

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS****Advanced GCE****CHEMISTRY****2815/04**

Methods of Analysis and Detection

Friday

**23 JANUARY 2004**

Afternoon

50 minutes

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** 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 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		
Qu.	Max.	Mark
1	9	
2	15	
3	11	
4	10	
<b>TOTAL</b>	<b>45</b>	

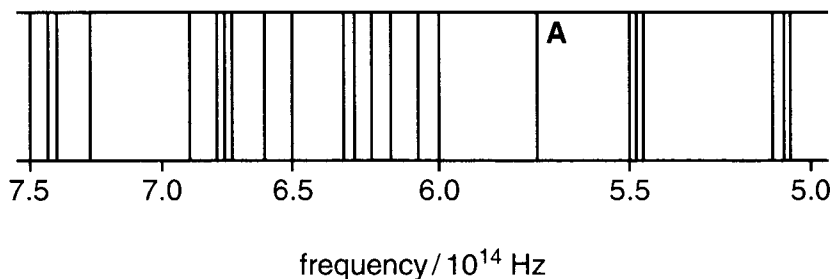
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**This question paper consists of 10 printed pages and 2 blank pages.**

Answer **all** the questions.

- 1 This question is about the use of spectroscopy in analysing radiation from space.

Analysis of light from a star in the constellation Orion produced the line spectrum shown below.



- (a) What does the existence of lines tell us about the atoms which produce them?

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

- (b) The spectral line marked **A** at  $5.68 \times 10^{14}$  Hz shows the presence of an element in the star.

- (i) Explain how electrons in the atoms produce lines such as **A** in the spectrum.

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

- (ii) Calculate the energy, in  $\text{J mol}^{-1}$ , of the radiation that produced this line.

$$h = 6.63 \times 10^{-34} \text{ J s}; L = 6.02 \times 10^{23} \text{ mol}^{-1}$$

answer .....  $\text{J mol}^{-1}$  [2]

- (c) Careful analysis of the spectrum shows a converging series of lines for this element.

Why do the lines converge?

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

(d) Emission spectra have important uses, particularly in quantitative analytical chemistry.

State **one** example of such use, outlining how the technique used is able to give quantitative results.

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.....  
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[3]

[Total: 9]

2 The composition of a peptide may be identified by breaking it down into individual amino acids and then using electrophoresis to analyse the mixture produced.

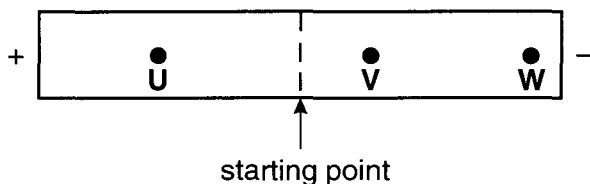
(a) State the reagent and the conditions used to break down peptides into amino acids.

reagent .....

conditions .....

..... [3]

(b) The diagram below shows the results of electrophoresis on a mixture of amino acids, **U**, **V** and **W**, carried out at pH 7. The amino acids are singly charged.



(i) Identify which amino acid, **U**, **V** or **W**, has the smallest  $M_r$ . ..... [1]

(ii) The electrophoresis was carried out again, this time at pH 5, and the spot labelled **U** moved towards the negative electrode.

Explain why **U** would move in the direction indicated. You may use  $H_2NCHRCOOH$  as the formula of **U**.

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

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

Describe how the components in a mixture of volatile liquids may be separated and analysed using gas/liquid chromatography. You may use a diagram to help with your description.

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..... [5]

Quality of Written Communication [1]

(d) State what is meant by the following terms used in chromatography.

(i) *R<sub>f</sub> value* .....

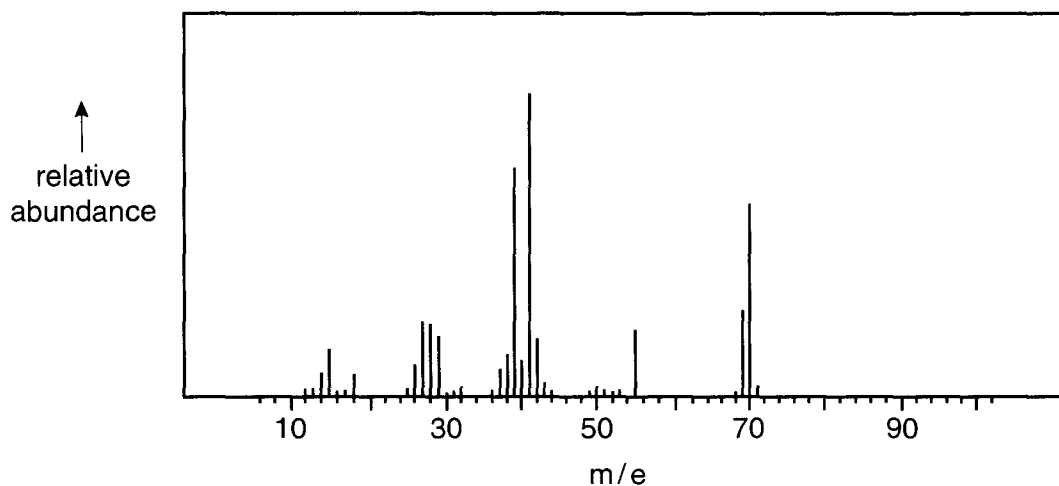
..... [1]

(ii) *retention time* .....

