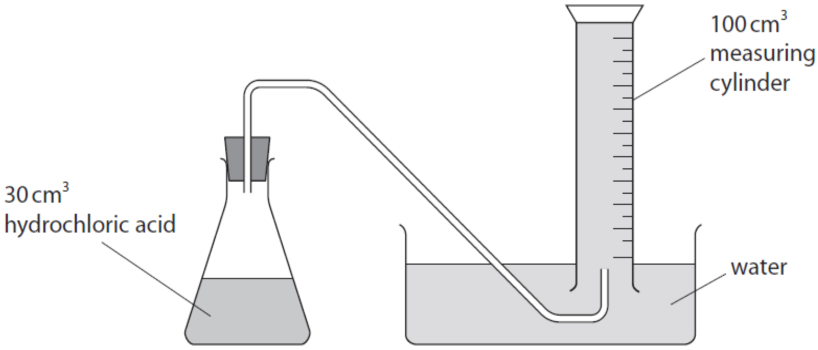
DELEGATE BOOKLET

Agenda of Event

Time	Item
10:00	Introductions
10:10	Assessment Objectives
11:10	Break
11:30	Assessment Objective AO2
12:45	Lunch
13:45	Assessment Objective AO3
15:00	Writing Examination Questions
15:30	Plenary

WCH11 – 21(b)

(b) A student carried out an investigation to determine the molar volume of carbon dioxide using this apparatus.

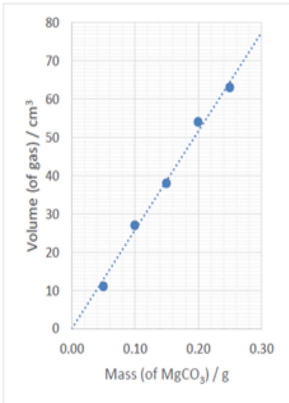


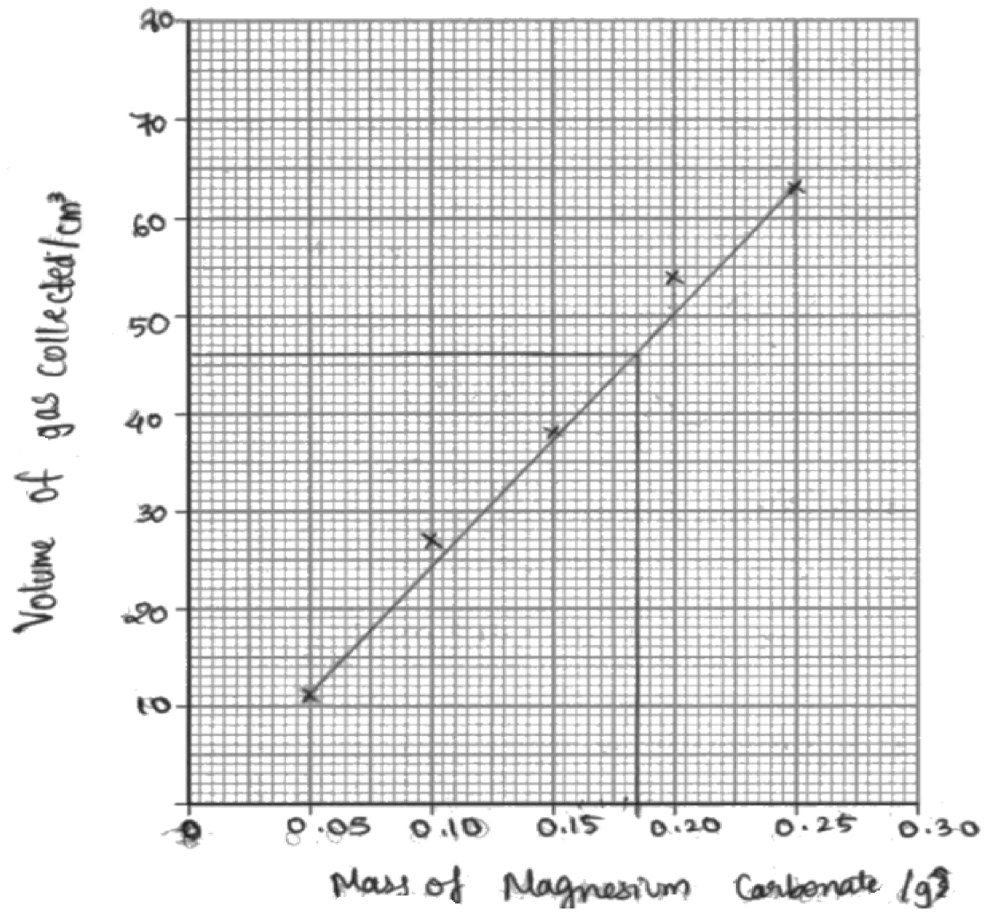
The student carried out five experiments, adding a different mass of magnesium carbonate each time.

