

**ADVANCED GCE****CHEMISTRY**

Methods of Analysis and Detection

2815/04

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

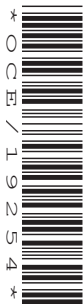
OCR Supplied Materials:

- Data Sheet for Chemistry (inserted)

Other Materials Required:

- Scientific calculator

Wednesday 27 January 2010
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.

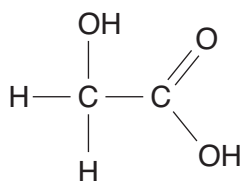
INFORMATION FOR CANDIDATES

- 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.

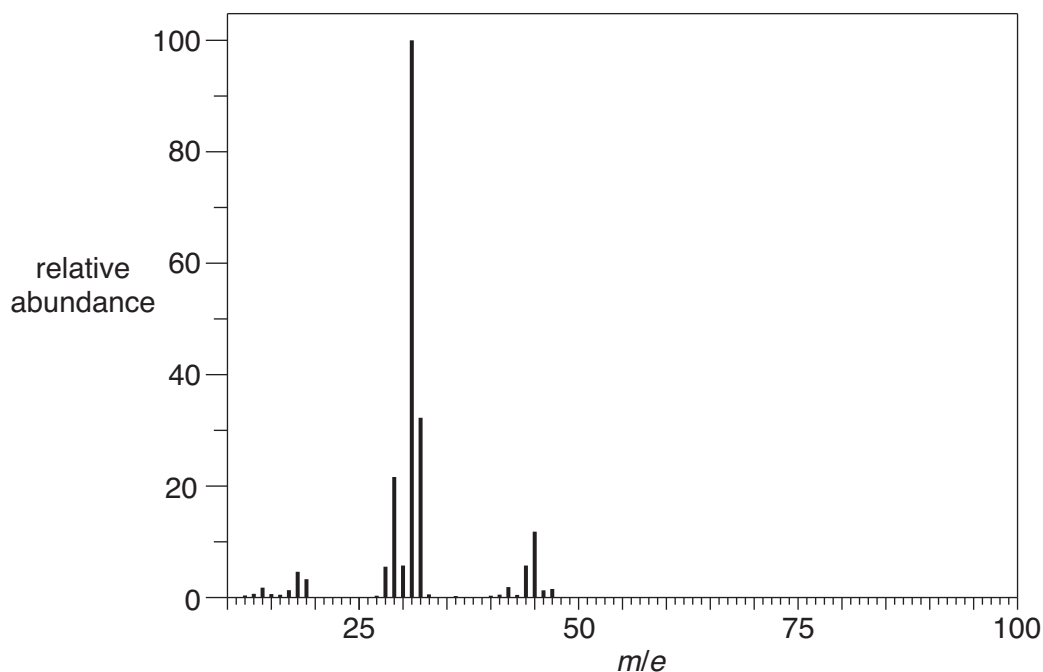
Examiner's Use Only:			
1			
2			
3			
4			
5			
Total			

Answer **all** the questions.

- 1 Compound **A**, shown below, can be extracted from a variety of plants and is commonly used in skin creams.



The mass spectrum of compound **A** is shown below.



- (a) After inspection of the mass spectrum of compound **A**, an analyst wrote the comment:

*'The molecular ion peak appears to be missing from the spectrum
and the base peak is due to a fragment ion with m/e = 31.'*

- (i) Explain what is meant by the following terms.

molecular ion peak

.....

.....

base peak

.....

..... [2]

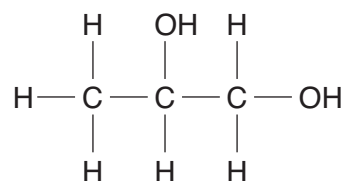
- (ii) Suggest why the molecular ion peak is missing from the mass spectrum.

.....
 [1]

- (iii) Suggest a possible structure for the ion that gives the base peak at $m/e = 31$ in the mass spectrum.

.....
 [1]

- (b) Another ingredient commonly used in skin creams is propane-1,2-diol.



Suggest and explain **one** difference and **one** similarity between the mass spectrum, the infra-red spectrum and the n.m.r. spectrum of compound **A** and of propane-1,2-diol.

mass spectrum

.....

infra-red

.....

n.m.r.

