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CAMBRIDGE
International Education

Cambridge International AS & A Level

CHEMISTRY **9701/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2026**

MARK SCHEME

Maximum Mark: 30

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.

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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.

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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.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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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
	Unclear
	Information missing or insufficient for credit
	Benefit of the doubt given
	Contradiction in response otherwise markworthy, mark not given
	Part of the correct answer has been seen. Full credit has not been awarded.
	Error carried forward applied
	Incorrect or insufficient point ignored while marking the rest of the response
	Rounding error

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Annotation	Meaning
POT	Power of ten error
REP	Repeat error
SEEN	Blank page **or** part of script seen
SF	Error in number of significant figures
TE	Transcription error

Mark scheme abbreviations

R	reject the response
A	accept the response
I	ignore the response
ecf	error carried forward
BOD	benefit of doubt given
ora	or reverse argument
owtte	or words to that extent
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

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Question	Answer	Marks	Guidance
1(a)	pipeclay triangle	1	**A** clay triangle / clay pipe triangle / triangle clay pipe **I** tripod, gauze, triangular holder
1(b)	to prevent spitting	1	**A** to prevent cracking / damaging / breaking crucible **A** to prevent losing solid / (mixture) **X** / solid jumping out (of crucible) **A** to prevent splitting **A** $CaCl_2$ or $Ca(NO_3)_2$ for solid **R** burning
1(c)	NO_2 is a hazardous gas	1	**A** NO_2 gas is toxic / poisonous / acidic / corrosive **A** NO_2 is an irritant to eyes / by inhaling **A** $NO_2(g)$ for NO_2 gas **I** flammable, harmful **R** answers about O_2
1(d)(i)	**M1** mass lost on heating is 17.81 – 16.53 g = 1.28 g relative molecular mass of $(4NO_2 + O_2)$ = 216.0 1.28 g is 1.28 / 216 mol = 0.005926 mol of $(4NO_2 + O_2)$ **M2** number of moles $NO_2 = 4 \times 0.005926 = 0.0237$ mol	2	award 2 marks for 0.0237 award 1 marks for 0.0278, 0.0618, 0.135 and 0.0156 1.28 g is NO_2 and O_2 in the ratio of 4:1 relative mass of $(4NO_2 + O_2) = 4 \times 14.0 + 10 \times 16.0 = 216.0$ g mol^{-1} 1.28 g is 1.28 / 216 mol = 0.005926 mol of $(4NO_2 + O_2)$ NO_2 is $\times 4$ this. **A** 2 or more SF ecf from incorrect **M1**: **A** a number of moles $\times$ 4 [**A** if assume all gas released to be NO_2 = 0.0278 mol **A** if 5.07 g is assumed to be all $Ca(NO_3)_2$ then 5.07 / 164.1 = 0.0309 mol $Ca(NO_3)_2$ so 2×0.0309 = 0.0618 mol **A** if 3.79 g is assumed to be CaO so 3.79 / 56.1 = 0.06756 mol CaO then $2 \times 0.06756 = 0.135$ mol **A** if 1.28 g is assumed to be $Ca(NO_3)_2$ then 1.28 / 164.1 = 0.00780 mol $Ca(NO_3)_2$ so $2 \times 0.0078 = 0.0156$ mol]

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Question	Answer	Marks	Guidance
1(d)(ii)	Correct working must be shown. percentage error = $(2 \times 0.005 / 17.81) \times 100\ \% = 0.0561$	1	**A** the following values are amongst acceptable values for the answer following a correct expression 0.06, 0.056, 0.05 etc. **I** ignore missing $\times$ 100 if correct answer is given (2×0.005) may be seen as $(0.01 / 2 \times 2)$
1(d)(iii)	increase the mass of mixture **X** used	1	**A** any wording that implies increasing the mass of **X** e.g. weigh a larger sample / reactant / contents **A** use a bigger amount of **X** / Use a larger quantity of **X** / use more **X** etc. **A** use a larger mass of 'crucible + **X**' **A** 'use a larger mass' or more than 5.07 g **I** 'use a large mass' alone **I** repeat and take mean **I** changes to heating e.g. heat for longer **R** more accurate balance or any other change to apparatus e.g. increase mass of crucible alone **R** incorrect use of weight for mass **R** heat to constant mass
1(e)	**M1** mol of $Ca(NO_3)_2$ in original sample = 0.5×0.0223 mol = 0.01115 mol **M2** mass $Ca(NO_3)_2$ in original sample = 0.01115 mol $\times$ 164.1 g mol^{-1} = 1.829715 g % by mass $Ca(NO_3)_2$ = 1.829715 / 4.98 $\times$ 100% = 36.7%	2	award 2 marks for 36.7 **A** more SF e.g. 1.829715 g 36.741265% **A** 36.7 rounded to 37 for **M2** **I** rounding errors after 3SF. If **M1** is rounded to 0.0112 mol and then used in **M2** award **M1** only ecf for **M2** from incorrect **M1** and allow final answer to be rounded to 2SF

