

Cambridge International AS & A Level

CHEMISTRY**9701/31**

Paper 3 Advanced Practical Skills 1

October/November 2025**MARK SCHEME**Maximum Mark: 40

Published

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

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- 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.

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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.
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- 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.
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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.

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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.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	Correct point or mark awarded
	Incorrect point or mark not awarded
	Information missing or insufficient for credit
	Benefit of the doubt given
	Contradiction in response otherwise markworthy, mark not given
	Error in number of decimal places
	Error carried forward applied
	Incorrect or insufficient point ignored while marking the rest of the response
	Rounding error
	Repeat error
 or /	Blank page or part of script seen

Annotation	Meaning
SF	Error in number of significant figures
TE	Transcription error

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Question	Answer	Marks
1(a)	I The following data are 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 recorded for accurate titrations, AND Correct headings and units in the accurate titration table - initial / start AND (burette) reading / volume - final / end AND (burette) reading / volume - titre OR volume used/added/ OR FA 2 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 recorded to 0.05 cm ³	1
	IV The final accurate titre recorded must be within 0.10 cm ³ of any other accurate titre	1
	Accuracy (Q) marks Round burette readings to the nearest 0.05 cm ³ . Check and correct titre subtractions where necessary. Examiner selects the best mean titre, using the following hierarchy: - two (or more) accurate identical titres (ignoring any that are labelled 'rough'), <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two(or more) accurate titres within 0.10 cm³, <i>etc.</i> Calculate the candidate's mean titre value Calculate the supervisor's mean titre value Calculate the difference (δ) between the candidate's mean titre and the supervisor's mean titre	
	Award accuracy Q marks as follows: V Award if $\delta \leq 0.50 \text{ cm}^3$ VI Award if $\delta \leq 0.30 \text{ cm}^3$ VII Award if $\delta \leq 0.20 \text{ cm}^3$	3

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Question	Answer	Marks
1(b)	Correctly calculates mean titre to 2 dp • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. • Working/explanation must be shown OR ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 dp and be rounded to nearest 0.01 cm³. (e.g. 26.675 cm³ must be rounded to 26.68 cm³)	1
1(c)(i)	All answers to (c)(ii), (c)(iii) and (c)(iv) to 3 – 4 sf	1
1(c)(ii)	Correctly calculates amount of manganate(VII) = $0.02 \times \text{volume in (b)} / 1000 \text{ mol}$	1
1(c)(iii)	Correctly uses M1 Amount of ethanedioic acid = (c)(ii) $\times 5 / 2 \text{ mol}$ M2 Concentration of FA 1 = (c)(ii) $\times 5 / 2 \times 1000 / 25 \text{ mol dm}^{-3}$	2
1(c)(iv)	Correctly uses $M_r = 6.2(0) / \text{(c)(iii)}$	1
1(c)(v)	$(M_r - 90) / 18$ AND correctly calculates answer as integer	1
1(d)	H ⁺ needed in the reaction / H ⁺ used in / appears in the equation	1

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Question	Answer	Marks
2(a)	I Six correct headings with units in results space • (Mass) crucible + lid / g • (Mass) crucible + lid + FA 4 / g • (Mass) crucible + lid + residue / contents after first heating / g • (Mass) crucible + lid + residue after second heating / g • (Mass) FA 4 (used) / g • (Mass) residue / g Display of units: / g, (g), in g, in gram(me)s or in (column) heading covering all entries	1
	II Four readings in space provided • All four weighings recorded to same decimal places (either to two or to three) • Reading after 2nd heating within + 0.02 and – 0.05 of reading after 1st heating	1
	II Correct subtractions • Correct calculations of mass FA 4 and residue AND • Mass of FA 4 is between 2.90 and 3.40 g.	1
	IV and V Accuracy Theoretical value = 1.78 Calculate and record candidate's mass ratio = mass FA 4 / mass of residue. Award IV if $1.51 \leq \text{candidate's mass ratio} \leq 2.05$ Award V if $1.60 \leq \text{candidates mass ratio} \leq 1.96$	2

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Question	Answer	Marks
2(b)(i)	Correctly uses M1 Amount ZnSO_4 = mass residue / 161.5 mol AND answer given to 2 – 4 sf Correctly calculates M2 Amount H_2O = mass water lost / 18 mol AND answer given to 2–4 sf	2
2(b)(ii)	M1 $y = \text{moles H}_2\text{O} / \text{moles ZnSO}_4$ M2 Expression evaluated and y correctly calculated quoted as integer	2
2(c)	The (anhydrous ethanedioic) acid would decompose (on heating) / is flammable	1

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Question	Answer	Marks						
FA 5 is MgSO4•7H2O; FA 6 is KMnO4; FA 7 is acidified KMnO4(aq); FA 8 is MnSO4 or MnCl2; FA 9 is MnO2								
3(a)(i)	M1 Heat (solid FA 5) AND observe condensation, droplets, steam, water vapour M2 Make an aqueous solution of FA 5 / dissolve in water to use for tests M3 (To portion of the solution) add aqueous NH3 AND white ppt AND insoluble in excess NH3 M4 (To portion of the solution) add aqueous barium chloride or barium nitrate AND white precipitate M5 to distinguish sulfate / sulfite (white precipitate from M4) insoluble in hydrochloric OR nitric acid OR KMnO4 is not decolourised / remains purple (added after M4 or directly to FA 5 (aq))	5						
3(a)(ii)	<table><tr><td>Zn2+</td><td>X</td></tr><tr><td>SO42-</td><td>✓</td></tr><tr><td>H2O</td><td>✓</td></tr></table>	Zn2+	X	SO42-	✓	H2O	✓	1
Zn2+	X							
SO42-	✓							
H2O	✓							
3(b)(i)	• (FA 6) starting colour purple • solid jumps / moves around • black residue • test with glowing splint • splint relights / glows more brightly	2						
3(b)(ii)	(dark) Green	1						

