CAMBRIDGE
International Education

Cambridge International AS & A Level

CHEMISTRY **9701/32**

Paper 3 Advanced Practical Skills 2 **May/June 2026**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

This document consists of **17** printed pages.

[Turn over

General marking principles

All examiners must apply these marking principles when marking candidate responses.

1	Examiners must award marks for each response in line with: • the specific **content** defined in the mark scheme • the specific **skills** defined in the mark scheme or in the level descriptions • the **standard of response** required as exemplified by the standardisation scripts.
2	Examiners must award **whole marks** (not half marks, or other fractions).
3	Examiners must award marks **positively**. This means that: • marks are not deducted for errors or omissions • marks are awarded for correct/valid answers as defined in the mark scheme and also for **other valid answers** which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate • the quality of spelling, punctuation and grammar are judged **only** when the mark scheme indicates that these features are **specifically assessed** in the question. However, the meaning of all responses must be unambiguous.
4	Examiners must **consistently** apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly.
5	Examiners must use the **full range of marks** defined in the mark scheme, unless limited by the quality of the candidate responses seen.
6	Examiners must award marks according to the mark scheme and **must not** award marks with grade thresholds or grade descriptions 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	<u>'List rule' guidance</u> 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
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

Mark Scheme abbreviations

/	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
underline	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
M	marking point
ppt	precipitate
sf	significant figures

When awarding accuracy marks in **Question 1** record:

- candidate number
- candidate ΔT ($T_{max} - T_o$)
- difference (δ) from supervisor value
- mark awarded

When awarding accuracy marks in **Question 2** record:

- candidate number
- candidate ratio ($\frac{mass\ of\ FB3}{mass\ of\ residue}$)
- mark awarded

In either question, where more than half the candidates score no marks against the supervisor value, **please contact your team leader (TL).**

Reject <u>either</u> a rounding error (RE) <u>or</u> a transcription error (TE) only once in the paper. Note: Reject REs <u>only</u> in 'correctly calculates'. Reject fractions in place of decimal answers only once in the paper.

Practical issues at a centre sometimes mean that candidates cannot access all of the marks. In such cases, contact your TL. Candidate marks may need to be scaled.

Restarts: In calculations sections of quantitative analysis questions, candidates may gain credit in a question part by using either a previous incorrect answer **or** they may 'restart' the calculation using their experimental data correctly. Annotate either 'ecf' or 'allow: restart'.

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td rowspan="3">1(a)</td><td>M1 Records thermometer readings to .0 or .5 ºC
for ALL times in the table</td><td>1</td><td>R if all .0 or all .5.</td></tr>
<tr><td colspan="3">If candidate’s T_0 or T_{max} is not given to .0 or .5, round to nearest .0 or .5 before calculating ΔT
Examiner calculates the ΔT for candidate (= highest T reached in table – T_0).
Write and ring supervisor’s ΔT on each candidate’s script.
Calculate and record the difference, δ, between the supervisor’s and candidate’s value.</td></tr>
<tr><td>Award accuracy marks as follows:
<table>
<tr><td>Supervisor ΔT / ºC</td><td>< 10.0</td><td>10.0 – 19.5</td><td>20.0 – 29.5</td><td>30.0 – 39.5</td><td>⩾ 40.0</td></tr>
<tr><td>M2</td><td>± 1.0</td><td>± 2.0</td><td>± 2.5</td><td>± 3.0</td><td>± 3.5</td></tr>
<tr><td>M3</td><td>± 0.5</td><td>± 1.0</td><td>± 1.5</td><td>± 2.0</td><td>± 2.5</td></tr>
</table></td><td>2</td><td>If Supervisor ΔT < 5.0 ºC, contact TL.</td></tr>
</table>

