CAMBRIDGE
International Education

Cambridge International AS & A Level

CHEMISTRY **9701/23**

Paper 2 AS Level Structured Questions **May/June 2026**

MARK SCHEME

Maximum Mark: 60

Published

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

This document consists of **19** printed pages.

[Turn over

General marking principles

All examiners must apply these marking principles when marking candidate responses.

1	Examiners must award marks for each response in line with: • the specific **content** defined in the mark scheme • the specific **skills** defined in the mark scheme or in the level descriptions • the **standard of response** required as exemplified by the standardisation scripts.
2	Examiners must award **whole marks** (not half marks, or other fractions).
3	Examiners must award marks **positively**. This means that: • marks are not deducted for errors or omissions • marks are awarded for correct/valid answers as defined in the mark scheme and also for **other valid answers** which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate • the quality of spelling, punctuation and grammar are judged **only** when the mark scheme indicates that these features are **specifically assessed** in the question. However, the meaning of all responses must be unambiguous.
4	Examiners must **consistently** apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly.
5	Examiners must use the **full range of marks** defined in the mark scheme, unless limited by the quality of the candidate responses seen.
6	Examiners must award marks according to the mark scheme and **must not** award marks with grade thresholds or grade descriptions in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	Correct point **or** mark awarded
	Incorrect point **or** mark not awarded
	Unclear
	Information missing or insufficient for credit
	Benefit of the doubt given
	Contradiction in response otherwise markworthy, mark not given
	Part of the correct answer has been seen. Full credit has not been awarded.
	Error carried forward applied
	Incorrect or insufficient point ignored while marking the rest of the response
	Rounding error

Annotation	Meaning
REP	Repetition
SEEN	Blank page **or** part of script seen
SF	Error in number of significant figures
TE	Transcription error

Mark scheme abbreviations

R	reject the response
A	accept the response
I	ignore the response
ecf	error carried forward
BOD	benefit of doubt given
ora	or reverse argument
owtte	or words to that extent
underline	actual word given must be used by candidate (grammatical variants excepted)
( )	the word / phrase in brackets is not required but sets the context
max	indicates the maximum number of marks that can be given
M	marking point

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1(a)(i)</td><td>
<table>
<tr><th>element</th><th>formula of chloride</th><th>type of bonding</th><th>type of reaction, if any of the chloride with cold water</th></tr>
<tr><td>sodium</td><td>NaCl</td><td>ionic</td><td>no reaction / none
A dissolves / dissociates / dissolution</td></tr>
<tr><td>silicon</td><td>$SiCl_4$</td><td>covalent</td><td>hydrolysis
R hydration</td></tr>
</table>
</td><td>**3**</td><td>•✓•✓•✓

I giant / molecular in ‘bonding’</td></tr>
<tr><td>1(a)(ii)</td><td>$PCl_5 + 4\,H_2O \rightarrow H_3PO_4 + 5\,HCl$</td><td>**1**</td><td>**I** $PCl_5 + H_2O \rightarrow POCl_3 + 2\,HCl$</td></tr>
<tr><td>1(b)(i)</td><td>$Cl_2 + H_2O \rightarrow HCl + HOCl$</td><td>**1**</td><td>**A** $Cl_2 + H_2O \rightarrow 2H^+ + Cl^- + OCl^-$</td></tr>
<tr><td>1(b)(ii)</td><td>($HOCl$ **AND** / **OR** ClO^-) kill bacteria</td><td>**1**</td><td>chloric(I)acid / hypochlorous acid = $HOCl$
ClO^- = chlorate(I)
I chlorine / Cl_2
A ecf product(s) of the reaction kill bacteria if 1b(i) correct
A microbes / microorganisms / microbes
BOD pathogens
I viruses
A ‘destroys’ for kills
I sterilises / harms / removes</td></tr>
<tr><td>1(c)(i)</td><td>$Cl_2 > Br_2 > I_2$
OR
oxidising power decreases down the group.</td><td>**1**</td><td>**A** relative reactivity for relative oxidising power
I attempted explanations</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1(c)(ii)</td><td>
<table>
<tr><th>aqueous halogen</th><th>colour of aqueous halogen</th><th>appearance after NaBr(aq) is added</th><th>identity of halide ions present in mixture after the reaction</th></tr>
<tr><td>Cl_2(aq)</td><td>pale green</td><td>orange / brown
A yellow alone
R red-brown</td><td>Cl^- (and Br^-)</td></tr>
<tr><td>I_2(aq)</td><td>red-brown</td><td>pale(r) (red-brown)
A (paler) red-brown
A no change</td><td>Br^-</td></tr>
</table>
</td><td>3</td><td>•✓✓✓

