

Mark Scheme (Results)

January 2024

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

Question Number	Answer	Additional Guidance	Mark
1(a)(i)	An answer that makes reference to the following point:		(1)
	• Cu ²⁺ / copper(II)	Allow [Cu(H ₂ O) ₆] ²⁺ Ignore just 'copper'	

Question Number	Answer	Additional Guidance	Mark
1(a)(ii)	An answer that makes reference to the following point:		(2)
	• $Zn(H_2O)_4(OH)_2/Zn(OH)_2$ (1)	Accept Zn(OH) ₂ (H ₂ O) ₄ Ignore inclusion of brackets [] provided no charge given	
	• $[Zn(NH_3)_4]^{2+}$ (1)	Ignore Zn ²⁺ Do not award Al ³⁺ Do not award a hexa amine zinc complex ion Do not award [Zn(NH ₃) ₄ (H ₂ O) ₂] ²⁺ Do not award [Zn(OH) ₄] ²⁻	

Question Number	Answer	Additional Guidance	Mark
1(a)(iii)	An answer that makes reference to the following point:		(2)
	• brown precipitate forms (1)	Allow solid/ppte/ppt for precipitate Ignore shades of brown and colours given with brown e.g. red-brown/ orange-brown/yellow-brown score M1 Do not award green ppt changes to brown	
	• which does not dissolve (in excess) (1)	Allow which does not change Allow TE on incorrect colour precipitate not dissolving	

Question Number	Answer	Additional Guidance	Mark
1(a)(iv)	An answer that makes reference to the following point: • Mn ²⁺ / manganese(II)	Allow [Mn(H ₂ O) ₆] ²⁺ Ignore just 'manganese'	(1)

Question Number	Answer	Additional Guidance	Mark
1(a)(v)	An answer that makes reference to the following point:		(1)
	• oxidation	Allow redox Ignore references to air Do not award if given with other reaction types	

Question Number	Answer		Additional Guidance	Mark
1(b)	An answer that makes reference to the following points:			(3)
	• the (precipitate) colours can be difficult to distinguish	(1)	Accept off-white/cream/very pale yellow can be hard to differentiate from white Allow the colours are similar	
			Do not award 'the colours are the same' but allow 'the colours look the same'	
	add dilute/ aqueous ammonia	(1)	Allow ammonia solution Ignore use of concentrated ammonia to confirm presence of silver bromide precipitate	
	• if the precipitate dissolves then chloride ions are present and if the precipitate remains then bromide ions are present	(1)	Allow chloride ppt. dissolves but bromide ppt. doesn't Allow bromide ppt only dissolves in concentrated ammonia	
			Penalise reference to chlorine/bromine for M3 Penalise incorrect ppt formulae once only	
			Ignore any references to iodide ions or iodide ppts	

Question Number	Answer	Additional Guidance	Mark
1(c)	• Fe ₂ (SO ₄) ₃	Allow (Fe) ₂ (SO ₄) ₃	(1)
	1 62(304)3	71110W (1 C)2(504)5	

Question Number	Answer	Additional Guidance	Mark
1(d)	An answer that makes reference to the following point		(1)
	accept any nitrogen-containing anion	Nitrate/ Nitrate(V)/NO ₃ ⁻ Nitrite/Nitrate(III)/NO ₂ ⁻ Nitride/N ³⁻ Allow Amide/Azanide/NH ₂ ⁻ Allow Azide/N ₃ ⁻ If name and formula are given both must be correct	

(Total for Question 1 = 12 marks)

• displayed formula of propanal (1)	Additional Guidance	Mark
• displayed formula of propanal (1)		(2)
	Allow grey solid Allow precipitate for solid Allow silver forms on the sides of the test tube Ignore just 'mirror'	
	H—C—C—C—H Allow structural/skeletal formulae or any combination thereof Ignore a molecular formula Ignore any name even if incorrect Ignore bond angles and bond lengths Do not award a formula with —COH	

Question Number	Answer	Additional Guidance	Mark
2(b)(i)	An answer that makes reference to the following point:		(1)
		Ignore classification of alcohol	
	alcohol	Ignore named alcohol	
		Ignore drawing of group	
		Do not award hydroxide/phenol	
		Allow alcohol to be given in a word equation with the alcohol indicated as X such as	
		carboxylic acid + alcohol(\mathbf{X}) \Rightarrow ester + water	

Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	An answer that makes reference to the following points:		(2)
	• suitable displayed formula of propan-2-ol (1)	H OH H H—C ₁ -C ₂ -C ₁ -H H H H	
	• labelling of the two carbon environments (1)	Ignore connectivity of OH Accept any suitable labelling of the two environments such as shown above Ignore any labelling of hydrogen atoms All three carbon atoms need to be labelled so the following does not score HOHH HC1-C2-C-H H H H No TE on incorrect compounds Allow M2 if the propan-2-ol is missing one hydrogen	

Question Number	Answer		Additional Guidance	Mark
2(c)(i)	An answer that makes reference to the following points:			(2)
	• (pale) yellow precipitate	(1)	Allow solid/ppte/ppt/crystals for precipitate Ignore any formulae given even if incorrect Ignore initial brown colour Do not award 'bright' yellow ppt	
	• antiseptic smell	(1)		
			Stand alone marks Do not award observations of an incorrect test	

Question Number	Answer	Additional Guidance	Mark
2(c)(ii)	An answer that makes reference to the following point:	Accept skeletal/displayed/structural or any combination thereof	(1)
	• propanone / suitable formula of propanone	CH ₃ COCH ₃ / H O H H—C—C—C—H Allow acetone H H H Allow propan-2-one/ 2-propanone	
		Ignore a molecular formula If name and formula given then both must be correct	

Question Number	Answer	Additional Guidance	Mark
2(d)	suitable displayed formula of propanoic acid	Allow H C C C C O H H H H O H C C C O H H H Ignore other types of formulae Ignore name even if incorrect	(1)

(Total for Question 2 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
3(a)(i)	An answer that makes reference to the following point • because the acid was in excess		(1)
	or the vanadate(V) was the limiting factor	Allow so all the vanadate(V) would react Do not award to ensure that all the zinc reacts	

Question Number	Answer	Additional Guidance	Mark
3(a)(ii)	An answer that makes reference to the following point		(1)
	because the zinc reacts with the (sulfuric) acid	Accept $H_2SO_4 + Zn \rightarrow ZnSO_4 + H_2$ $2H^+ + Zn \rightarrow Zn^{2+} + H_2$ Allow acid + metal \rightarrow salt + hydrogen Ignore state symbols even if incorrect Allow zinc reduces hydrogen ions to hydrogen gas	
		Do not award if the equation is incorrect	

Question Number	Answer	Additional Guidance	Mark
3(a)(iii)	An answer that makes reference to the following point so the reaction occurs in a reasonable time / to speed up the reaction (rate)	Accept the reaction is slow because the surface area of the granulated zinc is low Allow the reaction is slow at room temperature Allow activation energy is high Allow energy is needed to start the reaction Do not award so the reaction goes to completion Do not award the reaction is endothermic	(1)

Question Number	Answer		Additional Guidance	Mark
3(a)(iv)	An explanation that makes reference to the following points:		Ignore any initial solid colours	(3)
			Initial colour is yellow of $V(V)/V{O_2}^+ / +5$	
	 two correct colours and oxidation states 	(1)	Colour then blue of $V(IV)/VO^{2+}$ / +4	
	third correct colour and oxidation state	(1)	Colour then green of $V(III)/V^{3+}/+3$	
	fourth correct colour and oxidation state	(1)	Final colour is purple which is $V(II)V^{2+} / +2$	
			Allow lavender/violet/mauve for purple Do not award lilac for purple	
			If colours are not linked to the oxidation states then allow one mark for the correct colour sequence of yellow – blue – green – purple	
			If the oxidation states are not linked to colours/incorrect colours then allow one mark for the correct oxidation number sequence, V+5 to V+4 to V+3 to V+2	
			Ignore reference to a green colour seen as the colour changes from yellow to blue	

