

Mark Scheme

Q1.

Question Number	Correct Answer	Mark
	B	1

Q2.

Question Number	Correct Answer	Reject	Mark
	B		1

Q3.

Question Number	Correct Answer	Mark
	D	1

Q4.

Question Number	Correct Answer	Mark
	A	1

Q5.

Question Number	Correct Answer	Reject	Mark
(a)	<p>First mark Enthalpy change when 1 mol of gaseous ions (1)</p> <p>ALLOW energy change/heat change/energy evolved/released/ given out/exothermic</p> <p>Second mark Is dissolved/hydrated/solvated such that further dilution causes no further heat change OR Is dissolved to produce an infinitely dilute solution/in excess water (1)</p> <p>ALLOW Is dissolved to produce a solution of 1.0 mol dm⁻³</p>	<p>Energy required or energy taken in</p> <p>Atoms or molecules (0)</p> <p>1 mol of water</p>	2

Question Number	Acceptable Answers	Reject	Mark
(b)(i)	K ⁺ (aq) (+) F ⁻ (aq)	K ⁺ F ⁻ (aq)	1

Question Number	Acceptable Answers	Reject	Mark
(b)(ii)	$\Delta H_{\text{sol}} = -\Delta H_1 + \Delta H_2$ OR $\Delta H_{\text{sol}} = \Delta H_2 - \Delta H_1$		1

Question Number	Acceptable Answers	Reject	Mark
(b)(iii)	(Standard) Lattice(enthalpy/energy/ ΔH)	LE/Lat - Lattice	1

Question Number	Acceptable Answers	Reject	Mark
(b)(iv)	<p>First mark Selection of (-)817 rather than (-)807 (1)</p> <p>Second mark $\Delta H_{\text{sol}} = 817 - 805 = (+)12 \text{ (kJ mol}^{-1}\text{)}$ (1)</p> <p>Just (+)12 (kJ mol⁻¹) (2)</p> <p>ALLOW TE for second mark e.g. for 807 gives (+) 2 (kJ mol⁻¹)</p> <p>ALLOW TE from incorrect b(ii)</p>	-12 (max 1)	2

Question Number	Acceptable Answers	Reject	Mark
(c)(i)	<p>EITHER No change/no measurable change in temperature</p> <p>OR (Very small) decrease in temperature (1)</p> <p>Thermometer not sensitive/precise enough/precision of thermometer is + or - 0.5 °C/graduations too large (1)</p> <p>Amount of energy taken in is small /ΔH_{sol} is small/mass of sodium chloride is small/slightly endothermic (1)</p>	<p>Any reference to temp increase /exothermic</p> <p>Just accuracy +/- 1 °C</p>	3

Question Number	Acceptable Answers	Reject	Mark
* (c)(ii)	<p>(The reaction is endothermic so)</p> <p>Entropy(change) of surroundings decreases OR ΔS_{sur} is negative OR $-\Delta H/T$ is negative (1)</p> <p>But entropy (change)of system increases (as there is an increase in disorder) OR ΔS_{sys} is positive (1)</p> <p>Increase in entropy of system outweighs/greater than decrease in entropy of surroundings / value for entropy change of system is greater than entropy change of surroundings (1)</p> <p>Total entropy (change) is positive (1)</p> <p>All marks are stand alone</p>	<p>S_{sur} is negative</p> <p>S_{sys} is positive</p>	4

Question Number	Acceptable Answers	Reject	Mark
* (d)	<p>Any four from:</p> <p>The difference between Born Haber and theoretical LE is greater for LiI than for LiCl (1)</p> <p>(845 and 848 =) 3 for LiCl whereas (738 and 759 =) 21 for LiI (1)</p> <p>Iodide ion is larger than chloride ion/lower charge density on iodide ion (1)</p> <p>The iodide ion is more likely (than the chloride ion) to be polarized (by lithium ion) (1)</p> <p>LiI likely to have more covalent character than LiCl (1)</p>	<p>Reject values with +</p> <p>Iodine/Chlorine atoms or molecules</p> <p>Iodine/Chlorine atoms or molecules</p>	4

Q6.

Question Number	Acceptable Answers	Reject	Mark
(a)(i)	$\Delta S_{\text{system}}^{\ominus} = 109.2 + (6 \times 69.9) - 343 \quad (1)$ $= (+)185.6 (\text{J mol}^{-1} \text{K}^{-1}) / (+)186 (\text{J mol}^{-1} \text{K}^{-1}) \quad (1)$ OR $(+)0.186 (\text{kJ mol}^{-1} \text{K}^{-1}) \quad (2)$ IGNORE units even if incorrect correct answer with no working scores 2 Value using 1 for H ₂ O = -163.9 scores 1 Use of value for H ₂ O(g) (188.7) gives $898.4 (\text{J mol}^{-1} \text{K}^{-1}) \quad (1)$ correct value with incorrect sign scores 1	185	2

Question Number	Acceptable Answers	Reject	Mark
(a)(ii)	Yes as (solid and) liquid forms (from solid) / number of moles increases OR If $\Delta S_{\text{system}}^{\ominus}$ in (i) is negative the sign is not as expected as liquid forms from solid / number of moles increases	Disorder increases, with no ref to liquid or number of moles	1

