Pearson Edexcel

Mark Scheme (Results)

Summer 2021

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

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: • 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**

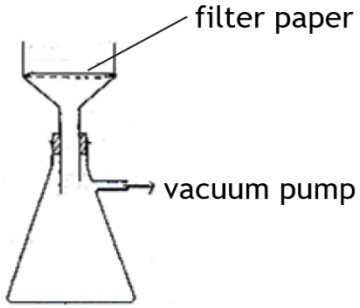
(Total for Question 1 = 15 marks)

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	

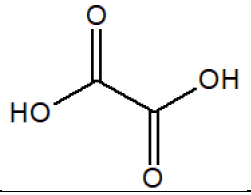
Question Number	Answer	Additional guidance	Mark
2(f)(i)	• to remove (soluble) impurities	Ignore to wash the crystals	1

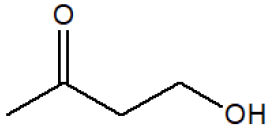
Question Number	Answer	Additional guidance	Mark
2(f)(ii)	• hot ethanol would dissolve the tetraamminecopper(II) sulfate-1-water/$Cu(NH_3)_4SO_4.H_2O$ **OR** so only a very small/the minimum amount of tetraamminecopper(II) sulfate-1-water/ $Cu(NH_3)_4SO_4.H_2O$ dissolves (in cold ethanol)	Allow product/salt/complex/crystals/ 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

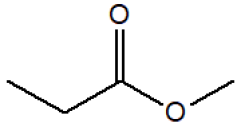
Question Number	Answer	Additional guidance	Mark
2(g)(i)	• M_r values of $CuSO_4.5H_2O$ **and** $Cu(NH_3)_4SO_4.H_2O$ (1) • mols of $CuSO_4.5H_2O$ **and** mols $Cu(NH_3)_4SO_4.H_2O$ **OR** theoretical mass $Cu(NH_3)_4SO_4.H_2O$ (1) • percentage yield to 2SF or 3SF (1)	Example of calculation: M_r $CuSO_4.5H_2O$ = 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**

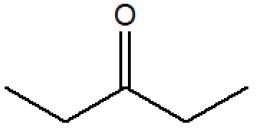
Question Number	Answer	Additional guidance	Mark
2(g)(ii)	An answer which makes reference to the following point: • damp crystals	 Allow wet/not properly dried/some ethanol/water remains Allow product etc for crystals Ignore just impurities Do not award it is a hydrated salt/has water of crystallisation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