

## CHERRY HILL TUITION AQA CHEMISTRY AS PAPER 9 MARK SCHEME

Question	Marking Guidance	Mark	Comments
1(a)(i)	chlorotrifluoromethane	1	Spelling must be correct but do not penalise "flouro" Ignore use of 1-
1(a)(ii)	CF <sub>3</sub> •	1	May be drawn out with dot on C OR if as shown dot may be anywhere
1(a)(iii)	An unpaired / non-bonded / unbonded / free / a single / one / lone <u>electron</u>	1	NOT "bonded electron" and NOT "paired electron" NOT "pair of electrons" NOT "electron <sub>s</sub> " Ignore "(free) radical"
1(b)	M1 $\text{Cl}\cdot + \text{O}_3 \longrightarrow \text{ClO}\cdot + \text{O}_2$ M2 $\text{ClO}\cdot + \text{O}_3 \longrightarrow 2\text{O}_2 + \text{Cl}\cdot$	2	Mark independently Equations could gain credit in either position The dot can be anywhere on either radical Penalise the absence of a dot on the first occasion that it is seen and then mark on. Do <u>not</u> make the same penalty in the next equation, but penalise the absence of a dot on the other radical. Apply the list principle for additional equations
1(c)(i)	(If any factor is changed which affects an <u>equilibrium</u> ), the (position of) <u>equilibrium</u> will <u>shift/move</u> so as to <u>oppose the change</u> . OR (When a system / reaction in <u>equilibrium</u> is disturbed), the <u>equilibrium</u> <u>shifts/moves</u> in a direction which tends to <u>reduce the disturbance</u>	1	Must refer to <u>equilibrium</u> Ignore reference to "system" alone A variety of wording will be seen here and the key part is the last phrase. An alternative to shift/move would be the idea of <u>changing/altering the position</u> of equilibrium
1(c)(ii)	M1 The (forward) reaction / to the right is <u>endothermic</u> or <u>takes in heat</u> OR The reverse reaction / to the left is <u>exothermic</u> or <u>gives out heat</u> M2 The <u>equilibrium</u> moves / <u>shifts</u> to <u>oppose the increase in temperature</u>	2	M2 depends on a correct statement for M1 For M2 accept The <u>equilibrium</u> moves / <u>shifts</u> <ul style="list-style-type: none"> <li>to <u>take in heat / lower the temperature</u></li> <li>to promote the endothermic reaction and <u>take in heat / lower the temperature</u></li> <li>to oppose the change and <u>take in heat / lower the temperature</u></li> </ul> (leading to the formation of more ozone)
1(d)	Any one of <ul style="list-style-type: none"> <li>Pentane <u>does not contain chlorine</u> OR <u>C-Cl</u> (bond)</li> <li>Pentane is <u>chlorine-free</u></li> <li>Pentane <u>does not release chlorine</u> (atoms / radicals)</li> </ul>	1	Ignore reference to F OR OR C-F OR halogen Ignore "Pentane is not a CFC" Ignore "Pentane is a hydrocarbon" Ignore "Pentane only contains C and H" Ignore "Pentane is C <sub>5</sub> H <sub>12</sub> "

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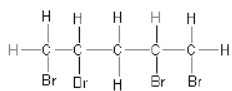
Question	Marking Guidance	Mark	Comments
2 (a)	<p><b>M1</b> AgNO<sub>3</sub> OR silver nitrate OR any <u>soluble</u> silver salt</p> <p><b>M2</b> remains colourless or no reaction or no (observed) change or no precipitate</p> <p><b>M3</b> <u>white precipitate</u> or <u>white solid</u> / <u>white suspension</u></p>	3	<p>An insoluble silver salt OR Tollens' OR ammoniacal silver nitrate or HCl / AgNO<sub>3</sub> is CE = 0 for the clip</p> <p>For M1</p> <p>Credit acidified (or HNO<sub>3</sub>) silver nitrate for M1 and mark on</p> <p>If silver ions or incorrect formula for silver nitrate, penalise M1 but mark M2 and M3</p> <p>If no reagent or incorrect reagent in M1, then no marks for M2 or M3</p> <p>For M2</p> <p>Ignore "nothing"</p> <p>Ignore "no observation"</p> <p>Ignore "clear"</p> <p>Ignore "dissolves"</p> <p>For M3</p> <p>Ignore "cloudy solution" OR "suspension"</p>
