

A-LEVEL CHEMISTRY

CHM6X Investigative and Practical Skills in A2 Chemistry
Mark scheme

2420
June 2014

Version: 1.1 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

Stage 1 Assessment (Task 1)

Marking Guidelines	Mark	Additional Guidance
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>

<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 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>(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-</p>

		<p>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 examiner 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>
Total	7	

Stage 1 Assessment (Task 2)

	Observations with X (ammonium iron(II) sulfate)	Observations with Y (zinc sulfate)	Observations with Z (copper(II) sulfate)
Test 1 Use a graduated plastic pipette to add about 1 cm ³ of the sample to a boiling tube. Add sodium hydroxide solution dropwise with shaking until you observe no further change. You should not fill more than half the boiling tube. Allow to stand for about 10 minutes.	<u>Green</u> precipitate (1) No visible change in excess (1) Brown precipitate (allow darkens) on standing (1) Mark independently	White precipitate (1) Dissolves in excess (1) No visible change on standing (1) Mark independently	Blue precipitate (1) No visible change in excess (1) No visible change on standing (1) Mark independently
Test 2 Use a graduated plastic pipette to add about 1 cm ³ of the sample to a test tube. Add about 10 drops of potassium iodide solution and shake the mixture. Allow to stand for 5 minutes before making your observation.	No visible change (1) (ignore any reference to the colour of solution)	No visible change (1)	Brown solution (1) White / (pale) brown precipitate (1) (Do not allow yellow)
Test 3 Use a graduated plastic pipette to add about 1 cm ³ of the sample to a test tube. Add 5 drops of potassium thiocyanate solution. Then add 5 drops of hydrogen peroxide solution.	Peach / orange solution (1) (Accept <u>pale</u> red solution)	No visible change (1)	Green solution (1) White / (pale) green precipitate (1)
Then add about 5 drops of hydrogen peroxide solution	Red solution (1) (do not allow 'darkens')	No visible change (1)	

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>19 scoring points</p> <p>17–19 points scores 6 marks</p> <p>14–16 points scores 5 marks</p> <p>11–13 points scores 4 marks</p> <p>8–10 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 6. If the teacher results differ from the published grid, consult your team leader 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 each time.</p> <p>Do not accept 'cloudy', 'misty', 'milky' or 'emulsion' for the precipitate mark.</p> <p>Penalise missing 'solution' once only.</p> <p>Penalise missing 'precipitate' each time but allow 'solid', 'residue', 'sediment' or 'suspension'.</p>
Total	7	

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	1	<p>Allow any set of concordant results for the average.</p> <p>Do not penalise precision but must be to a minimum of two decimal places (eg 25.725 could appear as 25.73).</p> <p>Allow correct rounding to the precision of the burette (eg 25.725 could appear as 25.70 or 25.75).</p> <p>Do not award to students who have been given the teacher's value.</p> <p>Allow without working so long as it is clear which results have been used – look at the Candidate Results Sheet as well.</p>
2(a)	$Q1 \times (0.02 \div 1000)$ $\times 5$	 1 1	<p>Do not penalise precision but must be to a minimum of 2 significant figures.</p> <p>Correct answer only.</p> <p>Correct answer without working scores 1 mark only.</p>
2(b)	$Q2(a) \times 10$	1	Do not penalise precision but must be to a minimum of 2 significant figures.

3(a)	<u>151.9</u>	1	Allow this answer only (ignore 'g' as unit).
3(b)	Q2(b) × Q3(a) (answer required)	1	Do not penalise precision but must be to a minimum of 2 significant figures. Allow consequential marking.
3(c)	Mass of water = 5.60 – Q3(b) Moles of water = M1 / 18 $n = M2 / Q2(b)$ rounded to nearest integer	1 1 1	Mass of water in 1 mol is M1 / Q2(b). $n = M2 / 18$ rounded to nearest integer. Lose M3 if not an integer value. Using given value of 2.60 g, $n = 10$ Allow if an empirical formula calculation is done instead. Correct answer with no working scores M3 only.
4	Sulfuric acid is in excess / sulfuric acid not used in titration calculation / solution X was made up in sulfuric acid	1	Apply list principle for any additional incorrect statements.

