

Question			Answer	Mark	Guidance												
1	(a)	(i)	<table border="1"> <thead> <tr> <th>Particle</th> <th>Relative charge</th> <th>Number of particles present in a $^{140}\text{Ce}^{2+}$ ion.</th> </tr> </thead> <tbody> <tr> <td>Protons</td> <td>+1</td> <td>58</td> </tr> <tr> <td>Neutrons</td> <td>Nil (or 0)</td> <td>82</td> </tr> <tr> <td>Electrons</td> <td>-1</td> <td>56</td> </tr> </tbody> </table> <p>One mark per column ✓ ✓</p>	Particle	Relative charge	Number of particles present in a $^{140}\text{Ce}^{2+}$ ion.	Protons	+1	58	Neutrons	Nil (or 0)	82	Electrons	-1	56	2	<p>DO NOT ALLOW '+' or '-' without '1' DO NOT ALLOW 1 without charge ALLOW 1+ AND 1- IGNORE '-' (ie a dash) for relative charge of a neutron</p>
			Particle	Relative charge	Number of particles present in a $^{140}\text{Ce}^{2+}$ ion.												
			Protons	+1	58												
			Neutrons	Nil (or 0)	82												
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(b)	(i)	Hydrogen ✓	1	<p>ALLOW H₂ IGNORE 'H'</p>													
		(ii)	<p>Ce₂(SO₄)₃ ✓ (Cerium) loses three electrons (to form 3+ ion) ✓</p>	2	<p>ALLOW alternative phrases for 'loses' eg 'gives away', 'donates' IGNORE '3 electrons transferred' unless a correct direction is given eg ALLOW (Ce) transfers 3 electrons to ... OR (Ce) transfers 3 electrons forming Ce³⁺ IGNORE references to sulfate gaining electrons IGNORE references to reduction and oxidation</p>												
		(iii)	A hydrogen ion (of an acid) has been replaced by a metal ion ✓	1	<p>For hydrogen ion: ALLOW 'H⁺' OR 'proton' but DO NOT ALLOW 'H' OR 'hydrogen' without 'ion' For metal ion: ALLOW 'cerium ion' OR 'Ce³⁺' OR 'Ce²⁺' OR 'Ce ion' But DO NOT ALLOW 'Ce' without 'ion' OR 'cerium' without 'ion' IGNORE 'ammonium ion'</p>												

Question		Answer	Mark	Guidance	
	(c)	<p>Check the answer line. If answer = 1080 cm³ award 2 marks</p> <p>Amount of Eu = $9.12 / 152.0 = 0.06(00)$ mol ✓</p> <p>Amount of O₂ = $0.0600 \times 3/4 = 0.045(0)$ mol and Volume of O₂ = $0.0450 \times 24000 = 1080$ cm³ ✓</p>	2	<p>If there is an alternative answer, check to see if there is any ECF credit possible using working below. ALLOW calculator value or rounding to 2 significant figures or more but IGNORE 'trailing zeroes' eg 0.200 is allowed as 0.2.</p> <p>ALLOW incorrectly calculated <i>amount</i> of Eu x 3/4 and x 24000 correctly calculated for 2nd mark Eg 2605.7 would come from $(9.12/63) \times 3/4 \times 24000$ (note: a mass of Eu x 3/4 and x 24000 would not score M2)</p>	
1	(d)	(i)	The simplest whole number ratio of atoms (of each element) present in a compound ✓	1	ALLOW smallest OR lowest for simplest ALLOW molecule for compound
		(ii)	<p>Check the answer line. If answer = O₁₂S₃Tm₂ award 2 marks</p> <p>O = $30.7 / 16.0$ S $15.4 / 32.1$ Tm = $53.9 / 168.9$ OR 1.9(2) mol 0.480 mol 0.319 mol ✓</p> <p>O₁₂S₃Tm₂ ✓</p>	2	<p>ALLOW 0.479 OR 0.48 for mol of S ALLOW 0.32 for mol of Tm</p> <p>DO NOT ALLOW Tm₂(SO₄)₃ as empirical formula IGNORE Tm₂(SO₄)₃ if seen in working.</p>
	(e)	(i)	32 ✓	1	
		(ii)	9 ✓	1	
			Total	13	

