Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/36**

Paper 3 Advanced Practical Skills 2 **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.

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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.

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	Mark
1(a)	**I Unambiguous headings and units for four weighings (g), / g, in g or g next to each entry** • (Mass of) conical / flask + H_2O_2 / solution/**FB 1** = **W** • (Mass of) container + solid / catalyst / MnO_2 / **FB 2** = **X** • (Mass of) container (empty / with residual MnO_2) = **Y** • (Mass of) conical / flask and contents (at end / after reaction / after 30 minutes) = **Z**	**3**
	II Weighings and mass of FB 2 recorded. • All weighings (minimum 3) recorded to same decimal places (either 2 dp or 3 dp) • mass of **FB 2**, correctly calculated. (**X** – **Y**)	
	III: Accuracy (Q) mark in **1(a)** **Award III** if candidate's mass loss (calculated to 2 dp) is within, or equal to, 25% of supervisor's mass loss (calculated to 2 dp). Mass loss = **W** + (**X** – **Y**) – **Z**	
1(b)(i)	**Mass of oxygen correctly calculated** Mass loss = weighing 1 + mass of **FB 2** added – weighing 4 = **W** + (**X** – **Y**) – **Z** **and** answer given to a minimum of 2 significant figures (sf)	**1**
1(b)(ii)	**Equation with state symbols** $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$	**1**
1(b)(iii)	**Correctly uses (b)(i) to calculate [H_2O_2(aq)] in FB 1** **M1:** correct expression/answer for amount of O_2 liberated: $n(O_2) = {}^{\textbf{(b)(i)}}/_{\textbf{32}}$ mol (does not need to be evaluated) **M2**: concentration of H_2O_2 **and** answer given to 2–4 sf [H_2O_2(aq)] = 40 × 2 × answer to step 1 (final answer is approx = 2.5 × **(b)(i)**) mol dm^{-3})	**2**

Question	Answer	Mark
1(b)(iv)	**Correct use** of **(b)(iii) to calculate volume strength of H_2O_2** Volume strength = **(b)(iii)** × 0.5 × 24.0 (= **(b)(iii)** × 12) vol **and** answer given to 2–4 sf	**1**
1(c)(i)	**EITHER** (Continuing) effervescence shows that reaction is **not** complete. **OR** no (more) fizzing shows that reaction has finished / is complete. **or** mass of flask and contents is constant shows reaction is complete (owtte)	**1**
1(c)(ii)	**M1**: Plug prevents escape of liquid droplets *(owtte)* **or** plug stops solution / **FB 1** fizzing out *(owtte)* **or** plug traps aerosol formed	**1**
	M2: Student is <u>correct</u> *(must be stated explicitly)* **and** provided that plug is pre-weighed	**1**
1(c)(iii)	**EITHER** Mass is **same** as listed in **(a)** (or value stated) **and** MnO_2 is a **catalyst** **OR** MnO_2 is a **catalyst** so its mass will **not change** (during the reaction)	**1**

Question	Answer	Mark
2(a)	**I All the following data are recorded** • two burette readings **and** the titre for the rough titration • initial and final burette readings for **two** (or more) accurate titrations	
	II Appropriate headings and units 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 / **FB 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.	
	For assessment of accuracy (Q) marks, the Examiner should round all burette readings to the nearest 0.05 cm^3. Check and correct subtractions for supervisor and candidates. 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 (**d**) between the candidate's mean titre and the supervisor's mean titre. Write and ring the supervisor's value near each candidate's table of results. Write the value of **d** on each script. **Award the accuracy (Q) marks as shown below**.	
	Award **V** if **d ⩽ 0.80** (cm^3) Award **VI** if **d ⩽ 0.50** Award **VII** if **d ⩽ 0.30** **Tolerance for low titres:** If supervisor's titre is < 10.0 cm^3, tolerances are 0.15, 0.25, 0.40 cm^3.	**7**

