Version 1.0

General Certificate of Education
June 2010

Chemistry CHEM2

Chemistry in Action

Mark Scheme

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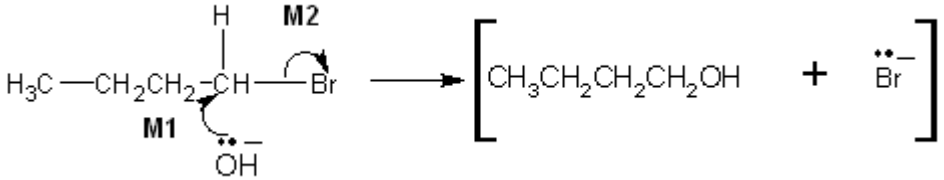
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Q	Part	Sub Part	Marking Guidance	Mark	Comments
1	a	i	**M1** drawn curve <u>starts at reactants</u> and <u>ends at products</u> **M2** curve peak is <u>below</u> the one drawn in the question (and may show one/two humps)	2	Tapered lines into the original curve gain credit for M1 Mark M1 and M2 independently
1	a	ii	Exothermic (reaction)	1	Ignore "ΔH is negative"
1	a	iii	∑ bond (enthalpy) <u>reactants</u> < ∑ bond (enthalpy) <u>products</u> The sum for H_2 and I_2 / reactants is <u>less than / lower than / smaller than</u> the sum for 2HI / products OR The sum for 2HI /products is <u>more than / larger than / bigger than</u> the sum for H_2 and I_2 / reactants	1	Accept "It OR the sum will be <u>smaller</u> or <u>less</u>"
1	a	iv	**M1** p **M2** $-(q-p)$ ***OR*** $p-q$ ***OR*** $-q+p$	2	M2 demands that the sign for an exothermic reaction is part of the outcome mathematically. Ignore case

1	b	i	Increase / speed up / faster (rate of attainment of equilibrium) ***OR*** Increase / speed up / faster rate of <u>both</u> forward <u>and</u> reverse reaction ***OR*** Increase / speed up / faster rate of reaction	1	Credit "It took less time"

1	b	ii	**M1** Increase / speed up / faster (rate of attainment of equilibrium) **M2** <u>More particles / molecules</u> in a <u>given volume / space</u> ***OR*** the <u>particles /</u> <u>molecules</u> are clos<u>er</u> together ***OR*** an increase in concentration. **M3** <u>More / higher chance</u> of <u>successful / effective / productive collisions</u> (between particles) ***OR*** <u>more collisions / higher chance of collisions (of particles) with $E>E_{Act}$</u>	3	If M1 is blank, mark on and credit M1 in the text If M1 is given as "decrease" / "no effect" / "no change" then CE= 0 for clip In M1, if increase <u>both</u> the forward and reverse reaction, but no mention of rate, penalise M1 but mark on. In M1, if increase <u>either</u> forward rate <u>or</u> reverse rate <u>only</u>, then penalise M1 but mark on. Penalise M3 if an increase in the value of E_{Act} / energy of particles is stated. Max 1 for M2 and M3 if reference to "atoms"

Q	Part	Sub Part	Marking Guidance	Mark	Comments
2	a	i	Splitting/ breaking C─ X / bond(s) using / by (adding) / with water ***OR*** Splitting/ breaking the molecule / substance / compound using / by (adding) / with water	1	NOT simply the reaction of / with water NOT simply the addition or adding of water. NOT the "splitting of water" Accept any halogen bond, but penalise other specified bonds
2	a	ii	**M1** yellow ONLY **M2** $Ag^+ + I^- \longrightarrow AgI$ $(Ag^+ I^-)$	2	For M1, penalise cream(y) OR white Ignore pale or light or dark (yellow) For M2, ignore state symbols
2	a	iii	**M1** AgF OR silver fluoride is soluble / dissolves (in water) **M2** No result OR no precipitate OR no (visible) change would occur OR colourless solution	2	Accept "silver flouride" Mark independently Ignore reference to C **–** F bond breakage in M1 Ignore "no reaction" and "nothing"

