Mark Scheme (Results)

Summer 2023

Pearson Edexcel GCE
In 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.

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(a)	The only correct answer is **B** (+1 | 1 | 0 | 1) ***A*** *is not correct because the data for the neutron are the data for an electron* ***C*** *is not correct because the data for the proton are the data for an electron* ***D*** *is not correct because the data for the neutron and proton have been swapped*	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	An answer that makes reference to the following point • spherical	Allow a diagram of a sphere Ignore circular / description of a circle	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	An answer that makes reference to the following point • (a pair of electrons) with opposite spin	Allow different direction of spin	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(c)	• calculation of the relative abundance of the third isotope **(1)** • calculation of relative isotopic mass of the third isotope **(1)**	Example of calculation: 100 – 92.2 – 3.1 = 4.7(%) (ans 1) (28.11 x 100) – (28 x 92.2) – (30 x 3.1) (ans 1) = 29.021 = 29 Allow for M2 the assumption that the relative isotopic mass is 29 with correct calculation showing that 29 gives the correct relative atomic mass. Allow 3, 4, 5 SF Allow TE on incorrect (ans 1) Correct answer with no working scores 0	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(d)	An answer that makes reference to the following point: • $^{21}_{10}Ne$	Allow ^{21}Ne	**(1)**

(Total for Question 1 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)(i)	An answer that makes reference to the following point: • (relative formula mass is used because) the salt is a giant (ionic) structure / it is not a molecular structure	Allow it is not molecular Allow it is not a molecule Allow it is not made up of molecules Allow molecular mass is only used for molecules Ignore it is a compound Ignore just ionic Do not award it is a molecule / molecules	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(a)(ii)	An answer that makes reference to the following point: • it is measured relative to / compared to 1/12 of the mass of an atom of carbon-12	Allow it is the mass of an atom relative to 1/12 of the mass of an atom of carbon-12 Allow it has the units of grams ÷ grams / g ÷ g (so no units) Allow relative measurements are a comparison so have no units Allow because it is not an actual mass but a relative mass Ignore just 'it is a relative mass'	**(1)**

Question Number	Answer	Mark
2(a)(iii)	The only correct answer is **C** (402.7) ***A*** *is not correct because this is the sum of the atomic numbers not masses* ***B*** *is not correct because this has* $6H_2$ *but only one O from the water of crystallisation* ***D*** *is not correct because this is the mass if the sulfate were* $(S_4O_4)_2$	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(a)(iv)	An answer that makes reference to the following point: • calculation of amount of substance	Example of calculation: $\frac{25.0}{402.7}$ = 0.062081 / 0.0621 / 0.062 / 6.2081 x 10^{-2} / 6.21 x 10^{-2} / 6.2 x 10^{-2} (mol) Allow answer in mmol Allow TE on incorrect multiple-choice answer(A gives 0.12136, B gives 0.077471, D gives 0.041996) Ignore SF except 1 SF	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(b)	An answer that makes reference to the following points: • lilac flame due to potassium ions / K^+ **(1)** • magnesium ion / Mg^{2+} gives no flame colour **(1)** • white precipitate (of $Mg(OH)_2$ / from the magnesium / from Mg^{2+}) **(1)** • potassium ions do not form a precipitate (with sodium hydroxide) **(1)**	Penalise omission of ions once only Allow potassium atoms / potassium / K would produce a lilac flame Do not award magnesium atoms / magnesium / Mg / gives no flame colour Allow any link to magnesium If formula of magnesium hydroxide is given it must not be incorrect e.g MgOH or $MgOH_2$ Allow KOH is soluble	**(4)**

