OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY 2815/04

Methods of Analysis and Detection

Wednesday **30 JANUARY 2002** Afternoon 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	14	
2	9	
3	12	
4	10	
TOTAL	45	

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

Registered Charity Number: 1066969
[Turn over

Answer **all** questions.

1 Chromatography is a useful technique used in analysis.

(a) **(i)** State what is meant by the term R_f *value* in chromatography.

.....

.....[1]

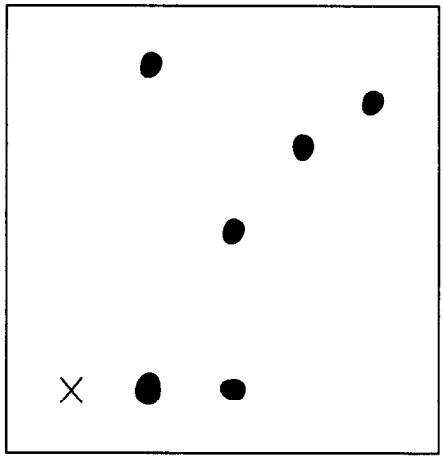
(ii) Give an example of a chromatographic technique in which R_f values are used.

.....[1]

(b) Paper chromatography is an example of the use of partition. Between what two phases does this partition occur?

.....[1]

(c) The diagram below shows the results of two-way paper chromatography of a mixture of dyes.



(i) Briefly describe what is meant by *two-way chromatography*.

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.....[3]

(ii) Deduce how many components were in the original mixture of dyes.

.....[1]

(d) Thin-layer chromatography relies on a different physical process from paper chromatography.

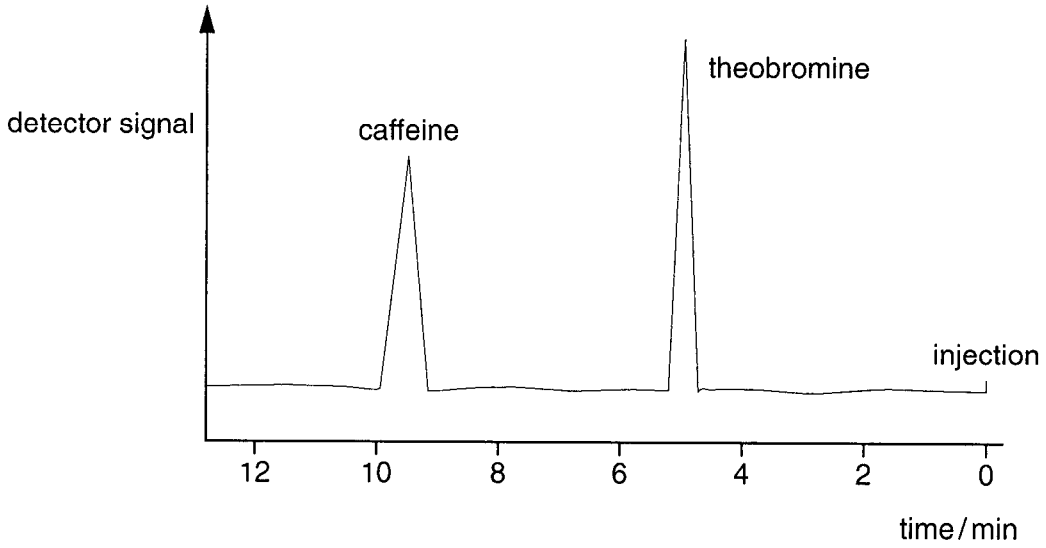
(i) Identify this process. .....[1]

(ii) Give **two** advantages of thin-layer chromatography over paper chromatography.

.....

.....[2]

(e) The diagram shows the print-out from a gas-liquid chromatography analyser.



(i) Which component is held **least** strongly on the column?

.....[1]

(ii) Calculate the percentage of this component in the mixture.

[2]

(iii) Suggest why gas-liquid chromatography is **not** generally a suitable technique for analysing mixtures of dyes.

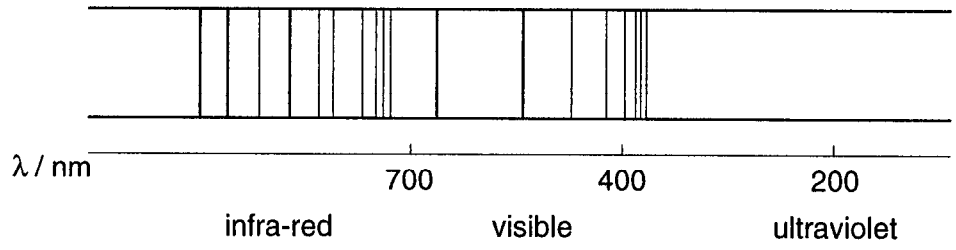
.....

