

# Edexcel International AS/A Level

IAL Chemistry

**ONLINE** Module 1

Understanding assessment  
and improving delivery

Event Code:

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First teaching in 2018, first assessment 2019

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# Introductions



# Aims and Objectives

- introduction to assessment objectives: what are they and why they are used
- analysis of some recent questions matching them to assessment objectives
- investigate different assessment objectives looking at feedback from the previous exam series
- discuss strategies for teaching to ensure students can access questions targeting different assessment objectives
- network, discuss best practice and share ideas with other teachers



# Assessment Objectives



# Assessment Objectives

- What are they, why do we use them, what does the wording mean?
- What balance of AOs are there in the exams?
- Assigning AOs  
Look at a couple of questions  
Which AO would you assign to each question part?



What are AOs and why do we use them?



# What is an AO?

## Assessment objectives

The requirements that students need to meet to succeed in the qualification. Each assessment objective has a unique focus, which is then targeted in examinations or coursework

Assessment objectives may be assessed individually or in combination



# Definitions of AOs

		% in IAS	% in IA2	% in IAL
<b>AO1</b>	Demonstrate knowledge and understanding of science.	34–36	29–31	32–34
<b>AO2 (a)</b>	Application of knowledge and understanding of science in familiar and unfamiliar contexts.	34–36	33–36	33–36
<b>(b)</b>	Analysis and evaluation of scientific information to make judgements and reach conclusions.	9–11	14–16	11–14
<b>AO3</b>	Experimental skills in science, including analysis and evaluation of data and methods.	20	20	20

## Specification p75





# AO1

Demonstrate knowledge and understanding of science

Recall facts and reasons

Example of command words:

Add/Label

Complete/Record

Describe (straightforward known ideas)

Explain (a simple idea or reason)

Give/State/Name

Write (a familiar equation)



# A02(a)

Application of knowledge and understanding of science in familiar and unfamiliar contexts

Apply facts and reasons to contexts

Example of command words:

Assess

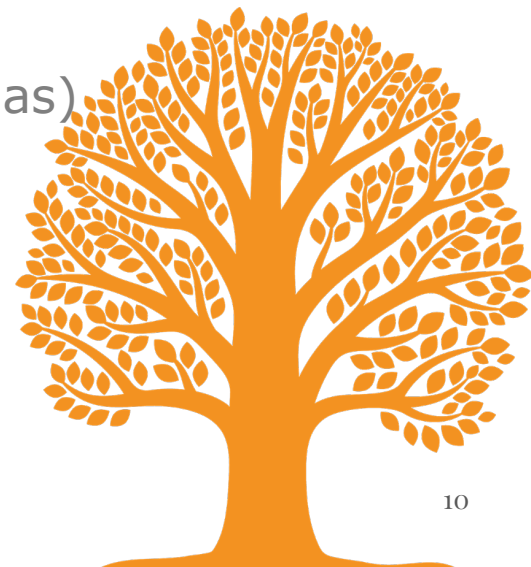
Criticise

Deduce

Evaluate

Explain (for more complex ideas)

Suggest



# AO2(b)

Analysis and evaluation of scientific information to make judgements and reach conclusions

Use information to explain facts and reasons or use information with facts and reasons to establish new ideas

Example of command words:

Assess

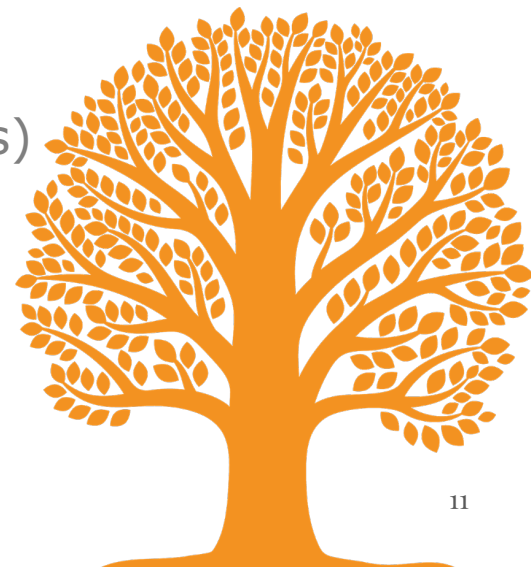
Criticise

Deduce

Evaluate

Explain (for more complex ideas)

Suggest



# AO3

Experimental skills in science, including analysis and evaluation of data and methods

Practical skills including recall of some key practical activities

Explanation for the steps involved may be looked at in both familiar and unfamiliar contexts as will the evaluation of data and methods

Any of the command words might be used



# Definitions of AOs

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<b>(b)</b>	Analysis and evaluation of scientific information to make judgements and reach conclusions.	9–11	14–16	11–14
<b>AO3</b>	Experimental skills in science, including analysis and evaluation of data and methods.	20	20	20



# Assigning AOs



# WCH12 June 2019 Q21

**21** The halogenoalkane 1-chlorobutane reacts under suitable conditions with potassium hydroxide to form the alcohol butan-1-ol.

(a) (i) Name a suitable solvent for the potassium hydroxide in this reaction.

(1)

---

(ii) State the type and mechanism of this reaction.

(1)

---

(iii) Draw the mechanism for this reaction.

Use curly arrows, and show relevant dipoles and lone pairs.

(3)

**(a)(i) AO1**

**(a)(ii) AO1**

**(a)(iii) AO2a**



# WCH12 June 2019 Q21

(b) A student carried out the reaction.

After separation and purification, the mass of butan-1-ol formed was 12.1 g.

The yield of the reaction was 64.0%.

Calculate the volume of 1-chlorobutane used in the reaction.

Give your answer to an appropriate number of significant figures.

[Density of 1-chlorobutane =  $0.886 \text{ g cm}^{-3}$ ]

(4)

**AO2a**





# WCH12 June 2019 Q23

**23** Propanoic acid,  $\text{CH}_3\text{CH}_2\text{COOH}$ , is a colourless liquid used as a preservative in animal feed. Propanoic acid can be formed by oxidising the alcohol propan-1-ol.

- (a) Write the balanced equation for the oxidation of propan-1-ol to form propanoic acid. Use  $[\text{O}]$  to represent the oxygen from the oxidising agent. State symbols are not required. (1)

**AO1**



# WCH12 June 2019 Q23

\*(b) Propan-1-ol is heated with a concentrated solution of acidified potassium dichromate(VI).

Explain how the conditions used affect the rate of the reaction **and** ensure that propanoic acid is the only organic product. (6)

**Recall that high concentration and temperature give fast rate is AO1**

**Explanation of these is AO2a**

**Deduction of the fact that they will give propanoic acid as the only product is AO2b**



# WCH12 June 2019 Q23

- (c) A student suggested using universal indicator to check for the presence of propanoic acid formed in the reaction mixture.

