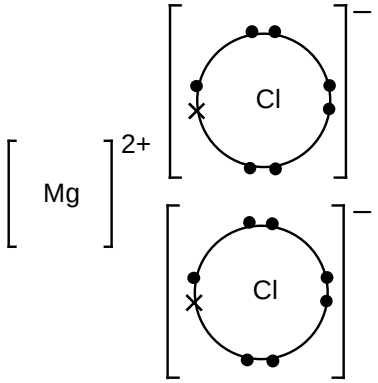
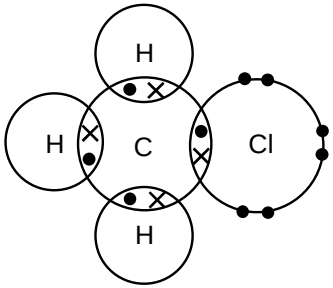
Question			Answer	Mark	Guidance
1	(a)		<table><tr><td>particle</td><td>rel charge</td><td>rel mass</td><td>position</td></tr><tr><td>proton</td><td>+1</td><td>1</td><td>nucleus</td></tr><tr><td>neutron</td><td>nil/0</td><td>1</td><td>nucleus</td></tr><tr><td>electrons</td><td>-1</td><td>1/2000</td><td>in shells</td></tr></table> ✓	1	1 mark for whole table **ALLOW** '+' on its own for rel charge of proton **DO NOT ALLOW** '1' on its own for rel charge of proton **DO NOT ALLOW** 'positive' for rel charge of proton For neutron **ALLOW** 'neutral' **ALLOW '**–' on its own for rel charge of electron **DO NOT ALLOW** 'negative' for rel charge of electron **IGNORE** '+' if precedes '1' for mass **IGNORE** 'middle/centre' for nucleus
	(b)		The energy required to remove an electron ✓ from each **atom** in **one mole** ✓ of **atoms** in the **gaseous** state ✓	1 1 1	**ALLOW** 'energy to remove one mole of electrons from one mole of gaseous atoms' for three marks **ALLOW** 'The energy required to remove an electron from one mole of gaseous atoms to form one mole of gaseous 1+ ions' for two marks as it does not meet the 2nd marking point For third mark: **ALLOW** ECF of wrong particle being gaseous If no attempt at a definition, **ALLOW one** mark for the equation below, including state symbols $X(g) \rightarrow X^+(g) + e^-$ **OR** $X(g) - e^- \rightarrow X^+(g)$ **ALLOW** e for electrons **IGNORE** state symbol for electron
	(c)		<table><tr><td>a 2p orbital</td><td>2 ✓</td></tr><tr><td>the 3s sub-shell</td><td>2 ✓</td></tr><tr><td>the 4th shell</td><td>32 ✓</td></tr></table>	1 1 1	
	(d)		A repeating pattern (of properties shown across different periods) ✓	1	**ALLOW** 'repeating trend' **DO NOT ALLOW** just 'trend' **OR** 'pattern'
	(e)	(i)	C ✓	1	
		(ii)	Al ✓	1	
		(iii)	N ✓	1	
		(iv)	Al ✓	1	
		(v)	Mg ✓	1	
			Total	**13**	

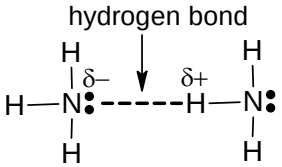
Question			Answer	Mark	Guidance
2	**(a)**		$MgCO_3 \rightarrow MgO + CO_2$ ✓	**1**	**IGNORE** state symbols
	(b)	**(i)**	$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$ Correct balanced equation ✓ Correct states for correct species ✓	**1** **1**	 **ALLOW** states mark if MgCl used in place of $MgCl_2$
		(ii)	Similarity: (Both) dissolve **OR** disappear. ✓ Difference: One effervesces **OR** fizzes **OR** bubbles **OR** gas produced ✓	**1** **1**	**ALLOW** (both) 'go clear' **ALLOW** CO_2 produced **DO NOT ALLOW** incorrect gases **DO NOT ALLOW** responses which suggest **A** will effervesce e.g. as **B** will fizz more
		(iii)	203.3	**1**	**DO NOT ALLOW** 203 or 203.0 **IGNORE** units
		(iv)	 magnesium (ion) with 8 (or no) outermost electrons **AND** 2 x chloride (ions) with '*dot-and-cross*' outermost octet ✓ correct charges ✓	 **1** **1**	**For 1st mark,** if 8 electrons shown around cation then 'extra' electron around anion must match symbol chosen for electrons in cation Shell circles not required **IGNORE** inner shell electrons **ALLOW** correct diagram of a $[Cl^-]$ ion with '2 x' **OR** '2' in front **OR** 'x 2' after the diagram. **ALLOW** correct diagram of $[Cl^-]$ ion with subscript 2. i.e. $[Cl^-]_2$. **DO NOT ALLOW** $[Cl^-_2]$ $[Cl]^-_2$ i.e. for first mark charges do not need to be seen

