CAMBRIDGE
International Education

# Cambridge International AS & A Level

**CHEMISTRY** **9701/38**

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 **20** printed pages.

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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:<br><br>• the specific **content** defined in the mark scheme<br>• the specific **skills** defined in the mark scheme or in the level descriptions<br>• 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:<br><br>• marks are not deducted for errors or omissions<br>• 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<br>• 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><br><br>For questions that require ***n*** responses (e.g. State **two** reasons …):<br><br>• The response should be read as continuous prose, even when numbered answer spaces are provided.<br>• Any response marked *ignore* in the mark scheme should not count towards ***n***.<br>• Incorrect responses should not be awarded credit but will still count towards ***n***.<br>• 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.<br>• Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science. |

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| | |
|---|---|
| 6 | <u>Calculation specific guidance</u><br><br>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'.<br><br>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.<br><br>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.<br><br>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 | <u>Guidance for chemical equations</u><br><br>Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.<br><br>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 |
| ^ | 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 |

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

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**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 |

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Accuracy marks must be recorded on the spreadsheet provided, on an accuracy grid or on a blank part of the Supervisor's script. If using a spreadsheet or accuracy grid, this must be printed and stapled inside the Supervisor script. The relevant Supervisor results must be written and ringed on **each candidate script**.
When awarding the accuracy (Q) mark in **Question 1**, record:

- candidate number
- candidate titre
- difference from supervisor, $\delta$
- mark awarded
- any adjustment (spread adjustment (SA), 50-adjustment (50-A) or rough titration adjustment (RTA))

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

- candidate mass of **FB 6**
- candidate mass loss
- 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'.

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1(a) | **I** The following data are recorded:<br>• two burette readings **and** titre for the rough titration<br>**and**<br>• initial and final burette readings for **two** (or more) accurate titrations | **1** | Headings and units are **not** required for this mark. Must be red pen on page 2.<br>**A** Rough titration readings may be labelled in the accurate table.<br>**I** errors in values for rough titration, e.g. an initial reading of 50, incorrect subtractions, etc. |
| | **II Titre values** recorded for accurate titrations **and correct headings** and **units** in a single **accurate** titration table<br>• initial/start **and** (burette) reading/volume<br>• final/end **and** (burette) reading/volume<br>• titre **or** volume **used/added or FB 1 used/added**<br>• unit: / $cm^3$ **or** ($cm^3$) **or** in $cm^3$ (for each heading) **or** $cm^3$ unit given for each volume recorded. | **1** | **A** 'vol' or 'V' or 'value' for 'reading / volume'.<br>**R** if initial and final burette readings do not match the data (**A** 50 as initial volume).<br>**R** 'difference' or 'amount' or 'change' or 'titrate' (for titre).<br>**R** ml / cc.<br>**I** 'total' (titre).<br>**I** Headings relating to solution turning yellow. |
| | **III** All accurate burette readings recorded to 0.05 $cm^3$ | **1** | **R** if:<br>• 50(.00) is used as an initial burette reading<br>• More than one final burette reading is 50(.00)<br>• Any burette reading is greater than 50(.00).<br><br>The requirement to record to 0.05 applies to burette readings, including 0.00 $cm^3$ (if this was the initial reading), but it does not apply to the **titre.** |
| | **IV** The **final** accurate titre recorded must be within 0.10 $cm^3$ of any other accurate titre | **1** | **R** if these two titres are derived from **any** burette readings recorded as integers (apart from initial 0 $cm^3$)<br>**R** if titre values not calculated but **A BOD** if all initial burette readings are 0(.00).<br>**I** any reading labelled rough. |



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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1(a) | **Accuracy (Q) marks**<br>Round burette readings to the nearest 0.05 $cm^3$. Check and correct titre subtractions where necessary.<br><br>Examiner selects the best mean titre, using the following hierarchy:<br>• two (or more) accurate identical titres (ignoring any that are labelled 'rough'), *then*<br>• two (or more) accurate titres within 0.05 $cm^3$, *then*<br>• two (or more) accurate titres within 0.10 $cm^3$, *etc*<br><br>Calculate the difference (δ) between the candidate's mean titre and the supervisor's mean titre.<br>Write and ring supervisor's value next to the accurate titration table for each candidate.<br>Also write the candidate's mean value (calculated by examiner) and difference between supervisor's and candidate's value, δ. | | |



