

A-LEVEL CHEMISTRY

CHM3X Investigative and Practical Skills in AS Chemistry
Mark scheme

2420
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Version: 1.2 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>
Correctly weighs out the mass of succinic acid to the precision of the balance	(W) 1	<p>Precision must be consistent across the three masses.</p> <p>Must be a correct subtraction.</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 to mass ratio, measured against a teacher value</p> <p>For both teacher value and student value: Calculate average titre without rounding Divide by mass to obtain X Round X to 2 decimal places</p> $R = [(X(\text{teacher}) - X(\text{student})) / X(\text{teacher})] \times 100\%$ <p>Where X = average titre / mass</p> <p>This mark can be awarded independent of precision</p> <p>R < 1.5% R < 2.5% R < 3.5% R < 4.5%</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</p>

		<p>mark for accuracy.</p> <p>A student may have two sets of concordant titres which do not overlap. 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>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	8	

Stage 1 Assessment (Task 2)

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>7 points scores 5 marks</p> <p>5–6 points scores 4 marks</p> <p>3–4 points scores 3 marks</p> <p>2 points scores 2 marks</p> <p>1 point scores 1 mark</p>	(A) 5	<p>Mark to the grid on page 7 or to the Teacher results. Give the student the best score from any combination of these.</p> <p>If answers contradict, eg 'No visible change with effervescence' or 'white solution with white precipitate' 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>Ignore 'cloudy', 'misty', 'milky' or 'emulsion'.</p> <p>Ignore 'clear'.</p>
Total	6	

	Observations with solution P/Q	Additional Guidance
<p>Test 1(a) Test with dilute nitric acid and silver nitrate solution Place about 10 drops of solution P in a clean test tube. Add about 10 drops of dilute nitric acid, followed by about 5 drops of silver nitrate solution. Shake the mixture. Keep this mixture for Test 1(b).</p>	White precipitate (1)	Accept suspension, sediment, solid (deposit) as well as precipitate. Ignore cloudy, misty, milky or emulsion. Penalise reference to white solution.
<p>Test 1(b) Test with ammonia solution Add ammonia solution, dropwise with gentle shaking, until in excess. The test tube should not be more than half full.</p>	(Colourless) solution (1)	Accept precipitate dissolves or disappears. If not 'solution', must refer to precipitate dissolving / disappearing.
<p>Test 2 Test with dilute sulfuric acid Place about 10 drops of solution P in a clean test tube. Add about 10 drops of dilute sulfuric acid. Shake the mixture.</p>	No visible change (1)	Accept no change, stays the same or colourless solution.
<p>Test 3 Test with sodium hydroxide Place about 10 drops of solution P in a clean test tube. Add about 10 drops of dilute sodium hydroxide. Shake the mixture.</p>	White precipitate (1)	Accept suspension, sediment, solid (deposit) as well as precipitate. Ignore cloudy, misty, milky or emulsion. Penalise reference to white solution.
<p>Continue to add sodium hydroxide, dropwise with gentle shaking, until in excess. The test tube should not be more than half full.</p>	No visible change (1)	Accept ppt stays Ignore references to dilution effects Only score this mark if previous mark was awarded.
<p>Test 4 Test with dilute hydrochloric acid and barium chloride solution Place about 10 drops of solution Q in a clean test tube. Add about 10 drops of dilute hydrochloric acid, followed by about 10 drops of barium chloride solution. Shake the mixture.</p>	No visible change (1)	Accept no change, stays the same or colourless solution.
<p>Test 5 Flame test Take one of the wooden splints labelled 'splints soaked in solution Q' from the beaker containing solution Q. Adjust a Bunsen burner until the flame is blue but not roaring. Hold the splint in a Bunsen burner flame and record the colour observed. Ignore any orange/yellow colour caused by impurities containing sodium ions.</p>	Red (1)	Accept red / red-orange / crimson. Ignore orange / yellow.

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>Answer must be to at least 2 decimal places.</p> <p>The second place can be the nearest 0 or 5 or a correct mathematical average of the concordant titres. eg 27.75 and 27.80 would average as 27.775. Also allow 27.75 27.78 or as 27.80</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	$(\text{Answer to Q1} \times 0.100) / 1000$	1	Do not penalise precision but must be to a minimum of 2 significant figures.

3(a)	(Moles of acid in 25 cm ³ =) Q2 / 2 (Moles of acid in 250 cm ³ =) M1 × 10 Answer given to 3 significant figures	1 1 1	M1 and M2 can be in either order. M3 can only be awarded if either M1 or M2 have been awarded. Correct answer given to only 2 significant figures scores 2 marks. Correct answer (3 significant figures) with no working scores 1 mark only.
3(b)	M_r = student's mass of succinic acid / answer to Q3(a) Student subtracts 90 in order to find M_r of (CH ₂) _n Student calculates value of 'n' to nearest whole number	1 1 1	Mark consequential to student's results. Allow student's mass of acid / 0.0114 (this gives answer of n = 3) Allow this mark for a correct method. Correct answer with no working scores 1 mark only. If not a whole number, lose M3
4	(0.01 × 100) / student's mass of succinic acid	1	Ignore precision.
5	Used in small amounts / mass	1	Do not accept answers linked to sweetness. Ignore reference to concentration / dilution. Ignore 'weak acid'.

