Mark Scheme (Results)

Summer 2022

Pearson Edexcel GCE
Chemistry (8CH0)
Paper 01 Core Inorganic and Physical Chemistry

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Answer	Mark
1	**The only correct answer is D** ($1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$) **A** *is not correct because two electrons have been removed instead of added to the sulfur atom* **B** *is not correct because this is the electronic configuration of the sulfur atom* **C** *is not correct because this is the incorrect electronic configuration of the sulfur atom*	**(1)**

(Total for Question 1 = 1 mark)

Question Number	Answer	Mark
2	**The only correct answer is C** (503 965 3458 4530) **A** *is not correct because there is no significant rise from 2nd to 3rd IE, therefore not a Group 2 element* **B** *is not correct because there is a significant rise between 1st and 2nd IEs, indicating a Group 1 element* **D** *is not correct because there is a significant rise from 3rd to 4th IE, indicating a Group 3 element*	**(1)**

(Total for Question 2 = 1 mark)

Question Number	Acceptable Answer	Additional Guidance	Mark
3 (a)	An answer that makes reference to the following points: • first error: 'emitted' **and** correction: replace with 'absorbed' **(1)** • second error: 'ions (move up)' **and** correction: remove 'ions' replace with 'electron(s)' **(1)** • third error: 'is always' **and** correction: remove 'always' replace with 'may be / sometimes' **(1)**	Allow the three errors in any order The mark is for replacement by 'electron(s)' Allow 'electron(s) **in** ions' Allow expression that implies that the radiation can be emitted as visible light, e.g. 'usually' visible light Do not award 'the error is lower energy levels' replace with return to ground state	**(3)**

Question Number	Answer	Mark
3 (b)	**The only correct answer is C** (sodium iodide) **A** *is not correct because calcium in calcium chloride gives a 'brick red' flame* **B** *is not correct because lithium in lithium carbonate gives a 'crimson red' flame* **D** *is not correct because strontium in strontium bromide gives a 'red' flame*	**(1)**

Question Number	Answer	Mark
3 (c)	**The only correct answer is D** (Platinum) **A** *is not correct because copper will give a flame colour* **B** *is not correct because iron is insufficiently inert* **C** *is not correct because magnesium will burn with a white flame*	**(1)**

Question Number	Answer		Mark
3 (d)(i)	• silver nitrate (solution) / chlorine	Allow correct formula/$AgNO_3$ If both name and formula are given both must be correct Allow acidified silver nitrate (solution) Ignore addition of nitric acid Do not award sulfuric acid / hydrochloric acid Do not award conc. sulfuric acid here but allow TE in dii	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
3 (d)(ii)	An answer that makes reference to the following points: • cream/off-white precipitate **(1)** • AgBr **(1)**	Do not accept just 'white' or 'yellow' Accept (very) pale yellow Ignore name Ignore unbalanced equation Award (2) marks for use of chlorine: orange / brown fumes / solution Br_2 (gas / aq) Allow TE (2) marks for use of conc. sulfuric acid in 3di choking fumes SO_2 (g)	**(2)**

(Total for Question 3 = 8 marks)

Question Number	Answer	Mark
4 (a)	**The only correct answer is C** (p = 1, n = 2, e = 1) **A** *is not correct because the number of protons (p) and neutrons (n) are reversed, and the number of electrons is incorrect* **B** *is not correct because an atom of* ^{3}H *contains one electron* **D** *is not correct because the number of protons (p) and neutrons (n) are reversed, and an atom of* ^{3}H *contains only one electron*	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (b)(i)	• relative abundance of missing isotope (^{37}Cl) **(1)** • relative height of missing peak **(1)**	Example of calculation (100 – 75.5) = 24.5 $\frac{82.5 \times 24.5}{75.5} = 26.772$ Ignore SF except 1 SF DNA incorrect rounding for M2 Correct answer with no working scores (2) TE on M1	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (b)(ii)	• (there are) three (possible) combinations of the two isotopes in chlorine molecules/Cl_2	Allow a specific illustration using these 3 combinations $^{35}Cl^{35}Cl = 70$ $^{35}Cl^{37}Cl = 72$ $^{37}Cl^{37}Cl = 74$	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (b)(iii)	• probability of two ^{35}Cl atoms **(1)** • probability of ^{35}Cl and ^{37}Cl atoms **(1)** • probability of two ^{37}Cl atoms **(1)**	Example of calculation ¾ x ¾ = 9/16 = 0.5625 2 x ¾ x ¼ = 6/16 = 2 x 0.1875 = 0.36995 ¼ x ¼ = 1/16 = 0.0625 (so ratio is 9:6:1) Allow alternative explanations and calculations but the logic must be clear. e.g. probability tree (3 max) measurement of peak heights from graph (2 max) eg 3.8:2.4:0.4 = ratio 9:6:1 (approx.)	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (c)(i)	• relative molecular mass	170 May be shown on graph Do not award peak at 171	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (c)(ii)	• $C_{12}H_{26}$	Allow TE from (c)(i) provided H/C could exist eg DNA 57 = C_4H_9 Allow $C_{13}H_{14}$	(1)

