

A-LEVEL Chemistry

CHM3X – Investigative and Practical Skills in AS Chemistry
Mark scheme

Specification 2420
June 2015

Version:V1 Final Mark Scheme

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

Stage 1 Assessment (Task 1)

| Marking Guidelines | Mark | Additional Guidance |
|--|-------------|---|
| Student reads the burette correctly | No mark | If the student does not read the burette correctly the centre should have told the student the correct reading. |
| Results recorded clearly and in full in a sensible table | (R) 1 | <p>If you can read it, it is clear.</p> <p>'Full' means the table must have 'initial reading', 'final reading' and titre values' for at least two sets of results.</p> <p>Labels such as 'initial reading', 'final reading' etc are not essential.</p> <p>The table does not have to have gridlines.</p> <p>Allow a clear answer outside a table box.</p> <p>Lose this mark if initial reading is recorded as 50 cm³</p> <p>Lose this mark if there is an arithmetic error in calculating a titre.</p> <p>Do not penalise missing units but lose this mark if units are incorrect.</p> <p>Do not penalise a student who does more than 5 titrations.</p> |
| All titre volumes to 0.05 cm ³ | (P) 1 | <p>For example, accept 20.35, 20.30 but do not accept 20.3</p> <p>Allow zero entries as 0 or 0.0</p> <p>If a set of readings are labelled 'rough' ignore their precision, unless used to calculate the average.</p> |

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| <p>Concordant if two titres are within 0.10 cm³ of each other</p> | <p>(C)1</p> | <p>Award the mark for concordancy if the table contains at least two concordant results, even if the student has not recognised these as concordant titres.</p> <p>Do not award this mark if two concordant results are only achieved by incorrect arithmetic.</p> <p>Can score concordancy mark if titre volumes are only recorded to 1 decimal place but will lose Precision mark.</p> |
| <p>The accuracy of the student's average titre, measured against a teacher value or a class average for the titration. Use the value which gives the best outcome for the student.</p> <p>This mark can be awarded independent of precision</p> <p>Average titre is within 2% of teacher value Average titre is within 2.5% of teacher value Average titre is within 3% of teacher value Average titre is within 3.5% of teacher value</p> <p>There is no penalty in the task for an incorrectly calculated average titre</p> | <p>(A) 4 3 2 1</p> | <p>If a student has two concordant titres then both concordancy and accuracy marks can be awarded.</p> <p>If a student does not have two concordant titres but does have two titres within 0.20 cm³ of each other, then the concordancy mark cannot be awarded but the accuracy marks can.</p> <p>Titres which differ from each other by more than 0.20 cm³ cannot receive concordancy or accuracy marks.</p> <p>Check that the student has calculated the average titre correctly. If not, calculate the correct average and base the student's accuracy mark on the correct average. The student does not have to use all of the concordant titres in obtaining an average. (An incorrect average titre must be penalised in Q1).</p> <p>If a student has one set of concordant results, and has correctly identified these results, base the accuracy mark on the student's average titre</p> <p>A student may have one set of concordant titres, but uses a non-concordant titre in calculating the average. Average all the student's concordant titres, and use this average to determine the mark for accuracy.</p> |

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| | | <p>A student may have two sets of concordant titres which do not overlap. Use the set of concordant titres that gives the higher accuracy mark, even if the student chooses the other set. Allow a correct calculation of an average titre for either set of concordant titres.</p> <p>A student may have two sets of concordant results which do overlap. Use whichever of the two averages would give a better mark for accuracy.</p> <p>Do not penalise a student who has done more than five titrations.</p> <p>If the initial burette reading is given as 50.00, and the final titre is given as, say 22.30, the titre could be 22.30 or 27.70. Use the value which gives the student the higher accuracy mark.</p> |
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Stage 1 Assessment (Task 2)

