



Pearson

Mark Scheme (Results)

Summer 2017

Pearson Edexcel GCE In Chemistry
8CH0/01 Core Inorganic and
Physical Chemistry

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Summer 2017

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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 Answer	Additional Guidance	Mark
1(a)(i)	<p>A description that makes reference to the following points:</p> <ul style="list-style-type: none"> • use of a nichrome / platinum wire / ceramic / silica rod (1) • use of (conc.) HCl/HCl(aq)/dilute HCl <p>AND</p> <p>dip into the sample and place in / over a (blue) Bunsen burner flame (1)</p>	<p>Allow splint, spray method for both marks</p> <p>Reject just 'nichrome', nickel/chromium, inoculation loop, spatula, capillary tubing</p> <p>Reject other acids, just 'acid'</p> <p>Assume blue/roaring flame if not stated but reject use of yellow/safety flame</p>	(2)

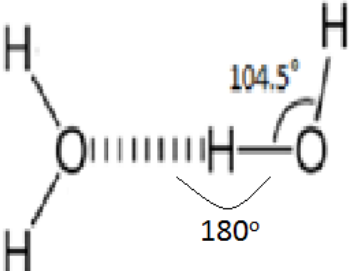
Question Number	Answer	Mark
1(a)(ii)	<p>1(a)(ii). The only correct answer is A</p> <p><i>B is not correct because this would give a red flame (brick red)</i></p> <p><i>C is not correct because this would give a red flame (carmine red)</i></p> <p><i>D is not correct because this would give a red flame (crimson red)</i></p>	(1)

Question Number	Answer	Mark
1(a)(iii)	<p>1(a)(iii). The only correct answer is C</p> <p><i>A is not correct because bromine is a brown gas, but bromide does not decompose to give it.</i></p> <p><i>B is not correct because nitrate(III) not nitrate(V) and does not give NO₂ by decomposing</i></p> <p><i>D is not correct because O²⁻ does not decompose in this way</i></p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
1(b)	<p>K_2CO_3 / $KHCO_3$</p> <p>K^+ with any anion</p> <p>CO_3^{2-} / HCO_3^- with any cation</p>	<p>For 1 mark allow names</p> <p>(1) Award 1 mark for a correct formula containing K^+, HCO_3^- or CO_3^{2-}, eg KCl, or Na_2CO_3</p> <p>(1) Award 1 mark for an incorrect formula containing both potassium and carbonate/hydrogencarbonate e.g. KCO_3</p> <p>Do not award any marks for KCO_2</p> <p>Ignore equations even if incorrect, but award marks for the compound as a reactant.</p>	(2)

(Total for Question 1 = 6 marks)

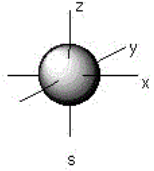
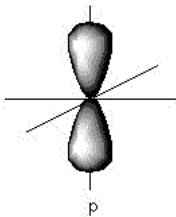
Question Number	Answer	Mark
2(a)(i)	<p>2(a)(i). The only correct answer is C</p> <p><i>A is not correct because oxygen does have a higher mass number but it is not the cause of polarity</i></p> <p><i>B is not correct because oxygen does have a larger atomic radius but it is not the cause of polarity</i></p> <p><i>D is not correct because oxygen does have more electrons but this is not the cause of polarity</i></p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
2 (a)(ii)	 <ul style="list-style-type: none"> correct shape of two water molecules and hydrogen bond show at about 180° but not necessarily labelled (1) HOH bond angle 104.5° and OHO angle 180° (1) 	<p>Allow about 10° tolerance by eye.</p> <p>Allow 104 – 105°</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
2 (a)(iii)	<p>An explanation that makes reference to two of the following points:</p> <ul style="list-style-type: none"> more open / more space between molecules (making it less dense) (1) due to (3 Dimensional) lattice / ring structure in ice (1) hydrogen bonds longer than the covalent bonds (1) 	<p>Do not award MP1 if the gaps are full of air molecules</p> <p>May be shown as a diagram</p> <p>Allow reverse arguments for liquid water</p>	(2)

Question Number	Answer	Mark
2 (b)	<p>2(b). The only correct answer is C</p> <p><i>A is not correct because barium hydroxide is the most soluble group 2 hydroxide</i></p> <p><i>B is not correct because calcium is below magnesium in the Periodic Table so this is more soluble</i></p> <p><i>D is not correct because group 1 hydroxides are very soluble compared to group 2 hydroxides</i></p>	(1)

