GCE AS/A LEVEL

2410U20-1

FRIDAY, 27 MAY 2022 – AFTERNOON

CHEMISTRY – AS UNIT 2

ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

1 hour 30 minutes plus your additional time allowance

Surname: _____

First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

	For Examiner's use only		
	Question	Maximum Mark	Mark Awarded
SECTION A	1. to 5.	10	
SECTION B	6.	15	
	7.	17	
	8.	10	
	9.	12	
	10.	16	
	Total	80	

ADDITIONAL MATERIALS

In addition to this paper you will need a calculator.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Diagram Booklet.

The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball – point pen, black felt tip or your usual method.

Write your name, centre number and candidate number in the spaces on the front cover.

Answer ALL questions in SECTION A.
Answer ALL questions in SECTION B.

Write your answers in the spaces provided.
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.

Candidates are advised to allocate their time appropriately between SECTION A (10 MARKS) and SECTION B (70 MARKS).

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 Question 9 (c).

SECTION A

ANSWER ALL QUESTIONS.

1. Bromine water can be used to test for alkenes.

(a) (i) State the expected colour change for a positive test for alkenes.

_____

_____

[1 mark]

continued on the next page . . .

Question 1 (a) continued

1. (a) (ii) Draw the structure of the product formed when propene reacts with bromine water below.

SPACE FOR DIAGRAM:

[1 mark]

continued on the next page . . .

Question 1 continued

1. (b) Identify another reagent that can be used to test for the presence of alkenes.

_____

_____

[1 mark]

2. Bonds in hydrocarbons are formed by the overlap of orbitals between each atom.

(a) Draw an *s* – orbital and a *p* – orbital in the space below.

SPACE FOR DIAGRAM:

[1 mark]

continued on the next page . . .

Question 2 continued

2. (b) Look at the diagram for Question 2 (b) in the separate Diagram Booklet.
The diagram shows a simple organic molecule.

Name the type of bond shown in the diagram.

[1 mark]

3. A student suspects an unlabelled organic liquid is a carboxylic acid. Name the reagent(s) that must be added to the unknown organic liquid to test for the presence of a carboxylic acid. Give the expected observations for a positive result.

_____

_____

_____

_____

_____

_____

[2 marks]

4. Look at the diagram for Question 4 in the separate Diagram Booklet.

The diagram shows a generic organic molecule.

Complete the equation on the diagram to show the product of addition polymerisation.

[1 mark]

5. State the meaning of the term ‘standard enthalpy change of formation’.

_____

_____

_____

_____

_____

[2 marks]

Total for SECTION A = 10 marks

SECTION B

ANSWER ALL QUESTIONS.

6. Butanone can be prepared from but – 2 – ene using a three – step synthesis.

(a) Look at the diagram for Question 6 (a) in the separate Diagram Booklet.
The diagram represents the first step, but – 2 – ene is reacted with HBr to form 2 – bromobutane.

(i) CIRCLE the species in the diagram that represents the electrophile.

[1 mark]

continued on the next page . . .

Question 6 (a) continued

6. (a) (ii) Name the type of bond fission that takes place in the H — Br bond in the first step of the mechanism.

_____

_____

[1 mark]

continued on the next page . . .

Question 6 continued

6. (b) In the second step, 2 – bromobutane undergoes nucleophilic substitution to form butan – 2 – ol.

Look at the diagram for Question 6 (b) in the separate diagram booklet.
The diagram shows the structural formula equation for the reaction.

(i) Use curly arrows to complete the equation to show the mechanism of the nucleophilic substitution. Include any relevant partial charges.

[2 marks]

continued on the next page . . .

Question 6 (b) continued

6. (b) (ii) Give the reagents and conditions required for this nucleophilic substitution.

_____

_____

_____

[2 marks]

(iii) State the classification of alcohol to which butan – 2 – ol belongs.

_____

_____

[1 mark]

continued on the next page . . .

Question 6 continued

6. (c) In the final step, butan – 2 – ol is heated with acidified potassium manganate(VII) to produce butanone.

(i) State the role of the acidified potassium manganate(VII) in this reaction.

_____

_____

[1 mark]

continued on the next page . . .

Question 6 (c) continued

6. (c) (ii) Explain why butanone can be removed from the reaction as it is formed using distillation, leaving unreacted butan – 2 – ol in the reaction mixture.

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 6 continued

6. (d) Butan – 2 – ol can also be made directly by hydration of but – 2 – ene in the presence of dilute sulfuric acid, which acts as a catalyst.

Look at the diagram for Question 6 (d) in the separate Diagram Booklet. The diagram shows the structural formulae in this reaction.

(i) Suggest why the overall yield of the two – step synthesis is likely to be lower than the yield of the direct hydration.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 6 (d) continued

6. (d) (ii) Reaction of butan-2-ol with CONCENTRATED sulfuric acid results in the formation of three isomers with the formula C_4H_8.

I. Name the type of reaction used to form alkenes from alcohols.

_____

_____

[1 mark]

II. Look at the table for Question 6 (d) (ii) II. in the separate Diagram Booklet.

Give the structure and NAME of the three isomers formed in the table.

[3 marks]

(Total for Question 6 = 15 marks)

7. Petroleum ether **(50 – 70)** is a mixture of different alkanes extracted from crude oil which is commonly used as an organic solvent. The major components of petroleum ether **(50–70)** are the structural isomers of C_6H_{14}.

(a) (i) Give the meaning of the term 'structural isomer'.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 7 (a) continued

7. (a) (ii) Look at the table for Question 7 (a) (ii) in the separate Diagram Booklet.

Complete the table showing important information about the isomers of C_6H_{14}.

[3 marks]

(iii) State the relationship between the boiling temperature and the carbon chain length. Explain this relationship in terms of intermolecular forces.

_____

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 7 continued

7. (b) Hexane can be used as a fuel in a combustion reaction.

(i) Write an equation for the complete combustion of hexane in excess oxygen.

_____

_____

[2 marks]

continued on the next page . . .

Question 7 (b) continued

7. (b) (ii) The enthalpy change of combustion ($\Delta_c H^\theta$) for hexane is approximately $-4160\ kJ\ mol^{-1}$.

Explain why the enthalpy change of combustion for the isomers of hexane should be similar.

[2 marks]

continued on the next page . . .

Question 7 (b) continued

7. (b) (iii) 2, 2 – dimethylbutane is the isomer of C_6H_{14} which ignites most readily. Suggest a reason for this.

_____

_____

_____

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 7 (b) continued

7. (b) (iv) When hexane burns in a limited supply of oxygen it undergoes a different reaction known as incomplete combustion:

$$C_6H_{14} + 6.5O_2 \longrightarrow 6CO + 7H_2O$$

The bond enthalpy values for the bonds present in these molecules are given in the table below:

Bond	Average bond enthalpy / kJ mol^{-1}
C — C	348
C — H	413
O = O	495
C ≡ O (in CO)	1072
O — H	464

continued on the next page . . .

