Question	Expected answers	Marks
1 (a)	Correct oxidation states for **each** atom i.e. Ca = +2, C = +4 and O = -2 (1); Oxidation numbers do not change during the reaction / no electron transfer during reaction (1)	2
(b)	$MgCO_3$ decomposition easier than $CaCO_3$ / higher decomposition temperature with $CaCO_3$ / ora (1); Mg^{2+} higher charge density than Ca^{2+} / both have the same charge but Mg^{2+} has a smaller ionic radius (1); So Mg^{2+} will polarise CO_3^{2-} more than Ca^{2+} can / more distortion of the CO_3^{2-} electron cloud by Mg^{2+} (1)	3
(c)	ΔH = +1207 +(-635) + (-393) / correct energy cycle drawn / ΔH_fproduct – ΔH_f reactants (1); ΔH = +179 (kJ mol^{-1})(1)	2
(d)	Mg^{2+} + O^{2-} → MgO (1); (3916 kJ of) energy is released (1); when one mole of **solid** magnesium oxide is made from its constituent **gaseous** ions (1)	3
(e) (i)	Enthalpy change of atomisation (of oxygen) (1)	1
(ii)	**Any two from** Mg^+ has one more proton than electrons / same number of protons but one fewer electron (1); Electron is lost from a particle that carries an overall positive charge (rather than being neutral) (1); So (outer) electron more firmly attracted to the nucleus (1)	2
(iii)	Correct energy level diagram labelled with correct formulae / correct cycle labelled with correct formulae (1); **Any two from** Correct state symbols (1); Correct energy values shown in the Born-Haber cycle (1) Correct labels for the enthalpy changes (1) **And** Lattice enthalpy = -735 +(-1445) + (-150) + (-878) + 141 + (-247) + (-602) (1)	4
(f)	Furnace lining / aw (1)	1
		Total = 18

Question			Expected answers	Marks
2	(a)		Have variable oxidation states / aw (1); (Elements or compounds are) often catalysts (1)	2
	(b)	(i)	$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$ / $[Cu(H_2O)_6]^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s) + 6H_2O(l)$ / $[Cu(H_2O)_6]^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(H_2O)_4(s) + 2H_2O(l)$	1
	(b)	(ii)	Colorimeter needs a clear solution / precipitate will interfere with the passage of light / precipitate may absorb light / colorimeter has been set up to measure the concentration of just the complex ion (1)	1
	(c)		Points plotted correctly (1); Two **straight** lines of best fit that intersect (1)	2
	(d)	(i)	0.0025 (1)	1
		(ii)	10 (cm^3)	1
		(iii)	Answer to part (ii) x 10^{-3} / 0.010 (1)	1
		(iv)	x = 4 and y = 2 (1)	1
	(e)	(i)	Has a lone pair / it is an electron pair donor (1)	1
		(ii)	Lone pair in the ammonia ligand is more like a bond (pair) / ammonia ligand has four bond (pairs) (1); So equal repulsion between all four electron pairs or bonds with the ligand / extra repulsion due to presence of lone-pair in ammonia / aw (1)	2
	(f)	(i)	$[Cu(H_2O)_6]^{2+} + 4Cl^- \rightarrow [CuCl_4]^{2-} + 6H_2O$ / $[Cu(H_2O)_6]^{2+} + 4HCl \rightarrow [CuCl_4]^{2-} + 6H_2O + 4H^+$ / $Cu^{2+} + 4HCl \rightarrow CuCl_4^{2-} + 4H^+$	1
		(ii)	Tetrahedral shape with either wedges or correct bond angles / square planar shape (1)	1
				Total = 15

Question	Expected answers	Marks
3	**Any eleven from** **Sodium oxide / magnesium oxide** Magnesium oxide has a (giant) ionic structure (1); (so it has a) high melting point (1); (because there is a) strong interaction between the positive ions and the negative ions / because there is a strong electrostatic attraction between ions (1); **Aluminium oxide** Aluminium oxide has ionic bonding with a high degree of covalent character / polar covalent bonding / intermediate bonding (1); It has a giant structure (1); (So it has a) high melting point (1); **Sodium oxide / magnesium oxide / aluminium oxide** Do not conduct electricity as a solid since its ions are not free to move (1); But will conduct electricity as a molten liquid because the ions are free to move (1); **Silicon dioxide** Giant molecular / giant covalent (1); High melting point (1); (because) it has many strong covalent bonds / aw (1); Does not conduct electricity (1) (because there are) no free electrons / all electrons localised in covalent bonds (1); **Sulphur dioxide / sulphur trioxide** Sulphur dioxide has a simple molecular structure / simple covalent (1); (so it has a) low melting point (1); (because) molecules are held together by weak intermolecular forces / van der Waals forces (1); Sulphur dioxide does not conduct electricity (1); (because there are) no free electrons / all electrons localised in covalent bonds (1);	12

Question	Expected answers	Marks
3	**Reaction with water** Magnesium oxide is basic / magnesium oxide reacts with water to form an alkaline solution / magnesium oxide is slightly soluble in water giving a basic solution (1); (because) oxide ions react with water to give hydroxide ions / $O^{2-} + H_2O \rightarrow 2OH^-$ / $MgO + H_2O \rightarrow Mg(OH)_2$(1); Aluminium oxide is amphoteric / aluminium oxide does not react / does not dissolve in water (1); (because the) lattice enthalpy is too high /aw (1); Silicon dioxide does not dissolve in water (1); Silicon dioxide is an acidic oxide (1); Sulphur dioxide is an acidic oxide / sulphur dioxide reacts with water to form an acidic solution (1); $SO_2 + H_2O \rightarrow H_2SO_3$ (1); (Since) covalent oxides are acidic oxides (1) **And** QWC – award one mark if the question has been addressed with no significant omissions and the candidate has illustrated answers with correct and appropriate scientific terms (1)	
		Total = 12