

Question		Answer	Marks	Guidance
1	(a)	<p>The (weighted) mean mass of an atom (of an element) OR The (weighted) average mass of an atom (of an element) ✓</p> <p>compared with 1/12th (the mass) ✓</p> <p>of (one atom of) carbon-12 ✓</p>	3	<p>ALLOW average atomic mass DO NOT ALLOW mean mass of an element ALLOW mean mass of isotopes OR average mass of isotopes DO NOT ALLOW the singular; 'isotope'</p> <p>For second and third marking points ALLOW compared with (the mass of) carbon-12 which is 12</p> <p>ALLOW mass of one mole of atoms ✓ compared to 1/12th ✓ (mass of) one mole OR 12g of carbon-12 ✓</p> <p>ALLOW $\frac{\text{mass of one mole of atoms}}{1/12\text{th mass of one mole OR } 12\text{g of carbon-12}}$</p>
	(b)	<p>FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 32.09 award 2 marks</p> <p>$\frac{32 \times 95.02 + 33 \times 0.76 + 34 \times 4.22}{100}$</p> <p>OR</p> <p>30.4064 + 0.2508 + 1.4348</p> <p>OR</p> <p>= 32.092 (calculator value) ✓</p> <p>(A_r =) 32.09 ✓</p>	2	<p>ALLOW one mark for ECF from transcription error in first sum provided final answer is to 2 decimal places and is between 32 and 34 and is a correct calculation of the transcription</p> <p>Answer must be 2 decimal places</p>

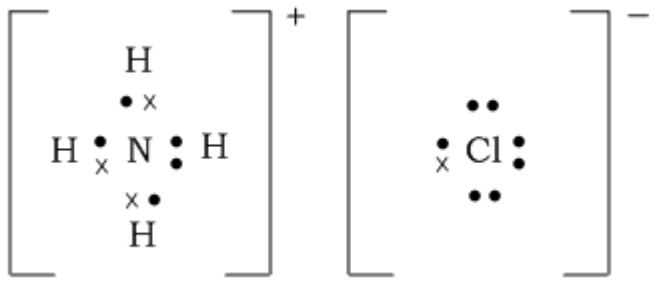
Question		Answer	Marks	Guidance															
1	(c)	<table border="1"> <thead> <tr> <th></th> <th>protons</th> <th>neutrons</th> <th>electrons</th> <th></th> </tr> </thead> <tbody> <tr> <td>^{33}S</td> <td>16</td> <td>17</td> <td>16</td> <td>✓</td> </tr> <tr> <td>$^{34}\text{S}^{2-}$</td> <td>16</td> <td>18</td> <td>18</td> <td>✓</td> </tr> </tbody> </table>		protons	neutrons	electrons		^{33}S	16	17	16	✓	$^{34}\text{S}^{2-}$	16	18	18	✓	2	Mark by row
	protons	neutrons	electrons																
^{33}S	16	17	16	✓															
$^{34}\text{S}^{2-}$	16	18	18	✓															
	(d)	<p>FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 5.78×10^{22} award 2 marks</p> <p>(mol of atoms) = $0.0120 \times 8 = 0.0960$ (mol) OR (no. of molecules) = $0.0120 \times 6.02 \times 10^{23} = 7.224 \times 10^{21}$ OR (no. of S atoms in 1 mole of S_8) = $8 \times 6.02 \times 10^{23} = 4.816 \times 10^{24}$ ✓</p> <p>Correctly calculates (number of atoms) = $0.0120 \times 8 \times 6.02 \times 10^{23}$ = 5.78×10^{22} (atoms) ✓</p>	2	<p>If there is an alternative answer, check to see if there is any ECF credit possible using working below</p> <p>ALLOW 5.8×10^{22} up to calculator value of 5.7792×10^{22} ALLOW correct rounding of ECF to 2 significant figures or more up to calculator value ALLOW answers in non standard form such as 0.578×10^{23} correctly rounded to 2 or more significant figures</p>															
	(e) (i)	<p>Creating the dipole mark Uneven distribution of electrons ✓</p> <p>Type of dipole mark Creates or causes an instantaneous dipole OR temporary dipole (in a molecule) ✓</p> <p>Induction of a second dipole mark Causes induced dipoles in neighbouring molecules ✓</p>	3	<p>Use annotations with ticks, crosses, ECF etc for this part ALLOW movement of electrons ALLOW changing electron density</p> <p>ALLOW 'transient', 'oscillating' 'momentary' 'changing' DO NOT ALLOW induces a temporary dipole for the second marking point</p> <p>ALLOW induces a dipole in neighbouring molecules ALLOW causes a resultant dipole in other molecules ALLOW atoms for molecules</p>															