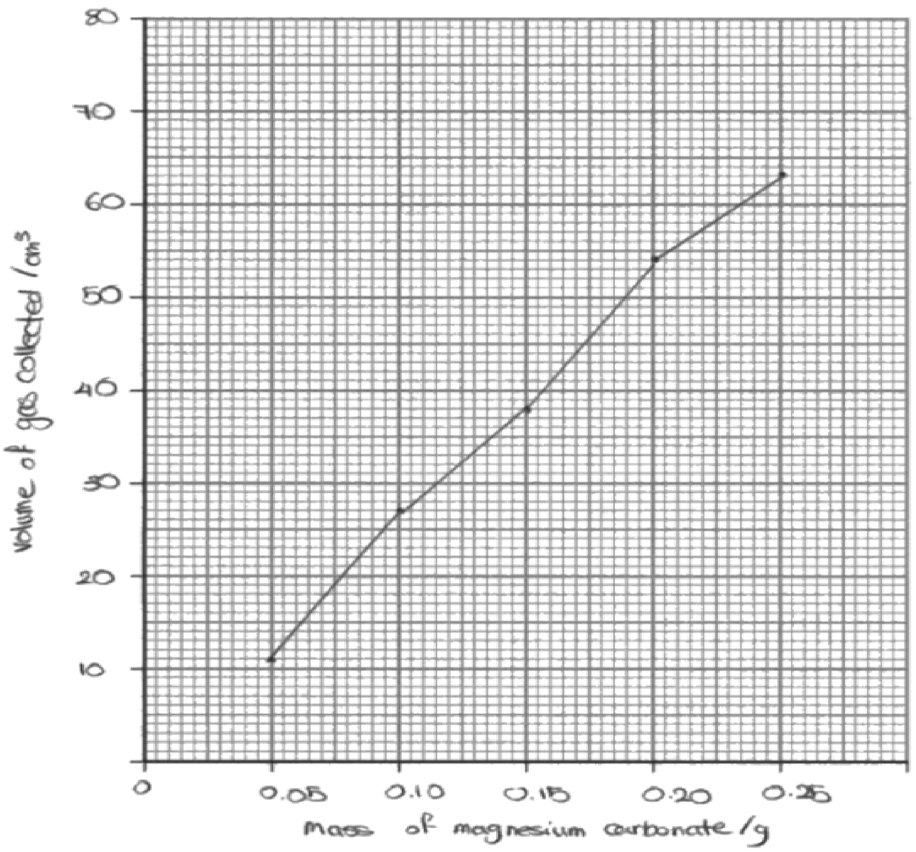
The results are shown in the table.

Mass of magnesium carbonate / g	Volume of gas collected / cm^3
0.05	11
0.10	27
0.15	38
0.20	54
0.25	63

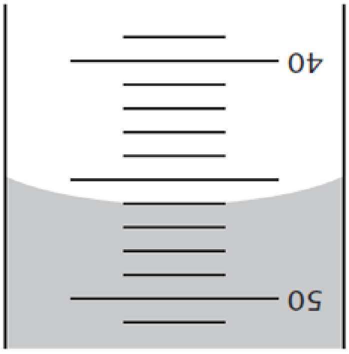
(i) Plot a graph of these results. (3)

Question Number	Answer	Additional guidance	Mark
21 (b)(i)	• suitable choice of scale so that the points cover at least 50% of the grid in both directions and correct choice of axes i.e. mass on x axis, suitably labelled including units **(1)** • all points plotted correctly (within ½ square) **(1)** • **straight** line of best fit (passes through the origin) **(1)**	Example of graph:  Allow no origin Allow units in brackets e.g. (g) instead of / g Any extrapolated line should pass within 2 squares of origin. Straight best fit lines that are not extrapolated are not penalised. If axes are the wrong way round, only MP1 is penalised.	(3)


Volume of gas collected/cm³
80
70
60
50
40
30
20
10
0
0.05
0.10
0.15
0.20
0.25
0.30
Mass of Magnesium Carbonate /g


Volume of gas collected /cm³
80
70
60
50
40
30
20
10
0
0.05
0.10
0.15
0.20
0.25
Mass of magnesium carbonate /g

(ii) A student carried out a further experiment using a different mass of magnesium carbonate.



Give the volume of gas collected using the **inverted** measuring cylinder. (1)

Give the volume of gas collected using the **inverted** measuring cylinder.

(1)

46 cm^3

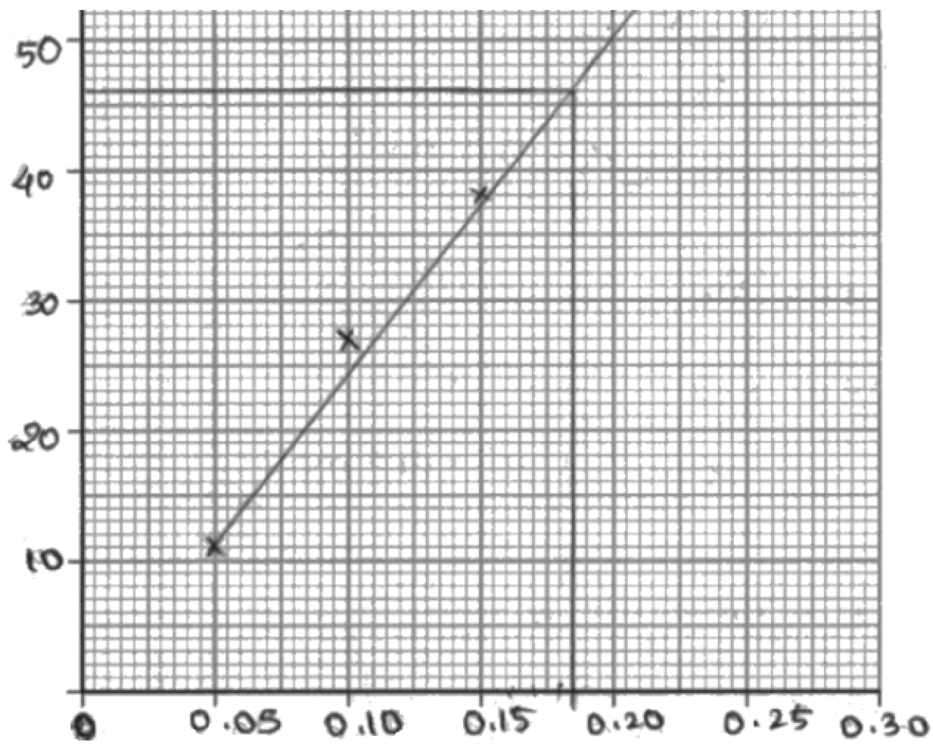
Give the volume of gas collected using the **inverted** measuring cylinder.

