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General Certificate of Education (A-level)
January 2012

Chemistry CHEM2

(Specification 2420)

Unit 2: Chemistry In Action

Final

Mark Scheme

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Question	Marking Guidance	Mark	Comments
1(a)(i)	$SiO_2 + \mathbf{2}Cl_2 + \mathbf{2}C \longrightarrow SiCl_4 + \mathbf{2}CO$ ***OR*** $SiO_2 + \mathbf{2}Cl_2 + C \longrightarrow SiCl_4 + CO_2$	1	Ignore state symbols Credit multiples of either equation
1(a)(ii)	(fractional) distillation ***OR*** G(L)C or gas (-liquid-) chromatography	1	
1(b)(i)	$SiCl_4 + \mathbf{2}H_2 \longrightarrow Si + \mathbf{4}HCl$	1	Ignore state symbols Credit multiples Penalise ionic HCl
1(b)(ii)	Reducing agent / reductant / reduces $SiCl_4$ / reduces (silicon) / electron donor	1	
1(b)(iii)	Explosion / explosive ***OR*** (highly) flammable / inflammable ***OR*** readily / easily ignites / burns / combusts	1	
1(c)	$\mathbf{2}MgO + Si \longrightarrow \mathbf{2}Mg + SiO_2$	1	Ignore state symbols Credit multiples

Question	Marking Guidance	Mark	Comments
2(a)	**In either order** **M1** Concentrations (of reactants and products) remain or stay constant / the same **M2** Forward rate = Reverse / backward rate	2	For M1 accept [ ] for concentration NOT "equal concentrations" and NOT "concentration(s) is/are the same" NOT "amount" Ignore "dynamic" and ignore "speed" Ignore "closed system" It is possible to score both marks under the heading of a single feature
2(b)	**M1** Catalysts increase rate of / speed up both forward and reverse / backward reactions **M2** increase in rate / affect on rate / speed is equal / the same	2	If M1 is given as "no effect" / "no change" then CE= 0 for clip Ignore references to "decrease in rate"
2(c)(i)	**M1** (The yield) increases / goes up / gets more **M2** There are more moles / molecules (of gas) on the left / of reactants ***OR*** fewer moles / molecules (of gas) on the right / products ***OR*** there are 4 moles / molecules (of gas) on the left and 2 moles / molecules on the right. ***OR*** (equilibrium) shifts / moves to the side with less moles / molecules **M3 Can only score M3 if M2 is correct** The equilibrium shifts / moves (from left to right) to oppose the increase in pressure	3	If M1 is given as "decreases" / "no effect" / "no change" then CE= 0 for clip, but mark on from a blank. Ignore "volumes", "particles" "atoms" and "species" for M2 For M3, not simply "to oppose the change" For M3 credit the equilibrium shifts / moves to lower / decrease the pressure (There must be a specific reference to the change that is opposed)

2(c)(ii)	**M1** The yield decreases / goes down / gets less **M2** (Forward) reaction is <u>exothermic</u> ***OR*** <u>gives out / releases heat</u> ***OR*** reverse reaction is <u>endothermic</u> ***OR*** <u>takes in / absorbs heat</u> **Can only score M3 <u>if M2 is correct</u>** The <u>equilibrium shifts / moves</u> (from right to left) to <u>oppose the increase in temperature</u>	3	If M1 is given as "increase" / "no effect" / "no change" then CE= 0 for clip, but mark on from a blank. For M3, <u>not</u> simply "to oppose the change" For M3 credit the <u>equilibrium shifts / moves</u> to <u>absorb the heat</u> OR to <u>cool the reaction</u> OR to <u>lower the temperature</u> (There must be a <u>specific</u> reference to the change that is opposed)

2(d)(i)	Must be comparative <u>Higher rate</u> of reaction ***OR*** <u>increase / speed up the rate</u> (of reaction) ***OR*** Gets to equilibrium <u>faster/ quicker</u> ***OR*** <u>faster or quicker rate / speed</u> of attainment of equilibrium	1	Credit correct reference to rate being <u>too (s)low / (s)lower</u> at temperatures less than 600 K Ignore statements about the "yield of ammonia"