Give a reason why the result of this test is **not** likely to be conclusive. (1)

**AO2b**



# WCH12 June 2019 Q23

- (d) The permitted mass of propanoic acid used in animal feed is in the range  $1000\text{--}3000\text{ mg kg}^{-1}$ . A titration method may be used to check the concentration of propanoic acid in animal feed.

A  $50.0\text{ cm}^3$  sample of propanoic acid solution was extracted from 50 g of an animal feed.

The sample was added to a volumetric flask and the volume made up to  $250.0\text{ cm}^3$  and mixed thoroughly. A pipette was used to transfer  $25.0\text{ cm}^3$  of the diluted acid into a conical flask containing an indicator.

The contents of the conical flask were titrated with a solution of sodium hydroxide,  $\text{NaOH(aq)}$ , with concentration  $0.00668\text{ mol dm}^{-3}$ .

The procedure was repeated twice and the results obtained are shown.

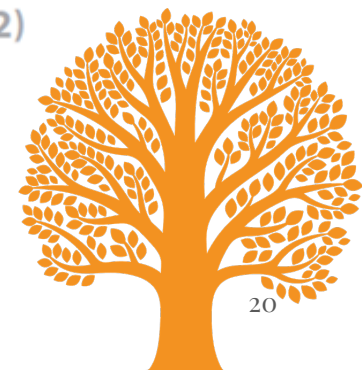
	Run 1	Run 2	Run 3
Titre / $\text{cm}^3$	23.20	22.10	22.20

- (i) Phenolphthalein is a suitable indicator for this titration.

State the colour **change** at the end-point.

(2)

**A01 1 mark, A02a 1 mark**

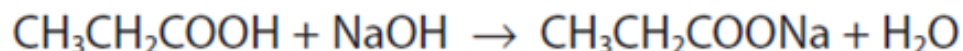


# WCH12 June 2019 Q23

- (ii) Suggest **two** possible reasons why the titre for Run 1 is greater than the other two titres.

(2)

- (iii) The equation for the reaction of propanoic acid with sodium hydroxide is



Calculate the mass in grams of propanoic acid extracted from the animal feed.

Give your answer to an appropriate number of significant figures.

(5)

**(d)(ii) AO2b 2 marks**

**(d)(iii) AO1 2 marks, AO2a 3 marks**



# WCH12 June 2019 Q23

- (iv) Use your answer to (d)(iii) to determine whether the acid in this sample lies within the permitted range for use in animal feed. (2)
- (v) Suggest how the animal feed would be affected if the amount of propanoic acid was outside the permitted range. (1)

**(d)(iv) and (v) are both AO2a**



# A02



# AO2

## In this section:

Why do we ask AO2?

What types of AO2 questions are there?

Consideration of some questions from recent papers

Some marking / feedback to see good and poor student answers

Teaching strategies:

How can we make sure students succeed at AO2?





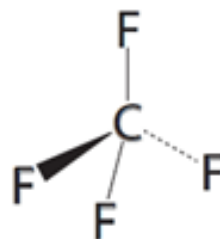
# Why do we ask AO2?

- While AO1 is focused on recall of knowledge and explanation, AO2 focuses on application, analysis and evaluation
- AO2a      Application of knowledge in familiar and unfamiliar contexts
- AO2b      Analysis and evaluation of information



# Example multiple choice Qs (WCH11)

4 Which is correct for tetrafluoromethane ( $\text{CF}_4$ )?



**A02a**

	Bonds	Molecule
<input checked="" type="checkbox"/> <b>A</b>	polar	polar
<input checked="" type="checkbox"/> <b>B</b>	non-polar	polar
<input checked="" type="checkbox"/> <b>C</b>	polar	non-polar
<input checked="" type="checkbox"/> <b>D</b>	non-polar	non-polar



## Example multiple choice Qs (WCH11)

5 Which pair of ions gives the strongest ionic bonding?

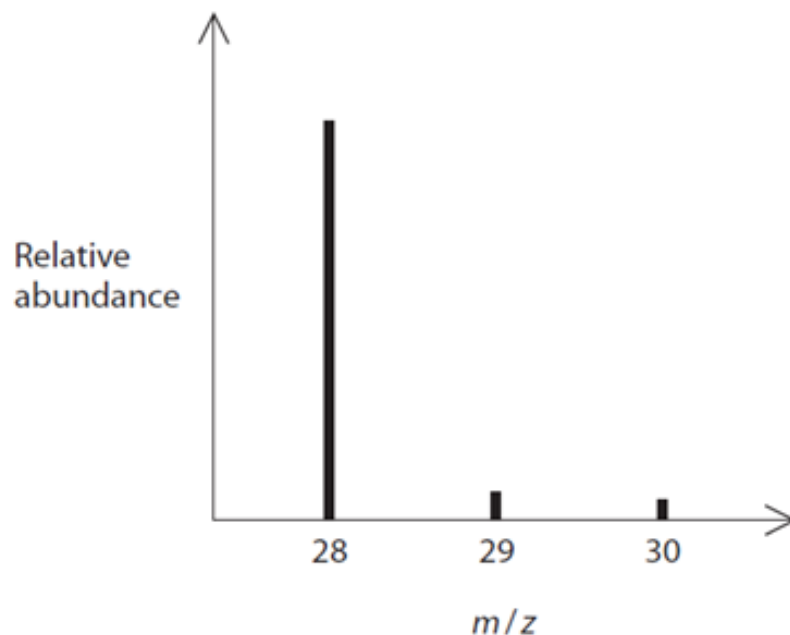
- ☐ **A**  $\text{Na}^+$  and  $\text{F}^-$
- ☐ **B**  $\text{K}^+$  and  $\text{Br}^-$
- ☐ **C**  $\text{Mg}^{2+}$  and  $\text{O}^{2-}$
- ☐ **D**  $\text{Ca}^{2+}$  and  $\text{S}^{2-}$

**AO2a**



# Example multiple choice Qs (WCH11)

12 The mass spectrum of a sample of silicon is shown.



AO2b

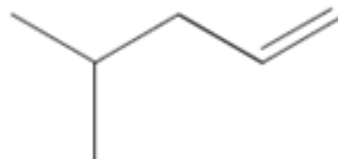
What is the **best** estimate for the relative atomic mass of silicon in this sample?

