OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

CHEMISTRY   **2815/04**

Methods of Analysis and Detection

Tuesday   **25 JUNE 2002**   Morning   50 minutes

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

Candidate Name		Centre Number	Candidate Number

TIME   50 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		
Qu.	Max.	Mark
1	9	
2	12	
3	14	
4	10	
TOTAL	45	

This question paper consists of 9 printed pages and 3 blank pages.
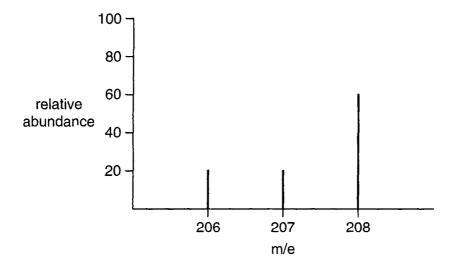
2

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3

Answer **all** questions.

1 **(a)** The amino acid content of a protein may be examined using electrophoresis.
Briefly outline how a protein may be broken down into its constituent amino acids ready for analysis.

....

....

....

....[3]

(b) The diagrams below show the positions of a sample of a mixture of amino acids on a strip of filter paper before and after electrophoresis.

before   **+** [●   ] **–**

after   **+** [●   ●   ●   ♪] **–**
                            Q

(i) On the **lower** diagram,

1. label with a **P**, any amino acid which was positively charged at the pH of the buffer solution used,

2. label with an **S**, the amino acid which is likely to have the smallest M_r.   [2]

(ii) Explain why the amino acid labelled **Q** did **not** move during electrophoresis.

....

....[2]

(c) A modified form of electrophoresis is used in the technique known as 'DNA fingerprinting'.

State **two** uses of DNA fingerprinting.

....

....[2]

[Total : 9]

[Turn over

2 **(a)** The mass spectrum shown below was obtained from a sample of lead.

Calculate the relative atomic mass, A_r, of the sample to one decimal place. Show your working.

[2]

(b) Compound **J** gave a mass spectrum with an M peak at 122. The ratio of the heights of the M and $(M + 1)$ peaks was 15.0 to 1.15. Compound **J** could be either $C_4H_{10}O_4$ or $C_7H_6O_2$.

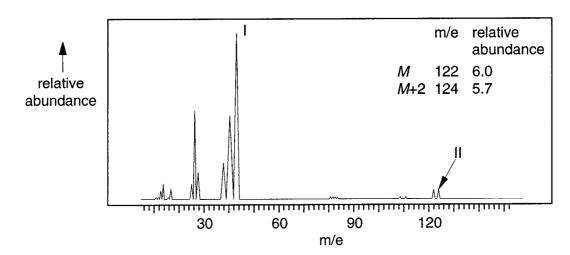Show, by calculation, which of the two formulae is correct.

[3]

5

(c) High resolution mass spectrometry can be used to distinguish between compounds with very similar values for M_r.

In countries, such as Kenya, which have limited oil resources, 'gasohol' (a mixture of gasoline and ethanol) is used as a fuel for motor vehicles. In testing for possible pollutants from cars burning 'gasohol', the mass spectrum of the exhaust gases showed peaks at m/e values of 30.0105 and 32.0261.

element	relative isotopic mass
hydrogen, ^1H	1.0078
carbon, ^{12}C	12.0000
nitrogen, ^{14}N	14.0031
oxygen, ^{16}O	15.9949

Using the table of accurate relative isotopic masses above, identify the **two** pollutants. Show your working.

[2]

(d) The mass spectrum shown below was produced from compound **L**, C_xH_yZ.

	m/e	relative abundance
M	122	6.0
M+2	124	5.7

(i) By examining the M and $(M + 2)$ peaks, deduce the identity of **Z**.

....[1]

(ii) Identify the species responsible for peaks **I** and **II**.

I ....   **II** ....   [3]

(iii) Suggest a structural formula for compound **L**.

