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Chemistry CHEM2

(Specification 2420)

Unit 2: Chemistry in Action

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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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_3•	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 electron	1	NOT "bonded electron" and NOT "paired electron" NOT "pair of electrons" NOT "electrons" Ignore "(free) radical"
1(b)	**M1** $Cl\bullet + O_3 \longrightarrow ClO\bullet + O_2$ **M2** $ClO\bullet + O_3 \longrightarrow \mathbf{2}O_2 + Cl\bullet$	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 not 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 equilibrium), the (position of) equilibrium will shift/move so as to oppose the change. OR (When a system / reaction in equilibrium is disturbed), the equilibrium shifts/moves in a direction which tends to reduce the disturbance	1	Must refer to equilibrium 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 changing/altering the position of equilibrium
1(c)(ii)	**M1** The (forward) reaction / to the right is endothermic or takes in heat ***OR*** The reverse reaction / to the left is exothermic or gives out heat **M2** The equilibrium moves / shifts to oppose the increase in temperature	2	M2 depends on a correct statement for M1 For M2 accept The equilibrium moves / shifts • to take in heat / lower the temperature • to promote the endothermic reaction and take in heat / lower the temperature • to oppose the change and take in heat / lower the temperature (leading to the formation of more ozone)
1(d)	Any one of • Pentane does not contain chlorine OR C–Cl (bond) • Pentane is chlorine-free • Pentane does not release chlorine (atoms / radicals)	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_5H_{12}

Question	Marking Guidance	Mark	Comments
2(a)(i)	**M1** The peak of the new curve is displaced to the right. **M2 All of the following** are required • The new curve starts at the origin • The peak of the new curve is lower than the original • and the new curve only crosses the original curve once • and an attempt has been made to draw the new curve correctly towards the energy axis but not to touch the original curve • the new curve must not start to diverge from the original curve	2	M1 is low demand M2 is higher demand.
2(a)(ii)	**M1** Increase in the number / proportion of molecules with $E \geq E_a$ OR more molecules have $E \geq E_a$ OR more molecules have sufficient energy to react **M2** More effective / productive / successful collisions	2	Ignore "molecules have more energy" Ignore "more energetic collisions" Ignore "molecules gain activation energy" Ignore "more collisions" Accept "particles" for "molecules" but NOT "atoms" Ignore "chance of collision"; this alone does not gain M2
2(b)(i)	Iron ***OR*** Fe	1	

2(b)(ii)	**M1** Catalysts provide an alternative route / pathway / mechanism ***OR*** (in this case) surface adsorption / surface reaction occurs. **M2** that has a lower activation energy ***OR*** lowers the activation energy	2	For M1, not simply "provides a surface" alone For M2, the candidate may use a definition of activation energy without referring to the term

Question	Marking Guidance	Mark	Comments
3(a)	**M1** $AgNO_3$ OR silver nitrate OR any <u>soluble</u> silver salt **M2** remains colourless or no reaction or no (observed) change or no precipitate **M3** <u>white precipitate</u> or <u>white solid / white suspension</u>	3	An insoluble silver salt OR Tollens' OR ammoniacal silver nitrate or HCl / $AgNO_3$ is CE = 0 for the clip For M1 Credit acidified (or HNO_3) silver nitrate for M1 and mark on If silver ions or incorrect formula for silver nitrate, penalise M1 but mark M2 and M3 If no reagent or incorrect reagent in M1, then no marks for M2 or M3 For M2 Ignore "nothing" Ignore "no observation" Ignore "clear" Ignore "dissolves" For M3 Ignore "cloudy solution" OR "suspension"

