Question Number	Answer	Mark
7	**The only correct answer is C** (3.00 dm^3) ***A*** *is incorrect because this is the volume if oxygen were the only gas produced* ***B*** *is incorrect because this is the volume if oxygen were the only gas and 1 mol of calcium nitrate gave 1 mol of oxygen* ***D*** *is incorrect because this is the volume of gas if 1 mol of calcium nitrate gave 5 mol of gas*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is A** (chlorine) ***B*** *is not correct because the bromide ions are oxidised* ***C*** *is not correct because bromine is a product in the reaction with chlorine* ***D*** *is not correct because the iodide ions are oxidised*	**(1)** **Computer**

Question Number	Answer	Mark
9	**The only correct answer is B** (579 1979 2963 6200) ***A*** *is incorrect because there is a large jump between 3rd and 4th ionisation energy, so Group 3, but lower first ionisation energy than B so lower in the group* ***C*** *is incorrect because there is not a relatively large jump between the 3rd and 4th ionisation energies* ***D*** *is incorrect because there is not a relatively large jump between the 3rd and 4th ionisation energies*	**(1)**

Question Number	Answer	Mark
8	**The only correct answer is D** (buckminsterfullerene C_{60}) ***A*** *is incorrect because silver has a giant metallic lattice* ***B*** *is incorrect because sodium chloride has a giant ionic lattice* ***C*** *is incorrect because carbon has giant covalent lattice*	**(1)**

Question Number	Answer	Mark
4	**The only correct answer is D** (16, 20) ***A*** *is incorrect because both elements are in the p block* ***B*** *is incorrect because both elements are in the p block* ***C*** *is incorrect because both elements are in the p block*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is C** ([Ar] ↑↑↑↑↑ ↑) ***A*** *is not correct because the electrons in 4s and 3d have been paired before all the orbitals had been occupied* ***B*** *is not correct because the electrons in the 4s orbital has been paired before all the 3d orbitals had been occupied* ***D*** *is not correct because 4s orbital is doubly filled and these electrons have parallel spins*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is C** ($10.0\ cm^3$ of $0.90\ mol\ dm^{-3}$ magnesium chloride solution) ***A** is incorrect because this solution contains 0.012 mol of chloride ions* ***B** is incorrect because this solution contains 0.012 mol of chloride ions* ***D** is incorrect because this solution contains 0.012 mol of chloride ions*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is D** (sulfur molecules have more electrons than phosphorus molecules) ***A** is incorrect because there is no electronegativity difference so no dipole in sulfur or phosphorus* ***B** is incorrect because the covalent bonds do not break during melting, only intermolecular forces between simple molecular structures are broken* ***C** is incorrect because sulfur has a simple molecular structure, S_8*	**(1)**

Question Number	Answer	Mark
1	**The only correct answer is B** (*neutron number 44, electron number 36*) ***A** is incorrect because the number of electrons is for a ^{79}Br atom* ***C** is incorrect because the number of neutrons is for a ^{81}Br atom* ***D** is incorrect because the number of neutrons is for a $^{81}Br^-$ ion*	**(1)**

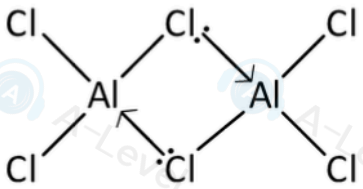
Question Number	Answer	Mark
3	**The only correct answer is C** (2.408×10^{22}) ***A** is incorrect because this is the number of H_2SO_4 molecules in 0.0100 mol* ***B** is incorrect because this is the number of oxygen molecules required to give this many oxygen atoms* ***D** is incorrect because this is the number of atoms in 0.0100 mol of H_2SO_4*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is B** (Mg^{2+} and O^{2-}) ***A** is not correct because the ions are only singly charged* ***C** is not correct because the ions are larger* ***D** is not correct because the ions are larger and singly charged*	**(1)**

Question Number	Answer	Mark
10	**The only correct answer is C** ($Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$) ***A** is incorrect because atom economy is 59.4%* ***B** is incorrect because atom economy is 65.8%* ***D** is incorrect because atom economy is 91.2%*	**(1)**

Question Number	Answer	Mark
11	**The only correct answer is D** (yellow blue) *A is incorrect because both the ions are moving in the wrong direction* *B is incorrect because only the copper(II) ions have been attracted to an electrode* *C is incorrect because only the chromate(VI) ions have been attracted to an electrode*	**(1)** **Computer**

