

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 NOT = answers which are not worthy of credit () = words which are not essential to gain credit _____ = (underlining) key words which must be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument			
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)	$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ (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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2 (c) (i)	Moles of $\text{Ba}(\text{NO}_3)_2 = 0.005$ 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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3	<p>Transition element $\text{Cu}^{2+} 1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$ (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)</p> <p>Complex ion Example of a copper complex ion e.g. $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ 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);</p> <p>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)</p> <p>Properties Several oxidation states e.g. copper has +1 and +2 or iron has +2 and +3 (1);</p> <p>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)</p>		11	<p>Allow has at least one half-filled d orbital / partially filled 3d sub-shell</p> <p>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</p> <p>Electron pair donor, electron pair acceptor and dative bond marks can awarded from an appropriate diagram</p> <p>Ignore copper has a +3 Ignore iron has a +6 oxidation state</p>

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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 <ul style="list-style-type: none"> • 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	