Question	Answer	Marks	Guidance
1(b)(i)	**M1** Temperature on *y*-axis and time on *x*-axis **and** axes clearly labelled with unambiguous names **or** units **and** some numbers for scales	1	**A** temp., *T* (for temperature axis name). **A** *t* (for time axis name). **A** min, mins for minutes. **A** time scale in seconds. **R** C (alone), C° for temp. **R** m for units of time.
	M2 Linear scales based on 1, 2 or 5 per large square **and** include (space for) 10.0 °C above maximum temperature (T_{max}) recorded **and** scales chosen so that points plotted cover more than half of each axis (i.e. > 5 large squares up y-axis covered by plot points)	1	**A** scales based on 4, 10, 20 etc. per large square. **R** other scales based on e.g. 3, 7, 9 etc. **R** if any part of the scale is non-linear, including the ends not used for plotting. **A** if data are not plotted. **A** graph rotated to fit landscape. **IF** $\Delta T \geqslant 40$ °C, then for > 50% axis used, measure from lowest point to T_{max} + 10 °C.
	M3 All recorded points plotted correctly to within half a small square and in the correct square If fewer than 20 readings recorded in **(a)**, **A** minimum 14 recorded and plotted – but **all** recorded temperatures must be plotted	1	**R** if scale is non-linear in the region of plotting, but **I** non-linear regions beyond plot. **A** if scale is not based on 1, 2, 4, 5 or 10. **I** point plotted at *t* = 2 min in line with first four points. Scan all points. Closely check *t* = 0, max *T* and final *T*. Check spacing of points along *x*-axis – should be even (excluding gap at *t* = 2 min). Annotate script with a small dot on the *x*-axis scale or near point for each point checked. If the point should be on a line, it must be on the line (you should not be able to see white space between the plot and the axis line). If it should not be on the line, it must not be so. Blobs/crosses should be less than ½ a small square across and be correctly centred.

Question	Answer	Marks	Guidance
1(b)(i)	**M4** Two lines of best fit drawn **and** extrapolated to t = 2 minutes Left-hand line must be a straight line Right-hand line must be a **smooth** curve	1	**A** (maximum of) 2 points to be circled or labelled as anomalous. **R** additional lines of best fit. Left-hand line: if 3 temperatures are the same (1 different), then line **must** be horizontal. Right-hand curve must **not** be an S-shape.
1(b)(ii)	**Correctly uses** the graph to determine ΔT at 2 minutes **and** answer given to 1 decimal place	1	**MUST** have working shown on graph. Minimum is vertical line at t = 2 min connecting the two lines of best fit. Or a mark on (or near) y-axis where RH line crosses t = 2 min. **A** reading from y-axis within ½ small square. **A** T_0 either from table **or** read from graph **A** 2 dp if value read from y-axis correct to 2dp. **R** integer value. **R** if right hand line lower than T_{max} where it crosses t = 2 mins **unless** T_{max} labelled anomalous.
1(c)(i)	(appearance of filtrate): colourless (solution) **and** (appearance of residue): pink-brown (solid/powder)	1	**I** clear, transparent etc. for colourless. **A** 'no colour'. **A** pink / (dark) brown / black / black-grey / dark-grey. **R** red. **R** grey (alone).

Question	Answer	Marks	Guidance
1(c)(ii)	**M1** Selects sodium hydroxide (aqueous) **and** selects NH_3 (aqueous)	1	**A** selects (aqueous) ammonia only **and** white ppt **and** soluble in excess for **M1** and **M2** ✓✓.
	M2 Observation for **both** is: white ppt **and** soluble in excess	1	**I** additional reagents and observations.
	M3 M is Zn / zinc	1	**M3** is dependent on correct observations in **M2**. **A** Zn^{2+} (charge must be correct). **NO ECF** for **M3** from incorrect tests / observations.
1(d)(i)	$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$ **or** $\mathbf{M}(s) + Cu^{2+}(aq) \rightarrow \mathbf{M}^{2+}(aq) + Cu(s)$	1	State symbols required. **ECF** from incorrect conclusion in **(c)(ii)** only **IF** the metal selected is more reactive than Cu (even if not in QA table on p10).
1(d)(ii)	**Correctly calculates** energy change = $25 \times 4.18 \times \Delta T$ (J) **and** answer given to 2–4 significant figures	1	**A** use of ΔT from graph **or** table. **ECF** use of incorrect ΔT from **1(b)(ii)**. **I** signs. **R** c = 4.2 used in working. **IF** no working, final answer must be correct to 3–4 sf. Do not penalise sf more than once in **1(d)**.
1(d)(iii)	**M1 shows use** of data to calculate amount of $CuSO_4 = 0.95 \times {}^{25}/_{1000}$ (mol) = 0.024 / 0.0238 / 0.02375	1	**M1** answer, if given, must be to 2 – 4 sf. **R** if evaluated = 0.02 (1sf).
	M2 working to show enthalpy change $\Delta H_r = {}^{\text{(d)(ii)}}/_{(1000 \times \text{ answer to } \mathbf{M1})}$ (kJ mol^{-1}) **and** negative sign shown **and** final answer given to 2–4 significant figures	1	**ECF** M2 from M1 (e.g. use of 0.95 as moles). Expected answer $\Delta H_r = -{}^{\text{(d)(ii)}}/_{23.75}$ (kJ mol^{-1}) ✓✓.

