OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY 2814

Chains, Rings and Spectroscopy

Thursday **24 JANUARY 2002** Morning 1 hour 30 minutes

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

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 are advised to show all the steps in any calculations.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry*.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	14	
2	11	
3	12	
4	17	
5	11	
6	14	
7	11	
TOTAL	90	

This question paper consists of 15 printed pages and 1 blank page.

Registered Charity Number: 1066969
[Turn over

For Examiner's Use

Answer **all** the questions.

1 Benzene can be nitrated to form nitrobenzene, $C_6H_5NO_2$.

(a) Draw the structural formula for **benzene** and give its empirical formula.

structure:

empirical formula ..... [2]

(b) State the reagents needed for the nitration of benzene.

..... [2]

(c) An electrophile is formed during the nitration of benzene.

(i) What is the formula of this electrophile?

..... [1]

(ii) Write an equation for the production of the electrophile.

..... [1]

(iii) Use curly arrows to show the mechanism for the nitration of benzene.

[4]

(d) 10.0 g of benzene was nitrated to give 13.3 g of nitrobenzene. Calculate the percentage yield, giving your answer to three significant figures.

[4]

[Total : 14]

[Turn over

For Examiner's Use

2 Amines are commonly occurring compounds. Ethylamine, $C_2H_5NH_2$, is a primary amine responsible for the smell of decaying fish.

(a) Explain the meaning of the term *primary amine.*

.....

..... [1]

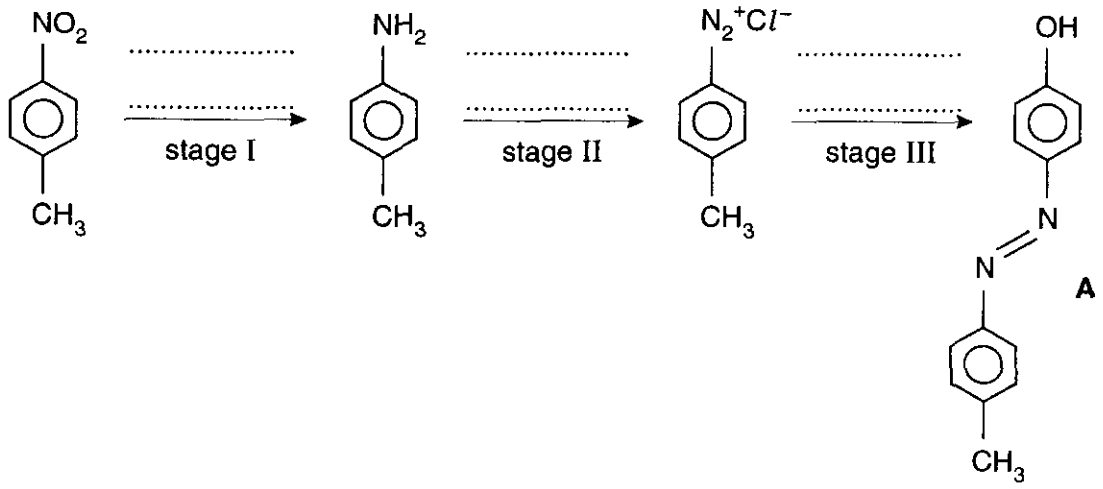
(b) Ethylamine and phenylamine are bases.

Write an equation to show ethylamine acting as a base.

..... [2]

(c) Aromatic amines such as phenylamine are intermediates in the synthesis of many other compounds such as **A** below.

(i) Complete the scheme by writing the reagents on the lines provided.



[5]

(ii) Write the equations for stages I and III.

stage I

stage III

[2]

(iii) State a general use for compounds such as **A**.

..... [1]

[Total : 11]

BLANK PAGE

Question 3 starts on page 6

3 **(a)** Esters are well known as compounds providing the flavour in many fruits and the scent of some flowers. The ester $CH_3(CH_2)_2COOCH_3$ contributes to the aroma of apples.

(i) Name the ester $CH_3(CH_2)_2COOCH_3$.