.....[1]

[Total : 14]

[Turn over

2 **(a)** The diagram below shows part of the emission spectrum of atomic hydrogen.



(i) Describe the processes which produce the lines in the spectrum.

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.....

.....[1]

(ii) Examination of the spectrum reveals several series of lines. Why do these series exist?

.....

.....[1]

(iii) Each of the series of lines converges. What does the **convergence point** signify?

.....

.....[1]

(b) One of the lines in the visible region of the spectrum of atomic hydrogen has a wavelength of 485 nm.
Calculate the energy, in $kJ\,mol^{-1}$, of this electronic transition.
[Velocity of light = $3.00 \times 10^{8}\,m\,s^{-1}$; the Planck constant = $6.63 \times 10^{-34}\,J\,s$; the Avogadro constant = $6.02 \times 10^{23}\,mol^{-1}$]

[3]

For Examiner's Use

(c) Outline the quantitative determination of sodium ions in blood using flame emission spectroscopy.

[Your answer does not need to include any details of how the spectrum is obtained.]

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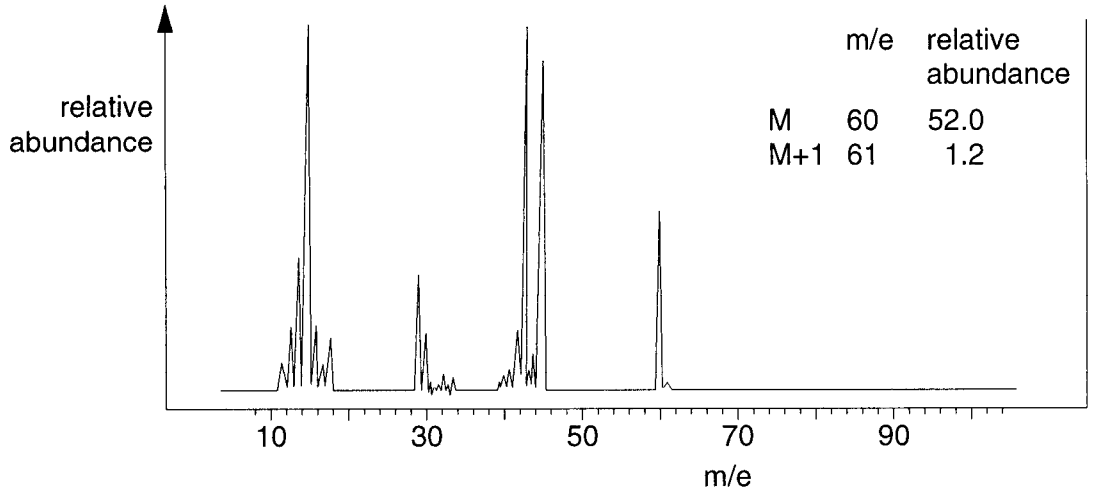
.....[3]

[Total : 9]

3 The disposal of plastic waste is a continuing problem, largely because plastic is not biodegradable. One method suggested for its disposal is incineration, with the energy produced providing local heat and power. This, however, has its own problems due to the production of potentially toxic compounds formed by the breakdown of polymer molecules.

(a) A molecule **P**, formed by the breakdown of one of the polymers in a sample of plastic waste, produced the mass spectrum shown.



Use the M and (M+1) peaks in the mass spectrum to determine the number of carbon atoms present in **P**.

[2]

(b) The infra-red spectrum of **P** shows a large absorption at around 1700 cm^{-1} and a broad absorption at around 3100 cm^{-1}.

(i) Use this to suggest bonds that could be present in **P**.

1700 cm^{-1} .....

3100 cm^{-1} ..... [2]

(ii) Use your answers and suitable data from the mass spectrum to suggest a structural formula for **P**.

[2]

(c) The mass spectrum of another molecule **Q** produced by the breakdown of plastic waste showed an (M+2) peak as well as M and (M+1) peaks.

(i) What does this tell you about **Q**?

.....[1]

(ii) The M and (M+2) peaks were in the approximate ratio of 3:1. What further information does this give you about **Q**?

.....[1]

(d) Suggest **two** reasons why mass spectrometry is **not** a useful technique for identifying polymers.

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.....[2]

(e) In a waste incineration plant, gases from the furnace were monitored using high resolution mass spectrometry. Two potentially harmful gases, **R** and **S**, were identified with *m/e* values of 27.0109 and 27.9949 respectively.

