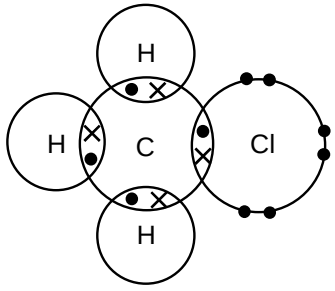
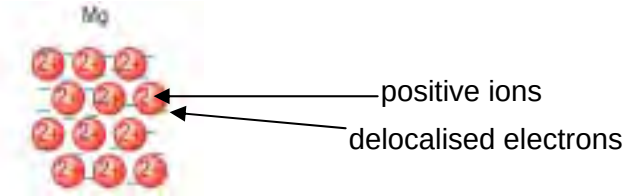
Question			er	Mark	Guidance
1	(a)		$2NaOH + Cl_2 \rightarrow NaClO + NaCl + H_2O$ ✓	1	**ALLOW** NaOCl **IGNORE** state symbols
	(b)	(i)	Sodium chlorate(V) ✓	1	**ALLOW** sodium chlorate V **DO NOT ALLOW** sodium chlorate 5
		(ii)			***USE annotations with ticks, crosses, con, ECF, etc for this part.***
			Cl in $NaClO_3$ is (+)5 **AND** Cl in $NaClO_4$ is (+)7 **AND** Cl in NaCl is –1 ✓	1	**ALLOW** 5+, 7+ 1– Look for oxidation numbers seen above equation. **DO NOT ALLOW** Cl^- in NaCl
			Chlorine has been both oxidised and reduced **OR** The oxidation number of chlorine has increased **AND** decreased ✓	1	**The second and third marking points must refer to chlorine** **ALLOW** 'it' for 'chlorine' if oxidation numbers of chlorine are given **ALLOW** Cl for 'chlorine' **DO NOT ALLOW** Cl_2 for 'chlorine'
			Chlorine has been oxidised from (+)5 to (+)7 **AND** chlorine has been reduced from (+)5 to –1 ✓ (These points would secure marking points 2 and 3) $4NaClO_3 \rightarrow 3NaClO_4 + NaCl$ +5 +7 –1 This diagram gets all 3 marks oxidation reduction	1	**ALLOW** 'correct' references to oxidation and reduction even if based on incorrect oxidation numbers of chlorine **IGNORE** references to electron loss / gain if correct. **DO NOT ALLOW** 3rd mark for reference to electron loss/gain If oxidation numbers are correct, **ALLOW** 1 mark for 'chlorine is oxidised to form $NaClO_4$' **ALLOW** 1 mark for 'chlorine is reduced to form NaCl' **ALLOW** one mark for 'disproportionation is when a species is both oxidised and reduced' whether or not chlorine is mentioned
	(c)	(i)	Chlorinated hydrocarbons are carcinogens **OR** toxic **OR** Chlorine is toxic **OR** poisonous ✓	1	**ALLOW** CH_3Cl for 'chlorinated hydrocarbons' **IGNORE** 'harmful' **IGNORE** 'carcinogenic' for chlorine
			(Chlorine) kills bacteria **OR** 'kills germs' 'kills micro-organisms' **OR** 'makes water safe to drink' **OR** 'sterilises water' **OR** 'disinfects' ✓	1	**DO NOT ALLOW** 'antiseptic' **ALLOW** 'to make water potable' **ALLOW** 'removes' for 'kills' **IGNORE** 'virus' **IGNORE** 'purifies water' **IGNORE** 'cleans water'

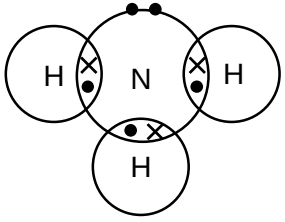
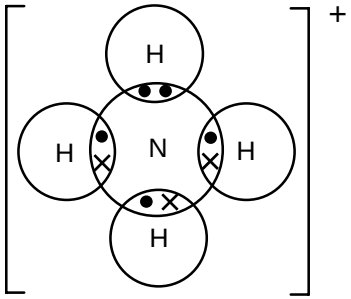
Question			er	Mark	Guidance
1	(c)	(ii)	Electron pairs in covalent bonds shown correctly using dots and crosses in a molecule of CH_3Cl **AND** lone pairs correct on Cl ✓  	**1**	Must be '*dot-and cross'* **ALLOW** different symbol for third 'type' of electron Circles for outer shells not needed **IGNORE** inner shells Non-bonding electrons of chlorine do not need to be shown as pairs
		(iii)	Tetrahedral **OR** tetrahedron ✓	**1**	
	(d)		Add $AgNO_3$(aq) **OR** Ag^+(aq) **OR** silver nitrate **OR** $AgNO_3$ ✓	**1**	**ALLOW** Ag^+(aq) seen in the ionic equation **IGNORE** references to nitric acid **IGNORE** references to adding water or dissolving the brine **DO NOT ALLOW** references to any other additional reagent as well as the silver nitrate for the first mark
			White precipitate ✓	**1**	White **AND** precipitate required **DO NOT ALLOW** hint of any other colour **IGNORE '**turns grey' **ALLOW** solid as alternative for precipitate
			$Ag^+ + Cl^- \rightarrow AgCl$ ✓	**1**	**IGNORE** states
			Add dilute NH_3 and precipitate (completely) dissolves **OR** disappears ✓	**1**	**DO NOT ALLOW** conc. NH_3 **DO NOT ALLOW** any mention of incomplete dissolving **ALLOW** (for 4th mark) 'add Cl_2(aq)' **AND '**no colouration would be seen' **OR** 'no change' **OR** 'no reaction'
			Total	**13**	

Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	Potassium **AND** argon ✓	1	**ALLOW** K and Ar
		(ii)	They are arranged in increasing atomic number **OR** Neither would show properties **OR** trends of rest of group **OR** Neither would show properties **OR** trends of rest of period **OR** They are arranged by electron configuration ✓	1	**ALLOW** any correct property difference e.g. This would place a reactive metal in the same group as noble gases **ALLOW** they do not fit in with the rest of the group
	(b)	(i)	$2Mg + O_2 \rightarrow 2MgO$ ✓	1	**ALLOW** multiples. Correct species must be seen **IGNORE** state symbols
		(ii)	Fizzes **OR** bubbles **OR** gas produced **OR** effervescing ✓ Mg dissolves **OR** Mg disappears **OR** a solution is formed ✓	2	**DO NOT ALLOW** 'carbon dioxide gas produced' **DO NOT ALLOW** 'hydrogen produced' without 'gas' **ALLOW** 'it for Mg' **IGNORE** Mg reacts **IGNORE** temperature change **IGNORE** steam produced
		(iii)	Quicker **OR** more vigorous **OR** gets hotter	1	**MUST** be a comparison of a reaction observation, not just 'more reactive' **ALLOW** any comparison of greater rate including more bubbles etc. **DO NOT ALLOW** more gas produced

Question	Expected Answers	Marks	Additional Guidance
(c)	Mg has a **giant** structure ✓	6	
	Mg has **metallic** bonding OR description of metallic bonding as positive ions and **delocalised** electrons ✓		**Metallic OR delocalised** seen spelt correctly at least **ONCE**
	(There is electrostatic attraction between) positive ions and electrons ✓		**DO NOT ALLOW** as label nuclei **OR** protons for positive ions **ALLOW labelled** diagram of metallic bonding for second and third marks  Lattice must have at least two rows of positive ions. If a Mg ion is shown it must correct charge **ALLOW** for labels:+ ions, positive ions, cations **DO NOT ALLOW** as label nuclei **OR** protons for positive ions **ALLOW** e^- or e as label for electron **DO NOT ALLOW** '–' without label for electron
	Cl has a simple molecular **OR** simple covalent (lattice) ✓		**Covalent OR molecule OR molecular** seen spelt correctly at least **ONCE** **ALLOW** Cl is a (covalent) **molecule**
	Cl has van der Waals' forces (between molecules) **OR** Cl has instantaneous dipole–induced dipoles **OR** temporary dipole–temporary dipole ✓		**IGNORE** Cl has intermolecular bonding

			van der Waals' forces are weak **and** metallic bonds are strong **OR** van der Waals' forces are weak**er** than metallic bonds **OR** Less energy is needed to overcome van der Waals' than metallic bonds ✓		**ALLOW** ECF from incorrect descriptions of giant structure with strong bonds; e.g. Mg has giant ionic structure **ALLOW** ECF from any incorrect intermolecular forces e.g. permanent dipole –dipole from marking point 5 **ALLOW** vdW easi**er** to break ORA
	(d)	**(i)**	O goes from –2 to 0 ✓ N goes from +5 to +4 ✓ N is reduced **AND** O is oxidised ✓	**3**	Oxidation numbers may be seen with equation Third mark is dependent upon seeing a reduction in oxidation number of N and an increase in oxidation number of O **ALLOW** ECF for third mark for N is oxidised **and** O is reduced if incorrect oxidation numbers support this **IGNORE** references to strontium **IGNORE** references to electron loss **OR** gain **DO NOT ALLOW** 'One increases and one decreases'

	(d)	**(ii)**	Calculates correctly: Mol of $Sr(NO_3)_2 = \frac{5.29}{211.6} = 0.0250$ ✓ Calculates correctly: Mol of gas = 5/2 × 0.0250 = 0.0625 ✓ Calculates correctly: Volume of gas = 24.0 × 0.0625 = 1.50 dm^3 ✓	**3**	**ALLOW** 0.025 **ALLOW** ECF for first answer × 2.5 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes **ALLOW** ECF for second answer × 24(.0) as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes **DO NOT ALLOW** ECF of first answer × 24(.0) (which gives 0.6(0) dm^3) as this has not measured the volume of any gas, simply 0.0250 mol of solid $Sr(NO_3)_2$ converted into a gas i.e. This answer would give **one** mark **ALLOW** 1.5 dm^3 **ALLOW** ECF producing correct volume of NO_2 only i.e. 1.2(0) dm^3 would give **two** marks **OR** **ALLOW** ECF producing correct volume of O_2 only i.e. 0.3(0) dm^3 would give **two** marks
			Total	**18**	

Question			Expected Answers	Marks	Additional Guidance
3	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	