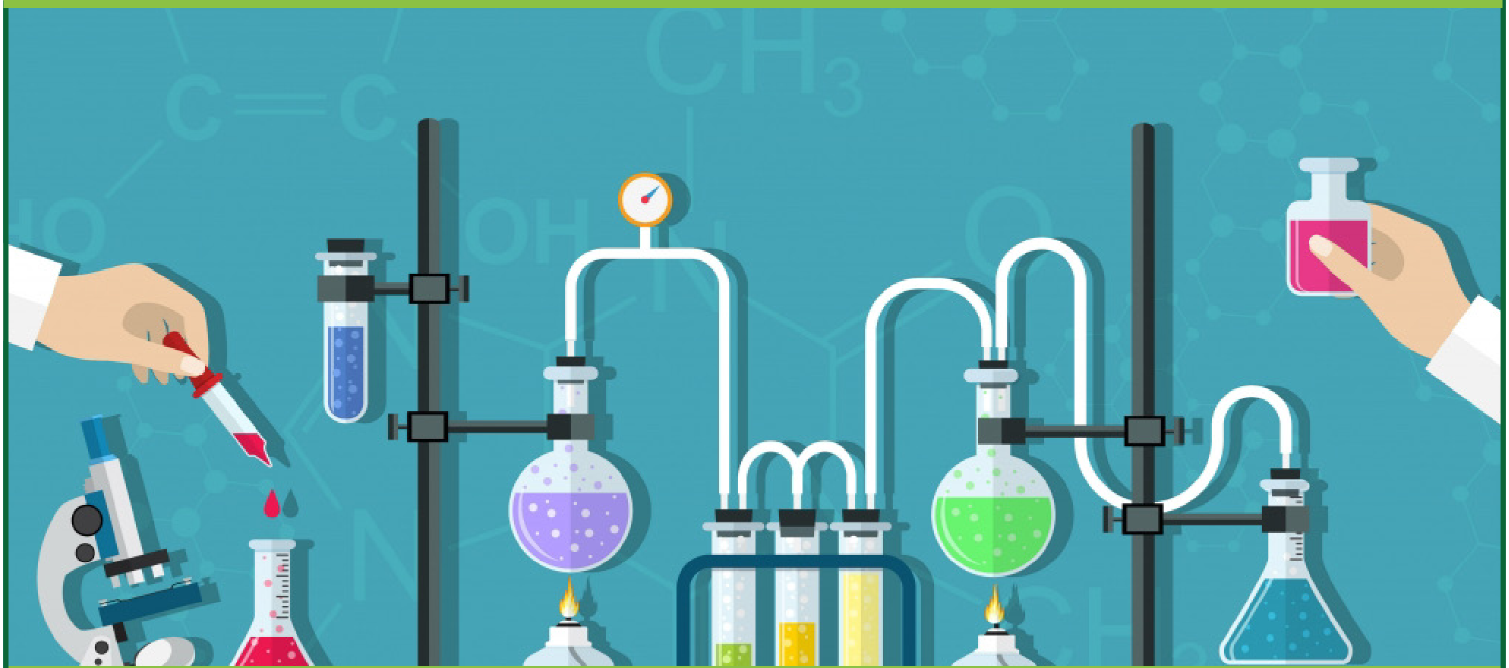
Bentley Wood
High School for Girls

Chemistry
GCSE to A level

Bridging Work
Year 11 into 12 for 2023/24



Name: ____________________

Tutor Group: ______________

Teacher: _________________________

Year 11 to 12 AS Level Chemistry Bridging Work

Welcome to Bentley Wood Chemistry!

Studying Chemistry provides you with a privileged insight to the processes that define our everyday world. The skills you will develop as a chemist are highly transferable enabling you to continue your academic trajectory in a multitude of different fields. You will use and develop powers of critical and creative thinking and demonstrate your chemical knowledge through a diverse range of practical experiments.

Course content

The course allows you to develop a myriad of skills in the classroom by seamlessly integrating these throughout the course topics. These can be in the form of practical work as well as presentational skills. Learning is sequenced to allow you to cumulatively build on your knowledge and take ownership of your learning as you progress from topic to topic. The innovative nature of Chemistry means that this field is constantly evolving, and our students are encouraged to complement their learning with wider, up-to-date research in order to expand their contextual appreciation of the subject.

Methods of study

Chemistry lessons are varied however, we aim to incorporate as many practical experiences as part of our lessons as possible. This is so that students can appreciate the concomitant link between theoretical chemical work and experimental research. This is particularly crucial for those continuing with scientific learning in higher education. You will receive regular feedback from class teachers throughout your studies and will also evaluate your learning through peer assessment, group work, class discussions, presentations, experimentation and research.

How will it be examined?

Our exam board is AQA and our students complete the Linear Chemistry qualification; the AS qualification will not count towards the final grade of an A Level. However, there are opportunities throughout the course for learning to be regularly examined and for you to reflect on where your learning currently stands and how to make progress going forward.

Career opportunities

A qualification in Chemistry is in high demand and will set you apart in any field you continue your studies in. Many courses such as medicine, engineering and dentistry require an A Level in Chemistry as a prerequisite for the course. What careers could you consider in the future with chemistry? Analytical Chemistry, Banking, Atmospheric Chemistry, Engineering, Forensic Science, Marine Chemistry, Medicinal Chemistry, Accounting, Medicine, Veterinary Medicine, and Patent Attorney – these are just a few! Many employers value the analytical and creative problem solving skills that are developed at Chemistry A-level.

Year 11 to 12 AS Level Chemistry Bridging Work

What is bridging work?

The bridging work has been designed to help you bridge the gap between your GCSE science studies and the AS Chemistry course. This work will be essential for you to complete prior to your studies with us in September.

Why is bridging work important?

Bridging work for AS/A Level chemistry is crucial to help you start approaching scientific problems creatively and innovatively as scientists do in everyday life! This work should also help you gauge whether this is the best subject choice for you – you only have four choices so getting this right will be important for your academic career in sixth form.

This booklet is separated into two sections:

1. Section 1: Subject based knowledge – aimed at building cumulatively on your GCSE chemistry knowledge.
2. Section 2: Skills based knowledge – transferable skills that are vital for your success at A Level chemistry.

There will also be an optional research task to complete for those who would like to stretch their learning even further before our September start!

Is the bridging work assessed?

In short – yes! This will be the first assessed piece of work your AS teacher will mark. It will enable us to understand your strengths and your areas for improvement. It will also provide us with the opportunity to gauge your work ethic and whether this is to the standard we would expect to see at AS/A Level Chemistry.

AS/A Level Chemistry

Studying AS/A Level Chemistry will develop your organisational skills as well as your subject knowledge. You will need to have the ability to work well autonomously as we will expect additional reading around topics – this will ensure you can perform the best you can throughout your studies.

