

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

Methods of Analysis and Detection

Tuesday

**25 JANUARY 2005**

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.

<b>FOR EXAMINER'S USE</b>		
<b>Qu.</b>	<b>Max.</b>	<b>Mark</b>
<b>1</b>	<b>10</b>	
<b>2</b>	<b>10</b>	
<b>3</b>	<b>12</b>	
<b>4</b>	<b>13</b>	
<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 Mass spectrometry is an important technique used in helping determine the structure of organic compounds, such as drug testing and the identification of pollutants.

(a) The mass spectrum of an organic compound shows a significant (M+1) peak.

(i) What causes this peak? .....[1]

(ii) Explain how this peak can give more information about the compound.

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

(b) Halogenoalkanes containing a single chlorine or bromine atom will also show a peak at (M+2). For each halogen, state which isotope causes the (M+2) peak.

chlorine ..... bromine ..... [1]

(c) Bromochloromethane,  $\text{CH}_2\text{BrCl}$ , can be used for fumigating grain to prevent insect attack. The mass spectrum of bromochloromethane has an M peak at  $m/e$  128, together with (M+2) and (M+4) peaks.

(i) Which molecular ions give rise to the

M peak .....

(M+2) peak .....

(M+4) peak? ..... [2]

(ii) Suggest the ratio of the heights of the M : (M+2) : (M+4) peaks.

[1]

(d) Two isomeric alcohols **A** and **B** have the formula  $C_4H_{10}O$ .

The mass spectrum of **A** shows a major peak at  $m/e$  ( $M-45$ ) but **no** peak at  $m/e$  ( $M-43$ ).

The mass spectrum of **B** shows major peaks at **both**  $m/e$  ( $M-45$ ) and  $m/e$  ( $M-43$ ).

Suggest a reason for these different fragmentation patterns, and hence the structural formulae for **A** and **B**.

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.....

**A**

**B**

[3]

[Total: 10]

2 Chromatography is a versatile technique that may be used to separate and identify compounds.

(a) (i) Name a type of chromatography that is used to separate and identify dissolved substances.

.....[1]

(ii) State what quantitative value may be determined from the chromatogram to identify the substances present in the solution.

.....[1]

(iii) Sketch a chromatogram to show how the value in (ii) is determined.

[1]

(b) Gas-liquid chromatography is used to separate and identify gases and liquids.

(i) State what quantitative value is normally used to identify the components in this type of chromatography.

.....[1]

(ii) Sketch the chromatogram to show how the value in (i) is determined.

[1]

(c) (i) State the physical process on which the separation used in gas-liquid chromatography depends.

.....[1]

(ii) Describe briefly how the separation works.

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.....[4]

[Total: 10]

3 This question is about absorption and emission in the u.v./visible region of the electromagnetic spectrum.

(a) Use your knowledge of the electronic structure of atoms to explain how hydrogen produces an emission spectrum.

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

(b) Explain why the emission spectrum of hydrogen consists of separate lines.

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

(c) The wavelength of a line in the emission spectrum of hydrogen is 125 nm. Calculate the energy responsible for this line.

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

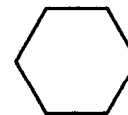
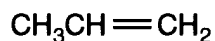
energy ..... J [2]

(d) Organic molecules also produce spectra in the u.v./visible region.

(i) What name is given to the part of an organic molecule that causes absorption of energy in the u.v./visible region of the spectrum?

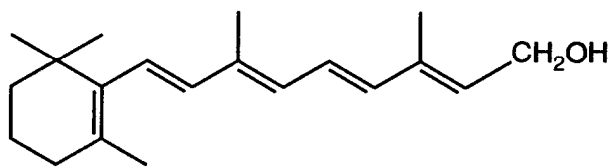
.....[1]

(ii) Circle those molecules given below that will absorb in the u.v./visible region.

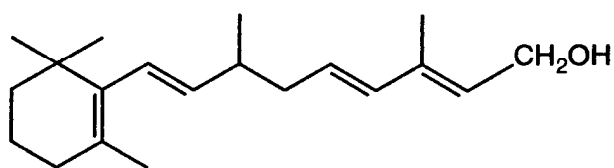


[3]

- (e) Vitamin A is an important molecule which is necessary for good vision.  
Vitamin A is pale yellow in colour. The related compound C is colourless.



vitamin A



compound C

Explain this difference in colour.

