



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.

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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.

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.

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

Question	Answer	Mark
1(a)	I Four (or more) experiments completed AND Table on page 4 with correct headings showing • volume of FA 1 • volume of water • time • rate Allow vol. Ignore V or FA 1 alone. Ignore extra columns of data. Ignore data for this mark.	1
	II Correct units for all data (in heading or for each entry) • volume: in cm^3 or $/\text{cm}^3$ or (cm^3) or cm^3 • time: $/\text{s}$ or (s) or s by each time Allow <i>in seconds</i> • rate: $/\text{s}^{-1}$ or (s^{-1}) or s^{-1} Ignore factor of 1000	1
	III All times recorded to nearest second (minimum of 3 times) AND volumes of FA 1 and water recorded to the nearest 0.05 cm^3	1
	IV Three additional experiments with volume FA 1 not less than 6.00 cm^3, not more than 20.00 cm^3 and no volume less than 2.00 cm^3 close to another volume. Reject if further additional experiments carried out. Reject if all 3 additional experiments are between 20 and 10 cm^3.	1
	V Volumes of water chosen so that FA1 + water = 20.00 cm^3 for additional experiments carried out. Reject if FA 1 = 0 Reject if no times recorded.	1

Question	Answer	Mark
1(a)	VI Correctly calculates rate for all experiments and answer shown to 2–4 sf. Use of significant figures or decimal places does not have to be consistent. Allow for a minimum of 3 experiments attempted.	1
	Round times to the nearest second before awarding Q marks. Convert times recorded as decimals to seconds, e.g. 1.42 (1:42) = 102 s VII Award if all candidate's times increase with decrease in volume of FA 1 . Reject if fewer than 4 experiments carried out.	1
	<i>Calculate candidate's ratio $\frac{\text{time for FA 1} = 10}{\text{time FA 1} = 20}$ to 2 dp and record the value under the results table.</i>	
	VIII Award if ratio is between 3.20 and 4.80	1
	IX Award if ratio is between 3.50 and 4.50	1
	X Award if ratio is between 3.80 and 4.20	1
1(b)	I Linear scales that cover more than half the space in both directions including (0,0) AND axes correctly orientated and clearly labelled <i>If scale is non-linear then II is not available.</i>	1
	II Points plotted correctly. Points must be within half a small square of the correct position. If the point should be on a line it must be on the line and if it should not be on the line it must not be so. 'Blobs' should be less than half a small square across and be correctly centred. Reject if the scale is non-linear.	1

Question	Answer	Mark
1(b)	III Line of best fit drawn which ignores anomalous results identified by the candidate. The line may be a smooth curve or straight AND use a minimum of 3 points. Ignore points which are circled or labelled as anomalous. Reject if a point has been shown at the origin and the line of best fit does not pass within 5 small squares of (0,0).	1
1(c)	Correct lines drawn within 1 small square Allow if horizontal line drawn and some mark shown at 5.	1
	Rate must be read to within correct half a small square, compared with examiner-read value. AND Correctly calculates $1000 / \text{rate}$ AND answer correct to 2–4 sf or a whole number of seconds (unless penalised in 1(a)VI). Reject if the portion of the scale used for the reading is non-linear.	1
1(d)(i)	Correctly calculates Expt 1: 20 cm^3 in total volume $60 \text{ cm}^3 \Rightarrow 1.67 \times 10^{-2} \text{ mol dm}^{-3}$ Expt 2: 10 cm^3 in total volume $60 \text{ cm}^3 \Rightarrow 0.83 \times 10^{-2} \text{ mol dm}^{-3}$	1
	$\frac{20}{10} = \frac{1.67}{0.83}$ so directly proportional Allow directly proportional as total volume unchanged but volume of FA 1 / KI doubled / halved.	1
	<i>If neither mark is awarded, then allow a total of one mark in (d)(i) for a correct calculation of moles of KI in Experiments 1 and 2 (1×10^{-3} and $5 \times 10^{-4} \text{ mol}$ respectively).</i>	

Question	Answer	Mark
1(d)(ii)	Graph: comment must refer to the shape of the line drawn. <u>Curve</u>: as concentration / volume (of iodide ions) increases rate increases more / not directly proportional as line is a curve / not a straight line <u>Straight line</u>: rate is proportional to concentration (of iodide ions) / proportional as line has a positive gradient Reject directly proportional unless the straight line passes within 5 small squares of (0,0). OR Table: compares ratio of concentrations / volumes of FA 1 with ratio of rates	1
	Reason: (plotted points give) line of increasing gradient (This mark is not available if a straight line was drawn.) OR t_2 greater than $2t_1$ (or similar correct comparison) e.g. 'not directly proportional as rate increases more than concentration / volume'	1
1(e)(i)	$\text{S}_2\text{O}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{S}(\text{s}) + \text{SO}_2(\text{aq/g}) + \text{H}_2\text{O}(\text{l})$	1
1(e)(ii)	worse – less thio / FA 3 left in the reaction mixture to react with iodine formed / so time decreased for each run (owtte) e.g. 'some FA 2 reacts with FA 3 before starting the experiment.' Allow: same – the concentration of thio / FA 3 is very small so slow reaction with Fe^{3+} / acid / FA 2 so negligible effect / similar decrease in concentration of thio / FA 3 for each run so effects cancel better – quicker to transfer all the other reactants into the 1st beaker / takes more time to pour from measuring cylinder	1
1(f)(i)	Volumes of FA 1 , FA 3 and FA 4 are unchanged.	1
	FA 2 + water = 20 cm^3 Reject if these volumes are unchanged from Experiment 2 values.	1

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Question	Answer	Mark
1(f)(ii)	Correctly calculates $t = 178 \times \frac{10}{\text{vol FA 2}}$ Reject if volumes FA 2 + water $\neq 20 \text{ cm}^3$	1

