Mark Scheme (Results)

October 2022

Pearson Edexcel International Advanced Level in Chemistry (WCH16)
Paper 01: Practical Skills in Chemistry II

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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.

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.

Question Number	Acceptable Answers	Additional Guidance	Mark
1(a)(i)	An answer that makes reference to the following point: • $[Co(H_2O)_6]^{2+}$	Allow 'round' brackets Ignore name Ignore absence of square brackets Ignore Co^{2+} / $Co^{2+}(aq)$	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
1(a)(ii)	An answer that makes reference to the following point: • SO_4^{2-}	Allow SO_4^{-2} Ignore name	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
1(a)(iii)	An answer that makes reference to the following point: • a blue (solution forms)	Accept pink solution turns blue Ignore shades Ignore reference to steamy/ misty fumes Do not award if given with any incorrect observation Do not award incorrect initial colour	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
1(a)(iv)	An answer that makes reference to the following point: • deprotonation	 Allow acid-base Ignore precipitation Do not award ligand substitution / ligand replacement	**1**

Question Number	Acceptable Answers		Additional Guidance	Mark
1(a)(v)	An answer that makes reference to the following points: EITHER		Ignore shades in both alternatives	**3**
	• (precipitate) dissolves	(1)	Allow (precipitate) disappears Allow blue colour dissolves Do not award if precipitate is not blue	
	• yellow / straw / brown **solution** forms	(1)	Blue ppt turns into yellow solution scores (2)	
	• $[Co(NH_3)_6]^{2+}$	(1)	Allow $[Co(NH_3)_6]^{3+}$ Ignore absence of square brackets	
	OR			
	• yellow / straw / brown **solution** forms	(1)		
	• which darkens / forms dark brown (solution on standing)	(1)	Allow red-brown	
	• $[Co(NH_3)_6]^{2+}$	(1)	Allow $[Co(NH_3)_6]^{3+}$ Ignore absence of square brackets	

Question Number	Acceptable Answers	Additional Guidance	Mark
1(b)	An answer that makes reference to the following points: • known mass of $CoCl_2 \cdot xH_2O(s)$ measured (1) • heat sample (strongly) in crucible / evaporating basin (with lid using blue flame on Bunsen burner) (1) • until mass of sample is constant (to ensure all water is removed / all $CoCl_2 \cdot xH_2O(s)$ has broken down) (1) • difference in (initial and final) mass (= mass of water removed) (1)	Allow weight for mass Allow a clearly annotated diagram Do not award use of beaker/ conical flask/test tube Do not award use of heating mantle Ignore heat until all the water is removed/evaporated Allow M3 and M4 for method involving a desiccator/oven but not for the addition of drying agent Do not award M4 for response involving recrystallisation or distillation	**4**

Total for Question 1 = 11 marks

Question Number	Acceptable Answers	Additional Guidance	Mark
2(a)	An answer that makes reference to the following points: • filter to remove sand / to separate the sodium hydroxide (1) • rinse (sand) with deionised / distilled water (to ensure all the sodium hydroxide solution is separated) (1)	M1 can be shown with a suitable labelled diagram Accept decant or description of Allow solid for sand Allow use of Buchner funnel Allow use of sieve Ignore hot/cold references to filtration Allow rinse with solvent	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
2(b)	An answer that makes reference to the following points: • use of (250 cm^3) volumetric flask (1) • add deionised / distilled water **and** up to the mark **and** mix (1)	Allow graduated / standard flask Do not allow beaker/conical flask/measuring cylinder M2 independent of M1 but reference to 'mark' or volume line or 250 cm^3 required Allow any indication of mixing e.g. shake, invert, swirl Allow 'pure water' Just 'water' is insufficient unless qualified at some point	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
2(c)	• **(M1)** calculation of initial moles of NaOH **AND** calculation of moles of HCl (1) • **(M2)** calculation of moles of NaOH in 250 cm^3 (1) • **(M3)** calculation of moles of NaOH that reacted with $(NH_4)_2SO_4$ (1) • **(M4)** calculation of mass of $(NH_4)_2SO_4$ (1) • **(M5)** calculation of percentage by mass of $(NH_4)_2SO_4$ in fertiliser (1)	<u>Example of calculation</u> (20 ÷ 1000) × 1 = 0.02 (mol) (12.75 ÷ 1000) × 0.0500 = 6.375×10^{-4} (mol) $6.375 \times 10^{-4} \times (250 \div 25) = 6.375 \times 10^{-3}$ (mol) $0.02 - 6.375 \times 10^{-3} = 0.013625$ (mol) 0.013625 ÷ 2 × 132.1 = 0.89993 (g) Allow TE from M1 to M4 (0.89993 ÷ 5.75) × 100 = 15.651 % = 15.7 % Allow TE from M4 to M5 if answer is < 100 % Ignore SF Note penalise rounding errors once only in M1-M5 Final answer without working scores (5) 22.2 % scores (4) omission of x10 in step 2 31.3 % scores (4) omission of ÷ 2 in step 4 44.5% scores (3) omission of x10 and ÷ 2 62.6% scores (4) multiplied by 2 instead of ÷ 2 Allow use of 132 for step 4	**5**

