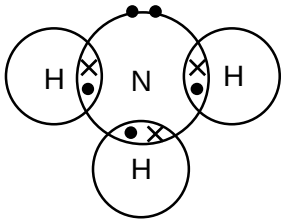
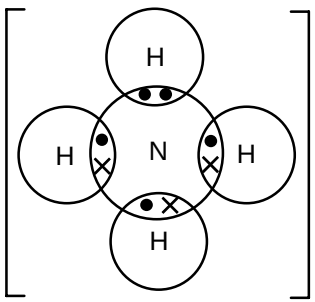
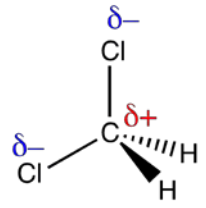
Question			Expected Answers	Marks	Additional Guidance
1	a	i	a shared pair of electrons ✓	1	**ALLOW** any response that communicates electron pair **ALLOW** shared pairs
		ii	 ✓	1	Must be '*dot-and-cross*' circles for outer shells **NOT** needed **IGNORE** inner shells Non-bonding electrons of N do not 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	 '*Dot-and-cross*' 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 ✓ 109.5º ✓	2	**ALLOW** 109–110º
		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	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ ✓	1	**ALLOW** $2NH_4OH + H_2SO_4 \rightarrow (NH_4)_2SO_4 + 2H_2O$ **ALLOW** $NH_3 + H^+ \rightarrow NH_4^+$ **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)		$Cl_2 + 2NaOH \rightarrow NaClO + NaCl + H_2O$ ✓	1	**ALLOW** multiples **IGNORE** state symbols **ALLOW** OH^- and ClO^-, i.e. $Cl_2 + 2OH^- \rightarrow ClO^- + Cl^- + H_2O$ **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)	 Correct orientation of 3-D tetrahedral arrangement of bonds around C atom ✓ δ+ on C atom **AND** δ– on both Cl atoms ✓	2	For a 3D structure, 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.: **ALLOW** any 3D representation with a minimum of one bond into the plane of paper **AND** minimum of one out of plane of paper **ALLOW** 2 lines in the plane + 2 different bonds for M1 **IGNORE** dipole charges on H
		(iii)	The dipoles do not cancel out **OR** Because the molecule is non-symmetrical ✓	1	**ALLOW** partial charges do not cancel **IGNORE** charges do not cancel **ALLOW** (the more) electronegative atoms are on one side of the molecule
	(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)	The (weighted) mean **mass** of an **atom** (of an element) **OR** The (weighted) average **mass** of an **atom** (of an element) ✓ compared with 1/12th (the mass) ✓ of (one atom of) carbon-12 ✓	**3**	**ALLOW** average atomic mass **DO NOT ALLOW** mean mass of an element **ALLOW** mean mass of isotope**s OR** average mass of isotope**s** **DO NOT ALLOW** the singular 'isotope' 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** 12**g** of carbon **OR** **ALLOW** $\frac{\text{mass of one mole of atoms}}{\text{1/12th mass of one mole OR 12g of carbon-12}}$
	(c)	(ii)	123 ✓	**1**	**ALLOW** ^{123}Sb **OR** Sb-123 **OR** antimony-123 **ALLOW** 123.0 **IGNORE** working
	(d)	(i)	(Trigonal) Pyramidal ✓ (Sb has) three bonding pairs **AND** one lone pair of electrons ✓ **Pairs** of electrons repel ✓	**3**	**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 **IGNORE** electrons repel **DO NOT ALLOW** atoms repel

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

Question			Answer	Mark	Guidance
4	(a)		M1 *Trend **AND** nuclear charge mark* (from Li to F) atomic radius decreases **AND** nuclear charge increases or number of protons increases✓ M2 *same shell/shielding mark* (outer) electrons are in same shell **OR** (outer) electrons experience similar or same shielding ✓ **OR** same number of shells M3 *nuclear attraction mark* Greater **nuclear** attraction on (outer) **electrons** or **shells** **OR** (Outer) **electrons** or **shells** are attracted more strongly to the **nucleus** ✓	3	**ALLOW ORA** throughout if it is clear that the Period is being crossed right to left **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' **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' Quality of written communication 'nucleus' **OR** 'nuclear' spelled correctly once and used in context for third marking point **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

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

Question			Answer	Mark	Guidance
	(c)	(ii)	*Definition of disproportionation mark* M1 (Disproportionation) is the (simultaneous) oxidation and reduction of the same element (in the same redox reaction) ✓ M2 Assigning of oxidation numbers Cl in Cl_2 is 0 **AND** Cl in NaCl is -1 **AND** Cl in $NaClO_3$ is +5 ✓ M3 Chlorine has been oxidised from 0 to +5 AND Chlorine has been reduced from 0 to –1 ✓ 'Chlorine has been oxidised from 0 in Cl_2 to +5 in $NaClO_3$ and chlorine has been reduced from 0 in Cl_2 to -1 in NaCl' would secure M2 and M3 $3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$ 0 -1 +5 reduction oxidation This diagram, along with a correct definition, would secure all three marks.	3	**ALLOW** 'an element' OR 'a species' for 'the same element' Assume 'it' means disproportionation M1 can be awarded for 'chlorine is oxidised and reduced **and** this is disproportionation' **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 **ALLOW** 1– **AND** 5 **AND** 5+ **DO NOT ALLOW** chloride in place of chlorine except for NaCl **DO NOT ALLOW** Cl^- in NaCl AND Cl^{5+} in $NaClO_3$ (ie do not allow ionic charges for oxidation numbers) **ALLOW** Cl **OR** Cl_2 for chlorine **DO NOT ALLOW** M2 if incorrect oxidation numbers of other elements are seen in the text eg H = +2 **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 **DO NOT ALLOW** ECF if two oxidation numbers are incorrectly assigned **IGNORE** references to electron loss/gain If oxidation numbers are correct ALLOW third mark for: chlorine is oxidised to form $NaClO_3$ **AND** chlorine is reduced to form NaCl
			Total	**11**	