Question			er	Marks	Guidance
1	(e)	(ii)	Only one type of atom OR No (permanent) dipoles OR non-polar OR no polar bonds ✓	1	ALLOW no difference in electronegativity IGNORE 'No hydrogen bonding' IGNORE 'No lone pairs'
	(f)		+ 2 ✓	1	ALLOW 2(+)
	(g)	(i)	There are no waters of crystallisation ✓	1	ALLOW 'without water' 'no water' etc IGNORE dehydrated
		(ii)	248.2 ✓	1	IGNORE units DO NOT ALLOW 248
		(iii)	FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 7.91 (g) award 2 marks (amount of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$) = $12.41/248.2$ OR = $0.05(00)$ (mol) ✓ (mass of $\text{Na}_2\text{S}_2\text{O}_3$) = $0.05 \times 158.2 = 7.91$ (g) ✓	2	If there is an alternative answer, check to see if there is any ECF credit possible using working below ALLOW ECFs from answer to (g)(ii) for both marking points ALLOW ECF for calculated mol of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O} \times 158.2$ correctly calculated for the 2nd mark ALLOW calculator value or rounding to 3 significant figures or more but IGNORE 'trailing' zeroes, eg 0.200 allowed as 0.2

Question			er	Marks	Guidance
1	(h)	(i)	Sulfur has six bonded pairs (and no lone pairs) ✓ Electron pairs repel (one another equally) ✓	2	ALLOW 'It has six bonded pairs' ALLOW bonds for bonded pairs IGNORE regions OR areas of negative charge ALLOW 'bonds repel' DO NOT ALLOW 'Atoms repel' or 'electrons repel' 'Lone pairs repel more than bonded pairs' would score the second mark but would contradict the first mark if there is no reference to no lone pairs
		(ii)	The ability of an atom to attract electrons ✓ in a (covalent) bond ✓ (The octahedral shape) is symmetrical ✓	3	ALLOW dipoles cancel out IGNORE polar bonds repel IGNORE charges cancel
			Total	23	

Question			Answer	Marks	Guidance
2	(a)	(i)	$\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HClO} + \text{HCl}$ ✓	1	
		(ii)	(Chlorine compounds are) carcinogenic OR (Chlorine compounds are) toxic OR poisonous ✓	1	ALLOW 'they' OR 'chlorinated hydrocarbons' OR 'it' for 'chlorine compounds' IGNORE harmful OR dangerous IGNORE references to HCl or HClO IGNORE chlorine is toxic DO NOT ALLOW chlorine is carcinogenic
	(b)	(i)	Precipitation ✓	1	
		(ii)	$\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$ ✓	1	Equation AND state symbols required for mark DO NOT ALLOW spectator ions
	(c)	(i)	$8.604/143.4 = 0.06(00)$ (mol) ✓	1	

Question			Answer	Marks	Guidance
2	(c)	(ii)	<p>If a Group 2 chloride is used amount of Group 2 chloride = $\frac{1}{2} \times 0.0600$ OR = 0.0300 mol ✓</p> <p>Mass of 1 mol of Group 2 chloride = <u>2.86</u> = 95.3(3) ✓ 0.0300</p> <p>[Relative atomic mass of M = 95.3(3) – 71.0) = 24.3 (g mol⁻¹)] AND metal = Mg ✓</p>	3	<p>DO NOT ALLOW 24.3 and Mg without appropriate working</p> <p>Check to see if there is any ECF credit possible using working below</p> <p>ALLOW calculator value or rounding to 2 significant figures or more but IGNORE 'trailing' zeroes, eg 0.200 allowed as 0.2</p> <p>ALLOW ECF for correctly calculated $\frac{1}{2} \times$ answer to (c)(i)</p> <p>Must be at least 1 decimal place for second marking point</p> <p>ALLOW ECF for 2.86/mol of metal chloride seen above eg MCl will give 0.0600 mol of metal chloride and this will likely give 2.86/0.0600 = 47.7 eg MCl_3 will give 0.0200 mol of metal chloride and this will likely give 2.86/0.0200 = 143.0</p> <p>ALLOW ECF for mass of Group 2 chloride – 71.0 provided it is not a negative value</p> <p>ALLOW ECF even if molar mass of chloride was given as a whole number above</p> <p>ALLOW ECF for mass of metal chloride – 35.5 if amount of metal chloride = 0.0600 mol eg 47.7 – 35.5 = 12.2 AND Be</p> <p>ALLOW ECF for mass of metal chloride – 106.5 if amount of metal chloride = 0.0200 mol eg 143.0 – 106.5 = 36.5 AND Ca</p>

