Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/35**

Paper 3 (Advanced Practical Skills 2) **May/June 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 May/June 2021 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	Marks
1(a)	**I** Unambiguous headings and data are recorded in the space provided • mass of container with **FA 1** *(do not allow 'weight')* • mass of (empty) container • mass of **FA 1** used	**1**
	II All the following data is 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 **and** (burette) reading / volume • final / end **and** (burette) reading / volume • titre **or** volume used / added / **or FA 3** added *(not 'difference' or 'total' or 'amount') Allow 'Vol', but not V* • unit: /cm^3 **or** (cm^3) **or** in cm^3 (for each heading) **or** cm^3 unit given for each volume recordedUnits: (cm^3) or /cm^3 or in cm^3 or cm^3 by every entry	**1**

Question	Answer	Marks
1(a)	**IV** All accurate burette readings to 0.05 cm^3	**1**
	V The **final** accurate titre recorded is within 0.10 cm^3 of any other accurate titre	**1**
	For assessment of accuracy (Q) marks, the Examiner should round any 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 products of mass and titre for candidate and supervisor to **one d.p**, as shown below. • **Product = 'best' mean titre × mass of FA 1 used.** (Theoretical product value = 56.0 cm^3 g) *If no weighings are discernible, assume mass of **FA 1** = 2.25 g* Calculate the difference (**δ**) between the candidate's product and the supervisor's product. Award the accuracy (**Q**) marks as shown below.	
	Award accuracy marks as follows: **VI** Award if $\delta \leqslant 2.0$ cm^3 g **VII** Award if $\delta \leqslant 1.0$ cm^3 g **VIII** Award if $\delta \leqslant 0.5$ cm^3 g (3)	**8**
1(b)	Correctly calculates mean accurate 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 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)	**Correctly calculates** (to 3 or 4 sig fig) No of moles of Na_2CO_3 used = 0.00113 **or** 0.001125	**1**

Question	Answer	Marks
1(c)(ii)	**Correct equation AND calculates moles of HX** • Na_2CO_3 + **2**HX → **2**NaX **+ CO_2** + **H_2O** **and** • No of moles of HX = 0.00226(0) **or** 0.00225(0)	**1**
1(c)(iii)	**Correct expression shown for scale up** M1: No of moles HX in 250 cm^3 = **(c)(ii)** × 250 / mean titre **Correctly uses expression for M_r** M2: M_r = mass of **FA 1** used/moles of **FA 1** in 250 cm^3 **and** answer given to 3 or 4 sf **and** to the correct power of 10	**2**
1(c)(iv)	**Appropriate identity of E** A_r = answer **(iii)** − 14 − 3 − 48 (= **(iii)** – 65) **and E** chosen with A_r closest to this value.	**1**
1(d)	**Correct expression for % error** = (2 × balance error/mass of **FA1** used) x 100	**1**
1(e)	M1: **Method** Add (aqueous silver nitrate to) **FA 3 or** to a solution of **FA 1** M2: **Observation and conclusion** No reaction / no change / no precipitate / colourless solution (formed) **and** AgX is soluble	**2**
1(f)	**Accept one answer from** • end-point **colour** change is indistinct / difficult to see • **colour** change occurs over addition of significant volume • accept an answer based on pH curve – e.g. **colour** change range not within 'vertical' part of graph	**1**

Question	Answer	Marks
2(a)	**I Unambiguous headings and correct units for four weighings** • Mass of crucible, lid (empty) • Mass of crucible, lid and **FA 4** (or 'contents before heating') • Mass of crucible, lid and contents after heating / residue (1) • Mass of crucible, lid and contents after heating / residue (2)	**1**
	II Readings are appropriately recorded • All weighings shown are recorded to same decimal places (one or more). • Mass of **FA 4** is within range 2.00–2.20 g *(from weighings)* Third and fourth weighings are within 0.04 g of each other (or identical if a 1 dp balance was used)	**1**
	III Correct subtractions (answers given to 2 or more sig fig) **and** Mass of **FA 4** used **and** mass of water lost both listed.	**1**
	Accuracy marks **Use the theoretical mass ratio water/FA 4 = 0.147** • Examiner must check and correct (if needed) the mass of **FA 4** used and water removed (after re-heating) by the candidate. • Work out ratio **mass of water/mass of FA 4** for the candidate (to 3 dp) Award accuracy marks as follows:	
	IV Award if ratio in range 0.137–0.157 **V** Award if ratio in range 0.142–0.152 (2)	**5**
2(b)(i)	**Correctly calculates percentage by mass of water** Answer = ratio (see above) × 100	**1**
2(b)(ii)	**Assumption** The residue does not decompose when heated / the mass loss is **only** due to water (OWTTE)	**1**

Question	Answer	Marks
	FA 4 is $BaCl_2 \cdot 2H_2O$; **FA 5** is $(NH_4)_2CO_3$	
3(a)(i)	**Correct reagents** M1: (Reagents needed are) silver nitrate **and** ammonia M2: White ppt with $AgNO_3$ **and** Precipitate is partially / mostly soluble in (excess) ammonia. M3: the precipitate (of silver chloride) should dissolve completely in excess ammonia/ the ppt is insoluble in (excess) ammonia	**3**
3(a)(ii)	M1: White precipitate / solid **and** cation is barium M2: **Ionic equation** $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$	**2**

Question	Answer	Marks
3(b)	**Calculation of no of moles of water** M1: M_r of anhydrous salt = 208.3 M2: n(anhy salt : water) =$\frac{\text{mass residue}}{M_r}$: $\frac{\text{mass water}}{18}$ = ans : ans M3: ratio of moles and answer given to integer value or up to 4 sf **OR** M2: Candidate shows valid working to calculate M_r of hydrated salt **or** working to calculate mass of water from 1 mole **FA 4**. (e.g. M_r (hydrated salt) = 208.3 × mass **FA 4** used / mass residue) **or** mass water (in 1 mol **FA 4**) = 208.3 × mass water lost / mass of residue M3 Candidate attempts to divide mass of water by 18 **and** expresses moles of water as an integer **or** up to 4 sf	**3**
3(c)(i)	**Heating FA 5:** there are four marking points * **FA 5** is a white solid / powder / crystals * Condensation / steam / water vapour forms * (Gas / vapour / ammonia) turns (red) litmus blue * No residue / solid left (in the tube) **or** solid disappears / sublimes 3 or 4 asterisks (*) = 2 marks 2 asterisks (*) = 1 mark	**2**

Question	Answer	Marks
3(c)(ii)	**FA 5 + acid:** there are 6 marking points *Fizzing / bubbling / effervescence (but not 'gas produced') *Rapid / vigorous (reaction) owtte *Solid dissolves / (colourless) solution formed *Reaction is endothermic / solution gets colder *Attempts to test with limewater *<u>Gas / carbon dioxide</u> turns limewater milky / white precipitate 'cloudy' is not accepted, but 'cloudy white' is OK. 2 asterisks (*) = 1 mark (round down)	**3**
3(c)(iii)	**gas** / **ammonia** turns (red) litmus blue.	**1**
3(c)(iv)	**Conclusion** **FA 5** is $(NH_4)_2CO_3$	**1**