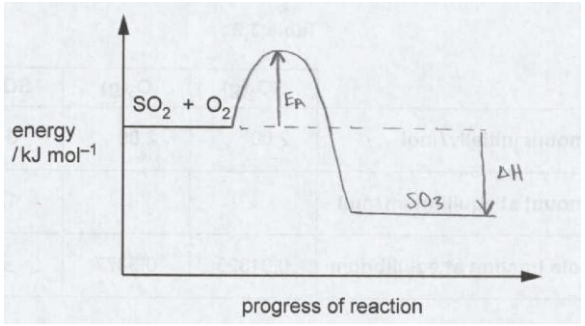
M1 shade of brown on addition NaBr to Cl_2 must be different to that when it is added to I_2

e.g. orange in test-tube with Cl_2 AND brown in test-tube with I_2 then BOD ‘brown’</td></tr>
<tr><td>1(d)</td><td>**M1** (after addition of Ag^+(aq))……(pale) yellow precipitate

M2 (after addition of NH_3(aq))……precipitate remains / precipitate does not dissolve / precipitate does not disappear</td><td>2</td><td>precipitate = ppt(e) = crystals = powder = (insoluble) solid
M1 I shades
R any other colour
M2 A no change / no reaction / no visible change if ppt seen in **M1**
M2 A insoluble (if ppt given in **M1**)
M2 A yellow ppt if yellow ppt seen in **M1**
M2 A precipitate is insoluble
M2 A ecf ppt remains on incorrect colour ppt in **M1**
M2 BOD ‘no observation’
M2 I colour of **M1** precipitate
M2 I ‘no reaction’</td></tr>
</table>

Question	Answer	Marks	Guidance
2(a)	(down the group) **M1** (atomic radius) increases **OR** (atom) volume increases **OR** Ne < Ar < Kr < Xe **M2** (down the group) the number of shells (of electrons) increases	**2**	shells = energy levels **I** number of sub-shells increases **I** nuclear attraction of outer electron decreases **I** increased shielding effect outweighs the increase in nuclear charge **I** outer electron further way
2(b)	**M1** neon / Ne (most like an ideal gas) **M2** it has the smallest volume **M3** weakest vdw / temporary dipole – induced dipole attractions / London (dispersion) forces / London forces	**3**	**M2** and **M3** comparative term required once only e.g. Ne has smaller volume and weak vdw **M2 BOD** 'it is the smallest (atom)' **M2 I** mass **BOD** molecules for atoms intermolecular forces / IMF's = vdw **M3 BOD** least for weakest **M3 A** 'forces of attraction between atoms' **I** smallest number of electrons

Question	Answer	Marks	Guidance
2(c)	**M1** PV=nRT **M2** use of appropriate pressure value with volume e.g. convert volume to m^3 and kPa to Pa OR $101 \times 617.0 \times 10^{-3}$ etc. **M3** calculate value for n $n = (101\,000 \times 617.0 \times 10^{-6}) \div 8.31 \times 300$ = 0.024997 / 0.025 **M4** (1.775 / M_r(X) = 0.02499 / 0.025) M_r = 71(.0)	**4**	Final answer 71(.0) ✓✓✓✓ **M1 I** subsequent incorrect rearrangement **M2 A** from calculations which produce consistent conversion for volume and pressure ie 101 and 617(.0) $\times 10^{-3}$ (**I** ref to units for volume & pressure even if incorrect) **M3** & **M4 A** ecf from incorrect conversion of volume and / or pressure units **M3 A** ecf from transcription errors / incorrect T using correct manipulation of PV=nRT **M4 A** ecf from number of moles calculated **M4 A** ecf from M3 **I** units

