PEARSON EDEXCEL A-LEVEL CHEMISTRY · 9CH0

CHEMISTRY



MARK SCHEME

TOPIC 4: INORGANIC CHEMISTRY AND THE PERIODIC TABLE

SCORE	PERCENTAGE
/212	%

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Mark Scheme

Q1.

Question Number	Acceptable Answers	Reject	Mark
(a) (i)	**In (a) any units given must be correct. Penalise once only** **IGNORE SF except 1SF. Penalise once only** **If rounding is done then must be correct, penalise once only** **TE throughout** n = (0.100 x 0.0141) = 1.41×10^{-3} / 0.00141 (mol)	1×10^{-3}	**1**

Question Number	Acceptable Answers	Reject	Mark
(a) (ii)	7.05×10^{-4} / 0.000705 (mol) ALLOW TE = ans to (i) ÷ 2 1.4×10^{-3} gives 7.0×10^{-4} 0.0014 gives 0.00070	7.10×10^{-4} / 0.000710	**1**

Question Number	Acceptable Answers	Reject	Mark
(a) (iii)	c = ($7.05 \times 10^{-4} \div 0.05$) = 1.41×10^{-2} / 0.0141 (mol dm^{-3}) ALLOW TE = ans to (ii) ÷ 0.05 OR ALLOW TE = ans to (ii) x 20		**1**

Question Number	Acceptable Answers	Reject	Mark
(a) (iv)	$Ca(OH)_2$ M_r = 74.1 **(1)** ALLOW 74 m = (1.41 x 10^{-2} x 74.1) = 1.04481 = 1.045 = 1.04 (g dm^{-3}) **(1)** If M_r = 74 then m= 1.0434 = 1.04 (g dm^{-3}) ALLOW TE = ans to (iii) x 74.1 ALLOW TE for second mark if ans to (iii) x incorrect Mr value OR 7.05 x 10^{-4} x 74.1 = 0.0522405 = 0.0522 (g) **(1)** (0.0522 ÷ 0.05) = 1.044 (g dm^{-3}) **(1)**	1.05	**2**

Question Number	Acceptable Answers	Reject	Mark
(a)(v)	It's only a rangefinder / It's a rough OR approximate titration / It's an estimation / More than 0.2 cm^3 from other titres / Overshot on first titration / Not concordant ALLOW It is anomalous / It is out of range It differs / is not consistent with titrations 1 and 2 Titrations 1 and 2 are more consistent If a list of suggestions is given, a wrong cancels a right	Not titrated accurately It is not precise Control Just 'it's a trial'	**1**

Question Number	Acceptable Answers	Reject	Mark
(a) (vi)	**Pipette** 50.0 cm^3 (of distilled water) into weighed beaker and find the mass ALLOW "fill the **pipette**" (with water) and transfer into weighed beaker and find the mass / measure the mass of the **pipetted** distilled water **(1)** ALLOW alternative containers to beaker. Use the density of water to determine the exact volume / density of water is 1(.00)g cm^{-3} /check it weighs 50(.0) g **(1)** Stand-alone marks	"Transfer 50cm^3 water into a beaker" without reference to pipette. Approx. 50g Use of lime water Use of solution	2

Question Number	Acceptable Answers	Reject	Mark
(b)	A – (Strong) heat / high temperature **(1)** B – $CaCl_2 + H_2O$ (Both needed) **(1)** C – $Ca(OH)_2$ **(1)** D – Ca **(1)** IGNORE state symbols even if wrong IGNORE any number in front of species, e.g.$½O_2$ or 2Ca given in D	Warm / Gentle heat Reflux Combustion / burnt Answers suggesting reaction with air or oxygen CaCl CaOH Ca_2	**4**

Question Number	Acceptable Answers	Reject	Mark
(c)	Bubble(s) / Fizz(ing) / Effervescence IGNORE references to colourless solution, solid disappearing and energy / temperature changes and further tests eg effect on limewater	Coloured or colourless fumes Cloudy solution Just 'CO_2 forming' Just '(colourless) gas forming' Bubbles of any gas except CO_2	**1**

Question Number	Acceptable Answers	Reject	Mark
(d)	**Method 1:** Calcium is larger **ion** / calcium has a bigger **ionic** radius / or reverse argument for magnesium **ion** Use of the reverse argument applies throughout **(1)** (Distance between centres of ions increases so) weaker attraction/weaker bond between (calcium and carbonate) ions OR Shielding is greater in the calcium ion so weaker attraction (of calcium nucleus for carbonate ion) **(1)** **Method 2:** Calcium **ion** has a lower charge density **(1)** weaker attraction (between ions) **(1)** IGNORE references to polarization and the breaking of the covalent bonds in the carbonate ion	Calcium is bigger Any reference to atoms/molecules scores 0 Reference to ionization energy/weaker attraction for own electrons	2

Question Number	Acceptable Answers	Reject	Mark
(e)	Calcium's flame is yellow-red /orange-red / red / brick red Magnesium has no colour (Both needed for first mark) **(1)** Electrons excited / promoted (by heat energy) **(1)** (Colour produced from) energy / light emitted as electron returns (to ground state) **(1)**	Crimson Magnesium is white / bright Just "Mg / Ca decomposes" Electrons escape the orbitals	**3**

Q2.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following points:	An answer that states 'covalent bonds break' or 'bonds between atoms break' or refers to 'ions' scores (0) overall Allow reverse argument for M1 and M2	**(2)**
	• from chlorine to iodine / down the group, the number of electrons (in the molecule / atom) increases / changes from 34 to 106 / 17 to 53 **(1)**	Allow iodine has more / most electron shells (than chlorine and/or bromine) Ignore 'the size of the atoms /molecules increases from chlorine to iodine' Do not allow incorrect numbers of electrons	
	• so the strength of the London / instantaneous dipole-(induced) dipole forces increases / there are more London / instantaneous dipole-(induced) dipole forces **and** more energy is needed to separate the molecules **(1)**	Allow iodine has the strongest London force **and** most energy is needed to separate the molecules Allow more energy is need to overcome / break the London forces / bonds instead of separate the molecules Allow dispersion forces / van der Waals forces for London forces Ignore higher temperature needed to separate the molecules Do not award dipole-dipole forces / just 'intermolecular forces'	

Q3.

