

F321 Atoms, Bonds and Groups

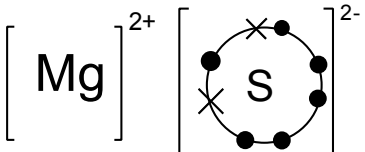
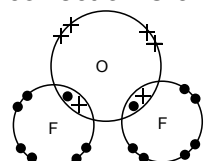
Question		Expected Answers	Marks	Additional Guidance
1	(a)	<p>Mass of the isotope compared to 1/12th OR mass of the atom compared to 1/12th ✓</p> <p>(the mass of a) carbon-12 OR ^{12}C (atom) ✓</p>	2	<p>IGNORE Reference to average OR weighted mean (i.e. correct definition of relative atomic mass will score both marks)</p> <p>ALLOW mass of a mole of the isotope/atom with 1/12th the mass of a mole OR 12 g of carbon-12 for two marks.</p> <p>ALLOW 2 marks for: ‘Mass of the isotope OR mass of the atom compared to ^{12}C atom given a mass of 12.0’ i.e. ‘given a mass of 12’ OR C12 is 12 communicates the same idea as 1/12th.’</p> <p>ALLOW 12C OR C12</p> <p>ALLOW 2 marks for: $\frac{\text{mass of the isotope}}{\text{mass of 1/12th mass of carbon - 12}}$ i.e. fraction is equivalent to ‘compared to’</p> <p>ALLOW 1 mark for a mix of mass of atom and mass of mole of atoms, i.e. ‘mass of the isotope/mass of an atom compared with 1/12th the mass of a mole OR 12 g of carbon-12.’</p> <p>DO NOT ALLOW mass of ‘ions’ OR mass of element</p>
	(b)	<p>$\frac{(151 \times 47.77) + (153 \times 52.23)}{100}$</p> <p>OR 72.1327 + 79.9119 OR 152.0446 (calculator value) ✓ $A_r = 152.04$ ✓</p>	2	<p>ALLOW Correct answer for two marks</p> <p>ALLOW One mark for ECF from transcription error in first sum provided final answer is to 2 decimal points and is to between 151 and 153 and is a correct calculation of the transcription</p>

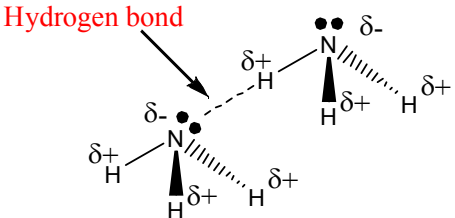
Question		Expected Answers	Marks	Additional Guidance
	(c) (i)	^{153}Eu has (2) more neutrons OR ^{153}Eu has 90 neutrons AND ^{151}Eu has 88 neutrons ✓	1	ALLOW There are a different number of neutrons IGNORE Correct references to protons / electrons DO NOT ALLOW Incorrect references to protons / electrons
	(ii)	(It has the) same number of protons AND electrons OR Both have 63 protons and 63 electrons ✓	1	ALLOW Same number of protons AND same electron configuration DO NOT ALLOW 'Same number of protons' without reference to electrons (and vice versa)

Question		Expected Answers	Marks	Additional Guidance
	(d)	<p>Xe has a bigger atomic radius OR Xe has more shells ✓</p> <p>Xe has more shielding ✓</p> <p>The nuclear attraction decreases OR Outermost electrons of Xe experience less attraction (to nucleus) OR Increased shielding / distance outweighs the increased nuclear charge ✓ ORA throughout</p>	3	<p>ALLOW Xe has more energy levels ALLOW Xe has electrons in higher energy level ALLOW Xe has electrons further from nucleus IGNORE Xe has more orbitals OR more sub-shells DO NOT ALLOW 'different shell' or 'new shell'</p> <p>ALLOW More screening There must be a clear comparison ie more shielding OR increased shielding. i.e. DO NOT ALLOW Xe 'has shielding' ALLOW Xe has more electron repulsion from inner shells</p> <p>ALLOW Xe has less nuclear pull IGNORE Xe has less effective nuclear charge DO NOT ALLOW nuclear charge for nuclear attraction</p>
Total			9	

Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	The H ⁺ ion in an (nitric) acid has been replaced by a metal ion OR by a Ca ²⁺ ion ✓	1	DO NOT ALLOW it has been produced by the reaction of an acid and a base as this is stated in the question. IGNORE references to replacement by NH ₄ ⁺ ions or positive ions. ALLOW H OR Hydrogen for H ⁺ ; DO NOT ALLOW Hydrogen atoms ALLOW Ca OR Calcium for Ca ²⁺ . DO NOT ALLOW Calcium atoms ALLOW 'metal' for 'metal ion'
		(ii)	2HNO ₃ (aq) + Ca(OH) ₂ (aq) → Ca(NO ₃) ₂ (aq) + 2H ₂ O(l) Formulae ✓ Balance AND states ✓	2	ALLOW multiples ALLOW (aq) OR (s) for Ca(OH) ₂
		(iii)	Accepts a proton OR accepts H ⁺ ✓	1	ALLOW H ⁺ + OH ⁻ → H ₂ O ALLOW OH ⁻ reacts with H ⁺ OR OH ⁻ takes H ⁺ ALLOW OH ⁻ 'attracts' H ⁺ if 'to form water' is seen DO NOT ALLOW OH ⁻ neutralises H ⁺ ('neutralises' is in the question)
	(b)	(i)	Calculates correctly $\frac{0.0880 \times 25.0}{1000} = 2.20 \times 10^{-3}$ mol OR 0.00220 mol ✓	1	ALLOW 0.0022 OR 2.2×10^{-3} mol
		(ii)	Calculates correctly $\frac{0.00220}{2} = 1.10 \times 10^{-3}$ mol OR 0.00110 mol ✓	1	ALLOW 0.0011 OR 1.1×10^{-3} mol ALLOW ECF for answer (i)/2 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes
		(iii)	$\frac{0.00110 \times 1000}{17.60} = 0.0625$ mol dm ⁻³ OR 6.25×10^{-2} mol dm ⁻³ ✓	1	ALLOW 0.063 OR 6.3×10^{-2} mol dm ⁻³ ALLOW ECF for answer (ii) × 1000/17.60 OR ECF from (i) for answer (i)/2 × 1000/17.60 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes

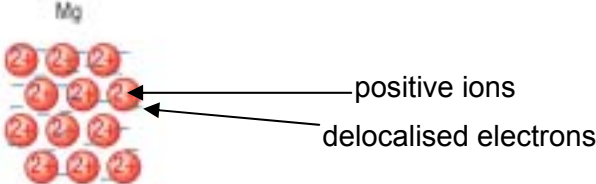
	(c)	(i)	(The number of) Water(s) of crystallisation ✓	1	IGNORE hydrated OR hydrous
		(ii)	142.1 ✓ $x = \frac{(322.1 - 142.1)}{18.0} = 10$ ✓	2	ALLOW 142 ALLOW M_r expressed as a sum ALLOW ECF from incorrect M_r and x is calculated correctly ALLOW ECF values of x from nearest whole number to calculator value ALLOW 2 marks if final answer is 10 without any working
			Total	10	

Question			Expected Answers	Marks	Additional Guidance
3	(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 or 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 ₂ O ✓ Lone pairs correct on O and both F atoms ✓ 	2	Must be ' <i>dot-and-cross</i> ' 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°. ✓ There are 2 bonded pairs and 2 lone pairs ✓ Lone pairs repel more than bonded pairs ✓	3	ALLOW 103–105° (103° 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)	<p>(At least) two NH_3 molecules with correct dipole shown with at least one H with δ^+ and one N with δ^- ✓</p> <p>(Only) one hydrogen bond from N atom on one molecule to a H atom on another molecule ✓</p> <p>Lone pair shown on the N atom and hydrogen bond must hit the lone pair ✓</p> 	3	<p>DO NOT ALLOW first mark for ammonia molecules with incorrect lone pairs</p> <p>DO NOT ALLOW first mark if H_2O, NH_2 or NH is shown</p> <p>ALLOW hydrogen bond need not be labelled as long as it clear the bond type is different from the covalent N–H bond</p> <p>ALLOW a line (i.e. looks like a covalent bond) as long as it is labelled 'hydrogen bond'</p> <p>ALLOW 2-D diagrams</p> <p>ALLOW two marks if water molecules are used. One awarded for a correct hydrogen bond and one for the involvement of lone pair</p>
(ii)	<p>Liquid H_2O is denser than solid ✓</p> <p>In solid state H_2O molecules are held apart by hydrogen bonds OR ice has an open lattice ✓</p> <p>OR</p> <p>H_2O has a relatively high boiling point OR melting point ✓</p> <p>(relatively strong) hydrogen bonds need to be broken OR a lot of energy is needed to overcome hydrogen bonds OR hydrogen bonds are strong ✓</p>	2	<p>ORA</p> <p>ALLOW ice floats for first mark</p> <p>ALLOW higher melting OR boiling point than expected</p> <p>DO NOT ALLOW H_2O has a high melting / boiling point</p> <p>ALLOW other properties caused by hydrogen bonding not mentioned within the specification</p> <p>E.g. high surface tension – strong hydrogen bonds on the surface</p>
	Total	13	