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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1(a) | **Award accuracy Q marks as follows**: | | A **spread adjustment (SA)** is required if titres selected (by examiner) differ ⩾ 1.00 $cm^3$.<br>A **50-adjustment (50-A)** is required if 50.(00) is used as initial volume. Use mean of final volume **or** actual titre (whichever gives the better Q score).<br>A **rough titration adjustment (RTA)** is required if **only** a rough titration was carried out. Use the rough titre to award Q marks.<br>If an **adjustment** is required:<br>**V** Award if δ ⩽ 0.30 $cm^3$<br>**VI** Award if δ ⩽.0.20 $cm^3$<br>**VII** Not available.<br><br>If only **one** accurate titration was carried out, use it to award Q marks as normal.<br>**A** (BOD) accuracy marks from titre values with no readings shown.<br><br>For Supervisor's mean titre ⩾ 50.00 $cm^3$:<br>3 marks: 0.30, 2 marks: 0.50, 1 mark: 0.80 $cm^3$<br><br>For Supervisor's mean titre ⩽ 10.00 $cm^3$:<br>3 marks: 0.10, 2 marks: 0.15, 1 mark: 0.25 $cm^3$<br><br>For Supervisor's mean titre ⩽ 5.00 $cm^3$:<br>3 marks not available, 2 marks: 0.05, 1 mark: 0.10 $cm^3$<br><br>Adjustments apply as above. |
| | **V** Award if δ ≤ 0.50 $cm^3$ | **1** | |
| | **VI** Award if δ ≤.0.30 $cm^3$ | **1** | |
| | **VII** Award if δ ⩽ 0.20 $cm^3$ | **1** | |



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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1(b) | **Correctly calculates mean titre**<br>• Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 $cm^3$.<br>• Working/explanation must be shown **or** ticks must be put next to the two (or more) accurate readings selected.<br>• The mean should be quoted to 2 dp and be rounded to nearest 0.01 $cm^3$. (e.g. 26.675 $cm^3$ must be rounded to 26.68 $cm^3$) | **1** | **A** mean expressed to 1 dp, if **all** accurate burette readings were given to 1 dp or a mix of 1 dp and integers and the mean is **exactly** correct.<br><br>e.g. if titres are 26.0 and 26.2: mean = 26.1 is correct<br>e.g. if titres are 26.0 and 26.1: mean = 26.1 is wrong (should be 26.05 $cm^3$)<br><br>**A** ecf if in (a) no readings but only titre values given **or** no titre calculated and initial reading is 0.(00) $cm^3$.<br><br>**R** this mark if:<br>• The rough titre was used to calculate the mean.<br>• The candidate did only one accurate titration.<br>• Burette readings were incorrectly subtracted to obtain **any** of the accurate titre values.<br>• All burette readings used to calculate the mean were recorded as integers. |
| 1(c)(i) | **All** answers given to parts **(ii)**, **(iii)** and **(iv)** recorded to **3 or 4 sf**. | **1** | Answers must be given for all three question parts.<br>If no value on the answer line, accept final **calculated** value in the working.<br>Some relevant working is required for at least one question part. |
| 1(c)(ii) | **M1** Correctly displays<br>$M_r$ = (39.1 + 126.9 + 3 × 16) = 214 | **1** | **A** number string.<br>**R** either 39 or 127. |
| | **M2** Correctly uses<br>amount of $IO_3^-$ = $^{3.35}/_{214} \times {}^{25}/_{1000}$ = 3.91(4) × $10^{-4}$ | **1** | **A** ecf from incorrect $M_r$.<br>**A** 3.91(4) × $10^{-4}$ with no working seen for **M2**.<br>**R M2** if no $M_r$ used in calculation.<br>**R M2** Rounding to 1 or 2 sf shown during a 2-part calculation (not correct use). |
| 1(c)(iii) | Correctly uses<br>amount of $S_2O_3^{2-}$ = 6 × **1(c)(ii)** | **1** | No working required if answer to 3 sf or more. |



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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1(c)(iv) | Correctly uses<br>Concentration = **1(c)(iii)** × 1000 / **1(b)** | **1** | No working required if answer to 3 sf or more. |



