Abbreviations, annotations and conventions used in the Mark Scheme	/	= alternative and acceptable answers for the same marking point
	;	= separates marking points
	NOT	= answers which are not worthy of credit
	( )	= words which are not essential to gain credit
	___	= (underlining) key words which **<u>must</u>** be used to gain credit
	ecf	= error carried forward
	AW	= alternative wording
	ora	= or reverse argument

Question	Expected answers	Marks	Additional guidance
1 (a) (i)	Electron affinity -696 (1 mark); Atomisation of Cl_2 +244 (1 mark); From top to bottom 2^{nd} IE +1150, 1^{st} IE +590, atomisation of Ca +178 formation -796 (1 mark)	3	**Allow** 244, 1150, 590 and 176 i.e. without plus sign
(ii)	-796 - 178 - 590 - 1150 - 244 + 696 (1); **But** -2262 (with no working) (2)	2	**Allow** ecf from the wrong figures on the Born-Haber cycle 1 error **max one mark** 2 errors **0 mark**
(iii)	Magnesium fluoride more exothermic than calcium chloride / ora because Ionic radius of Mg^{2+} is less than that of Ca^{2+} / charge density of magnesium ion is greater than that of calcium ion / ora (1); Ionic radius of F^- is less than that of Cl^- / charge density of fluoride ion is greater than that of chloride ion / ora (1); Stronger (electrostatic) attraction between cation and anion in MgF_2 than in $CaCl_2$ / stronger ionic bonds in MgF_2 (1)	3	Answer must refer to the correct particle. **Not** Mg or magnesium has a smaller radius or fluorine has a smaller radius **Allow** magnesium or fluorine has a smaller ionic radius
(b)	**Any two from** For second ionisation energy the electron lost is closer to the nucleus / AW (1); For second ionisation energy the electron is lost from a particle that is already positive (1); For second ionisation energy there is one more proton than electron (1) So outer electron more firmly attracted to the nucleus (1)	2	**Allow** ora
		Total = 10	

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Question	Expected answers	Marks	Additional guidance
2 (a)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$ (1); Has an incomplete set of 3d electrons (1)	2	**Allow** 3d orbitals are not completely occupied / incomplete 3d sub-shell **Allow** has half-filled d orbitals
(b) (i)	**Any two from** Variable oxidation state / variable valency (1); Act as catalysts (1); Form complexes / form complex ions (1); Form coloured compounds (1)	2	**Not** high melting point / good thermal and electrical conductors / high density etc
(c)	Iron (II) ions give a green ppt (1); Iron (III) ions give an orange-rust ppt (1)	2	Precipitate must be used once **Allow** solid instead of ppt
(d)	$4Fe^{2+} + O_2 + 4H^+ \rightarrow 4Fe^{3+} + 2H_2O$ Correct reactants and products (1); Correct balancing (1)	2	
(e) (i)	Copper may react with potassium manganate(VII) / iron(III) ions formed in titration may be reduced back to iron(II) ions by the copper (1)	1	
(ii)	MnO_4^- gains electrons and is reduced / Mn oxidation state changes from +7 to +2 so it is reduced (1); Fe^{2+} loses electrons and is oxidised / Fe oxidation state changes from +2 to +3 so it is oxidised (1)	2	
(iii)	Moles of MnO_4^- = 4.50×10^{-4} (1); Moles of Fe^{2+} = 5 × moles MnO_4^- / 2.25×10^{-3} (1); Mass of Fe = moles of Fe^{2+} × 55.8 / 0.1256 (1); Percentage = 18.6 % (1)	4	**Allow** answers that use 56 for A_r of Fe this gives 18.7 **Allow** ecf
		Total = 15	

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Question	**Expected answers**	**Marks**	**Additional guidance**
3 (a)	(Pale blue solution) to a (light) blue ppt (1); with excess dark blue solution (1)	2	
(b)	Octahedral shape with clear indication of 3D either by construction lines or wedges etc (1); 90^o (1)	2	**Ignore** mistakes with the ligands question focuses on octahedral and the bond angle
(c)	Water molecule 2 lone pairs (and 2 bond pairs) (1); Water ligand 1 lone pair and 3 bond pairs / lone pair is now a bond pair / water has one less lone pair when it is a ligand (1); Lone pairs repel more than bond pairs (1)	3	**Not** atoms repel
		Total = 7	

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Question	**Expected answers**	**Marks**	**Additional guidance**
4	**Twelve from** **Chemical formula** Correct formula of all oxides – MgO, Al_2O_3, SO_2 or SO_3 (1); Number of outer electrons per atom increases / oxidation state of element increases (1); **Structure and bonding – Any three from** Correct bonding – MgO is ionic, Al_2O_3 has intermediate bonding and SO_2 or SO_3 are covalent (1); Correct structure - MgO and Al_2O_3 both giant structures, SO_2 or SO_3 simple (1); Ionic 'dot-and-cross' diagram for MgO or Al_2O_3 (1); Covalent 'dot-and-cross' diagram for SO_2 or SO_3(1); **Action of water – Any four from** MgO reacts water to give an alkaline solution (1); because the oxide ions react with water molecules / $MgO + H_2O \rightarrow Mg(OH)_2$ / $O^{2-} + H_2O \rightarrow 2OH^-$ (1); Al_2O_3 does not react with water / does not dissolve in water (1); SO_2 or SO_3 reacts to give acidic solutions (1); $SO_2 + H_2O \rightarrow H_2SO_3$ / $SO_3 + H_2O \rightarrow H_2SO_4$ (1) **Melting points** MgO or Al_2O_3 has electrostatic attraction between ions (1); SO_2 or SO_3 has van der Waals forces / has permanent dipole-permanent dipole attraction / instantaneous dipole (1); Comparison of strength of forces in ionic and simple molecular e.g. strong and weak / comparison of forces in Al_2O_3 and simple molecule (1) **And** QWC – one mark for a well ordered and structured answer. Property clearly linked with explanation on at least two occasions (1)	13	**Ignore** any other formulae **Allow** marks from diagrams e.g. dot and cross or lattice **Allow** Al_2O_3 ionic bonding with covalent character / polar covalent (1) **Allow** attraction between positive and negative ions / attraction between magnesium ions and oxide ions **Allow** strong ionic bonds and weak intermolecular forces
		Total = 13	