Question Number	Acceptable Answers	Additional Guidance	Mark
2(d)(i)	An explanation that makes reference to the following points: • NH_3 (remaining) will react with the HCl / acid (in the titration) (1) • so titre would be greater (1) • so (it would appear that there is a) lower percentage of $(NH_4)_2SO_4$ (in the fertiliser) (1)	Allow reference to neutralisation M2 dependent on some attempt at M1 such as ammonia remaining Allow less $(NH_4)_2SO_4$ (in the fertiliser) M3 can be awarded provided there is reference to greater titre Allow (1) as a TE if titre is stated to be smaller which means the percentage will be higher	**3**

Question Number	Acceptable Answers	Additional Guidance	Mark
2(d)(ii)	An answer that makes reference to the following point: • place (damp) red litmus (paper into vapour) **and** which should remain red (if all NH_3 removed)	Do not award dip the litmus into the solution Allow (litmus) goes blue if any NH_3 remains Ignore reference to pungent smell Allow place (damp) universal indicator (paper) into vapour **and** which should remain yellow (if all NH_3 removed) / goes blue or purple if any NH_3 remains Allow place stopper of conc. HCl bottle near mouth of reaction vessel/ use HCl**(g)** **and** which will not form white smoke if NH_3 all removed	**1**

Total for Question 2 = 13 marks

Question Number	Acceptable Answers	Additional Guidance	Mark
3(a)	• calculation of mass of ethanol **and** calculation of mass of butanoic acid (1) • calculation of moles of ethanol **and** calculation of moles of butanoic acid **and** statement that moles of butanoic acid > moles of ethanol / butanoic acid is in excess (because the ratio is 1:1) (1)	<u>Example of calculation</u> 5 × 0.79 = 3.95 (g) 10 × 0.96 = 9.6 (g) 3.95 ÷ 46 = 0.085870 (mol) 9.6 ÷ 88 = 0.1091 (mol) 0.1091 > 0.085870 (mol) Allow statement that moles of ethanol < moles of butanoic acid Allow TE from M1 to M2 Ignore SF Allow (2) for n(ethanol) = 0.085870 and n(butanoic acid) = 0.1091 so butanoic acid in excess because the masses must have been determined Calculation dividing molar mass by density scores (0)	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(b)	An explanation that makes reference to the following points: • CO_2 is produced which increases **pressure** / to prevent build up of **pressure** from the CO_2 produced (inside funnel if tap not opened / stopper not removed) (1) • $H_2SO_4 + 2NaHCO_3 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2$ / $C_3H_7COOH + NaHCO_3 \rightarrow C_3H_7COO^{(-)}Na^{(+)} + H_2O + CO_2$ / $H^+ + HCO_3^- \rightarrow CO_2 + H_2O$ $H^+ + NaHCO_3 \rightarrow Na^+ + CO_2 + H_2O$ (1)	Allow just '**pressure** increases/to relieve **pressure'** provided CO_2 given as a product in an equation even if the equation is incorrect Allow 'gas is produced which increases **pressure**' Do not allow if incorrect gas stated Do not award reference to explosion Ignore state symbols even if incorrect Accept other formulae except molecular Allow $H_2SO_4 + NaHCO_3 \rightarrow NaHSO_4 + H_2O + CO_2$ Use of RCOOH in equation	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(c)	An explanation that makes reference to the following points: Any two from three **Either** • aqueous layer will not flow (from the funnel when tap is open) (1) • as stopper prevents air from entering top of funnel (to keep pressure constant) (1) • due to creation of lower pressure / vacuum (inside) (1) **Or** • some of the (aqueous) liquid flows out (of the funnel) (1) • bubbles of air (enter through tap) / flow is stopped (1) • (which) mixes/disturbs the two layers (1)	Do not award