Cambridge Assessment International Education

# Cambridge International AS & A Level

**CHEMISTRY** **9701/22**

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.





[Turn over

## 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:

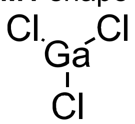
Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

| |
|---|
| GENERIC MARKING PRINCIPLE 5:<br><br>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:<br><br>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. |

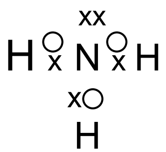
**Science-Specific Marking Principles**

| | |
|---|---|
| 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)<br><br>For questions that require ***n*** responses (e.g. State **two** reasons …):<br><br>• The response should be read as continuous prose, even when numbered answer spaces are provided<br>• Any response marked *ignore* in the mark scheme should not count towards ***n***<br>• Incorrect responses should not be awarded credit but will still count towards ***n***<br>• 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<br>• Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science. |

| | |
|---|---|
| 6 | Calculation specific guidance<br><br>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'.<br><br>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.<br><br>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.<br><br>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<br><br>Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.<br><br>State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme. |

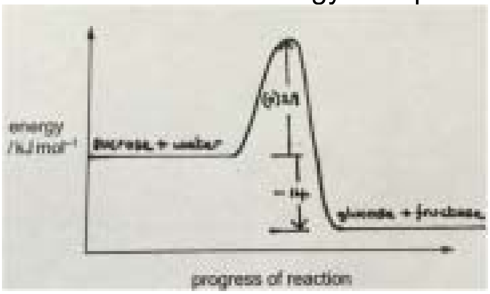
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>EITHER<br>M1 (weighted) average/mean mass of the isotope(s)/an atom(s)<br>M2 relative to 1/12 of the mass (of an atom) of $^{12}C$ (where an atom of $^{12}C$ is exactly12).<br>OR<br>M1 mass of one mol of atoms<br>M2 relative / compared to 1/12 (the mass) of 1 mol of C-12 OR<br>in which one mol C-12 (atom) has a mass of (exactly) 12 g</td><td>2</td></tr>
<tr><td>1(b)</td><td>M1 60.11/100 x 69 + 39.89/100x71<br>M2 69.80</td><td>2</td></tr>
<tr><td>1(c)</td><td><table><tr><td>isotope</td><td>nucleon number</td><td>total number of electrons in lowest energy level</td><td>type of orbital contains the electron in the highest energy level</td></tr><tr><td>$^{71}Ga$</td><td>M1 71</td><td>M2 2</td><td>M3 p (-orbital)</td></tr></table></td><td>3</td></tr>
<tr><td>1(d)</td><td>M1 shape<br><br><br>M2 bond angle 120(°)</td><td>2</td></tr>
<tr><td>1(e)(i)</td><td>$Ga_2O_3 + 6HCl \rightarrow 2GaCl_3 + 3H_2O$</td><td>1</td></tr>
</table>

| Question | Answer | Marks |
|---|---|---|
| 1(e)(ii) | **M1** *Identity of correct gallium containing product*<br>$NaGa(OH)_4$ OR $NaGaO_2$<br><br>**M2** *correctly balanced equation for reaction of $Ga_2O_3$ with NaOH(aq)*<br>**EITHER**<br>$Ga_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaGa(OH)_4$<br>**OR**<br>$Ga_2O_3 + 2NaOH \rightarrow 2NaGaO_2 + H_2O$ | 2 |

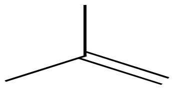
| Question | Answer | Marks |
|---|---|---|
| 2(a) | $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ | 1 |
| 2(b) |  | 1 |
| 2(c)(i) | $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$<br>(+)4 (+)5 (+)2<br><br>3 correct oxidation numbers – 2 marks<br>2 correct oxidation numbers – 1 mark | 2 |
| 2(c)(ii) | *relates the term disproportionation to the reaction described*<br>**M1** <u>nitrogen /N</u> (in nitrogen dioxide) is both gaining electrons and losing electrons during the reaction<br>**M2** *refer to relevant transfer of electrons when $NO_2$ reacts to form $HNO_3$ and NO*<br>$NO_2$ to $HNO_3$ involves loss of electron(s)<br>**AND**<br>$NO_2$ to NO involves gain of electron(s) | |

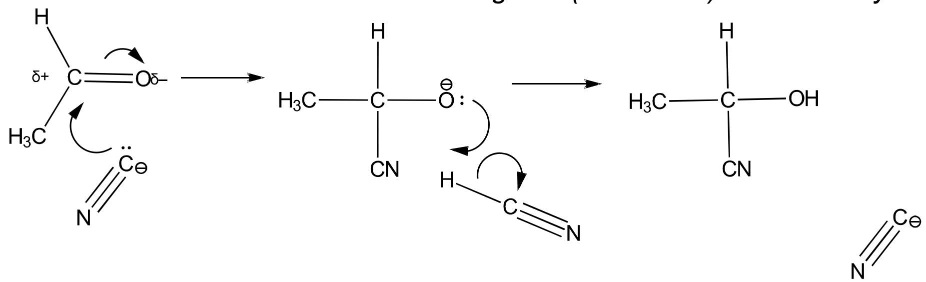
| Question | Answer | Marks |
|---|---|---|
| 2(d) | **M1** *state the effect of NO gas on contact with moist air*<br>NO reacts with water **OR** NO reacts with oxygen and water.<br>**M2** *consequence of M1 in terms of atmospheric pollution*<br>causing acid rain **OR** photochemical smog / ground level ozone OR destroy ozone layer | **2** |
| 2(e) | **M1** *number of mol in sample of $NH_4NO_3$*<br>40t $NH_4NO_3$ = 500 000 mol ammonium nitrate<br>**M2** *ratio of mol $NO_2$: $NH_4NO_3$*<br>3/2 mol $NO_2$ :1 mol $NH_4NO_3$<br>**M3** *volume of no mol $NO_2$ at rtp using 1 mol = 24$dm^3$*<br>18 000 000 $dm^3$ of $NO_2$ | **3** |
| 2(f) | fertiliser | **1** |

