EXAM PAPERS PRACTICE

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Practice questions created by actual examiners and assessment experts

Detailed mark scheme

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Time allowed
72 Minutes

Score /61

Percentage %

CHEMISTRY

Edexcel AS & A LEVEL

Mark Scheme

Paper 1: Advanced Inorganic and Physical Chemistry

Question Number	Acceptable Answers	Reject	Mark
1(a)(i)	Ammonia / barium chloride is toxic OR Ammonia / barium chloride is poisonous OR Barium hydroxide is corrosive / caustic OR Ammonia (solution) is corrosive OR Ammonium chloride is harmful / eye-irritant ALLOW Barium hydroxide is toxic / poisonous IGNORE Use of fume cupboard / gloves, etc	References to just 'barium' Ammonium chloride "is toxic"	(1)

Question Number	Acceptable Answers	Reject	Mark
1(a)(ii)	$\Sigma S^{\ominus}_{(products)}$ = ((2 x 192) + (10 x 70) + 124 =) (+)1208 (J mol^{-1} K^{-1}) (1) $\Sigma S^{\ominus}_{(reactants)}$ = ((2 x 95) + 427 =) (+)617 (J mol^{-1} K^{-1}) (1) $\Delta S^{\ominus}_{system}$ = (1208 – 617 =) +591 J mol^{-1} K^{-1} Allow units in any order (1) Correct answer without working scores 3		(3)

Question Number	Acceptable Answers	Reject	Mark
*1(a)(iii	(Positive value as expected because) 3 moles → 13 moles / more moles of products (than reactants) Allow 'molecules' for moles If numbers (of compounds) are stated, then these must be 3 and 13 COMMENT: Ignore any type of particle(s) mentioned (1) (Two) solids → a gas / a liquid (+ 1 solid) OR "No gaseous reactants, but gaseous products (formed)" (1)	(0) Overall if ΔS^{e}_{system} negative or entropy decrease	(2)

Question Number	Acceptable Answers	Reject	Mark
1(b)	$\Delta S^{e}_{surroundings} = (-\Delta H \div T) = -\frac{162\,000 \text{ J mol}^{-1}}{298 \text{ K}}$ (1) $= -543.6241611/-544 \text{ J mol}^{-1} \text{ K}^{-1}$ Allow $-0.544 \text{ kJ mol}^{-1} \text{ K}^{-1}$ (1) Correct answer without working scores 2 IGNORE sf except 1 sf	−543 543	(2)

Question Number	Acceptable Answers	Reject	Mark
1(c)	$\Delta S^{e}_{total} = \Delta S^{e}_{system} + \Delta S^{e}_{surroundings}$ ΔS^{e}_{total} = ans (a)(ii) + ans (b) = +591 − 544 = +47 J mol^{-1} K^{-1} TE on answers from (a)(ii) and (b)		(1)

Question Number	Acceptable Answers	Reject	Mark
1(d)	M1: $\Delta S^{\ominus}_{surroundings}$ becomes less negative / more positive smaller in MAGNITUDE (because you are dividing $-\Delta H$ by a larger T) IGNORE Just "smaller" / just "decreases" / just "bigger" / just "greater" (1) M2: $\Delta S^{\ominus}_{system}$ / ΔH are not (significantly) affected by a change in temperature (1) M3: (So) $\Delta S^{\ominus}_{total}$ increases ALLOW a TE for M3 $\Delta S^{\ominus}_{total}$ decreases, only if incorrect M1 (i.e. $\Delta S^{\ominus}_{surroundings}$ becomes "less positive") (1) Mark M1, M2 and M3 in any order within candidate's answer		(3)

Question Number	Acceptable Answers	Reject	Mark
1(e)(i)	(K = $e^{(-44/8.31)}$=) 0.005017/ 5.017 x 10^{-3} Ignore any units Allow any sf except 1 sf		(1)

Question Number	Acceptable Answers	Reject	Mark
1(e)(ii)	Barium hydroxide will not be (very) soluble / will be sparingly soluble and K value suggests that the equilibrium lies to the left-hand side / reactants OR (1x10^{-10}<) K <1 so reactants predominant No TE on incorrect large value in (e)(i)	Just 'K is small'	(1)

Question Number	Acceptable Answers	Reject	Mark
1(e)(iii)	Hydroxides get more soluble as you descend Group 2 (1) M2: ΔS^{e}_{total} gets less negative / more positive as you go from $Ca(OH)_2$ to $Ba(OH)_2$ IGNORE Just "smaller" / just "decreases" / just "bigger" / just "greater" (1) ALLOW Reverse argument No TE on calculated value "more negative" for $Ba(OH)_2$ Mark M1 and M2 independently		(2)

