Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/31**

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.

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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.

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** Unambiguous headings **and** correct units • (Mass of) crucible and lid • (Mass of) crucible, lid and **FA 1** (or 'contents before heating') • (Mass of) crucible, lid and residue / oxide / contents after first heating / contents after cooling • (Mass of) crucible, lid and residue / oxide / contents after second heating / contents after cooling • (Mass of) **FA 1** used	**1**
	II Weighings recorded appropriately • Four weighings recorded in the space provided • All weighings recorded to same number of decimal places (one or more) • Mass used between 1.40 and 1.60 g	**1**
	III Mass after second heating within 0.05 g of mass after first heating for 2 or 3 dp balance. Mass **FA 1** and residue calculated correctly.	**1**
	IV and **V** Award **IV** if mass ratio within 0.30 of supervisor Award **V** if mass ratio within 0.15 of supervisor	**2**
1(b)(i)	Correctly calculates Mass CO_2 = mass **FA 1** – mass X_2O **OR** total mass before heating – total mass after 2nd heating	**1**
1(b)(ii)	Correctly calculates moles X_2CO_3 = moles of CO_2 = **(b)(i)** / 44 correctly calculated **AND** to 2–4 sf	**1**
1(b)(iii)	**Correctly uses:** M_r of X_2CO_3 = $\frac{\text{mass FA 1 used}}{\text{ans (b)(ii)}}$ **AND** Ans to 2–4 sf	**1**

Question	Answer	Marks
1(b)(iv)	**Correctly shows and uses:** M1: $A_r = \frac{\textbf{(b)(iii)} - 60}{2}$ M2: Chooses Group 1 nearest A_r using value from M1 **and** explains reason that it is closer to the A_r value. $0.1 < Li \leqslant 14.9$ $15.0 \leqslant Na \leqslant 31.1$ $31.2 \leqslant K \leqslant 62.3$ $62.3 \leqslant Rb \leqslant 109.2$ $109.2 \leqslant Cs \leqslant 250$	**2**
1(c)	If no change in mass between first and second heating decomposition was complete OR Not complete if further loss of mass	**1**

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 *'Correct' headings and units are not required for this mark*	**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 3 and** used / added + unit *Units: (cm^3) or / cm^3 or in cm^3 or cm^3 by every entry*	**1**
	III All accurate burette readings to 0.05 cm^3	**1**
	IV The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre. *Do **not** award the mark if any 'accurate' burette readings (apart from initial 0) are given to **zero** dp.*	**1**
	Award **V** if $\delta \leqslant 0.50$ cm^3 Award **VI** if $\delta \leqslant 0.30$ 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 quoted to 2 dp. Working must be shown or ticks must be put next to the two (or more) accurate titres selected.	**1**
2(c)(i)	Answers for **(c)(ii)**, **(c)(iii)**, **(c)(iv)** to 3–4 sf	**1**
2(c)(ii)	Correctly calculates $n(H_2SO_4) = 0.050 \times$ **(b)** / 1000	**1**
2(c)(iii)	Correctly uses [**FA 4**] = **(c)(ii)** × 2 × 40 mol dm^{-3}	**1**
2(c)(iv)	Correctly calculates [**FA 2**] = **(c)(iii)** × 10 mol dm^{-3}	**1**

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Question	Answer	Marks
2(c)(v)	Correctly uses M1: $M_r = \frac{26.3}{\textbf{(c)(iv)}}$ = Answer M2: Use of Answer – 17 and identify **Z** < Li ⩽ 14.9 15.0 ⩽ Na ⩽ 31.1 31.2 ⩽ K ⩽ 62.3 62.3 ⩽ Rb ⩽ 109.2 109.2 ⩽ Cs ⩽ 250	**2**
2(d)	Correctly uses $\lvert A_r$ from **(c)(v)** − A_r from periodic table$\rvert \times 100 / A_r$ from periodic table Answer from default = 18.16 or 18.2 or 18 %	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td colspan="3">FA 5 is BaCl_2(aq); FA 6 is H_2SO_4(aq); FA 7 is NaOH(aq); FA 8 is HCOOH(aq)</td></tr>
<tr><td>3(a)(i)</td><td>
<table>
<tr><th></th><th>FA 5</th><th>FA 6</th><th>FA 7</th></tr>
<tr><td>H_2SO_4</td><td>white ppt / solid *</td><td>no (visible) reaction / no change / no ppt / solution remains colourless *</td><td>no (visible) reaction / no change / no ppt / solution remains colourless *</td></tr>
<tr><td>Na_2CO_3</td><td>white ppt / solid *</td><td>effervescence / fizzing / bubbles *
gas / CO_2 turns limewater milky / cloudy white / forms white ppt *</td><td>no (visible) reaction / no change / no ppt / solution remains colourless *</td></tr>
<tr><td>MgCl_2</td><td>no (visible) reaction / no change / no ppt / solution remains colourless *</td><td>no (visible) reaction/ no change / no ppt / solution remains colourless *</td><td>white ppt / solid *</td></tr>
</table>
</td><td>5</td></tr>
<tr><td>3(a)(ii)</td><td>M1: Cation in FA 5 is Ba^{2+} or Ca^{2+}
M2: Cation in FA 6 is H^+
M3: Anion in FA 7 is OH^-</td><td>3</td></tr>
<tr><td>3(a)(iii)</td><td>Test for OH^-
Add specified (aqueous) metal compound
gives appropriate (coloured) ppt
OR
Add a specified nitrate and Al and warm
Positive test for ammonia
OR
Add a specified ammonium compound and warm
Positive test for ammonia</td><td>1</td></tr>
<tr><td>3(a)(iv)</td><td>Yes, because the test gave a named ppt of specified hydroxide which is insoluble (in water).
OR
Yes, because it gave ammonia gas (on warming) which is alkaline.</td><td>1</td></tr>
</table>

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Question	Answer	Marks
3(b)(i)	M1: Test 1 purple / pink to colourless / (pale) yellow / pale brown OR $KMnO_4$ is decolourised M2: Test 2 effervescence / fizzing / bubbles **AND** gas/ H_2 pops with a lighted splint / burns with a pop	**2**
3(b)(ii)	M1: (**FA 8**) can be oxidised / is a reducing agent M2: (**FA 8**) is an acid	**2**