(Total for Question 2 = 6 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
3 (a)	<p>s-orbital circle or attempt at a sphere</p> <p>(1)</p> <p>p-orbital dumbbell type shape on any axis / any direction</p> <p>(1)</p>	<p>e.g.</p>  <p>s</p>  <p>p</p> <p>Allow a diagram of 3 p-orbitals on the same set of axes or 3 separate p-orbitals on different axes</p> <p>Ignore 2 electrons per orbital</p> <p>Allow electron density map types</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
3 (b)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> • makes mention of energy/enthalpy/(heat) energy/heat (change/required) <p>AND</p> <p>to remove an electron (1)</p> <ul style="list-style-type: none"> • one mole/1 mol (1) • makes mention of gaseous atom(s) (but not as the product of ionisation) (1) <p>ALTERNATIVE ANSWER</p> <ul style="list-style-type: none"> • energy change per mole / kJ mol^{-1} for $\text{X(g)} \rightarrow \text{X}^+(\text{g}) + \text{e}^{(-)}$ (1) • one mark for species (1) • one mark for correct state symbols (1) 	<p>IGNORE any references to standard conditions</p> <p>Do not award "Energy given out..."</p> <p>Do not award Just 'gaseous element'/ 'gaseous substance'</p> <p>Max 2 for $\text{X(g)} + \text{e}^{(-)} \rightarrow \text{X}^+(\text{g}) + 2 \text{e}^{(-)}$</p>	(3)

Question Number	Acceptable Answer	Additional Guidance	Mark																								
3 (c)(i)	<div data-bbox="510 272 1149 858" data-label="Figure"> <table border="1"> <caption>Data points from the line graph</caption> <thead> <tr> <th>Category</th> <th>Value</th> </tr> </thead> <tbody> <tr><td>A</td><td>1700</td></tr> <tr><td>B</td><td>2100</td></tr> <tr><td>C</td><td>500</td></tr> <tr><td>D</td><td>750</td></tr> <tr><td>E</td><td>550</td></tr> <tr><td>F</td><td>800</td></tr> <tr><td>G</td><td>1000</td></tr> <tr><td>H</td><td>950</td></tr> <tr><td>I</td><td>1250</td></tr> <tr><td>J</td><td>1500</td></tr> <tr><td>K</td><td>450</td></tr> </tbody> </table> </div> <p data-bbox="376 898 672 1002">G above F AND H between G and F</p> <p data-bbox="376 1042 719 1145">I above H and below A AND J above I and below B</p> <p data-bbox="376 1185 533 1216">K below C</p>	Category	Value	A	1700	B	2100	C	500	D	750	E	550	F	800	G	1000	H	950	I	1250	J	1500	K	450	<p data-bbox="1305 268 1865 339">Points which are not joined with lines are perfectly acceptable.</p> <p data-bbox="1216 970 1272 1010">(1)</p> <p data-bbox="1305 1058 1854 1121">Do not penalise I below G if MP1 not awarded</p> <p data-bbox="1216 1114 1272 1153">(1)</p> <p data-bbox="1216 1185 1272 1225">(1)</p>	<p data-bbox="1944 268 2000 308">(3)</p>
Category	Value																										
A	1700																										
B	2100																										
C	500																										
D	750																										
E	550																										
F	800																										
G	1000																										
H	950																										
I	1250																										
J	1500																										
K	450																										

Question Number	Acceptable Answer	Additional Guidance	Mark
3 (c)(ii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li data-bbox="383 379 1272 448">• D has one more proton / has a higher nuclear charge (1) <li data-bbox="383 555 1272 624">• the electron being removed in C and D are from the same subshell / s-subshell / (s) orbital (1) 	<p>Allow same shell / energy level Allow the electron in D is closer to the nucleus than C / atomic radius decreases</p> <p>Ignore references to shielding, and full s-orbital which is more stable.</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
3 (c)(iii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li data-bbox="383 882 1272 951">• (the electron being removed from E) is from a new subshell / p-subshell / p-orbital (1) <li data-bbox="383 1026 1272 1094">• which is more shielded from the nucleus than the s-subshell (from which the electron is removed in D) <p>OR</p> <ul style="list-style-type: none"> <li data-bbox="383 1201 1272 1270">• which is further from the nucleus than the s-subshell / orbital (in E) (1) 	<p>Do not award 'in a new quantum shell' Allow electron removed from a higher energy level.</p> <p>Do not award clear reference to the outer electron in E being further from the nucleus than outer electron in D/atomic radius increasing from D to E</p> <p>Do not award clear reference to the outer electron in E being further from the nucleus than outer electron in D/atomic radius increasing from D to E</p>	(2)

