



ADVANCED SUBSIDIARY GCE
CHEMISTRY
 Methods of Analysis and Detection

2815/04

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

OCR Supplied Materials:

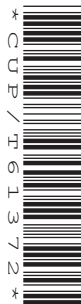
- Data Sheet for Chemistry (inserted)

Other Materials Required:

- Scientific calculator

Friday 23 January 2009
Morning

Duration: 50 minutes



Candidate Forename		Candidate Surname	
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Centre Number						Candidate Number				
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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 **45**.
- 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 **12** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	9	
2	9	
3	12	
4	8	
5	7	
TOTAL	45	

Answer **all** the questions.

- 1 Mass spectrometry and n.m.r. spectroscopy are important analytical techniques. They can be used to distinguish between the isomers 1-bromopropane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$, and 2-bromopropane, $\text{CH}_3\text{CHBrCH}_3$.

- (a) The relative molecular mass of 2-bromopropane is 123.

The mass spectrum of 2-bromopropane contains peaks at m/e 122 and 124.

- (i) Identify the ion responsible for the peaks at:

m/e 122

m/e 124 [2]

- (ii) What are the relative heights of the peaks at m/e 122 and 124?

..... [1]

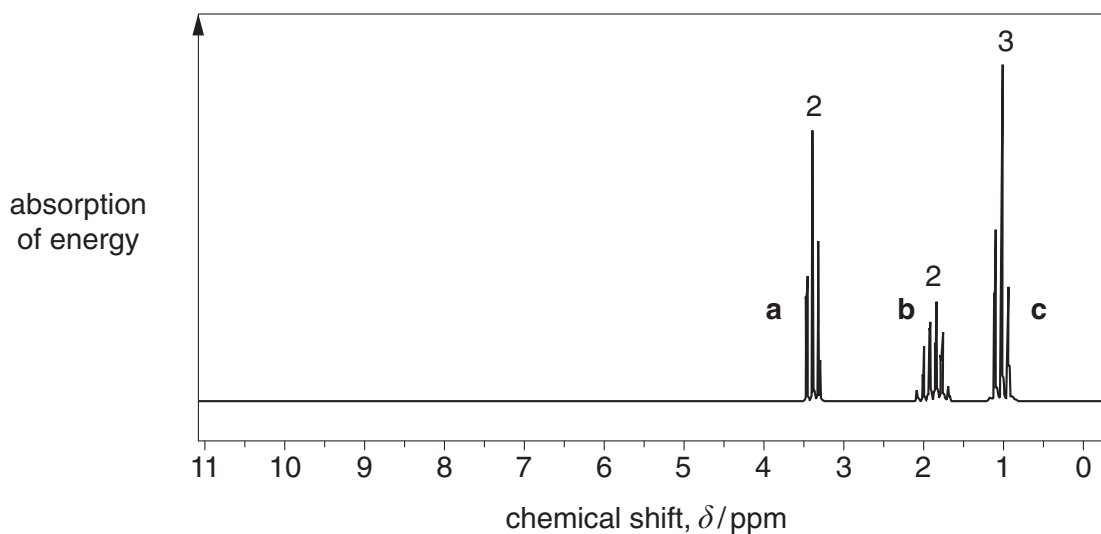
- (b) Mass spectra can be used to distinguish between 1-bromopropane and 2-bromopropane.

Deduce the m/e value of a peak that would be found in the mass spectrum of 1-bromopropane but **not** in the mass spectrum of 2-bromopropane.

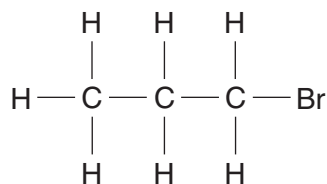
..... [1]

- (c) 1-Bromopropane and 2-bromopropane can be distinguished using n.m.r. spectroscopy.

In the ^1H n.m.r. spectrum of 1-bromopropane, shown below, there are peaks labelled **a**, **b** and **c**.



- (i) Write **a**, **b** or **c** next to the appropriate hydrogen atoms in the diagram below to identify which hydrogen atoms cause each peak.



[2]

- (ii) Explain why peak **c** is a triplet.

..... [1]

- (iii) How many peaks will be present in the ^1H n.m.r. spectrum of 2-bromopropane, and what will the relative peak areas be?

