Surname	Centre Number	Candidate Number
First name(s)		2



S23-B410U20-1



TUESDAY, 23 MAY 2023 – MORNING

CHEMISTRY – AS component 2 Energy, Rate and Chemistry of Carbon Compounds

1 hour 30 minutes

		For Examiner's use only		e only
		Question	Maximum Mark	Mark Awarded
	Section A	1. to 6.	10	
ADDITIONAL MATERIALS	Section B	7.	19	
In addition to this examination paper, you will need a:		8.	12	
• Data Booklet supplied by WJEC.		9.	9	
INSTRUCTIONS TO CANDIDATES		10.	16	
Use black ink or black ball-point pen. Do not use gel pen or correction fluid. You may use a pencil for graphs and diagrams only.		11.	14	
		Total	80	
Write your name, centre number and candidate	`		· · · · · · · · · · · · · · · · · · ·	

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer all questions.

Section B Answer all questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 80.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

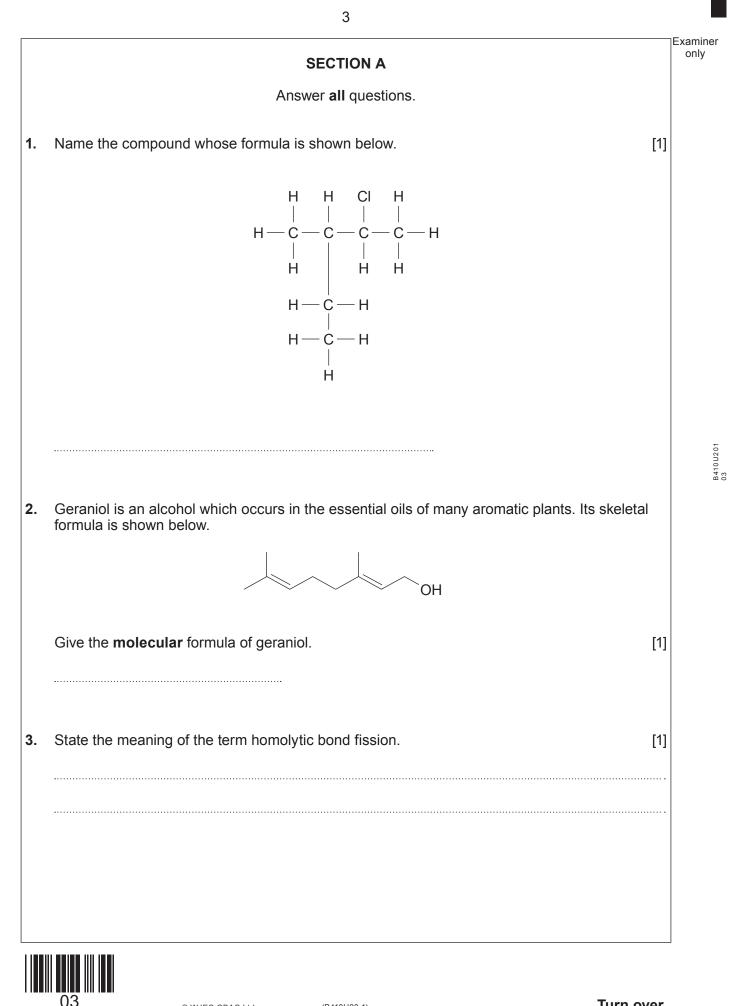
The assessment of the quality of extended response (QER) will take place in Q.9(a).