Question			Answer	Marks	Guidance
2	(d)	(i)	A shared pair of electrons AND both electrons are donated by one atom ✓	1	
		(ii)	NH_4^+ AND Cl^- ✓	1	ALLOW $\text{NH}_4\text{Cl} \rightarrow \text{NH}_4^+ + \text{Cl}^-$ OR $\text{NH}_4^+ + \text{Cl}^- \rightarrow \text{NH}_4\text{Cl}$
		(iii)	Ammonium ion with three covalent 'dot-and-cross' bonds AND one dative covalent bond ✓ Chloride ion with $8e^-$ AND 1 of these electrons different ✓ 	2	ALLOW other symbols for dots and crosses eg triangles IGNORE charges IGNORE 'dative' arrow within the lone pair of the N atom
	(e)	(i)	(Thermal) decomposition ✓	1	

Question			Answer	Marks	Guidance
2	(e)	(ii)	<p>FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 242 (cm³) award 3 marks</p> <p>(amount of KClO₃) = 0.824/122.6 OR = 0.00672 (mol) ✓</p> <p>(amount O₂) = (mol of KClO₃) 0.00672 × 3/2 OR = 0.0101 (mol)</p> <p>(volume of O₂) = 0.0101 × 24 000 = 242 (cm³) ✓</p>	3	<p>IGNORE over rounding to two significant figures once DO NOT ALLOW over rounding to two significant figures twice eg ALLOW the following answer for 3 marks 241 (cm³) (0.00672 was rounded to 0.0067 OR 0.0101 was rounded to 0.010)</p> <p>ALLOW the following answers for 2 marks 240 (cm³) (0.00672 was rounded to 0.0067 AND 0.0101 was rounded to 0.010) 252 (cm³) (0.00672 was rounded to 0.007) 161 cm³ (no multiplying by 3/2)</p> <p>If there is an alternative answer, check to see if there is any ECF credit possible using working below ALLOW up to correctly rounded calculator value of 0.006721044046</p> <p>ALLOW up to correctly rounded calculator value ALLOW ECF for mol of KClO₃ × 3/2 for 2nd mark</p> <p>ALLOW ECF for (mol of KClO₃) × 3/2 × 24000</p>
			Total	16	

Question		Answer	Mark	Guidance
3	(a) (i)	mol of H _x A = $\frac{25.00 \times 0.0500}{1000} = 1.25 \times 10^{-3}$ OR 0.00125 mol ✓ 1000	1	ALLOW 0.0013 OR 1.3×10^{-3} ALLOW correct answer only without working
	(ii)	mol of NaOH = $\frac{12.50 \times 0.200}{1000} = 2.5(0) \times 10^{-3}$ OR 0.0025(0) mol ✓	1	ALLOW correct answer without working
	(iii)	<u>Answer 2a(ii)</u> rounded to nearest whole number ✓ Answer 2a(i) If 2a(i) and 2a(ii) are correct this will be $x = \frac{2.50 \times 10^{-3} \text{ mol}}{1.25 \times 10^{-3} \text{ mol}} = 2$ OR H ₂ A	1	ALLOW answer without working if answers to 2a(i) AND 2a(ii) are seen DO NOT ALLOW responses without seeing answers in 2a(i) AND 2a(ii)
	(b) (i)	HNO ₃ ✓ CuO + 2HNO ₃ → Cu(NO ₃) ₂ + H ₂ O ✓	2	IGNORE state symbols ALLOW correct multiples
	(ii)	(Electrostatic) attraction between oppositely charged ions ✓	1	Attraction is essential IGNORE references to metal and non-metal
	(iii)	Ions are mobile OR ions can move ✓	1	IGNORE 'free ions' IGNORE 'delocalised ions' IGNORE ions can move when molten IGNORE charge carriers DO NOT ALLOW Any mention of electrons moving ALLOW ions move when in a liquid IGNORE responses which give liquid ions
	(iv)	(+) 5 ✓	1	ALLOW V

Question		Answer	Mark	Guidance
	(c)	$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ✓	1	ALLOW $\text{Cu}(\text{NO}_3)_2 6\text{H}_2\text{O}$ ALLOW $\text{Cu}(\text{NO}_3)_2(\text{H}_2\text{O})_6$ ALLOW $\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ DO NOT ALLOW $\text{CuN}_2\text{O}_6 \cdot 6\text{H}_2\text{O}$
		Total	9	