Across the two-week timetable, you will have twelve fifty minute lessons where we will be embedding theoretical learning with practical work. This will enable you to prepare for undergraduate practical skills in Higher Education should you choose to continue your studies in chemistry.

We study AQA A Level Chemistry at Bentley Wood. To support your learning, you will have access to digital Chemistry A Level textbooks to compliment your studies. There are other resources we recommend to supplement and extend your learning and revision during the exam periods:

- https://www.physicsandmathstutor.com/chemistry-revision/
- https://www.savemyexams.co.uk/a-level-chemistry-aqa/
- https://www.chemguide.co.uk/
- The Royal Society of Chemistry (rsc.org)
- https://www.cgpbooks.co.uk/secondary-books/as-and-a-level/science/chemistry/car73-a-level-chemistry-aqa-year-1-2-complete-revi
- Recommended podcasts for wider learning: https://www.chemistryworld.com/podcasts
- Recommended reading: Chemistry Review

Year 11 to 12 AS Level Chemistry Bridging Work

Section 1: Subject Based Knowledge

Q1.

A student investigated the reactions of copper carbonate and copper oxide with dilute hydrochloric acid.

In both reactions one of the products is copper chloride.

(a) A student wanted to make 11.0 g of copper chloride. The equation for the reaction is:

$$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$$

Calculate the mass of copper carbonate the student should react with dilute hydrochloric acid to make 11.0 g of copper chloride.

____

____

____

Mass of copper carbonate = ___________________________ g

(4)

(b) The percentage yield of copper chloride was 79.1 %.

Calculate the mass of copper chloride the student actually produced.

____

____

Actual mass of copper chloride produced = _____________ g

(2)

(c) Look at the equations for the two reactions:

Reaction 1 $CuCO_3(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l) + CO_2(g)$

Reaction 2 $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$

The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula masses of all reactants from equation}} \times 100$$

Calculate the percentage atom economy for Reaction 2.

____

____

____

____

____

____

Percentage atom economy = ________________________ %

(3)

(d) The atom economy for Reaction 1 is 68.45 %.
Compare the atom economies of the two reactions for making copper chloride.

Give a reason for the difference.

____

____

(1)
(Total 10 marks)

Q2.

This question is about Group 7 elements.

Chlorine is more reactive than iodine.

(a) Name the products formed when chlorine solution reacts with potassium iodide solution.

____

____

(1)

(b) Explain why chlorine is more reactive than iodine.

____

____

____

____

____

____

(3)

(c) Chlorine reacts with hydrogen to form hydrogen chloride.

Explain why hydrogen chloride is a gas at room temperature.

Answer in terms of structure and bonding.

___

___

___

___

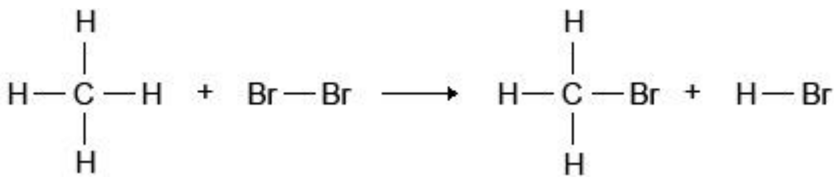
___

___

(3)

(d) Bromine reacts with methane in sunlight.

The diagram below shows the displayed formulae for the reaction of bromine with methane.



The table below shows the bond energies and the overall energy change in the reaction.

	C—H	**Br—Br**	**C—Br**	**H—Br**	**Overall energy change**
Energy in kJ/mol	412	193	**X**	366	−51

Calculate the bond energy **X** for the C—Br bond.

Use the diagram and the table above.

___

___

___

___

___

____

____

Bond energy **X** =________________ kJ/mol

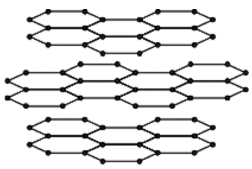
(4)

(Total 11 marks)

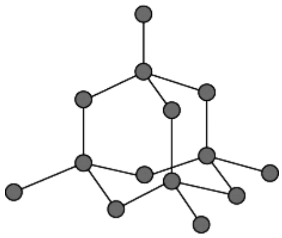
Q3.

Graphite and diamond are different forms of the element carbon. Graphite and diamond have different properties.

The structures of graphite and diamond are shown below.



Graphite



Diamond

(a) Graphite is softer than diamond.

Explain why.

____

____

____

____

____

____

____

____

(4)

(b) Graphite conducts electricity, but diamond does not.

Explain why.

____

____

____

____

____

____

(3)

(Total 7 marks)

Q4.

This question is about copper.

(a) Copper can be extracted by smelting copper-rich ores in a furnace.

The equation for one of the reactions in the smelting process is:

$$Cu_2S(s) + O_2(g) \longrightarrow 2\ Cu(s) + SO_2(g)$$

Explain why there would be an environmental problem if sulfur dioxide gas escaped into the atmosphere.

____

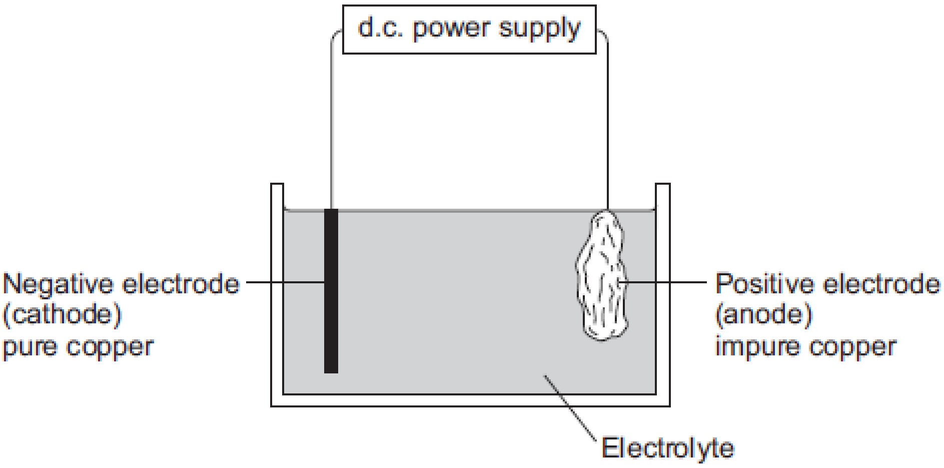
____

____

____

(2)

(b) The impure copper produced by smelting is purified by electrolysis, as shown below.



Copper atoms are oxidised at the positive electrode to Cu^{2+} ions, as shown in the half equation.

$$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$$

(i) How does the half equation show that copper atoms are oxidised?

____

____

(1)

(ii) The Cu^{2+} ions are attracted to the negative electrode, where they are reduced to produce copper atoms.

Write a balanced half equation for the reaction at the negative electrode.

____

(1)

(iii) Suggest a suitable electrolyte for the electrolysis.

____

(1)

(c) Copper metal is used in electrical appliances.