(1)

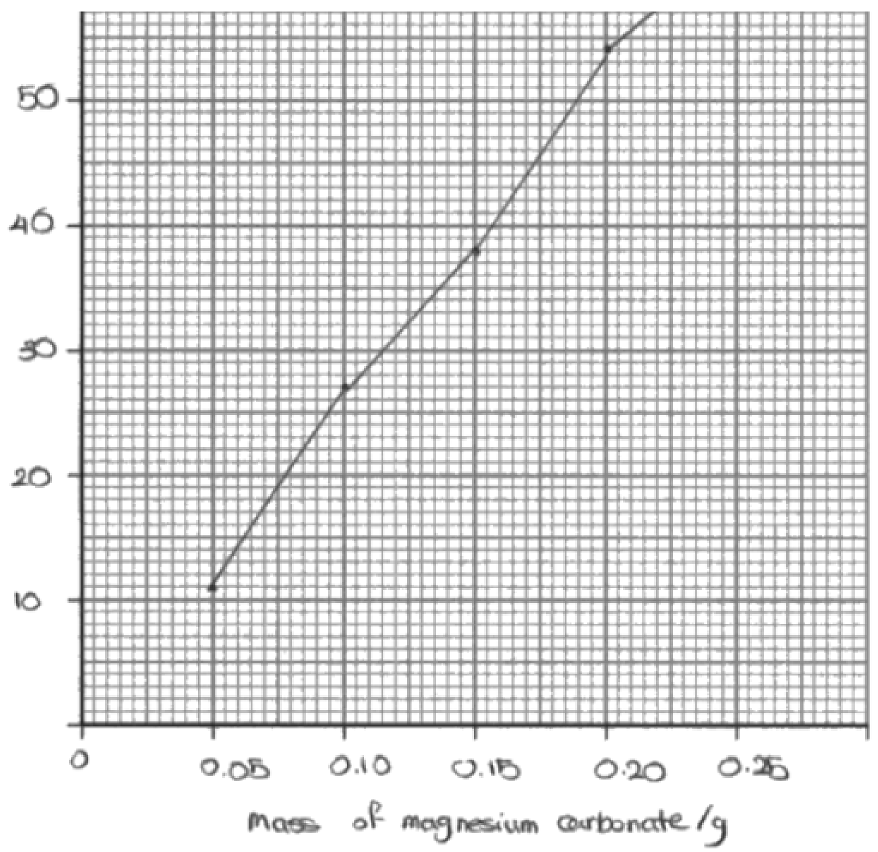
54 cm^3

(iii) Determine the mass of magnesium carbonate added in the experiment in (b)(ii), using your graph. (1)

Question Number	Answer	Additional guidance	Mark
21(b)(iii)	• 0.18 (g)	Accept answers from 0.17 (g) to 0.19 (g) Ignore SF TE on (b)(ii) and the graph, eg 54 (cm^3) gives 0.215 (g) Ignore units even if incorrect	(1)


50
40
30
20
10
0
0.05
0.10
0.15
0.20
0.25
0.30

0.185g


50
40
30
20
10
0
0.05
0.10
0.15
0.20
0.25
mass of magnesium carbonate / g

0.20 g

(iv) Calculate the molar volume of carbon dioxide using your answers to parts (b)(ii) and (b)(iii).
Give your value to an appropriate number of significant figures and include units.
[A_r values: Mg = 24.3 C = 12.0 O = 16.0] **(4)**

Question Number	Answer	Additional guidance	Mark
21 (b)(iv)		Example of calculation:	(4)
	• calculation of molar mass of magnesium carbonate **(1)**	84.3 OR expression used correctly: [24.3 + 12 + (3×16)]	
	• calculation of moles of magnesium carbonate **(1)**	n= 0.18 ÷ 84.3 = 0.0021352 / 2.1352×10^{-3} (mol)	
	• calculation of molar volume **(1)**	46 ÷ 0.0021352 = 21 543 / 2.1543×10^{4} (cm^3) = 22 dm^3 (mol^{-1}) / 22 000 cm^3 (mol^{-1}) Or 21.5 dm^3 (mol^{-1}) / 21 500 cm^3 (mol^{-1}) TE on any reasonable pair of values obtained from the candidates' graph or table provided eg 54cm^3 and 0.215(g) → 2.5504×10^{-3} (mol) → 21 200 cm^3	
	• answer given to **2 or 3 SF and** units **(1)** M4 dependent on award of M3	Correct answer scores 4 marks Final answer must not be given as a fraction to get MP4 Ignore units except for MP4	