Question Number	Answer	Mark
3 (d)	<p>3(d). The only correct answer is C</p> <p><i>A is not correct because this does not show a large increase for the fourth ionisation so is not in Group 3</i></p> <p><i>B is not correct because it shows a large increase for the third ionisation so is in Group 2</i></p> <p><i>D is not correct because it is a Group 3 element as it has a large increase for the fourth ionisation but it has a first ionisation energy which is lower than C so it is below it in Group 3, so cannot be Boron</i></p>	(1)

(Total for Question 3 = 13 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (a)(i)	$\text{Cl}_2 + 2\text{e}^{(-)} \rightarrow 2\text{Cl}^-$	Allow multiples Ignore state symbols even if incorrect	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (a)(ii)	$\text{Cl}_2 + 4\text{OH}^- \rightarrow 2\text{ClO}^- + 2\text{H}_2\text{O} + 2\text{e}^{(-)}$	Allow multiples $\text{Cl}_2 + 2\text{OH}^- \rightarrow 2\text{ClO}^- + 2\text{H}^+ + 2\text{e}^{(-)}$ Ignore state symbols even if incorrect	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (a)(iii)	$\text{Cl}_2 + 2\text{OH}^- \rightarrow \text{Cl}^- + \text{ClO}^- + \text{H}_2\text{O}$	Allow multiples Ignore state symbols even if incorrect Do not award mark if electrons are un-cancelled	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (a)(iv)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> (disproportionation is simultaneous) oxidation and reduction of an element (in the same species) (1) chlorine changes from 0 to -1 and +1 (1) 	Allow statement that chlorine is oxidised and reduced This can be shown on the equation in a(iii)	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (b)	ClO_3^-	(1) Allow NaClO_3 / KClO_3	(2)
	(Cl is) +5 / 5+	(1) Allow (+)V Do not award 5 unless +5/5+ seen in the formula or as a label on the formula	

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (c)(i)	$\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$	Allow multiples Ignore state symbols even if incorrect	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
4 (c)(ii)	An answer that makes reference to the following points:	2nd mark dependent on first.	(2)
	• chlorine/bromine toxic/poisonous	(1) Do not award harmful, but allow MP2 if correct for toxic.	
	• (Carry out the experiment in a) fume cupboard	(1)	
	OR		
	• bromine corrosive	(1)	
	• wear gloves	(1)	

(Total for Question 4 = 10 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
5 (a) (i)	$(1s^2) 2s^2 2p^6 3s^2$	ALLOW $1s^2$ repeated	(1)

Question Number	Answer	Mark
5 (a) (ii)	<p>5(a)(ii). The only correct answer is C</p> <p><i>A is not correct because this describes ionic bonding and magnesium has metallic bonding</i></p> <p><i>B is not correct because this describes covalent bonding and magnesium has metallic bonding</i></p> <p><i>D is not correct because this describes intermolecular forces and magnesium has metallic bonding</i></p>	(1)

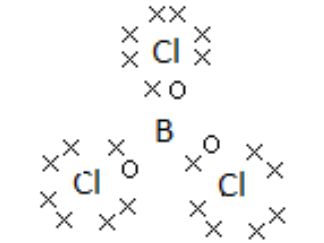
Question Number	Acceptable Answer	Additional Guidance	Mark
5 (b)	<p>An answer that makes reference to the following points:</p> <p>Mass of an atom of an isotope (1)</p> <p>relative to 1/12th mass of an atom of carbon-12. (1)</p> <p>OR</p> <p>$\frac{\text{Mass of one atom of an isotope} \times 12}{\text{Mass of one atom of carbon-12}}$ (2)</p>	<p>Atom needs only to be mentioned in MP1.</p> <p>Reject just "average / mean mass of an atom" But allow "average / mean mass of an atom of an isotope"</p> <p>Ignore mention of moles throughout and 12g in respect to carbon-12.</p>	(2)