2 (b)	<p><b>M1</b> any <u>soluble</u> sulfate by name or formula e.g. sodium sulfate or sulfuric acid.</p> <p><b>M2</b> <u>white precipitate</u> or <u>white solid</u> / <u>white suspension</u></p> <p><b>M3</b> remains colourless or no reaction or no (observed) change or no precipitate</p> <p>OR as an alternative</p> <p><b>M1</b> NaOH / KOH</p> <p><b>M2</b> remains colourless or no reaction or no (observed) change</p> <p><b>M3</b> <u>white precipitate</u> or <u>white solid</u> / <u>white suspension</u></p>	3	<p>An insoluble sulfate OR conc H<sub>2</sub>SO<sub>4</sub> is CE=0 for the clip</p> <p>If no reagent or incorrect reagent in M1, then no marks for M2 or M3</p> <p>For the M1 soluble sulfate</p> <p>If sulfate ions or incorrect formula for the chosen sulfate, penalise M1 but mark M2 and M3</p> <p>For the M1 NaOH/KOH</p> <p>If ammonia, then CE=0</p> <p>If hydroxide ions or incorrect formula for the chosen hydroxide, penalise M1 but mark M2 and M3</p> <p>For no (observed) change in both alternatives</p> <p>Ignore "nothing"</p> <p>Ignore "no observation"</p> <p>Ignore "clear"</p> <p>Ignore "dissolves"</p> <p>For the white precipitate in both alternatives</p> <p>Ignore "cloudy solution" OR "suspension"</p>
2 (c)	<p><b>M1</b> <u>ammonia</u> (can be dilute or concentrated)</p> <p><b>M2</b> <u>dissolves</u> OR <u>soluble</u> OR (forms a) <u>colourless</u> solution OR goes <u>colourless</u></p> <p><b>M3</b> does not dissolve OR not soluble Or remains as a solid OR no (observed) change OR no reaction OR yellow solid remains</p> <p>OR if concentrated ammonia has been used, accept yellow solid turns white.</p> <p>OR as an alternative using <u>conc</u> sulfuric acid</p> <p><b>M1</b> <u>concentrated sulfuric acid</u> OR <u>c(onc) H<sub>2</sub>SO<sub>4</sub></u></p> <p><b>M2</b> <u>misty</u> / <u>white fumes</u> / <u>gas</u></p> <p>OR remains white</p> <p>OR no change (in colour)</p> <p><b>M3</b> turns <u>black</u> (solid)</p> <p>OR <u>purple fumes</u> / <u>gas</u></p> <p>OR correct reference to H<sub>2</sub>S <u>observation</u> (e.g. <u>bad egg smell</u>)</p>	3	<p>For M1</p> <p>If incorrect formula or "ammonium", penalise M1 but mark M2 and M3</p> <p>If no reagent or incorrect reagent in M1, then no marks for M2 or M3</p> <p>For M3</p> <p>Ignore "nothing"</p> <p>Ignore "no observation"</p> <p>For the alternative using sulfuric acid</p> <p>If dilute sulfuric acid or "aq" (alone) or the idea of concentrated not included CE=0</p> <p>If incorrect formula, penalise M1 but mark M2 and M3</p> <p>If no reagent or incorrect reagent in M1, then no marks for M2 or M3</p>
2 (d)	<p><b>M1</b> acidified potassium dichromate or K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>/H<sub>2</sub>SO<sub>4</sub> OR K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>/H<sup>+</sup> OR acidified K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub></p> <p><b>M2</b> (orange to) <u>green</u> solution OR goes <u>green</u></p> <p><b>M3</b> (solution) remains <u>orange</u> or no reaction or no (observed) change</p> <p>Alternative using KMnO<sub>4</sub>/H<sub>2</sub>SO<sub>4</sub></p> <p><b>M1</b> acidified potassium manganate(VII) or KMnO<sub>4</sub>/H<sub>2</sub>SO<sub>4</sub> OR KMnO<sub>4</sub>/H<sup>+</sup> OR acidified KMnO<sub>4</sub></p> <p><b>M2</b> <u>colourless</u> solution OR goes <u>colourless</u></p> <p><b>M3</b> (solution) remains <u>purple</u> or no reaction or no (observed) change</p>	3	<p>If no reagent