



Rewarding Learning

ADVANCED
General Certificate of Education
2025

Centre Number

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Candidate Number

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Life and Health Sciences

Assessment Unit A2 2

assessing

Organic Chemistry



[AZ021]

AZ021

FRIDAY 6 JUNE, AFTERNOON

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete questions in black ink and use a dark HB pencil for drawings and graphs.

Do not write with a gel pen.

Answer **all six** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is **100**.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You may use a scientific calculator.

Quality of written communication will be assessed in question **5(a)(i)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

14679



24AZ02101

1 This question is about hydrocarbons and their reactions.

(a) The IUPAC names of seven hydrocarbons are listed below.

Circle **all** the hydrocarbons that are unsaturated.

butane

but-1-ene

ethane

ethene

methane

propane

propene

[1]

(b) Draw the structural formula of propane.

[1]

(c) State the molecular formula of propene.

[1]

(d) Draw the structural formula of a branched chain isomer of but-1-ene.

[1]



(e) (i) Methane reacts with chlorine in the presence of UV light to form trichloromethane.

Name this type of reaction.

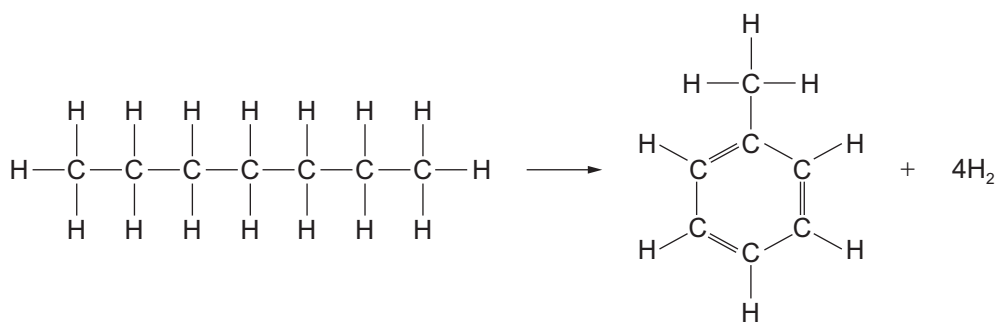
_____ [1]

(ii) Write a balanced symbol equation for the formation of trichloromethane from methane and chlorine.

_____ [2]

(f) Heptane (C_7H_{16}) can be reformed to produce toluene (C_7H_8).

The structural equation for this process is shown below.



Explain how this equation shows that heptane is being reformed.

_____ [2]



- (g) (i) Hexadecane ($C_{16}H_{34}$) undergoes cracking to form octane (C_8H_{18}) and one other organic product in a 1:2 ratio respectively.

Determine the molecular formula for the other organic product formed from the cracking of hexadecane.

Molecular formula _____ [1]

- (ii) Name the homologous series to which octane (C_8H_{18}) belongs.

Explain your reasoning.

Homologous series _____

Reasoning _____

_____ [2]





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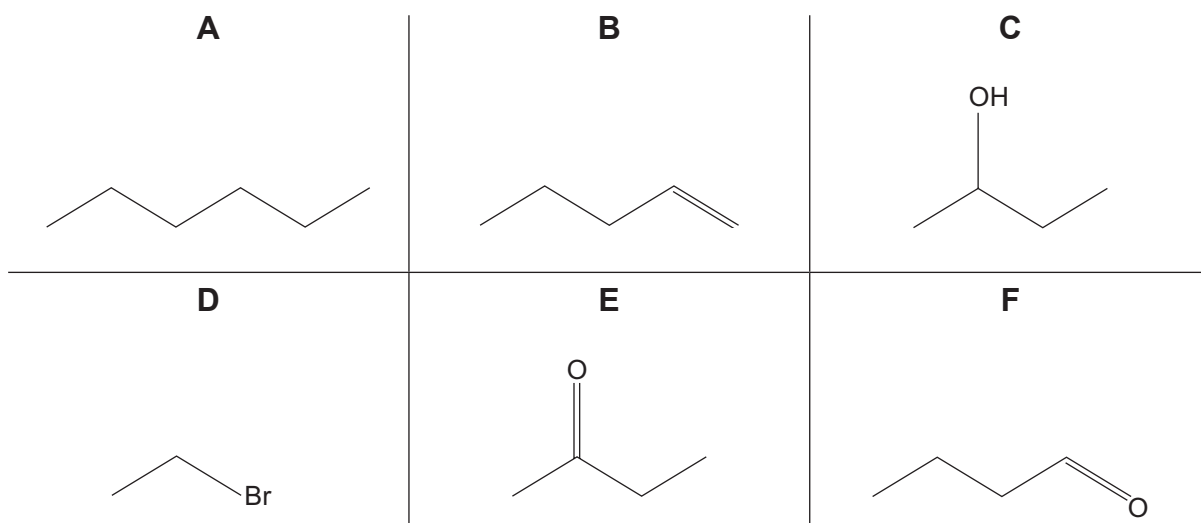
14679

