Mark Scheme (Results)

Summer 2016

Pearson Edexcel
International Advanced Level
in Chemistry (WCH06) Paper 01
Chemistry Laboratory Skills

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Correct Answer	Reject	Mark
1(a)(i)	$[Zn(OH)_4]^{2-}$ OR $[Zn(H_2O)_2(OH)_4]^{2-}$ OR $[Zn(OH)_4(H_2O)_2]^{2-}$ **ALLOW** -2 for 2- as charge $[ZnO_2]^{2-}$ **IGNORE** State symbols, even if incorrect Omission of square brackets	$Zn(OH)_6^{4-}$ $[Zn(H_2O)_4(OH)_2]^{2-}$ $Zn(OH)_2$ $[Zn(H_2O)_2(OH^-)_4]^{2-}$/ any charges on **ligands**	**(1)**

Question Number	Correct Answer	Reject	Mark
1(a)(ii)	$[Zn(NH_3)_4]^{2+}$ OR $[Zn(H_2O)_2(NH_3)_4]^{2+}$ OR $[Zn(NH_3)_4(H_2O)_2]^{2+}$ **IGNORE** State symbols, even if incorrect Omission of square brackets	$[Zn(NH_3)_6]^{2+}$	**(1)**

Question Number	Correct Answer	Reject	Mark
1(b)(i)	$Cr^{3+}(aq) + 3OH^-(aq) \rightarrow Cr(OH)_3(s)$ **OR** $[Cr(H_2O)_6]^{3+}(aq) + 3OH^-(aq) \rightarrow$ $[Cr(OH)_3(H_2O)_3](s) + 3H_2O(l)$ **IGNORE** Omission of square brackets **IGNORE** $Cr^{3+}(aq) + 3NaOH(aq) \rightarrow$ $Cr(OH)_3(s) + 3Na^+(aq)$	One or more incorrect state symbols, e.g. H_2O(**aq**)	**(1)**

Question Number	Correct Answer	Reject	Mark
1(b)(ii)	(Before addition of H_2O_2) +3 ALLOW "3+" / "Cr^{3+}" **(1)** (After addition of H_2O_2) +6 ALLOW "6+" / "Cr^{6+}" **(1)** Penalise omission of the '+' sign once only NOTE: If Cr(III) and Cr(VI) given, award **(1)**		**(2)**

Question Number	Correct Answer	Reject	Mark
1(c)	Mn^{2+} / $[Mn(H_2O)_6]^{2+}$ **IGNORE** Names State symbols, even if incorrect	$Mn(OH)_2$	**(1)**

(Total for Question 1 = 6 marks)

Question Number	Correct Answer	Reject	Mark
2(a)(i)	**EXPECTED ANSWER** **1st mark:** Calculates moles of NaOH to neutralise 5 cm^3 of equilibrium mixture $= \frac{0.500 \times 42.4}{1000} = 0.0212$ (mol) **(1)** **2nd mark:** Calculates moles of NaOH to neutralize 25 cm^3 of equilibrium mixture = 5 x 0.0212 = 0.106 (mol) **(1)** **3rd mark:** Calculates moles of CH_3COOH in 25 cm^3 of equilibrium mixture = 0.106 – 0.0100 (= 0.0960) **(1)** Mark TE for 2nd and 3rd mark on moles of NaOH calculated **ESSENTIALLY** First mark: Calculates moles of NaOH Second mark: Scaling x 5 Third mark: Subtraction of moles of HCl		**(3)**

	ALTERNATIVE ROUTE ALSO SEEN: **1st mark:** Calculates moles of NaOH to neutralise all the acid in 5.00 cm^3 of the equilibrium mixture $= \frac{0.500 \times 42.4}{1000} = 0.0212$ (mol) **(1)** **2nd mark:** Calculates moles of HCl in 5.00 cm^3 (= 0.01÷5) = 0.002(00) and finds moles CH_3COOH in 5.00 cm^3 = (0.0212 – 0.002(00) =) = 0.0192 (mol) CH_3COOH in 5.00 cm^3 **(1)** **3rd mark:** Calculates moles of CH_3COOH in 25.0 cm^3 of equilibrium mixture by 5 x 0.0192 (= 0.0960) **(1)** Mark TE for 2nd and 3rd mark on moles of NaOH calculated **NOTE** Alternative approaches are possible **ESSENTIALLY THIS ROUTE:** First mark: Calculates moles of NaOH Second mark: Scaling and subtraction of moles of HCl to find moles CH_3COOH Third mark: Scaling x 5		