- ☐ A 28.0
- ☐ B 28.2
- ☐ C 28.8
- ☐ D 29.0



# Example multiple choice Qs (WCH11)

16 What is the name of the product when this molecule reacts with chlorine gas?



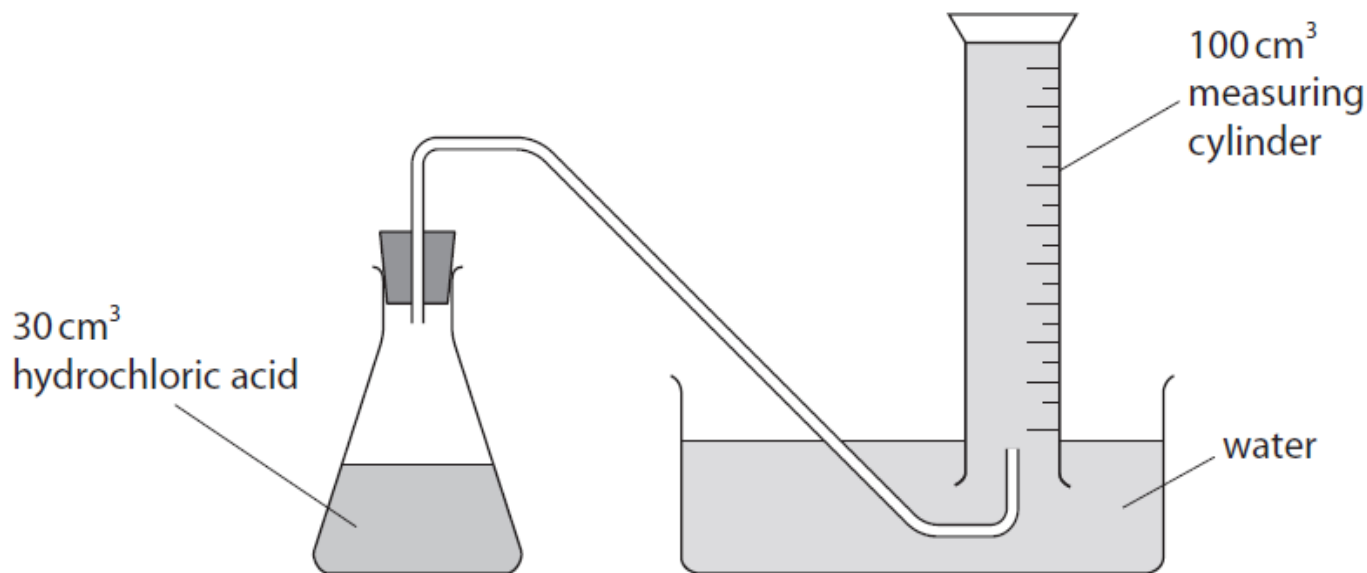
- ☐ **A** 5,5-dichloro-2-methylpentane
- ☐ **B** 4,5-dichloro-2-methylpentane
- ☐ **C** 2,3-dichloro-4-methylpentane
- ☐ **D** 1,2-dichloro-4-methylpentane

AO2b



# 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.



# WCH11 – 21(b)(i)

The results are shown in the table.

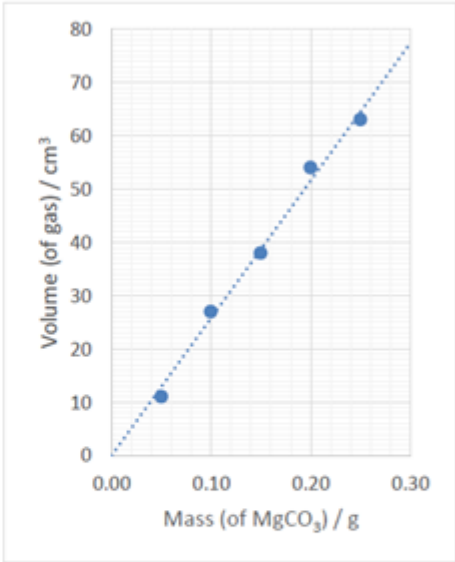
Mass of magnesium carbonate / g	Volume of gas collected / cm <sup>3</sup>
0.05	11
0.10	27
0.15	38
0.20	54
0.25	63

**AO2a**

(i) Plot a graph of these results.

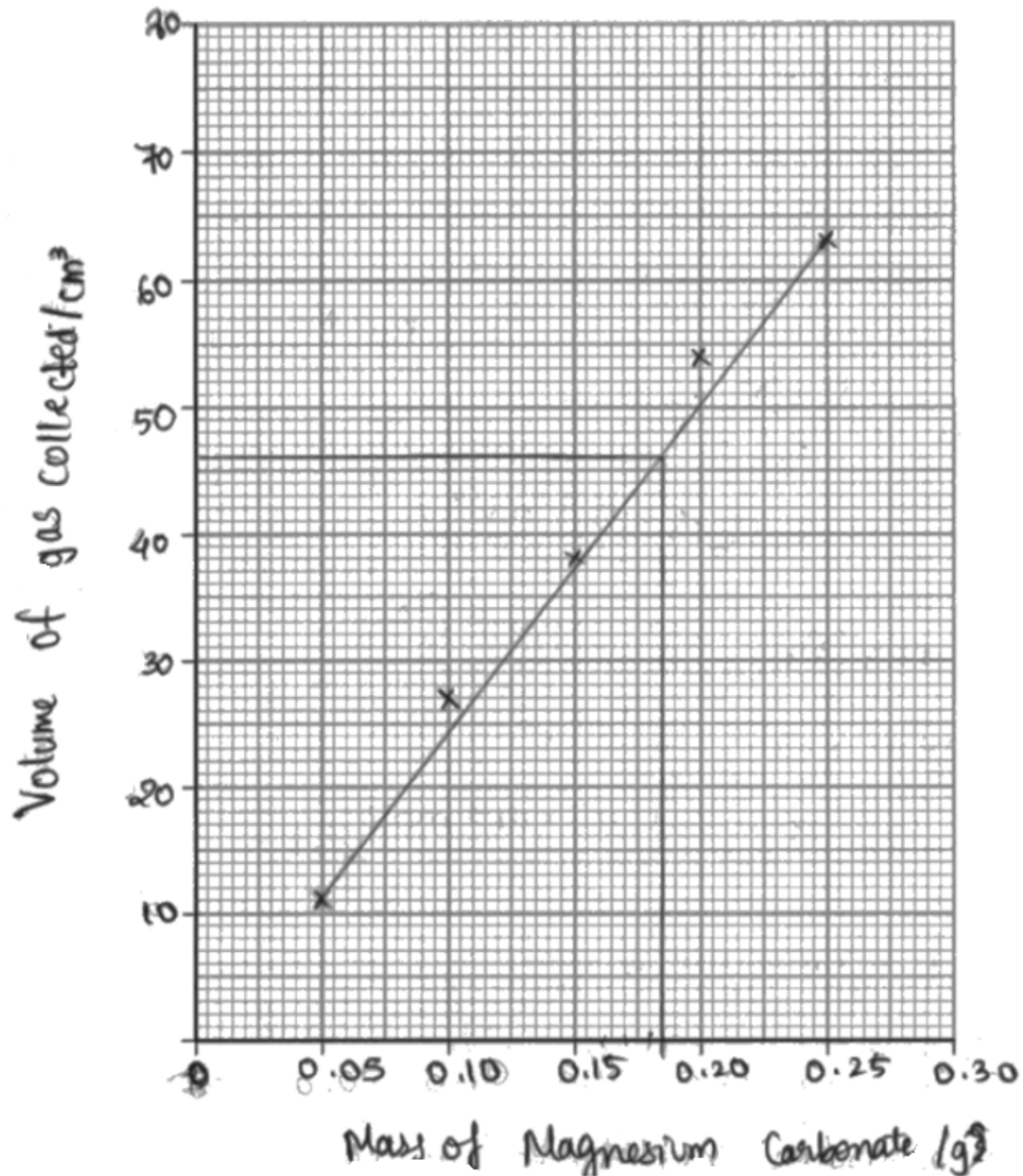
(3)