Question	Answer	Marks	Guidance
2(a)	**M1** Unambiguous headings **and** correct units to cover 7 entries All data in **a single** table • (mass of) crucible and lid • (mass of) crucible, lid and **FB3** / hydrated salt / $CuSO_4$•**x**H_2O • (mass of) crucible, lid and contents / anhydrous salt / $CuSO_4$ • (mass of) crucible, lid and contents / etc after reheating • (mass of) **FB3** / hydrated salt / $CuSO_4$•**x**H_2O • (mass of) residue / anhydrous salt / $CuSO_4$ • (mass) loss / water lost / water **and** Unit for all seven pieces of data recorded: / g, (g), in g	**1**	**A** consistent omission of lid. **R** weight for mass. **A** two tables (balance readings and calculations). **A** residue for anhydrous salt. **A** dehydrated for anhydrous. **R FB3** in headings <u>after heating</u>. Third and fourth reading must be distinguished. e.g. 'contents' then 'residue' as implied in the method. **A** on heating / cooling 1 and on heating / cooling 2. **A** unambiguous heading for a third heating. **I** calculated 'mass of residue after 1st heating'. **A** in grams / grammes. **R** gram, / (g), (/ g).
	M2 All balance readings given consistently either to 2 or to 3 decimal places (dp) **and** final heating within +0.02 to –0.05 g of previous heating **M3** Correct subtractions to determine mass of FB3 used **and** mass of residue **and** mass of water lost	**1**	**A** 4 dp. **A** 1 dp **only if** use of 1 dp balances is stated in the supervisor's **report**. **IF** 1dp balance used, final two readings after heating must be identical. **R** if any balance reading is impossible. **A** values seen next to appropriate line in method. **IF** mass on second heating is **greater** than mass on first heating, candidate may use **either** value. Do not read subtractions from part **(b)**.
	Check and correct subtractions for supervisor and candidates. If mass on second heating is **greater** than mass on first heating, use mass from first heating to determine ratio. Calculate supervisor's mass ratio = $^{\text{mass FB3}}/_{\text{mass residue}}$ to 2 dp. Write and ring this value on each candidate's script. Calculate and record (near the results table) the candidate's mass ratio to 2 dp		
	M4 Award if candidate's mass ratio is within 10% of supervisor value	**1**	**IF** fewer than 50% of candidate score **M4**, consider using default of 1.56.

Question	Answer	Marks	Guidance
2(b)(i)	**Correctly calculates** amount of $CuSO_4$ = $^{\text{mass of residue}}/_{159.6}$ (mol) **and** answer given to 2–4 sf	**1**	**A** correct string of A_rs for 159.6. **A** use of their value from the table in **(a) or** a correct restart value. **R** incorrect M_r used in working. Do not penalise sf more than once in **2(b)**. Do not penalise sf if already penalised in **1(d)**.
2(b)(ii)	**M1 correctly calculates** amount of water = $^{(\text{mass of FB 3} - \text{mass of residue})}/_{18}$ (mol) **and** answer given to 2–4 sf	**1**	**ECF** use of mass of residue in **(b)(ii) IF** mass of water lost was used in **(b)(i)**. **A** use of incorrect subtractions in **(a)**. **A** alternative method: $\left[\frac{\text{mass FB3}}{\textbf{(b)(i)}} - 159.6\right]/18$
	M2 shows use of $^{\text{amount of water}}/_{\textbf{(b)(i)}}$ **and** answer is an integer	**1**	**R** non-integer values of **x**. **R x** = 0**.**
2(c)	(residue is) white / grey * solid * (solid) turns blue * forms blue solution * 'steam' / crucible warms up / fizzing sound / popping sound * **2* = 1 mark**	**2**	**I** residue for solid. **R** ppt for solid. **A** blue-green solution. **I** fizzing (alone). 5 * available, round down.
2(d)(i)	copper oxide / CuO (formed) **or** sulfate / $CuSO_4$ decomposes / (anhydrous solid / residue) undergoes further decomposition	**1**	**R** burns / combusts / oxidises.