2	b		The bond that takes <u>less</u> energy to break / the low<u>er</u> bond enthalpy (energy) / weak<u>er</u> bond means the precipitate / reaction / hydrolysis occurs fas<u>ter</u> / quick<u>er</u> /takes <u>less time</u> ***OR*** The bond that takes <u>more</u> energy / the high<u>er</u> bond enthalpy (energy) / strong<u>er</u> bond means the precipitate / reaction / hydrolysis occurs slow<u>er</u>/ takes long<u>er</u> / takes <u>more time</u>	1	Insist on comparative on <u>both</u> bond strength and rate of reaction
2	c	i	An <u>electron pair donor</u> ***OR*** Forms a covalent or co-ordinate or dative bond by <u>donating a pair of electrons</u>	1	Answer must refer to an electron pair. Credit "lone pair" "Attracted" does not equal "donated"
2	c	ii	 **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. **NB The arrows here are double-headed**	2	Penalise M1 if covalent NaOH 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 Award 1 mark only for C-Br bond breakage if **<u>an S_N1 mechanism</u>** is used. Do not penalise the use of "sticks"

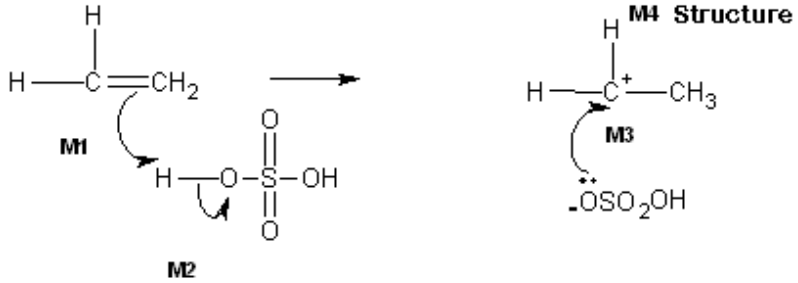
2	d	i	Structure of tertiary carbocation $(CH_3)_3C^+$ or drawn out	1	Insist on a full positive charge on the central C atom. Penalise a bond to the positive charge. Be lenient on vertical C-C bonds
2	d	ii	Tertiary carbocation / carbonium ion (from 2-bromo-2-methylpropane) is more stable (than the primary carbocation / carbonium ion) ***OR*** Primary carbocation / carbonium ion (from 2-bromo-2-methylpropane) is less stable (than the tertiary carbocation / carbonium ion)	1	**QoL** Ignore reference to the alleged relative stability of haloalkanes

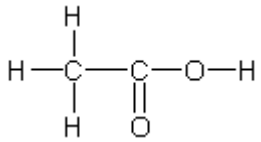
Q	Part	Sub Part	Marking Guidance	Mark	Comments
3	a	i	**4**FeS_2 + **11**O_2 ⟶ **2**Fe_2O_3 + **8**SO_2 **2** **5½** **(1)** **4**	1	Or multiples of this equation
3	a	ii	**M1** **(+) 4** **M2** **– 1**	2	Ignore working M1, credit (+) IV M2, credit – I
3	b		**M1** Lower / smaller / decreases / reduced yield ***OR*** equilibrium shifts (right) to left **M2** **(**Forward) reaction is exothermic OR reverse reaction is endothermic **M3** (By Le Chatelier's principle) equilibrium responds / shifts / moves (R to L) to lower the temperature ***OR*** to absorb the heat ***OR*** to cool the reaction	3	If M1 is blank, mark on and credit M1 in the text. If M1 is incorrect, only credit correct M2 Mark M2 independently – it may be above the arrow in the equation For M3, not simply "to oppose the change / temperature"
3	c		**M1** Fe_2O_3 + **3**CO ⟶ **2**Fe + **3**CO_2 **M2** Reducing agent ***OR*** Reduce(s) (Fe_2O_3 / iron(III) oxide) ***OR*** Electron donor ***OR*** to remove the oxygen (from iron(III) oxide to form CO_2) ***OR*** reductant	2	Or multiples Ignore state symbols For M2, credit "reduction"