Question Number	Answer	Additional guidance	Mark
(a)	• Fe^{2+} / $Fe(H_2O)_6^{2+}$ (1) • Cr^{3+} / $Cr(H_2O)_6^{3+}$ (1)	Allow Ni^{2+} / $Ni(H_2O)_6^{2+}$ V^{3+} / $V(H_2O)_6^{3+}$ Ignore names	2
(b)(i)	Cr^{3+} / $Cr(H_2O)_6^{3+}$	Ignore names	1
(b)(ii)	$Cr(OH)_3$/ $Cr(H_2O)_3(OH)_3$	Ignore names	1
(b)(iii)	$Cr(OH)_6^{3-}$	Accept other correct species Ignore names (no ecf from (b)(i))	1
(c)	Any **one** from: • purple to colourless • purple (solution) decolourised	Allow final colour of solution to be orange Allow pink for purple	1
(d)(i)	Cl^-	Reject Cl Ignore names	1
(d)(ii)	An explanation that makes reference to the following points: ammonia solution cannot be used because: • ammonia reacts with the iron ions to form a precipitate (1) **or** • a precipitate of (Iron(II) hydroxide/ $Fe(OH)_2$/ $Fe(H_2O)_4(OH)_2$ forms (1) **Plus** • and so obscures the dissolving of the white precipitate (1)		2

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	• balanced equation	Example of equation $3Cl_2 + 6OH^- \rightarrow 5Cl^- + ClO_3^- + 3H_2O$ Allow multiples Ignore state symbols even if incorrect	(1)

Question Number	Answer	Additional Guidance	Mark
(ii) Clip with (i)	An explanation that makes reference to the following points: • oxidation number for chlorine changes from 0 to -1 so it is **reduced** **(1)** • oxidation number for chlorine changes from 0 to +5 so it is **oxidised** **(1)**	Ignore general definitions of disproportionation Accept oxidation numbers and their changes shown with equation Allow 1 out of 2 marks for three correct oxidation numbers of the chlorine	**(2)**

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following points: • magnesium decomposes at lower temperature / more readily (1) • because it is a smaller ion with the same charge (1) • so polarises the anion (more) (1) • and weakens the carbon–oxygen bond (1)	Allow for four marks reverse argument for Ca^{2+} ions magnesium ion has a larger charge density distorts the electron cloud	**4**

Q6.

Question Number	Answer	Mark
	The only correct answer is D (pale green – orange - purple) **A** *is not correct because chlorine is not orange and the colour stated for bromine is for the pure liquid state and solid iodine can appear black but not in an organic solvent* **B** *is not correct because solid iodine can appear black but not in an organic solvent* **C** *is not correct because chlorine is not orange and the colour stated for bromine is in the pure liquid state*	(1)

Q7.

Question Number	Acceptable Answer	Additional Guidance	Mark
	A description that makes reference to the following points: • add (excess) dilute ammonia / dilute NH_3 (to the precipitate) **and** the precipitate is insoluble /does not dissolve **(1)** • add (excess) concentrated (aqueous) ammonia / concentrated NH_3 (to the precipitate) **and** it is soluble / dissolves / forms a colourless solution **(1)**	Allow ammonium hydroxide for ammonia Ignore pure ammonia / ammonia with no concentration / ammonia gas Allow no change for the observation Allow 'if it dissolves it is not bromide' Allow redissolves for soluble **Note** If no other mark is awarded allow (1) for adding dilute and concentrated ammonia with no / incorrect observation(s) **Alternative test**: add concentrated sulfuric acid **(1)** brown fumes **(1)**	**(2)**

Q8.

Question Number	Acceptable Answers	Additional Guidance	Mark
	An answer that makes reference to the following point: • to react with / remove any carbonate / sulfite / sulfate(IV) (ions)	Allow equation for the reaction with acid e.g. $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$ Allow to prevent any other ions forming a precipitate (with barium ions / Ba^{2+}) Allow to rule out the possibility of carbonate / sulfite / sulfate(IV) ions giving a false result Ignore just 'to remove impurities / other (an)ions' / 'react with precipitates' Ignore to dissolve barium carbonate / sulfite Ignore reference to hydrogencarbonate	**(1)**

Q9.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following points:	Allow the oxidation numbers written by the species in the table (+)6 only needs to be mentioned once in M1 or M2 Allow references to potassium halides / halogens / hydrogen halides instead of halide ions For full marks, the answer must identify iodide as the strongest reducing agent	**(3)**
	• iodide ions are the strongest reducing agent because iodide ions / I^- / (potassium) iodide reduces sulfur (in sulfuric acid) from +6 to 0 in sulfur / −2 in H_2S **(1)**	Only 1 oxidation number change is needed. If both are given, both must be correct	
	• (whereas) bromide ions / Br^- / (potassium) bromide reduces sulfur (in sulfuric acid) from +6 to +4 **(1)**	Allow bromide ions are stronger reducing agents than chloride ions because they are oxidised from −1 to 0	
	• (whereas) chloride ions / Cl^- / (potassium) chloride do not reduce sulfuric acid / sulfur / S (as there is no change in oxidation number of Cl or S) **(1)**	Allow just 'it is not a redox reaction'	

Q10.

Question Number	Answer	Mark
	The only correct answer is C (there is no change) **A** *is not correct because magnesium ions have no effect on flame colour* **B** *is not correct because the elemental magnesium and not the metal ions give a white colour* **D** *is not correct because magnesium ions have no effect on flame colour*	(1)

Q11.

Question Number	Answer	Mark
	The only correct answer is A (green) **B** *is not correct because this is the colour for potassium ions* **C** *is not correct because this is the colour for lithium, calcium and strontium ions* **D** *is not correct because this is the colour for sodium ions*	**(1)**

Q12.