2(d)(ii)	<u>Less</u> electrical <u>pumping cost</u> ***OR*** Use lower pressure <u>equipment / valves / gaskets / piping</u> etc. ***OR*** Uses less expensive <u>equipment</u>	1	Not just "less expensive" alone Not just "less energy or saves energy" alone Credit correct <u>qualified</u> references to higher pressures Ignore references to safety

Question	Marking Guidance	Mark	Comments
3(a)	Number / proportion / percentage / fraction of molecules	1	Ignore "particles"
3(b)	None ***OR*** no effect ***OR*** no change	1	
3(c)	**X**	1	
3(d)	**Answers in either order** **M1** collision ***OR*** collide **M2** collision / molecules / particles with the activation energy ***OR*** with $E \geq E_{act}$ ***OR*** with sufficient /enough energy ***OR*** with the minimum energy ***OR*** with the correct orientation	2	Mark independently Ignore "correct" amount of energy
3(e)	A small increase in temperature results in many more / much higher proportion of / a lot more / significantly more molecules / particles / collisions with $E \geq E_{act}$ / energy greater than the activation energy / sufficient energy / enough energy / minimum energy to react (compared with a small increase in concentration)	1	Not just "more molecules with $E \geq E_{act}$" The answer must convey that the increase is **significant** Accept reference to "atoms", molecules", "particles" Ignore "species"

Question	Marking Guidance	Mark	Comments
4(a)(i)	reduction ***OR*** reduced ***OR*** redox ***OR*** reduction-oxidation	1	Not "oxidation" alone
4(a)(ii)	Fe^{3+} + **3**e^- ⟶ Fe	1	Ignore state symbols Do not penalise absence of charge on electron Credit Fe^{3+} ⟶ Fe – **3**e^- Credit multiples
4(b)(i)	**Because (one of the following)** CO is not the only product ***OR*** (Some) complete combustion (also)occurs ***OR*** CO_2 is (also) formed Further oxidation occurs	1	Reference to "incomplete combustion to form CO" does not answer the question
4(b)(ii)	The <u>enthalpy change</u> / <u>heat (energy) change at constant pressure</u> in a reaction is <u>independent of the route / path taken</u> (and depends only on the initial and final states)	1	

4(b)(iii)	**M1** The <u>enthalpy change</u> / <u>heat change at constant pressure</u> when <u>1 mol</u> of a compound / substance / element **M2** is <u>burned completely</u> / <u>undergoes complete combustion</u> in (excess) <u>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 / specified states under standard conditions</u> / 100 kPa / 1 bar <u>and</u> specified T / 298 K	3	For M1, credit correct reference to molecule/s or atom/s For M3 Ignore reference to 1 atmosphere
4(c)	**M1 (could be scored by a correct mathematical expression which <u>must</u> have <u>all</u> ΔH symbols and the $\sum$)** **M1** ΔH_r = $\sum\Delta H_f$ (**products**) - $\sum\Delta H_f$ (**reactants**) ***OR*** <u>correct cycle of balanced equations with 2Fe, 3C and $3O_2$</u> **M2** ΔH_r = 2(+14) + 3(– 394) – (– 822) – 3(–111) = 28 –1182 + 822 + 333 (This also scores M1) **M3** = **(+) 1** (kJ mol^{-1}) **(Award 1 mark ONLY for – 1)** **(Award 1 mark ONLY for – 27)**	3	Correct answer gains full marks Credit 1 mark ONLY for –1 (kJ mol^{-1}) Credit 1 mark ONLY for – 27 (kJ mol^{-1}) i.e. assuming value for Fe(l) = 0 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 a correct method; this requires either a correct cycle with 2Fe, 3C and $3O_2$ OR a clear statement of M1 which could be in words and scores <u>only M1</u>
4(d)(i)	$C(s) + O_2(g) \longrightarrow CO_2(g)$	1	State symbols essential Possible to include C(s, graphite)