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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 2(a)(i) | **I Unambiguous** headings **and** correctly displayed units in the space provided<br>• (Mass of) crucible (+ lid)<br>• (Mass of) crucible (+ lid) + **FB 6** (or contents before heating)<br>• (Mass of) crucible (+ lid) + residue / **$MX_2$** / (anhydrous) metal salt/ anhydrous **FB 6 /** contents (after heating / after cooling)<br>• (Mass of) **FB 6**<br>• (Mass of) residue / **$MX_2$** / (anhydrous) metal salt / anhydrous **FB 6** contents (after heating / after cooling)<br>• (Mass) loss / lost / change in mass / mass of water<br>**And**<br><br>Units must be '/' or 'in' or '()' **AND** g or 'grams' in column headings or with every entry | **1** | Use of lid must be consistent.<br>There must be something in the crucible after heating.<br>Mass before and after heating must be unambiguous<br>If multiple data sets provided, use first set.<br>**R** weight for mass.<br>**R** gram, gr, / (g), (/g).<br>**R** starting/initial mass; ending/final mass only.<br>**R** '**FB 6**' alone after heating.<br>**R** incorrect display of units unless **R** in **1(a)**.<br><br>**A** balance readings to 4 dp.<br>**A** 1 dp readings if the supervisor report states '1 dp balance only'.<br>**R** if heated more than once. **I** heating to 1 min. |
| | **II Three required weighings recorded** in the space provided<br>**and**<br>all weighings recorded to the same number of decimal places (2 or 3); | **1** | **A** trailing zeros to be missing from calculated masses.<br>**A M3** from figures alongside method but do not look ahead to calculations.<br>If candidate has heated more than once they should use the greatest mass loss.<br>**R** if mass lost and mass of residue are transposed. |
| | **III** Correct subtractions to give masses of **FB 6**, residue and mass loss<br>**and**<br>values are correctly labelled | **1** | If candidate has heated more than once use the greatest mass loss.<br>Write CMR and ringed SMR on each script.<br>If default value is required use<br>Default value for $BaCl_2.2H_2O$ = 6.79.<br>Default value for $CaCl_2.2H_2O$ = 4.09.<br>**This must be discussed with TL.** |



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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 2(a)(i) | **IV Accuracy (Q) mark**<br>Calculate candidate's mass ratio (CMR) (to 2 dp)<br>= mass **FB 6** / mass lost<br>Calculate supervisor's mass ratio (SMR) (to 2 dp)<br>= mass **FB 6** / mass lost<br><br>Award **IV** if the candidate mass ratio is within 7% of the supervisor mass ratio i.e., CMR range = 0.93 SMR to 1.07 SMR | 1 | |
| 2(a)(ii) | **Anion test**<br><br>**M1** (Add) **water** to dissolve the residue / add **water** to make a solution | 1 | **A** use of nitric acid for water.<br>**A** testing **FB 6**.<br>**R** use of sulfuric or hydrochloric acid to make solution (**M1** and **M2**).<br>**I** 'residue' (aq) an alternative to dissolving. |
| | **M2** (use of) silver nitrate / $AgNO_3$ **and** white precipitate (observed) | 1 | **I** $Ag^+$ for $AgNO_3$, but ecf to **M3**.<br>**I** addition of nitric acid.<br>**R M2** if any other reagents used, but **I** $KMnO_4$.<br>**R** if ppt is soluble in silver nitrate / excess. |
| | **M3** (use of) ammonia / $NH_3$ **and** correct conclusion = $Cl^-$ / chloride | 1 | **M3 is dependent attempt at M2.**<br>**R** $Br^-$ / bromide (no ecf).<br>**R** $Cl_2$.<br>**I** $Cl$.<br>**I** observation with ammonia / $NH_3$. |
| 2(b)(i) | **correctly calculates n($H_2O$)**<br>n($H_2O$) = mass loss / 18<br>**and**<br>answer given to 2 – 4 sf | 1 | **A** Mass loss derived from **either** the weighings **or** from the masses of **FB 6** and residue.<br>If candidate has confused mass of residue with mass loss in **(a)**, mark ecf.<br>**A** Re-start.<br>**A** no working if answer to 3 – 4 sf.<br>**R** incorrect sf **once only** within **2(b).** |