| Marking Guidelines | Mark | Additional Guidance |
|---|-------|---|
| Results recorded clearly and in full in a table | (R) 1 | <p>If you can read it, it is clear.</p> <p>Full means completes all of the boxes.</p> <p>Allow a table without gridlines.</p> |
| <p>The accuracy of the observations.</p> <p>24 scoring points</p> <p>22–24 points scores 6 marks</p> <p>18–21 points scores 5 marks</p> <p>13–17 points scores 4 marks</p> <p>8–12 points scores 3 marks</p> <p>4–7 points scores 2 marks</p> <p>1–3 points scores 1 mark</p> | (A) 6 | <p>Mark to the grid on page 7. If answers contradict, eg 'No visible change with effervescence' then scoring point is not awarded.</p> <p>Look for the basic colour; ignore additional shades if the answer is unambiguous.</p> <p>Accept 'no change', 'stays the same', 'nvc' as well as 'no visible change'. Penalise 'no reaction' and ignore nothing happens</p> <p>Accept 'bubbles of gas', 'fizzes', 'colourless gas formed' or 'CO₂ evolved' as well as 'effervescence'. Do not allow 'CO₂ formed/produced'</p> <p>If "precipitate" is missing, accept solid, suspension, sediment deposit.</p> <p>Penalise missing "precipitate owtte" every time</p> <p>Penalise missing "solution" once only</p> <p>Ignore 'clear' with reference to a solution.</p> <p>Ignore 'cloudy', 'misty', 'milky' or 'emulsion'.</p> <p>Penalise "white solution" every time</p> |

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Expected observations

| | A NaBr | B Na₂SO₄ | C NaCl | D NaHCO₃ | E NaCl + NaHCO₃ |
|--|---|---|---|--|--|
| Test 1(a) BaCl₂ | Colourless solution / No visible change (1) | White precipitate (1) | Colourless solution / No visible change (1) | White precipitate (1) | White precipitate (1) |
| Test 1(b) HNO₃ to 1a | Colourless solution / No visible change (1) | White precipitate / No visible change (1) | Colourless solution / No visible change (1) | Effervescence (1) Precipitate dissolves or colourless soln (1) | Effervescence (1) Precipitate dissolves or colourless soln (1) |
| Test 2(a) AgNO₃ | Cream / yellow / off-white precipitate (1) Do not allow white even if teacher reports white | Colourless solution / No visible change (1) | White precipitate (1) | Cream / yellow / off-white precipitate (1) Do not allow white even if teacher reports white | Cream / yellow / off-white precipitate (1) Do not allow white even if teacher reports white |
| Test 2(b) HNO₃ to 2(a) | Cream / yellow / off-white precipitate or No visible change (1) | Colourless solution / No visible change (1) | White precipitate / No visible change (1) | Effervescence (1) Precipitate dissolves or colourless soln (1) | Effervescence (1) White precipitate (1) |

Stage 2 Assessment (Written Test): Section A

- Ignore absence of units unless units are required in the Marking Guidelines.
- Incorrect units lose the mark.
- Incorrect rounding of calculations must be penalised, but only once per paper.

| Question | Marking Guidelines | Mark | Additional Guidance |
|----------|--|-------------------|---|
| 1 | Calculates the correct average titre using concordant results only (at least two results) | 1 | <p>Do not penalise precision.</p> <p>Answer must be to 2 decimal places.</p> <p>The second place can be the nearest 0 or 5 or a correct mathematical average of the concordant titres ($\pm 0.2 \text{ cm}^3$)</p> <p>Do not award to students given teacher's results.</p> <p>Allow a correct calculation of an average titre for either set of two sets of concordant results, even from incorrect arithmetic in the Task table.</p> <p>Award this mark for a correct answer on the Written Test even if it is different from the average titre on the Candidate Results Sheet.</p> <p>Lose this mark if the student has no concordant titres.</p> |
| 2 | <p>M1 $Q1 \times 0.0500 / 1000$</p> <p>M2 $M1 \times (1000 / 25.0) \times 2$</p> | <p>1</p> <p>1</p> | <p>Allow any correct method.</p> <p>Minimum of 2 sig fig.</p> <p>Correct answer scores two marks.</p> |
| 3 | $Q2 \times 50$ | 1 | Minimum of 2 sig fig. |

