

Question Number	Acceptable Answers	Reject	Mark
<b>1(a)</b>	$(50 \times 4.18 \times 15.5 =) 3239.5 \text{ (J)}$  IGNORE any sign given ALLOW $3.2395 \text{ kJ}$ (units are essential for this answer)		<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
<b>1(b)</b>	$(1.46 \div 56.1 =) 0.026025.. \text{ (mol)} \quad (1)$  $(\Delta H = 3.2395 \div 0.026025 = -124.47\dots)$ $\quad \quad \quad -124 \text{ kJ mol}^{-1} \quad (1)$  OR  $(1.46 \div 56.1 =) 0.0260 \text{ (mol)} \quad (1)$  $(\Delta H = 3.2395 \div 0.0260 = -124.596154)$ $\quad \quad \quad -125 \text{ kJ mol}^{-1} \quad (1)$  ALLOW the use of $\text{CaO} = 56$ $= (-124.255 \text{ kJ mol}^{-1}) -124 \text{ kJ mol}^{-1}$  ALLOW TE from answer to (a)	+ sig	<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>1(c)(i)</b>	<p>Any three reasons from:</p> <p>Heat/energy loss (to the surroundings / to the apparatus)/ Lack of lid/no lid/ heat capacity of the cup not taken into account/heat capacity of the cup is not zero (1)</p> <p>Inaccuracy of thermometer/temperature readings (1)</p> <p>Impure CaO/Absorbed moisture from the air (1)</p> <p>Heat capacity is not 4.18/ the mass of solution is not 50 g/ density of solution is not 1 g cm<sup>-3</sup> (1)</p> <p>IGNORE non-standard conditions/ stirring/human error/incomplete transfer of solid</p>	<p>Incomplete reaction</p> <p>Just 'heat lost to the thermometer'</p>	<b>3</b>

Question Number	Acceptable Answers	Reject	Mark
<b>1(c)(ii)</b>	<p><b>Marking point 1</b> (<math>Q = (250 \times 4.18 \times 25) = 26125 \text{ (J)}</math>)</p> <p>OR</p> <p>(<math>26125 \div 1000 = 26.125 \text{ (kJ)}</math>) (1)</p> <p><b>Marking point 2</b> (<math>n = 26.125 \div 196.8 = 0.132749 \text{ (mol)}</math>) (1)</p> <p><b>Marking point 3</b> Mass = (<math>0.132749 \times 56.1 = 7.4472189 = 7.45 \text{ (g)}</math>) (1)</p> <p>ALLOW (<math>0.132749 \times 56 = 7.433944 = 7.43 \text{ (g)}</math>)</p> <p>Correct answer alone scores 3 marks</p>	<p>7.5</p>	<b>3</b>

Question Number	Acceptable Answers	Reject	Mark
<b>1(d)(i)</b>	<p><b>Marking point 1</b> Arrow downwards from CaCO<sub>3</sub> to the box, with 2HCl(aq) alongside (1)</p> <p><b>Marking point 2</b> Correct entities and states in box CaCl<sub>2</sub>(aq) + H<sub>2</sub>O(l) + CO<sub>2</sub>(g) (1)</p> <p><b>Marking point 3</b> Correct use of Hess' Law (<math>\Delta H = \Delta H_{\text{CaCO}_3} - \Delta H_{\text{CaO}}</math>) e.g. <math>-18.8 - -196.8 =</math> (1)</p> <p><b>Marking point 4</b> <math>\Delta H = +178</math> (kJ mol<sup>-1</sup>) (1)</p>		4

Question Number	Acceptable Answers	Reject	Mark
<b>1(d)(ii)</b>	<p>Products on line below CaCO<sub>3</sub>(s) with both arrows going down from CaCO<sub>3</sub> and CaO</p> <p>Example</p> <p style="text-align: center;"> <math>\text{CaO(s) + CO}_2\text{(g) + 2HCl(aq)}</math>  <math>\text{(2HCl(aq) + CaCO}_3\text{(s))}</math>  <math>\text{CaCl}_2\text{(aq) + CO}_2\text{(g) + H}_2\text{O(l)}</math> </p> <p>ALLOW the word 'products' for formulae</p>		1