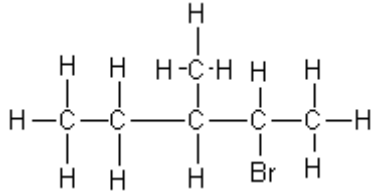
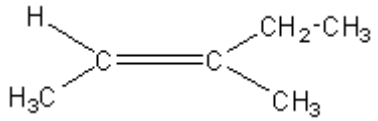
Q	Part	Sub Part	Marking Guidance	Mark	Comments
4	a		The molecular ion is • The molecule with one / an electron knocked off / lost ***OR*** • The molecule with a (single) positive charge ***OR*** • the ion with / it has the largest / highest / biggest m/z (value / ratio) ***OR*** • the ion with / it has an m/z equal to the M_r	1	Ignore the highest or biggest m/z peak Ignore "the peak to the right" Ignore "compound"
4	b	i	2(14.00307) + 15.99491 = 44.00105	1	A sum is needed to show this
4	b	ii	Propane / C_3H_8 and carbon dioxide / CO_2 (and N_2O) or they or both the gases / molecules or all three gases / molecules have an (imprecise) M_r of 44.0 (OR 44) ***OR*** they have the same M_r or molecular mass (to one d.p)	1	This could be shown in a calculation of relative masses for propane and carbon dioxide
4	b	iii	By definition ***OR*** The standard / reference (value / isotope)	1	Ignore "element" Ignore "atom"

4	c	i	**M1 (could be scored by a correct mathematical expression)** $\Delta H = \sum \Delta H_{products} - \sum \Delta H_{reactants}$ OR a correct cycle of balanced equations **M1 and M2 can be scored with correct moles as follows** ΔH + 2(– 46) = +82 +3(– 286) ΔH – 92 = – 776 ΔH = 92 – 776 OR 92 + 82 – 858 **M3** ΔH = **– 684** (kJ mol^{-1}) **(This is worth 3 marks)** **Award 1 mark ONLY for + 684**	3	Full marks for correct answer. Ignore units. Deduct one mark for an arithmetic error.
4	c	ii	The value is quoted at a pressure of 100 kPa OR 1 bar or 10^5 Pa ***OR*** All reactants and products are in their standard states / their normal states at 100 kPa or 1 bar	1	Ignore 1 atmosphere / 101 kPa Ignore "constant pressure"

Q	Part	Sub Part	Marking Guidance	Mark	Comments
5	a		to neutralise stomach acidity ***OR*** as an antacid ***OR*** eases indigestion / heartburn	1	Ignore milk of magnesia Credit suitable reference to indigestion / laxative / relief of constipation
5	b	i	an electron acceptor ***OR*** (readily) gains / accepts / receives electron(s)	1	NOT an electron pair acceptor Ignore removes / takes away / attracts electrons
5	b	ii	Br_2 ONLY	1	Ignore "bromine" Apply the list principle
5	b	iii	$H_2SO_4 + \mathbf{2}H^+ + \mathbf{2}e^- \longrightarrow SO_2 + \mathbf{2}H_2O$ ***OR*** $SO_4^{2-} + \mathbf{4}H^+ + \mathbf{2}e^- \longrightarrow SO_2 + \mathbf{2}H_2O$	1	Ignore state symbols Ignore absence of negative charge on electron Or multiples of equations

5	c	i	(acid) catalyst ***OR*** catalyses (the reaction) ***OR*** to speed up the reaction / increase the rate (of reaction)	1	Ignore "provides H^+ ions" Accept phonetic spelling
5	c	ii	 **M1** must show an arrow from the double bond towards the H atom of the H – O bond OR HO on a compound with molecular formula for H_2SO_4 (or accept H_2SO_3 here) M1 could be to an H+ ion and M2 an independent O – H bond break on a compound with molecular formula for H_2SO_4 or H_2SO_3 **M2** must show the breaking of the O ─ H bond. **M3** must show an arrow from the lone pair of electrons on the correct oxygen of the negatively charged ion towards the positively charged carbon atom. **M4** is for the structure of the carbocation. **NB The arrows here are double-headed**	4	M2 Ignore partial charges unless wrong M3 NOT HSO_4^- For M3, credit <u>as shown</u> or <u>$^-{:}OSO_3H$</u> ONLY with the negative charge anywhere on this ion OR <u>correctly</u> drawn out with the negative charge placed correctly on oxygen Max 3 marks for wrong reactant Do not penalise the use of "sticks"

5	c	iii	Primary ***OR*** 1^{o} (alcohol)	1	
5	c	iv	<u>Displayed formula</u> for ethanoic acid, CH_3COOH 	1	All the bonds must be drawn out and this includes the O ─ H bond Ignore bond angles.

