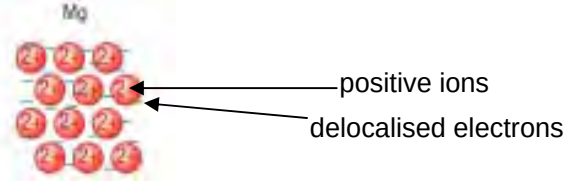
Question			Expected Answers	Marks	Additional Guidance
1	(a)		*Advantage* removes or kills bacteria **OR** kills germs **OR** kills micro-organisms **OR** make it safe to drink **OR** sterilises water **OR** disinfects water ✓ *Disadvantage* it is toxic **OR** poisonous **OR** could form chlorinated hydrocarbons ✓	**2**	**ALLOW** to make water potable **IGNORE** virus **IGNORE** 'purifies water' **DO NOT ALLOW** 'antiseptic' **ALLOW forms** carcinogens **OR** forms toxins **IGNORE** harmful **DO NOT ALLOW** 'it causes cancer' **DO NOT ALLOW** "It kills you"
	(b)		$3d^{10}\ 4s^2\ 4p^5$ ✓	**1**	**ALLOW** $4s^2\ 3d^{10}\ 4p^5$ **ALLOW** subscripts or $3D^{10}$ **ALLOW** answers with $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ appearing twice
	(c)	**(i)**	$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ ✓	**1**	**IGNORE** state symbols **ALLOW** any correct multiple including fractions
		(ii)	Yellow / orange / red / brown ✓	**1**	**ALLOW** any combination of these, but no others
	(d)	**(i)**	Disproportionation ✓	**1**	**ALLOW** versions which sound the same **DO NOT ALLOW** disproportional **OR** disproportionate **OR** disproportion
		(ii)	$Cl_2 + 2NaOH \rightarrow NaClO + NaCl + H_2O$ ✓ $3Cl_2 + 6NaOH \rightarrow NaClO_3 + 5NaCl + 3H_2O$ Cl_2 and NaOH as reactants **AND** $NaClO_3$ and NaCl as products✓ Rest of the equation ✓	**3**	**ALLOW** multiples for either equation **ALLOW** $3Cl_2 + 6NaOH \rightarrow 2NaClO_3 + 4NaCl + 3H_2$
		(iii)	$NaClO_4$ ✓	**1**	**ALLOW** Na_3ClO_5 etc
			Total	**10**	

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	Magnesium ions have a greater charge✓ Magnesium has more (delocalised **OR** outer) **electrons**✓ Magnesium has greater attraction between **ions** and **electrons OR** has stronger **metallic** bonds ✓	3	***USE annotations with ticks, crosses, ecf, etc for this part.*** **ALLOW REVERSE ARGUMENT** e.g. sodium ions have a smaller charge **ALLOW** Mg^{2+} / Mg ion / Na ion / Na^{+} ion **ALLOW** 'charge density' as alternative to 'charge' **ALLOW REVERSE ARGUMENT** e.g. sodium has fewer electro **ALLOW REVERSE ARGUMENT** e.g. sodium has less attractions between **ions** and **electrons** **OR** has weaker **metallic** bonds ✓
		ii	Cl_2 **OR** S_8 has intermolecular **OR** van der Waals' forces ✓ S_8 has stronger intermolecular forces **OR** van der Waals' forces than Cl_2 **OR** S_8 has more electrons ✓	2	**ALLOW REVERSE ARGUMENT** ie Cl_2 has weaker intermolecular forces **OR** van der Waals' forces **DO NOT ALLOW** comparison involving covalent bonds **ALLOW REVERSE ARGUMENT** Cl_2 has fewer electrons

Question			Expected Answers	Marks	Additional Guidance
	b			3	***USE annotations with ticks, crosses, ecf, etc for this part.***
			nuclear charge increases/ protons increase ✓		**Nuclear OR proton(s) OR nucleus spelt correctly ONCE** **IGNORE** 'atomic number increases' **IGNORE** 'nucleus gets bigger' 'charge increases' is not sufficient **ALLOW** 'effective nuclear charge increases' **OR** 'shielded nuclear charge increases'
			electrons added to the same shell **OR** screening **OR** shielding remains the same ✓		**IGNORE** reference to atomic radius staying the same **ALLOW** shielding is similar **DO NOT ALLOW** extra shielding
			greater attraction **OR** greater pull ✓		A comparison **must** be included: i.e. '**greater** pull', '**more** pull', 'held **more** tightly';
			Total	**8**	

4	**(a)**		<table><tr><td>particle</td><td>rel charge</td><td>rel mass</td><td>position</td></tr><tr><td>proton</td><td></td><td>1</td><td>nucleus</td></tr><tr><td>neutron</td><td>nil/</td><td>1</td><td>nucleus</td></tr><tr><td>electrons</td><td></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**	