Question Number	Acceptable Answers	Reject	Mark
<b>2(a)</b>	(Contains) <b>only</b> (C—C) single bonds/ <b>only</b> $\sigma$ bond(s)  OR (Contains) no (C=C) double bond(s)/no triple bond(s)  OR Cannot undergo addition (reactions)  ALLOW Has maximum number of hydrogen atoms / has maximum amount of hydrogen /can form no more bonds / no pi-bonds.  IGNORE references to alkanes  (1)  (Compound of) carbon and hydrogen <b>ONLY/ENTIRELY/PURELY</b> (1)	"Mixture of carbon and hydrogen only"	2

Question Number	Acceptable Answers	Reject	Mark
<b>2(b)(i)</b>	Measure mass (of cylinder) before and after (burning)		1

Question Number	Acceptable Answers	Reject	Mark
<b>2(b)(ii)</b>	Energy transferred = $(100 \times 4.18 \times 27.1 =)$ 11327.8 (J) / 11.328 <b>kJ</b> Ignore SF except 1 SF		1

Question Number	Acceptable Answers	Reject	Mark
<b>2(b)(iii)</b>	Mol propane = $0.33 / 44 = 0.0075$ (1)  $\Delta H_c = (-11.3278 / 0.0075) = (-1510.4)$ $= -1510 \text{ (kJ mol}^{-1}\text{)}$ (1)  Sign and 3SF (1)  Allow TE from b(ii)		3

Question Number	Acceptable Answers	Reject	Mark
<b>2(b)(iv)</b>	Incomplete combustion  Allow carbon monoxide forms soot forms  Ignore references to specific heat capacity of the apparatus or evaporation <b>of propane</b>	Evaporation of water  Transfer losses  Not under standard conditions  Not all the fuel burns	1

Question Number	Acceptable Answers	Reject	Mark
<b>2(c)(i)</b>	$\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$ <p style="text-align: center;">+ 6490 kJ mol<sup>-1</sup></p> $3\text{C}(\text{g}) + 8\text{H}(\text{g}) + 10\text{O}(\text{g})$ <p>Balancing <b>and</b> state symbol required</p>		1

Question Number	Acceptable Answers	Reject	Mark
<b>2(c)(ii)</b>	$Z = (6x \text{C}=\text{O} + 8x\text{O}-\text{H} = 4830 + 3712)$ $= (+)8542 \text{ (kJ mol}^{-1}\text{)}$		1

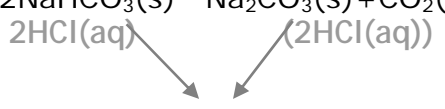
Question Number	Acceptable Answers	Reject	Mark
<b>2(c)(iii)</b>	$\Delta H_x = 6490 - 8542 = -2052 \text{ (kJ mol}^{-1}\text{)}$ <p>Allow TE from 21(c)(ii)</p>		1

Question Number	Acceptable Answers	Reject	Mark
<b>2(c)(iv)</b>	Bond energy calculation based on H <sub>2</sub> O(g) OR $\Delta H_c^\ominus$ based on H <sub>2</sub> O(l)  Allow Bond energy varies with environment/ mean bond energies do not equal actual bond energies for these reactants  Ignore reference to standard conditions		1