Question	Answer	Mark
2(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 to nearest 0.01 cm^3. *(e.g. 26.625 cm^3 must be rounded to 26.63 cm^3)* • Allow the mean expressed to 1 dp, if **all** accurate burette readings were given to 1 dp **and** the mean is **exactly** correct. *(e.g. 26.0 and 26.2 = 26.1 is allowed)* *(e.g. 26.0 and 26.1 = 26.1 is wrong – should be 26.05)*	**1**
2(c)(i)	**Answers to parts (c)(ii), (c)(iii) and (c)(iv) all** quoted to 3 or 4 significant figures.	**1**
2(c)(ii)	**Correct calculation of amount of $KMnO_4$** Amount of $KMnO_4$ = vol in **(b)** $\times$ $^{0.018}/_{1000}$ mol	**1**
2(c)(iii)	**Correct use of (c)(ii) to calculate amount of H_2O_2.** Amount of H_2O_2 = 2.5 $\times$ **(c)(ii)** mol	**1**
2(c)(iv)	**Correct use of (c)(iii) to calculate conc^n of H_2O_2 in FB 1**. $[H_2O_2]$ = **(c)(iii)** $\times$ $^{250}/_{10}$ $\times$ $^{1000}/_{25}$ = 1000 $\times$ **(c)(iii)** mol dm^{-3}	**1**
2(d)(i)	**Comparing accuracy of the two methods** **Expt 2(a)** is <u>more</u> accurate **and one** reason (from the list below): • Two (or more) consistent titres are obtained in **2(a)** • Mass loss in **1(a)** is small, giving high(er) **percentage** error. • The reaction in **2(a)** has definite / sudden / sharp end / finish point • The reaction in **1(a)** is not complete (provided this agrees with answer **1(c)(i)**)	**1**
2(d)(ii)	**Errors compared** (Error in volume measured by burette =) 2 $\times$ 0.05 > 0.06	**1**

Question	Answer	Mark
	FB 6 is dilute HNO_3; **FB 8** is $FeSO_4$(aq)	
3(a)(i)	Off-white / cream / yellow precipitate (formed)	**1**
3(a)(ii)	**Test for nitrogen anion** **M1**: Add (excess) NaOH + heat + aluminium **M2**: Effervescence / gas / NH_3 turns (red) litmus blue **Test to distinguish between nitrate and nitrite** **M3**: Add (a few drops of acidified) $KMnO_4$ *(manganate(VII) if name used)* **and** **purple** colour remains / ($KMnO_4$) is **not** decolourised	**3**
3(a)(iii)	**FB 6** is HNO_3 *(formula required)*	**1**
3(b)(i)	**11 Observations shown in the table** **Test 1 (+ ammonia)** • green precipitate • insoluble / no change **in excess** (ammonia) • (precipitate / mixture) turns brown (on surface) **Test 2 (+ aq Ba^{2+} then HC*l*)** • (with Ba^{2+}) white precipitate *(not 'off-white': soluble in excess is a CON)* • (with acid) (ppt) is insoluble (in acid) **or** no change / no reaction **Test 3 (+ FB 1 then NaOH)** • (with H_2O_2) (solution) turns / turns yellow / **light** brown / **pale** brown • Effervescence / bubbling (in either box) • (Gas) relights glowing splint • (with NaOH) red-brown / brown / rust precipitate • Precipitate is insoluble / does not dissolve / no change **in excess** (NaOH) **Test 4 ($KMnO_4$)** • ($KMnO_4$) decolourised **or** changes (from purple) to colourless / pale yellow	**5**

Question	Answer	Mark
3(b)(ii)	**Ionic equation** **M1**: OH^- is used in the equation **M2**: $Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$	**2**
3(b)(iii)	**EITHER** **M1**: Iron(II) oxidised to iron(III) / $Fe^{2+} \rightarrow Fe^{3+} + e^-$ **or** H_2O_2 oxidises Fe^{2+} **M2**: (Brown) ppt is $Fe(OH)_3$ / ppt (produced) is red-brown **OR** **M1**: H_2O_2 disproportionates **or** H_2O_2 is oxidised and reduced. **M2**: Oxygen is produced **OR** **M1:** $2Fe^{2+}(aq) + 2H^+(aq) + H_2O_2(aq) \rightarrow 2Fe^{3+}(aq) + 2H_2O(l)$ **M2:** it is stated which species is oxidised / reduced	**2**