

**ADVANCED GCE****CHEMISTRY**

Chains, Rings and Spectroscopy

**2814/01**

Candidates answer on the Question Paper  
A calculator may be used for this paper

**OCR Supplied Materials:**

- *Data Sheet for Chemistry* (inserted)

**Other Materials Required:**

- Scientific calculator

**Monday 1 February 2010**  
**Morning**

**Duration:** 1 hour 30 minutes



Candidate  
Forename

Candidate  
Surname

Centre Number

Candidate Number

**INSTRUCTIONS TO CANDIDATES**

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

**INFORMATION FOR CANDIDATES**

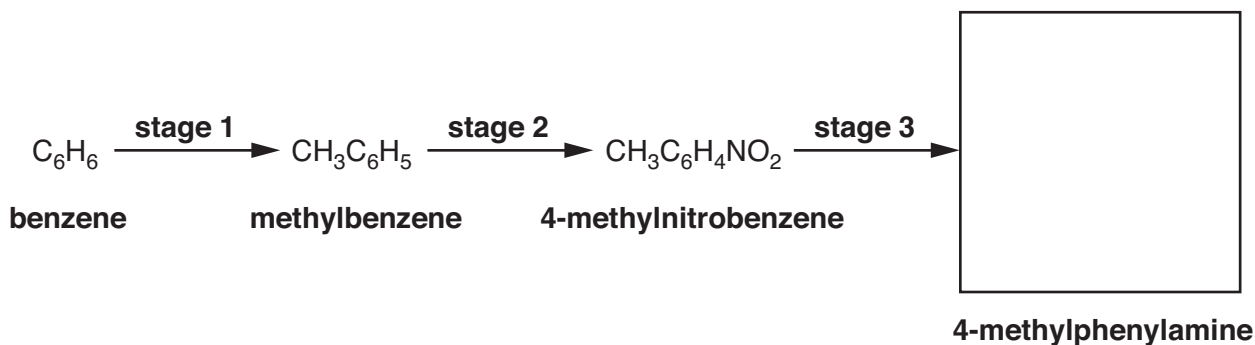
- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **90**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- This document consists of **16** pages. Any blank pages are indicated.

Examiner's Use Only:

1			
2			
3			
4			
5			
6			
7			
<b>Total</b>			

Answer **all** the questions.

- 1 4-Methylphenylamine is manufactured from benzene in three stages, as shown below.



- (a) In the box above draw the displayed formula of 4-methylphenylamine. [1]

- (b) In this question, one mark is available for the quality of use and organisation of scientific terms.

- State the type of reaction, the reagents and conditions and write a balanced equation for **stage 2** and **stage 3**.
- Describe, with the aid of curly arrows, the mechanism for **stage 2**. Include an equation for the formation of the electrophile.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

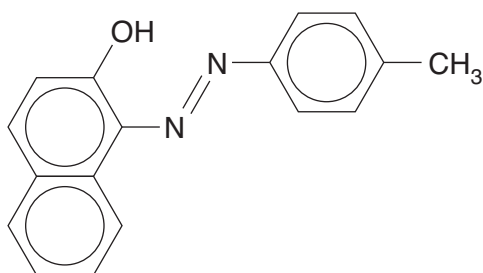
.....

.....

.....

.....

**(c)** 4-Methylphenylamine can be converted into the azo dye, shown below, via a diazonium ion.



- [1]

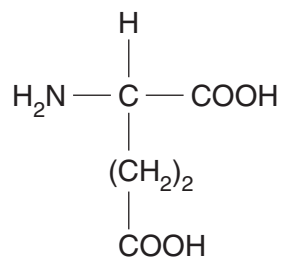
- number of C atoms ..... number of H atoms ..... [2]

© OCR 2010

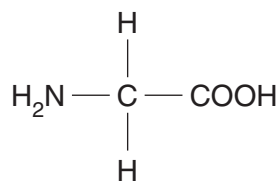
**Turn over**

- 2 Glutamic acid and glycine are both  $\alpha$ -amino acids that occur widely in living organisms.

The structures of the amino acids are shown below.



**glutamic acid**



**glycine**

- (a) State the general formula of an  $\alpha$ -amino acid.

..... [1]

- (b) Glutamic acid has optical isomers but glycine does not.

Explain why.

Include suitable 3-D diagrams in your answer.

.....  
 .....  
 .....  
 .....