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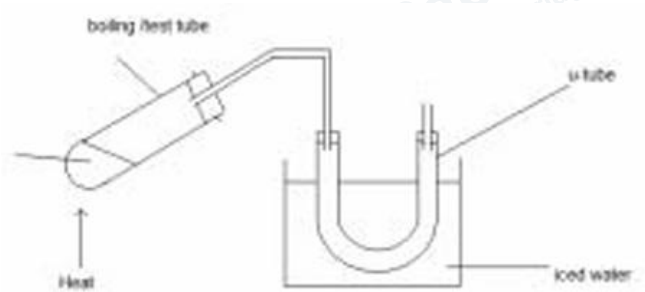
Question	Answer	Marks	Guidance
1(f)(i)	heat to constant mass	1	**A** description of the process of heating to constant mass e.g. reheat and reweigh until mass remains constant **A** repeat steps 3 and 4 to constant mass response must include (re)heat and constant mass
1(f)(ii)	The percentage by mass will be smaller. **AND** mass of gas lost is smaller (than the maximum possible) **OR** mass of solid remaining after heating is higher (than actual mass)	1	**A** NO_2 or O_2 or both for gas **A** amount / mol for mass **I** not all NO_2 released **I** calculated mass of $Ca(NO_3)_2$ (that decomposes) is lower than actual value
1(g)	**M1** attempted use of ice / cold water for condensing the gas without loss of the NO_2 as gas **M2** in an unsealed collection vessel surrounded by iced / cold water  	2	**M1 A** coolant/cool water for ice If a condenser is seen, max 1 mark • must be angled downwards towards unsealed collection vessel • must show water in and out of jacket • ignore position of water in and out • condensed NO_2 must be delivered into a vessel surrounded by ice/cold water. If a condenser is delivering into a u-tube and ice, then 2 marks can be awarded.

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2(a)</td><td>only (direct) light from the LED should be allowed to reach the photocell</td><td>1</td><td>A to prevent outside light entering (the colorimeter)
A to prevent outside light reaching the photocell
for outside light A external light / background light /surrounding light
for photocell A detector
A no (indirect) light via reflections
A the only source of light is from the LED
I other light for outside light
I light absorbed unless it is absorbed by the photocell</td></tr>
<tr><td>2(b)(i)</td><td>
<table>
<tr><th>concentration of I_3^-(aq) / mol dm^{-3}</th><th>resistance of photocell, R_s / kΩ</th><th>absorbance, A</th></tr>
<tr><td>3.60×10^{-6}</td><td>34.28</td><td>0.839</td></tr>
<tr><td>2.94×10^{-6}</td><td>23.42</td><td>0.684</td></tr>
<tr><td>2.20×10^{-6}</td><td>16.01</td><td>0.519</td></tr>
<tr><td>1.52×10^{-6}</td><td>9.68</td><td>0.300</td></tr>
<tr><td>7.90×10^{-7}</td><td>7.50</td><td>0.189</td></tr>
</table>
</td><td>1</td><td>Must be 3 DP</td></tr>
<tr><td>2(b)(ii)</td><td>distilled water (with few drops of starch solution)</td><td>1</td><td>A (acidified) I^-(aq)/solution (with few drops of starch solution)
A acidified I^- ions (with few drops of starch solution)
A I_3^- solution/(aq) with no starch</td></tr>
<tr><td>2(b)(iii)</td><td>concentration of I_3^-</td><td>1</td><td></td></tr>
</table>