Question		Answer	Mark	Guidance
2	(a)	Cl (has been oxidised) from Cl = -1 to Cl = 0 ✓ Mn (has been reduced) from Mn = +4 to Mn = +2 ✓	2	ALLOW 4+ OR 4 OR 2+ OR 2 ALLOW oxidation numbers written above the equation but IGNORE these if oxidation numbers are given in the text ALLOW one mark for Cl is oxidised because the oxidation number increased by 1 AND Mn is reduced because the oxidation number decreased by 2 ALLOW one mark if all oxidation numbers are correct but redox is incorrect. IGNORE HCl is oxidised AND MnO ₂ is reduced IGNORE correct references to electron loss/gain DO NOT ALLOW incorrect references to electron loss/gain
	(b)	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 3d ⁵ 4s ² ✓	1	ALLOW 4s ² 3d ⁵ IGNORE 1s ² seen twice
	(c)	Cl ₂ + 2NaOH → NaClO + NaCl + H ₂ O ✓	1	ALLOW multiples IGNORE state symbols ALLOW OH ⁻ and ClO ⁻ , i.e. Cl ₂ + 2OH ⁻ → ClO ⁻ + Cl ⁻ + H ₂ O ALLOW NaOCl
2	(d) (i)	(The solution would turn) yellow OR orange OR brown ✓	1	ALLOW shades and colours (eg dark yellow, yellow-orange) DO NOT ALLOW 'purple'
	(d) (ii)	Cl ₂ (g) + 2I ⁻ (aq) → I ₂ (aq) + 2Cl ⁻ (aq) ✓	1	ALLOW multiples State symbols required ALLOW Cl ₂ (aq)
	(e) (i)	The ability of an atom to attract electrons ✓ (Electron pair) in a (covalent) bond ✓	2	ALLOW 'Measure' for ability ALLOW 'attraction' for 'ability to attract' ALLOW 'The ability of an atom to attract a shared pair of electrons' for two marks

Question			Answer	Mark	Guidance								
2	(e)	(ii)	<p>Correct orientation of 3-D tetrahedral arrangement of bonds around C atom ✓</p> <p>δ+ on C atom AND δ- on both Cl atoms ✓</p>	2	<p>For a 3D structure,</p> <table border="1"> <tr> <td>For bond in the plane of paper, a solid line is expected:</td> <td></td> </tr> <tr> <td>For bond out of plane of paper, a solid wedge is expected:</td> <td></td> </tr> <tr> <td>For bond into plane of paper, ALLOW:</td> <td></td> </tr> <tr> <td>ALLOW a hollow wedge for 'in bond' OR an 'out bond', provided it is different from the other in or out wedge e.g.:</td> <td></td> </tr> </table> <p>ALLOW any 3D representation with a minimum of one bond into the plane of paper AND minimum of one out of plane of paper</p> <p>ALLOW 2 lines in the plane + 2 different bonds for M1</p> <p>IGNORE dipole charges on H</p>	For bond in the plane of paper, a solid line is expected:		For bond out of plane of paper, a solid wedge is expected:		For bond into plane of paper, ALLOW :		ALLOW a hollow wedge for 'in bond' OR an 'out bond', provided it is different from the other in or out wedge e.g.:	
For bond in the plane of paper, a solid line is expected:													
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		(iii)	<p>The dipoles do not cancel out OR Because the molecule is non-symmetrical ✓</p>	1	<p>ALLOW partial charges do not cancel IGNORE charges do not cancel ALLOW (the more) electronegative atoms are on one side of the molecule</p>								
	(f)		55% ✓	1									
Total				12									