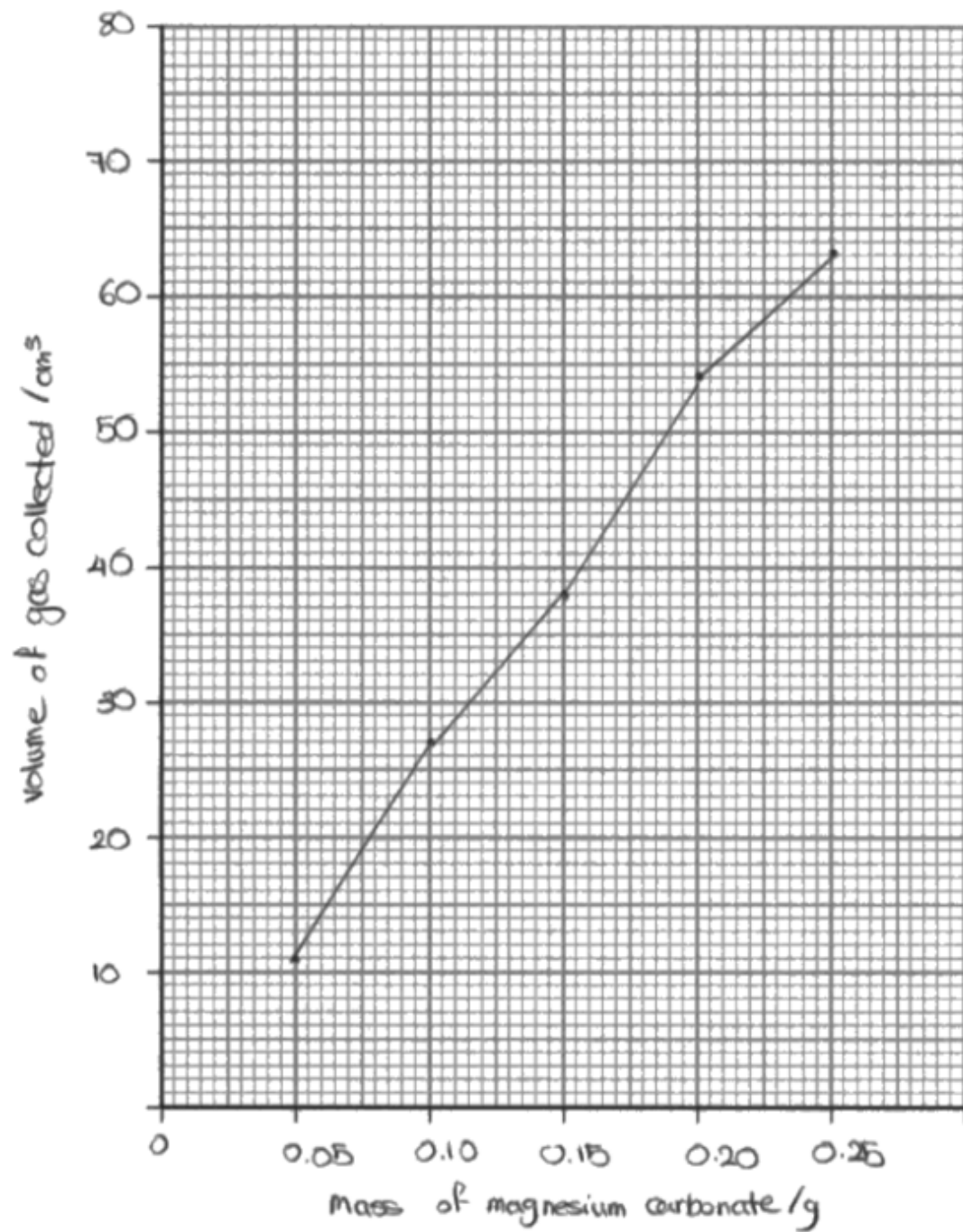


Question Number	Answer	Additional guidance	Mark
21 (b)(i)	<ul style="list-style-type: none"> <li>• suitable choice of scale so that the points cover at least 50% of the grid in both directions and correct choice of axes i.e. mass on x axis, suitably labelled including units (1)</li> <li>• all points plotted correctly (within ½ square) (1)</li> <li>• <b>straight</b> line of best fit (passes through the origin) (1)</li> </ul>	<p>Example of graph:</p>  <p>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.</p>	(3)









# Examiners' Report

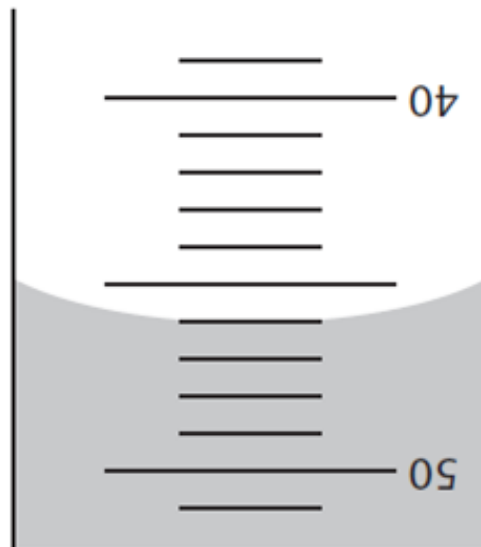
The majority of candidates scored two or three marks for their drawing of the graph.

Occasionally candidates lost a mark for having the axes the wrong way around, but the most frequent error was in the line of best fit. Candidates were expected to have points on either side of the line (ideally it should pass through the origin for this experiment) and use a ruler to draw a single straight line.



# WCH11 – 21(b)(ii)

- (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)

**The value ( $46 \text{ cm}^3$ )**

**AO2a**



## WCH11 – 21(b)(ii)

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

(1)

46 cm<sup>3</sup>

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

(1)

54

~~46~~ cm<sup>3</sup>



# Examiners' Report

The upside-down measuring cylinder proved challenging for some candidates but transfer errors were given if they continued with their answer through the calculation. The common incorrect answers were  $54\text{cm}^3$  and, to a lesser extent,  $45\text{cm}^3$ .



