Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

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CHEMISTRY **9701/33**

Paper 3 Advanced Practical Skills 1 **October/November 2019**

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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This document consists of **13** printed pages.

Cambridge Assessment International Education

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.

Question	Answer	Marks
1(a)	**I** All the following data recorded • two burette readings and titre for the rough titration • initial and final burette readings for **two** (or more) accurate titrations	**1**
	II Titre values shown, 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 / **FB 4 and** 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**
	III All accurate burette readings are recorded to the nearest .05 cm^3.	**1**
	IV The **final** accurate titre recorded is within 0.10 cm^3 of any other accurate titre.	**1**
	Award **V** if $\delta \leqslant 0.80$ (cm^3) (Where δ is difference to the supervisor's value)	**1**
	Award **VI** if $\delta \leqslant 0.50$ (cm^3)	**1**
	Award **VII** if $\delta \leqslant 0.30$ (cm^3)	**1**

Question	Answer	Marks
1(b)	**Correctly calculates** mean titre from two (or more) accurate titres where the total spread is ⩽ 0.20 cm^3. **AND** Answer is given to 2 d.p. **AND** Working must be shown or ticks must be put next to the two (or more) accurate titres selected.	**1**
1(c)(i)	**Significant figures** **All** answers in **(ii)–(iv)** are expressed to 3 or 4 sig. fig.	**1**
1(c)(ii)	**Correctly calculates no of moles of NaOH used.** No. of moles NaOH = $^{6.00}/_{40} \times {}^{\text{answer } \textbf{(b)}}/_{1000}$	**1**
1(c)(iii)	$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$ **or** $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ **AND** No. of moles of HC*l* = same as in moles of NaOH in **(ii)**	**1**

Question	Answer	Marks
1(c)(iv)	**Correct expression shown (for the first step)** (Two steps) Concentration HCl in **FA 3** = ans **(c)(iii)** × 1000 / 25 **Allow** ans **(c)(iii)** × 40 (Concentration of **FA 2** = Concentration of **FA 3** × 25) **OR** moles of **FA 3** in 250 cm^3 = ans **(c)(iii)** × 250 / 25 **Allow** ans **(c)(iii)** × 10 (moles of **FA 2**) in 1 dm^3 = ans above × 1000 / 10)	**1**
	Answer = **(c)(iii)** × 1000	**1**

Question	Answer	Marks
2(a)	**I Suitable tables/lists with values entered in the space provided.** • Three clearly labelled masses *(***do not allow** *'weight')* with correct units • Three unambiguous labelled temperatures, with units	**1**
	II Readings and subtraction in 2(a) and 2(d) • All four measured temperatures recorded to .0 or .5 °C • Both temperature changes correctly subtracted. • All masses in **(a)** and **(d)** recorded to one or more d.p. (balance readings must be consistent d.p. within each experiment) • Both masses correctly subtracted.	**1**
	Accuracy marks Round all thermometer readings to 0.5 °C. Check the candidate's and supervisor's subtractions and compare the candidate's [corrected] **temperature rise** with the supervisor's. The difference between candidate and supervisor is δ. See table below for marks available.	**2**

Sup ΔT_{max}	> 40.0 °C	30.5–40.0 °C	20.5–30.0 °C	10.5–20.0 °C	5.5–10.0 °C	< 5.5 °C
1 mark	$\delta \leqslant 5.0$ °C	$\delta \leqslant 4.0$ °C	$\delta \leqslant 3.0$ °C	$\delta \leqslant 2.0$ °C	$\delta \leqslant 1.0$ °C	$\delta \leqslant 0.5$ °C
2 marks	$\delta \leqslant 2.5$ °C	$\delta \leqslant 2.0$ °C	$\delta \leqslant 1.5$ °C	$\delta \leqslant 1.0$ °C	$\delta \leqslant 0.5$ °C	not available

Question	Answer	Marks
2(b)(i)	**Correctly calculates heat change** Heat change = 40 × 4.2 × temp rise **AND** Answer is correct to 2–4 s.f.	**1**
2(b)(ii)	**Correctly calculates number of moles of MgO** No. of moles of MgO used = $^{\text{mass used}}/_{40.3}$ **AND** Answer is correct to 2–4 s.f.	**1**
2(b)(iii)	**Correctly uses (i)/(ii) and negative sign shown** Enthalpy change = $-\,^{\mathbf{(b)(i)}}/_{\mathbf{(b)(ii)}} \times \,^{1}/_{1000}$ **AND** Answer is given to 2–4 s.f.	**1**
2(c)	**Correct expression(s) shown in 'excess' calculation** Candidate must compare the number of moles of MgO and HC*l* used **and** correctly use the mole ratio of 1:2. <u>Example of working</u> No. of moles of HC*l* used = 0.04 × ans **1(c)(iv)** (**or** n = 0.04 × 3.75 = 0.15) Maximum no. moles MgO that can be used = 0.5 × n Note – there are other valid ways of doing this calculation.	**1**

