

Question	Answer	
2(a)	ΔH_{hyd} increases from left to right due to increase in charge ionic radius decreases from left to right causing increased attractive force to water molecules	[1] [1] [1]
2(b)(i)	$\text{Mg}^{2+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq})$	[1]
2(b)(ii)	Enthalpy change of hydration of magnesium ions and chloride ions $\Delta H_{\text{hyd}}\text{Mg}^{2+} + 2\Delta H_{\text{hyd}}\text{Cl}^{-}$	[1] [1]
2(b)(iii)	Selects 155, 1920 and 364 only 2×364 answer -2493	[1] [1] [1]
2(c)	The number of arrangements of the particles and of the energy in the system	[1]
2(d)	$\Delta G = \Delta H - T\Delta S$ answer $+10.5$	[1] [1]
2(e)(i)	No, ΔG is positive	[1]
2(e)(ii)	Becomes more / soluble because ΔG becomes more negative / less positive / smaller / closer to zero	[1]

Question	Answer	
3(a)(i)	$[\text{H}^{+}] = 10^{-12.35}$ OR $[\text{H}^{+}] = 4.47 \times 10^{-13}$ $K_{\text{w}}/4.47 \times 10^{-13}$ OR $\text{pOH} = 1.65$ $[\text{OH}^{-}] = 10^{-1.65}$	[1] [1] [1] [1] [1]

Question	Answer	Marks
7(a)(i)	<ul style="list-style-type: none"> energy change when one electron is added to each atom /ion in one mole of gaseous atoms /ions <p>Award one mark for two correct statements. Award two marks for four correct statements</p>	2
7(a)(ii)	M1 energy change when 1 mole of an ionic compound is formed M2 from gas phase ions/ gaseous ions	2

Question	Answer	Marks
7(b)	M1 use of data (with no multipliers) 31, 131, -2678 M2 extraction of data 908, 1730, 193 M3 use of (2×325) M4 evaluation of <u>their</u> expression correctly, as shown $\Delta H_{\text{f}}(\text{ZnBr}_2) = 131 + (908 + 1730) + 193 + 31 + (2 \times 325) + (-2678)$ $= -335 \text{ kJ mol}^{-1}$ [4]	4
7(c)(i)	Br is a largest ion/larger ion than Cl so attraction between Br and Zn^{2+} is smaller	1
7(c)(ii)	O^{2-} is a smallest ion/smaller ion than Cl AND O^{2-} has the highest charge/ higher charge than Cl (so attraction between O^{2-} and Zn^{2+} is larger)	1

Question	Answer	Marks										
1(a)(i)	[Ar] <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>1↓</td><td>1↓</td><td>1↓</td><td>1↓</td><td>1↓</td><td> </td><td> </td><td> </td><td> </td><td> </td> </tr> </table>	1↓	1↓	1↓	1↓	1↓						1
1↓	1↓	1↓	1↓	1↓								
1(a)(ii)	<p>one • for each of the eight species (including state symbol) on the correct line AND one • e⁻ any three [1] any six [2] all nine [3]</p>	3										
1(a)(iii)	<ul style="list-style-type: none"> EA becomes less negative/ less exothermic (down group / S to Te) atomic radii increases OR outer shell gets farther from nucleus OR electron added at higher energy level OR more shielding (of outer shells) less nuclear attraction OR less attraction for incoming/added electron any two [1] all three [2]											
1(a)(iv)	M1: O ²⁻ (has same charge but) smaller (radius than S ²⁻) ORA OR oxygen has a smaller ion (than S ²⁻)	1										
	M2: stronger ionic bond OR greater attraction between Zn ²⁺ and O ²⁻ ORA	1										

Question	Answer	Marks
1(b)(i)	ΔS negative AND more moles / molecules of gaseous reactants ORA OR ΔS negative AND moles / molecules of gas are reduced (in the reaction)	1
1(b)(ii)	$\Delta S = 50.8 + 197.7 - 43.7 - 5.7 = (+)199.1 \text{ (J K}^{-1} \text{ mol}^{-1}\text{)}$	1
1(b)(iii)	$\Delta G = \Delta H - T\Delta S$ ALLOW $G = \Delta H - T\Delta S$ $= +733 - (800 + 273) \times 0.218 = (+)499.086 \text{ (kJ mol}^{-1}\text{) min 3sf}$	1
1(c)(i)	$\text{Zn(NO}_3)_2 \rightarrow \text{ZnO} + 2\text{NO}_2 + \frac{1}{2}\text{O}_2$ OR $2\text{Zn(NO}_3)_2 \rightarrow 2\text{ZnO} + 4\text{NO}_2 + \text{O}_2$	1
1(c)(ii)	increases (in thermal stability down the group) AND (cat)ion(ic) radius / ion size increases (down the group)	1
	less polarisation / less distortion of anion/ of nitrate ion/NO ₃ ⁻ / NO ₃ ²⁻ OR less weakening of N—O bond	1
1(c)(iii)	Mg(NO ₃) ₂ only ALLOW Mg ²⁺ / magnesium	1