# WCH11 – 21(b)(iii)

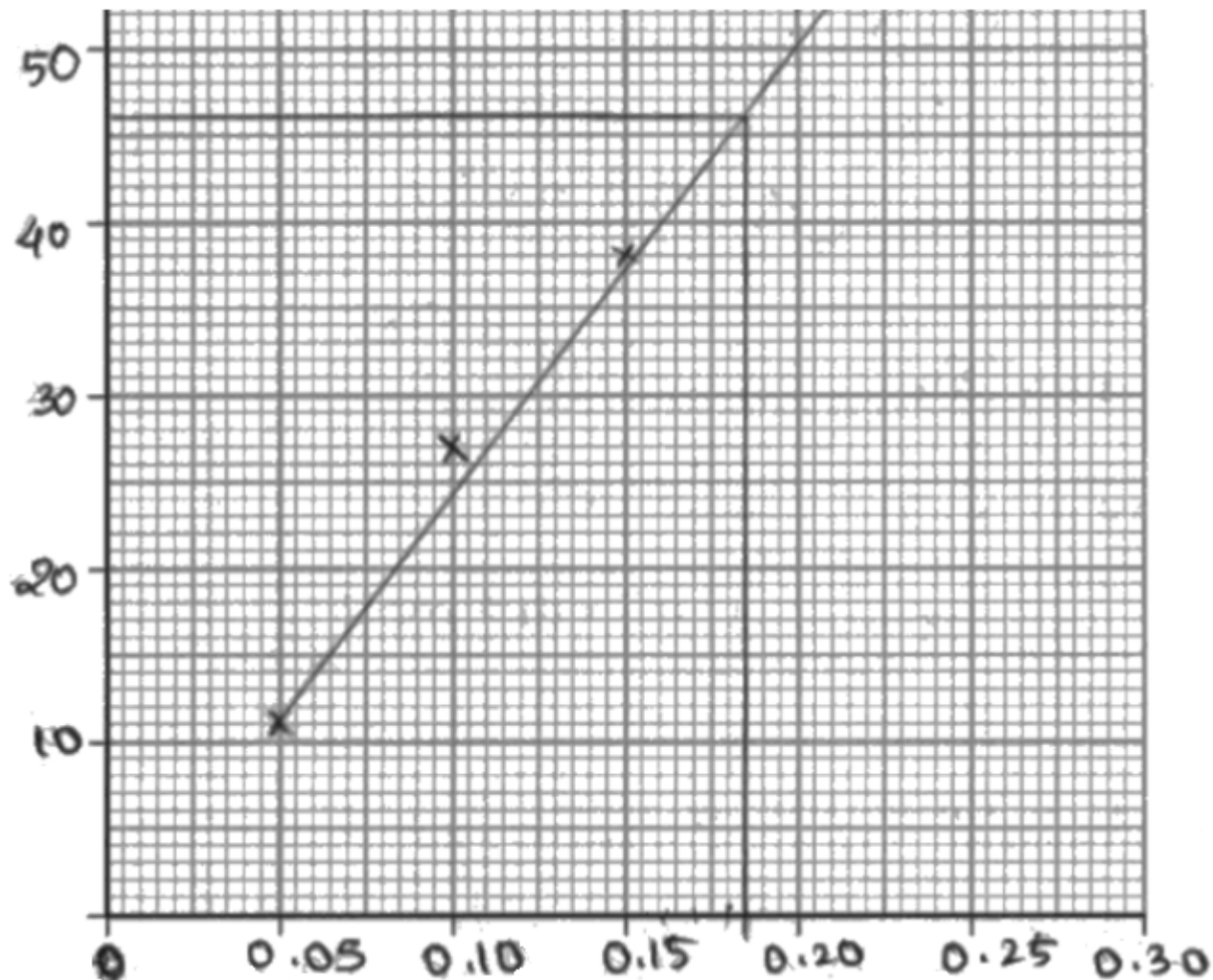
(iii) Determine the mass of magnesium carbonate added in the experiment in (b)(ii), using your graph. (1)

Question Number	Answer	Additional guidance	Mark
21(b)(iii)	<ul style="list-style-type: none"><li>0.18 (g)</li></ul>	Accept answers from 0.17 (g) to 0.19 (g) Ignore SF  TE on (b)(ii) and the graph, eg 54 (cm <sup>3</sup> ) gives 0.215 (g)  Ignore units even if incorrect	(1)

