Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/31**

Paper 3 Advanced Practical Skills 1 **October/November 2020**

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.

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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.

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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.

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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.

Rounding errors (RE) and transcription errors (TE) are penalised only once in the paper.

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Question	Answer	Marks
1(a)	**I** Clearly shows initial and final mass **and** both recorded to the same precision **and** with correct units. Units: (g) or / g or in g or g by every entry (including mass used if given) Reject weight	**1**
	II The following data must be shown • burette readings ***and*** titre for rough titration • 2 × 2 'box' showing both accurate burette readings	**1**
	III Headings and units correct for accurate titration table **and** headings match readings. • initial / start **and** (burette) reading / volume • final / end **and** (burette) reading / volume • titre **or** volume / **FA 2 and** used / added Units: (cm^3) or / cm^3 or in cm^3 or cm^3 by every entry Allow vol for volume, value for reading Allow change in volume Reject difference, total or amount	**1**
	IV All accurate burette readings are recorded to 0.05 cm^3 (including 0.00) Reject if 50(.00) is used as an initial burette reading; Reject if more than one final burette reading is 50(.00) Reject if any burette reading is > 50(.00)	**1**
	V The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre. Ignore any titre labelled 'rough' Reject if any 'accurate' burette reading (apart from an initial 0 cm^3) is given to zero dp.	**1**
	Check and correct titre and mass subtractions where necessary. *Examiner selects the best mean titre.* *Apply hierarchy: 2 identical, titres within 0.05 cm^3, titres within 0.10 cm^3, etc.Examiner calculates supervisor's corrected average titre × supervisor's corrected mass to 1 dp.* *Examiner calculates candidate's corrected average titre × candidate's corrected mass to 1 dp.* *Subtract the candidate product value from that of the supervisor: δ*	

Question	Answer	Marks
1(a)	Award **VI** if $4.0 < \delta \leqslant 6.0$ g cm^3	**1**
	Award **VI** and **VII** if $2.0 < \delta \leqslant 4.0$ g cm^3	**1**
	Award **VI**, **VII** and **VIII** if $\delta \leqslant 2.0$ g cm^3	**1**
	If there is only one accurate titration award accuracy marks based on that titration without further penalty. If **only** a rough titration is shown award accuracy marks based on this value but cancel one accuracy mark. Apply spread penalty as follows:if titres selected (by examiner) differ $\geqslant 1.00$ cm^3 then cancel one accuracy mark. *If Supervisor's value $\leqslant 10.00$ cm^3 then halve tolerances* *(3 marks: $\delta \leqslant 1.0$; 2 marks: $\delta \leqslant 2.$; 1 mark: $\delta \leqslant 3.0$ g cm^3)*	
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 **(ii)** and both parts of **(iii)** are quoted to 3−4 sf.	**1**
1(c)(ii)	Correctly calculates 1.25×10^{-3}	**1**
1(c)(iii)	Correctly uses 2.50×10^{-3} **AND** $2.50 \times 10^{-3} \times \dfrac{250}{(\mathbf{b})} \left(= \dfrac{0.625}{(\mathbf{b})} \right)$	**1**
1(c)(iv)	Correctly uses correctly calculated mass from $\dfrac{(\mathbf{a})}{\text{ans}(\mathbf{iii})}$	**1**
	Display of $\dfrac{(\text{ANS} - 158.2)}{18}$	**1**
1(c)(iv)	Uses values to calculate x to the nearest integer	**1**

Question	Answer	Marks
1(d)(i)	Uncertainty in a single reading: *for 1 dp balance allow the uncertainty given to be ± 0.1 or 0.05* *for 2 dp balance allow the uncertainty given to be ± 0.01 or 0.005, etc.* **AND** Display of $\left(\frac{2\times\text{uncertainty given}}{\text{candidate mass}}\right)\times 100$	**1**
1(d)(ii)	Correctly uses $\left(\frac{(100-(\mathbf{d})(\mathbf{i}))}{100}\right)\times$ candidate's M_r **OR** $\frac{(\text{mass}(\mathbf{a})-2\times(\text{single})\text{ uncertainty})}{ans(\mathbf{c})(\mathbf{iii})}$ Allow numerator as (mass **(a)** – single uncertainty) if lack of doubling already penalised in **(d)(i)**.	**1**
1(e)	Titre value is less because concentration of thiosulfate is greater	**1**
1(f)	The indicator colour change is easier to see blue-black to colourless. **OR** The dark colour of the aqueous iodine makes the burette harder to read.	**1**

