Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/34**

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 with data are recorded in the space provided • (mass of) container with **FB 1** • (mass of) (empty) container • (mass of) **FB 1** used **correctly subtracted** Unit must be shown.	**1**
	II 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 **and** (burette) reading / volume • final/end **and** (burette) reading / volume • titre **or** volume used / added **or FB 2** 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 recorded to 0.05 cm^3	**1**
	V The **final** accurate titre recorded is within 0.1(0) cm^3 of any other accurate titre	**1**
	Accuracy (Q) marks Round burette readings to the nearest 0.05 cm^3. Check and correct titre subtractions where necessary. Examiner selects the best mean titre. Apply 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.* Calculate the products of (mass × titre) for candidate and supervisor, as shown below, to **one d.p**,. **Product = mean titre × mass of FB 1 used (cm^3 g)** *If no weighings are discernible, assume mass of **FB 1** = 6.40 g* Calculate the difference (δ) between the candidate's product and the supervisor's product. Award the accuracy (Q) marks as shown below. Write and ring supervisor's value next to the accurate titration table of each candidate, also candidate mean value (calculated by examiner) and difference between supervisor's and candidate's value, δ.	

Question	Answer	Marks
1(a)	**Award accuracy marks as follows**: **VI** Award if $\delta \leqslant 6.0\,cm^3\,g$ **VII** Award if $\delta \leqslant .4.0\,cm^3\,g$ **VIII** Award if $\delta \leqslant 2.0\,cm^3\,g$ (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)	**Sig fig mark** **All** answers given for **(c)(ii)**, **(iii)**, **(iv)** and **(v)** must be to 3 or 4 sf	**1**
1(c)(ii)	**Correctly calculates** No of moles of thio = mass weighed / 248.**2**	**1**
1(c)(iii)	**Correct use of (ii)** Moles thio used = **(c)(ii)** × mean titre / 250	**1**
1(c)(iv)	**Correct use of (iii)** **Concentration of $KMnO_4$** = 1000 / 25 × 2 / 5 × 1 / 2 × **(c)(iii)** mol dm^{-3} = **(c)(iii)** × 8	**1**
1(c)(v)	**Correct use of (iv)** **Mass of $KMnO_4$** (g dm^{-3}) = **(c)(iv)** × 158(.0)	**1**
1(d)(i)	**Correct expression** **% error** = ([3.16 – **(c)(v)**] / **3.16**) × 100 **or** ([**(c)(v)** – 3.16] / **3.16**) × 100	**1**
1(d)(ii)	Student is **not** correct since KI / **FB 4** is used in excess	**1**

Question	Answer	Marks
2(a)(i)	**M1: Unambiguous table/ list of data – 3 pieces of data shown** • **two** thermometer readings recorded with clear headings and units • temperature rise shown correctly calculated Units must be ºC either with each value or as heading or in body of text: (º C), / ºC, in ºC, in degrees Celsius.	
	M2: Accuracy mark Check and correct temperature rise for supervisor and candidate. Write supervisor's temp rise on the script in a ring Calculate the difference δ between these temperature rises. Award this Q mark if $\delta \leqslant$ **1.0 °C**	**2**
2(a)(ii)	**Correctly calculates energy released** Energy = 55 × 4.2 × temp rise (J) **and** answer given to 2–4 sf	**1**
2(a)(iii)	**M1: Shows that HC*l* is in excess by calculating n(NH_3) and n(HC*l*)** (no. of moles ammonia) = 2 × 0.030 = 0.060 mol **and** (no. of moles of HC*l*) = 3 × 0.025 = 0.075 (so is in excess)	
	M2: Correct use • ΔH = energy / (1000 × no. of moles NH_3 used) (= q / 0.06) (ΔH = **(a)(ii)**/60) • Answer must have negative sign and be expressed to 2–4 sf	**2**

Question	Answer	Marks
2(b)(i)	**M1: Unambiguous table/ list of data – 6 pieces of data shown with units** • (mass of) container + **FB 8** / solid / NH_4Cl • (mass of) container (empty or with residual **FB 8**) • (mass of) **FB 8** / solid / NH_4Cl **or** mass used • initial temperature / thermometer reading • final / lowest / minimum temperature / thermometer reading • temp change / decrease	
	M2: Correct data collected (all bullets below are correct) • two thermometer readings are shown • both thermometer readings recorded to .0 or .5 • two balance readings are shown • both balance readings to the same number of dp • subtractions correct	
	M3: Accuracy mark Check and correct temp decrease for supervisor and candidate. Write supervisor's temperature decrease on the script in a ring. Calculate the difference δ between these temperature decreases. Award this Q mark if $\delta \leqslant$ **1.5 °C**	**3**
2(b)(ii)	**Correct expressions** • Energy = 30 × 4.2 × temperature decrease • Moles NH_4Cl = mass used / 53.5 • Enthalpy change = energy / (1000 × moles NH_4Cl) • Answer given with positive sign **and** 2 or more sig figs 2 bullets = 1 mark (round down)	**2**
2(c)	**Correctly uses data and answers (a)(iii) and (b)(ii)** ΔH = – 30.5 – 74.8 + ans **2(a)(iii)** – ans **2(b)(ii)** **or** correct numerical answer given to 2 or more sf	**1**

Question	Answer	Marks
	FB 9 is (basic) $ZnCO_3$; **FB 10** is NaOH(aq)	
3(a)(i)	**Observations when heated** White solid / powder * Condensation in tube / water vapour formed / steam formed / droplets / liquid inside top of test-tube * Yellow (residue) formed (when hot) * (After cooling,) solid / residue becomes paler / goes white * 2 asterisks (*) = 1 mark (round down)	**2**
3(a)(ii)	**Observations with sulfuric acid** (Mark as four '*') fizzing / bubbling / effervescence * reaction is rapid / vigorous **or** colourless solution formed / solid / **FB 9** dissolves / disappears * Attempts to test with limewater * Gas / CO_2 turns lime water milky / cloudy white / white ppt * 2 asterisks (*) = 1 mark (round down)	**2**
3(a)(iii)	**Tests on solution** (Mark as four asterisks) **With NaOH**: white ppt * soluble / forms (colourless) solution **in excess** (NaOH) * **With NH_3**: white ppt * soluble / forms (colourless) solution **in excess** (NH_3) * 2 asterisks (*) = 1 mark (round down)	**2**
3(a)(iv)	**FB 9 is zinc carbonate / $ZnCO_3$**	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(b)(i)</td><td>Observations with FB 10
Test 1
+ Cu^{2+}(aq): (pale) blue precipitate *

then heat: black or dark brown precipitate / solid (formed) *

+ Al: fizzing / bubbling / effervescence *

<u>gas</u><u>/NH$_3$</u> (with Al) turns (red) litmus blue *

Test 2
+ Al: fizzing / bubbling / effervescence *
(gas/hydrogen) ‘pops’ with a lighted spill/splint
or gas has no effect on red litmus paper (OWTTE) *
Al/solid dissolves/ disappears
or colourless solution forms *
then + HCl: (faint) white / pale grey / off white precipitate forms *

Test 3
+ Cr^{3+}(aq): grey-green precipitate *

then + excess FB 10: precipitate dissolves in excess (FB 10)
or green solution formed *

2 asterisks (*) = 1 mark (round down)</td><td>5</td></tr>
<tr><td>3(b)(ii)</td><td>Conclusion
<table><tr><td>cation</td><td>anion</td></tr><tr><td>unknown</td><td>OH$^-$ / hydroxide</td></tr></table></td><td>1</td></tr>
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