Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/31**

Paper 3 Advanced Practical Skills 1 **May/June 2022**

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 2022 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	<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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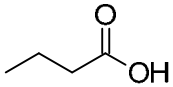
Question	Answer	Marks
1(a)	**I** All the following data are recorded: • two burette readings **and** titre for the rough titration • initial and final burette readings for **two** (or more) accurate titrations	**1**
	II Appropriate headings and units in the accurate titration table and titre values recorded for accurate titrations • initial / start **and** (burette) reading / volume • final / end **and** (burette) reading / volume • titre **or** volume used / added / **or FA 2** added • unit: / cm^3 **or** (cm^3) **or** in cm^3 (for each heading) **or** cm^3 unit given for each volume recorded	**1**
	III All accurate burette readings are recorded to the nearest 0.05 cm^3	**1**
	IV The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre	**1**
	For assessment of accuracy marks, round all burette readings to the nearest 0.05 cm^3. Check and correct subtractions where necessary. Then select the 'best' titres using the hierarchy: • two (or more) accurate identical titres (ignoring any that are labelled 'rough'), *then* • two (or more) accurate titres within 0.05 cm^3, *then* • two (or more) accurate titres within 0.10 cm^3, *etc.* These best titres should be used to calculate the mean titre, expressed to nearest 0.01 cm^3. Write the Supervisor's [corrected] mean titre in a ring on each candidate script. Calculate the difference (δ) between the candidate's mean titre and the Supervisor's. Write the value of δ on each script. Award the accuracy marks as shown below.	
	Award **V** if $\delta \leqslant 0.50$ (cm^3) Award **VI** if $\delta \leqslant 0.30$ Award **VII** if $\delta \leqslant 0.20$	**3**

Question	Answer	Marks
1(b)	Candidate must average two (or more) titres that are within a total spread of not more than 0.20 cm^3 **AND** working / explanation must be shown or ticks must be put next to the two (or more) accurate titres selected **AND** mean quoted to 2 decimal places	**1**
1(c)(i)	Correctly calculates moles of NaOH used = $0.110 \times$ **(b)** / 1000 **AND** answer to 3 or 4 sig fig	**1**
1(c)(ii)	Correctly uses **(c)(i)** to calculate M_r = 10.5 / **(c)(i)** $\times$ 40	**1**
1(c)(iii)	**M1** Identity of carboxylic acid [must be consistent with the M_r in **(c)(ii)**] **M2** Skeletal formula (must correspond to candidate's name of acid) 	**2**
1(d)(i)	Correct equation with state symbols $NH_2CH_2COOH(aq) + NaOH(aq) \rightarrow NH_2CH_2COONa(aq) + H_2O(l)$	**1**
1(d)(ii)	Student's titre would be larger **AND** M_r of amino acid is 75 / is lower than M_r of **FA 1** so more moles of amino acid are present ORA	**1**

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Question	Answer	Marks
2(a)	**I** Unambiguous headings and units for four weighings: • (mass of) crucible, lid (empty) • (mass of) crucible, lid and **FA 4** (or 'contents before heating') • (mass of) crucible, lid and MgO / residue after first heating • (mass of) crucible, lid and MgO / residue after second heating	**1**
	II Readings are appropriately recorded: • all weighings recorded to same decimal places (two or more) • mass of **FA 4** is within range 0.80 g–1.80 g (from weighings) • fourth weighing within +0.02 and –0.05 g of third weighing	**1**
	III Correct subtractions to give masses of **FA 4** and MgO / residue	**1**
	IV and **V:** Accuracy marks Calculate supervisor's mass ratio (to 2 d.p.) = $\frac{\text{mass FA 4}}{\text{mass of residue}}$ Calculate the candidate's mass ratio (to 2 d.p.) = $\frac{\text{mass FA 4}}{\text{mass of residue}}$ Calculate 20% of this ratio and calculate ratio $\pm$ this ratio Award **IV** if δ is within the range 0.00–0.25 Award **V** if δ is within the range 0.00–0.10	**2**
2(b)(i)	Correctly calculates moles of MgO = $\frac{\text{mass of residue}}{40.3}$ **AND** answer to 2–4 sig fig	**1**
2(b)(ii)	Correctly uses **(b)(i)** to calculate M_r of **X** = $\frac{\text{mass lost}}{\text{moles of MgO}}$ **OR** M_r of **X** = $\left(\frac{\text{mass FA 4}}{\text{moles of MgO}}\right) - 40.3$ **AND** answer to 2–4 sf	**1**
2(b)(iii)	**X** is water / steam / H_2O / CO_2	**1**
2(b)(iv)	**FA 4** is magnesium hydroxide	**1**