.....

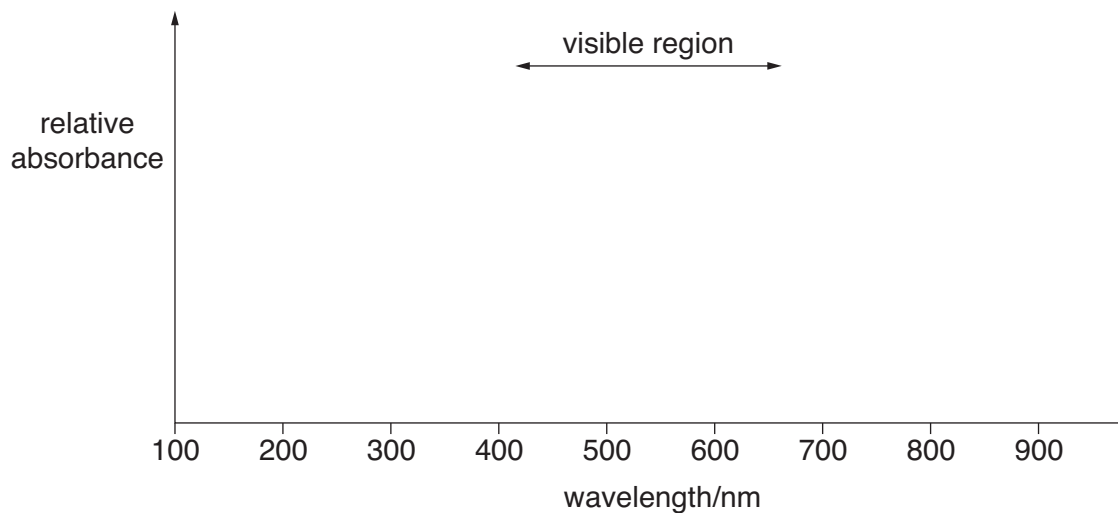
 [6]

[Total: 10]

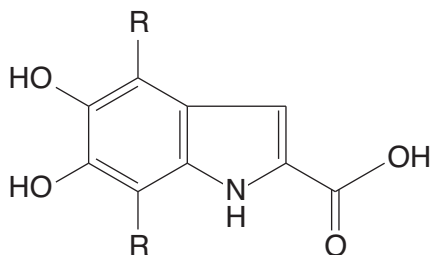
- 2 Melanin is a complex compound synthesised by the body to provide protection from sunlight. Melanin strongly absorbs radiation in both the ultraviolet and the visible region but this absorption tails off in the infra-red region of the electromagnetic spectrum.

(a) Use the grid below to sketch an absorption spectrum for melanin that matches the description above.

[1]



(b) Melanin contains structural features that act as chromophores. Part of the structure of melanin is shown below.



(R = rest of melanin's structure)

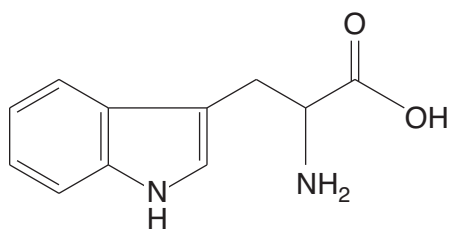
(i) Explain what is meant by the term *chromophore*.

.....
 [1]

(ii) On the diagram above, circle **four** different structural features of melanin that act as chromophores.

[2]

- (c) Another molecule containing chromophores is tryptophan, shown below. Amino acids such as tryptophan can be obtained by the hydrolysis of protein.



tryptophan

- (i) State the reagents and the conditions required to break down the protein into its constituent amino acids.

.....

 [2]

- (ii) State the technique that could be used to separate the amino acids in the mixture obtained from the protein.

..... [1]

- (iii) Suggest how the presence of tryptophan could be confirmed using the technique in (ii).

.....

 [2]

[Total: 9]

- 3 Human blood serum contains both sodium and potassium ions, Na^+ and K^+ .

A high concentration of K^+ ions can be an indicator of disease or internal injury.

