Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/33**

Paper 3 Advanced Practical Skills 1 **March 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.

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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.

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Question	Answer	Marks
1(a)	10 thermometer readings recorded, all to .0 or .5 ºC **AND** at least one reading at .0 and one at .5	**1**
	Examiner calculates supervisor's greatest ΔT (= $T_{max} - T_{initial}$) and writes it ringed on each candidate script. Examiner calculates candidate's ΔT at the same volume then calculates the difference, δ, from the supervisor value.	**2**
	Award 2 marks if $\delta \leqslant 1.5\,°C$ for ΔT 10.5–15.0 **Award 1** mark if $1.5\,°C < \delta \leqslant 2.0\,°C$ ΔT 10.5–15.0	
1(b)(i)	Temperature on *y*-axis and volume of **FA 2** on the *x*-axis **AND** some numbers for scales **AND** with unambiguous names **or** units	**1**
	Linear scales chosen so that the graph occupies more than half the available length for both axes	**1**
	All points recorded accurately plotted	**1**
	Two lines of best fit drawn and extrapolated **AND** Lines must give a sharp intersection at a temperature equal to or higher than the highest recorded temperature	**1**
1(b)(ii)	Correct volume from intersection to 1 or 2 dp	**1**
1(b)(iii)	Correct expression with answer to 2 – 4 sf Concentration = $\boxed{\frac{25 \times 1.9}{2 \times \textbf{(b)(ii)}}}$	**1**
1(c)(i)	ΔT = T at intercept – initial T from table **OR** ΔT = T at intercept – T at intersect on *y*-axis	**1**

Question	Answer	Marks
1(c)(ii)	Correctly calculates % error = 4.167, 4.17 or 4.2%	**1**
1(c)(iii)	One of: • temperature started dropping between additions (of acid)/ heat loss so ΔT low(er) (than it should be) • maximum temperature at intersection is lower (than it should be) as insufficient readings near end point • alkali volume less than 25 cm^3 as measuring cylinder used.	**1**

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Question	Answer	Marks
2(a)	**I** The following data must be shown: • burette readings **and** titre for rough titration • 2 × 2 'box' showing both accurate burette readings.	**1**
	II Headings and units correct for accurate titration table and headings match readings. • initial / start **AND** (burette) reading / volume + unit • final / end **AND** (burette) reading / volume + unit • titre **OR** volume / **FA 4 AND** used / added + unit	**1**
	III All accurate burette readings given to the nearest 0.05	**1**
	IV The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre.	**1**
	Accuracy marks *Check and correct titre subtractions where necessary. Exclude any titre from the calculation for the mean where final burette reading is greater than 50(.00). Examiner selects the best titres for calculating the mean, using the hierarchy:* *2 identical titres, titres within 0.05 cm^3, titres within 0.10 cm^3 etc.* *Examiner subtracts (corrected) candidate's titre from Supervisor's titre.* *Write and ring Supervisor's value next to the accurate titration table of each candidate, also candidate mean value (calculated by examiner) and δ.*	
	Award **V** if $\delta \leqslant 0.50$ cm^3 Award **VI** if $\delta \leqslant 0.30$ cm^3 Award **VII** if $\delta \leqslant 0.20$ cm^3	**3**
2(b)	Candidate must average two (or more) titres that are **all** within 0.20 cm^3 **AND** give the answer to 2 dp. **AND** working must be shown or ticks must be put next to the two (or more) accurate titres selected.	**1**
2(c)(i)	All final answers for **(c)(ii)**, **(c)(iii)**, **(c)(iv)** are to 3–4 sf	**1**

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Question	Answer	Marks
2(c)(ii)	Correctly calculates amount of (n) $Na_2S_2O_3$ = 0.1 × **(b)** / 1000 mol **AND** n(I_2) = ans / 2	**1**
2(c)(iii)	Correctly calculates initial amount of (n) I_2 = 2.5(0) × 10^{-3} mol **AND** n(I_2) that reacted = 2.5(0) × 10^{-3} – final answer to **(ii)**	**1**
2(c)(iv)	Correctly uses amount of (n) Na_2SO_3 = final answer to **(iii)** × 100 mol	**1**
2(c)(v)	**M1** Correctly uses M_r $Na_2SO_3 \bullet xH_2O$ = $\frac{31.5(0)}{\textbf{(c)(iv)}}$ **AND** M_r Na_2SO_3 = 126.1	**1**
	M2 n(H_2O) = (answer above – 126.1)/18 **AND** answer is a (correctly rounded) integer **OR** **M1** mass(Na_2SO_3) = **(c)(iv)** × 126.1 **AND** mass(H_2O) = 31.5(0) – answer above **M2** n(H_2O) = mass above / 18 **AND** x = n(H_2O) / n(Na_2SO_3) **AND** answer is a (correctly rounded) integer	**1**

Question	Answer	Marks
2(d)	agree: Na_2CO_3 would neutralise acid (formed in reaction between sulfite and iodine which would react with the thiosulfate) / some thio would (otherwise) react with the acid (formed) **OR** disagree: (no advantage) as the reaction of thio with acid is slow **OR** disagree: (no advantage) as Na_2CO_3 will react with iodine (so less to react with thio)	**1**

Question	Answer	Marks
	FA 7 is $Na_2S_2O_3$; **FA 8** is A*l* $NH_4(SO_4)_2$(aq)	
3(a)(i)		**4**

	FA 7	**FA 8**
Test 1 + H^+	(slow formation of) white / off-white / cream / **pale** yellow ppt *	no change / no (visible) reaction / no ppt*
+ Ba^{2+}	no change (provided ppt reported with H^+) / ppt remains / insoluble *	white ppt *
Test 2 + MnO_4^-	purple to colourless / $KMnO_4$ decolourises*	no change / no (visible) reaction / stays purple * *Not 'no ppt' alone*
Test 3 + Fe*Cl*$_3$	purple colour fades / turns colourless (on standing) *	no change / no (visible) reaction / solution stays yellow *

2 x * = 1 mark

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)(ii)</td><td>FA 7 = $S_2O_3^{2-}$</td><td>1</td></tr>
<tr><td></td><td>FA 8 = SO_4^{2-}</td><td>1</td></tr>
<tr><td>3(b)(i)</td><td>selects NaOH and NH_3
AND
uses both NaOH and NH_3 to excess / warms at least one NaOH mixtures</td><td>1</td></tr>
<tr><td></td><td>
<table>
<tr><th></th><th>FA 7</th><th>FA 8</th></tr>
<tr><td>+ NaOH</td><td>no change / no (visible) reaction / no ppt *</td><td>white ppt *
soluble in excess *</td></tr>
<tr><td>+ warm</td><td>no change to (red) litmus / *
ignore no reaction
ignore bubbling</td><td>gas / NH_3 turns (red) litmus blue *</td></tr>
<tr><td>+ NH_3</td><td>Ignore</td><td>white ppt *
insoluble in excess *</td></tr>
</table>
2 x * = 1 mark (round down)
</td><td>3</td></tr>
<tr><td>3(b)(ii)</td><td>M1 FA 8 = Al^{3+} from fully correct observations
OR
FA 8 = NH_4^+ from litmus turning blue

M2 FA 7 is unknown and both ions in FA 8 correct</td><td>2</td></tr>
</table>

Question	Answer	Marks
3(b)(iii)	One of: $Al^{3+}(aq) + 3OH^-(aq) \rightarrow Al(OH)_3(s)$ $Al(OH)_3(s) + OH^-(aq) \rightarrow [Al(OH)_4]^-(aq)$ $NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$ *Allow ecf from **(b)(ii)** on incorrect cations*	**1**