or incorrect reagent in M1, then no marks for M2 or M3</p> <p>For M1</p> <p>If "dichromate" or "dichromate(IV)" or incorrect formula or no acid, penalise M1 but mark M2 and M3</p> <p>For M2 ignore dichromate described as "yellow" or "red"</p> <p>For M3</p> <p>Ignore "nothing"</p> <p>Ignore "no observation"</p> <p>For M1</p> <p>If "manganate" or "manganate(IV)" or incorrect formula or no acid, penalise M1 but mark M2 and M3</p> <p>Credit alkaline KMnO<sub>4</sub> for possible full marks but M2 gives <u>brown precipitate</u> or solution goes <u>green</u></p>

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3(a)	$\text{Mg}^{2+} + 2\text{OH}^- \longrightarrow \text{Mg}(\text{OH})_2$	1	NOT multiples Ignore state symbols
(b)	$\text{Mg}(\text{OH})_2 + 2\text{HCl} \longrightarrow \text{MgCl}_2 + 2\text{H}_2\text{O}$	1	Or multiples or ionic, with or without the spectator ions Ignore state symbols Accept either of these two equations $\text{OH}^- + \text{H}^+ \longrightarrow \text{H}_2\text{O}$ $\text{Mg}^{2+} + 2\text{Cl}^- \longrightarrow \text{MgCl}_2$
(c)	$\text{Mg}^{2+} + 2\text{e}^- \longrightarrow \text{Mg}$	1	Or multiples Ignore state symbols Credit electrons subtracted from RHS Ignore absence of charge on e
d)(i)	<b>M1</b> use of $\text{Cl}_2$ and C <b>M2</b> balanced equation consequential on correct reactants $\text{TiO}_2 + 2\text{Cl}_2 + 2\text{C} \longrightarrow \text{TiCl}_4 + 2\text{CO}$ <b>OR</b> $\text{TiO}_2 + 2\text{Cl}_2 + \text{C} \longrightarrow \text{TiCl}_4 + \text{CO}_2$	2	Or multiples Ignore state symbols
d)(ii)	$\text{TiCl}_4 + 2\text{Mg} \longrightarrow \text{Ti} + 2\text{MgCl}_2$	1	Or multiples Ignore state symbols
d)(iii)	Reducing agent <b>OR</b> reduces $\text{TiCl}_4$ <b>OR</b> Electron donor	1	Credit "reduction" or "reductant" Penalise "electron pair donor"
	<b>M1</b> Hydrogen / $\text{H}_2$ produced <b>OR</b> an equation to produce hydrogen / $\text{H}_2$ (eg $\text{Mg} + 2\text{H}_2\text{O} \longrightarrow \text{Mg}(\text{OH})_2 + \text{H}_2$ ) (eg $\text{Mg} + \text{H}_2\text{O} \longrightarrow \text{MgO} + \text{H}_2$ ) <b>M2 requires correct M1</b> risk of explosion OR forms explosive mixture (with air) <b>OR</b> (highly) flammable	2	For M1 Do not penalise an incorrect equation; the mark is for $\text{H}_2$ or hydrogen Allow one mark only for "exothermic reaction with steam / $\text{H}_2\text{O}$ " for a candidate who has not scored M1 Ignore "violent" reaction

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4 (a)(i)	<u>More absorption / less transmittance</u> of infrared radiation by it / water vapour <b>OR</b> <u>broader absorption</u> by OH <b>OR</b> <u>less absorption / more transmittance</u> of infrared radiation by carbon dioxide	1	Must be comparative This may be described and must not be contradictory Credit answers which refer correctly to " <u>transmittance</u> " (more absorption = less transmittance)
(a)(ii)	<b>M1</b> $\text{CO}_2$ contains C=O (stated like this or in words or strongly implied) OR is O=C=O <b>M2 depends on correct M1</b> <b>OR</b> expected absorption / peak (for C=O) is missing <b>OR</b> expected absorption / peak (for C=O) is shifted to $2300(\text{cm}^{-1})$ <b>OR</b> asymmetric stretching is occurring (due to C=O)	2	If M1 and M2 not scored, give one mark for either No absorption / peak at $1700(\text{cm}^{-1})$ / $1715(\text{cm}^{-1})$ OR no absorption in the range $1680 - 1750(\text{cm}^{-1})$ Ignore "carbon-oxygen bonds", "C-O bonds" Ignore reference to other absorptions For M2 Allow "dip" OR "spike" OR "low transmittance" as alternatives for absorption.
