CAMBRIDGE
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CHEMISTRY **9701/34**

Paper 3 Advanced Practical Skills 2 **May/June 2024**

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 2024 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 descriptions 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** 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** Correct 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 **III** All accurate burette readings are recorded to the nearest 0.05 cm^3. **IV** The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre.	**7**
	Accuracy marks Round all burette readings to the nearest 0.05cm^3 then check and correct titre subtractions, where necessary. Select the 'best' mean titre, using the following 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* The 'best' titres should be used to calculate the mean titre, expressed to the nearest 0.01 cm^3. Calculate the supervisor's mean titre to 2 decimal places. Calculate the candidate's mean titre to 2 decimal places. Calculate the difference δ between the candidate's titre and the supervisor's titre.	
	V Award if $\delta \leqslant 0.50$ cm^3 **VI** Award if $\delta \leqslant .0.30$ cm^3 **VII** Award if $\delta \leqslant 0.20$ cm^3 If Supervisor's mean titre < 10.00 cm^3 then halve the tolerances (0.25, 0.15, 0.10 cm^3). If Supervisor's mean titre < 5.00 cm^3 then use the tolerances 0.15, 0.10, 0.05 cm^3.	

Question	Answer	Marks
1(b)	Correctly calculates the mean titre to 2 decimal places. • 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 put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 decimal places and be rounded to nearest 0.01 cm^3.	**1**
1(c)(i)	answers to (c)(ii), (c)(iii) and (c)(iv) are given to 3 or 4 significant figures	**1**
1(c)(ii)	Correctly calculates amount of KOH used = $^{5.05}/_{56.1} \times {}^{25}/_{1000}$ mol = 0.00225(0) (mol) **OR** 2.25(0) x 10^{-3} (mol)	**1**
1(c)(iii)	**M1** ionic equation: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ **M2** correct use of (b) **AND** (c)(ii) [**FB 2** / HC*l*] = (c)(ii) $\times$ $^{1000}/_{(b)}$ (mol dm^{-3})	**2**
1(c)(iv)	Correct use of (c)(iii) **M1** mol of HC*l* reacting with **FB 1** = 0.10 $\times$ 5.00 – (c)(iii) **M2** amount of **FB 1** used = $^{\text{(mol HC}l\text{ from M1)}}/_{4}$ **AND** M_r of **FB 1** = $^{22.5}/_{\text{amount FB 1 used}}$	**2**
1(d)	the acid / HC*l* (added to **FB 1**) would no longer be in excess / HC*l* becomes the limiting reagent **OR** no HC*l* would be left (to do the titration) / insufficient HCl to react with <u>all</u> the **FB 1** / (metal) carbonate **OR FB 1** / (metal) carbonate is <u>now</u> / <u>will be</u> in excess (so titration will not be possible)	**1**

Question	Answer	Marks
2(a)	**I** Headings, units and precision of data • All four balance readings consistent to either 2 or 3 decimal places • unambiguous headings for (mass of) **FB 1** and (mass of) residue / **M**O in the space provided • units given next to each balance reading and correctly displayed units for mass of **FB 1** and mass of residue / **M**O **II** Quantities • fourth reading is within +0.02 and -0.05 g of third reading • mass of **FB 1** used **AND** mass of residue correctly calculated • mass of **FB 1** used within range 1.50–2.50 g	**4**
	Accuracy marks mass ratio = $^{\text{mass FB 1}}/_{\text{mass of residue}}$ Calculate supervisor's mass ratio to 2 d.p. Calculate candidate's mass ratio to 2 d.p. Award **III** if candidate's mass ratio is within 10% of the supervisor's mass ratio. Award **IV** if candidate's mass ratio is within 5% of the supervisor's mass ratio.	
2(b)(i)	**M**CO_3•**M**$(OH)_2$(s) → 2**M**O(s) + CO_2(g) + H_2O(g)	**1**
2(b)(ii)	Correctly calculates mol (CO_2) = $^{\text{mass lost}}/_{(44 + 18)}$ **AND** answer given to 2–4 significant figures	**1**
2(b)(iii)	Correct use of (b)(ii) M_r = $^{\text{mass of FB 1 used}}/_{\textbf{(b)(ii)}}$ **AND** answer given to 2–4 significant figures	**1**