Question Number	Answer	Mark
5 (c)	<p>5(c). The only correct answer is A</p> <p><i>B is not correct because this has 25 neutrons and not 13</i></p> <p><i>C is not correct because this has 13 protons and not 12</i></p> <p><i>D is not correct because this has 25 protons and not 12</i></p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
5 (d)	<ul style="list-style-type: none"> • calculates percentage of 3rd isotope (1) <li style="padding-left: 20px;">this is a standalone mark • lays out suitable equation including unknown (1) • consolidates (1) • 24.0 (1) 	<p>Example of calculation $(100 - (10.00 + 11.01)) = 78.99$</p> <p>$\frac{(78.99 \times \text{isotopic mass}) + (25.0 \times 10.00) + (26.0 \times 11.01)}{100} = 24.3$</p> <p>78.99 x isotopic mass = 1893.74</p> <p>Isotopic mass = $\frac{1893.74}{78.99} = 24.0$ (23.97443) must be 3 s.f</p> <p>Correct answer with some further working scores last 3 marks</p> <p>Correct answer with no working scores last mark</p> <p>Allow 24 provided there is clear calculation.</p>	(4)

(Total for Question 5 = 9 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
6 (a) (i)	$2B + 3Cl_2 \rightarrow 2BCl_3$	Allow multiples Ignore state symbols even if incorrect	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
6 (a) (ii)	 <p>ALLOW</p> <p>All dots or all crosses</p>	Ignore inner shell electrons and circles	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
6 (a)(iii)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> 3 bonding pairs of electrons (bonding environments) (and no non-bonding / lone pairs of electrons in the outer shell of boron) (1) (the bonding pairs of electrons) move apart to minimise repulsion (1) 	<p>Accept 3 pairs of electrons</p> <p>Do not award 3 bonding pairs repel each other equally</p> <p>Accept move as far apart as possible / maximise separation</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
6 (b)	<p>Determine empirical formula</p> <p>finds mass of Cl</p> <p>AND</p> <p>finds moles of aluminium and chlorine</p> <p>determines ratio and hence empirical formula is AlCl_3</p>	<p><u>Example of calculation</u></p> <p>$0.500 - 0.101 = 0.399(\text{g})$</p> <p>AND</p> <p>$0.101/27.0 = 0.00374074 / 3.74... \times 10^{-3}$</p> <p>AND</p> <p>$0.399/35.5 = 0.01123944 / 1.12... \times 10^{-2}$</p> <p>$\frac{0.01123944}{0.00374074} = 3.005$</p> <p>Could use $(0.101/0.5) \times 100 = 20.2\%$</p> <p>$20.2/27.0 = 0.74814815$</p> <p>AND</p> <p>$79.8/35.5 = 2.2478873$</p> <p>$\frac{2.2478873}{0.74814815} = 3.005$</p>	(6)

	<p>Determine molecular mass</p> <p>converts p into Pa / N m⁻² and V into m³</p> <p>rearrange $pV = nRT$ and finds number of moles</p> <p>finds molecular mass</p> <p>finds molecular formula</p>	<p>(1)</p> $p = 1.00 \times 10^2 \times 10^3 = 100\,000 / 1 \times 10^5$ <p>AND</p> <p>(1)</p> $V = 73.6 / 1\,000\,000 \text{ or } 7.36 \times 10^{-5}$ <p>(1)</p> $n = \frac{100000 \times (73.6/1000000)}{8.31 \times 473} = 0.001872 \text{ or } 1.872473 \times 10^{-3} \text{ (mol)}$ <p>(1)</p> $M_r = \frac{0.500}{1.872473 \times 10^{-3}} = 267.03$ $\frac{267.03}{27.0 + (35.5 \times 3)} = 2 \text{ so Al}_2\text{Cl}_6$ <p>COMMENT MP 3-5 and identity of Al₂Cl₆ without incorrect working scores 6 marks</p>	
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Question Number	Acceptable Answer	Additional Guidance	Mark												
*6 (c)	<p>This question assesses a student’s ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.</p> <p>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.</p> <p>The following table shows how the marks should be awarded for indicative content.</p> <table border="1" data-bbox="383 660 1158 928"> <thead> <tr> <th data-bbox="383 660 770 759">Number of indicative marking points seen in answer</th> <th data-bbox="770 660 1158 759">Number of marks awarded for indicative marking points</th> </tr> </thead> <tbody> <tr> <td data-bbox="383 759 770 794">6</td> <td data-bbox="770 759 1158 794">4</td> </tr> <tr> <td data-bbox="383 794 770 829">5-4</td> <td data-bbox="770 794 1158 829">3</td> </tr> <tr> <td data-bbox="383 829 770 865">3-2</td> <td data-bbox="770 829 1158 865">2</td> </tr> <tr> <td data-bbox="383 865 770 900">1</td> <td data-bbox="770 865 1158 900">1</td> </tr> <tr> <td data-bbox="383 900 770 928">0</td> <td data-bbox="770 900 1158 928">0</td> </tr> </tbody> </table>	Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points	6	4	5-4	3	3-2	2	1	1	0	0	<p>Guidance on how the mark scheme should be applied:</p> <p>The mark for indicative content should be added to the mark for lines of reasoning.</p> <p>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).</p> <p>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).</p>	(6)
Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points														
6	4														
5-4	3														
3-2	2														
1	1														
0	0														