Question Number	Answer	Mark
	The only correct answer is D (nichrome wire and concentrated hydrochloric acid) **A** *is not correct because iron wire is not used* **B** *is not correct because iron wire is not used* **C** *is not correct because concentrated hydrochloric acid and not water is needed*	**(1)**

Q13.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to: • (potassium ions) lilac **and** (strontium ions) crimson / red	Allow scarlet Ignore 'shades' except Do not award 'brick red' / 'orange-red'	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to: • the crimson/red colour will mask/hide/obscure the (lighter) lilac colour	Allow 'one colour will hide the other' Allow only one colour seen Allow difficult to distinguish the two colours Allow TE from colours in (i) Do not award colour from chloride ions Do not award idea of new colour resulting from both Ignore reference to impurities	(1)

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to: • nichrome produces no colour (when heated in the flame test) **or** iron can produce a colour/sparks **(1)** • nichrome is inert/ stable to heat/unreactive **or** iron reacts with oxygen/air and or hydrochloric acid **(1)**	Allow does not change the flame colour Ignore references to melting/cost Ignore reference to nichrome not being a transition element	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to: • (the wire is heated) to remove the residue of any previous sample being tested	Allow 'to clean the wire' Ignore 'to sterilise/sanitise/disinfect the wire'	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to: • the acid can become contaminated with residue from previous tests (which can give incorrect results)		(1)

Question Number	Answer	Additional Guidance	Mark
(iv)	An answer that makes reference to: • (concentrated hydrochloric acid) forms volatile chlorides	Allow (the wire is moistened) to enable some of the solid metal salt to become attached/stick to the wire (and then tested in the Bunsen flame) Do not award reference to bonding or reacting or adsorb or absorb with the wire	(1)

Q15.

Question Number	Answer	Additional Guidance	Mark
(i)	Any two observations from • solid dissolves / melts **(1)** • condensation on sides of test tube **(1)** • brown gas/ brown fumes/ brown $NO_2(g)$ produced **(1)** • white solid / powder forms **(1)**	Do not award magnesium dissolved / just 'solid disappears' Allow 'steam given off' Ignore NO_2 / O_2 / gas given off/ bubbles/ effervescence / gas relights a glowing splint Allow red-brown Ignore 'precipitate' Ignore 'magnesium oxide forms' Do not award 'Mg^{2+} forms'	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following points: • Nitrates increase in stability down Group 2 as ionic radius increases (as you go down group) **(1)** • so polarising ability of metal (ion) decreases / distorts (the electron cloud of) the anion less **(1)** • weakening of N-O bonds (in nitrate ion) is less **(1)**	Allow charge density decreases as you go down Group 2 Do not award **just** 'atomic radius increases' There has to be a mention of ions somewhere in M1 or M2 Allow reverse argument	(3)

Q16.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An answer that makes reference to the following points: • ammonium **(1)** • bromide **(1)**	Mark independently Allow names in either order Ignore symbols as well as names Do not award ammonia Do not award bromine Allow (1) for just NH_4Br	**(2)**

Q17.

Question Number	Acceptable Answers	Additional Guidance	Mark
	• correct equation	Example of equation $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$ Allow multiples Allow Na^+ on both sides if crossed through Ignore state symbols even if incorrect	**(1)**

Q18.

Question Number	Answer	Additional Guidance	Mark
(i)	• ionic equation (1) • state symbols (1)	Example of equation $Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$ Allow multiples M2 dependent on M1 or near miss	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that includes • halide ion with some justification attempt (1) • calculation of expected mass of silver halides (1)	Incorrect halide scores (0) Bromide (ion)/Br^- Do not award 'bromine (ion)' 0.01 mol of AgCl = 1.43 (g) AgBr = 1.88 (g) AgI = 2.35 (g) OR Mass of 1.0 mol is 188 g so subtraction of 107.9 for Ag means X = 80.1 so closest is Br TE on incorrect formula silver halide in d(i)	(2)

Q19.

Question Number	Answer	Additional Guidance	Mark
(i)	• (The cation in **X** is) Fe^{2+} / iron(II) / Fe(II) (1) • (The anion in **X** is) SO_4^{2-} / sulfate(VI) (1)	Allow Fe^{+2} Allow sulfate / SO_4^{-2} Do not award sulfite / sulfate(IV)	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	• species and balancing (1) • state symbols (1)	<u>Examples of equation</u> $Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$ **or** $[Fe(H_2O)_6]^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s) + 6H_2O(l)$ **or** $[Fe(H_2O)_6]^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(H_2O)_4(s) + 2H_2O(l)$ Ignore missing square brackets TE on cation that forms an insoluble hydroxide in **Test 1** State symbols conditional on correct species or 'near miss' / non-ionic equation	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following point: • Fe^{2+} is oxidised (to Fe^{3+}) by oxygen / air	Allow iron(III) hydroxide / iron(III) (ions) are formed by reaction with oxygen / air TE on cation in **Test 1** Allow just 'the precipitate / it is oxidised by oxygen / air'	(1)

Question Number	Answer	Additional Guidance	Mark
(iv)	An answer that makes reference to the following point: • to react with / remove any carbonate / sulfite / sulfate(IV) ions **or** to eliminate the possibility of carbonate / sulfite / sulfate(IV) ions	Allow to prevent any other ions forming a precipitate with barium ions / Ba^{2+}	(1)

Q20.

Question Number	Acceptable Answers	Additional Guidance	Mark
(i)	An answer that makes reference to the following points: **setting up of the dipole** • uneven distribution of **electrons**/ (random) movement of **electrons** / (random) fluctuations of **electrons** **(1)** **type of dipole** • (results in an) instantaneous dipole / temporary dipole (in the first molecule) **(1)** **induction of a second dipole** • causes/induces a (second) dipole on another molecule **(1)**	M1 & M3 could be scored for an appropriate diagram Allow "Change in **electron** density" Allow "transient dipole" / "oscillating dipole" Do not award for "permanent dipole" Allow neighbouring molecule / adjacent molecule Do not award for "permanent dipole"	(3)

Question Number	Acceptable Answers	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following points: **relative number of electrons** • bromine has more **electrons** (than chlorine) / bromine has one more shell of **electrons** (than chlorine) **(1)** **relative strength of intermolecular forces** • (so) bromine has stronger (London) forces (between molecules) / more (heat) energy is needed to overcome the London forces between bromine molecules / greater temporary dipole – induced dipole forces **(1)**	Allow reverse arguments Allow correct formulae Bromine has 35/70 electrons and chlorine has 17/34 electrons Ignore comments about protons, molecular mass etc Do not award "more outer shells" Ignore comments about 'points of contact' Allow more (London) forces Allow "bonds between molecules" Award **(0)** marks overall if any implication that **covalent** bonds are broken (on boiling)	**(2)**

Q21.