Question Number	Answer	Additional Guidance	Mark
25(a)(i)	• trigonal planar	Allow triangular planar	**(1)**

Question Number	Answer	Additional Guidance	Mark
25(a)(ii)	An answer that makes reference to the following points: • eight correct covalent bonds **(1)** • correctly identifying the two dative covalent bonds between the monmoers by means of arrow from chlorine to aluminium **(1)**	An example of a diagram:  Bonds between aluminium atoms lose M1 Ignore bond angles and lengths Ignore dot-cross diagrams Ignore missing lone pair electrons on arrow Do not award lone pair on aluminium for M2	**(2)**

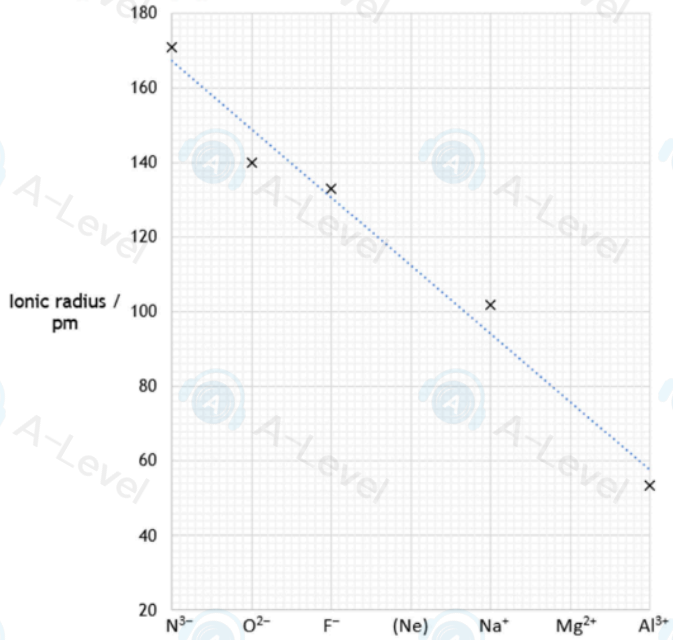
Question Number	Answer	Additional Guidance	Mark
25(b)	• balanced equation	$AlCl_3 + 3H_2O \rightarrow 3HCl + Al(OH)_3$ Allow equation with Al_2Cl_6 Allow multiples Ignore state symbols even if incorrect	**(1)**

Question Number	Answer	Additional Guidance	Mark
25(c)	• calculation of moles of sodium hydroxide **(1)** • use of ratio **(1)** • M_r of aluminium hydroxide **and** mass of aluminium hydroxide **(1)**	An example of a calculation: $0.15 \times 1.5 = 0.225$ mol $0.225 \div 3 = 0.075$ $27.0 + (3 \times (16 + 1)) = 78$ $78 \times 0.075 = 5.85$ (g) Correct answer scores 3 marks TE throughout Ignore SF except 1SF **Common incorrect answer:** 17.55(g) scores 2 (M1 and M3)	**(3)**

Question Number	Answer		Additional Guidance	Mark
25(d)(i)	A description that makes reference to the following points: • **strong** electrostatic (attraction) • between cations and delocalised electrons • Al^{3+} **and** 3 electrons per ion	**(1)** **(1)** **(1)**	Do not award references to covalent bonding for M1 Allow "positively charged ions" for cations Allow aluminium ions for cations Do not award nuclei / protons Do not award M2 for reference to intermolecular forces Allow +3 charge M2 and M3 may be shown in a diagram	**(3)**

Question Number	Answer		Additional Guidance	Mark
25(d)(ii)	An explanation that makes reference to the following points: • **delocalised** electrons flow (under a potential difference) • layers/ions/atoms slide over each other (while still being held together by delocalised electrons)	**(1)** **(1)**	Allow voltage is applied Allow **delocalised** electrons can move (and conduct/carry charge) Do not award mobile ions Do not award reference to intermolecular forces for M2	**(2)**

(Total for Question 25 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
24(a)(i)	• axis labelled with unit **and** allowing the data to fill over half of y-axis **(1)** • 5 **points** in the table correctly plotted to within half a small square **(1)**	An example of the graph:  A scale of 30pm per large square does not score M1 Non-linear axes negate M1 **and** M2 – but an axis break is allowed NB trend line does not need to be present for M1 or M2 Ignore x-axis label even if incorrect Ignore point for Neon even if not on the line	**(2)**

