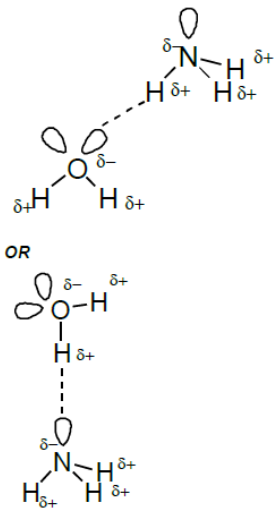
Question	Marking Guidance	Mark	Comments
1(a)	Average/mean mass of 1 atom (of an element) 1/12 mass of one atom of ^{12}C ***OR*** Average/mean mass of atoms of an element 1/12 mass of one atom of ^{12}C ***OR*** Average/mean mass of atoms of an element x12 mass of one atom of ^{12}C ***OR*** (Average) mass of one mole of atoms 1/12 mass of one mole of ^{12}C ***OR*** (Weighted) average mass of all the isotopes 1/12 mass of one atom of ^{12}C ***OR*** Average mass of an atom/isotope (compared to C-12) on a scale in which an atom of C-12 has a mass of 12	1 1 This expression = 2 marks.	If moles and atoms mixed, max = 1 Mark top and bottom line independently. All key terms must be present for each mark.
1(b)	$\frac{(70x3) + (72x4) + 73 + (74x5)}{13} = \frac{941}{13}$ $= 72.4$	1 1 1	 72.4 only.
1(c)	$^{(72)}Ge^+$ or germanium$^+$	1	Must show '+' sign. Penalise wrong mass number.
1(d)	70 Lowest mass / lowest m/z	1 1	If M1 incorrect or blank CE = 0/2 Ignore symbols and charge even if wrong. Accept lightest. Accept fewest neutrons.
1(e)	Electron(s) transferred / flow (at the detector) (From detector / plate) to the (+) ion	1 1	M1 must refer to electron flow at the detector. If M1 incorrect CE = 0/2 Do not allow from a charged plate.
1(f)	They do not have the same electron configuration / they have different number of electrons (in the outer shell)	1	Ignore electrons determine the properties of an atom. Ignore they are different elements or different number of protons.

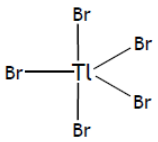
2)

stion	Marking Guidance	Mark	Comments
(a)	Giant covalent / giant molecular / macromolecular	1	Not giant alone. Not covalent alone.
(b)	Shared pair of electrons / one electron from each C atom	1	
(c)	No delocalised / free / mobile electrons	1	Allow all (outer) electrons involved in (covalent) bonds. Ignore ions.
(d)	CH	1	Allow HC C and H must be capital letters.

3)

stion	Marking Guidance	Mark	Comments
(a)	Hydrogen bonding / hydrogen bonds / H-bonding / H-Bonds	1	Not just hydrogen.
(b)		3	One mark for minimum of 4 correct partial charges shown on the N-H and O-H One mark for the 3 lone pairs. One mark for H bond from the lone pair on O or N to the $H^{\delta+}$ The N-H-O should be linear but can accept if the lone pair on O or N hydrogen bonded to the $H^{\delta+}$ If wrong molecules or wrong formula, CE = 0/3
(c)	(Phosphine) does not form hydrogen bonds (with water)	1	

4)

stion	Marking Guidance	Mark	Comments
(a)	$Al + 1.5Cl_2 \rightarrow AlCl_3$	1	Accept multiples. Also $2Al + 3Cl_2 \rightarrow Al_2Cl_6$ Ignore state symbols.
(b)	Coordinate / dative (covalent) Electron pair on Cl^- donated to $Al(Cl_3)$	1 1	If wrong CE=0/2 if covalent mark on. QoL Lone pair from Cl^- not just Cl Penalise wrong species.
(c)	Al_2Cl_6 or $AlBr_3$	1	Allow Br_3Al or Cl_6Al_2 Upper and lower case letters must be as shown. Not $2AlCl_3$
(d)	$SiCl_4$ / silicon tetrachloride	1	Accept silicon(4) chloride or silicon(IV) chloride. Upper and lower case letters must be as shown. Not silicon chloride.
(e)	 Trigonal bipyramid(al)	1 1	Accept shape containing 5 bonds and no lone pairs from Tl to each of 5 Br atoms. Ignore charge.
(f)(i)	Cl—— Tl —— Cl	1	Accept this linear structure only with no lone pair on Tl
(f)(ii)	(Two) bonds (pairs of electrons) repel equally / (electrons in) the bonds repel to be as far apart as possible	1	Dependent on linear structure in 5(f)(i). Do not allow electrons /electron pairs repel alone.
(g)	Second	1	