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Question	Answer	Marks	Guidance
2(b)(iv)	**M1** all 5 points plotted correctly **M2** straight line of best fit through origin passing through or close to all points except anomaly (point 2)	**2**	Place plotting tick on grid above line of best fit. Place line tick in left-hand margin Place a cross beside an incorrect point ecf from 2(b)(i) **R** if point 2 is on a vertical gridline **R** if point 4 is on a horizontal gridline **R** line of best fit that does not extend from the origin to cover all plotted points. **R** if line of best fit is one square or more from origin on either axis A line of best fit between the first and last (correctly plotted) points is acceptable as long as it goes close enough to the origin. All points except anomaly should be on the line of best fit. Point marked as anomalous (ringed) should not be used in determining the line of best fit. **A** ecf acceptable line of best fit drawn for incorrectly plotted points. **R** line of best fit if the points (except anomaly) not approximately evenly distributed on both sides of line **I** extra points added which are used in later calculations **I** remnants of lines that the candidate has tried to erase **R** curved line **R** double or “sketchy” lines.

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Question	Answer	Marks	Guidance
2(b)(v)	most anomalous point circled **AND** any one reason from: • not enough starch added (in step 2) • less than 10.0 cm^3 solution transferred (from boiling tube to measuring cylinder in step 4) • solution (from step 2) was left for less than 10 minutes (in step 3)	**1**	Expected answer is point 2 at (1.52×10^{-6}, 0.300 below the line of best fit) **A** light intensity (in colorimeter) increased **A** ora for ecf point above line of best fit **A** light got into the colorimeter/black box not shut (no ora for point above line of best fit) **I** reading of absorbance was too low **I** comments about temperature/heat **I** starch not mixed properly **I** systematic error **I** evaporation **I** reference to rates
2(c)(i)	to allow all the I_3^- ions form a complex (with the starch)	**1**	**A** for complete reaction (of the I_3^- ions and starch) **A** enough time for the complex to form completely **I** to reach equilibrium **I** reference to rate of reaction **I** all the starch reacts
2(c)(ii)	10 cm^3 volumetric pipette	**1**	**A** graduated pipette as long as volume is not < 10 cm^3 **A** 10 cm^3 pipette **A** volumetric pipette **I** 'pipette' alone **R** burette
2(c)(iii)	**M1** absorbance = 0.640 **M2** concentration read from the graph to nearest ±½ square and given to 3 SF	**2**	**A** 0.64 with working shown Concentration should be read from the graph to nearest ±½ square. **I** any figures after 3SF **I** trailing zeros (allow 2.7 for 2.70) **A** non-standard form 2.75×10^{-6} mol dm^{-3} is a common answer

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Question	Answer	Marks	Guidance
2(c)(iv)	(15 / 1000) × 2(c)(iii)	1	**A** 2 SF minimum **A** calculator value from 2(c)(iii) (e.g. 2.725 used for 2.73 given in 2(c)(iii)) **I** trailing zeros **A** non-standard form
2(c)(v)	2(c)(iv) × (1000 / 7500)	1	If using the given value, then: $3.23 \times 10^{-8} \times 1000 / 7500 = 4.31 \times 10^{-9}$ mol dm^{-3} **A** calculator value from 2(c)(iv) **A** 2 SF minimum **A** non-standard form
2(c)(vi)	increases **AND** (the value of) the concentration of I_3^- increases (at same absorbance)	1	
2(c)(vii)	9.87 + 0.14 × 9.87 = 11.25 **AND** 13.66 – 0.14 × 13.66 = 11.75 **AND** the concentration of O_3 is different (because the extremes of the ranges do not overlap)	1	**A** any set of calculations which gives 11.25 and 11.75
2(c)(viii)	R_s increases **AND** the light has a longer path length (through the solution)	1	**A** light travels through a deeper solution **A** light interacts with more I_3^- particles **A** absorbance increases with depth (of solution) **I** light interacts with more I_3^- solution(aq) **I** more light is absorbed alone **I** measuring cylinder is deeper
2(c)(ix)	concentration of I_3^- will be higher giving a lower percentage error	1	**A** amount / mol of I_3^- for concentration of I_3^- **I** uncertainty for percentage error **A** uncertainty percentage error for percentage error alone

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