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Question	Answer	Marks
2(c)	Student is not correct because there is no spitting / frothing during heating **OR** student is correct because there was spitting / frothing during heating	**1**
2(d)	*2 d.p. balance uncertainty = 0.01 g* ***or*** *0.005 g* *3 d.p. balance uncertainty = 0.001 g* ***or*** *0.0005 g* Correct expression for % error = $(^{2 \times \text{balance uncertainty}} / _{\text{mass of residue}}) \times 100$	**1**

Question	Answer	Marks
	FA 5 is $NaNO_3$; **FA 6** is $Al_2(SO_4)_3$; **FA 7** is I_2 + KI	
3(a)(i)	**M1**: 'table' (2 × 2 min) with headings: 'test / experiment / reagents' and 'observations' **AND** two (or more) reagents listed in the space **M2**: (*eliminating ammonium ion*) heat **FA 5** with (aqueous) NaOH **AND** no effervescence / (damp red) litmus stays red **M3**: (*identifying NO_2^- / NO_3^-)* add Al to warm NaOH and **FA 5** **AND** fizz / gas / NH_3 turns (damp red) litmus blue **M4**: (*eliminating NO_2^-)* anion is NO_3^- / nitrate / nitrate(V) **AND** **Either** add (a few drops of) (acidified) $KMnO_4$ / potassium manganate(VII) **AND** no change / no reaction / (solution) remains purple **Or** add (dilute) named mineral acid to (solid or aqueous) **FA 5 AND** no brown fumes / no blue solution / no reaction / no change produced	**4**

Question	Answer	Marks
3(a)(ii)	• solid melts / solid dissolves / liquid forms • fizzing / bubbling / effervescence • (gas) re-lights glowing splint / spill • oxygen produced • (on cooling), (pale) yellow solid formed **or** residue is yellow *3 or more bullets = 2 marks* *2 bullets = 1 mark*	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(b)(i)</td><td>
<table>
<tr><td>test</td><td>FA 6</td><td>FA 7</td></tr>
<tr><td>Test 1
NaOH</td><td>White ppt / solid (formed) *
Soluble in excess *</td><td>Decolourises / turns (pale) yellow *
(ppt is CON)</td></tr>
<tr><td>Test 2 Ba^{2+}</td><td>White ppt</td><td>No change / no reaction</td></tr>
<tr><td>+ HCl</td><td>AND ppt insoluble / remains / no change / no reaction *</td><td>AND no change / no reaction *</td></tr>
<tr><td>Test 3 starch</td><td></td><td>Dark blue / blue-black / black (colour formed) (ignore state)</td></tr>
<tr><td>+ thio</td><td></td><td>AND colourless solution (forms)
ALLOW turns colourless / decolourises *</td></tr>
<tr><td>Test 4 Ag^{+}</td><td>No change / no reaction / no ppt</td><td>Yellow / brown ppt (forms) *</td></tr>
<tr><td>+ NaOH</td><td>AND ppt (forms) (ignore colour) *</td><td>Pale yellow ppt
ALLOW ppt turns paler yellow *
IGNORE use of excess NaOH</td></tr>
<tr><td>Test 5 + NH_3</td><td>White ppt AND ppt is insoluble in excess (NH_3) *</td><td></td></tr>
</table>
2 * = 1 mark (round down)
</td><td>5</td></tr>
<tr><td>3(b)(ii)</td><td>FA 6 = A$l_2(SO_4)_3$ [1]
FA 7 = I_2 [1] AND KI [1]</td><td>3</td></tr>
</table>

Question	Answer	Marks
3(b)(iii)	$Al^{3+}(aq) + 3OH^-(aq) \rightarrow Al(OH)_3(s)$ **OR** $Al(OH)_3(s) + OH^-(aq) \rightarrow [Al(OH)_4]^-(aq)$ **OR** $I_2(aq) + 6OH^-(aq) \rightarrow I^-(aq) + IO_3^-(aq) + 3H_2O(l)$	**1**