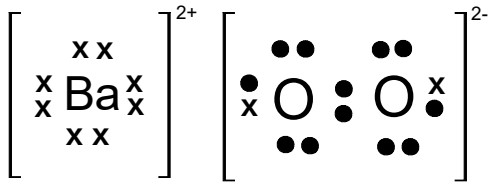
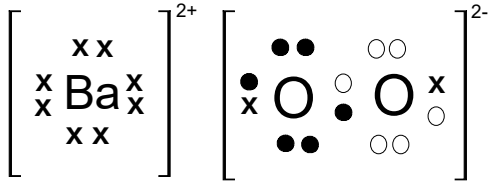
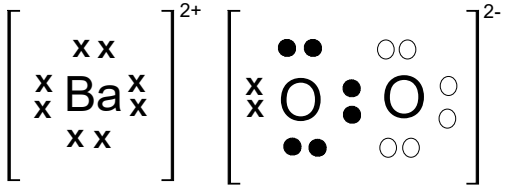
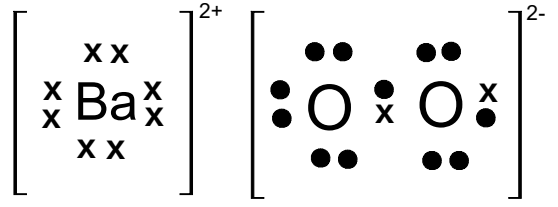
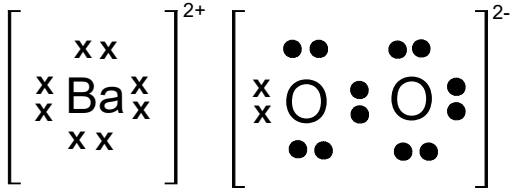
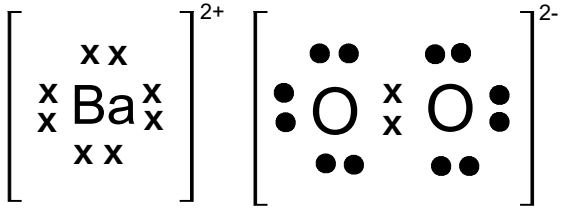
Question			Answer	Mark	Guidance
1	(a)		M1 *Trend **AND** nuclear charge mark* (from Li to F) atomic radius decreases **AND** nuclear charge increases or number of protons increases✓ M2 *same shell/shielding mark* (outer) electrons are in same shell **OR** (outer) electrons experience similar or same shielding ✓ **OR** same number of shells M3 *nuclear attraction mark* Greater **nuclear** attraction on (outer) **electrons** or **shells** **OR** (Outer) **electrons** or **shells** are attracted more strongly to the **nucleus** ✓	**3**	**ALLOW ORA** throughout if it is clear that the Period is being crossed right to left **ALLOW** 'proton number increases' **IGNORE** 'atomic number increases' **IGNORE** 'nucleus gets bigger' **IGNORE** 'effective nuclear charge increases' **DO NOT ALLOW** 'charge increases' without reference to nuclear' **IGNORE** there is shielding **DO NOT ALLOW** sub-shells **OR** orbitals **DO NOT ALLOW** 'electrons are at a similar distance' This will also contradict M1 **ALLOW** 'there is no change in shielding' **IGNORE** 'shielding has no effect' **DO NOT ALLOW** 'there is no shielding' Quality of written communication 'nucleus' **OR** 'nuclear' spelled correctly once and used in context for third marking point **ALLOW** pull for attraction **IGNORE** for M3, 'electrons are pulled closer to nucleus' as this is a re-statement of the trend mark. **DO NOT ALLOW** 'greater nuclear charge' for 'greater nuclear attraction' for M3

Question			Answer	Mark	Guidance
	(b)	**(i)**	$(1s^2)\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6$ ✓	**1**	**ALLOW** ... $4s^2\ 3d^{10}4p^6$ **ALLOW** subscripts **AND** 3D **IGNORE** $1s^2$ seen twice
	(b)	**(ii)**	Cream **AND** precipitate ✓	**1**	**ALLOW** solid **OR** ppt for precipitate **IGNORE** 'does not dissolve' OR 'partially dissolves'
	(b)	**(iii)**	$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ ✓	**1**	Equation **AND** state symbols required
	(c)	**(i)**	***Equation*** $2NaOH + Cl_2 \rightarrow NaCl + NaClO + H_2O$ ✓ ***Conditions*** cold **AND** dilute (sodium hydroxide) ✓	**2**	**ALLOW** correct multiples **IGNORE** state symbols **ALLOW** room temperature OR ≤ 20^OC for cold