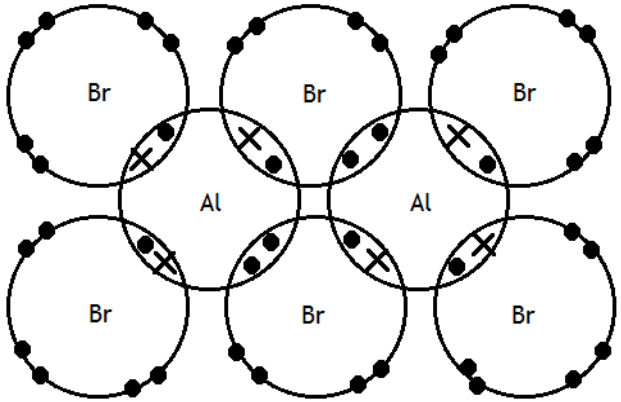
Question Number	Answer	Mark
2(c)(i)	The only correct answer is **C** (dilute hydrochloric acid and barium chloride solution) ***A*** *is not correct because this would give a white precipitate of silver chloride due to a reaction hydrochloric acid and silver nitrate* ***B*** *is not correct because sulfate ions are also present in the sulfuric acid and silver nitrate is used to test for halides* ***D*** *is not correct because this would give a white precipitate of barium sulfate due to the sulfuric acid*	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(c)(ii)	An answer that makes reference to the following point: • balanced ionic equation including state symbols	For answers C or D $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ For answers A or B Allow TE for $2Ag^{+}(aq) + SO_4^{2-}(aq) \rightarrow Ag_2SO_4(s)$ Allow multiples Do not award uncancelled spectator ions Do not award $Ag^{+}(aq) + Cl^{-}(aq) \rightarrow AgCl(s)$	**(1)**

(Total for Question 2 = 10 marks)

Question Number	Answer	Mark
3(a)(i)	The only correct answer is **B** (increases in oxidation number | gains electrons to form a negative ion) ***A*** *is not correct because metals lose electrons and Group 7 elements gain them* ***C*** *is not correct because metals lose electrons to form a positive ion* ***D*** *is not correct because Group 7 elements decrease in oxidation number*	**(1)**

Question Number	Answer	Mark
3(a)(ii)	The only correct answer is **C** (the percentage by mass of calcium in the product is 33 %) ***A*** *is not correct because bromine does react less vigorously than chlorine under the same conditions* ***B*** *is not correct because bromine does oxidise the calcium* ***D*** *is not correct because calcium ions do give a brick-red flame test*	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(a)(iii)	An answer that makes reference to the following points: • two dative covalent bonds from a bridging bromine to an aluminium **(1)** • all the remaining electrons correct **(1)**	Example of diagram  Dots and crosses may be swapped Ignore inner shells If all dots or all crosses allow M1 only	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(a)(iv)	• PtF_6	Do not award PF_6 / $PtFl_6$ Do not award PTF_6	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(a)(v)	An answer that makes reference to the following points: • calculation of percentage of iodine and moles of iodine **(1)** • calculation of moles of chromium and CrI_3 **(1)**	100 - 12 = 88 (%) 88 ÷ 126.9 = 0.69346 (mol) (ans 1) Must see either sum or answer 12 ÷ 52 = 0.23077 / 0.231 / 2.3077 x 10^{-1} / 2.31 x 10^{-1} (ans 2) Must see either sum or answer (ans 1) ÷ (ans 2) = 3.0050 So CrI_3 Correct answer with no working or some correct working scores 1	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(b)(i)	An answer that makes reference to the following points: • going down the group as the bond length increases, the bond strength decreases / less energy is required to break the bonds **(1)** • bonding electrons are further from the nucleus / more shielded so less attracted / less tightly held / less energy needed to separate **(1)**	Ignore bond enthalpy decreases Ignore comments about reactivity Allow outer electrons instead of bonding electrons Award poorer / weaker overlap between bonding orbitals Allow reverse argument Allow atomic radius increases Ignore comments about electrons being removed Do not award ionic radius increases	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(b)(ii)	An answer that makes reference to the following points:	Single reactions between a halogen and halide, other than the expected answer can score max 2 for any two correct points. Series of 2 or more tests can score full marks if the relative reactivity of iodine and chlorine are shown, but do not award a marking point for a mistake in any of the tests.	**(3)**
	• description of test-tube reaction **(1)**	Solutions of chlorine and potassium iodide mixed (in test tube) Allow chlorine water Allow addition only one reactant as a solution Allow pale green for chlorine solution Ignore addition of organic solvent to confirm iodine present If state symbols are given in the equation allow this as evidence the reaction is in solution	
	• expected observation and inference **(1)**	Expected result brown solution (containing iodine) and inference of relative reactivity based on observed result Allow red-brown, orange-brown instead of brown Do not award purple solution of aqueous iodine	
	• equation **(1)**	Equation to match the stated reagents in the form $Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$ Ignore state symbols even if incorrect Ignore non-ionic equations as working, even if incorrect	