$\frac{m}{Mr} = \frac{0.185}{84.3}$ Mr $MgCO_3$ = 84.3

= 2.1945×10^{-3} mols

1 mol $MgCO_3$ → 1 mol CO_2

2.1945×10^{-3} → x

∴ x = 2.1945×10^{-3} mols

V = n × Vm

$\frac{46}{1000} = 2.1945 \times 10^{-3} \times Vm$

Vm = 20.96 dm^3

Vm = 21.0 dm^3 = 21 dm^3

CO_2 =

v = 54 cm^3

m = 0.20 g

Ar = 44

n = 4.55×10^{-3} mol

n × 24 dm^3 =

4.55×10^{-3} mol × 24 = 0.109 ≈ 0.11 mol dm^3

(v) The acid must be in excess for each experiment.

Calculate the **minimum** concentration of hydrochloric acid needed for 30 cm^3 of acid to completely react with 0.25 g of magnesium carbonate.

$$MgCO_3 + 2HCl + MgCl_2 + H_2O + CO_2$$ **(2)**

Question Number	Answer	Additional guidance	Mark
21 (b)(v)	• moles of magnesium carbonate and moles of acid in 30 cm^3 **(1)** • calculation of minimum concentration with units **(1)**	Example of calculation: n = 0.25 / 84.3 n = 0.0029655 or 0.00297 **and** 1:2 stoichiometry ∴0.00593 (moles acid) Accept 0.00594 from 0.00297 (0.00593 / 30) × 1000 = 0.198 mol dm^{-3} Accept answers from 0.198 to 0.200 mol dm^{-3} Allow TE throughout e.g. M_r from 21(b)(iv) Ignore SF Correct answer with no working scores 2	**(2)**

M_r $MgCO_3$ = 84.3 g mol^{-1}

$\frac{m}{Mr} = \frac{0.25}{84.3} = 2.966\times10^{-3}$ mols

1 mol $MgCO_3$ → 2 mols HCl

2.966×10^{-3} → x

x = 5.931×10^{-3} mols

C = n/v

= $\frac{5.931\times10^{-3}}{(30\div1000)}$ = 0.1977 moldm^{-3}

= 0.198 moldm^{-3}

= 0.20 moldm^{-3}

C = $\frac{n}{v}$

$MgCO_3$ =

m = 0.25g

Ar = 84.3

moles = $\frac{m}{Ar}$ = 2.97×10^{-3} mol

HCl =

v = 30 cm^3 = 0.03 dm^3

n = 5.94×10^{-3} mol

C = $\frac{n}{v}$ = $\frac{5.94\times10^{-3} mol}{0.03 dm^3}$ = 0.198 mol/dm^3

(c) The value of molar volume calculated in (b)(iv) was lower than the student expected.

Give **two** reasons for the value being lower than expected.

Assume that the correct amounts of hydrochloric acid and magnesium carbonate were used. **(2)**

Question Number	Answer	Additional guidance	Mark
21 (c)	An answer that makes reference to any two of the following points:		(2)
	• loss of gas before the bung is inserted / other named reason **(1)**	Do not allow "loss of gas" unless a reason is given eg delivery tube not positioned correctly so not all goes into measuring cylinder, badly fitting bung Ignore leaks	
	• some carbon dioxide dissolved in the water **(1)**	Allow gas for carbon dioxide	
	• temperature of the lab was <u>lower</u> than standard temperature. **(1)**	Ignore higher pressure Do not award higher temperature / lower pressure / suck-back	
		Ignore impurities in $MgCO_3$ Ignore incomplete reaction	

• Student removed cork first before the tube

• Student didn't take readings correctly due to parallax error with cylinder

firstly CO_2 dissolves in water meaning some CO_2 ~~water~~ ~~not~~ had dissolved in the water bath and wasn't measured

Also the stopper may have not been placed fast enough so some of the CO_2 escaped

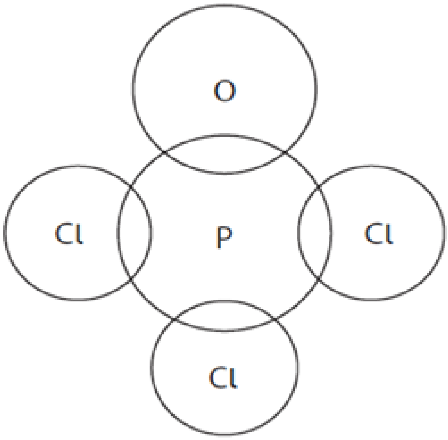
WCH11 – Q23(c)

(c) The compound $POCl_3$ has a simple molecular structure.

(i) Complete the dot-and-cross diagram for the $POCl_3$ molecule.

