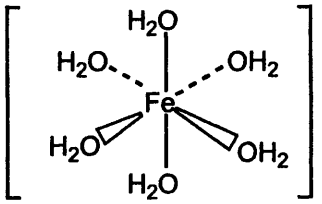
Question	Expected answers	Marks	Additional guidance
1 (a)	Correct electronic structures magnesium either 8 electrons in outer shell or none and oxide with 8 electrons in the outer shell (1); Correct charge on the ions, Mg^{2+} and O^{2-} (1)	2	**Allow** all dots or all crosses **Allow** diagrams that show the movement of electrons from magnesium to oxygen but electrons must not be shown twice **Ignore** inner shells
(b) (i)	Correct 'dot-and-cross' diagram showing two double covalent bonds shown to each oxygen atom and a lone pair on sulphur (1)	1	**Allow** dative bonds between sulphur and oxygen
(ii)	**Any three from** V-shaped / bent / non-linear (1); Bond angle of between 120-110° (1); Idea of electron pairs repel one another (1): Extra repulsion from the lone pair to explain bond angle less than 120° / three 'electron pairs repelling (equally) to explain an angle of 120° (1)	3	**Not** bonds or atoms repelling **Allow** ecf from wrong dot-and-cross diagram in (b) (i) Correct shape (1) Correct bond angle (1) Idea of electron pair repelling (1) Comment about number of electron pairs or lone pair (1) **If no dot and cross diagram** drawn in (b) (i) then the only marks allowed will be the correct shape of SO_2

Question	Expected answers	Marks	Additional guidance
1 (c)	MgO - Strong (electrostatic) attraction between (positive and negative) ions / strong ionic bonds / strong giant ionic (lattice) (1); SO_2 - Weak intermolecular force / weak van der Waals forces / weak permanent dipole-dipole interaction (1)	2	The nature of the attractive force must be stated as well as an indication of the strength of the attraction **Allow** MgO is giant ionic and SO_2 is a simple molecule (1) if no other marks have been awarded
(d) (i)	Magnesium hydroxide / $Mg(OH)_2$ (1)	1	
(ii)	$SO_2 + H_2O \rightleftharpoons H_2SO_3$ / $SO_2 + H_2O \rightleftharpoons H^+ + HSO_3^-$ / $SO_2 + H_2O \rightleftharpoons 2H^+ + SO_3^{2-}$ (1)	1	**Allow** arrow or equilibrium symbol **Ignore** state symbols
(iii)	X is basic and Y is acidic / solution of X contains hydroxide ion and solution of Y contains hydrogen ions / Y can donate protons and X can accept them / it is an acid-base reaction / idea of neutralisation (1)	1	**Allow** an equation showing a correct reaction **Allow** an alkali-acid reaction **Ignore** makes a salt
		Total = 11	

Question	Expected answers	Marks	Additional guidance
2 (a)	Octahedral shape with some indication of three dimensions (1); Bond angle 90° (1)  	2	**Allow** use of wedges and dotted lines to indicate three dimensions **Allow** three dimensions if at least two bond angles of 90° are shown that clearly demonstrate 3D **If two different bond angles** do not award bond angle mark
(b)	Lone pair on oxygen / electron pair on oxygen (1); Donated to the (central) metal (ion) (1) **Or** A dative bond exists between water and the central metal (ion) (1) and if electron pair comes from oxygen (1)	2	**Allow** water is an electron pair donor **Allow** metal (ion) is an electron pair acceptor **Allow** marks from a diagram
(c) (i)	All Points plotted correctly (1); Two straight lines of best fit that intersect (1)	2	**Allow** to nearest half small square
(ii)	13.0 – 13.6 (1)	1	**Unit not needed** **Allow** ecf from incorrect graph
(iii)	Answer to part (ii) × 10^{-3} × 0.0500 (1)	1	**Allow** ecf
(iv)	20 – Answer to part (ii)	1	
(v)	Answer to part (iv) × 10^{-3} × 0.100 (1)	1	**Allow** ecf
(vi)	x = 1 and y = 5 (1)	1	**Allow** ecf of x and y that add up to 6
(d) (i)	Moles of K = 0.014, Fe = 0.0035, C = 0.021 and N = 0.021 / molar ratio is K:Fe:C:N is 14:3.5:21:21 (1); $K_4Fe(CN)_6$ / $K_4FeC_6N_6$ (1)	2	**Ignore** order of atoms in the formula
(ii)	$[Fe(CN)_6]^{4-}$ (1)	1	**Allow** $Fe(CN)_6^{4-}$ / $FeC_6N_6^{4-}$
		Total = 14	