3(b)	**M1** any <u>soluble</u> sulfate by name or formula e.g. sodium sulfate or sulfuric acid. **M2** <u>white precipitate</u> or <u>white solid / white suspension</u> **M3** remains colourless or no reaction or no (observed) change or no precipitate ***OR*** as an alternative **M1** NaOH / KOH **M2** remains colourless or no reaction or no (observed) change **M3** <u>white precipitate</u> or <u>white solid / white suspension</u>	3	An insoluble sulfate OR conc H_2SO_4 is CE=0 for the clip If no reagent or incorrect reagent in M1, then no marks for M2 or M3 For the M1 soluble sulfate If sulfate ions or incorrect formula for the chosen sulfate, penalise M1 but mark M2 and M3 For the M1 NaOH/KOH If ammonia, then CE=0 If hydroxide ions or incorrect formula for the chosen hydroxide, penalise M1 but mark M2 and M3 For no (observed) change in both alternatives Ignore “nothing” Ignore “no observation” Ignore “clear” Ignore “dissolves” For the white precipitate in both alternatives Ignore “cloudy solution” OR “suspension”

3(c)	**M1** ammonia (can be dilute or concentrated) **M2** dissolves OR soluble OR (forms a) colourless solution OR goes colourless **M3** does not dissolve OR not soluble Or remains as a solid OR no (observed) change OR no reaction OR yellow solid remains OR if concentrated ammonia has been used, accept yellow solid turns white. OR as an alternative using conc sulfuric acid **M1** concentrated sulfuric acid OR c(onc) H_2SO_4 **M2** misty / white fumes / gas OR remains white OR no change (in colour) **M3** turns black (solid) OR purple fumes / gas OR correct reference to H_2S observation (e.g. bad egg smell)	3	For M1 If incorrect formula or "ammonium", penalise M1 but mark M2 and M3 If no reagent or incorrect reagent in M1, then no marks for M2 or M3 For M3 Ignore "nothing" Ignore "no observation" For the alternative using sulfuric acid If dilute sulfuric acid or "aq" (alone) or the idea of concentrated not included CE=0 If incorrect formula, penalise M1 but mark M2 and M3 If no reagent or incorrect reagent in M1, then no marks for M2 or M3

3(d)	**M1** acidified potassium dichromate or $K_2Cr_2O_7/H_2SO_4$ OR $K_2Cr_2O_7/H^+$ OR acidified $K_2Cr_2O_7$ **M2** (orange to) green solution OR goes green **M3** (solution) remains orange or no reaction or no (observed) change Alternative using $KMnO_4/H_2SO_4$ **M1** acidified potassium manganate(VII) or $KMnO_4/H_2SO_4$ OR $KMnO_4/H^+$ OR acidified $KMnO_4$ **M2** colourless solution OR goes colourless **M3** (solution) remains purple or no reaction or no (observed) change	3	If no reagent or incorrect reagent in M1, then no marks for M2 or M3 For M1 If "dichromate" or "dichromate(IV)" or incorrect formula or no acid, penalise M1 but mark M2 and M3 For M2 ignore dichromate described as "yellow" or "red" For M3 Ignore "nothing" Ignore "no observation" For M1 If "manganate" or "manganate(IV)" or incorrect formula or no acid, penalise M1 but mark M2 and M3 Credit alkaline $KMnO_4$ for possible full marks but M2 gives brown precipitate or solution goes green

Question	Marking Guidance	Mark	Comments
4(a)	$MnO_2 + \mathbf{2}CO \longrightarrow Mn + \mathbf{2}CO_2$	1	Or multiples Ignore state symbols
4(b)	$Al \longrightarrow Al^{3+} + \mathbf{3}e^-$	1	Or multiples Ignore state symbols Credit electrons subtracted from LHS Ignore absence of charge on e
4(c)	$\mathbf{2}CuO + C \longrightarrow \mathbf{2}Cu + CO_2$ OR $CuO + C \longrightarrow Cu + CO$	1	Or multiples Ignore state symbols
4(d)(i)	*Any one from the following three ONLY* • Low(er) energy requirement • Low(er) temperature • Copper is obtained from low grade ore	1	Apply the list principle
4(d)(ii)	$Fe + Cu^{2+} \longrightarrow Fe^{2+} + Cu$	1	Or multiples Ignore state symbols