Question 7 (b) (iv) continued

7. (b) (iv) I. Using a Hess cycle or otherwise, calculate the enthalpy change of this reaction.

SPACE FOR WORKING:

enthalpy change = _____ kJ mol^{-1}

[3 marks]

continued on the next page . . .

Question 7 (b) (iv) continued

7. (b) (iv) II. Use THE ENTHALPY VALUES from parts (b) (ii) and (b) (iv) I. to explain quantitatively why it is important to maintain an excess of oxygen while burning hexane as a fuel.

[2 marks]

continued on the next page . . .

Question 7 (b) continued

7. (b) (iv) III. State a health hazard associated with the incomplete combustion of hexane.

_____

_____

_____

[1 mark]

(Total for Question 7 = 17 marks)

8. Compound A contains only carbon, hydrogen and an unknown halogen.

Refluxing compound A in aqueous sodium hydroxide followed by the addition of nitric acid and aqueous silver nitrate produces a white precipitate.

Elemental analysis of compound A indicates it contains 39.02% carbon and 3.25% hydrogen by mass.

When bromine is added to compound A, 123 g of compound A reacts with 320 g of bromine.

The ^{1}HNMR spectrum of compound A consists of only one peak.

The ^{13}CNMR spectrum of compound A consists of two peaks.

continued on the next page . . .

Question 8 continued

Look at Diagram 1 and Diagram 2 for Question 8 in the separate Diagram Booklet.

Diagram 1 shows the infrared spectrum and Diagram 2 shows the simplified mass spectrum.

Use ALL of the data provided to determine the identity of compound A.

Explain your answer using information from all of the data sources provided.

[10 marks]

(Total for Question 8 = 10 marks)

9. Chloe was investigating the effect of using catalysts on the rate of reaction.

She added $50\ cm^3$ of $0.1\ mol\ dm^{-3}$ iron(III) nitrate solution to $50\ cm^3$ of $0.2\ mol\ dm^{-3}$ sodium thiosulfate solution.

The reaction forms a deep violet iron(III) complex which is unstable and is gradually reduced to form a light green iron(II) complex.

Chloe monitored the rate of reaction by measuring the absorption of light at a wavelength of $500\ nm$ every 10 seconds for two minutes using a data logger.

continued on the next page . . .

Question 9 continued

9. (a) The violet complex appears black at the beginning of the reaction. State the name of the technique used to monitor the rate of reaction by measuring the absorption of light.

_____

_____

[1 mark]

continued on the next page . . .

Question 9 continued

9. (b) Chloe repeated the experiment three times adding $1\ cm^3$ of a different catalyst each time at a concentration $0.10\ mol\ dm^{-3}$.

Look at the diagram for Question 9 (b) in the separate Diagram Booklet.
The graph shows Chloe's results.

(i) State which catalyst is the most effective. Explain your answer.

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 9 (b) continued

9. (b) (ii) Calculate the initial rate of reaction for the reaction catalysed by the copper(II) ions.

SPACE FOR WORKING:

rate = _____ s^{-1}

[2 marks]

continued on the next page . . .

Question 9 (b) continued

9. (b) (iii) Each catalysed reaction contained the same number of moles of catalyst at the beginning of the reaction. Calculate the moles of catalyst left at the end of the reaction.

SPACE FOR WORKING:

moles = _____ mol

[1 mark]

continued on the next page . . .

Question 9 continued

9. (c) Increasing temperature and the addition of a catalyst are two ways of increasing the rate of a reaction.

Using your knowledge of the Boltzmann distribution and particle theory, explain how the rate of reaction is increased using these two different methods. You may use a diagram(s) to support your answer.

SPACE FOR DIAGRAM:

continued on the next page . . .

Question 9 (c) continued

[6 marks QER]

(Total for Question 9 = 12 marks)

10. The crystallisation of sodium ethanoate from a super – saturated solution is used to release heat in reusable hand warmers.

(a) A super – saturated solution of sodium ethanoate was made by dissolving 320 g of hydrated sodium ethanoate ($CH_3COONa.3H_2O$) in 60 cm^3 of hot water. It was then allowed to cool to room temperature, which was measured as 17°C.

A thermometer was added to the solution, which caused the sodium ethanoate to start crystallising. The temperature of the process was recorded every 30 seconds for 3 minutes.

continued on the next page . . .

Question 10 (a) continued

The results are shown in the table below:

Time / s	Temperature / °C
0	17
30	27
60	35
90	41
120	40
150	39
180	38

continued on the next page . . .

Question 10 (a) continued

Look at the diagram for Question 10 (a) in the separate Diagram Booklet.
The diagram is a grid.

(i) Plot the results from the table on the grid.

[2 marks]

(ii) Use your graph to calculate the maximum temperature change for this crystallisation.

SPACE FOR WORKING:

maximum temperature change

= _____ °C

[2 marks]

continued on the next page . . .

Question 10 (a) continued

10. (a) (iii) Use the TOTAL MASS of the sodium ethanoate solution and the temperature change from the graph to calculate the enthalpy change of crystallisation per mole of sodium ethanoate. Assume the density of water is $1.00\ g\ cm^{-3}$ and the specific heat capacity of sodium ethanoate solution is $4.18\ JK^{-1}\ g^{-1}$.

$$M_r\ (CH_3COONa.3H_2O) = 136$$

SPACE FOR WORKING:

continued on the next page . . .

SPACE FOR WORKING continued

enthalpy change = _____ kJ mol^{-1}

[4 marks]

10. (a) (iv) Suggest a reason why the experimental enthalpy change is often lower than the theoretical enthalpy change.

_____

_____

_____

[1 mark]

continued on the next page . . .

Question 10 continued

10. (b) Sodium ethanoate can be made in a neutralisation reaction.

Look at the equation for Question 10 (b) in the separate Diagram Booklet.

Complete the equation.

[2 marks]

continued on the next page . . .

Question 10 continued

10. (c) The carboxylic acid used to produce sodium ethanoate can be produced using an oxidation reaction.

(i) Name the reagents and give the expected observations.

_____

_____

_____

_____

_____

[2 marks]

continued on the next page . . .

Question 10 (c) continued

10. (c) (ii) Look at the diagram for Question 10 (c) (ii) in the separate Diagram Booklet.

A student proposed that the apparatus shown should be used to perform this oxidation reduction experiment.

continued on the next page . . .

Question 10 continued

The teacher said that this would not work and would be unsafe.

Draw a labelled diagram of the apparatus that should be used in this experiment.