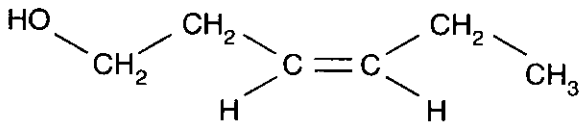
..... [1]

(ii) State the reagents and conditions for the hydrolysis of this ester in the laboratory.

.....

..... [3]

(b) Leaf alcohol, **B**, is a stereoisomer that can form when insects eat leaves.



B

(i) Draw the skeletal formula of **B**.

[1]

(ii) Draw the geometric isomer of **B**.

[1]

(iii) Draw a structure for the ester expected when **B** reacts with ethanoic acid in the presence of an acid catalyst. Show **all** the bonds in the ester group.

[2]

(c) A chemist analysed a sample of **B** and determined its M_r value

(i) Deduce the M_r value that the chemist would expect for leaf alcohol.

expected M_r ..... [1]

(ii) What technique could the chemist have used to determined the M_r for leaf alcohol?

..... [1]

(iii) A chemist reacted **B** to form a product **C** with an M_r 18 units less than that of **B**.

Suggest a structrure for **C** and deduce the type of reaction that took place.

structure of ***C***

type of reaction ..... [2]

[Total : 12]

For Examiner's Use

4 Propene is in the 'top 20' most heavily used chemical feedstocks in the U.S.A. It is used for the manufacture of polymers such as poly(propene).

(a) Suggest, with a reason, the names of **two** other alkenes you might expect to find in the 'top 20' feedstocks.

.....

.....

.....

..... [3]

(b) Explain why there are three different stereochemical forms of poly(propene). These forms are described as atactic, isotactic and syndiotactic. Illustrate your answer with diagrams.

(In this question, 1 mark is available for the quality of written communication.)

.....

.....

.....

.....

.....

.....

.....

.....

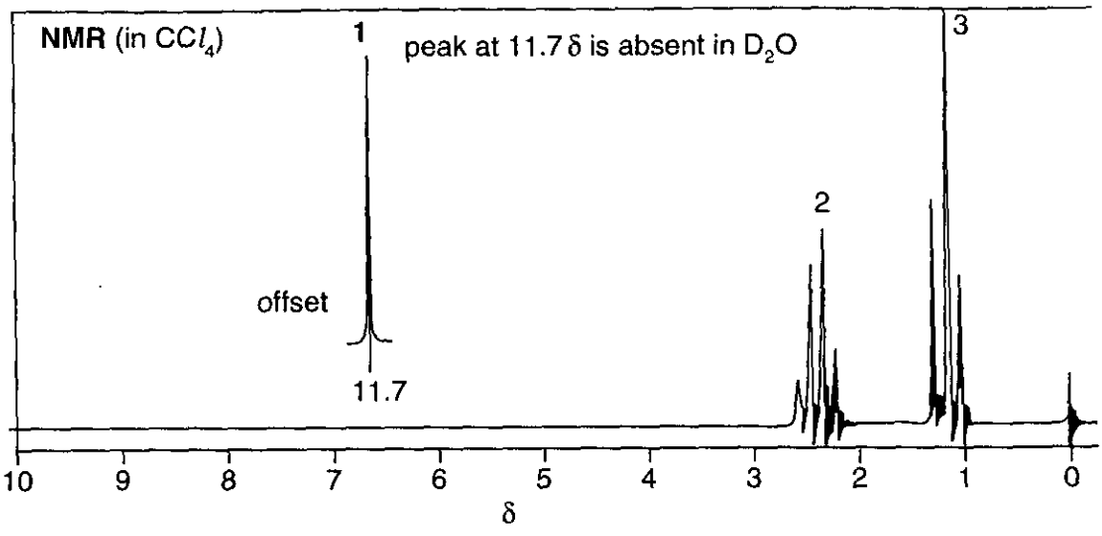
.....

.....

.....

[7]

(c) Propanoic acid, CH_3CH_2COOH, can be synthesised from propene. The nmr spectrum of propanoic acid is shown below.



(i) Use the *Data Sheet* to explain the chemical shifts and splitting patterns shown by each peak in this nmr spectrum.

.....

.....

.....

.....

.....

.....

.....

..... [6]

(ii) Explain why the peak at 11.7 δ disappears on addition of D_2O.