..... [1]

[Total: 15]

- 3 Compound **A** has an  $M_r$  of 70 and contains the elements carbon, hydrogen and oxygen only. The mass spectrum shown below was obtained from compound **A**.



- (a) (i) The ratio of the  $M : (M+1)$  peaks is 52 : 2.3. Determine the number of carbon atoms in compound **A**.

[2]

- (ii) The  $M_r$  of compound **A** is 70. Suggest a molecular formula for compound **A**.

.....

[1]

- (b) Suggest which fragments have been **lost from the molecular ion** to form the peaks at  $m/e$  55 and  $m/e$  41.

fragment **lost** to give  $m/e$  55 .....fragment **lost** to give  $m/e$  41 .....

[2]

- (c) Suggest a formula for the fragment **ion** which gives the peak at  $m/e$  41.

.....

[1]

- (d) Compound **A** reacts with hydrogen bromide to form compound **B** by an addition reaction. The mass spectrum of compound **B** shows an  $M$  and an  $(M+2)$  peak.

What will be the relative heights of the  $M$  and  $(M+2)$  peaks? ..... [1]

- (e) Compound **A** absorbs in the uv/visible region of the spectrum. Use this, your answer to (a)(ii) and the information in (d) to draw a possible structural formula of the compound.

[1]

- (f) Compound **A** is heated in a sealed container. From amongst the products formed, two gases were isolated each with an  $M_r$  of approximately 28.

(i) Predict the identity of the two gases. .... and ..... [2]