Question	Answer	Marks	Guidance
2(d)(ii)	**Mass** loss increases therefore 'x' increases	**1**	**A** 'it' for 'x'. **A mass** of anhydrous salt will be smaller therefore 'x' increases. **A** change would be (very) small so wouldn't make difference to overall integer value for 'x'. **I** *calculated* moles of water will be greater. **R** more water is lost/removed.

Question	Answer	Marks	Guidance
	FB 4 is a mixture of $CuCO_3$ and $FeSO_4 \cdot 7H_2O$		
3(a)	green (solid) * powder and crystals * (on gentle heating) (solid/powder) turns black * condensation * (stronger heating) (black) solid jumps around * gas turns (damp blue) litmus red * white specks / solid turns grey * white fumes * 2 * = 1 mark, **maximum 3** marks	**3**	**A** UI paper in place of litmus. **A** gas forms white ppt * with limewater * but record the mark in **3(b)** – see below. 8 * available − round down.

Question	Answer	Marks	Guidance
3(b)	**M1** (filtrate / **FB6**) colourless / (pale) green (solution) ✓ **M2** + **M3** (residue + acid) rapid / vigorous * effervescence / fizzing / bubbling * (test gas with) limewater * gas / CO_2 gives **white ppt** * blue / blue-green / (darker) green / cyan / turquoise solution * 2 * = 1 mark, **maximum** 2 marks	**3**	**R** yellow / yellow-green / dark-green. **A** gas / CO_2 gives white ppt * with limewater * from **(a)** if not seen here. Underline observation in **(a)** and write appropriate number of * against 'seen in **(a)**'. 5 * available, round down.

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3(c)</td><td>
<table>
<tr><td>test</td><td>observations</td></tr>
<tr><td>Test 1
+ NaOH</td><td>green ppt *
(which is insoluble in excess)</td></tr>
<tr><td>and warm</td><td>(damp red) litmus paper unchanged / stays red *
ppt turns brown / red-brown (at surface) *</td></tr>
<tr><td>+ Al</td><td>effervescence *
gas ‘pops’ with a lighted splint *</td></tr>
<tr><td>Test 2
+ NH_3</td><td>green ppt *
insoluble in excess *
ppt turns brown / red-brown (at surface) *</td></tr>
<tr><td>Test 3
+ $Ba(NO_3)_2$ (aq)</td><td>white ppt *
R use of additional reagent, e.g. HCl</td></tr>
<tr><td>Test 4
add hydrochloric or nitric acid to ppt from Test 3 *</td><td>white ppt / ppt insoluble / no change *

Observation dependent on correct test</td></tr>
</table>
2 * = 1 mark, maximum 5 marks</td><td>5</td><td>A dark green / dark grey / black (for green ppt).
I grey (alone).
R grey-green ppt .

A orange-brown / rust (for brown ppt).
A ppt turns brown * in either of top two boxes.

R test gas with litmus goes red or blue.

R grey-green ppt.
A (green) ppt darkens (for ppt turns brown).
A orange-brown / rust (for brown ppt).

R off-white / cream etc.
I insoluble in excess (in Test 3).
R soluble in excess (in Test 3).

A Test 4 = addition of $BaCl_2$ / $Ba(NO_3)_2$ and HCl / HNO_3 * then observation = white ppt (forms) *.
R incorrect formula / H^+ for reagents in Test 4.
R ‘no observation’ for ‘no change’.
I $KMnO_4$ test (and result).
11 * available, round down.</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3(d)</td><td>
<table>
<tr><th></th><th>cation</th><th>anion</th></tr>
<tr><td>FB 5</td><td>Cu^{2+}</td><td>CO_3^{2-}</td></tr>
<tr><td>FB 6</td><td>Fe^{2+}</td><td>SO_4^{2-}</td></tr>
</table>
Any 2 or 3 correct = 1 mark
All 4 correct = 2 marks
</td><td>2</td><td>
R FB5 ions if no observations in (b).
R FB6 ions if no results in Table 3.1.
A ‘unknown’ for FB5 cation.

A 1 mark for:
FB 5 = copper(II) and carbonate
and
FB 6 = iron(II) and sulfate.

A 1 mark for:
<table>
<tr><th></th><th>cation</th><th>anion</th></tr>
<tr><td>FB 5</td><td>CO_3^{2-}</td><td>Cu^{2+}</td></tr>
<tr><td>FB 6</td><td>SO_4^{2-}</td><td>Fe^{2+}</td></tr>
</table>
NO ECF from incorrect observations in (c).
</td></tr>
</table>