Question			Answer	Mark	Guidance
	(c)	(ii)	*Definition of disproportionation mark* M1 (Disproportionation) is the (simultaneous) oxidation and reduction of the same element (in the same redox reaction) ✓ M2 Assigning of oxidation numbers Cl in Cl_2 is 0 **AND** Cl in NaCl is -1 **AND** Cl in $NaClO_3$ is +5 ✓ M3 Chlorine has been oxidised from 0 to +5 AND Chlorine has been reduced from 0 to –1 ✓ 'Chlorine has been oxidised from 0 in Cl_2 to +5 in $NaClO_3$ and chlorine has been reduced from 0 in Cl_2 to -1 in NaCl' would secure M2 and M3 $3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$ 0 -1 +5 reduction oxidation This diagram, along with a correct definition, would secure all three marks.	3	**ALLOW** 'an element' OR 'a species' for 'the same element' Assume 'it' means disproportionation M1 can be awarded for 'chlorine is oxidised and reduced **and** this is disproportionation' **ALLOW** oxidation numbers written above the equation if not seen in the text but **IGNORE** oxidation numbers written above the equation if seen in the text **ALLOW** 1– **AND** 5 **AND** 5+ **DO NOT ALLOW** chloride in place of chlorine except for NaCl **DO NOT ALLOW** Cl^- in NaCl AND Cl^{5+} in $NaClO_3$ (ie do not allow ionic charges for oxidation numbers) **ALLOW** Cl **OR** Cl_2 for chlorine **DO NOT ALLOW** M2 if incorrect oxidation numbers of other elements are seen in the text eg H = +2 **ALLOW ECF** for third marks if ONE incorrect oxidation number is assigned but directional changes are correct eg Cl = 0 and -1 and +3 instead 0 and -1 and +5 **DO NOT ALLOW** ECF if two oxidation numbers are incorrectly assigned **IGNORE** references to electron loss/gain If oxidation numbers are correct ALLOW third mark for: chlorine is oxidised to form $NaClO_3$ **AND** chlorine is reduced to form NaCl
			Total	**11**	

Question			Answer	Mark	Guidance
2	(a)	(i)	$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ ✓	1	
	(a)	(ii)	$BaCO_3$ **OR** $RaCO_3$ ✓	1	**ALLOW** formula if seen as reactant in an equation **IGNORE** name
	(b)		FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = $SrCl_2 \cdot 2H_2O$ award 3 marks M1 Correctly calculates Mol of $SrCl_2 \cdot 6H_2O$ = (5.332 / 266.6) = 0.02 mol ✓ M2 Correctly calculates Mol of water given off [(5.332 – 3.892)/18] = 0.08 mol ✓ M3 Correctly calculates 0.08/0.02 = 4 mol of water lost from one mol of $SrCl_2 \cdot 6H_2O$ Therefore Answer = $SrCl_2 \cdot 2H_2O$ ✓	3	**Allow alternative methods** **eg** M1 Correctly calculates mol of $SrCl_2 \cdot 6H_2O$ as 5.332/266.6 = 0.02(00) mol **DO NOT ALLOW** M1 if a second mass is divided by 266.6 M2 Correctly calculates molar mass of partially hydrated product as 3.892/ 0.02(00) = 194.6 M3 Correctly calculates mass of H_2O present as 194.6 – 158.6 = 36.0 **AND** product is $SrCl_2 \cdot 2H_2O$ **ALLOW** ECF for the third mark for showing 158.6 taken from an incorrect stated molar mass leading to an ECF formula **OR** **ALLOW** 266.6 – 194.6 = 72.0 to find amount of water lost
	(c)	(i)	**Reaction 1:** $Ba + 2H_2O \rightarrow Ba(OH)_2 + H_2$ ✓ **Reaction 2:** $Ba_3N_2 + 6H_2O \rightarrow 3Ba(OH)_2 + 2NH_3$ Correct products ✓ Balancing ✓	3	Ignore state symbols
	(c)	(ii)	Giant ionic (lattice) ✓	1	**ALLOW** 'Giant lattice with ionic bonds' **ALLOW** 'Giant ionic bonds' **DO NOT ALLOW** 'atoms or molecules or dipoles'