4(d)(ii)	These two enthalpy changes are for <u>the same reaction / same equation / same reactants and products</u> ***OR*** They <u>both make one mole of carbon dioxide only from carbon and oxygen</u> (or this idea clearly implied) ***OR*** The <u>same number and same type of bonds are broken and formed</u>	1	Penalise reference to CO_2 being produced by a different route "both form CO_2" is not sufficient (since other products might occur e.g.CO)

Question	Marking Guidance	Mark	Comments
5(a)(i)	**M1 0** **M2 (+) 5**	2	Accept Roman V for M2
5(a)(ii)	$I_2 + 10HNO_3 \longrightarrow \mathbf{2}HIO_3 + \mathbf{10}NO_2 + \mathbf{4}H_2O$	1	Accept multiples
5(b)	**M1** $IO_3^- + \mathbf{6}H^+ + \mathbf{5}I^- \longrightarrow \mathbf{3}I_2 + \mathbf{3}H_2O$ **M2** $NaIO_3$ ***OR*** IO_3^- ***OR*** iodate ions ***OR*** iodate(V) ions etc. Accept "the iodine in iodate ions" but NOT "iodine" alone	2	For M1, ignore state symbols Credit multiples Accept $2\frac{1}{2}I_2 + \frac{1}{2}I_2$ as alternative to $3I_2$ Electrons must be cancelled For M2 Do not penalise an incorrect name for the correct oxidising agent that is written in addition to the formula. Accept "the iodine / I in iodate ions" but NOT "iodine" alone
5(c)(i)	Iodine ***OR*** I_2	1	Insist on correct name or formula
5(c)(ii)	$H_2SO_4 + \mathbf{6}H+ + \mathbf{6}e^- \longrightarrow S + \mathbf{4}H_2O$ $SO_4^{2-} + \mathbf{8}H+ + \mathbf{6}e^- \longrightarrow S + \mathbf{4}H_2O$	1	Ignore state symbols Credit multiples Do not penalise absence of charge on the electron
5(d)	hydrogen sulfide ***OR*** H_2S ***OR*** hydrogen sulphide	1	

5(e)(i)	$Ag^+ + I^- \longrightarrow AgI$ ONLY	1	Ignore state symbols No multiples
5(e)(ii)	The (yellow) precipitate / solid / it does not dissolve / is insoluble ***OR*** turns to a white solid ***OR*** stays the same ***OR*** no (visible/ observable) change ***OR*** no effect / no reaction	1	ignore "nothing (happens)" ignore "no observation"
5(e)(iii)	The silver nitrate is acidified to • react with / remove (an)ions that would interfere with the test • prevent the formation of other silver precipitates / insoluble silver compounds that would interfere with the test • remove (other) ions that react with the silver nitrate • react with / remove carbonate / hydroxide / sulfite (ions)	1	Ignore reference to "false positive" Do not penalise an incorrect formula for an ion that is written in addition to the name. If only the formula of the ion is given, it must be correct
5(f)(i)	An electron donor ***OR*** (readily) donates / loses / releases / gives (away) electron(s)	1	Penalise "electron pair donor" Penalise "loss of electrons" alone Accept "electron donator"
5(f)(ii)	$Cl_2 + \mathbf{2}e^- \longrightarrow \mathbf{2}Cl^-$	1	Ignore state symbols Do not penalise absence of charge on electron Credit $Cl_2 \longrightarrow \mathbf{2}Cl^- - \mathbf{2}e^-$ Credit multiples