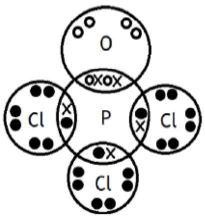
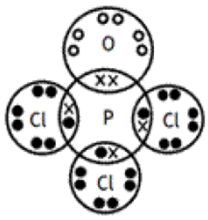
Use crosses (×) for the phosphorus electrons, dots (●) for the chlorine electrons and circles (o) for the oxygen electrons.

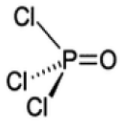
(2)

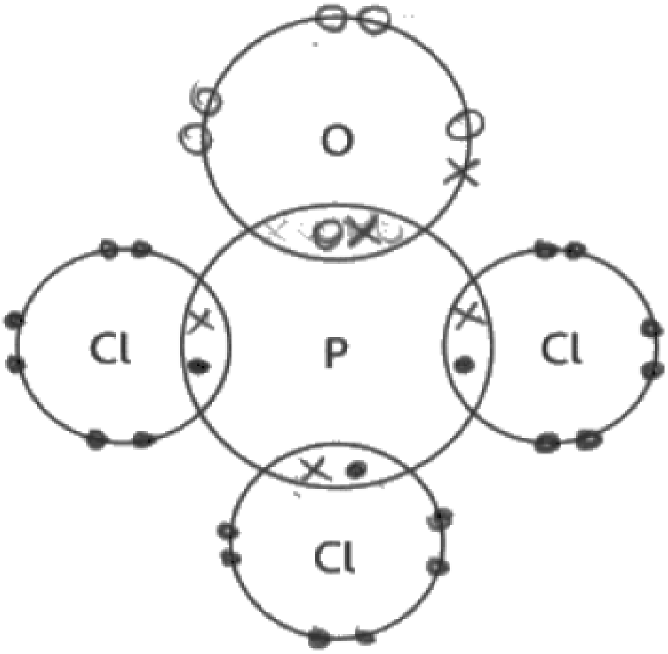


(ii) Explain the shape of this molecule using the electron-pair repulsion theory.

(3)

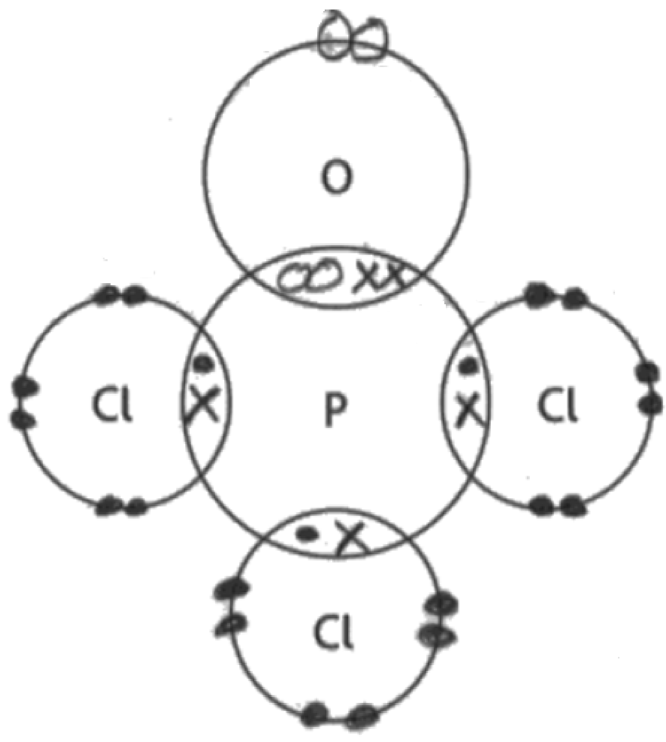
Question Number	Answer	Additional guidance	Mark
23 (c)(i)	A diagram that includes: • phosphorus singly covalently bonded to three chlorine atoms and three lone pairs on each chlorine **(1)** • phosphorus doubly bonded to an oxygen atom and two lone pairs on the oxygen or a dative covalent bond from the phosphorus and three lone pairs on the oxygen **(1)**	 OR  Penalise absence of lone pairs once only Allow lone pairs to appear as separate electrons Allow any representation of electrons **but** electrons in a dative covalent bond must appear to be the same	**(2)**

Question Number	Answer	Additional guidance	Mark
23 (c)(ii)	An answer that makes reference to the following points: • (based on) tetrahedron / tetrahedral (arrangement) **(1)** • four regions of bonding electrons **(1)** • adopt the positions of minimum repulsion **(1)**	MP1 can be given for a 3-D diagram  Accept 5 bonding pairs, where two (in double bond) behave as one. Allow 4 bonding pairs Allow phosphorous bonds to 4 other atoms Accept repel to maximum separation Allow maximise the distance between the bonding pairs Allow to achieve lowest (potential) energy state Ignore to become most stable Do not award maximum repulsion Ignore bond angles throughout Ignore lone pairs throughout	**(3)**



(3)

It will have a ~~octahedral~~ trigonal bipyramidal Shape
The Chlorines have the Same repulsive strength ~~so~~ while the oxygen has a lower repulsive strength so there will be a strong repulsion between Cl and O ~~b~~ pushing the O away while the Cl are close to each other.



The shape of this molecule is a tetra hedral structure with a bond angle of 109.5 and ~~th~~ it has this bond angle as according to the vsepr's theory it shows minimum repulsion between bonding electron pairs, and lone pairs of electrons.

