Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/32**

Paper 3 Advanced Practical Skills 2 **May/June 2022**

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 2022 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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PUBLISHED

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** 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	**7**
	II Correct headings and units in the accurate titration table **and** titre values recorded for accurate titrations • initial / start **and** (burette) reading / volume + unit • final / end **and** (burette) reading / volume + unit • titre + unit **or** volume / **FB 1 and** used / added + unit	
	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	
	For assessment of accuracy marks, round all 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. Write the candidate's mean titre on each script. Write the Supervisor's [corrected] mean titre in a ring on each candidate script. Calculate the difference (δ) between the candidate's mean titre and the supervisor's mean titre. Write the value of δ on each script. Award the accuracy marks as shown below.	
1(a)	Award **V** if $\delta \leqslant 0.50$ (cm^3) Award **VI** if $\delta \leqslant 0.30$ Award **VII** if $\delta \leqslant 0.20$	
1(b)	Correctly calculates the mean titre correct to 2 dp from accurate titres that are within 0.20 cm^3 total spread	**1**
1(c)(i)	All final answers for **(c)(ii)**, **(c)(iii)**, and **(c)(iv)** are to 3–4 sf	**1**

Question	Answer	Marks
1(c)(ii)	Correctly calculates n(NaOH) = 0.1 × **(b)** / 1000 **AND** n($NaHSO_4$) = same answer	**1**
1(c)(iii)	Correctly uses [$NaHSO_4$] = final answer **(c)(ii)** × 1000 / 25 (= **(c)(ii)** × 40) **AND** answer above × 120.1	**1**
1(c)(iv)	Correctly uses % $NaHSO_4$ = $\left(\frac{\text{final answer } \mathbf{(c)(ii)}}{12.53}\right) \times 100$	**1**

Question	Answer	Marks
2(a)	**I** Ten thermometer readings recorded, all shown to .0 or .5 ºC **AND** at least one reading at .0 and one at .5	**3**
	For assessment of accuracy marks, round all thermometer readings to the nearest 0.5 °C. Calculate the supervisor's greatest ΔT (= $T_{max} - T_{initial}$) and write it ringed on each candidate script. Note volume (V) at which the T_{max} occurs. Calculate the candidate's ΔT at the same volume (= $T_{at\ V} - T_{inital}$) then calculate the difference, δ, from the supervisor value. Award of accuracy marks For supervisor ΔT 10.0 – 20.0: **II** Award if $\delta \leqslant 2.0$ ºC **III** Award if $\delta \leqslant 1.0$ ºC	
2(b)(i)	**I** Axes unambiguously labelled temperature **or** °C on *y*-axis **AND** volume / **FB 5** / H_2SO_4 / acid **or** cm^3 on the *x*-axis **AND** some numbers for scales	**4**
	II Suitable scales chosen	
	III All points recorded in the table are accurately plotted	
	IV Lines of best fit drawn (straight or smoothly curved lines) **AND** extrapolated to intersect	
2(b)(ii)	Correct volume from suitable intersect to 1 or 2 dp **AND** correct ΔT to 1 dp	**1**
2(c)(i)	Correctly calculates $n(H_2SO_4) = 1.00 \times$ volume **(b)(ii)** / 1000 **AND** answer to 2–4 significant figures	**1**

Question	Answer	Marks
2(c)(ii)	Correctly calculates Q = (25 + V**(b)(ii)**) × 4.18 × Δ*T***(b)(ii)** **and** answer to 2–4 sf	**1**
2(c)(iii)	Correctly uses $\Delta H = \left(\frac{\textbf{(c)(ii)}}{2 \times \textbf{(c)(i)}} \right)$ / (1000) **AND** answer given to minimum 2 sf **AND** units kJ mol^{-1} or J mol^{-1} to match use or absence of ÷ 1000 **AND** negative sign	**1**
2(d)(i)	Correct expression [(− 57.6 – **(c)(iii)**) / 57.6] × 100 **OR** [(**(c)(iii)** – (– 57.6)) / 57.6] × 100	**1**
2(d)(ii)	take more readings (near the end point) **AND** to improve position of intersection / owtte	**1**
2(e)(i)	Correctly uses n(NaOH) = **(c)(i)** × 2 × $\frac{1000}{25}$	**1**