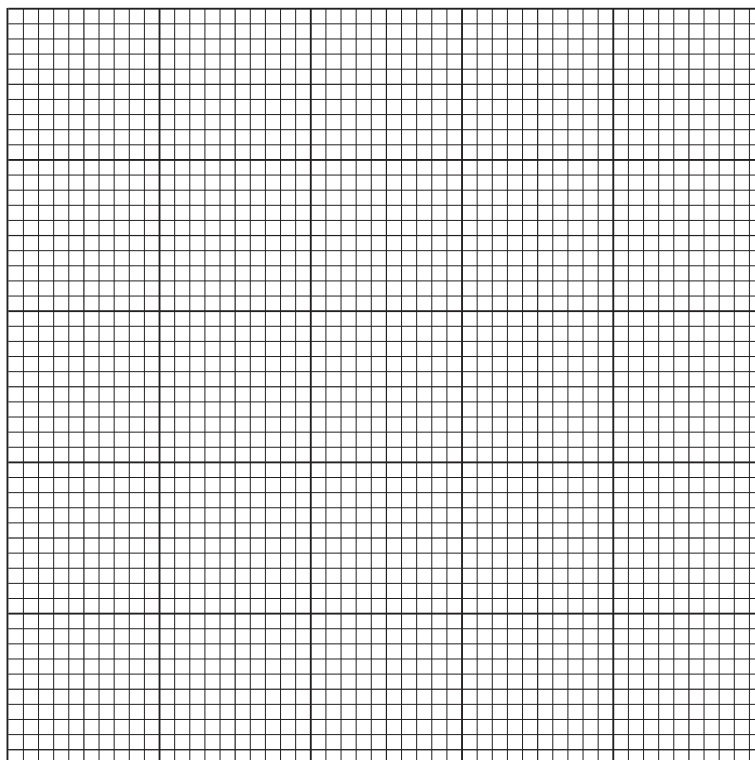
The concentration of K^+ ions can be determined using atomic emission spectroscopy.

- (a) An analyst prepared solutions of known K^+ ion concentration and measured the relative emission of each solution. The results are shown in **Table 3.1**.

K^+ ion concentration $/10^{-3} \text{ mol dm}^{-3}$	relative emission reading
0.0	0
2.0	13
4.0	25
6.0	37
8.0	50

Table 3.1

- (i) Plot a calibration graph for the analysis using the data in **Table 3.1**.



[2]

- (ii) The analyst then used the calibration graph to analyse a sample of blood serum from a patient. He obtained 10cm^3 of blood serum and diluted it to 100cm^3 . The diluted solution was found to have a relative emission reading of 28.

Calculate the concentration of K^+ ions in the patient's blood.

answer = mol dm^{-3} [2]

- (b) The atomic emission spectrum of potassium includes a line at 404 nm.

Calculate the energy of this line in kJ mol^{-1} .

the velocity of light	=	$3.00 \times 10^8 \text{ms}^{-1}$
the Planck constant	=	$6.63 \times 10^{-34} \text{Js}$
the Avogadro constant	=	$6.02 \times 10^{23} \text{mol}^{-1}$

Quote your answer to **three** significant figures.

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

[Total: 8]

- 4 Forensic scientists use chromatography and electrophoresis to analyse samples found at the scene of a crime.

- (a) Thin-layer chromatography relies on the physical processes of partition and adsorption depending on the conditions used.

Explain both of these processes as they occur in thin-layer chromatography.

partition

.....

adsorption

..... [2]

- (b) In this question, one mark is available for the quality of spelling, punctuation and grammar.

Gel electrophoresis can be used to produce a 'genetic fingerprint' which can be used to help identify suspects who may have been present at the scene of a crime.

Using your knowledge of electrophoresis, describe and explain how prepared samples of DNA can be used to produce such a genetic fingerprint analysis.

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..... [6]

Quality of Written Communication [1]

[Total: 9]

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TURN OVER FOR QUESTION 5

- 5 While working on an organic synthesis, a research chemist isolated a compound **T**. Mass spectrometry revealed that **T** had an M_r of 72. From this analysis, 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) High resolution mass spectrometry can be used to distinguish between C_5H_{12} and C_4H_8O .