Q	Part	Sub Part	Marking Guidance	Mark	Comments
6	a	i	**3**-bromo-**3**-methylpentane ONLY	1	Must be correct spelling but ignore hyphens and commas
6	a	ii	<u>Electrophilic addition</u> (reaction)	1	Both words needed Accept phonetic spelling
6	a	iii	**M1** Displayed formula of 2-bromo-3-methylpentane  **M2** Position(al) (isomerism)	2	All the bonds must be drawn out but ignore bond angles **Do not forget to award this mark**
6	a	iv	Structure of (E)-3-methylpent-2-ene 	1	The arrangement of groups around the double bond must be clear with the ethyl group attached in the correct order. Ignore bond angles. Accept C_2H_5 for ethyl Be lenient on C ─ C bonds. The main issue here is whether they have drawn an (E) isomer. Accept "sticks" for C ─ H bonds and correct skeletal formula

6	b	i	**M1** **R** is represented by **Spectrum 2** **M2** Spectrum 2 shows an infrared absorption / spike / dip / trough / peak with any value(s) / range within the range 1620 to 1680 (cm^{-1}) OR this range quoted / identified and this is due to C=C OR this information could be a correctly labelled absorption on the spectrum OR Spectrum 1 does not have an infrared absorption in range 1620 to 1680 (cm^{-1}) and does not contain C=C.	2	Award M1 if it is obvious that they are referring to the second spectrum (or the bottom one) M2 depends on a correct M1 Ignore other correctly labelled peaks Ignore reference to "double bond" or "alkene"
6	b	ii	Functional group (isomerism)	1	
6	b	iii	Cyclohexane ***OR*** Methylcyclopentane etc.	1	Named correctly Ignore structures and ignore numbers on the methyl group of methylcyclopentane

Q	Part	Sub Part	Marking Guidance	Mark	Comments
7	a	i	**M1 Initiation** $Cl_2 \longrightarrow 2Cl\bullet$ **M2 First propagation** $Cl\bullet + CH_3CH_3 \longrightarrow \bullet CH_2CH_3 + HCl$ C_2H_6 **M3 Second propagation** $Cl_2 + \bullet CH_2CH_3 \longrightarrow CH_3CH_2Cl + Cl\bullet$ C_2H_5Cl **M4 Termination (must make C_4H_{10})** $2 \bullet CH_2CH_3 \longrightarrow C_4H_{10}$ or $CH_3CH_2CH_2CH_3$	4	Penalise absence of dot once only. Penalise + or – charges <u>every time</u> Penalise incorrect position of dot on ethyl radical once only. Penalise $C_2H_5\bullet$ once only Accept $CH_3CH_2\bullet$ with the radical dot above / below / to the side of <u>the CH_2</u> Mark independently
7	a	ii	**M1** ultra-violet / uv / sun light OR (very) high temperature OR 500 $^oC \geq T \leq 1000\ ^oC$ **M2** (free-)<u>radical substitution</u>	2	Ignore "heat" for M1 Both words needed for M2 For M2, ignore the word "mechanism"
7	b	i	$Cl_2 + H_2O \longrightarrow HClO + HCl$ ***OR*** $Cl_2 + H_2O \longrightarrow 2H^+ + ClO^- + Cl^-$	1	Accept HOCl or ClOH Accept other ionic or mixed representations Ignore state symbols

7	b	ii	**M1** Any one from • in swimming pools • in drinking water • to sterilise / disinfect / sanitise water • in water treatment **M2** The (health) benefit outweighs the risk or wtte OR a clear statement that once it has done its job, little of it remains OR used in (very) dilute concentrations / small amounts / low doses	2	Ignore the manufacture of bleach Ignore "to clean water" Ignore "water purification" Mark independently but M1 can score from (M2) explanation
7	b	iii	Sodium chlorate(I) or sodium hypochlorite	1	Must be named Ignore (in)correct formulae Insist on the (I) in the name
7	c	i	$Cl_2 + \mathbf{2}Br^- \longrightarrow Br_2 + \mathbf{2}Cl^-$	1	Or half this equation Ignore state symbols
7	c	ii	**M1** **The relative size (of the molecules/atoms)** Bromine is larger than chlorine OR has more electrons/electron shells ***OR*** It is larger / It has a larger atomic radius / it is a larger molecule / atom **M2** **How size of the intermolecular force affects energy needed** The forces between bromine / Br_2 molecules are stronger (than the forces between chlorine / Cl_2 molecules leading to more energy needed to separate the molecules) (or converse) ***OR*** bromine / Br_2 has stronger / more (VdW) intermolecular forces. (or converse)	2	For M1 ignore whether it refers to molecules or atoms. CE=0 for reference to (halide) ions Ignore molecular mass **QoL** for clear reference to the difference in size of the force between molecules Penalise M2 if covalent bonds are broken