Question Number	Acceptable Answer		Additional Guidance	Mark
4 (d)	An answer that makes reference to the following points:		<u>Example of calculation</u>	**(4)**
	• calculation of moles of carbon/carbon dioxide	**(1)**	Moles of carbon dioxide = 3.14 ÷ 44 = 0.071364 (mol) Moles of carbon = 0.071364 (mol)	
	• calculation of moles of water	**(1)**	Moles of water = 1.29 ÷ 18 = 0.071667 (mol)	
	• calculation of moles of hydrogen	**(1)**	Moles of hydrogen = 0.071667 x 2 = 0.14333 (mol)	
	• calculation of empirical formula	**(1)**	Ratio of moles C:H = 0.071364:0.14333 = 1:2.(001) Empirical formula = CH_2 TE on M4 for lost M3 (no x2), so CH TE on moles of C and H	

(Total for Question 4 = 13 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
5 (a)	• 222 (K)	allow answers in the range 200 to 240 (K)	**(1)**

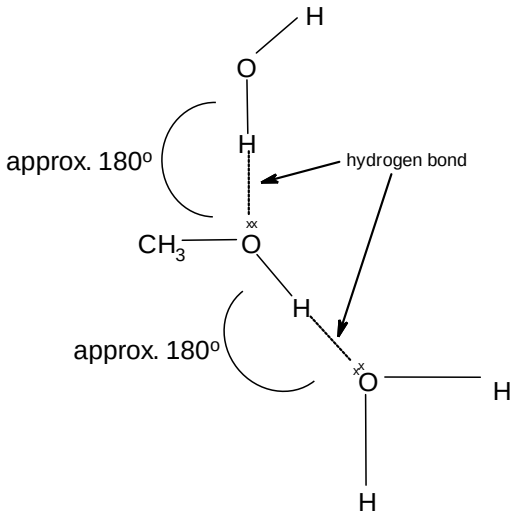
Question Number	Answer	Mark
5 (b)	**The only correct answer is B** (50 ^{o}C) **A** *is not correct because 40 ^{o}C would imply much greater disruption to the intermolecular forces* **C** *is not correct because two side groups would be expected to provide more disruption to intermolecular forces* **D** *is not correct because the trend (caused by side groups) is to lower the boiling temperature*	**(1)**

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>5 (c)</td>
<td>Choose an item.
This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.
The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5-4</td><td>3</td></tr>
<tr><td>3-2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
The following table shows how the marks should be awarded for structure and lines of reasoning.
<table>
<tr><th></th><th>Number of marks awarded for structure and sustained lines of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with</td><td>2</td></tr>
</table>
</td>
<td>Guidance on how the mark scheme should be applied:

The mark for indicative content should be added to the mark for lines of reasoning.
For example, an answer with five indicative marking points that is partially structured with some linkages and lines of reasoning, scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).

If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).

In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.</td>
<td>(6)</td>
</tr>
</table>

	linkages and fully sustained lines of reasoning demonstrated throughout.		If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).	
	Answer is partially structured with some linkages and lines of reasoning.	1		
	Answer has no linkages between points and is unstructured.	0		
	Indicative content: • IP1 **hydrogen bonding** between water/solvent and methanol/solute • IP2 suitable diagram • IP3 same strength/comparable to the bonding in either component on its own		<u>Example of suitable diagram</u>  Allow either/both hydrogen bond(s). Allow any number of hydrogen bonds, if all correct. O-H-O bond angle must be approx. 180° (either in diagram or mentioned in text) Ignore lone pair and dipole	