[Turn over



24AZ02105

2 The skeletal formulae of six different organic compounds, **A** to **F**, are given below.



(a) Compound **A** is a colourless liquid that reacts with oxygen in combustion reactions.

(i) State the empirical formula of compound **A**.

_____ [1]

(ii) Write a balanced symbol equation for the combustion of compound **A** in a plentiful supply of oxygen.

_____ [2]

(iii) What change to the reaction conditions would result in the formation of carbon monoxide or soot?

_____ [1]



(b) Compound **B** contains a C=C.

It is a reactive hydrocarbon.

(i) Describe a chemical test that could be carried out in a laboratory to show that compound **B** contains a C=C.

State the expected observations for a positive test.

[4]

(ii) Explain in terms of sigma or pi bonds why compound **B** is a reactive hydrocarbon.

[2]

(c) Compound **B** reacts with hydrogen in the presence of a catalyst.

(i) State the name of this type of reaction and suggest the name of a suitable catalyst.

Type of reaction _____

Catalyst _____ [2]

(ii) Write a balanced symbol equation for the reaction of compound **B** with hydrogen and state the IUPAC name of the organic product formed.

IUPAC name _____ [2]

[Turn over



- (d) Compound **C** can be dehydrated to form two different organic compounds, **X** and **Y**.

Compound **X** does not have a geometric isomer.

Compound **Y** exists as a pair of E–Z geometric isomers.

- (i) Name the reagent that could be used to dehydrate compound **C**.

_____ [1]

- (ii) Write a balanced structural equation for the dehydration of compound **C** to form compound **X** and state the IUPAC name of the organic product formed.

IUPAC name _____ [2]

- (iii) Complete the table below to show the structural formula of the E and Z geometric isomers of compound **Y**.

Geometric isomer of compound Y	Structural formula
E	
Z	

[2]



(e) Compound **D** can be prepared in a reaction using hydrogen bromide.

Complete the mechanism for this reaction.

Reactants

Intermediates

Product



[5]

(f) Compound **E** is a ketone and compound **F** is an aldehyde.

They are structural isomers.

(i) Explain why compounds **E** and **F** are structural isomers.

_____ [2]

(ii) State the IUPAC name of compound **E**.

_____ [1]

(iii) Describe a chemical test that could be carried out in a laboratory to show that compound **F** is an aldehyde.

State the expected observations for a positive test.

_____ [4]

[Turn over



3 Nylon and polythene are polymers that have many important uses.

(a) There are various forms of nylon.

Nylon-6,6 is made from the monomer 1,6-diaminohexane.

Nylon-4,6 is made from the monomer 1,4-diaminobutane.

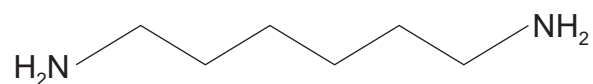
(i) Define the term **monomers**.

_____ [1]

(ii) Name the type of polymerisation reaction used to prepare nylon-6,6.

_____ [1]

(iii) The skeletal formula of 1,6-diaminohexane is given below.



Suggest the **structural formula** of 1,4-diaminobutane.

[1]



(b) Polythene is made from an alkene monomer.

Write a balanced structural equation to represent the polymerisation reaction used to produce polythene.

