Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/33**

Paper 3 Advanced Practical Skills 1 **October/November 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 October/November 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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

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	<u>‘List rule’ guidance</u> 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	<u>Calculation specific guidance</u> 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	<u>Guidance for chemical equations</u> 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)	**I** All the following data are recorded • two burette readings **and** titre for the rough titration • initial and final burette readings for **two** (or more) accurate titrations	
	II **Appropriate headings** and units shown in the **accurate** titration table **and titre values** recorded for accurate titrations. • initial / start **and** (burette) reading/volume • final / end **and** (burette) reading/volume • titre **or** volume / **FA 3 and** used / added • unit: / cm^3 **or** (cm^3) **or** in cm^3 (for each heading) **or** cm^3 unit given for each volume recorded	
	III All **accurate** burette readings are recorded to the nearest 0.05 cm^3. *The requirement to record to 0.05 applies to burette readings, including 0.00 cm^3 (if this was the initial reading), but it does **not** apply to the titre.*	
	IV The **final** accurate titre recorded is within 0.10 cm^3 of any other accurate titre. *Do **not** include a reading if it is labelled 'rough'.*	
	For assessment of accuracy (Q) marks, the Examiner should round all 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 mean titre and the supervisor's. **Award three accuracy (Q) marks as shown below.**	
	Award **V** if $\delta \leqslant$ **0.60** (cm^3) Award **VI** if $\delta \leqslant$ **0.40** Award **VII** if $\delta \leqslant$ **0.20** **Tolerances** for low titres**:** If supervisor's titre is $\leqslant$ 10.00 cm^3, tolerances are 0.30, 0.20, 0.10 cm^3. If supervisor's titre is $\leqslant$ 5.00 cm^3 then tolerances are 0.15, 0.10, 0.05 cm^3.	**7**

Question	Answer	Marks
1(b)	**Correctly calculates the mean titre.** • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm^3. • Working/explanation **must** be shown ***or*** ticks must be shown next to the two (or more) accurate readings selected. • The mean should be quoted to **2 dp**, and be rounded correctly to nearest 0.01 cm^3. *(e.g. 26.625 cm^3 must be rounded to 26.63 cm^3)* • Allow a mean expressed to 1 dp, if **all** accurate burette readings were given to 1 dp **and** the mean is **exactly** correct. *(e.g. mean of 26.0 and 26.2 = 26.1 is allowed)* *(e.g. mean of 26.0 and 26.1 = 26.1 is wrong: it should be 26.05)*	**1**
1(c)(i)	**All answers to parts (c)(ii), (c)(iii)** and **(c)(iv)** quoted to 3 or 4 significant figures (sf).	**1**
1(c)(ii)	**Correct calculation of no of moles of $Na_2S_2O_3$** No of moles = $0.120 \times {}^{\text{mean titre}}/_{1000}$	**1**
1(c)(iii)	**Correct use of 1(c)(ii)** **M1:** amount of $KMnO_4$ in 25 cm^3 **FA 1** = 0.2 × **(c)(ii)** mol **M2:** Conc^n of $KMnO_4$ = 40 × 0.2 × **(c)(ii)** = 8 × **(c)(ii)** mol dm^{-3}	**2**
1(c)(iv)	**Correct use of (c)(iii)** to calculate volume of **FA 1** Volume of **FA 1** = ${}^{50}/_{158} \times {}^{1}/_{\textbf{(c)(iii)}}$	**1**
1(d)	No **and FA 2** is used in excess (so exact volume is not important)	**1**