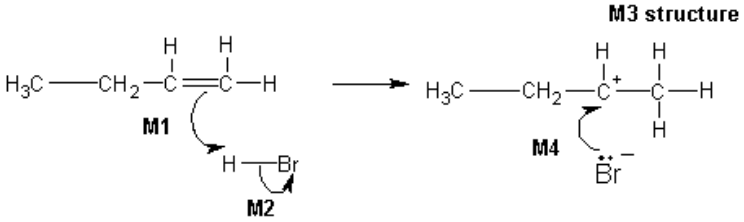
5(f)(iii)	For M1 and M2, iodide ions are stronger reducing agents than chloride ions, because **M1 Relative size of ions** Iodide ions / they are larger /have more electron levels(shells) (than chloride ions) / larger atomic / ionic radius ***OR*** electron to be lost/outer shell/level (of the iodide ion) is further the nucleus ***OR*** iodide ion(s) / they have greater / more shielding ***OR*** converse for chloride ion **M2 Strength of attraction for electron(s)** The electron(s) lost /outer shell/level electron from (an) iodide ion(s) less strongly held by the nucleus compared with that lost from a chloride ion ***OR*** converse for a chloride ion	2	Ignore general statements about Group VII trends or about halogen molecules or atoms. Answers must be specific CE=0 for the clip if "iodine ions / chlorine ions **QoL** CE=0 for the clip if "iodide ions are bigger molecules / atoms" **QoL** Insist on iodide ions in M1 and M2 or the use of it / they / them, in the correct context (or chloride ions in the converse argument) Must be comparative in both M1 and M2

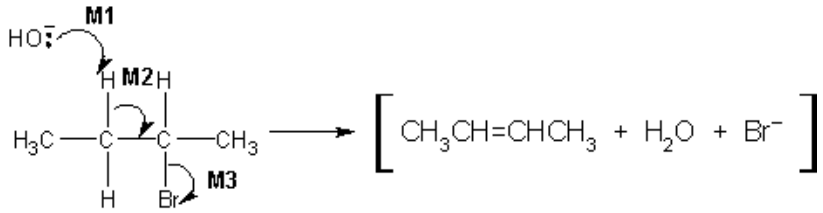
Question	Marking Guidance	Mark	Comments
6(a)	**For 2 marks at least <u>one correct reference either to M_r</u> or <u>value to 5 decimal places</u> required** **M1** Compounds <u>1 and 3</u> (butanal and butanone) have the same M_r (to 5dp) <u>because</u> **either** • they contain the <u>same</u> number of atoms of the same / each element • are <u>both</u> C_4H_8O • have the <u>same molecular formula</u> • contain the <u>same number</u> of C,H and O atoms **M2** Compound <u>2</u> (pentane) has a different M_r (to 5dp) <u>because</u> **either** • it has d<u>ifferent</u> numbers of atoms of different elements • is C_5H_{12} / <u>only contains</u> C and H • <u>different molecular formula</u> • does not contain oxygen (atom) / C=O	2	**QoL** (associated with the bold statement here) It may be possible to award 2 marks if there is a clear statement about oxygen having a different precise A_r in the context of the comparison NB The word “similar” does not mean “the same”

6(b)		**WithTollens' (reagent)** **M1** silver mirror ***OR*** black solid/precipitate (NOT silver (mirror) precipitate) **M2 (**stays) colourless ***OR*** no change / no reaction ***OR*** no silver mirror	**With Fehling's (solution)** **M1** Red solid/precipitate (Credit orange or brown solid) **M2 (**stays) blue ***OR*** no change / no reaction ***OR*** no red solid ***OR*** no (red) precipitate	2	**N.B No mark is awarded for the reagent** If no reagent given allow 1 mark for a consistent statement of M1 and M2 For M2, ignore "nothing (happens)" And ignore "no observation"