Use the table of accurate relative isotopic masses below to suggest identities for **R** and **S**.

element	relative isotopic mass
hydrogen	1.0078
carbon	12.0000
nitrogen	14.0031
oxygen	15.9949

R .....

S .....

[2]

[Total : 12]

For Examiner's Use

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

While working on an organic synthesis, a research student isolated a compound **T**. Mass spectrometry revealed that **T** had an M_r of 72. From this the student proposed that **T** could be either C_5H_{12} or C_4H_8O. Compound **T** does not have a ring in its structure.

(a) Explain, in detail, how ultraviolet/visible spectroscopy could be used to distinguish between these two possible compounds.

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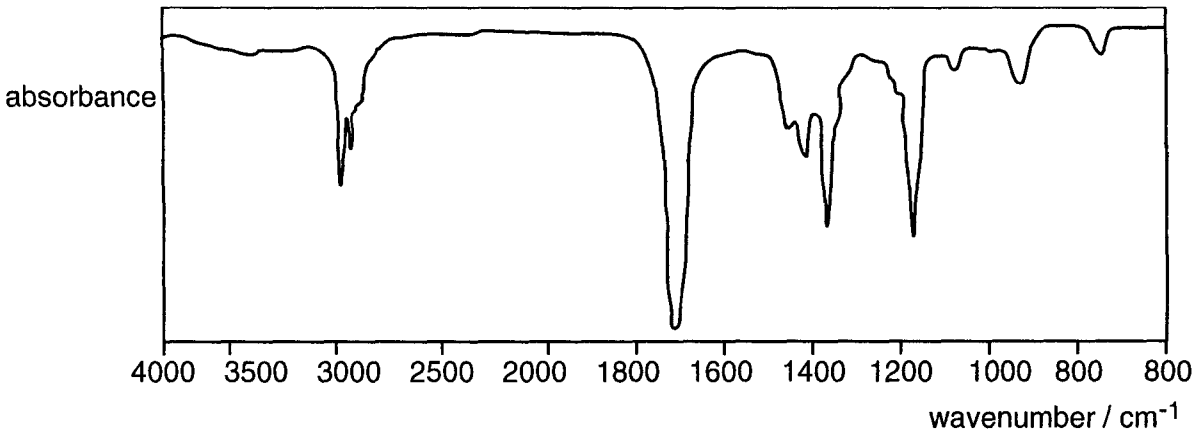
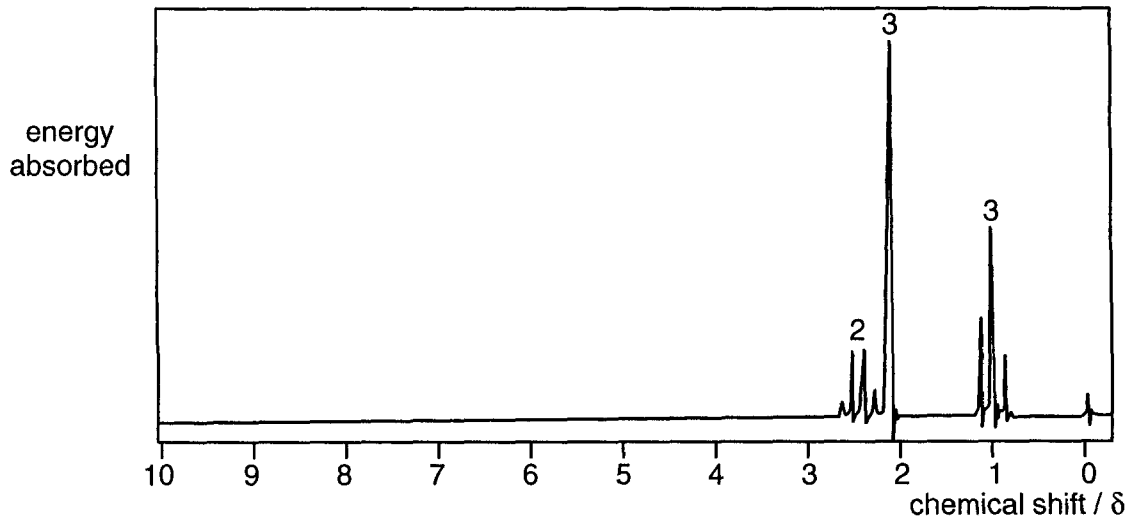
.....[3]

(b) The infra-red and n.m.r. spectra below were obtained from **T**. Deduce a possible structural formula for **T**, indicating clearly the evidence you have used from each spectrum.





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.....[7]

[Total :10]