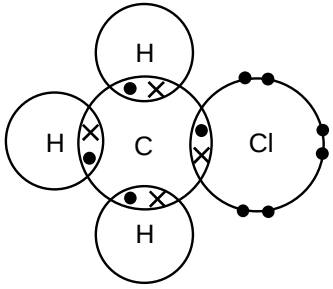
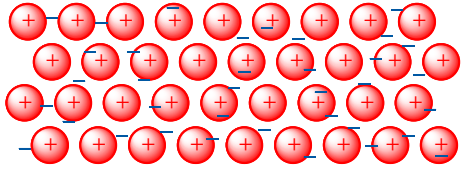
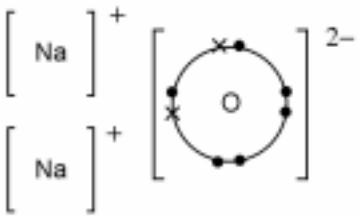
Question			er	Mark	Guidance
1	(a)		$2NaOH + Cl_2 \rightarrow NaClO + NaCl + H_2O$ ✓	1	**ALLOW** NaOCl **IGNORE** state symbols
	(b)	(i)	Sodium chlorate(V) ✓	1	**ALLOW** sodium chlorate V **DO NOT ALLOW** sodium chlorate 5
		(ii)			***USE annotations with ticks, crosses, con, ECF, etc for this part.***
			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)		 regular arrangement of **labelled** + ions with some attempt to show electrons ✓ scattering of labelled electrons **between** other species **OR** a statement anywhere of **delocalised** electrons (can be in text below) ✓ metallic bond as (electrostatic) **attraction** between the electrons and the positive ions ✓	**3**	Lattice must have at least 2 rows of positive ions If a metal ion is shown (e.g. Na^+), it must have the correct charge **ALLOW** for labels: + ions, positive ions, cations If '+' is unlabelled in diagram, award the label for '+' from a statement of 'positive ions' in text below **DO NOT ALLOW** as label or text positive atom **OR** protons **OR** nuclei **ALLOW** e^- **OR** e as label for electron **DO NOT ALLOW** '–' as label for electron
	(b)	**(i)**	$4\ Na + O_2 \longrightarrow 2\ Na_2O$ **OR** $2\ Na + ½\ O_2 \longrightarrow Na_2O$ ✓	**1**	**ALLOW** correct multiples including fractions **IGNORE** state symbols
		(ii)	(electrostatic) attraction between oppositely charged ions✓	**1**	

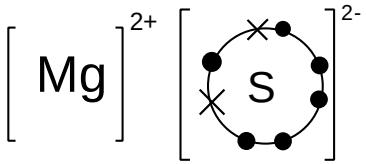
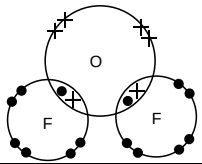
Question			Expected Answers	Marks	Additional Guidance
		(iii)	 Na shown with either 8 or 0 electrons **AND** O shown with 8 electrons **with** 6 crosses and 2 dots (or vice versa) ✓ Correct charges on both ions ✓	**2**	**For 1st mark,** if 8 electrons shown around cation then 'extra' electron(s) around anion must match symbol chosen for electrons in cation Shell circles not required **IGNORE** inner shell electrons **ALLOW:** $2[Na^+]$ $2[Na]^+$ $[Na^+]_2$ (brackets not required) **DO NOT ALLOW** $[Na_2]^{2+}$ / $[Na_2]^+$ / $[2Na]^{2+}$ **DO NOT ALLOW**: $[Na_2]^{2+}$ $[Na_2]^+$ $[2Na]^{2+}$ $[Na]_2^+$
	(c)		sodium is a (good) conductor because it has mobile electrons **OR** delocalised electrons **OR** electrons can move ✓ sodium oxide does not conduct as a solid ✓ sodium oxide conducts when it is a liquid ✓ ions cannot move in a solid ✓ **ions** can move **OR** are mobile when liquid ✓	**5**	**Throughout this question, 'conducts' and 'carries charge' are treated as equivalent terms.** **DO NOT ALLOW** 'free electrons' for mobile electrons **ALLOW** poor conductor **OR** bad conductor 'Sodium oxide only conducts when liquid' is insufficient to award 'solid conductivity' mark **ALLOW** ions are fixed in place **IGNORE** electrons **IGNORE** charge carriers **IGNORE** 'delocalised ions' or 'free ions' for mobile ions Any mention of electrons moving is a **CON**
			Total	**12**	