Question Number	Acceptable Answer	Additional Guidance	Mark								
*6 (c) contd	<p>The following table shows how the marks should be awarded for structure and lines of reasoning.</p> <table border="1" data-bbox="383 352 1292 748"> <thead> <tr> <th data-bbox="383 352 891 451"></th> <th data-bbox="891 352 1292 451">Number of marks awarded for structure of answer and sustained line of reasoning</th> </tr> </thead> <tbody> <tr> <td data-bbox="383 451 891 584">Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td> <td data-bbox="891 451 1292 584">2</td> </tr> <tr> <td data-bbox="383 584 891 683">Answer is partially structured with some linkages and lines of reasoning.</td> <td data-bbox="891 584 1292 683">1</td> </tr> <tr> <td data-bbox="383 683 891 748">Answer has no linkages between points and is unstructured.</td> <td data-bbox="891 683 1292 748">0</td> </tr> </tbody> </table> <p>Indicative content:</p> <ul data-bbox="427 874 1433 1337" style="list-style-type: none"> aluminium and chlorine electronegativity difference 1.5 AND aluminium and fluorine electronegativity difference 2.5 aluminium chloride (mostly) covalent / (small) molecule aluminium fluoride (bonds) more polar aluminium chloride molecular so weak(er) intermolecular forces / London forces 		Number of marks awarded for structure of answer and sustained line of reasoning	Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2	Answer is partially structured with some linkages and lines of reasoning.	1	Answer has no linkages between points and is unstructured.	0	<p>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.</p> <p>Reasoning marks may be reduced for extra incorrect chemistry</p> <p>Allow all 3 electronegativity values / difference between F and Cl is 1 / difference between differences is 1/ F is 4, CL is 3 and this is a significant difference</p> <p>Allow mostly/more ionic</p> <p>Allow weak(er) dipole-dipole interactions Do not award any suggestion of breaking covalent bonds</p>	(6)
	Number of marks awarded for structure of answer and sustained line of reasoning										
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2										
Answer is partially structured with some linkages and lines of reasoning.	1										
Answer has no linkages between points and is unstructured.	0										

	<ul style="list-style-type: none">aluminium fluoride is a giant structure/ strong electrostatic forces of attraction between the ionsmore energy needed to break the stronger bonds to cause sublimation in aluminium fluoride	Allow stronger dipole-dipole attractions Allow (dative) covalent bonds breaking (to form small molecule / AlF_3)	
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(Total for Question 6 = 16 marks)