(Total for Question 3 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)	An answer that makes reference to the following points: • **giant** metallic structure / giant lattice structure **(1)** • **strong** (electrostatic) attraction between metal ions / positive ions / cations and delocalised electrons **(1)**	Allow just lattice structure Allow large instead of giant Allow giant crystal structure Allow **many** ions and a sea of / many delocalised electrons Do not award just metallic structure Do not award giant covalent lattice Do not award giant ionic lattice Ignore references to energy Allow electrons moving / free to move within the metal for the delocalised electrons May be shown on a labelled diagram	**(2)**

Question Number	Answer		Additional Guidance	Mark
4(b)	• calculation of moles of magnesium chloride	**(1)**	Example of calculation: $\frac{4.00}{95.3}$ = 0.041973 (ans 1) Do not award = 0.04	**(4)**
	• (calculation of moles of chlorine gas required) and calculation of moles of HCl required	**(1)**	(moles of Cl_2 : moles of $MgCl_2$ = 1:1 moles of Cl_2 = (ans 1) = 0.041973 (ans 2) and moles of HCl : moles of Cl_2 = 8:3 moles of HCl = 8÷3 x (ans 2) = 0.11193 (ans 3)	
	• calculation of volume of hydrochloric acid	**(1)**	volume = moles/concentration = (ans 3)÷11.5 volume = 0.0097328 (dm^3) / 9.7328 (cm^3)	
	• answer in cm^3 and to 2 SF or 3SF with one decimal place	**(1)**	9.8 (cm^3) Allow 9.7 / 10 / 10.0 Allow TE throughout	

Question Number	Answer	Mark
4(c)	The only correct answer is **D** (react vigorously with reducing agents) ***A*** *is not correct because the symbol shown is for oxidising agents, not flammable* ***B*** *is not correct because the symbol shown is for oxidising agents not explosive* ***C*** *is not correct because the symbol given is for oxidising agents which do not usually react dangerously with oxygen*	**(1)**

(Total for Question 4 = 7 marks)

Question Number	Answer	Additional Guidance	Mark
5(a)	An answer that makes reference to the following point: • (electronegativity is) the ability of an atom to attract the (bonding / shared) **pair** of electrons (in a covalent bond)	Allow the ability of an atom to attract the bonding electrons from a covalent bond Do not award an electron instead of pair of electrons	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(b)	An answer that makes reference to the following points: • less electronegative down the group **(1)** • because the (pair of) electrons (in the covalent bond) are further from the nucleus **(1)** • with **more** shielding electrons **(1)**	Allow reverse arguments for trend being more electronegative up the group Allow outer / valence electrons Allow the atomic radius increases down the group Ignore the ionic radius increases down the group Allow there are **more** shells of electrons Ignore any reference to effective nuclear charge / Do not award the nuclear charge remains the same	**(3)**