Question	Answer	Marks
2(d)(i)	**Readings written in space provided** • Two thermometer readings are recorded both above 10 °C • Two masses are recorded giving mass of $MgCO_3$ between 2–5 g.	**1**
	Accuracy mark Check temperature subtractions of candidate and of supervisor. Compare the [corrected] candidate's temperature rise with the supervisor's. The difference is δ. • If δ is less than or equal to 2.0 °C, award the mark	**1**
2(d)(ii)	**Observations (two required)** Fizzing / bubbles / effervescence **AND** **either** solid dissolves / disappears / colourless solution formed **or** reaction is brisk / rapid / vigorous / violent	**1**
2(d)(iii)	**Correct expression(s) for enthalpy change, with negative sign** Enthalpy change = $-40 \times 4.2 \times \text{temp rise} \times {}^{84.3}/_{\text{mass } MgCO_3} \times {}^{1}/_{1000}$	**1**
2(e)	**Enthalpy change correctly calculated with correct sign** Answer = **(b)(iii) – (d)(iii) and** to minimum 2 s.f. unless answer is an integer. If default values are used, the answer must be -44.4 kJ mol^{-1}.	**1**

Question	Answer	Marks
2(f)	Plot a cooling curve (after the maximum temperature reached) **OR** plot a graph to get better value of ΔT **OR** use increased masses of **FA 4** and / or **FA 5** / mass of solid (added) **OR** heat the acid **before** adding solid / **FA 4** and / or **FA 5** **Ignore** answers related to the apparatus used.	1
2(g)	Correct single reading error (see below) **and** MgO has the greater % error (**Allow** $MgCO_3$ if this was the smaller mass.) *If candidate used a 1 d.p. balance for this solid, error is 0.05* ***or*** *0.1 g* *If candidate used a 2 d.p. balance for this solid, error is 0.005* ***or*** *0.01 g* *If candidate used a 3 d.p. balance for this solid, error is 0.0005* ***or*** *0.001 g*	1
	Correct calculation of % error for MgO $\%\ \text{error} = 2 \times \left({}^{\text{single error}}/_{\text{mass of MgO used}}\right) \times 100$	1

Question	Answer	Marks
	FA 6 = Zn; **FA 7** = $NaNO_3$; **FA 9** = Na_2SO_3	
3(a)	**Observation** Bubbling / fizzing / effervescence *(Ignore 'gas formed')*	1
	Test for hydrogen during reaction (Gas) pops with a lighted splint / burns with a pop (**allow** *explodes*)	1
	Deduction **FA 6** is a metal **and** gives hydrogen (with an acid)	1
3(b)(i)	**Heating FA 7 – observations** • **FA 7**) melts / (partially) dissolves / becomes liquid / becomes a solution • (liquid is) yellow **or pale** brown • Fizzing / bubbling / effervescence occurs • (Gas / oxygen) re-lights a glowing splint • **Gas** turns (blue) litmus red • **After standing** / **cooling** white / off-white / cream / paler solid (formed). Award 1 mark for two correct observations from the list, award 2 marks for four or more correct observations. **MAX. 2 marks**	2

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(b)(ii)</td><td>

Observations in the table (see below)
Expected observations are in the table below.
Award 1 mark for every two correct observations (*)

Reject no observation the first time seen.
Reject a dash every time.

<table>
<tr><th>test</th><th>observation with FA 8</th><th>observation with FA 9</th></tr>
<tr><td>To a 1 cm depth in a test-tube, add a few drops of acidified potassium manganate(VII).</td><td>No (visible) reaction / no change or solution (in test tube) becomes pink / purple / solution / $KMnO_4$ / MnO_4^- stays purple *</td><td>from purple to colourless
or $KMnO_4$ / MnO_4^- decolourised</td></tr>
<tr><td>To a 1 cm depth in a test-tube, add a few drops of aqueous barium chloride or aqueous barium nitrate.</td><td>no reaction / no change / no precipitate / solution remains colourless *</td><td>white precipitate (formed) *</td></tr>
<tr><td>To a 1 cm depth in a boiling tube, add an equal volume of aqueous sodium hydroxide.
Warm carefully, then</td><td>no reaction / no change / no precipitate *</td><td>no reaction / no change /
no precipitate *</td></tr>
<tr><td>add aluminium foil.</td><td><u>gas / ammonia</u> turns (moist red) litmus blue *</td><td>fizzing / bubbling / effervescence
or
gas / H_2 pops with a lighted splint *</td></tr>
</table>

</td><td>4</td></tr>
<tr><td>3(b)(iii)</td><td>

Both anions correct
- **FA 8** = nitrate / NO_3^-
- **FA 9** = sulphite / SO_3^{2-}

</td><td>1</td></tr>
</table>

Question	Answer	Marks
3(b)(iv)	**One relevant ionic equation with state symbols** • $Ba^{2+}(aq) + SO_3^{2-}(aq) \rightarrow BaSO_3(s)$ • $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ • $2MnO_4^{-}(aq) + 6H^{+}(aq) + 5SO_3^{2-}(aq) \rightarrow 5SO_4^{2-}(aq) + 2Mn^{2+}(aq) + 3H_2O(l)$ • $3NO_3^{-}(aq) + 27H^{+}(aq) + 3Al(s) \rightarrow 3NH_3(g) + 9H_2O(l) + 3Al^{3+}(aq)$	1