for liquid flow due to 'normal' functioning of separating funnel	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(d)(i)	An answer that makes reference to the following point: • name or formula of a suitable drying agent	(anhydrous) sodium sulfate / Na_2SO_4 /calcium chloride / $CaCl_2$ (anhydrous) calcium sulfate / $CaSO_4$ / magnesium sulfate / $MgSO_4$ Allow silica gel/silica crystals Ignore any other conditions except aqueous Do not award copper sulfate / $CuSO_4$ / cobalt chloride / $CoCl_2$ /silicone gel If name and formula given then both must be correct	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(d)(ii)	An explanation that makes reference to the following points: • (no more drying agent is needed) when liquid is no longer cloudy / drying agent stops clumping together	Allow when liquid clears/ goes transparent/ liquid goes translucent Allow drying agent remains as a powder Allow use cobalt chloride paper which turns pink (from blue) if water is still present Allow drying agent stops sticking to the glass Ignore drying agent is no longer crystalline Do not award reference to colour change Do not award reference to water/aqueous layer The use of $CuSO_4$ has already been penalised in (i) so the mark can be awarded here if reference is made either to the presence of a blue colour due to copper(II) sulfate and requiring more drying agent or the absence of blue colour meaning that no more copper(II) sulfate is needed	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(d)(iii)	An answer that makes reference to the following point: • distillation	 Allow redistillation Ignore ‘fractional’ Ignore ‘simple’ Do not award ‘steam distillation’	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
3(e)(i)	An explanation that makes reference to the following points: • (peak between 2.2 and 2.4 ppm is due to) hydrogens attached to carbon attached to carbonyl carbon / **H**-C-C=O **(1)** • and is a triplet as adjacent carbon atom has 2 hydrogen atoms attached (so n+1 = 3) **(1)**	Allow protons attached to C adjacent to carbonyl C highlighted or labelled on drawing of structure Do not award if described as aldehyde or ketone or amide Allow is a triplet as group is attached to a CH_2 group Allow 3-splits/3-splitting peak / 3 peaks for triplet Allow use of hydrogens and of protons interchangeably but penalise once only the use of the symbol H^+ Penalise once only in either M1 or M2 if reference is made to mass spectrum fragments e.g. $CH_3CH_2CH_2CO^+$	**2**

Question Number	Acceptable Answers		Additional Guidance	Mark
3(e)(ii)	An answer that makes reference to the following points: the proton NMR spectrum of ethyl propanoate will			**3**
	• have 1 fewer peak (than the 5 of ethyl butanoate / have 4 peaks	**(1)**	Allow proton environment for peaks Ignore just 'it has less peaks' Do not award carbon environments	
	• there will be no sextet (at 1.7 ppm)	**(1)**	Allow hextet/6-splitting peak for sextet Allow peak due to $CH_3C\mathbf{H}_2CH_2$ not evident Ignore just no peak between 1.6 and 1.9 ppm	
	• the triplet (at 2.2 - 2.4) will become a quartet	**(1)**	Allow have (an extra) quartet instead of multiplet Allow spectrum has two not three triplets Allow spectrum has two not one quartet Allow spectrum has two triplets and two quartets Allow 3-splits/3-splitting peak(let) / 3 peaks for triplet Allow 4-splits etc for quartet Ignore reference to peak integrations/area ratios even if incorrect A list of the peaks of each compound scores (2) only unless there is a comparison such as the use of 'but'/ 'only'/ 'whereas' etc	

(Total for Question 3 = 14 marks)