Question	Answer	Marks
FA 5 is $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}(\text{s})$; FA 6 is $\text{MnO}_2(\text{s})$; FA 7 is $\text{KI}(\text{aq})$		
2(a)(i)	Any three observations on heating FA 5: - initially pink crystals (on gentle heating) solid turns white / paler (pink) - condensation / water droplets / water vapour / misty fumes ¹ (gas) turns (damp blue) litmus red - melts / liquid formed / dissolves (solid / liquid) turns brown / ochre / yellow-brown ² - residue is dark brown / black solid ³ ¹ Allow steam ² Reject red-brown ³ Reject ppt Ignore bubbles of gas Ignore incorrect positive gas tests	3
2(a)(ii)	FA 6 + H_2O_2 : Effervescence / bubbling / fizzing	1
	(Gas / O_2) relights glowing splint	1

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Question	Answer	Mark
2(a)(iii)	Observations using FA 5(aq) : + NaOH: off-white / beige / buff / pale / light brown ppt AND one of: insoluble in excess or darkens on standing / turns brown / darker brown	1
	+ H ₂ O ₂ : (fizz, etc.) Ignore this box unless there is a ppt + NaOH: dark brown / black ppt Reject if ppt is formed with H ₂ O ₂ or if ppt dissolves in excess NaOH Allow additional mark for gas relights glowing splint if not awarded in (a)(ii) .	1
2(b)(i)	Selects for halide: (aqueous) AgNO ₃ / silver nitrate and (followed by) NH ₃ / (aqueous) ammonia Ignore preliminary use of nitric acid.	1
	Selects for anion containing sulfur: (aqueous) BaCl ₂ / Ba(NO ₃) ₂ or names and HCl / HNO ₃ or names Reject if use of sulfuric acid is shown.	1
	<i>If neither mark is awarded, allow 1 mark for:</i> <i>AgNO₃ / silver nitrate – halide</i> AND <i>BaCl₂ / Ba(NO₃)₂ (or name) – S-anion</i> <i>Reject if use of sulfuric acid with Ba²⁺ salt is shown.</i>	

Question	Answer	Mark															
2(b)(ii)	Expected observations: <table border="1"> <thead> <tr> <th></th><th>FA 5</th><th>FA 7</th></tr> </thead> <tbody> <tr> <td>+ Ag⁺</td><td>white ppt *</td><td>(pale) yellow ppt *</td></tr> <tr> <td>+ NH₃</td><td>(ppt) colour darkens / off-white / buff / beige / pale brown *</td><td>(ppt) insoluble *</td></tr> <tr> <td>+ Ba²⁺</td><td>no change / no ppt / no reaction / not needed *</td><td>no change / no ppt / no reaction / not needed *</td></tr> <tr> <td>+ H⁺</td><td>ignore</td><td>ignore</td></tr> </tbody> </table> Two * = 1 mark (round down). Allow 1 mark for the following observations with NH₃(aq) if AgNO₃(aq) was not selected: FA 5: off-white / beige / buff / pale / light brown ppt AND FA 7: no reaction		FA 5	FA 7	+ Ag ⁺	white ppt *	(pale) yellow ppt *	+ NH ₃	(ppt) colour darkens / off-white / buff / beige / pale brown *	(ppt) insoluble *	+ Ba ²⁺	no change / no ppt / no reaction / not needed *	no change / no ppt / no reaction / not needed *	+ H ⁺	ignore	ignore	3
	FA 5	FA 7															
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2(b)(iii)	One box = one * Two * = 1 mark (round down). <table border="1"> <thead> <tr> <th></th><th>FA 5</th><th>FA 7</th></tr> </thead> <tbody> <tr> <td>cation</td><td>Mn²⁺</td><td>unknown</td></tr> <tr> <td>anion</td><td>Cl⁻</td><td>I⁻</td></tr> </tbody> </table> Ignore K⁺ for FA 7. Allow names (manganese(II), unknown, chloride, iodide) for 1 mark.		FA 5	FA 7	cation	Mn ²⁺	unknown	anion	Cl ⁻	I ⁻	2						
	FA 5	FA 7															
cation	Mn ²⁺	unknown															
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Question	Answer	Mark
2(b)(iv)	FA 5 + Cl_2 : no reaction / no (visible) change Allow turns black / dark brown if Mn^{2+} identified.	1
	FA 7 + Cl_2 : solution turns yellow / brown or black / dark grey ppt Allow ecf for bromide for either (not both) FA 5 or FA 7 : solution turns yellow / red-brown / brown. Allow solution turns orange for either Br^- or I^- . Allow no reaction / no (visible) change if SO_3^{2-} / SO_4^{2-} identified.	1



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| 5 | <p><u>'List rule' guidance</u></p> <p>For questions that require <i>n</i> responses (e.g. State two reasons ...):</p> <ul style="list-style-type: none"> • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked <i>ignore</i> in the mark scheme should not count towards <i>n</i>. • Incorrect responses should not be awarded credit but will still count towards <i>n</i>. • 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 <i>n</i> responses may be ignored even if they include incorrect science. |

6 Calculation specific guidance

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	II Correct units for all data (in heading or for each entry) • volume: in cm^3 or cm^3 or (cm^3) or cm^3 • time: / s or (s) or s by each time Allow <i>in seconds</i> • rate: / s^{-1} or (s^{-1}) or s^{-1} Ignore factor of 1000	1
	III All times recorded to nearest second (minimum of 3 times) AND volumes of FA 1 and water recorded to the nearest 0.05 cm^3	1
	IV Three additional experiments with volume FA 1 not less than 6.00 cm^3, not more than 20.00 cm^3 and no volume less than 2.00 cm^3 close to another volume. Reject if further additional experiments carried out. Reject if all 3 additional experiments are between 20 and 10 cm^3.	1
	V Volumes of water chosen so that FA1 + water = 20.00 cm^3 for additional experiments carried out. Reject if FA 1 = 0 Reject if no times recorded.	1