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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2(b)(ii)</td><td>Correct use of (b)(i) to find $M_r$ of $MX_2$<br>$M_r = [{}^{(\text{mass of residue x 2})}/_{\mathbf{2(b)(i)}}]$<br>and<br>answer given to 2 – 4 sf</td><td>1</td><td>A $M_r = [{}^{(\text{mass of residue})}/_{\mathbf{((b)(i) \div 2)}}]$<br>A $M_r = [{}^{(\text{mass of } \mathbf{FB\ 6})}/_{\mathbf{((b)(i) \div 2)}}] - 36$<br><br>If candidate has confused mass of residue with mass loss in (a), mark ecf.<br>A Re-start.<br>A no working if answer to 3 – 4 sf.</td></tr>
<tr><td>2(b)(iii)</td><td>$A_r$ = 2(b)(ii) – 2 × correct $A_r$ of halide ion in 2(a)(ii)<br>and<br>answer given to 2 – 4 sf<br>and<br>M = correct choice of Group 2 metal<br>and<br>cation has 2+ charge</td><td>1</td><td>put dot on $A_r$ if correct.<br>ecf from incorrect halide in 2(a)(ii).<br>A ecf from non-halide $X^-$ ion in 2(a)(ii).<br>A $A_r$ in working.<br>A absence of display of the decimal in any $A_r$ (e.g. 80 for 79.9) if already R in 1(c)(ii).<br>A name of Group 2 metal (with / without charge).<br>R if no use of (a)(ii) and (b)(ii).<br>R if (b)(ii) not derived from experimental results.<br>If ecf results in a negative $A_r$ A with 'not possible to identify $M^{2+}$ or $Be^{2+}$.
<table>
<tr><th>$A_r$</th><th>M</th></tr>
<tr><td>< 16.7</td><td>Be</td></tr>
<tr><td>16.7 ⩽ $A_r$ < 32.2</td><td>Mg</td></tr>
<tr><td>32.2 ⩽ $A_r$ < 63.9</td><td>Ca</td></tr>
<tr><td>63.9 ⩽ $A_r$ < 112.5</td><td>Sr</td></tr>
<tr><td>112.5 ⩽ $A_r$ < 250</td><td>Ba</td></tr>
<tr><td>> 250</td><td>Ra</td></tr>
</table></td></tr>
</table>



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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2(c)(i)</td><td>Correct expression<br><br>(|(Actual $M_r$ $MX_2$ – 2(b)(ii))| ÷ Actual $M_r$ $MX_2$) × 100</td><td>1</td><td>A ecf from whole number $A_r$ (e.g. 24 for Mg, 80 for Br) in 2(b)(iii).<br>A Expression with |(Actual $M_r$ $MX_2$ – 2(b)(ii))| evaluated (and rest of expression correct).<br>A correct number strings for actual $MX_2$.<br>A any valid mathematical method to calculate percentage error.<br>R if (b)(ii) not derived from experiment results.<br>I answer but A to confirm missing × 100.<br>A ecf for any formula identified in 2(b)(ii) from table.<br><br>
<table>
<tr><th>M</th><th>$M_r$(M$Cl_2$)</th><th>$M_r$(M$Br_2$)</th><th>$M_r$(M$I_2$)</th></tr>
<tr><td>Be</td><td>80</td><td>168.8</td><td>262.8</td></tr>
<tr><td>Mg</td><td>95.3</td><td>184.1</td><td>278.1</td></tr>
<tr><td>Ca</td><td>111.1</td><td>199.9</td><td>293.9</td></tr>
<tr><td>Sr</td><td>158.6</td><td>247.4</td><td>341.4</td></tr>
<tr><td>Ba</td><td>208.3</td><td>297.1</td><td>391.1</td></tr>
</table></td></tr>
<tr><td>2(c)(ii)</td><td>Heat to constant mass</td><td>1</td><td>I use a balance to more dp.<br>I use more mass of FB 6.<br>I heat for longer.<br>I use a desiccator.<br>I Repeat experiment.</td></tr>
</table>



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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| **FB 7** = $KMnO_4$ **FB 8** = mix of $Na_2SO_3$ and $NH_4Cl$ **FB 9** = $H_2SO_4$ | | | |
| 3(a)(i) | • (**FB 7**) starting colour (dark) purple<br>• solid jumps/moves around<br>• black residue<br>• (gas) relights glowing splint<br>• (gas produced is) Oxygen / $O_2$ | **2** | blob 1 **A** purple-black.<br>blob 2 **A** spitting.<br>blob 3 **A** black solid **or** black powder for residue if clearly at the end.<br>blob 4 **A** glowing splint relights with a pop.<br>blob 4 **A** glowing splint glows more brightly.<br>blob 1 and 3 **I** form a purple solid.<br>**R** blobs 4 and 5 if another incorrect positive gas test.<br>**R** precipitate (**CON** 1 blob).<br>**I** vapour / effervescence / black gas / black fumes / black smoke / solid melts / condensation / solid pops / solid crackles.<br>**I** intermediate colours of solids, e.g. green.<br><br>'black solid / powder jumping' = 1 blob.<br>'purple solid jumping' = 2 blobs.<br><br>2 blobs = 1 mark – max 2. |
| 3(a)(ii) | O / Oxygen is oxidised **and** Mn / Manganese is reduced<br><br>**or**<br><br>O is oxidised to $O_2$ (gas) **or** O (is oxidised from) -2 to 0<br><br>**or**<br><br>Mn is reduced to $K_2MnO_4$ / $MnO_2$ **or** Mn (is reduced) from +7 to +6 / +4 | **1** | **A** oxidation number increases / loses electrons = oxidised.<br>**A** oxidation number decreases / gain electrons = reduced.<br>**R** K oxidised or reduced.<br>**R** disproportionation.<br><br>**A** (bod) $O^{2-}$ (is oxidised) to O / $O_2$ but **R** $O^{(2-)}$ **<u>ion</u>** / oxide ion (is oxidised).<br><br>**I** Manganate / $MnO_4^-$ is reduced.<br>**R** Manganate / $MnO_4^-$ is oxidised.<br>**I** Mn (is reduced) to +3 / +2. |