WCH13 Q2

A group of students was asked to investigate a liquid organic compound **A**.
They were told that it was an alcohol with molecular formula $C_4H_{10}O$.

(a) A chemical test may be used to confirm the presence of the hydroxyl group in **A**.

Identify a suitable reagent for this test, giving the positive result. (2)

Question number	Answer	Additional guidance	Mark
2(a)	An answer that makes reference to the following points: • suitable reagent (1) • observation (1)	Phosphorus(V) chloride / phosphorus pentachloride / PCl_5 (solid) Allow thionyl chloride / $SOCl_2$ Do not award PCl_5 / $SOCl_2$ **solution** but allow the result mark Steamy fumes / (dense) white fumes / misty fumes Do not award white smoke Allow add sodium (1) and effervescence / fizzing / bubbles (1) add named carboxylic acid **and** strong acid catalyst (1) gives fruity smell (1) Do not award acidified dichromate and orange to green	(2)

Add PCl_5

steamy misty fumes are

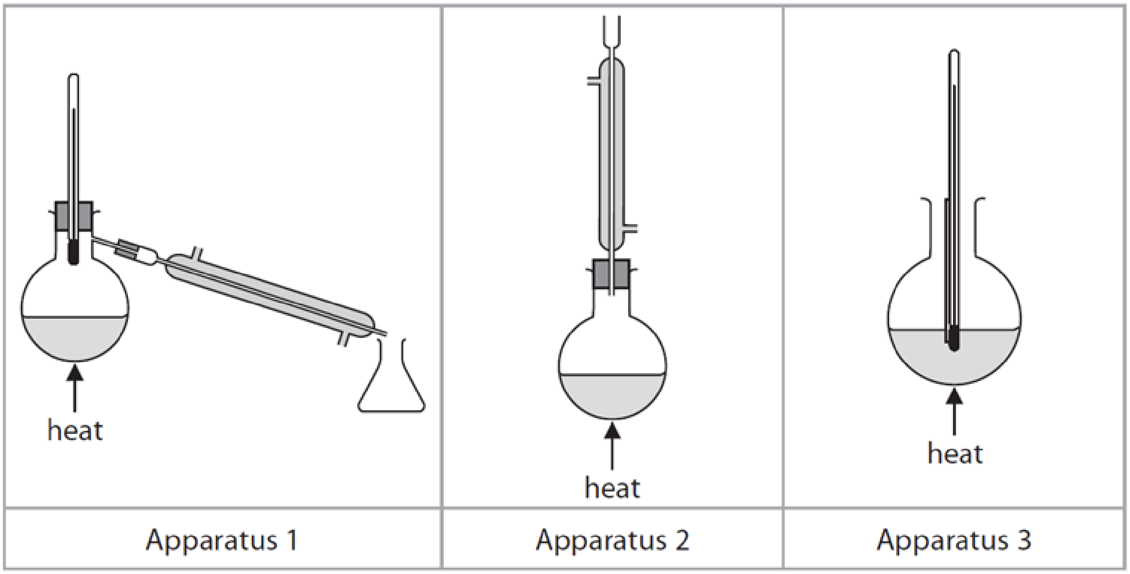
seen, HCl gas released

or add $K_2Cr_2O_7$, orange - green ½

Add potassium chloride (✓)

Misty fumes.

(b) The students suggested that oxidation of **A** would help to identify it.
The sets of apparatus shown below were provided for the students' use.



(i) Identify the reagent mixture that can be used to oxidise **A**. **(1)**

Question number	Answer	Additional guidance	Mark
2(b)(i)	• potassium dichromate(VI) / $K_2Cr_2O_7$ / sodium dichromate(VI) / $Na_2Cr_2O_7$ **and** sulfuric acid / H_2SO_4	Allow omission of the oxidation number Just 'acid / acidified' $Cr_2O_7^{2-}/H^+$ Ignore heat / reflux / concentrated Do not award Potassium manganate (VII) potassium chromate((VI)) Incorrect oxidation number e.g. potassium dichromate(IV) hydrochloric acid / HCl / Nitric acid / HNO_3	(1)

Pottasium Dichromate (V)

Acidified Potassium dichromate (H^+ / $K_2Cr_2O_7$)

acidified potassium dichromate

(ii) One student said that if **A** was a primary alcohol this could be shown by oxidising it to the corresponding aldehyde and testing the product.

Identify which apparatus (1, 2 or 3) should be used for this oxidation. Justify your answer.

(2)

Question number	Answer	Additional guidance	Mark
2(b)(ii)	An answer that makes reference to the following points: • choice of apparatus 1 **(1)** • the ease of oxidation of the aldehyde **(1)**	Example of a justification: The aldehyde is easily oxidised (to a carboxylic acid) / more easily oxidised than the alcohol Allow To prevent further oxidation Partial oxidation occurs Use of reflux (apparatus 2) results in further oxidation M1 and M2 are standalone	**(2)**

You should apparatus A, which is distillation ~~as if you use the~~ ~~6~~ as an aldehyde is easily oxidised into carboxylic acid if you use the reflux reaction

(2)

1 should be used because aldehyde has low boiling temerature so it will evaporate ~~g~~ and escape quickly so it needs to be condensed into new beaker.