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Question	Answer	Marks																							
3(c)(i)	'No change' 2 correct = *, 3 correct = ** 2* = 1 mark Max mark = 4 <table><tr><th rowspan="2">test</th><th colspan="3">observations</th></tr><tr><th>FA 7</th><th>FA 8</th><th>FA 9</th></tr><tr><td>Test 1 Add hydrogen peroxide</td><td>Bubbles/ effervescence * Purple / FA 7 (solution) to colourless (solution) * (Gas / oxygen) relights glowing splint *</td><td>No change</td><td>Bubbles / effervescence * (Gas/ oxygen) relights glowing splint *</td></tr><tr><td>Test 2 Add sodium hydroxide, then</td><td></td><td>Off-white ppt*</td><td>No change</td></tr><tr><td>leave to stand</td><td></td><td>brown ppt on standing*</td><td></td></tr><tr><td>Test 3 Add aqueous iron(II) sulfate</td><td>Turns colourless / yellow OR colourless / yellow solution formed*</td><td>No change</td><td></td></tr></table>	test	observations			FA 7	FA 8	FA 9	Test 1 Add hydrogen peroxide	Bubbles/ effervescence * Purple / FA 7 (solution) to colourless (solution) * (Gas / oxygen) relights glowing splint *	No change	Bubbles / effervescence * (Gas/ oxygen) relights glowing splint *	Test 2 Add sodium hydroxide, then		Off-white ppt*	No change	leave to stand		brown ppt on standing*		Test 3 Add aqueous iron(II) sulfate	Turns colourless / yellow OR colourless / yellow solution formed*	No change		4
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3(c)(ii)	manganese / Mn	1																							

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Question	Answer			Marks
3(c)(iii)		FA 6 / FA 7	FA 8	1
	oxidation state	(+)7	(+)2	

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BOD	Benefit of the doubt given
CON	Contradiction in response otherwise markworthy, mark not given
DP	Error in number of decimal places
ECF	Error carried forward applied
I	Incorrect or insufficient point ignored while marking the rest of the response
RE	Rounding error
REP	Repeat error
SEEN or /	Blank page or part of script seen

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Mark Scheme abbreviations

;	separates marking points
/	alternative responses for the same marking point
R	reject the response
A	accept the response
I	ignore the response
ecf	error carried forward
AVP	any valid point
ora	or reverse argument
AW	alternative wording
<u>underline</u>	actual word given must be used by candidate (grammatical variants excepted)
()	the word / phrase in brackets is not required but sets the context
max	indicates the maximum number of marks that can be given
M1 etc.	marking point
owtte	or words to that effect

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Question	Answer	Marks
1(a)	I Five experiments completed AND Table to show Volume of FA 1 , Volume of water, Time and Rate	1
	II Correct units for all data Volume: / cm ³ OR (cm ³) OR in cm ³ OR cm ³ by each volume Time: / s OR (s) OR in s OR s by each time Rate: / s ⁻¹ OR (s ⁻¹) OR in s ⁻¹ OR s ⁻¹ by each rate	1
	III All times recorded to nearest second AND Volumes of FA 1 and water both given 2 d.p. ending with 0 or 5	1
	IV Three additional experiments with volume FA 1 $\geq 15.00 \text{ cm}^3$, $< 40.00 \text{ cm}^3$ and no volume closer than 5.00 cm^3 to another volume. AND Volumes of water chosen so that total volume = 40.00 cm^3 for additional experiments.	1
	V Correctly calculates rate for all experiments and shown to 2 – 4 s.f.	1
	VI Award if all times recorded increase with decreasing volume of FA 1 .	1
	Examiner corrects time for $V_{\text{FA1}} = 40.00 \text{ cm}^3$ and $V_{\text{FA1}} = 20.00 \text{ cm}^3$ to the nearest s then calculates t_{20} / t_{40} to 2 d.p.	
	VII Award if candidate's ratio is within the range 1.80 to 2.30.	1
	VIII Award if candidate's ratio is within the range 1.90 to 2.20.	1

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Question	Answer	Marks
1(b)(i)	I Unambiguous labelled axes with rate on the y-axis and volume of FA 1 on the x-axis OR correct units AND suitable linear scales starting at (0,0).	1
	II Points plotted correctly.	1
	III Line of best fit drawn, straight line or smooth curve, that ignores anomalous results identified by the candidate.	1
1(b)(ii)	M1 Correct line(s) drawn AND Rate correctly read within half a small square. M2 ^{1000 / rate} AND correctly calculates answer to 2 – 4 s.f.	2
1(c)	M1 Correct line of best fit M2 (Rate and volume of FA 1 are) not directly proportional as the (straight) line / data / results does not / do not pass through the origin / (0,0) OR M1 unavailable for line of best fit through the origin. M2 (Rate and volume of FA 1 are) directly proportional as the (straight) line / data / results pass through the origin / (0,0)	2

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Question	Answer	Marks
2(a)	I 6 correct unambiguous headings shown, with units, in list / table • (mass of) container + FA 3 / solid / $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ • (mass of) container (empty OR with residual FA 3) • (mass of) FA 3 / solid / $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ OR mass used OR mass added • initial temperature / thermometer reading • lowest / minimum / final temperature / thermometer reading • temperature change / decrease Mass units: /g OR in g OR (g) OR g by every reading Temperature units: / °C OR in °C OR (°C) OR °C by every reading	1
	II All readings shown to appropriate precision • all four balance / thermometer readings shown • both thermometer readings to .0 OR .5 • both weighings consistently to either 2 d.p. OR to 3 d.p.	1
	III Subtractions correctly calculated • mass of solid correct AND temperature change correct	1
	IV ΔT is within 1.0 °C of expected temperature change for the mass used	1
2(b)(i)	Correctly calculates amount of FA 3 = $\frac{\text{mass FA 3 in 2(a)}}{248.2} \text{ mol}$ AND answer given to 2–4 s.f.	1
2(b)(ii)	Correctly calculates energy change = $30 \times 4.18 \times \Delta T \text{ J}$ AND answer given to 2 – 4 sf	1

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Question	Answer	Marks
2(b)(iii)	Correctly uses $(b)(ii) / (b)(i) \times 1000$ AND plus sign shown AND answer given to 2 – 4 sf	1
2(c)	M1 repeating experiment with $\text{Na}_2\text{S}_2\text{O}_3$ OR adding $\text{Na}_2\text{S}_2\text{O}_3$ in water M2 any two from: - known volume of water - known mass of solid - measuring the temperature change. M3 indicating that use of Hess's law is needed M4 $\Delta H_r = \Delta H$ from their additional experiment – (b)(iii)	4

