



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.

This document consists of **10** printed pages.

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.

PUBLISHED**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	<p><u>'List rule' guidance</u></p> <p>For questions that require <i>n</i> responses (e.g. State two reasons ...):</p> <ul style="list-style-type: none"> • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked <i>ignore</i> in the mark scheme should not count towards <i>n</i>. • Incorrect responses should not be awarded credit but will still count towards <i>n</i>. • 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 <i>n</i> responses may be ignored even if they include incorrect science.

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.

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 $\text{CO}_2 = \frac{\text{volume of gas}}{24000} \text{ mol}$ AND answer to 2–4 significant figures	1
1(b)(ii)	M1 correctly uses amount of $\text{HCl} = (\mathbf{b})(\mathbf{i}) \times 2 \text{ in } 50 \text{ cm}^3 \text{ mol}$ M2 concentration of $\text{HCl} = \text{answer above} \times 20 \text{ mol dm}^{-3}$ 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)	<i>One of the following:</i> <ul style="list-style-type: none"> • 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)	<p>I Seven thermometer readings recorded</p> <p>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 cm³.</p> <p>III Two appropriate extra volumes chosen AND volume of water used + volume of FB 4 = 10(.00) cm³ The volumes selected must be at least 0.50 cm³ 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 cm³ and the other 9.50 or 10.00 cm³.</p> <p>Accuracy marks Calculate the supervisor's ΔT at 5.00 cm³ 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.</p> <p>IV Award if $\delta \leq 1.0$ °C V Award if $\delta \leq 0.5$ °C</p>	5

Question	Answer	Marks
2(b)	<p>I Axes correctly labelled with temperature AND / °C or (°C) on the <i>y</i>-axis volume / FB 4 AND / cm³ or (cm³) on the <i>x</i>-axis AND suitable scales selected to occupy more than half of the available space on both axes and including 2 °C above the highest recorded temperature on the <i>y</i>-axis</p> <p>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.</p> <p>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.</p> <p>IV Correct volume of FB 4 at intersection AND given to 1 (or 2) d.p.</p>	4
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 = $\frac{2.2 \times \text{volume in (b)}}{1000}$ 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 = $\frac{\text{(c)(iv)}}{[\text{(c)(ii)} \times 1000]}$ kJ mol ⁻¹ AND answer with negative sign given	1

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Question	Answer	Marks
2(d)(i)	Correct expression $\% \text{ error} = \left[\frac{(-)57.6 - (-)(\mathbf{c})(\mathbf{v})}{(-)57.6} \right] \times 100$	1
2(d)(ii)	<i>Any one of:</i> <ul style="list-style-type: none">• Measure initial temperatures of water AND FB 4• Take more readings near the largest maximum temperature• Record initial temperature for each experiment	1

Question	Answer				Marks															
FB 5 is H ₂ SO ₄ (aq); FB 6 is HCl(aq); FB 7 is HCOOH(aq); FB 8 is H ₂ O ₂ (aq); FB 9 MgSO ₄ (aq)																				
3(a)(i)	<table border="1" data-bbox="409 316 1865 850"> <thead> <tr> <th data-bbox="409 316 562 381"><i>test</i></th> <th data-bbox="562 316 882 381">FB 5</th> <th data-bbox="882 316 1202 381">FB 6</th> <th data-bbox="1202 316 1543 381">FB 7</th> <th data-bbox="1543 316 1865 381">FB 8</th> </tr> </thead> <tbody> <tr> <td data-bbox="409 381 562 584">Test 1 Mg</td> <td data-bbox="562 381 882 584">fizz * H₂/ gas pops with lighted splint / burns with pop *</td> <td data-bbox="882 381 1202 584">fizz * H₂/ gas pops with lighted splint / burns with pop</td> <td data-bbox="1202 381 1543 584">slower * fizz * H₂/ gas pops with lighted splint / burns with pop</td> <td data-bbox="1543 381 1865 584">no change / no effect / no visible reaction / no fizzing *</td> </tr> <tr> <td data-bbox="409 584 562 850">Test 2 KMnO₄</td> <td data-bbox="562 584 882 850">no change / no effect / no (visible) reaction OR KMnO₄ remains purple *</td> <td data-bbox="882 584 1202 850">no change / no effect / no (visible) reaction OR KMnO₄ remains purple *</td> <td data-bbox="1202 584 1543 850">purple to colourless / yellow / brown OR KMnO₄ turns colourless / decolourises / yellow / brown *</td> <td data-bbox="1543 584 1865 850">purple to colourless OR KMnO₄ turns colourless / decolourises *</td> </tr> </tbody> </table> <p data-bbox="338 887 501 916">2 * = 1 mark</p> <p data-bbox="338 959 1879 1018">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.</p> <p data-bbox="338 1026 1850 1085">The gas test for H₂ 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 *.</p> <p data-bbox="338 1093 1536 1121">A slight change in colour (purple to brown *) may be noted with KMnO₄ and FB 6 on heating.</p>				<i>test</i>	FB 5	FB 6	FB 7	FB 8	Test 1 Mg	fizz * H ₂ / gas pops with lighted splint / burns with pop *	fizz * H ₂ / gas pops with lighted splint / burns with pop	slower * fizz * H ₂ / gas pops with lighted splint / burns with pop	no change / no effect / no visible reaction / no fizzing *	Test 2 KMnO ₄	no change / no effect / no (visible) reaction OR KMnO ₄ remains purple *	no change / no effect / no (visible) reaction OR KMnO ₄ remains purple *	purple to colourless / yellow / brown OR KMnO ₄ turns colourless / decolourises / yellow / brown *	purple to colourless OR KMnO ₄ turns colourless / decolourises *	5
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Question	Answer	Marks
3(a)(ii)	<p>M1 FB 7 is methanoic acid / HCOOH / HCO₂H AND FB 8 is hydrogen peroxide / H₂O₂</p> <p>M2 Correct explanation for one of FB 7 or FB 8 from observations in table:</p> <p>Methanoic acid / FB 7 Fizzes with Mg / H₂ produced and slowest (reaction) OR oxidised by KMnO₄ / decolourises KMnO₄ (allow yellow / brown unless the same observations are given with FB 6)</p> <p>OR Hydrogen peroxide / FB 8 no fizz / no reaction with Mg OR decolourises KMnO₄ immediately / without heating / oxidised by KMnO₄ immediately</p>	2
3(a)(iii)	<p>M1 EITHER add (aqueous) AgNO₃ / silver nitrate AND white ppt with FB 6 OR add (aqueous) barium chloride / BaCl₂ / barium nitrate / Ba(NO₃)₂ AND white ppt with FB 5</p> <p>M2 FB 5 is sulfuric acid / H₂SO₄ AND FB 6 is hydrochloric acid / HCl AND from correct observation</p>	2
3(a)(iv)	$\text{Mg(s)} + 2\text{H}^+(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{H}_2(\text{g})$	1
3(a)(v)	<p>M1 magnesium: effervescence / fizz / bubbling</p> <p>M2 potassium manganate(VII): no effect / no (visible) reaction / KMnO₄ remains purple</p>	2
3(b)	<p>2 * = 1 mark</p> <p>use of (aqueous) NaOH AND NH₃ *</p> <p>with NaOH white ppt * ppt insoluble in excess *</p> <p>with NH₃ white ppt * ppt insoluble in excess *</p> <p>cation is Mg²⁺ *</p>	3