Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/32**

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.

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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	Marks
1(a)	**I** Unambiguous headings and units for four <u>weighings</u> • (Mass of) crucible, lid (empty) • (Mass of) crucible, lid and **FB 1** (or "contents before heating") • (Mass of) crucible, lid and residue / MO / contents after first heating • (Mass of) crucible, lid and residue / MO / contents after 2nd heating • Units must be ' / ' or 'in' or "()" **AND** g or 'grams' in column headings or with every entry	**5**
	II Four weighings are recorded in space provided • All weighings recorded to same decimal places (2 or 3) • Fourth weighing is within +0.02 and -0.04 g of third weighing	
	III Correct subtractions to give masses of **FB 1** and MO / residue. • These values (with unambiguous headings) must be on page 2	
	Accuracy marks Calculate supervisor's mass ratio (to 2 d.p.) = $^{\text{mass FB 1}}/_{\text{mass of residue}}$ Calculate candidate's mass ratio (to 2 dp) = $^{\text{mass FB 1}}/_{\text{mass of residue}}$ Difference (δ) between the candidate's mass ratio and the supervisor's mass ratio	
	IV if δ is within 25% of the supervisor ratio **V** if δ is within 10% of the supervisor ratio	
1(b)(i)	$MCO_3 \bullet M(OH)_2$ (s) → **2**MO (s) + CO_2 (g) + H_2O (g)	**1**
1(b)(ii)	Correctly calculates amount of CO_2 produced $n(CO_2)$ = mass lost / (44 + 18) **AND** answer to 2–4 significant figures	**1**
1(b)(iii)	Correct use of **(b)(ii)** to calculate M_r M_r = mass of **FB 1** used / mol of CO_2 produced **AND** answer to 2–4 significant figures	**1**
1(b)(iv)	Correct use of M_r to calculate A_r $A_r = [M_r - (60 + 34)] / 2$ **AND** answer to 2–4 significant figures	**1**

Question	Answer	Marks
1(c)	relative atomic mass will be lower **AND** mass loss will be greater **OR** amount (in mol) of CO_2 (and water) will be greater **AND** amount (in mol) of basic carbonate (calculated) will be greater **OR** M_r lower	**1**
1(d)	student is not correct **AND** sulfuric acid will not show if the metal hydroxide is still present **OR** student is correct **AND** if decomposition was not complete, residue would fizz with acid **OR** if decomposition was complete, residue would not fizz with acid **OR** carries out experiment and gives correct conclusion based on observation	**1**

Question	Answer	Marks
2(a)	**I** Data from weighings of **FB 3** recorded in space provided • three masses recorded, with unambiguous headings and unit • subtraction correct (for mass of **FB 3**) • mass of **FB 3** used is between 0.80 and 1.80 g (from weighings)	**8**
	II 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	
	III 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 2 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	
	IV All accurate burette readings are recorded to the nearest 0.05 cm^3	
	V The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre	
	Accuracy 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 Supervisor's ratio (mean titre / mass of **FB 3**) to two decimal places. Calculate the candidate's ratio (mean titre / mass of **FB 3**) to two decimal places. Calculate the difference (δ) between the candidate's ratio and the supervisor's ratio.	
	Award **VI** if $\delta \leqslant 0.80$ Award **VII** if $\delta \leqslant 0.50$ Award **VIII** if $\delta \leqslant 0.30$ ($cm^3\,g^{-1}$)	

Question	Answer	Marks
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)*	**1**
2(c)(i)	All answers to parts **(c)(ii)**, **(c)(iv)**, **(c)(v)** and **(c)(vi)** given to 3 or 4 significant figures.	**1**
2(c)(ii)	Correct calculation of number of moles of HC*l* number of moles = vol in **(b)** x 0.046 / 1000	**1**
2(c)(iii)	Ionic equation correct (including state symbols) $CO_3^{2-}(aq) + \mathbf{2}H^+(aq) \rightarrow CO_2(aq) + H_2O(l)$	**1**
2(c)(iv)	Correct use of **(b)**, **(c)(ii)** and **(c)(iii)** to calculate concentration of $\mathbf{X}_2CO_3$ $[X_2CO_3] = 0.5 \times$ **(c)(ii)** $\times$ $^{1000}/_{25}$ mol dm^{-3}	**1**
2(c)(v)	Calculation of M_r of **FB 3** M_r of $\mathbf{X}_2CO_3 = 4 \times$ mass **FB 3** used / **(c)(iv)**	**1**
2(c)(vi)	Calculation of A_r from M_r A_r of X = (M_r – 60) / 2	**1**
2(c)(vii)	Appropriate name / symbol of **X** **X** must be in Group 1 and have nearest A_r to value calculated in **(c)(vi)**	**1**

Question	Answer	Marks
	FB 6 is $MgSO_4$, **FB 7** is $NaNO_2$, **FB 8** is $AgNO_3$, **FB9** is ethanol and **FB 10** is CH_3COOH	
3(a)(i)	No mark for reagents (NaOH and NH_3) **M1** NaOH: white ppt **AND** insoluble in excess (NaOH) **M2** NH_3: white ppt **AND** insoluble in excess (ammonia)	**2**
3(a)(ii)	**M1** Add (aq) $BaCl_2$ or $Ba(NO_3)_2$ **AND** gives a white ppt **M2** ppt is insoluble in excess (dil) HCl or (dil) HNO_3 (**not** H_2SO_4) **OR FB 6** does not decolourise $KMnO_4$ / $KMnO_4$ remains purple	**2**
3(a)(iii)	$MgSO_4$	**1**
3(b)	For each part award one mark for suitable reagent(s) to distinguish between the suggested identities. Then award one mark for correct observation and conclusion.	
3(b)(i)	**FB 7** **M1** Add (a few drops of) (acidified) $KMnO_4$ **M2** $KMnO_4$ goes colourless / decolorised **AND FB 7** is (sodium) nitrite / $NaNO_2$	**2**
3(b)(ii)	**FB 8** **M1** → **M2** Add dilute HCl or $BaCl_2$ → white ppt **OR** add aq Na_2CO_3 → white / beige / pale-brown / off white / cream ppt **OR** add (aq) NaOH → brown ppt **OR** add Mg → black ppt **AND FB 8** is silver nitrate / $AgNO_3$	**2**
3(b)(iii)	**FB 9** Add (aqueous) iodine **AND** (aqueous) NaOH Gives (pale) yellow / cream / off-white precipitate **AND FB 9** is ethanol / CH_3CH_2OH / C_2H_5OH	**2**

Question	Answer	Marks
3(b)(iv)	**FB 10** Add Mg (strip) **OR** Na_2CO_3 **OR** named indicator **OR** warm with (a few drops of) (acidified) $KMnO_4$ Fizzing **OR** correct final colour of indicator **OR** $KMnO_4$ stays purple (or no change) **AND FB 10** is ethanoic acid / CH_3COOH / CH_3CO_2H	**2**