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Mark Scheme (Results)

Summer 2016

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.
- 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	Acceptable Answers	Additional Guidance	Mark
1(a)(i)	• chlorine is a gas **and** iodine is a solid	Ignore any colours, even if incorrect Do not award reference to ions once in (i)/(ii) Allow use of Cl and I	**(1)**
1(a)(ii)	• astatine is a solid **and** (as the number of electrons increases) the strength of the London forces increases / more London forces	Allow for 'London forces' instantaneous dipole – induced dipole / van der Waals' forces / dispersion forces / induced dipole forces / temporary dipole Ignore ID-ID References to stability The trend is increasing melting (and boiling) temperature down the group	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
1(b)	$Cl_2 + 2NaOH \rightarrow NaCl + NaClO + H_2O$ **(1)** • (Type of reaction) disproportionation **(1)**	Accept multiples and ionic equations. Allow NaOCl $Cl_2 + 2OH^- \rightarrow Cl^- + ClO^- + H_2O$ Ignore state symbols even if incorrect Ignore redox Mark independently	**(2)**

Question Number	Answer	Mark
1(c)	**D** (white smoke)	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
1(d)	An explanation that makes reference to the following points: • electronegativity is the (relative) ability of an atom to attract the (bonding) electron**s** (in a covalent bond) **(1)** • fluorine is more electronegative than chlorine/fluorine is the most electronegative (element) **(1)** • so fluorine is δ— **and** chlorine is δ+ **(1)**	Penalise fluor**ide**/chlor**ide** / molecules once only Allow 'element' for atom Do not allow 'species' for atom Allow fluorine has an electronegativity of 4.0 and chlorine of 3.0 Could be shown on a diagram Ignore references to overall polarity No TE on incorrect M2	**(3)**

Question Number	Answer	Mark
1(e)	**C** (1.81×10^{23})	**(1)**

(Total for Question 1 = 9 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
2(a)	An answer that makes reference to any **two** of the following: • no electrons are found within the nucleus **(1)** • the isotopes of chlorine have 18 and 20 neutrons not electrons **(1)** • electrons are not in rings around the nucleus but in orbitals **(1)**	Answers can be given in either order. Check for answers alongside the written text if not given on the lines provided. Allow chlorine only has 17 electrons/ chlorine doesn't have 35/37 electrons Allow isotopes have different number of neutrons not electrons Allow isotopes have same number of electrons Allow regions / energy levels / shells / sub shells	**(2)**

Question Number	Answer	Mark
2(b)	**C** (six protons, seven neutrons and five electrons)	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
2(c)(i)	An answer that makes reference to the following points: • the (weighted) **average mass / mean mass** of an atom of an element **(1)** • compared to **1/12th** the mass of an atom of **carbon-12**/ compared to a scale where one atom of **carbon-12** has a mass of (exactly) **12** **(1)**	The word 'atom' must be used at least once in the answer for both marks to be awarded. Do not award 12**g** This can be written as a mathematical expression.	**(2)**

Question Number	Acceptable Answers	Additional Guidance	Mark
2(c)(ii)	ALLOW • calculation of the percentages of the two lithium isotopes **(1)** • calculation of RAM **(1)** • evaluation of correct answer to 2/3/4 s.f. **(1)** **or** • calculation of the mass of lithium-7 and the numerator of the RAM expression **(1)** • dividing by 5 and calculating the RAM **(1)** • evaluation of correct answer to 2/3/4 s.f. **(1)**	<u>Example of calculation:</u> Lithium-6 percentage =(0.460 ÷ 5.000 x 100=) 9.2% Lithium-7 percentage = 4.540 ÷ 5.000 x 100=) 90.8% RAM =((0.092 x 6.015) + (0.908 x 7.016))= 6.9239 RAM = 6.9 / 6.92 / 6.924 <u>Alternative example of calculation:</u> Mass of lithium-7 = 4.54 RAM = ((0.460 x 6.015) + (4.54 x 7.016)) ÷ 5 = 6.9239 RAM = 6.9 / 6.92 / 6.924 Correct answer to 2/3/4 s.f. with no working scores 3 marks Ignore g mol^{-1} / amu Reject g / %	**(3)**

Question Number	Acceptable Answers	Additional Guidance	Mark
2(d)	An explanation that makes reference to the following points: • Br_2 has a mass of 160 (and 158 and 162) **(1)** • Br_2^{2+} has a m/z = 80 **(1)**	Allow molecule made of one atom ^{79}Br and one atom ^{81}Br	**(2)**

(Total for Question 2 = 10 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
3(a)(i)	• calculation of moles of magnesium	Example of calculation: (n= 0.04 ÷ 24.3 =) 0.001646 (mol) Allow 0.04 ÷ 24 = 0.001667 (mol) Ignore significant figures except 1	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(a)(ii)	• calculation of moles of hydrogen	Answer to (a)(i)	**(1)**