[4]

- (c) Amino acids form different ions at different pH values.

- (i) Draw the structure of the ion formed by glycine at pH 2.

[1]

- (ii) Draw the structure of the ion formed by glutamic acid at pH 14.

[2]

- (d) Glutamic acid and glycine can react to form a mixture of dipeptides.

Draw two dipeptides formed when one molecule of glutamic acid reacts with one molecule of glycine.

[3]

- (e) In the presence of a suitable catalyst, glutamic acid is esterified by an excess of ethanol to form a compound with molecular formula  $C_9H_{17}NO_4$ .

- (i) Identify a suitable catalyst for this reaction.

..... [1]

- (ii) Draw the structure of the compound with molecular formula  $C_9H_{17}NO_4$ .

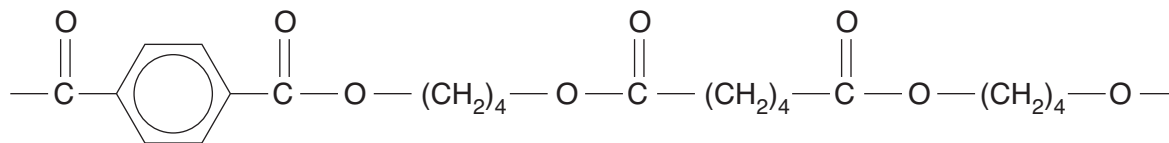
[2]

[Total: 14]

Turn over

- 3 Ecoflex® is a biodegradable plastic made by combining three different monomers.

A short section of the Ecoflex® polymer is shown below.



- (a) Draw a circle around an ester link in the section of Ecoflex® shown above. [1]

- (b) One of the monomers used to make Ecoflex® is  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ .

- (i) Give the systematic name of  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ .

..... [1]

- (ii) Draw the structures of the other two monomers used to make Ecoflex®.

[2]

- (c) The monomer  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$  can be made in the laboratory by oxidising compound **X**,  $\text{C}_6\text{H}_{10}\text{O}_2$ .

- (i) Draw the displayed formula **and** the skeletal formula of compound **X**.

[2]

- (ii) Write a balanced equation for the oxidation of compound **X** to form  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ .

Use [O] to represent the oxidising agent.

..... [1]

- (iii) Explain how infra-red spectra of compound **X** and  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$  could be used to confirm that the oxidation had taken place.

.....

.....

..... [1]

- (d) Poly(but-1-ene) can be made from the monomer but-1-ene,  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ .

Draw a section of poly(but-1-ene) to show **two** repeat units.

[1]

- (e) Ecoflex® and poly(but-1-ene) are both polymers but the type of polymerisation reaction used to make each one is different.

State the type of polymerisation reaction used to make each polymer.

ecoflex®.....

poly(but-1-ene) ..... [1]

- (f) Describe how the structure of atactic poly(but-1-ene) differs from isotactic poly(but-1-ene).

.....

.....

.....

.....

..... [2]

[Total: 12]

- 4 In 1893, a chemist discovered an organic acid which became known as Feist's acid,  $C_6H_6O_4$ .

(a)  $2.50 \times 10^{-3}$  mol of Feist's acid was completely burnt.

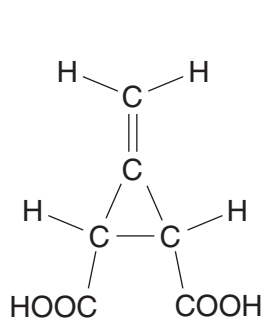
Calculate the volume of carbon dioxide and mass of water that would be formed at r.t.p.

1 mol of a gas occupies  $24 \text{ dm}^3$  at r.t.p.

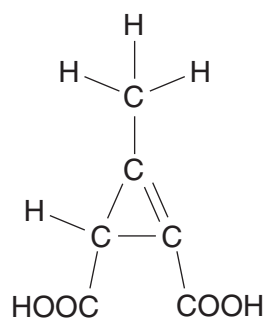
volume of carbon dioxide = .....  $\text{cm}^3$

mass of water = ..... g [4]

(b) Two possible structures for Feist's acid are shown below.