**AO2a**





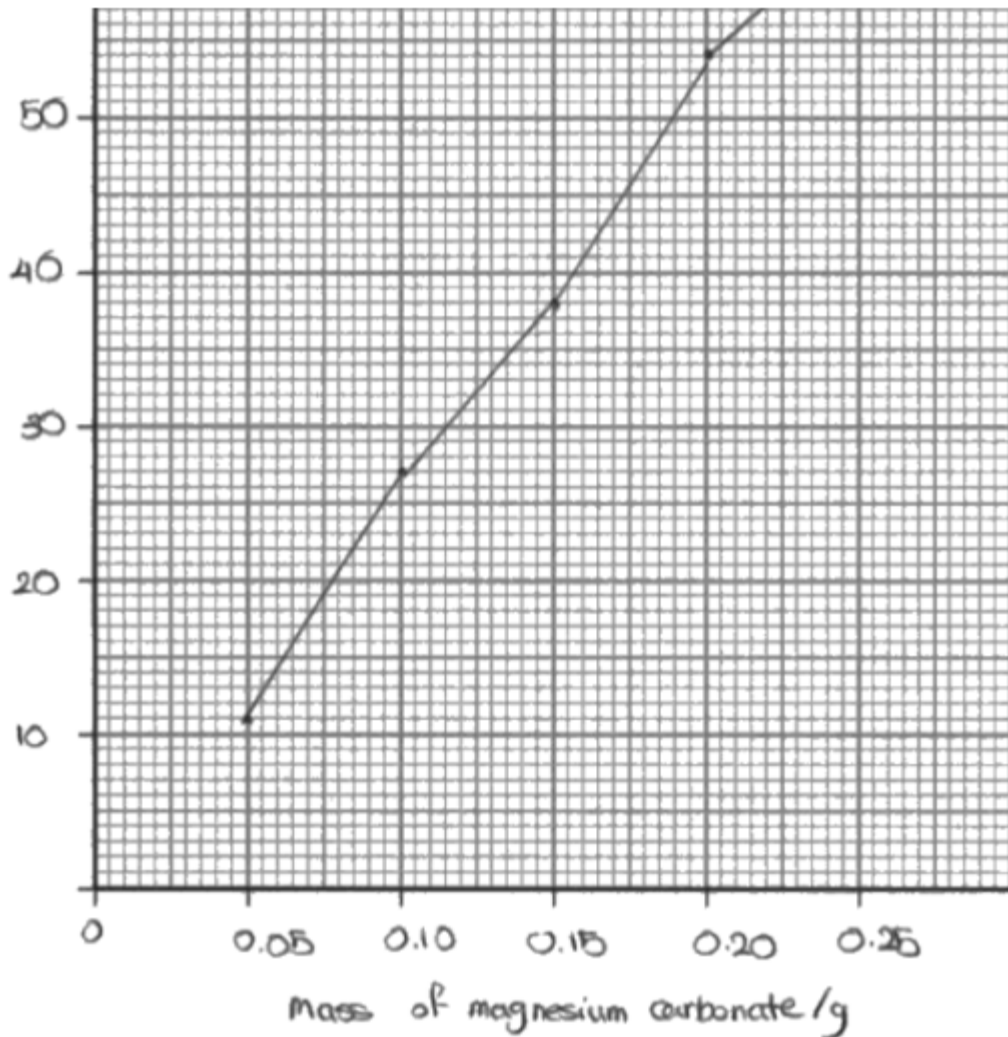


(iii) Determine the mass of magnesium carbonate added in the experiment in (b)(ii), using your graph. (1)

0.185g







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

0.20 g



# Examiners' Report

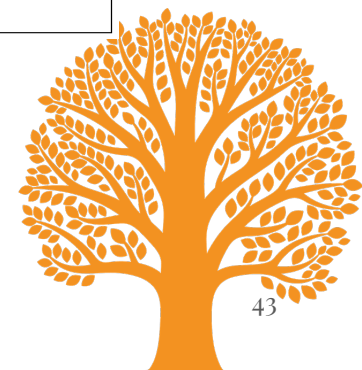
Part Q21(b)(iii) was sometimes answered using the table or the gradient of the line, rather than the candidates' own graph, but this was allowed.



- (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)	<ul style="list-style-type: none"> <li>calculation of molar mass of magnesium carbonate (1)</li> <li>calculation of moles of magnesium carbonate (1)</li> <li>calculation of molar volume (1)</li> <li>answer given to <b>2 or 3 SF and</b> units (1) M4 dependent on award of M3</li> </ul>	<p>Example of calculation:</p> <p>84.3 OR expression used correctly: [24.3 + 12 + (3×16)]</p> <p><math>n = 0.18 \div 84.3 = 0.0021352 / 2.1352 \times 10^{-3}</math> (mol)</p> <p><math>46 \div 0.0021352 = 21\,543 / 2.1543 \times 10^4 (\text{cm}^3)</math>   <math>= 22 \text{ dm}^3 (\text{mol}^{-1}) / 22\,000 \text{ cm}^3 (\text{mol}^{-1})</math>  Or <math>21.5 \text{ dm}^3 (\text{mol}^{-1}) / 21\,500 \text{ cm}^3 (\text{mol}^{-1})</math></p> <p>TE on any reasonable pair of values obtained from the candidates' graph or table provided eg <math>54 \text{ cm}^3</math> and <math>0.215(\text{g}) \rightarrow 2.5504 \times 10^{-3} (\text{mol}) \rightarrow 21\,200 \text{ cm}^3</math></p> <p>Correct answer scores 4 marks Final answer must not be given as a fraction to get MP4 Ignore units except for MP4</p>	(4)

**A02a**



$$\frac{m}{M_r} = \frac{0.135}{84.3} \quad M_r \text{ MgCO}_3 = 84.3$$

$$= 2.1945 \times 10^{-3} \text{ mols}$$



$$2.1945 \times 10^{-3} \longrightarrow x$$

$$\therefore x = 2.1945 \times 10^{-3} \text{ mols}$$

$$V = n \times V_m$$

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

$$V_m = 20.96 \text{ dm}^3$$

$$V_m = 21.0 \text{ dm}^3 = 21 \text{ dm}^3$$



$\text{CO}_2 =$

$$V = 54 \text{ cm}^3$$

~~Mass~~

$$m = 0.20 \text{ g}$$

$$A_r = 44$$

$$n = 4.55 \times 10^{-3} \text{ mol}$$

$$n \times 24 \text{ dm}^3 =$$

$$4.55 \times 10^{-3} \text{ mol} \times 24 = 0.1092 \approx 0.11 \text{ mol dm}^3$$



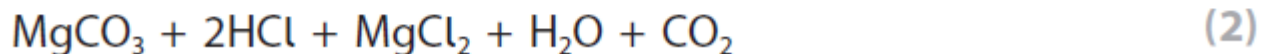
# Examiners' Report

The most frequent error in part Q21(b)(iv) was the failure to use the volume from the measuring cylinder in their calculation. Often candidates quoted the molar volume and tried to use this to calculate the experimental molar volume. The final mark was for an answer of 2 or 3 significant figures with units.



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

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



Question Number	Answer	Additional guidance	Mark
21 (b)(v)	<ul style="list-style-type: none"> <li>moles of magnesium carbonate and moles of acid in 30 cm<sup>3</sup> (1)</li> <li>calculation of minimum concentration with units (1)</li> </ul>	<p>Example of calculation:</p> <p><math>n = 0.25 / 84.3</math>  <math>n = 0.0029655</math> or <math>0.00297</math>  <b>and</b>            1:2 stoichiometry  <math>\therefore 0.00593</math> (moles acid)            Accept <math>0.00594</math> from <math>0.00297</math></p> <p><math>(0.00593 / 30) \times 1000 = 0.198 \text{ mol dm}^{-3}</math></p> <p>Accept answers from  <math>0.198</math> to <math>0.200 \text{ mol dm}^{-3}</math></p> <p>Allow TE throughout e.g. <math>M_r</math> from 21(b)(iv)            Ignore SF</p> <p>Correct answer with no working scores 2</p>	(2)

**AO2a**



$$M_r \text{ MgCO}_3 = 84.3 \text{ g mol}^{-1}$$

$$\frac{m}{M_r} = \frac{0.25}{84.3} = \cancel{2.966} \times 10^{-3} \text{ mol}$$



$$2.966 \times 10^{-3} \rightarrow x$$

$$x = 5.931 \times 10^{-3} \text{ mol}$$

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

$$= \frac{5.931 \times 10^{-3}}{(30 \div 1000)} = 0.1977 \text{ mol dm}^{-3}$$

$$= 0.198 \text{ mol dm}^{-3}$$

$$= 0.20 \text{ mol dm}^{-3}$$





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



$$m = 0.25 \text{ g}$$

$$A_r = 84.3$$

$$\text{moles} = \frac{m}{A_r} = 2.97 \times 10^{-3} \text{ mol}$$



$$V = 30 \text{ cm}^3 = 0.03 \text{ dm}^3$$

$$n = 5.94 \times 10^{-3} \text{ mol}$$

$$C = \frac{n}{V} = \frac{5.94 \times 10^{-3} \text{ mol}}{0.03 \text{ dm}^3} = \underline{0.198 \text{ mol/dm}^3}$$



# Examiners' Report

Part Q21(b)(v), the calculation of the minimum concentration, was answered well with over half of candidates scoring both marks. Some errors in rounding were seen, but significant figures were not tested here. The common errors were omission of the 1:2 molar ratio or forgetting to convert the volume into  $\text{dm}^3$  and still giving the units as  $\text{mol dm}^{-3}$ .