6	(Fermentation reaction) produces CO ₂ CO ₂ causes global warming OR in this case, no effect / carbon neutral because CO ₂ removed by photosynthesis / plant	1	
		1	Allow CO ₂ is a greenhouse gas. Must give a reason if 'no effect'.
7(a)	White precipitate with sodium hydroxide / Test 3 / magnesium hydroxide formed	1	If no precipitate in Test 3 allow either: No precipitate in Test 2 because magnesium sulfate is soluble. Or you cannot tell.
7(b)	No visible change with sulfuric acid / Test 2 because barium sulfate is insoluble / would form a white precipitate	1	No precipitate in Test 3 because barium hydroxide is soluble.
7(c)	Chloride ions / Cl ⁻ White precipitate with AgNO ₃ / Test 1a and Dissolved (in ammonia / Test 1b)	1	Do not accept chlorine, but mark on.
		1	Both statements required for this mark.
Total		16	

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)	$(Q = mc\Delta T)$ $= 50 \times 4.18 \times 27.3$ $= \mathbf{5706 \text{ J}}$ (accept 5700 and 5710)	1 1	If incorrect (eg mass = 0.22 or 50.22 g) CE = 0/2 Accept 5.7 kJ with correct unit. Ignore sign.
8(b)	M_r of 2-methylpropan-2-ol = 74(.0) Moles = mass / M_r $= 0.22 / 74(.0)$ $= \mathbf{0.00297 \text{ moles}}$ $\Delta H = -5706 / (0.002970 \times 1000)$ $= \mathbf{-1921 \text{ (kJ mol}^{-1}\text{)}}$ (Allow -1920, -1919)	1 1 1	For incorrect M_r , lose M1 but mark on. If 0.22 is used in part 8(a), answer = $-8.45 \text{ kJ mol}^{-1}$ scores 3 If uses the value given (5580 J), answer = $-1879 \text{ kJ mol}^{-1}$ scores 3 Answer without working scores M3 only. Do not penalise precision. Lack of negative sign loses M3

8(c)	$\Delta H = \Sigma\Delta H \text{ products} - \Sigma\Delta H \text{ reactants}$ OR a correct cycle	1	Correct answer with no working scores 1 mark only.
	$\Delta H = -(-360) + (4 \times -393) + (5 \times -286)$	1	M2 also implies M1 scored.
	$\Delta H = \mathbf{-2642}$ (kJ mol ⁻¹) This answer only.	1	Allow 1 mark out of 3 for correct value with incorrect sign.
8(d)	$(-2422 - Q8(b)) \times 100 / -2422$ Expect answers in region of 20.7	1	Ignore negative sign. If error carried forward, 0.22 allow 99.7 If 5580 J used earlier, then allow 22.4
8(e)	Reduce the distance between the flame and the beaker / put a sleeve around the flame to protect from drafts / add a lid / use a copper calorimeter rather than a pyrex beaker / use a food calorimeter	1	Any reference to insulating material around the beaker must be on top. Accept calibrate the equipment using an alcohol of known enthalpy of combustion.
8(f)	Incomplete combustion	1	

9	<p><u>Acidified</u> potassium dichromate</p> <p>Either</p> <p>Obs with 2-methylpropan-2-ol No visible change</p> <p>Obs with butan-2-ol <u>Orange to green</u> (both colours needed)</p> <p>or</p> <p>Obs with 2-methylpropan-2-ol orange</p> <p>Obs with butan-2-ol green</p>	<p>1</p> <p>1</p> <p>1</p>	<p>Accept words or formulae.</p> <p>Accept acidified potassium permanganate.</p> <p>Accept Lucas reagent (conc HCl, ZnCl₂) (cloudy in 5 mins for 2°, instantly for 3°).</p> <p>Mark on for incomplete reagent.</p> <p>Incorrect reagent CE = 0/3</p> <p>Inclusion of Tollen's etc with acidified potassium dichromate is incorrect reagent.</p> <p>Not no reaction.</p>
Total		14	

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(a)	(Measure the) <u>volume of gas</u> / <u>mass of the container + contents</u> Suitable named piece of equipment	1 1	Gas syringe (or inverted burette or measuring cylinder, as long as student has referred to the cylinder being filled with water) / balance. Equipment must be correct for the measurement stated.
10(b)	Any one of: <ul style="list-style-type: none"> • Mass of magnesium • Surface area of magnesium 	1	Allow amount of magnesium.
10(c)(i)	Gravity: Conical flask or beaker and funnel / Vacuum: Sealed container with a side arm and Buchner or Hirsch funnel Filter paper	1 1	Must be either gravity filtration (with a V-shaped funnel) or vacuum filtration (with a side-arm conical flask) appropriately drawn. Must show filter paper as at least two sides of a triangle (V-shaped) for gravity filtration or horizontal filter paper for vacuum filtration.
10(c)(ii)	Wash with / add (a small amount of cold) water	1	Ignore filtering.
Total		6	