(b)(i)	An activity which has no <u>net / overall</u> (annual) <u>carbon emissions to the atmosphere / air</u> <b>OR</b> An activity which has no <u>net / overall</u> (annual) <u>greenhouse gas emissions to the atmosphere / air</u> . <b>OR</b> There is no change in the <u>total amount of carbon dioxide / carbon / greenhouse gas present in the atmosphere / air</u>	1	The idea that the <u>carbon / <math>\text{CO}_2</math></u> given out equals the <u>carbon / <math>\text{CO}_2</math></u> that was taken in <u>from the atmosphere / air</u>  Answer <u>must</u> refer to the atmosphere or air
(b)(ii)	$\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4 + 3\text{CO}_2 \longrightarrow 3\text{MgCO}_3 + 2\text{SiO}_2 + 2\text{H}_2\text{O}$	1	Allow multiples

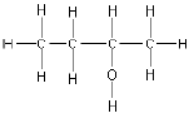
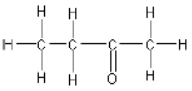
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5 (a)(i)	(Free-) radical substitution	1	Both words needed
(a)(ii)	UV light / Ultra-violet light / sunlight OR high temperature / $150^{\circ}\text{C} \leq T \leq 500^{\circ}\text{C}$	1	
(a)(iii)	Propagation (Step)	1	Ignore "first" or "second" Accept phonetic spelling
(a)(iv)	M1 Termination (Step) M2 $2\text{CH}_3\text{CH}_2\text{CH}_2\cdot \longrightarrow \text{C}_6\text{H}_{14}$	2	In M2 $\text{C}_6\text{H}_{14}$ may be drawn out as $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ The dot may be anywhere around the terminal $\text{CH}_2$ on the radical Accept $\text{C}_3\text{H}_7\cdot$ with dot anywhere Penalise the absence of any radical dot
(a)(v)	$\text{C}_3\text{H}_8 + 8\text{Br}_2 \longrightarrow \text{C}_3\text{Br}_8 + 8\text{HBr}$	1	Or multiples
(b)(i)	M1 Double bonds are <u>electron-rich</u> OR <u>electron pair donors</u> OR centres of <u>electron density</u> . M2 Bromine becomes <u>polarised</u> / <u>becomes polar</u> OR forms an <u>induced dipole</u> OR becomes $\delta+$ / $\delta-$	2	M1 QoL – require <u>one</u> of these terms Ignore "(very) negative" and "nucleophile" as applied to the double bond. Penalise M2 for ion formation from bromine For M2, do not credit dipole formation <u>solely</u> as a consequence of electronegativity
(b)(ii)	<u>Electrophilic addition</u>	1	Both words needed Accept phonetic spelling
(b)(iii)	Structure for 1,2,4,5-tetrabromopentane, for example $\text{BrCH}_2\text{CHBrCH}_2\text{CHBrCH}_2\text{Br}$ OR 	1	Must be clear that they have drawn 1,2,4,5-tetrabromopentane and does NOT need to be displayed Credit use of "sticks" for each C-H bond
(c)	+ M1 Structure of $\text{CH}_3\text{CHCH}_3$ M2 (Secondary) Carbocation OR (secondary) carbonium ions	2	Mark independently For M1 the positive charge must be on the central carbon atom Penalise bond to positive charge Penalise answers which show more than the correct carbocation e.g. the mechanism, unless the intermediate is clearly identified Credit use of "sticks" for each C-H bond For M2, penalise "primary" or "tertiary"

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6 (a)(i)	<u>Electron pair donor</u> OR Species which uses a <u>pair of electrons to form a co-ordinate / covalent bond.</u>	1	Credit "lone pair" as alternative wording  Credit "electron pair donator"
