Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2022**

MARK SCHEME

Maximum Mark: 30

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.

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

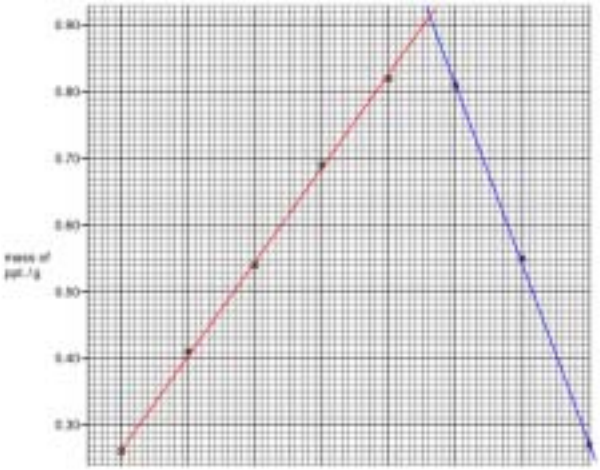
Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

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)	number of moles NaCl = $\frac{250.0}{1000} \times 0.200 = 0.05(00)$ mass of sodium chloride = 0.05(00) × (23.0 + 35.5) = 2.925 g	**1**
1(b)	(measure mass of weighing boat containing sodium chloride before transfer, **then**) measure the mass of weighing boat (and residue) (after transfer).	**1**
1(c)	**M1** add a (small) volume of distilled water (to the small beaker) **AND** dissolve the sodium chloride **M2** transfer the solution **and** washings into a 250 cm^3 volumetric flask **AND** make up to the mark with distilled water	**2**

Question	Answer	Marks
1(d)(i)	**M1** ***Extra step*** wash the precipitate / residue (with cold distilled water) [a] **OR** reheat (and reweigh) until mass is constant [b] **OR** rinse the beaker into filter (washings) [c] **OR** filter solution again [d] **M2** ***Explanation*** to remove (unreacted) sodium chloride and/or lead compound [a] **OR** to ensure all water has been removed from the solid [b] **OR** to ensure all solid/ppt has been transferred into the filter [c] **OR** to collect any precipitate that passed through the filter paper first time [d]	**2**
1(d)(ii)	$\frac{2 \times 0.05}{10} \times 100$ = 1(.0%) correct working **must** be shown	**1**
1(d)(iii)	repeat the experiment and/or compare with results from other students **AND** consistent results are obtained	**1**

Question	Answer	Marks
1(e)(i)	Two appropriate straight lines of best fit drawn that intersect. 	**1**
1(e)(ii)	**M1** volume of intersection correctly read from graph plotted in **(e)(i)**. (expected volumes: NaC*l*(aq) ≈ 33.25 cm^3, lead compound(aq) ≈ 16.75 cm^3) **M2** molar ratio consistent with volumes given for **M1**. (expected ratio = 2 : 1)	**2**
1(f)	empirical formula consistent with molar ratio given in **(e)(ii)**. (expected answer: $PbCl_2$)	**1**

Question	Answer	Marks
1(g)	**investigation 1** repeat measurement (of height of precipitate) until it is constant **OR** leave (for a longer time) until height of precipitate is constant (before measuring) **investigation 2** use a smaller volume of lead compound (in each case) **OR** add larger volumes of sodium chloride (until it is in excess)	**2**

Question	Answer	Marks
2(a)(i)	thermostatically controlled water bath	**1**
2(a)(ii)	flammable substance(s) are used (in the experiment)	**1**
2(b)(i)	(50 cm^3) burette	**1**
2(b)(ii)	10(.00) cm^3 (volumetric) pipette	**1**
2(c)	reduces the reaction rate (of hydrolysis reaction) **OR** quenches the reaction	**1**
2(d)	volume of sodium hydroxide (solution used in titration)	**1**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(e)(i)</td><td>
<table>
<tr><th>time / s</th><th>titre, V_t / cm^3</th><th>$V_{final} - V_t$ / cm^3</th></tr>
<tr><td>60</td><td>1.25</td><td>46.00</td></tr>
<tr><td>300</td><td>7.75</td><td>39.50</td></tr>
<tr><td>600</td><td>17.75</td><td>29.50</td></tr>
<tr><td>900</td><td>20.00</td><td>27.25</td></tr>
<tr><td>1200</td><td>24.25</td><td>23.00</td></tr>
<tr><td>1500</td><td>28.40</td><td>18.85</td></tr>
<tr><td>1800</td><td>31.15</td><td>16.10</td></tr>
<tr><td>2700</td><td>38.00</td><td>9.25</td></tr>
<tr><td>Final</td><td>47.25</td><td>(0.00)</td></tr>
</table>
</td><td>1</td></tr>
<tr><td>2(e)(ii)</td><td>concentration of the 2-bromo-2-methylpropane</td><td>1</td></tr>
<tr><td>2(e)(iii)</td><td>M1 all points plotted correctly

M2 smooth curve of best fit line drawn passing close to all points except anomaly</td><td>2</td></tr>
<tr><td>2(e)(iv)</td><td>M1 selects the point most anomalous to the plotted line of best fit
(point at 600, 29.5 expected)

M2 reaction was not effectively quenched</td><td>2</td></tr>
</table>

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Question	Answer	Marks
2(e)(v)	**M1** correctly placed construction lines shown on the graph to determine at least one half-life correctly **OR** both co-ordinates from line of best fit correctly recorded in the form (x,y) for either first $t_{½}$ **OR** second $t_{½}$ **M2** two sets of co-ordinates from line of best fit correctly recorded for first $t_{½}$ **AND** second $t_{½}$ in the form (x,y) **M3** two half-lives correctly calculated from listed co-ordinates (expected value: 1159 s)	**3**
2(e)(vi)	first order **AND** half-lives are constant (within experimental error)	**1**

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