_____ [2]

(c) Polythene is chemically inert.

One of the waste management strategies used to deal with polythene waste is incineration.

This can lead to air pollution.

(i) State two other waste management strategies used to deal with polythene waste.

1. _____

2. _____ [2]

(ii) The development of biodegradable polymers has helped to improve sustainability and to reduce the air pollution caused by the incineration of polythene and other polymer waste.

Define the term **biodegradable polymer**.

_____ [1]

(iii) State one other way in which chemists are attempting to reduce the air pollution caused by the incineration of polythene and other polymer waste.

_____ [1]

[Turn over



4 Four alcohols, **K**, **L**, **M** and **N**, all have the molecular formula, C_4H_9OH .

(a) Alcohol **K** is a primary alcohol with a straight chain.

Draw the skeletal formula of alcohol **K** and state its IUPAC name.

Skeletal formula

IUPAC name _____ [2]

(b) Alcohol **L** is butan-2-ol.

It is a secondary alcohol.

(i) Define the term **secondary alcohol**.

_____ [1]

(ii) Name a suitable reagent that can be used to oxidise alcohol **L**.

_____ [2]

(iii) Write a balanced structural equation, using [O] to represent a suitable oxidising agent, for the oxidation of alcohol **L**.

_____ [2]



(c) Alcohol **M** is 2-methylpropan-1-ol.

It can be oxidised in separate reactions to form organic compounds **T** and **U**.

Compound **T** is obtained when the oxidation is carried out under reflux with excess oxidising agent. Compound **U** is obtained by distilling it off as soon as it forms.

(i) Draw the structural formula of alcohol **M**.

_____ [1]

(ii) Classify alcohol **M** as primary, secondary or tertiary.

_____ [1]

(iii) Identify the homologous series to which compound **T** belongs.

_____ [1]

(iv) Draw the skeletal formula of compound **T**.

[1]

(v) State the molecular formula and IUPAC name of compound **U**.

Molecular formula _____

IUPAC name _____ [2]

[Turn over



(d) Alcohol **N** is 2-methylpropan-2-ol.

It cannot be oxidised.

(i) State why alcohol **N** cannot be oxidised.

_____ [1]

(ii) Name the reagent and state the IUPAC name of a suitable halogenoalkane that could be used to prepare alcohol **N**.

Reagent _____

Halogenoalkane _____ [2]





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[Turn over



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[6]

(ii) Name a technique that could be used to purify laboratory prepared aspirin.

[1]

(iii) At the end of the purification process the crystals of pure aspirin are separated from the remaining liquid by vacuum filtration.

Draw a labelled diagram of the assembled apparatus used for vacuum filtration.

[4]

[Turn over



(b) A student hypothesised that the aspirin they had prepared was pure.

To test this hypothesis, they placed a small sample of their aspirin in a test tube and dissolved it using distilled water.

They then added a few drops of a pale yellow solution.

The mixture turned violet.

(i) Suggest the name of the pale yellow solution.

_____ [1]

(ii) State what the student should conclude about the purity of the aspirin they prepared.

_____ [1]

(iii) State the name of another laboratory technique that could be used to test their hypothesis.

_____ [1]



- (c) An alternative method used to prepare aspirin in the laboratory uses salicylic acid and ethanoyl chloride.

The equation for this reaction and the relative molecular mass of each of the reactants and products are given below.



**Relative
molecular
mass**

138

78.5

180

36.5

A sample of aspirin was prepared using 3.05 g of salicylic acid and 2.50 g of ethanoyl chloride.

The yield of aspirin was 3.10 g.

- (i) The molar ratio of the reactants in the equation is 1:1.
Show that the ethanoyl chloride was in excess.

[2]

- (ii) Calculate the percentage yield of aspirin.
Show your working out.

_____ % [3]

[Turn over



6 This question is about the analysis of two organic compounds, **Q** and **R**.

(a) Elemental analysis was carried out on compound **Q**, a straight chain organic compound.

The following percentage composition by mass was recorded.

Element	Percentage composition by mass /%
C	62.069
H	10.345
O	27.586

(i) Show that the empirical formula of compound **Q** is C_3H_6O .