TOTAL FOR QUESTION = 16 MARKS

Question Number	Acceptable Answers	Reject	Mark
2 (a)(i)	+89.6 – [+32.7 + 165] (1) = −108.1 J mol^{-1} K^{-1}/ J K^{-1} mol^{-1} Value, sign and units (1) Ignore SF except one Internal TE for recognisable numbers allowed, for example: $\Delta H^{\ominus}_{at}$ magnesium chloride (147.7→ -223.1) Halving $S^{\ominus}$ [Cl_2] (82.5 → -25.6) Correct answer with no working (2) +/no sign 108.1 J mol^{-1} K^{-1}/ J K^{-1} mol^{-1} (1)		2

Question Number	Acceptable Answers	Reject	Mark
2 (a)(ii)	(The sign is negative because) Any two from: • (A solid and) a gas reacting to form a solid. OR (Entropy decreases because) a gas reacting to form a solid. • There are fewer ways of arranging particles in a solid than a gas or vice-versa. OR Decrease in disorder as solid more ordered than gas or vice versa • Two mol(es) of reactant forming one mole of product. (Ignore two molecules form one molecule) OR Number of mol(es)/molecules decreases OR Fewer/less mol(es) of products than reactants	Energy... '(Positive) Answer is as expected...' (0)	2

Question Number	Correct Answer	Reject	Mark
2 (b)	$\Delta S^{\ominus}_{total} = \Delta S^{\ominus}_{surroundings} + \Delta S^{\ominus}_{system}$ OR = +2152 + (-108.1) = (+)2043.9 Value 2043.9 / 2044 (1) = (+)2040 (J mol^{-1} K^{-1}) 3SF This mark conditional on correct value or correct TE value from (a)(i) (1) Accept TE from (a)(i), for example, -223.1 → +1928.9 → +1930 -25.6 → +2126.4 → +2130 Correct answer (2040, etc) with or without working scores 2		2

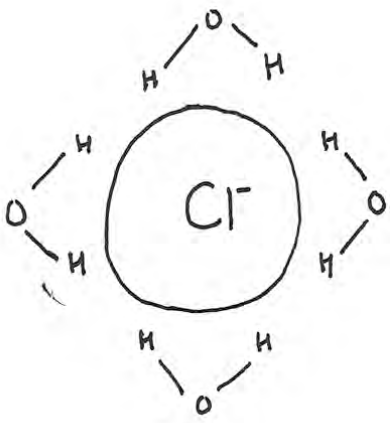
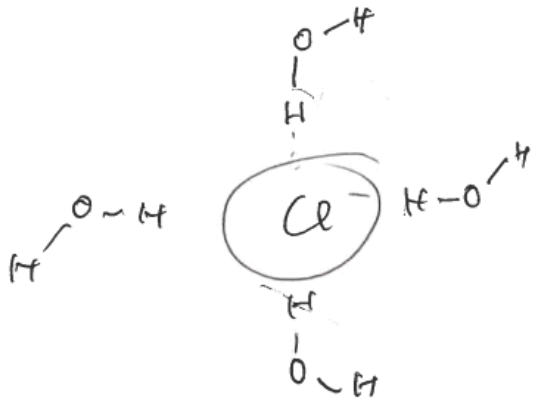
Question Number	Correct Answer1	Reject	Mark
2 (c)	$\Delta S^{\ominus}_{surroundings} = -\frac{\Delta H^{\ominus}}{298}$ $\Delta H^{\ominus} = -\Delta S^{\ominus}_{surroundings} \times 298$ OR $\Delta H^{\ominus} = -2152 \times 298$ (1) $= -641.296$ $= -641.3$ (kJ mol^{-1}) (1) ALLOW $= -641.3 \times 10^3$ J mol^{-1} Note 1. -640.1338 = -640.1 (if 2040/answer to part (b) used to recalculate entropy change of surroundings first.) (2) 2. $\Delta H^{\ominus} = +641.3$ (kJ mol^{-1}) (1) 3. $\Delta H^{\ominus} = -\frac{\Delta S^{\ominus}_{surroundings}}{298}$ (0) Ignore SF except one		2

Question Number	Correct Answer	Reject	Mark
2 (d)(i)	50 x 4.2 x 22.5 = 4725 (J) Ignore sign ALLOW 4.725 kJ Ignore SF except one		1