Question			Answer	Mark	Guidance
4	(a)	(i)	<p>Creating the dipole mark uneven distribution of electrons ✓</p> <p>Type of dipole mark creates an instantaneous dipole OR temporary dipole ✓</p> <p>Induction of a second dipole mark causes induced dipole(s) in neighbouring molecules ✓</p>	3	<p>Use annotations with ticks, crosses ECF etc. for this part ALLOW movement of electrons ALLOW changing electron density</p> <p>ALLOW 'transient', 'oscillating', 'momentary', 'changing'</p> <p>ALLOW 'induces a dipole in neighbouring molecules' ALLOW 'causes a resultant dipole in neighbouring molecules' ALLOW 'atoms' for 'molecules'</p>
		(ii)	<p>boiling points increase down the group ✓</p> <p>greater number of electrons OR stronger intermolecular forces OR stronger van der Waals' forces ✓</p> <p>more energy needed to break intermolecular OR van der Waals' forces ✓</p>	3	<p>Use annotations with ticks, crosses ECF etc. for this part ALLOW Bpt of iodine is highest OR Bpt of chlorine is lowest ALLOW Cl for chlorine etc. For 'down the group' ALLOW 'as molecules get bigger'</p> <p>ALLOW number of electron shells increases IGNORE 'more shells' (if no reference to electrons) ALLOW 'more' for 'stronger' ALLOW iodine has most electrons ALLOW chlorine has fewest electrons</p> <p>DO NOT ALLOW any implication that the attraction is between atoms not molecules for third mark</p>
	(b)		<p>Same number of outer(most) electrons OR same outer(most) electron structure ✓</p>	1	<p>ALLOW same number of electrons in outer shell ALLOW It has seven outer electrons IGNORE same group DO NOT ALLOW 'same number of electrons'</p>

Question			Answer	Mark	Guidance
4	(c)	(i)	<p>Colours: (Add Br₂ to NaCl,) (Cyclohexane layer) turns orange OR yellow ✓</p> <p>(Add Br₂ to NaI,) (Cyclohexane layer) turns purple OR lilac OR violet OR pink OR mauve ✓</p> <p>Equation: Br₂ + 2I⁻ → I₂ + 2Br⁻ ✓</p> <p>Reactivity: Reactivity decreases down the group OR Oxidising power decreases down the group ✓</p> <p>Explanations: Chlorine will gain electron easiest OR form negative ion easiest ✓</p> <p>Because chlorine (atom) is smallest OR Outer(most) shell of chlorine least shielded OR Nuclear attraction on electrons of chlorine is greatest ✓</p>	6	<p>Use annotations with ticks, crosses ECF etc. for this part</p> <p>ALLOW any combination of these but no others</p> <p>ALLOW any combination of these but no others</p> <p>DO NOT ALLOW 'precipitate' with either colour</p> <p>DO NOT ALLOW equation mark if incorrect equation(s) also seen IGNORE Br₂ + 2Cl⁻ → Br₂ + 2Cl⁻ IGNORE correct non-ionic version of equation IGNORE state symbols</p> <p>ALLOW Chlorine is the most reactive ALLOW Cl for chlorine etc. ALLOW Iodine is the least reactive</p> <p>ALLOW chlorine is best at electron capture ALLOW chlorine has 'greatest' electron affinity IGNORE chlorine is most electronegative DO NOT ALLOW explanations in terms of displacement <i>Quality of Written Communication – Electron(s) OR negative spelled correctly at least ONCE for marking point 5</i></p> <p>ALLOW Chlorine atom has fewest shells ALLOW outer(most) shell closest to the nucleus ALLOW Chlorine atom has lowest shielding ORA for marking points 4, 5 and 6</p>

Question		er	Mark	Guidance
4	(c) (ii)	Bromine is toxic ✓	1	ALLOW cyclohexane is toxic ALLOW bromine irritates the lungs DO NOT ALLOW Cl ₂ is toxic IGNORE 'strong smelling' IGNORE 'halogens' are toxic
	(d) (i)	2F ₂ + 2H ₂ O → 4HF + O ₂ ✓	1	ALLOW correct multiples, including use of ½ O ₂ ALLOW 4FH IGNORE state symbols
	(ii)	Oxygen has been oxidised as (oxidation number has increased from) O = -2 to O = 0 ✓ Fluorine has been reduced as (oxidation number has decreased from) F = 0 to F = -1 ✓	2	IGNORE references to oxygen in any incorrect products DO NOT ALLOW O ₂ = -2 → O = 0 but ALLOW F ₂ = 0 → F = -1 ALLOW 'F is reduced from 0 to -1' regardless of product (or no product) in 5d(i) except ALLOW ECF for F = -2 if H ₂ F is seen ALLOW one mark for O = -2 and O ₂ = 0 AND F ₂ = 0 and F = -1 if no reference OR incorrect reference to oxidation / reduction is seen Look at equation in 5d(i) for oxidation numbers if not seen in 5d(ii) IGNORE reference to electron loss / gain if correct DO NOT ALLOW incorrect reference to electron loss / gain
	(e) (i)	(1s ²) 2s ² 2p ⁶ 3s ² 3p ⁶ 3d ¹⁰ 4s ² 4p ¹ ✓	1	IGNORE 1s ² twice ALLOW 4s ² before 3d ¹⁰ ALLOW '3D'
	(ii)	GaF ₃ ✓	1	
Total			19	