

## Mark Scheme

Question	Answer	Marks	Guidance
1	C	1	

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2	(a)	$\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$ ✓ Effervescence <b>AND</b> solid dissolves ✓	2	State symbols are required <b>ALLOW</b> solid disappears
	(b)	Lattice enthalpy of $\text{MgCl}_2$ is more exothermic than $\text{CaCl}_2$ ✓ because magnesium ion/ $\text{Mg}^{2+}$ is smaller (than calcium ions/ $\text{Ca}^{2+}$ ) <b>OR</b> $\text{Mg}^{2+}$ has a greater charge density ✓ therefore the attraction between $\text{Mg}^{2+}$ and $\text{Cl}^-$ is greater (than between $\text{Ca}^{2+}$ and $\text{Cl}^-$ ) ✓	3	<b>ORA</b> throughout <b>ALLOW</b> 'charge density' here <b>only</b> <b>ALLOW</b> magnesium/Mg is smaller <b>DO NOT ALLOW</b> $\text{Mg}^{2+}$ has a smaller <b>atomic</b> radius <b>DO NOT ALLOW</b> chlorine ions <b>DO NOT ALLOW</b> Mg has greater attraction <b>ALLOW</b> 'attracts with more force' for greater attraction but <b>DO NOT ALLOW</b> 'greater force' (could be repulsion)
	(c)	(i) F B G E D FIVE correct ✓✓✓ FOUR correct ✓✓ THREE correct ✓	3	<b>ALLOW</b> 1450 736 G 76 -642 <b>IF</b> only one or two correct, award 0 marks.
		(ii) $-642 - (+76 + (2 \times 150) + 736 + 1450 + (2 \times -349))$ ✓ $-642 - 1864 = -2506$ ✓ ( $\text{kJ mol}^{-1}$ )	2	<b>ALLOW</b> for 1 mark: $-2705$ (2 x 150 and 2 x 349 not used for Cl) $-2356$ (2 x 150 not used for Cl) $-2855$ (2 x 349 not used for Cl) $+2506$ (wrong sign) <b>DO NOT ALLOW</b> any other answers

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(d)*	<p><i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i></p> <p><b>Level 3 (5–6 marks)</b> Describes and explains concisely the trend in reactivity of the halogens <b>AND</b> Full observations of redox reactions backed up by at least two equations</p> <p><i>There is a well-developed explanation which is clear and logically structured. The observations and equations are relevant to those trends explained. Clear and confident knowledge of relevant technical language.</i></p> <p><b>Level 2 (3–4 marks)</b> Describes and explains the trend in reactivity of the halogens <b>AND</b> Is able to recall a redox reaction by suitable observations and correctly link to an equation</p> <p><i>There is an explanation with some structure. The observations and equations are in the most-part relevant to the trend explained. Sound grasp of relevant technical language.</i></p> <p><b>Level 1 (1–2 marks)</b> Describes the trend in reactivity of the halogens with some attempt at explanation <b>AND</b> Is able to recall a redox reaction either by suitable observation or by equation</p>	6	<p><b>Indicative scientific points may include:</b></p> <p><b>Trend in reactivity</b></p> <ul style="list-style-type: none"> <li>• More shells or increasing radius down the group</li> <li>• Increased shielding down the group</li> <li>• More difficult to gain an electron</li> </ul> <p><b>Observations</b></p> <ul style="list-style-type: none"> <li>• Reaction of <math>Cl_2</math> or <math>Br_2</math> with <math>I^-</math>: orange/brown solution <b>OR</b> purple in organic</li> <li>• Reaction of <math>Cl_2</math> with <math>Br^-</math>: yellow solution <b>OR</b> orange in organic</li> </ul> <p><b>Reaction equations</b></p> <ul style="list-style-type: none"> <li>• <math>Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-</math></li> <li>• <math>Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-</math> <b>OR</b> <math>Br_2 + 2I^- \rightarrow I_2 + 2Br^-</math></li> <li>• Order of reactivity linked to observations</li> </ul>

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			<p><i>The information about the trend is basic and communicated in an unstructured way. The information is supported by only observation or equation and the relationship to the trend may not be clear.</i></p> <p><i>Basic grasp of relevant technical language</i></p> <p><b>0 marks</b> No response or no response worthy of credit.</p>		
			<b>Total</b>	<b>16</b>	

## Mark Scheme

Question	Answer	Marks	AO element	Guidance
3	B	1	AO1.1	

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Question			Answer	Marks	Guidance
4	(a)	(i)	(enthalpy change when) 1 mole of gaseous ions react <b>OR</b> 1 mole of hydrated/aqueous ions are formed ✓  gaseous ions dissolve in <b>water</b> <b>OR</b> gaseous ions form aqueous/hydrated ions ✓	2	<b>IGNORE</b> 'energy released' <b>OR</b> 'energy required'
	(a)	(ii)	<p> <math>\text{Ca}^{2+}(\text{g}) + 2\text{F}^{-}(\text{g})</math> ✓  <math>\text{Ca}^{2+}(\text{aq}) + 2\text{F}^{-}(\text{g})</math> ✓  <math>\text{Ca}^{2+}(\text{aq}) + 2\text{F}^{-}(\text{aq})</math> ✓  <math>\text{CaF}_2(\text{s})</math> ✓ </p>	4	<p>Correct species <b>AND</b> state symbols required for each mark. (mark independently)</p> <p>On 2nd line, <b>ALLOW</b> <math>\text{Ca}^{2+}(\text{g}) + 2\text{F}^{-}(\text{aq})</math> (i.e. <math>\text{F}^{-}</math> hydrated before <math>\text{Ca}^{2+}</math>)</p> <p>On 3rd line, <b>ALLOW</b> <math>\text{CaF}_2(\text{aq})</math></p> <p><b>DO NOT ALLOW</b> when first seen but <b>ALLOW ECF</b> for '2' missing and for use of the following ions  <math>\text{Fl}^{-}</math>  <math>\text{F}_2^{-}</math>  <math>\text{Ca}^{+/3+}</math></p>

