



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.

This document consists of **9** printed pages.

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.

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

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) | <p>I Appropriate headings and units for recorded data in the space provided. (Mass of) container + FA 2 (Mass of) container (+ residual FA 2) (Mass of) FA 2 (used) (Volume of) carbon dioxide Mass units: / g or in g or (g) or g by every reading Volume units: / cm³ or in cm³ or (cm³) or cm³ by every reading</p> <p>II Balance readings recorded to same number of dp (2 or 3) and volumes given as integers and correctly calculates: mass of solid / FA2 used and volume of gas collected</p> <p>III Volume of gas collected in range 100–200 cm³</p> | 3 |
| 1(b)(i) | <p>Correctly calculates amount CO₂ = volume of gas / 24000 and amount of Na₂CO₃ is the same Both answers correctly rounded to 2–4 sf</p> | 1 |
| 1(b)(ii) | <p>Correctly uses $M_r = \text{mass of FA 2} / \text{amount Na}_2\text{CO}_3 \text{ from (i)}$ Answer to 2–4 sf</p> | 1 |
| 1(b)(iii) | <p>Correctly uses M1: $M_r \text{ of } x\text{H}_2\text{O} = M_r \text{ (from (ii))} - 106$ M2: $x = M_r \text{ of } x\text{H}_2\text{O} / 18$ and Final answer to 2–4 sf</p> | 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) | <p>I The following data must be shown</p> <ul style="list-style-type: none"> • two burette readings and titre for rough titration • initial and final burette readings for two (or more) accurate titrations <p>II Titre values shown for accurate titrations and appropriate headings and units in the accurate titration table</p> <ul style="list-style-type: none"> • initial / start and (burette) reading / volume • final / end and (burette) reading / volume • titre or volume / FA 3 and used / added <p>unit: /cm³ or (cm³) or in cm³(for each heading) or cm³ unit given for each volume recorded</p> <p>III All accurate burette readings are to nearest 0.05 cm³.</p> <p>IV The final accurate titre recorded is within 0.10 cm³ of any other accurate titre.</p> <p>Round burette readings to the nearest 0.05 cm³. Check and correct titre subtractions where necessary. Examiner selects the best mean titre. Apply hierarchy: 2 identical, titres within 0.05 cm³, titres within 0.10 cm³, etc. Examiner subtracts (corrected) candidate's titre from Supervisor's titre, δ.</p> <p>Award the accuracy (Q) marks as follows: V, VI, VII Award V if $\delta \leq 0.50 \text{ cm}^3$ Award VI if $\delta \leq 0.30 \text{ cm}^3$ Award VII if $\delta \leq 0.20 \text{ cm}^3$</p> | 7 |
| 1(e) | <p>Candidate calculates mean correctly to 2 dp</p> <ul style="list-style-type: none"> • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. • Working/ explanation must be shown or ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 dp and be rounded to the nearest 0.01 cm³. | 1 |
| 1(f)(i) | Answers to (ii) and (iii) given to 3–4 sf | 1 |
| 1(f)(ii) | <p>Correctly calculates Amount of HCl = 0.1 × volume (e) / 1000</p> | 1 |

| Question | Answer | Marks |
|-----------|--|----------|
| 1(f)(iii) | <p>Correctly uses Amount $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O} = \text{(ii)} / 2$ and multiply by 40</p> | 1 |
| 1(f)(iv) | <p>Correctly uses $M_r = 14.30 / \text{(iii)}$ $M_r \text{ of } x\text{H}_2\text{O} = M_r - 106$ $x = M_r \text{ of } x\text{H}_2\text{O} / 18$</p> | 1 |
| 1(g)(i) | <p>Correct expression Uncertainty in a single reading = ± 0.001 or 0.0005 and $\frac{2 \times \text{uncertainty given}}{14.3} \times 100$</p> | 1 |
| 1(g)(ii) | <p>Correctly uses $(100 + \text{final answer to (g)(i)}) / 100 \times 242.2$ or $(14.3 + 2 \times (\text{single}) \text{ uncertainty}) / \text{answer f(iii)}$</p> | 1 |

