

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY

2812

Chains and Rings

Thursday

10 JUNE 2004

Morning

1 hour

Candidates answer on the question paper.

Additional materials:

Data Sheet for Chemistry

Scientific calculator

Candidate Name	Centre Number	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.
- Write your answers in the spaces provided 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

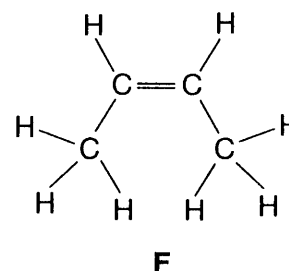
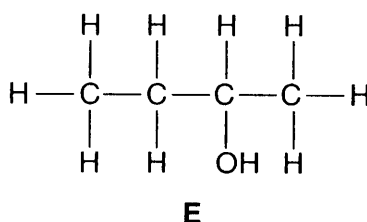
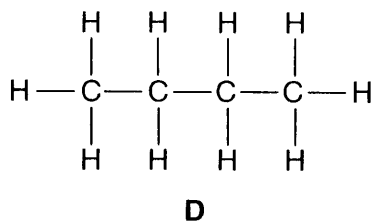
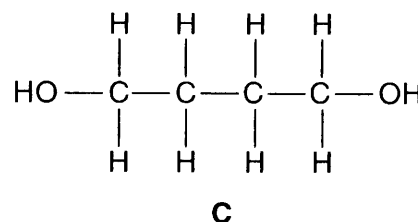
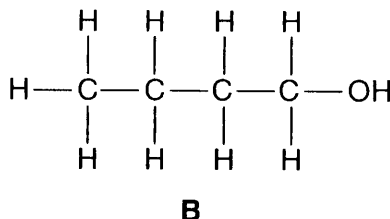
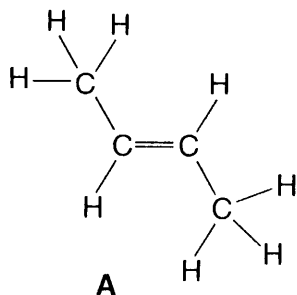
- The number of marks is given in brackets [] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry*.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Question Number	Max.	Mark
1	7	
2	18	
3	14	
4	12	
5	9	
TOTAL	60	

This question paper consists of 11 printed pages and 1 blank page.

Answer **all** the questions.

1 This question is about the compounds **A–F** below.



(a) Answer the following questions by referring to the compounds **A–F**.

(i) What is the molecular formula of compound **D**?

.....[1]

(ii) What is the empirical formula of compound **C**?

.....[1]

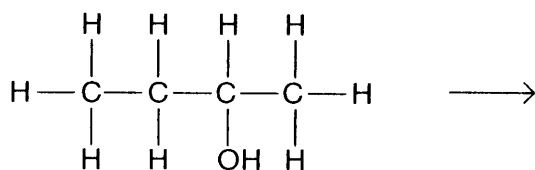
(iii) Which two compounds are structural isomers of each other?

..... and[1]

(iv) Which two compounds are *cis-trans* isomers of each other?

..... and[1]

(b) Compound **E** can be dehydrated to form compound **A**. Complete a balanced equation for this reaction.



[1]

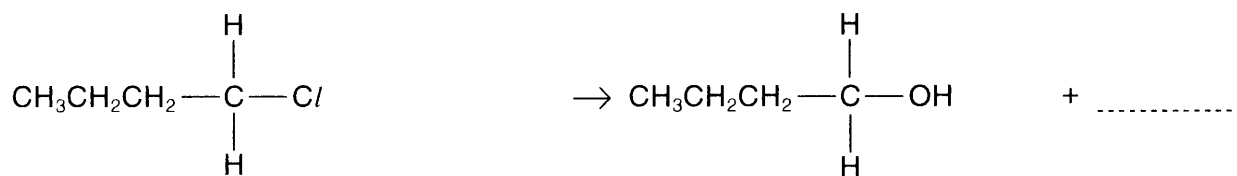
- (c) Compound **C** can be dehydrated to form a new compound, **G**, with the molecular formula, C_4H_6 . Suggest a structural formula and a name for **G**.

name[2]

[Total: 7]

- 2 Halogenoalkanes, such as 1-chlorobutane, are hydrolysed with hot aqueous alkali, $\text{OH}^-(\text{aq})$, to form alcohols.

(a) Describe, with the aid of curly arrows, the mechanism of the hydrolysis of 1-chlorobutane with $\text{OH}^-(\text{aq})$ ions to produce butan-1-ol. Show any relevant lone pairs of electrons and dipoles.



[4]

(b) Another halogenoalkane, **H**, has a relative molecular mass of 127 and has the following composition by mass:
C, 37.8%; H, 6.3%; Cl, 55.9%.