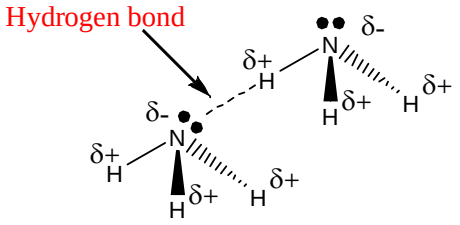
Question			er	Marks	Guidance
3	(a)		<table><tr><th>solid</th><th>melting point / °C</th><th>type of lattice</th></tr><tr><td>K</td><td>6</td><td></td></tr><tr><td>KBr</td><td></td><td>giant ionic ✓</td></tr><tr><td>H_2O</td><td></td><td>simple molecular ✓</td></tr></table>	2	giant **AND** ionic required simple **AND** molecular required **ALLOW** simple covalent
	(b)		*Particle mark 1:* In K, (electrostatic attraction between) positive ions/cations **AND** e^- / electrons ✓ *Particle mark 2:* In KBr, (electrostatic attraction between) **oppositely OR** positively **AND** negatively charged ions ✓ *Forces mark:* K has metallic bonding **OR** K has attraction between positive ions and electrons **AND** KBr has ionic bonding **OR** KBr has attraction between oppositely charged ions ✓ *In H_2O,* *Forces mark:* hydrogen bonding ✓ *Particles mark (QWC):* (Between) molecules ✓ Order of strength of forces: KBr > K > H_2O **OR** ionic bonding > metallic bonding > hydrogen bonding ✓	6	**Use annotations with ticks, crosses, ECF etc for this part** **ALLOW labels** from diagrams if not seen in text **ALLOW** K^+ and Br^- for 'oppositely charged ions' **DO NOT ALLOW '**atoms' in KBr **IGNORE** 'metallic lattice' for metallic bonding' **AND** 'ionic lattice' for 'ionic bonding' **DO NOT ALLOW** , for forces mark, incorrect forces for K and KBr, such as covalent, van der Waals' seen anywhere in the response **IGNORE** references to van der Waals' forces in water **ALLOW** 'intermolecular' **OR** 'molecular' for particles mark *Quality of Written Communication*: 'molecules' **OR** 'intermolecular' **OR** 'molecular' spelt correctly once and used in context for the fifth marking point The order of all **three** substances **OR** bonding must be referred to for this mark **ALLOW** responses which use comparatives such as strong and extremely strong to differentiate strength of forces **ALLOW** answers that inform KBr > K > H_2O IGNORING incorrect forces used above

Question			er	Marks	Guidance
	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE IF answer = 72(.0) (cm^3) award 3 marks amount of K = 0.2346 / 39.1 **OR** = 6.(00) × 10^{-3} **OR** 0.006(00) mol ✓ amount of H_2 = (mol of K) / 2 **OR** = 3.(00) × 10^{-3} **OR** 0.003(00) mol ✓ Volume of gas = (mol of H_2) × 24000 **OR** = 72(.0) (cm^3) ✓	3	If there is an alternative answer, check to see if there is any ECF credit possible using working below **ALLOW** mol of K x 0.5 correctly calculated for 2nd mark **ALLOW** mol of H_2 x 24000 correctly calculated for 3rd mark **ALLOW** 144 (cm^3) from 0.006 x 24000 for two marks **ALLOW** 0.072 from 0.003 x 24 for two marks **ALLOW** calculator value or rounding to 2 significant figures or more **BUT IGNORE** 'trailing' zeroes, eg 0.200 allowed as 0.2
			Total	**11**	

