

# Structural Analysis (combined techniques) AS & A Level Question Paper 2

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	
Topic	Structural Analysis ( combined techniques)
Paper	AS & A Level
Booklet	Question Paper 2

**Time allowed:** 62 minutes

**Score:** /46

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

## Question 1

Infrared spectroscopy and mass spectrometry are used to identify substances.

(a) Police use breathalysers to detect ethanol in the breath of drivers.

(i) Some modern breathalysers use infrared spectroscopy.

Suggest **two** characteristic infrared absorptions that could be used to identify the presence of ethanol vapour.

[2]

(ii) Some older breathalysers used the redox reaction between acidified dichromate(VI) ions and ethanol. A colour change was seen which indicated the presence of ethanol in the breath.

What is the colour change that would be seen in this breathalyser if ethanol was present in the breath?

[1]

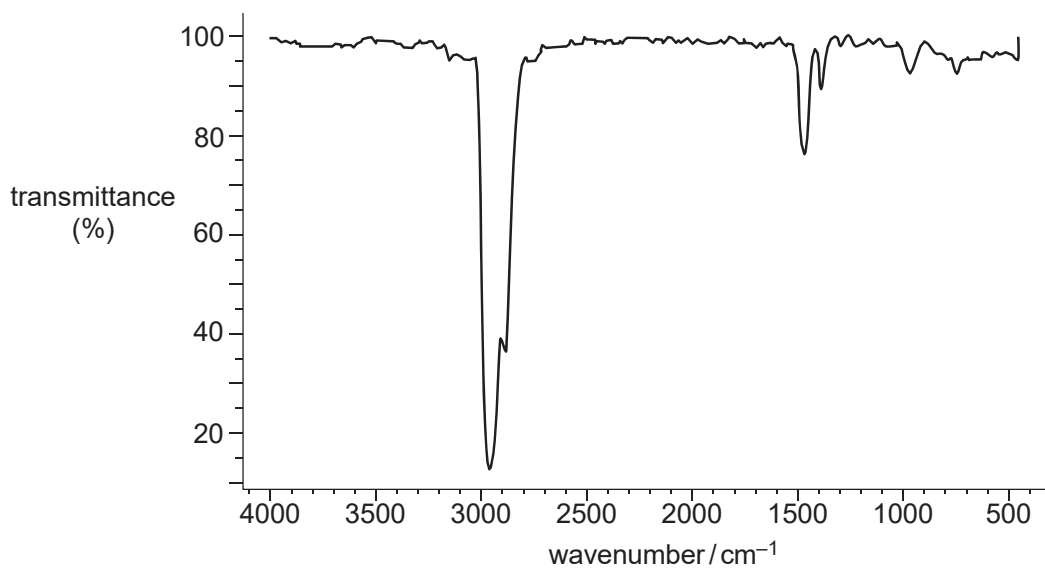
(iii) Give an equation to show the reaction between acidified dichromate(VI) ions and ethanol.

Use [O] to represent the acidified dichromate(VI) ions, the oxidising agent.

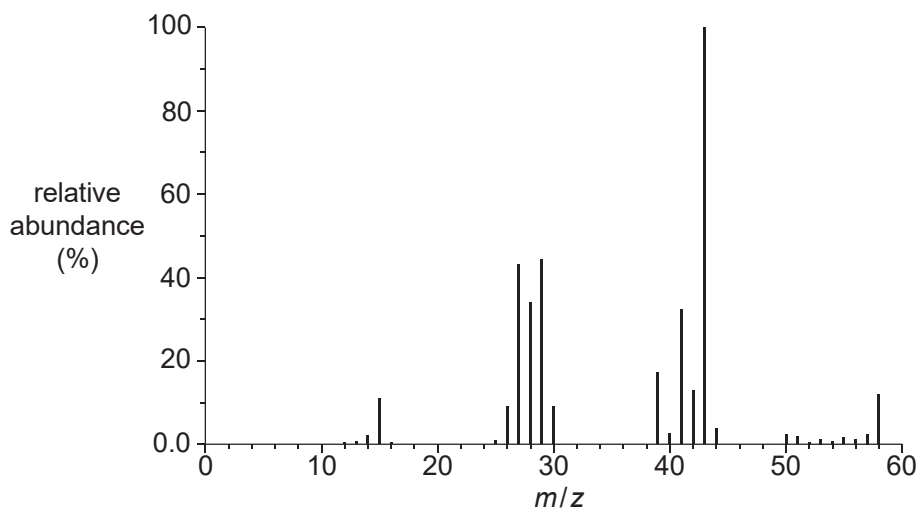
[2]

(b) Infrared spectroscopy and mass spectrometry are used in the search for organic molecules in outer space.

Compound **A** has been analysed by infrared spectroscopy.



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



- (i) A research chemist concludes that compound **A** is a hydrocarbon.

