Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/33**

Paper 3 Advanced Practical Skills 1 **March 2021**

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 March 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **12** 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	‘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** Headings and data are recorded in the space provided • (mass of) container with **FA 2** • (mass of empty) container • (mass of) **FA 2** (used) Subtraction for the mass of **FA 2** used must be correct *Headings must be unambiguous and include either 'mass' or g for each piece of datum. Reject 'weight'.*	**1**
	II The following data must be shown: • two burette readings **and** titre for the rough titration • initial and final burette readings for **two** (or more) accurate titrations	**1**
	III **Titre values** recorded for accurate titrations, **and** correct headings and units in the **accurate** titration table • initial/start **and** (burette) reading / volume • final/end **and** (burette) reading / volume • titre **or** volume / **FA 1 and** used / added *reject 'difference' or 'total' or 'amount' or 'V' but allow 'vol'* • unit: / cm^3 or (cm^3) or in cm^3 for each heading **or** cm^3 unit given for each volume recorded	**1**
	IV All accurate burette readings are recorded to the nearest 0.05 cm^3, including 0.00. *Reject 50(.00) as an initial burette reading* *Reject if more than one final burette reading is 50.(00)* *Reject any burette reading is greater than 50.(00)*	**1**
	V: The **final** accurate titre recorded is within 0.10 cm^3 of any other accurate titre *Ignore any titre labelled 'rough'* *Reject if any 'accurate' burette reading is recorded as an integer (apart from an initial 0 cm^3)*	**1**
	Check and correct titre and mass subtractions where necessary. *Examiner selects the best mean titre.* *Apply hierarchy: 2 identical, titres within 0.05 cm^3, titres within 0.10 cm^3, etc. Examiner calculates supervisor's corrected average titre / supervisor's mass of **FA 2** to 2 dp.* *Examiner calculates candidate's corrected average titre / candidate's mass of **FA 2** to 2 dp.* *Subtract the candidate value from that of the supervisor: δ*	

Question	Answer	Marks
1(a)	Award **VI** if $0.40 < \delta \leqslant 0.60\ cm^3\ g^{-1}$	**1**
	Award **VI** and **VII** if $0.20 < \delta \leqslant 0.40\ cm^3\ g^{-1}$	**1**
	Award **VI**, **VII** and **VIII** if $\delta \leqslant 0.20\ cm^3\ g^{-1}$	**1**
	If there is only one accurate titration award accuracy marks based on that titration without further penalty. If **only** a rough titration is shown award accuracy marks based on this value but cancel one accuracy mark. Apply spread penalty as follows: if titres selected (by examiner) differ $\geqslant 1.00\ cm^3$ then cancel one accuracy mark. *If Supervisor's value $\leqslant 10.00\ cm^3$ then halve tolerances*	
1(b)	Candidate calculates the mean correctly: • Candidate must take the average of two (or more) accurate 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 dp**, and be rounded to nearest $0.01\ cm^3$	**1**
1(c)(i)	All answers given to **(c)(ii)** – **(c)(v)** must be to 3 or 4 sig fig *(Minimum 3 answers required to award the mark)*	**1**
1(c)(ii)	Correctly calculates: no of moles of H_2SO_4 used = $0.0550 \times {}^{\text{mean titre}}/_{1000}$ *The candidate's mean titre must be used.*	**1**
1(c)(iii)	Correct equation and correctly uses **(ii)** • $\mathbf{2}MHCO_3 + H_2SO_4 \rightarrow M_2SO_4 + \mathbf{2CO_2} + \mathbf{2H_2O}$ *Allow multiples and ignore state symbols.* **AND** • no of moles of **M**HCO_3 = 2 × answer **(ii)**	**1**
1(c)(iv)	Correctly uses **(iii)** $M_r = {}^{\text{mass of FA 2 used}}/_{10 \text{ x answer } \textbf{(iii)}}$	**1**

Question	Answer	Marks
1(c)(v)	Correct use of M_r and appropriate identity of M • A_r = answer **(iv)** – 61 **AND** • M identified as Group 1 metal with closest A_r *Li 0–14.9; Na 15.0–31.0; K 31.1–62.2; Rb 62.3–109.1; Cs 109.2–250* *Reject if the A_r calculated is > 250 or if A_r < 0*	**1**
1(d)(i)	Correct expression % error = $^{0.06}/_{25} \times 100$ (= 0.24 %) *No answer needed but reject incorrect answer.* *No mark for just 0.24 without some working.*	**1**
1(d)(ii)	Student is **in**correct **AND** error in burette reading = 2 × 0.05 **>** 0.06 *(or candidate **compares** the % errors, 0.40 % and 0.24 %)* *Reject suggestion that error in 1 burette reading is 0.1*	**1**

Question	Answer	Marks
2(a)	**I Table of data: 6 correct headings shown** • Mass of crucible (and lid) • Mass of crucible (lid) and **FA 4** (or 'contents before heating') • Mass of crucible (lid) and contents/residue after heating (1) • Mass of crucible (lid) and contents/residue after heating (2) • Mass of **FA 4** (used) • Mass of **FA 5 / residue** obtained (may be two readings) *Reject **FA 4** in 3rd and 4th readings.* *Lid can be omitted (provided this is done consistently for all readings).*	**1**
	II Readings recorded appropriately • Unit given for **all** data quoted. *All four weighings needed.* *Units: / g or (g) or in gram(me)s in general mass heading or after every entry / heading* • All weighings recorded to same number of decimal places (one or more). • Third and fourth weighings are within 0.04 g of each other *(**or** both equal if a one decimal place balance was used)* *Reject if any readings are impossible (e.g. 4th weighing lower than 1st **or** 4th greater than 2nd)*	**1**
	III Correct subtractions for masses Mass of **FA 4** used **and** residue / **FA 5** obtained are correctly shown.	**1**
	IV and V: Accuracy (Q) marks • For assessment of accuracy, examiner must check and correct (if necessary) the masses of **FA 4** used and of residue obtained by the candidate. • Write and ring the theoretical ratio of 1.58 on the candidate's script. • Calculate ratio ($^{\text{mass FA 4}}/_{\text{mass of residue}}$) for candidate's results to 2 dp • Calculate δ, the difference between these two ratios.	