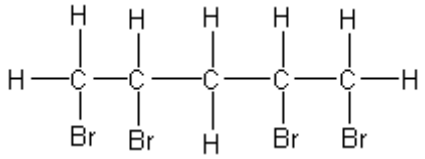
Question	Marking Guidance	Mark	Comments
5(a)	$Mg^{2+} + \mathbf{2}OH^- \longrightarrow Mg(OH)_2$	1	NOT multiples Ignore state symbols
5(b)	$Mg(OH)_2 + \mathbf{2}HCl \longrightarrow MgCl_2 + \mathbf{2}H_2O$	1	Or multiples or ionic, with or without the spectator ions Ignore state symbols Accept either of these two equations $OH^- + H^+ \longrightarrow H_2O$ $Mg^{2+} + 2Cl^- \longrightarrow MgCl_2$
5(c)	$Mg^{2+} + \mathbf{2}e^- \longrightarrow Mg$	1	Or multiples Ignore state symbols Credit electrons subtracted from RHS Ignore absence of charge on e
5(d)(i)	**M1** use of Cl_2 and C **M2** balanced equation consequential on correct reactants $TiO_2 + \mathbf{2}Cl_2 + \mathbf{2}C \longrightarrow TiCl_4 + \mathbf{2}CO$ ***OR*** $TiO_2 + \mathbf{2}Cl_2 + C \longrightarrow TiCl_4 + CO_2$	2	Or multiples Ignore state symbols
5(d)(ii)	$TiCl_4 + \mathbf{2}Mg \longrightarrow Ti + \mathbf{2}MgCl_2$	1	Or multiples Ignore state symbols

5(d)(iii)	Reducing agent ***OR*** reduces $TiCl_4$ ***OR*** Electron donor	1	Credit "reduction" or "reductant" Penalise "electron pair donor"

5(e)	**M1** Hydrogen / H_2 produced ***OR*** an equation to produce <u>hydrogen / H_2</u> (eg $Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2$) (eg $Mg + H_2O \longrightarrow MgO + H_2$) **M2 requires correct M1** risk of explosion OR forms explosive mixture (with air) ***OR*** (highly) flammable	2	For M1 Do not penalise an incorrect equation; the mark is for H_2 or hydrogen Allow one mark only for "<u>exothermic reaction</u> with steam / H_2O" for a candidate who has not scored M1 Ignore "violent" reaction

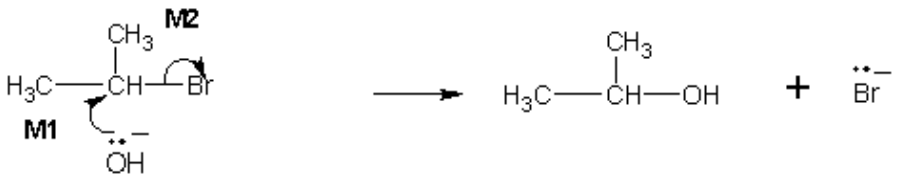
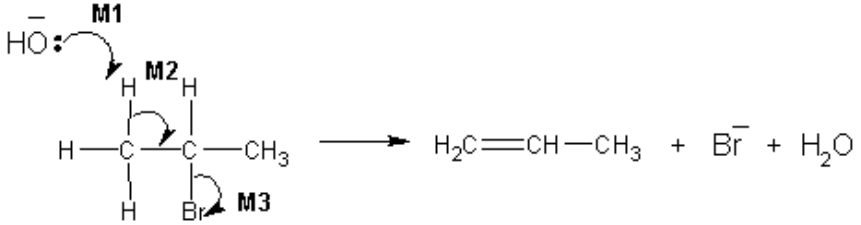
Question	Marking Guidance	Mark	Comments
6(a)(i)	More absorption / less transmittance of infrared radiation by it / water vapour ***OR*** broader absorption by OH ***OR*** less absorption / more transmittance of infrared radiation by carbon dioxide	1	Must be comparative This may be described and must not be contradictory Credit answers which refer correctly to "transmittance" (more absorption = less transmittance)
6(a)(ii)	**M1** CO_2 contains C=O (stated like this or in words or strongly implied) OR is O=C=O **M2 depends on correct M1** ***OR*** expected absorption / peak (for C=O) is missing ***OR*** expected absorption / peak (for C=O) is shifted to 2300(cm^{-1}) ***OR*** 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 (cm^{-1}) / 1715 (cm^{-1}) OR no absorption in the range 1680 – 1750 (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.
6(b)(i)	An activity which has no net / overall (annual) carbon emissions to the atmosphere / air ***OR*** An activity which has no net / overall (annual) greenhouse gas emissions to the atmosphere / air. ***OR*** There is no change in the total amount of carbon dioxide / carbon /greenhouse gas present in the atmosphere / air	1	The idea that the carbon / CO_2 given out equals the carbon / CO_2 that was taken in from the atmosphere / air Answer must refer to the atmosphere or air
6(b)(ii)	$Mg_3Si_2O_5(OH)_4 + \mathbf{3}CO_2 \rightarrow \mathbf{3}MgCO_3 + \mathbf{2}SiO_2 + \mathbf{2}H_2O$	1	Allow multiples

