Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/34**

Paper 3 Advanced Practical Skills 2 **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.

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)	Accuracy marks Write and ring the supervisor's volume of gas evolved on each candidate script. **M1** volume of gas recorded within 25% of supervisor value **M2** volume of gas recorded within 10% of supervisor value **AND** rounded to nearest integer	**2**
1(b)(i)	Correctly calculates amount of CO_2 = $\frac{\text{volume of gas}}{24000}$ mol **AND** answer to 2–4 significant figures	**1**
1(b)(ii)	**M1** correctly uses amount of HC*l* = **(b)(i)** × 2 in 50 cm^3 mol **M2** concentration of HC*l* = answer above × 20 mol dm^{-3} **AND** answer to 2–4 significant figures	**2**
1(c)(i)	**M1** solid / calcium carbonate / $CaCO_3$ / **FB 2** / residue still present / when reaction finished / at the end **M2** solid / calcium carbonate / $CaCO_3$ / **FB 2** is in excess **OR** the acid is the limiting reagent (ora)	**2**
1(c)(ii)	*One of the following:* • specified method to keep solid and acid apart until bung fitted (e.g. divided flask / suspend solid in ignition tube / weighing boat / small beaker and may be shown as a labelled diagram) • use lumps of solid to reduce rate of reaction • use more dilute acid to reduce rate of reaction • cool (reaction) flask / acid to reduce rate of reaction	**1**

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Question	Answer	Marks
2(a)	**I** Seven thermometer readings recorded **II** All thermometer readings recorded to nearest 0.5 °C with at least one at .0 and one at .5 **AND** all burette readings to .#0 or .#5 cm^3. **III** Two appropriate extra volumes chosen **AND** volume of water used + volume of **FB 4** = 10(.00) cm^3 The volumes selected must be at least 0.50 cm^3 from any other. One value must be the volume between the first highest temperature and one of the adjacent temperatures. The second must not be between the same two set experiments as value one. If there is no maximum temperature for experiments 1–5 then the one value must be between 7.00 and 9.00 cm^3 and the other 9.50 or 10.00 cm^3. Accuracy marks Calculate the supervisor's ΔT at 5.00 cm^3 of added **FB 4** (initial thermometer reading). This value must be written and ringed on each candidate's script. Calculate and record candidate's ΔT for the same pair of readings. Calculate and record the difference, δ, from supervisor. **IV** Award if $\delta \leqslant 1.0$ ºC **V** Award if $\delta \leqslant 0.5$ ºC	**5**

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Question	Answer	Marks
2(b)	**I** Axes correctly labelled with temperature **AND** / ºC or (ºC) on the *y*-axis volume / **FB 4 AND** / cm^3 or (cm^3) on the *x*-axis **AND** suitable scales selected to occupy more than half of the available space on both axes and including 2 ºC above the highest recorded temperature on the *y*-axis	**4**
	II All points recorded in the table are accurately plotted. Those on the line must be exactly on the line; those not on the line must be in the correct half of the small square.	
	III Lines of best fit Two straight lines of best fit drawn with a ruler. The two lines must give a sharp intersection at (or above) the highest temperature. There must be at least 3 points considered for the line of best fit where the maximum temperature is increasing. Any points labelled anomalous are disregarded.	
	IV Correct volume of **FB 4** at intersection **AND** given to 1 (or 2) d.p.	
2(c)(i)	All answers to **(c)(ii), (iii), (iv)** and **(v)** are given to 2–4 significant figures	**1**
2(c)(ii)	Correctly calculates amount of HCl = $\frac{2.2 \times \text{volume in } \textbf{(b)}}{1000}$ mol	**1**
2(c)(iii)	Correctly uses concentration of NaOH = **(c)(ii)** × 100 mol dm^{-3}	**1**
2(c)(iv)	**M1** correctly calculates ΔT_{max} (from table or graph) **OR** correct figures for calculation shown **M2** correctly calculates energy released = 20(.00) × 4.18 × ΔT_{max} **AND** answer correct	**2**
2(c)(v)	Correctly uses enthalpy change = $\frac{\textbf{(c)(iv)}}{[\textbf{(c)(ii)} \times 1000]}$ kJ mol^{-1} **AND** answer with negative sign given	**1**