SPACE FOR DIAGRAM:

[3 marks]

(Total for Question 10 = 16 marks)

END OF PAPER

TOTAL FOR PAPER = 80 MARKS

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

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

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

GCE AS/A LEVEL

2410U20-1

FRIDAY, 27 MAY 2022 – AFTERNOON

CHEMISTRY – AS UNIT 2

ENERGY, RATE AND CHEMISTRY OF CARBON COMPOUNDS

The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

Diagram Booklet

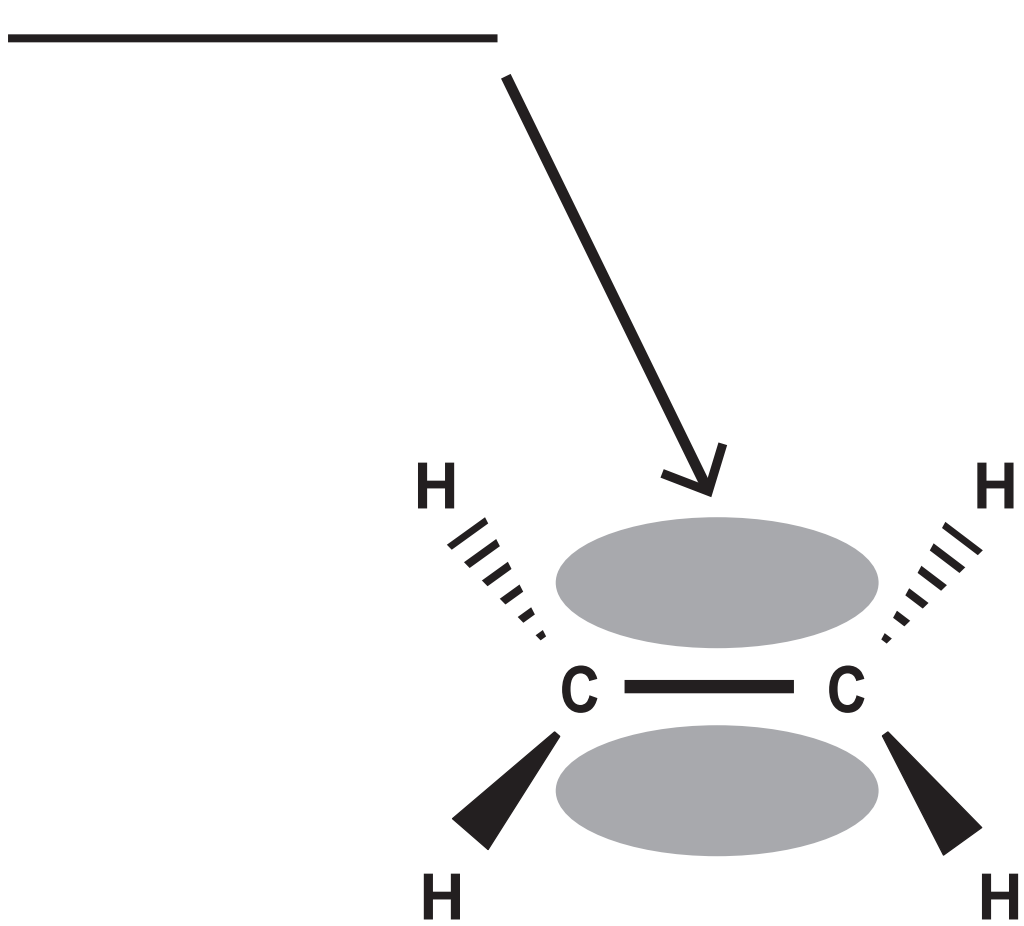
Surname: _____

First name(s): _____

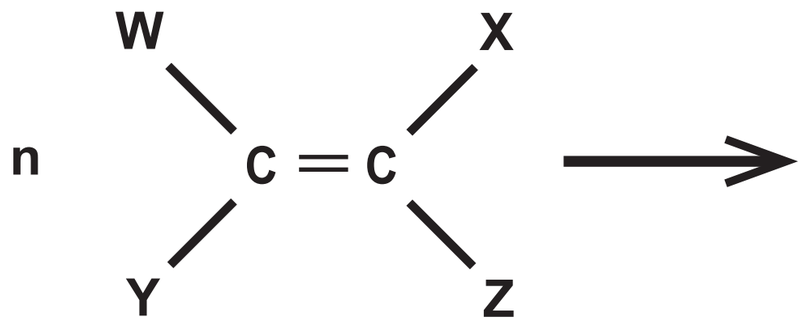
Centre Number: _____

Candidate Number: 2 _____

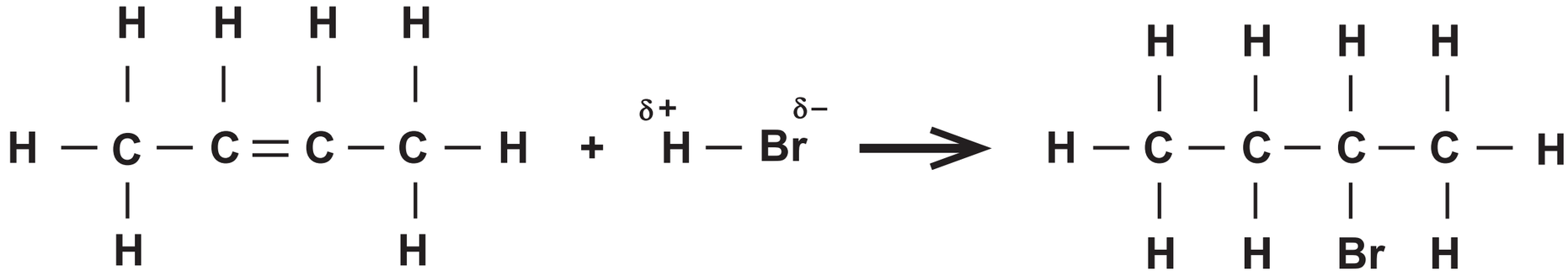
Question 2 (b)