Question	Marking Guidance	Mark	Comments
7(a)(i)	(Free-) radical substitution	1	Both words needed
7(a)(ii)	UV light / Ultra-violet light / sunlight OR high temperature / $150^oC \leq T \leq 500^oC$	1	
7(a)(iii)	Propagation (Step)	1	Ignore "first" or "second" Accept phonetic spelling
7(a)(iv)	**M1** Termination (Step) **M2** $\mathbf{2}CH_3CH_2CH_2\bullet \longrightarrow C_6H_{14}$	2	In M2 C_6H_{14} may be drawn out as $CH_3CH_2CH_2CH_2CH_2CH_3$ The dot may be anywhere around the terminal CH_2 on the radical Accept $C_3H_7\bullet$ with dot anywhere Penalise the absence of any radical dot
7(a)(v)	$C_3H_8 + \mathbf{8}Br_2 \longrightarrow C_3Br_8 + \mathbf{8}HBr$	1	Or multiples

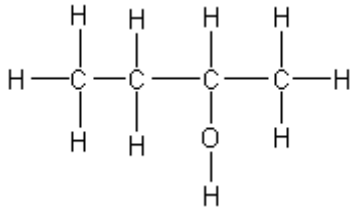
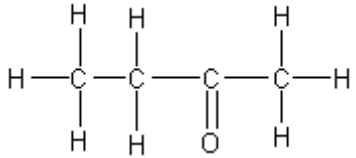
7(b)(i)	**M1** Double bonds are electron-rich OR electon pair donors OR centres of electron density. **M2** Bromine becomes polarised / becomes polar OR forms an induced dipole OR becomes δ+/ δ-	2	M1 **QoL** – require one of these terms Ignore "(very) negative" and "nucleophile" as applied to the double bond. Penalise M2 for ion formation from bromine For M2, do not credit dipole formation solely as a consequence of electronegativity
7(b)(ii)	Electrophilic addition	1	Both words needed Accept phonetic spelling
7(b)(iii)	Structure for 1,2,4,5-tetrabromopentane, for example $BrCH_2CHBrCH_2CHBrCH_2Br$ 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

7(c)	+ **M1** Structure of CH_3CHCH_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”