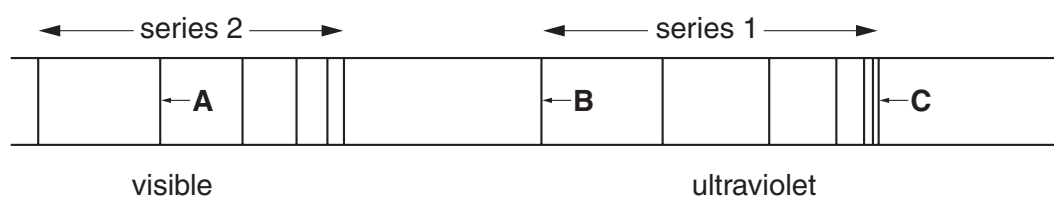
number of peaks

relative peak areas

[2]

[Total: 9]

- 2 The diagram below shows part of the emission spectrum of atomic hydrogen. Two series of lines are shown.



- (a) Describe the process which produces a line in the spectrum.

.....

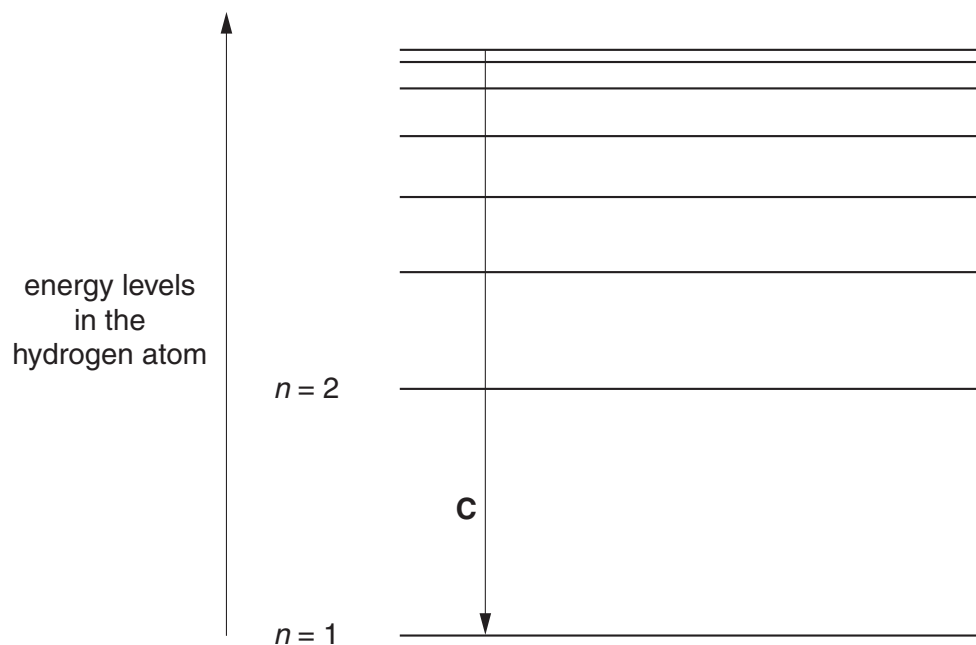
 [2]

- (b) Why is there more than one series of lines in the spectrum?

.....
 [1]

- (c) The diagram below shows the transition responsible for line C.

Draw and label the transitions responsible for lines A and B.



[2]

(d) The wavelength of line **C** is $9.12 \times 10^{-8} \text{ m}$.

Calculate the energy, in kJ mol^{-1} , for the transition represented by line **C**.

$$c = 3.00 \times 10^8 \text{ m s}^{-1}; \quad h = 6.63 \times 10^{-34} \text{ J s}; \quad L = 6.02 \times 10^{23} \text{ mol}^{-1}.$$

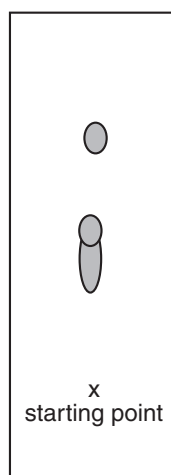
answer = kJ mol^{-1} [4]

[Total: 9]

- 3 Separation of the components in mixtures can be achieved by both chromatography and electrophoresis.

(a) A sample of urine was found to contain a mixture of caffeine, theophylline and theobromine all of which are found naturally in the cocoa plant. The separation of these three components was attempted using paper chromatography.

The results are shown below.



(i) Define the term R_f value.

.....
 [1]

(ii) Suggest why two components in the mixture were **not** separated effectively.

..... [1]

(iii) Suggest how you might separate all three components in the mixture using paper chromatography. State your reasoning.

.....

 [2]

(iv) Paper chromatography works by partition.

Explain what is meant by *partition* in paper chromatography.

.....

 [2]

- Outline how electrophoresis separates amino acids.
- Explain the importance of pH in the separation of amino acids by electrophoresis.