Question			Answer	Mark	Guidance
3	(a)	(i)	Mol of H ₂ SO ₄ = 0.100 x 18.00/1000 = 1.80 x 10 ⁻³ mol ✓	1	ALLOW calculator value or rounding to 2 significant figures or more but IGNORE 'trailing zeroes' throughout Q4. eg 0.200 is allowed as 0.2
		(ii)	Mol of NaOH in = 1.80 x 10 ⁻³ x 2 x 1000/25.0 = 0.144 mol dm ⁻³ ✓	1	ALLOW ECF for (a)(i) x 2 x 1000/25
	(b)	(i)	<p>Check the answer line. If answer = 0.0184 mol award 2 marks</p> <p>Mol of NaHCO₃ in 25.0 cm³ = [0.100 x 11.50/1000] x 2 = 0.00230 mol ✓</p> <p>Mol of NaHCO₃ in 200 cm³ = 0.00230 x 200/25.0 = 0.0184 mol ✓</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 for an alternative method for M1 Total mol of H₂SO₄ used = [0.100 x 29.50/1000] = 0.00295 mol</p> <p>Mol of H₂SO₄ reacting with NaHCO₃ = 0.00295 – answer to (a)(i) Expected answer = .00295 – 0.00180 = 0.00115 mol</p> <p>Mol of NaHCO₃ in 25.0 cm³ = 0.00115 x 2 = 0.00230 mol</p> <p>ALLOW ECF for mol of NaHCO₃ x 200/25.0</p> <p>For ECF in M2 titration values of 11.50 or 29.50 must have been used in M1</p> <p>Second marking point is for scaling up number of mol of NaHCO₃ by 200/25.0 (Usually seen as '8')</p>
		(ii)	Mass of NaHCO ₃ = 0.0184 x 84.0 = 1.55 g ✓ (must be three significant figures)	1	ALLOW ECF for (b)(i) x 84.0 correctly calculated and rounded to three significant figures.
			Total	5	

Question			Answer	Mark	Guidance
4	(a)	(i)	$2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$ ✓	1	ALLOW multiples e.g. $\text{Ca} + \frac{1}{2}\text{O}_2 \rightarrow \text{CaO}$ IGNORE state symbols
		(ii)	Thermal decomposition ✓	1	
	(b)		Base: A substance which readily accepts H^+ ions (from an acid) ✓ Alkali: releases OH^- ions into (aqueous) solution ✓	2	ALLOW proton acceptor ALLOW Is soluble and releases OH^- ions (into aqueous solution)
	(c)		Effervescence OR fizzing OR bubbling OR gas produced AND The solid OR calcium OR the metal would dissolve OR disappear OR a (colourless) solution forms ✓ $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$ ✓	2	IGNORE 'hydrogen produced' but ALLOW 'hydrogen gas produced' DO NOT ALLOW an incorrectly named gas (eg CO_2) produced ALLOW multiples IGNORE state symbols
	(d)		Nitric acid OR HNO_3 ✓ $\text{CaCO}_3 + 2\text{HNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{H}_2\text{O} + \text{CO}_2$ ✓	2	ALLOW reagent mark if no response is seen but HNO_3 is seen in the equation IGNORE calcium carbonate on reagent line ALLOW multiples IGNORE state symbols DO NOT ALLOW H_2CO_3 for $\text{H}_2\text{O} + \text{CO}_2$
			Total	8	

Question			Answer	Mark	Guidance
5	(a)		period = 5 AND block = p ✓	1	
5	(b)	(i)	<p>Atom(s) of an element</p> <p>AND</p> <p>with different numbers of neutrons (and with different masses) ✓</p>	1	<p>ALLOW for 'atoms of an element':</p> <p>Atoms of the same element</p> <p>OR</p> <p>Atoms with the same number of protons</p> <p>OR</p> <p>Atoms with the same atomic number</p> <p>IGNORE different relative atomic masses</p> <p>IGNORE different mass number</p> <p>IGNORE same number of electrons</p> <p>DO NOT ALLOW different number of electrons</p> <p>DO NOT ALLOW 'atoms of elements' for 'atoms of an element'</p> <p>DO NOT ALLOW 'an element with different numbers of neutrons) (ie atom(s) is essential)</p>
5	(b)	(ii)	<p>same number of electrons in outer shell</p> <p>OR</p> <p>same electron configuration OR electron structure ✓</p>	1	<p>IGNORE same number of protons</p> <p>IGNORE same number of electrons</p> <p>IGNORE they are the same element</p>
5	(b)	(iii)	51p 70n 51e ✓	1	

