
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.

Cambridge International is publishing the mark schemes for the October/November 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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

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.

Question	Answer	Marks
1(a)	I All the following data recorded <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • initial / start and (burette) reading / volume • final / end and (burette) reading / volume • titre or volume / FB 4 and used / added • unit: / cm³ or (cm³) or in cm³ (for each heading) or cm³ 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 $\delta \leq 0.80$ (cm ³) (Where δ is difference to the supervisor's value)	1
	Award VI if $\delta \leq 0.50$ (cm ³)	1
	Award VII if $\delta \leq 0.30$ (cm ³)	1

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Question	Answer	Marks
1(b)	<p>Correctly calculates mean titre from two (or more) accurate titres where the total spread is $\leq 0.20 \text{ cm}^3$.</p> <p>AND Answer is given to 2 d.p.</p> <p>AND Working must be shown or ticks must be put next to the two (or more) accurate titres selected.</p>	1
1(c)(i)	<p>Significant figures All answers in (ii)–(iv) are expressed to 3 or 4 sig. fig.</p>	1
1(c)(ii)	<p>Correctly calculates no of moles of NaOH used. No. of moles NaOH = $\frac{6.00}{40} \times \frac{\text{answer (b)}}{1000}$</p>	1
1(c)(iii)	<p>$\text{NaOH(aq)} + \text{HCl(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)}$ or $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O(l)}$</p> <p>AND No. of moles of HCl = same as in moles of NaOH in (ii)</p>	1

Question	Answer	Marks
1(c)(iv)	<p>Correct expression shown (for the first step) (Two steps)</p> <p>Concentration HCl in FA 3 = ans (c)(iii) \times 1000 / 25 Allow ans (c)(iii) \times 40 (Concentration of FA 2 = Concentration of FA 3 \times 25)</p> <p>OR</p> <p>moles of FA 3 in 250 cm³ = ans (c)(iii) \times 250 / 25 Allow ans (c)(iii) \times 10 (moles of FA 2) in 1 dm³ = ans above \times 1000 / 10)</p>	1
	Answer = (c)(iii) \times 1000	1

Question	Answer						Marks																					
2(a)	I Suitable tables/lists with values entered in the space provided. <ul style="list-style-type: none"> • Three clearly labelled masses (do not allow <i>‘weight’</i>) with correct units • Three unambiguous labelled temperatures, with units 						1																					
	II Readings and subtraction in 2(a) and 2(d) <ul style="list-style-type: none"> • 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																					
	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="width: 12.5%;">Sup ΔT_{\max}</th> <th style="width: 12.5%;">> 40.0 °C</th> <th style="width: 12.5%;">30.5–40.0 °C</th> <th style="width: 12.5%;">20.5–30.0 °C</th> <th style="width: 12.5%;">10.5–20.0 °C</th> <th style="width: 12.5%;">5.5–10.0 °C</th> <th style="width: 12.5%;">< 5.5 °C</th> </tr> </thead> <tbody> <tr> <td>1 mark</td> <td>$\delta \leq 5.0$ °C</td> <td>$\delta \leq 4.0$ °C</td> <td>$\delta \leq 3.0$ °C</td> <td>$\delta \leq 2.0$ °C</td> <td>$\delta \leq 1.0$ °C</td> <td>$\delta \leq 0.5$ °C</td> </tr> <tr> <td>2 marks</td> <td>$\delta \leq 2.5$ °C</td> <td>$\delta \leq 2.0$ °C</td> <td>$\delta \leq 1.5$ °C</td> <td>$\delta \leq 1.0$ °C</td> <td>$\delta \leq 0.5$ °C</td> <td>not available</td> </tr> </tbody> </table>						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	$\delta \leq 5.0$ °C	$\delta \leq 4.0$ °C	$\delta \leq 3.0$ °C	$\delta \leq 2.0$ °C	$\delta \leq 1.0$ °C	$\delta \leq 0.5$ °C	2 marks	$\delta \leq 2.5$ °C	$\delta \leq 2.0$ °C	$\delta \leq 1.5$ °C	$\delta \leq 1.0$ °C	$\delta \leq 0.5$ °C	not available	
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Question	Answer	Marks
2(b)(i)	<p>Correctly calculates heat change Heat change = $40 \times 4.2 \times \text{temp rise}$ AND Answer is correct to 2–4 s.f.</p>	1
2(b)(ii)	<p>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.</p>	1
2(b)(iii)	<p>Correctly uses (i)/(ii) and negative sign shown Enthalpy change = $- \text{(b)(i)}/\text{(b)(ii)} \times 1/1000$ AND Answer is given to 2–4 s.f.</p>	1
2(c)	<p>Correct expression(s) shown in ‘excess’ calculation Candidate must compare the number of moles of MgO and HCl used and correctly use the mole ratio of 1:2.</p> <p><u>Example of working</u> No. of moles of HCl used = $0.04 \times \text{ans 1(c)(iv)}$ (or $n = 0.04 \times 3.75 = 0.15$) Maximum no. moles MgO that can be used = $0.5 \times n$</p> <p>Note – there are other valid ways of doing this calculation.</p>	1