	Or hydrogen bonding is present in methanol and in water • IP4 hydration of Na^+ and Cl^- • IP5 suitable diagram of at least one ion • IP6 the ionic bonding is stronger than the bonding between sodium and/or chloride ions and methanol	Allow 'solvation/hydration of the ions', provided it is clear that both ions are included. <u>Example of suitable diagram</u>  allow solvation/hydration by any number of water molecules ⩾1 If dipole shown on water, must be correct	

(Total for Question 5 = 8 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>6 (a)</td><td>

- any **two** correct **(1)**
- additional **two** correct **(1)**

</td><td>

Substance	Structure	Bonding	Melting temperature / K
silicon(IV) oxide	(giant)	(covalent)	1883
potassium chloride	*giant*	*ionic*	1043
iron	*giant*	(metallic)	1808
iodine	*simple molecular*	(covalent)	387

Allow just molecular for iodine structure

</td><td>(2)</td></tr>
</table>

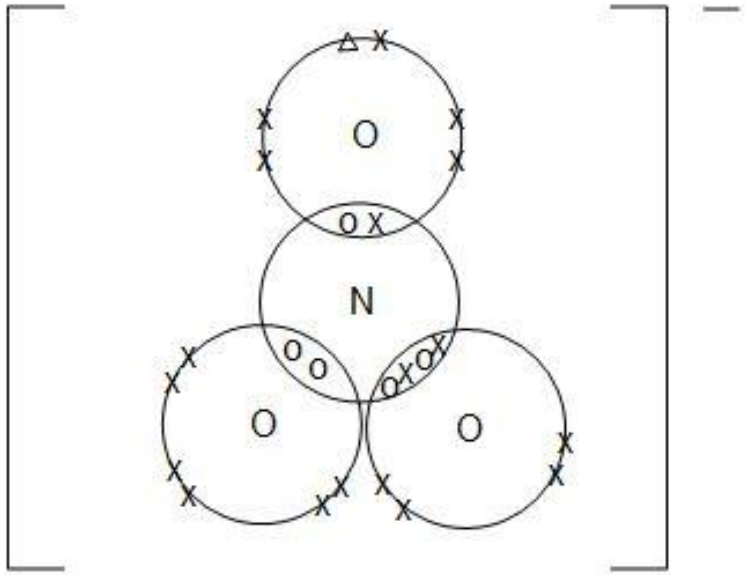
Question Number	Acceptable Answer		Additional Guidance	Mark
6 (b)	An explanation that makes reference to the following points:			**(3)**
	• silicon(IV) oxide/ silicon dioxide (is a giant structure therefore) contains many (strong covalent) bonds	**(1)**	Allow silicon oxide	
	• iodine – (only) weak intermolecular / London forces/bonds must be broken	**(1)**	Do not award covalent bonds are broken Accept dispersion force / instantaneous dipole-induced dipole / van der Waals	
	• more **energy** is required to break the stronger bonds in silicon(IV) oxide/ silicon dioxide (hence higher melting temperature)	**(1)**	Allow reverse argument M3 can be awarded even if M2 is incorrect	

Question Number	Acceptable Answer	Additional Guidance	Mark
6 (c)	An explanation that makes reference to the following points: • molten/liquid potassium chloride conducts because it contains ions that can move (so they carry charge) **(1)** • (in solid and molten state iron conducts) because it contains delocalised electrons (that move and carry charge) **(1)** • solid potassium chloride contains ions in a solid lattice so they cannot move (and carry charge). **(1)**		**(3)**

(Total for Question 6 = 8 marks)

Question Number	Answer	Mark
7 (a)	**The only correct answer is D** (Be, Rb, Ba and Ra) **A** *is not correct because chlorine is in Group 7 therefore it is a p block element* **B** *is not correct because cobalt is a transition element therefore it is a d block element* **C** *is not correct because aluminium is a Group 3 element therefore it is a p block element*	**(1)**

Question Number	Answer	Mark
7 (b)	**The only correct answer is B** (solubility of sulfates decreases and solubility of hydroxides increases down group 2) **A** *is not correct because the solubility of Group 2 sulfates deceases down the group* **C** *is not correct because the solubility of Group 2 hydroxides increases down the group* **D** *is not correct because the solubility of Group 2 sulfates decreases down the group and the solubility of Group 2 hydroxides increases down the group*	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
7 (c)(i)	• dot-and-cross diagram	 Allow diagrams with all dots/all crosses etc Allow lone pairs with electrons separated Ignore covalent bonds (if shown) 'extra' electron may be shown as different shape, colour etc. The double bond can be to any of the three oxygens	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
7 (c)(ii)	An answer that makes reference to the following points: • balanced equation	<u>Example of equation</u> $2LiNO_3 \rightarrow Li_2O + 2NO_2 + ½O_2$ Allow multiples of equation Ignore state symbols even if incorrect	**(1)**