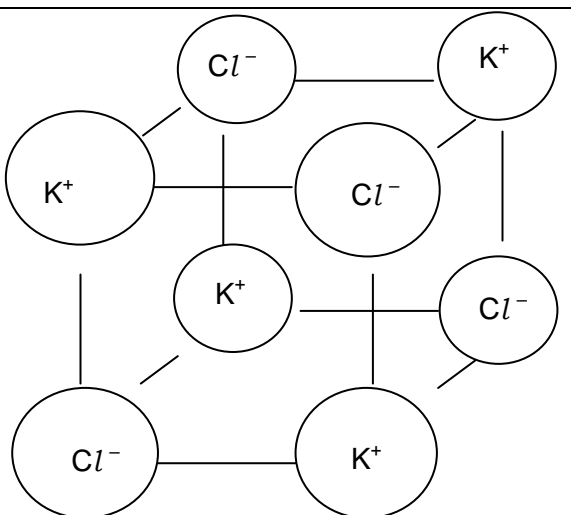
Question			Answer	Mark	Guidance
5	(c)	(i)	<p>The (weighted) mean mass of an atom (of an element) OR The (weighted) average mass of an atom (of an element) ✓</p> <p>compared with 1/12th (the mass) ✓</p> <p>of (one atom of) carbon-12 ✓</p>	3	<p>ALLOW average atomic mass DO NOT ALLOW mean mass of an element 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 For three marks; ALLOW mass of one mole of atoms compared to 1/12th (mass of) one mole OR 12g of carbon OR ALLOW <u> mass of one mole of atoms </u> 1/12th mass of one mole OR 12g of carbon-12</p>
5	(c)	(ii)	123 ✓	1	<p>ALLOW ¹²³Sb OR Sb-123 OR antimony-123 ALLOW 123.0 IGNORE working</p>
5	(d)	(i)	<p>(Trigonal) Pyramidal ✓</p> <p>(Sb has) three bonding pairs AND one lone pair of electrons ✓</p> <p>Pairs of electrons repel ✓</p>	3	<p>ALLOW alternative phrases/words to repel eg 'push apart' ALLOW lone pairs repel more than bonding pairs ALLOW bonds for bonded pairs ALLOW lp and bp</p> <p>IGNORE electrons repel DO NOT ALLOW atoms repel</p>

Question			Answer	Mark	Guidance
5	(d)	(ii)	<p>There is a difference in electronegativities (between Sb and Cl)</p> <p>OR (Sb-Cl) bonds are polar OR have a dipole</p> <p>OR Dipoles seen on the diagram ✓</p> <p>The molecule is not symmetrical AND dipoles do not cancel ✓</p>	2	<p>ALLOW Because Cl is more electronegative (than Sb) OR Because Sb is more electronegative (than Cl)</p> <p>ALLOW description that electrons are drawn along a covalent bond</p> <p>IGNORE single δ^+ or single δ^- for dipole</p> <p>IGNORE diagram if M1 awarded in text</p> <p>ALLOW partial charges do not cancel</p> <p>IGNORE references to lone pair causing dipoles</p>
			Total	13	

Question		Answer	Mark	Guidance
6	(a)	<p>FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = CH₄N₂O award 2 marks</p> <p>C H N O</p> <p>20.00/12.0 6.67/1.0 46.67/14.0 26.66/16.0</p> <p>OR</p> <p>1.67 6.67 3.33 1.67 ratio of mol ✓</p> <p>to give CH₄N₂O ✓</p>	2	<p>ALLOW 1.66 for C OR 1.66 for O</p> <p>IGNORE Significant figures beyond the 3rd significant figure. (eg ALLOW 3.3335 for N OR 1.666 for C)</p> <p>ALLOW ECF from incorrectly calculated ratio of mol, DO NOT ALLOW ECF from using an atomic number OR any original sums inverted (eg 12.00/20.00) ALLOW any order of atoms</p>
6	(b)	NH ₄ ⁺ ✓ NO ₃ ⁻ ✓	2	Mark incorrect ions first
6	(c) (i)	H ₃ PO ₄ ✓	1	ALLOW formula if seen as reactant in an equation IGNORE name
6	(c) (ii)	Calcium oxide OR calcium hydroxide OR calcium carbonate ✓	1	IGNORE formulae IGNORE lime, quicklime and limestone
Total			6	

