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CAMBRIDGE
International Education

Cambridge International AS & A Level

CHEMISTRY **9701/33**

Paper 3 Advanced Practical Skills 1 **February/March 2024**

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 February/March 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level 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 descriptions 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.

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	<u>'List rule' guidance</u> 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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Q marks

When awarding the accuracy (Q) mark in Question 2, each Examiner must round each temperature to the nearest .0 or .5 °C, check subtractions on the Supervisor's and Candidate's scripts and must use the **corrected** values to assess accuracy.

Penalise rounding errors or transcription errors once only on the whole paper.

Significant figure errors are penalised once per question.

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Question	Answer	Marks
1(a)	**I** A single table with 4 headings for results on page 4 with indication of the 4 items of data to be recorded (volume of **FA 1**, volume of water, time and rate) **AND** the 2 specified experiments carried out	**1**
	II Correct headings and units for 4 required items of data: • volume of **FA 1** (used) **and** / cm^3 or (cm^3) or in cm^3 • volume of (distilled) water **and** / cm^3 or (cm^3) or in cm^3 • (reaction) time **and** /s or (s) or in seconds • rate **and** /s^{-1} or (s^{-1}) or in s^{-1}	**1**
	III Precision of data recorded: • all volumes recorded to 2 dp with the final digit being 0 or 5 cm^3 • all times to the nearest second	**1**
	IV 3 additional volumes chosen with intervals not less than 2.00 cm^3 **AND** no volume less than 12.50 cm^3 **AND** water added in each additional experiment to make total volume of **FA 1** and water equal to 25.00 cm^3	**1**
	V All rates correctly calculated using 1000 / time to minimum 2 sf	**1**
	VI Reaction time decreases as volume of **FA 1** increases for **all five** experiments	**1**
	Examiner corrects times (if necessary) to the nearest second for Experiments 1 and 2 and calculates ratio $t_{12.5} / t_{25}$ to 2 dp Write the ratio, ringed, near the mark boxes Award **VII** for ratio between 1.70–2.40 Award **VII** and **VIII** for ratio between 1.90–2.20	**2**

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Question	Answer	Marks
1(b)	**I Axes unambiguously labelled** (relative) rate **or** s^{-1} on *y*-axis **AND** volume / **FA 1** / (sodium) thiosulfate / $Na_2S_2O_3$ / cm^3 on *x*-axis **AND** some numbers for scales	**1**
	II Suitable scales chosen Linear scales based on 1, 2 or 5 **AND** scale chosen so that plotted points occupy <u>more than</u> half the available space along each axis	**1**
	III All points recorded in the table are accurately plotted. <u>All</u> points recorded plotted correctly to within half a small square **AND** in the correct small square or on the line if it should be on the line **AND** minimum of 4 experiment points plotted	**1**
	IV Line of best fit drawn	**1**
1(c)	**M1** 2 lines drawn on the graph – vertical from 23.50 on the *x*-axis to the line of best fit and horizontal from the line to the *y*-axis. **M2** Correctly uses time = 1000 / (relative) rate	**2**
1(d)	Time is longer **AND** extra water would lower the concentration / dilute (**FA 1** or reactants)	**1**
1(e)(i)	The student is correct (that time would be greater) **AND** the **depth** (of solution / ppt / mixture) is less	**1**

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Question	Answer	Marks
1(e)(ii)	The student is not correct / (The (relative) rate is smaller but) the rate is <u>not</u> slower **AND** (the solution) concentrations have not changed / the frequency of successful collisions remains the same / more sulfur is required to obscure the insert owtte.	**1**

Question	Answer	Marks
2(a)	**M1** Unambiguous headings and correct units for: • (Mass of) container + **FA 4 and** g / grams • (Mass of) container (+ residue) **and** g / grams • Initial / **FA 3** (temperature) **and** °C • Maximum (temperature) **and** °C • (Mass of) magnesium / **FA 4** (added) **and** g / grams • (Temperature) change **and** °C	**1**
	M2 Readings are appropriately recorded against headings • Both temperature measurements recorded to the nearest 0.5 °C **AND** • Both balance readings recorded to a consistent number of decimal places (either 2 or 3) **AND** • Correct calculations of mass of **FA 4** and temperature change	**1**
	M3 Examiner checks and corrects ΔT if necessary ΔT within x °C of supervisor value	**1**
2(b)(i)	Correctly calculates: $50 \times 4.18 \times \Delta T$ **AND** answer to 2–4 sf	**1**

