Mark Scheme 2815/01
June 2005

TRENDS + PATTERNS

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Abbreviations, annotations and conventions used in the Mark Scheme

/ = alternative and acceptable answers for the same marking point
; = separates marking points
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ecf = error carried forward
AW = alternative wording
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Question	Expected answers	Marks	Additional guidance
1 (a)	Correct electronic structures magnesium either 8 electrons in outer shell or none and **both** chloride ions with 8 electrons in the outer shell (1); Correct charge on the ions, Mg^{2+} and Cl^- (1); Correct 'dot-and-cross' diagram for $SiCl_4$ with four covalent Si—Cl bonds and all lone pairs for chlorine (1)	3	
(b)	$MgCl_2$ dissolves / dissociates / ionises / forms a colourless solution / equation showing dissociation (1); With a pH of (almost) 7 (1); $SiCl_4$ is hydrolysed / reacts with water (1); to give a white precipitate / steamy fumes / white fumes / misty fumes (1); and a pH of 3 or below (1); $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ (1)	6	**Not** $MgCl_2$ fizzes or forms a white ppt **Allow** for $MgCl_2$ any pH between 6 and 7 **Ignore** state symbols in the equation **Allow** $Si(OH)_2Cl_2$ or $Si(OH)_4$ in the equation
(c)	$MgCl_2$ is giant ionic and $SiCl_4$ is a simple molecule (1) $MgCl_2$ – (Electrostatic) attraction between **ions** / attraction between (positive and negative) **ions** / aw (1); $SiCl_4$ - intermolecular attraction / van der Waals forces of attraction (1); Force of attraction in $MgCl_2$ is **stronger** than in $SiCl_4$ / ora (1)	3	The comparison of the strengths of forces/bonding must refer to the correct type of bonding e.g. strong ionic bonding and weak van der Waals (1) **Not** ionic bonds are stronger than covalent bonds

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Question	Expected answers	Marks	Additional guidance
1 (d) (i)	Al_2Cl_6 (1)	1	
(ii)	$2Al + 3Cl_2 \rightarrow Al_2Cl_6$ (1)	1	**Allow** any correct multiple of equation **Allow** ecf from wrong formula in (i)
(iii)	(Solid aluminium chloride is covalent but) in solution has **ions** that can **move** / (solid aluminium chloride has no ions but) in solution **ions** can **move** (1)	1	**Not** ions cannot move in solid **Not** reference to ionic solid
(e)	PCl_6^- (1)	1	
		Total = 16	

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Question	Expected answers	Marks	Additional guidance
2 (a) (i)	$CaCO_3 \rightarrow CaO + CO_2$ (1)	1	**Ignore** state symbols
(ii)	Calcium ion has a larger charge density than barium ion / Ca^{2+} has a smaller ionic radius than Ba^{2+} / ora (1); So calcium ion polarises the carbonate (ion) **more** than the barium ion / so Ca^{2+} distorts the CO_3^{2-} **more** than Ba^{2+} / ora (1)	2	Particles referred to must be correct **Not** Ca has a higher charge density **Not** calcium has a higher charge density **Allow** calcium has a smaller ionic radius **Allow** correct description of **more** polarisation **Allow** CO_3^- **Not** Ca^{2+} polarises CO_3
(b) (i)	Oxidation state of nitrogen goes from +5 to +4 (1); Oxidation state of oxygen goes from -2 to 0 (1); Correct linking of changes of oxidation state with reduction **and** with oxidation (1)	3	If oxidation state of barium given is incorrect **max 1** for the oxidation numbers. **Allow** ecf from wrong oxidation states for the correct linking mark **Both** oxidation **and** reduction needed
(ii)	Correct use of molar ratios (1); Correct cycle (1); (+)1000 (kJ mol^{-1}) (1)	3	**Award** full marks for (+) 1000 (kJ mol^{-1}) **Only allow** ecf for final lattice energy answer from a correct cycle **Allow** -1000 (1), + 467 (2), +901 (2), +1558 (2),

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Question	Expected answers	Marks	Additional guidance
2 (c) (i)	Moles of $Ba(NO_3)_2$ = 0.005 or 0.00502 (1); Moles of gas made = 0.0125 / 0.0126 (1); Volume of gas = 300 cm^3 to 302 cm^3 (1)	3	**Allow** ecf within question **Ignore** significant figures
(ii)	Decomposition temperature may be too high / too much gas will be produced / to fill a gas syringe need a smaller amount of solid / gas syringe too small (1)	1	**Allow** NO_2 is toxic / barium compounds are toxic Answer is **consequential** on answer to (i)
(d) (i)	Enthalpy change when one mole of a solid / energy released when one mole of solid (1); Is made from its gaseous ions (1)	2	**Not** energy required **Allow** marks via an equation **Allow** ionic compound / crystals instead of solid
(ii)	Calcium (ion) has a higher charge density / smaller (ionic) radius / ora (1); So it is **more** strongly attracted to the oxide (ion) / ora (1)	2	**Allow** calcium oxide has stronger ionic bond / ora
		Total = 17	

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Question	Expected answers	Marks	Additional guidance
3	**Transition element** Cu^{2+} $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$ (1); Transition elements have one oxidation state that has an incomplete set of 3d electrons / have one ion with a half-filled 3d orbital (1)	11	**Allow** has at least one half-filled d orbital / partially filled 3d sub-shell
	Complex ion Example of a **copper** complex ion e.g. $[Cu(H_2O)_6]^{2+}$ or $CuCl_4^{2-}$ (1); Diagram of the copper complex showing three dimensions e.g. use of wedges or dotted lines (1); Correct bond angle to match the complex / correct name of the shape of the complex (1);		If a copper complex that does not exist is used then first three marks not available If a correct iron complex is given then example mark cannot be awarded **Allow** square planar where appropriate
	Ligand is an electron **pair** donor (1); Copper(II) ion is an electron **pair** acceptor (1); Dative bond exists between ligand and the copper(II) ion (1)		Electron pair donor, electron pair acceptor and dative bond marks can awarded from an appropriate diagram
	Properties Several oxidation states e.g. copper has +1 and +2 or iron has +2 and +3 (1);		Ignore copper has a +3 Ignore iron has a +6 oxidation state
	Forms coloured compounds e.g. copper(II) chloride is green or iron(II) sulphate is pale green (1); Element or compound has catalytic properties e.g. Iron is a catalyst in the Haber process (1)		

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Question	**Expected answers**	**Marks**	**Additional guidance**
3	**Quality of written communication** *Use of technical terms – at least three terms from the* following list are used in the correct context • ligand • dative bond • *coordinate bond* • tetrahedral • square planar • octahedral • oxidation (state) • catalyst • electron pair • lone pair • orbital • sub-shell (1)	1	*Put a ring around* the technical terms
		Total = 12	