Question	Answer	Marks
2(a)	Award **IV** only if $0.05 < \delta \leqslant 0.10$	**1**
	Award **IV** and **V** if $\delta \leqslant 0.05$	**1**
2(b)(i)	*2 or 3 bullets = 1 mark* *4 bullets = 2 marks* • fizzing / bubbling / effervescence • gas turns lime water milky / white ppt / cloudy white *Reject 'cloudy' alone* • gas is identified as carbon dioxide *Reject if an incorrect positive gas test is observed* • reaction is rapid / vigorous **or** colourless solution forms / (all) solid dissolves	**2**
2(b)(ii)	CO_3^{2-} / carbonate	**1**
2(b)(iii)	**2**$MHCO_3(s) \rightarrow CO_2(g)$ + **H_2O(g or l) + M_2CO_3(s)** *Allow use of the symbol of Group 1 metal identified in question 1*	**1**
2(b)(iv)	**Correctly calculates no of moles of CO_2** $n(CO_2) = {}^{\text{mass loss during heating}}/_{62}$ *Answer must be given correct to 2–4 sig figs* *Allow ecf from (incorrect) subtraction mass shown in list (**FA 4** – residue / **FA 5**)*	**1**
2(b)(v)	**Correct use of (iv) to calculate M_r** $M_r = {}^{\text{mass of FA 4 used}}/_{2 \times \text{answer } \mathbf{(iv)}}$ *Answer to 2 – 4 sf but do **not** penalise sf more than once in **Q2**.* *Ecf on incorrect mole ratio in equation*	**1**

Question	Answer	Marks
2(b)(vi)	**Any one answer from the following:** • **2** is more accurate since fewer readings required. • **2** is more accurate since there is less <u>cumulative</u> error / fewer processes involved *Reject less total error* • **1** is more accurate because **2** was **not** heated to constant mass. *Candidate must refer to their results* *Reject if mass readings after heating are within 0.02 of each other* • **1** is more accurate since titres were consistent / concordant. *Ignore comments about burettes/pipettes being more accurate*	**1**

Question	Answer	Marks
	FA 6 is NH_4Cl; **FA 7** is NH_4I; **FA 8** is $BaCl_2$	
3(a)(i)	1 mark for correct gas test: (gas / vapour / fumes) turn (moist red) litmus to blue *Reject if incorrect gas identified* 1 mark for any two bulleted observations correct: • solid sublimes / white solid forms near top of tube *(owtte; allow residue for solid)* *Reject 'solid evaporated'* *Allow 'white layer formed around glass tube' (bod)* • white **and** smoke / vapour / fumes produced *Reject 'effervescence'* *Reject 'gas'* • no residue (at bottom of tube) *Allow 'crystals disappear completely'* • after heating for some time, gas turns (moist blue) litmus to red	**2**
3(a)(ii)	ammonium **/** NH_4^+ *Reject if more than one ion identified*	**1**

Question	Answer	Marks
3(b)(i)	14 observations. Two * = 1 mark (round down) *Reject 'no observation' (for 'no change') the first time seen, then allow*	**6**

test	reagent	**FA 7**	**FA 8**
1	$KMnO_4$	Solution / turns **and** yellow / red-brown / orange-brown / brown * *Reject any reference to purple colour at end* *Reject ppt*	***Ignore***
	starch	black / dark blue / blue-black / black-purple * *Reject purple on its own*	***Ignore***
2	$AgNO_3$	(pale) yellow precipitate (formed) * *Reject creamish-yellow*	white precipitate (formed) * *Reject off-white*
	NH_3	ppt does not dissolve / insoluble / no change *	ppt (mostly) dissolves **or** partially dissolves **or** (slightly) cloudy mixture forms **or** <u>some</u> white ppt remains * *Reject 'clear solution'*
3	NaOH (cold)	no reaction / no change / no precipitate * *Allow 'no visible observation'*	white precipitate **and** insoluble in excess * *Reject any variation on white, e.g. off-white*
	NaOH (hot)	<u>gas / NH_3</u> turns (red) litmus to blue *	***Ignore** observations when heated* *(**but** reject litmus goes blue at **any** stage of this test)*
	Al	***Ignore** observation(s) with Al*	fizzing / bubbling **/** effervescence **or** gas / H_2 pops with lighted spill *
4	H_2SO_4	no change / no reaction **or** solution <u>remains</u> colourless * *Reject 'no ppt'*	white precipitate (formed) *

Question	Answer	Marks
3(b)(ii)	**FA 7** is NH_4I **FA 8** is $BaCl_2$ **ALLOW** $CaCl_2$ / $CaBr_2$ / $BaBr_2$ for **FA8** *If **both** are named correctly award **one** mark (out of 2).* *If **both** cations are correct, award **one** mark (out of 2).*	**2**
3(b)(iii)	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ *State symbols are required. Allow ecf for Ca^{2+} or Mg^{2+} in **(ii)***	**1**