[1]

[Total : 12]

[Turn over

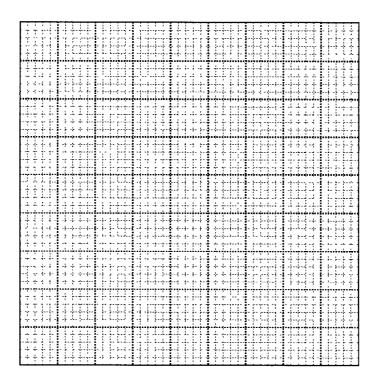**3** **(a)** The sodium content of a sample of soil was determined using flame emission spectroscopy. A series of standard solutions was prepared and gave the following emission readings.

concentration / $\mu g\,cm^{-3}$ 0   20   40   60   80
emission reading   3   21   40   58   77

(i) Plot a calibration graph for these standard solutions. $1\mu g = 10^{-6}\,g$

[2]

(ii) A 1.00 g sample of soil was dissolved in hydrochloric acid. The solution was neutralised, and then made up to $100\,cm^3$. The emission reading of this sample was found to be 47. Calculate the percentage by mass of sodium in the soil.

[2]

(b) The sodium emission produces an intense yellow light of wavelength 590 nm.
[Velocity of light = $3.00 \times 10^6\,m\,s^{-1}$; the Planck constant = $6.63 \times 10^{-34}\,J\,s$; the Avogadro constant = $6.02 \times 10^{23}\,mol^{-1}$]

(i) Calculate the frequency of this light.

Answer .... s^{-1} [1]

7

(ii) Calculate the energy, in $kJ\,mol^{-1}$, of this light.

Answer .... $kJ\,mol^{-1}$ [2]

(c) Organic molecules can absorb energy in the uv/visible region of the spectrum.

(i) What process in a molecule is responsible for such absorptions?

....

....[1]

(ii) State **two** functional groups which lead to such absorptions in organic molecules.

....

.... [2]

(d) Compounds **M** and **N** are found in sun-screen preparations. Both compounds absorb ultraviolet radiation.

M   **N**

(i) Suggest why these compounds absorb radiation of different wavelengths.

....

....[2]

(ii) Deduce which compound absorbs at **shorter** wavelengths, and explain your answer.

Compound ....

Explanation ....

....

....[2]
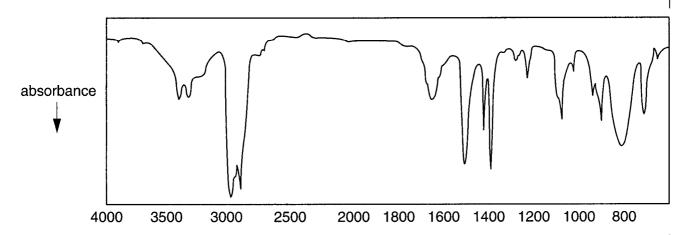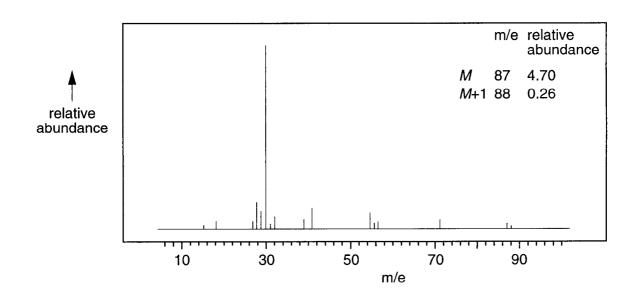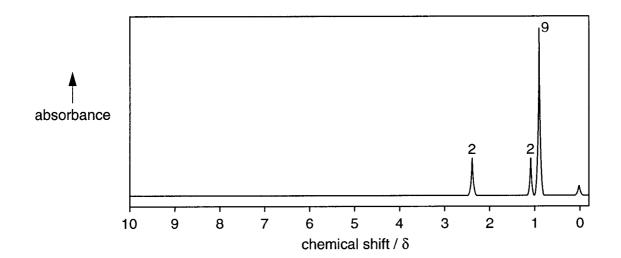
[Total : 14]

[Turn over

4 *In this question one mark is awarded for quality of written communication.*

The spectra shown below were obtained from compound **Q**, which contains the elements carbon, hydrogen and nitrogen only.

	m/e	relative abundance
M	87	4.70
M+1	88	0.26

9

(a) Consider the infra-red, mass and n.m.r. spectra in turn. Explain what information each spectrum gives about the structure of **Q**.

....

....

....

....

....

....

....

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....

....

....[7]

(b) Use your answers to **(a)** to suggest what functional group(s) are present in **Q** and hence give a possible structure for the compound.

[2]

Quality of Written Communication [1]

[Total : 10]

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