Describe the bonding in a metal, and explain why metals conduct electricity.

____

____

____

____

____

____

____

____

____

(4)

(Total 9 marks)

Q5.

Scientists found that a compound contained: 22.8% sodium; 21.8% boron; and 55.4% oxygen. Use the percentages to calculate the empirical formula of the compound. To gain full marks you **must** show all your working.

____

____

____

____

____

____

____

____

____

____

Empirical formula = ______________________________

(Total 5 marks)

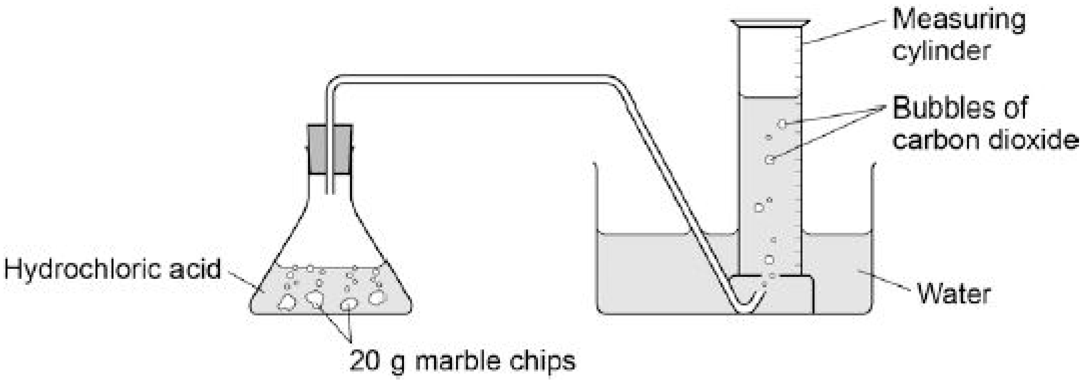
Q6.

Marble chips are mainly calcium carbonate ($CaCO_3$).

A student investigated the rate of reaction between marble chips and hydrochloric acid (HCl).

Figure 1 shows the apparatus the student used.

Figure 1



(a) Complete and balance the equation for the reaction between marble chips and hydrochloric acid.

__________ + __________ → $CaCl_2$ + __________ + __________

(2)

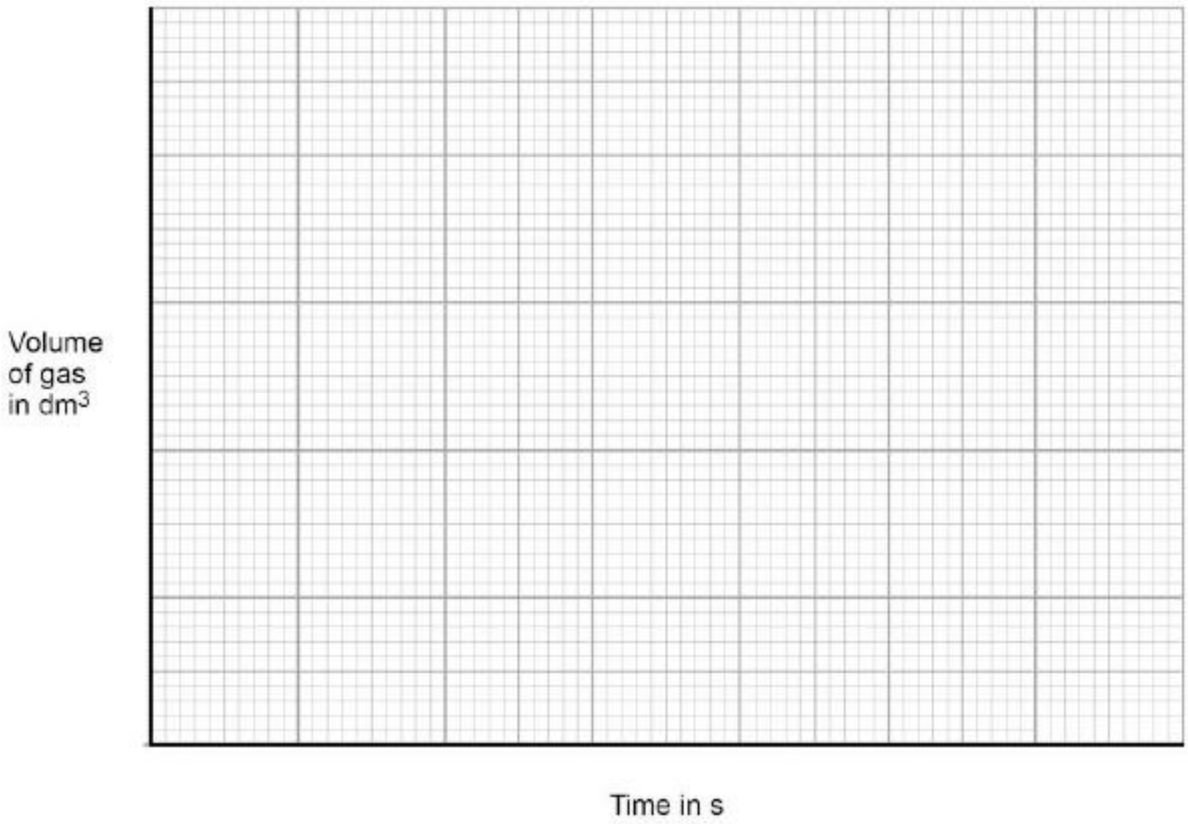
(b) The table below shows the student's results.

Time in s	Volume of gas in dm^3
0	0.000
30	0.030
60	0.046
90	0.052
120	0.065
150	0.070
180	0.076
210	0.079
240	0.080
270	0.080

On **Figure 2**:

- Plot these results on the grid.
- Draw a line of best fit.

Figure 2



(4)

(c) Sketch a line on the grid in **Figure 2** to show the results you would expect if the experiment was repeated using 20 g of smaller marble chips.

Label this line **A**.

(2)

(d) Explain, in terms of particles, how and why the rate of reaction changes during the reaction of calcium carbonate with hydrochloric acid.

