



AQA Qualifications

A-LEVEL

Chemistry

CHM3X-Investigative and Practical Skills in AS Chemistry
Mark scheme

2420
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Version: 1.0 Final

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

Task 1

| Marking Guidelines | Mark | Additional Guidance |
|--|------|---|
| Results recorded clearly and in full in a sensible table | (R) | <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) | <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> |
| Concordant if two titres are within 0.10 cm ³ of each other | (C) | Award the mark for concordancy if the table contains at least two concordant results, even if the student has not recognised these |

| | | |
|---|--------------------------------|--|
| | | <p>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.d.p. but will lose Precision mark.</p> |
| <p>The accuracy of the student's average titre, measured against a teacher value for the titration</p> <p>This mark can be awarded independent of precision</p> <p>Average titre is within 1% of teacher value Average titre is within 1.5% of teacher value Average titre is within 2% of teacher value Average titre is within 2.5% of teacher value</p> <p>There is no penalty in the task for an incorrectly calculated average titre</p> <p>Enter your mark for burette (B), recording (R), precision (P), concordancy (C) and accuracy (A) in the table at the bottom of each Candidate Results Sheet</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> |

| | | |
|--------------|----------|---|
| | | <p>A student may have two sets of concordant titres which do not overlap. The teacher should choose 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>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> <p>If most students score low marks for accuracy, contact your Assessment Adviser.</p> |
| Total | 7 | |

Task 2 (for observation – 2012 wording)

| Marking Guidelines | Mark | Additional Guidance |
|--|--------------|--|
| Results recorded clearly and in full in a table | (R) 1 | If you can read it, it is clear. Full means completes all of the boxes. Allow a table without gridlines. |
| <p>The accuracy of the observations.</p> <p>scoring points</p> <p>18 – 20 points scores 6 marks</p> <p>15 - 17 points scores 5 marks</p> <p>12 – 14 points scores 4 marks</p> <p>9 – 11 points scores 3 marks</p> <p>5 – 8 points scores 2 marks</p> <p>1 – 4 points scores 1 mark</p> | (A) 6 | <p>Mark to the grid on page . If the teacher results differ from the published grid, consult your Assessment Adviser for guidance.</p> <p>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', 'no reaction', 'stays the same', 'nvc' as well as 'no visible change'.</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>Do not accept 'clear' instead of colourless.</p> <p>Do not accept 'cloudy', 'misty', 'milky' or 'emulsion'.</p> |
| Total | 7 | |

| TEST | W (BaCl ₂) | X (CaBr ₂) | Y (MgSO ₄) | Z (Al ₂ (SO ₄) ₃) |
|---|--|--|--|--|
| Test 1(a) Test with dilute nitric acid and silver nitrate solution | White precipitate (1) | Cream / White precipitate (1) * | NVC (1) | NVC (1) |
| Test 1(b) Test with dilute ammonia solution | Colourless solution (or precipitate dissolves) (1) | Precipitate lightens/ sparingly soluble/ NVC (1) | NVC (1) | NVC (1) |
| Test 2 Test with dilute sulfuric acid | White precipitate (1) | NVC (1) | NVC (1) | NVC (1) |
| Test 3 Test with sodium hydroxide solution | NVC (1) NVC in excess (1) | White precipitate (1) NVC in excess (1) | White precipitate (1) NVC in excess (1) | White precipitate (1) Dissolves / colourless solution in excess (1) |

Note: Two marks for each observation in Test 3

Mark independently for Test 3

Penalise contradictions every time

If mark is awarded based on (incorrect) Teacher Observation, write letter T next to tick.

Do not allow Yellow, but allow Pale Yellow

Section A Ignore absence of units unless units are required in the Marking Guidelines. Incorrect units lose the mark.