Question Number	Acceptable Answer						Additional Guidance	Mark																		
7 (a)	<table border="1" data-bbox="383 300 1288 592"> <thead> <tr> <th data-bbox="383 300 573 371">Titration</th> <th data-bbox="573 300 719 371">1</th> <th data-bbox="719 300 857 371">2</th> <th data-bbox="857 300 1003 371">3</th> <th data-bbox="1003 300 1144 371">4</th> <th data-bbox="1144 300 1288 371">5</th> </tr> </thead> <tbody> <tr> <td data-bbox="383 371 573 488">Total Titre /cm³</td> <td data-bbox="573 371 719 488">26.00</td> <td data-bbox="719 371 857 488">24.00</td> <td data-bbox="857 371 1003 488">25.10</td> <td data-bbox="1003 371 1144 488">24.10</td> <td data-bbox="1144 371 1288 488">24.05</td> </tr> <tr> <td data-bbox="383 488 573 592">Concordant results (✓)</td> <td data-bbox="573 488 719 592"></td> <td data-bbox="719 488 857 592">✓</td> <td data-bbox="857 488 1003 592"></td> <td data-bbox="1003 488 1144 592">✓</td> <td data-bbox="1144 488 1288 592">✓</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li data-bbox="427 632 1294 663">• Correct total titres (1) <li data-bbox="427 703 1294 735">• Correct 3 ticks and mean titre = 24.05 (cm³) (1) <li data-bbox="427 775 1294 879">• Moles of sodium carbonate in 100 cm³ AND moles of sodium carbonate in 10 cm³ (1) <li data-bbox="427 991 1294 1023">• Moles of HCl (1) <li data-bbox="427 1094 1294 1126">• concentration of HCl (1) 						Titration	1	2	3	4	5	Total Titre /cm ³	26.00	24.00	25.10	24.10	24.05	Concordant results (✓)		✓		✓	✓	<p data-bbox="1330 448 1928 512">Allow lack of second decimal place 0, on one number only (as a slip)</p> <p data-bbox="1330 663 1671 695"><u>Example of Calculation</u></p> <p data-bbox="1330 735 1928 799">Moles of sodium carbonate in 100 cm³ = 1.30/106 = 0.012264151 (mol)</p> <p data-bbox="1330 839 1960 943">So moles of sodium carbonate in 10 cm³ = 0.012264151/10 = 0.0012264151 (mol)</p> <p data-bbox="1330 983 1832 1046">Moles of HCl = 0.0012264151 x 2 = 0.0024528302</p> <p data-bbox="1330 1094 1928 1230">So concentration of HCl = 0.0024528302 / (24.05/1000) = 0.1019887 = 0.102 (mol dm⁻³)(to 3 s.f.)</p> <p data-bbox="1330 1238 1928 1302">Allow 0.10 provided working given which is equal to 0.10 to 2 s.f.</p> <p data-bbox="1330 1310 1868 1374">Correct final answer with alternative route scores 3 marks</p> <p data-bbox="1330 1382 1805 1414">Allow TE on incorrect mean titre</p>	(5)
Titration	1	2	3	4	5																					
Total Titre /cm ³	26.00	24.00	25.10	24.10	24.05																					
Concordant results (✓)		✓		✓	✓																					

Question Number	Answer	Mark
7 (b)	<p>7(b). The only correct answer is C</p> <p><i>A is not correct because this is the reverse of the correct colour change</i></p> <p><i>B is not correct because this is doing the reverse titration (acid in flask and carbonate in burette)</i></p> <p><i>D is not correct because this is going beyond the endpoint to an acidic solution</i></p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
7 (c)	<p>An explanation that makes reference to the following two points:</p> <p>Add drop by drop AND So that too much acid is not added / to avoid 'overshooting' the end-point (1)</p> <p>Swirl / shake / agitate AND To ensure a homogenous mixture/allow all acid and alkali to react (1)</p> <p>Any one from:</p> <p>Rinse the sides of the flask with distilled/deionised water between additions AND To rinse all reactants into the solution so all can react</p>	<p>If no other mark awarded, award 1 for three correct actions</p> <p>Do not award to make the reading more precise / accurate (as this is given in the question)</p> <p>Do not award ensuring the burette is vertical measuring to the bottom of the meniscus parallax errors reducing the speed of the titration fewer drops of indicator</p>	(3)