____

____

____

____

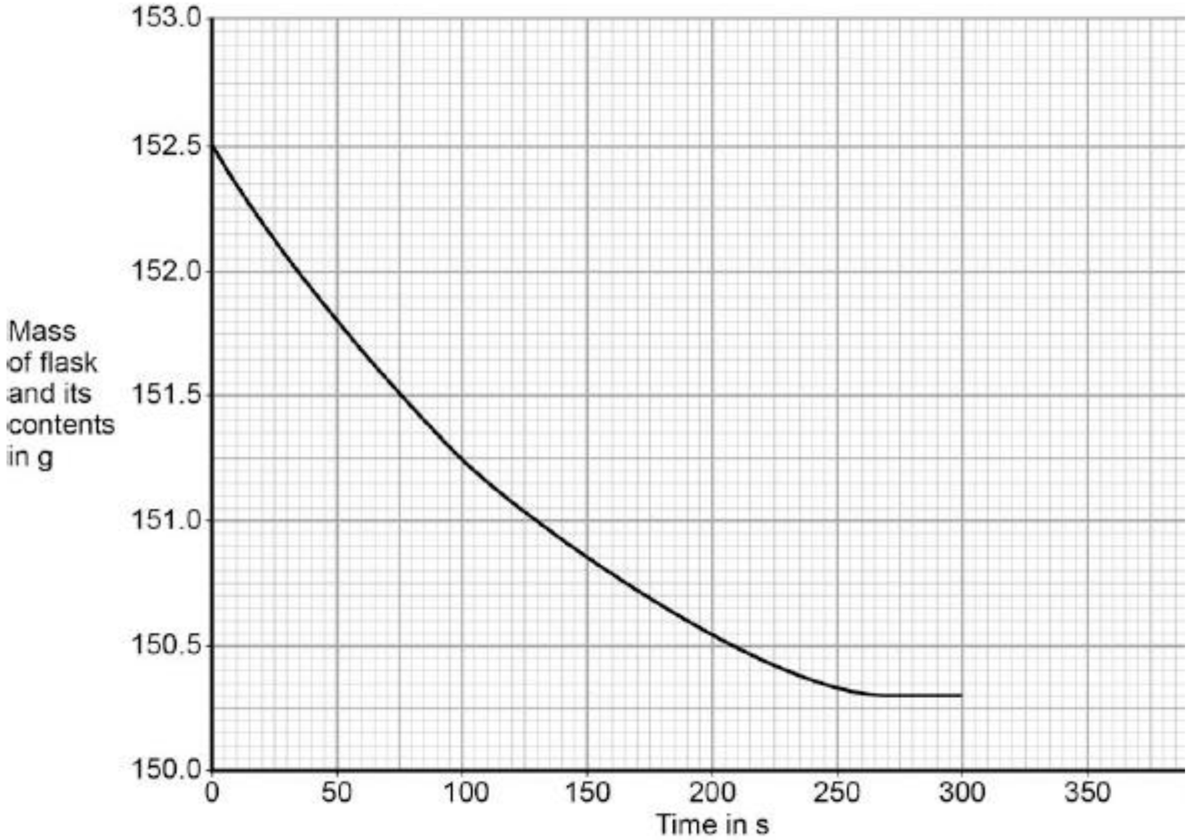
____

(4)

(e) Another student investigated the rate of reaction by measuring the change in mass.

Figure 3 shows the graph plotted from this student's results.

Figure 3



Use **Figure 3** to calculate the mean rate of the reaction up to the time the reaction is complete.

Give your answer to three significant figures.

____

____

____

____

____

____

Mean rate of reaction = _______________________ g / s

(4)

(f) Use **Figure 3** to determine the rate of reaction at 150 seconds.

Show your working on **Figure 3**.

Give your answer in standard form.

____

____

____

____

____

Rate of reaction at 150 s = ______________________ g / s

(4)

(Total 20 marks)

Year 11 to 12 AS Level Chemistry Bridging Work

Section 2: Skills Based Knowledge

1. Convert these numbers to standard form:

a 0.003
b 5 000
c 0.4
d 7 000 000
e 20 000
f 0.0005

2. Convert these numbers in non-standard form:

a 6×10^{-6}
b 6×10^{6}
c 1×10^{-3}
d 1×10^{3}
e 8×10^{5}
f 8×10^{-5}

3. Round each of the following numbers to the required number of significant figures:

a) 1 478 258 (5sf)

……………………

b) 0.08956 (3sf)

……………………

c) 7.00198 (2sf)

……………………

d) 4 (3sf)

……………………

e) 0.01 (4sf)

……………………

f) 0.02314 (2sf)

……………………

4. Balance the following equations:

1) $Ca + O_2 \rightarrow CaO$

2) $Na_2O + H_2O \rightarrow NaOH$

3) $Al + O_2 \rightarrow Al_2O_3$

4) $Na + Cl_2 \rightarrow NaCl$

5) $Na_2CO_3 \rightarrow Na_2O + CO_2$

6) $K + O_2 \rightarrow K_2O$

7) $C_4H_8 + O_2 \rightarrow CO_2 + H_2O$

8) $Fe_2O_3 + HCl \rightarrow FeCl_3 + H_2O$

9) $F_2 + KBr \rightarrow KF + Br_2$

10) $C_5H_{12} + O_2 \rightarrow CO_2 + H_2O$

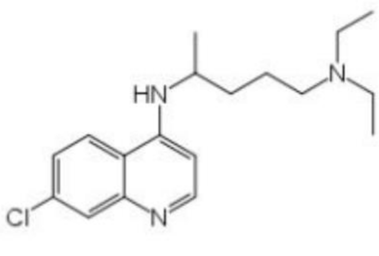
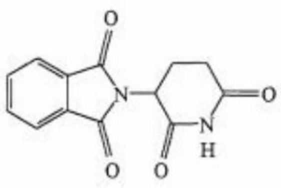
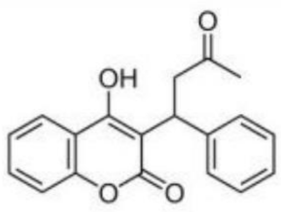
11) $NH_3 + O_2 \rightarrow NO + H_2O$

12) $HNO_3 \rightarrow NO_2 + H_2O + O_2$

Go Further: Research Task!

Choose one (or more) of the following pharmaceutical drugs and find out:

1. **Common brand names**
2. **Class of drug**
3. **Brief history of discovery**
4. **State the chemical functional group found in the compound**
5. **Uses**
6. **List any side effects**