Question Number	Correct Answer	Reject	Mark
2 (d)(ii)	There are two legitimate answers to this part. If both methods have been used, you must send the item to review under mark scheme (−)4725 ÷ 0.0300 = −157.5 (kJ mol^{-1}) /−157500 J mol^{-1} OR (−)4725 ÷ 0.0500 = /−94.5 (kJ mol^{-1}) /−94500 J mol^{-1} ALLOW TE answer (d)(i) ÷ 0.0300/0.0500 Ignore SF except one Value (1) Sign (1) The mark for the negative sign is awarded for their calculation even if value is wrong, providing any energy divided by moles or energy multiplied by 1/number of moles calculation has been done.		2

Question Number	Correct Answer	Reject	Mark
2 (d)(iii)	There are two correct answers: Using 0.03 gives the answer of -381.75 kJ mol^{-1} Using 0.05 gives the answer of -350.25 kJ mol^{-1} Both these answers score full marks with or without correct working. First mark Appreciation of Hess's Law either in words, numbers, symbols or on the diagram For example, $\Delta H_{solution}$ + Lattice energy $= \Delta H_{hydration}\, Mg^{2+} + (2)\Delta H_{hydration}\, Cl^{-}$ (1) Second mark $2\ \Delta H_{hydration}\, Cl^{-} = -2526 - 157.5 -$ $(-1920) = -763.5$ OR $2\ \Delta H_{hydration}\, Cl^{-} = -2526 - 94.5 -$ $(-1920) = -700.5$ ALLOW Any number or group of numbers minus (-1920) (1) Third mark $\Delta H_{hydration}\, Cl^{-} = -381.75$ (kJ mol^{-1}) OR $\Delta H_{hydration}\, Cl^{-} = -350.25$ (kJ mol^{-1}) Any number, wherever it has come from,		3

	divided by two can score this mark, provided that the sign is consistent. (1) Ignore SF except one Use of lattice energy – 2326 gives −281.75/−250.25 scores (2) ALLOW TE from (d)(ii)		

Question Number	Correct Answer	Reject	Mark
2 (d)(iv)	 OR  • One/several water molecule(s) all correctly orientated. • $H^{\delta+}$/ hydrogen (one or two hydrogens from each water molecule) towards chloride ion • with negative charge either on chlorine or on the whole hydrated ion. ALLOW • A minus sign with a ring around it for the Cl^- • Bonds shown by lines/broken lines/dotted lines/wedges	$Cl^-.H_2O$ $H^{\delta-}$ / H^+ / H^- $Cl^{\delta-}$ / Cl (with no charge)	1

Question Number	Correct Answer	Reject	Mark
2(d)(v)	Both marks may be awarded in either part. First mark (Temperature increases) because the reaction/process/dissolving/hydration of ions is exothermic. OR Strong(er) forces between the δ+ H and Cl^- OR Strong(er) forces between the δ– O and Mg^{2+} OR Strong(er) ion-dipole forces OR Formation of bonds releases energy OR Strong(er) bonds formed OR Enthalpy of hydration is greater than lattice energy (1) Second mark (Volume decreases so) shorter bonds between ion and water molecules ALLOW Water molecules more tightly arranged/pack better/occupy less space OR Water molecules more ordered/ clustered (around the ions). (1)	The breaking of the lattice is exothermic. Ions more tightly arranged Ions more ordered	2

Question Number	Acceptable Answers	Reject	Mark
3(a)(i)	+104.6 – [+41.4 +165] (1) = -101.8 J mol^{-1} K^{-1} Value, sign and unit (1) Ignore SF except one Internal TE allowed for recognisable numbers, for example: $\Delta H^{\ominus}_{at}$ calcium instead of $S^{\ominus}$ (178.2 → -238.6) OR Halving $S^{\ominus}$ [Cl_2] (82.5 → -19.3) Correct answer with no working (2) +/no sign 101.8 J mol^{-1} K^{-1} (1)		2

Question Number	Acceptable Answers	Reject	Mark
3 (a)(ii)	(The sign is negative because) Any two from: • (A solid and) a gas reacting to form a solid. OR (Entropy decreases because) a gas reacting to form a solid. • There are fewer ways of arranging particles in a solid than a gas or vice-versa. OR Decrease in disorder as solid more ordered than gas or vice versa • Two mol(es) of reactant forming one mole of product. (Ignore two molecules form one molecule) OR Number of mol(es)/molecules decreases OR Fewer/less mol(es) of products than reactants COMMENT If answer to (a)(i) is positive then answer should start 'Answer is not as expected because...' Then score as above (which can score full marks).	 Energy...	2

