Cambridge Assessment International Education

# Cambridge International AS & A Level

**CHEMISTRY** **9701/31**

Paper 3 Advanced Practical Skills 1 **October/November 2023**

MARK SCHEME

Maximum Mark: 40

**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 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.



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**PUBLISHED**

## 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.

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| 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<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. |

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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.

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| Question | Answer | Marks |
|---|---|---|
| 1(a) | **I** Appropriate headings and units for recorded data in the space provided.<br>(Mass of) container + **FA 2**<br>(Mass of) container (+ residual **FA 2**)<br>(Mass of) **FA 2** (used)<br>(Volume of) carbon dioxide<br>Mass units: / g or in g or (g) or g by every reading<br>Volume units: / $cm^3$ or in $cm^3$ or ($cm^3$) or $cm^3$ by every reading<br><br>**II** Balance readings recorded to same number of dp (2 or 3)<br>**and**<br>volumes given as integers<br>**and**<br>correctly calculates:<br>mass of solid / FA2 used and volume of gas collected<br><br>**III** Volume of gas collected in range 100–200 $cm^3$ | **3** |
| 1(b)(i) | **Correctly calculates**<br>amount $CO_2$ = volume of gas / 24000<br>**and**<br>amount of $Na_2CO_3$ is the same<br>Both answers correctly rounded to 2–4 sf | **1** |
| 1(b)(ii) | **Correctly uses**<br>$M_r$ = mass of **FA 2** / amount $Na_2CO_3$ from **(i)**<br>Answer to 2–4 sf | **1** |
| 1(b)(iii) | **Correctly uses**<br>**M1:** $M_r$ of **x**$H_2O$ = $M_r$ (from **(ii)**) – 106<br>**M2: x** = $M_r$ of **x**$H_2O$ / 18<br>**and**<br>Final answer to 2–4 sf | **2** |
| 1(c)(i) | It is an improvement **and** carbon dioxide is less soluble (if water is hot) | **1** |
| 1(c)(ii) | Amount of carbon dioxide / sodium carbonate is more, ($M_r$ is less) so **x** is smaller | **1** |

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| Question | Answer | Marks |
|---|---|---|
| 1(d) | **I** The following data must be shown<br>• two burette readings **and** titre for rough titration<br>• initial and final burette readings for two (or more) accurate titrations | |
| | **II** Titre values shown for accurate titrations **and** appropriate headings and units in the accurate titration table<br>• initial / start **and** (burette) reading / volume<br>• final / end **and** (burette) reading / volume<br>• titre **or** volume **/ FA 3 and** used / added<br>unit: /$cm^3$ **or** ($cm^3$) **or** in $cm^3$(for each heading) **or** $cm^3$ unit given for each volume recorded | |
| | **III** All accurate burette readings are to nearest 0.05 $cm^3$. | |
| | **IV** The final accurate titre recorded is within 0.10 $cm^3$ of any other accurate titre. | |
| | Round burette readings to the nearest 0.05 $cm^3$. Check and correct titre subtractions where necessary. Examiner selects the best mean titre.<br>Apply hierarchy:<br>2 identical, titres within 0.05 $cm^3$, titres within 0.10 $cm^3$, etc.<br>Examiner subtracts (corrected) candidate's titre from Supervisor's titre, $\delta$. | |
| | Award the accuracy (Q) marks as follows:<br>**V**, **VI**, **VII**<br>Award **V** if $\delta \leqslant 0.50\ cm^3$<br>Award **VI** if $\delta \leqslant 0.30\ cm^3$<br>Award **VII** if $\delta \leqslant 0.20\ cm^3$ | **7** |
| 1(e) | Candidate calculates mean correctly to 2 dp<br>• Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 $cm^3$.<br>• Working/ explanation must be shown or ticks must be put next to the two (or more) accurate readings selected.<br>• The mean should be quoted to **2 dp** and be rounded to the nearest 0.01 $cm^3$. | **1** |
| 1(f)(i) | Answers to **(ii)** and **(iii)** given to 3–4 sf | **1** |
| 1(f)(ii) | **Correctly calculates**<br>Amount of HC$l$ = 0.1 × volume **(e)** / 1000 | **1** |