(iii) A chemical test may be used to confirm the presence of an aldehyde.
Identify the reagent used, giving the positive result of the test. **(2)**

Question number	Answer	Additional guidance	Mark
2(b)(iii)	An answer that makes reference to the following points: • suitable reagent **(1)** • result of the selected test **(1)**	**Route 1** (warm with) (blue) Fehling's / (blue) Benedict's reagent Red / brown **and** precipitate / solid **Route 2** (warm with) Tollens' reagent Silver mirror or grey/ black precipitate Ignore Brady's reagent Do not award potassium dichromate(VI) No observation TE on incorrect reagent	**(2)**

Add Flemmings reagent, the positive result is a red precipitate Forms.

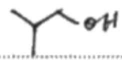
→ Acidified potthusium dicromate (VI)
→ The mixture turns from orange to green.

Use Benedicts solution. A brick red precipitate would form if the compound is an ~~t~~ aldehyde.

(iv) State whether or not a positive result for the test in (b)(iii), together with the molecular formula, would allow the alcohol **A** to be identified.
Justify your answer. **(1)**

Question number	Answer	Additional guidance	Mark
2(b)(iv)	An answer that makes reference to the following points: • The alcohol cannot be identified **and** because there are two primary alcohols with the molecular formula $C_4H_{10}O$	Accept Alcohol could be butan-1-ol / $CH_3CH_2CH_2CH_2OH$ or 2-methylpropan-1-ol / $(CH_3)_2CHCH_2OH$ both alcohols needed Allow any clear structural / displayed / skeletal formulae Ignore just 'carbon chain could be straight or branched' just 'there are isomers'	**(1)**

NO. Even if the result for b/iii is positive, the alcohol A has still two structural isomers : $CH_3(CH_2)_3OH$ and $(CH_3)_2CHCH_2OH$.



~~Yes~~ as NO as the alcohol might be branched or straight chained which can't be determined with this test

(v) Another student said that if **A** was a secondary alcohol this could be shown by oxidising it to the corresponding ketone.
Identify which apparatus (1, 2 or 3) should be used for this oxidation.
Justify your answer. **(2)**

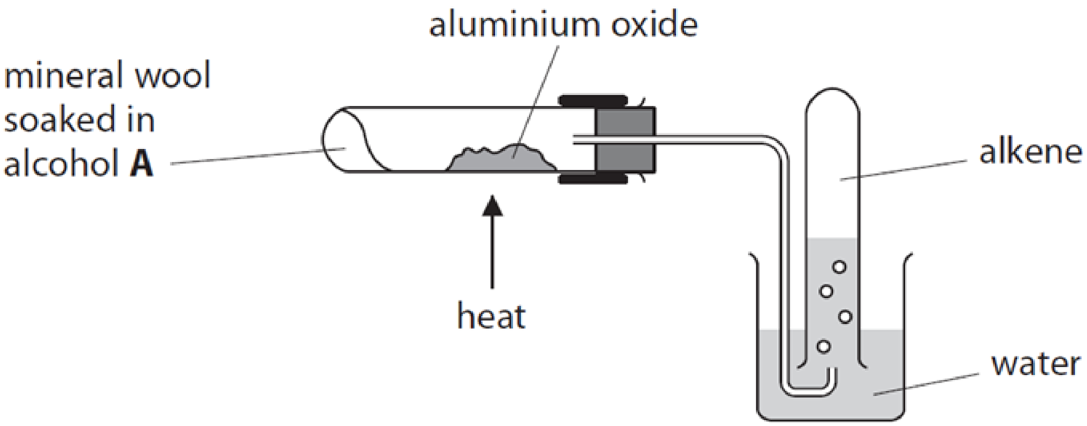
Question number	Answer	Additional guidance	Mark
2(b)(v)	An answer that makes reference to the following points: • choice of apparatus 2 **(1)** • ensuring complete reaction / oxidation **(1)**	M2 dependent on M1 Ignore subsequent distillation Ignore reference to preventing loss of volatile reagents or products. Just 'because the ketone does not oxidise further' Just 'reaction is slow'	**(2)**

Apparatus 1, because ketone cannot be further ~~oxidation~~ oxidising.

Apparatus 2 should be used. Heating under reflux can make sure alcohol condenses back into mixture. The reaction goes to completion.

(c) In a further experiment, the students passed the vapour of **A** over heated aluminium oxide to form an alkene.

The apparatus used is shown.



(i) Give **two** reasons for the use of the mineral wool. **(2)**

Question number	Answer	Additional guidance	Mark
2(c)(i)	An answer that makes reference to any **two** of the following points: • the mineral wool holds the alcohol in place (at the end of the tube) **(1)** • the alcohol vapour would not pass over the catalyst slowly enough to react (without the mineral wool) **(1)** • the mineral wool is chemically inert / does not react with the alcohol **(1)**	Ignore large surface area / high melting temperature / good absorbant / prevents evaporation (of the alcohol)/ slow reaction Allow prevents the alcohol mixing with the aluminium oxide / Al_2O_3 / catalyst Allow so the alcohol is not heated directly (by the Bunsen) Ignore Any reference to alcohol burning Allow mineral wool does not burn	**2** **exp**

The mineral wool was used to hold the alchol in one place so it doesnot react with the aluminium oxide, and it was used because the mineral wool is ~~the~~ unreactive and will not react with the reagents.