Question	Answer	Mark
1(a)	VI Correctly calculates rate for all experiments and answer shown to 2–4 sf. Use of significant figures or decimal places does not have to be consistent. Allow for a minimum of 3 experiments attempted.	1
	Round times to the nearest second before awarding Q marks. Convert times recorded as decimals to seconds, e.g. 1.42 (1:42) = 102 s VII Award if all candidate's times increase with decrease in volume of FA 1 . Reject if fewer than 4 experiments carried out.	1
	<i>Calculate candidate's ratio $\frac{\text{time for FA 1} = 10}{\text{time FA 1} = 20}$ to 2 dp and record the value under the results table.</i>	
	VIII Award if ratio is between 3.20 and 4.80	1
	IX Award if ratio is between 3.50 and 4.50	1
	X Award if ratio is between 3.80 and 4.20	1
1(b)	I Linear scales that cover more than half the space in both directions including (0,0) AND axes correctly orientated and clearly labelled <i>If scale is non-linear then II is not available.</i>	1
	II Points plotted correctly. Points must be within half a small square of the correct position. If the point should be on a line it must be on the line and if it should not be on the line it must not be so. 'Blobs' should be less than half a small square across and be correctly centred. Reject if the scale is non-linear.	1

Question	Answer	Mark
1(b)	III Line of best fit drawn which ignores anomalous results identified by the candidate. The line may be a smooth curve or straight AND use a minimum of 3 points. Ignore points which are circled or labelled as anomalous. Reject if a point has been shown at the origin and the line of best fit does not pass within 5 small squares of (0,0).	1
1(c)	Correct lines drawn within 1 small square Allow if horizontal line drawn and some mark shown at 5.	1
	Rate must be read to within correct half a small square, compared with examiner-read value. AND Correctly calculates $1000 / \text{rate}$ AND answer correct to 2–4 sf or a whole number of seconds (unless penalised in 1(a)VI). Reject if the portion of the scale used for the reading is non-linear.	1
1(d)(i)	Correctly calculates Expt 1: 20 cm^3 in total volume $60 \text{ cm}^3 \Rightarrow 1.67 \times 10^{-2} \text{ mol dm}^{-3}$ Expt 2: 10 cm^3 in total volume $60 \text{ cm}^3 \Rightarrow 0.83 \times 10^{-2} \text{ mol dm}^{-3}$	1
	$\frac{20}{10} = \frac{1.67}{0.83}$ so directly proportional Allow directly proportional as total volume unchanged but volume of FA 1 / KI doubled / halved.	1
	<i>If neither mark is awarded, then allow a total of one mark in (d)(i) for a correct calculation of moles of KI in Experiments 1 and 2 (1×10^{-3} and $5 \times 10^{-4} \text{ mol}$ respectively).</i>	

Question	Answer	Mark
1(d)(ii)	Graph: comment must refer to the shape of the line drawn. <u>Curve</u> : as concentration / volume (of iodide ions) increases rate increases more / not directly proportional as line is a curve / not a straight line <u>Straight line</u> : rate is proportional to concentration (of iodide ions) / proportional as line has a positive gradient Reject directly proportional unless the straight line passes within 5 small squares of (0,0). OR Table: compares ratio of concentrations / volumes of FA 1 with ratio of rates	1
	Reason: (plotted points give) line of increasing gradient (This mark is not available if a straight line was drawn.) OR t_2 greater than $2t_1$ (or similar correct comparison) e.g. 'not directly proportional as rate increases more than concentration / volume'	1
1(e)(i)	$\text{S}_2\text{O}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{S}(\text{s}) + \text{SO}_2(\text{aq/g}) + \text{H}_2\text{O}(\text{l})$	1
1(e)(ii)	worse – less thio / FA 3 left in the reaction mixture to react with iodine formed / so time decreased for each run (owtte) e.g. 'some FA 2 reacts with FA 3 before starting the experiment.' Allow: same – the concentration of thio / FA 3 is very small so slow reaction with Fe^{3+} / acid / FA 2 so negligible effect / similar decrease in concentration of thio / FA 3 for each run so effects cancel better – quicker to transfer all the other reactants into the 1st beaker / takes more time to pour from measuring cylinder	1
1(f)(i)	Volumes of FA 1 , FA 3 and FA 4 are unchanged.	1
	FA 2 + water = 20 cm^3 Reject if these volumes are unchanged from Experiment 2 values.	1

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Question	Answer	Mark
1(f)(ii)	Correctly calculates $t = 178 \times \frac{10}{\text{vol FA 2}}$ Reject if volumes FA 2 + water $\neq 20 \text{ cm}^3$	1

Question	Answer	Marks
FA 5 is $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}(\text{s})$; FA 6 is $\text{MnO}_2(\text{s})$; FA 7 is $\text{KI}(\text{aq})$		
2(a)(i)	Any three observations on heating FA 5 : - initially pink crystals (on gentle heating) solid turns white / paler (pink) - condensation / water droplets / water vapour / misty fumes ¹ (gas) turns (damp blue) litmus red - melts / liquid formed / dissolves (solid / liquid) turns brown / ochre / yellow-brown ² - residue is dark brown / black solid ³ ¹ Allow steam ² Reject red-brown ³ Reject ppt Ignore bubbles of gas Ignore incorrect positive gas tests	3
2(a)(ii)	FA 6 + H_2O_2 : Effervescence / bubbling / fizzing	1
	(Gas / O_2) relights glowing splint	1