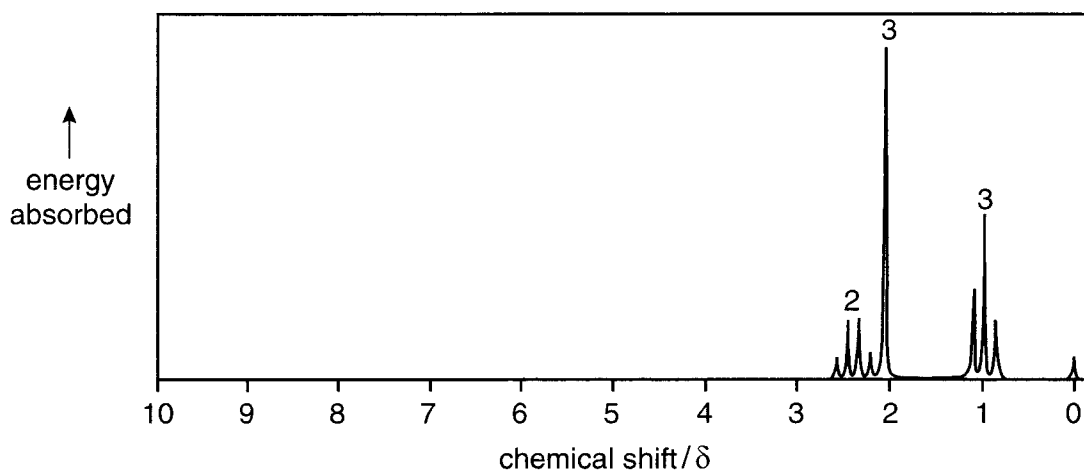
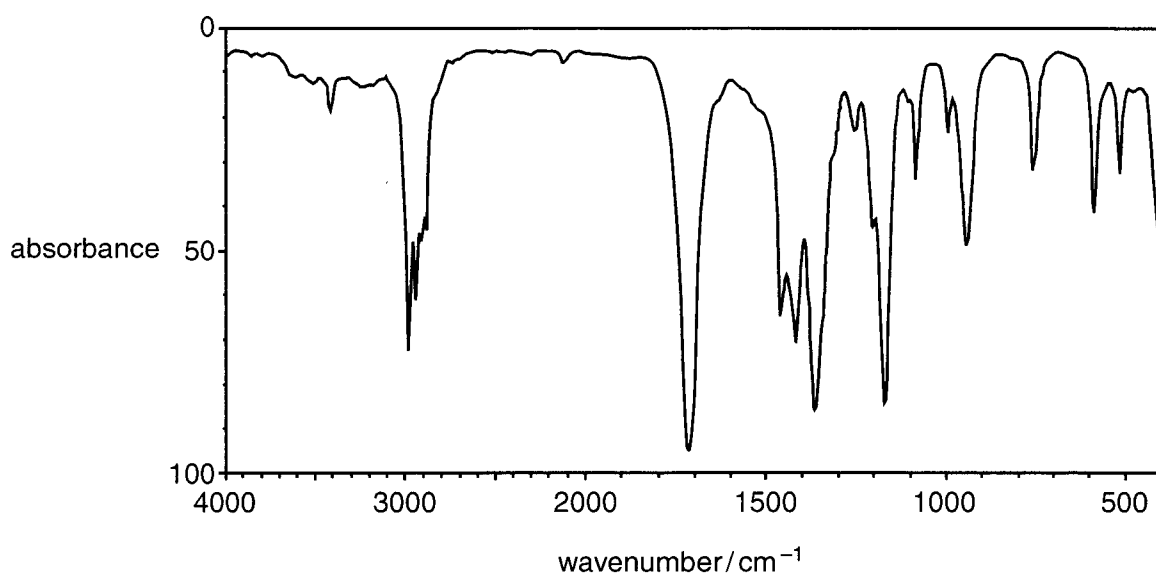
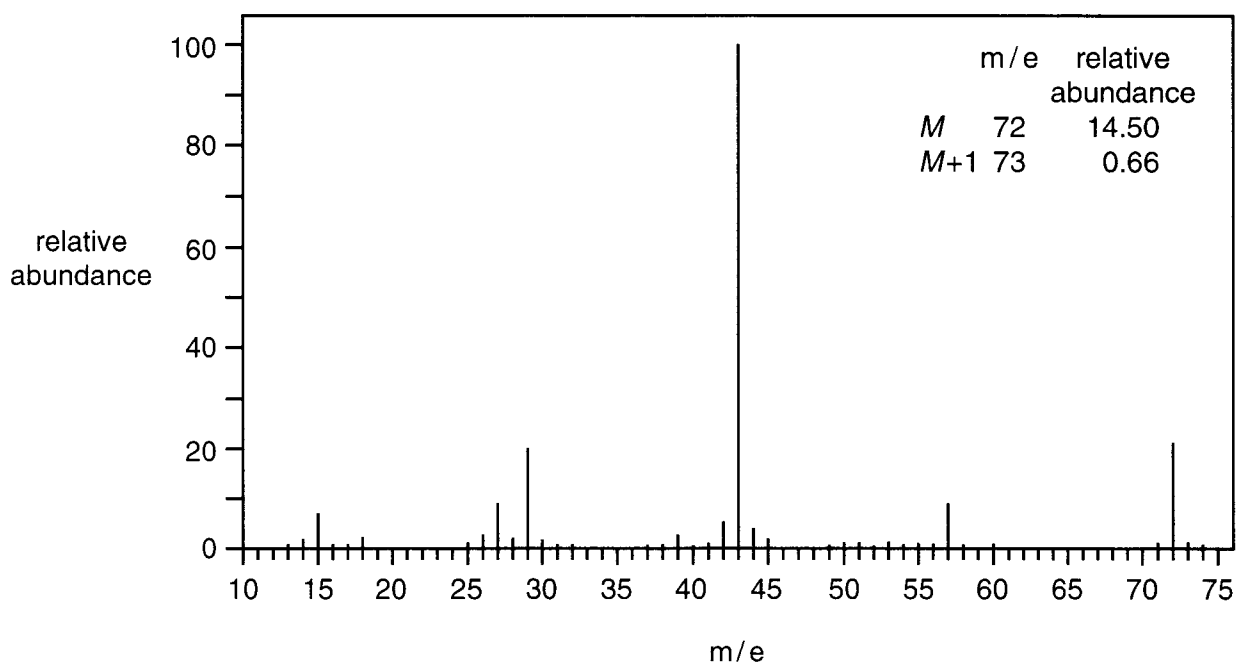
- (ii) High resolution mass spectrometry revealed that one of these gases had a molecular ion peak at  $m/e$  28.0312. Use the table of relative isotopic masses to identify this gas. Show your working.

element	relative isotopic mass
hydrogen, $^1\text{H}$	1.0078
carbon, $^{12}\text{C}$	12.0000
oxygen, $^{16}\text{O}$	15.9949

[1]

[Total: 11]

- 4 In this question, you will need to use data from the spectra given below to try to identify the compound **D** that produced them.





(a) Compound **D** has the formula  $C_xH_yO$ .

Use the mass spectrum to deduce the values of  $x$  and  $y$ , showing how you arrive at your answer.

[3]

(b) Use the spectra to identify structural features present in **D**, and hence suggest a structural formula for the compound.

Explain clearly how you make your deductions from the spectral data.

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[7]

[Total: 10]

**END OF QUESTION PAPER**