Question Number	Correct Answer	Reject	Mark
2(a)(ii)	(Amount of C_2H_5OH) = 0.096(0) **(1)** (amount of $CH_3COOC_2H_5$ = 0.153 − 0.096(0)) = 0.057(0) TE on moles of C_2H_5OH calculated **(1)** (amount of H_2O = 0.556 − 0.096(0)) = 0.46(0) TE on moles of C_2H_5OH calculated **(1)** **Max (2) if answers rounded to 1 S.F.**		**(3)**

Question Number	Correct Answer	Reject	Mark
2(a)(iii)	(K_c =) $\dfrac{[C_2H_5OH(l)][CH_3COOH(l)]}{[CH_3COOC_2H_5(l)][H_2O(l)]}$ **IGNORE** Missing or incorrect state symbols	Round brackets / missing square brackets	**(1)**

Question Number	Correct Answer	Reject	Mark
2(a)(iv)	Kc = 0.35149 **(1)** = 0.351 **(1)** Answer MUST be given to 3 sf to score M2 Max 1 if ANY units are given TE on moles calculated in (a)(ii) Only TE on an incorrect K_c expression is for omission of $H_2O(l)$ – scores max (1)	0.35**2** for 2nd mark	**(2)**

Question Number	Correct Answer	Reject	Mark
2(a)(v)	The volumes (all) cancel OR The number of moles is the same on both sides of the equation OR Same mole ratio OR 1:1 (mole) ratio of components/compounds **ALLOW** Just 'Same number of moles' **IGNORE** 'V is constant' or 'Volumes are all the same' or Just 'units cancel' or 'Kc has no units' or "The volume is the same so they cancel out" or "Moles are (directly) proportional to the concentration"	'Concentrations cancel' scores **(0)**	**(1)**

Question Number	Correct Answer	Reject	Mark
2(b)(i)	(Effect on K_c) – M1 Greater / larger / more / increases / bigger ALLOW Teacher's (Kc) value is smaller / less **(1)** (Explanation) – M2 (Calculated) moles of (ethanoic) **acid** would appear to be greater / more (ethanoic) **acid** For M2 to be awarded, there MUST be mention of more **acid**/ more $\mathbf{CH_3COOH}$ **(1)** **NOTE** Mark scoring points M1 and M2 independently		**(2)**

Question Number	Correct Answer	Reject	Mark
2(b)(ii)	(Effect on K_c) – M1 Greater / larger / more / increases / bigger ALLOW Teacher's (K_c) value is smaller / less **(1)** (Explanation) – M2 (Forward) reaction is endothermic **OR** Backward / reverse reaction is exothermic **(1)** **NOTE** Mark M1 and M2 independently **IGNORE** Just "ΔH is positive" OR "K_c (only) dependent on temperature" **IGNORE** References to equilibrium position shifting to the right (with increasing temperature)		**(2)**

Question Number	Correct Answer	Reject	Mark
2(c)(i)	(Volume is) less / lower **AND** pipette is calibrated to be measured from the bottom of the meniscus **ALLOW for 2nd part of answer** (volume) should be read from bottom / base of the meniscus OR A diagram showing the bottom of meniscus on the mark		**(1)**

Question Number	Correct Answer	Reject	Mark
2(c)(ii)	(Volume is) same / not changed **AND** (volume from burette) is (difference between) two readings / is measured by difference **ALLOW** Any idea that the error cancels out		**(1)**

Question Number	Correct Answer	Reject	Mark
2(c)(iii)	$\frac{2 \times 0.05}{42.60} \times 100\% = (\pm)\ 0.23474\ (\%)$ **IGNORE** S.F. but answer must be rounded correctly **NOTE** 0.2/ 0.23 / 0.235 / 0.2347 / 0.23474 all score the available mark **IGNORE** Any signs or the omission of ± in front of the final answer	(±)0.2**4** /(±)0.23**4** scores **(0)**	**1**

(Total for Question 2 = 17 marks)

Question Number	Correct Answer	Reject	Mark
3(a)	**First, look at answer line. If answer = 50%, award (2) marks.** **1st mark:** Moles of ester $\left(= \frac{6.0 \times 1.05}{150} = \frac{6.3}{150}\right)$ = 0.042 (mol) **(1)** **2nd mark:** % yield $= \frac{0.021}{0.042} \times 100\%$ = 50 (%) **ALLOW** TE on moles of ester calculated **(1)** ALTERNATIVE ROUTES: **1st mark:** Mass of ester (= 0.021 x 150) = 3.15 (g) **and** Theoretical mass of ester (= 6.0 x 1.05) = 6.30 (g) **2nd mark:** % yield $= \frac{3.15}{6.30} \times 100\%$ = 50 (%) **(1)**	Yield > 100%	**(2)**

