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 $Sr(NO_3)_2$ = $\dfrac{5.29}{211.6}$ = 0.0250 ✓	3	**ALLOW** 0.025
		Calculates correctly: Mol of gas = $5/2 \times$ 0.0250 = 0.0625 ✓		**ALLOW** ECF for first answer × 2.5 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes
		Calculates correctly: Volume of gas = 24.0 × 0.0625 = 1.50 dm³ ✓		**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) dm³) 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 dm³
				ALLOW ECF producing correct volume of NO_2 only i.e. 1.2(0) dm³ would give **two** marks
				OR
				ALLOW ECF producing correct volume of O_2 only i.e. 0.3(0) dm³ 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	nuclear charge increases/ protons increase ✓	3	***USE annotations with ticks, crosses, ecf, etc for this part.*** **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) | | | | | | | 1 | 1 mark for whole table |

particle	rel charge	rel mass	position
proton		1	nucleus
neutron	nil/	1	nucleus
electrons		1/2000	in shells

✓

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 ✓ — **1**

from each **atom** in **one mole** ✓ — **1**

of **atoms** in the **gaseous** state ✓ — **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)

a 2p orbital	2 ✓		**1**
the 3s sub-shell	2 ✓		**1**
the 4th shell	32 ✓		**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** | |

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