Question Number	Answer	Additional Guidance	Mark
5(c)	An answer that makes reference to the following points: • (a continuum of bonding) has two extreme bonding types, ionic and covalent **(1)** • electronegativity differences between two atoms of intermediate value result in intermediate bonding **(1)**	This question may be answered in many different ways. Allow ideas such as bonds with low electronegativity difference are covalent, while those with large difference are ionic. If values are given ignore the values but accept differences bigger than x are ionic those smaller than y are covalent for M1. Allow ideas such as the electronegativity difference decreases a bond is more covalent, as it increases it is more ionic Ignore references to polarity of ions The higher the difference in electronegativity the more ionic the compound is (1) and the lower the difference the more covalent scores (1)	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(d)	An answer that makes reference to the following points: • sodium / magnesium chloride is an **ionic** compound **and** so conducts electricity when molten **(1)** • chlorine / phosphorus(III) chloride / silicon tetrachloride are simple **covalent** structures **and** so have low melting temperatures / so do not conduct electricity (when molten) **(1)** • aluminium chloride is ionic with covalent character / has intermediate bonding **and** so has a low sublimation temperature / so does not conducting electricity **(1)**	A named substance must be given for each mark. The bonding in each substance should be linked to a property in the table. Do not penalise more than 3 correctly named substances Allow is ionically bonded Allow so has a high melting temperatures Allow molecular structure Do not award giant molecular structure Allow is covalently bonded Allow requires little energy to break intermolecular forces Allow it is ionic as a solid but becomes covalent when it sublimes Allow aluminium chloride is polar covalent Allow aluminium chloride has dative covalent bonds Allow melting temperature for sublimation temperature Allow high melting/sublimation temperature in comparison to the covalent substances. Allow high melting/sublimation temperature in comparison to the ionic substances. If no other mark awarded allow the bonding goes from ionic to covalent due to decreasing electrical conductivity / melting temperatures for (1)	**(3)**

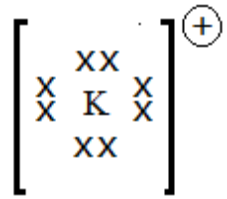
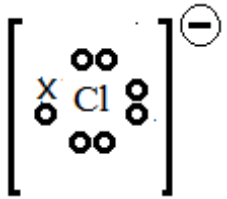
(Total for Question 5 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
6(a)(i)	An answer that makes reference to the following points: • oxidation is loss of electrons and reduction is gain of electrons		(1)

Question Number	Answer	Additional Guidance	Mark
6(a)(ii)	An answer that makes reference to the following points: • (Iodine / I in) potassium iodide / iodide ion / KI / I^- is the reducing agent because each iodide loses 1 electron (to form iodine) **(1)** • (sulfur in) sulfuric acid / sulfate ion / H_2SO_4 / SO_4^{2-} is the oxidising agent because each sulfur gains (eight) electrons (when forming H_2S) **(1)**	Allow a description of the transfer of one electron from iodide ion to the sulfur in the sulfate ion Do not award just iodine / I / I_2 is the reducing agent Allow iodine is the reducing agent because iodide ion loses 1 electron (to form iodine) Allow sulfur (in sulfate) is the oxidising agent because each gains (eight) electrons Do not award incorrect oxidation states of sulfur If no other mark is awarded allow (1) for correct reducing agent (from options in M1) and correct oxidising agent (from options in M2) If no other mark is scored allow 1 for iodide goes from –I/-1 to 0 and sulfur goes from +VI / +6 to –II / -2	(2)

Question Number	Answer	Additional Guidance	Mark
6(b)	An answer that makes reference to the following points: • substances in the equation **(1)** • balancing **(1)** • oxidation number change for bromine from 0 to +5 and –1 **(1)** • (oxidation number changes must be balanced) so there must be five bromide ion / Br^- formed for each bromate ion / BrO_3^- **(1)**	$3Br_2 + 6OH^- \rightarrow BrO_3^- + 5Br^- + 3H_2O$ Allow any bromide compound e.g. NaBr Ignore state symbols even if incorrect Do not award $NaOH^-$ and $NaBrO_3^-$ Do not award HBr Ignore 1 in front of BrO_3^- allow multiples Allow TE on use of NaBr, but must balance Allow incorrect descriptions of oxidation and reduction, e.g. bromine is reduced from 0 to +5 as long as oxidation states are correct NOTE: Redox was examined earlier Ignore reference to balancing OH^- and H_2O	**(4)**

(Total for Question 6 = 7 marks)