Question Number	Acceptable Answer		Additional Guidance	Mark
7 (c)(iii)	An answer that makes reference to the following points:		Example of calculation Ignore SF for M1, M2, M3 except 1SF, penalise once only	**(4)**
	• calculation of moles of sodium nitrate	**(1)**	Moles of sodium nitrate = 0.5÷85 = 5.8824×10^{-3} (mol)	
	• calculation of moles of oxygen	**(1)**	Moles of oxygen gas O_2 = $5.8824 \times 10^{-3} \div 2$ = 2.9412×10^{-3} (mol)	
	• substitution in $pV = nRT$ and rearrangement	**(1)**	$pV = nRT$ $V = \frac{nRT}{p} = \frac{2.9412 \times 10^{-3} \times 8.31 \times 298}{101000}$	
	• final answer to 2SF only and in cm^3	**(1)**	(= 7.21136×10^{-5} m^3) =72 (cm^3) If M2 not divided by 2 then final answer = 140 cm^3 – scores (3) marks. 144 cm^3 – scores (2) marks. Correct final answer with no working scores (4) Allow TE throughout	

Question Number	Acceptable Answer	Additional Guidance	Mark
7 (c)(iv)	• incomplete reaction / decomposition	Ignore pressure not 101 kPa or temperature not 298 K Do not award reversible reaction / impure reactant or product / oxygen soluble in water / side reactions	**(1)**

Question Number	Acceptable Answer		Additional Guidance	Mark
7 (d)	An answer that makes reference to the following points:			**(3)**
	• Group 2 ions have larger charge (than Group 1 ions) Or Group 2 ions have a 2+ charge and Group 1 ions have a 1+ charge	**(1)**	Allow the charge density of Group 2 ions is larger (than Group 1 ions) Allow reversed argument for Group 1 ions Ignore reference to size	
	• Group 2 ions polarise bonds in the carbonate ion more (effectively)	**(1)**	Allow distort / polarise	
	• the C−O/C=O bond is weakened	**(1)**		

