Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/21**

Paper 2 AS Level Structured Questions **May/June 2020**

MARK SCHEME

Maximum Mark: 60

Published

Students did not sit exam papers in the June 2020 series due to the Covid-19 global pandemic.

This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

Mark schemes should usually be read together with the Principal Examiner Report for Teachers. However, because students did not sit exam papers, there is no Principal Examiner Report for Teachers for the June 2020 series.

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

Cambridge International is publishing the mark schemes for the June 2020 series for most Cambridge IGCSE™ and Cambridge International A & 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	'List rule' guidance (see examples below) 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)	(different) number of neutrons.	**1**
1(a)(ii)	the relative abundance / % abundance of (each) the isotopes.	**1**
1(b)(i)	**M1** *attractions between atoms within a gallium trichloride molecule* covalent (bonds) **M2** *attractions between gallium trichloride molecules* temporary induced dipoles	**2**
1(b)(ii)	coordinate / dative (covalent)	**1**
1(c)(i)	$4Ga + 3O_2 \rightarrow 2Ga_2O_3$ **M1** correct formula of Ga_2O_3 **M2** correctly balanced equation based on Ga + O_2 and formula of gallium oxide in M1	**2**
1(c)(ii)	amphoteric	**1**

Question	Answer	Marks
2(a)(i)	$2CuSO_4(aq) + 4KI(aq) \rightarrow 2CuI(s) + (1)I_2(aq) + 2K_2SO_4(aq)$ **M1** correct balancing **M2** correct state symbols	**2**
2(a)(ii)	Oxidation state of copper in $CuSO_4$ (+)2 AND Oxidation state of copper in CuI (+)1	**1**
2(a)(iii)	**M1** redox	**1**
	M2 iodide ions – lost electron(s) AND copper ions – gained electron(s)	**1**

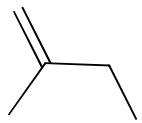
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(b)</td><td>
<table>
<tr><td>Mass of 0.0982mol $CuSO_4$ in 17.43g $CuSO_4.\mathbf{y}H_2O$</td><td>M1 calculate M_r $CuSO_4$ using Ar from data booklet
63.5 + 32.1 + 64.0 = 159.6
M2 use Mr to calculate mass of $CuSO_4$
(0.0982 × M1) =15.67272g</td></tr>
<tr><td>number of water in 17.43g of $CuSO_4$ $\mathbf{y}H_2O$</td><td>M3 calculate the mass amount of water in sample AND use this value to calculate the amount of water present
(17.43-15.67)/18 = 0.097778 mol</td></tr>
<tr><td>value of y</td><td>M4 use the ratio of M2: 0.0982 to find y
(mol H_2O ÷ mol $CuSO_4$) = 1</td></tr>
</table>
</td><td>4</td></tr>
</table>

Question	Answer	Marks
3(a)	**M1** (enthalpy / energy change) when one mole of a compound/substance is formed **M2** from its elements in their standard states	2
3(b)	**M1** <u>use</u> *of correct stoichiometry in calculation* 3xΔH_f NO_2 1x-ΔH_f H_2O 2xΔH_f HNO_3 1xΔH_f NO **M2** *correct signs associated with the appropriate* ΔH_f values/terms *used for the calculation of* $\Delta H_{reaction}$ **M3** $\Delta H_{reaction}$ = –(102 – 286) + (–346 + 91.1) = –70.9 kJ mol^{-1}	3
3(c)	**M1** nitrogen has a triple bond **M2 EITHER** high energy is needed to break the bond **OR** at normal temperatures there is not enough energy to break the bond / to overcome the activation energy	2
3(d)	lightning	1

Question	Answer	Marks
3(e)(i)	**M1** *define homogeneous* (homogeneous catalyst is) in the same phase / state as the reactants **M2 and M3** *Define catalyst* *All 3 points scores 2 marks. Any 2 points scores 1 mark* increase the rate **AND** lowers the activation energy **AND** without being chemically altered at the end of the reaction / are regenerated at the end of the reaction	
3(e)(ii)	**M1** $NO_2 + SO_2 \rightarrow NO + SO_3$ **M2** $NO + ½\ O_2 \rightarrow NO_2$	**2**

Question	Answer	Marks
4(a)	Accepts a proton / H^+ (ion)	**1**
4(b)	*Two reasons why product mixture is added to soil – allow in any order* **M1** Acts as a fertiliser / adds nutrients (for plants) **M2** Neutralise acid soils / increases the pH of acid soil	**2**
4(c)	<table><tr><td></td><td>name of shape</td><td>bond angle / °</td></tr><tr><td>CO_2</td><td>Linear</td><td>180</td></tr><tr><td>NH_3</td><td>Pyramid(al)</td><td>107</td></tr><tr><td>H_2O</td><td>non-linear / V / bent</td><td>104.5</td></tr></table>All 6 correct – 3 marks 4 or 5 correct – 2 marks 2 or 3 correct – 1 mark	**3**

Question	Answer	Marks
5(a)(i)	Cl	**1**
5(a)(ii)	HCl **AND** H_2O	**1**
5(a)(iii)	**M1** CO_3^{2-} **M2** propanoic acid – effervesce. (Propan-1-ol – no reaction)	**2**
5(b)(i)	ultraviolet light / uv	**1**
5(b)(ii)	homolytic fission (of chlorine (gas) / Cl_2)	**1**
5(c)(i)	carbonyl / aldehyde / ketone	**1**
5(c)(ii)	tertiary halogenoalkane	**1**
5(d)(i)	*Two structures representing the intermediate* **M1** $C_2H_5C^+HCH_3$ **M2** $CH_3CH_2CH_2C^+H_2$	**2**
5(d)(ii)	*Identify the most stable intermediate* **M1** $C_2H_5C^+HCH_3$ *explanation* **M2** (more / 2 alkyl groups attached so) it has the greater inductive / electron donating effect	**2**

Question	Answer	Marks
6(a)		**1**
6(b)(i)	hot **AND** concentrated	**1**
6(b)(ii)	oxidation	**1**

Question	Answer	Marks
6(c)	*Structural formula of **X**:* HCO_2H OR HCOOH	**1**
6(d)	**M1** *reagent* (2,4–) DNPH / (2,4)-dinitrophenylhydrazine **M2** *observation* yellow / orange / red precipitate	**2**
6(e)	*Predict **two** differences, with reasons, between spectra of **Y**, $CH_3CH_2COCH_3$ and 2-methylbut-1-ene (shown)* *first difference* **M1** absence of peak/ absorption at 3100 (cm^{-1}) as no longer any =C–H present (in **Y**) *second difference* **M2** peak at 1650 (cm^{-1}) moves to the left to any value / range of values between 1670 and 1740) due to disappearance of C=C (in **Y**) and appearance of C=O (in **Y**) OR absence of peak at 1650 (cm^{-1}) as no longer any C=C present (in **Y**) AND appearance of peak (in **Y**) at (any value / range of values) between 1670-1740(cm^{-1}) due to C=O	**2**
6(f)(i)	$CH_3CH_2CO_2H + 4[H] \rightarrow CH_3CH_2CH_2OH + H_2O$	**1**
6(f)(ii)	propan-1-ol ALLOW propan-2-ol as error carried forward from **6f(i)**	**1**
6(g)(i)	*Molecular formula of **W*** $C_3H_6O_2$	**1**
6(g)(ii)	*Possible structure of **W*** CH_3COOCH_3 **OR** $HCOOCH_2CH_3$	**1**