Question Number	Answer	Mark
11	**The only correct answer is D** (magnesium iodide) ***A** is incorrect because Na^+ has a smaller charge than Mg^{2+} and Cl^- is smaller than I^-* ***B** is incorrect because Na^+ has a smaller charge than Mg^{2+}* ***C** is incorrect because Cl^- is smaller than I^-*	**(1)**

Question Number	Answer	Mark
12	**The only correct answer is C** (Sc^{3+}) ***A** is incorrect because this has no electrons so cannot be isoelectronic with a noble gas* ***B** is incorrect because this has one electron fewer than neon* ***D** is incorrect because though it has no s-electrons it has 10 d-electrons, 10 more than argon*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is B** ($Mg^{2+}(aq) + 2OH^-(aq) \rightarrow Mg(OH)_2(s)$) ***A** is not correct because the magnesium ion should be 2+* ***C** is not correct because the magnesium ion should be 2+ and the magnesium hydroxide should be solid* ***D** is not correct because the magnesium hydroxide should be solid*	**(1)**

Question Number	Answer	Mark
5	**The only correct answer is C** (x = 2, y = 7, z = 4) ***A** is incorrect because x must be 2 to match the 4 P in P_4O_{10}* ***B** is incorrect because z must be 4 to give 8 H to match the H in $2P_2H_4$* ***D** is incorrect because x must be 2 to match the 4 P in P_4O_{10}*	**(1)**

Question Number	Answer	Mark
3	**The only correct answer is D** (0.025 mol of copper(II) sulfate) ***A** is incorrect because 0.33 mol water has a mass of 5.94 g* ***B** is incorrect because 0.25 mol magnesium has a mass of 6.075 g* ***C** is incorrect because 0.033 mol glucose has a mass of 5.94 g*	**(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
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	Mark
6	**The only correct answer is C** (between 20 g and 40 g) ***A*** *is incorrect because the atomic mass of silver is greater than that of copper so more than 20 g will be formed* ***B*** *is incorrect because the atomic mass of silver is greater than that of copper so more than 20 g will be formed* ***D*** *is incorrect because the atomic mass of silver is less than twice that of copper so less than 40 g will be formed*	**(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
8	**The only correct answer is C** ($11.34\ g\ cm^{-3}$) ***A*** *is incorrect because they have divided the* A_r *by the number of moles* ***B*** *is incorrect they have used the atomic number not the mass number* ***D*** *is incorrect because this is the number of moles*	**(1)**

Question Number	Answer	Mark
16	**The only correct answer is C** (2.107×10^{24}) ***A*** *is incorrect because moles of methane correctly calculated multiplied by L* ***B*** *is incorrect because moles of methane incorrectly calculated and then multiplied by L* ***D*** *is incorrect because moles of methane incorrectly calculated and then multiplied by 4 and L*	**(1)**

Question Number	Answer	Mark
10(a)	**The only correct answer is B** (ions of $Cl^-(g)$ and $S^{2-}(g)$ have the same ionic radius) *A is incorrect because Cl(g) atoms have the highest first ionisation energy of these elements.* *C is incorrect because the sodium atoms have the largest atomic radius.* *D is incorrect because P atoms have 3 unpaired electrons, more than any other atom.*	**(1)**

Question Number	Answer	Mark
10(b)	**The only correct answer is D** (S) *A is incorrect because Al is not held together by intermolecular forces as it is a metallic structure* *B is incorrect because Si is held together by covalent bonds not intermolecular forces* *C is incorrect because P is held together by intermolecular forces, but has a lower melting temperature than S*	**(1)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>21(a)</td><td>

- M1 % (of hydrogen) **(1)**
- M2 calculation of moles **(1)**
- M3 divide by the lowest number of moles to get empirical formula **(1)**
- M4 calculation of M_r of empirical formula **(1)**

- M1 % (of hydrogen) **(1)**
- M2 multiplication of % by M_r (row 2) **(1)**
- M3 calculation of ratio number (row 3) **(1)**
- M4 divide by the lowest number to get empirical formula (row 4) **(1)**

</td><td>

<u>Example of calculation</u>

100 − 17.48 – 77.67 = 4.85 (%)

B	O	H
17.48/10.8	77.67/16	4.85/1
1.6185	4.854	4.85
1.6185/1.6185 = 1	4.85/1.6185 = 2.996	4.85/1.6185 = 2.996

1 x 10.8 + 3 x 16 + 3 x 1 = 61.8 (g mol^{-1})

If they only use 2 elements, they can score one mark for M2 and M3 being correct for both B and O