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3(a)</td><td> 

correct shape profile
arrow label ΔH from reactant line to product line
arrow label E_A (from reactant line to maximum on hump)
•✓✓</td><td>2</td><td>max 1 endothermic profile with correct labels & arrows for E_A and / or ΔH

ΔH single headed arrows used in correct direction only.
A E_A shown as a double headed arrow
BOD vertical line

A half-headed arrows
A ‘square’ humps
I missing products / incorrect labels on product line
I ‘–‘ sign on $-\Delta H$

BOD poorly represented lines / arrows if approximate position and length (and direction) is correct</td></tr>
<tr><td>3(b)</td><td>M1 (if a change in conditions occurs) the equilibrium shifts

M2 to minimise the change (in conditions)</td><td>2</td><td>M1 A equilibrium moves / equilibrium changes
M1 I there will be a ‘change in the system’
M2 minimise = oppose = counteract = resists = reverse</td></tr>
<tr><td>3(c)</td><td><table><tr><th></th><th>use temp. greater than 450°C</th><th>without a catalyst</th></tr><tr><td>effect on value of equilibrium constant, K_p</td><td>decreases</td><td>no change</td></tr><tr><td>effect on yield of product at equilibrium</td><td>decreases</td><td>no change</td></tr><tr><td>effect on rate of reaction</td><td>increases</td><td>decreases</td></tr></table>•✓•✓•✓</td><td>3</td><td>All independent including K_p and yield marks</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3(d)(i)</td><td>
<table>
<tr><th></th><th>$SO_2(g)$</th><th>$O_2(g)$</th><th>$SO_3(g)$</th></tr>
<tr><td>amount initially / mol</td><td>2</td><td>2</td><td>0</td></tr>
<tr><td>amount at equilibrium / mol</td><td>M1 0.04(0)</td><td>M2 (2-0.98) = 1.02</td><td>1.96</td></tr>
<tr><td>mol fraction at equilibrium</td><td>0.01325</td><td>0.3377</td><td>M3 (1.96 / 3.02) = 0.649(007)</td></tr>
</table>
</td><td>3</td><td>Independent marks

If M3 not 0.649 look to see if ecf from M1 and / or M2

M3 A 0.649 / 0.65

M3 A ecf from M1 and / or M2

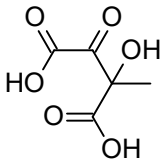
M3 A 1 – (0.01325 + 0.3377) = 0.649(05)</td></tr>
</table>

Question	Answer	Marks	Guidance
3(d)(ii)	$\frac{(0.621 \times 200)(0.621 \times 200)}{(0.360 \times 200)(0.360 \times 200)(0.019 \times 200)}$ = 0.783(1) kPa^{-1} **OR** 7.83(1) × 10^{-4} Pa^{-1} ✓✓✓ **M1** correct expression for K_p using numerical values **M2** correct value for K_p. **M3** kPa^{-1}	**3**	0.783(1) kPa^{-1} ✓✓✓ 7.83(1) × 10^{-4} Pa^{-1} ✓✓✓ **M1 I** use of [ ] for ( ) **M2 A** ecf from **M1** for transcription errors of mol fraction values **M2 A** ecf from **M1** for inverted expression i.e. $\frac{0.360 \times 200)(0.360 \times 200)(0.019 \times 200}{(0.621 \times 200)(0.621 \times 200)}$ = 1.27(7) **AND M3** kPa **M3 A** kPa^{-1} if no expression / incorrect K_p expression **M3 A** ecf for appropriate units based on incorrect expression for K_p **M3 A** 'no unit' if expression used involved no reference to 200kPa and only mol fraction (= 156.6) **M3 A** Pa^{-1} if calculation is based on conversion of kPa to Pa i.e. 7.83(1) × 10^{-4} Pa^{-1} ✓✓✓ **I** 1 / kPa **I** $K_p = (ppSO3)^2 \div (ppSO_2)^2 \times (ppO_2)$