[4]

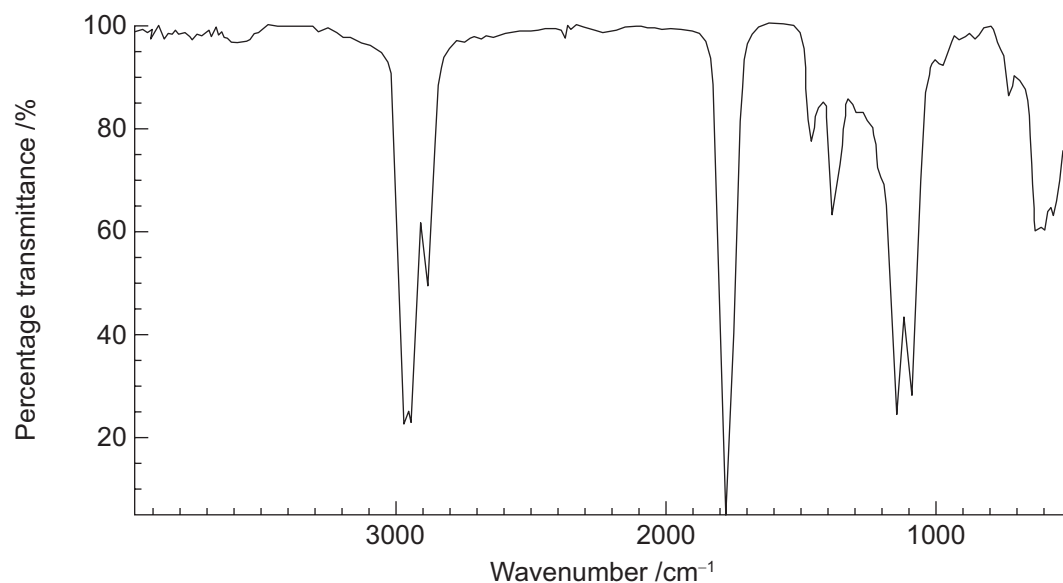
(ii) The relative molecular mass of compound **Q** is 116.

Determine the molecular formula of compound **Q**.
Show your working out.

Molecular formula _____ [2]



(iii) The infrared spectrum of compound **Q** and infrared bond absorbance data are shown below.



Source: Principal Examiner

Wavenumber /cm ⁻¹	Bond	Compound
750 – 1100	C–C	Alkanes, alkyl groups
1000 – 1300	C–O	Alcohols, carboxylic acids
1600 – 1700	C=C	Alkenes
1650 – 1800	C=O	Carboxylic acids, aldehydes, ketones
2500 – 3200	O–H	Carboxylic acid
2750 – 2850	C–H	Aldehydes
2850 – 3000	C–H	Alkanes, alkyl groups, alkenes
3200 – 3600	O–H	Alcohols

Source: CCEA

Identify the homologous series to which compound **Q** belongs.

Explain your reasoning.