..... [1]

[Total : 17]

[Turn over

For Examiner's Use

5 A diagram of a section of nylon-6,6 is shown below.

$$—CO(CH_2)_4CONH(CH_2)_6NHCO(CH_2)_4CONH(CH_2)_6NH—$$

(a) Identify the monomer(s) from which nylon-6,6 is obtained.

.....

..... [2]

(b) State and explain the type of polymerisation reaction which gives nylon-6,6.

.....

.....

..... [2]

(c) Proteins and polypeptides are polymers which have been described as being similar to nylon-6,6.

Suggest with the aid of diagrams and equations.

- **one** structural similarity
- **one** chemical similarity
- **one** important difference

(In this question, 1 mark is available for the quality of written communication.)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [7]

[Total : 11]

[Turn over

For Examiner's Use

6 Like esters, carbonyl compounds can contribute to the smell of plants and food. The carbonyl compounds **D** and **E** are structural isomers.

D CH_3COCH_3 **E** CH_3CH_2CHO

(a) Name compounds **D** and **E**.

(i) **D** .....

(ii) **E** .....

[2]

(b) State the reagents you would use and the observations you would make for a simple chemical test

(i) in which **D** and **E** behave in the same way;

reagent(s) .....

observation ..... [2]

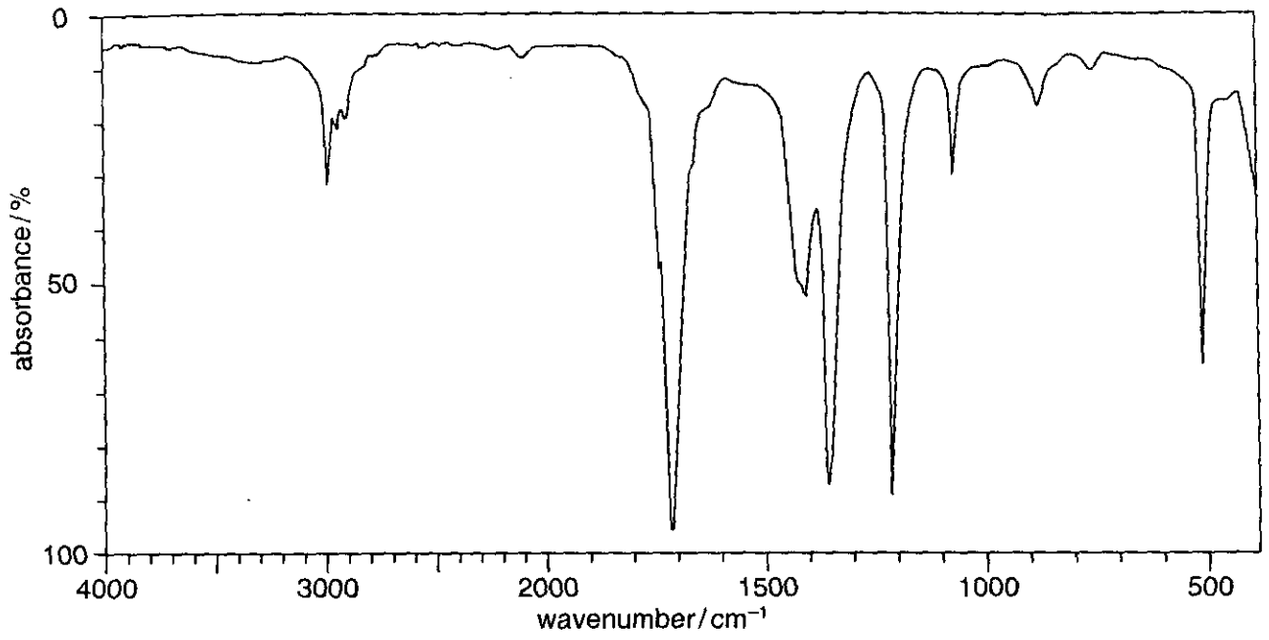
(ii) which can be used to distinguish between **D** and **E**.

reagent(s) .....

observation for **D** .....

observation for **E** ..... [3]

(c) The infrared spectrum of **D** is shown below.



