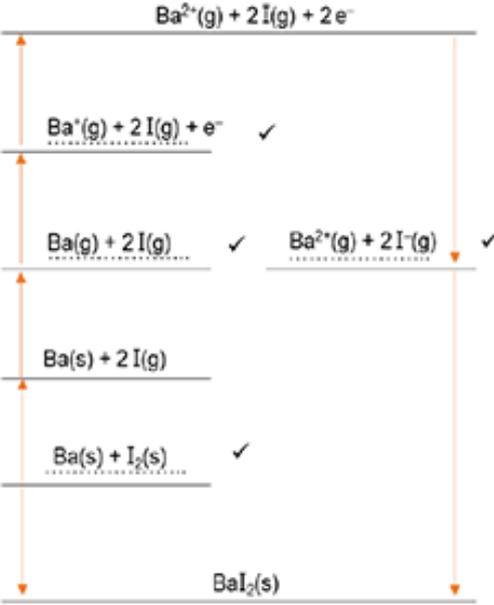


Question	Answer/Indicative content	Marks	Guidance
1	i Rubidium chlorate(VII) ✓	1 (AO 1.1)	<p>ALLOW Rubidium(I) chlorate(VII) Rubidium chlorate(VII)</p> <p>IGNORE Rubidium (VII)chlorate Rubidium chlorate(IV) Rubidium chlorate (7) Rubidium perchlorate</p> <p>Examiner's Comments</p> <p>Candidates had difficulty in naming a compound using Roman numerals for an element which can have different oxidation numbers. For the name of RbClO₄, many omitted the number entirely, showing just rubidium chlorate. Many inventive names such as rubidium chlorotetraoxide were seen. Some candidates wrote the correct VII before chlorate and many different Roman oxidation numbers were seen. Roman numerals' use in naming compounds is part of chemical nomenclature, included in the specification.</p>
	ii FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 54.0 OR 54.1 OR 54.2 (kJ mol ⁻¹) award 3 marks ----- Energy change from mcΔT Energy in J OR kJ = 102 × 4.18 × 1.5 OR 639.54 (J) OR 0.63954 (kJ) ✓ ----- Amount in mol of RbClO₃ $n(\text{RbClO}_3) = \frac{2.00}{169} \text{ OR } 0.0118 \dots\dots$ (mol) ✓ ----- Δ_{sol}H(RbClO₃) $= \frac{0.63954}{0.0118 \dots\dots} = (+) 54.0 \checkmark$ From unrounded values, ΔH = 54.04113 Examples of mixed acceptable intermediate rounding, e.g. $\frac{0.640}{0.0118} \Delta H = 54.237 \rightarrow 54.2$	3 (AO 2.8 ×3)	<p>ALLOW ECF throughout</p> <p>IGNORE sign IGNORE RE and SF in 1st 2 marks</p> <p>0.01183431953 unrounded ALLOW 54 (from 54.0) CARE 54.00 is a rounding error ----- COMMON ERRORS 52.98 OR 53.14 2 marks 100 instead of 102: Energy = 100 × 4.18 × 1.5 = 627 J From unrounded n, $\Delta H = \frac{0.627}{0.0118 \dots\dots} = 52.98 \text{ kJ mol}^{-1}$ OR 53.0 (3SF) OR 53 From rounded 0.0118, $\Delta H = \frac{0.627}{0.0118} = 53.14 \text{ OR } 53.1$ ----- 0.02078 OR 0.0208 1 mark </p>

Question	Answer/Indicative content	Marks	Guidance
	$\frac{0.63954}{0.01183} \Delta H = 54.06 \rightarrow 54.1$		<p>102 and 2 swapped: Energy = $2 \times 4.18 \times 1.5 = 12.54 \text{ J}$</p> $n = \frac{102}{169} = 0.60355\dots$ <p>ECF $\Delta H = \frac{0.01254}{0.60355\dots} = 0.0208 \text{ kJ mol}^{-1}$</p> <hr/> <p>1.06 2 marks 102 for n instead of 2.00:</p> $n = \frac{102}{169} = 0.60355\dots$ $\Delta H = \frac{0.63954}{0.60355\dots} = 1.06 \text{ kJ mol}^{-1}$ <p>OR</p> <p>2 for energy instead of 102 Energy = $2 \times 4.18 \times 1.5 = 12.54 \text{ J}$</p> $\Delta H = \frac{0.01254}{0.0118\dots} = 1.06 \text{ kJ mol}^{-1}$ <hr/> <p>107.4 – 107.7 2 marks 8.314 for c instead of 4.18: Energy = $102 \times 8.314 \times 1.5 = 1272 \text{ J}$ Energy = $102 \times 8.31 \times 1.5 = 1271.4 \text{ J}$ $\Delta H = 107.4 - 107.7 \text{ kJ mol}^{-1}$ <i>depends on intermediate rounding</i> CHECK</p> <hr/> <p>Apply ECF for any other comparable responses. If in doubt contact TL</p> <p>Examiner's Comments</p> <p>This question was a good discriminator, producing marks across the whole 3 mark range. More successful candidates correctly calculated the energy change, moles of RbClO_3 and enthalpy change of solution. However, there were pitfalls for many including the following:</p> <ul style="list-style-type: none"> calculating the energy change using the mass of water rather than the mass of the solution. This was despite the supplied information that the specific heat capacity of the solution is the same as for water. Candidates