	1st mark: Mass of benzoic acid (= 0.021 x 122) = 2.56 (g) **and** Theoretical mass of benzoic acid (= 0.042 x 122) = 5.12 (g) **2nd mark:** % yield $= \frac{2.56}{5.12} \times 100\%$ = 50 (%) Check all working if answer given differs from 50%		

Question Number	Correct Answer	Reject	Mark
3(b)	**EITHER – via 'moles' NaOH** Moles NaOH = $\frac{1}{40}$ = **0.025** (mol) **(1)** which is less than the moles of ester / which is less than 0.042 (mol) / 0.025 < 0.042 **(1)** For M2, allow TE on moles of ester from 3(a), provided moles of ester is >0.025 **OR – via 'mass' NaOH** (Minimum) mass of NaOH required (= 0.042 x 40) = **1.68** (g) **(1)** which is more than the 1 g of NaOH used **(1)** For M2, allow TE on moles of ester from 3(a), provided moles of ester is >0.025 **NOTE** M2 can only be awarded for linking their answer to the mass / moles required		**(2)**

Question Number	Correct Answer	Reject	Mark
3(c)	(Not necessary as) NaOH in excess OR A bigger excess of NaOH will have no effect **NOTE:** Answer needs to make reference/explain that the NaOH will (still) be in excess		**(1)**

Question Number	Correct Answer	Reject	Mark
3(d)	Recrystallisation **ALLOW** Mis-spellings, as long as meaning remains clear **NOTE** The mark available is for the identification of the technique described	Crystallisation	**(1)**

Question Number	Correct Answer	Reject	Mark
3(e)	C_6H_5COONa **OR** $C_6H_5COO{-}Na+$ **OR** $C_6H_5CO2{-}Na+$ **OR** C_6H_5CO2Na **ALLOW** Displayed formula / skeletal formula **IGNORE** Any names	$C_7H_5O_2Na$ $C_6H_5COO{-}Na$	**(1)**

Question Number	Correct Answer	Reject	Mark
3(f)	Product was still dissolved **OR** Product had not all crystallised / "product had not all precipitated" **ALLOW** Any idea of insufficient time for the crystals to form / product remaining in solution / product left in filtrate / 'crystals' remain in solution		**(1)**

Question Number	Correct Answer	Reject	Mark
3(g)(i)	Sample 2 is purer / pure **OR** Sample 1 is less pure / impure **OR** Samples differ in purity **ALLOW** Recrystallisation has removed (some of the) impurities		**(1)**

Question Number	Correct Answer	Reject	Mark
3(g)(ii)	**1st Mark:** The 2-nitro isomer / (compound) **P** **(1)** M1 is a stand-alone mark, subject to only one isomer being suggested **2nd Mark:** Impurities **lower** the melting temperature **OR** Cannot be Q as melting temperature range (of Sample 2) is greater than melting temperature of Q **OR** Cannot be R as melting temperature (range) of R is too high / too far away (from 144^{o}C to 146^{o}C) **(1)** **IGNORE** References to Sample 1's melting range being closest to that of Q	(0) overall **if more than one isomer** suggested References to **boiling** temperatures – no M2	**(2)**

Question Number	Correct Answer	Reject	Mark
3(h)(i)	In P **and** Q there are 5 proton environments / 5 peaks **(1)** In R there are only 3 proton environments / 3 peaks **(1)** (therefore you can only identify R / can't distinguish) **ALLOW** Hydrogen in lieu of proton **IGNORE** Any chemical shift values quoted	If states that all three isomers have 5 peaks, **(0)** overall	**(2)**

Question Number	Correct Answer	Reject	Mark
3(h)(ii)	(m/e value =) 167 **IGNORE** Any other fragments		**(1)**

(Total for Question 3 = 14 marks)

Question Number	Correct Answer	Reject	Mark
4(a)(i)	$2NH_4VO_3 \rightarrow V_2O_5 + 2NH_3 + H_2O$ **ALLOW** Multiples $\rightleftharpoons$ sign instead of $\rightarrow$ **IGNORE** State symbols, even if incorrect		**(1)**