Question Number	Answer	Additional Guidance	Mark
24(a)(ii)	• appropriate straight best fit line on graph **(1)** • value for Mg radius (read from graph) **(1)**	At least one point above and below the line Allow a line connecting N^{3-}, F^-, Al^{3+} Allow 70 – 80 (pm) Marks are independent	**(2)**

Question Number	Answer	Additional Guidance	Mark
24(a)(iii)	An explanation that makes reference to the following points: • (ionic) radius decreases (with (increasing) atomic number) **(1)** • because there are more protons (in the nucleus) **(1)** • and the ions are isoelectronic **(1)**	Must be a trend not a comparison for M1 Ignore "across the period" Do not award atomic radius Allow nuclear charge increases Ignore mass to charge ratio Ignore atomic number Ignore electrostatic force between electrons and nucleus is increasing (if no mention of protons) Accept there is no variation in shell/shielding / all have 10 electrons / the same number of electrons / same electronic configuration	**(3)**

Question Number	Answer	Additional Guidance	Mark
24(b)(i)	An answer that makes reference to the following point: • **giant ionic** lattice	Allow crystal for lattice Allow giant ionic structure Do not award linear shape Do not award references to covalency or molecules Allow this answer given in 24(b)(ii) provided this is not negated by the 24(b)(i) answer	**(1)**

Question Number	Answer	Additional Guidance	Mark
24(b)(ii)	A description that makes reference to the following points: • sodium fluoride does not conduct electricity when **solid** **(1)** • sodium fluoride does conduct when in aqueous solution / molten **(1)** • because the ions cannot move (in a solid) **and** the ions are free to move when the substance is in solution / molten **(1)**	Allow poor conductor / insulator Ignore carry charge Allow because the ions are in fixed positions Do not award M3 if there is reference to sodium fluoride having delocalised electrons Must mention solutions **and** molten to gain all three marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
24(b)(iii)	An explanation that makes reference to the following points: • the fluoride ion has a single charge **and** a small (ionic) radius / size **(1)** • so the electron cloud is difficult to **distort** **(1)**	Allow opposite argument i.e. ions that are large and bigger charges are easy to polarise, but you can't polarise fluoride due to its size and charge for M1 Allow small/low charge Allow small size Ignore low size Do not award M1 for atomic radius Ignore comments about electronegativity Allow "it is difficult to **distort**" Marks are independent	**(2)**

(Total for Question 24 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
23(a)(i)	• calculation of abundance of 5th isotope **(1)** • expression for relative atomic mass **(1)** • calculation of x given to 2SF **(1)**	Example of calculation 100 – 20.5 – 7.8 – 36.5 – 7.8 = 27.4 (%) $72.6 = \frac{(70 \times 20.5) + (73 \times 7.8) + (74 \times 36.5) + (76 \times 7.8) + (x \times 27.4)}{100}$ OR $72.6 = \frac{1435 + 569.4 + 2701 + 592.8 + (x \times 27.4)}{100}$ OR $72.6 = \frac{5298.2 + (x \times 27.4)}{100}$ Allow TE from M1 $x = \frac{7260 - 5298.2}{27.4} = 1961.8 \div 27.4 = 71.59 = 72$ Allow TE from M2 provided final answer is between 68 – 78 Correct answer with some working scores 3 Correct answer with no working scores 1	**(3)**

Question Number	Answer	Additional Guidance	Mark
23(a)(ii)	An answer that makes reference to the following point: • the number of protons **and** neutrons / nucleons must be an integer / whole number	Ignore the values in the table with the least significant figures have 2 SF	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(b)	An answer that makes reference to the following points: Similarity • (the atoms) have the same total / sum of the numbers of protons and of neutrons **(1)** Difference • (an atom of) germanium(-76) has 2 fewer protons / (an atom of) selenium(-76) has 2 more protons • (an atom of) germanium(-76) has 2 more neutrons / (an atom of) selenium(-76) has 2 fewer neutrons **(1)** • (an atom of) germanium(-76) has 2 fewer electrons / (an atom of) selenium(-76) has 2 more electrons **(1)**	M2, M3 and M4 must be quantitative Allow the atoms have the same mass number Allow germanium has 32 protons and selenium has 34 protons Allow germanium has 44 neutrons and selenium has 42 neutrons Allow germanium has 32 electrons and selenium has 34 electrons Allow germanium has 4 outer-shell electrons and selenium has 6 outer-shell electrons If none of M2, M3 and M4 have been awarded allow 1 mark for **two** of the following: • germanium has more neutrons • germanium has fewer protons • selenium has more electrons Allow reverse argument(s)	**(4)**

(Total for Question 23 = 8 marks)