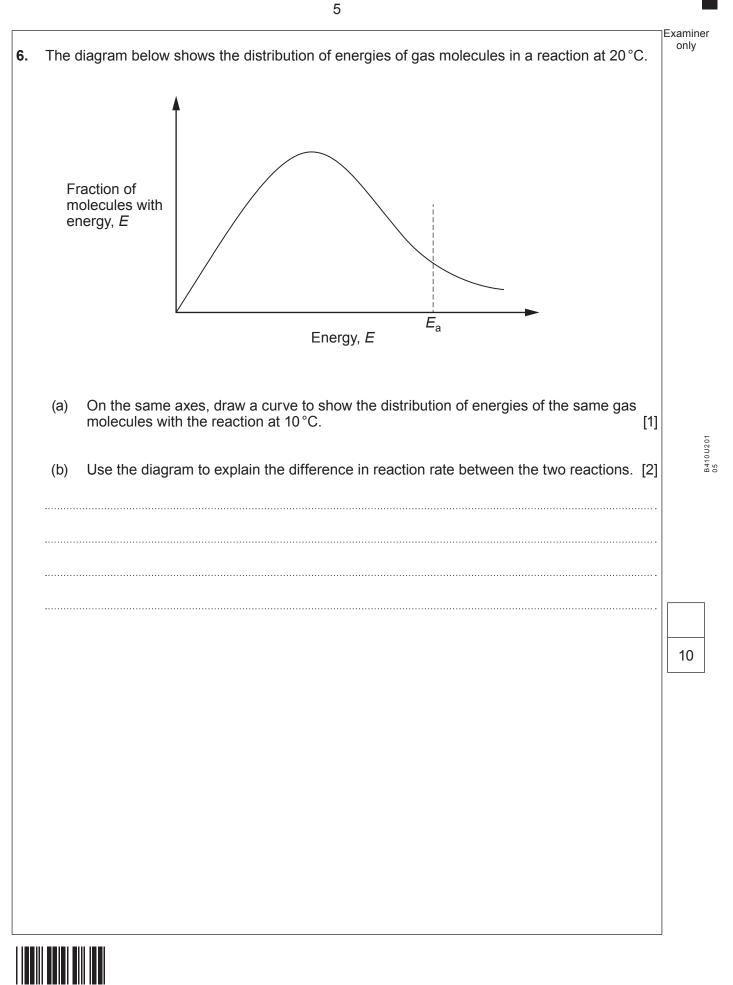
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		Examin
4.	Hydrofluorocarbons, HFCs, are synthetic compounds which have replaced chlorofluorocarbons, CFCs, as refrigerants in cooling systems because they do not deplete the ozone layer.	only
	Explain why HFCs do not deplete the ozone layer. [2]	
5.	Draw the structure of (<i>E</i>)-2-iodobut-2-ene. [2]	
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		6	
		SECTION B	Examin only
		Answer all questions.	
7.	(a)	Propan-2-ol is the simplest example of a secondary alcohol. It is a common ingredient in many antiseptics.	n
		A student carried out an experiment to determine the enthalpy change of combustion of propan-2-ol.	
		A spirit burner containing propan-2-ol was placed under a beaker containing 100 cm ³ of water. The burner was ignited and the alcohol allowed to burn until the temperature of the water rose by 25.4 °C. After the burner had cooled it was found that 0.362 g of propan-2-ol had been burned.	
		(i) State what is meant by a secondary alcohol. [1]
		(ii) Write an equation for the complete combustion of propan-2-ol. [1	
		(iii) Calculate a value for the enthalpy change of combustion of propan-2-ol in kJ mol ⁻¹ . [4	-]
		$\Delta_{\rm c}H = \dots$ kJ mol ⁻	1

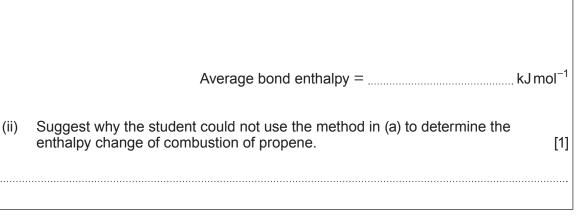


(iv)	The teacher said that the actual value for the enthalpy change of combustion of propan-2-ol is $-2006 \text{ kJ mol}^{-1}$.
	Calculate the percentage error in the student's experimental value. [1]
	Percentage error =%
(V)	Suggest one reason, other than heat loss, why the value obtained for the enthalpy change of combustion is smaller than the theoretical value. [1]



The equation for the combustion of propene is as shown. $\Delta_{\rm c} H^{\rm \theta} = -2058 \text{ kJ mol}^{-1}$ $C_{3}H_{6}(g) + 4\frac{1}{2}O_{2}(g) \longrightarrow 3CO_{2}(g) + 3H_{2}O(g)$ Use this and the average bond enthalpy values given in the table to calculate the average bond enthalpy for the O = O bond. (i) [4]