Question Number	Correct Answer	Reject	Mark
4(a)(ii)	Heat to constant mass **OR** Test with indicator paper to show that an alkaline gas / ammonia is no longer being given off **OR** Test with hydrogen chloride / HCl until no more white smoke (observed) **IGNORE** Just 'no more ammonia is given off', **unless** a test is suggested / 'no more steam is given off' / references to smell / references to colour change(s) in the reactant or products / references to (stopping of) "fizzing" or "effervescence" or "bubbles"		**(1)**

Question Number	Correct Answer	Reject	Mark
4(b)	(In air) hydrogen is explosive / hydrogen would catch fire / hydrogen is flammable / hydrogen is inflammable **NOTE** **Need to identify hydrogen by name or by formula (H_2)** **IGNORE** V_2O_3 toxic		**(1)**

Question Number	Correct Answer	Reject	Mark
4(c)(i)	**1st mark – for moles of V^{3+}** Moles V^{3+} (= $\frac{1.498}{149.8}$) x 2 = 0.02(00) **(1)** **2nd mark – for division by 0.25(0)** Concentration of V^{3+}(aq) (= $\frac{0.02(00)}{0.25(0)}$) = 0.08(00) (mol dm^{-3}) **(1)** **ALLOW** TE for M2 from calculated moles of V^{3+} [e.g. answer of 0.04(00) (mol dm^{-3}) scores **(1)** mark] **IGNORE** Incorrect units at any stage Correct answer with no working scores **(2)**		**(2)**

Question Number	Correct Answer	Reject	Mark
4(c)(ii)	• H^+(aq) **or** H_3O^+(aq) **AND** • SO_4^{2-}(aq) **or** HSO_4^-(aq) **NOTE:** Two correct ions are needed for the one mark **IGNORE** Any missing or incorrect state symbols	SO_3^{2-}(aq)	**(1)**

Question Number	Correct Answer	Reject	Mark
4(d)(i)	Marks can be scored in either order: **1st Mark:** States that for VO_2^{+} to VO^{2+} OR gives an equation (even if unbalanced) OR Makes reference to the 1st step **and** (E^o_{cell} =) **+0.83** (V) **(1)** **2nd Mark:** States that for VO^{2+} to V^{3+} OR gives an equation (even if unbalanced) OR Makes reference to the 2nd step **and** (E^o_{cell} =) **+0.17** (V) **(1)** Penalise missing + sign once only **NOTE:** If only the e.m.f. values of +0.83 (V) **and** +0.17 (V) are given without any reference to the reactions under consideration, then award **(1)**		**(2)**

Question Number	Correct Answer	Reject	Mark
4(d)(ii)	Activation energy is (too) high **OR** Rate of reaction is (very) slow **ALLOW** Concentrations (of solutions) **not** 1 mol dm−3 / Any references to departure from standard conditions		**(1)**

Question Number	Correct Answer	Reject	Mark
4(d)(iii)	$SO_2 + 2VO_2^{+} \rightarrow SO_4^{2-} + 2VO^{2+}$ **ALLOW** Multiples $\rightleftharpoons$ sign instead of $\rightarrow$ **IGNORE** State symbols, even if incorrect or missing	ANY uncancelled H^{+}, H_2O and e^{-}	**(1)**

Question Number	Correct Answer	Reject	Mark
4(e)	These answers may be given in any order: **First mark (M1):** Platinum wire (connecting the two solutions) – replace with salt bridge **ALLOW** Any correct description of a salt bridge (e.g. filter paper soaked in KNO_3 solution) if the term 'salt bridge' has not been used in answer **(1)** **Second mark (M2):** Vanadium electrode (in left-hand beaker) – replace with platinum/Pt (electrode) **NOTE** This is the only acceptable electrode **(1)** **Third mark (M3):** $Al_2(SO_4)_3(aq)$ solution concentration is 1 mol dm^{-3} **OR** concentration of $Al_2(SO_4)_3(aq)$ is incorrect – replace with a solution of concentration 0.5 mol dm^{-3} / solution must be 1 mol dm^{-3} (concentration) $Al^{3+}(aq)$ / use (1 mol dm^{-3}) $Al(NO_3)_3$ **(1)**	Use of KOH / Na_2CO_3 / any insoluble salt for the salt bridge / just "use a piece of filter paper"	**(3)**

(Total for Question 4 = 13 marks)

TOTAL FOR PAPER = 50 MARKS

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