

Question	Expected answers	Marks	Additional guidance
1 (a) (i)	(Enthalpy change of) formation (of magnesium oxide) (1); (Enthalpy change of) atomisation (of magnesium) (1); First ionisation enthalpy (of magnesium) (1)	3	Allow (enthalpy change of) sublimation (of magnesium) Allow first ionisation energy
(ii)	$\text{Mg}^{2+}(\text{g})$ and $\text{O}^{2-}(\text{g})$ (1)	1	State symbols essential
(iii)	Electron being gained is repelled by the negative charge of the ion / aw (1)	1	
(b) (i)	Lattice enthalpy = $-149 - 736 - 1450 - 248 - 650 - 602$ (1); = -3835 (kJ mol^{-1}) (1)	2	Allow ecf from one error (1)
(ii)	Lattice enthalpy of barium oxide is less exothermic than that of magnesium oxide / lattice enthalpy is smaller in magnitude / ora (1); Mg^{2+} has a smaller ionic radius than Ba^{2+} / Mg^{2+} has a higher charge density than Ba^{2+} / ora (1); So stronger attraction between the positive and negative ion (1)	3	Not bigger or smaller lattice enthalpy Correct particles must be used e.g. not Mg has a smaller radius Allow so has stronger ionic bonds
(c)	High melting point / (very) large lattice enthalpy / aw (1)	1	Not resistant to heat
(d) (i)	$\text{BaCO}_3 \rightarrow \text{BaO} + \text{CO}_2$ (1)	1	State symbols not essential
(ii)	Decomposition temperature higher for BaCO_3 / ora (1) Polarising ability of cation decreases from Mg^{2+} to Ba^{2+} (1); Polarisation causes distortion of the charge cloud around the carbonate ion / polarisation weakens the covalent bonds within the carbonate ion (1)	3	Particles used must be correct e.g. not Mg is more polarising Allow marks via a diagram
		Total = 15	

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2 (a)	Often are catalysts (1)	1	Allow compounds are often paramagnetic Not metallic properties
(b) (i)	Tetrahedral / or a clear drawing of a tetrahedral ion (1); Bond angle of $109.5 \pm 0.5^\circ$ (1)	2	Allow square planar (1) with bond angle of 90° (1) Tetrahedral structure must have at least one wedge
(ii)	Cl^- (1)	1	
(iii)	(Concentrated) hydrochloric acid / (concentrated) solution of an ionic chloride (1)	1	Allow correct formula
(iv)	Suitable equation e.g. $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{Cl}^- \rightarrow [\text{CuCl}_4]^{2-} + 6\text{H}_2\text{O}$ Or $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+} + 4\text{H}_2\text{O}$; Reaction in which a ligand is swapped or displaced by another ligand / aw (1)	2	Not ligand is substituted
		Total = 7	

Question	Expected answers	Marks	Additional guidance
3 (a)	Oxidation - Oxidation number of oxygen changes from -1 to 0; Reduction - oxidation number of oxygen changes from -1 to -2 (1)	2	Allow one mark if all the oxidation numbers for oxygen (and hydrogen) are correct
(b) (i)	$2\text{MnO}_4^- + 6\text{H}^+ + 5\text{H}_2\text{O}_2 \rightarrow 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 5\text{O}_2$ Correct reactants and products (1); Balancing (1)	2	Ignore electrons for the first mark
(ii)	Moles of $\text{MnO}_4^- = 17.5 \times 10^{-3} \times 0.0200 / 3.5 \times 10^{-4}$ (1); Moles of $\text{H}_2\text{O}_2 = 2.5 \times \text{moles of } \text{MnO}_4^- / 8.75 \times 10^{-4}$ (1); Conc of $\text{H}_2\text{O}_2 = \frac{8.75 \times 10^{-4}}{0.025} = 0.0350$ (mol dm ⁻³) (1)	3	Allow ecf within question Allow 0.035 Not 0.04 / 0.03
(c)	Aqueous sodium hydroxide / potassium thiocyanate / ammonium thiocyanate (1); Appropriate observation e.g. orange-red / brown / brown-red / foxy-red ppt with NaOH(aq) or (blood) red with KSCN (1)	2	Allow hydroxide (ions) or thiocyanate (ions)
		Total = 9	

Question	Expected answers	Marks	Additional guidance
4	<p>Chemical formula Correct formula of all chlorides (1); Number of outer electrons per atom increases / oxidation number increases (1);</p> <p>Structure and bonding NaCl or MgCl₂ are ionic and AlCl₃ or SiCl₄ are covalent (1) NaCl or MgCl₂ are giant and AlCl₃ or SiCl₄ are simple (1) And any two from Correct 'dot-and-cross' diagram for one of the ionic chlorides (1); Correct 'dot-and-cross' diagram for one of the covalent chlorides (1); Correct structure/bonding for Al₂Cl₆ showing the dative bonding (1); Drawing of NaCl lattice (1);</p> <p>Action of water Any four from Ionic chlorides dissolve in water / NaCl or MgCl₂ dissolve in water (1); Ionic chlorides give a neutral solution / NaCl gives a neutral solution or pH 7 / MgCl₂ gives a slightly acidic solution or pH 6-7 (1); Covalent chlorides are hydrolysed / covalent chlorides react / SiCl₄ or AlCl₃ react or are hydrolysed (1); Covalent chlorides give acidic solutions / SiCl₄ or AlCl₃ give acidic solutions or pH less than 6 (1)</p> <p>Suitable equation e.g. $\text{SiCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + 4\text{HCl}$ (1)</p> <p>Melting points NaCl, MgCl₂ or ionic chlorides have electrostatic attraction between ions / attraction between positive and negative ions (1); AlCl₃, SiCl₄ or simple molecular lattice have van der Waals force of attraction (1); Strong ionic bonds and weak intermolecular forces (1) QWC – one mark for technical terms Award one mark if the candidate has illustrated the answers correctly using at least three of the technical terms (1) - hydrolysis, hydration, intermolecular, ionic covalent, lattice, electrostatic, van der Waals, polarisation, dative bonding.</p>	14	<p>Allow AlCl₃ or Al₂Cl₆</p> <p>Do not award mark if one bonding or one structure is wrong</p> <p>Do not penalise incorrect answers in these two marks</p> <p>Allow dissociate in water</p> <p>Allow polarisation of water molecules by Al³⁺ As alternative to hydrolysis mark</p> <p>Allow other species such as Si(OH)₄</p> <p>Not weak covalent bonds</p>
		Total = 14	