(Total for Question 7 = 12 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (a)	• calculation of total of moles of gas in product **(1)** • calculation using Avogadro number to find number of molecules **(1)**	Example of calculation Moles of HCl = 40 ÷ 24000 = 1.6667 x 10^{-3} / 0.0016667 1.6667 x 10^{-3} x 6.02 x 10^{23} = 1.0033 x 10^{21} For MP2, allow TE on moles of HCl Ignore SF Penalise rounding errors once only	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8(b)(i)	An answer that makes reference to the following points: • the covalent bond in hydrogen chloride changes tc an ionic bond in aqueous solution	Both types of bond required Accept covalent bond breaks, ions are formed Accept $HCl(g) \rightarrow H^+(aq) + Cl^-(aq)$ or $HCl(g) + H_20(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8(b)(ii)	• correct species on each side of equation **(1)** • correct states for all species **(1)**	Example of equation: $HCl(g) + NH_3(g) \rightarrow NH_4Cl(s)$ / $NH_4^+Cl^-(s)$ / $NH_4^+(s) + Cl^-(s)$ Allow (aq) or (g) for reactants Do not award (liquid) for either reactant Two products will lose both marks	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8(b)(iii)	An answer that makes reference to the following points: • first observation **(1)** • second observation **(1)**	Allow observations in any order Sodium carbonate/Na_2CO_3/(white) solid dissolves/disappears/forms a colourless solution Effervescence/fizzing/bubbles Ignore gas/carbon dioxide given off Do not award if any named gas other than carbon dioxide, eg hydrogen or oxygen	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (b)(iv)	A description that makes reference to the following points: • remove a fixed amount of one solution using a pipette into a conical flask and fill up the burette with other solution **(1)** • add a named indicator **and** colour change **(1)** • add solution from burette to flask until indicator changes colour **(1)** • technique mark **(1)** • repeat titrations (until concordant results obtained) **(1)**	Allow use of any suitable flask in place of conical flask. Allow any recognised acid/base indicator: methyl red / orange, phenolphthalein etc. Ignore litmus /UI. Do not award reversed colour change Do not penalise reverse colour change again here. Any one from: Rinsing burette/pipette with appropriate solution, use of white tile, adding slowly, swirling flask etc. Ignore mention of ‘rough’ or ‘trial’ runs etc	**(5)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (c)(i)	• half-equation	<u>Example of half-equation</u> $2Cl^- \rightarrow Cl_2 + 2e^{(-)}$ Allow multiples Allow $2Cl^- - 2e^{(-)} \rightarrow Cl_2$ Ignore state symbols even if incorrect DNA reverse equation	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (c)(ii)	An answer that makes reference to the following points: • calculation of moles of HCl **(1)** • calculation of theoretical moles of Cl_2 produced **(1)** • calculation of theoretical volume of Cl_2 **(1)** • calculation of % yield **(1)** **and** comparison with expected yield	<u>Example of calculation</u> $(5.0 \times 5.0) \div 1000 = 0.025 / 2.5 \times 10^{-2}$ (mol) $0.025 \div 4 = 0.00625 / 6.25 \times 10^{-3}$ (mol) $0.00625 \times 24000 = 150$ (cm^3) % yield = (70÷150) x 100 = 46.7/47(%) **and** less than expected / did not achieve expected yield / expected yield is 75% of 150 =112.5 cm^3 Allow calculation of actual moles of Cl_2 for MP3, then calculation of yield based on moles for MP4: $70 \div 24000 = 2.9167 \times 10^{-3}$ (mol) then % yield and comparison for MP4 $(2.9167 \times 10^{-3} \div 0.00625) \times 100 = 46.7/47(\%)$ Ignore SF except 1 Allow TE at each stage	**(4)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (d)(i)	An answer that makes reference to the following points • recognises/states that disproportionation reactions contain one element that is both reduced and oxidised **(1)** • identifies the relevant oxidation number changes in chlorine **(1)**	Allow answers in terms of just Chlorine i.e. Chlorine is both oxidised and reduced Do not award: Chlorine **molecule** both oxidised and reduced Cl changes from 0 in Cl_2 to -1 in NaCl **and** 0 in Cl_2 to +5 in $NaClO_3$ Allow oxidation numbers shown on equation	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (d)(ii)	An answer that makes reference to the following points • all molar masses correct **(1)** • correct use of multiples **(1)** • calculation of atom economy **(1)**	<u>Example of calculation</u> $NaClO_3$ = 106.5 NaCl = 58.5 H_2O = 18 Allow calculation of molar masses of left-hand side Cl_2 = 71, NaOH = 40 (5 x 58.5 and 1 x 106.5 and 3 x 18) or (3 x 71 and 6 x 40) M1 and M2 may be combined: total molar mass = 453 = 106.5 x 100 ÷ ((5 x 58.5) + 106.5 + (3 x 18)) = 23.51% Ignore SF except 1 SF TE on molar masses and multiples	**(3)**

(Total for Question 8 = 22 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
9 (a)	An answer that makes reference to the following points: • calculation of mass of carbon required **(1)** • calculation of total mass of reactants **(1)** **and** mass of reactants = mass of products **OR** • mathematical expression of total mass of reactants/products **(1)** • evaluation **(1)**	<u>Example of calculations</u> Moles of water = moles of carbon Moles of carbon =1000000 ÷ 18 = 55556 / 5.5556 x 10^4 Mass of carbon = 55556 x12 ÷10^3 = 672 / 666.67 (kg) Answer depends on no of SF used for moles of carbon. Check. Mass of reactants = mass of products = 1000 + 666.72 = 1666.7 (kg) $1000\frac{(18 + 12)}{18}$ or $1000\frac{(28 + 2)}{18}$ 1666.7 (kg) Ignore SF except 1 SF Allow TE throughout Correct answer with no working scores (2)	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9 (b)	An answer that makes reference to the following points: • limewater turns cloudy **(1)** • identifies carbon dioxide **(1)** • anhydrous copper(II) sulfate turns (from white to) blue **(1)** • identifies water **(1)** • the U tube should be placed before the boiling tube **(1)**	Distinguishes water as product of combustion from water originating from the limewater	**(5)**

(Total for Question 9 = 7 marks)

Total for Paper = 80 marks

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