Question		Answer	Mark	Guidance
7	(a)	Oxidised AND because aluminium has lost (three) electrons ✓	1	ALLOW 'donated' for 'lost' IGNORE where electrons are transferred to IGNORE $\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$ DO NOT ALLOW 'an electron' or incorrect number of electrons
	(b)	FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 2.88 dm ³ award 2 marks Mol of H ₂ = 0.12 ✓ Volume of H ₂ = 0.12 x 24.0 = 2.88 dm ³ ✓	2	ALLOW ECF from incorrectly calculated moles of H ₂ 0.08 x 24 = 1.92 gets 1 mark
	(c)	FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 10.7 g award 2 marks Correctly calculates molar mass of AlCl ₃ = 133.5 g ✓ Mass of AlCl ₃ formed = 0.0800 x 133.5 = 10.7 (g) ✓	2	If there is an alternative answer, check to see if there is any ECF credit possible using working below ALLOW ECF for incorrect molar mass of AlCl ₃ multiplied by 0.0800 and correctly rounded to 3 significant figures
	(d)	FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 200(.0) cm ³ award 2 marks Correctly calculates moles of HCl needed = 0.0800 x 3 = 0.24(0) mol ✓ Volume of HCl = 0.24(0) x 1000/1.2 = 200 cm ³ ✓	2	If there is an alternative answer, check to see if there is any ECF credit possible using working below ALLOW ECF for incorrect mol of HCl x 1000/1.20 ALLOW 66.7 (66.67 or 66.667 etc) for 1 mark DO NOT ALLOW 66.6 (66.66 or 66.666 etc)
Total			7	

Question			Answer	Marks	Guidance
8	(a)	(i)	<p>Mass of the isotope compared to 1/12th OR mass of the atom compared to 1/12th ✓ (the mass of an atom of) ^{12}C ✓</p>	2	<p>ALLOW for ^{12}C: carbon-12 OR C-12 OR C 12 OR 12C</p> <p>ALLOW mass of a mole of the isotope OR mass of a mole of atoms compared to 1/12th the mass of mole or 12 g of ^{12}C for two marks</p> <p>ALLOW mass of the isotope or mass of the atom compared to ^{12}C which has a mass of 12(.0) for two marks</p> <p>ALLOW one mark for responses which have individual atoms compared to one mole of 12C and vice versa eg mass of the isotope or mass of the atom compared to ^{12}C which has a mass of 12(.0) g eg mass of an atom compared to 1/12th mass of one mole of ^{12}C eg mass of one mole of atoms compared to 1/12th the mass of an atom of 12C</p> <p>ALLOW 2 marks for responses expressed as a fraction eg $\frac{\text{mass of the isotope}}{\text{mass of 1/12th mass of } ^{12}\text{C}}$</p> <p>IGNORE (weighted) mean OR average</p> <p>DO NOT ALLOW mass of element or mass of ion</p>
		(ii)	<p>19p and 20n ✓ $^{41}\text{K}^+$ and 19p ✓</p>	2	<p>Mark by row ALLOW 41K+</p>
	(b)		<p>$(1s^2) 2s^2 2p^6 3s^2 3p^2$ ✓</p>	1	<p>ALLOW $1s^2$ repeated ALLOW subscripts AND upper case etc</p>

Question			Answer	Marks	Guidance
8	(c)	(i)	<p>First check the answer on the answer line. If answer = 3.01×10^{22} award 3 marks</p> <p>170.1 ✓ (ALLOW in working shown as $28.1 + 35.5 \times 4$)</p> <p>Correctly calculates amount of molecules $8.505 / 170.1 = 0.05(00)$ mol ✓</p> <p>Correctly calculates number of molecules $0.05 \times 6.02 \times 10^{23} = 3.01 \times 10^{22}$ ✓</p>	3	<p>ALLOW 0.301×10^{23} for three marks</p> <p>If there is an alternative answer, check to see if there is any ECF credit possible using working below.</p> <p>ALLOW ECF from incorrect molar mass of SiCl_4 ALLOW 0.05(00) (mol) for two marks</p> <p>ALLOW ECF for incorrect number of mol of SiCl_4</p> <p>ALLOW calculator value or rounding to 3 significant figures or more BUT IGNORE 'trailing' zeroes, eg 0.200 allowed as 0.2.</p> <p>DO NOT ALLOW any marks for: $8.505 \times 6.02 \times 10^{23} = 5.12 \times 10^{24}$</p>
		(ii)	 <p>4 K and 4 Cl correctly arranged ✓ 4 K⁺ and 4 Cl⁻ correctly arranged ✓</p>	2	<p>ALLOW the structure with ALL Cl⁻ and K⁺ transposed</p> <p>ALLOW labels if seen outside circles but linked with an arrow eg K⁺ → ○</p>
			Total	10	