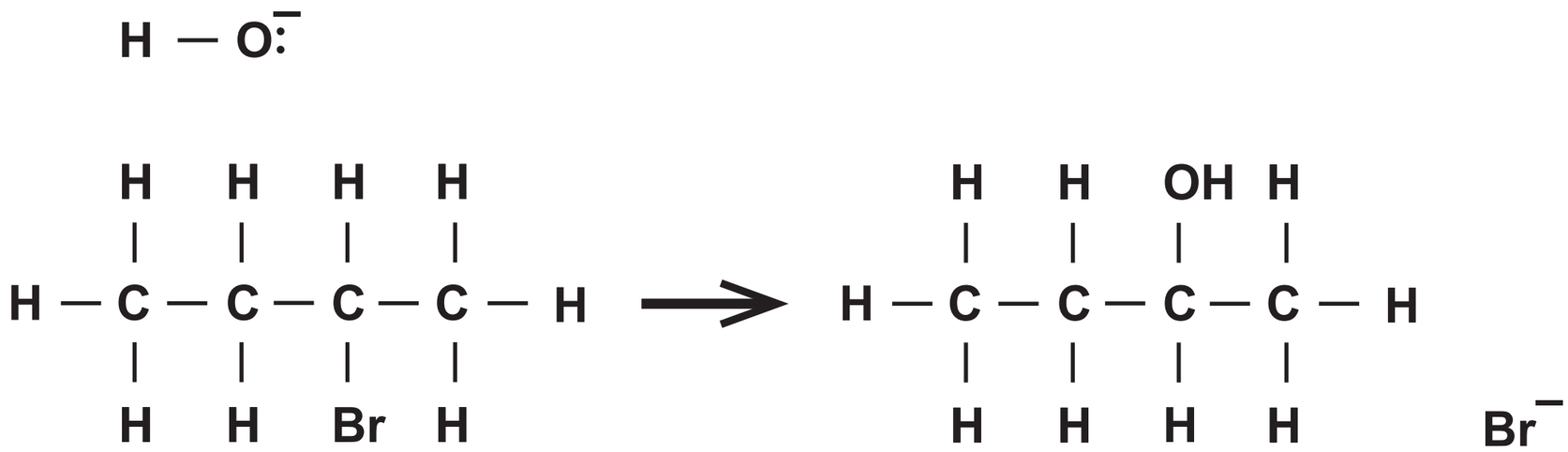
Question 4



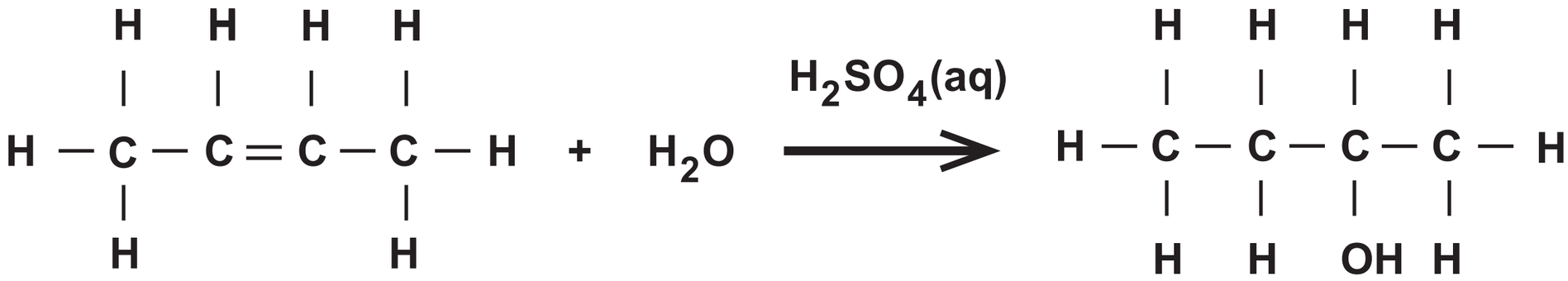
Question 6 (a)



Question 6 (b)



Question 6 (d)

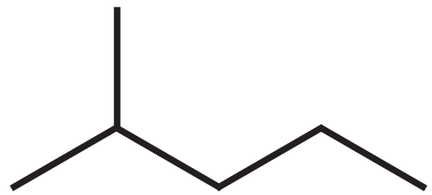
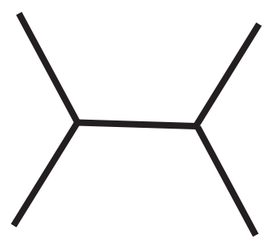
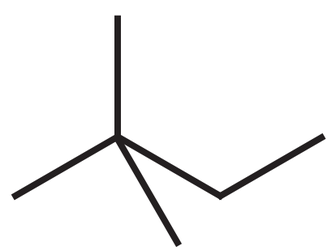


Question 6 (d) (ii) II.

Table

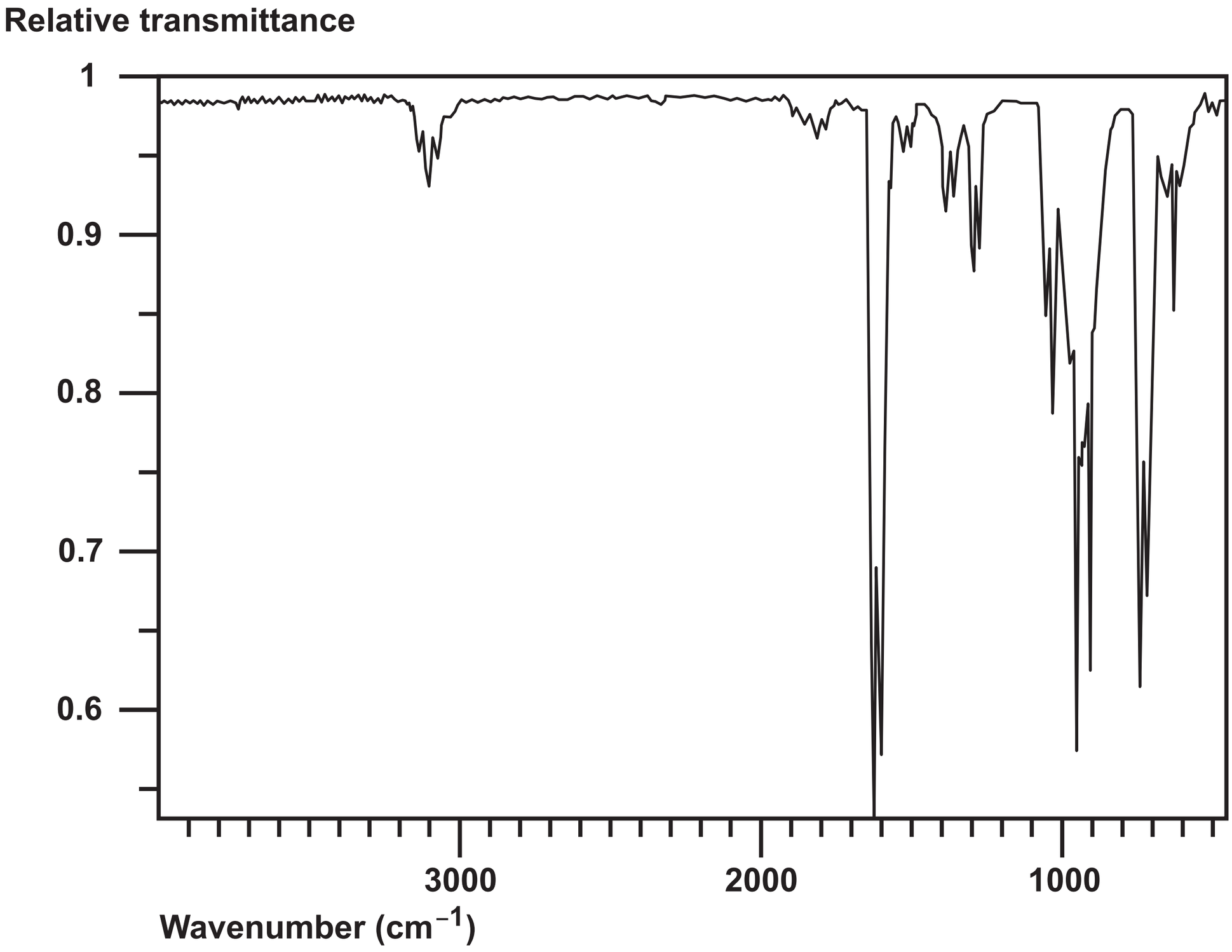
Structure	Structure	Structure
Name:	**Name:**	**Name:**