5	<p>Add (acidified) silver nitrate (solution)</p> <p>No visible change</p>	<p>1</p> <p>1</p>	<p>No need for acidified (student has already been told this) but if HCl given as the acid, penalise both marks.</p> <p>Ignore addition of ammonia (unless contradicts).</p> <p>Do not allow 'yellow precipitate' unless qualified as absent and correct observation also stated.</p> <p>Penalise incorrect colour for precipitate.</p> <p>M2 depends on M1</p> <p>Allow use of a named copper(II) salt solution not giving a precipitate (of CuI) and correct observation given.</p>
6(a)	<p>Precipitate is CuI</p> <p><u>Brown</u> solution is I₂ / I₃⁻</p>	<p>1</p> <p>1</p>	<p>Check student observations, must match.</p>
6(b)	<p>0.15–0.54 < 0 (or e.m.f. = –0.39)</p> <p>Need positive value for reaction to occur</p>	<p>1</p> <p>1</p>	<p>OR its less positive E° value shows that Cu²⁺ is a weaker oxidising agent than iodine (for M1 and M2).</p> <p>OR one E° value (specified) is greater than the other (for M1).</p> <p>Must link M1 to the chemical consequences for this reaction in order to access M2 (eg hence the reaction does not occur because...)</p> <p>Accept correct equation that would occur (or statement that the backwards reaction would occur) for M2</p>

7	Al^{3+} or aluminium (ions) or Al	1	Allow Zn^{2+} or Zinc (ions) or Zn Penalise incorrect charges on ions. Mark consequential to student's results (eg if white precipitate insoluble in excess, could be Mg^{2+}).
Total		17	

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
8(a)	Sensible scales Plots points correctly,	1 1	Plotted points (including 0,0) must cover more than half the graph paper. If axis wrong way round lose this mark but mark on consequentially. Do not allow broken axis.
8(b)	Ring around the origin	1	
8(c)	Line through points is smooth Line through points is best fit and ignores anomaly (allow one plot ± 2 small square)	1 1	Line must pass within ± 1 small square of each plotted point except the anomaly (allow one plot ± 2 small square – at 40 or 60s). Lose this mark if student's line is doubled. Kinked line loses this mark. Lose this mark if the line does not pass through the origin ± 1 small square. Lose this mark if the line deviates to anomaly.

8(d)	Draws suitable tangent	1	Must touch the curve at 30s and must not cross the curve. Lose this mark if the tangent is unsuitable but mark on.
	Chooses appropriate x and y values from their graph	1	Mark consequentially if axes plotted the wrong way around. Allow information clearly shown on graph.
	Correctly calculates y/x	1	Difference in x values and y values must be at least 10 small squares in either direction.
	Gives answer with correct units ($\text{mol dm}^{-3} \text{s}^{-1}$) or correct variant	1	Lose this mark if answer not to minimum of 2 significant figures and no units or incorrect units are given. If student has used axis the wrong way round, the unit mark can be awarded for either the correct unit based on their graph or for the correct unit for rate.
9(a)	Negative ions <u>repel</u> one another	1	
9(b)	Positive ions <u>attract</u> negative ions in catalysed process	1	Allow activation energy decreases. Allow alternative route with lower E_a Ignore references to heterogenous catalysis.
9(c)	$\text{S}_2\text{O}_8^{2-} + 2\text{e}^- \longrightarrow 2\text{SO}_4^{2-}$	1	Allow multiples including fractions. Ignore state symbols.

9(d)	$\text{S}_2\text{O}_8^{2-} + 2\text{I}^- \longrightarrow 2\text{SO}_4^{2-} + \text{I}_2$	1	Allow multiples including fractions. Ignore state symbols. Allow the correct equation involving I_3^- $\text{S}_2\text{O}_8^{2-} + 3\text{I}^- \longrightarrow 2\text{SO}_4^{2-} + \text{I}_3^-$
Total		13	

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	Side-arm flask / side-arm test tube	1	Do not allow sealed side-arm flask.
	Flat-bottomed filter funnel with filter paper clearly shown	1	<p>Either Buchner or Hirsch versions are suitable.</p> <p>Allow Hirsch funnel and <u>horizontal</u> filter paper.</p> <p>Allow three-dimensional filter funnels.</p> <p>Do not allow standard Y-shaped funnel.</p> <p>Do not allow sealed funnel.</p> <p>If it is not clearly air-tight between the funnel and the flask, maximum 1 mark.</p>
11	Heat melting point tube in an oil bath	1	<p>Accept 'melting point apparatus' or Thiele tube.</p> <p>Do not accept water bath.</p>
	<u>slowly near the melting point</u>	1	<p>Ignore any additional correct details.</p> <p>Apply list principle for additional incorrect details.</p>

12(a)	To make sure all the solutions (from both the burette and pipette) react with each other / are in the flask	1	Penalise 'solid' or 'residue'. Do not allow any suggestion of removal of species.
12(b)	Water does not change the number of moles <u>of either reagent / reactants</u>	1	Water is not a reagent / does not react with either reactant. Do not allow 'water is not involved in the reaction'. Apply list principle.
Total		6	