Question Number	Answer	Additional Guidance	Mark
7(a)	• diagrams for K^+ ions **and** diagram for Cl^- ion	Example of diagram   Allow positive and negative charges anywhere on the ions, with or without brackets Allow any symbol for electrons Allow no electrons around the potassium Ignore inner shells of electrons	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(b)	A description that makes reference to the following points: • Ca^{2+}, Cl^- and K^+ have the same number of electrons / are isoelectronic **(1)** • Br^- has one more shell of electrons than the other ions so it is largest **(1)** • from Cl^- to K^+ to Ca^{2+} there are more protons (in the nucleus) **(1)** • so (the order of increasing size of ion is) $Ca^{2+} < K^+ < Cl^- < Br^-$ **(1)**	Marks can be scored by comparison of pairs of ions, so for example a comparison of Ca^{2+} and K^+ saying they have the same number of electrons and a similar comparison of Ca^{2+} and Cl^- scores M1 Ignore they have the same number of shells of electrons Allow Br^- has more shells of electrons Allow from Cl^- to K^+ to there are two more protons in the nucleus and from K^+ to Ca^{2+} there is one more proton in the nucleus. Ignore Ca^{2+} has the highest charge, then K^+ then Cl^- without explanation Ignore nuclear charge unless clearly explained as the number of protons rather than charge on the ion Allow Ca^{2+}, K^+, Cl^-, Br^- Allow order of decreasing size if described as such. This mark is stand alone	**(4)**

Question Number	Answer	Mark
7(c)	The only correct answer is **A** (0.0233) ***B*** *is not correct because the value assumes the formula of calcium hydroxide is CaOH* ***C*** *is not correct because the value assumes that 17.3 g is the mass of calcium not calcium hydroxide* ***D*** *is not correct because this assumes the relative formula mass of calcium hydroxide is 29 (the sum of the atomic numbers)*	**(1)**

(Total for Question 7 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
8(a)(i)	An answer that makes reference to the following points: • decrease the concentration (of the nitric acid) / use ethanoic acid / a weak acid **(1)** • decrease in reaction rate would result in slower formation of carbon dioxide (so less gas lost) **(1)**	Allow use a different acid that is less reactive M2 dependent on M1 Allow just results in a decrease in reaction rate Allow it will take longer to react	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(a)(ii)	An answer that makes reference to the following points: • use a pot / container / tube / vial to contain the calcium carbonate / acid (to keep them separate) **(1)** • replace the bung and then shake / agitate / swirl the conical flask so the substances mix **(1)**	Credit may be scored in (a)(i) Allow put the test tube of calcium carbonate in the conical flask Allow a container for the acid Allow the point / container / ignition tube to be tied to a piece of string and trapped by the bung Do not award adding the calcium carbonate and replace the bung quickly Allow bung is lifted very slightly to allow a container attached to string to mix with the acid Move the flask so the reactants mix / reaction happens Scores 1 Allow for 1 mark attach large chips / calcium carbonate to string / thread **and** lift the bung very slightly to allow the calcium carbonate to drop /	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(b)	An answer that makes reference to two of the following points: • use a gas syringe (instead of collecting over water) or bubble CO_2 through the water (before the experiment to form a saturated solution) **(1)** • bubble CO_2 through the nitric acid (before the experiment to saturate the solution) or add a pinch of (calcium) carbonate to the acid before the reaction (to saturate the solution) **(1)**	One mark from each pair Allow saturate it with carbon dioxide first Ignore changing water to a different solvent Allow saturate it with carbon dioxide first	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(c)(i)	Either • correct reading of the volume for a selected mass of calcium carbonate from the line of best fit to within half a square on the scale **(1)** • calculation of the number of moles of calcium carbonate for a particular mass **(1)** • calculation of the molar volume giving the answer in dm^3 **(1)** Or • correct reading of the volume for a selected mass of calcium carbonate from the line of best fit to within half a square on the scale **(1)** • second correct reading of the volume for a selected mass **(1)** • calculation of the gradient and molar volume, giving the answer in dm^3 **(1)**	Example of calculation: for 0.25 g of calcium carbonate the volume of gas produced is 56 cm^3 $\frac{0.25}{100} = 0.0025 / 2.5 \times 10^{-3}$ molar volume = $\frac{56}{0.0025}$ = 22,400 (cm^3 mol^{-1}) = 22.4 (dm^3 mol^{-1}) Allow TE on their mass and volume for M2 and M3 Ignore SF except 1 SF unless 1 SF is correct from their values of mass and volume, when 1 SF should be ignored for 0.25 g of calcium carbonate the volume of gas produced is 56 cm^3 for 0.10 g of calcium carbonate the volume of gas produced is 22 cm^3 $\frac{56 - 22}{0.25 - 0.10}$ = 226.67 = 22.7 (dm^3 mol^{-1}) An answer between 21.6 and 23.2 with no working scores (1) Correct answer with some working scores (3)	**(3)**

