



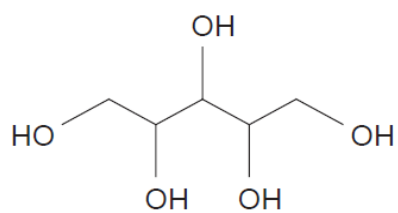
GCE A LEVEL CHEMISTRY

S21-A410

Assessment Resource G

Organic Chemistry and Analysis

1. A stick of chewing gum for diabetics contains xylitol.



- (a) Give the molecular formula of xylitol. [1]

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- (b) State the number of signals in the ^{13}C NMR spectrum of xylitol. Give your reasoning. [2]

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2. Liquefied petroleum gas (LPG) consists largely of propane (M_r 44) and butane (M_r 58).

- (a) A sample of LPG has a mass of 10.48 g. It contains 3.52 g of propane with the rest being butane. The sample was completely burned, giving only carbon dioxide and water.

Calculate the total volume of carbon dioxide produced, measured at 298 K and 1 atm pressure. [5]

Volume = dm^3

- (b) In practice LPG contains small quantities of other materials including ethanethiol, $\text{C}_2\text{H}_5\text{SH}$ (M_r 62). This is added to LPG so that any escape is detectable by its smell.

A 600 g sample of LPG contains 17 mg of ethanethiol.

Calculate the percentage by mass of sulfur in the LPG, assuming that all the sulfur comes from the ethanethiol. [3]

Percentage = %

- (c) The C₄ component of LPG contains both methylpropane (boiling temperature -12 °C) and butane (boiling temperature -0.5 °C).

Explain why these two compounds have different boiling temperatures even though they have the same molecular formula. [2]

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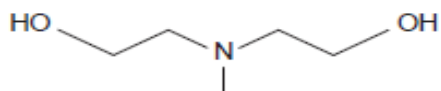
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- (d) The combustion of LPG and other hydrocarbons causes the emission of carbon dioxide, which is a cause of global warming.

One method of removing carbon dioxide from power station emissions is by its absorption into a solution containing certain amines.

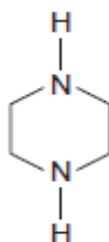
An amine that can be used for this method is N-methyldiethanolamine.



Some properties of this amine are shown below. Suggest a reason why each of the properties given are advantageous in this use. [4]

Property	Advantage
Reacts with both carbon dioxide and hydrogen sulfide
It has a high boiling temperature
It is immiscible with hydrocarbons
Its reaction with both carbon dioxide and hydrogen sulfide is exothermic

- (e) Piperazine is sometimes used with N-methyldiethanolamine in the removal of carbon dioxide from power station flue gases.



piperazine

- (i) Explain why piperazine acts as a base. [1]

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- (ii) Give the structure of the compound formed when 1 mol of piperazine reacts with 2 mol of hydrochloric acid. [1]

- (f) Alkanes react with chlorine in a radical reaction.

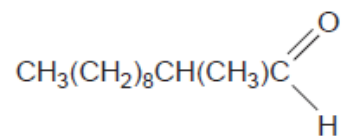
For example



Deduce the structure of an isomer of formula C_5H_{12} which will give only one possible monochloride, $\text{C}_5\text{H}_{11}\text{Cl}$, on reaction with chlorine. Explain your reasoning. [2]

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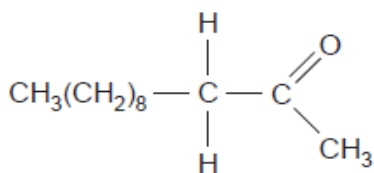
3. (a) A perfume contains 2-methylundecanal, $C_{12}H_{24}O$.



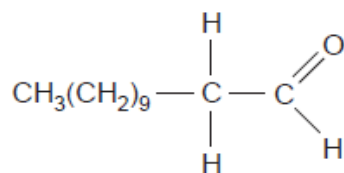
Compounds **D** to **G** all contain some features similar to 2-methylundecanal.

For **each** compound suggest how you could distinguish the structure from 2-methylundecanal.

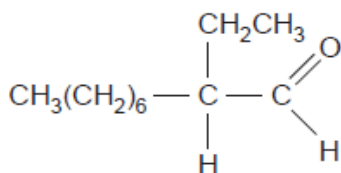
You may use physical and chemical tests but **not** spectroscopic methods in your answer. [6 QER]



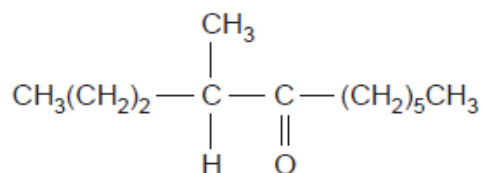
compound **D**



compound **E**



compound **F**



compound **G**

(b) Lycopene, $C_{40}H_{56}$, is the compound responsible for the red colour in tomatoes. This unsaturated hydrocarbon contains 13 carbon to carbon double bonds in each molecule.