(a)(ii)	<u>Replacement of the halogen (atom) (by the nucleophile)</u> OR The <u>carbon-halogen bond / C-X</u> breaks and a bond forms with the nucleophile or between the carbon and the nucleophile	1	They must describe the idea of substitution in a haloalkane.  Accept the idea that a nucleophile replaces the halogen which becomes a halide ion  Penalise reference to "halogen molecule" and penalise the idea that the haloalkane contains a halide
(a)(iii)	<u>Splitting molecules using / by water</u> OR <u>breaking / splitting / dissociating (C-X) bond(s) / using / by water</u>	1	NOT simply the reaction with water or simply the addition of water.  Ignore "compound"
(a)(iv)	(Heat) <u>energy / enthalpy required / needed / absorbed</u> (at constant pressure) <u>to break / split it / the (carbon-halogen) bond</u> OR (Heat) <u>energy / enthalpy required / needed / absorbed</u> (at constant pressure) <u>for homolysis of the (C-X / the carbon-halogen) bond</u>	1	Ignore bond formation  Ignore "average"
(b)	<p>M1 must show an arrow from the lone pair of electrons on the oxygen atom of the negatively charged hydroxide ion to the central C atom. M2 must show the movement of a pair of electrons from the C-Br bond to the Br atom. Mark M2 independently. Award full marks for an S<sub>N</sub>1 mechanism in which M1 is the attack of the hydroxide ion on the intermediate carbocation.</p>	2	Penalise M1 if covalent KOH is used Penalise M2 for formal charge on C or incorrect partial charges Penalise once only for a line and two dots to show a bond. Max 1 mark for the wrong reactant Accept the correct use of "sticks"
(c)(i)	<p>M1 must show an arrow from the lone pair on oxygen of a negatively charged hydroxide ion to the <u>correct</u> H atom M2 must show an arrow from the correct C-H bond to the C-C bond and should only be awarded if an attempt has been made at M1 M3 is independent provided it is from the <u>original molecule</u> Award full marks for an E1 mechanism in which M2 is on the correct carbocation.</p>	3	Penalise M1 if covalent KOH Penalise M3 for formal charge on C or incorrect partial charges Penalise once only for a line and two dots to show a bond. Max 2 marks for wrong reactant Accept the correct use of "sticks" for the molecule except for the C-H being attacked
(c)(ii)	<b>M1</b> Stated that the spectrum has an <u>absorption / absorbance / peak in the range 1620 cm<sup>-1</sup> to 1680 (cm<sup>-1</sup>)</u> or specified <u>correctly in this range</u> from the spectrum <b>M2</b> depends on <u>correct range or wavenumber being specified</u> <b>M2</b> ( Infrared absorption) <u>due to C=C OR carbon-carbon double bond</u>	2	QoL for correct M1 statement which includes both the word absorption (or alternative) <u>and</u> the correct range or wavenumber Allow "peak" OR "dip" OR "spike" OR "trough" OR "low transmittance" as alternatives for absorption. For M2 it is not sufficient simply to state that an alkene has C=C M2 could be on the spectrum Ignore reference to other absorptions

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7 (a)(i)	Hexan-1-ol	1	ONLY
(a)(ii)	Homologous (series)	1	ONLY
(a)(iii)	Displayed formula for butan-2-ol 	1	All bonds must be drawn out including the O—H bond Ignore bond angles
(a)(iv)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + [\text{O}] \longrightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} + \text{H}_2\text{O}$	1	Require this whole equation as written or formulae drawn out Penalise "sticks"