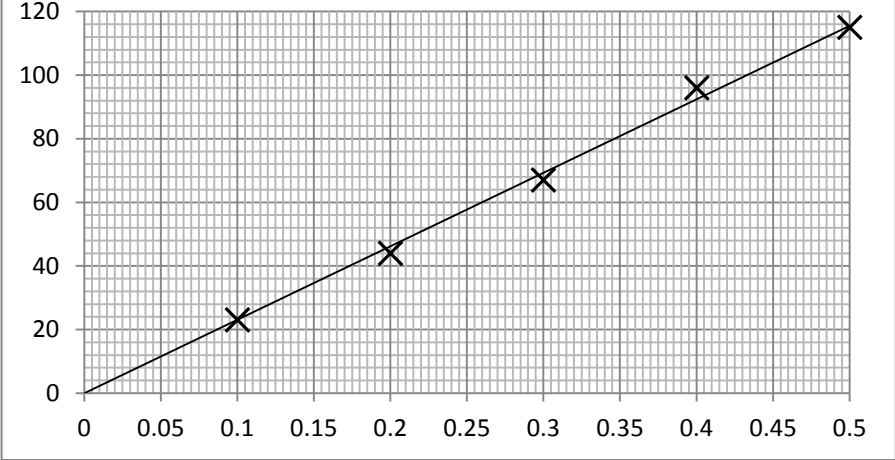
	<p>OR</p> <p>Use a white tile/paper</p> <p>AND</p> <p>To clearly see change of colour</p> <p>OR</p> <p>Compare the colour of the solution at the end-point with previous titrations</p> <p>AND</p> <p>To ensure consistency of end-point colour</p> <p>OR</p> <p>Rinse the end of the jet of the burette (with distilled water)</p> <p>AND</p> <p>To ensure all the hydrochloric acid is in the conical flask (no drip left on burette) (1)</p>		
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(Total for Question 7 = 9 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (a) (i)	$\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ <p>Balanced equation (1)</p> <p>State symbols (1)</p>	<p>Accept</p> $\text{CaCO}_3(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ <p>2nd mark dependent on first or near miss.</p> <p>Reject $\text{H}_2\text{CO}_3(\text{aq})$ in equation, but allow state symbol mark if otherwise correct.</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (a) (ii)	Finds molar mass of calcium carbonate	<p><u>Example of calculation</u></p> <p>Mr of calcium carbonate $= 40.1 + 12 + (16 \times 3) = 100.1 \text{ (g mol}^{-1}\text{)}$</p> <p>Allow $= 40 + 12 + (16 \times 3) = 100 \text{ (g mol}^{-1}\text{)}$</p> <p>Accept answer with no working</p>	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (a)(iii)	<ul style="list-style-type: none"> • calculate moles of calcium carbonate in 0.50 g (1) • moles of hydrochloric acid in 20 cm³ <p>AND</p> <p>Show the hydrochloric acid is in excess with appreciation of 2:1 ratio in equation for reaction (1)</p>	<p><u>Example of calculation</u></p> <p>moles of calcium carbonate = $0.50/100.1 = 0.004995 = 0.0050$ (mol)</p> <p>moles of hydrochloric acid in 20 cm³ = $20/1000 \times 2 = 0.040$ (mol)</p> <p>0.04 (moles of hydrochloric acid) reacts with 0.02 (moles of calcium carbonate) therefore the acid is in (a four times) excess.</p> <p>OR</p> <p>0.0050 (moles of calcium carbonate) reacts with 0.010 (moles of hydrochloric acid) therefore the acid is in (a four times) excess</p> <p>Ignore calculations using other masses of calcium carbonate</p>	(2)

Question Number	Acceptable Answer	Additional Guidance		Mark
8 (b) (i)	<p>Points plotted accurately AND axes labelled (1)</p> <p>Points plotted must cover more than half of graph paper AND Reasonable straight line of best fit which may extend to the origin (1)</p> <p>Allow ecf on reasonable line on incorrectly plotted points.</p>	<p>Do not award for reversed axes</p> <p>Volume (of CO₂) / cm³</p>		(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (b) (ii)	Straight line through the origin (therefore volume is directly proportional to mass)	Allow 'There is a positive correlation.'	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (c)	Either <ul style="list-style-type: none"> • finds gradient from graph • molar volume given to 2 s.f. with units OR <ul style="list-style-type: none"> • moles of calcium carbonate • molar Volume 	<p><u>Example calculation</u></p> <p>Gradient = $\frac{\text{volume}}{\text{mass}} = 231$ (cm³ per gram)</p> <p>Allow correctly calculated values in the range = 210 to 250</p> <p>(Molar Volume = Gradient x Mr)</p> <p>Molar Volume = 231 x 100.1 (or x 100)</p> <p style="padding-left: 40px;">= 23 (dm³) (must be 2 s.f)</p> <p>Answer to 2 s.f. (and units)</p> <p>Allow TE from any gradient</p> <p>OR</p> <p>Data may be used from any experiment number eg using data from Experiment 5</p> <p>Moles of calcium carbonate = 0.50/100.1 = 0.0050</p> <p>Molar Volume = 115/0.005 = 23 (dm³)</p> <p>Allow data from a point on the line calculated using route 2</p>	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
8 (d)	To saturate the solution with CO ₂ / to stop the CO ₂ formed from dissolving		(1)

(Total for Question 8 = 11 marks)

TOTAL FOR PAPER = 80 MARKS

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