Pearson Edexcel

Mark Scheme (Results)

Summer 2021

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	Answer	Additional guidance	Mark
1(a)(i)	• $VO_3^- + 2H^+ \rightarrow VO_2^+ + H_2O$	Allow multiples Ignore state symbols even if incorrect Do not award uncancelled SO_4^{2-} ions	**1**

Question Number	Answer	Additional guidance	Mark
1(a)(ii)	• yellow	Ignore pale/light/dark/bright Do not award any other colour	**1**

Question Number	Answer	Additional guidance	Mark
1(a)(iii)	An explanation that makes reference to the following points: • correct colours of the oxidation states of vanadium (1) • correct explanation for first / initial green (1)	+5 (oxidation state of vanadium) is yellow **and** +4 is blue **and** +3 is green **and** +2 is violet Allow starting colour/answer to (a)(ii) for yellow Allow just all oxidation states/species have the correct colours Initial green is due to mixture of VO_2^+ and VO^{2+} (rather than V^{3+}) Accept initial green is due to mixture of +5 and +4 oxidation states / mixture of yellow and blue Allow vanadium cannot be oxidised from +3 to +4 in these conditions / by zinc	**2**

Question Number	Answer	Additional guidance	Mark
1(a)(iv)	An explanation which makes reference to the following: • oxidation of vanadium (from +2 to +3) by oxygen/O_2 (1) • oxygen/O_2 isn't a strong enough oxidising agent to oxidise vanadium(III) (under these conditions) (1)	 Allow air for oxygen Allow aerial oxidation Do not award +2 to +4/+5 **Standalone mark** Allow oxygen/O_2 cannot oxidise +3 Allow oxidation to +4/+5 has a high activation energy Allow oxidation to +4/+5 is too slow Allow any indication that no further oxidation (of +3) occurs eg V^{3+} ions are harder to oxidise Ignore just no further reaction occurs Ignore just V^{3+} is stable	**2**

Question Number	Answer	Additional guidance	Mark
1(b)(i)	Any two from: • $[CuCl_4]^{2-}$ (1) • $[Cu(H_2O)_6]^{2+}$ (1) • $[Cu(H_2O)_5Cl]^{+}$ (1)	Ignore missing square brackets Do not award any complexes containing NH_3/NH_4^+ Accept $[CuCl_3]^-$ / $[Cu(H_2O)_3Cl_3]^-$ Do not award $[CuCl_2]^-$ Allow $[Cu(H_2O)_4]^{2+}$ Comment allow correct names: tetrachlorocuprate(II) hexaaquacopper(II) pentaaquachlorocopper(II)	**2**

Question Number	Answer	Additional guidance	Mark
1(b)(ii)	• turns (from blue-green to) green	Accept turns green then yellow Accept turns yellow Allow turns green-yellow or any combination	**1**

Question Number	Answer	Additional guidance	Mark
1(b)(iii)	A description which includes: • (pale) blue precipitate (of copper((II)) hydroxide)	 Allow solid/ppt/ppte for precipitate Ignore gas evolved Ignore deep blue solution Do not award effervescence Do not award incorrect name/formula of precipitate	**1**

Question Number	Answer		Additional guidance	Mark
1(b)(iv)	An answer which makes reference to the following points: • (gas evolved is) ammonia • (test for ammonia) turns (damp red) litmus paper blue **OR** produces white smoke with HCl	 (1) (1)	 Accept NH_3 Allow just $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$ Allow turns universal indicator paper blue Do not award white/misty fumes Ignore $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$	**2**

Question Number	Answer	Additional guidance	Mark
1(c)	An explanation that makes reference to the following points: • (formation of) ethanoic acid / CH_3COOH (on addition of concentrated sulfuric acid) (1) • (formation of) ester / ethyl ethanoate (on addition of ethanol) (1) • anion $\mathbf{Y}^-$ is CH_3COO^- / ethanoate (1)	Accept acetic acid Allow just carboxylic acid Accept $CH_3COOC_2H_5$ Accept ethyl acetate Allow name or formula of any **ethyl** ester Accept salt is ammonium ethanoate/$CH_3CO_2NH_4$ Accept ammonium acetate Allow name or formula of any carboxylate ion containing between one and four carbon atoms	**3**