Question	Answer	Marks																				
FA 4 is acidified $\text{Fe}_2(\text{SO}_4)_3(\text{aq})$; FA 5 is $\text{Al}_2(\text{SO}_4)_3(\text{aq})$; FA 6 is $\text{HCOOH}(\text{aq})$; FA 7 is $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3(\text{l})$																						
3(a)(i)	2 * = 1 mark (round down). Max 5 marks. <table border="1"> <thead> <tr> <th rowspan="2"><i>test</i></th><th colspan="2"><i>observations</i></th></tr> <tr> <th>FA 4</th><th>FA 5</th></tr> </thead> <tbody> <tr> <td>1 + $\text{NaOH}(\text{aq})$</td><td>red-brown / brown ppt AND insoluble in excess *</td><td>white ppt * soluble in excess *</td></tr> <tr> <td>2 + $\text{NH}_3(\text{aq})$</td><td>red-brown / brown ppt AND insoluble in excess *</td><td>white ppt AND insoluble in excess *</td></tr> <tr> <td>3 + $\text{Na}_2\text{CO}_3(\text{aq})$</td><td>fizzing * gas gives white ppt with limewater * red-brown ppt *</td><td>white ppt * fizzing * gas gives white ppt with limewater (award if not awarded for FA 4)</td></tr> <tr> <td>4 + $\text{BaCl}_2(\text{aq})$ / $\text{Ba}(\text{NO}_3)_2(\text{aq})$</td><td>white ppt AND</td><td>white ppt *</td></tr> <tr> <td>5 + $\text{H}^+ / \text{KMnO}_4(\text{aq})$</td><td>stays purple / no change AND</td><td>stays purple / no change *</td></tr> </tbody> </table>	<i>test</i>	<i>observations</i>		FA 4	FA 5	1 + $\text{NaOH}(\text{aq})$	red-brown / brown ppt AND insoluble in excess *	white ppt * soluble in excess *	2 + $\text{NH}_3(\text{aq})$	red-brown / brown ppt AND insoluble in excess *	white ppt AND insoluble in excess *	3 + $\text{Na}_2\text{CO}_3(\text{aq})$	fizzing * gas gives white ppt with limewater * red-brown ppt *	white ppt * fizzing * gas gives white ppt with limewater (award if not awarded for FA 4)	4 + $\text{BaCl}_2(\text{aq})$ / $\text{Ba}(\text{NO}_3)_2(\text{aq})$	white ppt AND	white ppt *	5 + $\text{H}^+ / \text{KMnO}_4(\text{aq})$	stays purple / no change AND	stays purple / no change *	5
<i>test</i>	<i>observations</i>																					
	FA 4	FA 5																				
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2 + $\text{NH}_3(\text{aq})$	red-brown / brown ppt AND insoluble in excess *	white ppt AND insoluble in excess *																				
3 + $\text{Na}_2\text{CO}_3(\text{aq})$	fizzing * gas gives white ppt with limewater * red-brown ppt *	white ppt * fizzing * gas gives white ppt with limewater (award if not awarded for FA 4)																				
4 + $\text{BaCl}_2(\text{aq})$ / $\text{Ba}(\text{NO}_3)_2(\text{aq})$	white ppt AND	white ppt *																				
5 + $\text{H}^+ / \text{KMnO}_4(\text{aq})$	stays purple / no change AND	stays purple / no change *																				

Question	Answer			Marks
3(a)(ii)	ions	FA 4	FA 5	3
	cations	Fe ³⁺ ; H ⁺	Al ³⁺	
	anions	SO ₄ ²⁻	SO ₄ ²⁻	
	5 ions correct = 3 marks 3 or 4 ions correct = 2 marks 2 ions correct = 1 mark			
3(b)(i)	2 * = 1 mark (round down)			3
	test	observations		
		FA 6	FA 7	
	1 + H ⁺ / KMnO ₄ (aq)	(turns paler pink)	(purple fades slightly)	
	and warm	decolourises / turns colourless / turns (pale) yellow *	decolourises / turns colourless / turns (pale) yellow *	
	2 + I ₂ (aq) + NaOH (and warm)	no change *	ppt * that is (pale) yellow *	
	3 + Na ₂ CO ₃ (aq)	fizzing *	no change *	

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Question	Answer	Marks
3(b)(ii)	M1 (FA 6) is methanoic acid because it produces CO_2 / reacts with sodium carbonate AND it can be oxidised / it reacts with KMnO_4 M2 (FA 7) is propan-2-ol as it gives a ppt in test 2 OR gives a positive tri-iodomethane/iodoform test OR has the $-\text{CH}(\text{OH})\text{CH}_3$ group	2
3(c)	Correct equation $\text{CH}_3\text{CH}_2\text{COOH} + \text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3 + \text{H}_2\text{O}$ OR $\text{C}_2\text{H}_5\text{COOH} + \text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_2\text{H}_5\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$	1

Cambridge International AS & A Level

CHEMISTRY**9701/34**

Paper 3 Advanced Practical Skills 2

October/November 2025**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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Cambridge International is publishing the mark schemes for the October/November 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **12** 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 descriptions 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.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

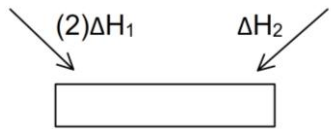
The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	Correct point or mark awarded
	Incorrect point or mark not awarded
	Information missing or insufficient for credit
	Benefit of the doubt given
	Contradiction in response otherwise markworthy, mark not given
	Error in number of decimal places
	Error carried forward applied
	Incorrect or insufficient point ignored while marking the rest of the response
	Rounding error
	Repeat error
 or /	Blank page or part of script seen

Annotation	Meaning
SF	Error in number of significant figures
TE	Transcription error

Question	Answer	Marks
1(a)	I Unambiguous headings AND units for all six recorded readings and calculated values in experiment 1: • (mass of) container + FB 2 / solid / g • (mass of) container (+ residue) / g • (mass of) FB 2 / solid (used / added) / g • initial temperature OR temperature of FB 1 / °C • final temperature / °C • temperature change / °C	1
	II • All four weighings recorded to same decimal places (either 2 or 3). • All four temperatures recorded to .0 or .5°C	1
	III Correct subtractions to give all four calculated values: • mass of FB 2 used and mass of FB 3 used • changes in temperature for experiments 1 and 2.	1
	Accuracy (Q) marks Calculate the candidate's <i>temperature to mass ratio</i> for experiment 1 to 2 d.p.: Ratio = ΔT (experiment 1) / mass of FB2 . Calculate the supervisor's ratio for experiment 1 to 2 d.p. Calculate the difference, δ , between the candidate's value (rounded to 2 d.p.) and the supervisor's value (rounded to 2 d.p.).	
	IV award if $\delta \leq 0.50$	1
1(b)(i)	M1: Correctly calculates both M_r values: M_r of $\text{NaHCO}_3 = 84$ AND M_r of $\text{Na}_2\text{CO}_3 = 106$	1
	M2: Correctly calculates both amounts using subtractions from (a) $n = \text{mass in (a)} / M_r (\text{mol})$ AND both answers given to 2–4 sf	1
1(b)(ii)	Correctly calculates both values of energy change energy change = $20 \times 4.18 \times \Delta T$ (J) AND both answers given to 2–4 sf	1
1(b)(iii)	M1: Correct display of $\Delta H = (\text{b})(\text{ii}) / (\text{b})(\text{i})$ for experiment 1 or experiment 2.	1