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Question	Answer	Marks
2(d)(i)	<p>Readings written in space provided</p> <ul style="list-style-type: none"> Two thermometer readings are recorded both above 10 °C Two masses are recorded giving mass of MgCO₃ between 2–5 g. 	1
	<p>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.</p> <ul style="list-style-type: none"> If δ is less than or equal to 2.0 °C, award the mark 	1
2(d)(ii)	<p>Observations (two required) Fizzing / bubbles / effervescence AND either solid dissolves / disappears / colourless solution formed or reaction is brisk / rapid / vigorous / violent</p>	1
2(d)(iii)	<p>Correct expression(s) for enthalpy change, with negative sign Enthalpy change = $-40 \times 4.2 \times \text{temp rise} \times \frac{84.3}{\text{mass MgCO}_3} \times \frac{1}{1000}$</p>	1
2(e)	<p>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 $-44.4 \text{ kJ mol}^{-1}$.</p>	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.) <i>If candidate used a 1 d.p. balance for this solid, error is 0.05 or 0.1 g</i> <i>If candidate used a 2 d.p. balance for this solid, error is 0.005 or 0.01 g</i> <i>If candidate used a 3 d.p. balance for this solid, error is 0.0005 or 0.001 g</i>	1
	Correct calculation of % error for MgO $\% \text{ error} = 2 \times \left(\frac{\text{single error}}{\text{mass of MgO used}} \right) \times 100$	1

Question	Answer	Marks
FA 6 = Zn; FA 7 = NaNO₃; FA 9 = Na₂SO₃		
3(a)	Observation Bubbling / fizzing / effervescence (<i>Ignore 'gas formed'</i>)	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 <ul style="list-style-type: none"> • 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). <p>Award 1 mark for two correct observations from the list, award 2 marks for four or more correct observations. MAX. 2 marks</p>	2

Question	Answer	Marks															
3(b)(ii)	<p>Observations in the table (see below) Expected observations are in the table below. Award 1 mark for every two correct observations (*)</p> <p>Reject no observation the first time seen. Reject a dash every time.</p> <table border="1" data-bbox="349 477 1942 1211"> <thead> <tr> <th data-bbox="349 477 815 544"><i>test</i></th> <th data-bbox="815 477 1382 544"><i>observation with FA 8</i></th> <th data-bbox="1382 477 1942 544"><i>observation with FA 9</i></th> </tr> </thead> <tbody> <tr> <td data-bbox="349 544 815 711">To a 1 cm depth in a test-tube, add a few drops of acidified potassium manganate(VII).</td> <td data-bbox="815 544 1382 711">No (visible) reaction / no change or solution (in test tube) becomes pink / purple / solution / KMnO_4 / MnO_4^- stays purple *</td> <td data-bbox="1382 544 1942 711">from purple to colourless or KMnO_4 / MnO_4^- decolourised</td> </tr> <tr> <td data-bbox="349 711 815 876">To a 1 cm depth in a test-tube, add a few drops of aqueous barium chloride or aqueous barium nitrate.</td> <td data-bbox="815 711 1382 876">no reaction / no change / no precipitate / solution remains colourless *</td> <td data-bbox="1382 711 1942 876">white precipitate (formed) *</td> </tr> <tr> <td data-bbox="349 876 815 1040">To a 1 cm depth in a boiling tube, add an equal volume of aqueous sodium hydroxide. Warm carefully, then</td> <td data-bbox="815 876 1382 1040">no reaction / no change / no precipitate *</td> <td data-bbox="1382 876 1942 1040">no reaction / no change / no precipitate *</td> </tr> <tr> <td data-bbox="349 1040 815 1211">add aluminium foil.</td> <td data-bbox="815 1040 1382 1211"><u>gas / ammonia</u> turns (moist red) litmus blue *</td> <td data-bbox="1382 1040 1942 1211">fizzing / bubbling / effervescence or gas / H_2 pops with a lighted splint *</td> </tr> </tbody> </table>	<i>test</i>	<i>observation with FA 8</i>	<i>observation with FA 9</i>	To a 1 cm depth in a test-tube, add a few drops of acidified potassium manganate(VII).	No (visible) reaction / no change or solution (in test tube) becomes pink / purple / solution / KMnO_4 / MnO_4^- stays purple *	from purple to colourless or KMnO_4 / MnO_4^- decolourised	To a 1 cm depth in a test-tube, add a few drops of aqueous barium chloride or aqueous barium nitrate.	no reaction / no change / no precipitate / solution remains colourless *	white precipitate (formed) *	To a 1 cm depth in a boiling tube, add an equal volume of aqueous sodium hydroxide. Warm carefully, then	no reaction / no change / no precipitate *	no reaction / no change / no precipitate *	add aluminium foil.	<u>gas / ammonia</u> turns (moist red) litmus blue *	fizzing / bubbling / effervescence or gas / H_2 pops with a lighted splint *	4
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3(b)(iii)	<p>Both anions correct</p> <ul style="list-style-type: none"> • FA 8 = nitrate / NO_3^- • FA 9 = sulphite / SO_3^{2-} 	1															

Question	Answer	Marks
3(b)(iv)	One relevant ionic equation with state symbols <ul style="list-style-type: none">• $\text{Ba}^{2+}(\text{aq}) + \text{SO}_3^{2-}(\text{aq}) \rightarrow \text{BaSO}_3(\text{s})$• $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$• $2\text{MnO}_4^{-}(\text{aq}) + 6\text{H}^{+}(\text{aq}) + 5\text{SO}_3^{2-}(\text{aq}) \rightarrow 5\text{SO}_4^{2-}(\text{aq}) + 2\text{Mn}^{2+}(\text{aq}) + 3\text{H}_2\text{O}(\text{l})$• $3\text{NO}_3^{-}(\text{aq}) + 27\text{H}^{+}(\text{aq}) + 3\text{Al}(\text{s}) \rightarrow 3\text{NH}_3(\text{g}) + 9\text{H}_2\text{O}(\text{l}) + 3\text{Al}^{3+}(\text{aq})$	1