



Cambridge International AS & A Level

CHEMISTRY

9701/34

Paper 3 Advanced Practical Skills 2

May/June 2023

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 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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.

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.

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)	<p>I All thermometer readings to .0 or .5 °C AND at least one at .0 °C and one at .5 °C</p> <p>Accuracy marks Examiner calculates ΔT_{\max} for supervisor. Examiner calculates ΔT_{\max} for candidate. Calculate and record the difference between supervisor and candidate value, δ.</p> <p>II and III Award accuracy marks as shown:</p> <table border="1" data-bbox="338 555 1088 794"> <tbody> <tr> <td data-bbox="338 555 524 655">Supervisor ΔT_{\max}</td> <td data-bbox="524 555 712 655">≤ 6.5 °C</td> <td data-bbox="712 555 900 655">7.0–15.0 °C</td> <td data-bbox="900 555 1088 655">>15.0 °C</td> </tr> <tr> <td data-bbox="338 655 524 724">1 mark</td> <td data-bbox="524 655 712 724">$\delta \leq 1.0$ °C</td> <td data-bbox="712 655 900 724">$\delta \leq 1.5$ °C</td> <td data-bbox="900 655 1088 724">$\delta \leq 2.0$ °C</td> </tr> <tr> <td data-bbox="338 724 524 794">2 marks</td> <td data-bbox="524 724 712 794">$\delta \leq 0.5$ °C</td> <td data-bbox="712 724 900 794">$\delta \leq 1.0$ °C</td> <td data-bbox="900 724 1088 794">$\delta \leq 1.5$ °C</td> </tr> </tbody> </table>	Supervisor ΔT_{\max}	≤ 6.5 °C	7.0–15.0 °C	>15.0 °C	1 mark	$\delta \leq 1.0$ °C	$\delta \leq 1.5$ °C	$\delta \leq 2.0$ °C	2 marks	$\delta \leq 0.5$ °C	$\delta \leq 1.0$ °C	$\delta \leq 1.5$ °C	3
Supervisor ΔT_{\max}	≤ 6.5 °C	7.0–15.0 °C	>15.0 °C											
1 mark	$\delta \leq 1.0$ °C	$\delta \leq 1.5$ °C	$\delta \leq 2.0$ °C											
2 marks	$\delta \leq 0.5$ °C	$\delta \leq 1.0$ °C	$\delta \leq 1.5$ °C											
1(b)(i)	<p>M1 Temperature on y-axis and volume of FB 2 added on the x-axis AND with unambiguous names or units AND some numbers for scales</p> <p>M2 Linear scales which include 2 °C above highest T in table AND plotted points/data and 2 °C above highest T in table, would occupy at least 5 × 5 big squares</p> <p>M3 All recorded points plotted correctly</p> <p>M4 Two lines of best fit drawn (straight line or smooth curve) covering all plotted points ignoring points labelled anomalous AND extrapolated to intersect</p>	4												
1(b)(ii)	Reads and records volume of FB 2 at intersection to 1 or 2 decimal places	1												
1(c)(i)	<p>Correctly uses results to calculate energy released $Q = (25 + \text{volume in (b)(ii)}) \times 4.18 \times \text{temp rise}$ AND answer to 2 or more significant figures</p>	1												

Question	Answer	Marks
1(c)(ii)	Correctly calculates amount of NaOH $(= 1.9 \times 25 / 1000) = 4.75 \times 10^{-2}$ AND answer given to 2–4 significant figures	1
1(c)(iii)	Correct use of (c)(i) and (c)(ii) to calculate enthalpy change $= - \text{(c)(i)} / [\text{(c)(ii)} \times 1000]$ AND answer given to 2–4 significant figures with negative sign shown	1
1(c)(iv)	Correct expression evaluated $M_r \text{ CH}_3\text{CHXCOOH} = [312.5 \times \text{(b)(ii)}] / [\text{(c)(ii)} \times 1000]$	1
1(c)(v)	Correct use of (c)(iv) to identify acid $A_r = \text{(c)(iv)} - 73$ AND correct choice of acid $\text{CH}_3\text{CHF}\text{COOH} \leq 100.25$ $100.25 < \text{CH}_3\text{CHCl}\text{COOH} \leq 130.7$ $130.7 < \text{CH}_3\text{CHBr}\text{COOH} \leq 176.4$ $176.4 < \text{CH}_3\text{CHICOOH}$	1
1(c)(vi)	Correct expression evaluated $[\text{actual } M_r - \text{(c)(iv)}] \times 100 / \text{actual } M_r$ $\text{CH}_3\text{CHF}\text{COOH} = 92.0$ $\text{CH}_3\text{CHCl}\text{COOH} = 108.5$ $\text{CH}_3\text{CHBr}\text{COOH} = 152.9$ $\text{CH}_3\text{CHICOOH} = 199.9$	1