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

Question			Expected Answers	Marks	Additional Guidance
5	(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)	$2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ ✓	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)	<p>Mg has a giant structure ✓</p> <p>Mg has metallic bonding OR description of metallic bonding as positive ions and delocalised electrons ✓</p> <p>(There is electrostatic attraction between) positive ions and electrons ✓</p> <p>Cl has a simple molecular OR simple covalent (lattice) ✓</p> <p>Cl has van der Waals' forces (between molecules) OR Cl has instantaneous dipole–induced dipoles OR temporary dipole–temporary dipole ✓</p>	6	<p>Metallic OR delocalised seen spelt correctly at least ONCE</p> <p>DO NOT ALLOW as label nuclei OR protons for positive ions</p> <p>ALLOW labelled diagram of metallic bonding for second and third marks</p>  <p>Lattice must have at least two rows of positive ions. If a Mg ion is shown it must correct charge</p> <p>ALLOW for labels: + ions, positive ions, cations</p> <p>DO NOT ALLOW as label nuclei OR protons for positive ions</p> <p>ALLOW e⁻ or e as label for electron</p> <p>DO NOT ALLOW '–' without label for electron</p> <p>Covalent OR molecule OR molecular seen spelt correctly at least ONCE</p> <p>ALLOW Cl is a (covalent) molecule</p> <p>IGNORE Cl has intermolecular bonding</p>

		<p>van der Waals' forces are weak and metallic bonds are strong</p> <p>OR</p> <p>van der Waals' forces are weaker than metallic bonds</p> <p>OR</p> <p>Less energy is needed to overcome van der Waals' than metallic bonds ✓</p>		<p>ALLOW ECF from incorrect descriptions of giant structure with strong bonds; e.g. Mg has giant ionic structure</p> <p>ALLOW ECF from any incorrect intermolecular forces e.g. permanent dipole –dipole from marking point 5</p> <p>ALLOW vdW easier to break</p> <p>ORA</p>
(d)	(i)	<p>O goes from –2 to 0 ✓</p> <p>N goes from +5 to +4 ✓</p> <p>N is reduced AND O is oxidised ✓</p>	3	<p>Oxidation numbers may be seen with equation</p> <p>Third mark is dependent upon seeing a reduction in oxidation number of N and an increase in oxidation number of O</p> <p>ALLOW ECF for third mark for N is oxidised and O is reduced if incorrect oxidation numbers support this</p> <p>IGNORE references to strontium</p> <p>IGNORE references to electron loss OR gain</p> <p>DO NOT ALLOW 'One increases and one decreases'</p>

	(d)	(ii)	<p>Calculates correctly: Mol of $\text{Sr}(\text{NO}_3)_2 = \frac{5.29}{211.6} = 0.0250 \checkmark$</p> <p>Calculates correctly: Mol of gas = $5/2 \times 0.0250 = 0.0625 \checkmark$</p> <p>Calculates correctly: Volume of gas = $24.0 \times 0.0625 = 1.50 \text{ dm}^3 \checkmark$</p>	3	<p>ALLOW 0.025</p> <p>ALLOW ECF for first answer $\times 2.5$ as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes</p> <p>ALLOW ECF for second answer $\times 24(.0)$ as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes</p> <p>DO NOT ALLOW ECF of first answer $\times 24(.0)$ (which gives $0.6(0) \text{ dm}^3$) as this has not measured the volume of any gas, simply 0.0250 mol of solid $\text{Sr}(\text{NO}_3)_2$ converted into a gas i.e. This answer would give one mark</p> <p>ALLOW 1.5 dm^3</p> <p>ALLOW ECF producing correct volume of NO_2 only i.e. $1.2(0) \text{ dm}^3$ would give two marks</p> <p>OR</p> <p>ALLOW ECF producing correct volume of O_2 only i.e. $0.3(0) \text{ dm}^3$ would give two marks</p>
Total			18		