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| 4 | 63.75 g | 1 | If no units given, assume g. Units must be shown if not g. Do not penalise precision (allow 64 and 63.8). |
| 5 | An equilibrium would be set up owtte | 1 | Ignore any comments about (activation) energy or solubility of ammonia |
| 6(a) | A and C and E | 1 | Any order. Consequential on student's results. Eg if ppt in solution D does not dissolve, must include D |
| 6(b) | B | 1 | Consequential on student's results. Eg if ppt in solution D and / or E does not dissolve, must include D and / or E |
| 7 | E This answer only A white precipitate / precipitate remains (formed with silver nitrate solution) in Test 2b / after nitric acid has been added and effervescence / CO ₂ produced with nitric acid | 1 1 | If not E, CE = 0 Allow cream etc precipitate <u>changes to</u> white precipitate in Test 2b / after nitric acid has been added |
| 8(a) | NaBr or NaI | 1 | Ignore names |
| 8(b) | <u>Conc NH₃</u> If NaBr given in 8a the precipitate would dissolve OR If NaI given in 8a the precipitate would not dissolve | 1 1 | If both NaBr and NaI given in 8a, then either answer acceptable, but only if clear which of NaBr and NaI (or which of AgBr and AgI) is being referred to |

Stage 2 Assessment (Written Test): Section B

- Ignore absence of units unless units are required in the Marking Guidelines.
- Incorrect units lose the mark.
- Incorrect rounding of calculations must be penalised, but only once per paper.

| Question | Marking Guidelines | Mark | Additional Guidance |
|----------|---|------|---|
| 9(a) | Mass of crucible and boric acid on the y-axis | 1 | Axes must be labelled but do not penalise lack of units (unless incorrect). |
| | Suitable scale used | 1 | Plotted points must cover at least half the printed grid.(both directions). |
| | All points plotted correctly | 1 | Allow +/- one small square. |
| | Suitable line drawn | 1 | Good best-fit line based on their points (+/- one small square). Do not award if kinked, doubled or very thick line. |
| 9(b) | Constant mass had been achieved | 1 | Allow No more water to be lost. Decomposition / reaction complete |
| 9(c) | 2.35 (g) only | 1 | |
| 9 (d) | $2.35 / 18.0 = 0.131$ (mol) | 1 | Minimum of 2 sig fig (0.1305 is incorrect) |
| 9 (e) | Mass of $\text{HBO}_2 = 33.50 - 27.78 = 5.72$ (g) | 1 | |

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|-------|---|-------------|--|
| | Amount of $\text{HBO}_2 = 5.72 / 43.8$ = 0.1306 mol | 1 1 | Allow consequential marking based on answer from M1 Minimum of 2 sig fig. Answer scores 3 |
| 9 (f) | Moles of $\text{HBO}_2 = \text{moles of H}_2\text{O}$ Or 1:1 ratio | 1 | |
| 9 (g) | M1 Amount of $\text{B}_2\text{O}_3 = 0.1306 \div 2 = 0.0653$ (mol) M2 Mass of $\text{B}_2\text{O}_3 = 0.0653 \times 69.6$ M3 = 4.54 g | 1 1 1 | Allow consequential marking based on answer to 9(e) Failure to divide by 2 is CE (lose M1 and M2) AE if Mr incorrect Answer must be to 3 significant figures (18.2 or 9.09 gain one mark only) If alternative value of 0.124 used: $0.124 / 2 = 0.062$ $0.062 \times 69.6 = 4.32$ (g) |
| 9 (h) | Release of water / water vapour / steam | 1 | |
| 9 (i) | Protects the wood from <u>oxygen / air</u> or Prevents release of <u>flammable</u> vapour or (Glass) forms a seal | 1 | |

Stage 2 Assessment (Written Test): Section C

- Ignore absence of units unless units are required in the Marking Guidelines.
- Incorrect units lose the mark.
- Incorrect rounding of calculations must be penalised, but only once per paper.

| Question | Marking Guidelines | Mark | Additional Guidance |
|----------|--|--------|--|
| 10 | Increase in volume Smaller increase in T above room temperature Or increased contact between calorimeter and water Or smaller heat loss by evaporation / from the surface | 1 1 | If a volume is quoted it must be less than 300 |
| 11 (a) | H ₂ SO ₄ | 1 | Allow H ₃ PO ₄ or HCl |
| 11 (b) | Dichromate / Cr(VI) reduced or Cr(III) formed. | 1 | Allow Cr ⁶⁺ and Cr ³⁺ |
| 11 (c) | The alcohol is flammable | 1 | Allow enables temperature to be controlled |
| 11 (d) | Tollens' Silver mirror OR Fehling's Red precipitate OR Benedict's Red precipitate | 1 1 | |

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