Bond	Average bond enthalpy/kJmol ⁻¹
c=c	612
C – C	348
С—Н	412
C=0	805
0—Н	463





(b)

Examiner only

to f	orm an	ol can react with ethanoic acid in the presence of concentrated sulfuric acie ester and water. This reaction is reversible so an equilibrium mixture is and the ester is removed by distillation.	d
(i)	Write	e the equation for the reaction between propan-2-ol and ethanoic acid.	
	Clea	rly show the structure of the ester formed.	[2]
(ii) 		ain fully why the ester can be separated from the equilibrium mixture by lation.	[2]
(iii)	I.	Explain why the yield of ester in the equilibrium mixture is increased by removing the ester.	[1]
	Π.	Concentrated sulfuric acid is a dehydrating agent. Suggest why the yield of ester in the equilibrium mixture is increased by adding concentrated sulfuric acid.	[1]



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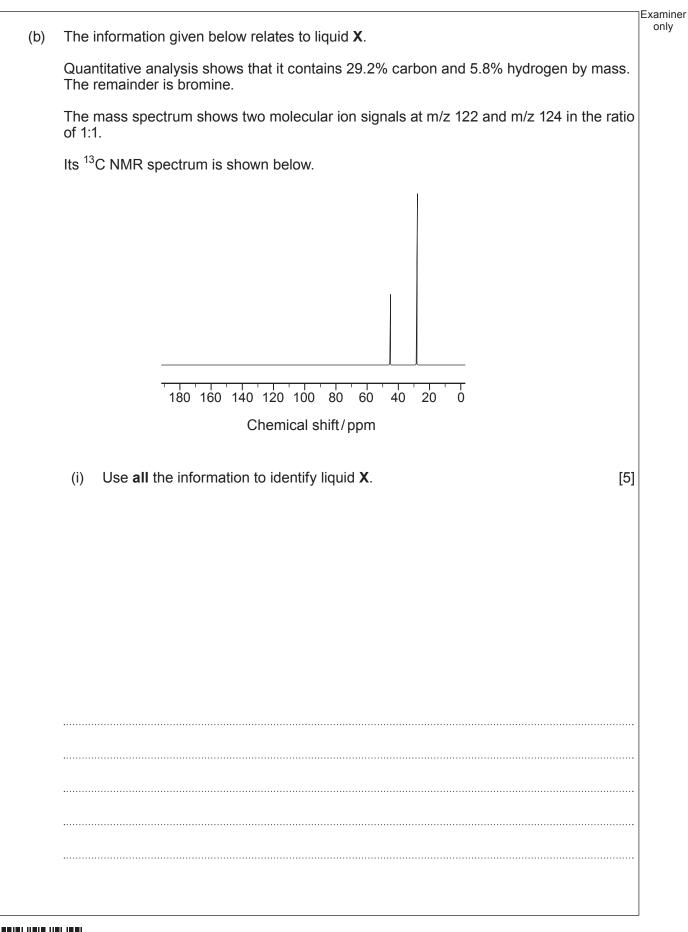


Examiner 8. Alkanes and alkenes are hydrocarbons. Alkanes can be obtained from fossil fuels such (a) as petroleum. Alkenes can be obtained by cracking long-chain hydrocarbons. They are more reactive than alkanes. (i) The use of fossil fuels to meet our energy needs has many disadvantages, but there are some benefits. Give one advantage of the use of fossil fuels. [1] Name a **solid** pollutant that may form if a fossil fuel is burned incompletely in air. (ii) [1] (iii) Explain why alkenes are more reactive than alkanes. [2] One molecule of decane, $C_{10}H_{22}$, can be cracked to give one molecule of pentane (iv) and two other products. Write an equation for this reaction. [1]

