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Detailed mark scheme

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2002

XVIII

1583

Time allowed
46 Minutes

Score

/38

Percentage

%

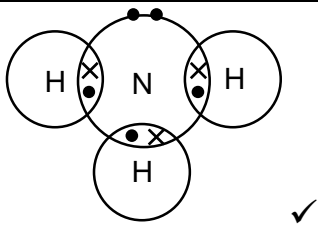
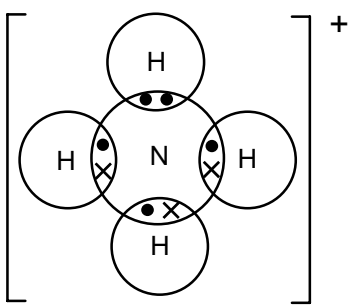
CHEMISTRY

**OCR
AS & A LEVEL**

Mark Scheme

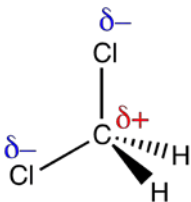



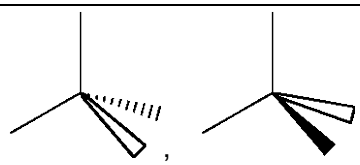



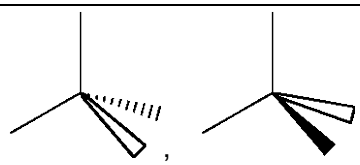



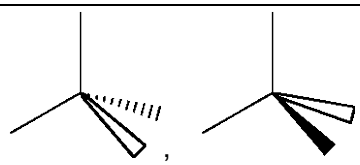
Module 2: Foundations in chemistry

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Question			Expected Answers	Marks	Additional Guidance
1	a	i	a shared pair of electrons ✓	1	ALLOW any response that communicates electron pair ALLOW shared pairs
		ii		1	Must be ' <i>dot-and-cross</i> ' circles for outer shells NOT needed IGNORE inner shells Non-bonding electrons of N do not need to be shown as a pair.
		iii	Shape: pyramidal OR (trigonal) pyramid ✓ Explanation: There are 3 bonded pairs and 1 lone pair ✓ Lone pairs repel more than bonded pairs ✓	3	ALLOW 'bonds' for 'bonded pairs' DO NOT ALLOW 'atoms repel' DO NOT ALLOW electrons repel ALLOW LP for 'lone pair' ALLOW BP for bonded pair
	b	i	$1s^2 2s^2 2p^6 3s^2 3p^6$ ✓	1	ALLOW subscripts
		ii	 ' <i>Dot-and-cross</i> ' diagram to show four shared pairs of electrons one of which is a dative covalent bond (which must consist of the same symbols) ✓	1	IGNORE inner shells IGNORE '+' sign BUT a DO NOT ALLOW '-' sign. Brackets and circles not required

Question			Expected Answers	Marks	Additional Guidance
		iii	tetrahedral ✓ 109.5° ✓	2	ALLOW 109–110°
		iv	ions OR electrons cannot move in a solid ✓ ions can move OR are mobile in solution ✓	2	ALLOW ions can move in liquid DO NOT ALLOW ions can move when molten ALLOW 1 mark for: 'Ions can only move in solution'
	c	i	$2\text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4$ ✓	1	ALLOW $2\text{NH}_4\text{OH} + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4 + 2\text{H}_2\text{O}$ ALLOW $\text{NH}_3 + \text{H}^+ \rightarrow \text{NH}_4^+$ ALLOW any correct multiple IGNORE state symbols
		ii	when the H^+ in an acid is replaced by a metal ion OR an ammonium ion OR a + ion ✓	1	ALLOW H for H^+ ; ALLOW 'metal' for 'metal ion' i.e.: H in an acid can be replaced by a metal
		iii	accepts a proton OR accepts H^+ ✓	1	ALLOW donates a lone pair ALLOW removes H^+ ALLOW forms OH^- ions
		iv	132.1 ✓	1	IGNORE units NO OTHER ACCEPTABLE ANSWER
			Total	15	