(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)	<p>An answer that makes reference to any two of the following points:</p> <ul style="list-style-type: none"> <li>loss of gas before the bung is inserted / other named reason <b>(1)</b></li> <li>some carbon dioxide dissolved in the water <b>(1)</b></li> <li>temperature of the lab was <u>lower</u> than standard temperature. <b>(1)</b></li> </ul>	<p>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</p> <p>Allow gas for carbon dioxide</p> <p>Ignore higher pressure            Do not award higher temperature / lower pressure / suck-back</p> <p>Ignore impurities in <math>\text{MgCO}_3</math>            Ignore incomplete reaction</p>	<b>(2)</b>

**A02b**



- Student removed cork first before the tube

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



firstly  $\text{CO}_2$  dissolves in water meaning some  
 $\text{CO}_2$  ~~was~~ had dissolved in <sup>the</sup> water <sup>bath</sup> and wasn't measured

Also the stopper may have not been placed fast  
enough so some of the  $\text{CO}_2$  escaped



# Examiners' Report

## ***Question 21 (c)***

This question continues from Q21(b) and candidates are expected to be familiar with experimental issues that may arise in Core Practical 1 and, in this situation, apply their experience to an unexpected result of a calculation.

Most candidates gained one mark here, usually for saying that the carbon dioxide had dissolved in the water. "Leaks" was not acceptable without an explanation of how the loss of gas occurred. References to conditions being different to standard conditions had to be qualified. Frequently, candidates talked about the reaction being incomplete or there being impurities in the magnesium carbonate which were not accepted answers. Some also mentioned human errors such as reading errors (including parallax).



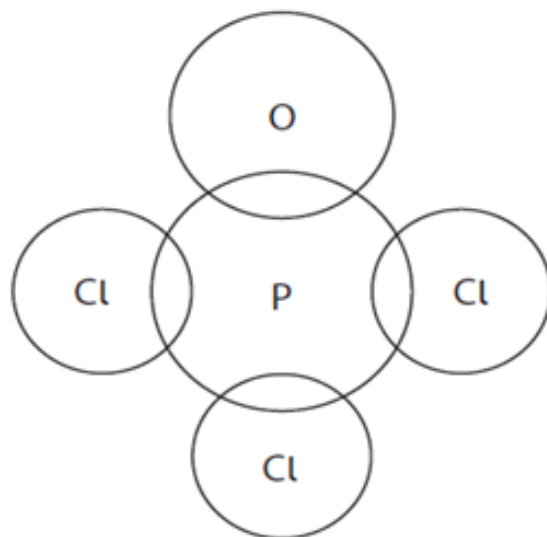
# WCH11 – Q23(c)

(c) The compound  $\text{POCl}_3$  has a simple molecular structure.

(i) Complete the dot-and-cross diagram for the  $\text{POCl}_3$  molecule.

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

(2)

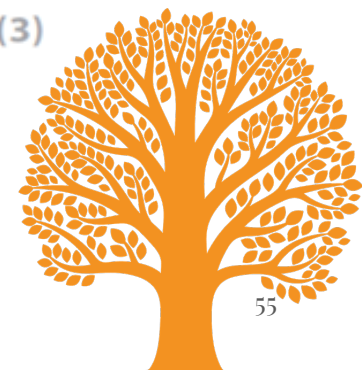


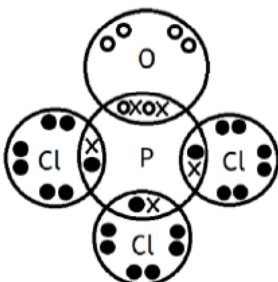
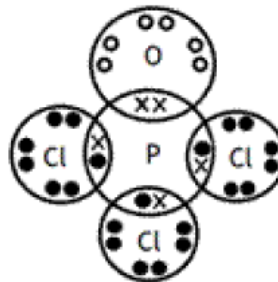
(ii) Explain the shape of this molecule using the electron-pair repulsion theory.

(3)

**(c)(i) A02b**

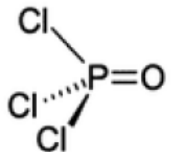
**(c)(ii) A02a**



Question Number	Answer	Additional guidance	Mark
23 (c)(i)	<p>A diagram that includes:</p> <ul style="list-style-type: none"> <li>phosphorus singly covalently bonded to three chlorine atoms and three lone pairs on each chlorine (1)</li> <li>phosphorus doubly bonded to an oxygen atom and two lone pairs on the oxygen</li> </ul> <p>or</p> <p>a dative covalent bond from the phosphorus and three lone pairs on the oxygen (1)</p>	<div data-bbox="1251 121 1530 442">  <p>OR</p>  </div> <p>Penalise absence of lone pairs once only</p> <p>Allow lone pairs to appear as separate electrons</p> <p>Allow any representation of electrons <b>but</b> electrons in a dative covalent bond must appear to be the same</p>	(2)