Question			Answer	Mark	Guidance
		(iii)		1	Ba must have a 2+ charge Ba can be with or without octet. **IGNORE** lack of charge on O_2^{2-} ion
			OR		
					O_2^{2-} ion to have 12 electrons belonging to O atoms + 2 other electrons of another symbol. The 2 other electrons must match Ba if Ba has an octet. If O electrons are shown as 6 of one symbol and 6 of another, each O must have six electrons of the same symbol
			OR		
					**ALLOW**
			OR		
					**OR**
					
			Total	**10**	

Question			Answer	Marks	Guidance
3	(a)			5	**FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED** 'Down the group' is not required **ORA** throughout
			Reactivity increases (down the group) ✓		**ALLOW** alternative phrases for 'reactivity increases'
			Increasing size mark Atomic radius increases **OR** There are more shells ✓		**ALLOW** 'there are more energy levels' **ALLOW** 'electrons are in higher energy levels' **ALLOW** 'electrons are further from the nucleus' **IGNORE** there are more orbitals **OR** more sub-shells **ALLOW** 'different shell' **OR** 'new shell'
			Increased shielding mark There is **more** shielding ✓		There must be clear comparison ie 'more shielding' **OR** 'increased shielding' **ALLOW** there is **more** electron repulsion from inner shells **DO NOT ALLOW** responses which have no comparative eg 'there is shielding'
			Nuclear attraction (to electron) mark Nuclear attraction (to electron) decreases **OR** (outermost) electrons experience less attraction (to nucleus) **OR** Increased nuclear charge is outweighed by increased shielding/distance ✓		**ALLOW** 'there is less nuclear pull' **OR** 'electrons less tightly held' **IGNORE** there is less effective nuclear charge **IGNORE** 'nuclear charge' for 'nuclear attraction' If question is answered in terms of only Group 7, then **ONLY** marks 2, 3 and 4 can be awarded
			Ease of electron loss mark Easier to remove (outer) electron(s) **OR** Ionisation energy decreases ✓		**ALLOW** easier to oxidise
			Quality of written communication *electron(s)* ***OR*** *ionisation* ***OR*** *ionization* ***OR*** *oxidise* ***OR*** *oxidize spelled correctly at least once for last marking point*		

Question			Answer	Marks	Guidance
	(b)	**(i)**	$AgNO_3$(aq) **OR** silver nitrate **OR** $AgNO_3$ ✓	1	**ALLOW** Ag^+(aq)
		(ii)	Yellow **AND** precipitate ✓	1	**ALLOW** shades of yellow but not creamy yellow **ALLOW** ppt or solid for precipitate
		(iii)	Ag^+ (aq) + I^-(aq) ➔ AgI(s) ✓	1	**ALLOW** correct multiples
		(iv)	**concentrated** (aqueous) NH_3 ✓	1	
			Total	**9**	

Question			Answer	Marks	Guidance
4	(a)	(i)	*Nuclear charge mark* (Across the period) number of protons increases **OR** greater nuclear charge ✓ ***Quality of written communication*** *– nuclear* ***OR*** *proton(s)* ***OR*** *nucleus spelled correctly ONCE for the first marking point* *Distance / shielding mark* (Outermost) electrons are in the same shell **OR** (Outermost) electrons experience the same shielding **OR** Atomic radius decreases ✓ *Nuclear attraction (to electron) mark* Greater nuclear attraction (on outermost electrons) **OR** (outer) electrons are attracted more strongly (to the nucleus) ✓	3	**FULL ANNOTATIONS WITH TICKS, CROSSES, CON, etc MUST BE USED** Comparison should be used for each mark **IGNORE** atomic number increases, but **ALLOW** proton number increases **IGNORE** nucleus gets bigger **IGNORE** 'effective nuclear charge increases' **DO NOT ALLOW** 'charge' increases without reference to nuclear **ALLOW** shielding is similar BUT **IGNORE** 'there is shielding' **DO NOT ALLOW** sub-shells **OR** orbitals **ALLOW** greater nuclear pull for greater nuclear attraction **DO NOT ALLOW** use of greater nuclear charge for greater nuclear attraction for third mark
		(ii)	(Diamond and graphite form) **gaseous atoms** (of carbon when they are ionised) ✓	1	**ALLOW** the **atoms** are in the **gaseous** state

