Cambridge Assessment International Education

# Cambridge International AS & A Level

**CHEMISTRY** **9701/33**

Paper 3 Advanced Practical Skills 1 **May/June 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 May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.



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## 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. |

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**Science-Specific Marking Principles**

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|---|---|
| 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** The following data must be shown<br>• burette readings and titre for rough titration<br>• 2 × 2 "box" showing both accurate burette readings | **7** |
| | **II** Headings and units correct for accurate titration table and headings match readings<br>• initial / start and (burette) reading / volume + unit<br>• final / end and (burette) reading / volume + unit<br>• titre or volume / **FA 1 AND** used / added + unit<br>Units: ($cm^3$) or / $cm^3$ or in $cm^3$ in heading or $cm^3$ by every entry | |
| | **III** All accurate burette readings to 0.05 $cm^3$ | |
| | **IV** The final accurate titre recorded is within 0.10 $cm^3$ of any other accurate titre | |
| | **Accuracy marks**<br>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 accuracy marks as follows:<br>**V** Award if $\delta \leq 0.50\ cm^3$<br>**VI** Award if $\delta \leq 0.30\ cm^3$<br>**VII** Award if $\delta \leq 0.20\ cm^3$ | |
| 1(b) | Correctly calculates mean accurate titre:<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 decimal places (dp) and be rounded to nearest 0.01 $cm^3$. | **1** |
| 1(c)(i) | Correctly calculates<br>amount of $KMnO_4$ = 0.02 × **(b)** / 1000 mol<br>**AND** answer given to 3–4 significant figures | **1** |

| Question | Answer | Marks |
|---|---|---|
| 1(c)(ii) | Correctly calculates<br>amount of $Fe^{2+}$ = 5 × **(c)(i)** mol<br>**AND** answer given to 3–4 significant figures | **1** |
| 1(c)(iii) | Correctly calculates<br>**M1** $M_r(NH_2OH•HCl)$ = 69.5<br><br>**M2** amount of $NH_2OH•HCl = {}^{3.3}/_{69.5} \times {}^{25}/_{1000}$<br>= $1.187 \times 10^{-3}$ / $1.19 \times 10^{-3}$ mol<br>**AND** final answer given to 3 or more significant figures | **2** |
| 1(c)(iv) | Correctly uses<br>mole ratio $n(Fe^{2+})$ **:** $n(NH_2OH•HCl)$ = **(c)(ii)** / **(c)(iii)**<br>**AND** states equation number that fits their data | **1** |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | **I** Readings recorded to show precision of apparatus<br>• measuring cylinder to 0.5 $cm^3$<br>• stopclock to 1 s<br><br>**II** Suitable volumes selected<br>• total volume = 60.0 $cm^3$<br>• volumes of **FA 4** + distilled water = 50.0 $cm^3$<br>• volume of **FA 4** must be ≥ 20.0 $cm^3$ | **4** |
| | **Accuracy marks**<br>Correct times to the nearest integer.<br>Calculate candidate's ratio of times for $^{\text{expt 2}}/_{\text{expt 1}}$ (to 2 decimal places) | |
| | Award accuracy marks as follows:<br>**III** Ratio is between 1.50 and 2.00<br>**IV** Ratio between 1.60 and 1.90 | |
| 2(b)(i) | Correctly calculates for all three experiments<br>**M1** concentration = volume used × 0.1/60<br>**M2** rate = 1000 / time **AND** answer given to 2–4 significant figures | **2** |

| Question | Answer | Marks |
|---|---|---|
| **Question** | **Answer** | **Marks** |
| 2(b)(ii) | **M1** Correctly uses results or calculated quantities<br>Calculates ratios between any pair of experiments for both concentration and rate<br><br>**M2** Selects expression<br>Ticks appropriate box<br>**AND**<br>**either** from comparison of ratios showing rate $\alpha$ concentration has better agreement<br>**or** $^{\text{rate}}/_{\text{concentration}}$ is constant (within experimental error) (owtte) (unlike $^{\text{rate}}/_{\text{concentration}^2}$) | **2** |
| 2(c) | Correctly calculates<br>$\left(^{0.5}/_{30(.0)}\right) \times 100 = 1.667\%$ **or** 1.67% **or** 1.7 % | **1** |
| 2(d) | **M1** Carry out more experiments with different volumes of **FA 4** (and distilled water) (to obtain more times)<br><br>**M2**<br>**EITHER** Plot a graph of rate vs concentration (and/or conc$^2$) (owtte)<br>**OR** Plot graph and draw line of best fit<br><br>**ALTERNATIVELY**<br>calculates the ratio $^{\text{rate}}/_{\text{concentration}}$ or $^{\text{rate}}/_{\text{concentration}^2}$<br><br>**M3** answer is dependent on what is given for **M2** (graph of or calculation of $^{\text{rate}}/_{\text{conc or vol}}$ or $^{\text{rate}}/_{\text{conc}^2 \text{ or vol}^2}$)<br><br>Straight line implies proportional<br>**OR** increasing gradient / curve implies square relationship / rate $\alpha$ concentration$^2$<br>**OR** (if $^{\text{rate}}/_{\text{conc}}$ used) candidate links constant value of ratio being proportional to the concentration | **3** |

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| Question | Answer | Marks |
|---|---|---|
| | **FA 5** is $NaHSO_4(s) + Na_2CO_3(s)$ and **FA 6** is $NH_4Cl(aq)$ | |
| 3(a)(i) | Award one mark for each correct statement up to max two marks.<br>• condensation (further up tube) / moisture / water / steamy fumes<br>• gas / $CO_2$ gives white ppt with limewater<br>• white and residue / solid on cooling / at the end | **2** |
| 3(a)(ii) | **M1** effervescence / fizzing / bubbling<br>**M2** colourless solution forms | **2** |
| 3(a)(iii) | + NaOH: no change | **1** |
| 3(b)(i) | + $HNO_3$<br>**M1** fizzing<br>**AND**<br>**either** (colourless) solution formed / solid dissolves<br>**or** reaction is rapid (owtte)<br><br>**M2** gas gives white ppt with limewater | **2** |
| 3(b)(ii) | $H^+$ ions are present (owtte) | **1** |
| 3(b)(iii) | **M1** add $BaCl_2$ / $Ba(NO_3)_2$ **AND** gives white ppt.<br><br>**M2**<br>**EITHER** ppt insoluble in $HCl$ or $HNO_3$<br>**OR** $KMnO_4$ is not decolourised / ($KMnO_4$) solution remains purple (free standing) | **2** |
| 3(b)(iv) | anions \| $CO_3^{2-}$ \| $SO_4^{2-}$ | **1** |
| 3(b)(v) | One of:<br>• $2H^+(aq) + CO_3^{2-}(aq)/(s) \rightarrow CO_2(g) + H_2O(l)$<br>• $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ | **1** |

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| Question | Answer | Marks |
|---|---|---|
| 3(c) | **M1** selects NaOH(aq) **AND** warms<br>**M2** (colourless) gas / $NH_3$ turns (damp red) litmus paper blue (on warming with NaOH)<br>**M3** $NH_4^+$ / ammonium (ion) (present) | **3** |