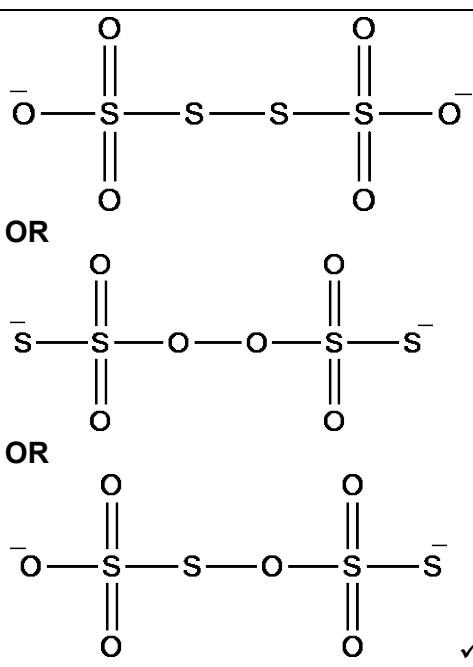
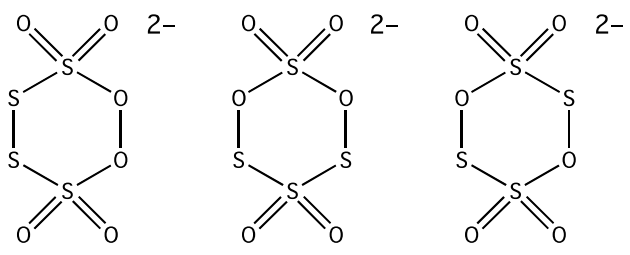
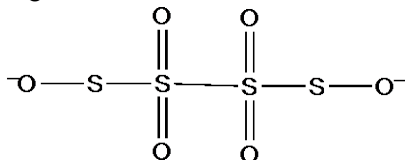


Question	Answer	Marks	AO element	Guidance
5 (a) (i)*	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p><b>Level 3 (5–6 marks)</b> Calculates <b>CORRECT</b> enthalpy change with correct – signs for <math>\Delta_{\text{sol}}H</math> (CuSO<sub>4</sub>(s)) for <b>reaction 5.2</b> <b>AND</b> <math>\Delta_rH</math>, for <b>reaction 5.1</b>.</p> <p><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><b>Level 2 (3–4 marks)</b> Calculates a value of <math>\Delta_{\text{sol}}H</math> (CuSO<sub>4</sub>(s)) for <b>reaction 5.2</b> from the: Energy change <b>AND</b> Amount in mol of CuSO<sub>4</sub>.</p> <p><i>There is a line of reasoning presented with some structure.</i> <i>The information presented is relevant and supported by some evidence.</i></p> <p><b>Level 1 (1–2 marks)</b> Processes experimental data to obtain the: Energy change from <math>mc\Delta T</math> <b>OR</b> Amount in mol of CuSO<sub>4</sub>.</p> <p><i>There is an attempt at a logical structure with a line of reasoning.</i> <i>The information is in the most part relevant.</i></p>	6	AO3.1 ×4  AO3.2 ×2	<p>Indicative scientific points may include:</p> <p><b>1. Processing experimental data</b> <b>Energy change from <math>mc\Delta T</math></b></p> <ul style="list-style-type: none"> <li>Energy in J OR kJ <i>Using 50.70 g, 50.0 g</i> = <b>50.70</b> × 4.18 × 13.5 = <b>2861</b> (J) OR <b>2.861</b> (kJ) 3SF or more (2.861001 unrounded) <b>OR</b> <b>50.0</b> × 4.18 × 13.5 = <b>2821.5</b> (J) OR <b>2.8215</b> (kJ)</li> </ul> <hr/> <p><b>Amount in mol of CuSO<sub>4</sub></b></p> <ul style="list-style-type: none"> <li><math>n(\text{CuSO}_4) = \frac{7.98}{159.6} = 0.0500</math> (mol)</li> </ul> <hr/> <p><b>2. ± value of <math>\Delta_{\text{sol}}H(\text{CuSO}_4(\text{s}))</math> for reaction 5.2</b></p> <p>From <math>m = 50.70</math> g = ± <math>\frac{2.861}{0.0500} = \pm 57.22</math> (kJ mol<sup>-1</sup>) (–57.22002 unrounded)</p> <p>From <math>m = 50.0</math> g = ± <math>\frac{2.8215}{0.0500} = \pm 56.43</math> (kJ mol<sup>-1</sup>)</p> <hr/> <p><b>3. CORRECT enthalpy changes for reactions 5.2 and 5.1 with signs (using 50.70 g ONLY)</b></p> <p><b>Reaction 5.2</b> = <b>–57.22</b> (kJ mol<sup>-1</sup>) 3SF or more with correct – sign</p> <p><b>Reaction 5.1</b> <math>\Delta_rH = \Delta_{\text{sol}}H(\text{CuSO}_4(\text{s})) - \Delta_{\text{sol}}H(\text{CuSO}_4 \cdot 5\text{H}_2\text{O}(\text{s}))</math> = –57.22 – 8.43 = <b>–65.65</b> (kJ mol<sup>-1</sup>) 3SF or more with correct – sign</p> <p><b>NOTE:</b> A clear and logically structured response would include an energy cycle <b>ALLOW</b> omission of trailing zeroes <b>ALLOW</b> minor slips</p>

