Version 1.0 – Final Mark Scheme

**General Certificate of Education (A-level)
June 2016**

Chemistry   **CHM6X**

(Specification 2420)

Unit 6X: Practical and Investigative Skills

Externally-Assessed Practical Assignment

Marking Guidelines

General Certificate of Education (A-level) Chemistry – Unit ?X: Practical and Investigative Skills – CHM?X – June 2014

Marking Guidelines are prepared by the Principal Moderator and considered, together with the relevant questions, by a panel of subject teachers.

Task Assessment

Marking Guidelines	Mark	Additional Guidance
Results recorded clearly and in full in a sensible table 2nd titre value must be the total volume added and not just the additional volume of solution after end point 1.	(R)	If you can read it, it is clear.
		'Full' means the table must have 'initial reading', 'final reading' and titre values' for at least two sets of results.
		Labels such as 'initial reading', 'final reading' etc are not essential.
		The table does not have to have gridlines.
		Allow a clear answer outside a table box.
		Lose this mark if initial reading is recorded as 50 cm^3
		Lose this mark if there is an arithmetic error in calculating a titre.
		Do not penalise missing units but lose this mark if units are incorrect.
		Do not penalise a student who does more than 5 titrations.
		If the initial burette reading is given as 50.0 then R = 0

Marking Guidelines	Mark	Additional Guidance
All titre volumes to 0.05 cm^3	(P)	For example, accept 20.35, 20.30 but do not accept 20.3
		Allow zero entries as 0 or 0.0
		If a set of readings are labelled 'rough' ignore their precision, unless used to calculate the average.

Marking Guidelines	Mark	Additional Guidance
Concordant if two titres are within 0.10 cm^3 of each other for each of the endpoints	(C)	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. Do not award this mark if two concordant results are only achieved by incorrect arithmetic. Can score concordancy mark if titre volumes are only recorded to 1.d.p. but will lose Precision mark.

The **accuracy** of the student's average titres, measured against a teacher values for the titration for end point 2 only. This mark can be awarded independent of precision Do we need to change these values? Both average titres are within 1.5% of teacher values Both average titres are within 2% of teacher values Both average titres are within 2.5% of teacher values Both average titres are within 3% of teacher values There is no penalty in the task for an incorrectly calculated average titre Enter your mark for, recording (R), precision (P), concordancy (C) and accuracy (A) in the table at the bottom of each Candidate Results Sheet	(A) 4 3 2 1	If a student has two concordant titres then both concordancy and accuracy marks can be awarded. If a student does not have two concordant titres but does have two titres within 0.20 cm^3 of each other, then the concordancy mark cannot be awarded but the accuracy marks can. Titres which differ from each other by more than 0.20 cm^3 cannot receive concordancy or accuracy marks. 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). 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 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. 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.

Do not penalise a student who has done more than five titrations.

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. |

Total	7

Task Assessment

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.

Marking Guidelines	Mark	Additional Guidance
The accuracy of the observations. 27 scoring points **22 – 27 points scores 6 marks** **18 – 21 points scores 5 marks** **14 – 17 points scores 4 marks** **10 – 13 points scores 3 marks** **6 – 9 points scores 2 marks** **3 – 5 points scores 1 mark**	**(O) 6**	Mark to the grid on page . If the teacher results differ from the published grid, consult your Assessment Adviser for guidance.
		If answers contradict, eg 'No visible change with effervescence' then scoring point is **not** awarded.
		Look for the basic colour; ignore additional shades if the answer is unambiguous.
		Penalise missing 'solution' once only.
		Penalise missing 'precipitate' every time.
		Accept 'no change', 'no reaction', 'stays the same', 'nvc' as well as 'no visible change'.
		Accept 'bubbles of gas', 'fizzes', 'colourless gas formed' or 'gas evolved' as well as 'effervescence'.
		Ignore CO_2
		Do not accept 'clear' instead of colourless.
		Do not accept 'cloudy', 'misty', 'milky' or 'emulsion'.

Total	7	

Observations for tests on Solution A

Test	Observations
Part 1 – the addition of zinc	P1 Yellow solution (1) P2 Green solution (1) (allow shades of green) P3 (Pale) blue solution (1) P4 Green solution (1) (allow shades of green) P5 Mauve / purple / violet solution (1) P6 Effervescence (1) – at any point in the observations Observations must be in the correct order.
Part 2 – the addition of potassium manganate(VII)	P7 Green solution (1) P8 Pale blue solution (1) P9 Green solution (1) P10 Yellow solution (1) P11 Pink / purple / red solution (1) Ignore any colours after the pink/purple solution Observations must be in the correct order.

Observations for tests on Solutions B, C and D

	Solution B Cu(II)	**Solution C** Fe(II)	**Solution D** Fe(III)
Test 1 Test with dilute sodium carbonate	Blue or green precipitate (1)	Green precipitate (1) (No shades of blue)	Brown precipitate (1) Effervescence (1) Ignore any redissolving of ppt. Allow any shades of brown or orange
Test 2 Test with sodium hydroxide solution	Pale blue precipitate (1) Allow any shade of blue but NOT green or shades of (e.g. blue-green) NVC (in excess / on standing) (1)	Green precipitate (1) (Not shades of blue) Darkens / turns brown on standing (1) Allow any shades of brown or orange	Brown precipitate (1) Ignore any initial redissolving NVC (in excess / on standing) (1) Allow any shades of brown or orange
Test 3 Test with ammonia solution	Blue precipitate (1) Allow any shade of blue but NOT green or shades of green (e.g. blue-green). (precipitate re-dissolves in excess) <u>Dark/deep</u> blue solution (1)	Green precipitate (1) (Not shades of blue) Darkens / turns brown on standing (1) Allow any shades of brown or orange	Brown precipitate (1) NVC in excess (1) Allow any shades of brown or orange