Question	Answer	Marks
2(a)(i)	**I** **Six unambiguous headings recorded, with correctly displayed units and in the space provided.** • Units: (°C), / g, in g, **or** °C or g against each value • (Mass of) container + **FA 6** / MgO / contents / solid / g • (Mass of) (empty) container (+ residue) / g • (Mass of) **FA 6** / MgO (used) / g • (Initial) temperature / °C • Maximum / final temperature / °C • Temperature rise / change / ΔT / °C	**3**
	II **Precision of <u>readings</u>** in <u>both</u> experiments, **2(a)** and **2(b).** • Four weighings to same number of decimal places (2 or 3) • Four thermometer readings to .0 or .5 °C	
	III **Correct subtractions** to calculate masses of **FA 6 and FA 8** **and** for the temperature changes in **both (a) and (b)**.	
2(a)(ii)	**Correct calculation** of energy change Energy change = 30 × 4.18 × temp rise (= 125.4 × ΔT) AND answer correctly rounded to 2–4 sf *Do not penalise inappropriate sf twice in question 2.*	**1**
2(a)(iii)	**Correct use of (a)(ii)** M1: Correct display Amount of MgO = $^{\text{mass used}}/_{\mathbf{40.3}}$ mol (no answer required) M2: Correctly uses Enthalpy change = $^{\textbf{(a)(ii)}}/_{\text{mol MgO}} \times {}^{1}/_{1000}$ kJ mol^{-1} **and** answer shows negative sign **and** is quoted to 2–4 sf	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td rowspan="3">2(b)(i)</td><td>I Six pieces of data recorded in the space provided (same readings are required as in (a)(i))
• Three temperatures
• Three masses</td><td></td></tr>
<tr><td>Accuracy marks in 2(b)
• Round thermometer readings to 0.5 ºC if necessary
• Check supervisor’s and candidate’s subtractions for temp rise
• Calculate difference (δ) between supervisor and candidate (to 0.5 ºC).</td><td></td></tr>
<tr><td>II + III: Accuracy marks in 2(b)
<table>
<tr><td>ΔT_{sup} / ºC</td><td><5.0</td><td>5.0–9.5</td><td>10.0–19.5</td><td>20.0–29.5</td><td>$\geqslant$ 30.0</td></tr>
<tr><td>1 mark</td><td>±1.0</td><td>±1.5</td><td>2.0</td><td>2.5</td><td>3.0</td></tr>
<tr><td>2 marks</td><td>±0.5</td><td>±1.0</td><td>1.0</td><td>1.5</td><td>2.0</td></tr>
</table></td><td>3</td></tr>
<tr><td>2(b)(ii)</td><td>Correct use of data in enthalpy calculation
M1: Amount $Mg(OH)_2$ reacting = 0.5 × mol HCl (since $Mg(OH)_2$ in excess)
= 0.5 × 0.030 × 2.00 = 0.030 mol
M2: Correct use of data in remainder of calculation (all three bullets correct)
• Energy released = 30 × 4.18 × temp rise in (b) (J)
• Enthalpy change = $^{\text{heat released}}/_{1000}$ x 0.030 kJ mol^{-1}
• Answer has negative sign and is quoted to 2–4 sig fig.</td><td>2</td></tr>
<tr><td>2(c)</td><td>Enthalpy change (correctly calculated, with correct sign)
ΔH_r = (a)(iii) – (b)(ii) kJ mol^{-1}</td><td>1</td></tr>
</table>

Question	Answer	Marks
FA 9 is $ZnCO_3$; **FA 10** is ammonium iron(III) sulfate, $NH_4Fe(SO_4)_2$		
3(a)	**Test for anion** **EITHER** Add specified mineral acid * Fizzing / effervescence / bubbling occurs ***** (Bubble) gas/CO_2 through limewater ***** White ppt formed * Colourless **solution** formed **or** vigorous (owtte) reaction * **OR** Heat the solid ***** (Bubble) gas / CO_2 through limewater ***** White ppt formed * Solid goes yellow / yellow-green (when hot) ***** Solid becomes paler on cooling / goes white (on cooling) * **Test for cation** To a solution * made using acid * Add (aqueous) sodium hydroxide or ammonia * White ppt formed * Soluble in excess alkali * [Maximum mark for observations above = 3] **FA 9** is $ZnCO_3$ ***** *(formula required)* 2 * = 1 mark. [Maximum mark for **3(a)** = 4]	**4**

Question	Answer	Marks
3(b)(i)	**Observations**: **11 * available** = 5 marks rounding down. **Test 1 (KI)** (Solution) turns dark yellow / brown / red-brown / orange-brown / yellow-brown * (**With starch**) (goes) dark blue / blue-black / black * *(Ignore state)* **Test 2 (Ba^{2+})** White precipitate * (**With acid**) precipitate insoluble / no change * **Test 3 ($AgNO_3$)** No change / no precipitate / no reaction / solution remains colourless/pale yellow * (**with NH_3**) brown / red-brown / orange-brown / rust precipitate * **Test 4 (NaOH etc.)** Brown/red-brown/orange-brown/rust precipitate * Ppt is **in**soluble in excess NaOH * (**with heat**) Gas / ammonia turns (damp red) litmus blue * (**with A*l***) effervescence / fizzing / bubbling occurs * Gas/H_2 'pops' with lighted splint **or** gas / ammonia turns (damp red) litmus blue *	**5**
3(b)(ii)	**Ions** are NH_4^+ and Fe^{3+} and SO_4^{2-}	**2**
3(b)(iii)	**M1**: Tests 1 **and** 4 involve redox *(both must be correct)* **M2**: Any **one** strand of explanation correct (from those listed below) • Iodide ion is oxidised to iodine (or $2I^- \rightarrow I_2 + 2e^-$) • Fe^{3+} is reduced to Fe^{2+} (or $Fe^{3+} + e^- \rightarrow Fe^{2+}$) • Fe^{3+} is the oxidising agent **and** I^- is the reducing agent • Fe^{3+} is reduced **and** I^- is oxidised • Iodine changes from oxidation state -1 to 0 • Aluminium is oxidised to aluminium ions (or $Al \rightarrow Al^{3+} + 3e^-$) • Water / hydroxide ions is / are reduced to hydrogen • Al is the reducing agent **and** water / OH^- ions ions is / are the oxidising agent • Al is oxidised **and** water / OH^- ions is / are reduced	**2**
3(b)(iv)	$Fe^{3+}(aq) + 3OH^-(aq) \rightarrow Fe(OH)_3(s)$ **OR** $NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$ or (g)	**1**