Question Number	Answer	Additional Guidance	Mark
8(c)(ii)	• rearranges the ideal gas equation **(1)** • converts temperature into Kelvin **(1)** • calculates V and gives unit **(1)**	Example of calculation: $V = \frac{nRT}{P}$ $T = 22 + 273 = 295$ (K) $V = \frac{1 \times 8.31 \times 295}{101000} = 0.024272$ m^3 / 24.272 dm^3 mol^{-1} TE on M2 Allow dm^3 Correct answer with no working scores (1) Correct answer with some correct working in M2 scores (3) Ignore SF except 1 SF	**(3)**

(Total for Question 8 = 12 marks)

Question Number	Answer	Mark
9(a)	The only correct answer is **B** (578 1817 2745 11 578) ***A*** *is not correct because there is a big jump between the second and third ionisation energies so it is in Group 2* ***C*** *is not correct because there is no big jump between the third and fourth ionisation energies* ***D*** *is not correct because there is no big jump between the third and fourth ionisation energies*	**(1)**

Question Number	Answer	Additional Guidance	Mark
9(b)(i)	An answer that makes reference to the following points: • equation **(1)** • state symbols **(1)**	<u>Example of equation</u> $Be^{+}(g) \rightarrow Be^{2+}(g) + e^{-}$ / $Be^{+}(g) - e^{-} \rightarrow Be^{2+}(g)$ Dependent on M1 or near miss e.g. $Be(g) \rightarrow Be^{2+}(g) + 2e^{-}$ $Be(g) \rightarrow Be^{+}(g) + e^{-}$	**(2)**

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*9(b)(ii)</td>
<td>
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><td>Number of indicative marking points seen in answer</td><td>Number of marks awarded for indicative marking points</td></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><td></td><td>Number of marks awarded for structure of answer and sustained line of reasoning</td></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning.</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured.</td><td>0</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, which 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.

Reasoning marks may be reduced for extra incorrect chemistry
</td>
<td>6</td>
</tr>
</table>

Question Number	Acceptable Answer	Additional Guidance	Mark
***9(b)(ii) contd**	**Indicative content:** • IP1 trend ionisation energy becomes less endothermic on descending the group • IP2 distance electrons are removed from a shell that is further from the nucleus • IP3 shielding electrons more shielded / experience greater repulsion from inner electrons • IP4 nuclear charge (despite the) nuclear charge / number of protons being greater (down the group) • IP5 position of electrons (the second ionisation energy is more endothermic because) the electron is removed from the same shell/subshell • IP6 repulsion (for the second ionisation energy) there is less repulsion by electrons / shielding (than in the first)	Ignore more exothermic Allow decreases Allow increasing atomic radius Ignore atoms get larger/bigger Ignore there are more shells Allow energy level Allow repulsion from electrons in the same orbital Allow the electron is being removed from a positive ion Allow the same number of protons attracts one fewer electrons	

Question Number	Answer	Additional Guidance	Mark
9(b)(iii)	An explanation that makes reference to the following points: • (the sum of the first two ionisation energies) decreases down the group so the reactivity increases (with chlorine) **(1)** • because Group 2 elements form ionic bonds / react by losing their (outer 2) electrons **(1)**	Allow smaller for decrease Allow less energy is required for electrons to be lost so reactions might be faster down the group	**(2)**

(Total for Question 9 = 11 mark)

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