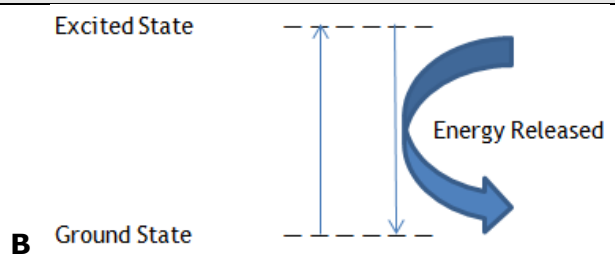
Question Number	Acceptable Answers		Additional Guidance	Mark
3(a)(iii)	• temperature changed to Kelvin	**(1)**	Example of calculation: 24°C = 297 K	**(4)**
	• rearrangement of equation so $V=nRT \div p$ and substituting the numbers	**(1)**	$V = \frac{0.001646 \times 8.31 \times 297}{101000}$	
	• calculation of V in m^3 / dm^3	**(1)**	$= 4.022 \times 10^{-5}$ (m^3)	
	• answer converted in cm^3 and to a whole number	**(1)**	$= 4.022 \times 10^{-5} \times 10^6 = 40$ cm^3	

Question Number	Acceptable Answers	Additional Guidance	Mark
3(b)	An answer that making reference to any of the following: • To identify anomalies **and** discard • To identify random errors **and** discard • Identify precise results **and** use them • Identify imprecise results **and** discard them	Allow To improve reliability/ reproducibility Ignore reference to confidence in the results Ignore 'make results more precise' Do not award "to improve accuracy"	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(c)	An answer that makes reference to three of the following linked pairs: • **issue:** hydrogen escapes from the apparatus **(1)** • **improvement:** use a sealed apparatus with a gas syringe /use a conical flask / bung with a gas syringe **(1)** • **issue:** magnesium ribbon covered with oxide **(1)** • **improvement:** clean with abrasive before weighing **(1)** • **issue**: mass of magnesium may be less than 0.04 g (i.e. as low as 0.035 g) **or** mass of magnesium required is too small to be measured accurately by the balance available **(1)** • **improvement:** use more precise balance/ use larger mass (so percentage error is less) **(1)** • **issue:** large measuring cylinder cannot measure volume accurately (as the graduations are too far apart) **(1)** • **improvement:** use a smaller measuring cylinder/burette/ conical flask / bung with a gas syringe **(1)**	Maximum **three** marks for issues identified Maximum **three** marks for improvement identified which must be linked with associated issue identified or near-miss Do not award impurities in magnesium Allow measurement uncertainty for measurement accuracy If more than three issues are given, then maximum 4 marks if incorrect chemistry is stated e.g. reference to 'not all the magnesium reacting' Ignore reference to: The solubility of hydrogen gas Changes in temperature Changes in acid concentration Air already in the apparatus Measuring the length of Mg	**(6)**

(Total for Question 3 = 13 marks)

Question Number	Answer	Mark
4(a)	**C** (potassium chloride)	**(1)**

Question Number	Answer	Mark
4(b)	 **B**	**(1)**

Question Number	Answer	Mark
4(c)	**B** (magnesium sulfate)	**(1)**

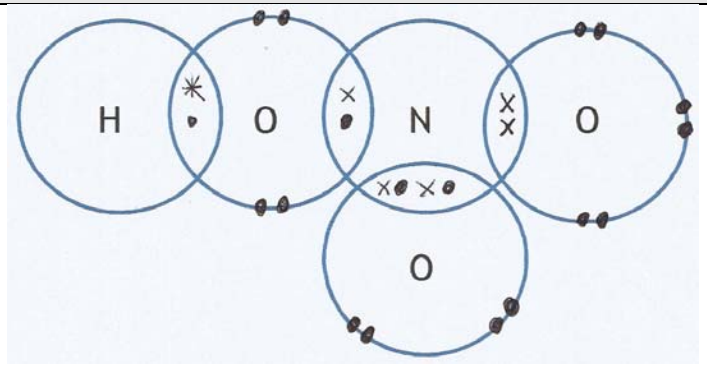
Question Number	Acceptable Answers	Additional Guidance	Mark
4(d)	• (Observation) white **and** precipitate **(1)** • hydrochloric acid **and** potassium chloride **(1)**	Do not allow 'off-white' Allow white solid Allow spelling of 'percipitate' Ignore identity of precipitate even if incorrect Both names are essential but can be in either order. Accept formulae HCl and KCl. Allow A and C. Mark independently	**(2)**