Question	Answer	Marks
	M2: Correctly uses $\Delta H = (\mathbf{b})(\mathbf{ii}) / ((\mathbf{b})(\mathbf{i}) \times 1000)$ AND + sign for ΔH_1 AND – sign for ΔH_2 AND both answers given to 2–4 sf	1
1(b)(iv)	M1: Drawing of enthalpy cycle $(2\text{NaHCO}_3(\text{s}) \rightarrow \text{Na}_2\text{CO}_3(\text{s}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}))$ 	1
	M2: Correctly calculates $\Delta H_r = 2\Delta H_1 - \Delta H_2$	1

Question	Answer	Marks
2(a)	I All the following data are 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 recorded for accurate titrations, AND Correct headings and units in the accurate titration table - initial / start AND (burette) reading / volume - final / end AND (burette) reading / volume - titre OR volume used / added / or FB 5 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 0.05 cm ³ .	1
	IV: The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre	1
	Accuracy (Q) marks Round burette readings to the nearest 0.05 cm ³ . Check and correct titre subtractions where necessary. Select the best mean titre, using the following hierarchy: - two (or more) accurate identical titres (ignoring any that are labelled 'rough'), <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two (or more) accurate titres within 0.10 cm³, <i>etc</i> Calculate the candidate's mean titre value. Calculate the supervisor's mean titre value. Calculate the difference (δ) between the candidate's mean titre and the supervisor's mean titre.	
	Award accuracy Q marks as follows: V award if $\delta \leq 0.60 \text{ cm}^3$ VI award if $\delta \leq 0.40 \text{ cm}^3$ VII award if $\delta \leq 0.20 \text{ cm}^3$	3

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Question	Answer	Marks
2(b)	Correctly calculates mean titre to 2 d.p. • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. • Working / explanation must be shown OR ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 d.p. and rounded to nearest 0.01 cm³.	1
2(c)(i)	Final answers to both parts (c)(ii) and (c)(iii) quoted to 3 or 4 sf.	1
2(c)(ii)	Correctly calculates amount of HCl = $0.2 \times (\mathbf{b}) / 1000$ (mol) AND gives same answer for amount of NaHCO ₃	1
2(c)(iii)	Correctly uses mass of NaHCO ₃ = (c)(ii) $\times 40 \times 84(.0)$ (g)	1
	Correctly uses percentage by mass = $[(17.20 - \text{mass of NaHCO}_3) / 17.20] \times 100$ OR percentage by mass = $100 - [(\text{mass of NaHCO}_3 / 17.20) \times 100]$	1
2(d)	M1: (ΔH_1) smaller / less positive (for impure NaHCO ₃)	1
	M2: Impurity does not react with the acid / FB 5	1

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Question	Answer	Marks
FB 7 is $\text{CuCO}_3(\text{s})$; FB 8 is $\text{FeSO}_4(\text{aq})$		
3(a)(i)	- selects (aqueous) silver nitrate and (aqueous) ammonia * - white ppt * - soluble in (aqueous) ammonia * NaCl * 2 * = 1 mark	2
3(a)(ii)	(The acid) removes / reacts with the hydrogencarbonate ions OR silver ions react with hydrogencarbonate ions	1
3(b)(i)	- green (at start) * - turns to a black powder / solid * - powder very fluid / moves around the test-tube * - condensation (on walls of test-tube) * 2 * = 1 mark	2
3(b)(ii)	- forms green-blue solution * - effervescence * - vigorous reaction * - attempts to test with limewater * - gas / carbon dioxide gives white precipitate / solid with limewater * 2 * = 1 mark	2

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Question	Answer	Marks						
3(b)(iii)	<table><tr><td>Test 1 Add NaOH(aq)</td><td>(pale) blue precipitate insoluble in excess *</td></tr><tr><td>Test 2 Add NH₃(aq)</td><td>(pale) blue precipitate * (precipitate dissolves forming) dark / deep blue solution in excess *</td></tr><tr><td>Test 3 Add aluminium foil</td><td>effervescence / fizzing* (gas) pops with a lighted splint * pink-brown solid * turns colourless / pale blue solution formed * gets hotter *</td></tr></table>	Test 1 Add NaOH(aq)	(pale) blue precipitate insoluble in excess *	Test 2 Add NH ₃ (aq)	(pale) blue precipitate * (precipitate dissolves forming) dark / deep blue solution in excess *	Test 3 Add aluminium foil	effervescence / fizzing* (gas) pops with a lighted splint * pink-brown solid * turns colourless / pale blue solution formed * gets hotter *	4
	Test 1 Add NaOH(aq)	(pale) blue precipitate insoluble in excess *						
	Test 2 Add NH ₃ (aq)	(pale) blue precipitate * (precipitate dissolves forming) dark / deep blue solution in excess *						
	Test 3 Add aluminium foil	effervescence / fizzing* (gas) pops with a lighted splint * pink-brown solid * turns colourless / pale blue solution formed * gets hotter *						
Metal ion in FB 7 : Cu ²⁺ *								
2 * = 1 mark								
3(c)(i)	<table><tr><td>Test 1 Add NaOH(aq)</td><td>green precipitate * insoluble in excess * (precipitate) turns brown (on surface) *</td></tr><tr><td>Test 2 Add acidified KMnO₄</td><td>purple to colourless / (pale) yellow solution OR KMnO₄ decolourised*</td></tr></table>	Test 1 Add NaOH(aq)	green precipitate * insoluble in excess * (precipitate) turns brown (on surface) *	Test 2 Add acidified KMnO ₄	purple to colourless / (pale) yellow solution OR KMnO ₄ decolourised*	2		
	Test 1 Add NaOH(aq)	green precipitate * insoluble in excess * (precipitate) turns brown (on surface) *						
	Test 2 Add acidified KMnO ₄	purple to colourless / (pale) yellow solution OR KMnO ₄ decolourised*						
	2 * = 1 mark							
Metal ion in FB 8 : Fe ²⁺								
3(c)(ii)	Redox reaction AND change to colourless linked to reduction of manganate(VII) ions OR change to yellow colour linked to oxidation of Fe ²⁺ or production of Fe ³⁺ .	1						