Q	Part	Sub Part	Marking Guidance	Mark	Comments
8	a		**Three conditions <u>in any order</u> for M1 to M3** **M1** yeast or zymase **M2** $30^{o}C \geq T \leq 42\ ^{o}C$ **M3** anaerobic / no oxygen / no air OR neutral pH **M4** $C_6H_{12}O_6 \longrightarrow \mathbf{2}C_2H_5OH + \mathbf{2}CO_2$ OR $\mathbf{2}C_6H_{12}O_6 \longrightarrow \mathbf{4}C_2H_5OH + \mathbf{4}CO_2$	4	Mark independently Penalise “bacteria” and “phosphoric acid” using the list principle Ignore reference to “aqueous” or “water” (i.e. not part of the list principle) Or other multiples
8	b		**M1** Carbon-neutral **M2** <u>6 (mol / molecules) CO_2 / carbon dioxide taken in / used / used up</u> (to form glucose or in photosynthesis) **M3** <u>6 (mol / molecules) CO_2 / carbon dioxide</u> given out <u>due to **2** (mol / molecules) CO_2 / carbon dioxide from fermentation / Process 2 and **4** (mol / molecules) CO_2 / carbon dioxide from combustion / Process 3</u>	1 1 1	Ignore “biofuel” It is NOT sufficient in M2 and M3 for equations alone without commentary or annotation or calculation

8	c		**M1** **(could be scored by a correct mathematical expression)** (Sum of) bonds broken – (Sum of) bonds made / formed = Δ*H* ***OR*** (∑) $B_{reactants}$ – (∑) $B_{products}$ = Δ*H* (where B = bond enthalpy / bond energy) **M2** Reactants = (+) 4719 ***OR*** Products = (–) 5750 **M3** Overall + 4719 –5750 = **–1031** ($kJmol^{-1}$) **(This is worth 3 marks)** **Award 1 mark ONLY for +1031** Candidates may use a cycle and gain full marks. **M4** Mean bond enthalpies are not specific for this reaction ***OR*** they are average values from many different compounds / molecules	3 1	For M1 there must be a correct mathematical expression using ΔH or "enthalpy change" Award full marks for correct answer. Ignore units. M2 is for either value underlined M3 is NOT consequential on M2 **Do not forget to award this mark**

8	d		**M1** q = m c ΔT (this mark for correct mathematical formula) **M2** = 6688 (J) OR 6.688 (kJ) OR 6.69 (kJ) OR 6.7 (kJ) **M3** 0.46g is 0.01 mol therefore ΔH = **– 669** $kJmol^{-1}$ OR **– 670** $kJmol^{-1}$ OR **– 668.8** $kJmol^{-1}$ **M4** Incomplete combustion	4	Award M1, M2 and M3 for correct answer to the calculation Penalise M3 ONLY if correct answer but sign is incorrect In M1, do not penalise incorrect cases in the formula If m = 0.46 or m = 200.46 OR if ΔT = 281, CE and penalise M2 and M3 If c = 4.81 (leads to 7696) penalise M2 ONLY and mark on for M3 = – 769.6 OR – 770 Ignore incorrect units in M2 **Do not forget to award this mark. Mark independently**