**Total = 12 marks**

Question Number	Acceptable Answers	Reject	Mark
<b>3(a)(i)</b>	$25 \times 4.18 \times 11 = 1149.5$ (J) ALLOW 1.1495 <b>kJ</b>  Otherwise ignore units even if incorrect  IGNORE sign  IGNORE SF except one or two SF	1149.5 <b>kJ</b>	<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
<b>3(a)(ii)</b>	$-115 \text{ kJ mol}^{-1}$ ALLOW $-115000 \text{ J mol}^{-1}$  Sign with correct value <b>(1)</b> Units and three significant figures <b>(1)</b>  Mark independently ALLOW TE from (i) $-114 \text{ kJ mol}^{-1}$ (rounding error) scores 1 $-115.0 \text{ kJ mol}^{-1}$ scores 1  Values of $-4600$ and $-3.86$ are quite common  ALLOW K and j in any case in units	J or kJ alone	<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>3(b)</b>	<p> <math>2\text{NaHCO}_3(\text{s}) \quad \text{Na}_2\text{CO}_3(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})</math>  <math>2\text{HCl}(\text{aq}) \quad \quad \quad 2\text{HCl}(\text{aq})</math>  </p> <p> <math>2\text{NaCl}(\text{aq}) + 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})</math> </p> <p><b>First mark</b></p> <p>Arrow from products in top line to lower line and correct entities <b>(1)</b></p> <p><math>\text{NaCl} + \text{CO}_2 + \text{H}_2\text{O}</math></p> <p><b>Second mark</b></p> <p><math>2\text{NaCl}(\text{aq}) + 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})</math></p> <p>Correct state symbols and balancing <b>(1)</b></p> <p><math>\Delta H^\circ = +91.6 \text{ OR } +91.7 \text{ (kJ mol}^{-1}\text{)}</math></p> <p>ALLOW no positive sign only if correct</p> <p>Working with correct signs given <b>(3)</b></p> <p>OR</p> <p><b>Third mark</b></p> <p>Correct use of Hess's Law</p> <p>(in numbers or symbols) consistent with arrow direction <b>(1)</b></p> <p><b>Fourth mark</b></p> <p><math>2x(-115) = \Delta H^\circ - 321.6</math></p> <p>Correct multiples and numbers <b>(1)</b></p> <p>ALLOW</p> <p>2 x any number (including -4600 and -3.86) except 2 x +/- 321.6</p> <p>Notice Third and Fourth marks can be scored by <math>\Delta H^\circ = 2(-115) - (-321.6)</math></p>		<b>5</b>



	<p><b>Fifth mark</b></p> $\Delta H^\circ = 2(-115) - (-321.6)$ $= +91.6 \text{ (kJ mol}^{-1}\text{)}$ <p>OR</p> $\Delta H^\circ = 2(-114.95) - (-321.6)$ $= +91.7 \text{ (kJ mol}^{-1}\text{)}$ <p>Correct value for their calculation with correct sign</p> <p>IGNORE SF except 1</p> <p>ALLOW no positive sign only if correct working with correct signs given <b>(1)</b></p> <p>Omitting 2x gives +206.6 (could get 4 marks)</p> <p>-4600 gives -598.4</p> <p>-3.86 gives +313.88</p>		
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Question Number	Acceptable Answers	Reject	Mark
<b>3(c)</b>	$((\pm) 0.5 \times 2 \times 100 / 11 )$ $= (\pm)9.09 \text{ (\%)}$  ALLOW at 9.0909/9.091/9.1 and 9	9.10/9.0	<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
<b>3(d)</b>	<p><b>First mark</b></p> <p>It is used as a raising agent / self raising flour / baking soda / baking powder</p> <p>OR</p> <p>Causes cakes / (soda) bread to rise / expand. <b>(1)</b></p> <p><b>Second mark</b></p> <p>Carbon dioxide (released on heating causes cakes / bread to rise)</p> <p>OR</p> <p>It reacts with acid to form carbon dioxide (in baking powder) providing bread /cake etc is mentioned <b>(1)</b></p> <p>ALLOW</p> <p>Used in cooking green vegetables</p> <p>To keep green colour</p>	<p>To make pastry rise</p> <p>Bicarbonate of soda</p> <p>Gas</p> <p>Air</p> <p>Neutralizing acid foods</p>	<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>4(a)</b>	The heat/enthalpy/energy change (for a reaction) is independent of the path(way)/route  IGNORE any extra detail referring to "initial and final states"		<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
<b>4(b)(i)</b>	$\text{CH}_4 + 1\frac{1}{2}\text{O}_2 \xrightarrow{\quad\quad\quad} \text{CO} + 2\text{H}_2\text{O}$ <p>CO<sub>2</sub> + 2H<sub>2</sub>O (1) Both arrows in correct direction downwards (1) IGNORE state symbols, even if incorrect  Mark the two points independently</p>		<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>4(b)(ii)</b>	$\Delta H = - 890 - (- 283) \quad (1)$ $= - 607 \text{ (kJ mol}^{-1}\text{)} \quad (1)$ <p>Correct answer with no working scores (2)  NOTE: +607 (kJ mol<sup>-1</sup>) scores (1) only</p>		<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>*4</b> <b>(b) (i)</b>	Cannot stop the reaction at CO OR the reaction produces CO <sub>2</sub> /complete combustion occurs OR may produce some carbon/soot OR cannot react exact amounts of methane to oxygen	non-standard conditions  <b>Just</b> incomplete combustion occurs  <b>Just</b> forming 'other products' / <b>just</b> a 'mixture of products'  <b>Just</b> methane is 'very reactive' / 'explosive'  <b>Just</b> heat loss  Cannot measure the temperature change	<b>1</b>