(i) Show that the empirical formula of compound **H** is $\text{C}_2\text{H}_4\text{Cl}$.

[2]

(ii) Deduce the molecular formula of compound **H**.

[1]

(iii) Compound **H** can also be hydrolysed with hot aqueous alkali to form butane-1,3-diol. Draw the structure of butane-1,3-diol.

[1]

(iv) Deduce the structure of compound **H**.

[1]

(c) 1-Chlorobutane can also react with OH^- ions to form but-1-ene.

(i) State a suitable solvent for this reaction.

.....[1]

(ii) Name the type of reaction.

.....[1]

(iii) Draw the structure of but-1-ene.

[1]

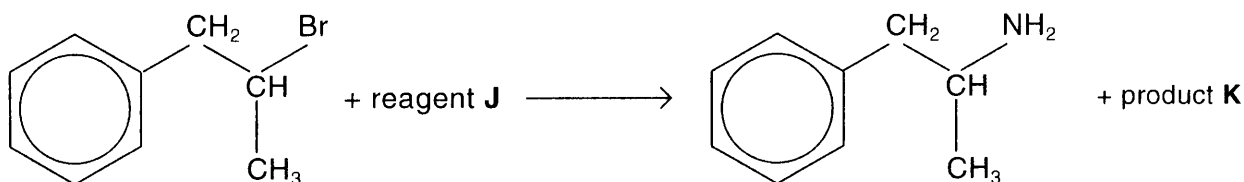
(iv) Write a balanced equation for the reaction.

.....[1]

(d) But-1-ene can undergo polymerisation. Draw a section of the polymer that can be formed from but-1-ene. Show **two** repeat units.

[2]

(e) Amphetamine is a pharmaceutical that acts as a stimulant. It increases the heart rate and dilates the air passages in the lungs. A possible reaction scheme for the preparation of amphetamine is shown below.



(i) Identify reagent **J**.

.....[1]

(ii) Identify product **K**.

.....[1]

(iii) Suggest suitable conditions for this reaction.

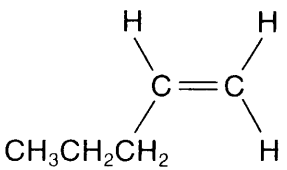
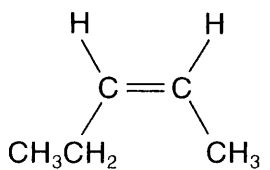
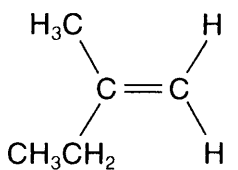
.....[1]

[Total: 18]

- 3 (a) Many organic molecules show structural isomerism. State what is meant by the term *structural isomerism*.

.....
[2]

- (b) Isomers 1, 2 and 3, shown below, are unsaturated structural isomers of C_5H_{10} .

 <p>isomer 1</p>	 <p>isomer 2</p>	 <p>isomer 3</p>

- (i) Complete the boxes by drawing two other unsaturated structural isomers of C_5H_{10} .

[2]

- (ii) Name isomer 3.

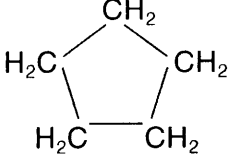
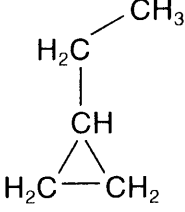
.....[1]

- (iii) Draw the skeletal formula of isomer 2.

[1]

(c) There are several **cycloalkanes** that are structural isomers of C_5H_{10} .

(i) Complete the boxes by drawing two other structural isomers of C_5H_{10} that are also **cycloalkanes**.

			
isomer L		ethylcyclopropane	

[2]

(ii) Name isomer **L** drawn in (c)(i).

.....[1]

(iii) Draw the skeletal formula of isomer **L**.

[1]

(d) Isomer **L**, C_5H_{10} , reacts with Cl_2 in the presence of UV light to produce the organic product C_5H_9Cl . The reaction takes place in three stages: initiation, propagation and termination.

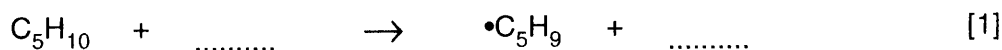
(i) The reaction is initiated by the fission of Cl_2 . State the type of fission involved.

.....[1]

(ii) Write an equation to illustrate the fission of Cl_2 in (d)(i).

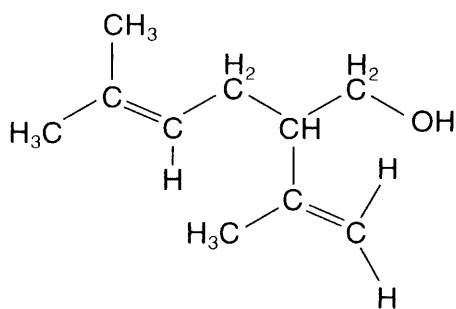
.....[1]

(iii) The fission of Cl_2 leads to a chain reaction involving two propagation steps. Complete the equations for the two propagation steps.