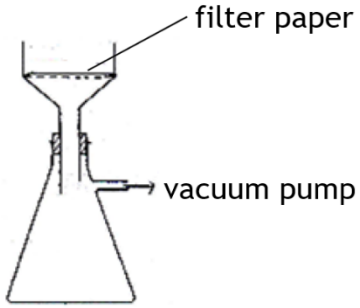
(Total for Question 1 = 15 marks)

Question Number	Answer	Additional guidance	Mark
2(a)	Any one of: • quicker • do not need the accuracy of a graduated pipette	Allow volume is approximate/to 1SF Ignore there are not 8 cm^3 pipettes Ignore water is in excess	**1**

Question Number	Answer	Additional guidance	Mark
2(b)	• dark blue	Allow deep/royal for dark Do not award 'just' blue Do not award mention of any other colour Ignore any reference to the formation of a precipitate that subsequently dissolves	**1**

Question Number	Answer	Additional guidance	Mark
2(c)	• ammonia/NH_3 (gas) is toxic	Accept poisonous/corrosive/irritant for toxic Ignore harmful/dangerous/health hazard	**1**

Question Number	Answer	Additional guidance	Mark
2(d)	• the tetraamminecopper(II) sulfate-1-water/ $Cu(NH_3)_4SO_4.H_2O$ is less soluble in (aqueous) ethanol (than water so crystallises)	Allow product/salt/complex/crystals/ precipitate/solid/it for tetraamminecopper(II) sulfate-1-water Allow insoluble in ethanol	**1**

Question Number	Answer	Additional guidance	Mark
2(e)	A diagram showing:	Example of diagram:  	**3**
	• Buchner funnel **and** labelled filter paper (1)	Funnel must show perforations/holes below the filter paper Allow any properly shaped Buchner funnel Allow sintered glass funnel Do not award porous paper Do not award fluted filter paper	
	• Buchner flask **and** (rubber) seal (1)	Allow conical flask with side arm	
	• (side arm with) vacuum pump (1)	Allow vacuum/pump/reduced pressure/aspirator/suction Ignore just water tap Do not award pressure out/negative pressure	

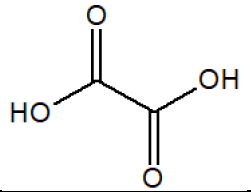
Question Number	Answer	Additional guidance	Mark
2(f)(i)	• to remove (soluble) impurities	Ignore to wash the crystals	**1**

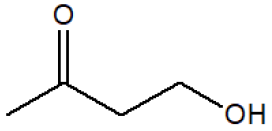
Question Number	Answer	Additional guidance	Mark
2(f)(ii)	• hot ethanol would dissolve the tetraamminecopper(II) sulfate-1-water/$Cu(NH_3)_4SO_4.H_2O$ **OR** so only a very small/the minimum amount of tetraamminecopper(II) sulfate-1-water/ $Cu(NH_3)_4SO_4.H_2O$ dissolves (in cold ethanol)	Allow product/salt/complex/crystals/ precipitate/solid/it for tetraamminecopper(II) sulfate-1-water Allow just so it does not dissolve Allow just it is less soluble in cold ethanol Do not award insoluble in ethanol Ignore just to minimise loss of product	**1**

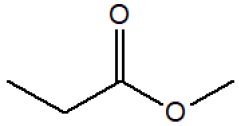
Question Number	Answer	Additional guidance	Mark
2(g)(i)	• M_r values of $CuSO_4.5H_2O$ **and** $Cu(NH_3)_4SO_4.H_2O$ (1) • mols of $CuSO_4.5H_2O$ **and** mols $Cu(NH_3)_4SO_4.H_2O$ **OR** theoretical mass $Cu(NH_3)_4SO_4.H_2O$ (1) • percentage yield to 2SF or 3SF (1)	Example of calculation: M_r $CuSO_4.5H_2O$ = 249.6 Allow 249.5 M_r $Cu(NH_3)_4SO_4.H_2O$ = 245.6 Allow 245.5 Mols $CuSO_4.5H_2O$ = $\frac{2.17}{249.6}$ (= 0.0086939 / 8.6939×10^{-3}) Mols $Cu(NH_3)_4SO_4.H_2O$ = $\frac{2.54}{245.6}$ (= 0.010342 / 1.0342×10^{-2}) Theoretical mass $Cu(NH_3)_4SO_4.H_2O$ = 0.0086939 × 245.6 = 2.1352 (g) TE on M1 % yield = 0.010342/0.0086939 × 100 = 118.96 = 119%/120% **OR** % yield = 2.54/2.1352 × 100 = 119%/120% Allow 119.0% TE on M2 Correct answer with some working scores (3) Just 2.54/2.17 × 100 = 117%/120% scores (0) Just 2.17/2.54 × 100 = 85.4%/85% scores (0) If no other mark awarded, M_r **and** mols of $CuSO_4.5H_2O$ / $Cu(NH_3)_4SO_4.H_2O$ scores (1)	**3**