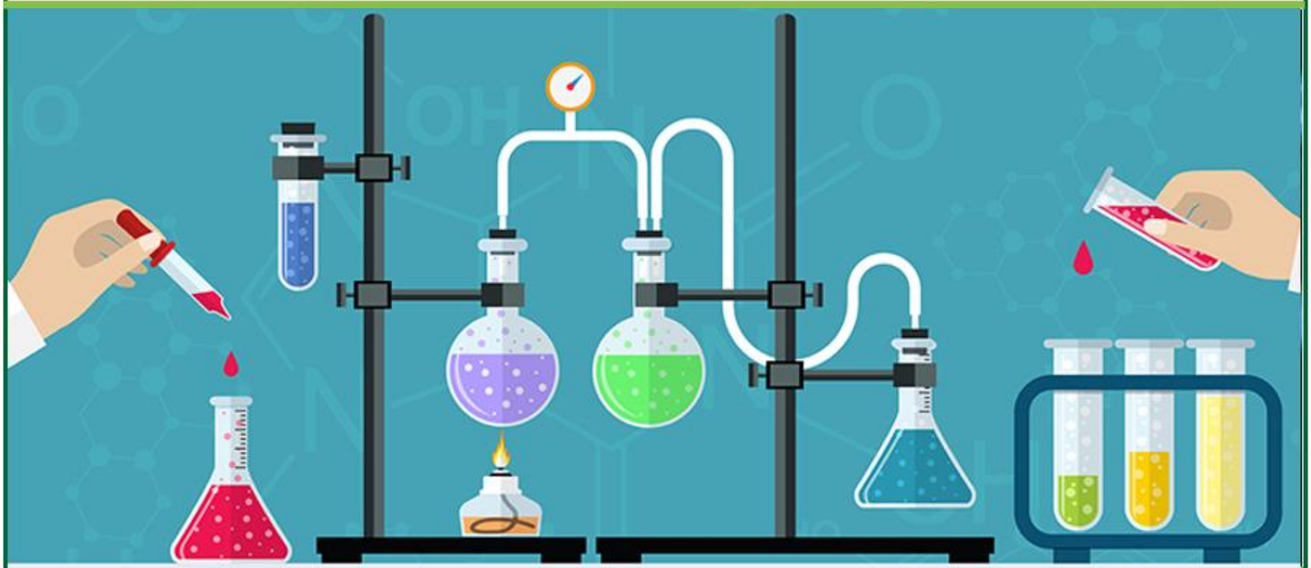
Chloroquine	Thalidomide	Warfarin
		

Bentley Wood High School for Girls

Chemistry Department

Year 12 into 13 Bridging Work

2023



Name:________________________

Tutor Group: ___________________

Teacher: ______________________________

Y12 into 13 Bridging Work Chemistry 2023

Table of Contents

Introduction: Revision and Exam Preparation:

Year 13 Chemistry builds upon the fundamental principles and theories you have learned so far. As you delve deeper into this discipline, you will explore a wide range of topics, including organic chemistry, thermodynamics, chemical kinetics, electrochemistry, and more. These concepts will not only enhance your understanding of the world around you but will also equip you with the analytical and creative problem-solving skills necessary for your scientific learning beyond Bentley Wood!

This bridging work will encourage you to develop critical thinking skills and the ability to apply theoretical knowledge to exam questions and practical scenarios. Please use the summer as an opportunity to further consolidate your learning from Year 12. You will have **one exam** in your first lesson back in September. This will assess your learning in Year 12 following on from your AS exams, as well as the topics introduced in this bridging work. A summary of these topics are:

- **Periodicity – including Period 3 Oxides**
- **Kp**
- **Thermodynamics**
- **^{13}C NMR**
- **^{1}H NMR**

A reminder that all 3 A-Level papers will test on your AS understanding + Paper 3 is specifically a synoptic exam of everything you have learnt over the 2 years!

You must hand in all revision in your first lessons back. This will be checked by your teachers as either pass/borderline/fail.

1. Year 13 Preparation: Complete the preparation tasks on the following pages which will help you prepare for the first topics in Year 13.

You must hand in your answers in your first lessons back. This will be checked by your teachers as either pass/borderline/fail.

Your initial topics coming back will be:

i. **Thermodynamics**
ii. **^{1}H NMR (Continued) + Go Further**

<u>i. Thermodynamics</u>

Make <u>key notes</u> on this topic (please hand these in together with this booklet in September) and then answer the following questions. Read pages 4-21 in your Kerboodle textbook to support you.

Q1.

The diagram shows an incomplete Born–Haber cycle for the formation of caesium iodide. The diagram is not to scale.

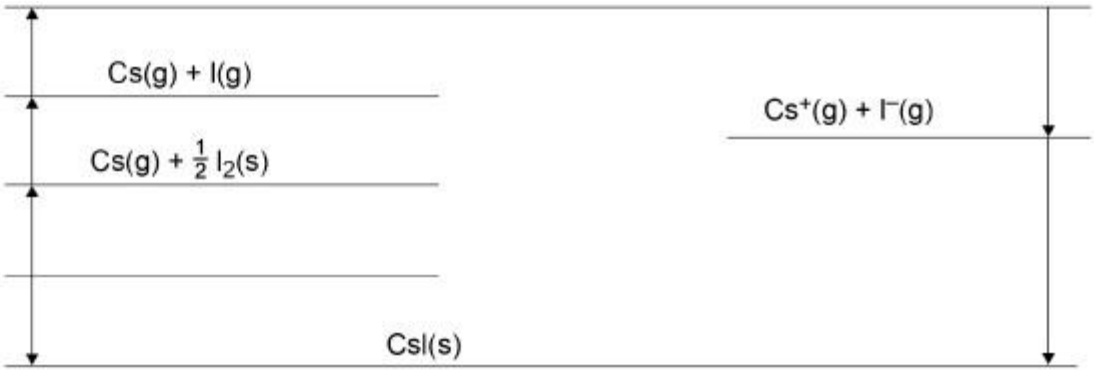


Table 1 gives values of some standard enthalpy changes.

Table 1

Name of enthalpy change	**$\Delta H^{\ominus}$ / kJ mol^{-1}**
Enthalpy of atomisation of caesium	+79
First ionisation energy of caesium	+376
Electron affinity of iodine	−314
Enthalpy of lattice formation of caesium iodide	−585
Enthalpy of formation of caesium iodide	−337

(a) Complete the diagram above by writing the formulas, including state symbols, of the appropriate species on each of the two blank lines.

(2)

(b) Use the diagram above and the data in **Table 1** to calculate the standard enthalpy of atomisation of iodine.

Standard enthalpy of atomisation of iodine ___________________________ kJ mol^{-1}

(2)

(c) The enthalpy of lattice formation for caesium iodide in **Table 1** is a value obtained by experiment.

The value obtained by calculation using the perfect ionic model is –582 kJ mol^{-1}

Deduce what these values indicate about the bonding in caesium iodide.

____

____

(1)

(d) Use data from **Table 2** to show that this reaction is **not** feasible at 298 K

$$CsI(s) \rightarrow Cs(s) + \frac{1}{2}I_2(s) \qquad \Delta H^{\ominus} = +337 \text{ kJ mol}^{-1}$$

Table 2

	CsI(s)	**Cs(s)**	**I_2(s)**
$S^{\ominus}$ / kJ mol^{-1}	130	82.8	117

(4)

(Total 9 marks)

ii. ^{1}H NMR Continued

Continue to make progress with your ^{1}H NMR learning by answering the following questions.

1 a)

An organic compound **I** is analysed, using a combination of techniques. The analytical data is shown below.