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Question	Answer	Mark
2(a)(iii)	Observations using FA 5(aq) : + NaOH: off-white / beige / buff / pale / light brown ppt AND one of: insoluble in excess or darkens on standing / turns brown / darker brown	1
	+ H ₂ O ₂ : (fizz, etc.) Ignore this box unless there is a ppt + NaOH: dark brown / black ppt Reject if ppt is formed with H ₂ O ₂ or if ppt dissolves in excess NaOH Allow additional mark for gas relights glowing splint if not awarded in (a)(ii) .	1
2(b)(i)	Selects for halide: (aqueous) AgNO ₃ / silver nitrate and (followed by) NH ₃ / (aqueous) ammonia Ignore preliminary use of nitric acid.	1
	Selects for anion containing sulfur: (aqueous) BaCl ₂ / Ba(NO ₃) ₂ or names and HCl / HNO ₃ or names Reject if use of sulfuric acid is shown.	1
	<i>If neither mark is awarded, allow 1 mark for:</i> <i>AgNO₃ / silver nitrate – halide</i> AND <i>BaCl₂ / Ba(NO₃)₂ (or name) – S-anion</i> <i>Reject if use of sulfuric acid with Ba²⁺ salt is shown.</i>	

Question	Answer	Mark															
2(b)(ii)	Expected observations: <table border="1"> <thead> <tr> <th></th><th>FA 5</th><th>FA 7</th></tr> </thead> <tbody> <tr> <td>+ Ag⁺</td><td>white ppt *</td><td>(pale) yellow ppt *</td></tr> <tr> <td>+ NH₃</td><td>(ppt) colour darkens / off-white / buff / beige / pale brown *</td><td>(ppt) insoluble *</td></tr> <tr> <td>+ Ba²⁺</td><td>no change / no ppt / no reaction / not needed *</td><td>no change / no ppt / no reaction / not needed *</td></tr> <tr> <td>+ H⁺</td><td>ignore</td><td>ignore</td></tr> </tbody> </table> Two * = 1 mark (round down). Allow 1 mark for the following observations with NH₃(aq) if AgNO₃(aq) was not selected: FA 5: off-white / beige / buff / pale / light brown ppt AND FA 7: no reaction		FA 5	FA 7	+ Ag ⁺	white ppt *	(pale) yellow ppt *	+ NH ₃	(ppt) colour darkens / off-white / buff / beige / pale brown *	(ppt) insoluble *	+ Ba ²⁺	no change / no ppt / no reaction / not needed *	no change / no ppt / no reaction / not needed *	+ H ⁺	ignore	ignore	3
	FA 5	FA 7															
+ Ag ⁺	white ppt *	(pale) yellow ppt *															
+ NH ₃	(ppt) colour darkens / off-white / buff / beige / pale brown *	(ppt) insoluble *															
+ Ba ²⁺	no change / no ppt / no reaction / not needed *	no change / no ppt / no reaction / not needed *															
+ H ⁺	ignore	ignore															
2(b)(iii)	One box = one * Two * = 1 mark (round down). <table border="1"> <thead> <tr> <th></th><th>FA 5</th><th>FA 7</th></tr> </thead> <tbody> <tr> <td>cation</td><td>Mn²⁺</td><td>unknown</td></tr> <tr> <td>anion</td><td>Cl⁻</td><td>I⁻</td></tr> </tbody> </table> Ignore K⁺ for FA 7. Allow names (manganese(II), unknown, chloride, iodide) for 1 mark.		FA 5	FA 7	cation	Mn ²⁺	unknown	anion	Cl ⁻	I ⁻	2						
	FA 5	FA 7															
cation	Mn ²⁺	unknown															
anion	Cl ⁻	I ⁻															

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Question	Answer	Mark
2(b)(iv)	FA 5 + Cl_2 : no reaction / no (visible) change Allow turns black / dark brown if Mn^{2+} identified.	1
	FA 7 + Cl_2 : solution turns yellow / brown or black / dark grey ppt Allow ecf for bromide for either (not both) FA 5 or FA 7 : solution turns yellow / red-brown / brown. Allow solution turns orange for either Br^- or I^- . Allow no reaction / no (visible) change if SO_3^{2-} / SO_4^{2-} identified.	1

Cambridge International AS & A Level

CHEMISTRY**9701/34**

Paper 3 Advanced Practical Skills 2

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.

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This document consists of **14** printed pages.

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.

Penalise rounding errors (RE) or transcription errors (TE) once only on the paper.

Question	Answer	Mark
1(a)	I Four weighings written in the space provided AND All weighings are recorded to the same number of decimal places (minimum one dp). <i>Headings are not required for this mark but some indication needed regarding to what they refer.</i>	1
	II Appropriate headings and units (minimum four in the space provided and one must be for after heating) • mass of crucible and lid / g • mass of crucible, lid and FB 1 / g • mass of crucible, lid and residue after first heating / g • mass of crucible, lid and residue after second heating / g • mass of FB 1 (used) / g • mass of residue / anhydrous salt obtained / g Allow omission of lid but its use or omission must be consistent Allow 'solid' or 'contents' or 'anhydrous FB 1' for 'residue' Reject 'FB 1' for 'residue' Reject 'weight' Allow units displayed as / g or (g) or in gram(me)s in general mass heading or after every entry / heading	1
	III Masses of FB 1 and of residue are correctly subtracted AND Mass after 2nd heating is within 0.05 g of mass after first heating Note: the mass of residue must be calculated from the lower balance reading after heating Note: if a one dp balance was used, the two masses must be identical	1
	<i>Check all subtractions, and use the corrected values (if necessary)</i> <i>Calculate the ratio for supervisor $\frac{\text{mass FB 1}}{\text{mass residue}}$ to 2 dp</i> <i>Write this value, ringed, on each candidate's script.</i> <i>Calculate the candidate's ratio $\frac{\text{mass FB 1}}{\text{mass residue}}$ to 2 dp</i> <i>Calculate the δ value, the difference between these two ratios</i>	