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(a)	(iii)	<p><b>FIRST, CHECK THE ANSWER ON ANSWER LINE</b>  <b>IF answer = <math>-504 \text{ (kJ mol}^{-1}\text{)}</math> award 2 marks</b>  <b>IF answer = <math>-1008 \text{ (kJ mol}^{-1}\text{)}</math> award 1 mark</b>            -----</p> <p><math>2 \times \Delta_{\text{hyd}}H(\text{F}^-)</math>  <math>= [-2630 + 13] - (-1609)</math>  <b>OR</b> <math>-2617 + 1609</math>  <b>OR</b> <math>-1008 \text{ (kJ mol}^{-1}\text{)}</math> ✓</p> <p><math>\Delta_{\text{hyd}}H(\text{F}^-) = \frac{-1008}{2} = -504 \text{ ✓ (kJ mol}^{-1}\text{)}</math></p>	2	<p><b>IF</b> alternative answer, check to see if there is any <b>ECF</b> credit possible using working below.</p> <p>'-' sign is needed.</p> <p><b>COMMON ERRORS</b> for 1 mark:  <math>(+)</math>2694: <i>signs all reversed</i>  <math>-2113</math>: <i>sign wrong for <math>-1609</math></i>  <math>-2126</math>: <i>sign wrong for 2630</i>  <math>-517</math>: <i>sign wrong for 13</i>  <math>+504</math>: <i>sign wrong</i></p> <p><b>IF ALL 3</b> relevant values from the information at the start of Q16a(iii) have <b>NOT</b> been used, award zero marks unless one number has a transcription error, where 1 mark can be awarded ECF</p>
(a)	(iv)	<p><b>Correct comparison of <math>\Delta_{\text{hyd}}</math> linked to sizes</b>  <math>\Delta_{\text{hyd}}H(\text{F}^-)</math> more negative/exothermic (than <math>\Delta_{\text{hyd}}H(\text{Cl}^-)</math>)  <b>AND</b>  <math>\text{F}^-</math> has smaller size (than <math>\text{Cl}^-</math>) ✓</p> <p><b>Comparison of attraction between ions and water</b>  <math>\text{F}^-</math> OR smaller sized ion linked to greater attraction to <math>\text{H}_2\text{O}</math> ✓</p>	2	<p><b>ORA</b>  <b>IGNORE</b> 'atomic' before radius when comparing size of ions  <b>IGNORE</b> charge density</p> <p><b>IGNORE</b> electronegativity  <b>IGNORE</b> nuclear attraction  <b>DO NOT ALLOW</b> 'forms stronger hydrogen bonds with water' <b>OR</b> 'forms stronger van der Waals' forces with water'  <b>ALLOW</b> 'forms bonds' for attraction'  <b>DO NOT ALLOW</b> <math>\text{F}^-</math> greater attraction to <math>\text{H}_2\text{O}</math> if given as larger ion            Assume 'F' / 'Fluorine' means 'ions' but <b>DO NOT ALLOW</b> 'F molecules'</p>

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Question		Answer	Marks	Guidance
	(b) (i)	<p><b>Average bond enthalpy</b></p> <p>Breaking of one mole of bonds ✓</p> <p>In gaseous molecules ✓</p>	2	<p><b>IGNORE</b> energy required <b>OR</b> energy released <b>IGNORE</b> heterolytic / homolytic</p> <p><b>DO NOT ALLOW</b> bonds formed</p> <p><b>DO NOT ALLOW</b> ionic bonds</p> <p><b>IGNORE</b> species for molecules</p>
	(b) (ii)	<p><b>FIRST, CHECK ANSWER ON ANSWER LINE</b></p> <p><b>IF answer = (+) 158 award 3 marks</b></p> <p>-----</p> <p><b>Bond enthalpy of F–F</b></p> <p>(<math>\Delta H</math> for (O–H) bonds broken =) 1856 <b>OR</b> <math>4 \times 464</math> (kJ mol<sup>-1</sup>) ✓</p> <p>(<math>\Delta H</math> for bonds made =) 2770 (kJ mol<sup>-1</sup>) <b>OR</b> 498 <b>AND</b> 2272 (kJ mol<sup>-1</sup>) <b>OR</b> 498 <b>AND</b> <math>4 \times 568</math> (kJ mol<sup>-1</sup>) ✓</p> <p>(bond enthalpy) F–F = <math>\frac{2770 - 1856 - 598}{2}</math> = (+)158 (kJ mol<sup>-1</sup>) ✓</p>	3	<p><b>ANNOTATE ANSWER WITH TICKS AND CROSSES</b></p> <p><b>IGNORE</b> sign</p> <p><b>IGNORE</b> sign</p> <p><b>ALLOW ECF</b></p> <p><b>Common errors</b></p> <p><b>Award 2 marks</b> for; –158 (Wrong sign) (±)316 (No ÷ 2) (+) 622 (use of <math>2 \times 464</math>) (+) 457 (omitting – 598) (+) 756 (use of +598)</p> <p><b>Award 1 mark</b> for; (+) 970 (use of <math>2 \times 464</math> and +598)</p>
		<b>Total</b>	<b>15</b>	