Cambridge International AS & A Level

CHEMISTRY**9701/35**

Paper 3 Advanced Practical Skills 1

October/November 2025**MARK SCHEME**Maximum Mark: 40

Published

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The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	Correct point or mark awarded
	Incorrect point or mark not awarded
	Information missing or insufficient for credit
BOD	Benefit of the doubt given
CON	Contradiction in response otherwise markworthy, mark not given
DP	Error in number of decimal places
ECF	Error carried forward applied
I	Incorrect or insufficient point ignored while marking the rest of the response
RE	Rounding error
REP	Repeat error
SEEN or /	Blank page or part of script seen

Annotation	Meaning
SF	Error in number of significant figures
TE	Transcription error

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Question	Answer	Marks
1(a)	I The following data are 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 recorded for accurate titrations, AND Correct headings and units in the accurate titration table - initial / start AND (burette) reading / volume - final / end AND (burette) reading / volume - titre OR volume used/added/ OR FA 2 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 recorded to 0.05 cm ³	1
	IV The final accurate titre recorded must be within 0.10 cm ³ of any other accurate titre	1
	Accuracy (Q) marks Round burette readings to the nearest 0.05 cm ³ . Check and correct titre subtractions where necessary. Examiner selects the best mean titre, using the following hierarchy: - two (or more) accurate identical titres (ignoring any that are labelled 'rough'), <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two(or more) accurate titres within 0.10 cm³, <i>etc.</i> Calculate the candidate's mean titre value Calculate the supervisor's mean titre value Calculate the difference (δ) between the candidate's mean titre and the supervisor's mean titre	
	Award accuracy Q marks as follows: V Award if $\delta \leq 0.50 \text{ cm}^3$ VI Award if $\delta \leq 0.30 \text{ cm}^3$ VII Award if $\delta \leq 0.20 \text{ cm}^3$	3

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Question	Answer	Marks
1(b)	Correctly calculates mean titre to 2 dp • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. • Working/explanation must be shown OR ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 dp and be rounded to nearest 0.01 cm³. (e.g. 26.675 cm³ must be rounded to 26.68 cm³)	1
1(c)(i)	All answers to (c)(ii), (c)(iii) and (c)(iv) to 3 – 4 sf	1
1(c)(ii)	Correctly calculates amount of manganate(VII) = 0.02 × volume in (b) / 1000 mol	1
1(c)(iii)	Correctly uses M1 Amount of ethanedioic acid = (c)(ii) × 5 / 2 mol M2 Concentration of FA 1 = (c)(ii) × 5 / 2 × 1000 / 25 mol dm ⁻³	2
1(c)(iv)	Correctly uses $M_r = 6.2(0) / (c)(iii)$	1
1(c)(v)	$(M_r - 90) / 18$ AND correctly calculates answer as integer	1
1(d)	H ⁺ needed in the reaction / H ⁺ used in / appears in the equation	1

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Question	Answer	Marks
2(a)	I Six correct headings with units in results space • (Mass) crucible + lid / g • (Mass) crucible + lid + FA 4 / g • (Mass) crucible + lid + residue / contents after first heating / g • (Mass) crucible + lid + residue after second heating / g • (Mass) FA 4 (used) / g • (Mass) residue / g Display of units: / g, (g), in g, in gram(me)s or in (column) heading covering all entries	1
	II Four readings in space provided • All four weighings recorded to same decimal places (either to two or to three) • Reading after 2nd heating within + 0.02 and – 0.05 of reading after 1st heating	1
	II Correct subtractions • Correct calculations of mass FA 4 and residue AND • Mass of FA 4 is between 2.90 and 3.40 g.	1
	IV and V Accuracy Theoretical value = 1.78 Calculate and record candidate's mass ratio = mass FA 4 / mass of residue. Award IV if $1.51 \leq \text{candidate's mass ratio} \leq 2.05$ Award V if $1.60 \leq \text{candidates mass ratio} \leq 1.96$	2

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Question	Answer	Marks
2(b)(i)	Correctly uses M1 Amount ZnSO_4 = mass residue / 161.5 mol AND answer given to 2 – 4 sf Correctly calculates M2 Amount H_2O = mass water lost / 18 mol AND answer given to 2–4 sf	2
2(b)(ii)	M1 $y = \text{moles H}_2\text{O} / \text{moles ZnSO}_4$ M2 Expression evaluated and y correctly calculated quoted as integer	2
2(c)	The (anhydrous ethanedioic) acid would decompose (on heating) / is flammable	1

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Question	Answer	Marks						
FA 5 is MgSO4•7H2O; FA 6 is KMnO4; FA 7 is acidified KMnO4(aq); FA 8 is MnSO4 or MnCl2; FA 9 is MnO2								
3(a)(i)	M1 Heat (solid FA 5) AND observe condensation, droplets, steam, water vapour M2 Make an aqueous solution of FA 5 / dissolve in water to use for tests M3 (To portion of the solution) add aqueous NH3 AND white ppt AND insoluble in excess NH3 M4 (To portion of the solution) add aqueous barium chloride or barium nitrate AND white precipitate M5 to distinguish sulfate / sulfite (white precipitate from M4) insoluble in hydrochloric OR nitric acid OR KMnO4 is not decolourised / remains purple (added after M4 or directly to FA 5 (aq))	5						
3(a)(ii)	<table><tr><td>Zn2+</td><td>X</td></tr><tr><td>SO42-</td><td>✓</td></tr><tr><td>H2O</td><td>✓</td></tr></table>	Zn2+	X	SO42-	✓	H2O	✓	1
Zn2+	X							
SO42-	✓							
H2O	✓							
3(b)(i)	• (FA 6) starting colour purple • solid jumps / moves around • black residue • test with glowing splint • splint relights / glows more brightly	2						
3(b)(ii)	(dark) Green	1						

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Question	Answer	Marks																							
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3(c)(ii)	manganese / Mn	1																							

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Question	Answer			Marks
3(c)(iii)		FA 6 / FA 7	FA 8	1
	oxidation state	(+)7	(+)2	

Cambridge International AS & A Level

CHEMISTRY**9701/36**

Paper 3 Advanced Practical Skills 2

October/November 2025**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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Cambridge International is publishing the mark schemes for the October/November 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **12** 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 descriptions 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.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	Correct point or mark awarded
	Incorrect point or mark not awarded
	Information missing or insufficient for credit
	Benefit of the doubt given
	Contradiction in response otherwise markworthy, mark not given
	Error in number of decimal places
	Error carried forward applied
	Incorrect or insufficient point ignored while marking the rest of the response
	Rounding error
	Repeat error

Annotation	Meaning
SEEN or /	Blank page or part of script seen
SF	Error in number of significant figures
TE	Transcription error