[5]

Quality of Written Communication [1]

[Total: 12]

- 4 A large number of organic compounds absorb energy in the ultraviolet/visible region of the spectrum. This results in electronic transitions between energy levels in the molecules.

(a) The formulae of four molecules are given below. For each molecule state whether or not it would absorb in the ultraviolet/visible region. Explain your answers.

$\text{CH}_3\text{CH}_2\text{NH}_2$

.....

$\text{C}_6\text{H}_5\text{CH}_3$

.....

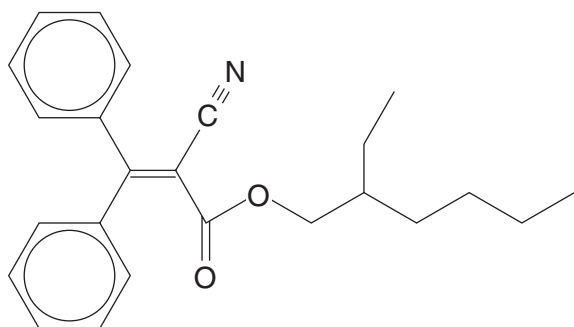
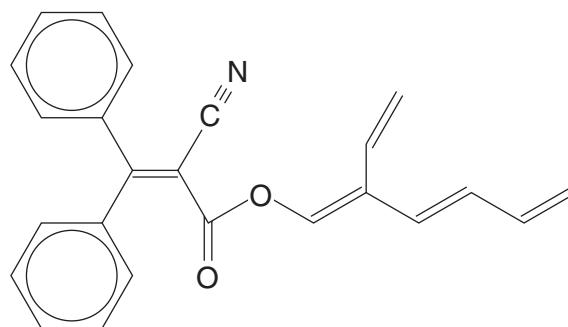
$\text{CH}_3\text{CH}_2\text{CH}_3$

.....

$\text{CH}_3\text{CH}_2\text{CN}$

..... [4]

- (b) Compounds **X** and **Y** both absorb energy in the ultraviolet/visible region. Compound **X** is colourless but compound **Y** is coloured.

compound **X**compound **Y**

- (i) Explain why only compound **Y** is coloured.

.....

 [3]

- (ii) Suggest why compound **X** could be used to help protect the skin as part of a sunscreen.

.....

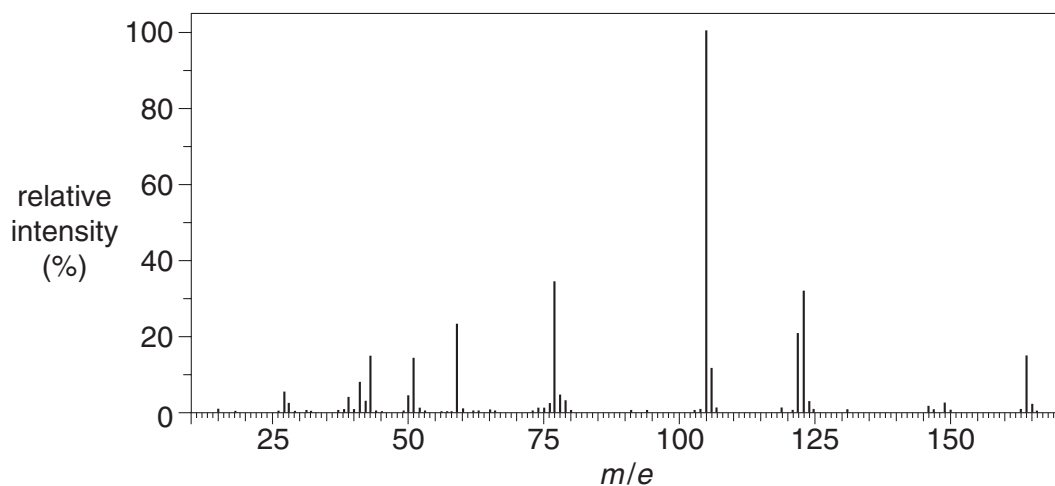
 [1]

[Total: 8]