Question			Answer	Mark	Guidance
2	(c)		$\frac{1.82}{24.3}$ $\frac{1.05}{28.1}$ $\frac{2.40}{16.0}$ To give 0.0749 0.0374 0.150 Ratio of moles ✓	1	**ALLOW** '24' for Mg (giving 0.0758) and '28' for Si (giving 0.0375) **ALLOW** any correct ratios of moles as calculator value **OR** correct rounding **to 2 sig figs or more** **ALLOW** method from masses being converted to percentages
			Answer = Mg_2SiO_4 ✓	1	**ALLOW** correct answer from a ratio of moles where it is clear that the candidate has divided by the atomic numbers. **ALLOW** ECF for formula from incorrect ratio of moles due to over-rounding calculator error or upside down mole calculation
	(d)	(i)	$\frac{32.00}{1000}$ x 0.500 = 1.60 x 10^{-2} (mol) **OR** 0.0160 (mol)✓	1	**ALLOW** 0.016 (mol) **IGNORE** trailing zeroes
		(ii)	$\frac{1.60 \times 10^{-2}}{2}$ = 8.00 x 10^{-3} (mol) **OR** 0.00800 (mol)✓	1	**ALLOW** ECF for answer **d(i)** / 2 **ALLOW** 0.008 or 8 × 10^{-3} (mol) Ignore trailing zeroes **ALLOW** 0.0080 or 8.0 × 10^{-3}
		(iii)	Molar mass $Mg(OH)_2$ = 58.3 ✓	1	**DO NOT ALLOW** 58 **OR** 58.0
			mass $Mg(OH)_2$ = 58.3 × 8.00 x 10^{-3} = 0.466(4) g ✓	1	**ALLOW** answer to **d(ii)** × 58.3 **ALLOW** 0.47 **ALLOW** ECF for **d(ii)** × incorrect molar mass as calculator value **OR** correct rounding to 2 sig figs or more
			% $Mg(OH)_2$ = $\frac{0.4664}{0.500}$ × 100 = 93.3% ✓	1	**ALLOW** 93% **OR** 93.2% **OR** 93.28% **DO NOT ALLOW d(ii)**/0.5 x 100 **ALLOW** (answer to second marking point/0.500) × 100 as calculator value **OR** correct rounding to 2 sig figs or more **ALLOW** moles method for 3 marks Molar mass = 58.3 0.500/58.3 = =0.00857(6) 0.00800/0857(6) × 100 = 93.3% **ALLOW** correct answer without working for 3 marks
			Total	**15**	

Question			Answer	Mark	Guidance
3	(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 oxidation reduction This diagram gets all 3 marks	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			Answer	Mark	Guidance
3	(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			Answer	Mark	Guidance
4	(a)	(i)	The hydrogen **ions OR** H^+ **OR** protons (of hydrochloric acid) are replaced by zinc **ions OR** Zn^{2+} ✓	1	**ALLOW** Zn ions **OR** positive ions replace H **ions OR** a metal ion has replaced a hydrogen ion **OR** protons **DO NOT ALLOW** Zn replaces H. Ions are key either in word form or symbol form **DO NOT ALLOW** Zn^+ i.e. if charge is shown it must be correct
		(ii)	$Zn_3(PO_4)_2$ ✓	1	**ALLOW** $ZnHPO_4$ **OR** $Zn(H_2PO_4)_2$ **ALLOW** $Zn_3P_2O_8$
	(b)				***USE annotations with ticks, crosses, con, ECF, etc for this part.***
			reactivity increases (down the group) ✓	1	'down the group' not required **ALLOW** alternative phrases for 'reactivity increases'
			Increasing size mark atomic radii increases **OR** there are more shells ✓	1	**ALLOW** 'there are more energy levels' **ALLOW** 'electrons are in a higher energy level' **ALLOW** 'the electrons are further from nucleus' **IGNORE** there are more orbitals **OR** more sub-shells **IGNORE** 'different shell' or 'new shell'
			Increased shielding mark there is **more** shielding ✓	1	**ALLOW** '**more** screening' There must be a clear comparison i.e. '**more** shielding' **OR** '**increased** shielding'. i.e. **DO NOT ALLOW** 'there is shielding' **ALLOW** 'there is **more** electron repulsion from inner shells' *'***more'** *is essential*
			Nuclear attraction mark The nuclear attraction decreases **OR** (outermost) electrons experience less attraction (to nucleus) **OR** Increased shielding / distance outweighs the increased nuclear charge ✓	1	**ALLOW** 'there is less nuclear pull' **OR** 'electrons less tightly held' **IGNORE** 'there is less effective nuclear charge' **IGNORE** 'nuclear charge' for 'nuclear attraction'
			easier to remove (outer) electrons **OR** ionisation energy decreases ✓ **ORA** throughout	1	**ALLOW** 'easier to oxidise' ***Quality of Written Communication –*** *'electron(s)'* ***OR*** *'ionisation'* ***OR*** *'ionization'* ***OR*** *'oxidise'* ***OR*** *oxidize' spelled correctly at least once for 5th marking point*
			Total	7	