Homologous series _____

Reasoning _____

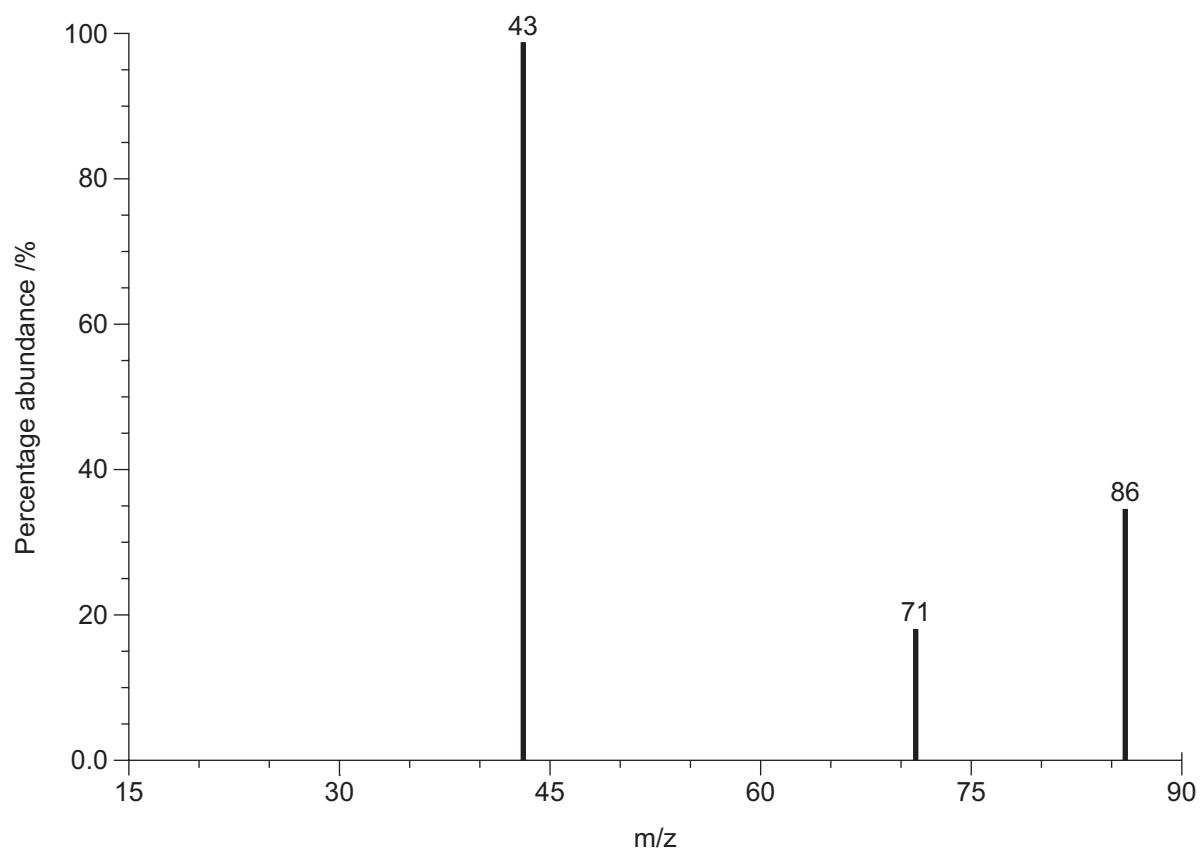
[3]

[Turn over



(b) Compound **R** is a branched chain ketone with the molecular formula $C_5H_{10}O$.

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



Source: Principal Examiner

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- (i) Complete the table below to show the molecular formulae of the ion fragments that cause the peaks at the m/z values indicated.

m/z value	Molecular formula of ion fragment
43	$C_2H_3O^+$
71	
86	

[2]

- (ii) Determine the structural formula and the IUPAC name of the branched chain ketone, **R**.

Structural formula

IUPAC name _____

[2]

THIS IS THE END OF THE QUESTION PAPER



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Question Number	Marks
1	
2	
3	
4	
5	
6	

Total Marks	
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Examiner Number

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AS 3 and A2 2
Periodic Table of the Elements

For the use of candidates taking
Advanced Subsidiary and
Advanced Level Examinations

**Copies must be free from notes or additions of any
kind. No other type of data booklet or information
sheet is authorised for use in the examinations**

gce a/as examinations
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sciences

THE PERIODIC TABLE OF ELEMENTS

Group

I	II											III	IV	V	VI	VII	0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H Hydrogen 1																	4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La * Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac † Actinium 89	261 Rf Rutherfordium 104	262 Db Dubnium 105	266 Sg Seaborgium 106	264 Bh Bohrium 107	277 Hs Hassium 108	268 Mt Meitnerium 109	271 Ds Darmstadtium 110	272 Rg Roentgenium 111	285 Cn Copernicium 112						
			140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	145 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71	
			232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	242 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	245 Bk Berkelium 97	251 Cf Californium 98	254 Es Einsteinium 99	253 Fm Fermium 100	256 Md Mendelevium 101	254 No Nobelium 102	257 Lr Lawrencium 103	

* 58–71 Lanthanum series

† 90–103 Actinium series

a	x
b	

a = relative atomic mass (approx)

x = atomic symbol

b = atomic number