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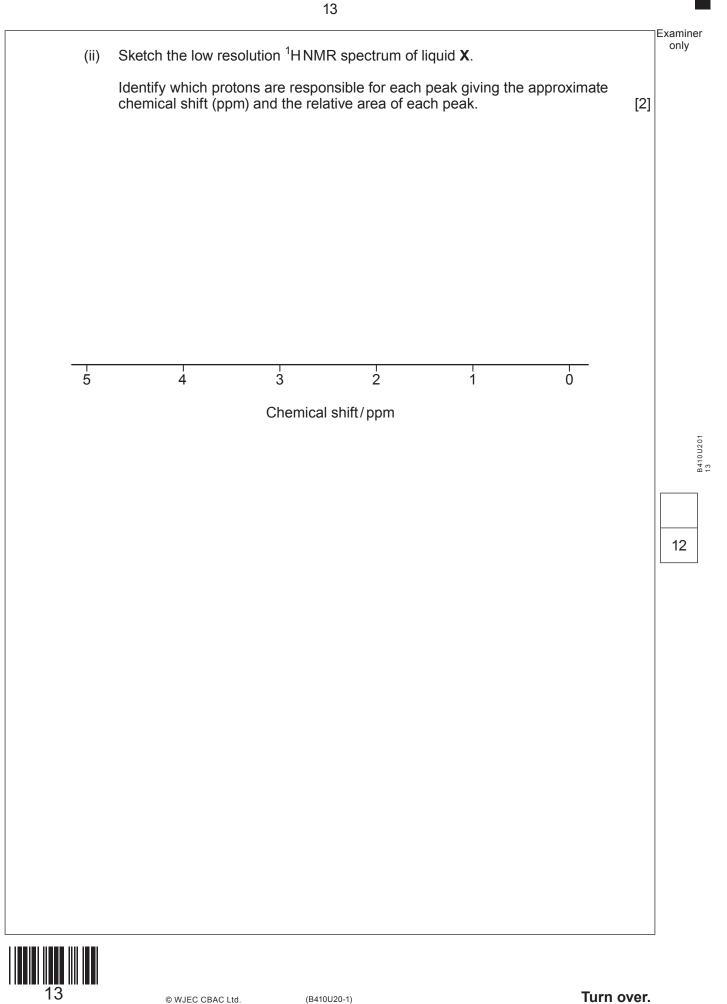


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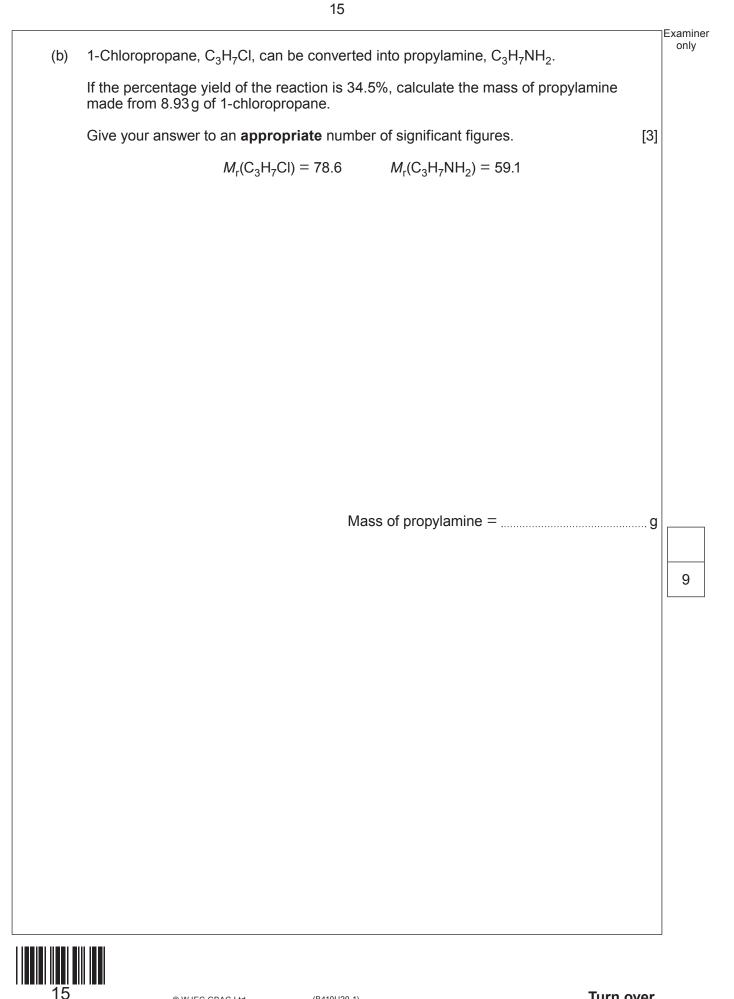