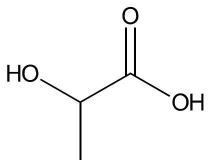
| Question | Answer | Marks |
|---|---|---|
| 3(a) | hydrolysis | **1** |
| 3(b) | **M1** both have molecular formula - $C_6H_{12}O_6$<br>**M2** *idea that in glucose and fructose there are the same number and type of atoms present but the atoms are arranged in a different order ie* one has a carbonyl group at the end of the chain/molecule and the other has a carbonyl group in the middle of the chain/molecule | **2** |
| 3(c)(i) | *value for the activation energy for the reaction **A** (no enzyme) compared to reaction **B** (with enzyme)*<br>value / range of values that are more (+) 29 kJ $mol^{-1}$ | **1** |
| 3(c)(ii) | *value for the enthalpy change for reaction **A** (no enzyme) compared to reaction **B** (with enzyme)*<br>-14 kJ $mol^{-1}$ | **1** |

| Question | Answer | Marks |
|---|---|---|
| 3(c)(iii) | **M1** show the energy of the reactants > products AND label $\Delta H$ using the predicted value given in **(ii)**<br>**M2** show activation energy 'hump' AND label using the value given in **(i)**<br><br> | 2 |
| 3(d)(i) | **M1** (enthalpy change) when 1 mole of sucrose<br>**M2** burns/combusts/reacts in excess air/oxygen<br>**OR**<br>completely burns/combusts/reacts in air/oxygen | 2 |
| 3(d)(ii) | **M1** *for finding amount of energy released per gram of sucrose using* $\Delta H$ /Q = mc$\Delta$T OR $\Delta H$ = – mc$\Delta$T<br>= (-)250x4.18x(40.7-25) = (-)16406.5 J per gram OR(-)16.4065 kJ / g<br>**M2** *for finding amount (mol) sucrose in1g = 1/342 mol*<br>***M3*** *= M1 / (M2x1000)*<br>$\Delta H$ = - 5610 kJ $mol^{-1}$ (3 sig figs) OR -5611 kJ $mol^{-1}$ (4 sig figs) | 3 |

| Question | Answer | Marks |
|---|---|---|
| 4(a)(i) | Bromine / Br | 1 |
| 4(a)(ii) | $Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$ OR $Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ | 1 |
| 4(a)(iii) | **M1** *reagent*<br>Add (aqueous) ammonia<br>**M2** *expected result*<br>**EITHER** (Dilute ammonia) – partial amount precipitate dissolves OR not much precipitate dissolves<br>**OR** add concentrated ammonia – precipitate dissolves | 2 |

| Question | Answer | Marks |
|---|---|---|
| 4(b)(i) | $CH_3CH_2CH_2CH_2CH_2Br$ | **1** |
| 4(b)(i) | **M1** primary/ 1° (carbo)cation formed is not very stable<br>**M2 EITHER** (as) only one alkyl group exerting an inductive effect<br>**OR** only one alkyl group so the charge is (more) localised on the C+ | **2** |
| 4(c)(i) | elimination | **1** |
| 4(c)(ii) | $C_4H_9Cl + NaOH \rightarrow C_4H_8 + NaCl + H_2O$ | **1** |
| 4(c)(iii) |  ONLY | **1** |
| 4(c)(iv) | **M1** 2-chloro(-2-)methylpropane<br>**M2** 1-chloro(-2-)methylpropane<br>ALLOW in any order | **2** |

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(a)</td><td>
<table>
<tr><td>Rxn.</td><td>name of mechanism</td><td>Name of reagents and conditions</td></tr>
<tr><td>1</td><td>M1 electrophilic addition</td><td>M2 steam AND<br>concentrated phosphoric acid (catalyst)</td></tr>
<tr><td>2</td><td></td><td>M3 & M4 Two marks for name of reagent and both conditions.<br>One mark for name of reagent and one conditions<br>acidified potassium dichromate ((VI))<br>condition 1 warm<br>condition 2 distil NOT reflux</td></tr>
<tr><td>6</td><td>M5 nucleophilic substitution</td><td>M6<br>ammonia (alcoholic) AND<br>heat in a sealed tube / heat under pressure</td></tr>
</table>
</td><td>6</td></tr>
<tr><td>5(b)(i)</td><td>mechanism for ethanal and HCN using $CN^-$ (from KCN) as the catalyst<br><br><br>M1arrow from lone pair of electrons on $:CN^-$ to C of C=O<br>M2 correct dipole on $C^{\delta+}=O^{\delta-}$ AND arrow from the double bond to or beyond the O of C=O<br>M3 arrow from lone pair of electrons on O of intermediate to H of HCN AND arrow from H-C bond to C of H-C≡N</td><td>3</td></tr>
</table>

| Question | Answer | Marks |
|---|---|---|
| 5(b)(ii) | ALLOW in any order<br>**M1** nitrile<br>**M2** (secondary) alcohol | **2** |
| 5(b)(iii) | <br>ALLOW any unambiguous structure | **1** |