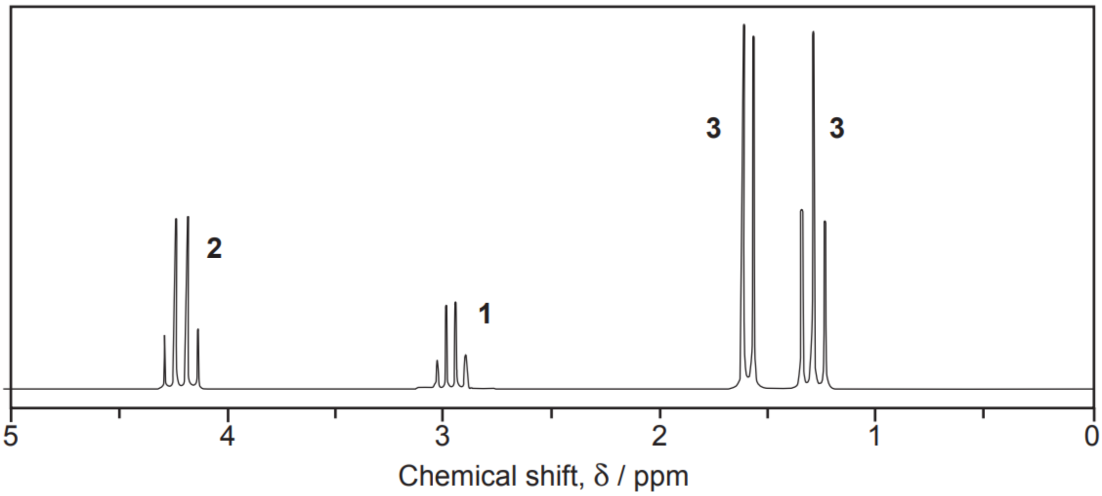
Elemental analysis by mass

C, 56.69%; H, 7.09%; N, 11.02%; O, 25.20%

Mass spectrum

Molecular ion peak at m/z = 127.0

Proton NMR spectrum



The IR spectrum shows a peak between 1680-1750 cm^{-1} and a peak at 2220-2260 cm^{-1}.

Deduce the structure of compound I. Show **all** your reasoning.

____

____

____

____

____

____

____

(6)

b) For the next question, you need to **analyse and mark out of 6**, two real student responses to an ^{1}H NMR A-Level question. You then need to attempt the question yourself.

For context: D_2O is a solvent that can be used in ^{1}H NMR which masks O-H or N-H peaks in a spectrum.

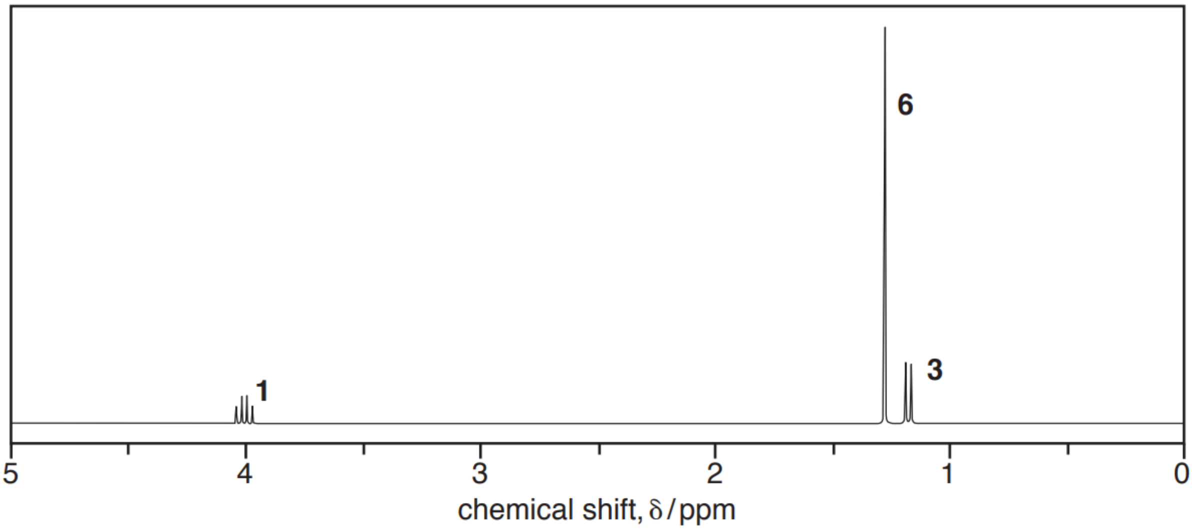
Question:

A scientist is researching compounds that might be suitable as fuel additives.
One of the compounds gives the analytical results below.

Elemental analysis by mass:
C: 54.54%; H: 9.10%; O: 36.36%

Mass spectrum:
Molecular ion peak at *m*/*z* = 132.0

^{1}H NMR spectrum in D_2O

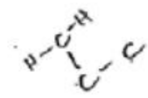


The numbers by the peaks are the relative peak areas.

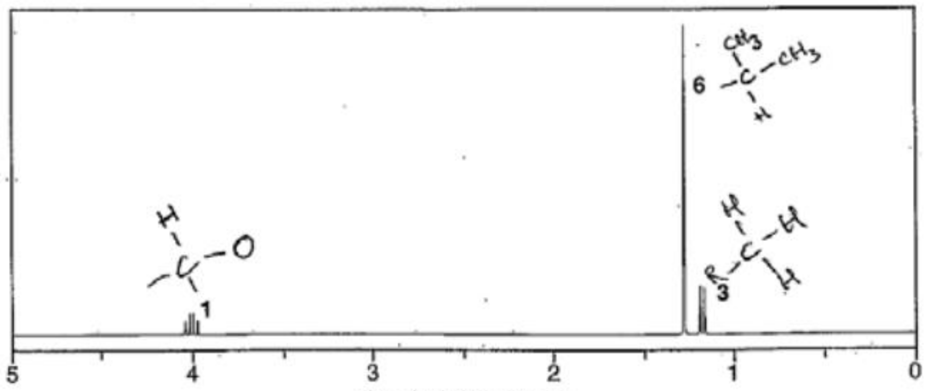
When the spectrum is run without D_2O, there are **two** additional peaks with the same relative peak areas at 11.0 ppm and 3.6 ppm.

Student A Answer:

Mass spectrum:
Molecular ion peak at m/z = 132.0



^{1}H NMR spectrum in D_2O



The numbers by the peaks are the relative peak areas.

When the spectrum is run without D_2O, there are **two** additional peaks with the same relative peak areas at 11.0 ppm and 3.6 ppm.

empirical formula of compound:

C : H : O

$\frac{54.54}{12}$: $\frac{9.1}{1}$: $\frac{36.36}{16}$

4.545 : 9.1 : 2.2725

2 : 4 : 1 = C_2H_4O

∴ molecular formula : $\frac{132}{44}$ = 3

= $C_6H_{12}O_3$

~~integration~~ relative peak area : Hydrogen atoms 1 : 1 and each additional peak area = 1.

∴ singlet at 1.3 ppm is R — C — CH_3 (with CH_3 below)

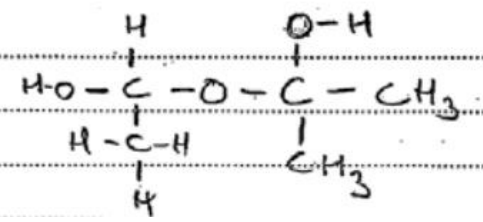
doublet at 1.2 ppm is R – CH_3

quartet at 4.0 ppm is O – C – H

the two peaks which appear with D_2O are two –OH groups.