Question	Marking Guidance	Mark	Comments
8(a)(i)	Electron pair donor OR Species which uses a pair of electrons to form a co-ordinate / covalent bond.	1	Credit “lone pair” as alternative wording Credit “electron pair donator”
8(a)(ii)	Replacement of the halogen (atom) (by the nucleophile) OR The carbon-halogen bond / C-X 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
8(a)(iii)	Splitting molecules using / by water OR breaking / splitting / dissociating (C–X) bond(s) / using / by water	1	NOT simply the reaction with water or simply the addition of water. Ignore “compound”
8(a)(iv)	(Heat) energy / enthalpy required / needed / absorbed (at constant pressure) to break / split it / the (carbon-halogen) bond OR (Heat) energy / enthalpy required / needed / absorbed (at constant pressure) for homolysis of the (C—X / the carbon-halogen) bond	1	Ignore bond formation Ignore “average”

8(b)	 **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_N1 mechanism in which M1 is the attack of the hydroxide ion on the intermediate carbocation.	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"
8(c)(i)	 **M1** must show an arrow from the lone pair on oxygen of a negatively charged hydroxide ion <u>to the 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.	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

8(c)(ii)	**M1** Stated that the spectrum has an absorption / absorbance / peak in the range 1620 cm^{-1} to 1680 (cm^{-1})or specified correctly in this range from the spectrum **M2 depends on correct range or wavenumber being specified** **M2** (Infrared absorption) due to C=C OR carbon-carbon double bond	2	**QoL for correct M1 statement which includes both the word absorption (or alternative) and 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

Question	Marking Guidance	Mark	Comments
9(a)(i)	Hexan-1-ol	1	ONLY
9(a)(ii)	Homologous (series)	1	ONLY
9(a)(iii)	Displayed formula for butan-2-ol 	1	All bonds must be drawn out including the O—H bond Ignore bond angles
9(a)(iv)	$CH_3CH_2CH_2CH_2OH + [O] \longrightarrow CH_3CH_2CH_2CHO + H_2O$	1	Require this whole equation as written or formulae drawn out Penalise "sticks"
9(a)(v)	Displayed formula for butanone (credit possible enols, ethers and cyclic structures for C_4H_8O) 	1	All bonds must be drawn out Ignore bond angles

9(b)	**M1** q = m c ΔT OR calculation 175 x 4.18 x 8 **M2** = **5852** (J) OR 5.85 (kJ) OR 5.9 (kJ) (This also scores M1) **M3** 0.005 mol, therefore ΔH = **–1170** ($kJmol^{-1}$) OR ΔH = **–1170.4** ($kJmol^{-1}$) OR ΔH = **–1200** ($kJmol^{-1}$)	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 $J\ mol^{-1}$ If m = 5×10^{-3} OR if ΔT = 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 = – 1350 (– 1347)
9(c)(i)	**M1** The enthalpy change (or heat change at constant pressure) when 1 mol of a compound / substance / alcohol **M2** is burned completely in oxygen OR burned in excess oxygen **M3** with all reactants and products / all substances in standard states OR all reactants and products / all substances in normal states under standard conditions OR 100 kPa / 1 bar and a specified T / 298 K	3	For M3 Ignore reference to 1 atmosphere

9(c)(ii)	**M1 (could be scored by a correct mathematical expression)** **M1** $\Delta H = \sum\Delta H_f$ (**products**) - $\sum\Delta H_f$ (**reactants**) OR a correct cycle of balanced equations **M2** = 4(–394) + 5(–286) – (–327) (This also scores M1) **M3** = **– 2679** (kJ mol^{-1}) OR **– 2680** (kJ mol^{-1}) **Award 1 mark ONLY for (+) 2679 OR (+) 2680**	3	Correct answer to calculation gains full credit Credit 1 mark if + 2679 (kJ mol^{-1}) For other incorrect or incomplete answers, proceed as follows • check for an arithmetic error (AE), which is either a transposition error or an incorrect multiplication; this would score 2 marks (M1 and M2) • If no AE, check for correct method; this requires either a correct cycle with $4CO_2$ and $5H_2O$ OR a clear statement of M1 which could be in words and scores only M1
9(d)(i)	**M1 This is about the change in formula up the series** Each alcohol in the series (compared with the previous one) increases by / has an extra CH_2 OR has one more C-C and two more C-H **M2 This is about the reaction and bond breaking/making** Combustion of each alcohol in the series breaks one more C-C and two more C-H compared with the previous one AND forms one more mol CO_2 and one more mol H_2O OR A statement in which there is the idea that the extra OR additional OR difference in number of bonds broken and formed (as the series increases) is the same OR has the same difference in energy	2	N.B. If the first statement here for M2 is given , both marks score