Question			Answer	Mark	Guidance
4	(a)		The ability of an **atom** to attract electrons ✓ in a covalent bond ✓	2	**ALLOW** 'attraction of an **atom** for electrons' **ALLOW** 'pull' for 'attract' **DO NOT ALLOW** 'element' for 'atom' **ALLOW** 'shared pair' or 'bond(ing) pair' for 'covalent bond'
	(b)		δ^+N–Fδ^- **AND** δ^-N–Brδ^+ ✓	1	**ALLOW** d+ / d- **DO NOT ALLOW** + / –
	(c)	(i)	octahedral **OR** octahedron ✓	1	
		(ii)	 Diagram of BF_3 showing three '*dot-and-cross*' bonds between B and F and all F atoms with complete octet of electrons ✓ Diagram of NH_3 showing three '*dot-and-cross*' bonds between N and H and N atom has a lone pair ✓ ***Marking points 3, 4 and 5 may be awarded independently*** electron pairs repel ✓ NH_3 has **one lone** pair and **three bonding** pairs of electrons **AND** lone pair of electrons repels **more** than bonding pairs ✓ BF_3 has **three** (bonding) pairs of electrons (which repel equally) ✓	5	**Use annotations with ticks, crosses ECF etc. for this part** **ALLOW** diagrams without circles Must be '*dot-and-cross*' **IGNORE** 'electrons repel' **DO NOT ALLOW** 'atoms repel' **ALLOW** 'bonds repel' **ALLOW** 'bonds' for 'bonding pairs' **ALLOW** 'four pairs' in place of 'one lone pair and three bonding pairs' The third marking point can be gained from statements seen in fourth or fifth marking points

Question			er	Mark	Guidance
4	(c)	(iii)	BF_3 is **symmetrical** ✓ The **dipoles** cancel out ✓	2	**IGNORE** 'polar bonds cancel' **IGNORE** 'charges cancel'
			Total	**11**	

Question			Expected Answers	Marks	Additional Guidance
5	(a)	(i)	(Electrostatic) **attraction** between oppositely charged **ions**. ✓	1	**IGNORE** force **IGNORE** references to transfer of electrons **MUST** be ions, not particles
		(ii)	Mg shown with either 8 of 0 electrons **AND** S shown with 8 electrons **with** 2 crosses and 6 dots (or vice versa) ✓ Correct charges on both ions ✓ 	2	Mark charges on ions and electrons independently **For first mark**, if 8 electrons are shown around the Mg then 'extra electrons' around S must match the symbol chosen for electrons around Mg Shell circles not required **IGNORE** inner shell electrons Brackets are not required
	(b)	(i)	Electron pairs in covalent bonds shown correctly using dots and crosses in a molecule of the F_2O ✓ Lone pairs correct on O and both F atoms ✓ 	2	Must be '*dot-and-cross*' circles for outer shells **NOT** needed **IGNORE** inner shells Non-bonding electrons of O do not need to be shown as pairs Non-bonding electrons of F do not need to be shown as pairs
		(ii)	Predicted bond angle 104–105^{O}. ✓ There are 2 bonded pairs and 2 lone pairs ✓ Lone pairs repel more than bonded pairs ✓	3	**ALLOW** 103–105^{O} (103^{O} is the actual bond angle) **ALLOW** responses equivalent to second marking point. e.g. There are 4 pairs of electrons and 2 of these are lone pairs **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 **ALLOW** LP repel more if bonded pairs have already been mentioned

Question			Expected Answers	Marks	Additional Guidance
	(c)	(i)	(At least) two **NH_3** molecules with correct dipole shown with at least one H with δ^+ and one N with δ^- ✓	3	**DO NOT ALLOW** first mark for ammonia molecules with incorrect lone pairs **DO NOT ALLOW** first mark if H_2O, NH_2 or NH is shown
			(Only) one hydrogen bond from N atom on one molecule to a H atom on another molecule ✓		**ALLOW** hydrogen bond need not be labelled as long as it clear the bond type is different from the covalent N–H bond **ALLOW** a line (i.e. looks like a covalent bond) as long as it is labelled 'hydrogen bond)
			Lone pair shown on the N atom and hydrogen bond must hit the lone pair ✓  		**ALLOW** 2-D diagrams **ALLOW** two marks if water molecules are used. One awarded for a correct hydrogen bond and one for the involvement of lone pair
		(ii)	Liquid H_2O is denser than solid ✓ In solid state H_2O molecules are held apart by hydrogen bonds **OR** ice has an open lattice ✓ **OR** H_2O has a relatively high boiling point **OR** melting point ✓ (relatively strong) hydrogen bonds need to be broken **OR** a lot of energy is needed to overcome hydrogen bonds **OR** hydrogen bonds are strong ✓	2	ORA **ALLOW** ice floats for first mark **ALLOW** higher melting **OR** boiling point than expected **DO NOT ALLOW** H_2O has a high melting / boiling point **ALLOW** other properties caused by hydrogen bonding not mentioned within the specification E.g. high surface tension – strong hydrogen bonds on the surface
			Total	**13**	