| Question | Answer | Marks | | | | | | | | | | | | | | | | |
|---|---|---|--|-----|-----|-----|---------------------------|------------------------------------|------------------------------------|---|-----------------------|---|---|--------|--|---|---------------------------------------|--|
| FA 6 NaNO₃ FA 7 NaNO₂ FA 8 NH₄Cl FA 9 KMnO₄ FA 10 MnCl₂ or MnSO₄ | | | | | | | | | | | | | | | | | | |
| 2(a)(i) | <p>M1: Correct three ions listed in space provided M2: Table to show FA6 / FA7 / FA8 and test reagents M3: NaOH and heat listed as a reagent M4: Only FA8 gives off a gas that turns (damp red) litmus blue M5: Add Al to NaOH and heat M6: FA6 gives off a gas that turns (damp red) litmus blue M7: To a new sample add either (acidified) KMnO₄ or named acid M8: Only FA7 either turns KMnO₄ colourless or gives off a brown gas with a named acid</p> | 8 | | | | | | | | | | | | | | | | |
| <p>Expected observations for reference:</p> <table border="1" data-bbox="338 651 1547 1182"> <thead> <tr> <th data-bbox="338 651 640 716">reagent</th> <th data-bbox="640 651 943 716">FA6</th> <th data-bbox="943 651 1245 716">FA7</th> <th data-bbox="1245 651 1547 716">FA8</th> </tr> </thead> <tbody> <tr> <td data-bbox="338 716 640 815">NaOH (aq) and heat</td> <td data-bbox="640 716 943 815">No (visible) reaction / No fizz</td> <td data-bbox="943 716 1245 815">No (visible) reaction / No fizz</td> <td data-bbox="1245 716 1547 815">gas test with (damp red) litmus to blue</td> </tr> <tr> <td data-bbox="338 815 640 949">Then add Al</td> <td data-bbox="640 815 943 949">gas test with (damp red) litmus to blue</td> <td data-bbox="943 815 1245 949">gas test with (damp red) litmus to blue</td> <td data-bbox="1245 815 1547 949">Ignore</td> </tr> <tr> <td data-bbox="338 949 640 1182">(Acidified) KMnO₄ (heat with solution) or named acid</td> <td data-bbox="640 949 943 1182">Purple remains / No decolouration No (visible) reaction /</td> <td data-bbox="943 949 1245 1182">Purple to colourless Brown gas</td> <td data-bbox="1245 949 1547 1182">Purple remains / No decolouration No (visible) reaction No fizz</td> </tr> </tbody> </table> | | | reagent | FA6 | FA7 | FA8 | NaOH (aq) and heat | No (visible) reaction / No fizz | No (visible) reaction / No fizz | gas test with (damp red) litmus to blue | Then add Al | gas test with (damp red) litmus to blue | gas test with (damp red) litmus to blue | Ignore | (Acidified) KMnO ₄ (heat with solution) or named acid | Purple remains / No decolouration No (visible) reaction / | Purple to colourless Brown gas | Purple remains / No decolouration No (visible) reaction No fizz |
| reagent | FA6 | FA7 | FA8 | | | | | | | | | | | | | | | |
| NaOH (aq) and heat | No (visible) reaction / No fizz | No (visible) reaction / No fizz | gas test with (damp red) litmus to blue | | | | | | | | | | | | | | | |
| Then add Al | gas test with (damp red) litmus to blue | gas test with (damp red) litmus to blue | Ignore | | | | | | | | | | | | | | | |
| (Acidified) KMnO ₄ (heat with solution) or named acid | Purple remains / No decolouration No (visible) reaction / | Purple to colourless Brown gas | Purple remains / No decolouration No (visible) reaction No fizz | | | | | | | | | | | | | | | |

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