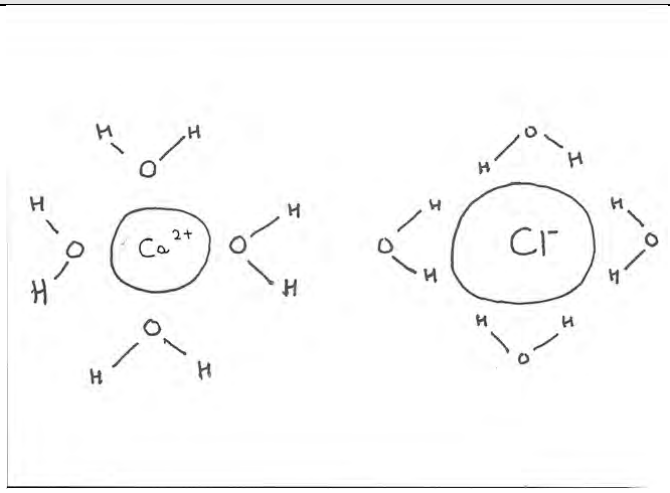
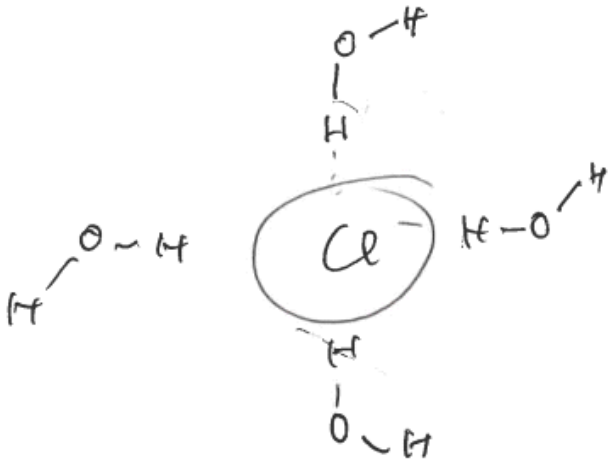
Question Number	Correct Answer	Reject	Mark
3 (b)	$\Delta S^{\ominus}_{total} = \Delta S^{\ominus}_{surroundings} + \Delta S^{\ominus}_{system}$ OR = +2670 + (-101.8) = (+)2568.2 Value 2568.2/2568 (1) = (+)2570 ($J\ mol^{-1}\ K^{-1}$) 3SF This mark is conditional on correct value or correct TE value from (a)(i) (1) Accept TE from (a)(i) -238.6 → +2431.4 → +2430 -19.3 → 2650.7 → +2650 Correct answer (2570, etc) with or without working scores (2)		2

Question Number	Correct Answer1	Reject	Mark
3 (c)	$\Delta S^{\ominus}_{surroundings} = -\frac{\Delta H^{\ominus}}{298}$ $\Delta H^{\ominus} = -\Delta S^{\ominus}_{surroundings} \times 298$ OR $= -2670 \times 298$ (1) $= -795.660$ $= -795.7$ (kJ mol^{-1}) (1) ALLOW $= -795.7 \times 10^{3}$ J mol^{-1} Note 1. -796 = -796.1964 (if 2570 used to calculate entropy change of surroundings first.) 2. $\Delta H^{\ominus}$ (= + $\Delta S^{\ominus}_{surroundings}$ x 298) = +795.7 (kJ mol^{-1}) (1) But $\Delta H^{\ominus} = -\frac{\Delta S^{\ominus}_{surroundings}}{298}$ (0) Ignore SF except one		2

Question Number	Correct Answer	Reject	Mark
3 (d)(i)	50 x 4.2 x 15.0 = 3150 (J) Ignore sign ALLOW 3.15 kJ Ignore SF except one		1

Question Number	Correct Answer	Reject	Mark
3 (d)(ii)	3150/0.05 or 20 x 3150 = -63 (kJ mol^{-1}) /-63000 J mol^{-1} Allow TE answer (d)(i) / 0.05 Ignore SF except one Value (1) Sign (1) The mark for the negative sign is awarded for the calculation even if the value is wrong, providing any energy divided by moles or energy multiplied by 1/number of moles calculation has been done.		2

Question Number	Correct Answer	Reject	Mark
*3(d)(iii)	The correct answer: -380.5/-381 kJ mol^{-1} Full marks with or without correct working. First mark Appreciation of Hess's Law either in words, numbers, symbols or on the diagram For example, $\Delta H_{solution}$ + Lattice energy = $\Delta H_{hydration}\, Ca^{2+}$ + (2)$\Delta H_{hydration}\, Cl^{-}$ (1) Second mark 2 $\Delta H_{hydration}\, Cl^{-}$ = −2258 − 63 − (−1560) = −761 ALLOW Any number or group of numbers minus (-1560) (1) Third mark $\Delta H_{hydration}\, Cl^{-}$ = − 380.5/-381 (kJ mol^{-1}) Any number, wherever it has come from, divided by two can score this mark, provided that the sign is consistent. (1) Ignore SF except one Use of lattice energy – 2223 gives −363 scores (2) ALLOW TE from (d)(ii)		3