ΔT_{sup} / °C	<5.0	5.0–9.5	10.0–14.5	15.0–19.5	20.0–24.5	25.0–29.5	30.0–34.5	35.0–39.5
M3:	±0.5	±1.0	1.5	2.0	2.5	3.0	3.5	4.0

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Question	Answer	Marks
2(b)(ii)	Correctly calculates: amount of **FA 3** = 0.05 × 1.0 = 0.050 mol **AND** amount of **FA 4** = candidate's mass / 24.3 **AND** **FA 3** / $CuSO_4$ is in excess	**1**
2(b)(iii)	**M1** Correctly uses: ΔH = **(b)(i)** / (1000 × n(**FA 4**) from **2(b)(ii)**) **M2** sign is negative **AND** answer to 2–4 sf	**2**
2(c)	**M1** Measure the temperature of **FA 3** (at regular intervals and) **before** adding **FA 4** **AND** (Stir the mixture and) measure the temperature of the mixture at regular intervals after **adding FA 4** until temperature is steady or decreasing **M2** Plot a graph of temperature against time **AND** point of addition of **FA 4** must be given in text or clearly shown/labelled on sketch graph **M3** extrapolate lines of best fit to find $\Delta T_{(max)}$ or ΔT at time of addition (of **FA 4**)	**3**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)</td><td>FA 5 is $Na_2S_2O_3$; FA 6 is H_2SO_4 FA 7 is Na_2SO_3 FA 8 is Cu_2O</td><td></td></tr>
<tr><td></td><td>11 * observations
2* = 1 mark (round down)

<table>
<tr><th rowspan="2">test</th><th colspan="3">observations</th></tr>
<tr><th>FA 5</th><th>FA 6</th><th>FA 7</th></tr>
<tr><td>Test 1</td><td>*purple (solution) / MnO_4^-/ $KMnO_4$
and
turns colourless / decolourised</td><td>*no change / (MnO_4^-) stays purple / does not decolourise ($KMnO_4$)</td><td>*purple (solution) / MnO_4^- / $KMnO_4$
and
turns colourless / decolourised</td></tr>
<tr><td></td><td>*white / off-white / cream / pale yellow ppt forms</td><td>*no change
and</td><td>no change</td></tr>
<tr><td>Test 2</td><td>*no change
and</td><td>*effervescence / bubbling / fizzing

*(gas) pops with a lighted splint</td><td>*no change</td></tr>
<tr><td>Test 3</td><td>no change</td><td>*white ppt</td><td>*white ppt</td></tr>
</table></td><td>5</td></tr>
<tr><td>3(b)(i)</td><td>FA 5 is $S_2O_3^{2-}$; FA 6 is SO_4^{2-} FA 7 is SO_3^{2-}

2 correct = 1 mark
3 correct = 2 marks</td><td>2</td></tr>
</table>

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Question	Answer	Marks
3(b)(ii)	**M1** Cation is H^+ **AND** chooses Na_2CO_3 / sodium carbonate / other named carbonate **or** named indicator **M2** effervescence / fizzing / bubbling **or** suitable indicator colour **AND** gas / CO_2 gives a white ppt with limewater / suitable indicator colours before and after use, e.g. blue litmus goes red	**2**
3(c)	$Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$ **or** $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ **or** $Ba^{2+}(aq) + SO_3^{2-}(aq) \rightarrow BaSO_3(s)$	**1**
3(d)(i)	Residue: red-brown / brown / pink / pink-brown (solid) **AND** filtrate: (pale) blue (solution)	**1**
3(d)(ii)	Brown / yellow-brown / orange-brown / red-brown (mixture)	**1**
3(d)(iii)	(On addition of NaOH) blue ppt insoluble in excess	**1**

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