Question			Answer/Indicative content	Marks	Guidance
					<p>should understand that m in $mc\Delta T$ is the mass of the substance that produces ΔT</p> <ul style="list-style-type: none"> calculating an incorrect value for the molar mass of RbClO_3. Instead of 169, this was often seen as 120.5 (using the atomic number of 37 for Rb, rather than the mass number of 85.5) and 185 (for RbClO_4) using values of m at the wrong stages in the calculation. e.g. 2 g with the energy change and 102 g or 100 g with the moles calculation calculating the correct numerical value for the enthalpy change of solution, but then placing a '-' sign in front of the value, despite ΔT being for a decrease in temperature. <p>Finally, as with all multi-step calculations, candidates are advised to use calculator values throughout. Any intermediate rounding introduces rounding errors in the final value. The final value can be rounded either to the significant figures demanded by the question or to the lowest number of significant figures used in the provided data.</p>
			Total	4	

Question	Answer/Indicative content	Marks	Guidance
2	i 	4 (AO 1.2 × 4)	<p>Examiner's Comments</p> <p>Some candidates wrote illegible state symbols where (g) and (s) were impossible to tell apart. Also, many candidates choose to write state symbols as a very small sub-script, e.g. Ba(s) or I₂(s). The convention is to use lower case letters of normal size, e.g. Ba(s) or I₂(g). The most common errors were the iodine state symbol, with both (g) and (l) being used, and the use of 2l for I₂. Some candidates missed state symbols in one species, missed electrons with the two ions, or gave a charge on the top left iodine.</p>
	ii <p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = -1872 award 2 marks</p> <p>-----</p> <p>$\Delta H_{\text{lattice}} =$ $2(+296) - 965 - 503 - 180 + 2(-107) - 602$ \checkmark</p> <p>$\Delta H_{\text{lattice}} = -1872 \text{ (kJ mol}^{-1}\text{)} \checkmark$</p>	2 (AO 2.2 × 2)	<p>ALLOW for 1 mark +1872 (wrong sign on answer)</p> <p>Common errors for 1 mark</p> <ul style="list-style-type: none"> -3056 (-296 × 2 instead of 296 × 2) -2168 (296 × 1 instead of 296 × 2) -1765 (-107 × 1 instead of -107 × 2) -1512 (180 instead of -180) -1444 (107 × 2 instead of -107 × 2) -866 (503 instead of -503) -668 (602 instead of -602) +58 (965 instead of -965) <p>For other answers, check for a single transcription error or calculation error which could merit 1 mark if all values have been used.</p> <p>DO NOT ALLOW any answer which involves two errors</p> <p>Examiner's Comments</p> <p>The correct was answer seen frequently, along with lots of the common errors. Candidates tended to forget the mole ratio and did not multiply either -107 or +296 by two. Some candidates applied the cycle incorrectly and therefore used the wrong sign for an enthalpy change, leading to them attaining 1 mark.</p>
	Total	6	

Question			Answer/Indicative content	Marks	Guidance
3			D	1 (AO 1.1)	<u>Examiner's Comments</u> This question was another challenging idea. The correct answer was D. Many candidates chose A or C, possibly due to fluorine's high electronegativity.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
4			A	1(AO1.1)	<u>Examiner's Comments</u> This question proved to be difficult, with fewer candidates selecting the correct answer of A. Option C was the most common distractor as many candidates did not know the standard state of bromine. Option B was selected by those candidates who confused the definitions of average bond enthalpy with the enthalpy change of atomisation.
			Total	1	