Question	Answer	Mark
1(a)	Award IV only if $0.05 < \delta \leq 0.10$	1
	Award V if $\delta \leq 0.05$ Default value for $Al_2(SO_4)_3 \cdot 16H_2O = 1.84$ Default value for $Al_2(SO_4)_3 \cdot 18H_2O = 1.95$	1
1(b)(i)	Correctly calculates no of moles of water Moles of water = correct mass loss / 18 AND Answer is given to 2–4 significant figures Do not penalise sf more than once in 1(b) .	1
1(b)(ii)	Correct use of (b)(i) to calculate no of moles of residue moles of residue = (b)(i) / 16 AND answer given to 2–4 sf	1
1(b)(iii)	Correct use of (b)(ii) to calculate M_r of anhydrous salt $M_r = \text{mass of residue} / (b)(ii)$ AND answer given to 2–4 sf Allow ecf from calculated value in 1(a) .	1
1(b)(iv)	Correct expression to calculate A_r of metal $A_r = [(b)(iii) - 3 \times 96.1] / 2$ AND answer given to 3 or 4 sf 96.1 or 288.3 or 32.1 (or equivalent) must be seen in working. Allow expression to be shown in two (or more) steps Reject any extra working	1

Question	Answer	Mark
1(b)(v)	<i>Identity of metal (aluminium). Metal must be an element in Group 13.</i> The metal must have the A_r closest to the value calculated. $0 < B^* \leq 18.9 : 18.9 \leq \mathbf{Al} \leq 48.3 : 48.4 \leq \mathbf{Ga} \leq 92.2 : 92.3 \leq \mathbf{In} \leq 159.6 : 159.6 \leq \mathbf{Tl} \leq 300$. * Allow B if the A_r is appropriate even though it is a non-metal. Allow $\mathbf{Al}^{3+}$ for $\mathbf{Al}$, etc.	1
1(c)(i)	Lid prevents <u>solid</u> spitting or frothing out of crucible Allow FB 1 / crystals / salt for solid	1
1(c)(ii)	No: because the final two readings were [almost] identical and showing that <u>no more water</u> can be driven off. OR Yes: because the final two readings were not equal and so it shows that <u>more water still needs to be driven off</u>. Allow No: because the residue mass changes and anhydrous salt / residue may decompose. Allow Yes: I need to reheat to check the accuracy as the mass has increased (on 2nd heating) Allow absence of No / Yes provided the answer can be inferred from the explanation. Reject 'yes' if final two weighings are identical.	1

Question	Answer	Mark
2(a)	I Minimum 6 temperatures recorded Reject if any temperature recorded is below 10.0 °C.	1
	II Precision of recording All thermometer readings recorded to .0 °C or to .5 °C AND volumes in Experiment 6 recorded to 0.05 cm ³	1
	III One extra reading chosen. • Volume of water + volume of FB 3 = 10.00 cm ³ . • Volume of FB 3 must be between 2.50 and 7.50 cm ³ Reject if volume of FB 3 is within 0.50 cm ³ of prescribed values.	1
	<i>Round all thermometer readings to nearest 0.5 °C, if necessary. Calculate candidate's and supervisor's temp rises at 6.00 cm³ added. Write supervisor's temperature rise in a ring on candidate's script. Work out δ the difference between candidate and supervisor rise.</i>	
	Award IV if $1.0 < \delta \leq 2.0$ °C	1
	Award V if δ is ≤ 1.0 °C	1
	Note: Reduce tolerance bands to 0.5 °C and 1.0 °C if the supervisor's ΔT value is less than 10 °C	

Question	Answer	Mark
2(b)	I Graph axes - Linear scales chosen so that plotted points fill over half of the large grid line boxes (allowing for +3 °C 'extra' on the y-axis: 6 × 5 large squares) - Axes are unambiguously labelled with name or units. - If ΔT is plotted on y-axis, only mark I is forfeited.	1
	II Plotting All recorded points plotted (minimum 6) Reject if points that should be on a line are not on the line Reject if points are not within half a small square of the correct small square Reject if 'blobs' which are more than half a small square are plotted or if they are not correctly centred	1
	III Two straight lines drawn and extrapolated - Two straight lines <u>of best fit</u> drawn with a ruler (ignoring any points labelled as anomalous) - Lines give a sharp intersection / discontinuity at or above the highest T (unless labelled anomalous)	1
	IV Correct reading from on graph Volume of FB 3 (giving $T_{\max}$) correct to within half a small square and correctly expressed to 1 or 2 dp. Reject if the intersect is in a non-linear part of the scale.	1
2(c)(i)	Energy = 20 × 4.2 × temp rise (J) and answer given to 2–4 sf	1
2(c)(ii)	Moles = $\frac{\text{ans in 2(b)} \times 1.95}{1000}$ and answer given to 2–4 sf <i>Allow use of the default value (5.7 cm³ gives answer of 1.112×10^{-2} mol)</i>	1
2(c)(iii)	Enthalpy change = $-\frac{(c)(i)}{1000 \times (c)(ii)}$ and answer given to 2–4 sf	1

Question	Answer	Mark
2(c)(iv)	$2\text{NaOH(aq)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow \text{Na}_2\text{SO}_4\text{(aq)} + 2\text{H}_2\text{O(l)}$ Allow $\text{H}^+\text{(aq)} + \text{OH}^-\text{(aq)} \rightarrow \text{H}_2\text{O(l)}$	1
2(c)(v)	$[\text{NaOH}] = 2(\text{c})(\text{ii}) \times 2 \times 1000 / 10$ or $[\text{NaOH}] = 1.95 \times \text{vol acid} \times 2 / 10$ Allow ecf from equation giving NaHSO_4 $(\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{H}_2\text{O})$ $[\text{NaOH}] = 1.95 \times \text{vol acid} \times 1 / 10$ Reject value from an incorrect equation in (c)(iv)	1
2(d)	<u>One</u> mark from the following points: • Use larger volumes of both FB 2 <u>and</u> FB 3 / (both) solutions / (both) reagents (reduces % error in volume measurement) • Measure initial temperature of water <u>and</u> FB 3 (as well as FB 2) • Record initial temp for each experiment Allow increase concentrations of FB 2 <u>and</u> FB 3 / (both) solutions / (both) reagents	1