What evidence is there to support this conclusion? [2]

- (ii) How does the mass spectrum confirm that compound **A** has a molecular formula of  $C_4H_{10}$ ? [1]

- (iii) Draw the structural isomers of  $C_4H_{10}$ . [1]

- (iv) Identify the fragment ions that give rise to the following peaks in the mass spectrum. [3]

- (v) Use your answer to part (iv) to identify which of the isomers in part (iii) is compound **A**. Explain your reasoning.

[1]

[Total 13 Marks]

## Question 2

Compound **G** was extracted from the leaves of a plant. A sample of **G** was analysed by a research chemist. A summary of the chemist's results is shown in the table.

type of analysis	evidence
infrared spectroscopy	absorptions at 1080, 1720 and a very broad absorption at 2900 $\text{cm}^{-1}$
percentage composition by mass	C, 26.7%; H, 2.22%; O, 71.1%
volumetric analysis	0.00105 mol of <b>G</b> has a mass of 0.0945 g

Use this information to suggest a possible structure for compound **G**.



*In your answer, you should make clear how your explanation is linked to the evidence.*

[8]

[Total 8 Marks]

### Question 3

In this question, you are asked to suggest structures for several organic compounds.

- (a) Compounds **F**, **G** and **H** are **unbranched** alkenes that are isomers, each with a relative molecular mass of 70.0.

Compounds **F** and **G** are *E/Z* stereoisomers.

Compound **H** is a structural isomer of compounds **F** and **G**.

- Explain what is meant by the terms *structural isomer* and *stereoisomer*.
- Explain why some alkenes have *E/Z* isomerism.
- Analyse this information to suggest possible structures for compounds **F**, **G** and **H**.



In your answer you should make clear how each structure fits with the information given above.

[11]

- (b) An analytical chemist was provided with a compound **J** which has an unbranched carbon skeleton. After analysis, the chemist obtained the following results.

type of analysis	evidence
infrared spectroscopy	broad absorption at $3350\text{ cm}^{-1}$
percentage composition by mass	C, 70.59%; H, 13.72%; O, 15.69%
mass spectrometry	molecular ion peak at $m/z = 102.0$

Use this information to suggest all the possible structures for the **unbranched** compound **J**.



In your answer you should make clear how your explanation is linked to the evidence. [8]

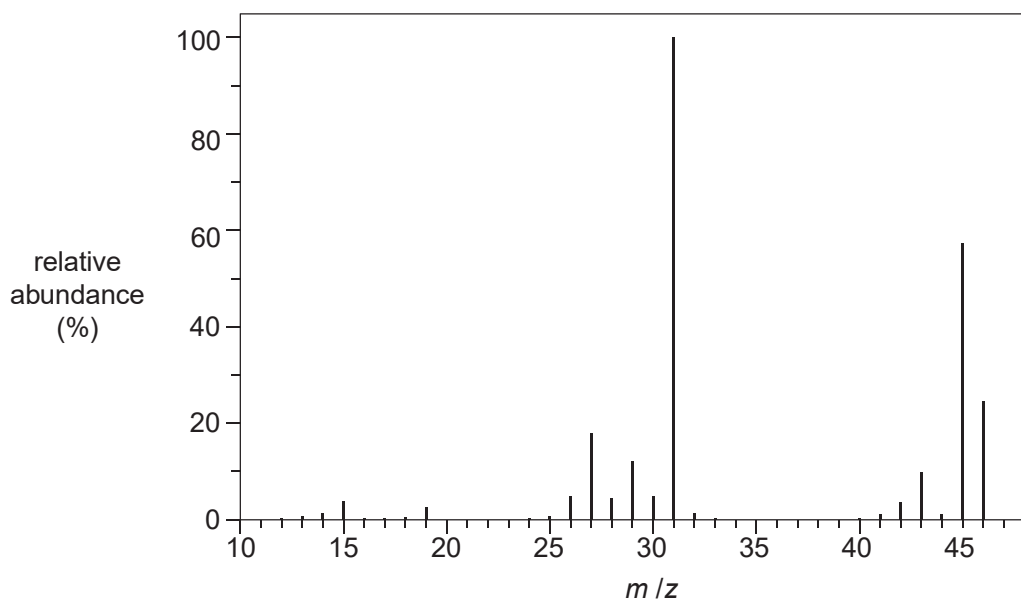
[Total 19 Marks]

## Question 4

Mass spectrometry is used in analysis.

(a) Compound **O** contains carbon, hydrogen and oxygen.

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



(i) Identify the  $m/z$  value that corresponds to the molecular ion. [1]

(ii) Write the formula of the ion that gives rise to the peak at  $m/z = 31$ . [1]

(iii) Suggest the molecular formula for **O**. [1]

(b) A scientist analyses a sample of Moon rock. She uses mass spectrometry to find out which metal the sample contains.

The mass spectrum of the sample shows  $m/z$  peaks as shown in the table.

$m/z$ value	percentage abundance (%)
63	72.2
65	27.8

Positive ions,  $X^+$ , of the metal were responsible for the two  $m/z$  peaks.

Identify the metal **X** by calculating its relative atomic mass to **one decimal place**. [3]

[Total: 6 Marks]