Question	Answer	Marks
1(a)	I Seven unambiguous headings for readings, with correctly displayed units, in results space • (mass of) (empty) crucible / g • (mass of) crucible + FB 1 / (hydrated) aluminium sulfate / g • (mass of) crucible and residue / contents, after 1st heating / g • (mass of) crucible and residue / contents, after 2nd heating / g • (mass of) FB 1 / g • (mass of) residue / g • (mass of) water / mass loss / g	1
	II Four weighings in space provided • All four <u>weighings</u> recorded to same decimal places (either to two or to three). • Reading after 2nd heating is within +0.02 and –0.05 g of reading after 1st heating.	1
	III Correct subtractions to give masses of FB 1 , residue and mass lost. • All masses correctly subtracted. • Mass of FB 1 used in range 1.80 g–2.00 g (from weighings)	1
	IV and V: Accuracy (Q) marks in (a) Calculate candidate's mass ratio (to 2 d.p.) = $\frac{\text{mass FB 1}}{\text{mass of residue}}$ IV award if ratio is in the range 1.56–2.12 (inclusive) V award if ratio is in the range 1.66–2.02 (inclusive)	2
1(b)(i)	Correct calculation, amount of water amount = $\frac{\text{mass loss}}{18}$ mol AND answer to 2–4 sf	1
1(b)(ii)	Correct calculation, amount of FB 1 amount = $\frac{\text{mass of residue}}{342.3}$ mol AND answer to 2–4 sf	1
1(b)(iii)	Correct use of mole ratio $x = \frac{(b)(i)}{(b)(ii)}$ AND answer given as closest integer	1

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Question	Answer	Marks
1(c)(i)	FB 1 / solid at start / before heating is crystalline / finely divided AND residue is lumpy / 'crusty' OR has a 'skin'	1
1(c)(ii)	Lid is to prevent solid / solution from spitting / frothing out.	1
1(c)(iii)	Student is not correct. AND mass / amount of water / lost will be lower / too low / mass OR amount of anhydrous (salt) will be higher / too high OR ratio $\frac{\text{mol water}}{\text{mol residue}}$ will be lower.	1

Question	Answer	Marks
2(a)	I The following data are 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 recorded for accurate titrations, AND correct headings and units in the accurate titration table - initial / start AND (burette) reading / volume - final / end AND (burette) reading / volume - titre OR volume used / added / OR FB 3 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 recorded to 0.05 cm ³	1
	IV The final accurate titre recorded must be within 0.10 cm ³ of any other accurate titre	1
	Accuracy (Q) marks Round burette readings to the nearest 0.05 cm ³ . Check and correct titre subtractions where necessary. Select the best mean titre, using the following hierarchy: - two (or more) accurate identical titres (ignoring any that are labelled 'rough'), <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two (or more) accurate titres within 0.10 cm³, <i>etc.</i> Calculate the candidate's mean titre value. Calculate the supervisor's mean titre value. Calculate the difference (δ) between the candidate's mean titre and the supervisor's mean titre.	
	Award accuracy Q marks as follows: V award if $\delta \leq 0.50 \text{ cm}^3$ VI award if $\delta \leq 0.30 \text{ cm}^3$ VII award if $\delta \leq 0.20 \text{ cm}^3$	3

Question	Answer	Marks
2(b)	Correctly calculates mean titre • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. • Working / explanation must be shown OR ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 d.p. and be rounded to nearest 0.01 cm³.	1
2(c)(i)	M1 Shows working $3.48 / 158$ OR $3.48 \times (b) / 1000$ OR $(b) / 1000 \times 1 / 158$ M2 Correctly uses amount KMnO ₄ used = $3.48 / 158 \times (b) / 1000$ AND final answer given to 3 or 4 sf	2
2(c)(ii)	$5\text{Fe}^{2+}(\text{aq}) + \text{MnO}_4^{-}(\text{aq}) + 8\text{H}^{+}(\text{aq}) \rightarrow 5\text{Fe}^{3+}(\text{aq}) + \text{Mn}^{2+}(\text{aq}) + 4\text{H}_2\text{O}(\text{l})$	1
2(c)(iii)	Correct use Concentration = $2(\text{c})(\text{i}) \times 5 \times 1000 / 25 \text{ mol dm}^{-3}$ AND final answer given to 3 or 4 sf	1
2(c)(iv)	Correct use M1 M_r of hydrated iron(II) sulfate = $30.00 / (\text{c})(\text{iii})$ M2 $y = [M_r - 151.9] / 18$ AND answer is given as an integer	2
2(d)	Student is incorrect AND H ₂ SO ₄ is used in excess (so the exact volume does not matter) / H ₂ SO ₄ / the acid is not the limiting reagent	1
2(e)	y will be greater AND one of: • lower titre • fewer moles of KMnO₄ • fewer moles / decreased concentration of Fe²⁺ / FeSO₄ • higher M_r	[1]

Question	Answer	Marks
FB 5 is Zn; FB 6 is ZnSO ₄ (aq); FB 7 is ZnCO ₃		
3(a)(i)	2 • = 1 mark Test 1 (FeCl₃) • (Solution) becomes colourless / paler yellow / pale green • Fizzing / effervescence • (Pale) green / green-white precipitate (with NaOH) • Precipitate insoluble / no change with excess NaOH / ppt / solid turns brown (at surface) Test 2 (CuSO₄) • Pink-brown AND precipitate / solid / residue • (Solution) gets paler (blue) OR (solution) turns colourless • gets hotter (or in Test 3) Test 3 (H₂SO₄) • Fizzing / effervescence • (Gas) pops with lighted splint • (Gas is) hydrogen	4
3(a)(ii)	Ammonia gives a white precipitate AND soluble in excess	1
3(a)(iii)	FB 5 is zinc / Zn	1
3(a)(iv)	Copper is formed AND Copper ions gain electrons OR Copper changes oxidation state from (+)2 to 0 / Cu²⁺ changes oxidation state to 0 OR zinc ions formed AND zinc loses electrons OR Zinc / Zn changes oxidation state from 0 to (+)2	1
3(a)(v)	$\text{Zn}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Zn}(\text{OH})_2(\text{s})$	1

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Question	Answer	Marks
3(b)(i)	2 • = 1 mark • (FB 7 is a) white powder / solid • Condensation / water droplets • (Solid / FB 7) turns yellow (or yellow-green) (when hot) • Residue / solid goes paler (on cooling) or residue is white • Attempts to test gas with limewater • (Gas) gives white precipitate with limewater • Gas is CO₂ / carbon dioxide (evidence needed)	3
3(b)(ii)	M1 Add any specified mineral acid (name OR correct formula) to FB 7 . M2 Fizzing / effervescence AND carbonate / CO ₃ ²⁻	2