Question Number	Acceptable Answers	Additional Guidance	Mark
(a)	0.816 / 8.16 x 10^{-1} (g)		**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(b)	• calculation of moles of CO_2	Example of calculation: (moles CO_2 = $\frac{225}{24000}$ =) 0.009375 Allow 9.375 x 10^{-3} / 9.38 x 10^{-3} / 9.4 x 10^{-3} Ignore SF except 1SF	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(c)	• moles of MCO_3 **(1)** • method for calculation of molar mass of MCO_3 **(1)** • molar mass final answer to 1, 2 or 3 SF **(1)** • consequential identification of Group 2 metal by name or formula **(1)** NOTE Alternative method can score 3 MAX Calculation of moles of CO_3^{2-} **(1)** (Calculation of mass of CO_3^{2-}) Deduction of mass of M by subtraction **(1)** Calculation of Ar of M to 1, 2 or 3 SF **AND** Identification of group 2 metal **(1)**	Example of calculation: Moles of MCO_3 = moles CO_2 = 0.009375 (mol) Molar mass of MCO_3 = $\frac{0.816}{0.009375}$ (= 87.04 (g mol^{-1})) M2 subsumes mark for M1 = 87.0 / 87 / 90 (g mol^{-1}) NOTE M3 mark subsumes mark for M2 and M1 (87.0 – 60) = 27 **AND** Mg / Magnesium / $MgCO_3$ Allow TE on answers to parts (a) and (b), with Metal consequential on calculated molar mass but M must be a Group 2 element Moles CO_3^{2-} = 0.009375 (Mass of CO_3^{2-} = 0.009375 x 60 = 0.5625 g) Mass of M = 0.2535 g Ar = 0.2535/0.009375 = 27.0 / 27 / 30 (g mol^{-1}) **AND** Mg / Magnesium / $MgCO_3$	**(4)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(d)(i)	An explanation that makes reference to the following points: • the bung was not replaced quickly enough **(1)** • (So) CO_2 / gas lost (to the surroundings) **(1)**	 Allow bung not fitting tightly resulting in leaks Ignore references to CO_2 dissolving Ignore references to other types of gas leak Allow 'smaller volume of gas collected' / lower reading of gas volume Mark points M1 and M2 independently	**(2)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(d)(ii)	An answer that makes reference to the following point: The acid was (already) in excess (and more acid won't affect this)	Allow The carbonate is the limiting reactant / the acid is not the limiting reactant	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(d)(iii)	An explanation that makes reference to the following points: • rate of reaction is faster **and** powder has greater surface area **(1)** • no effect on (final) volume of gas **and** moles of (metal) carbonate are unchanged **or** because the rate is faster more gas will be lost before the bung is replaced so the (final) volume will be less **(1)**	Mark points M1 and M2 independently Both parts of statement needed Both parts of statement needed Allow mass / amount for moles Allow reactant for metal carbonate	**(2)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(e)(i)	• balanced equation with state symbols	Example of equation: $MCO_3(s) \rightarrow MO(s) + CO_2(g)$ Allow a correct equation for the decomposition of any Group 2 carbonate	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(e)(ii)	• subtractions to obtain masses **(1)** • calculation of moles of CO_2 **(1)** • calculation of molar mass of MCO_3 **(1)**	Example of calculation: (mass of CO_2 = 20.447 – 20.205) = 0.242 **AND** (mass of MCO_3 = 20.447 – 19.996) = 0.451 moles of $CO_2 = \frac{0.242}{44}$ = 0.0055(0) (mol) / 5.5(0) x 10^{-3} (mol) ALLOW TE from M2 to M3 Mr of $MCO_3 = \frac{0.451}{0.0055(0)}$ = 82 (g mol^{-1}) Correct answer with or without working scores 3 Ignore SF except 1 Ignore attempts to identify the metal	**(3)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(f)	An answer that makes reference to the following point: Student 3 used a smaller mass / less (and the uncertainty of the balance was the same) **or** Student 1 used a larger mass / more (and the uncertainty of the balance was the same)	Allow calculations comparing the two percentage errors: e.g. Student 1:- (0.001/0.816) x 100% = 0.12% **and** Student 3:- 0.001/0.451 x 100% = 0.22%	**(1)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(g)	An explanation that makes reference to the following points: • more CO_2 (would appear to be) given off **(1)** • (So) calculated molar mass is smaller **(1)** **OR** • Less MO would appear to have been formed **(1)** • Calculated molar mass would be greater **(1)**	 M2 dependent on M1 M2 dependent on M1	**(2)**

Q22.

Question Number	Acceptable Answers	Additional Guidance	Mark
(i)	**Test 1** • (gas is) ammonia / NH_3 **(1)** • (cation is) ammonium / NH_4^+ **(1)** **Test 2** • (cation is) cobalt(II) / Co^{2+} / $[Co(H_2O)_6]^{2+}$ **(1)** • (complex ion is) $[CoCl_4]^{2-}$ **(1)** **Test 3** • (precipitate is) barium sulfate / $BaSO_4$ **(1)** • (anion is) sulfate((VI)) / SO_4^{2-} **(1)**	If name and formula are given, both must be correct Mark independently Do not award gas is ammonium / NH_4 Do not award cation is ammonia / NH_3^+ Oxidation number of cobalt is needed in the name but allow cobalt **with** Co^{2+} Charge is needed on the ion Allow +2 and −2 for the charges on the ions Allow brackets around Cl Ignore missing square brackets in complex ions Do not award $[CoCl_6]^{4-}$ **Note** If cation in Test 2 is identified as copper(II) / Cu^{2+}, do not award M3 but M4 can be awarded as TE for $[CuCl_4]^{2-}$ Oxidation number of sulfate is not needed but if given must be correct e.g. do not award sulfate(IV)	**(6)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(ii)	• correct formula	Examples of correct formula $(NH_4)_2Co(SO_4)_2$ $(NH_4)_2SO_4.CoSO_4$ Allow NH_4, Co and SO_4 in any order Allow multiples Allow any combination of Co^{2+} / NH_4^+ / SO_4^{2-} that gives a neutral complex TE on the **three** ions identified in (a)(i) Ignore missing dot in second formula Ignore any amount of water of crystallisation	(1)

