Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/03**

Paper 3 Advanced Practical Skills **For examination from 2020**

MARK SCHEME

Maximum Mark: 40

Specimen

This document has **10** pages. Blank pages are indicated.

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 (see examples below) 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 Correct headings** The following data are recorded in the space provided • mass of container with **FA 2** • mass of (empty) container • mass of **FA 2** *'Mass' must be stated for each piece of data.* *Unit / g (etc.) must be given for each piece of data.* *Subtraction for mass of **FA 2** used must be correct.*	**1**
	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	**1**
	III Titre values recorded for accurate titrations, **and Appropriate headings** and units in the **accurate** titration table • initial / start (burette) reading / volume • final / end (burette) reading / volume • titre **or** volume / **FA 1 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	**1**
	IV 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.* *This mark is **not** awarded if:* • *50(.00) is used as an initial burette reading* • *more than one final burette reading is 50.(00)* • *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. • *Do **not** include a reading if it is labelled 'rough'.* • *Do **not** award the mark if any 'accurate' burette readings (apart from initial 0 cm^3) are given to **zero** dp.*	**1**

Question	Answer	Marks
For assessment of accuracy (Q) marks, each Examiner should round any burette readings to the nearest 0.05 cm^3, check subtractions and 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 candidate's ratio to 1 dp, as shown below. **Ratio = correct mean titre ÷ correct mass** Calculate the difference (δ) between the candidate's ratio and the supervisor's ratio. Accuracy marks are awarded as follows.		
1(a)	Award **VI**, **VII** and **VIII** if $\delta \leqslant$ **0.2** ($cm^3\ g^{-1}$)	**1**
	Award **VI** and **VII** if **0.2 < $\delta \leqslant$ 0.4**	**1**
	Award **VI**, only, if **0.4 < $\delta \leqslant$ 0.6**	**1**
	• ***Spread penalty**: if the two 'best' (corrected) titres used by the Examiner were $\geqslant$ 0.50 cm^3 apart, maximum 2 accuracy marks.* • *If **only** a rough titration is shown, award Q marks based on that, maximum 2 accuracy marks.*	

Question	Answer	Marks
1(b)	**Candidate calculates the mean correctly.** • 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 dp**, and be rounded to nearest 0.01 cm^3. *(e.g. 26.665 cm^3 must be rounded to 26.67 cm^3)* Two special cases, where the mean need not be to 2 dp: • Allow mean expressed to 3 dp **only** for 0.025 or 0.075 (*e.g. 26.325 cm^3*) • Allow mean if expressed to 1 dp, if **all** accurate burette readings (apart from initial 0) 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)* *This mark is not awarded if:* • *The rough titre was used to calculate the mean.* • *The candidate did only one accurate titration.* • *Burette readings were incorrectly subtracted to obtain **any** of the accurate titre values.* • ***All** burette readings used to calculate the mean were recorded as integers* ***Note**: the candidate's mean will sometimes be marked correct even if it was different from the mean calculated by the Examiner for the purpose of assessing accuracy.*	**1**
1(c)(i)	No. of moles of H_2SO_4 used = 0.05(0) × $^{(b)}/_{1000}$ to minimum 2 sf	**1**
1(c)(ii) and 1(c)(iii)	**2**$NaHCO_3$ + H_2SO_4 → Na_2SO_4 + **2**CO_2 + **2**H_2O **and** No. of moles of $NaHCO_3$ = 2 × answer **(i)**	**1**
1(c)(iv)	Mass of $NaHCO_3$ = answer **(iii)** × 10 × 84	**1**
1(c)(v)	% = $^{\text{answer (iv)}}/_{\text{mass of FA 2 used}}$ × 100	**1**
	All answers attempted in **(i)**, **(iii)**, **(iv)** & **(v)** are shown to 3 or 4 sf *Minimum 3 answers attempted to gain the mark*	**1**
1(c)(vi)	Any **one** of the following answers. • the impurity does not react **with (sulfuric) acid / FA 1 / $NaHCO_3$** • the impurity is **not** alkaline / acidic • the impurity is neutral	**1**

Question	Answer	Marks
1(c)(vii)	% error (= $^{0.1}/_{250}$ × 100) = 0.04%	1
	Total:	16