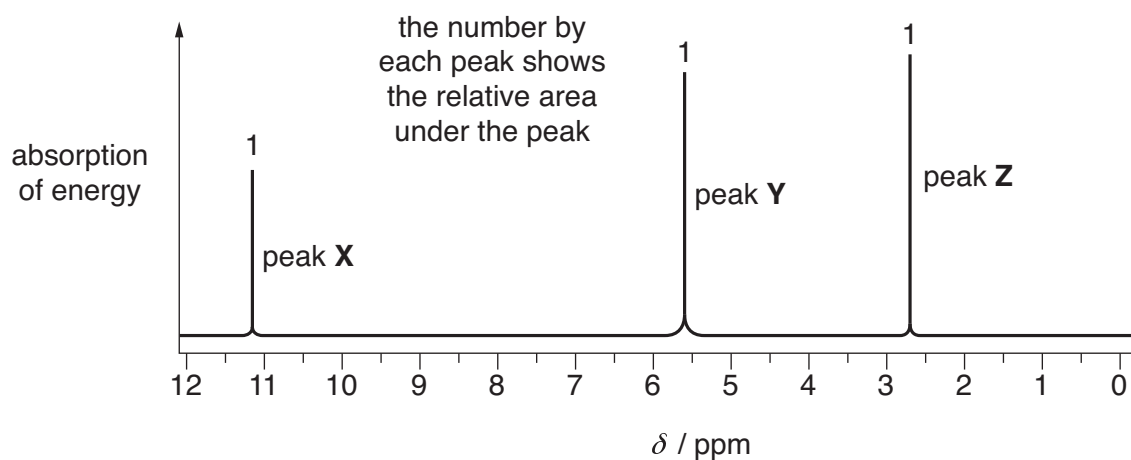


structure E



structure F

The n.m.r. spectrum of Feist's acid is shown below.





- (i) Identify the type of protons responsible for peak **X**.

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

- (ii) Explain how  $D_2O$  can be used to help confirm which protons are responsible for peak **X**.

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

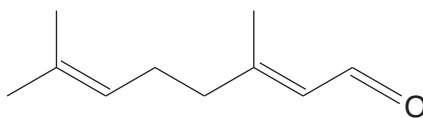
- (iii) Use peaks **Y** and **Z** to decide whether structure **E** or structure **F** is correct for Feist's acid.

Explain your reasoning and state how the n.m.r. spectrum for the other structure would differ.

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [3]

[Total: 10]

- 5 Neral,  $C_{10}H_{16}O$ , is a naturally occurring compound found in many plants. It has a sweet lemon smell and is used extensively in perfumery. The skeletal formula of neral is shown below.



- (a) Name the two functional groups in neral.

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

- (b) Neral has stereoisomers.

- (i) What is meant by the term *stereoisomers*?

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

- (ii) The stereoisomerism in neral is caused by one of the double bonds.

On the skeletal formula above, circle the double bond that gives rise to stereoisomerism.

Explain why this double bond causes stereoisomerism.

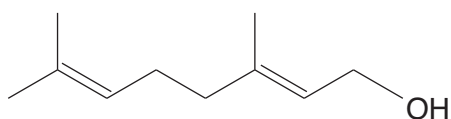
.....  
 .....  
 .....  
 .....  
 ..... [3]

- (c) Neral is used in scented candles. When burnt it produces carbon dioxide and water vapour.

Write a balanced equation for the complete combustion of neral.

..... [1]

- (d) Neral can be used in the laboratory to produce a variety of other compounds.  
Neral can be reduced to geraniol, shown below, which contributes to the smell of roses.



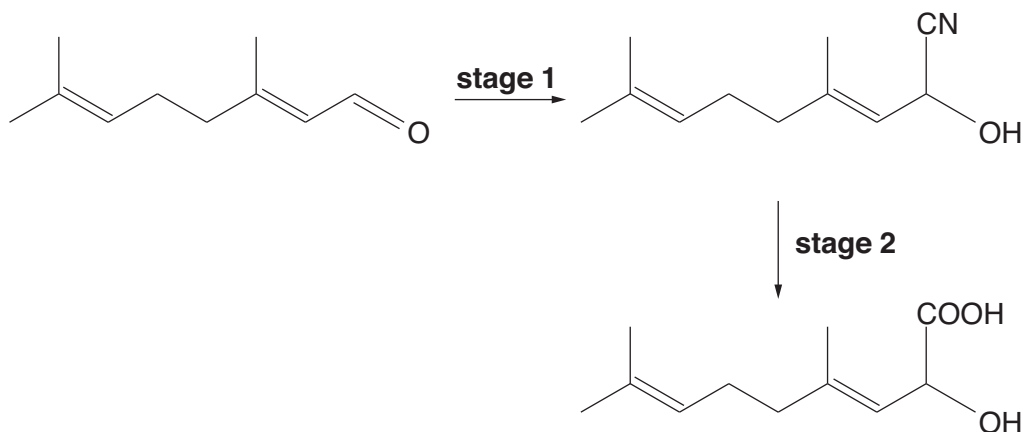
- (i) Identify a suitable reducing agent for this reduction of neral.