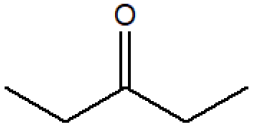
Question Number	Answer	Additional guidance	Mark
2(g)(ii)	An answer which makes reference to the following point: • damp crystals	Allow wet/not properly dried/some ethanol/water remains Allow product etc for crystals Ignore just impurities Do not award it is a hydrated salt/has water of crystallisation	**1**

(Total for Question 2 = 13 marks)

Question Number	Answer	Additional guidance	Mark
3(a)(i)	• (Compound) **E**	Accept correct structure: 	**1**

Question Number	Answer	Additional guidance	Mark
3(a)(ii)	• (Compound) **B**	Accept correct structure: 	**1**

Question Number	Answer	Additional guidance	Mark
3(a)(iii)	• (Compound) **F**	Accept correct structure: 	**1**

Question Number	Answer	Additional guidance	Mark
3(a)(iv)	• (Compound) **D**	Accept correct structure: 	**1**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>3(b)(i)</td><td>An answer that makes reference to the following points:

• chemical test (1)

• result of the selected test with A and B (1)</td><td>Result dependent on suitable test
If two or more tests given, all results must be correct to score (2)

Examples of correct answers:</td><td>2</td></tr>
<tr><td></td><td colspan="2"><table>
<tr><td>Chemical test</td><td>Result with A and B</td></tr>
<tr><td>(heat with) sodium dichromate((VI))/$Na_2Cr_2O_7$ and sulfuric acid/H_2SO_4
Allow just acidified dichromate / H^+ and $Cr_2O_7^{2-}$</td><td>(solution changes from orange to) green/blue with B (and no change with A)</td></tr>
<tr><td></td><td>OR</td></tr>
<tr><td>metal carbonate/metal hydrogencarbonate by name or formula</td><td>effervescence/fizzing/bubbles with A (and no change with B)</td></tr>
<tr><td></td><td>OR</td></tr>
<tr><td>magnesium/Mg</td><td>effervescence/fizzing/bubbles with A (and no change with B)</td></tr>
<tr><td></td><td>OR</td></tr>
<tr><td>ethanol/C_2H_5OH and a strong acid (by name or formula) and warm
Allow just H^+ for strong acid</td><td>fruity smell with A (and no change with B)</td></tr>
<tr><td></td><td>OR</td></tr>
<tr><td>ethanoic acid/CH_3COOH and a strong acid (by name or formula) and warm
Allow just H^+ for strong acid</td><td>fruity smell with B (and no change with A)</td></tr>
</table></td></tr>
<tr><td></td><td></td><td>Do not award sodium
Do not award PCl_5
Do not award iodoform test
Do not award Brady’s reagent/2,4-DNP(H)</td><td></td></tr>
</table>

Question Number	Answer	Additional guidance	Mark
3(b)(ii)	An answer that makes reference to the following points: • suitable test (1) • result of the selected test with **C** and **D** (1)	**Result dependent on test** (Warm with) iodine/I_2 **and** (aqueous) sodium hydroxide/NaOH/alkali Allow iodoform test Accept potassium iodide/KI **and** sodium chlorate((I))/NaClO (Pale) yellow precipitate with **C** (and no change with **D**) Allow antiseptic smell with **C** (and no change with **D**) If no other mark awarded, Brady's reagent/2,4-DNP(H) **and** measure melting temperature of (purified orange) solid **and** compare with data book scores (1)	**2**

Question Number	Answer	Additional guidance	Mark
3(c)(i)	• (the expansion of trapped) air		**1**

Question Number	Answer	Additional guidance	Mark
3(c)(ii)	• heat is distributed more uniformly/evenly (by convection)	Allow the temperature is more even/uniform Allow the temperature measurement is more accurate Allow the temperature rises more gradually Ignore references to evaporation	**1**