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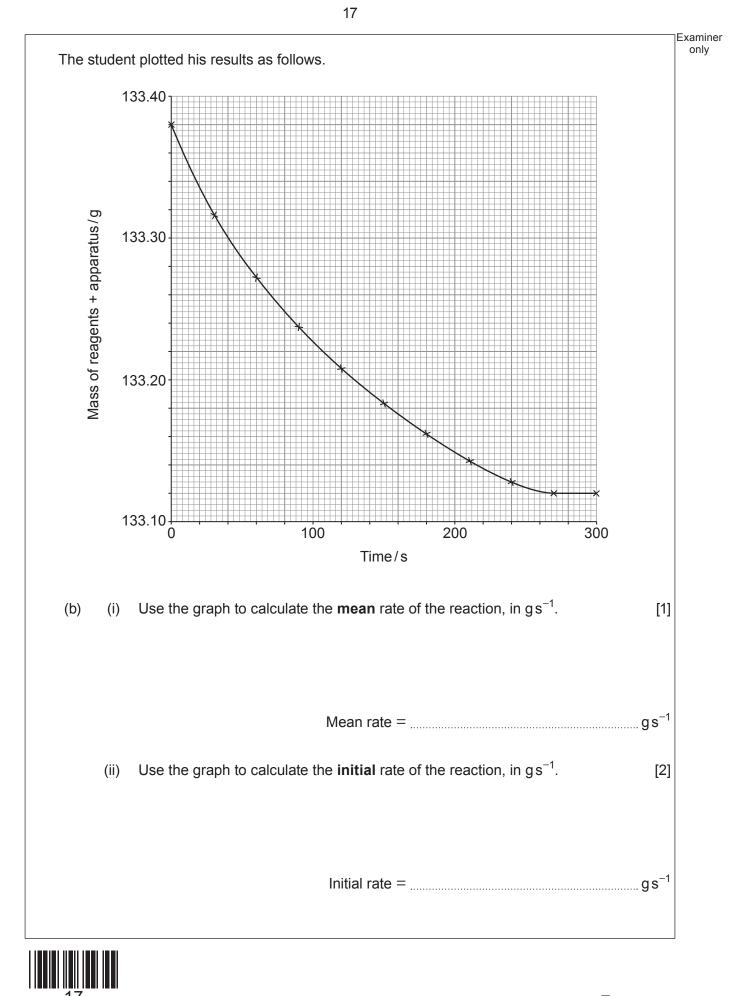


	1-chloropropane hex-1-ene propanoic acid
	1-chloropropane hex-1-ene propanoic acid
	Describe chemical tests, apart from the use of an indicator, that the student should carry out to positively identify each of the three liquids.
	You should include balanced equations for any reactions that occur. [6 QER]
• • • • • • • • •	



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		Examiner
10.	A student carried out an experiment to study the rate of the reaction between barium carbonate and hydrochloric acid.	only
	$BaCO_3$ + 2HCI \longrightarrow $BaCI_2$ + H_2O + CO_2	
	<i>M</i> _r 197	
	He started with 1.50 g of barium carbonate and 30.0cm^3 of 0.400 mol dm ⁻³ hydrochloric acid. The experiment was carried out at 25 °C and 1 atm.	
	He determined the rate by following the loss in mass over 5 minutes.	
	(a) State which reactant is in excess. Use the data given to justify your answer. [2]	
]
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(c)	(i)	Use the graph to describe how the rate of the reaction changes over the 5 minutes.	[1]
	(ii) 	Use collision theory to explain why the rate of this reaction changes as the reaction proceeds.	[2]
(d)		ine the method the student used to carry out this experiment. agram may be used in support of your answer.	[3]