..... [1]

- (ii) Write a balanced equation for this reduction of neral.  
Use [H] to represent the reducing agent.

..... [1]

- (e) Neral can be converted into a hydroxycarboxylic acid using a two stage process.



- (i) Describe, with the aid of curly arrows, the mechanism in **stage 1**.  
Show any relevant dipoles and lone pairs of electrons.

[5]

- (ii) State the type of reaction involved in **stage 2**.  
Identify the reagent and conditions used.

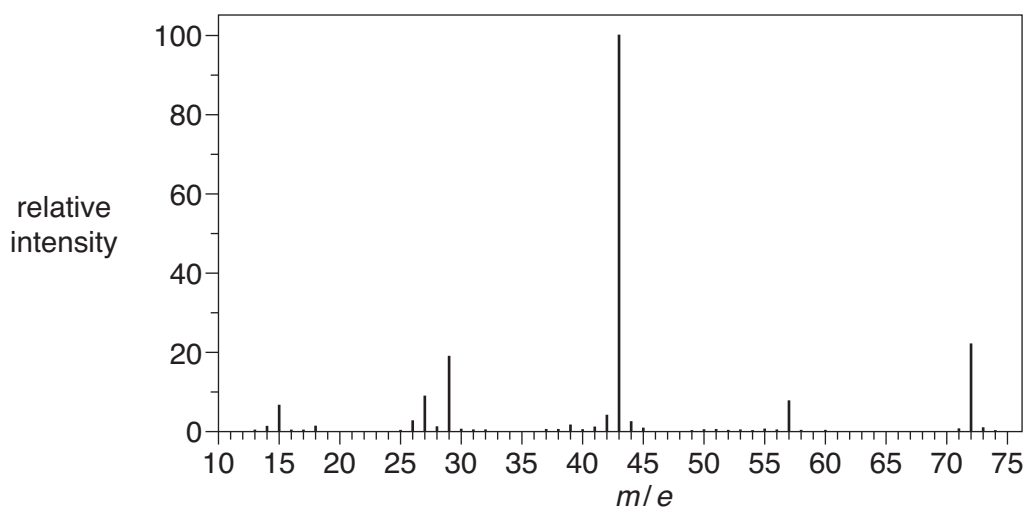
type of reaction .....

reagent and conditions ..... [3]

[Total: 17]

Turn over

- 6 Compounds **A**, **B** and **C** all have the same relative molecular mass. The mass spectrum of compound **A** is shown below.



- Compound **A** reacts with 2,4-dinitrophenylhydrazine to give an orange precipitate but does **not** give a positive result with Tollens' reagent.
- Compound **B** is a saturated hydrocarbon and the n.m.r. of compound **B** contains just one peak.
- The infra-red spectrum of compound **C** contains a broad absorption between 2500–3300  $\text{cm}^{-1}$  as well as an absorption between 1680–1750  $\text{cm}^{-1}$ .

Identify compounds **A**, **B** and **C**.

Show all of your reasoning.

compound <b>A</b>	compound <b>B</b>	compound <b>C</b>
-------------------	-------------------	-------------------

.....

.....

.....

.....

.....

.....



- 7** In this question, one mark is available for the quality of spelling, punctuation and grammar.

Cyclohexene reacts with bromine at room temperature. Benzene reacts with bromine only in the presence of a halogen carrier. Phenol rapidly decolourises bromine at room temperature.

Explain the different reactivities of bromine with cyclohexene, benzene and phenol. In your answer, include balanced equations and state the reaction type in each case.

[illegible]

**[10]**

**[Total: 11]**

© OCR 2010

**PLEASE DO NOT WRITE ON THIS PAGE**



**Copyright Information**

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations, is given to all schools that receive assessment material and is freely available to download from our public website ([www.ocr.org.uk](http://www.ocr.org.uk)) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.