| Question | Marking Guidelines | Mark | Additional Guidance |
|----------|---|-------------|--|
| 1 | Calculates the correct average titre using concordant results only | 1 | Allow any set of concordant results for the average. Do not penalise precision but must be to a minimum of two decimal places (e.g. 25.725 could appear as 25.73) Do not award to students who have been given the teacher's value. Allow without working. Ignore no units, penalise incorrect units |
| 2 | moles = $(2.00 \times 10^{-3}) \times (Q1/1000) = z$ | 1 | Do not penalise precision but must be to a minimum of 2 significant figures. |
| 3 | Moles of $\text{Mg}(\text{OH})_2 = z / 2$ Concentration = $\text{ANS} \times 1000 / 25.0$ Answer to 3 significant figures | 1 1 1 | |
| 4 | Moles in $250\text{cm}^3 = Q3 / 4$ Number of moles in $1 \text{ dm}^3 = (Q3/4) / (60/1000)$ | 1 1 | OR $(Z/2) \times 10$ $= Q3 \times 250/60$ Answer must be to 3 significant figures |
| 5 | $(0.5 / 250) \times 100$ $= 0.2\%$ | 1 | Do not penalise precision |

| | | | | |
|--------------|---|-----------|-----------|--|
| 6 | Solution X | | 1 | If solution X is incorrect, CE = 0 |
| | 1a (acidified) silver nitrate Cream precipitate | | 1 | |
| | 1b Precipitate did not dissolve or (only) dissolved slightly when dilute ammonia solution was added | | 1 | |
| 7 | Solution Z | | 1 | If solution Z is incorrect, CE = 0 |
| | Test 3 formed a white ppt which redissolved (in excess NaOH) | | 1 | |
| | Insoluble group 2 hydroxides do not dissolve in excess NaOH | | 1 | |
| 8 | Solution W | M1 | 1 | Allow Barium chloride (no other anion) or Solution Z with Al^{3+} Can only score M2 if M1 is correct or a barium compound |
| | Ba^{2+} | M2 | 1 | |
| Total | | | 16 | |

Section B Ignore absence of units unless units are required in the Marking Guidelines. Incorrect units lose the mark.

| Question | Marking Guidelines | Mark | Additional Guidance |
|----------|--|------|--|
| 9 | Weigh the spirit burner (alcohol) before and after combustion M1 | 1 | Do not allow "a known mass of alcohol" owtte |
| | Water in a calorimeter / beaker M2 | 1 | |
| | Measure volume of water (or mass) M3 | 1 | |
| | Burn the alcohol to heat the water M4 | 1 | |
| | Measure temperature rise <u>in water</u> M5 | 1 | |
| 10 | Incomplete combustion | 1 | Any two correct |
| | Evaporation of alcohol | 1 | |
| | Heat capacity of / heat absorption by the apparatus | | |
| | Inadequate stirring | | |

| | | | |
|--------------|---|-----------|---|
| 11 | Acidified potassium dichromate / manganate(VII) (Heat) | 1 | Allow sodium in place of potassium with appropriate colour change) If reagent incomplete lose M1 but mark on. If reagent incorrect, CE = 0/3 |
| | butan-1-ol orange to green / purple to colourless | 1 | |
| | 2-methylpropan-2-ol NVC / orange / purple | 1 | |
| 12 | $C_4H_9OH + 2O_2 \rightarrow 4C + 5H_2O$ Or $C_4H_9OH + 4O_2 \rightarrow 4CO + 5H_2O$ | 1 | Allow any correct balanced equations which include combinations of C, CO and/or CO_2 in the products but must be incomplete combustion. Allow build-up of carbon in engine costly to remove Allow global dimming if carbon given as product |
| | Engine would not run as efficiently / would need to use more fuel / would release less energy | 1 | |
| | CO / Particulates of carbon toxic | 1 | |
| Total | | 13 | |

Section C Ignore absence of units unless units are required in the Marking Guidelines. Incorrect units lose the mark.

| Question | Marking Guidelines | Mark | Additional Guidance |
|--------------|---|----------|--|
| 13 | Acidified (or a suitable acid) potassium dichromate (or suitable oxidising agent) | 1 | Penalise missing 'acidified' once in paper (Q11) Ignore additional distillation condenser The top of the condenser must not be sealed or covered in any way |
| | Heat source | 1 | |
| | Flask with vertical water condenser | 1 | |
| | No gaps in the apparatus apart from at the top where it must be open | 1 | |
| 14 | Filter | 1 | Must be in this order Allow other suitable methods for drying. If heat is mentioned, method of gentle heating must be specified. Heat, alone, is not sufficient |
| | Wash (the residue) with water | 1 | |
| | Dry by pressing between filter paper or in air | 1 | |
| TOTAL | | 7 | |