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><th></th><th>Lithium</th><th>Carbon (diamond)</th><th>Fluorine</th></tr>
<tr><td>Structure</td><td>Giant</td><td>Giant ✓</td><td>Simple</td></tr>
<tr><td>Force or bond overcome on melting</td><td>Metallic bond</td><td>Covalent (bond) ✓</td><td>van der Waals' (forces) OR induced dipoles ✓</td></tr>
<tr><td>Particles between which the force or bond is acting</td><td>Li^+ ions and (delocalised) electrons ✓</td><td>Atoms ✓</td><td>Molecules ✓</td></tr>
</table>
</td><td>6</td><td>ALLOW shared pair of electrons for covalent (bond)

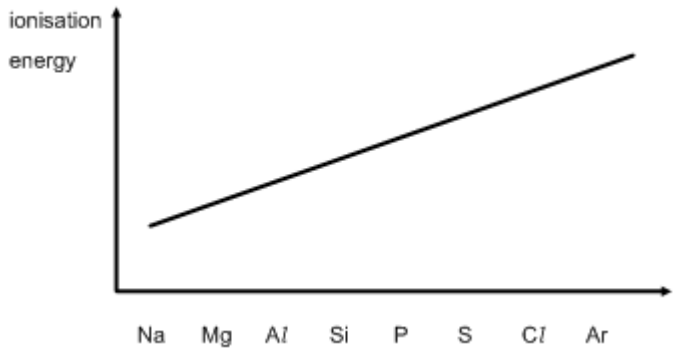
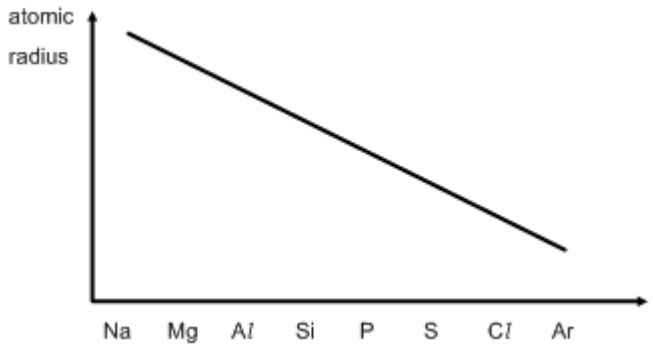
ALLOW vdw for van der Waals'
ALLOW temporary–induced or instantaneous–induced for van der Waals'

ALLOW Positive ions for Li^+ ions
IGNORE 'Lithium ions' but ALLOW 'Positive lithium ions'
DO NOT ALLOW Li^{2+}

IGNORE C and IGNORE F_2
IGNORE diagrams but ALLOW names of particles if seen as a label on a diagram

DO NOT ALLOW implication that covalent bonds are broken in fluorine for the particles mark of fluorine as this implies the particles are atoms</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>10</td><td></td></tr>
</table>

Question			Answer	Marks	Guidance
5	(a)		Periodicity ✓	1	**ALLOW** phonetic versions
	(b)		***Al bonding mark*** Al has metallic (bonding) **OR** has (electrostatic) attraction between positive ions and (delocalised) electrons ✓ ***Si bonding mark*** Si has covalent (bonding) **OR** has shared pairs of electrons between atoms ✓ ***P bonding mark*** P has **induced** dipoles **OR** has van der Waals' forces (between molecules) ✓ ***Structure mark 1*** Al **AND** Si are Giant ✓ ***Structure mark 2*** P is Simple molecular **OR** simple covalent ✓ ***Bond strength mark*** Metallic **AND** covalent are stronger than vdWs **OR** Bonds broken in Al **AND** in Si are stronger than the forces broken in P **OR** More energy is needed to overcome bonds in Al **AND** Si than the forces in P ✓	6	**Use annotations with ticks, crosses, ECF etc for this part** **DO NOT ALLOW** marking point 1 if Al has dipoles **OR** intermolecular forces **OR** molecules **OR** atoms **OR** attraction between nuclei and electrons **OR** attraction between oppositely charged ions **DO NOT ALLOW** marking point 2 if Si has dipoles **OR** intermolecular forces **OR** molecule**s** but **IGNORE** 'molecule' Must be induced dipoles **ALLOW** vdW for van der Waals' **IGNORE** P has covalent bonds for marking point 3 **Quality of Written Communication: 'giant' spelled correctly once and used in context for the fourth marking point** **DO NOT ALLOW** covalent bonds are broken in phosphorus for marking point 6, but **ALLOW** answers that inform Al and Si are stronger than P, ignoring incorrect forces or bonds used above **IGNORE** 'heat' but **ALLOW** 'heat energy'