Question Number	Acceptable Answers		Additional Guidance	Mark
4(e)	• fizzing/bubbles/effervescence	**(1)**	Reject 'solid dissolves'/precipitate forms/ references to hydrogen gas Ignore CO_2/ carbon dioxide/ gas given off	**(2)**
	$2H^+ + CO_3^{2-} \rightarrow CO_2 + H_2O$	**(1)**	Ignore state symbols even if correct	

(Total for Question 4 = 7 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
5(a)	• 19.95 (cm^3)	Example of calculation: (19.90 + 20.00)÷ 2 = 19.95 Titre from titration 1 should **not** be used	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
5(b)	A maximum of **four** marks for the calculation: • calculation of the number of moles of sodium hydroxide (= number of moles of diluted nitric acid) **(1)** • evaluation of concentration of diluted nitric acid in mol dm^{-3} **(1)** • evaluation of concentration of undiluted nitric acid in mol dm^{-3} **(1)** • conversion of concentration to g dm^{-3} **(1)** • answer to 1dp **and** comment that acid would be suitable for use (as the extra 0.5 is not significant) **(1)**	Allow any volume between 19.9 and 20.5 inclusive Allow TE for steps in calculation; including for final answer dependent on rounding in steps of calculation Correct answer to 1dp without working scores 4 marks Example of calculation: moles of sodium hydroxide, mol $n = (\frac{19.95 \times 0.08}{1000}) = 1.596 \times 10^{-3}$ concentration of diluted nitric acid, (mol dm^{-3}) $c = (\frac{1.596 \times 10^{-3} \times 1000}{25}) = 6.384 \times 10^{-2}$ concentration of undiluted nitric acid, $c = (\frac{6.384 \times 10^{-2} \times 250}{10}) = 1.596$ (mol dm^{-3}) concentration of undiluted nitric acid, $c = (1.596 \times 63) = 100.548$ (g dm^{-3}) = 100.5 (g dm^{-3}) Allow comment to be a TE on the calculated value to 1dp	**(5)**

Question Number	Acceptable Answers	Additional Guidance	Mark
5(c)	• hydrogen and oxygen on the left, all pairs of electrons correct **(1)** • nitrogen and one oxygen joined by a double bond, all pairs of electrons correct **(1)** • all other electron pairs correct **(1)**	 Allow 2N=O scores M2 but not M3 The arrangement on the oxygen atoms bonded solely to the nitrogen can be shown the other way round. Lone pairs of electrons do not have to be grouped together	**(3)**

Question Number	Acceptable Answers	Additional Guidance	Mark
5(d)	• 80.8(%)	Example of calculation: %=[252 ÷ (252 + 60)] x 100 = 80.769(%) Ignore sf except one Do not award 80.7(%)	**(1)**

(Total for Question 5 = 10 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
6(a)	An explanation that makes reference to the following points: • oxygen has one more lone pair (of electrons than nitrogen)/oxygen has two lone pairs (of electrons) but nitrogen only has one **(1)** • so the **repulsion** from the oxygen lone pairs is greater (and reduces the bond angle) or lone pair – lone pair **repulsion** is greater than lone pair – bonded pair (and reduces the bond angle) **(1)**	Check for lone pairs drawn on the molecules if not explicitly stated on the lines provided Allow water/ it has one more lone pair of electrons (than ammonia) Ignore any stated shapes even if incorrect Do not award atoms 'pushed together'	**(2)**

Question Number	Acceptable Answers	Additional Guidance	Mark
6(b)	An explanation that makes reference to the following points: • sulfur is a larger atom (than oxygen)/sulfur has a larger atomic radius/sulfur has more shells of electrons (than oxygen) **(1)** • so sulfur has greater (inner shell) shielding (than oxygen of the nucleus)/ more repulsion from inner shells **(1)** • which reduces the (nuclear) attraction for the bonding electrons (resulting in a longer bond length) **(1)**	Accept reverse argument for all marking points Ignore references to electronegativity Do not award ionic radius / reference to ions Do not award nuclear charge Mark all points independently	**(3)**

(Total for Question 6 = 5 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>7(a)</td>
<td>
This question assesses the 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 lines of reasoning</td></tr>
<tr><td>Answer shows a coherent 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, a response with four 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 were no linkages between the points, then the same indicative marking points would yield and overall score of 3 marks (3 marks for indicative content and zero marks for linkages).

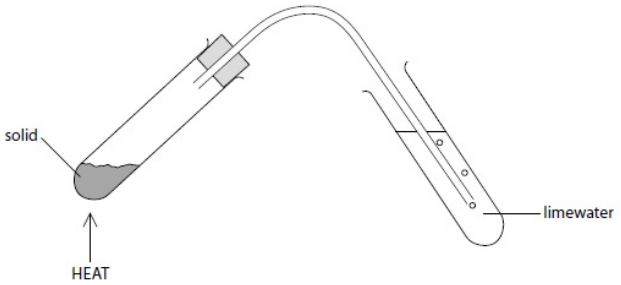
In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.