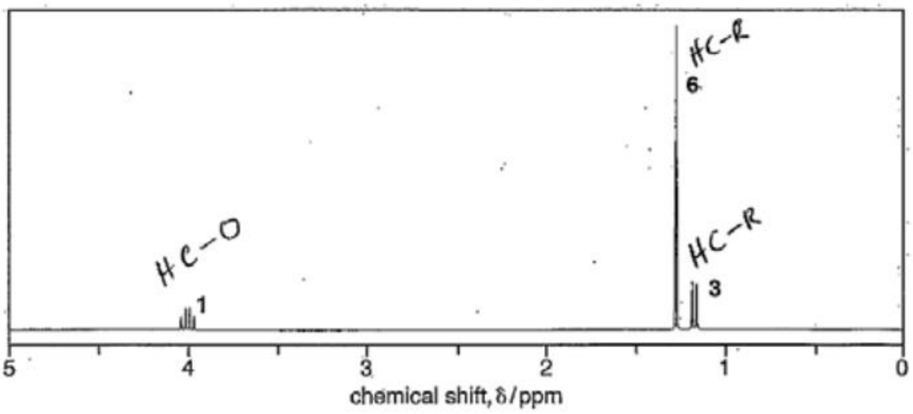
Additional answer space if required.

therefore Structure:



Your analysis of Student A's answer:

Student B's Answer:



The numbers by the peaks are the relative peak areas.

When the spectrum is run without D_2O, there are **two** additional peaks with the same relative peak areas at 11.0 ppm and 3.6 ppm.

$C = \frac{54.54}{12}$ $H = \frac{9.10}{1}$ $O = \frac{36.36}{16}$

$= \frac{4.545}{2.275}$ $= \frac{9.10}{2.2725}$ $= \frac{2.2725}{2.2725}$

$C = 2$ $H = 4$ $= 0$

Empirical = C_2H_4O = 44

m/z = 132 132/44 = 3 ∴ $3 \times (C_2H_4O)$

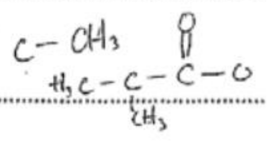
$= C_6H_{12}O_2$

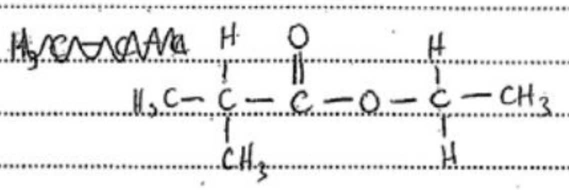
Chemical Shift	Relative Peak Area	Splitting Pattern	Adjacent H's	Inference
δ 1.2 ppm	3	doublet	1	CH_3-CH
δ 1.3 ppm	6 ×2 CH_3	singlet	0	$H_3C-C(CH_3)-C$
δ 4 ppm	1	quartet	3	$CH-CH_3$.

~~δ 11 ppm~~ ~~Ac~~ δ 11 ppm = –C(=O)OH

δ 3.6 ppm = HC–O

Additional answer space if required.





Your analysis of Student B's answer:

Your answer:

Use the information provided to suggest a structure for the compound.

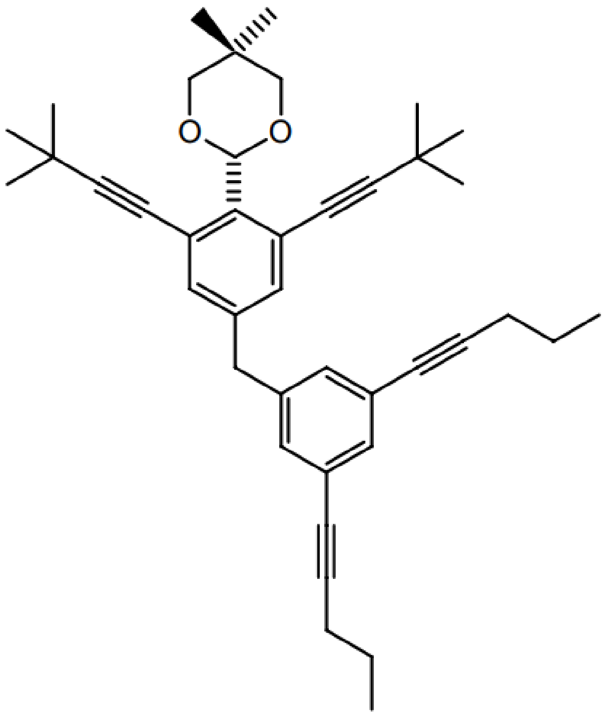
Show **all** your reasoning. **[6]**

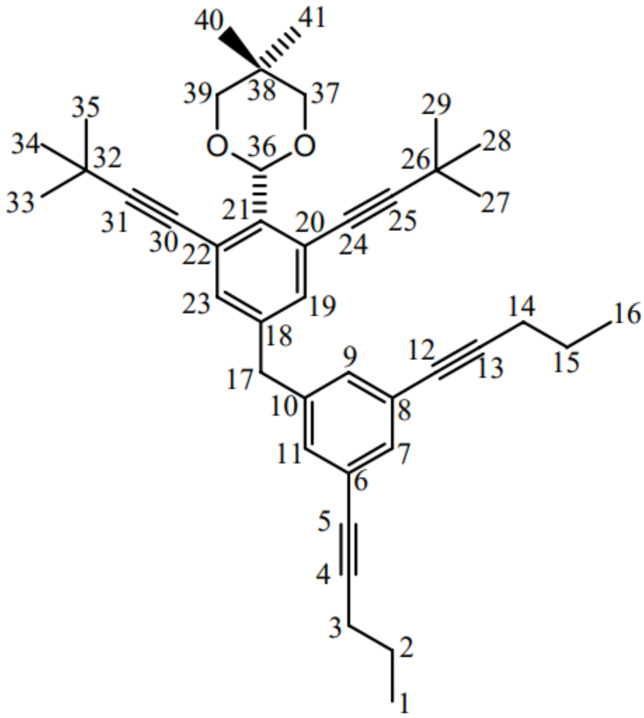
(6)

Go Further! You will need to utilise your prior knowledge together with additional reading on topics including arenes and chiral centres to support you with this question!

In June 2003, a research paper was published announcing the synthesis of the smallest representations of the human form: 2 nm tall anthropomorphic molecules, nicknamed 'NanoPutians' by their creators.

The molecules synthesised included 'NanoKid', 'NanoBaker' and 'NanoAthlete'. The compound shown to the right was called 'NanoBalletDancer' and has the formula $C_{41}H_{50}O_2$.