Question Number	Acceptable Answers	Reject	Mark
(a)(iii)	<p>First mark $\Delta S^{\circ}_{\text{surroundings}} = \frac{-88.1 \times (1000)}{298} \text{ (1)}$</p> <p>Second mark = -295.6375 = -295.6 J mol⁻¹ K⁻¹ (1) correct units must be shown but order not important</p> <p>OR</p> <p>-0.2956 kJ mol⁻¹ K⁻¹ (1) correct units must be shown but order not important</p> <p>correct answer with or without working and correct units scores (2) ignore sf except 1</p> <p>correct value with positive sign scores 1</p>		2

Question Number	Acceptable Answers	Reject	Mark
(a)(iv)	<p>(185.6-295.6) = -110 (J mol⁻¹ K⁻¹)</p> <p>OR</p> <p>-0.110 (kJ mol⁻¹ K⁻¹)</p> <p>could use 186 or 296 etc</p> <p>TE from (a)(i) and (iii)</p> <p>(+)602.8 (J mol⁻¹ K⁻¹) if value for 6H₂O(g) was used in (a) (i)</p> <p>-459.5 (J mol⁻¹ K⁻¹) if value for one H₂O was used in (a) (i)</p>	Answers where values in J are added to kJ	1

Question Number	Acceptable Answers	Reject	Mark
(a)(v)	<p>Decomposition (at 298 K) will not occur as $\Delta S_{\text{total}}^{\ominus}$ is negative / Reactions are only spontaneous if total entropy change is positive / decomposition not thermodynamically feasible / (hydrated cobalt chloride) is thermodynamically stable</p> <p>TE if answer to (a)(iv) is positive showing decomposition (at 298 K) may occur</p> <p>OR</p> <p>Positive total entropy change doesn't indicate rate of reaction</p>		1

Question Number	Acceptable Answers	Reject	Mark
(b)(i)	<p>First mark Thermometer (1)</p> <p>Second mark (dependent on first) depends on choosing thermometer</p> <p>as temperature change is small / (%) error in balance smaller than for temperature reading (%) error in pipette smaller than for temperature reading (can be shown by calculation) / as scale with greater degree of precision needed / scale with more graduations needed (1) <i>IGNORE</i> any references to 'accurate thermometer'</p>		2

Question Number	Acceptable Answers	Reject	Mark
(b)(ii)	<p>Use more cobalt chloride / less water (1)</p> <p>To increase temperature rise (1)</p> <p>Mark independently</p>	<p>Just 'use more reactants'</p> <p>Use more cobalt chloride and more water</p> <p>repeat expt</p> <p>add a lid or extra insulation to beaker</p> <p>use distilled water</p>	2

Question Number	Acceptable Answers	Reject	Mark
(c)(i) QWC	<p>Radius (of cation) increases (down group) OR any two values of radius: Mg²⁺ = 0.072, Ca²⁺ = 0.100 / Sr²⁺ = 0.113 (nm) data may be shown beside the table (1)</p> <p>Radius Co²⁺ = 0.065 nm OR Co²⁺ radius smaller than other ions (1)</p> <p>Data on EITHER Co²⁺ OR data showing increase in radius down Group II required for BOTH of first two marks</p> <p>Force of attraction between ions decreases (as radius of ions increases) / charge density of ions decreases / negative ion can come closer to nucleus of positive ion (1) ALLOW "weaker ionic bonds"</p> <p>Predict lattice energy -2550 to -2900 (kJ mol⁻¹) (1)</p> <p>IGNORE sign</p>	<p>Atomic radii unless ionic radii also given</p> <p>Radius of cobalt chloride</p> <p>Polarising power decreases</p>	4

Question Number	Acceptable Answers	Reject	Mark
(c)(ii) QWC	<p>First mark Reference to enthalpy of hydration (may be in equation $\Delta H_{\text{solution}} = -LE + \Delta H_{\text{hydration}}$) (1)</p> <p>Second mark Solubility depends on relative size of lattice energy and enthalpy of hydration (1)</p> <p>Third mark EITHER Solubility more likely if $\Delta H_{\text{solution}}$ is negative</p> <p>OR (If $\Delta H_{\text{solution}}$ is positive,) may / will dissolve if ΔS_{total} is positive</p> <p>ACCEPT solvation instead of hydration</p>		3

Question Number	Acceptable Answers	Reject	Mark
(d) QWC	<p>First mark Third ionization energy high(er) for Mg / Mg = 7733 kJ mol⁻¹, (third ionization energy for Co = 3232 kJ mol⁻¹) (1)</p> <p>Second mark (Third ionization energy for Mg is high) because the electron is being removed from an inner shell / full shell / 2p level / 2p orbital (1)</p> <p>OR</p> <p>Not compensated by higher lattice energy for Mg³⁺ (and so $\Delta H_{\text{formation}}$ of MgCl₃ would be highly endothermic) (1)</p>		2