Question Number	Acceptable Answers	Reject	Mark
1(a)	(50 x 4.18 x 15.5 =) 3239.5 (J) IGNORE any sign given ALLOW 3.2395 kJ (units are essential for this answer)		**1**

Question Number	Acceptable Answers	Reject	Mark

1(b)	(1.46 ÷ 56.1 =) 0.026025.. (mol) (1)
	
	(ΔH = 3.2395 ÷ 0.026025 = −124.47…)
	                    −124 kJ mol^{-1} (1)
	
	OR
	
	(1.46 ÷ 56.1 =) 0.0260 (mol) (1)
	
	(ΔH = 3.2395 ÷ 0.0260 = −124.596154)
	                    −125 kJ mol^{-1} (1)
	
	ALLOW the use of CaO = 56
	= (−124.255 kJ mol^{-1}) −124 kJ mol^{-1}
	
	ALLOW TE from answer to (a)
		+ sig	**2**

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Question Number	Acceptable Answers	Reject	Mark
1(c)(i)	Any three reasons from: 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) Inaccuracy of thermometer/temperature readings (1) Impure CaO/Absorbed moisture from the air (1) Heat capacity is not 4.18/ the mass of solution is not 50 g/ density of solution is not 1 g cm^{-3} (1) IGNORE non-standard conditions/ stirring/human error/incomplete transfer of solid	Incomplete reaction Just 'heat lost to the thermometer'	**3**

Question Number	Acceptable Answers	Reject	Mark
1(c)(ii)	**Marking point 1** (Q=(250 x 4.18 x 25) = 26125(J) OR (26125 ÷ 1000 =) 26.125 (kJ) (1) **Marking point 2** (n = 26.125 ÷ 196.8 =) 0.132749 (mol) (1) **Marking point 3** Mass = (0.132749 x 56.1 =) 7.4472189 = 7.45 (g) (1) ALLOW (0.132749 x 56 =) 7.433944 = 7.43 (g) Correct answer alone scores 3 marks	7.5	3

Question Number	Acceptable Answers	Reject	Mark
1(d)(i))	**arking point 1** Arrow downwards from $CaCO_3$ to the box, with 2HCl((aq)) alongside (1) **Marking point 2** Correct entities and states in box $CaCl_2(aq) + H_2O(l) + CO_2(g)$ (1) **Marking point 3** Correct use of Hess' Law ($\Delta H = \Delta H_{CaCO3} - \Delta H_{CaO}$) e.g. $-18.8 - -196.8 =$ (1) **Marking point 4** $\Delta H = +178(kJ\ mol^{-1})$ (1)		4

Question Number	Acceptable Answers	Reject	Mark
1(d)(ii)	Products on line below $CaCO_3(s)$ with both arrows going down from $CaCO_3$ and CaO Example ALLOW the word 'products' for formulae		1
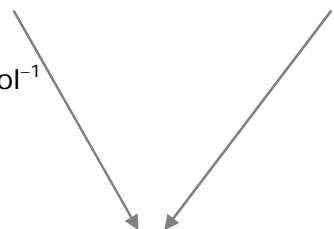
Question Number	Acceptable Answers	Reject	Mark
2(a)	(Contains) **only** (C—C) single bonds/ **only** σ bond(s) OR (Contains) no (C=C) double bond(s)/no triple bond(s) OR Cannot undergo addition (reactions) ALLOW Has maximum number of hydrogen atoms / has maximum amount of hydrogen /can form no more bonds / no pi-bonds. IGNORE references to alkanes **(1)** (Compound of) carbon and hydrogen **ONLY/ENTIRELY/PURELY** **(1)**	"**Mixture** of carbon and hydrogen only"	2

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

Question Number	Acceptable Answers	Reject	Mark
2(b)(ii)	Energy transferred = (100 x 4.18 x 27.1 =) 11327.8 (J) / 11.328 **kJ** Ignore SF except 1 SF		1

Question Number	Acceptable Answers	Reject	Mark
2(b)(iii)	Mol propane = 0.33/ 44 = 0.0075 **(1)** ΔH_c = (− 11.3278/ 0.0075) = (− 1510.4) = −1510 (kJ mol^{-1}) **(1)** Sign and 3SF **(1)** Allow TE from b(ii)		3

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

Question Number	Acceptable Answers	Reject	Mark
2(c)(i)	$C_3H_8(g) + \mathbf{5}O_2(g) \rightarrow \quad 3CO_2(g) + 4H_2O(g)$ + 6490 kJ mol^{-1} $3C\mathbf{(g)} + 8H(g) + \mathbf{10}\,O\,(g)$ Balancing **and** state symbol required		1

Question Number	Acceptable Answers	Reject	Mark
2(c)(ii)	$Z = (6x\ C=O + 8xO\text{-}H = 4830 + 3712)$ $= (+)8542$ (kJ mol^{-1})		1
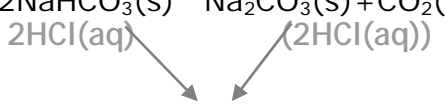
Question Number	Acceptable Answers	Reject	Mark
2(c)(iii)	$\Delta H_X = 6490 - 8542 = -2052$ (kJ mol^{-1}) Allow TE from 21(c)(ii)		1