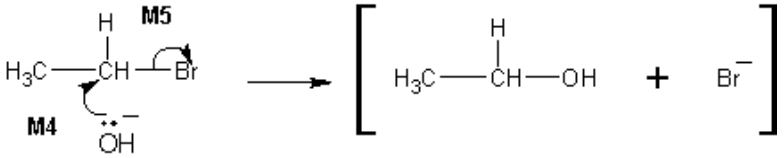
Question	Marking Guidance	Mark	Comments
7(a)(i)	Increases	1	
7(a)(ii)	Decreases	1	
7(a)(iii)	Increases	1	
7(b)	Calcium has a higher melting point than strontium, because **Correct reference to size of cations/proximity of electrons** **M1** (For Ca) delocalised <u>electron(s) closer to cations / positive ions / nucleus</u> ***OR*** <u>cations / positive ions / atoms are smaller</u> ***OR*** <u>cation / positive ion / atom or it has fewer (electron) shells / levels</u> **Relative strength of metallic bonding** **M2** (For Ca) has <u>stronger</u> attraction between the <u>cations / positive ions / nucleus</u> and the <u>delocalised electron(s)</u> ***OR*** <u>stronger metallic bonding</u> (assume argument refers to Ca but accept converse argument for Sr)	2	CE = 0 for reference to molecules or intermolecular forces or covalent bonds Ignore "Van der Waals forces (between atoms)" but penalise if between "molecules Ignore general Group 2 statements Answers must be specific Penalise M1 if Ca or Sr is said to have <u>more or less</u> delocalised electrons Ignore reference to shielding

7(c)(i)	Sulfuric acid / it contains <u>sulfate ions / SO_4^{2-}</u> ***OR*** <u>Sulfuric acid</u> would form a (white) <u>precipitate</u>	1	Do not penalise an <u>additional</u> but incorrect formula for sulfate ion. If only the formula of the sulfate ion is given, it must be correct
7(c)(ii)	$Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$ ONLY	1	Ignore state symbols No multiples

Question	Marking Guidance	Mark	Comments
8(a)	Position(al) (isomerism)	1	
8(b)	 **M1** must show an arrow from the double bond towards the H atom of the H–Br molecule **M2** must show the breaking of the H–Br bond. **M3** is for the structure of the secondary carbocation. **M4** must show an arrow from the lone pair of electrons on the negatively charged bromide ion towards the positively charged carbon atom of either a primary or secondary carbocation. **NB The arrows here are double-headed**	4	Penalise one mark from <u>their</u> total if half-headed arrows are used M1 Ignore partial negative charge on the double bond. M2 Penalise partial charges on H–Br bond if wrong way and penalise formal charges Penalise M3 if there is a bond drawn to the positive charge Penalise once only in any part of the mechanism for a line and two dots to show a bond <u>Maximum any 3 of 4 marks</u> for wrong reactant or primary carbocation. If Br_2 is used, <u>maximum 2 marks</u> for their mechanism Do not penalise the use of “sticks”

8(c)	 **M1** must show an arrow from the lone pair on oxygen of a negatively charged hydroxide ion <u>to a correct</u> H atom **M2** must show an arrow from a C-H bond adjacent to the C-Br bond towards the appropriate C-C bond. Only award if an arrow is shown attacking the H atom of an adjacent C-H (in M1) **M3** is independent provided it is from their <u>original molecule</u>. Award full marks for an E1 mechanism in which M2 is on the correct carbocation. **NB The arrows here are double-headed**	3	Penalise one mark from <u>their</u> total if half-headed arrows are used Penalise M1 if covalent KOH Penalise M3 for formal charge on C of the C-Br or incorrect partial charges on C-Br Penalise M3 if an extra arrow is drawn from the Br of the C-Br bond to, for example, K^+ Ignore other partial charges Penalise once only in any part of the mechanism for a line and two dots to show a bond. <u>Maximum any 2 of 3 marks</u> for wrong reactant <u>or</u> wrong product (if shown) <u>or</u> a mechanism that leads to but-1-ene Accept the correct use of “sticks” for the molecule except for the C-H being attacked