Q23.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following points:	Penalise omission of 'ion' **or** just 'calcium / Ca / magnesium / Mg' without charge, **or** reference to atom or molecule once only Ignore general references to ionic / covalent character	**(3)**
	• **Size** calcium ion / Ca^{2+} has larger (ionic) radius / is larger than magnesium ion **or** magnesium ion / Mg^{2+} has smaller (ionic) radius / is smaller than calcium ion **(1)**	Allow ionic radius increases down the group / decreases up the group Allow magnesium ions have a higher charge density (than calcium ions) Ignore atomic radius Ignore effective nuclear charge	
	• **Polarising power** so calcium ion/ Ca^{2+} causes less polarisation/ distortion **or** magnesium ion/ Mg^{2+}causes more polarisation/ distortion **(1)**	Allow the cation causes less / more polarisation if it is clear from M1 which cation is involved	
	• **What is polarised** of the nitrate (ion / electron cloud) / NO_3^- / anion / negative ion / N—O bonds / N=O bonds / NO bonds **(1)**	Do not allow this mark for carbonate / C-O bonds Do not allow mention of bond **between** cation and anion **Note** Nitrate ions are less polarised by Ca^{2+} / more polarised by Mg^{2+} scores M2 and M3	

Q24.

Question Number	Acceptable Answers	Additional Guidance	Mark
	An answer that makes reference to the following points: **mixing of 1st pair of solutions** • mix Br_2 with KCl **(1)** **mixing of 2nd pair of solutions** • mix Br_2 with KI **or** mix I_2 with KBr **(1)** **colours of halogen (in cyclohexane)** • colour seen for experiment 1/ bromine is orange / yellow **and** colour seen for experiment 2/ iodine is purple / pink / violet / lilac **(1)** **correct ionic equation** • $Br_2 + 2I^- \rightarrow 2Br^- + I_2$ **(1)** **(1)** • use of ONLY two correct experiments as above **(1)**	Ignore any reference to any additional reactions, e.g. with silver nitrate Award mark if correct ionic equation is given Ignore colours before the addition of cyclohexane Do not award brown Do not award red Allow multiples Ignore state symbols even if incorrect	**(5)**

Q25.

Question Number	Answer	Additional Guidance	Mark
(i)	• chlorine is oxidised **and** from 0 to +1 (in NaClO) **(1)** • chlorine is reduced **and** from 0 to -1 (in NaCl) **(1)**	Check the equation Allow (1) for three correct oxidation numbers if no other mark is awarded. Allow (1) max for general definition of disproportionation	**(2)**

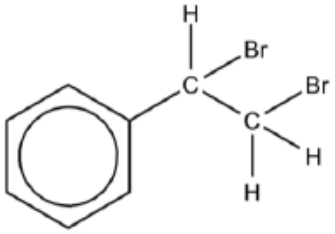
Question Number	Answer	Additional Guidance	Mark
(ii)	• equation	$6\,NaOH + 3\,Cl_2 \rightarrow NaClO_3 + 5\,NaCl + 3\,H_2O$ Allow multiples	**(1)**

Question Number	Answer	Mark
(iii)	**The only correct answer is C** (hot alkali) **A** *is not correct because high temperature is required* **B** *is not correct because high temperature is required* **D** *is not correct because high temperature and not excess chlorine is required*	(1)

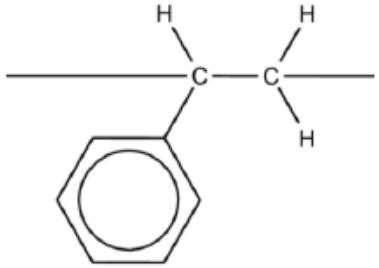
Q26.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	• orange to colourless	Allow brown / yellow to colourless	**1**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	A explanation that makes reference to the following points: • becomes polar / forms temporary dipole (1) • as electron density in C=C bond repels bond pair (of electrons in bromine) (1)	Polar bromine can be shown by using a diagram e.g. $\overset{\delta+}{Br}—\overset{\delta-}{Br}$	**2**

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	• addition (1) • structure (1)	<u>Example of structure:</u> 	**2**

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Question Number	Acceptable Answer	Additional Guidance	Mark
(iv)		Ignore addition of square brackets and n	**1**

Q27.

Question Number	Acceptable Answers	Additional Guidance	Mark
(a)(i)	An answer that makes reference to the following points: • cool the mixture because the reaction (with concentrated sulfuric acid / H_2SO_4) is (very) exothermic / releases (a lot of) heat **(1)** • anti-bumping granules are added to prevent violent / sudden / localised boiling **or** to prevent superheating / large bubbles forming **or** to promote smooth / even / controlled boiling **or** to promote the formation of small bubbles **or** to provide nucleation centres / (rough) surface for bubble formation **(1)** • heating under reflux is used to prevent the loss of any volatile substances / volatile reactants / volatile products / organic compound / named organic compound **or** to make sure the vapour / gas condenses **or** to prevent vapour escaping **(1)**	Ignore reaction is violent / to prevent splashing / to slow down the reaction / to stop reactants evaporating Do not award to quench the reaction / reference to explosion Ignore to stop bumping / spitting / explosion / liquid splashing out / vigorous reaction / loss of reactants / to distribute heat more evenly / any reference to rate / to promote smooth heating Allow so that the reaction goes to completion Ignore just 'to prevent gas escaping' / just 'to prevent loss of reactants / products' / just 'reactants / products are volatile' / 'because 1-bromobutane / butan-1-ol is flammable' / to increase yield / reference to safety Do not award for reference to oxidation or reduction	**(3)**

Question Number	Acceptable Answers	Additional Guidance	Mark
(a)(ii)	An answer that makes reference to the following points: • there is a gap between the condenser and the flask / seal the joint between the flask and condenser **and** so vapour / gas / reactants / products will escape **(1)** • the water is flowing the wrong way through the condenser / the water should go in at the bottom (and out at the top) **and** so it doesn't fill with water / is only part filled /there is an airlock **(1)** • there is a stopper on the condenser / there should not be a stopper on the condenser **and** so there will be a build-up of pressure (if the gap between condenser and flask is closed) **(1)**	Allow answers shown on annotated diagram e.g. gap circled Ignore any additional errors Ignore additional suggested modifications even if incorrect Do not award just 'the apparatus is not sealed' unless it is clear it means between the condenser and flask Allow so this will lower the yield of product / 1-bromobutane Ignore condenser is fitted the wrong way up Allow so there will be inefficient condensation / cooling Allow so the stopper will blow off / there will be an explosion / it will be dangerous	(3)