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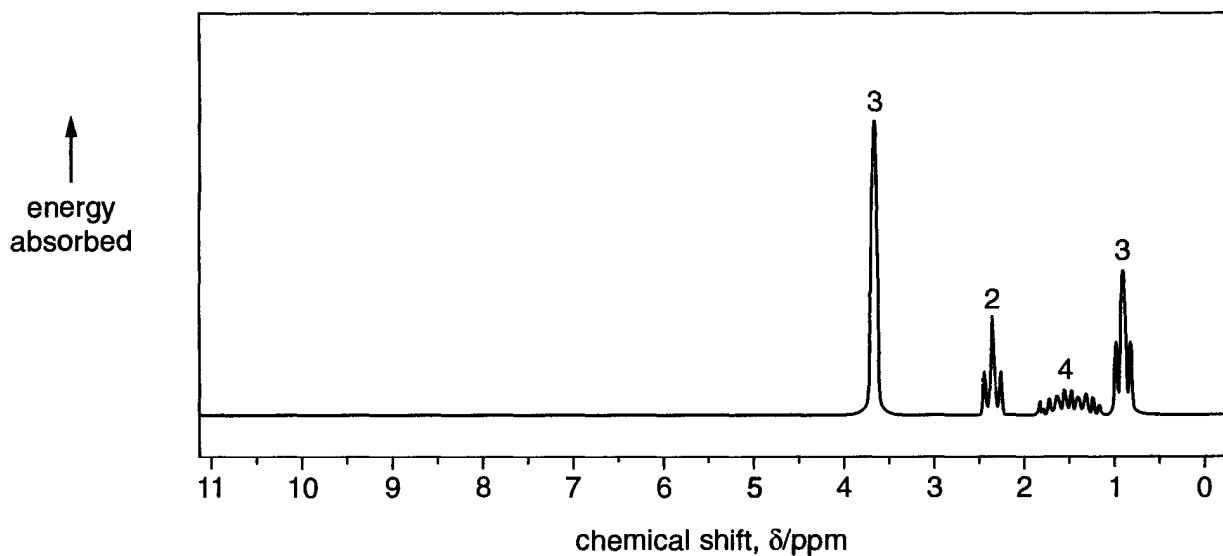
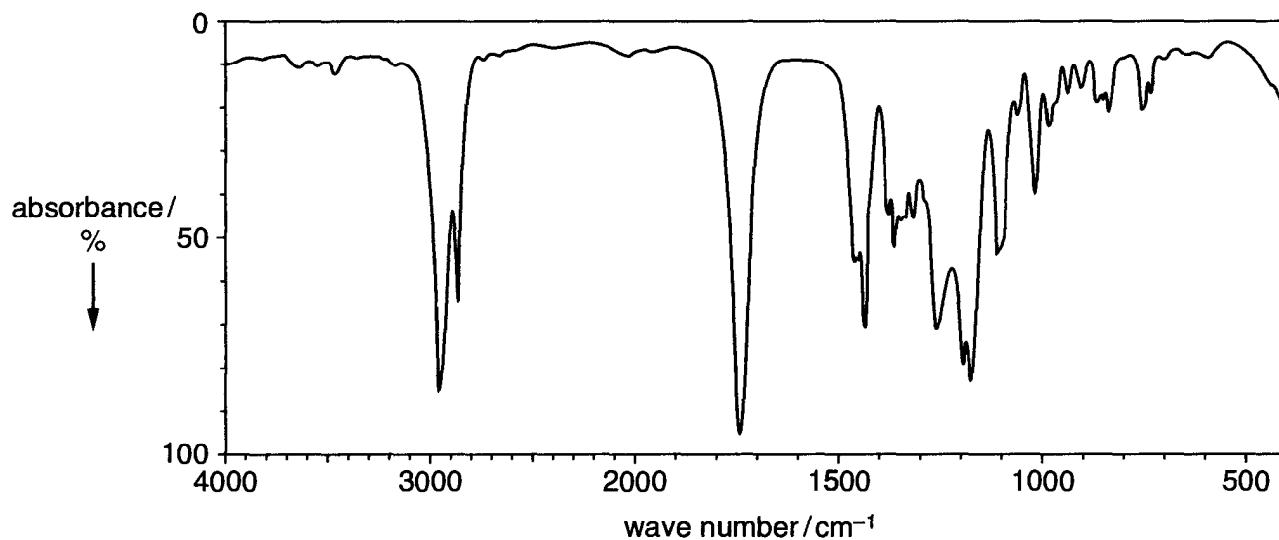
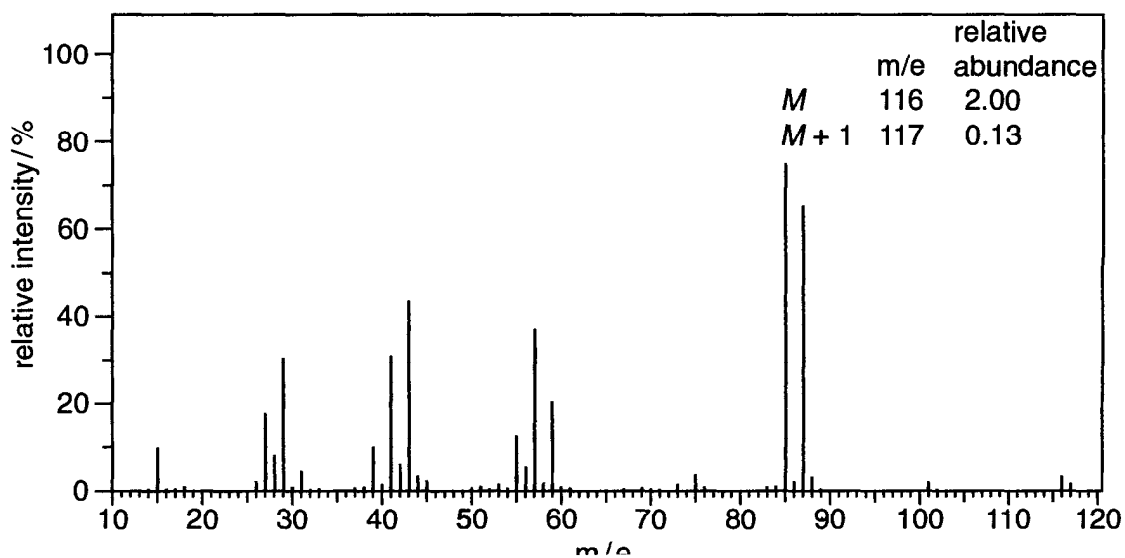
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.....[3]

[Total: 12]

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





- (a) Compound **D** has the formula  $C_xH_yO_2$ , and is saturated.  
Use the mass spectrum to deduce the values of  $x$  and  $y$ , showing how you arrive at your answer.

[3]

- (b) In this question, one mark is available for the quality of use and organisation of scientific terms.  
Use as much data as possible from each of the spectra to identify structural features present in **D**, and hence suggest a structural formula for the compound.

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structural formula of **D**

[9]

Quality of Written Communication [1]

[Total: 13]

**END OF QUESTION PAPER**