Question Number	Correct Answer	Reject	Mark
3 (d)(iv)		$Cl^-.H_2O$	2
	OR 		
	• One/several water molecule(s) all correctly orientated.		
	• $H^{\delta+}$/ hydrogen (one or two hydrogens from each water molecule) towards chloride ion and O / oxygen (one oxygen from each water molecule) towards calcium ion	$H^{\delta-}$ / H^+ / H^-	
	• With negative charge either on chlorine or on the whole hydrated ion and with double positive charge either on calcium or on the whole hydrated ion.		
	ALLOW • A minus sign with a ring around it for the Cl^- and a 2+ sign with a ring around it for the Ca^{2+}	$Cl^{\delta-}$ / Cl (with no charge)	
	• Bonds shown by lines/broken lines/dotted lines/wedges		

Question Number	Correct Answer	Reject	Mark
3(d)(v)	Both marks may be awarded in either part. First mark (Temperature increases) because the reaction/process/dissolving/hydration of ions is exothermic. OR Strong(er) forces between the δ+ H and Cl^- OR Strong(er) forces between the δ– O and Mg^{2+} OR Strong(er) ion-dipole forces OR Formation of bonds releases energy OR Strong(er) bonds formed OR Enthalpy of hydration is greater than lattice energy (1) Second mark (Volume decreases so) shorter bonds between ion and water molecules ALLOW Water molecules more tightly arranged/pack better/occupy less space OR Water molecules more ordered/ clustered (around the ions). (1)	The breaking of the lattice is exothermic. Ions more tightly arranged Ions more ordered	2

Question Number	Acceptable Answers	Reject	Mark
4(a)	Units are not required in (a) or (c) but if used should be correct. Penalise incorrect units in (a), (b) & (c) once only IGNORE case of J and K order of units First mark: 65.3/ 130.6 and 69.9 (J mol^{-1} K^{-1}) (1) Second mark: $\Delta S = 69.9 - (130.6 + 102.5)$ (1) Third mark: $\Delta S = -163.2 = -163$ (J mol^{-1} K^{-1}) (1) Correct answer with no working scores 3 Ignore SF except 1 SF TE at each stage If 65.3 used instead of 130.6 penalize once (answer is then $\Delta S = -97.9$ (J mol^{-1} K^{-1})	+163 or an positive answer	3

Question Number	Acceptable Answers	Reject	Mark
4(b)	$\Delta S_{surroundings} = -\Delta H / T$ or just numbers (1) $= +285800/298$ $= +959.06 = +959$ J mol^{-1} K^{-1} / $+0.959$ kJ mol^{-1} K^{-1} Correct value to 3SF (1) Correct units and positive sign (1) Correct answer with no working scores 3	answer with no sign	3

Question Number	Acceptable Answers	Reject	Mark
4(c)	$\Delta S_{total} = \Delta S_{system} + \Delta S_{surroundings}$ (1) Allow $\Delta S_{reaction}$ for ΔS_{system} ΔS_{total} = answer (a) + answer (b) = −163.2 + 959 = (+)795.8 = (+)796 (J mol^{-1} K^{-1}) If $\Delta S_{surroundings}$ = +959.06 then ΔS_{total} = +795.9 (1) Correct answer with no working scores 2 Ignore SF except 1 SF TE on values in (a) & (b) no TE on incorrect equation If answer to (a) = -97.9 (J mol^{-1} K^{-1}) ΔS_{total} = (+)861.1 (J mol^{-1} K^{-1})		2

Question Number	Acceptable Answers	Reject	Mark
4(d)	A mixture of hydrogen and oxygen is thermodynamically unstable because ΔS_{total} is positive OR Reaction between hydrogen and oxygen is thermodynamically feasible because ΔS_{total} is positive ALLOW ΔS for ΔS_{total} (1) No TE on negative ΔS_{total} from (c) The mixture is kinetically inert /stable or reaction is (very) slow because the activation energy is (very) high (1) Mixture / reaction is kinetically inert / stable but thermodynamically unstable / feasible scores 1 mark IGNORE References to spark / flame providing the (activation) energy for reaction	Reference to the stability of individual elements	2