Question	Answer	Marks
2(a)	<p>I Three weighings recorded in the space provided AND all weighings recorded to the same decimal places (2 or 3)</p> <p>II Correct headings AND correct displayed units</p> <ul style="list-style-type: none"> • (Mass of) crucible (+ lid) • (Mass of) crucible (+ lid) + FB 3 (or 'contents before heating') • (Mass of) crucible (+ lid) + residue / MO / metal oxide / contents (after heating) • (Mass of) FB 3 • (Mass of) residue / MO / metal oxide / contents after heating • (Mass) loss / FB 3 – residue/ CO₂ <p>Units must be 'g' or 'in' or '(g)' AND g or 'grams' in column headings or with every entry</p> <p>III Correct subtractions to give masses of FB 3, residue and mass loss AND values are correctly labelled AND mass of FB 3 is between 0.90 and 1.10 g.</p> <p>Accuracy marks Calculate supervisor's mass ratio (to 2 d.p.) = mass FB 3 / mass of residue Calculate candidate's mass ratio (to 2 dp) = mass FB 3 / mass of residue Difference (δ) between the candidate's mass ratio and the supervisor's mass ratio</p> <p>IV if δ is within 25% of the supervisor ratio V if δ is within 10% of the supervisor ratio</p>	5
2(b)(i)	<p>Correctly calculates amount of CO₂ lost = mass loss / 44 AND answer given to 2–4 significant figures</p>	1
2(b)(ii)	<p>Correct use of (b)(i) to calculate M_r M_r = mass of FB 3 used / (b)(i) AND answer given to 2–4 significant figures</p>	1
2(b)(iii)	<p>Correct use of (b)(ii) to identify A_r = (b)(ii) – 60 AND selects metal that forms a 2+ ion with suitable A_r</p>	1

Question	Answer	Marks
2(c)	The M_r would appear <u>lower</u> AND it would appear that greater amount / moles of CO_2 was lost	1
2(d)	M1 test: add named acid M2 fizz / effervescence / bubbles AND (some) FB 3 not decomposed (owtte) OR no fizz / effervescence / bubbles / no reaction AND FB 3 completely decomposed (owtte)	2

Question	Answer			Marks	
FB 4 is HNO ₃ (aq), FB 5 is HCOOH(aq), FB 6 is H ₂ SO ₄ (aq) and FB 7 is NaBr(aq)					
3(a)(i)	<i>observations</i>			7	
	<i>test</i>	FB 4	FB 5		FB 6
	Test 1 + KMnO ₄ (and warm)	no change / (KMnO ₄) stays purple / no (visible) reaction *	(solution) turns colourless / KMnO ₄ decolourised *		look to box below
		ignore			no change / (solution stays) purple / no (visible) reaction *
	Test 2 + Cu turnings	effervescence / fizzing / bubbling (on warming) * solution (turns) (pale) blue / green-blue / blue-green OR (pale) brown gas / bubbles *	no (visible) reaction / no change *		no (visible) reaction / no change *
	Test 3 + Mg ribbon	(slow) effervescence / fizzing / bubbling *	(slow) effervescence / fizzing / bubbling *		fast / rapid / vigorous gas made / fizz / effervescence / bubbling *
	gentle shake after leaving	Mg remaining OR effervescence *	Mg remaining OR effervescence *		becomes hot owtte / exothermic * no Mg remaining / colourless solution only *
anywhere in Test 3: (gas / H ₂) burns with a 'pop' / pops with a lighted splint * *					
2 * = 1 mark (round down)					

Question	Answer	Marks
3(a)(ii)	<p>M1 FB 4 is nitric acid / HNO₃ AND slower effervescence than FB 6 OR forms brown gas / NO₂ (with Cu) OR blue solution (with Cu) OR reacts with Cu</p> <p>M2 FB 5 is methanoic acid / HCOOH AND (only acid to) decolourise KMnO₄ (owtte) OR (only) methanoic acid can be oxidised</p> <p>M3 FB 6 is sulfuric acid / H₂SO₄ AND faster / fastest bubbling with Mg OR Mg disappears</p>	3
3(b)(i)	<p>M1 acidifies FB 7 with nitric acid (before testing with AgNO₃)</p> <p>M2 adds (aqueous) silver nitrate / AgNO₃ AND off-white / cream ppt</p> <p>M3 adds (aqueous) ammonia / NH₃ AND ppt partially soluble / insoluble AND bromine</p>	3
3(b)(ii)	<p>Two marks for fully correct equation (with excess NaOH): $2\text{NaOH} + \text{CH}_3\text{CHXCOOH} \rightarrow \text{CH}_3\text{CH(OH)COONa} + \text{NaX} + \text{H}_2\text{O}$ where X is the halogen identified in (b)(i) or 'X'</p> <p>One mark for: unbalanced equation with correct formulae OR $\text{NaOH} + \text{CH}_3\text{CHXCOOH} \rightarrow \text{CH}_3\text{CH(OH)COOH} + \text{NaX}$ OR $\text{NaOH} + \text{CH}_3\text{CHXCOOH} \rightarrow \text{CH}_3\text{CH(OH)COONa} + \text{HX}$</p>	2