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Question	Answer	Marks
2(a)	**I** Appropriate headings and units for data given. • volume of **FA 5** • volume of water • time • rate Volumes in cm^3 or / cm^3 or (cm^3). Time in seconds or / s or (s), rate in s^{-1} or (s^{-1}). Ignore 1000. Allow ecf for display of units if penalised in **1(a)**.	**1**
	II Both times recorded to the nearest second.	**1**
	Examiner corrects times to the nearest second. Examiner calculates ratio: $\frac{\text{time for experiment 2}}{\text{time for experiment 1}}$ to 1 dp.	
	III Award if this ratio is between 1.9 and 2.1.	**1**
	IV Both rates correctly calculated using $\frac{1000}{\text{time}}$ and recorded to a minimum of 2 sf.	**1**
2(b)	Agree because ratio is almost 2. **OR** Disagree because ratio is not 2. Allow answers in terms of time	**1**
2(c)	Records volumes of **FA 4**, **FA 5** and water. 3 additional volumes of **FA 5** chosen with intervals not less than 4.0 cm^3 **and** all volumes of **FA 5** $\geqslant$ 24.0 cm^3 and $\leqslant$ 36.0 cm^3	**1**
	In all 3 additional experiments water is added to make a total volume of **FA 5** + water = 40.0 cm^3 Allow for intervals of less than 4.0 cm^3 for **FA 5**. Allow if **FA 4** omitted. Reject if **FA 4** $\neq$ 20(.0) cm^3	**1**

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Question	Answer	Marks
	FA 6 = $Na_2SO_3(s)$; **FA 8** = $CuSO_4(aq)$	
3(a)(i)	+ $AgNO_3$ gives a white ppt	**1**
	soluble in **both** $NH_3(aq)$ and **FA 5** / thio	**1**
3(a)(ii)	Cl^- / chloride	**1**
3(a)(iii)	Selects $BaCl_2$ OR $Ba(NO_3)_2$ **and** HCl OR HNO_3 **OR** selects acidified (aqueous) $KMnO_4$ **OR** add named mineral acid and test for SO_2 (e.g. blue litmus turns red; acidified aqueous manganate(VII) paper turns colourless)	**1**
	Clear display of results to show: white ppt **and** (partially) soluble in acid **OR** $KMnO_4$ decolourises **OR** positive result for SO_2 **AND** **FA 6** = sodium sulfite	**1**
3(a)(iv)	$2Ag^+(aq) + SO_3^{2-}(aq) \rightarrow Ag_2SO_3(s)$ Allow sulfate if ppt seen in **(iii)**: $2Ag^+(aq) + SO_4^{2-}(aq) \rightarrow Ag_2SO_4(s)$(sic)	**1**
3(b)(i)	(Pale) blue ppt dissolves in excess to give a dark blue solution.	**1**
	+ H_2O_2 solution turns black / dark green **OR** black / dark green solid produced **AND** Effervescence / fizzing / bubbling	**1**
	gas / oxygen relights a glowing splint	**1**
3(b)(ii)	Cu^{2+} / copper(II)	**1**

Question	Answer	Marks
3(b)(iii)	+ KI(aq) (turns) brown / yellow-brown / orange-brown / grey-brown Ignore state Allow mustard (brown) Reject red-brown	**1**
	+ **FA 5** then (brown solution becomes paler) ppt is off-white / white Allow cream / pale grey ppt. Ignore effect of excess thio / **FA 5**.	**1**
3(b)(iv)	Any 2 of: • (mixture) turns brown owing to the production of iodine • ppt formed is copper(I) iodide (allow copper(II) iodide) • I^- is oxidised (by Cu^{2+}) OR Cu^{2+} is reduced (by I^-) I_2 is reduced (by $S_2O_3^{2-}$) OR S is oxidised (by I_2) (ignore oxidation state of S)	**2**