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<b>4(c)</b>	<b>First mark: State of the H<sub>2</sub>O</b> Water is in the gas phase/water is (formed) as steam/water is not in its standard state/water is not (formed as a) liquid <b>(1)</b>  <b>Second mark: Idea of an energy change when there is a change of state</b>  Change of state involves an energy change /energy change (for the reaction given) is less exothermic <b>(1)</b>  ALLOW 'more endothermic' instead of 'less exothermic'  IGNORE references to non-standard conditions	Energy change is more exothermic /less endothermic  Heat loss  'Incomplete combustion'	<b>2</b>

Question Number	Correct Answer	Reject	Mark
<b>5(a)</b>	<p><b>F mark</b> Enthalpy change when 1 mol of <b>gaseous</b> ions <b>(1)</b></p> <p>ALLOW energy change/heat change/energy evolved/released/ given out/exothermic</p> <p><b>Second mark</b> 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 <b>(1)</b></p> <p>ALLOW Is dissolved to produce a solution of 1.0 mol dm<sup>-3</sup></p>	<p>Energy required or energy taken in</p> <p>Atoms or molecules (0)</p> <p>1 mol of water</p>	<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>5(b)(i)</b>	K <sup>+</sup> (aq) (+) F <sup>-</sup> (aq)	K <sup>+</sup> F <sup>-</sup> (aq)	<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
<b>5(b)(ii)</b>	$\Delta H_{\text{sol}} = -\Delta H_1 + \Delta H_2$ OR $\Delta H_{\text{sol}} = \Delta H_2 - \Delta H_1$		<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
<b>5(b)(iii)</b>	(Standard) Lattice(enthalpy/energy/ $\Delta H$ )	LE/Lat - Lattice	<b>1</b>

Question Number	Acceptable Answers	Reject	Mark
<b>5(b)(iv)</b>	<p><b>First mark</b> Selection of (-)817 rather than (-)807 (1)</p> <p><b>Second mark</b> <math>\Delta H_{\text{sol}} = 817 - 805 = (+)12 \text{ (kJ mol}^{-1}\text{)}</math> (1)</p> <p>Just (+)12 (kJ mol<sup>-1</sup>) (2)</p> <p>ALLOW TE for second mark e.g. for 807 gives (+) 2 (kJ mol<sup>-1</sup>)</p> <p>ALLOW TE from incorrect b(ii)</p>	-12 (max 1)	<b>2</b>

Question Number	Acceptable Answers	Reject	Mark
<b>5(c)(i)</b>	<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 /<math>\Delta H_{\text{sol}}</math> 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>	<b>3</b>

Question Number	Acceptable Answers	Reject	Mark
*5(c)(ii)	<p>(The reaction is endothermic so)</p> <p>Entropy(change) of surroundings decreases OR <math>\Delta S_{\text{sur}}</math> is negative OR <math>-\Delta H/T</math> is negative (1)</p> <p>But entropy (change)of system increases (as there is an increase in disorder) OR <math>\Delta S_{\text{sys}}</math> 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><math>S_{\text{sur}}</math> is negative</p> <p><math>S_{\text{sys}}</math> is positive</p>	4

Question Number	Acceptable Answers	Reject	Mark
<b>*5(d)</b>	<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>	<b>4</b>