When assigning an NMR spectrum, the first step is to identify how many atoms there are in unique environments.

Both carbon atoms (^{13}C) and hydrogen atoms (^{1}H) give NMR signals. Each atom *in a different environment* will give rise to one signal.

For example, in the structure of NanoBalletDancer, carbon atoms 37 and 39 are equivalent; we may write (37 ≡ 39). Hence, although there are two carbon atoms (37 and 39) which have one oxygen atom attached, only *one* signal would be observed in a ^{13}C NMR spectrum due to these carbon atoms since they are equivalent.

(a) Which carbon atoms making up the benzene rings are equivalent? Write down $w \equiv x$, $y \equiv z$ etc for any equivalent atoms. How many signals *in total* would be observed due to benzene-ring carbons in a carbon NMR spectrum of NanoBalletDancer?

(b) List the groups of equivalent triple bond carbons in NanoBalletDancer. How many signals would be seen *in total* in the ^{13}C spectrum due to triple bond carbon atoms?

(c) How many different methyl groups ($–CH_3$ groups) are there in NanoBalletDancer? Again, list them in groups.

(d) How many different carbon environments are there in NanoBalletDancer – i.e. how many signals would be seen in total in the ^{13}C NMR spectrum?

Similarly, in ^{1}H NMR, the total number of signals depends on the number of different environments of hydrogen atoms in a structure. There are 13 different environments of hydrogens in NanoBalletDancer; their signals are labelled **A–M** in the spectrum below. The numbers of hydrogen atoms in each unique environment is given under the label. Hydrogen atoms in similar environments all have similar chemical shifts. For example, all the hydrogens on the benzene rings occur in the same region of the spectrum, i.e. they have a similar *chemical shift*.

However, ^{1}H NMR is complicated by *coupling*. If a hydrogen is within three bonds of another hydrogen *which is in a different environment*, instead of appearing as a single peak, its signal is split into a number of peaks. In general, if the hydrogen under consideration is within three bonds of *n* hydrogens in a different environment from the one under consideration, it will be split into (*n* + *1*) peaks. The ratio of the area under the peaks is given by Pascal's triangle as outlined below.

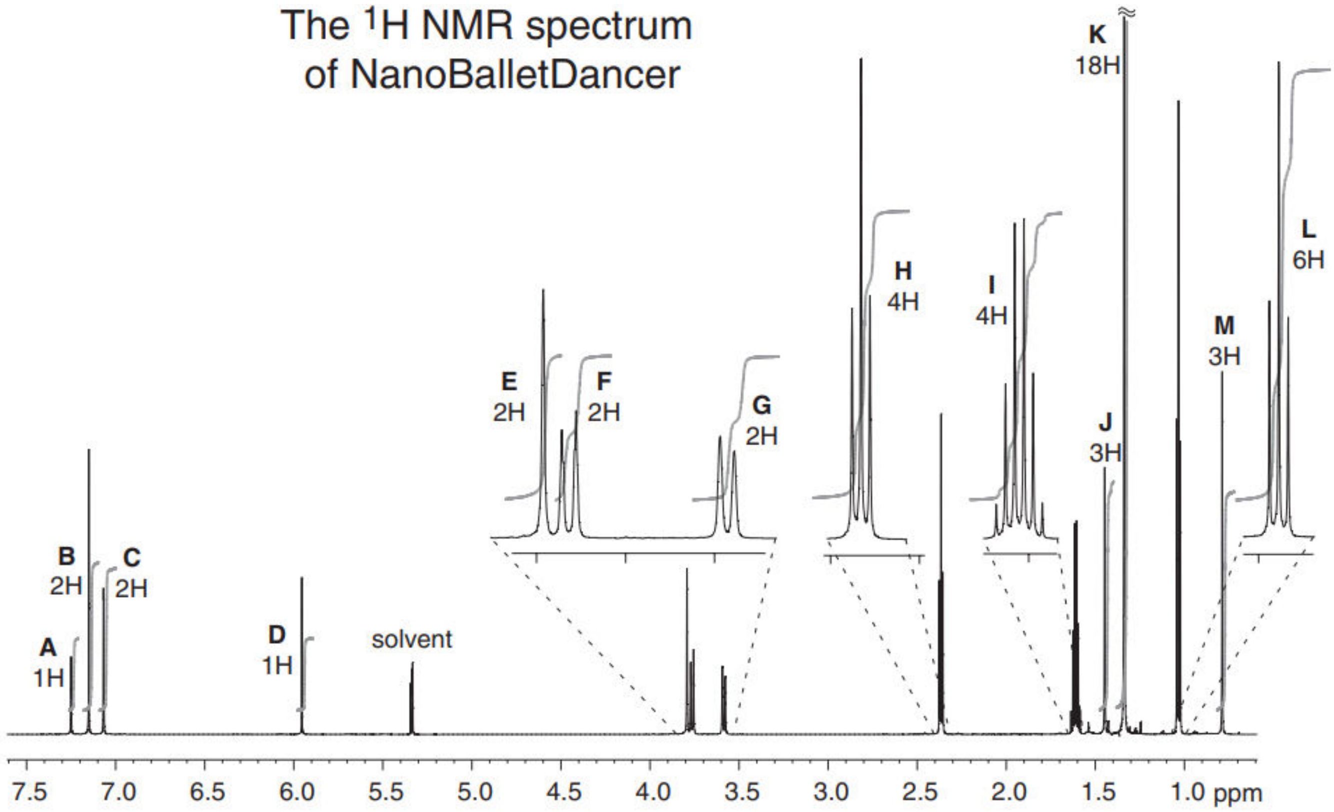
observed ratio	**for a hydrogen coupling to**
1	← 0 hydrogens
1 : 1	← 1 hydrogen
1 : 2 : 1	← 2 hydrogens
1 : 3 : 3 : 1	← 3 hydrogens
1 : 4 : 6 : 4 : 1	← 4 hydrogens

The signal for a given hydrogen is not split by any hydrogens *which are in the same environment* as it is in.

(e) Into how many peaks will the signal from a hydrogen that couples with 5 other hydrogens be split? What will the ratio of the peaks be?

It is possible to assign the ^{1}H NMR spectrum of NanoBalletDancer by considering the numbers of hydrogens in different environments, their chemical shifts, and their coupling patterns. For example, the signal at 7.15 ppm (**B**) is due to the hydrogen atoms on carbons 19 and 23.

(f) On the table in your answer sheet, assign (as far as possible) which signals are due to which hydrogen atoms. The assignment for signal **B** has already been filled in on the answer sheet. (For some signals, it might not be possible to decide between two alternative assignments – in which case just write '... *or* ...' on the answer sheet.)



The ¹H NMR spectrum
of NanoBalletDancer
A
1H
B
2H
C
2H
D
1H
solvent
E
2H
F
2H
G
2H
H
4H
I
4H
J
3H
K
18H
L
6H
M
3H
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0 ppm