Question Number	Answer	Additional Guidance	Mark
3(b)(i)	An answer that makes reference to the following point	Accept reverse argument	(1)
	 more (toxic sulfur dioxide) gas is likely to escape from the use of gas cylinders 	Allow reference to storage problems/leakage from gas cylinders	
	or less (toxic sulfur dioxide) gas is likely to escape from the use of reaction mixture method of preparation	Allow no loss of gas from the 'in situ' method of preparation	
		Allow small/controlled amount of sulfur dioxide is produced within the reaction mixture	
		Allow the sulfur dioxide reacts with the compounds as soon as it forms	
		Allow the sulfur dioxide produced is (already) aqueous	
		Allow transport difficulties of the gas cylinders	
		Ignore just references to toxicity of sulfur dioxide Ignore references to use of a fume cupboard	

Question Number	Answer	Additional Guidance	Mark
3(b)(ii)		Example of equation:	(1)
	• equation	$Na_2SO_3 + 2HC1 \rightarrow 2NaC1 + SO_2 + H_2O$	
		Ignore state symbols even if incorrect Allow	
		$SO_3^{2-} + 2H^+ \rightarrow SO_2 + H_2O$	
		Allow multiples	

Question Number	Answer	Additional Guidance	Mark
3(c)(i)	An answer that makes reference to the following point		(1)
	• filtration/decant	Allow suction filtration/filtration under pressure Allow hot filtration Allow filter Ignore washing the tin	

Question Number	Answer		Additional Guidance	Mark
3(c)(ii)	(M1) calculation of moles of vanadate/ vanadium(V)/ VO2 ⁺ and calculation of moles of manganate(VII)	(1)	Example of calculation $n(vanadate)=((25.0 \div 1000) \times 0.0200) = 5.00 \times 10^{-4} $ $/0.0005(mol)$ and $n(manganate)=((20.00 \div 1000) \times 0.0100) = 2.00 \times 10^{-4}$	(4)
		(1)	/0.0002(mol) ratio of 2:5 Allow division to give 2.5 or 1:2.5	
	Or	(1)(1)	manganate gains 2 x 5e ⁻ = 10 e ⁻ so the vanadium loses 10 e ⁻ = 5 x 2e ⁻ $n(\text{manganate}) = (2.00 \times 10^{-4} \times 5 =) 1.0 \times 10^{-3} \text{ (mol)}$	
	(1415) mor or electrons lost by each valuatate(v) for	(1)(1)	$n(vanadate) = (1.0 \times 10^{-3} \div 5.00 \times 10^{-4} =) 2$ $vanadium(V) \text{ is reduced by } 2e^- \text{ to } vanadium(III)$	
	(M4) results in final oxidation state of V(III)		Ignore SF No TE on an incorrect number of electrons gained and lost Correct final oxidation state without working scores (1) only	
			Some relevant working must be shown to score (4)	

Question Number	Answer		Additional Guidance	Mark
3(c)(iii)	An explanation that makes reference to the following points:			(2)
	the tin will be oxidised by the manganate(VII)	(1)	Accept the tin will reduce more vanadate/ vanadium(V) Allow tin will reduce the vanadium ion (which has been oxidised by manganate(VII) and so require more oxidation) Allow the tin would react with/reduce the manganate(VII)	
	so the titre will increase	(1)	M2 is dependent on M1 or a near-miss at an explanation of increased titre Allow M2 for increased titre if M1 has been lost due to referring to vanadium (metal) being reduced rather than vanadate	

(Total for Question 3 = 15 marks)

Question Number	Answer		Additional Guidance	Mark
4(a)	An answer that makes reference to the following points:			(2)
	• easier to safely handle/weigh/transfer a solid (than a liquid)	(1)	Allow easier to spill a liquid/ solid cannot be spilt Ignore references to melting/boiling temperatures Ignore reference to stability Ignore references to ease of storage	
	• (only) phenylamine is toxic and corrosive	(1)	Ignore phenylamine is more hazardous/has 2 more hazards Allow reverse argument	