Cambridge International AS & A Level

CHEMISTRY**9701/37**

Paper 3 Advanced Practical Skills 1

October/November 2025**MARK SCHEME**Maximum Mark: 40

Published

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Annotation	Meaning
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Question	Answer	Marks
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	II Titre values recorded for accurate titrations, AND Correct headings and units in the accurate titration table - initial / start AND (burette) reading / volume - final / end AND (burette) reading / volume - titre OR volume used/added/ OR FA 2 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 recorded to 0.05 cm ³	1
	IV The final accurate titre recorded must be within 0.10 cm ³ of any other accurate titre	1
	Accuracy (Q) marks Round burette readings to the nearest 0.05 cm ³ . Check and correct titre subtractions where necessary. Examiner selects the best mean titre, using the following hierarchy: - two (or more) accurate identical titres (ignoring any that are labelled 'rough'), <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two(or more) accurate titres within 0.10 cm³, <i>etc.</i> Calculate the candidate's mean titre value Calculate the supervisor's mean titre value Calculate the difference (δ) between the candidate's mean titre and the supervisor's mean titre	
	Award accuracy Q marks as follows: V Award if $\delta \leq 0.50 \text{ cm}^3$ VI Award if $\delta \leq 0.30 \text{ cm}^3$ VII Award if $\delta \leq 0.20 \text{ cm}^3$	3

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Question	Answer	Marks
1(b)	Correctly calculates mean titre to 2 dp • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. • Working/explanation must be shown OR ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 dp and be rounded to nearest 0.01 cm³. (e.g. 26.675 cm³ must be rounded to 26.68 cm³)	1
1(c)(i)	All answers to (c)(ii), (c)(iii) and (c)(iv) to 3 – 4 sf	1
1(c)(ii)	Correctly calculates amount of manganate(VII) = 0.02 × volume in (b) / 1000 mol	1
1(c)(iii)	Correctly uses M1 Amount of ethanedioic acid = (c)(ii) × 5 / 2 mol M2 Concentration of FA 1 = (c)(ii) × 5 / 2 × 1000 / 25 mol dm ⁻³	2
1(c)(iv)	Correctly uses $M_r = 6.2(0) / (c)(iii)$	1
1(c)(v)	$(M_r - 90) / 18$ AND correctly calculates answer as integer	1
1(d)	H ⁺ needed in the reaction / H ⁺ used in / appears in the equation	1

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Question	Answer	Marks
2(a)	I Six correct headings with units in results space • (Mass) crucible + lid / g • (Mass) crucible + lid + FA 4 / g • (Mass) crucible + lid + residue / contents after first heating / g • (Mass) crucible + lid + residue after second heating / g • (Mass) FA 4 (used) / g • (Mass) residue / g Display of units: / g, (g), in g, in gram(me)s or in (column) heading covering all entries	1
	II Four readings in space provided • All four weighings recorded to same decimal places (either to two or to three) • Reading after 2nd heating within + 0.02 and – 0.05 of reading after 1st heating	1
	II Correct subtractions • Correct calculations of mass FA 4 and residue AND • Mass of FA 4 is between 2.90 and 3.40 g.	1
	IV and V Accuracy Theoretical value = 1.78 Calculate and record candidate's mass ratio = mass FA 4 / mass of residue. Award IV if $1.51 \leq \text{candidate's mass ratio} \leq 2.05$ Award V if $1.60 \leq \text{candidates mass ratio} \leq 1.96$	2

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Question	Answer	Marks
2(b)(i)	Correctly uses M1 Amount ZnSO_4 = mass residue / 161.5 mol AND answer given to 2 – 4 sf Correctly calculates M2 Amount H_2O = mass water lost / 18 mol AND answer given to 2–4 sf	2
2(b)(ii)	M1 $y = \text{moles H}_2\text{O} / \text{moles ZnSO}_4$ M2 Expression evaluated and y correctly calculated quoted as integer	2
2(c)	The (anhydrous ethanedioic) acid would decompose (on heating) / is flammable	1

Question	Answer	Marks						
FA 5 is MgSO4•7H2O; FA 6 is KMnO4; FA 7 is acidified KMnO4(aq); FA 8 is MnSO4 or MnCl2; FA 9 is MnO2								
3(a)(i)	M1 Heat (solid FA 5) AND observe condensation, droplets, steam, water vapour M2 Make an aqueous solution of FA 5 / dissolve in water to use for tests M3 (To portion of the solution) add aqueous NH3 AND white ppt AND insoluble in excess NH3 M4 (To portion of the solution) add aqueous barium chloride or barium nitrate AND white precipitate M5 to distinguish sulfate / sulfite (white precipitate from M4) insoluble in hydrochloric OR nitric acid OR KMnO4 is not decolourised / remains purple (added after M4 or directly to FA 5 (aq))	5						
3(a)(ii)	<table><tr><td>Zn2+</td><td>X</td></tr><tr><td>SO42-</td><td>✓</td></tr><tr><td>H2O</td><td>✓</td></tr></table>	Zn2+	X	SO42-	✓	H2O	✓	1
Zn2+	X							
SO42-	✓							
H2O	✓							
3(b)(i)	(FA 6) starting colour purple - solid jumps / moves around - black residue - test with glowing splint - splint relights / glows more brightly	2						
3(b)(ii)	(dark) Green	1						

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Test 2 Add sodium hydroxide, then		Off-white ppt*	No change																						
leave to stand		brown ppt on standing*																							
Test 3 Add aqueous iron(II) sulfate	Turns colourless / yellow OR colourless / yellow solution formed*	No change																							
3(c)(ii)	manganese / Mn	1																							

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Question	Answer			Marks
3(c)(iii)		FA 6 / FA 7	FA 8	1
	oxidation state	(+)7	(+)2	

Cambridge International AS & A Level

CHEMISTRY**9701/38**

Paper 3 Advanced Practical Skills 2

October/November 2025**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 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **12** 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 descriptions 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.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	Correct point or mark awarded
	Incorrect point or mark not awarded
	Information missing or insufficient for credit
	Benefit of the doubt given
	Contradiction in response otherwise markworthy, mark not given
	Error in number of decimal places
	Error carried forward applied
	Incorrect or insufficient point ignored while marking the rest of the response
	Rounding error
	Repeat error

Annotation	Meaning
SEEN or /	Blank page or part of script seen
SF	Error in number of significant figures
TE	Transcription error