Question Number	Acceptable Answers	Reject	Mark
2(c)(iv)	Bond energy calculation based on $H_2O(g)$ OR $\Delta H_c^{\ominus}$ based on $H_2O(l)$ 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
3(a)(i)	25 x 4.18 x 11 = 1149.5 (J) ALLOW 1.1495 **kJ** Otherwise ignore units even if incorrect IGNORE sign IGNORE SF except one or two SF	1149.5 **kJ**	**1**

Question Number	Acceptable Answers	Reject	Mark
3(a)(ii)	-115 kJ mol^{-1} ALLOW -115000 J mol^{-1} Sign with correct value **(1)** Units and three significant figures **(1)** Mark independently ALLOW TE from (i) -114 kJ mol^{-1} (rounding error) scores 1 -115.0 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	**2**

Question Number	Acceptable Answers	Reject	Mark
3(b)	$2NaHCO_3(s)$ $Na_2CO_3(s) + CO_2(g) + H_2O(l)$ 2HCl(aq) (2HCl(aq)) $2NaCl(aq) + 2CO_2(g) + 2H_2O(l)$ **First mark** Arrow from products in top line to lower line and correct entities **(1)** $NaCl + CO_2 + H_2O$ **Second mark** **2**$NaCl$**(aq)** + **2**CO_2**(g)** + **2**H_2O**(l)** Correct state symbols and balancing **(1)** $\Delta H^o =$ **+**91.6 OR +91.7 (kJ mol^{-1}) ALLOW no positive sign only if correct Working with correct signs given **(3)** OR **Third mark** Correct use of Hess's Law (in numbers or symbols) consistent with arrow direction **(1)** **Fourth mark** **2x**(-115) = ΔH^o - 321.6 Correct multiples and numbers **(1)** ALLOW 2 x any number (including -4600 and -3.86) except 2 x +/- 321.6 Notice Third and Fourth marks can be scored by $\Delta H^o = 2(-115) - (-321.6)$		**5**

	Fifth mark		
	$\Delta H^o = 2(-115) - (-321.6)$		
	$= +91.6$ (kJ mol^{-1})		
	OR		
	$\Delta H^o = 2(-114.95) - (-321.6)$		
	$= +91.7$ (kJ mol^{-1})		
	Correct value for their calculation with correct sign		
	IGNORE SF except 1		
	ALLOW no positive sign only if correct working with correct signs given **(1)**		
	Omitting 2x gives +206.6 (could get 4 marks)		
	-4600 gives -598.4		
	-3.86 gives +313.88		

Question Number	Acceptable Answers	Reject	Mark
3(c)	(($\pm$) 0.5 x 2 x 100 /11) = ($\pm$)9.09 (%) ALLOW at 9.0909/9.091/9.1 and 9	 9.10/9.0	**1**

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

Question Number	Acceptable Answers	Reject	Mark
4(a)	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"		**1**

Question Number	Acceptable Answers	Reject	Mark
4(b)(i)	 CO_2 + **2**H_2O **(1)** Both arrows in correct direction downwards **(1)** IGNORE state symbols, even if incorrect Mark the two points independently		**2**

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

Question Number	Acceptable Answers	Reject	Mark
*4 (b) (i	Cannot stop the reaction at CO OR the reaction produces CO_2/complete combustion occurs OR may produce some carbon/soot OR cannot react exact amounts of methane to oxygen	non-standard conditions **Just** incomplete combustion occurs **Just** forming 'other products' /**just** a 'mixture of products' **Just** methane is 'very reactive'/ 'explosive' **Just** heat loss Cannot measure the temperature change	1

Question Number	Acceptable Answers	Reject	Mark
4(c)	**First mark: State of the H_2O** 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 **(1)** **Second mark: Idea of an energy change when there is a change of state** Change of state involves an energy change /energy change (for the reaction given) is less exothermic **(1)** ALLOW 'more endothermic' instead of 'less exothermic' IGNORE references to non-standard conditions	Energy change is more exothermic /less endothermic Heat loss 'Incomplete combustion'	2

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

Question Number	Acceptable Answers	Reject	Mark
5(b)(i)	K^+(aq) (+) F^-(aq)	K^+ F^-(aq)	**1**

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

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

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

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

Question Number	Acceptable Answers	Reject	Mark
*5(c)(ii)	(The reaction is endothermic so) Entropy(change) of surroundings decreases OR ΔS sur is negative OR -Δ*H*/*T* is negative **(1)** But entropy (change)of system increases (as there is an increase in disorder) OR ΔS sys is positive **(1)** 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)** Total entropy (change) is positive **(1)** All marks are stand alone	S sur is negative S sys is positive	4

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