Question	Answer		Mark
FB 4 is $\text{Zn}(\text{NO}_3)_2(\text{aq})$; FB 5 is $\text{Na}_2\text{SO}_3(\text{aq})$			
3(a)		FB 4 observations	FB 5 observations
	Test 1 Na_2CO_3	white precipitate (formed) * <i>Reject white ppt soluble in excess</i>	no reaction / no change / no ppt *
	Test 2 NH_3	white precipitate and soluble in excess *	no reaction / no change / no ppt *
		<i>Ignore any reference to NH_3 given off</i>	
	Test 3 Ba^{2+}	no change / no reaction / no ppt *	white precipitate * <i>Reject soluble in excess</i>
	Test 4 HNO_3 then AgNO_3	no change / no reaction / no bubbling and no change / no reaction / no ppt * <i>Ignore 'no ppt' on addition of acid, (mark not available)</i>	no change / no reaction / no bubbling and no change / no reaction / no ppt * <i>Allow white / grey / brown ppt</i> <i>Reject other colours</i>
Two * = 1 mark (round down).			

Question	Answer			Mark
3(b)		FB 4 observations	FB 5 observations	3
	NaOH	white precipitate * soluble in excess *	no change / no reaction / no ppt *	
	heat	Ignore (but see box below)		
	Al	(more) effervescence / ... *	(more) ... / fizzing / bubbling *	
		<i>'more' must be stipulated if bubbling, etc., reported on heating</i>		
		<u>gas / NH₃</u> turns (red) litmus blue *	(gas / H ₂) pops with a lighted splint *	
		<i>Reject gas test observation if NH₃ (or any other gas) was identified on heating alone</i>		
	Two * = 1 mark (round down). maximum 3 marks			

Question	Answer	Mark
3(c)	(acidified) KMnO_4 Allow potassium manganate(VII) / potassium permanganate Allow: $\text{K}_2\text{Cr}_2\text{O}_7$ / potassium dichromate (Other oxidising reagents are possible)	1
	<i>Explanation</i> KMnO_4 is an oxidising agent / KMnO_4 can be reduced. Allow similar explanation for $\text{K}_2\text{Cr}_2\text{O}_7$ / other suitable oxidising agent	1
	Observations with KMnO_4 FB 4: no reaction / no change / (purple solution) not decolourised / solution stays purple AND FB 5: KMnO_4 turns colourless / decolourised OR purple $\rightarrow$ colourless / purple colour disappears <i>allow turns brown</i> <i>allow purple $\rightarrow$ brown / turns brown (ignore any ppt)</i> Observations with $\text{K}_2\text{Cr}_2\text{O}_7$ FB 4: no reaction / no change / solution remains orange AND FB 5: orange to green (solution)	1
3(d)	FB 4: cation is Zn^{2+} anion is NO_3^- FB 5: cation is unknown* AND at least one test on each unknown was attempted* anion is SO_3^{2-} Two * = 1 mark (round down). <i>If all names of ions are correct, award 1 mark. (zinc, nitrate, unknown, sulfite)</i>	2

Question	Answer	Mark
3(e)	$\text{Zn}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Zn}(\text{OH})_2(\text{s})$ OR $\text{Zn}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{ZnCO}_3(\text{s})$ Allow ecf for any Group 2 cation or Al^{3+} identified in (d) for FB 4	1



Cambridge International AS & A Level

CHEMISTRY

9701/35

Paper 3 Advanced Practical Skills 1

October/November 2020

MARK SCHEME

Maximum Mark: 40

Published

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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: (cm³) or / cm³ or in cm³ or cm³ 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 cm³ (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 cm³ of any other accurate titre. Ignore any titre labelled 'rough' Reject if any 'accurate' burette reading (apart from an initial 0 cm³) is given to zero dp.	1
	<i>Check and correct titre and mass subtractions where necessary. Examiner selects the best mean titre. Apply hierarchy: 2 identical, titres within 0.05 cm³, titres within 0.10 cm³, 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</i>	

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Question	Answer	Marks
1(a)	Award VI if $4.0 < \delta \leq 6.0 \text{ g cm}^3$	1
	Award VI and VII if $2.0 < \delta \leq 4.0 \text{ g cm}^3$	1
	Award VI , VII and VIII if $\delta \leq 2.0 \text{ g cm}^3$	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 $\geq 1.00 \text{ cm}^3$ then cancel one accuracy mark. <i>If Supervisor's value $\leq 10.00 \text{ cm}^3$ then halve tolerances</i> <i>(3 marks: $\delta \leq 1.0$; 2 marks: $\delta \leq 2.$; 1 mark: $\delta \leq 3.0 \text{ g cm}^3$)</i>	
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 $2.50 \times 10^{-3} \times \frac{250}{\text{(b)}} \left(= \frac{0.625}{\text{(b)}} \right)$	1
1(c)(iv)	Correctly uses correctly calculated mass from $\frac{\text{(a)}}{\text{ans}(\text{iii})}$	1
	Display of $\frac{(\text{ANS} - 158.2)}{18}$	1
1(c)(iv)	Uses values to calculate x to the nearest integer	1

