Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/33**

Paper 3 Advanced Practical Skills 1 **October/November 2021**

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 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

© UCLES 2021

[Turn over

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.

© UCLES 2021

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.

© UCLES 2021

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.

© UCLES 2021

Question	Answer	Marks
1(a)	**I** Unambiguous headings **AND** correct units in the space provided • (mass) flask + acid / **FA 2** • (mass) container + **M**$_2$CO$_3$ / **FA 1** • (mass) container (+ residue) • (mass) flask + contents (provided this label not used for theoretical mass) • (mass) **FA 1** (added) • theoretical / total mass **or** flask + **FA 2** / acid + **FA 1** / **M**$_2$CO$_3$ • (mass) CO_2	**1**
	II Four balance readings recorded to the same number of decimal places **AND** answer to at least 1 decimal place	**1**
	III Three masses correctly calculated.	**1**
	IV Examiner calculates ratio $\frac{\text{mass FA 1}}{\text{mass carbon dioxide}}$ to 2 dp for candidate and difference from supervisor ratio. The mark is awarded for a difference $\leqslant 0.25$.	**1**
1(b)(i)	Correctly calculates amount of CO_2 = mass CO_2 lost / 44 mol **AND** answer given to 2 – 4 significant figures	**1**
1(b)(ii)	Correctly uses $M_r = \frac{\text{mass FA 1}}{\textbf{(b)(i)}}$ **AND** answer given to 2 – 4 sf (sf error is not penalised more than once in **1(b)**)	**1**

Question	Answer	Marks
1(b)(iii)	Correct expression A_r **M**$^+$ = $\frac{(\textbf{(b)(ii)} - 60)}{2}$ **AND** **M**$^+$ is the closest group 1 cation 0.1 < $Li^+ \leqslant$ 14.9 15.0 $\leqslant Na^+ \leqslant$ 31.1 31.2 $\leqslant K^+ \leqslant$ 62.3 62.3 $\leqslant Rb^+ \leqslant$ 109.2 109.2 $\leqslant Cs^+ \leqslant$ 250	**1**
1(c)(i)	Any one of: • saturate the acid with CO_2 **initially** • pre-heat the acid • use more concentrated acid • shake / swirl the flask **vigorously / more** • add named inert solute to solution	**1**
1(c)(ii)	M1: amount of acid added to flask, n(H^+) = 0.05 mol correct working or answer **OR** 2 × **(b)(i)** M2: n(H^+) **> 2** × n(**M**$_2CO_3$) where n(**M**$_2CO_3$) = **(b)(i) or** $\frac{\text{mass } \textbf{FA 1}}{\textbf{(b)(ii)}}$ Other valid methods may be awarded.	**2**

Question	Answer	Marks
2(a)	**I** The following data must be shown: • burette readings **and** titre for rough titration • 2 × 2 'box' showing both accurate burette readings.	**1**
	II Headings and units correct for accurate titration table and headings match readings. • initial / start **AND** (burette) reading / volume + unit • final / end **AND** (burette) reading / volume + unit • titre **OR** volume / **FA 4 AND** used / added + unit	**1**
	III **All** accurate burette readings given 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**
	Examiner calculates the mean titres for supervisor and candidate and awards marks according to the difference, d, in the values. Award **V** if $\delta \leqslant 0.60\ cm^3$ Award **VI** if $\delta \leqslant 0.40\ cm^3$ Award **VII** if $\delta \leqslant 0.20\ cm^3$	**3**
2(b)	Candidate must average two (or more) titres that are **all** within 0.20 cm^3 **AND** give the answer to 2 dp. **AND** working must be shown or ticks must be put next to the two (or more) accurate titres selected.	**1**
2(c)(i)	**All** answers for **(c)(ii)**, **(c)(iii)**, **(c)(iv)** are to 3 – 4 sf	**1**
2(c)(ii)	Correctly calculates amount of acid n(HCl) = 0.110 × **(b)** / 1000	**1**