Question	Answer	Marks
2(d)(i)	Correct expression % error = $\left[\frac{(-)57.6-(-)\mathbf{(c)(v)}}{(-)57.6}\right] \times 100$	**1**
2(d)(ii)	*Any one of:* • Measure initial temperatures of water **AND FB 4** • Take more readings **near** the largest maximum temperature • Record initial temperature for each experiment	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td colspan="2">FB 5 is $H_2SO_4(aq)$; FB 6 is HCl(aq); FB 7 is HCOOH(aq); FB 8 is $H_2O_2(aq)$; FB 9 $MgSO_4(aq)$</td><td></td></tr>
<tr><td>3(a)(i)</td><td>
<table>
<tr><th>test</th><th>FB 5</th><th>FB 6</th><th>FB 7</th><th>FB 8</th></tr>
<tr><td>Test 1
Mg</td><td>fizz *

H_2 / gas pops with lighted splint / burns with pop *</td><td>fizz *

H_2 / gas pops with lighted splint / burns with pop</td><td>slower * fizz *

H_2 / gas pops with lighted splint / burns with pop</td><td>no change / no effect / no visible reaction / no fizzing *</td></tr>
<tr><td>Test 2
$KMnO_4$</td><td>no change / no effect / no (visible) reaction
OR
$KMnO_4$ remains purple *</td><td>no change / no effect / no (visible) reaction
OR
$KMnO_4$ remains purple *</td><td>purple to colourless / yellow / brown
OR
$KMnO_4$ turns colourless / decolourises / yellow / brown *</td><td>purple to colourless
OR
$KMnO_4$ turns colourless / decolourises *</td></tr>
</table>
2 * = 1 mark

The relative rate of reaction of Mg with the three acids may be awarded from ‘rapid’ (owtte) fizz with either or both FB 5 and FB 6.
The gas test for H_2 may be awarded in any one of the three boxes for FB 5, FB 6 or FB 7. However, an incorrect gas ‘identified’ in Test 1 negates this *.
A slight change in colour (purple to brown *) may be noted with $KMnO_4$ and FB 6 on heating.
</td><td>5</td></tr>
</table>

Question	Answer	Marks
3(a)(ii)	**M1 FB 7** is methanoic acid / HCOOH / HCO_2H **AND FB 8** is hydrogen peroxide / H_2O_2 **M2** Correct explanation for one of **FB 7** or **FB 8** from observations in table: Methanoic acid / **FB 7** Fizzes with Mg / H_2 produced **and** slowest (reaction) **OR** oxidised by $KMnO_4$ / decolourises $KMnO_4$ (allow yellow / brown unless the same observations are given with **FB 6**) **OR** Hydrogen peroxide / **FB 8** no fizz / no reaction with Mg **OR** decolourises $KMnO_4$ immediately / without heating / oxidised by $KMnO_4$ immediately	**2**
3(a)(iii)	**M1** **EITHER** add (aqueous) $AgNO_3$ / silver nitrate **AND** white ppt with **FB 6** **OR** add (aqueous) barium chloride / $BaCl_2$ / barium nitrate / $Ba(NO_3)_2$ **AND** white ppt with **FB 5** **M2 FB 5** is sulfuric acid / H_2SO_4 **AND FB 6** is hydrochloric acid / HCl **AND** from correct observation	**2**
3(a)(iv)	$Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$	**1**
3(a)(v)	**M1** magnesium: effervescence / fizz / bubbling **M2** potassium manganate(VII): no effect / no (visible) reaction / $KMnO_4$ remains purple	**2**
3(b)	2 * = 1 mark use of (aqueous) NaOH **AND** NH_3 * with NaOH white ppt * ppt insoluble in excess * with NH_3 white ppt * ppt insoluble in excess * cation is Mg^{2+} *	**3**