Question Number	Acceptable Answers	Additional Guidance	Mark
(a)(iii)	An explanation that makes reference to the following points: • (brown vapour / it) is bromine / Br_2 **(1)** • bromide ions / Br^- / HBr oxidised (by concentrated sulfuric acid) **(1)**	Stand alone mark Do not award just 'Br' Do not award any other brown gas in addition to bromine Allow bromide ions / Br^- / HBr reduce sulfuric acid / act as a reducing agent Ignore sodium bromide / NaBr is oxidised Ignore just 'redox reaction' Do not award bromine is oxidised Do not award oxidation by anything other than sulfuric acid	(2)

Question Number	Acceptable Answers	Additional Guidance	Mark
(b)(i)	An answer that makes reference to the following: • aqueous layer is on the top **and** because water / it has a lower density than 1-bromobutane	Allow 'it' for aqueous layer Allow because 1-bromobutane has a higher density than water Ignore reference to butanol unless in a third layer Do not award water is 'lighter' Do not award reference to three layers	(1)

Question Number	Acceptable Answers	Additional Guidance	Mark
(b)(ii)	An answer that makes reference to the following points: Step **8** • (aqueous sodium hydrogencarbonate / $NaHCO_3$) reacts with / neutralises / removes the (hydrochloric) acid / H^+ (ions) in the mixture **(1)** Step **9** • (the tap is opened) to release the carbon dioxide / gas (formed) **or** to allow the carbon dioxide / gas to escape **or** to prevent the build-up of pressure **(1)** Step **10** • (anhydrous sodium sulfate is added) to remove / absorb water **(1)**	Do not award reacts with incorrect acid e.g. H_2SO_4 / HBr / ethanoic acid Ignore removes water Do not award an incorrect gas e.g. hydrogen Allow (anhydrous) sodium sulfate is a drying agent / added to dry the product Do not award dehydration / reacts with water	(3)

Question Number	Acceptable Answers	Additional Guidance	Mark
(b)(iii)	• starting temperature 99 or 100 or 101 (°C) **and** final temperature 103 or 104 or 105 (°C)	Do not award just one value / 102 (°C) Do not award 102 (°C) with another temperature	(1)

Question Number	Acceptable Answers	Additional Guidance	Mark
(b)(iv)	• calculation of mol of 1- bromobutane **(1)** • calculation of number of molecules **and** answer to 2/3 SF **(1)**	Example of calculation mol of 1-bromobutane = $\frac{12.0 \times 1.27}{136.9}$ = 0.11132 (mol) Do not award 0.1 number of molecules = $0.11132 \times 6.02 \times 10^{23}$ = 6.7×10^{22} / 6.70×10^{22} TE on a calculated mol 1-bromobutane using M_r Correct answer to 2 or 3 SF with no working scores (2)	**(2)**

Q28.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to: • addition of (dilute/strong) name/formula of acid **(1)** • effervescence/bubbling/fizzing **(1)**	 Allow weak acids If formula given then must be correct Allow Gas given off which turns limewater cloudy Do not award just 'gas/ CO_2 given off' Do not award incorrect observations such as precipitate forming due to addition of acid M2 dependent on M1 or 'near miss'	**(2)**

Q29.

Question Number	Answer	Additional Guidance	Mark
(i)	• (The cation in **Y** is) Cu^{2+} / copper(II) (1) • (The anion in **Y** is) Cl^- / chloride (1)	Allow Cu^{+2} Ignore water ligands Do not award just copper / Cu Do not award just 'chlorine' / Cl	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	• $[Cu(NH_3)_4(H_2O)_2]^{2+}$	Allow $[Cu(NH_3)_4]^{2+}$ Allow $[Co(NH_3)_6]^{2+}$ if Co^{2+} in (i) Ignore missing square brackets	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	A description that makes reference to the following points: • add dilute (aqueous) ammonia (and stir the mixture) (1) • the precipitate dissolves (1)	If Cl^- / chloride / chlorine ion: Allow add aqueous ammonia / $NH_3(aq)$ Do not award concentrated ammonia Conditional on use of ammonia Ignore colourless solution If Br^- / bromide / bromine ion identified in Test 4: precipitate is insoluble in dilute ammonia (1) but soluble in concentrated ammonia (1) If I^- / iodide / iodine ion identified in test 4: precipitate is insoluble (1) in dilute and concentrated ammonia (1) Do not award addition of concentrated sulfuric acid	(2)

Q30.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to: • addition of barium chloride/nitrate (solution) **(1)** • white precipitate forms **(1)**	 Accept formulae $BaCl_2$/$Ba(NO_3)_2$ Ignore addition of acids such as HCl or HNO_3 but do not award M1 if addition of sulfuric acid Allow white solid If ppt identified then must be correct M2 dependent on M1 or 'near miss'	**(2)**

Q31.

Question Number	Acceptable Answer	Additional Guidance	Mark
	• **A** = CaO(s) (1) • **B** = CO_2(g) (1) • **C** = $Ca(OH)_2$ (aq)/(s) (1) • **D** = $CaCl_2$(aq) (1) • **E** = $CaCO_3$(s) (1) correct formulae with incorrect / missing symbol scores (4) correct formulae with 2 or more incorrect / missing symbols scores (3)	 Allow $Ca(HCO_3)_2$(aq)	**5**

Q32.