Or

B	O	H
17.48 × 61.8/100	77.67 × 61.8/100	4.85 × 61.8/100
= 10.8	= 48	= 3
10.8/10.8 = 1	48/16 = 3	3/1 = 3

</td><td>(4)</td></tr>
</table>

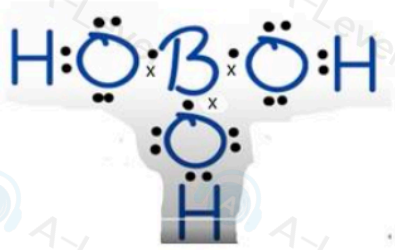
<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>21(b)(i)</td><td>

An answer that makes reference to the following points:

- correct electrons around B **(1)**
- correct electrons around the oxygens **(1)**
- correct electrons round the hydrogens **(1)**

</td><td>

Example of diagram
Allow any combination of dots and crosses or just dots or just crosses.



Ignore how the lone pair electrons are arranged in oxygen.
The marks are only awarded if the bond and number of bonds is correct between the correct two atoms.

Anything ionic score 0

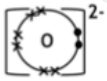
</td><td>(3)</td></tr>
</table>

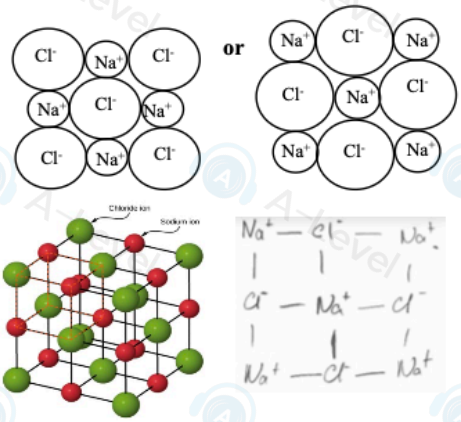
Question Number	Answer	Additional Guidance	Mark
21(b)(ii)	An answer that makes reference to the following points: • bond angle 120° **(1)** • 3 (bonding) pairs of electrons (round B) adopt a position of minimum repulsion **(1)**	Ignore trigonal planar/any shape even if incorrect Allow maximum separation of 3 electron pairs No TE on incorrect bond angle for M2 Do not award bonds for electrons Ignore electron pairs have equal repulsion Allow TE on structure in (b)(i) If structure in (b)(i) has 3 bonding and 1 lone pair of electrons M1 bond angle of 107° (allow 106-108) M2 lone pairs repel more than bonding pairs (and adopt a position of minimum repulsion/maximum separation) Any ionic structure from (b)(i) will score 0	**(2)**

(Total for Question 21 = 9 marks)

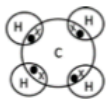
Question Number	Answer	Additional Guidance	Mark
23(a)(i)	An answer that makes reference to the following point: • (electrostatic force of) **attraction** between oppositely charged ions	Allow attraction between cations / positively charged metal ions and anions	**(1)**

Question Number	Answer	Additional Guidance	Mark
23(a)(ii)	An explanation that makes reference to the following points: • magnesium **ions** have a higher charge. **(1)** • magnesium ions have a smaller radius. **(1)**	Allow ORA about sodium ions Allow Mg^{2+} and Na^{+} Allow magnesium has a smaller ionic radius / magnesium ions are smaller If no other mark awarded allow one mark for Mg^{2+} / magnesium ion has a greater charge density Penalise any mention of covalent bonding or intermolecular forces once only.	**(2)**

Question Number	Answer	Additional Guidance	Mark
23(a)(iii)	An answer that makes reference to the following points: •  (1) •  (1)	**Mark independently** Allow eight electrons on outer shell instead of no electrons or no circle Allow single sodium ion Do not award Na^{+}_{2} Allow transferred electrons in any pattern Do not award all dots or all crosses for the oxide ion Ignore omission of square brackets	(2)

Question Number	Answer	Additional Guidance	Mark
23(a)(iv)	An answer that makes reference to the following points: • At least 9 correctly labelled sodium **and** chloride ions (1) • The correct structure of alternating sodium / positive and chloride / negative (ions) either in rows or 3D lattice (1)	 Ignore size of ions Do not award M1 if suggestion that sodium chloride is not NaCl	(2)

Question Number	Answer	Additional Guidance	Mark
23(b)(i)	An answer that makes reference to the following point: • (electrostatic force of) **attraction** between the **shared pair** of electrons and the nuclei (of two atoms)		**(1)**

