
International A-Level Chemistry

CH03 – Unit 3: Inorganic 2 and Physical 2

Mark scheme

9260

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Version/Stage: 1.1 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Question	Marking guidance	Mark	Comments
01.1	$[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4 \text{Cl}^- \rightleftharpoons [\text{CuCl}_4]^{2-} + 6 \text{H}_2\text{O}$ ligand substitution/exchange tetrahedral chloride ions are bigger (than water molecules) OR chloride ions have a negative charge	1 1 1 1	Allow →
01.2	spilt of d-orbitals OR d electrons move from ground to excited state visible light is absorbed remaining wavelengths are transmitted/reflected.	1 1 1	must have reference to d-electrons or electrons in the (3)d sub shell. do not allow emission of light
01.3	It changes the energy difference between the ground state and excited state	1	
01.4	6	1	
01.5	1,3-diaminopropane OR propane-1,3-diamine has a lone pair of electrons on each <u>nitrogen</u> OR each <u>nitrogen</u> is able to donate a pair of electrons	1 1	

01.6	(suitable test reagent such as) named carbonate / magnesium / UI (correct comparative observation based on reagent) fizzes faster with 3+, UI redder with 3+	1 1	
	Total	13	

Question	Marking guidance	Mark	Comments
02.1	SiO ₂ reacts with bases / NaOH / CaO / CaCO ₃	1	
02.2	It is an ionic lattice / giant ionic Contains oppositely charged ions/ + and - ions with strong forces of attraction between the ions	1 1 1	CE = 0/3 if mention of atoms / molecules / metallic Allow giant lattice if ions mentioned in answer Allow a lot of energy to separate oppositely charged ions. M3 dependent on M2 Max 1/3 if mention of electronegativity ie M1 only
02.3	SO ₃ is a bigger molecule than SO ₂ so <u>van der Waals'</u> forces <u>between molecules</u> are stronger	1 1	CE = 0 if mention of ions
02.4	no reaction or no hydrolysis or only dissolving occurs	1	Allow NaCl is the salt of a strong acid and a strong alkali
02.5	Al ³⁺ small and highly charged (and weakens the O-H bond the ligand) [Al(H ₂ O) ₆] ³⁺ + H ₂ O → [Al(H ₂ O) ₅ (OH)] ²⁺ + H ₃ O ⁺	1 1	Allow Al ³⁺ is highly polarising Allow Al ³⁺ weakens the O-H bond Accept equations with more than one H ₂ O reacting Allow formation of H ⁺

02.6	phosphoric(V) acid or H_3PO_4 AND hydrochloric acid or HCl	1	allow phosphoric acid
	Total	10	

Question	Marking guidance	Mark	Comments
03.1	$2 \text{ K}^+(\text{g}) + \text{O}^{2-}(\text{g})$	1	
	$2 \text{ K}(\text{s}) + \frac{1}{2} \text{ O}_2(\text{g})$	1	
03.2	the enthalpy change which accompanies the formation of one mole of gaseous atoms	1	If one mole of element then do not award this mark
	from the element in its standard state (under standard conditions)	1	
03.3	electron and ion both have negative charges and so repel each other	1	Allow have the same charge
03.4	(M1 expression in words or symbols) $\Delta_f H = \Delta_a H(\text{oxygen}) + 2 \times \Delta_a H(\text{K}) + 2 \times \Delta_{\text{IE}1} H + \Delta_{1\text{EA}} H + \Delta_{2\text{EA}} H - X$ OR $X = \Delta_a H(\text{oxygen}) + 2 \times \Delta_a H(\text{K}) + 2 \times \Delta_{\text{IE}1} H + \Delta_{1\text{EA}} H + \Delta_{2\text{EA}} H - \Delta_f H$	1	2328 scores 3 marks Allow answers given to 3 significant figures
	(M2 expression with correct numbers) $-362 = 248 + (2 \times 90) + (2 \times 418) + -142 + 844 + -X$ OR $X = 248 + (2 \times 90) + (2 \times 418) + -142 + 844 + 362$	1	
	enthalpy of lattice dissociation = (+)2328 kJ mol ⁻¹	1	

03.5	Experimental lattice enthalpy value allows for/includes covalent interaction / non-spherical ions / distorted ions / polarisation	1	Allow discussion of AgCl instead of AgF.
	Theoretical lattice enthalpy value assumes only ionic interaction / point charges / no covalent / perfect spheres / perfectly ionic	1	Allow AgF has covalent character OR AgF is not perfectly ionic in place of either point for 1 mark. CE = 0 for mention of molecules, atoms, macromolecular, mean bond enthalpy, intermolecular forces, electronegativity
03.6	chloride ion larger (than fluoride ion) (or reverse argument)	1	Penalise chlorine ion once only.
	Attraction between Ag^+ and Cl^- weaker (or reverse argument)	1	Allow chloride ion has smaller charge density but do not allow mass to charge ratio
	Total	12	

Question	Marking guidance	Mark	Comments
04.1	second box (yield decreases, K_p stays the same)	1	
04.2	$K_p = \frac{p \text{ C}_2\text{H}_2 \times p^3 \text{ H}_2}{p^2 \text{ CH}_4}$	1	ignore curved brackets, do not accept []
04.3	mole fractions of all three gases $\text{CH}_4 = 0.125$; $\text{C}_2\text{H}_2 = 0.225$; $\text{H}_2 = 0.65(0)$	1	
	partial pressures of all three gases $\text{CH}_4 = 62.5 \text{ kPa}$; $\text{C}_2\text{H}_2 = 112.5 \text{ kPa}$; $\text{H}_2 = 325 \text{ kPa}$	1	
	(answer to 3 significant figures) 9.89×10^5	1	
	(units =) kPa^2	1	
	Total	6	