Question Number	Acceptable Answers	Additional Guidance	Mark
4(a)	An answer that makes reference to the following point: • (volumetric / bulb / graduated) pipette (and pipette filler / safety filler)	 Allow syringe Do not award dropping or teat pipette / burette / measuring cylinder / gas syringe	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
4(b)(i)	An explanation that makes reference to the following point: • $V_{final} - V_t$ is proportional to [$CH_3CH_2CH_2COOCH_2CH_3$] **(1)**	 Allow $V_{final} - V_t$ is proportional to [reactant] Allow a product is being monitored (rather than a reactant) Ignore just 'volume if proportional to concentration'	**1**

Question Number	Acceptable Answers	Additional Guidance	Mark
4(b)(ii)	An answer that makes reference to the following points: • calculation of 1 half-life (1) • calculation of second half-life which is constant / has a similar value (and so first order) (1)	<u>Example of calculation</u> $t_1 = 0 – 0.70 = 0.70$ (h) $t_2 = 1.40 – 0.70 = 0.70$ (h) / $t_3 = 2.1 – 1.40 = 0.70$ (h) Allow half lives in range 0.75 – 0.65 (h) Allow correct conversion into minutes so range is 45 – 39 **minutes/min** Two correct half lives without any working and reference to constant value scores (1) Some correct working must be shown on the graph and even small dashes on the x axis is sufficient	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
4(b)(iii)	An explanation that makes reference to the following points: **Either** • no **and** either as order (determined) is with respect to ethyl butanoate only or water is a reactant (1) • because water is in excess (1) **Or** • yes, because water is in (very) large excess (1) • so (concentration of water) has no effect on the rate of reaction (1)	Allow reactants need to be equimolar to determine overall order / (additional experiment with ester in excess is needed) to find order with respect to water	**2**

Question Number	Acceptable Answers	Additional Guidance	Mark
4(b)(iv)	• tangent drawn at time = 2 hours (1) • changes in x and y determined (1) • calculation of rate (1) • correct units of $cm^3\ h^{-1}$ (1)	Standalone mark but absence of results in loss of M2 and M3 unless data points used <u>Example of calculation</u> change in y = (23 – 0) = 23 (cm^3) change in x = (2.8 – 0) = 2.8 (h) Allow range 22 − 24 for y, 2.7 − 2.9 for x (−)23 ÷ 2.8 = (−) 8.21 Allow range (−) 7.59 – 8.89 which scores M2 and M3 Mark consequentially on values from M2 Allow cm^3 /h and allow (per) hr or hour(s) for h Ignore the absence of negative sign given in front of rate Ignore SF except 1 SF Allow correct conversion into other units e.g. (−) 0.1369 $cm^3\ min^{-1}$ or cm^3 /min or (−) 2.282 x 10^{-3} $cm^3\ s^{-1}$ or (−) 0.002282 $cm^3\ s^{-1}$ Range of (−) 0.1265 – 0.1482 $cm^3\ min^{-1}$ for M3 and M4 No TE on units from an incorrect calculation expression Do not award units m for min M4 is a standalone mark but only allow use of minutes if values used are converted from hours Use of data points at 2h scores M3 and M4 only for (−) 3.5 $cm^3\ h^{-1}$ and or all other values only award M4 If no tangent then only award M4 unless use of data points as above	**4**

Question Number	Acceptable Answers	Additional Guidance	Mark
4(c)	An answer that makes reference to the following points: • this suggestion will quench the reaction / slow down the reaction (as reaction mixture at 100° C) (1) Either • it makes no difference (to validity) because the reaction is already very slow / takes 4 hours / no catalyst is used or it will make a difference/improve (validity) because otherwise the reaction will continue producing butanoic acid (at a significant rate) (1)	Allow stop the reaction Ignore just reference to cooling Do not award if slowing of reaction is related to other reaction/ slow the titration reaction(s) Allow reference to validity improved because acid concentration is fixed/unchanged or because otherwise the reaction will continue so the titre will change Do not award reference to ice increasing the volume and decreasing the concentration	**2**

Total for Question 4 = 12 marks
TOTAL FOR PAPER = 50 MARKS

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