

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY

Chains and Rings



2812

Wednesday

11 JANUARY 2006

Morning

1 hour

Candidates answer on the question paper.

Additional materials:

Data Sheet for Chemistry

Scientific calculator

Candidate
Name

Centre
Number

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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 blue or black ink, in the spaces provided on the question paper.
- Pencil may be used for diagrams and graphs **only**.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- 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		
Question Number	Max.	Mark
1	16	
2	10	
3	12	
4	12	
5	10	
TOTAL	60	

This question paper consists of 12 printed pages.

Answer **all** the questions.

- 1 Crude oil is a complex mixture of hydrocarbons. Initial separation is achieved by fractional distillation. The separate fractions are then further refined to produce hydrocarbons such as decane.

(a) (i) State what is meant by the term *hydrocarbon*.

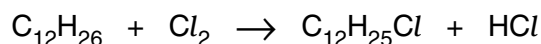
.....
 [1]

(ii) A molecule of decane contains ten carbon atoms. State the molecular formula of decane.

..... [1]

(iii) Deduce the empirical formula of decane. [1]

(b) Dodecane, $C_{12}H_{26}$, is a straight chain alkane that reacts with chlorine to produce a compound with molecular formula $C_{12}H_{25}Cl$.



The reaction is initiated by the formation of chlorine free radicals from chlorine.

(i) What is meant by the term *free radical*?

..... [1]

(ii) State the conditions necessary to bring about the formation of the chlorine free radicals from Cl_2 .

..... [1]

(iii) State the type of bond fission involved in the formation of the chlorine free radicals.

..... [1]

- (iv) The chlorine free radicals react with dodecane to produce $C_{12}H_{25}Cl$. Write equations for the **two** propagation steps involved.

.....
 [2]

- (v) How many different structural isomers can be formed when chlorine reacts with dodecane to form $C_{12}H_{25}Cl$?

answer [1]

- (c) Dodecane, $C_{12}H_{26}$, can be cracked into ethene and a straight chain alkane such that the molar ratio ethene : straight chain alkane is 2 : 1.

- (i) Write a balanced equation for this reaction.

..... [2]

- (ii) Name the straight chain alkane formed.

..... [1]

- (d) Straight chain alkanes such as heptane, C_7H_{16} , can be isomerised into branched chain alkanes and reformed into cyclic compounds.

- (i) Using **skeletal** formulae, write an equation to show the isomerisation of heptane into 2,2,3-trimethylbutane.

[2]

- (ii) Write a balanced equation to show the reforming of heptane into methylcyclohexane.

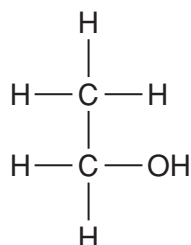
[2]

[Total: 16]

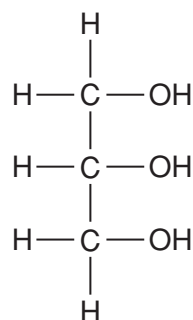
[Turn over

- 2 Ethanol and glycerol (propane-1,2,3-triol) are both produced industrially on a large scale.

Ethanol is manufactured by both fermentation and the hydration of ethene.
Glycerol is produced as a by-product of soap manufacture.



ethanol



glycerol

- (a) The relatively low volatility of alcohols such as ethanol can be explained by the existence of intermolecular bonds.

- (i) Explain what is meant by the terms:

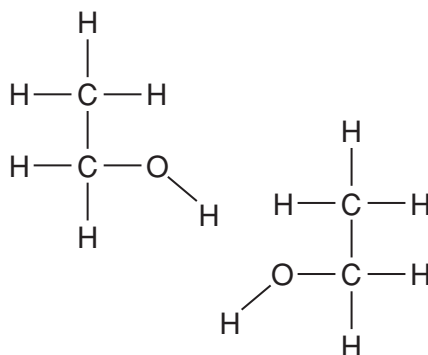
low volatility,

.....

intermolecular bonds,

..... [2]

- (ii) On the ethanol molecules below, label any relevant dipoles, show the intermolecular bond formed and state the type of intermolecular bond.



type of intermolecular bond

[3]

- (iii) Glycerol forms the same type of intermolecular bonds as ethanol. Predict, with a reason, whether the boiling point of glycerol will be higher or lower than that of ethanol.