(i) 4.78 dm^3 of hydrogen measured at 298 K and 1 atm pressure was needed to fully hydrogenate a certain mass of lycopene.

Calculate the mass of lycopene used. [4]

Mass = g

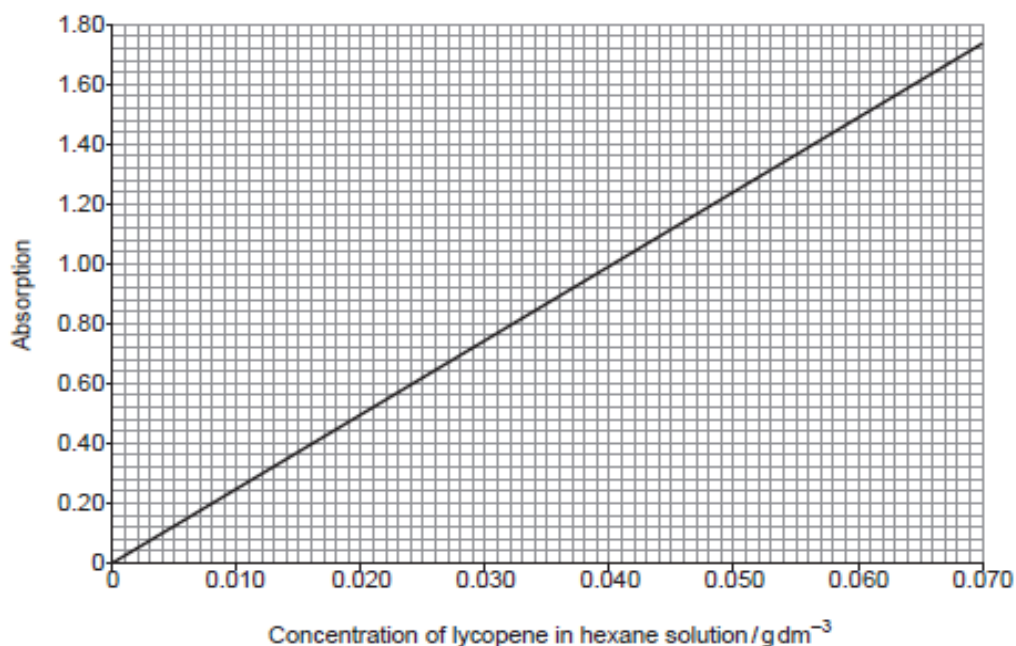
(ii) Lycopene is a bright red solid when seen in white light.

State which colour(s) present in white light are absorbed to result in this red colour. [1]

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(iii) The amount of lycopene present in tomatoes can be found by colorimetry.

The absorption values of a number of standard solutions are measured and their values used to produce a calibration graph.



A tomato of mass 20.0g was treated and the lycopene extracted into 10 cm³ of hexane. This solution gave an absorption reading of 1.24.

Use the graph to find the concentration of lycopene present and hence the percentage of lycopene in the tomato. [3]

Percentage = %

(iv) A solution of lycopene in hexane was used for the colorimetry in part (iii) as lycopene is insoluble in water.

Explain why lycopene is insoluble in water. [1]

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- (c) Many compounds that contain a conjugated double bond system (alternating double and single carbon to carbon bonds) absorb in the ultraviolet and visible regions of the electromagnetic spectrum.

The table shows the structure of some conjugated polyenes and the wavelengths of their maximum absorption values (λ_{\max}).

Compound	Number of C = C bonds	λ_{\max} /nm	Colour seen in white light
$\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{C}(\text{CH}_3)_2$	2	234	colourless
$\text{CH}_3-\text{CH}=\text{CH}-\text{CH}=\text{CH}-\text{CH}=\text{CH}-\text{CH}_3$	3	263	colourless
$\text{CH}_3-\text{CH}=\text{CH}-(\text{CH}=\text{CH})_3-\text{CH}=\text{CH}-\text{CH}_3$	5	326	colourless
β -carotene	11	450	yellow / orange
lycopene	13	505	red

Fill the gaps in the sentence below, using the words **increases** or **decreases**.

'As the number of conjugated carbon to carbon double bonds ,
 the wavelength of their absorption maxima ,
 the frequency and the energy ' [2]

- (d) The table shows the concentrations of seven coloured compounds in a tomato. The values were obtained by HPLC.

Compound	Concentration / $\mu\text{g g}^{-1}$
1	0.60
2	1.15
3	1.22
4	1.87
5	4.16
6	6.13
7	57.91

The main coloured component in a tomato is lycopene.

Suggest **two** ways by which you would know which of the peaks is given by lycopene.

[2]

1.

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2.

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