Question 7 (a) (ii)

Name	Shortened structural formula	Skeletal formula	Boiling temp / °C
hexane	$CH_3CH_2CH_2CH_2CH_2CH_3$		69
2 – methylpentane			62
3 – methylpentane	$CH_3CH_2CH(CH_3)CH_2CH_3$		63
	$(CH_3)_2CHCH(CH_3)_2$		58
2, 2 – dimethylbutane	$CH_3C(CH_3)_2CH_2CH_3$		50

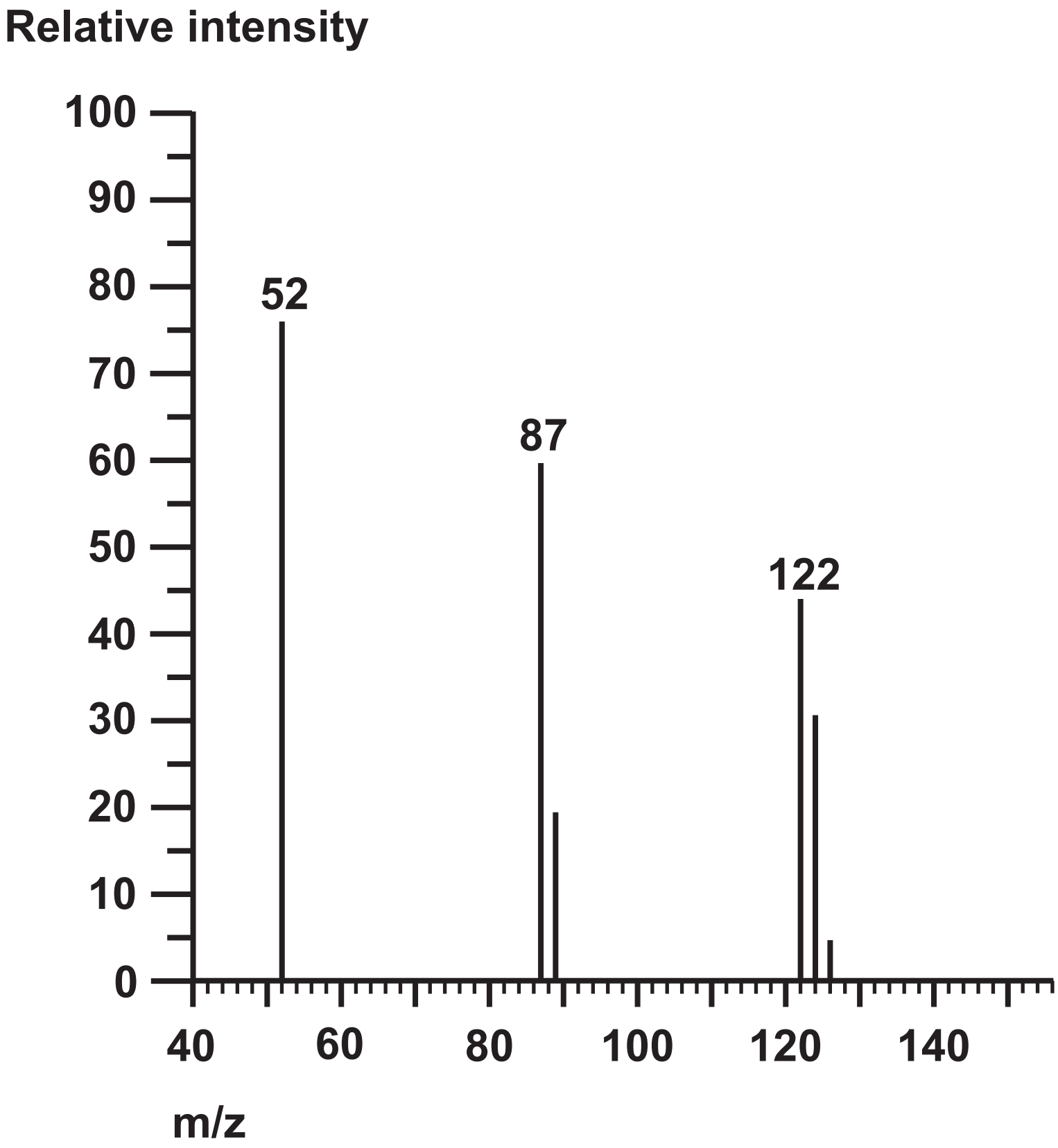
Question 8

Diagram 1: Infrared spectrum



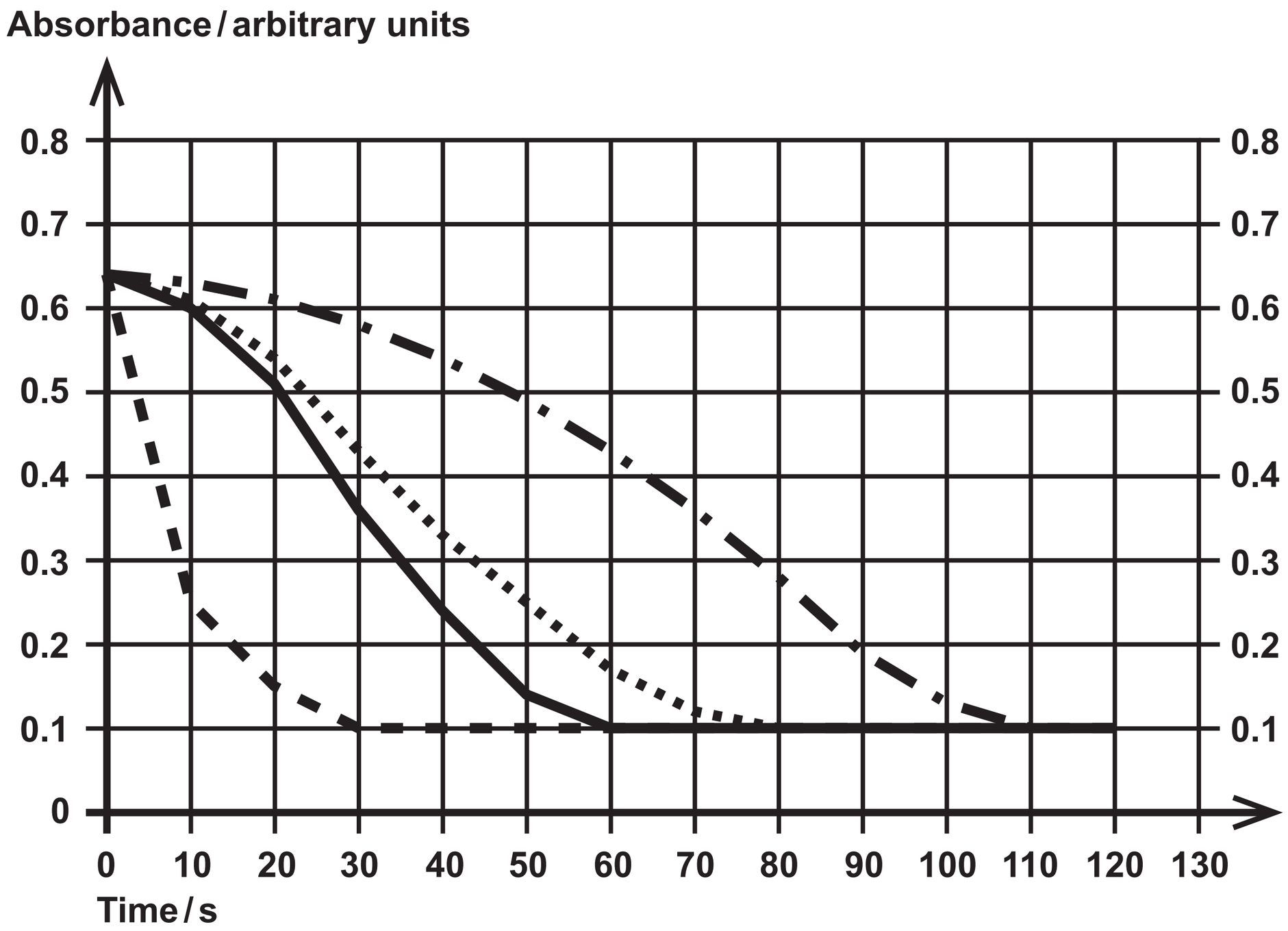
Question 8

Diagram 2: Mass spectrum



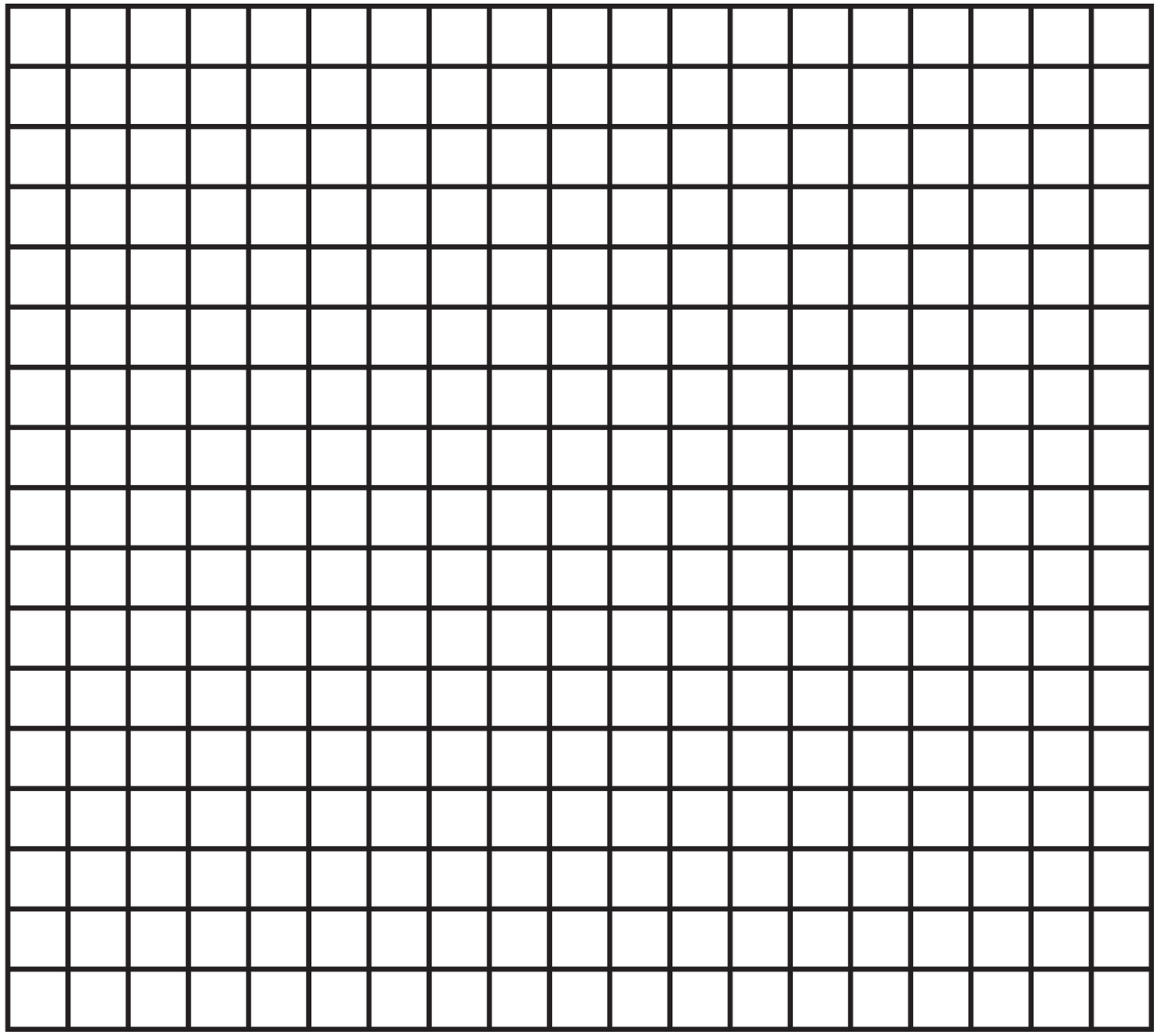
Question 9 (b)

Key: No catalyst; Fe^{2+}; Co^{2+}; Cu^{2+}



Question 10 (a)