(i) On the spectrum above, mark with a cross the absorption peak that identifies the functional group. Explain how you made your choice. (Use the *Data Sheet* provided to answer this question.)

.....

.....

..... [2]

(ii) Reduction of compound **D** with $NaBH_4$ produces a compound with the molecular formula C_3H_8O.

How would the infrared spectrum of this product be different from that of **D**?

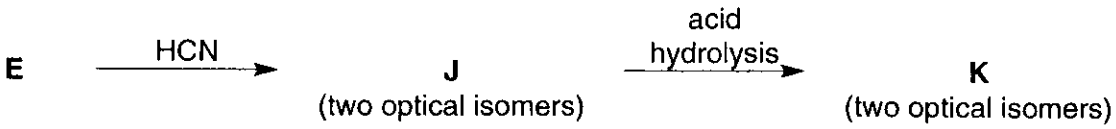
.....

..... [2]

[Turn over

For Examiner's Use

(d) Compound **K** can be synthesised in two steps from compound **E**, CH_3CH_2CHO. The sythetic steps are shown below.



(i) Draw the structural formula of **J**.

[1]

(ii) Draw three-dimensional structures to show clearly the **two** optical isomers of **K**.

[2]

[Total : 14]

7 The α-amino acid glycine, H_2NCH_2COOH, is used as a poultry feed additive and in the fertiliser industry. There are twenty naturally occurring α-amino acids.

(a) Draw the general formula for an α-amino acid.

[1]

(b) In the crystalline state, glycine contains zwitterions.

(i) Draw the structure of the zwitterion of glycine.

[1]

(ii) Explain how this zwitterion arises.

.....

.....

.....

.....

..... [2]

(iii) Crystals of glycine melt between 230 and 235°C. Explain why the melting point of glycine is higher than that of hydroxyethanoic acid, $HOCH_2COOH$ (m.p. 75–80 °C).

.....

.....

.....

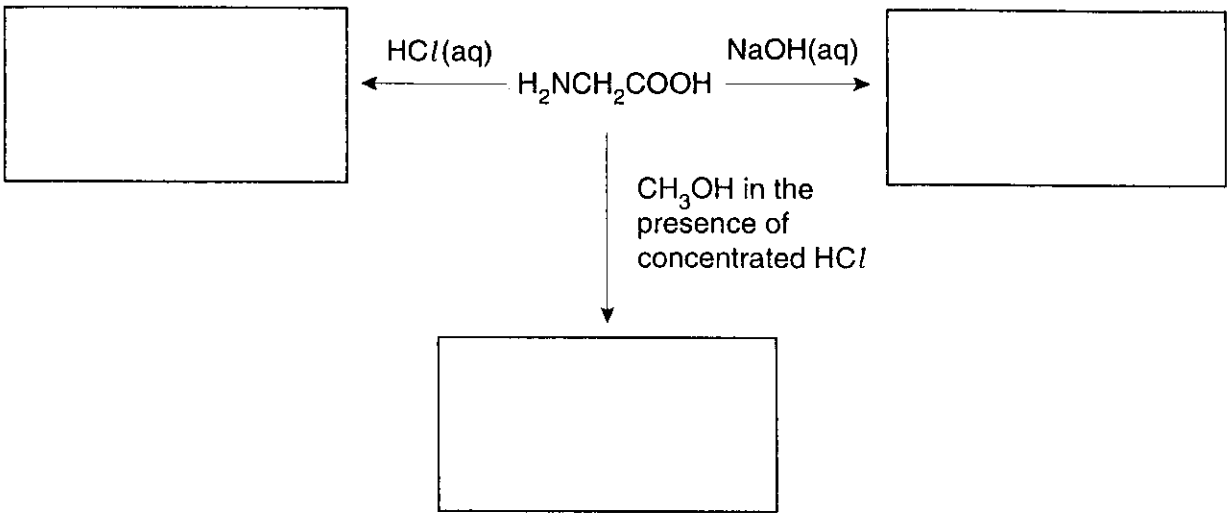
.....

.....

..... [3]

For Examiner's Use

(c) In the boxes below, draw suggested structures for the organic products obtained from glycine.



[4]

[Total : 11]