid to produce ester, **E**, which is found in pineapples.



E

(i) Draw the displayed formula of butan-1-ol.

[1]

(ii) Draw the structure of the carboxylic acid used to produce **E**.

[1]

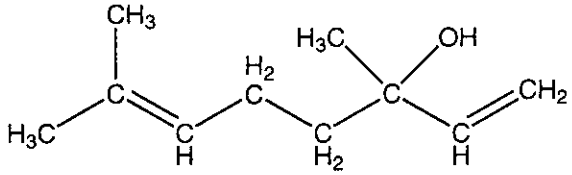
(iii) Write a balanced equation for the formation of **E** from butan-1-ol.

[1]

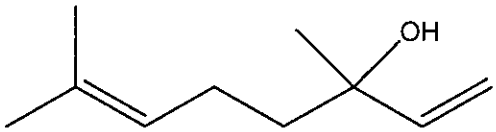
[Total : 11]

[Turn over

6 The structure of linalool, $C_{10}H_{18}O$, which occurs naturally in rose oil, is shown below.



structural formula



skeletal formula

(a) Identify the **two different** functional groups present in linalool.

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

(b) Linalool reacts with hydrogen in the presence of a catalyst. A fully saturated compound, **A**, is produced.

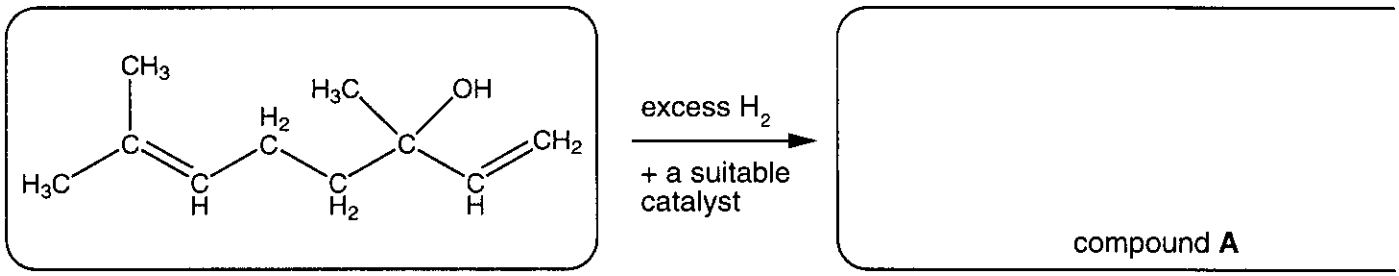
(i) Explain what is meant by the term *saturated.*

.....

.....[1]

(ii) Suggest a suitable catalyst for this reaction. .....[1]

(iii) Complete the reaction scheme below.



[2]

(iv) Draw the skeletal formula of **A**.

[1]

[Total : 7]

For Examiner's Use

7 **(a)** Explain what is meant by the terms *structural isomerism* and *cis-trans isomerism*. In your answer refer to isomers of C_4H_8 **only**. Clearly identify by formula and by name each isomer and state the key feature required for each type of isomerism.

(In this question, 2 marks are available for the quality of written communication)

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.....[11]

Question 7 part (b) overleaf

[Turn over

For Examiner's Use

Question 7 continued.

(b) Under certain conditions alkenes such as propene can react to form alcohols. State the reagents and conditions required. Write a balanced equation and explain why it is possible to produce **two** different alcohols.

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.....[5]

[Total : 16]