Question Number	Answer	Additional guidance	Mark
3(c)(iii)	• the boiling temperature of compound **A** is higher than 100°C/water	Allow the boiling temperature of mineral oil is higher than water Allow mineral oil boils above 180°C Allow mineral oil boils at a higher temperature than compound **A** Allow water boils below 120°C Ignore just water boils at 100°C Ignore references to evaporation	1

Question Number	Answer	Additional guidance	Mark
3(c)(iv)	• (boiling temperature depends on atmospheric) **pressure** (which) is variable	Allow boiling temperature is pressure dependent Ignore references to variation in just conditions/temperature	1

Question Number	Answer	Additional guidance	Mark
3(d)(i)	• solid **M** (anhydrous) calcium chloride/$CaCl_2$ (1) • solid **N** soda lime (1)	If name and formula given, both must be correct Allow (anhydrous) calcium sulfate/ sodium sulfate/magnesium sulfate/silica gel Do not award sulfuric acid/copper sulfate/ cobalt chloride/calcium oxide Allow potassium hydroxide/sodium hydroxide/ calcium hydroxide/calcium oxide Do not award limewater Correct substances in reverse order scores (1)	2

Question Number	Answer	Additional guidance	Mark
3(d)(ii)	• mass of hydrogen OR moles hydrogen (1)	Example of calculation: mass H = $\frac{2}{18} \times 1.28 = 0.14222$ (g) OR moles H = $\frac{1.28}{18} \times 2 = 0.14222$ (mols)	**4**
	• mass of carbon OR moles carbon (dioxide) (1)	mass C = $\frac{12}{44} \times 3.14 = 0.85636$ (g) OR moles C/CO_2 = $\frac{3.14}{44} = 0.071364$ (mols)	
	• mass of oxygen OR % mass of oxygen (1)	mass O = 1.57–0.14222–0.85636 = 0.57142/0.57 (g) OR % mass O = 100–9.0587–54.545 = 36.396/36% TE on M1 and M2 provided answer is positive	
	• calculated empirical formula (1)	C : H : O $\frac{0.85636}{12}$: $\frac{0.14222}{1}$: $\frac{0.57142}{16}$ 0.071363 : 0.14222 : 0.035714 2 : 4 : 1 empirical formula is C_2H_4O Allow use of percentage masses in ratio TE on M1, M2 and M3 Ignore SF except 1SF in mass and moles	

		Max (2) (M3 and M4) if 1.28 g and 3.14 g confused giving empirical formula $CH_{12}O_2$ If no other marks awarded, for 1.28 g and 3.14 g confused: mass/moles H = 0.348889 **AND** mass C = 0.349091 OR moles C = 0.029091 scores (1) If no other mark awarded, correct empirical formula scores (1) Comment empirical formula is C_2H_4O can be awarded if seen in (d)(iv) provided mole ratio correctly calculated	

Question Number	Answer	Additional guidance	Mark
3(d)(iii)	• (m/z =) 88	Accept answer clearly annotated on mass spectrum	**1**

Question Number	Answer	Additional guidance	Mark
3(d)(iv)	• molecular formula	(x = $\frac{M_r}{M_r(C_2H_4O)}$ = $\frac{88}{44}$ = 2) molecular formula is $C_4H_8O_2$ No TE on (d)(ii) or (d)(iii)	**1**

Question Number	Answer	Additional guidance	Mark
3(d)(v)	An answer which makes reference to the following points: • identification of compound **F** (1) • justification with reference to both molecular formula/M_r **AND** fragmentation pattern (1)	No TE on (d)(iv) Examples of justification: peak ~~s~~ at m/z = 29 (for $C_2H_5^+$) OR peak at m/z = 59 (for $COOCH_3^+$) OR no peak ~~s~~ at m/z = 43 (for CH_3CO^+) OR no peak at m/z = 45 (for $C_2H_4OH^+$) **AND** molecular formula $C_4H_8O_2$ / M_r = 88 peak ~~s~~ at m/z = 29 (for $C_2H_5^+$) **AND** **D** does not have molecular formula $C_4H_8O_2$ / M_r = 88 Ignore reference to peaks at m/z = 31/57 **F** as has peaks at m/z = 29 **AND** m/z = 59 scores (2) If neither M1 nor M2 awarded, any of the following scores (1) **B** as has molecular formula $C_4H_8O_2$ / M_r = 88 OR **A** as has M_r = 88 OR **D** as has a peak ~~s~~ at m/z = 29	**2**

(Total for Question 3 = 22 marks)
Total for Paper = 50 marks

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