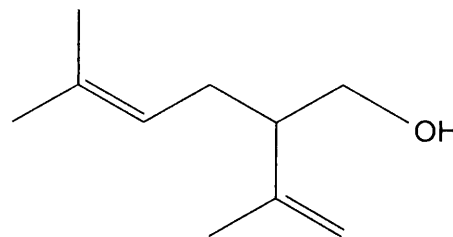


[Total: 14]

- 4 Lavandulol, $C_{10}H_{18}O$, is a fragrant oil which is found in lavender. The structural and the skeletal formulae of lavandulol are shown below.



structural formula



skeletal formula

- (a) (i) Identify **two** different functional groups in lavandulol.

..... and[2]

- (ii) Why does lavandulol **not** have *cis-trans* isomerism?

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

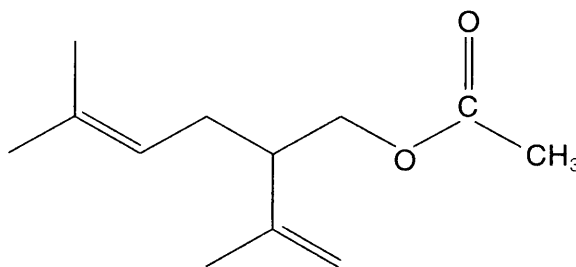
- (b) Lavandulol, $C_{10}H_{18}O$, also reacts with bromine to form a saturated organic product.

State what you would see in this reaction and deduce the molecular formula of the organic product.

observation[1]

molecular formula[2]

- (c) Lavandulol could be converted into an ester **X**, which is also found in lavender oil.

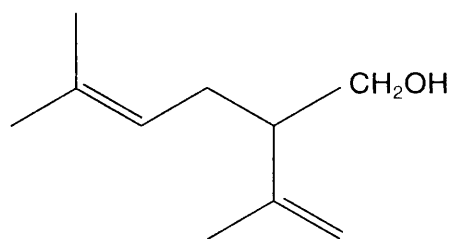
ester **X**

State a reagent and a catalyst that could be used to form ester **X** from lavandulol.

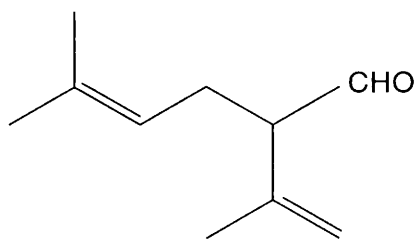
reagent[1]

catalyst[1]

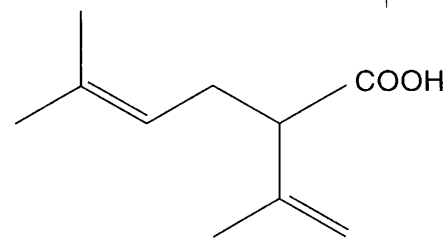
(d) Lavandulol can be oxidised to produce either compound **Y** or compound **Z**.



lavandulol
 $C_{10}H_{18}O$



compound Y
 $C_{10}H_{16}O$



compound Z
 $C_{10}H_{16}O_2$

- (i) Write a balanced equation for the oxidation of lavandulol to produce compound **Z**. Use the molecular formulae given above and use [O] to represent the oxidising agent.

.....[2]

- (ii) An infra-red spectrum of either compound **Y** or compound **Z** was obtained and was found to contain an absorption between $1680\text{--}1750\text{ cm}^{-1}$. However, there was no broad absorption between $2500\text{--}3300\text{ cm}^{-1}$.

By referring to your *Data Sheet*, use this information to deduce whether the infra-red spectrum was of compound **Y** or of compound **Z**. Show your reasoning.

The infra-red spectrum was of compound because

.....

.....

.....[2]

[Total: 12]

- 5 In this question, one mark is available for the quality of written communication.

Alkanes can be separated from crude oil because they have different boiling points. The table below shows the boiling points of some alkanes.

alkane	boiling point / °C	M_r
ethane	-89	30
propane	-42	44
butane	0	58
pentane	36	72
2-methylbutane	28	72
2,2-dimethylpropane	10	72

Explain the variation in boiling points of the alkanes shown. [5]

Explain why, in industry, alkanes such as octane are processed by isomerisation. [3]

Illustrate your answers by referring to suitable examples. Write equations where appropriate.

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Quality of Written Communication [1]

[Total: 9]

END OF QUESTION PAPER