Question	Answer	Marks
1(a)	I Seven unambiguous headings for readings, with correctly displayed units, in results space • (mass of) (empty) crucible / g • (mass of) crucible + FB 1 / (hydrated) aluminium sulfate / g • (mass of) crucible and residue / contents, after 1st heating / g • (mass of) crucible and residue / contents, after 2nd heating / g • (mass of) FB 1 / g • (mass of) residue / g • (mass of) water / mass loss / g	1
	II Four weighings in space provided • All four <u>weighings</u> recorded to same decimal places (either to two or to three). • Reading after 2nd heating is within +0.02 and –0.05 g of reading after 1st heating.	1
	III Correct subtractions to give masses of FB 1 , residue and mass lost. • All masses correctly subtracted. • Mass of FB 1 used in range 1.80 g–2.00 g (from weighings)	1
	IV and V: Accuracy (Q) marks in (a) Calculate candidate's mass ratio (to 2 d.p.) = $\frac{\text{mass FB 1}}{\text{mass of residue}}$ IV award if ratio is in the range 1.56–2.12 (inclusive) V award if ratio is in the range 1.66–2.02 (inclusive)	2
1(b)(i)	Correct calculation, amount of water amount = $\frac{\text{mass loss}}{18}$ mol AND answer to 2–4 sf	1
1(b)(ii)	Correct calculation, amount of FB 1 amount = $\frac{\text{mass of residue}}{342.3}$ mol AND answer to 2–4 sf	1
1(b)(iii)	Correct use of mole ratio $x = \frac{(b)(i)}{(b)(ii)}$ AND answer given as closest integer	1

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Question	Answer	Marks
1(c)(i)	FB 1 / solid at start / before heating is crystalline / finely divided AND residue is lumpy / 'crusty' OR has a 'skin'	1
1(c)(ii)	Lid is to prevent solid / solution from spitting / frothing out.	1
1(c)(iii)	Student is not correct. AND mass / amount of water / lost will be lower / too low / mass OR amount of anhydrous (salt) will be higher / too high OR ratio $\frac{\text{mol water}}{\text{mol residue}}$ will be lower.	1

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Question	Answer	Marks
2(a)	I The following data are 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 recorded for accurate titrations, AND correct headings and units in the accurate titration table - initial / start AND (burette) reading / volume - final / end AND (burette) reading / volume - titre OR volume used / added / OR FB 3 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 recorded to 0.05 cm ³	1
	IV The final accurate titre recorded must be within 0.10 cm ³ of any other accurate titre	1
	Accuracy (Q) marks Round burette readings to the nearest 0.05 cm ³ . Check and correct titre subtractions where necessary. Select the best mean titre, using the following hierarchy: - two (or more) accurate identical titres (ignoring any that are labelled 'rough'), <i>then</i> - two (or more) accurate titres within 0.05 cm³, <i>then</i> - two (or more) accurate titres within 0.10 cm³, <i>etc.</i> Calculate the candidate's mean titre value. Calculate the supervisor's mean titre value. Calculate the difference (δ) between the candidate's mean titre and the supervisor's mean titre.	
	Award accuracy Q marks as follows: V award if $\delta \leq 0.50 \text{ cm}^3$ VI award if $\delta \leq 0.30 \text{ cm}^3$ VII award if $\delta \leq 0.20 \text{ cm}^3$	3

Question	Answer	Marks
2(b)	Correctly calculates mean titre • Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. • Working / explanation must be shown OR ticks must be put next to the two (or more) accurate readings selected. • The mean should be quoted to 2 d.p. and be rounded to nearest 0.01 cm³.	1
2(c)(i)	M1 Shows working $3.48 / 158$ OR $3.48 \times (b) / 1000$ OR $(b) / 1000 \times 1 / 158$ M2 Correctly uses amount KMnO ₄ used = $3.48 / 158 \times (b) / 1000$ AND final answer given to 3 or 4 sf	2
2(c)(ii)	$5\text{Fe}^{2+}(\text{aq}) + \text{MnO}_4^{-}(\text{aq}) + 8\text{H}^{+}(\text{aq}) \rightarrow 5\text{Fe}^{3+}(\text{aq}) + \text{Mn}^{2+}(\text{aq}) + 4\text{H}_2\text{O}(\text{l})$	1
2(c)(iii)	Correct use Concentration = $2(\text{c})(\text{i}) \times 5 \times 1000 / 25 \text{ mol dm}^{-3}$ AND final answer given to 3 or 4 sf	1
2(c)(iv)	Correct use M1 M_r of hydrated iron(II) sulfate = $30.00 / (\text{c})(\text{iii})$ M2 $y = [M_r - 151.9] / 18$ AND answer is given as an integer	2
2(d)	Student is incorrect AND H ₂ SO ₄ is used in excess (so the exact volume does not matter) / H ₂ SO ₄ / the acid is not the limiting reagent	1
2(e)	y will be greater AND one of: • lower titre • fewer moles of KMnO₄ • fewer moles / decreased concentration of Fe²⁺ / FeSO₄ • higher M_r	[1]

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Question	Answer	Marks
FB 5 is Zn; FB 6 is ZnSO ₄ (aq); FB 7 is ZnCO ₃		
3(a)(i)	2 • = 1 mark Test 1 (FeCl₃) • (Solution) becomes colourless / paler yellow / pale green • Fizzing / effervescence • (Pale) green / green-white precipitate (with NaOH) • Precipitate insoluble / no change with excess NaOH / ppt / solid turns brown (at surface) Test 2 (CuSO₄) • Pink-brown AND precipitate / solid / residue • (Solution) gets paler (blue) OR (solution) turns colourless • gets hotter (or in Test 3) Test 3 (H₂SO₄) • Fizzing / effervescence • (Gas) pops with lighted splint • (Gas is) hydrogen	4
3(a)(ii)	Ammonia gives a white precipitate AND soluble in excess	1
3(a)(iii)	FB 5 is zinc / Zn	1
3(a)(iv)	Copper is formed AND Copper ions gain electrons OR Copper changes oxidation state from (+)2 to 0 / Cu²⁺ changes oxidation state to 0 OR zinc ions formed AND zinc loses electrons OR Zinc / Zn changes oxidation state from 0 to (+)2	1
3(a)(v)	$\text{Zn}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Zn}(\text{OH})_2(\text{s})$	1

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Question	Answer	Marks
3(b)(i)	2 • = 1 mark • (FB 7 is a) white powder / solid • Condensation / water droplets • (Solid / FB 7) turns yellow (or yellow-green) (when hot) • Residue / solid goes paler (on cooling) or residue is white • Attempts to test gas with limewater • (Gas) gives white precipitate with limewater • Gas is CO₂ / carbon dioxide (evidence needed)	3
3(b)(ii)	M1 Add any specified mineral acid (name OR correct formula) to FB 7 . M2 Fizzing / effervescence AND carbonate / CO ₃ ²⁻	2