The boiling point of glycerol will be than that of ethanol because

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

- (b) Ethanol can react with sodium to produce an alkoxide and a gas.

Write a balanced equation for the reaction between sodium and ethanol.

..... [2]

- (c) Glycerol shows similar properties to ethanol and can also react with sodium.

Draw the displayed formula of the alkoxide formed when glycerol reacts **completely** with sodium.

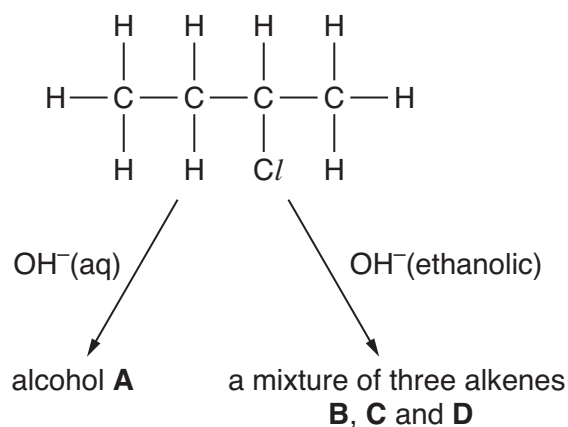
[2]

[Total: 10]

[Turn over

3 This question is about the halogenoalkane 2-chlorobutane.

2-Chlorobutane reacts with NaOH, but the products are dependent on the solvent used.



(a) 2-Chlorobutane reacts with OH^- in aqueous conditions to produce alcohol **A**.

(i) Identify alcohol **A**.

[1]

(ii) Describe, with the aid of curly arrows, the movement of the electrons in the mechanism. Show any relevant dipoles, lone pairs of electrons and the products.

[4]

(b) 2-Chlorobutane reacts with OH^- in ethanolic conditions to produce a mixture of three alkenes **B**, **C** and **D**.

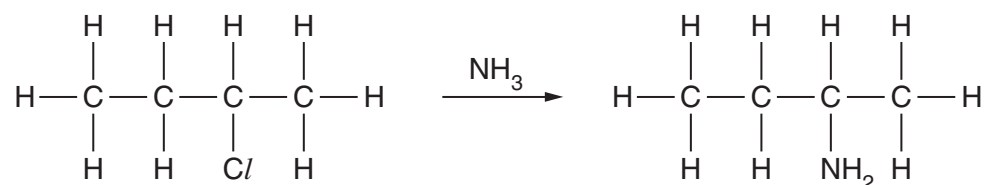
(i) State the type of reaction. [1]

(ii) Identify the **three** alkenes formed.

B	C	D
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[3]

(c) Ammonia behaves as a nucleophile and reacts with 2-chlorobutane to produce 2-aminobutane.



(i) State a suitable solvent for this reaction.

..... [1]

(ii) What is the molecular formula of the organic product?

..... [1]

(iii) The reaction between 2-chlorobutane and ammonia also produces a small amount of the product $\text{C}_8\text{H}_{19}\text{N}$.

Suggest the structure of this product.

[1]

[Total: 12]

[Turn over

- (iii) Explain how compound **E** and the carboxylic acid could be distinguished by infra-red spectroscopy.

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

- (c) Compound **E** reacts with an excess of HBr to produce a mixture of **two** organic compounds, each with the molecular formula $C_7H_{14}Br_2$.

Identify both organic compounds in the mixture.

[2]

[Total: 12]

[Turn over

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