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Question	Answer	Marks
1(d)(i)	Uncertainty in a single reading: <i>for 1 dp balance allow the uncertainty given to be ± 0.1 or 0.05</i> <i>for 2 dp balance allow the uncertainty given to be ± 0.01 or 0.005, etc.</i> AND Display of $\left(\frac{2 \times \text{uncertainty given}}{\text{candidate mass}} \right) \times 100$	1
1(d)(ii)	Correctly uses $\left(\frac{(100 - (\mathbf{d})(\mathbf{i}))}{100} \right) \times \text{candidate's } M_r$ OR $\frac{(\text{mass}(\mathbf{a}) - 2 \times (\text{single}) \text{uncertainty})}{\text{ans}(\mathbf{c})(\mathbf{iii})}$ 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

Question	Answer	Marks
2(a)	I Appropriate headings and units for data given. • volume of FA 5 • volume of water • time • rate Volumes in cm³ or / cm³ or (cm³). 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 cm³ and all volumes of FA 5 $\geq 24.0 \text{ cm}^3$ and $\leq 36.0 \text{ cm}^3$	1
	In all 3 additional experiments water is added to make a total volume of FA 5 + water = 40.0 cm³ Allow for intervals of less than 4.0 cm³ for FA 5. Allow if FA 4 omitted. Reject if FA 4 $\neq 20(.0) \text{ cm}^3$	1

Question	Answer	Marks
FA 6 = Na ₂ SO 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) → Ag ₂ SO ₃ (s) Allow sulfate if ppt seen in (iii): 2Ag ⁺ (aq) + SO ₄ ²⁻ (aq) → Ag ₂ SO ₄ (s)(sic)	1
3(b)(i)	(Pale) blue ppt dissolves in excess to give a dark blue solution.	1
	+ H ₂ O 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

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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

Cambridge International AS & A Level

CHEMISTRY**9701/36**

Paper 3 Advanced Practical Skills 2

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.

Cambridge International is publishing the mark schemes for the October/November 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **11** printed pages.

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.

Rounding errors and transcription errors are penalised only once in the paper.

Question	Answer	Marks
1(a)	I Unambiguous headings in layout of weighings and correct mass of FB 1 added and units correct: / g, (g) or in gram(me)s Reject 'weight'	1
	II Unambiguous recording of volume of CO ₂ with correct unit	1
	III Volume of gas collected is in the range 120–240 cm ³ Allow gas volume from (b)(i) if not recorded in (a) Note: if more than one expt. has been performed then all volumes collected must be within the limits above	1
1(b)(i)	Correctly calculates $\frac{V(a)}{24.0 \times 1000}$ and answer given to 2–4 sf	1
1(b)(ii)	Correctly uses mass FB 1 from (a) (b)(i) and answer given to 2–4 sf	1
1(b)(iii)	Correct expression $\frac{(b)(ii) - 138.2}{18}$ Note: 138.2 or 39.1 must be seen Allow expression to be shown in two (or more) steps	1
	x given as correct integer from candidate's expression	1

Question	Answer	Marks
1(c)	Any 2 of the following: • Heat water (before collecting gas) • Saturate water with CO₂ (before collecting gas) • Collect the gas over a (dilute) strong acid / any non-alkaline solution / use more concentrated acid in flask	2

Question	Answer	Marks
2(a)	I Headings and units Data set out in horizontal / vertical lines / columns showing • $2 \times$ mass of container + solid / FB 3 / FB 4 • $2 \times$ mass of container (+ residue) • $2 \times$ initial thermometer reading / temperature • $2 \times$ highest / lowest / final thermometer reading / temperature • $2 \times$ mass of solid (used / added) / FB 3 / FB 4 • $2 \times \Delta T$ / change in temperature Units: / g, ($^{\circ}\text{C}$), in gram(me)s Reject 'weight' unless already penalised in 1(a) Note: data must be included but not necessarily correct.	1
	II All four balance readings recorded to the same number of dp and thermometer readings recorded to .0 $^{\circ}\text{C}$ or .5 $^{\circ}\text{C}$ and written in the table Reject if all temperatures are below 10.0 $^{\circ}\text{C}$	1
	III Correctly calculates $2 \times$ mass of solid $2 \times$ change in temperature (ignore sign) Allow from 2(b)(i) and 2(b)(ii) if correctly calculated	1
<i>Examiner checks subtractions of supervisor and candidate.</i> <i>Write supervisor values (ringed) on the candidate script and calculate the differences, δ, from candidate.</i>		

Question	Answer	Marks									
2(a)	Award IV, V (Expt 1) and VI, VII (Expt 2) according to the table. <table border="1"> <tr> <td>Supervisor ΔT</td><td>5.0–10.0 °C</td><td>< 5.0 °C</td></tr> <tr> <td>1 mark</td><td>$\delta = 1.5$ °C</td><td>$\delta = 1.0$ °C</td></tr> <tr> <td>2 marks</td><td>$\delta = 1.0$ °C</td><td>$\delta = 0.0$ °C</td></tr> </table>	Supervisor ΔT	5.0–10.0 °C	< 5.0 °C	1 mark	$\delta = 1.5$ °C	$\delta = 1.0$ °C	2 marks	$\delta = 1.0$ °C	$\delta = 0.0$ °C	4
Supervisor ΔT	5.0–10.0 °C	< 5.0 °C									
1 mark	$\delta = 1.5$ °C	$\delta = 1.0$ °C									
2 marks	$\delta = 1.0$ °C	$\delta = 0.0$ °C									
2(b)(i)	Correctly calculates Q (heat energy) = $25 \times 4.2 \times \Delta T$ for both experiments and answers to 2–4 sf Allow ecf from incorrect ΔT Ignore signs Do not penalise incorrect sf more than once in (b)	1									
2(b)(ii)	Correctly uses $\frac{(25 \times 4.2 \times \Delta T) \times 106}{\text{mass FA3} \times 1000} \quad \frac{(25 \times 4.2 \times \Delta T) \times 286}{\text{mass FA4} \times 1000}$ One mark awarded for each correct calculation.	2									
	Correct signs shown and answers given to 2–4 sf	1									
2(b)(iii)	Attempt at use of Hess' law / energy level diagram / reverse equation Note: minimum display of working is correct direction of arrows and correct numbers shown / equations labelled and correct numbers shown)	1									
	Correctly uses $\Delta H_1 - \Delta H_2$ and correct sign and answer to 2–4 sf (Default answer = – 72.9)	1									
2(c)	No effect and same number / moles / amount / concentration of hydrogen ions	1									

