Version 1.2

General Certificate of Education (A-level)
June 2012

Chemistry CHM3X

(Specification 2420)

Unit 3X: Investigative and practical skills in AS Chemistry

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner 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 examiners 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 examiner understands and applies it in the same correct way. As preparation for standardisation each examiner 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, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

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.

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CHM3X Task 1 Assessment

Marking Guidelines	Mark	Additional Guidance
Student reads the burette correctly (not marked)		If the student does not read the burette correctly tell the student the correct reading.
Results recorded clearly and in full in a sensible table	**(R) 1**	If you can read it, it is clear. 'Full' means the table must have values for 'initial reading', 'final reading' and 'titre value' for at least two sets of results – these labels are not essential. The table does not have to have gridlines. Allow a clear answer outside the box. Lose this mark if the initial reading is recorded as 50. Lose this mark if there is any arithmetic error in calculating a titre. Do not penalise missing units but lose this mark if units are incorrect.
All titre volumes to 0.05 cm^3	**(P) 1**	For example, accept 20.30 and 20.35 but do not accept 20.3, 20.31, 20.32 etc. Allow zero entries as 0 or 0.0 If a set of readings are clearly labelled 'rough' or trial ignore their precision unless the titre is used in calculating the average.
Concordant if there are two titres are within 0.10 cm^3 of each other	**(C) 1**	Award this mark if the table contains two concordant titres, even if the student has not recognized these. Award this mark if titres are only to 1 decimal place but lose the precision mark. Lose this mark if concordant titres are only achieved by incorrect arithmetic.

The accuracy of the student's average titre, measured against a teacher value for the titration • average titre is within 1% of teacher value - 4 marks • average titre is within 1.5% of teacher value - 3 marks • average titre is within 2% of teacher value - 2 marks • average titre is within 2.5% of teacher value - 1 mark This mark is awarded independently of precision	**(A)** 4	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 has two titres within 0.20 cm^3 of each other, the concordancy mark cannot be awarded but the accuracy mark can. Titres which differ from each other by more than 0.20 cm^3 cannot receive concordancy nor accuracy marks. Check that the student has calculated the average titre correctly – if not, calculate the correct average and base the accuracy mark on this correct average. A student does not have to use all concordant titres, where there are more than two, to produce an average. If a student has only one set of concordant titres, and has correctly calculated the average, then base the accuracy mark on this average. If a student has only one set of concordant titres but includes a non-concordant titre in calculating the average then determine the correct average of the concordant titres and use this to award the accuracy mark. If a student has more than one set of concordant titres that do not overlap, choose that set that gives the highest accuracy mark even if the student chooses the other set. Allow a correct calculation of the average titre for either set in the later Written Test. 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 candidate the higher accuracy mark. Do not penalise students who do more than 5 titrations.

Total	**7**

CHM3X Task 2 Assessment

Marking Guidelines	Mark	Additional Guidance
Student reads the thermometer correctly to 1 decimal place (not marked)		If the student does not read the thermometer correctly tell the student the correct reading.
Results recorded clearly and in full in a sensible <u>table</u>	**(R) 1**	If you can read it, it is clear. 'Full' means completes the temperature row/column correctly, with no entry for the 4th minute if a space for this time has been left in the table. The table does not have to have gridlines. Allow a clear answer outside the box. Do not penalise missing units but lose this mark if units are incorrect. Lose this mark if no reading at time = 0.
All temperatures to 1 decimal place	**(P) 1**	
The accuracy of the student's temperature rise as calculated in the Written Test, measured against a teacher value • rise is within 3% of teacher value - 5 marks • rise is within 5% of teacher value - 4 marks • rise is within 8% of teacher value - 3 marks • rise is within 10% of teacher value - 2 marks • rise is within 12% of teacher value - 1 mark	**(A) 5**	It is essential that the student graph is checked carefully for plotting and extrapolation. Check that the answers to Section A questions 4(a), (b) and (c) are correct **before** allocating marks for accuracy – if an answer is incorrect underline this and write the correct value beside it. If the student's answer to Section A question 4(c) is wrong, underline the wrong value and write the correct value for the temperature rise alongside – use this corrected answer to question 4(c) to assess accuracy.
Total	**7**	

CHM3X 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	Correct value of average titre to two decimal places	1	Allow correct approximations eg from 23.55 and 23.60 allow 23.58, 23.57, 23.55 and 23.60
2	mol of NaOH = (25/1000) x 0.100 = 2.5×10^{-3}	1	Penalise precision only if answer given to one significant figure.
	molarity of HCl = 2.5/Q1	1	Correct answer with no working scores 2 marks.
3	Correct scale for graph	1	Lose this mark if graph does not occupy at least half the available grid. Lose this mark if the graph's y-axis starts at zero.
	Correct plotting of points to ± one small square	1	Lose this mark if the graph plot including the extrapolations goes off the printed grid.
	Correct lines of best fit before/after four minutes	1	Penalise doubled or kinked lines once. Allow a curve if appropriate.
	Correct extrapolations to the fourth minute	1	Allow this mark if the student's extrapolations to the 4th minute are natural extensions of the best fit lines as drawn. Students must extrapolate <u>both</u> lines correctly to the 4th minute.
4(a)	Average of the initial temperature of the HCl and the correct value for temperature of NaOH from graph at 4 mins	1	Do not penalise precision.
4(b)	Correct value for temperature of mixture **from graph as drawn** at 4 mins	1	Do not penalise precision.