Question	Answer	Marks
2(c)(iii)	Correctly uses n(M_2CO_3) in 25 cm^3 = $\frac{\textbf{(c)(ii)}}{2}$	**1**
2(c)(iv)	Correctly uses $M_r = \frac{7.46}{\textbf{(c)(iii)} \times 40}$	**1**
2(c)(v)	Correctly uses $\frac{(\textbf{(c)(iv)} - 60)}{2}$ **AND** **M**$^+$ is the closest group 1 cation $0.1 < Li^+ \leqslant 14.9$ $15.0 \leqslant Na^+ \leqslant 31.1$ $31.2 \leqslant K^+ \leqslant 62.3$ $62.3 \leqslant Rb^+ \leqslant 109.2$ $109.2 \leqslant Cs^+ \leqslant 250$	**1**
2(d)	Acid was more concentrated **because** smaller titre gives fewer moles of **M**$_2CO_3$ **OR** specimen calculation showing effect of different concentration provided. (*titre* ↓ = > $n(M_2CO_3)$ ↓ = > M_r↑) ORA	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td colspan="3">**FA 5** is $(NH_4)_2CO_3(s)$; **FA 7** is $CrK(SO_4)_2(aq)$; **FA 8** is $BaCl_2(aq)$</td></tr>
<tr><td>3(a)(i)</td><td>Award any two

• Sublimes / solid diminishes / disappears / solid formed on cooler part of tube / no residue
• Condensation / water droplets / steam
• Gas / NH_3 turns (damp red) litmus blue.

A positive test with limewater is credited in **(a)(ii)**</td><td>**2**</td></tr>
<tr><td>3(a)(ii)</td><td>Effervescence / bubbling / fizzing

AND

forms a white ppt with limewater/ limewater turns milky / chalky / cloudy white</td><td>**1**</td></tr>
<tr><td>3(b)(i)</td><td>M1, M2, M3 and M4 from observations table

2 * = 1 mark (round down)

<table>
<tr><th></th><th>FA 6</th><th>FA 7</th><th>FA 8</th></tr>
<tr><td>+ Ag^+</td><td>white ppt *
(insoluble in excess)</td><td>no (visible) reaction / no change / no ppt / solution **remains** blue / green / blue-green *</td><td>white ppt *
(insoluble in excess)</td></tr>
<tr><td>+ **FA 6**</td><td></td><td>effervescence / fizzing / bubbles *
(blue) solution turns green / greener *
grey-blue / grey-green / (pale) green ppt *
(award a positive limewater test in **(a)(ii)**)</td><td>white ppt *
(insoluble in excess)</td></tr>
<tr><td>+ **FA 7**</td><td></td><td></td><td>white ppt *
(insoluble in excess)</td></tr>
</table>
</td><td>**4**</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(b)(ii)</td><td>M1: Tabulates the two reagents and observations for FA 6, FA 7 and FA 8 in clearly labelled sections.

M2, M3, M4 and M5: from observations table

2 * = 1 mark (round down)

<table>
<tr><th></th><th>FA 6</th><th>FA 7</th><th>FA 8</th></tr>
<tr><td>+ NaOH</td><td>no (visible) reaction / no change / no ppt / remains colourless solution *</td><td>grey-green ppt * soluble in excess / (dark) green solution formed with excess *</td><td>(faint) white ppt
and insoluble in excess *
(allow no change / no (visible) reaction / no ppt)</td></tr>
<tr><td>+ warm *</td><td>gas / NH_3 turns (red) litmus blue *</td><td colspan="2">If (red) litmus turning blue is reported for either FA 7 or FA 8 then gas / NH_3 turns (red) litmus blue with FA 6 cannot be credited.</td></tr>
<tr><td>+ H_2SO_4</td><td>Fizzing / bubbling/ effervescence *
(award a positive limewater test in (a)(ii))</td><td>no (visible) reaction / no change / no ppt *</td><td>white ppt *
(insoluble in excess)</td></tr>
</table></td><td>5</td></tr>
<tr><td>3(c)(i)</td><td>M1, M2 and M3 from conclusions table:

2 * = 1 mark (round down)

<table>
<tr><th></th><th>cation</th><th>anion</th></tr>
<tr><td>FA 6</td><td>NH_4^+ *</td><td>CO_3^{2-} *</td></tr>
<tr><td>FA 7</td><td>Cr^{3+} *</td><td>SO_4^{2-} *</td></tr>
<tr><td>FA 8</td><td>Ba^{2+} / Ca^{2+} *</td><td>Cl^- *</td></tr>
</table></td><td>3</td></tr>
</table>

Question	Answer	Marks
3(c)(ii)	Correct ionic equation from test in **(a)** or **(b)** and ion given in **(c)(i)** Examples of correct ionic equations: $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ $Ba^{2+}(aq) + CO_3^{2-}(aq) \rightarrow BaCO_3(s)$ $Ba^{2+}(aq) + 2OH^-(aq) \rightarrow Ba(OH)_2(s)$ $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ $2Ag^+(aq) + CO_3^{2-}(aq) \rightarrow Ag_2CO_3(s)$ $Ca^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3(s)$	**1**