Question	Marking Guidance	Mark	Comments
1(a)(i)	Different number / amount of neutrons	1	Not different neutrons Ignore same protons and/or electrons CE incorrect statement relating to protons / electrons
1(a)(ii)	Same electron configuration / same number of electrons (in the outer shell)	1	Ignore same no of protons Ignore electrons determine chemical properties CE if wrong statement relating to protons / neutrons
1(b)	Average mass of 1 atom (of an element)  1/12 mass atom of <sup>12</sup> C  OR  Average/mean mass of atoms of an element  1/12 mass of one atom of <sup>12</sup> C  OR  (Average) mass of one mole of atoms  1/12 mass of one mole of <sup>12</sup> C  OR  (Weighted) average mass of all the isotopes  1/12 mass of one atom of <sup>12</sup> 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	If moles and atoms mixes Max = 1  Mark top and bottom line independently 1/12 on bottom line can be represented as x 12 on top line  This expression = 2 marks

1 (c) (i)	(64 x 12) + (66 x 8) + (67 x 1) + (68 x 6) (=1771) 27 27 27	1 1	If not 27 max 1 mark (for top line) Mark is for dividing by 27 or string If evidence of arithmetic or transcription error seen in M1 or M2 allow consequential M3 and consequential 1(c)(ii) 65.6 = 3 marks
1(c)(ii)	<sup>≤4</sup> Zn*	1	M1 for identifying Zn / zinc M2 is for the + sign and the 64 M2 is dependent on M1
1(d)	Size of the charge (on the ion) / different charges / different m/z	1	Allow forms 2+ ions QWC
1(e)	(ions hit detector and) cause current/(ions) accept electrons/cause electron flow/electric pulse caused bigger current = more of that isotope/current proportional to abundance	1	Implication that current depends on the number of ions M2 dependent on M1

Question	Marking Guidance	Mark	Comments
2(a)(i)	0.0212	1	Need 3 sig figs Allow correct answer to 3 sig figs eg 2.12 x 10 <sup>-2</sup>
2(a)(ii)	0.0106	1	Mark is for 2(a)(i) divided by 2 leading to correct answer ≥ 2 sig figs
2(a)(iii)	$M_r = \frac{100.1}{1.06 \text{ g}}$	1	Allow 100.1 as 'string' Need 3 sig figs or more Consequential on 2(a)(ii) x 100(.1)
2(a)(iv)	Neutralisation or acid / base reaction	1	Allow acid / alkali reaction Apply list principle
2(b)(i)	T = 304(K) and P = 100 000 (Pa)	1	Only T and P correctly converted
	100 000 x 3.50 x 10 <sup>-3</sup> OR n = PV 8.31 x 304 RT 0.139 (mol)	1	Allow <u>0.138 – 0.139</u>
2(b)(ii)	0.0276 – 0.0278(mol)	1	Allow answer to 2(b)(i) divided by 5 leading to a correct answer Allow 0.028

2(c)	4.20 g Ca(NO <sub>3</sub> ) <sub>2</sub>	1	
	Ca(NO <sub>3</sub> ) <sub>2</sub> H <sub>2</sub> O <u>4.20</u> 1.84 164(.1) 18	1	Mark is for dividing by the correct M, values M2 and M3 dependent on correct M1
	0.0256 0.102		M2 can be awarded here instead
	1 : 3.98		
	x = 4	1	If Ca(NO <sub>3</sub> ) <sub>2</sub> .4H <sub>2</sub> O seen with working then award 3 marks Credit alternative method which gives x = 4

Question	Marking Guidance	Mark	Comments
3(a)	lodine has more electrons / iodine is bigger (atom or molecule) / iodine has bigger M <sub>r</sub> / bigger surface area	1	
	Stronger / more van der Waals forces / vdw / London / temporarily induced dipole / dispersion forces between molecules	1	Stronger VdW intermolecular forces = M2 If stated VdW between atoms lose M2
3(b)(i)	H F	1	Mark is for 3 bp and 1 lp attached to N (irrespective of shape)
	F_B—F	1	Mark is for 3 bp and 0 lp attached to B (irrespective of shape)
	NHF <sub>2</sub> shape - pyramidal / trigonal pyramid BF <sub>3</sub> shape - <u>trigonal planar</u>	1	Accept tetrahedral / triangular pyramid Not triangular or triangular planar
3(b)(ii)	107°	1	Allow 106-108°
3(c)	Hydrogen bonds	1	Allow H-Bonds Not just Hydrogen Apply list principle eg Hydrogen bonding and dipole-dipole = 0
3(d)	Coordinate / dative covalent / dative	1	If covalent mark on If ionic / metallic CE = 0
	Lone pair / both electrons/ 2 electrons on N(HF <sub>3</sub> ) donated (to BF <sub>3</sub> )	1	Direction of donation needed here