Question number	Answer	Additional guidance	Marks
(a)	$Cl_2 + 2NaOH \rightarrow NaOCl + NaCl + H_2O$	Accept $Cl_2 + 2OH^- \rightarrow OCl^- + Cl^- + H_2O$ Ignore state symbols	1
(b)	An explanation that makes reference to the following points: • Cl has oxidation number +4 to in ClO_2 (1) • Cl (in ClO_2) changes oxidation number to +3 (ClO_2^-) and +5 (ClO_3^-) (1) • (therefore) chlorine/it (in ClO_2) has been both oxidised and reduced (1)	Accept 4+ Accept 3+ and 5+ Allow answers in any order	3
(c)(i)	A		1
(c)(ii)	An answer that makes reference to the following points: • Mn changes from +7 to +2 and Cl changes from -1 to 0 (1) • therefore ratio is MnO_4^- to $5Cl^-$ /the ratio of MnO_4^- to Cl^- is 1 to 5 (1)	Accept 7+ and 2+ Accept 1–	2
(d)(i)	An explanation that makes reference to the following points: • the HBr dissolves in water (in the air) (1) • and forms droplets (of hydrobromic acid) (1)		2
(d)(ii)	• the (conc.) H_2SO_4 is reduced to SO_2 (1)	Accept redox	1

Q33.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(i)	correct equation	Example of equation: $2NaN_3 \rightarrow 2Na + 3N_2$ Allow multiples Ignore state symbols even if incorrect	(1)

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(ii)	• conversion of volume and temperature to correct units **(1)** • rearrangement of ideal gas equation so n=$pV \div RT$ and calculation of n(N_2) in moles **(1)** • evaluation of n(NaN_3) **(1)** • answer converted into mass to 2/3 SF **(1)** Allow TE at each stage	Example of calculation: 67 dm^3 = 0.067 m^3, 300°C = 573 K n(N_2) = 140 000 x 0.067 = 8.31 x 573 = 1.9699…..(mol) n(NaN_3) = (2/3 x 1.9699…..=) 1.313….(mol) m= (1.313 …. x 65 = 85.3629..=) = 85.4 / 85 (g) Correct answer without working scores (4)	**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)	An answer that makes reference to the following points: • Nitrogen (is reduced) from +5 to 0 **(1)** • Sodium (is oxidised) from 0 to +1 **(1)** • Balanced equation **(1)**	Look for oxidation numbers annotated on the equation Do not award potassium oxidised Penalise omission of "+" sign, once only Example of balanced equation: **10**Na +**2**$KNO_3 \rightarrow K_2O$+ **5**Na_2O + N_2 Allow multiples	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
(c)	An answer that makes reference to the following points: • Neutralisation reaction / acid base reaction **(1)** • Sodium and/or potassium oxides are caustic / corrosive **(1)** • Salts (silicates) formed are inert / unreactive **(1)**	Allow salt formation Allow "metal oxides" Ignore "harmful" / "alkaline" Allow "not harmful"/ "not caustic" Ignore "neutral"	**(3)**

Question Number	Acceptable Answer	Mark
(d)	The only correct answer is **A** ***B*** *is incorrect because the peak would shift to the left and be higher* ***C*** *is incorrect because the peak would shift to the left not to the right* ***D*** *is incorrect because the peak would be shift to the left not to the right*	**(1)**

Q34.

Question Number	Answer	Additional Guidance	Mark
(i)	• equation	Example of equation $Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$ Accept ionic equation $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ Allow multiples Ignore state symbols even if incorrect	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following points: • **(M1)** the precipitate is a mixture of silver chloride and silver bromide **or** not all of the bromide ions were oxidised **(1)** • **(M2)** silver chloride/AgCl dissolves in dilute ammonia **(1)** • **(M3)** silver bromide/AgBr does not dissolve in dilute ammonia **(1)**	Allow Some bromide ions are still present/bromide ions were in excess/both chloride and bromide ions are present Do not award references to Cl^- dissolving Silver bromide only dissolves in concentrated ammonia	(3)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following point: • iodine is a weaker oxidising agent than chlorine **or** iodine cannot oxidise bromide ions **or** iodine is a stronger reducing agent	Accept reverse arguments Ignore Just references to reactivity/displacement e.g. iodine is less reactive/cannot displace	(1)

Q35.

Question Number	Answer	Mark
	The only correct answer is C (magnesium sulfate) ***A*** *is incorrect because Group 2 sulfates decrease in solubility down Group 2* ***B*** *is incorrect because Group 2 sulfates decrease in solubility down Group 2* ***D*** *is incorrect because Group 2 sulfates decrease in solubility down Group 2*	**(1)**

Q36.

Question Number	Answer	Mark
	The only correct answer is D ***A*** *is not correct because it is the 2nd most soluble* ***B*** *is not correct because it is the 3rd most soluble* ***C*** *is not correct because it is the least soluble*	**(1)**

Q37.

Question number	Acceptable Answer	Additional Guidance	Marks
(i)	An explanation that makes reference to the following points: • the outermost electron of the magnesium atom is in a quantum shell of lower energy (than that of the strontium atom) \ the outermost electron is in the 3s rather than the 5s (orbital) (1) • the outermost electron of the magnesium atom is closer to the nucleus so is more strongly attracted **OR** the outermost electron(s) of the magnesium atom experiences less shielding (that that of the strontium atom) so is more strongly attracted (1)	Ignore any mention of (effective) nuclear charge	**2**

Question number	Acceptable Answer	Additional Guidance	Marks
(ii)	An explanation that makes reference to the following points: **<u>EITHER</u>** • greater proton to electron ratio so greater attraction **/**electron is being removed from a positively charged particle (1) • remaining electron is closer to the nucleus (1) **<u>OR</u>** • after the first electron is removed the remaining electron experiences less repulsion (1) • therefore it has a lower energy (than before) (1)		**2**

Question number	Acceptable Answer	Additional Guidance	Marks
(iii)	An explanation that makes reference to the following points: • the third electron is removed from a different (quantum) shell / removed from the second (quantum) shell as opposed to the third (1) • of lower energy / closer to the nucleus **OR** • less shielding of the 2p electron (1)		**2**

Q38.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(i)	• 203.3 (g mol^{-1})	Allow 203 if Mg = 24	**1**

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(ii)	An answer that makes reference to the following point:		**1**

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(iii)	$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ equation and state symbols		**1**

