Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/31**

Paper 3 (Advanced Practical Skills 1) **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.

When awarding accuracy (Q) marks in **Question 1**, the following information must be recorded on a blank part of Supervisor's script/report or on the form provided or on a sheet of paper stapled to the Supervisor's script.

- candidate number
- candidate titre
- difference from Supervisor
- mark awarded
- any spread penalty

The Supervisor's results are treated as suspect in either experiment if more than 50% of the candidates score **zero** Q marks. In this case, or if no supervisor's results are supplied, each Examiner should consider using a mean value derived from 'consistent' candidates' results, but this must be discussed with your team leader. If a CDM is employed in **Question 1** then the better accuracy mark stands.
Rounding errors and transcription errors are penalised only once in the paper.

Question	Answer	Marks
1(a)	**I** The following data must be shown • burette readings ***and*** titre for rough titration • 2×2 'box' showing both accurate burette readings *'Correct' headings and units are not required for this mark*	**1**
	II Headings and units correct for accurate titration table and headings match readings. • initial/start **and** (burette) reading / volume + unit (*allow vol but not V*) • final/end **and** (burette) reading / volume + unit (*allow value for reading*) • titre or volume/**FA 2 and** used/added (*not 'difference' or 'total' or 'amount')* + unit *Units: (cm^3) or / cm^3 or in cm^3 or cm^3 by every entry*	**1**
	III All accurate burette readings to 0.05 cm^3 *Do **not** award this mark 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**
	IV The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre. *Do **not** award the mark if any 'accurate' burette readings (apart from initial 0) are given to **zero** dp.*	**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 difference (δ) between the candidate's titre and the supervisor's titre. Award the accuracy (**Q**) marks as shown below.	**1**
	Award **V** if $\delta \leqslant 0.50$ cm^3	**1**
	Award **VI** if $\delta \leqslant 0.30$ cm^3	**1**
	Award **VII** if $\delta \leqslant 0.20$ cm^3	

Question	Answer	Marks
1(b)	Candidate must average two (or more) titres that are **all** within 0.20 cm^3. Working must be shown or ticks must be put next to the two (or more) accurate titres selected.	**1**
1(c)(i)	Answers for **(c)(ii)**, **(c)(iii)**, **(c)(iv)** to 3–4 sf	**1**
1(c)(ii)	Correctly calculates $n(MnO_4^-) = 0.02 \times$ **(b)** / 1000	**1**
1(c)(iii)	Correctly uses $n(FeSO_4)$ in 25 cm^3 = **(c)(ii)** $\times 5 \times 40$	**1**
1(c)(iv)	Correctly uses mass($FeSO_4$) in 1 dm^3 = **(c)(iii)** $\times$ 151.9	**1**
1(c)(v)	Correctly uses $n(H_2O)$ = [26.52 – **(c)(iv)**] / 18	**1**
	ratio $n(H_2O)$: n($FeSO_4$) **AND** *x* given as integer **OR** M1: M_r hydrated salt = 26.52 / **(c)(iii)** M2: (26.52 / **(c)(iii)** – 151.9) / 18 **and** answer as integer	**1**
1(d)	(as) mole / amount / volume MnO_4^- smaller **or** (as) mass / moles / amount Fe^{2+} smaller	**1**
	mass/moles/amount water larger so (mole) ratio larger so *x* increases *Allow difference in titre/moles of MnO_4^- / Fe^{2+} will be too small to change the (integer) value of x for 1 mark.* *Allow for 1 mark: less MnO_4^- / Fe^{2+} **and** x increases*	**1**