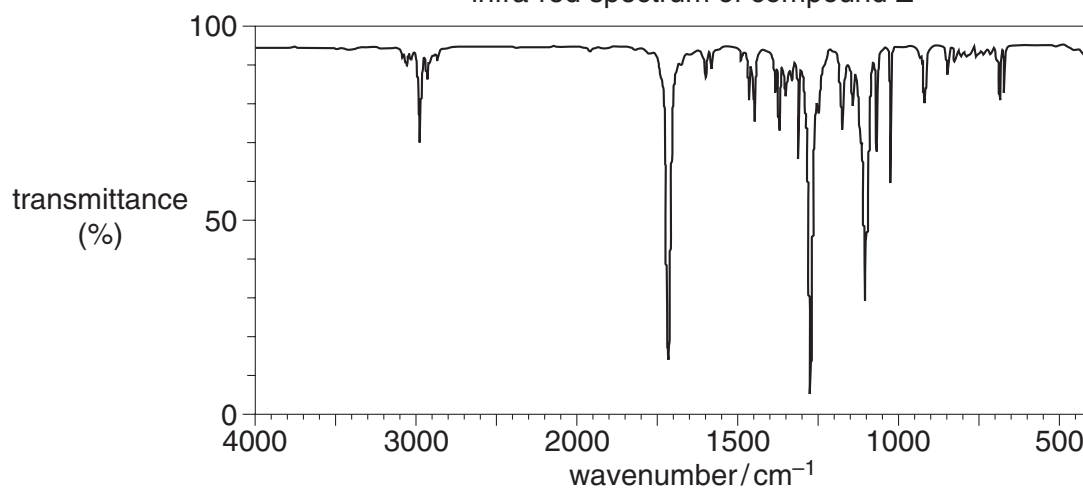
- 5 A food scientist was analysing compound **Z**, empirical formula C_5H_6O , which is used as a preservative in fruit juices.

The mass spectrum, infra-red spectrum and the 1H n.m.r. spectrum of compound **Z** are shown below.

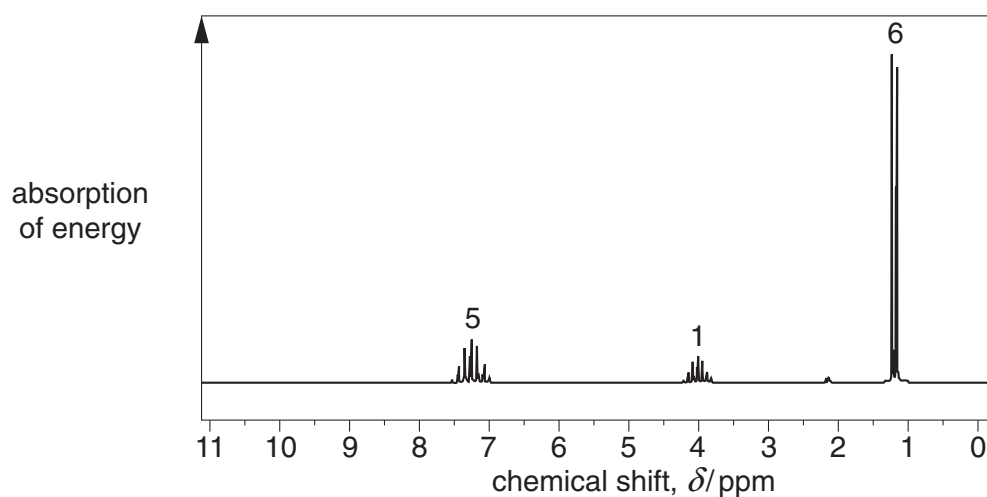
mass spectrum of compound **Z**



infra-red spectrum of compound **Z**



1H n.m.r. spectrum of compound **Z**



- (a) Use the spectra opposite to determine the molecular formula of compound **Z**. Explain your reasoning.

.....

.....

..... [2]

- (b) Use the spectra opposite to determine the structure of compound **Z**. Explain your reasoning.

.....

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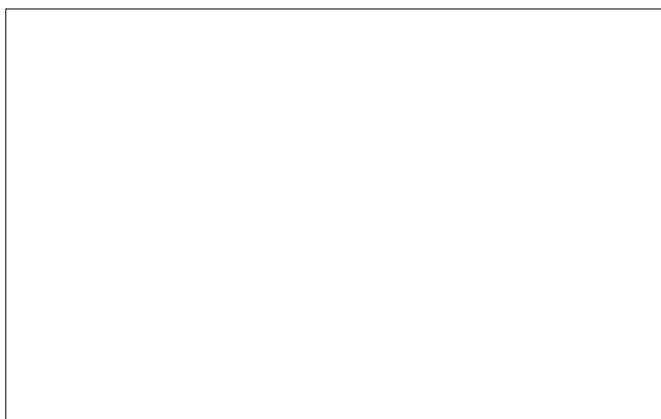
.....

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.....

.....

compound **Z** is



[5]

[Total: 7]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE



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