9(d)(ii)	**For the two marks M1 and M2** heat loss or heat 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	

Question	Marking Guidance	Mark	Comments
10(a)(i)	MnO_2 **(+) 4**	1	
10(a)(ii)	$MnO_2 + \mathbf{4}H^+ + \mathbf{2}e^- \longrightarrow Mn^{2+} + \mathbf{2}H_2O$	1	Or multiples Ignore state symbols Credit electrons subtracted from RHS Ignore absence of charge on e
10(a)(iii)	Iodide ion(s) is/are oxidised because they have <u>lost electron(s)</u>	1	Do not penalise reference to iodine; the mark is for electron loss
10(b)(i)	**M1** Cl_2 **0** **M2** HClO **(+) 1**	2	
10(b)(ii)	**M1** <u>Equilibrium</u> will <u>shift / move</u> <u>to the right</u> OR <u>L to R</u> OR to favour the <u>forward reaction</u> OR to produce <u>more HC*l*O</u> **M2** - **<u>Consequential on correct M1</u>** <u>To oppose the loss of HClO</u> OR <u>replaces the HClO</u> (that has reacted)	2	for M2 NOT just “to oppose the change”

10(c)(i)	The answers can be in **either order** **M1** $\mathbf{2}Br^- \longrightarrow Br_2 + \mathbf{2}e^-$ **M2** $\mathbf{4}H^+ + SO_4^{2-} + \mathbf{2}e^- \longrightarrow SO_2 + \mathbf{2}H_2O$ OR $\mathbf{2}H^+ + H_2SO_4 + \mathbf{2}e^- \longrightarrow SO_2 + \mathbf{2}H_2O$	2	NOT multiples Ignore state symbols Credit electrons subtracted from incorrect side Ignore absence of charge on e
10(c)(ii)	$KCl + H_2SO_4 \longrightarrow KHSO_4 + HCl$ OR $\mathbf{2}KCl + H_2SO_4 \longrightarrow K_2SO_4 + \mathbf{2}HCl$	1	Credit ionic equations
10(c)(iii)	For M1 and M2, chloride ions are weaker reducing agents than bromide ions, because **M1 Relative size of ions** Chloride ions are <u>smaller</u> than bromide ions OR chloride ion electron(s) are <u>closer</u> to the nucleus OR chloride ion has fewer (electron) shells / levels OR chloride ion has less shielding (or converse for bromide ion) **M2 Strength of attraction for electron being lost** <u>Outer shell / level electron(s)</u> OR <u>electron(s) lost</u> from a <u>chloride ion</u> is <u>more strongly held by the nucleus</u> compared with that lost from a <u>bromide ion</u> (or converse for bromide ion)	2	If the forces are described as intermolecular or Van der Waals then CE=0 Ignore general reference to Group 7 trend For M1 accept reference to chlorine/bromine or reference to atoms of these but NOT "chloride/bromide atoms" or "chlorine/bromine molecules" For M2 insist on reference to the correct ions This is the expected answer, but award credit for a candidate who gives a correct explanation in terms of hydration enthalpy, electron affinity and atomisation enthalpy.

General principles applied to marking CHEM2 papers by CMI+ (January 2011)

It is important to note that the guidance given here is generic and specific variations may be made at individual standardising meetings in the context of particular questions and papers.

