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Detailed mark scheme

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2002

XVIII

1583

Time allowed
75 Minutes

Score

/63

Percentage

%

CHEMISTRY

**Edexcel
AS & A LEVEL**

Mark Scheme

Paper 1: Advanced Inorganic and Physical Chemistry

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

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)	$C_3H_8(g) + 5O_2(g) \rightarrow \quad 3CO_2(g) + 4H_2O(g)$ $+ 6490 \text{ kJ mol}^{-1}$ $3C(g) + 8H(g) + 10\,O\,(g)$ Balancing and state symbol required		1

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

Question Number	Acceptable Answers	Reject	Mark
2(c)(iii)	$\Delta H_X = 6490 - 8542 = -2052 \text{ (kJ mol}^{-1})$ 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

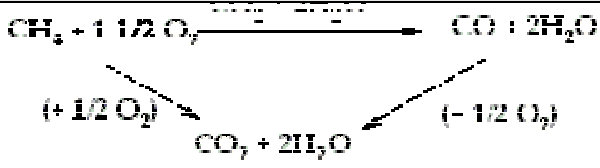| Question Number	Acceptable Answers	Reject	Mark
3(b)	$2NaHCO_3(s)$ $Na_2CO_3(s) + CO_2(g) + H_2O(l)$ $2HCl(aq)$ $(2HCl(aq))$ $2NaCl(aq) + 2CO_2(g) + 2H_2O(l)$ **First mark** Arrow from products in top line to lower line and correct entities (1) $NaCl + CO_2 + H_2O$ **Second mark** $2NaCl(aq) + 2CO_2(g) + 2H_2O(l)$ 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** $2 \times (-115) = \Delta H^o - 321.6$ 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		
	$\Delta H^o = 2(-115) - (-321.6)$ $\quad = +91.6$ (kJ mol^{-1}) OR $\Delta H^o = 2(-114.95) - (-321.6)$ $\quad = +91.7$ (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)	 $CO_2 + 2H_2O$ (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 ^{o}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 ^{o}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 -ΔH/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