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| Question | Answer | Marks |
|---|---|---|
| 1(f)(iii) | **Correctly uses**<br>Amount $Na_2CO_3 \cdot xH_2O$ = **(ii)** / 2<br>**and**<br>multiply by 40 | **1** |
| 1(f)(iv) | **Correctly uses**<br>$M_r$ = 14.30 / **(iii)**<br>$M_r$ of $\mathbf{x}H_2O$ = $M_r$ – 106<br>**x** = $M_r$ of $\mathbf{x}H_2O$ / 18 | **1** |
| 1(g)(i) | **Correct expression**<br>Uncertainty in a single reading = ± 0.001 or 0.0005<br>**and**<br>$\frac{2 \times \text{uncertainty given}}{14.3} \times 100$ | **1** |
| 1(g)(ii) | **Correctly uses**<br>(100 + final answer to **(g)(i)**) / 100 × 242.2<br><br>**or**<br><br>(14.3 + 2 × (single) uncertainty) / answer **f(iii)** | **1** |

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td colspan="3">FA 6 $NaNO_3$ FA 7 $NaNO_2$ FA 8 $NH_4Cl$ FA 9 $KMnO_4$ FA 10 $MnCl_2$ or $MnSO_4$</td></tr>
<tr><td>2(a)(i)</td><td>M1: Correct three ions listed in space provided<br>M2: Table to show FA6 / FA7 / FA8 and test reagents<br>M3: NaOH and heat listed as a reagent<br>M4: Only FA8 gives off a gas that turns (damp red) litmus blue<br>M5: Add Al to NaOH and heat<br>M6: FA6 gives off a gas that turns (damp red) litmus blue<br>M7: To a new sample add either (acidified) $KMnO_4$ or named acid<br>M8: Only FA7 either turns $KMnO_4$ colourless or gives off a brown gas with a named acid</td><td>8</td></tr>
<tr><td></td><td>Expected observations for reference:
<table>
<tr><td>reagent</td><td>FA6</td><td>FA7</td><td>FA8</td></tr>
<tr><td>NaOH (aq) and heat</td><td>No (visible) reaction /<br>No fizz</td><td>No (visible) reaction /<br>No fizz</td><td>gas test with (damp red) litmus to blue</td></tr>
<tr><td>Then<br>add A$l$</td><td>gas test with (damp red) litmus to blue</td><td>gas test with (damp red) litmus to blue</td><td>Ignore</td></tr>
<tr><td>(Acidified) $KMnO_4$<br>(heat with solution)<br><br>or<br><br>named acid</td><td>Purple remains /<br>No decolouration<br>No (visible) reaction /<br><br>No fizz</td><td>Purple to colourless<br><br>Brown gas</td><td>Purple remains /<br>No decolouration<br>No (visible) reaction<br><br>No fizz</td></tr>
</table></td><td></td></tr>
</table>

| Question | Answer | Marks |
|---|---|---|
| 2(a)(ii) | **FA 6** is $NO_3^-$ **FA 7** is $NO_2^-$ **FA 8** is $NH_4^+$ | **1** |
| 2(b)(i) | **Test 1**<br>6 * available. 2 * = 1 mark. Round down.<br>**Observations**<br>Black solid/residue *<br>Pops / jumps about (OWTTE) *<br>Glowing splint relights *<br>**Product**<br>Oxygen / manganese(IV) oxide / potassium manganate(VI) *<br><br>**Test 2**<br>(Dark) green * solution * | **3** |
| 2(b)(ii) | **M1: Test 3**<br>Purple to colourless / pale yellow / yellow-brown (solution)<br><br>**M2: Test 4**<br>Purple (to colourless) to brown (solution) | **2** |
| 2(b)(iii) | **M1:** Off -white ppt<br><br>**M2:** Ppt turns brown(er) (on standing)<br>**and** insoluble in excess (NaOH(aq)) | **2** |
| 2(b)(iv) | Manganese / Mn | **1** |

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