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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3(b)(i)</td><td>
<table>
<tr><td>test</td><td colspan="2">observations</td></tr>
<tr><td></td><td>FB 8</td><td>FB 9</td></tr>
<tr><td>Test 1<br>+$KMnO_4$</td><td>purple / $KMnO_4$ and turns<br>colourless / decolourised*</td><td>no change or<br>($KMnO_4$) remains<br>purple / does not decolourise*</td></tr>
<tr><td>Test 2<br>+ Mg</td><td>no change*</td><td>effervescence*<br>‘Pops’ with a lighted splint*<br>exothermic / tube gets warm*</td></tr>
<tr><td>Test 3<br>+ $Ba^{2+}$</td><td>white ppt*</td><td>white ppt*</td></tr>
<tr><td>Test 4<br>+ thiosulfate</td><td>no change*</td><td>(off-)white / cream / (pale) yellow ppt*<br>forms slowly*</td></tr>
</table>
2* = 1 mark
</td><td>5</td><td>2 blobs = 1 mark – max 5.<br>R ‘No observation’ first time seen.<br>R ‘–’ every time seen.<br><br>Test 1 must describe what is happening to the $KMnO_4$ (not to the solution to which it is added).<br><br>Test 1 I black / brown precipitate.<br>Test 1 FB 8 R (solution) remains colourless / colourless solution forms (alone).<br>Test 1 FB 9 R purple / pink solution formed (alone).<br><br>Test 2 A effervescence for FB 8 if it is clear there is more / greater / faster reaction with FB 9.<br>R any other positive gas tests (CON blob).<br>FB 8 I test for hydrogen.<br>I Mg dissolves.<br><br>I solid, residue, particles for ppt first time seen, then A<br>I cloudy / milky solutions (if ppt also present).<br>Test 3 R soluble in excess every time.<br>Test 3 R addition of acid once, then ecf but R if ppt with FB 9 is soluble.<br>If sulfuric acid, R every time.<br>Test 3 R addition of $KMnO_4$ once, then ecf.<br><br>Test 4 with FB 9 A 'no change' initially and (off-)white / cream / pale yellow ppt**.<br>A white solution / milky / cloudy forms slowly*.</td></tr>
</table>



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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 3(b)(ii) | **M1**: Use of NaOH **and** no ppt / no change reported | **1** | **I** use of ammonia / $KMnO_4$ in a separate test.<br>**I** flame tests.<br>**A** no ppt anywhere in **3(b)(ii)**.<br>**A** 'no observation' if **R** in **3(b)(i)**.<br>**R** any other tests. |
| | **M2**: warm the mixture | **1** | **A** heat.<br>**A** if ammonia added.<br>**R** use of aluminium.<br>**R** if NaOH not added. |
| | **M3**: **gas/$NH_3$** turns (red) litmus blue | **1** | **A** if aluminium used **I** positive hydrogen test.<br>There must be some reference to gas before testing with litmus paper to award **M3**.<br>**R** if NaOH not added.<br>**R** any other positive gas tests. |
| 3(b)(iii) | **M1** Cation = $NH_4^+$/ ammonium | **1** | **R** if **3(b)(ii)** not attempted. |
| | **M2** Anions = unknown **and** $SO_3^{2-}$/ sulfite | **1** | Anions:<br>**A** unknown and unknown.<br>**A** Nitrite and sulfate.<br>**R** if Tests 1 and 3 in **3(b)(i)** not attempted. |
| 3(b)(iv) | $H_2SO_4$ | **1** | Stand alone mark. |
| 3(b)(v) | $2H^+(aq) + Mg(s) \rightarrow Mg^{2+}(aq) + H_2(g)$<br>**or**<br>$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$<br>**or**<br>$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow S(s) + SO_2(g) + H_2O(l)$ | **1** | If $H_2SO_3$ in **3(b)(iv) A**:<br>$Ba^{2+}(aq) + SO_3^{2-}(aq) \rightarrow BaSO_3(s)$ |



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