Question	Answer	Marks
3(a)(i)	$(+193 + 242 + 590 + 1150 + (2 \times -349))$ [1] answer (+)1477 [1]	2
3(a)(ii)	$(-795 - 83 - 1477)$ [1] -2355 [1]	2
3(a)(iii)	$(-2355 - (2 \times -364))$ [1] -1627 [1]	2
3(a)(iv)	Z-Y or X-W [1]	1
3(a)(v)	less (exothermic) and both ions (in CaCl_2) are larger [1]	1
3(b)(i)	soluble barium salt AND soluble sulfate [1]	1
3(b)(ii)	less soluble (down the group) [1] ΔH_{hyd} and ΔH_{hyd} both decrease down the group [1] ΔH_{hyd} decreases more / faster / is dominant factor [1] ΔH_{sol} gets less exo / more endo [1]	4

Question	Answer	Marks
2(a)(i)	M1 the only number extracted: 762, 1560, 496 M2 correct multiplier, other four numbers used and calculation to the answer $-272 = +416 + \frac{1}{2}(496) + 762 + 1560 - 141 + 798 + \Delta H_{\text{lattice}}$ $\therefore \Delta H_{\text{lattice}} = -3915$ (kJ mol ⁻¹) ecf	2
2(a)(ii)	$20 \times [0.9(+2) + 0.1(+3)] - 2x = 0$ $\therefore x = 21$	1
2(a)(iii)	<ul style="list-style-type: none"> FeO more exothermic/more negative Fe²⁺ has smaller radius/higher charge density (also same charge) greater attraction/ stronger ionic bonds (between Fe²⁺ and O²⁻) All three for two marks	2

Question	Answer	Marks
2(b)(i)	<ul style="list-style-type: none"> Fe²⁺ reduced to Fe OR oxid no. Fe +2 → 0 Fe²⁺ oxidised to Fe³⁺ (in Fe₃O₄) OR oxid no. Fe +2 → +3 BOTH bullets required	1
2(b)(ii)	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$	1
2(b)(iii)	M1: coulombs and correct use of + 96500 M2: correct use of 3 and 8 M3: correct use of 55.8 and answer M1: $Q = It = 50 \times 6 \times 60^2$ OR 1.08×10^6 C AND no. of faraday = $1.08 \times 10^6 \div 96500$ OR 11.2 / 11.19 mol e ⁻ M2: $\text{Fe}^{2+} + 2\text{Fe}^{3+} + 8\text{e}^- \rightarrow 3\text{Fe}$ \therefore moles of Fe = $3/8 \times \text{M1} = 4.20$ mol Fe ecf M3: mass of Fe = $55.8 \times \text{M2} = 234.2$ g ecf 3sf min	3
2(c)(i)	Any one of: small size / compact, low mass, high voltage OWTTE	1
2(c)(ii)	Li from +1 to +1 Fe from +3 to +2	1
2(c)(iii)	$\text{LiC}_6 + \text{FePO}_4 \rightarrow \text{LiFePO}_4 + 6\text{C}$	1

Question	Answer	Marks
1(a)	M1 magnesium > calcium > strontium M2 ΔH_{latt} and ΔH_{hyd} both become less exothermic / less negative M3 ΔH_{latt} changes less OR ΔH_{hyd} is dominant factor M4 ΔH_{sol} becomes less exothermic / less negative / more positive / more endothermic	4
1(b)	M1 ΔH / energy change when 1 mole of an ionic solid / compound is formed M2 from gaseous ions (under standard conditions)	2
1(c)	M1 as ionic radii increases AND ΔH_{latt} less exothermic M2 as ionic charge increases AND ΔH_{latt} increases/more exothermic	2
1(d)(i)	<p>any two [1] any three [2] all four [3]</p>	3

Question	Answer	Marks
1(d)(ii)	M1 selection of ONLY six correct values (–381, 89, 419, 279, –200, 640) AND use of $\times 2$ as only multiplier with K M2 correct evaluation of data used ecf $-381 = (89 \times 2) + (419 \times 2) + 279 + (-200) + 640 + \Delta H^{\circ}_{\text{latt}}$ $\Delta H^{\circ}_{\text{latt}} = -2116 \text{ (kJ mol}^{-1}\text{)}$	2