Question	Answer	Marks
2(e)(ii)	**I** Correctly uses $\frac{\textbf{(e)(i)}}{20}$ **AND** answer to 2 or more sf	**2**
	II Explanation matches answer If conc NaOH > 0.1 mol dm^{-3} then 1st box ticked **and** (titre remains unchanged so actual) mol NaOH↑ so mol / amount / mass $NaHSO_4$↑ **OR** If conc NaOH approx. 0.1 mol dm^{-3} then 2nd box ticked **and** titre not / (only) slightly changed so within experimental error **OR** If conc NaOH < 0.1 mol dm^{-3} then 3rd box ticked **and** (titre remains unchanged so actual) mol NaOH↓ so mol / amount / mass $NaHSO_4$↓ **OR** If conc NaOH < 0.1 mol dm^{-3} then 1st box ticked **and** larger titre so moles / amount / mass $NaHSO_4$ calculated increases **OR** If conc NaOH > 0.1 mol dm^{-3} then 3rd box ticked **and** smaller titre so mol / amount / mass $NaHSO_4$ calculated decreases	

Question	Answer	Marks
	FB 6 is KI(s); **FB 7** is $MnCl_2$ + NH_4Cl(aq); **FB 8** is $FeSO_4$	
3(a)	**I Suitable reagents for anion** One of: If testing for <u>carbonate</u>: **I** named (dilute) acid (and limewater) **II** description of testing gas with limewater **III** no effervescence / no fizzing / no change **IV** unknown (provided test carried out and no contradictory result) **OR** If testing for <u>halide</u>: **I** (aqueous) $AgNO_3$ **and** NH_3 **II** use a solution of **FB 6** **III** (pale) yellow ppt, insoluble in NH_3 **IV** I^- (must be from (pale) yellow ppt) **OR** If testing for <u>nitrate / nitrite</u> : **I** sodium hydroxide **and** Al **II** warm in a boiling tube **III** gas does not turn litmus blue / red litmus stays red **IV** unknown (provided test carried out and no contradictory result)	

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(b)(i)</td><td>
<table>
<tr><th></th><th>FB 7</th><th>FB 8</th></tr>
<tr><td>+ H^+/ MnO_4^-</td><td>turns brown OR
brown solution OR
(dark) brown ppt *</td><td>purple (solution) / $KMnO_4$ / MnO_4^- AND
decolourised / turns yellow / turns colourless *</td></tr>
<tr><td>+ NH_3</td><td>off-white / pale brown ppt AND
insoluble in excess OR darkens / turns dark(er) brown *</td><td>green ppt AND
insoluble in excess OR turns brown / red-brown / rust (on standing) *</td></tr>
<tr><td>+ NaOH</td><td>off-white / pale brown ppt AND
insoluble in excess OR darkens / turns dark(er) brown *</td><td>green ppt AND
insoluble in excess OR turns brown / red-brown / rust (on standing) *</td></tr>
<tr><td>& warm</td><td>gas / NH_3 turns (damp red) litmus blue *</td><td>no (visible) reaction / no change *</td></tr>
</table>
2 * = 1 mark</td><td>4</td></tr>
<tr><td>3(b)(ii)</td><td>FB 7: Mn^{2+} and NH_4^+
FB 8: Fe^{2+}
3 cations correct = 2 marks
2 cations correct = 1 mark</td><td>2</td></tr>
<tr><td>3(b)(iii)</td><td>One of:
$Mn^{2+}(aq) + 2OH^-(aq) \rightarrow Mn(OH)_2(s)$
$Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$</td><td>1</td></tr>
<tr><td>3(b)(iv)</td><td>Redox / oxidation AND reduction (of manganate(VII))</td><td>1</td></tr>
</table>