Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/22**

Paper 2 AS Structured Questions **October/November 2021**

MARK SCHEME

Maximum Mark: 60

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

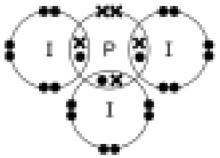
GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

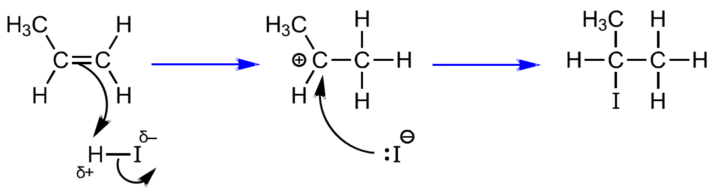
Science-Specific Marking Principles

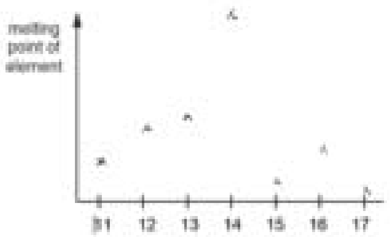
1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit 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	<u>‘List rule’ guidance</u> 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.

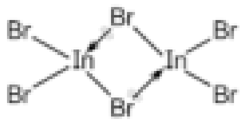
6	Calculation specific guidance Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'. For questions in which the number of significant figures required is not stated, credit should be awarded for 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.

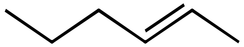
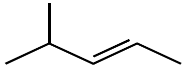
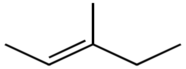
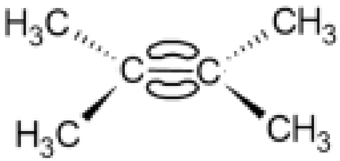
Question	Answer	Marks
1(a)(i)	**M1** (HI / I / iodine / hydrogen iodide has a) greater number of electrons **M2** greater induced dipoles (between molecules)	**2**
1(a)(ii)	**M1** bar at HF shows any boiling point above HI on graph **M2** *explanation of difference in boiling point of a sample of HF in terms of strength* (sum of) hydrogen bonds (and induced dipoles in HF) are **stronger** than (sum of) induced dipoles (and permanent dipoles in HCl / HBr / HI)	**2**
1(b)	(enthalpy / energy change) when one mole of a compound is formed from its elements in their standard states	**2**
1(c)(i)	$K_p = \frac{p\mathrm{HI}^2}{p\mathrm{H}_2\ \ p\,\mathrm{I}_2}$	**1**
1(c)(ii)	28.76 **OR** 28.8 **OR** 29	**1**
1(c)(iii)	**EITHER** **option 1** which assumes $\Delta H_{reaction}$ *is (still) endothermic (using the value shown in (b)).* **M1** (K_p) decreases **AND** endothermic / $\Delta H_{(f)}$ = + / positive **M2** reaction favours formation of reactants / hydrogen and iodine OR (product) yield / partial pressure of HI decreases / equilibrium shifts to the left **OR** **option 2** which realises that $\Delta H_{reaction}$ *is in fact exothermic (using bond energy data in Data Booklet)* **M1** (K_p) increases **AND** exothermic / $\Delta H_{(f)}$ = + / negative **M2** reaction favours formation of products / hydrogen iodide yield increases / partial pressure of HI increases / equilibrium shifts to the right	**2**
1(d)(i)	$4HI + O_2 \rightarrow 2I_2 + 2H_2O$	**1**