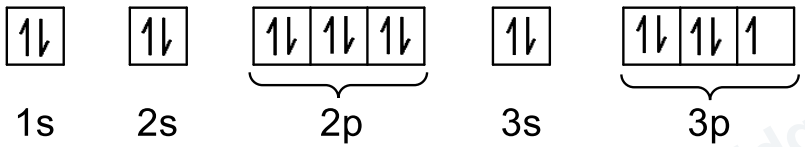
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4(a)(i)</td><td>
<table>
<tr><th></th><th>primary hydroxy groups</th><th>secondary hydroxy groups</th><th>tertiary hydroxy groups</th></tr>
<tr><td>number of groups in one molecule of V</td><td>2</td><td>1</td><td>1</td></tr>
</table>
</td><td>2</td><td>•✓✓</td></tr>
<tr><td>4(a)(ii)</td><td>
<table>
<tr><th>reagent</th><th>observation with V</th></tr>
<tr><td>Na(s)</td><td>M1 effervescence / fizzing / bubbling</td></tr>
<tr><td>2,4-dinitrophenylhydrazine (2,4-DNPH)</td><td>M2 none</td></tr>
<tr><td>Fehling’s reagent</td><td>none</td></tr>
</table>
</td><td>2</td><td>M1 I gas produced
M1 I identity of gas
M1 I test for gas
M1 I solid disappears / dissolves OR colourless solution
M1 I solid made

M2 A (remains) orange (solution) / no precipitate / no reaction / no observation
I turns orange</td></tr>
</table>

Question	Answer	Marks	Guidance
4(a)(iii)	Alcohols / Compound **V** are / is not oxidised by Fehling's reagent (aldehydes are oxidised by Fehling's reagent) **OR** Aldehydes are oxidised by Fehling's reagent (alcohols / Compound **V** are / is not oxidised by Fehling's reagent)	**1**	**A** for alcohol groups = hydroxy = hydroxyl = OH group **R** for alcohol groups = hydroxide / OH^- group **A** alcohol groups are not a strong enough reducing agent (to reduce Fehling's) **A** Fehling's reagent is not a strong enough oxidising agent to oxidise the alcohol groups **A** Fehling's is a strong enough oxidising agent to oxidise aldehydes **A** Fehling's is too mild to oxidise alcohols **A** Fehling's is not reduced by **V** / alcohols **A** Fehling's is reduced by aldehydes **I** Fehling's is a mild oxidising agent (unqualified) **I** aldehydes are easier to oxidise than alcohols **I** compound **V** has no aldehyde functional groups. **I** reacts with Fehling's **I** carbonyl **R** ketones are oxidised by Fehling's
4(b)(i)	(colour of mixture at start of the reaction) ……orange (colour of mixture after the reaction) ……green	**1**	**A** any shade of orange at start **A** after reaction any shade of green **BOD** blue / grey for green **BOD** brown for green (dichromate is in excess)

Question	Answer	Marks	Guidance
4(b)(ii)	 **OR** (HOOC)C=OC(COOH)(OH)CH_3	**1**	**A** any unambiguous structure **I** connectivity
4(c)(i)	**M1** (molecules / isomers with) the same molecular formula / same number of atoms of each element **M2** different arrangement of atoms	**2**	**A** similar = same **M1 A** same molecular formula **I** same chemical formulas **I** same / similar molecular number **M2 A** different structures **M2 A** different structural formulas / different displayed formulas / different skeletal formulas **I** arrangement of bonds / different arrangements in space **I** different carbon skeleton / functional groups / chain