Question Number	Answer		Additional Guidance	Mark
4(b)	(Method 1)calculation of moles of ethanoic anhydride	(1)	Example of calculation $m = (1.08 \times 2.0 =) 2.16 (g)$ and $n = (2.16 \div 102.0 =) 0.021176/2.1176 \times 10^{-2} (mol)$	(3)
	• calculation of moles of phenylammonium chloride	(1)	n = $(1.0 \div 129.5 =) 0.0077220 / 7.7220 \times 10^{-3} \text{ (mol)}$	
	• comparison of moles (in relation to reaction 1:1 molar ratio so is in excess)	(1)	ratio 2.74(23):1 is greater (than the reaction ratio of 1:1 so is in excess) or	
	(Method 2)		0.021176 > 0.0077220 (so in excess as 1:1 from equation)	
	• calculation of moles of phenylammonium chloride	(1)	$n = (1.0 \div 129.5 =) 0.0077220 / 7.7220 \times 10^{-3} \text{ (mol)}$	
	 calculation of volume of ethanoic anhydride (based on 1:1 molar ratio) 		m= $0.0077220 \times 102.0 = 0.787644 \text{ (g)}$ and V= $(0.787644 \div 1.08 =) 0.7293 \text{ (cm}^3)$	
	or calculation of mass of ethanoic acid needed and used (based on 1:1 molar ratio)	(1)	m(needed) = (0.0077220 x 102.0) = 0.787644 (g) and $m(used) = (1.08 \text{ x } 2.0 =) 2.16 \text{ (g)}$	
	• comparison of volume required in relation to volume used (so is in excess)		$2.0 > 0.7293 \text{ (cm}^3) \text{ (so in excess)}$	
	or comparison of mass required in relation to mass used	(1)	2.16 > 0.787644 (g) (so in excess)	
			Ignore SF throughout and ignore rounding errors	
			M3 requires some comparison of the moles/mass/volume of each reactant Allow TE from an incorrect moles/mass/volume for M3 Allow subtraction of moles/mass/vol for M3 to show excess	

Question Number	Answer		Additional Guidance	Mark
4(c)(i)	An explanation that makes reference to the following points:			(2)
	• (because) the filter paper lying flat seals (all) the holes in	(1)	Allow to make a good seal	
	the Buchner funnel		Allow 'covers' for seals	
	the curled up filter paper allows the mixture down the	(1)	Accept reverse argument	
	sides (and through the holes in the Buchner funnel) so some of the solid is lost		Allow solid is lost through the gap Allow reference to the mixture getting into the	
	so some of the solid is lost		flask without being filtered	
			Ignore reference to solid being 'trapped' in the side	
			folds of the filter paper	
			Ignore generic comments about poor filtering/	
			less pressure/ reduced suction/less drying	

Question Number	Answer		Additional Guidance	Mark
4(c)(ii)	An answer that makes reference to two of the following points:		Accept reverse argument for M2 and M3	(2)
	• (because) washing with water removes any soluble impurities (remaining on the crystals)	(1)		
	phenylethanamide is less soluble in cold water	(1)	Allow crystals/solid for phenylethanamide Allow less solid dissolves in cold water	
	 use of a small volume means that less is 'washed away'/OWTTE 	(1)	Allow small volume so no solid dissolves	
			Ignore reference to a reaction between the water and the solid	

Question Number	Answer	Additional Guidance	Mark
4(d)	An answer that makes reference to the following point		(1)
	to remove insoluble impurities (while the product is still soluble)	Allow to remove solid impurities Do not award soluble impurities	

Question Number	Answer	Additional Guidance	Mark
4(e)	A description that makes reference to the following points:		(1)
	 decreases/lowers and range increases/widens 	Accept values below 114°C with a range wider than 2°C Allow 'not sharp' for range increases	

Question Number	Answer	Additional Guidance	Mark
4(f)	An explanation that makes reference to the following points: • peak 1 could be either N-H of amide or the amine (1)	$3500 - 3300 (\text{cm}^{-1})$	(3)
	• because the 3500 – 3300 (cm ⁻¹) and 3500 – 3140 (cm ⁻¹) overlap (1	Do not award ranges that go below 3300 (cm ⁻¹) when describing peak 1	
	• peak 2 can only be of an C=O (stretching vibration) of amides 1700 – 1630 (cm ⁻¹) (because amines do not have this bond)	Allow single values within 1680 – 1650 (cm ⁻¹) which only amides have Do not award reference to 1700 – 1600 (cm ⁻¹) Allow ranges to be given in reverse order e.g. 3300 – 3500	

(Total for Question 4 = 14 marks)

TOTAL FOR PAPER = 50 MARKS