Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/31**

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: 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.

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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.

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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** Single table to show results for five experiments (volume of **FA 1**, volume of water, time and rate)	**8**
	II Appropriate headings and units for recorded data given Volume units for headings: / cm^3 or (cm^3) or in cm^3 Time units for headings: / s or (s) or in seconds Rate units for headings: / s^{-1} or (s^{-1}) or per second **OR** units of cm^3, s or s^{-1} against each entry	
	III All times recorded to nearest second **AND** all volumes given to 2 dp with the final digit being 0 or 5 cm^3	
	IV Three additional volumes chosen with intervals not less than 5 cm^3 **AND** all volumes of **FA 1** not less than 15.00 cm^3	
	V In all additional experiments water is added to make a total of 40.00 cm^3	
	VI All rates correctly calculated using 1000 / time All recorded to minimum of two significant figures or integer value **AND** from at least three experiments	
	Accuracy marks Calculate ratio: $\frac{\textit{Time for 20.00 cm}^3 \textit{ of } \textbf{\textit{FA 1}}}{\textit{Time for 40.00 cm}^3 \textit{ of } \textbf{\textit{FA 1}}}$ to two decimal places **VII** Award for ratio 1.70–2.40 **VIII** Award for ratio 1.90–2.20	
1(b)	**I** Rate on *y*-axis and volume of **FA 1** on *x*-axis with unambiguous labels or units	**4**
	II Linear scales (starting at 0,0) chosen so that the graph occupies at least half the available length for both axes	
	III Five recorded points plotted correctly	
	IV Draws a line of best fit straight line or smooth curve **AND** anomalous point(s), if any, should be ringed	

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Question	Answer	Marks
1(c)	Yes / directly proportional and as straight line through / close to origin **OR** no / not directly proportional and line not through origin / curve	**1**
1(d)	**M1** Line drawn at 12.50 cm^3 and line drawn across to rate axis **OR** marks on rate and volume axes within half a small square **M2** Time correctly calculated from candidate's rate	**2**
1(e)	**M1** Solution is less deep / shallower **M2** Time would be longer because of the need to have more S / solid to obscure insert owtte	**2**

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Question	Answer	Marks
2(a)	**I** Unambiguous headings and units covering all entries • (mass of) container + solid **FA 3 / FA 4** • (mass of) container (+ residue) • initial thermometer reading / temperature • lowest / highest reading / temperature • mass solid (used / added) / **FA 3 / FA 4** • change in temperature / ΔT Units: / g, (g), in g and / °C, (°C), in °C	**5**
	II All four balance readings to the same number of decimal places (2 or 3) **AND** thermometer readings to .0 °C or.5 °C **AND** written in the table / results space	
	III Correctly calculates for both experiments • mass solid • change in temperature	
	Accuracy marks Correct all temperatures to nearest .5 °C. Calculate ΔT for supervisor and for candidate. ΔT = initial temperature – lowest / highest temperature in table Calculate the difference, δ, between supervisor and candidate values	
	IV Award if $\delta \leqslant 1.0$ °C for experiment 1 **V** Award if $\delta \leqslant 1.0$ °C for experiment 2	
2(b)(i)	Correctly calculates Q = mcΔT for both experiments = $25 \times 4.18 \times \Delta T$ **AND** answers to 2–4 significant figures	**1**

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Question	Answer	Marks
2(b)(ii)	**M1** Correctly calculates M_r for each: 246.4 **AND** 120.4 **M2** Shows correct working (may be in more than 1 step) $\frac{\textbf{(b)(i) expt 1} \times 246.4}{\text{mass } \textbf{FA 3} \times 1000}$ **AND** $\frac{\textbf{(b)(i) expt 2} \times 120.4}{\text{mass } \textbf{FA 4} \times 1000}$ **M3** Shows correct sign for both values of ΔH **AND** answers from attempted calculation to 2–4 significant figures	**3**
2(b)(iii)	**M1** Shows attempt at use of Hess' law / energy level diagram / reverse equation ($\Delta H = \Delta H_1 - \Delta H_2$) **M2** Correct answer to 2–4 significant figures with appropriate sign	**2**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td colspan="2">FA 5 is $ZnSO_4•7H_2O$ and FA 6 is $CuCO_3$</td><td></td></tr>
<tr><td>3(a)(i)</td><td>M1 Test for water
Heat solid sample of FA 5
AND either (gentle heating) solution / liquid formed or solid / FA 5 dissolves / melts
or observes condensation / steam produced

M2 Add water / make a solution

M3 Test for magnesium
Add (aqueous) sodium hydroxide AND white ppt soluble in excess
OR add (aqueous) ammonia AND white ppt soluble in excess

M4 Test for sulfate
Add (aqueous) barium chloride / nitrate AND white ppt insoluble in hydrochloric / nitric acid
OR $KMnO_4$ is not decolourised owtte</td><td>4</td></tr>
<tr><td>3(a)(ii)</td><td><table><tr><th></th><th>yes</th><th>no</th></tr><tr><td>FA 5 contains magnesium ions</td><td></td><td>✓</td></tr><tr><td>FA 5 contains sulfate ions</td><td>✓</td><td></td></tr><tr><td>FA 5 contains water of crystallisation</td><td>✓</td><td></td></tr></table></td><td>1</td></tr>
<tr><td>3(b)(i)</td><td>green (solid) *
(goes) black (solid) *
condensation *
gas / carbon dioxide tested with limewater * gives white ppt *

Two marks for 4 or 5 points
One mark for 2 or 3 points</td><td>2</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(b)(ii)</td><td>
<table>
<tr><th>test</th><th>observations</th></tr>
<tr><td>Test 1
Hydrochloric acid</td><td>fizz / bubbles / effervescence *
use limewater *
blue solution * (formed)</td></tr>
<tr><td>Test 2
Ammonia</td><td>(pale) blue ppt *
(dissolves in excess) to dark / deep blue solution (as final observation) *</td></tr>
</table>
Two marks for 4 or 5 points
One mark for 2 or 3 points</td><td>2</td></tr>
<tr><td>3(b)(iii)</td><td>cation: copper(II) / Cu^{2+} AND anion: carbonate / CO_3^{2-}</td><td>1</td></tr>
<tr><td>3(b)(iv)</td><td>$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$ OR $M^{2+}(aq) + 2OH^-(aq) \rightarrow M(OH)_2(s)$

Use of OH^- scores one mark
Complete correct equation scores two marks</td><td>2</td></tr>
</table>