Question	Answer	Marks	Guidance
4(c)(ii)	**M1** compound **W AND** compound **V** **M2** both have (2) chiral centres / (2) asymmetric carbon atoms	**2**	**M1** compound **W AND** compound **V** ✓**M2** one or two chiral centre on **V** & **W** ✓ **M1** compound **V OR** compound **W M2** show one or two chiral centre on the isomer identified ^✓ **R** molecules / compounds for atoms / groups **R** C attached to 4 different alkyl groups **M2 A** they have a chiral centre / an asymmetric carbon (atom) chiral = 4 different groups / atoms bonded to a carbon **M2** may be indicated by annotation on Figure 4.2 e.g. $CH_2OHCH_2{}^*CH(OH)$ and / or $^*CH(OH)CH_2OH$
4(c)(iii)	methanoic acid	**1**	**A** formic acid
4(d)(i)	(isomer) **Y**	**1**	**A** the structure of isomer **Y**
4(d)(ii)	$3\ C_5H_{12}O_4 + \mathbf{8}\ Cr_2O_7^{2-} + \mathbf{64}\ H^+ \rightarrow 3\ C_5H_4O_8 + \mathbf{16}\ Cr^{3+} + \mathbf{44}\ H_2O$	**1**	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>5(a)(i)</td><td>
<table>
<tr><th>structure of product</th><th>systematic name of product</th></tr>
<tr><td>$CH_3(CH_2)_2Cl$</td><td>1 chloropropane</td></tr>
<tr><td>CH_3CHCl/CH_3</td><td>2-chloropropane</td></tr>
<tr><td>$(CH_3)_2CHCH(CH_3)_2$</td><td>2,4-dimethylbutane</td></tr>
<tr><td>$CH_3(CH_2)_4CH_3$</td><td>hexane</td></tr>
<tr><td>$CH_3(CH_2)_2CH(CH_3)_2$</td><td>2-methylpentane</td></tr>
</table>
</td><td>2</td><td>A any unambiguous structures</td></tr>
<tr><td>5(a)(ii)</td><td>free-radical substitution</td><td>1</td><td></td></tr>
<tr><td>5(b)(i)</td><td> 
</td><td>1</td><td>A any arrangement of 2 pairs and one single electron in 3 p
A double headed arrows.</td></tr>
<tr><td>5(b)(ii)</td><td>M1 $CH_3CH_2CH_3 + {\bullet}Cl \rightarrow {\bullet}CH_2CH_2CH_3 + HCl$

M2 ${\bullet}CH_2CH_2CH_3 + Cl_2 \rightarrow CH_3CH_2CH_2Cl + {\bullet}Cl$</td><td>2</td><td>M1 I $\bullet C_3H_7$
M1 R $CH_3\bullet CHCH_3$

I position of the dot
I absence of the dot

M2 A alkyl radical as $\bullet C_3H_7$ or $CH_3\bullet CHCH_3$</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>5(b)(iii)</td><td>M1 $CH_3CH_2CH_3 + \bullet Cl \rightarrow CH_3\bullet CHCH_3 + HCl$

M2 $2\,CH_3\bullet CHCH_3 \rightarrow (CH_3)_2CHCH(CH_3)_2$</td><td>2</td><td>A radicals with or without •

$(CH_3)_2CH\bullet = CH_3\bullet CHCH_3$

M1 A C_3H_7 for CH_3CHCH_3

M1 R $\bullet CH_2CH_2CH_3$
I position of the dot

M2 I alkyl radical as $\bullet C_3H_7$
M2 R $\bullet CH_2CH_2CH_3$</td></tr>
<tr><td>5(c)(i)</td><td>M1 two Cl isotopes

M2 ^{35}Cl is 3 times more abundant than ^{37}Cl</td><td>2</td><td>M1 A (2) different Cl isotopes
M1 BOD peaks are the isotopes of Cl
75% ^{35}Cl and 25% ^{37}Cl✓✓
^{35}Cl is 3 times more abundant than ^{37}Cl ✓✓
^{35}Cl is more abundant than ^{37}Cl ✓^
^{35}Cl : ^{37}Cl is 3 : 1 ✓✓</td></tr>
<tr><td>5(c)(ii)</td><td><table><tr><th>m / e value of peak</th><th>molecular formula of species responsible for peak</th></tr><tr><td>84</td><td>$(CH_2{}^{35}Cl_2)^+$ BOD $(C^{37}Cl{}^{35}Cl)^+$</td></tr><tr><td>86</td><td>$(CH_2{}^{35}Cl{}^{37}Cl)^+$ BOD $(C^{37}Cl_2)^+$</td></tr><tr><td>88</td><td>$(CH_2{}^{37}Cl_2)^+$</td></tr></table>•✓✓</td><td>2</td><td>max 1 for $(CH_2{}^{35}Cl_2)$ $(CH_2{}^{35}Cl{}^{37}Cl)$ $(CH_2{}^{37}Cl_2)$ … i.e. all else correct but no charge OR negative charge OR shown as free radicals
I lack of brackets
I dots
I position of positive charge</td></tr>
</table>