Question	Answer	Marks	AO element	Guidance
	<b>0 marks</b> – No response or no response worthy of credit.			
(a) (ii)	Temperature change = $0.2 \times \frac{100}{20} = 1(.0)^{\circ}\text{C}$ ✓	1	AO2.8	<b>IGNORE</b> direction of temperature change Working <b>NOT</b> required
(b)	<p><b>FIRST CHECK THE ANSWER IN ON ANSWER LINE</b> If answer = (+)156 (J K<sup>-1</sup> mol<sup>-1</sup>) award 4 marks</p> <hr/> <p><b>Part 1: Calc of <math>\Delta_r S</math></b> Use of 298 K (seen anywhere) <b>1 mark</b> ✓</p> <ul style="list-style-type: none"> <li>e.g. <math>-16.1 = -55.8 - 298 \times \Delta S</math></li> </ul> <hr/> <p><b>CORRECT</b> use of Gibbs' equation <b>1 mark</b></p> <ul style="list-style-type: none"> <li>using candidate's temperature (e.g. 298)</li> <li>with <math>-16.1</math> <b>AND</b> <math>-55.8</math></li> <li>to calculate <math>\Delta S</math> in kJ <b>OR</b> J ✓</li> </ul> <hr/> <p><b>Part 2: Calc of <math>S(\text{Na}_2\text{S}_2\text{O}_3)</math></b> <b>1 mark</b> <b>CORRECT</b> use of standard S data in question ✓ Seen anywhere (could be within an expression) e.g.</p> <ul style="list-style-type: none"> <li><math>372.4 - [S(\text{Na}_2\text{S}_2\text{O}_3) + (5 \times 69.9)]</math></li> <li><b>OR</b> <math>372.4 - (5 \times 69.9)</math></li> <li><b>OR</b> <math>372.4 - 349.5</math></li> <li><b>OR</b> 22.9</li> </ul> <p><b>IGNORE</b> sign, i.e. <b>ALLOW</b> <math>-22.9</math>, etc</p> <hr/> <p><b>CORRECT</b> calculation of <math>S(\text{Na}_2\text{S}_2\text{O}_3)</math> using candidate's calculated <math>\Delta S</math> in Part 1 <b>to 3 SF</b> <b>1 mark</b> ✓</p>	4	AO2.4 ×4	<p>Using 298 K, <math>\Delta S = \frac{-55.8 - (-16.1)}{298} = \frac{-39.7}{298}</math>  <math>= -0.133\dots(\text{kJ K}^{-1}\text{mol}^{-1})</math>  <b>OR</b> <math>-133\dots(\text{J K}^{-1}\text{mol}^{-1})</math>  <b>Sign required IGNORE units</b></p> <p>Calculator:  <math>-0.133221</math> (kJ K<sup>-1</sup> mol<sup>-1</sup>)  <math>-133.221</math> (J K<sup>-1</sup> mol<sup>-1</sup>)</p> <hr/> <p><b>ALLOW ECF</b> from incorrect temperature.</p> <hr/> <p>Using <math>-133</math>:  <math>S(\text{Na}_2\text{S}_2\text{O}_3) = 372.4 - 349.5 - (-133)</math>  <math>= 22.9 + 133</math>  <math>= (+)156(\text{J K}^{-1}\text{mol}^{-1})</math>  <b>3 SF required</b></p> <p><b>ALLOW ECF</b> from incorrect <math>\Delta_r S</math> (Part 1)</p>

Question		Answer	Marks	AO element	Guidance
(c)	(i)	109.5(°) <b>AND</b> tetrahedral ✓	1	AO1.2	<b>ALLOW</b> 109–110(°)
	(ii)	 <p>OR</p> <p>OR</p> <p>IGNORE absence of charges <b>OR</b> incorrect charges ✓</p>	1	AO3.1	<p><b>IGNORE</b> charges</p> <p><b>ALLOW</b> cyclic structures. Three 6-ring structures possible, e.g.</p>  <p><b>NOTE:</b> There <b>MUST</b> be 2 atoms in centre between 6-bonded S atoms. e.g. <b>DO NOT ALLOW</b></p>  <p><b>For other structures, contact TL</b></p>
<b>Total</b>			<b>13</b>		