Question			Answer	Marks	Guidance
	(c)	(i)	Increasing straight line **OR** curve from Na to Ar ✓  	1	**ALLOW** bar charts **OR** points **IGNORE** the standard of drawing as long as the trend is clear **IGNORE** decrease between Mg/Al and P/S Essentially the mark is for Na < Mg < Si < P < Cl < Ar **AND** Al < Si **AND** S< Cl
		(ii)	Decreasing straight line **OR** curve from Na to Ar ✓  	1	**ALLOW** bar charts **OR** points **IGNORE** the standard of drawing as long as the trend is clear **IGNORE** Ar Essentially the mark is for Na > Mg > Al > Si > P > S > Cl
			Total	**9**	

Question			Answer	Marks	Guidance
6	(a)		$(1s^2)\ 2s^2\ 2p^6\ 3s^2$ ✓	1	**IGNORE** $1s^2$ seen twice **ALLOW** subscripts
	(b)	(i)	$Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$ Equation correct ✓ State symbols correct ✓	2	**ALLOW** $Mg^+(g) - e^- \rightarrow Mg^{2+}(g)$ for 2 marks The second mark is dependent upon the first mark except for the following close attempts for the first mark: **ALLOW** the following for one mark as states are correct $Mg(g) \rightarrow Mg^{2+}(g) + 2e^-$ $Mg(g) + e^- \rightarrow Mg^{2+}(g) + 2e^-$ **ALLOW** e for electron **IGNORE** states on electron
		(ii)	***Ionic radius mark*** $Mg^{(+)}$ has smaller (ionic**)** radius **OR** has less shells ✓ ***Shielding mark*** (outermost electron) of $Mg^{(+)}$ experience less shielding ✓ ***Nuclear attraction mark*** More nuclear attraction on (outermost electrons) **OR** Outer electrons are attracted more strongly (to the nucleus) ✓ **ORA** throughout	3	**Use annotations with ticks, crosses, ECF etc for this part** **ALLOW** $Mg^{(+)}$ has less energy levels **ALLOW** $Mg^{(+)}$ has electrons in lower energy level **ALLOW** $Mg^{(+)}$ has electrons closer to nucleus **IGNORE** $Mg^{(+)}$ has less orbitals **OR** less sub-shells **IGNORE** atomic for ionic **IGNORE** 'different shell' **ALLOW** screening for shielding **ALLOW** $Mg^{(+)}$ has **less** electron repulsion from inner shells **Quality of Written Communication: 'nuclear' OR 'nucleus' OR 'electron(s)' spelled correctly once and used in context for the third marking point** **ALLOW** $Mg^{(+)}$ has more nuclear pull **IGNORE** $Mg^{(+)}$ has more effective nuclear charge **DO NOT ALLOW** more nuclear charge for more nuclear attraction for the third mark

Question			Answer	Marks	Guidance
	(c)	(i)	Sr^{2+} ✓ OH^- ✓	2	**ALLOW** $2OH^-$ **ALLOW** 2 marks for $Sr(OH)_2 \rightarrow Sr^{2+} + 2OH^-$ **ALLOW** 1 mark for $Sr^{2+} + 2OH^- \rightarrow Sr(OH)_2$ **IGNORE** H^+
		(ii)	Sr has lost (two) electron**s** ✓	1	**ALLOW** $Sr \rightarrow Sr^{2+} + 2e^-$ **IGNORE** references to oxidation numbers
		(iii)	SrO **AND** H_2O ✓	1	**ALLOW** acceptable alternatives from Sr salts and alkalis eg $SrCl_2$ + NaOH
	(d)	(i)	It shows the oxidation number of the sulfur **OR** the name without the IV is ambiguous ✓	1	**DO NOT ALLOW** 'the **charge** on sulfur' **DO NOT ALLOW** 'shows the oxidation number of the sulfate' **ALLOW** Otherwise it could be $SrSO_4$ **ALLOW** Sulfur has different oxidation numbers AW
		(ii)	H_2SO_3 ✓	1	
			Total	**12**	