Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/23**

Paper 2 AS Level Structured Questions **May/June 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 May/June 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	<u>Calculation specific guidance</u> 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	<u>Guidance for chemical equations</u> 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)	increases	1
1(a)(ii)	chlorine gas bromine liquid iodine solid	1
1(b)	**M1** observation with Cl_2(aq) (colourless / pale green to) orange / brown	1
	M2 observation with I_2(aq) no visible change	1
	M3 explanation chlorine is a stronger oxidising agent (than bromine) AND iodine is a weaker oxidising agent	1
1(c)	$Cl_2 + 2NaOH \rightarrow NaCl + NaClO + H_2O$	1
1(d)(i)	proton / H^+ acceptor	1
1(d)(ii)	$ClO^- + H_2O \rightarrow HClO + OH^-$	1
1(e)	**M1** *Use volume O_2 to express / find no mol O_2 produced* 24 / 24 000 mol O_2 produced = 1×10^{-3} (mol)	1
	M2 *Use 1:1 ratio to deduce no mol NaClO in 1000 cm^3 sample* M1 $\times$ 1000 / 5 = 0.2 (mol dm^{-3})	1
	M3 *Use amount of NaClO and its molecular mass (74.5) to find the mass of NaClO added* $^{-}$24 / 24 000 $\times$ 1000 / 5 $\times$ 74.5 = 14.9 (g dm^{-3})	1
1(f)	**M1** products contain Cl^- AND Cl_2	1
	M2 correct balanced equation $ClO^- + 2HCl \rightarrow Cl^- + H_2O + Cl_2$	1

Question	Answer	Marks
2(a)	**M1** H-bond between an O and an H in OH groups in water and methanol molecules	1
	M2 minimum three partial charges (in sequence) over one water and one methanol molecule, *i.e.*:	1
	M3 either $^{\delta-}$O—H$^{\delta+}$- - - - $^{\delta-}$O or H$^{\delta+}$- - - - $^{\delta-}$O—H$^{\delta+}$ lone pair of electrons on O of H-bond, in line with H-bond	1
2(b)(i)	**M1** (methanol) gas (particles / molecules) in equilibrium with liquid	1
	M2 (methanol) gas (particles) exert a pressure (on the walls of a container / on the surface of the liquid)	1
2(b)(ii)	(liquid) particles (at the surface) have enough energy (to overcome attractive forces / evaporate / to become a vapour)	1
2(b)(iii)	**M1** (liquid) H_2O molecules are held by stronger **hydrogen bonding** **OR** it takes more energy to break the **hydrogen bonds** between water molecules (in the liquid state) **OR** each water molecule forms two **hydrogen bonds** (whereas methanol can (only) form one per molecule	1
	M2 fewer H_2O liquid molecules (able to) escape / become gaseous **ora**	1
2(c)(i)	**M1** rates of forward and reverse / backward reactions are equal	1
	M2 closed / sealed system / container OR no change in measurable properties / no change in macroscopic properties	1
2(c)(ii)	**M1** mol fraction = 0.97 / (0.030 + 0.060 + 0.97) = 0.97 / 1.06 = (0.9151)	1
	M2 M1 $\times$ 1.0 $\times$ 10^7 = 9.2 $\times$ 10^6 (Pa) ✓✓	1
2(c)(iii)	*expression for* K_p **M1** $K_p = p(CH_3OH) / p(CO) \times p(H_2)^2$	1
	M2 units = Pa^{-2}	1

Question	Answer	Marks
3(a)(i)	<table><tr><td></td><td>state at room temp</td><td>observations on add'n of sample to water</td><td>identity of sample</td></tr><tr><td>**R**</td><td>solid</td><td>alkaline, colourless solution is made but some white solid remains</td><td>**M1** $Ba(OH)_2$ OR barium hydroxide</td></tr><tr><td>**S**</td><td>solid</td><td>white solid disappears, solution is neutral</td><td>**M2** $NaCl$ OR sodium chloride</td></tr><tr><td>**T**</td><td>liquid</td><td>misty fumes, white solid is made in vigorous reaction</td><td>**M3** $SiCl_4$ OR silicon(IV) chloride</td></tr><tr><td>**U**</td><td>solid</td><td>acidic, colourless solution is made in vigorous reaction</td><td>**M4** P_4O_{10} OR phosphorus(V) oxide</td></tr></table>	**4**
3(a)(ii)	SiO_2	**1**
3(a)(iii)	phosphoric acid / phosphoric(V)acid	**1**
3(b)(i)	*any **one** physical property typical of ceramic materials from:* • strong / retain strength (over certain temperatures / conditions) • non-conductors of electricity / electrical insulators • high melting points	**1**
3(b)(ii)	SiO_2	**1**

Question	Answer	Marks
3(c)	*% of O* **M1** 100 – 79.29 (= 20.71)	1
	M2 *express W and O as mol by / 183.8 and / 16 respectively*	1
	M3 *divide each by smallest number to give empirical formula* WO_3	1

Question	Answer	Marks
4(a)(i)	1,3-dichloropropan(-2-)one	1
4(a)(ii)	carbonyl / ketone	1
4(a)(iii)	$NaBH_4$ **OR** $LiAlH_4$	1
4(b)	see table below	4
4(c)	see table below	5

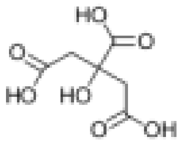
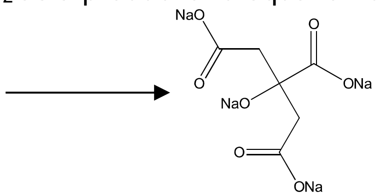
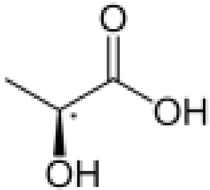
4(b):

reagent	observation with **Q**	observation with **R**
2,4-DNPH	**M1** red / orange / yellow AND precipitate / solid / crystals	**M2** red / orange / yellow AND precipitate / solid / crystals
$Na_2CO_3(aq)$	**M3** no visible change	**M4** fizz / effervescence

4(c):

step	reagent and conditions	type of rxn
1	**M1** HCN and (trace) KCN / NaCN	**M3** Addition
2	dilute sulfuric acid	**Hydrolysis**
3	**M2** KCN/NaCN in ethanol / alcohol	**M4** Substitution
4	dilute sulfuric acid	**Hydrolysis**

M5 type of reaction for step 2 AND step 4

Question	Answer	Marks
5(a)	**M1**all 3 COOH form COONa / CO_2Na / COO^-Na^+	1
	M2 the OH group forms CONa / CO^-Na^+	1
	M3 equation describes H_2 as a product and equation balanced correctly  **+4Na**  **+ $2H_2$** ✓✓✓ OR $C(CH_2COOH)_2(COOH)(OH) + 4Na \rightarrow C(CH_2COONa)_2(COONa)(ONa) + 2H_2$ ✓✓✓	1
5(b)(i)	**M1** *skeletal formula of 2-hydroxypropanoic acid* / *similar chiral isomer that meet the criteria in table* 	1
	M2 chiral carbon marked with *	1
5(b)(ii)	**M1** citric acid has a tertiary alcohol group so is not oxidised	1
	M2 **X** has a secondary alcohol group which is oxidised (to a ketone)	1
5(c)	**M1** chiral centre / non superimposable mirror image / has a C **attached** to 4 different groups	1
	M2 C=C where each C is attached to (two) different groups	1
5(d)	(molecules / isomers with) the same molecular formula / same number of atoms of each element AND different structural formulae / different structures	1