Question	Answer	Marks
2(b)(iv)	Correct expression and use to find A_r $A_r = {}^{[(b)(iii) - (60 + 34)]}/_{2}$	**1**
2(c)(i)	**FB 1** has decomposed to metal oxide / residue is metal oxide	**1**
2(c)(ii)	**EITHER** heating for a third time would **not** make it more accurate **AND** the fourth reading is equal (within 0.02 g) to the third **OR** heating for a third time would make it more accurate **AND** the fourth weighing is <u>not</u> the same as / lower than the third	**1**
2(c)(iii)	*One of the following reasons:* • experiment 2 has fewer readings / steps / sources of error ORA **OR** examples of extra steps in experiment 1 • experiment 2 end-point is easier to judge (because it is when mass is constant / experiment 1 end-point (colour change) is harder to judge) • burette / pipette has higher (percentage) error than balance	**1**

Question	Answer	Marks
	FB 5 is $(NH_4)_2CO_3$, **FB 6** is $Cr_2(SO_4)_3$, **FB 7** is HNO_3, **FB 8** is $ZnCO_3$ and **FB 9** is ethanol.	
3(a)(i)	• (**FB 5** is) white solid / powder **or** white / colourless crystals (at start) • condensation / steam produced • bullet 2 is linked to gentle heating / water vapour being produced immediately upon heating • no residue (at end) **OR FB 5** / solid disappears / evaporates / sublimes (owtte) • attempts to test with litmus (paper) • (Gas / NH_3) turns (moist red) litmus blue Two points needed for each mark.	**2**
3(a)(ii)	warm **FB 5** with (aqueous) NaOH **AND** gas / ammonia turns (red) litmus to blue	**1**
3(a)(iii)	• fizzing / bubbles / effervescence *(not 'gas formed')* • colourless solution formed / remains **or** vigorous / rapid reaction *(owtte)* • attempts to test with lime water • gas / carbon dioxide gives white ppt / solid with lime water *(not 'milky')* Two points needed for each mark.	**2**
3(a)(iv)	**FB 5** is $(NH_4)_2CO_3$	**1**
3(b)	award **M1** for suitable reagent to distinguish each pair award **M2** for correct observation **AND** the conclusion	
3(b)(i)	**M1** add NaOH **or** (acidified) $KMnO_4$ / potassium manganate(VII) **M2** (grey-)green ppt **AND** soluble / gives a (dark green) solution in excess (NaOH) **OR** ($KMnO_4$) remains purple / ($KMnO_4$) not decolourised **AND FB 6** is chromium(III) sulfate / $Cr_2(SO_4)_3$	**2**
3(b)(ii)	**M1** heat with (excess) NaOH **AND** A*l* **M2** gas / NH_3 turns litmus blue (after A*l* added) **AND FB 7** is nitric acid / HNO_3	**2**

Question	Answer	Marks
3(b)(iii)	**M1** dissolve / make a solution in a specified mineral acid **AND** add (aqueous) ammonia **or** (aqueous) NaOH **M2** With NH_3 / NaOH, gives white ppt **AND** soluble in excess **AND FB 8** is zinc carbonate / $ZnCO_3$ **OR** **M1** heat the solid alone **AND** observe the hot residue / solid **M2** (hot) residue is yellow **AND FB 8** is zinc carbonate / $ZnCO_3$	**2**
3(b)(iv)	**M1** add iodine **AND** (aqueous) NaOH **M2** (pale) yellow / cream / off-white precipitate (on standing) **AND FB 9** is ethanol / C_2H_5OH	**2**