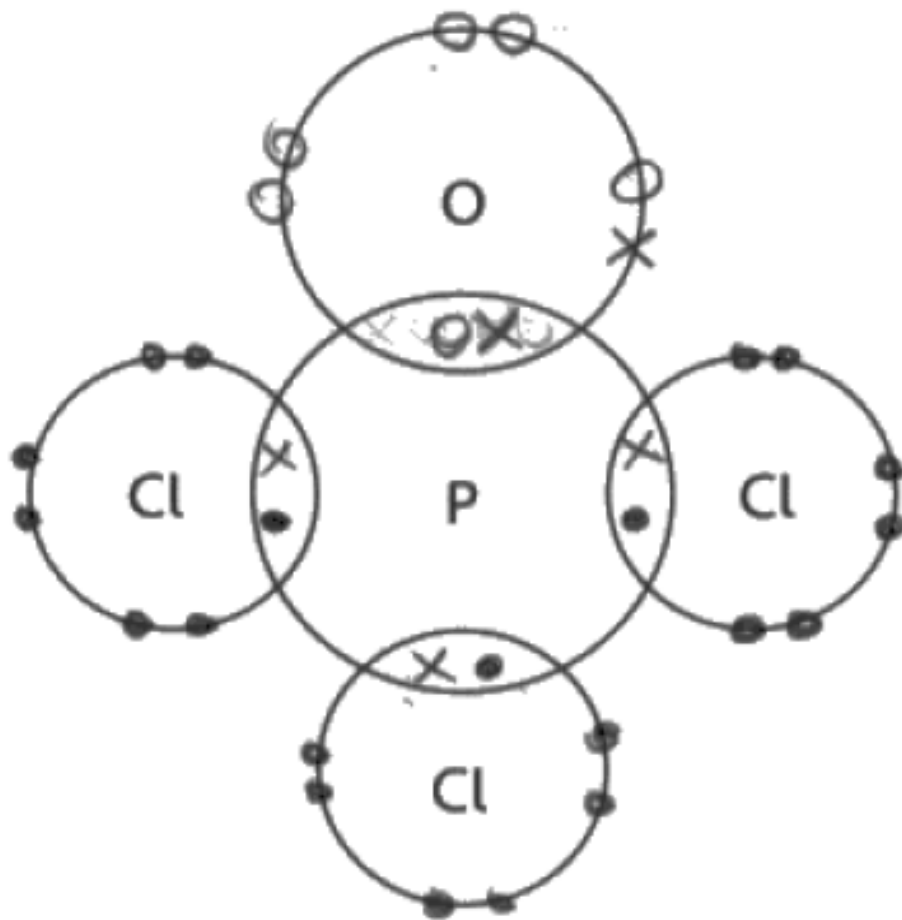




Question Number	Answer	Additional guidance	Mark
<b>23 (c)(ii)</b>	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• (based on) tetrahedron / tetrahedral (arrangement) <b>(1)</b></li> <li>• four regions of bonding electrons <b>(1)</b></li> <li>• adopt the positions of minimum repulsion <b>(1)</b></li> </ul>	<p>MP1 can be given for a 3-D diagram</p>  <p>Accept 5 bonding pairs, where two (in double bond) behave as one. Allow 4 bonding pairs Allow phosphorous bonds to 4 other atoms</p> <p>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</p> <p>Ignore bond angles throughout Ignore lone pairs throughout</p>	<b>(3)</b>



# WCH11 23(c)(i)

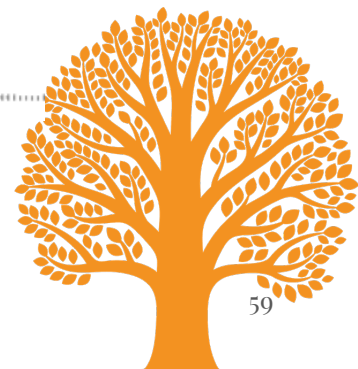


## WCH11 23(c)(ii)

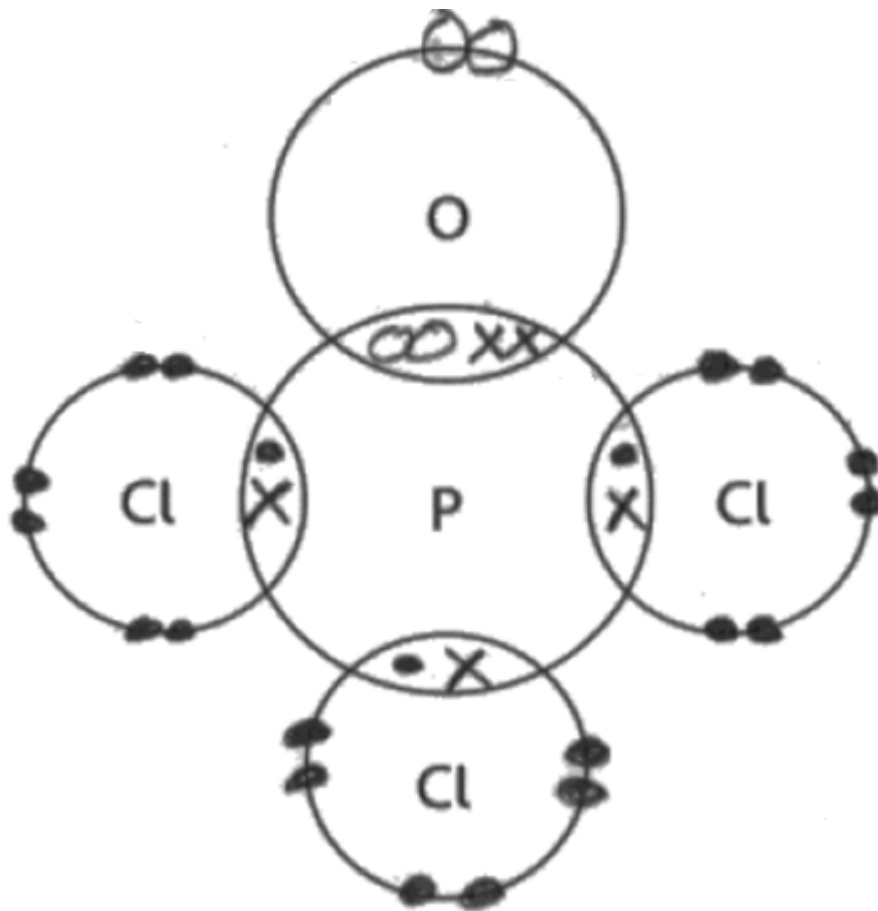
trigonal bipyramidal (3)

It will have a ~~octahedral~~ 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 ~~p~~ pushing the O away while the Cl are close to each other.



# WCH11 23(c)(i)



## WCH11 23(c)(ii)

The shape of this molecule is a tetrahedral structure with a bond angle of  $109.5^\circ$  and ~~the~~ 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.



# Examiners' report – WCH11

## Question 23 (c)

Two bonding patterns were acceptable answers here. The lack of lone pairs was only penalised once and this was the most common reason for less than full marks being awarded for the bonding diagram.

Explanations of electron pair repulsion theory were mixed, with candidates most often neglecting the four areas of electron density (allowed as phosphorous bonds or bonding pairs).

Some confusion was seen about the relationship between separation and repulsion.

The most frequent incorrect answer for the shape was pyramidal. This was regularly seen with dot and cross diagrams showing dative covalent bonding as candidates did not take the oxygen into account when describing the shape of the molecule - or trigonal bipyramidal, when candidates thought there were five areas of electron density.

Some candidates included unnecessary information about the differing repulsion between bonding pairs and lone pairs.



# Teaching Strategies

- Focus on understanding the requirements of questions looking carefully at what marks are awarded for
- Students should practice examination questions focusing on the use of mark schemes to understand the requirements of the questions
- Look at the wording of the question to identify where the context needs to be addressed (AO2) rather than simply facts and statements (AO1)



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