Basic principles

- **Examiners should note that throughout the mark scheme, items that are underlined are required information to gain credit.**
- **Occasionally an answer involves incorrect chemistry and the mark scheme records CE = 0, which means a chemical error has occurred and no credit is given for that section of the clip or for the whole clip.**

A. The "List principle" and the use of "ignore" in the mark scheme

If a question requires **one** answer and a candidate gives two answers, no mark is scored if one answer is correct and one answer is incorrect. There is no penalty if both answers are correct.

N.B. Certain answers are designated in the mark scheme as those which the examiner should "Ignore". These answers are not counted as part of the list and should be ignored and will not be penalised.

B. Incorrect case for element symbol

The use of an incorrect case for the symbol of an element should be penalised **once only** within a clip.
For example, penalise the use of "h" for hydrogen, "CL" for chlorine or "br" for bromine.

C. Spelling

In general

- The names of chemical compounds and functional groups **must be spelled correctly** to gain credit.
- Phonetic spelling may be acceptable for some chemical terminology.

N.B. Some terms may be required to be spelled correctly or an idea needs to be articulated with clarity, as part of the "Quality of Language" (**QoL**) marking. These will be identified in the mark scheme and marks are awarded only if the QoL criterion is satisfied.

D. Equations

In general

- Equations **must** be balanced.
- When an equation is worth two marks, one of the marks in the mark scheme will be allocated to one or more of the reactants or products. This is independent of the equation balancing.
- State symbols are generally ignored, unless specifically required in the mark scheme.

E. Reagents

The command word "Identify", allows the candidate to choose to use **either** the name or the formula of a reagent in their answer. In some circumstances, the list principle may apply when both the name and the formula are used. Specific details will be given in mark schemes.

The guiding principle is that a reagent is a chemical which can be taken out of a bottle or container. Failure to identify complete reagents **will be penalised**, but follow-on marks (e.g. for a subsequent equation or observation) can be scored from an incorrect attempt (possibly an incomplete reagent) at the correct reagent. Specific details will be given in mark schemes.
For example, **no credit** would be given for

- the cyanide ion or CN^- when the reagent should be potassium cyanide or KCN;
- the hydroxide ion or OH^- when the reagent should be sodium hydroxide or NaOH;
- the $Ag(NH_3)_2^+$ ion when the reagent should be Tollens' reagent (or ammoniacal silver nitrate). In this example, no credit is given for the ion, but credit could be given for a correct observation following on from the use of the ion. Specific details will be given in mark schemes.

In the event that a candidate provides, for example, **both** KCN and cyanide ion, it would be usual to ignore the reference to the cyanide ion (because this is not contradictory) and credit the KCN. Specific details will be given in mark schemes.

F. Oxidation states

In general, the sign for an oxidation state will be assumed to be positive unless specifically shown to be negative.

G. Marking calculations, such as those involving enthalpy changes

In general

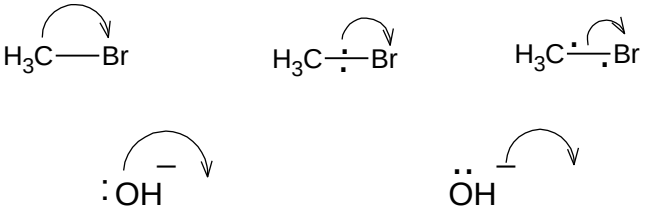
- The sign for an enthalpy change will be assumed to be positive unless specifically shown to be negative.
- A correct answer alone will score **full marks** unless the necessity to show working is specifically required in the question.
- A correct numerical value with the **wrong sign** will usually score **only one mark**.

All other values **gain no credit** except

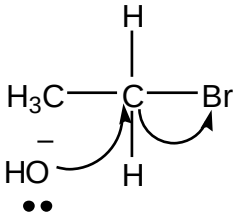
- Two marks can be awarded for correct chemistry with an arithmetic error.
- One mark can be awarded for a correct mathematical statement (or cycle) for the method.

H. Organic reaction mechanisms

Curly arrows should originate either from a lone pair of electrons or from a bond.
The following representations should not gain credit **and will be penalised each time** within a clip.