Question	Marking guidance	Mark	Comments
05.1	Any two of - no reactions to be reversed - no need for any current to be supplied - substances/consumables can be supplied continuously	2	
05.2	(A) hydrogen / H ₂	1	
	(C) water / H ₂ O	1	
05.3	(CO ₂ + 2 KOH →) K ₂ CO ₃ + H ₂ O	1	Accept products in either order
05.4	H ₂ + 2 OH ⁻ → 2 H ₂ O + 2 e ⁻	1	Accept fractions and multiples
05.5	2 H ₂ + O ₂ → 2 H ₂ O	1	Accept fractions and multiples
	Total	7	

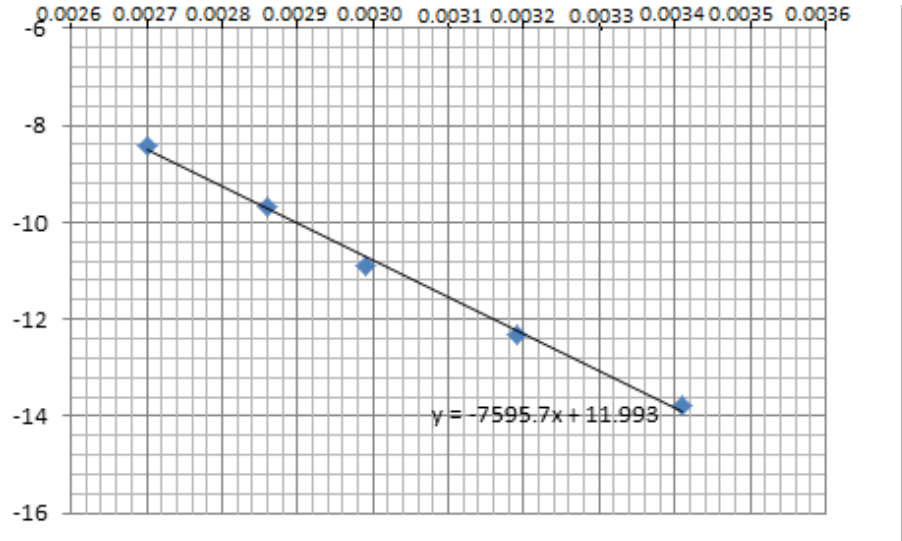
Question	Marking guidance	Mark	Comments
06.1	increase in disorder as OR more disorder in products six moles of water on right (compared to 1 mole of solid)	1	Accept six moles of liquid/water more disorganised than 1 mole of solid Allow liquid (on right) more disordered than solid (on left)
06.2	activation energy too/very high	1	
06.3	216 = (198 + 3 X) – (186 + 189) OR 3 X = 216 +186 +189 -198 X = 131 (J K ⁻¹ mol ⁻¹)	1	Correct answer with or without working scores 2. Mark on for either a transcription or arithmetic error.
		1	
06.4	$\Delta G = \Delta H - T\Delta S$	1	
	$\Delta G = 206 - 423(216/1000)$	1	If no conversion of T or ΔS then can score M1 only
	$\Delta G = 115 \text{ kJ mol}^{-1}$	1	Allow unrounded value of 114.632 must have correct units allow answers in J mol ⁻¹

06.5	not feasible because ΔG is positive	1	
06.6	straight line with negative gradient	1	
	Total	9	

Question	Marking guidance	Mark	Comments
07.1	(test 1) add (hydrochloric acid and) barium chloride (solution)	1	allow use of aqueous ammonia or a named soluble carbonate Allow reference to pungent gas do not award this mark if aqueous ammonia or named soluble carbonate is used.
	(observation) white precipitate	1	
	(test 2) add aqueous sodium hydroxide	1	
	(observations) brown precipitate	1	
	result gas which turns damp red litmus blue formed	1	
07.2	(dilute) sulfuric acid or H_2SO_4	1	allow nitric acid do not allow any other acid
07.3	colourless/(pale) green to (light) pink/purple	1	
	caused by unreacted/excess MnO_4^-	1	

07.4	moles MnO_4^- ($= 0.0151 \times 13.25/1000$) $= 2.00(075) \times 10^{-4}$	1	
	moles Fe^{2+} ($= 5 \times 2.00075 \times 10^{-4}$) $= 1.00(0375) \times 10^{-3}$	1	
	moles Fe^{2+} or Fe^{3+} in full $250 \text{ cm}^3 = 1.00(0375) \times 10^{-2}$	1	
	$M_r = 4.82 / 1.00(1) \times 10^{-2} = 481(.819)$ OR 482	1	
	$x = (482 - 266)/18 = 12$	1	
	Total	13	

[illegible]

08.5	all five points plotted correctly straight line of best fit drawn gradient of line drawn calculated correctly – this must have a negative sign. 	1 1 1	correct gradient is –7596.
08.6	gradient $\times (-8.31 / 1000)$ correct evaluation to nearest whole number or better gradient of –7596 gives $63(.12) \text{ (kJ mol}^{-1}\text{)}$	1 1	If –4500 is used answer = $(+)37(.395) \text{ kJ mol}^{-1}$
	Total	10	