5)

stion	Marking Guidance		Mark	Comments
(a)	Method 1	Method 2		
	Mass of H_2O = 4.38-2.46 (= 1.92 g)	Percentage of H_2O = 44%	1	If there is an AE in M1 then can score M2 and M3 If *M*, incorrect can only score M1
	$ZnSO_4$ H_2O 2.46 1.92 161.5 18 (0.0152 0.107) (1 : 7)	ZnSO4 H2O 56 44 161.5 18 (0.347 2.444) (1 : 7)	1	
	x = 7	x = 7	1	If x = 7 with working then award 3 marks. Allow alternative methods. If M1 incorrect due to AE, M3 must be an integer.
(b)	Moles HCl = 0.12(0)		1	
	mol $ZnCl_2$ = 0.06(0) ***OR*** 0.12 / 2		1	If M2 incorrect then CE and cannot score M2, M3 and M4.
	mass $ZnCl_2$ = 0.06 × 136.4		1	Allow 65.4 + (2 × 35.5) for 136.4
	= 8.18(4) (g) ***OR*** 8.2 (g)		1	Must be to 2 significant figures or more. Ignore units.
'(c)	Moles $ZnCl_2$ = 10.7 / 136.4 (= 0.0784)		1	
	OR moles Zn = 0.0784			
	Mass Zn reacting = 0.0784 × 65.4 = (5.13 g)		1	M2 is for their M1 × 65.4
	% purity of Zn = 5.13 / 5.68 × 100		1	M3 is M2 × 100 / 5.68 provided M2 is < 5.68
	= 90.2% ***OR*** 90.3%		1	Allow alternative methods. M1 = Moles $ZnCl_2$ = 10.7 / 136.4 (= 0.0784) M2 = Theoretical moles Zn = 5.68 / 65.4 (= 0.0869) M3 = M1 × 100 / M2 = (0.0784 × 100 / 0.0869) M4 = 90.2% ***OR*** 90.3%
'(d)	Ionic		1	If not ionic CE = 0/3
	Strong (electrostatic) attraction (between ions)		1	
	between oppositely charged ions / + and – ions / F^- and Zn^{2+} ions		1	If IMF, molecules, metallic bonding implied CE = 0/3

Question	Marking Guidance	Mark	Comments
6 (a)(i)	$3CuS(s) + \mathbf{8}HNO_3(aq) \longrightarrow \mathbf{3}CuSO_4(aq) + \mathbf{8}NO(g) + \mathbf{4}H_2O(l)$	1	
(a)(ii)	**(+) 5** **(+) 2**	2	
(a)(iii)	$\mathbf{4}H^+ + NO_3^- + \mathbf{3}e^- \longrightarrow \mathbf{2}H_2O + NO$	1	Ignore state symbols. Credit multiples of **this equation only.** Ignore absence of charge on the electron.
(a)(iv)	$S^{2-} + \mathbf{4}H_2O \longrightarrow SO_4^{2-} + \mathbf{8}e^- + \mathbf{8}H^+$	1	Ignore state symbols. Credit multiples of **this equation only.** Ignore absence of charge on the electron.
(b)	**M1** add scrap / recycled / waste iron (or steel) to the aqueous solution **M2** the iron is a more reactive metal *OR* Fe is a better reducing agent **M3** Cu^{2+} /copper ions are reduced / gain electrons *OR* $Cu^{2+} + 2e^- \longrightarrow Cu$ *OR* copper / Cu is displaced by Fe **M4** $Fe + Cu^{2+} \longrightarrow Fe^{2+} + Cu$ ONLY	4	If **M1** refers to iron / steel, but does not make it clear in the text that it is "scrap" / "waste" / "recycled", penalise **M1** but mark on. Credit zinc or magnesium as an alternative to iron for **M2**, **M3** and **M4** only, penalising **M1** Ignore absence of charge on the electron. For **M4**, ignore state symbols.