Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/32**

Paper 3 (Advanced Practical Skills 2) **May/June 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 May/June 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** Initial and final burette readings and volume added recorded for rough titre and accurate titre details tabulated. (*minimum 2 × 2 boxes with relevant information)*.	**1**
	II Initial and final burette readings recorded and vol of **FB 2** added recorded for each accurate titration. Headings and units correct for accurate titrations. Headings: initial / final **and** (burette) reading / volume **or** reading / volume at start / finish *Do not allow difference / change* **and** volume / **FB 2** added / used or titre **and** units (cm^3) or / cm^3 **or** in cm^3 **or** cm^3 by every entry *Accept vol but not V*	**1**
	III All accurate burette readings are recorded to the nearest 0.05 cm^3. Do not award this mark if: 50(.00) is used as an initial burette reading; More than one final burette reading is 50(.00) Any burette reading is > 50(.00)	**1**
	IV The final accurate titre recorded is within 0.1 cm^3 of any other accurate titre. *Do not award the mark if any accurate burette readings (apart from 0) are given to **zero** dp.*	**1**
	For assessment of accuracy (Q) marks, the Examiner should round any burette readings to the nearest 0.05 cm^3. Check and correct subtractions. 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. Calculate the difference (δ) between the candidate's titre and the supervisor's titre. Award the accuracy (**Q**) marks as shown below.	

Question	Answer	Marks
1(a)	**V, VI** and **VII** Award **V, VI** and **VII** for $\delta \leqslant 0.20\ cm^3$ Award **V** and **VI** for $0.20 cm^3 < \delta \leqslant 0.30\ cm^3$ Award **V** for $0.30\ cm^3 < \delta \leqslant 0.50\ cm^3$	**3**
1(b)	Candidate must average two (or more) titres that are **all** within $0.20\ cm^3$. Working must be shown or ticks must be put next to the two (or more) accurate titres selected.	**1**
1(c)(i)	Answers to **(ii)** and **(iii)** given to 3–4 sf.	**1**
1(c)(ii)	Correctly calculates moles of $HCl = \frac{0.1 \times \text{vol in } \textbf{(b)}}{1000}$	**1**
1(c)(iii)	Correctly uses **(c)(ii)** ÷ 2 **and** x 40	**1**
1(c)(iv)	Correctly uses M1: $M_r = \frac{11.30}{\text{moles from } \textbf{(c)(iii)}}$ M2: $xH_2O = M_r$ hydrated −106 **or** $M_r = 106 + 18x$ M3: xH_2O to calculate x = M2 / 18 **and** answer shown to 2–4 sf ALLOW alternative methods (e.g. ratio of anhydrous : water)	**3**

Question	Answer	Marks
2(a)	**I** Table/lists given for at least one experiment Unambiguous headings and correctly displayed units • (Mass of) cup • (Mass of) cup + **FB 3** • (Mass of) **FB 3** • Initial thermometer reading / temperature • Maximum / highest / final thermometer reading / temperature	**1**
	II Precision of all four readings • thermometer readings to .5 °C • balance readings to same number of dp	**1**
	III Masses of **FB 3** 1.90 to 2.10 **and** 3.90 to 4.10 g **and** subtractions correct	**1**
	IV and V Examiner to round thermometer readings to nearest .5 ºC, calculate ΔT values then calculate ratio to 1 dp: ΔT experiment 2 / ΔT experiment 1 Award **IV** if 1.6 to 2.4 Award **V** if 1.8 to 2.2	**2**
2(b)(i)	Correctly calculates heat energy = $25 \times 4.2 \times \Delta T$ to 2–4 sf	**1**
2(b)(ii)	Correctly uses moles Na_2CO_3 = $\frac{\textbf{(b)(i)}}{28100}$	**1**
2(b)(iii)	Correctly uses mass Na_2CO_3 = **(b)(ii)** $\times$ 106 Allow ecf for RFM anhydrous Na_2CO_3 in **1(c)(iv)**	**1**
2(b)(iv)	Correctly uses $\% = \frac{\textbf{(b)(iii)}}{\text{Mass } \textbf{FB3} \text{ from Expt 1}} \times 100$	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(c)</td><td>The enthalpy of solution of the impurity was = 0 / negligible / the impurity does not give out / absorb any heat / cause a temperature change when it dissolves / impurity does not dissolve in water</td><td>1</td></tr>
<tr><td>2(d)</td><td>Experiment 1 was more accurate because a smaller temperature rise meant that heat losses were less.
OR
Experiment 2 was more accurate because has a larger temperature rise and therefore a smaller percentage error in temperature rise.</td><td>1</td></tr>
<tr><td>3(a)</td><td>
<table>
<tr><td></td><td>FB 4</td><td>FB 5</td></tr>
<tr><td>Test 1
heat</td><td>blue / green solid *</td><td>white solid *</td></tr>
<tr><td></td><td>goes black *</td><td>goes yellow *</td></tr>
<tr><td></td><td colspan="2">condensation in either *</td></tr>
<tr><td>cooling</td><td>ignore</td><td>white / paler solid *</td></tr>
<tr><td>Test 2
+ H_2SO_4</td><td colspan="2">bubbles in both *</td></tr>
<tr><td></td><td>blue soln *</td><td>colourless soln *</td></tr>
<tr><td></td><td colspan="2">attempts limewater in either *</td></tr>
<tr><td></td><td colspan="2">white ppt / turns milky / cloudy white *</td></tr>
</table>
2 * = 1 mark (round down)
</td><td>5</td></tr>
</table>

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(b)</td><td>
<table>
<tr><th>test</th><th>FB 6</th><th>FB 7</th></tr>
<tr><td>edta</td><td>turns brighter / more intense / darker blue *
ALLOW light blue to dark blue</td><td>No (visible) change / no reaction *
ALLOW (solution) stays colourless</td></tr>
<tr><td>NaOH</td><td>Blue ppt
and
insoluble in excess *</td><td>White ppt *

Soluble in excess *</td></tr>
<tr><td>NH_3</td><td>(Pale) blue ppt *

(Soluble excess to) dark blue solution *</td><td>White ppt *

Soluble in excess *</td></tr>
<tr><td>Mg</td><td>Pink / brown / dark grey / black solid *
ALLOW ppt

Blue fades / bubbles *</td><td></td></tr>
<tr><td>KI</td><td>Brown / yellow-brown / ochre *
(ignore state)</td><td></td></tr>
<tr><td>+ starch</td><td>Black / blue-black / dark blue *</td><td></td></tr>
<tr><td>HCl</td><td>(Solution) goes green / yellow *</td><td></td></tr>
</table>
2 asterisks = 1 mark (round down)
</td><td>7</td></tr>
<tr><td>3(c)</td><td>2 asterisks = 1 mark (round down)
<table>
<tr><th></th><th>FB 4</th><th>FB 5</th></tr>
<tr><td>cation</td><td>Cu^{2+}*</td><td>Zn^{2+}*</td></tr>
<tr><td>anion</td><td>CO_3^{2-}*</td><td>CO_3^{2-}*</td></tr>
</table>
</td><td>2</td></tr>
</table>

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Question	Answer	Marks
3(d)	$Cu^{2+}(aq) + Mg(s) \rightarrow Cu(s) + Mg^{2+}(aq)$ If bubbles recorded in test 4, allow $Mg(s) + 2H^{+}(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$ Allow ecf on identity of **FB 6**	**1**