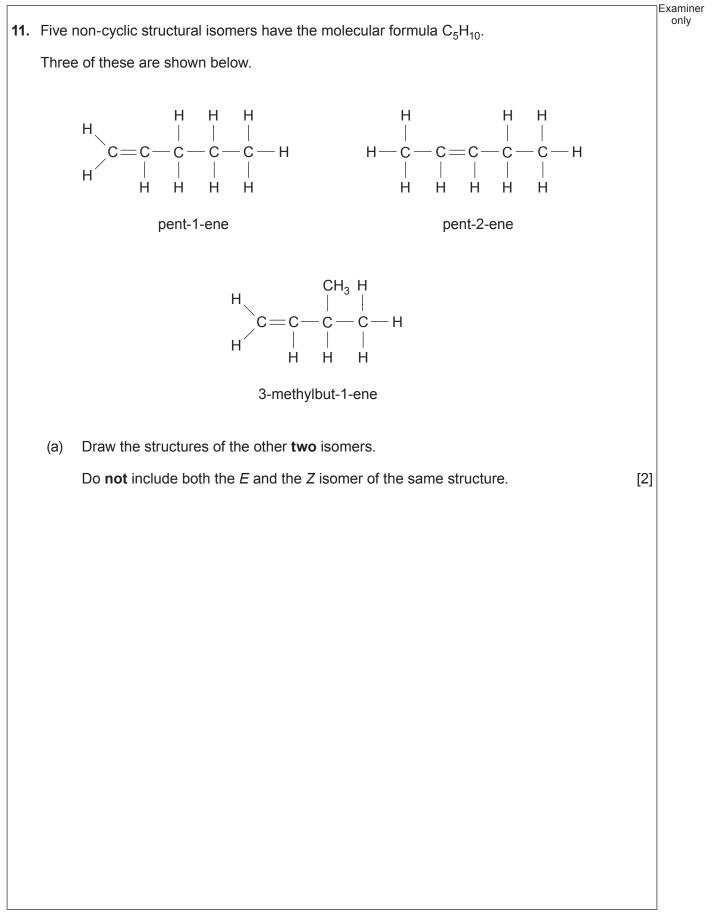


		Exan
(e)	Another method to follow this reaction is by measuring the volume of carbon dioxide produced over time.	on
	Name the apparatus you would use to collect the carbon dioxide.	[1]
(f)	Use the graph to calculate the volume (in cm^3) of carbon dioxide formed during this reaction at 25 °C.	
	You must show your working.	[2]
	Volume =	cm ³
(g)	Another student said that if you used the same mass of calcium carbonate instead o barium carbonate, the volume of carbon dioxide formed would be less because the relative formula mass of calcium carbonate is less.	f
	Is she correct? Justify your answer.	[2]
		1