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

	Indicative content • the sum of the first two ionisation energies for barium is lower / barium loses (its outer) electrons more easily • barium is a bigger atom/barium has a larger atomic radius/barium has more shells of electrons • barium has more shielding • these outweigh/exert a greater influence than • barium has more proton/greater nuclear charge • barium reacts faster/barium is more reactive	Allow reverse argument for strontium Allow max 5 IPs for reference to general trends only down group 2 Allow any reference to single ionisation Do not award for barium 'molecule'	

Question Number	Answer	Mark
7(b)	**C** ($Ba^{2+}(g) \rightarrow Ba^{3+}(g) + e^-$)	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
7(c)	An explanation that makes reference to the following points: • magnesium ion is smaller (than the potassium ion) **(1)** • magnesium ion has a higher charge (than the potassium cation)/ Mg ion is 2+ but K ion is 1+ **(1)** • magnesium ion polarises nitrate (ion more) / distorts the (electron cloud of) nitrate (ion more) **(1)** • so weakening the **N−O** bonds (more) / so weakening the **nitrate** bonds (more) **(1)**	Penalise the omission of Magnesium ion once only for M1 to M3 Allow for M2: Magnesium ion has a higher charge density Allow description of polarisation Do not award references to molecule Do not award the weakening of bonds in magnesium nitrate	**(4)**

Question Number	Acceptable Answers	Additional Guidance	Mark
7(d)(i)	A diagram of suitable apparatus such that: • a sample of the carbonate can be heated **(1)** • delivery tube into limewater **or** gas collected in gas syringe **(1)**	<u>Example diagram:</u>  Allow the collection of gas over water with measuring cylinder/burette Do not award M1 for heating a conical flask / crucible or for an open tube Do not award M1 for heating in a water bath Do not award M2 if the limewater is in a sealed apparatus	**(2)**

Question Number	Acceptable Answers	Additional Guidance	Mark
7(d)(ii)	Any one from: • same Bunsen setting • same distance between flame and test tube	Ignore reference to 'same apparatus' Allow same depth/volume of limewater / same amount of metal carbonate Do not award same mass / volume (of metal carbonate) Ignore Same amount of heat / same temperature	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
7(d)(iii)	An answer that makes reference to: • the time taken for the limewater to go cloudy **or** the time for given volume to be produced (for use of syringe)		**(1)**

(Total for Question 7 = 15 marks)

Question Number	Answer	Mark
8(a)	**A** (giant ionic)	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
8(b)(i)	• evaluation of the number of moles of S and F **(1)** • evaluation of ratio 1 : 2 and empirical formula **(1)**	<u>Example of calculation:</u> n(S) = (45.79 ÷ 32.1) = 1.426 n(F) = (54.21 ÷ 19.0) = 2.853 Ratio = (1.426 : 2.853) = 1:2 Empirical formula SF_2 Allow use of S = 32 (1.431) Correct answer with no working scores 2 marks Ignore any units Use of atomic numbers/ incorrect atomic mass scores 0 overall	**(2)**

Question Number	Acceptable Answers	Additional Guidance	Mark
8(b)(ii)	$S_8 + 8AgF_2 \rightarrow 4S_2F_2 + 8AgF$	Allow multiples	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
8(b)(iii)	An explanation that makes reference to the following points: • the oxidation number of sulfur increases from 0 to +1 and so is oxidation **(1)** • the oxidation number of silver decreases from +2 to +1 and so is reduction **(1)** • fluorine does not change from −1 **and** it is a redox reaction **(1)**	Check for any oxidation numbers which may be written near the equation if not given on the lines provided. Omission of reduction and oxidation scores max 1 for MP1 and MP2	**(3)**

Question Number	Acceptable Answers	Additional Guidance	Mark
8(c)	Any **two** of the following pairs of physical properties and explanations: • high melting/ boiling temperature **(1)** • **strong** (electrostatic) attraction between metal ions and delocalised electrons **(1)** • (good) electrical conductivity/ thermal conductivity **(1)** • mobile **delocalised** electrons **(1)** • malleability/ ductility **(1)** • the layers of ions/ atoms can easily slide over each other **(1)** • high density **(1)** • the ions/ atoms are tightly packed due to the strong attraction between them **(1)**	Explanation mark is dependent on stating the relevant physical property Ignore references to reactivity with water Allow references to hardness/strength Do not award if attraction to the nucleus is mentioned as this may imply ionisation Some reference to movement needed Allow 'carry charge' for movement / 'free to move' Ignore any comment referring to the appearance of a metal eg lustrous If more than two properties are given, incorrect chemistry negates correct answers	**(4)**

(Total for Question 8 = 11 marks)

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