Question	Marking Guidance	Mark	Comments
9(a)	**M1** $C_6H_{12}O_6 \longrightarrow$ **2**CH_3CH_2OH + **2**CO_2 ($2C_2H_5OH$) **M2** fermentation **M3** CH_3CH_2OH + **3**$O_2 \longrightarrow$ **2**CO_2 + **3**H_2O (C_2H_5OH) **M4** <u>A specified process</u> e.g. planting / harvesting / transport / extracting sugar / distilling ethanol solution / fertiliser production etc. **M5** The specified process <u>uses / burns</u> (fossil) <u>fuel that releases CO_2</u>	5	Mark independently For M1 and M3 ignore state symbols and credit multiples For M1 and M3 penalise C_2H_6O once only For M5, "releases / increases carbon emissions" is insufficient as an alternative to <u>releases CO_2</u>

9(b)	**M1** sodium or potassium hydroxide / NaOH / KOH **M2 depends on correct M1** warm / heat / reflux <u>and</u> aqueous or (aq) or water **M3** <u>nucleophilic substitution</u>  **NB The arrows here are double-headed** **M4** must show an arrow from the lone pair of electrons on the oxygen atom of the negatively charged hydroxide ion to the C atom. **M5** must show the movement of a pair of electrons from the C─ Br bond to the Br atom. Mark M5 independently provided it is from their <u>original molecule</u>. For M4 and M5, award full marks for an S_N1 mechanism **M6** One statement from • The yield is (very) low / not a high yield OR elimination occurs / ethene formed • The rate of reaction slow • <u>Bromoethane</u> has to be manufactured / made first • <u>Bromoethane</u> is expensive	6	Mark on to M2 from hydroxide ion Ignore OH^- if KOH/ OH^- For M2 ignore "dilute" For M2 penalise T > 100 ^oC Acidified KOH/NaOH or H_2SO_4 with KOH/NaOH loses M1 and M2 For M3, both words required Penalise M4 if covalent NaOH / KOH is used Penalise one mark from M4 or M5 if half-headed arrows are used Penalise M5 for formal charge on C of the C-Br or incorrect partial charges on C-Br Penalise once only for a line and two dots to show a bond. For M4 and M5, maximum 1 of 2 marks if wrong reactant is used. Penalise M5 if an extra arrow is drawn from the Br of the C-Br bond to, for example, K^+ Do not penalise the use of "sticks" For M6 ignore references to other costs and expenses

9(c)	**M1** concentrated phosphoric acid / conc. H_3PO_4 ***OR*** concentrated sulfuric acid / conc. H_2SO_4 **M2** hydration or (electrophilic) addition **For M3 and M4 any two from** • Excess ethene ***OR*** Excess steam / water / H_2O ***OR*** remove the ethanol as it forms ***OR*** recycle the ethene • Specified Pressure 50 atm $\leq$ P $\leq$ 100 atm ***OR*** 5000 kPa $\leq$ P $\leq$ 10000 kPa ***OR*** 5 MPa $\leq$ P $\leq$ 10 MPa • HighTemperature unless they give a value that is not in the ranges given here; ***OR*** 300 ^{o}C $\leq$ T $\leq$ 600 ^{o}C ***OR*** 570 K $\leq$ T $\leq$ 870 K	4	Answers in any order Ignore reference to support medium in M1 Do not apply the list principle to these three chosen criteria in M3 and M4 Accept a reference to “low temperature” if they specify a correct temperature range or a correct temperature in the range

Question	Marking Guidance	Mark	Comments
10(a)(i)	C	1	
10(a)(ii)	A	1	
10(a)(iii)	D	1	
10(a)(iv)	B	1	
10(b)	**M1** Br_2 ***OR*** bromine (water) ***OR*** bromine (in CCl_4 / organic solvent) **Either order** **M2** cyclohexane ***OR* A** or the alkane: remains orange / red / yellow / brown / the same ***OR*** no reaction ***OR*** reference to colour going to cyclohexane layer **M3** cyclohexene ***OR* D** or the alkene: decolourised / goes colourless / loses its colour **Alternatives** : potassium manganate(VII) **M1** $KMnO_4$ in acid **M2** purple **M3** colourless **M1** $KMnO_4$ in alkali / neutral **M2** purple **M3** brown solid Give appropriate credit for the use of iodine and observations	3	If M1, has no reagent or an incorrect reagent, CE=0 Ignore "acidified" For M1 penalise Br (or incorrect formula of other correct reagent), but mark on For M1, it must be a whole reagent and/or correct formulae If oxidation state given in name, it must be correct. For M2 credit "no change" Ignore "nothing" Ignore "nothing happens" Ignore "no observation" For M3, ignore "goes clear" No credit for combustion observations