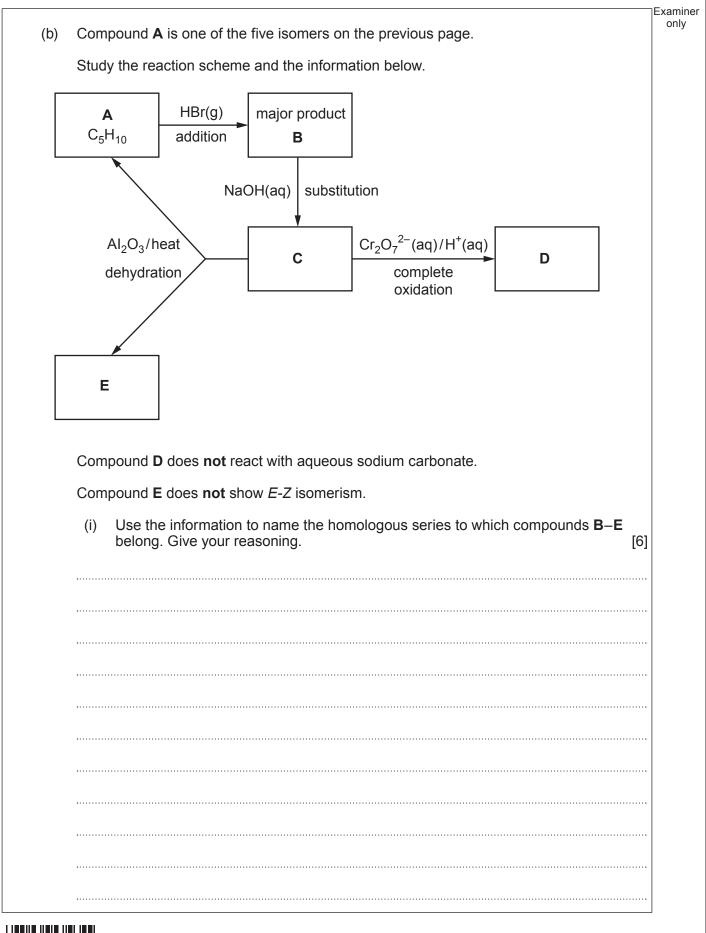














		Exami
(ii)	State what you would observe when compound C is oxidised to compound D .	[1] only
(iii)	Compound B can also undergo an elimination reaction.	
	State the reagent(s) and conditions needed for this reaction.	[1]
(iv)	Compound A can only be 3-methylbut-1-ene.	
	It cannot be pent-2-ene because its reaction with HBr would give two products significant quantities.	s in
	I. Explain why compound A cannot be pent-1-ene.	[2]
	 Explain why compound A cannot be either of the two isomers drawn in part (a). 	[2]
		······
		14
	END OF PAPER	
23	© WJEC CBAC Ltd. (B410U20-1)	over.

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.	Examine only



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TUESDAY, 23 MAY 2023 – MORNING

CHEMISTRY – AS component 2 Data Booklet

Avogadro constant
molar gas constant
molar gas volume at 273 K and 1 atm
molar gas volume at 298 K and 1 atm
Planck constant
speed of light
density of water
specific heat capacity of water
ionic product of water at 298 K
fundamental electronic charge

		22 1
		$6.02 \times 10^{23} \text{ mol}^{-1}$
R	=	8.31 J mol ⁻¹ K ⁻¹
V_m	=	22.4 dm ³ mol ⁻¹
V_m	=	$24.5 \text{ dm}^3 \text{ mol}^{-1}$
		$6.63 \times 10^{-34} \mathrm{Js}$
С	=	$3.00 \times 10^8 \mathrm{ms^{-1}}$
d	=	1.00 g cm ⁻³
		$4.18 \mathrm{Jg}^{-1}\mathrm{K}^{-1}$
		$1.00 \times 10^{-14} \text{ mol}^2 \text{dm}^{-6}$
e	=	1.60 × 10 ⁻¹⁹ C

temperature (K) = temperature (°C) + 273

 $1 \text{ dm}^3 = 1000 \text{ cm}^3$ $1 \text{ m}^3 = 1000 \text{ dm}^3$ 1 tonne = 1000 kg $1 \text{ atm} = 1.01 \times 10^5 \text{ Pa}$

Multiple	Prefix	Symbol	Multiple	Prefix	Symbol
10 ⁻⁹	nano	n	10 ³	kilo	k
10 ⁻⁶	micro	μ	10 ⁶	mega	М
10 ⁻³	milli	m	10 ⁹	giga	G

Infrared absorption values

Bond	Wavenumber/cm ⁻¹
C — Br	500 to 600
C - CI	650 to 800
C-O	1000 to 1300
C = C	1620 to 1670
C=0	1650 to 1750
$C \equiv N$	2100 to 2250
C - H	2800 to 3100
O—H (carboxylic acid)	2500 to 3200 (very broad)
O—H (alcohol / phenol)	3200 to 3550 (broad)
N - H	3300 to 3500

13 C NMR chemical shifts relative to TMS = 0

Type of carbon	Chemical shift, δ (ppm)
$-\overset{ }{\overset{c}{}}-\overset{ }{\overset{c}{}}-\overset{ }{\overset{c}{}}$	5 to 40
R — C — CI or Br	10 to 70
$\begin{array}{c} R - C - \overset{ }{C} - \overset{ }{C} \\ \parallel & \mid \\ O \end{array}$	20 to 50
$\mathbf{R} - \mathbf{C} - \mathbf{N}$	25 to 60
	50 to 90
]c=c	90 to 150
$R-C\equiv N$	110 to 125
	110 to 160
R — C — (carboxylic acid / es O	ster) 160 to 185
R — C — (aldehyde / ketone) O	190 to 220