For example, the following would score zero marks



When the curly arrow is showing the formation of a bond to an atom, the arrow can go directly to the relevant atom, alongside the relevant atom or **more than half-way** towards the relevant atom.

In free-radical substitution

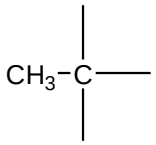
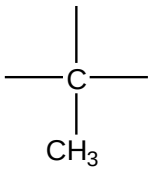
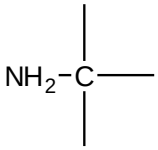
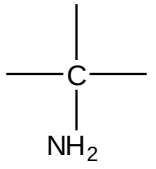
- The absence of a radical dot should be penalised **once only** within a clip.
- The use of double-headed arrows or the incorrect use of half-headed arrows in free-radical mechanisms should be penalised **once only** within a clip

In mass spectrometry fragmentation equations, the absence of a radical dot on the molecular ion and on the free-radical fragment would be considered to be two independent errors and both would be penalised if they occurred within the same clip.

I. Organic structures

In general

- Displayed formulae must show all of the bonds and all of the atoms in the molecule, but need not show correct bond angles.
- Bonds should be drawn correctly between the relevant atoms.
  For example, if candidates show the alcohol functional group as C ─ HO, they should be penalised **on every occasion**.
- Latitude should be given to the representation of C ─ C bonds in structures, given that CH_3─ is considered to be interchangeable with H_3C─ even though the latter would be preferred.
- Poor presentation of vertical C ─ CH_3 bonds or C ─ NH_2 bonds should **not** be penalised. For the other functional groups, such as ─ OH and ─ CN, the limit of tolerance is the half-way position between the vertical bond and the relevant atoms in the attached group.
  By way of illustration, the following would apply

(a)  allowed	(b)  allowed
(c)  allowed	(d)  allowed

- In most cases, the use of "sticks" to represent C — H bonds in a structure should **not** be penalised. The exceptions will include structures in mechanisms when the C — H bond is essential (e.g. elimination reactions in haloalkanes) and when a displayed formula is required.
- Some examples are given here of **structures** for specific compounds that should **not** gain credit

CH_3COH	for	ethanal
CH_3CH_2HO	for	ethanol
$OHCH_2CH_3$	for	ethanol
C_2H_6O	for	ethanol
CH_2CH_2	for	ethene
$CH_2.CH_2$	for	ethene
$CH_2:CH_2$	for	ethene

N.B. Exceptions may be made in the context of balancing equations

- Each of the following **should gain credit** as alternatives to correct representations of the structures.

$CH_2 = CH_2$	for	ethene, $H_2C=CH_2$
$CH_3CHOHCH_3$	for	propan-2-ol, $CH_3CH(OH)CH_3$

J. Organic names

As a general principle, non-IUPAC names or incorrect spelling or incomplete names should **not** gain credit.
Some illustrations are given here.

but-2-ol	should be **butan-2-ol**
2-hydroxybutane	should be **butan-2-ol**
butane-2-ol	should be **butan-2-ol**
2-butanol	should be **butan-2-ol**

2-methpropan-2-ol	should be **2-methylpropan-2-ol**
2-methylbutan-3-ol	should be **3-methylbutan-2-ol**
3-methylpentan	should be **3-methylpentane**
3-mythylpentane	should be **3-methylpentane**
3-methypentane	should be **3-methylpentane**
propanitrile	should be **propanenitrile**
aminethane	should be **ethylamine** (although aminoethane can gain credit)
2-methyl-3-bromobutane	should be **2-bromo-3-methylbutane**
3-bromo-2-methylbutane	should be **2-bromo-3-methylbutane**
3-methyl-2-bromobutane	should be **2-bromo-3-methylbutane**
2-methylbut-3-ene	should be **3-methylbut-1-ene**
difluorodichloromethane	should be **dichlorodifluoromethane**