Question			Answer	Mark	Guidance
2	(a)		Cl (has been oxidised) from Cl = -1 to Cl = 0 ✓ Mn (has been reduced) from Mn = +4 to Mn = +2 ✓	2	ALLOW 4+ OR 4 OR 2+ OR 2 ALLOW oxidation numbers written above the equation but IGNORE these if oxidation numbers are given in the text ALLOW one mark for Cl is oxidised because the oxidation number increased by 1 AND Mn is reduced because the oxidation number decreased by 2 ALLOW one mark if all oxidation numbers are correct but redox is incorrect. IGNORE HCl is oxidised AND MnO ₂ is reduced IGNORE correct references to electron loss/gain DO NOT ALLOW incorrect references to electron loss/gain
	(b)		1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 3d ⁵ 4s ² ✓	1	ALLOW 4s ² 3d ⁵ IGNORE 1s ² seen twice
	(c)		Cl ₂ + 2NaOH → NaClO + NaCl + H ₂ O ✓	1	ALLOW multiples IGNORE state symbols ALLOW OH ⁻ and ClO ⁻ , i.e. Cl ₂ + 2OH ⁻ → ClO ⁻ + Cl ⁻ + H ₂ O ALLOW NaOCl
3	(d)	(i)	(The solution would turn) yellow OR orange OR brown ✓	1	ALLOW shades and colours (eg dark yellow, yellow-orange) DO NOT ALLOW 'purple'
	(d)	(ii)	Cl ₂ (g) + 2I ⁻ (aq) → I ₂ (aq) + 2Cl ⁻ (aq) ✓	1	ALLOW multiples State symbols required ALLOW Cl ₂ (aq)
	(e)	(i)	The ability of an atom to attract electrons ✓ (Electron pair) in a (covalent) bond ✓	2	ALLOW 'Measure' for ability ALLOW 'attraction' for 'ability to attract' ALLOW 'The ability of an atom to attract a shared pair of electrons' for two marks

Question			Answer	Mark	Guidance								
	(e)	(ii)	<div></div> <p>Correct orientation of 3-D tetrahedral arrangement of bonds around C atom ✓</p> <p>$\delta+$ on C atom AND $\delta-$ on both Cl atoms ✓</p>	2	<div><p>For a 3D structure,</p><table><tr><td>For bond in the plane of paper, a solid line is expected:</td><td></td></tr><tr><td>For bond out of plane of paper, a solid wedge is expected:</td><td></td></tr><tr><td>For bond into plane of paper, ALLOW:</td><td></td></tr><tr><td>ALLOW a hollow wedge for 'in bond' OR an 'out bond', provided it is different from the other in or out wedge e.g.:</td><td></td></tr></table></div> <p>ALLOW any 3D representation with a minimum of one bond into the plane of paper AND minimum of one out of plane of paper</p> <p>ALLOW 2 lines in the plane + 2 different bonds for M1</p> <p>IGNORE dipole charges on H</p>	For bond in the plane of paper, a solid line is expected:		For bond out of plane of paper, a solid wedge is expected:		For bond into plane of paper, ALLOW :		ALLOW a hollow wedge for 'in bond' OR an 'out bond', provided it is different from the other in or out wedge e.g.:	
For bond in the plane of paper, a solid line is expected:													
For bond out of plane of paper, a solid wedge is expected:													
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ALLOW a hollow wedge for 'in bond' OR an 'out bond', provided it is different from the other in or out wedge e.g.:													
		(iii)	<p>The dipoles do not cancel out OR</p> <p>Because the molecule is non-symmetrical ✓</p>	1	<p>ALLOW partial charges do not cancel</p> <p>IGNORE charges do not cancel</p> <p>ALLOW (the more) electronegative atoms are on one side of the molecule</p>								
	(f)		55% ✓	1									
Total				12									