Q	Part	Sub Part	Marking Guidance	Mark	Comments
9	a		**M1** The yield of zinc oxide <u>increases / greater</u> **M2** Removal of the carbon dioxide results in the **<u>equilibrium</u>** **Either** Shifting / moving / goes <u>to the right</u> shifting / moving / goes <u>L to R</u> <u>favours the forward reaction / towards the products</u> **M3** (By Le Chatelier's principle) the reaction/equilibrium will respond so as <u>to replace the CO_2 / lost product</u> OR <u>to make more CO_2</u> OR <u>to increase concentration of CO_2</u>	3	If M1 is given as "decrease" OR "no effect" then CE= 0 For M3, not simply "to oppose the change / to oppose the loss of CO_2 / to oppose the removal of carbon dioxide."
9	b		**M1** Process 2 produces / releases SO_2 ***OR*** Process 2 produces / releases CO **M2** It / Process 3 avoids the release of SO_2 OR CO ***OR*** It / Process 3 (captures and) converts SO_2 to H_2SO_4 **M3** SO_2 causes acid rain OR is toxic / poisonous ***OR*** CO is toxic / poisonous	3	Ignore "global warming" and "greenhouse gases" and "the ozone layer" If both CO and SO_2 claimed to form acid rain, treat as contradiction
9	c		**M1** Process 3 (is expensive because it) uses <u>electrolysis</u> OR due to high <u>electricity / electrical</u> consumption **M2** this is justified because the product / zinc is pure	2	Ignore "energy" Penalise "pur<u>er</u>"

9	d		**M1** $Zn^{2+} + 2e^- \longrightarrow Zn$ **M2** the negative electrode OR the cathode	2	Ignore state symbols Ignore absence of negative charge on electron Accept electrons subtracted from RHS
9	e		**M1** The reaction of ZnO with sulfuric acid ***OR*** the second reaction in Extraction process 3 **M2** neutralisation or acid-base OR alternatively **M1** The reaction of zinc carbonate in Extraction process 1 **M2** (thermal) decomposition **M3** It / carbon is <u>oxidised / gains oxygen / changes oxidation state / number from 0 to +2 / increase in oxidation state / number</u> in Process 2	3	M1 could be the equation written out in both cases M2 depends on correct M1 **Do not forget to award this mark** Ignore reference to electron loss but penalise electron gain Ignore “carbon is a reducing agent”

9	f		**M1** $Zn + H_2O \longrightarrow ZnO + H_2$ **M2** <u>Zinc oxide and hydrogen</u> OR as an alternative **M1** $Zn + 2H_2O \longrightarrow Zn(OH)_2 + H_2$ **M2** <u>Zinc hydroxide and hydrogen</u>	2	Mark independently If ZnO_2 is given for zinc oxide in the equation, penalise M1 and mark on If ZnOH is given for zinc hydroxide in the equation, penalise M1 and mark on Ignore state symbols Credit multiples of the equation If M1 is blank, either of the M2 answers could score To gain <u>both</u> marks, the names must match the correct equation given.

General principles applied to marking CHEM2 papers by CMI+ June 2010

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**.

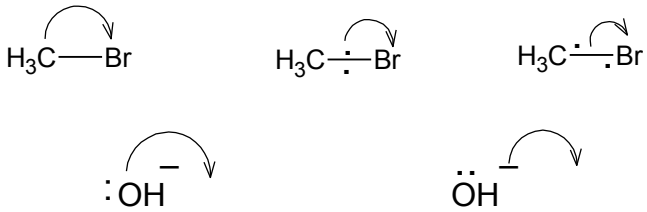
All other values **gain no credit** except

- 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.

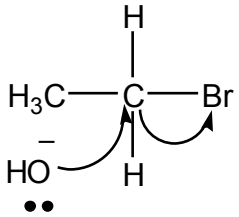
H. Organic reaction mechanisms

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

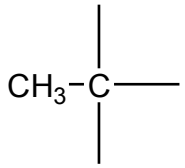
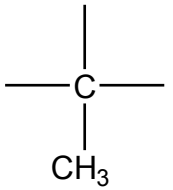
In mass spectrometry fragmentation equations, the absence of a radical dot on the molecular ion and on the free-radical fragment would be considered to be two independent errors and both would be penalised if they occurred within the same clip.

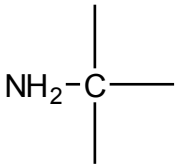
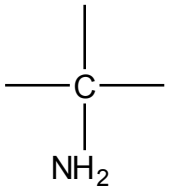
I. Organic structures

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 <u>may</u> 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**