(a)(v)	Displayed formula for butanone (credit possible enols, ethers and cyclic structures for $\text{C}_4\text{H}_8\text{O}$ ) 	1	All bonds must be drawn out Ignore bond angles
(b)	M1 $q = m c \Delta T$ OR calculation $175 \times 4.18 \times 8$ M2 = <b>5852</b> (J) OR 5.85 (kJ) OR 5.9 (kJ) (This also scores M1) M3 0.005 mol, therefore $\Delta H = \underline{-1170}$ (kJmol <sup>-1</sup> ) OR $\Delta H = \underline{-1170.4}$ (kJmol <sup>-1</sup> ) OR $\Delta H = \underline{-1200}$ (kJmol <sup>-1</sup> )	3	Award full marks for correct answer In M1, do not penalise incorrect cases in the formula Ignore incorrect units in M2 Penalise M3 ONLY if correct answer but sign is incorrect OR value is in J mol <sup>-1</sup> If $m = 5 \times 10^3$ OR if $\Delta T = 281$ , CE and only allow one mark for correct mathematical formula for M1 If $c = 4.81$ (leads to 6734) penalise M2 ONLY and mark on for M3 = <u>-1350</u> (-1347)
(c)(i)	M1 The <u>enthalpy change</u> (or heat change at constant pressure) when <u>1 mol</u> of a compound / substance / alcohol M2 is <u>burned completely in oxygen</u> OR <u>burned in excess oxygen</u> M3 with <u>all reactants and products / all substances in standard states</u> OR <u>all reactants and products / all substances in normal states under standard conditions</u> OR <u>100 kPa / 1 bar and a specified T / 298 K</u>	3	For M3 Ignore reference to 1 atmosphere
(c)(ii)	M1 (could be scored by a correct mathematical expression) M1 $\Delta H = \Sigma \Delta H_f(\text{products}) - \Sigma \Delta H_f(\text{reactants})$ OR a correct cycle of balanced equations M2 = $4(-394) + 5(-286) - (-327)$ (This also scores M1) M3 = <u>-2679</u> (kJ mol <sup>-1</sup> ) OR <u>-2680</u> (kJ mol <sup>-1</sup> ) Award 1 mark ONLY for (+) 2679 OR (+) 2680	3	Correct answer to calculation gains full credit Credit 1 mark if + 2679 (kJ mol <sup>-1</sup> ) For other incorrect or incomplete answers, proceed as follows <ul style="list-style-type: none"> <li>check for an arithmetic error (AE), which is either a transposition error or an incorrect multiplication; this would score 2 marks (M1 and M2)</li> <li>If no AE, check for correct method; this requires either a correct cycle with 4CO<sub>2</sub> and 5H<sub>2</sub>O OR a clear statement of M1 which could be in words and scores <u>only M1</u></li> </ul>
(d)(i)	M1 This is about the change in formula up the series Each alcohol in the series (compared with the previous one) <u>increases by / has an extra CH<sub>2</sub></u> OR has <u>one more C-C and two more C-H</u> M2 This is about the reaction and bond breaking/making Combustion of each alcohol in the series <u>breaks one more C-C and two more C-H compared with the previous one AND forms one more mol CO<sub>2</sub> and one more mol H<sub>2</sub>O</u> OR A statement in which there is the idea that the <u>extra OR additional OR difference in number of bonds broken and formed (as the series increases) is the same</u> OR <u>has the same difference in energy</u>	2	N.B. If the first statement here for M2 is given, both marks score

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(d)(ii)	For the two marks M1 and M2 <u>heat</u> loss or <u>heat</u> absorbed by the apparatus OR incomplete combustion / not completely burned OR The idea that the water may end up in the gaseous state (rather than liquid) OR reactants and/or products may not be in standard states.	2	
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