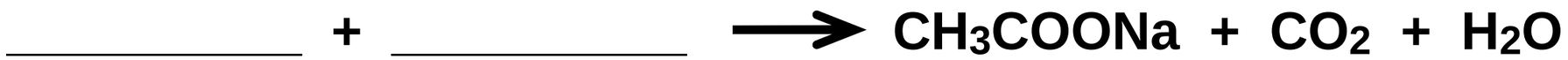
Temperature / °C



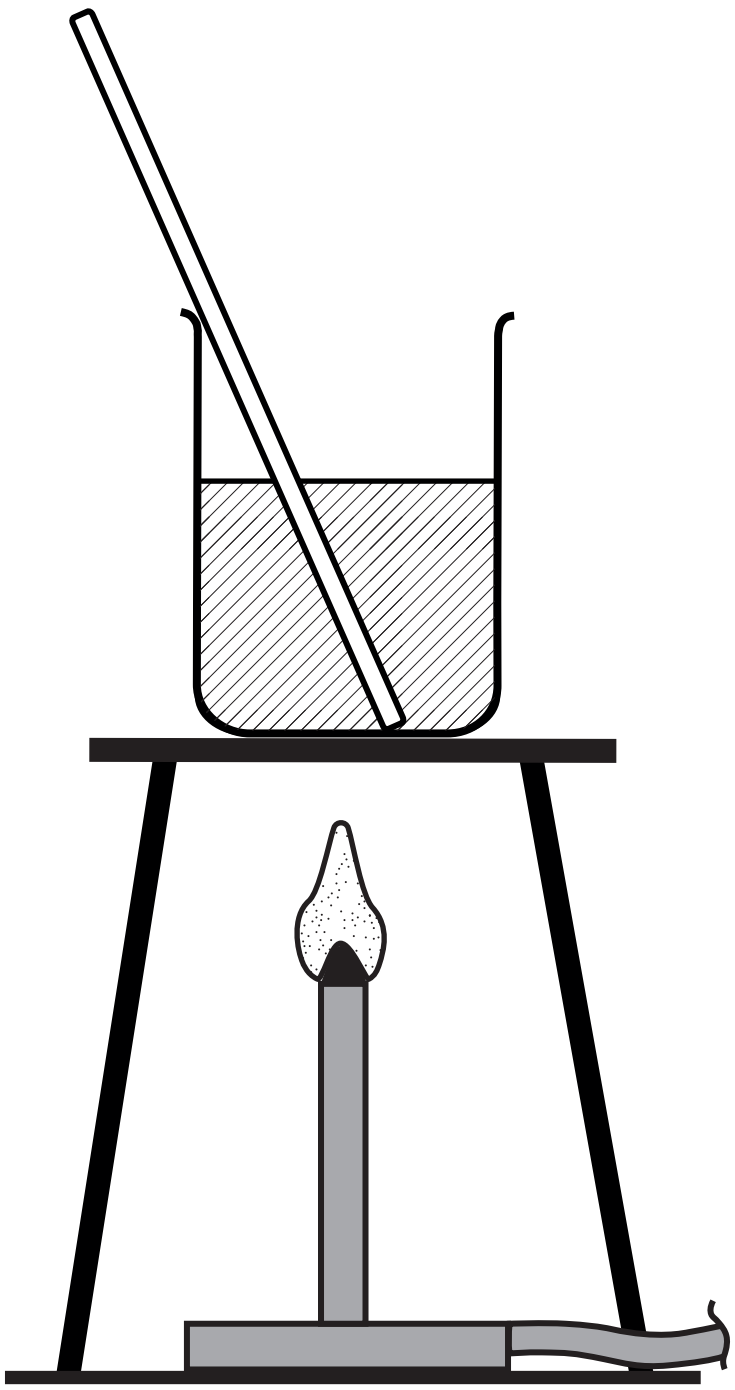
Time / s

Question 10 (b)

Equation



Question 10 (c) (ii)



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2410U20-1A

FRIDAY, 27 MAY 2022 – AFTERNOON

CHEMISTRY – AS unit 2

DATA BOOKLET

Avogadro constant	N_A	=	$6.02 \times 10^{23}\ \text{mol}^{-1}$
molar gas constant	R	=	$8.31\ \text{J mol}^{-1}\ \text{K}^{-1}$
molar gas volume at 273 K and 1 atm	V_m	=	$22.4\ \text{dm}^3\ \text{mol}^{-1}$
molar gas volume at 298 K and 1 atm	V_m	=	$24.5\ \text{dm}^3\ \text{mol}^{-1}$
Planck constant	h	=	$6.63 \times 10^{-34}\ \text{J s}$
speed of light	c	=	$3.00 \times 10^{8}\ \text{m s}^{-1}$
density of water	d	=	$1.00\ \text{g cm}^{-3}$
specific heat capacity of water	c	=	$4.18\ \text{J g}^{-1}\ \text{K}^{-1}$
ionic product of water at 298 K	K_w	=	$1.00 \times 10^{-14}\ \text{mol}^2\ \text{dm}^{-6}$
fundamental electronic charge	e	=	$1.60 \times 10^{-19}\ \text{C}$

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

$1\ \text{atm} = 1.01 \times 10^5\ \text{Pa}$

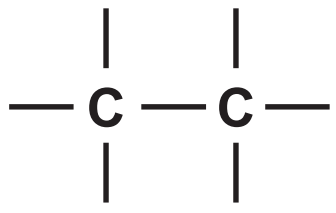
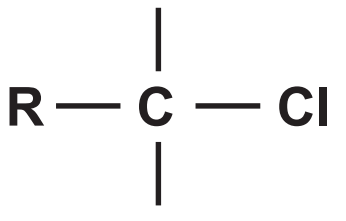
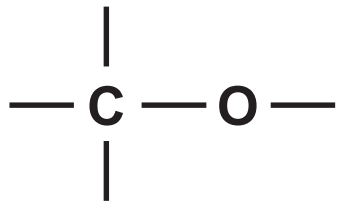
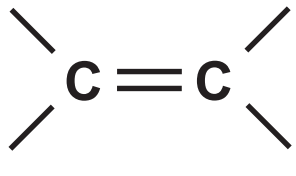
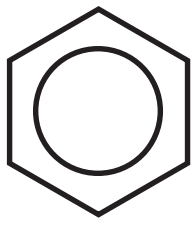
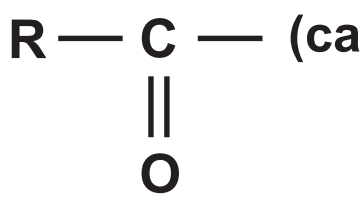
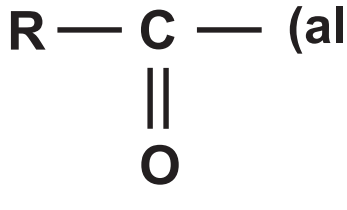
Multiple	Prefix	Symbol
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m

Multiple	Prefix	Symbol
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G

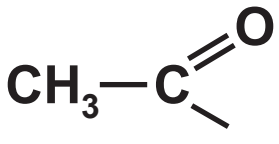
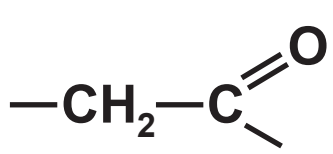
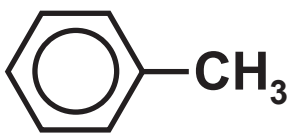
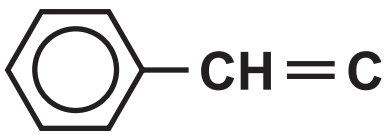
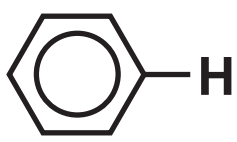
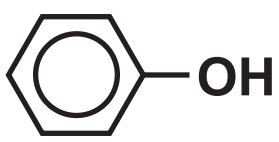
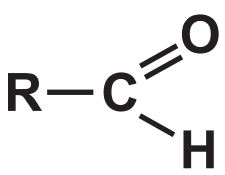
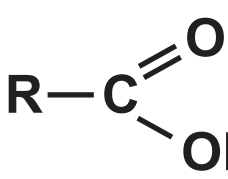
INFRARED ABSORPTION VALUES