Question	Expected answers	Marks	Additional guidance
3 (a)	Silver (1)	1	
(b)	0.0071 (g) (1)	1	
(c) (i)	$Ag + CuCl_2 \rightarrow AgCl + CuCl$ (1)	1	
(ii)	Oxidation because oxidation state of silver changes from 0 to +1 (1); Reduction because oxidation state of copper changes from +2 to +1 (1)	2	**Allow** ecf from wrong equation
(d) (i)	$(1s^2 2s^2 2p^6) 3s^2 3p^6 3d^9$ (1)	1	
(ii)	Copper(II) ions have an incomplete set of 3d electrons / partially filled d (sub) shell / partially filled d orbital (1)	1	
		Total = 7	

Question	Expected answers	Marks	Additional guidance
4		12	**Definition** maximum of two marks **Factors** maximum of four marks **Decomposition** maximum of six marks – marks can either come from the polarisation explanation or lattice enthalpy explanation but **not both**
	Definition – maximum of two marks The enthalpy change that accompanies the formation of one mole of a solid (compound) (1); from its constituent gaseous ions (1)		**Allow** marks from an equation **Allow** energy released / energy change **Not** energy required **Allow** ionic compound / salt
	Factors – maximum of four marks As ionic charge increases it becomes more exothermic / ora(1); Since there will be a stronger (electrostatic) attraction between the (positive and negative) ions / ora (1); As ionic radius decreases becomes more exothermic / ora (1); Since the ions become closer together / ora (1); so the (positive and negative) ions are more strongly attracted to one another / aw (1)		**Allow** lattice enthalpy becomes larger if it is clear from the definition that lattice enthalpy is exothermic / ora

Question	Expected answers	Marks	Additional guidance
4	**Decomposition – Maximum of six marks** $MCO_3 \rightarrow MO + CO_2$ (where M = Mg, Ca etc.) (1); Ease of decomposition decreases as the atomic number of the group 2 element increases / decomposition temperature increases / aw (1); Down the group the positive ion has a greater ionic radius (1); But the ions have the same charge / formulae of at least two ions with 2+ (1); **Polarisation approach** Idea that decomposition of the carbonate is related to polarisation (by cation) (1) Idea that polarisation means a distortion of the CO_3^{2-} electron cloud / aw (1); Idea that the distortion or polarisation weakens carbon oxygen covalent bond within the carbonate ion (1) **OR** **Lattice enthalpy approach** Lattice enthalpy of the oxides and the carbonates become less exothermic down the group / ora (1); Rate of decrease of the lattice energy of the oxide is much more than that for the carbonate / lattice enthalpy of oxide is the driving force for the decomposition / aw (1); Correct energy cycle for decomposition (1); This means that the enthalpy change for the decomposition is less endothermic the higher the metal is in the group (1)		**Allow** either a general equation or one with a specific group 2 metal **Allow** smaller charge density of M^{2+} down the group (1) if no reference to ionic radius or charge on ion **Not** charge density of M / charge on magnesium atom / atomic radii If one of these has a comparison then it scores an **extra mark** e.g. e.g. Mg^{2+} is more polarising than Ca^{2+} (1) **Allow** marks from suitable diagrams **Allow** lattice enthalpy decreases if earlier it is clear that it is exothermic

Question	Expected answers	Marks	Additional guidance
4	**QWC** One mark for the use of technical terms (1) Award one mark if candidate has illustrated answers with 3 correct and appropriate scientific terms from the following list charge density polarisation / polarised / polarising cation anion exothermic endothermic electrostatic covalent distortion electron cloud	1	**Ring** the technical words and put the tick by the QWC mark total
		Total = 13	