¹ H NMR chemical shifts	relative to TMS = 0
Type of proton	Chemical shift, δ (ppm)
$-CH_3$	0.1 to 2.0
R-CH ₃	0.9
$R-CH_2-R$	1.3
$CH_3 - C \equiv N$	2.0
CH ₃ -C	2.0 to 2.5
$-CH_2-C$	2.0 to 3.0
	2.2 to 2.3
HC-CI or HC-Br	3.1 to 4.3
HC-O	3.3 to 4.3
R-OH	4.5 *
-C = CH	4.5 to 6.3
-C = CH - CO	5.8 to 6.5
CH=C	6.5 to 7.5
∕⊖∕−н	6.5 to 8.0
О ОН	7.0 *
О́—ОН R−С ^O H R−С ^O OH	9.8 *
R-COH	11.0 *

*variable figure dependent on concentration and solvent

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7 0	4.00 Helium 2	19.0 20.2 F F Ne Fluorine Neon 9 10	35.5 40.0 CI Ar Chlorine Argon 17 18	79.9 83.8 Br Kr Bromine Krypton 35 36	127 131 1 Xe lodine Xenon 53 54	(210) (222) At Rn Astatine Radon 85 86		175 Lu 71	(257) Lr
9	p block	16.0 Oxygen 8	32.1 S Sulfur 16	79.0 Selenium 34	128 Te Tellurium 52	(210) Po Polonium 84		173 Yb Ytterbium 70	(254) No
2	d q	14.0 Nitrogen	31.0 Phosphorus 15	74.9 As Arsenic 33	122 Sb Antimony 51	209 Bi 83		169 Tm Thulium 69	(256) Md
4		12.0 C Carbon 6	28.1 Silicon 14	72.6 Germanium 32	119 S0 50	207 Pb Lead 82		167 Er Erbium 68	(253) Fm
က	Ļ	10.8 B Boron 5	27.0 Aluminium 13	69.7 Ga Gallium 31	115 In 10 10 10 10	204 TI 81		165 Ho Holmium 67	(254) Es
			Î	65.4 Zn 30	112 Cadmium 48	201 Hg Mercury 80		163 Dy Dysprosium 66	(²⁵¹) Cf
				63.5 Cu Copper 29	n Ag Ag 47	197 Au 79 79	f block	159 Tb Terbium 65	(245) BK
				tt Nickel	106 Pd Palladium 46	195 Pt 78		157 Gadolinium 64	(247) Cm
			_	58.9 CO Cobalt 27	m Rhodium 45	192 Ir 77		m (153) Eu 63	(243) Am
Group	relative	 atomic mass atomic number 	block	55.8 Fe Iron 26	m Ruthenium	m Osmium 76		n Bamarium 62	(242) Pu
G	Key	Ar Symbol Z	q	m Manganese	98.9 TC technetium 43	186 Re 75		(147) Promethium 61	(237) Np
				n Chromium 24	95.9 Mo AO 42	n Tungsten		m Neodymium 60	C 238
				50.9 Vanadium 23	92.9 Nb Niobium 41	181 Ta Tantalum 73		141 Pr 59	(231) Pa
				Titanium	91.2 Zr Zirconium 40	Hf Hafnium 72		Cerium 58 58	232 Th
	*		↓ ↓	45.0 Sc 21	88.9 Yttrium 39	139 La Lanthanum 57	AC between the second s	 Lanthanoid elements 	Actinoid
N ock		9.01 Be Beryllium	24.3 Mg Magnesium 12	40.1 Ca Calcium 20	87.6 Sr 38	137 Ba Barium 56	(226) Radium 88	© Ľ ▲	*
1 s block	 A 1.01 Hydrogen 1 	6.94 Li Lithium 3	23.0 Na Sodium 11	39.1 K Potassium 19	85.5 Rb Rubidium 37	133 Cs Caesium 55	(223) Fr Francium 87		
Period	~	2	S	4	£	9	7		