Question Number	Answer		Additional Guidance	Mark
23(b)(ii)	An answer that makes reference to the following points:			**(3)**
	• structure of methane	**(1)**		
	• structure of ammonia	**(1)**		
	• structure of water	**(1)**		

Question Number	Answer		Additional Guidance	Mark
23(b)(iii)	An answer that makes reference to the following points:			**(3)**
	• shape and bond angle for methane	**(1)**		
	• shape and bond angle for ammonia	**(1)**		
	• shape and bond angle for water	**(1)**		

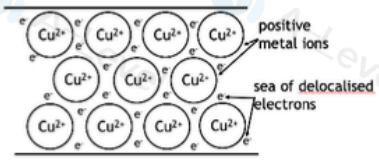
molecule	shape	bond angle
methane	tetrahedral	109.5°
ammonia	(trigonal) pyramidal	107°
water	non-linear / bent / V-shaped	104.5°

If no other mark scored 1 mark for either three correct bond angles or three correct shapes

Question Number	Answer		Additional Guidance	Mark
23(b)(iv)	An answer that makes reference to the following points: (Both ammonia and water have four pairs of electrons around the central atom)			**(2)**
	• ammonia has one lone pair and water has two lone pairs	**(1)**	Allow water has an extra lone pair	
	• lone pairs (of electrons) repel more than bonded pairs.	**(1)**	Ignore bond angles even if incorrect.	

Question Number	Answer	Additional Guidance	Mark
23(b)(v)	An answer that makes reference to the following points: • ethene is a simple molecule • ethene has weak intermolecular forces • poly(ethene) is a polymer • poly(ethene) strong intermolecular forces All four bullet points scores 2 Two or three bullet points scores 1	Allow London / van der Waals / dispersion forces for intermolecular forces Ignore monomer Do not award reference to breaking covalent bonds Allow poly(ethene) is a macromolecule / giant molecule for polymer Do not award reference to breaking covalent bonds	(2)

Question Number	Answer	Additional Guidance	Mark
23(c)(i)	An answer that makes reference to the following point: • **electrostatic** (force of) **attraction** between the positive / metal ions and the (sea of delocalised) electrons.		(1)

Question Number	Answer	Additional Guidance	Mark
23(c)(ii)	An explanation that makes reference to the following points: • **delocalised** electrons are able to move / flow (through the lattice and carry a charge) **(1)** • diagram showing lattice of Cu^{2+} ions and (sea of) electrons interspersed within the structure – approximately twice as many electrons as ions **(1)**	Delocalised electrons may be labelled in the diagram  Do not award ions move	(2)

(Total for Question 23 = 21 marks)

Question Number	Answer	Additional Guidance	Mark
20(a)(i)	An explanation that makes reference to the following points: 4 points award 2 marks 2 or 3 points award 1 mark • first ionisation increases (across the period) • due to increased nuclear attraction / because there is an increasing attraction between the electrons and the nucleus • as electrons are added to / removed from the same shell of electrons • the number of protons / positive charge increases	 Allow have similar shielding for same shell Allow nuclear charge increases	**(2)**

Question Number	Answer	Additional Guidance	Mark
20(a)(ii)	An explanation that makes reference to the following points: • boron **(1)** • the electron (being removed) is from the **2p** subshell (not the 2s as for Li and Be) **(1)** • which is further from the nucleus than the 2s electrons so is more **shielded** **(1)**	 Allow abbreviated electron configuration for boron ($2s^2\ 2p^1$) Accept just is more **shielded** Ignore just is further from the nucleus	**(3)**

Question Number	Answer	Additional Guidance	Mark
20(b)	An answer that makes reference to the following point: • sulfur / S		(1)

Question Number	Answer	Additional Guidance	Mark
20(c)(i)	• a cross on the line for boron between 2000 K and 3500 K (2573 K) (1) • a cross on the line for nitrogen below the cross for lithium (63 K) (1)	Allow any clear indication of the position of the melting temperature Allow the cross not perfectly on the line for each element	(2)

Question Number	Answer	Additional Guidance	Mark
20(c)(ii)	An explanation that makes reference to the following points: • Graphite / diamond / carbon are lattices / giant structure with **covalent** bonds (between the atoms) (1) • Held together by **strong** covalent bonds (1) • (which) require a lot of energy to break (1)	Do not award mention of ionic bonding / metallic bonding scores 0 overall Penalise use of molecules or intermolecular once only Allow sigma bonds for covalent bonds Allow (in diamond) each carbon is bonded to four other carbon atoms or (in graphite) each carbon is bonded to three other carbon atoms in layers Ignore macromolecular Ignore giant covalent bond	(3)

(Total for Question 20 = 11 marks)