Question	Answer	Marks
2(a)	**I Appearance** **FA 4**: white / colourless **and** crystals /solid **AND** obs during heating: swelling / steam / (some) solid melts / dissolves / white powder forms around the edges *Allow evaporation of water* *Allow bubbling / bubbles of water* *Ignore fizzing / effervescence*	**1**
	II Unambiguous headings and units in list / table of data: • (Mass of) crucible and lid *(not 'weight' in any reading)* • (Mass of) crucible, lid and **FA 4** (or 'contents before heating') • (Mass of) crucible, lid and residue / contents after heating • (Mass of) **FA 4** (used) • (Mass of) residue • (Mass of) water (lost) *Ignore mention of 1st heating if reheated* *Do not allow 'mass of **FA 4** after heating' in third weighing.* *Use of lid must be consistent.* *Unit must be given correctly in each case.*	**1**
	III Three weighings recorded and all listed subtractions (minimum one) correct • All weighings to the same number of dp • Mass of **FA 4** used between 2.40 and 2.60 g *If 4 weighings shown then all must be to the same number of dp*	**1**
	IV Accuracy mark Award if ratio between 1.80–2.10	**1**
2(b)(i)	**Correctly calculates** n(H_2O) = mass loss in **(a)** / 18 and answer to 2 or more sf **AND** n(MZ) = mass of residue in **(a)** / 120.4 and answer to 2 or more sf *If masses are not shown in **(a)** then values used must be correct*	**1**

Question	Answer	Marks
2(b)(ii)	**Shows use of** ratio n(MZ) : n(H_2O) **AND** *y* is an integer *Other correct methods are available.*	**1**
2(b)(iii)	**One of the following** • All water (of crystallisation) was lost / dehydration was complete • No MZ decomposed on heating	**1**
2(c)	**One of the following** • student incorrect **and** because there was no spitting (and therefore lid not required) • student correct **and** to catch any spitting (check observations for spitting or swelling) • student incorrect **and** because putting the lid on makes no difference to water (vapour) escaping	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)(i)</td><td>Test 1 no change / (pale) orange / (pale) red / (pale) pink solution
Allow solution becomes colourless / paler</td><td>1</td></tr>
<tr><td></td><td>Test 2
<table>
<tr><td>+ NaOH</td><td>green / dirty green / pale green / dark green ppt *
ppt turns brown (at surface) *</td></tr>
<tr><td>+ H_2SO_4</td><td>ppt dissolves or yellow / yellow-brown / orange-brown solution formed *</td></tr>
<tr><td>+ SCN^-</td><td>(solution) turns dark(er) orange / blood-red / red / dark(er) red / deep red / red-brown *
colour must be more intense than in Test 1</td></tr>
</table>
2 asterisks = 1 mark (round down)</td><td>2</td></tr>
<tr><td>3(a)(ii)</td><td>Fe^{3+} is formed (in Test 2)</td><td>1</td></tr>
<tr><td></td><td>oxidation of Fe^{2+} / redox</td><td>1</td></tr>
<tr><td>3(a)(iii)</td><td>NH_4SCN</td><td>1</td></tr>
<tr><td>3(a)(iv)</td><td>$Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$</td><td></td></tr>
<tr><td></td><td>correct product formula</td><td>1</td></tr>
<tr><td></td><td>balancing and state symbols</td><td>1</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td rowspan="3">3(b)(i)</td><td>prepare solution of FA 4</td><td>1</td></tr>
<tr><td>prepare a suitable table(s)
minimum 2 tests and columns/ rows for tests and for observations</td><td>1</td></tr>
<tr><td>2 asterisks = 1 mark (round down)
<table>
<tr><td>+NaOH *</td><td>white ppt *
insoluble in excess *</td></tr>
<tr><td>+ NH_3 *</td><td>white ppt*
insoluble in excess *</td></tr>
</table>
<table>
<tr><td>$BaCl_2$/$Ba(NO_3)_2$*
HCl / HNO_3 *</td><td>white ppt *
insoluble in excess suitable named acid *</td></tr>
<tr><td>OR
dilute acid * +
$KMnO_4$ *</td><td>no change / no reaction / solution remains purple **</td></tr>
</table>
Ignore additional reagents</td><td>5</td></tr>
<tr><td>3(b)(ii)</td><td>cation: Mg^{2+}
and
anion: SO_4^{2-}</td><td>1</td></tr>
</table>