Question			Answer	Mark	Guidance
5	(a)		Metallic lattice has delocalised **OR** mobile electrons **OR** metallic bonding has delocalised **OR** mobile electrons ✓	1	**IGNORE** 'free electrons' for 'mobile electrons' **DO NOT ALLOW** references to incorrect bonding
			Ionic lattice has no mobile ions **OR** ionic solid has no mobile ions ✓	1	**ALLOW** 'ions are fixed in place' **IGNORE** 'no mobile electrons' for solid ionic **IGNORE** 'no mobile charge carriers' for solid ionic
			molten ionic (compounds) have mobile ions ✓	1	**IGNORE** 'delocalised ions' **OR** 'free ions' for 'mobile ions' **DO NOT ALLOW** any mention of electrons moving **IGNORE** 'aqueous ionic compounds have mobile ions'
	(b)	(i)	Two (or more) ammonia molecules with at least one Hδ+ and at least one Nδ- (can be on the same or different molecules) ✓	1	There must be 3H atoms bonded to one N atom **DO NOT ALLOW** any Hδ- **OR** Nδ+ **ALLOW** 2-D NH_3 molecules **IGNORE** lone pair(s) for first marking point
			H-bond between H in one ammonia and lone pair of N in another ammonia molecule ✓  	1	All H-bonds drawn must hit the lone pair H-bond does not need to be labelled but must be different from covalent bond **DO NOT ALLOW** more than one lone pair on N for second marking point **ALLOW** a pair of molecules with two 'correct' hydrogen bonds forming a 'dimer'
		(ii)	Ice has stronger hydrogen bonds ✓	1	**ALLOW** 'more' for 'stronger' **OR** Ice has twice as many hydrogen bonds as ammonia **ALLOW** ice has strong**er** intermolecular forces than ammonia **OR** big**ger** permanent dipole than ammonia **DO NOT ALLOW** comparisons between different types of force **DO NOT ALLOW** reference to van der Waals' **IGNORE** 'more energy needed'
			O has two lone pairs (**AND** N has one) **OR** O more electronegative (than N) ✓	1	**ALLOW** O has more lone pairs

Question			Answer	Mark	Guidance
5	(c)				***USE annotations with ticks, crosses, con, ECF, etc for this part.***
			SiO_2 is **giant covalent** (lattice)✓	1	**ALLOW** macromolecular **OR** giant atomic **ALLOW** SiO_2 is a 'giant structure with covalent bonds' **ALLOW** even if reference to 'covalent' only appears later in answer. **DO NOT ALLOW** any reference to 'ionic' **OR** 'intermolecular' **OR** 'metallic' **Quality of Written Communication -** Covalent **OR** macromolecular **OR** atomic spelt correctly **ONCE** and used in context of the first marking point
			$SiCl_4$ is **simple molecular** (lattice) ✓	1	**ALLOW** simple covalent **DO NOT ALLOW** any reference to 'giant' **OR** 'ionic' **OR** 'metallic' **If neither of the 1st 2 marks have been awarded,** **ALLOW** 1 mark for SiO_2 is giant **AND** $SiCl_4$ is simple **OR** molecular
			van der Waals' forces in $SiCl_4$ ✓	1	**ALLOW** induced dipoles **DO NOT ALLOW** permanent dipoles
			Covalent bonds broken in SiO_2 ✓	1	**ALLOW** alternative words to broken e.g. overcome
			Forces **OR** bonds are stronger in SiO_2 (than in $SiCl_4$) **OR** more energy is needed to break forces **OR** bonds in SiO_2 (than in $SiCl_4$) ✓ **ORA**	1	**ALLOW** incorrect forces in $SiCl_4$ **OR** SiO_2 for this mark
			Total	**12**	

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