Question			Answer	Mark	Guidance
3	(a)		period = 5 AND block = p ✓	1	
	(b)	(i)	Atom(s) of an element AND with different numbers of neutrons (and with different masses) ✓	1	ALLOW for ' atoms of an element': Atoms of the same element OR Atoms with the same number of protons OR Atoms with the same atomic number IGNORE different relative atomic masses IGNORE different mass number IGNORE same number of electrons DO NOT ALLOW different number of electrons DO NOT ALLOW 'atoms of elements' for 'atoms of an element' DO NOT ALLOW 'an element with different numbers of neutrons' (ie atom(s) is essential)
	(b)	(ii)	same number of electrons in outer shell OR same electron configuration OR electron structure ✓	1	IGNORE same number of protons IGNORE same number of electrons IGNORE they are the same element
	(b)	(iii)	51p 70n 51e ✓	1	

Question			Answer	Mark	Guidance
	(c)	(i)	<p>The (weighted) mean mass of an atom (of an element) OR The (weighted) average mass of an atom (of an element) ✓</p> <p>compared with 1/12th (the mass) ✓</p> <p>of (one atom of) carbon-12 ✓</p>	3	<p>ALLOW average atomic mass DO NOT ALLOW mean mass of an element ALLOW mean mass of isotopes OR average mass of isotopes DO NOT ALLOW the singular 'isotope'</p> <p>For second AND third marking points ALLOW compared with (the mass of) carbon-12 which is 12 For three marks; ALLOW mass of one mole of atoms compared to 1/12th (mass of) one mole OR 12g of carbon OR ALLOW $\frac{\text{mass of one mole of atoms}}{1/12\text{th mass of one mole OR 12g of carbon-12}}$</p>
	(c)	(ii)	123 ✓	1	<p>ALLOW ^{123}Sb OR Sb-123 OR antimony-123 ALLOW 123.0 IGNORE working</p>
	(d)	(i)	<p>(Trigonal) Pyramidal ✓</p> <p>(Sb has) three bonding pairs AND one lone pair of electrons ✓</p> <p>Pairs of electrons repel ✓</p>	3	<p>ALLOW alternative phrases/words to repel eg 'push apart' ALLOW lone pairs repel more than bonding pairs ALLOW bonds for bonded pairs ALLOW lp and bp</p> <p>IGNORE electrons repel DO NOT ALLOW atoms repel</p>

Question			Answer	Mark	Guidance
	(d)	(ii)	<p>There is a difference in electronegativities (between Sb and Cl)</p> <p>OR (Sb-Cl) bonds are polar OR have a dipole</p> <p>OR Dipoles seen on the diagram ✓</p> <p>The molecule is not symmetrical AND dipoles do not cancel ✓</p>	2	<p>ALLOW Because Cl is more electronegative (than Sb) OR Because Sb is more electronegative (than Cl) ALLOW description that electrons are drawn along a covalent bond</p> <p>IGNORE single δ^+ or single δ^- for dipole</p> <p>IGNORE diagram if M1 awarded in text</p> <p>ALLOW partial charges do not cancel</p> <p>IGNORE references to lone pair causing dipoles</p>
			Total	13	

Question		Answer	Mark	Guidance
4	(a)	<p>M1 <i>Trend</i> AND <i>nuclear charge</i> mark (from Li to F) atomic radius decreases AND nuclear charge increases or number of protons increases✓</p> <p>M2 <i>same shell/shielding</i> mark (outer) electrons are in same shell OR (outer) electrons experience similar or same shielding ✓ OR same number of shells</p> <p>M3 <i>nuclear attraction</i> mark Greater nuclear attraction on (outer) electrons or shells OR (Outer) electrons or shells are attracted more strongly to the nucleus ✓</p>	3	<p>ALLOW ORA throughout if it is clear that the Period is being crossed right to left</p> <p>ALLOW 'proton number increases' IGNORE 'atomic number increases' IGNORE 'nucleus gets bigger' IGNORE 'effective nuclear charge increases' DO NOT ALLOW 'charge increases' without reference to nuclear'</p> <p>IGNORE there is shielding DO NOT ALLOW sub-shells OR orbitals DO NOT ALLOW 'electrons are at a similar distance' This will also contradict M1 ALLOW 'there is no change in shielding' IGNORE 'shielding has no effect' DO NOT ALLOW 'there is no shielding'</p> <p>Quality of written communication 'nucleus' OR 'nuclear' spelled correctly once and used in context for third marking point</p> <p>ALLOW pull for attraction IGNORE for M3, 'electrons are pulled closer to nucleus' as this is a re-statement of the trend mark. DO NOT ALLOW 'greater nuclear charge' for 'greater nuclear attraction' for M3</p>