4(c)	Q4(b) – Q4(a)	1	Answer must be given to one decimal place.

5	q = mcΔT	1	Allow this mark if correct figures are shown multiplied.
	= 50 x 4.18 x Q4(c)	1	Ignore any inclusion of water formed in the neutralization in the mass value.
	= Answer	1	Allow consequential answer on M2. Do not penalise precision. Unit not required but lose mark if incorrect unit shown. Ignore the sign of the heat change.

6	0.025 mol of NaOH were used (or HCl)	1	Allow this mark if correct figures are shown multiplied.
	ΔH = (–)Q5/25	1	Allow –62.4 based on 1560 J alternative in question.
	Answer has a negative sign	1	

Total	**16**

CHM3X 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
7	q = 500 x 4.18 x 40 = 83600 J	1 1	Do not penalise precision. Accept this answer only. Ignore conversion to 83.6 kJ if 83600 J shown. Unit not required but penalise if wrong unit given. Ignore the sign of the heat change. An answer of 83.6 with no working scores one mark only. An answer of 83600 with no working scores both marks.
8	Moles (= 83.6/51.2) = 1.63 Mass = 1.63 x 40(.0) = 65.2 (g)	1 2	Using 77400 alternative gives 1.51 mol Allow Q7 in kJ/51.2 Do not penalise precision. Allow 65.3 (g) Using 77400 alternative gives 60.4 to 60.5 Allow consequential answer on M1. 1 mark for M_r (shown, not implied) and 1 for calculation. Do not penalise precision.
9	Molarity = 1.63/0.500 = 3.26 mol dm^{-3}	1	Allow Q8 M1 x 2 Using 1.51 gives 3.02

10	Container splitting and releasing irritant/corrosive chemicals	1	Must have reference to both aspects; splitting or leaking (can be implied such as contact with body/hands) **and** hazardous chemicals. Allow 'burns skin/hands' as covering both points Ignore any reference to 'harmful'. Do not allow 'toxic'.
11(a)	$4Fe + 3O_2 \rightarrow 2Fe_2O_3$	1	Allow fractions/multiples in equation. Ignore state symbols.
11(b)	Iron powder particle size could be increased/surface area lessened Not all the iron reacts / less reaction / not all energy released / slower release of energy / lower rate of reaction Correct consequence of M2	1 1 1	Decrease in particle size, chemical error = 0/3 Change in oxygen, chemical error = 0/3 Mark points M2 and M3 independently. An appropriate consequence, for example • too slow to warm the pouch effectively • lower temperature reached • waste of materials
12(a)	Conserves resources / fewer disposal problems / less use of landfill / fewer waste products	1	Must give a specific point. Do not allow 'does not need to be thrown away' without qualification. Do not accept 'no waste'.
12(b)	Heat to/or above 80 ^{o}C (to allow thiosulfate to redissolve) Allow to cool before using again	1 1	Accept 'heat in boiling water'. If steps are transposed, max 1 mark. Reference to crystallisation here loses this mark.
Total		**14**	

CHM3X Written Test - Section C

Question	Marking Guidelines	Mark	Additional Guidance
13(a)	To prevent vigorous boiling/uneven boiling/bubbling vigorously	1	Reference to an effect on 'reaction' here loses this mark.
13(b)	Condenser	1	Accept 'condensation chamber' or 'condensation tube'.
	Should show effective water jacket and central tube	1	If a flask is also drawn then the condenser must be at an appropriate angle. Apparatus must clearly work. Ignore direction of water flow. Diagram must have a clear flow of vapour and water eg unblocked central tube or flow indicated by arrows.
14	(Mix the alcohol with warm) $K_2Cr_2O_7/H^+$ allows 3^o identification by lack of reaction	1	Scheme must allow the alcohol to be distinguished to get all marks.
	Distillation of initial product needed for $1^o/2^o$	1	If distillation stage not clear then max. 2 (M1 and M3). Awareness of correct reactions/lack of reaction relating to each class of alcohol is worth 1 mark.
	Effect of Tollens'/Fehling's on oxidation product to identify 1^o or 2^o (by default)	1	Reacting Tollens'/Fehling's with alcohols directly is incorrect and gains no M2 or M3. Detailed observations relating to the reactions are not needed but should be penalised where incorrect.
Total		**6**	