BOND	WAVENUMBER / cm^{-1}
C — Br	500 to 600
C — Cl	650 to 800
C — O	1000 to 1300
C ═ C	1620 to 1670
C ═ O	1650 to 1750
C ≡ 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)
	5 to 40
 or 	10 to 70
	20 to 50
	25 to 60
	50 to 90
	90 to 150
	110 to 125
	110 to 160
 (carboxylic acid / ester)	160 to 185
 (aldehyde / ketone)	190 to 220

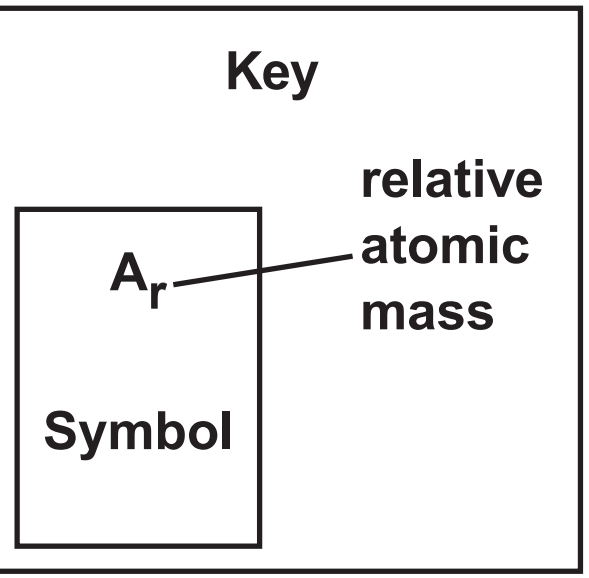
^{1}H NMR CHEMICAL SHIFTS RELATIVE TO TMS = 0

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
	2.0 to 2.5
	2.0 to 3.0
	2.2 to 2.3
HC—Cl 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
	6.5 to 7.5
	6.5 to 8.0
	7.0 *
	9.8 *
	11.0 *

*variable figure dependent on concentration and solvent

THE PERIODIC TABLE

Key



Period	Group 1	2										3	4	5	6	7	0
	s Block ↔		d Block ↔									p Block ↔					
1	1.01 H																4.00 He
2	6.94 Li	9.01 Be										10.8 B	12.0 C	14.0 N	16.0 O	19.0 F	20.2 Ne
3	23.0 Na	24.3 Mg										27.0 Al	28.1 Si	31.0 P	32.1 S	35.5 Cl	40.0 Ar
4	39.1 K	40.1 Ca	45.0 Sc	47.9 Ti	50.9 V	52.0 Cr	54.9 Mn	55.8 Fe	58.9 Co	58.7 Ni	63.5 Cu	65.4 Zn	69.7 Ga	72.6 Ge	74.9 As	79.0 Se	79.9 Br	83.8 Kr
5	85.5 Rb	87.6 Sr	88.9 Y	91.2 Zr	92.9 Nb	95.9 Mo	98.9 Tc	101 Ru	103 Rh	106 Pd	108 Ag	112 Cd	115 In	119 Sn	122 Sb	128 Te	127 I	131 Xe
6	133 Cs	137 Ba	139 La ►	179 Hf	181 Ta	184 W	186 Re	190 Os	192 Ir	195 Pt	197 Au	201 Hg	204 Tl	207 Pb	209 Bi	(210) Po	(210) At	(222) Rn
7	(223) Fr	(226) Ra	(227) Ac ►►															

f Block ↔

►Lanthanoid elements	140 Ce	141 Pr	144 Nd	(147) Pm	150 Sm	(153) Eu	157 Gd	159 Tb	163 Dy	165 Ho	167 Er	169 Tm	173 Yb	175 Lu
►►Actinoid elements	232 Th	(231) Pa	238 U	(237) Np	(242) Pu	(243) Am	(247) Cm	(245) Bk	(251) Cf	(254) Es	(253) Fm	(256) Md	(254) No	(257) Lr

THE PERIODIC TABLE – KEY

ATOMIC NUMBER – SYMBOL – NAME

1 H - Hydrogen	38 Sr - Strontium	75 Re - Rhenium
2 He - Helium	39 Y - Yttrium	76 Os - Osmium
3 Li - Lithium	40 Zr - Zirconium	77 Ir - Iridium
4 Be - Beryllium	41 Nb - Niobium	78 Pt - Platinum
5 B - Boron	42 Mo - Molybdenum	79 Au - Gold
6 C - Carbon	43 Tc - Technetium	80 Hg - Mercury
7 N - Nitrogen	44 Ru - Ruthenium	81 Tl - Thallium
8 O - Oxygen	45 Rh - Rhodium	82 Pb - Lead
9 F - Fluorine	46 Pd - Palladium	83 Bi - Bismuth
10 Ne - Neon	47 Ag - Silver	84 Po - Polonium
11 Na - Sodium	48 Cd - Cadmium	85 At - Astatine
12 Mg - Magnesium	49 In - Indium	86 Rn - Radon
13 Al - Aluminium	50 Sn - Tin	87 Fr - Francium
14 Si - Silicon	51 Sb - Antimony	88 Ra - Radium
15 P - Phosphorus	52 Te - Tellurium	89 Ac - Actinium
16 S - Sulfur	53 I - Iodine	90 Th - Thorium
17 Cl - Chlorine	54 Xe - Xenon	91 Pa - Protactinium
18 Ar - Argon	55 Cs - Caesium	92 U - Uranium
19 K - Potassium	56 Ba - Barium	93 Np - Neptunium
20 Ca - Calcium	57 La - Lanthanum	94 Pu - Plutonium
21 Sc - Scandium	58 Ce - Cerium	95 Am - Americium
22 Ti - Titanium	59 Pr - Praseodymium	96 Cm - Curium
23 V - Vanadium	60 Nd - Neodymium	97 Bk - Berkelium
24 Cr - Chromium	61 Pm - Promethium	98 Cf - Californium
25 Mn - Manganese	62 Sm - Samarium	99 Es - Einsteinium
26 Fe - Iron	63 Eu - Europium	100 Fm - Fermium
27 Co - Cobalt	64 Gd - Gadolinium	101 Md - Mendelevium
28 Ni - Nickel	65 Tb - Terbium	102 No - Nobelium
29 Cu - Copper	66 Dy - Dysprosium	103 Lr - Lawrencium
30 Zn - Zinc	67 Ho - Holmium	
31 Ga - Gallium	68 Er - Erbium	
32 Ge - Germanium	69 Tm - Thulium	
33 As - Arsenic	70 Yb - Ytterbium	
34 Se - Selenium	71 Lu - Lutetium	
35 Br - Bromine	72 Hf - Hafnium	
36 Kr - Krypton	73 Ta - Tantalum	
37 Rb - Rubidium	74 W - Tungsten	