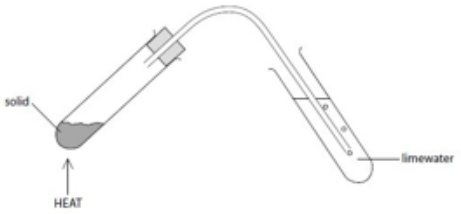
Question Number	Acceptable Answer	Additional Guidance	Mark
(b)	An answer that makes reference to the following points: • AgCl dissolves in dilute aqueous ammonia (and in concentrated aqueous ammonia (1) • AgBr is insoluble / only partially soluble in dilute aqueous ammonia, but is soluble in concentrated aqueous ammonia (1) • AgI is insoluble in both dilute and concentrated aqueous ammonia (1)		**3**

Q39.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following point: • (Identity of gas is) oxygen/O_2 **and** (test result is that the splint) relights	Do not award just 'O' Allow 'rekindle'/'reignites'	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following point: • (Identity of gas is) nitrogen dioxide **and** (appearance is) brown (gas/fumes)	If name and formula given then both must be correct Allow NO_2 Do not award NO or N_2O_4 Do not award if liquid referred to Do not award if two gases are given unless one of the gases stated is colourless oxygen Ignore shades of colour	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	• equation	Example of equation $2NaNO_3 \rightarrow 2NaNO_2 + O_2$ Accept multiples Ignore state symbols even if incorrect	(1)

Question Number	Answer	Additional Guidance	Mark
(iv)	A description that makes reference to following points: • use of a delivery tube to bubble gas into limewater **(1)** • compare the time taken for the limewater to go cloudy **(1)**	Allow annotated diagrams to illustrate the marking points Example of a diagram that could be given credit  Do not award if the apparatus setting would not be feasible such as • missing cork/bung or gaps around delivery tube • horizontal tube with limewater in • bung in the test tube with limewater Allow TE from an incorrect/unsuitable method Allow Any length of time, e.g. 10 minutes	(2)

Q40.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to • the magnesium ion/cation is smaller (than the barium ion/cation) **(1)** • which polarises the (large) carbonate (ion)/anion **(1)** • and weakens the carbon-oxygen bond (C-O/C=O) bonds **(1)**	Accept reverse arguments Penalise omission of ion once only Allow magnesium ion/cation has a higher charge density Do not award reference to just atom Accept 'which distorts the carbonate electron cloud' Do not award if molecules of carbonate are referred to Allow 'weakens the bonds **in** the carbonate ion' Allow 'less energy needed to break the C-O bond' Do not award if the bonds referred to are the ionic bonds between the metal ion and the carbonate ion	**(3)**

Q41.

Question number	Answer	Additional guidance	Marks
	An explanation that makes reference to the following points: • they get more stable down the group (1) • because the size of the cations increases/charge density of cations decreases (1) • and so carbonate ions are less polarised (1)		**3**

Q42.

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>*</td><td>This question assesses the student's ability to show a coherent and logically structured answer with linkages and fully sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5-4</td><td>3</td></tr>
<tr><td>3-2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
The following table shows how the marks should be awarded for structure and lines of reasoning
<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained lines of reasoning</th></tr>
<tr><td>Answer shows a coherent logical structure with linkages
and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table></td><td>Guidance on how the mark scheme should be applied:
The mark for indicative content should be added to the mark for lines of reasoning. For example, a response with four indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).
If there were no linkages between the points, then the same indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and zero marks for linkages).

If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).

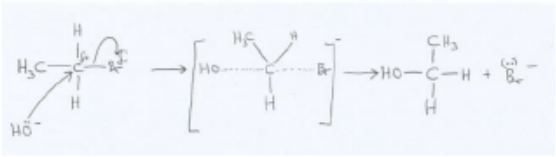
More than one indicative marking point may be made within the same comment or explanation

Deduct a reasoning mark if no comparison made

Penalise the use of 'atom' instead of ion once only against any indicative point</td><td>(6)</td></tr>
</table>

	Indicative content Similarities • **(IP1)** the differences in energy levels determines the colour of the flame test and complex ion Differences Flame test • **(IP2) heat** (energy) results in electron promotion • **(IP3)** return of an (excited) electron to a lower (energy) state Complex ion • **(IP4)** d orbitals are split (in energy by the ligands) • **(IP5) light** (energy) is needed for electron promotion • **(IP6)** the colour not absorbed is the colour seen	Ignore incorrect colours This can be mentioned separately or as a comparison Allow electrons excited by **heat** Allow electron is 'de-excited' to a lower (energy) state Do not award if d-d transitions stated Allow d subshell splitting Do not award singular "d orbital" splitting Accept "The colour seen is complimentary to that absorbed" Allow 'colour reflected is the colour seen' Do not award if colour attributed to 'fall' of electron to lower energy d orbital Do not award 'emission of light'	

Q43.

Question Number	Answer	Additional Guidance	Mark
(i)	• dipole on C—Br bond **and** curly arrow from C-Br bond to Br or just beyond **(1)** • curly arrow from **lone pair** on oxygen of hydroxide ion to carbon bonded to Br **(1)** • formula of transition state with correct charge, partial bonding **(1)** • correct final products **(1)**	 Dipole and curly arrow may be shown on transition state Allow curly arrow to C^+ of carbocation Do not award if carbocation formed as intermediate Square brackets are not essential Allow charge on Br or OH of transition state Allow longer bonds for partial bonding Ignore geometry of transition state Allow NaBr product if mechanism starts with NaOH Only penalise horizontal bond from the H of OH to C in the product e.g. $OH-CH_2CH_3$ Use of incorrect halogenoalkane loses this mark One mark max deducted for omission of charge on ions, including transition state S_N1 mechanism can score M1, M2 and M4 but not M3. M2 can be awarded for curly arrow from the lone pair on the oxygen of the hydroxide ion to the C+ of the carbocation intermediate	(4)

Question Number	Answer	Additional Guidance	Mark
(ii)	Reagents: nitric acid / HNO_3 **and** silver nitrate (solution) /$AgNO_3$ **(1)** (Result) cream/off-white precipitate **(1)**	Use of hydrochloric acid/HCl OR sulfuric acid/H_2SO_4 scores **(0)** Do not award acidified silver nitrate If name and formula given then both must be correct Allow (very) **pale** yellow Do not award just white or just yellow Ignore subsequent additions of ammonia even if incorrect Result mark dependent on reagents mark or 'near miss' such as omitting to add nitric acid, using ethanolic silver nitrate, incorrect formulae	(2)