10(c)	**M1** acidified potassium or sodium dichromate ***OR*** eg H_2SO_4 / $K_2Cr_2O_7$ ***OR*** H^+/ $K_2Cr_2O_7$ ***OR*** correct combination of formula and name **M2** oxidation ***OR*** oxidised ***OR*** redox **M3** secondary / 2^o (alcohol)	3	For M1, it must be a whole reagent and/or correct formulae If oxidation state given in name, it must be correct. Do not penalise incorrect attempt at formula if name is correct or *vice versa* Credit acidified potassium chromate(VI) / H_2SO_4 + K_2CrO_4
10(d)	**M1** **(**free-) radical substitution (mechanism) **M2** $Br_2 \longrightarrow 2Br\bullet$ **M3** $Br\bullet + CH_4 \longrightarrow \bullet CH_3 + HBr$ **M4** $Br_2 + \bullet CH_3 \longrightarrow CH_3Br + Br\bullet$ **M5 Condition** ultra-violet / uv / sun light ***OR*** high temperature ***OR*** 125 $^oC \leq T \leq$ 600 ^oC ***OR*** 400 K $\leq T \leq$ 870 K	5	M1 both words required Penalise absence of dot once only. Penalise + or – charges every time Accept dot anywhere on methyl radical Accept a correct termination step for 1 mark if neither M3 nor M4 are scored; otherwise ignore termination steps Mark independently NB If Cl_2 is used, penalise every time (this may be for M2,M3 and M4) If cyclohexane is used, penalise every time (this may be for M3 and M4) For M5 ignore “heat”

General principles applied to marking CHEM2 papers by CMI+ January 2012

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

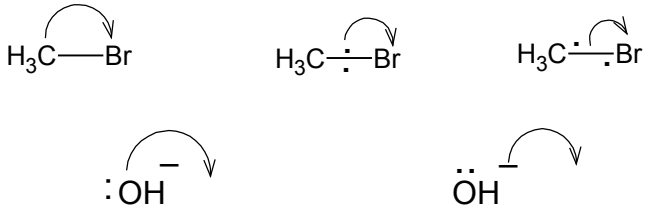
- The sign for an enthalpy change will be assumed to be positive unless specifically shown to be negative.
- A correct answer alone will score **full marks** unless the necessity to show working is specifically required in the question.
- A correct numerical value with the **wrong sign** will usually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

All other values **gain no credit** except

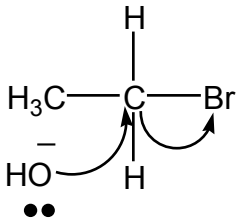
- Two marks can be awarded for correct chemistry with an arithmetic error.
- One mark can be awarded for a correct mathematical statement (or cycle) for the method.

H. <u>Organic reaction mechanisms</u>

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

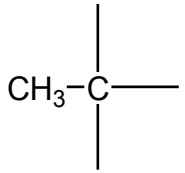
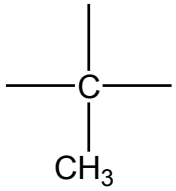
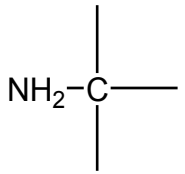
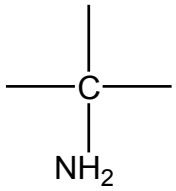
- The absence of a radical dot should be penalised **once only** within a clip.
- The use of double-headed arrows or the incorrect use of half-headed arrows in free-radical mechanisms should be penalised **once only** within a clip

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**