Question	Answer				Marks
FB 6 is Na ₂ CO ₃ (aq); FB 7 is CrCl ₃ (aq); FB 8 is FeSO ₄ (aq)					
3(a)(i)	14 observations. Two * = 1 mark (round down)				7
		FB 6	FB 7	FB 8	
+ NH ₃		no (visible) reaction / no change / no ppt *	grey-green ppt and insoluble in excess *	green ppt and insoluble in excess / turns brown *	
+ H ₂ SO ₄		effervescence / bubbling / fizzing * limewater test attempted * gas / CO ₂ turns limewater milky / cloudy white / forms white ppt *	no (visible) reaction / no change * <i>ignore no ppt</i>	no (visible) reaction / no change * <i>ignore no ppt</i>	
+ H ⁺ / MnO ₄ ⁻		purple remains / no reaction / no change / purple not decolourised * fizzing * <i>(limewater test and observation may be awarded here)</i>	purple remains / no reaction / no change / purple not decolourised / turns darker purple *	purple / MnO ₄ ⁻ and decolourised / solution turns yellow *	
+ FB 6			green ppt * <i>ignore excess</i> <i>allow white- green / grey-green ppt</i> <i>(limewater test and observation can be awarded here)</i>	(pale) green ppt * <i>ignore excess</i> <i>ignore turning brown</i>	

Question	Answer	Marks
3(a)(ii)	Carbonate or hydrogen carbonate identified from correct formula	1
	$2\text{H}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$	1
	Allow $\text{H}^+(\text{aq}) + \text{HCO}_3^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$	
3(a)(iii)	All three correct = 2 marks, 2 correct = 1 mark FB 6 = unknown (Ignore Na^+) FB 7 = Cr^{3+} FB 8 = Fe^{2+} Allow unknown and chromium(III) and iron(II) for 1 mark	2
3(b)(i)	Uses $\text{AgNO}_3(\text{aq})$ for halides and $\text{Ba}(\text{NO}_3)_2(\text{aq})$ / $\text{BaCl}_2(\text{aq})$ for S-anion OR AgNO_3 then NH_3 for halide (any named halide) OR $\text{Ba}(\text{NO}_3)_2(\text{aq})$ / BaCl_2 followed by HCl / HNO_3 for S-anion (sulfate and sulfite) Allow $\text{Ba}(\text{NO}_3)_2(\text{aq})$ / BaCl_2 then (separate test) (acidified) KMnO_4 for S-anion (sulfate and sulfite) Allow without state symbols. Ignore separate test of adding acid (test for carbonate). Ignore addition of HNO_3 before adding AgNO_3 .	1

Question	Answer	Marks																				
3(b)(ii)	Clear presentation in a 'table' of results to show FB 7 and FB 8 and two or more reagents. Note: the reagents need not be correct for this mark to be awarded Note: no observations are needed for this mark to be awarded	1																				
	6 observations. 2 * = 1 mark (round down) <table border="1"> <thead> <tr> <th rowspan="2">test</th><th colspan="2">observation</th></tr> <tr> <th>FB 7</th><th>FB 8</th></tr> </thead> <tbody> <tr> <td>+ Ag⁺</td><td>white ppt •</td><td>(slowly forms) (pale) brown ppt • <i>allow no change</i></td></tr> <tr> <td>+ NH₃</td><td>ppt turns grey-green / green ppt * <i>Reject ppt dissolves</i></td><td><i>ignore</i></td></tr> <tr> <td>+ Ba²⁺</td><td>no reaction / no change •</td><td>white ppt •</td></tr> <tr> <td>+ H⁺ to ppt OR</td><td><i>ignore</i></td><td>ppt insoluble •</td></tr> <tr> <td>(allow) + KMnO₄ to soln.</td><td><i>ignore</i></td><td>purple to colourless / yellow – as (a)(i) *</td></tr> </tbody> </table> Ignore observations for any other reagents	test	observation		FB 7	FB 8	+ Ag ⁺	white ppt •	(slowly forms) (pale) brown ppt • <i>allow no change</i>	+ NH ₃	ppt turns grey-green / green ppt * <i>Reject ppt dissolves</i>	<i>ignore</i>	+ Ba ²⁺	no reaction / no change •	white ppt •	+ H ⁺ to ppt OR	<i>ignore</i>	ppt insoluble •	(allow) + KMnO ₄ to soln.	<i>ignore</i>	purple to colourless / yellow – as (a)(i) *	3
test	observation																					
	FB 7	FB 8																				
+ Ag ⁺	white ppt •	(slowly forms) (pale) brown ppt • <i>allow no change</i>																				
+ NH ₃	ppt turns grey-green / green ppt * <i>Reject ppt dissolves</i>	<i>ignore</i>																				
+ Ba ²⁺	no reaction / no change •	white ppt •																				
+ H ⁺ to ppt OR	<i>ignore</i>	ppt insoluble •																				
(allow) + KMnO ₄ to soln.	<i>ignore</i>	purple to colourless / yellow – as (a)(i) *																				
3(b)(iii)	Both ions correct = 1 mark FB 7 = Cl⁻ FB 8 = SO₄²⁻ Ignore names of ions	1																				