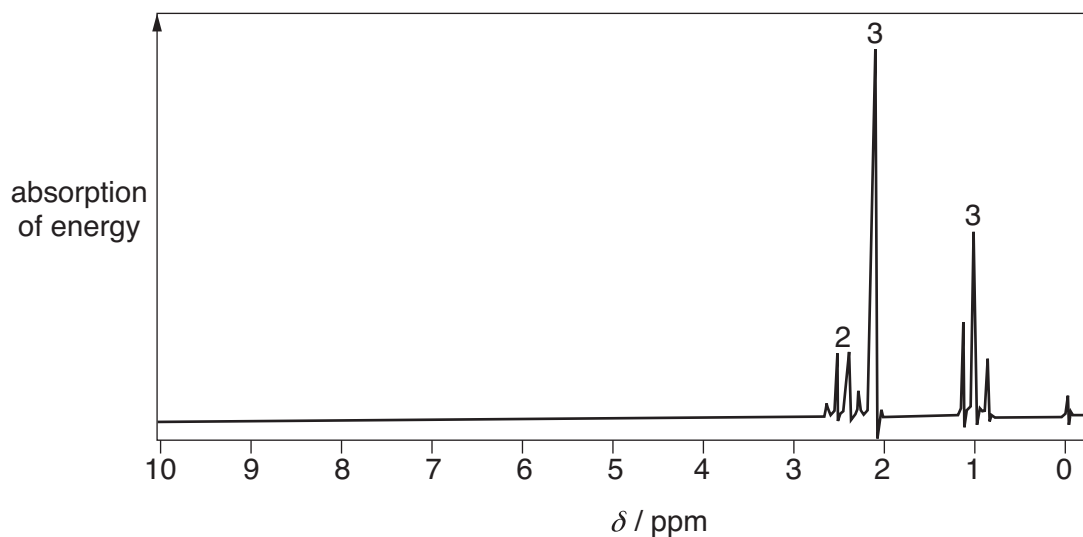
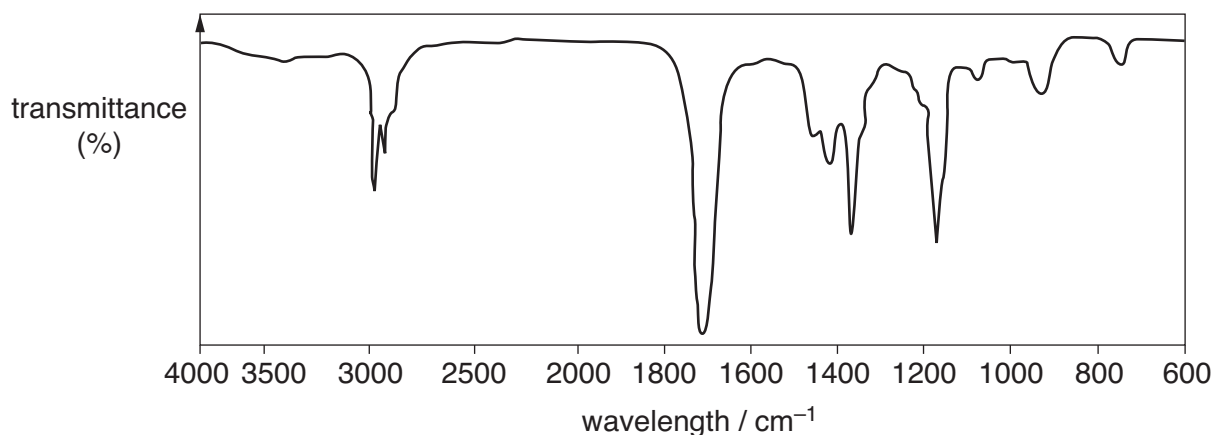
The precise values for relative isotopic masses are shown in the table below.

isotope	relative isotopic mass
1H	1.0078
^{12}C	12.0000
^{16}O	15.9949

Show, by calculation, how a high resolution mass spectrum could be used to distinguish between C_5H_{12} and C_4H_8O .

[2]

- (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.



END OF QUESTION PAPER

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