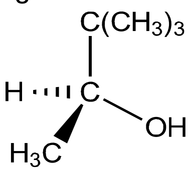
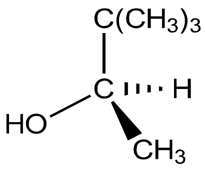
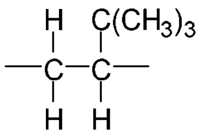
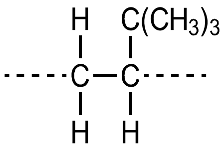
Question	Answer	Marks
1(d)(ii)	**M1** I / iodine (increases) oxidation number –1 → 0 so oxidation / is oxidised **OR** HI / is oxidised as I (increases) oxidation number –1 → 0 **M2** O (decreases) oxidation number 0 → –2 so reduction / is reduced	**2**
1(e)	**M1** pressure increases **M2** (pressure goes up as) number of moles/molecules increases in ratio 3 (gas) reactants to 5 (gas) products **OR** pressure is (directly) proportional to number of moles/molecules	**2**
1(f)(i)	 **M1** correct bonding pairs **M2** correct number of remaining outer electrons on each atom	**2**
1(f)(ii)	hydrolysis	**1**
1(f)(iii)	proton donor / H^+ donor fully dissociates / fully ionises	**2**
1(f)(iv)	$H_2PO_3^-$	**1**
1(g)(i)	**M1** 2-iodopropane – formed from a (more) stable (secondary) (carbo)cation/intermediate **M2** (because of) greater (positive) inductive effect / (+)I of two alkyl groups **OR** (because of positive) inductive effect / (+)I of more R / more methyl / more alkyl groups	**2**

Question	Answer	Marks
1(g)(ii)	 **M1** curly arrow from = of C=C to H **AND** curly arrow from bond of H—I to I **M2** curly arrow from lone pair of I^- to $C^{(+)}$ of their intermediate **M3** correct carbocation **AND** product for 2-iodopropane	**3**

Question	Answer	Marks
2(a)(i)	M | M | M | C | C | C | C	**1**
2(a)(ii)	All 3 points correct scores two marks Any 2 points scores one mark • *nuclear charge increases OR increasing proton number* e.g. 17 / Cl has a greater nuclear charge • *describe the similarity in shielding between the two elements* e.g. they have almost the same shielding • *describe the overall effect in terms of greater nuclear attraction for (outer) electrons* e.g. (outer) electrons are attracted more (strongly) to the nucleus	**2**
2(a)(iii)	**M1** describes the difference between 1st IE of elements 15 and 16 (P and S) in terms of either: spin-pair repulsion (in element 16 / S) **OR** electron pair repulsion (in element 16 / S) **M2** describes the location of the electron pair in the (3)p orbital which repel each other	**2**
2(a)(iv)	(+)1 | (+)2 | (+)3 | (+)4 | (+)5 | (+)6	**1**
2(a)(v)	**M1** (anions have) same number of electrons (but increasing proton number) **M2** increasing proton number / nuclear charge AND increasing attraction of nucleus for (outer) electrons **OR** (outer) electrons attracted more (strongly) to the nucleus AND because of increasing proton number / nuclear charge	**2**
2(b)		**2**

Question	Answer	Marks
2(c)	**M1** density of $_{13}Al$: value within range 2.5–5.0 (g cm^{-3}) **M2** cationic radius of $_{31}Ga$: value within range 0.055–0.075 (nm) **M3** boiling point of $_{49}In$: value within range 1500–2300 (K)	3
2(d)(i)	$InCl_3$	1
2(d)(ii)	$In_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaIn(OH)_4$	1
2(d)(iii)	 **M1** correct connectivity of In_2Br_6 **M2** showing the two correct dative covalent bonds	2

Question	Answer	Marks
3(a)	(2,3-)dimethylbut-2-ene	**1**
3(b)	 OR  OR  OR 	**1**
3(c)(i)		**1**
3(c)(ii)	sp^2	**1**
3(d)(i)	cold dilute acidified potassium manganate(VII)	**1**
3(d)(ii)	**M1** (2,4-DNPH will produce a) red / orange / yellow precipitate **M2 V** has a carbonyl group	**2**
3(d)(iii)	**M1** C—O in range 1040–1300 (cm^{-1}) **M2** C=O in range 1670–1740 (cm^{-1})	**2**
3(e)(i)	yellow precipitate	**1**
3(e)(ii)	Iodine / I_2	**1**
3(e)(iii)	$C_6H_{12}O$ + 2[H] $\rightarrow$ $C_6H_{14}O$	**1**

Question	Answer	Marks
3(e)(iv)	Draw two optical isomers of X. eg  OR  **M1** *One correct 3-dimensional representation of X* **M2** *3-d structure which represents the enantiomer of their X*	**1** **1**
3(e)(v)	heat **AND** concentrated H_2SO_4 / concentrated H_3PO_4 / concentrated sulfuric [(VI)] acid / concentrated phosphoric[(V)] acid	**1**
3(e)(vi)	 OR 	**1**
3(e)(vii)	high activation energy	**1**