Question	Answer/Indicative content	Marks	Guidance
5	<p>Level 3 (5-6 marks) Calculates correct enthalpy change with correct - sign for $\Delta_{\text{hy}}H(\text{Ca}^{2+})$, allowing for acceptable errors. <i>There is a well-developed line of reasoning which is clear and logically structured.</i> <i>The information presented is relevant and substantiated.</i></p> <p>Level 2 (3-4 marks) Calculates a value of $\Delta_{\text{sol}}H(\text{CaCl}_2(\text{s}))$ from the: Energy change AND Amount in mol of CaCl_2. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p>Level 1 (1-2 marks) Processes experimental data to obtain the: Energy change from $mc\Delta T$ OR Amount in mol of CaCl_2. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks - No response or no response worthy of credit.</p>	<p>6 (4 ×AO3.1) (2 ×AO3.2)</p>	<p><i>Indicative scientific points may include:</i></p> <p>1. Processing experimental data Energy change from $mc\Delta T$</p> <ul style="list-style-type: none"> • Energy in J OR kJ <p>= $106.6 \times 4.18 \times 18.5 = 8243.378$ (J) OR 8.243378 (kJ) 3SF or more Amount in mol of CaCl_2</p> <ul style="list-style-type: none"> • $n(\text{CaCl}_2) = \frac{9.28}{111.1} = 0.0835\dots\dots$ (mol) <p>0.08352835284 unrounded</p> <p>-----</p> <p>2. \pm value of $\Delta_{\text{sol}}H(\text{CaCl}_2(\text{s}))$ = $\pm \frac{8.24\dots\dots}{0.0835\dots\dots} = \pm 98.68957929$ (kJ mol⁻¹) 3 SF or more. From 3 SF: $\frac{8.24}{0.0835} = 98.7$</p> <p>-----</p> <p>3. CORRECT $\Delta_{\text{hy}}H(\text{Ca}^{2+})$ calculated with signs $\Delta_{\text{hy}}H(\text{Ca}^{2+}) = \text{L.E.} + \Delta_{\text{sol}}H(\text{CaCl}_2) - 2$ $\Delta_{\text{hy}}H(\text{Cl}^-) = -2223 + (-98.7) - (2 \times -378) = -1566$ (kJ mol⁻¹) 3SF or more with correct - sign From unrounded values, -1565.689579</p> <p>-----</p> <p>See next page for examples of acceptable errors</p> <p>Acceptable errors ALLOW omission of trailing zeroes ALLOW minor slips in rounding, transcription errors, etc throughout ALLOW one small error, e.g. subtracting mass of CaCl_2 for m $m = 106.60 - 9.28 = 97.32$ $q = 7.5257556$ (kJ) $\Delta_{\text{sol}}H = 90.09821629$ (kJ mol⁻¹) $\Delta_{\text{hy}}H(\text{Ca}^{2+}) = -1557$ (kJ mol⁻¹) OR adding mass of CaCl_2 for m $m = 106.60 + 9.28 = 115.88$ $q = 8.9610004$ kJ $\Delta_{\text{sol}}H = 107.2809423$ (kJ mol⁻¹) $\Delta_{\text{hy}}H(\text{Ca}^{2+}) = -1574$ (kJ mol⁻¹)</p> <p>Examiner's Comments</p> <p>This question was assessed by level of response (LoR). Candidates were required to process raw experimental results to determine one enthalpy change, and then to determine a second enthalpy change by using an energy cycle. Levels were</p>

Question	Answer/Indicative content	Marks	Guidance
			<p>determined by the accuracy of the candidates' processing of the results, calculations and use of the energy cycle. Marks within a level were determined by communication. This question discriminated extremely well.</p> <p>Level 3 candidates used the mass of solution as 106.6 g with $mc\Delta T$ to obtain an energy change of 8.24 kJ. They then divided this value by the moles of CaCl_2 that reacted (0.0835 mol) to obtain the enthalpy change of $-98.7 \text{ kJ mol}^{-1}$. Finally, they constructed an energy cycle which they then used to obtain the second enthalpy change of $-1566 \text{ kJ mol}^{-1}$.</p> <p>Level 2 candidates determined the first enthalpy change but may have used the approximate mass of 100 g for the mass of solution from the experimental method. Their energy cycle was often incorrect or absent, with the second enthalpy change calculated incorrectly.</p> <p>Level 1 candidates often calculated the initial energy change using $mc\Delta T$ but made little further correct progress.</p> <p>Less successful responses used the solid mass of calcium chloride (9.28 g) instead of the mass of the solution in their $mc\Delta T$ calculation.</p> <p>Overall, mathematical skills were displayed well but some basic errors were made, particularly with subtractions. This may have been the result of mis-keying values into a calculator and believing the answer displayed.</p> <p>Exemplar 3</p> $\frac{27.95 - 18.12}{111.1} = 0.08352$ $\frac{29.5 - 21}{100} = 18.5$ $\frac{106.6 \times 4.18 \times 18.5}{1000} = 8.243378$ $\frac{-8.243378}{0.08352} = -98.7 \text{ kJ}$ $-379 \times 2 = -758$ $+758 - 823 + 379 = -1089$ $\frac{-1089}{2} = -544.5 \text{ kJ}$

Question			Answer/Indicative content	Marks	Guidance
					Exemplar 3 is a Level 2 response. The candidate has calculated the initial energy change, the moles of calcium chloride and the first enthalpy change using a correct method. This response has not been given marks for the communication strand of Level 3 because there is nothing to indicate what the numbers refer to. The response could be summarised as a mass of numbers scrawled across the page. Unfortunately, this is the pattern of many responses. So, this response was given 3/6 marks.
			Total	6	