Question	Marking Guidance	Mark	Comments
4(a)(i)	Metallic	1	Allow body centred cubic
4(a)(ii)	+ + + + + + + + + + + + + + + + + + +	1	One mark for regular arrangement of particles. Can have a space between them  Do not allow hexagonal arrangement  One mark for + in each Ignore electrons  If it looks like ionic bonding then CE = 0/2
4(b)(i)	lonic	.1	CE = 0 for 4(b)(i) and 4(b)(ii) if not ionic
4(b)(ii)	Strong (electrostatic) attraction  Between oppositely charged ions / particles	1	Any mention of IMF or molecules / metallic / covalent in 4(b)(ii) then CE 0/2 Or + and – ions
4(c)	lodide / I⁻ bigger (ion) (so less attraction to the Na+ ion)	1	Need comparison Do not allow iodine is a bigger atom Ignore I' has one more e- shell CE = 0 if IMF / covalent / metallic mentioned

Question	Marking Guidance	Mark	Comments
5(a)	$Li(g) \rightarrow Li^{\dagger}(g) + e^{\prime}(g)$ $Li(g) - e^{\prime}(g) \rightarrow Li^{\dagger}(g)$ $Li(g) + e^{\prime}(g) \rightarrow Li^{\dagger}(g) + 2e^{\prime}$	1	One mark for balanced equation with state symbols Charge and state on electron need not be shown

Question	Marking Guidance	Mark	Comments
6 (a)(i)	M1 (could be scored by a correct mathematical expression which must have all ΔH symbols and the ∑ or sum)  M1 ΔH <sub>r</sub> = ∑ΔH <sub>r</sub> (products) - ∑ΔH <sub>r</sub> (reactants)  OR a correct cycle of balanced equations with  1C, 3H <sub>2</sub> and 1O <sub>2</sub> M2 ΔH <sub>r</sub> = -201 + (-242) - (-394)  ΔH <sub>r</sub> = -201 - 242 + 394  ΔH <sub>r</sub> = -443 + 394  (This also scores M1)  M3 = -49 (kJ mol <sup>-1</sup> )  (Award 1 mark ONLY for + 49)	3	Correct answer gains full marks  Credit 1 mark ONLY for + 49 (kJ mol <sup>-1</sup> )  For other incorrect or incomplete answers, proceed as follows  • check for an arithmetic error (AE), which is either a transposition error or an incorrect multiplication; this would score 2 marks (M1 and M2)  • If no AE, check for a correct method; this requires either correct cycle of balanced equations with 1C, 3H <sub>2</sub> and 1O <sub>2</sub> OR a clear statement of M1 which could be in words and scores only M1
'(a)(ii)	It is an element / elemental  OR  By definition	1	Ignore reference to "standard state"

(b)	M1 (The yield) increases / goes up / gets more  M2 There are more moles / molecules (of gas) on the left / of reactants  OR fewer moles / molecules (of gas) on the right / products  OR there are 4 moles / molecules (of gas) on the left and 2 moles / molecules on the right.  OR (equilibrium) shifts / moves to the side with less moles / molecules  M3: Can only score M3 if M2 is correct  The (position of) equilibrium shifts / moves (from left to right) to oppose the increase in pressure	3	If M1 is given as "decreases" / "no effect" / "no change" then CE= 0 for clip, but mark on only M2 and M3 from a blank M1  Ignore "volumes", "particles" "atoms" and "species" for M2  For M3, not simply "to oppose the change" For M3 credit the equilibrium shifts / moves (to right) to lower / decrease the pressure (There must be a specific reference to the change that is opposed)
(c)	M1 Yield increases / goes up  M2 The (forward) reaction / to the right is endothermic OR takes in / absorbs heat  OR  The reverse reaction / to the left is exothermic OR gives out / releases heat  Can only score M3 if M2 is correct  M3 The (position of) equilibrium shifts / moves (from left to right) to oppose the increase in temperature (QoL)	3	If M1 is given as "decrease" / "no effect" / "no change" then CE= 0 for clip, but mark on only M2 and M3 from a blank M1  For M3, not simply "to oppose the change" For M3, credit the (position of) equilibrium shifts / moves (QoL) to absorb the heat OR to cool the reaction OR to lower the temperature (There must be a specific reference to the change that is opposed)