Question			Answer	Mark	Guidance
	(b)	(i)	$(1s^2) 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 \checkmark$	1	ALLOW ... $4s^2 3d^{10} 4p^6$ ALLOW subscripts AND 3D IGNORE $1s^2$ seen twice
	(b)	(ii)	Cream AND precipitate \checkmark	1	ALLOW solid OR ppt for precipitate IGNORE 'does not dissolve' OR 'partially dissolves'
	(b)	(iii)	$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s) \checkmark$	1	Equation AND state symbols required
	(c)	(i)	Equation $2NaOH + Cl_2 \rightarrow NaCl + NaClO + H_2O \checkmark$ Conditions cold AND dilute (sodium hydroxide) \checkmark	2	ALLOW correct multiples IGNORE state symbols ALLOW room temperature OR $\leq 20^\circ C$ for cold

Question	Answer	Mark	Guidance
(c) (ii)	<p><i>Definition of disproportionation mark</i></p> <p>M1 (Disproportionation) is the (simultaneous) oxidation and reduction of the same element (in the same redox reaction) ✓</p> <p>M2 Assigning of oxidation numbers</p> <p>Cl in Cl₂ is 0 AND Cl in NaCl is -1 AND Cl in NaClO₃ is +5 ✓</p> <p>M3</p> <p>Chlorine has been oxidised from 0 to +5</p> <p>AND</p> <p>Chlorine has been reduced from 0 to -1 ✓</p> <p>‘Chlorine has been oxidised from 0 in Cl₂ to +5 in NaClO₃ and chlorine has been reduced from 0 in Cl₂ to -1 in NaCl’ would secure M2 and M3</p> <div> $3\text{Cl}_2 + 6\text{NaOH} \rightarrow 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$ <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 10px;"> <div style="text-align: center;"> 0 ↓ reduction </div> <div style="text-align: center;"> -1 ↑ oxidation </div> <div style="text-align: center;"> +5 ↑ oxidation </div> </div> </div> <p>This diagram, along with a correct definition, would secure all three marks.</p>	3	<p>ALLOW ‘an element’ OR ‘a species’ for ‘the same element’</p> <p>Assume ‘it’ means disproportionation</p> <p>M1 can be awarded for ‘chlorine is oxidised and reduced and this is disproportionation’</p> <p>ALLOW oxidation numbers written above the equation if not seen in the text but IGNORE oxidation numbers written above the equation if seen in the text</p> <p>ALLOW 1– AND 5 AND 5+</p> <p>DO NOT ALLOW chloride in place of chlorine except for NaCl</p> <p>DO NOT ALLOW Cl⁻ in NaCl AND Cl⁵⁺ in NaClO₃ (ie do not allow ionic charges for oxidation numbers)</p> <p>ALLOW Cl OR Cl₂ for chlorine</p> <p>DO NOT ALLOW M2 if incorrect oxidation numbers of other elements are seen in the text eg H = +2</p> <p>ALLOW ECF for third marks if ONE incorrect oxidation number is assigned but directional changes are correct eg Cl = 0 and -1 and +3 instead 0 and -1 and +5</p> <p>DO NOT ALLOW ECF if two oxidation numbers are incorrectly assigned</p> <p>IGNORE references to electron loss/gain</p> <p>If oxidation numbers are correct ALLOW third mark for: chlorine is oxidised to form NaClO₃ AND chlorine is reduced to form NaCl</p>
	Total	11	