- It is a good absorbant
- It doesnot react with the alkohol

(ii) Explain why it is necessary to remove the delivery tube from the heated tube immediately when heating stops. **(2)**

Question number	Answer	Additional guidance	Mark
2(c)(ii)	An explanation that makes reference to the following points: • the possibility of suck-back **(1)** EITHER • explanation of the cause of suck-back **(1)** OR • description of the consequences of suck-back **(1)**	Examples of correct responses: Suck-back will occur / Water will be drawn up into the reaction tube (from the water bath) Do not award suck-back of anything other than water (On cooling) the pressure in the tube drops and atmospheric pressure acting on the water in the water bath which causes a pressure difference (resulting in suck-back) Allow just drop in pressure / vacuum formed in the reaction tube. Do not award just 'cooling causes suck-back' just 'due to pressure differences' Cold water causes hot tube to crack Allow just test tube cracks/shatters Do not award water will react with the aluminium oxide / tube explodes	**(2)**

Because if it is not removed, it will create a vacum in the tube which would increase the pressure and cause the apparatus to burst spitting around all of the reactants.

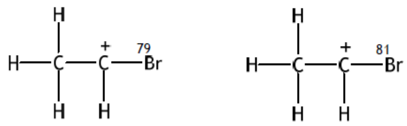
Pressure will decrease inside so water might go inside.

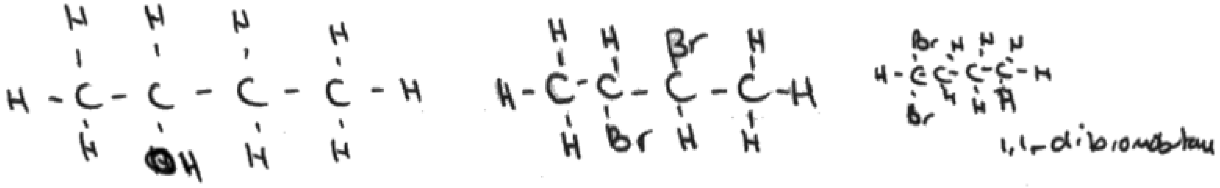
WCH13 Q2(d)(ii)

(ii) The mass spectrum of $C_4H_8Br_2$ had a pair of peaks at $m/z = 107$ and $m/z = 109$ and also peaks at $m/z = 79$ and $m/z = 81$ due to the isotopes of bromine.

One student suggested that these peaks showed that alcohol **A** must be butan-2-ol.

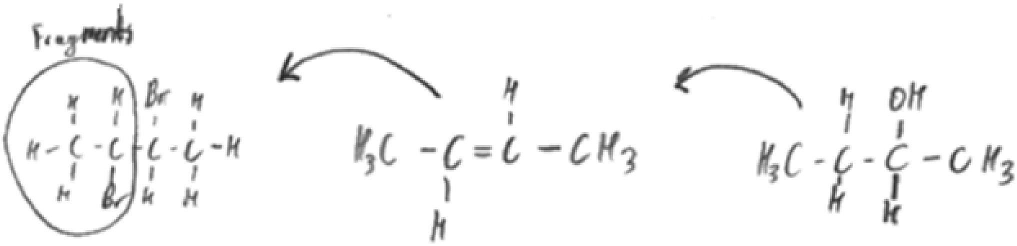
Explain how these peaks support the student's suggestion. (3)

Question number	Answer	Additional guidance	Mark
2(d)(ii)	An explanation that makes reference to the following points: • identification of the peaks by molecular formula or structure **(1)**	Do **not** penalise omission of charges $C_2H_4{}^{79}Br^+$ and $C_2H_4{}^{81}Br^+$ OR  Allow peaks due to $C_2H_4Br^{(+)}$	**(3)**
	• only 2,3-dibromobutane can produce the fragments at *m* / *z* = 107 and *m* / *z* = 109 **(1)**	Allow identifies $C_4H_8Br_2$ as 2,3-dibromobutane	
	• Identifies butan-2-ol as the **only** alcohol that can form but-2-ene (as a product of dehydration and only but-2-ene can form 2,3-dibromobutane) **(1)**	Do not award Just 'alcohol must be butan-2-ol' Just a sequence of structures	



Butan-2-ol 2,3-dibromobutane 1,1-dibromobutane

The peak at $m/z = 109$ suggests that there was a bromine on the second carbon which suggests that there could have been an OH group on the second carbon. The peak at $m/z = 107$ also suggests this as the fragment would be CH_3CHBr^{79}. This supports the students view that ~~the~~ alcohol A is butan-2-ol



The 79 m/z and ~~8~~ 81 m/z confirm that there is Br^+ isotopes in the ~~..~~ $C_4H_8Br_2$. 107 m/z and m/z 109 confirm that there are fragments of $C_2H_4Br^+$ which means the double bond was on the second carbon. During dehydration to form alkene the OH is taken away along with ~~...~~ H on the next neighbouring carbon meaning OH was taken away from second carbon and H from 3rd as that's where double bond formed. Therefore you would've ~~...~~ had butan-2-ol