Question	Answer	Marks
2(a)	**I** Four weighings recorded and correct headings given **and** mass of **FA 4** used and mass of residue recorded • (Mass of) crucible, (lid) • (Mass of) crucible, (lid) and **FA 4** (or contents before heating) • (Mass of) crucible, (lid) and contents / residue / **FA 4** after (first) heating • (Mass of) crucible, (lid) and contents / residue / **FA 4** after re-heating • (Mass of) **FA 4** • (Mass of) residue / **FA 5** / contents after heating *If 'mass' not written then 'g' must be with each entry.* *Use of lid must be consistent.*	1
	II • All weighings recorded to same decimal places (one or more). • Third and fourth weighings are within 0.05 g of each other *(or both equal if a one decimal place balance was used)* • Mass of **FA 4** and **FA 5** / residue must be correctly subtracted.	1
	III and IV: • For assessment of accuracy, examiner must check and correct (if necessary) the masses of **FA 4** used and of residue (smaller mass) obtained by the supervisor and by the candidate. • Work out ratio mass of $^{\text{FA 4}}/_{\text{mass of residue}}$ for the supervisor (2 dp) • Work out ratio mass of $^{\text{FA 4}}/_{\text{mass of residue}}$ for candidate (2 dp) • Calculate the difference (δ) between these two ratios. Award **III** and **IV** if $\delta \leqslant 0.05$ Award **III** if $0.05 < \delta \leqslant 0.10$	2
2(b)(i) and 2(b)(ii)	**(i)** Mass $NaHCO_3$ = ($^{\text{\% purity from 1(c)(v)}}/_{100}$) × mass of **FA 4** used **and** **(ii)** Mass impurity = mass of **FA 4** – answer **(i)** **or** mass impurity = $^{\text{\% impurity}}/_{100}$ × mass **FA 4**	1

Question	Answer	Marks
2(b)(iii)	Mass of decomposition solid = mass of residue (**FA 5**) from table – mass of impurity **(ii) and** expressed to 2, 3 or 4 sig fig **or** mass of decomposition solid = mass of $NaHCO_3$ – mass **lost** on heating [**(i)** – (mass **FA 4** – mass **FA 5**)]	**1**
2(b)(iv)	Mass of residue obtained = answer **(iii)** $\times$ $^{84}/_{\text{answer (i)}}$	**1**
2(b)(v)	If correct, (84 g) $NaHCO_3$ would give **40** g residue / NaOH (*owtte*) **or** mole ratio 1:**1.3** (so not 1:1) **or** Answers could refer to mass / moles of CO_2	**1**
2(c)(i)	Lid reduces / stops absorption of water (vapour) by solid / residue / **FA 5** while cooling	**1**
2(c)(ii)	Repeat the experiment **and** ignore anomalous results / to obtain concordant / consistent results **or** cool in a desiccator **or** use larger mass of **FA 4** / contents / solid	**1**
2(d)(i)	Any **two** observations required • fizzing / effervescence / bubbling • gas turns limewater milky / chalky / cloudy white / white ppt • solid dissolves / colourless solution **forms** • rapid / brisk effervescence = 2 observations	**1**
2(d)(ii)	**FA 5** contains carbonate ion / CO_3^{2-} **and** reference to fizzing (with acid) **or** to CO_2 liberated (with acid) **or** positive limewater test **or** correct equation	**1**
2(d)(iii)	**2**$NaHCO_3(s) \rightarrow H_2O(g) + CO_2(g) +$ **$Na_2CO_3(s)$**	**1**
2(d)(iv)	(From equation) 84 g $NaHCO_3$ should give 0.5 $\times$ 106 g residue (= 53 g) **and** gives a (sensible) comment based on student's 52.3 g	**1**
	Total:	**14**

Question	Answer	Marks
	FA 6 is $MnCl_2$; **FA 7** is $Al_2(SO_4)_3$	
3(a)(i)	**Ba^{2+} test: all observations correct** • **FA 6** – no change / no reaction / no ppt / solution stays colourless **with both** • **FA 7** – white precipitate with Ba^{2+} **and** • white ppt (remains) / insoluble / no reaction with HNO_3	**1**
	$AgNO_3$ test: both observations correct • **FA 6** – white precipitate • **FA 7** – no change / no reaction / solution stays colourless / no ppt	**1**
	Na_2CO_3 test: both observations correct • **FA 6** – no reaction / solid does not dissolve / no effervescence • **FA 7** – fizzing / bubbling / effervescence / **or** gas / CO_2 turns limewater milky / chalky / cloudy white / (forms) white ppt	**1**
3(a)(ii)	**FA 7** has lower pH **and** gas / CO_2 given off / it fizzes (more rapidly if fizzing with both) with sodium carbonate	**1**
3(b)	**Reagents**: NaOH **and** NH_3 (names or correct formulae)	**1**
	Observations – (3 × 1 mark) • **FA 6** + NaOH: off-white / buff / beige / light brown ppt • **FA 6** + NH_3: off-white / buff / beige / light brown ppt	**1**
	• **FA 6**: both ppts insoluble in excess **and** darken / turn brown with either	**1**
	• **FA 7** + NaOH: white ppt **and** soluble in excess • **FA 7** + NH_3: white ppt **and** insoluble in excess	**1**
3(c)	**Conclusions** (one mark for each). • **FA 6** is $MnCl_2$ • **FA 7** is $Al_2(SO_4)_3$	**2**
	Total:	**10**