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 titres using concordant results **only**	1	Both averages must be correct for this mark Do not insist on units but if present must be correct. Precision must be to at least 2 d.p.
2(a)	Volume = End point 2 – End point 1 (=ANS) Moles of HCl = 0.100 x (ANS/1000) = z Moles of hydrogencarbonate = z	1 1 1	Allow methods which calculate moles at end point 1 and end point 2 and then subtract. Ans to minimum 2 sig. fig. Must be clearly implied if not explicitly stated.
2(b)	Moles of hydrogencarbonate = moles of CO_2 = z Mass of CO_2 = 44.0 x z Correct answer in grams Answer to 3 sig. fig.	 1 1 1	If wrong mole ratio (or number of mols) used, CE cannot score M1 or M2.
3	% error = (0.15 / their value for End Point 1) x 100 Or allow difference between titres if this is a smaller value than end point 1	1	Do not allow use of titre for End Point 2

4	Cu^{2+} AND Green / blue precipitate (is Cu)	1	M1 is consequential to student's observations
			Metal ion can be identified from the equation
	$Cu(H_2O)_6^{2+} + CO_3^{2-} \rightarrow CuCO_3 + 6H_2O$	1	Allow alternative equations:
			$Cu^{2+} + CO_3^{2-} \rightarrow CuCO_3$
			Ignore state symbols unless wrong

5	Fe^{2+} AND Green precipitate (is Fe $(H_2O)_4(OH)_2$)	1	Consequential to student's observations
			Metal ion can be identified from the equation
	$Fe(H_2O)_6^{2+} + 2OH^- \rightarrow Fe (H_2O)_4(OH)_2 + 2H_2O$	1	Allow alternative equations:
			$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$
			Ignore state symbols unless wrong
			If the candidate does not get the ppt darkening on standing they can have Cr^{3+} as the metal ion, plus the suitable equation

6a	V^{2+}	1	This mark can be gained in the equation
			Wrong species, CE lose M1 and M2 but could score M3 for a correctly balanced equation forming their species
	$E^{\ominus}$ for $(Zn^{2+}/)Zn$ is more negative than all vanadium $E^{\ominus}$s except $V^{2+}(/V)$	1	Allow calculation of three successive cell e.m.f.s for M2.
	$2VO_2^+ + 8H^+ + 3Zn \rightarrow 2V^{2+} + 4H_2O + 3Zn^{2+}$	1	Allow correct equation consequential to M1 as long as it starts from the correct reactants and is balanced.

6b	Zinc would react with the manganate(VII)	1	Do not penalise missing oxidation state, but do not allow wrong oxidation state.
	Because the $(Zn^{2+}/)\underline{Zn}$ potential is more negative than for $\underline{MnO_4^-}(/ Mn^{2+})$	1	Has to show use of the data in Table 1
			Allow calculation of cell e.m.f. (+2.28) with justifying statement (positive / feasible) for M1 and M2.

		Calculation of cell e.m.f alone, or comparison of the two values alone, scores M2 only.

| **Total** | **17** | |

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
7 (a)	Sensible scales All points plotted accurately	1 1	If pH not on y-axis lose M1 Both axes must have labels (does not have to have units) Plotted points must cover at least half of the grid Allow ±1 small square
7 (b)	Line is smooth Avoids the anomalous point	1 1	Penalise very thick or doubled lines but make some allowance for drawing a complex curve for M1 Line must pass within ±1 small square of all points (except the anomalous)
7 (c)	Reads the volume off at the equivalence point and divides by 2 to find volume at half-equivalence Reads off pH at half-equivalence (pH = pK$_a$) K$_a$ = 10^{-pKa}	1 1 1	Volume at equivalence should be between 19 – 20cm^3 Consequential to their plotted points. Half-equivalence = 9.5 – 10cm^3 If candidate has used incorrect volume, CE loses M1 and M2 but can score M3 as a process mark. If candidate has misread volume from their graph, lose M1 4.40 - 4.50 Range of values for K$_a$ = 3.16 x 10^{-5} – 3.98 x 10^{-5} Mark M3 independently

7 (d)	Use of a buffer solution Rinses probe (with distilled/deionised water) between measurements Measures pH of more than one buffer solutions Plots a graph of pH of buffer against pH on probe **or** adjusts meter / probe **or** draws a calibration curve	3	Max 3 of 4 points Allow "solution of known pH" for "buffer"

7 (e)	pH range of steep section of curve **or** between 5 – 12 (or any values both within this range) Indicator's colour change must fall within this range	1 1	Allow pK indicator approx. equal to pH of centre of range

7 (f)	Adding the solution dropwise (near the end point)	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
8 (a)	Filter the solution (under vacuum)	1	If filtration is not the first step max. 2/4
	Wash with a (cold) solvent / water / ethanol	1	Steps must be in a logical sequence
	Dry the solid by a suitable method	1	
			Dessicator / oven / leaving out on the side overnight / washing with propanone
	Heat the dry product to constant mass to make sure it is dry	1	Suitable method for making sure it is dry
8 (b)	To form a saturated / highly-concentrated solution	1	So a saturated solution forms on cooling
	To prevent crystals forming during filtration process	1	To maximise the yield (allow for M1 or M2)
			To remove any insoluble impurites