Mark Scheme (Results)

January 2024

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.

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	Answer	Additional Guidance	Mark
1(a)(i)	An answer that makes reference to the following point: • Cu^{2+}/ copper(II)	Allow $[Cu(H_2O)_6]^{2+}$ Ignore just 'copper'	(1)

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

Question Number	Answer	Additional Guidance	Mark
1(a)(iii)	An answer that makes reference to the following point: • brown precipitate forms **(1)** • which does not dissolve (in excess) **(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 Allow which does not change Allow TE on incorrect colour precipitate not dissolving	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(a)(iv)	An answer that makes reference to the following point: • Mn^{2+}/ manganese(II)	 Allow $[Mn(H_2O)_6]^{2+}$ Ignore just 'manganese'	**(1)**

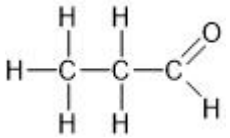
Question Number	Answer	Additional Guidance	Mark
1(a)(v)	An answer that makes reference to the following point: • oxidation	 Allow redox Ignore references to air Do not award if given with other reaction types	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)	An answer that makes reference to the following points: • the (precipitate) colours can be difficult to distinguish **(1)** • add dilute/ aqueous ammonia **(1)** • if the precipitate dissolves then chloride ions are present and if the precipitate remains then bromide ions are present **(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' Allow ammonia solution Ignore use of concentrated ammonia to confirm presence of silver bromide precipitate 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	**(3)**

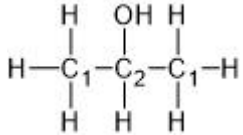
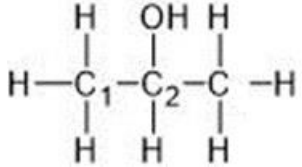
Question Number	Answer	Additional Guidance	Mark
1(c)	• $Fe_2(SO_4)_3$	Allow $(Fe)_2(SO_4)_3$	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(d)	An answer that makes reference to the following point • 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	**(1)**

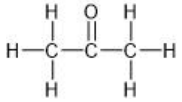
(Total for Question 1 = 12 marks)

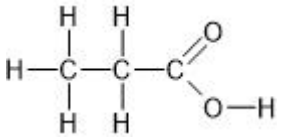
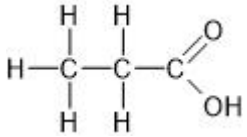
Question Number	Answer	Additional Guidance	Mark
2(a)	An answer that makes reference to the following points: • (positive result) silver mirror/silver solid **(1)** • displayed formula of propanal **(1)**	 Allow grey solid Allow precipitate for solid Allow silver forms on the sides of the test tube Ignore just 'mirror'  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	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)(i)	An answer that makes reference to the following point: • alcohol	 Ignore classification of 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(**X**) ⇌ ester + water	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	An answer that makes reference to the following points: • suitable displayed formula of propan-2-ol **(1)** • 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  No TE on incorrect compounds Allow M2 if the propan-2-ol is missing one hydrogen	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(c)(i)	An answer that makes reference to the following points: • (pale) yellow precipitate **(1)** • antiseptic smell **(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 Stand alone marks Do not award observations of an incorrect test	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(c)(ii)	An answer that makes reference to the following point: • propanone / suitable formula of propanone	Accept skeletal/displayed/structural or any combination thereof CH_3COCH_3 /  Allow acetone Allow propan-2-one/ 2-propanone Ignore a molecular formula If name and formula given then both must be correct	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(d)	• suitable displayed formula of propanoic acid	 Allow  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 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	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(a)(ii)	An answer that makes reference to the following point • 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 → salt + hydrogen Ignore state symbols even if incorrect Allow zinc reduces hydrogen ions to hydrogen gas Do not award if the equation is incorrect	**(1)**

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: • two correct colours and oxidation states **(1)** • third correct colour and oxidation state **(1)** • fourth correct colour and oxidation state **(1)**	Ignore any initial solid colours Initial colour is yellow of V(V)/VO_2^+ / +5 Colour then blue of V(IV)/VO^{2+} / +4 Colour then green of V(III)/V^{3+} / +3 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	**(3)**

Question Number	Answer	Additional Guidance	Mark
3(b)(i)	An answer that makes reference to the following point • more (toxic sulfur dioxide) gas is likely to escape from the use of gas cylinders or less (toxic sulfur dioxide) gas is likely to escape from the use of reaction mixture method of preparation	Accept reverse argument Allow reference to storage problems/leakage from gas cylinders 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	**(1)**

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

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

Question Number	Answer		Additional Guidance	Mark
3(c)(ii)	• (**M1**) calculation of moles of vanadate/ vanadium(V)/ VO_2^+ **and** calculation of moles of manganate(VII)	**(1)**	Example of calculation n(vanadate)=((25.0 ÷ 1000) x 0.0200) = 5.00×10^{-4} /0.0005(mol) **and** n(manganate)=((20.00 ÷ 1000) x 0.0100) = 2.00×10^{-4} /0.0002(mol)	**(4)**
	Either • (**M2**) ratio of manganate to vanadium	**(1)**	ratio of 2:5 Allow division to give 2.5 or 1:2.5	
	• (**M3**) number of electrons gained and lost	**(1)**	manganate gains 2 x $5e^-$ = 10 e^- so the vanadium loses 10 e^- = 5 x $2e^-$	
	Or • (**M2**) mol of electrons gained by manganate(VII)	**(1)**	n(manganate) = (2.00×10^{-4} x 5 =) 1.0×10^{-3} (mol)	
	• (**M3**) mol of electrons lost by each vanadate(V) ion	**(1)**	n(vanadate) = ($1.0 \times 10^{-3} \div 5.00 \times 10^{-4}$ =) 2	
	• (**M4**) results in final oxidation state of V(III)	**(1)**	vanadium(V) is reduced by $2e^-$ to vanadium(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: • the tin will be oxidised by the manganate(VII) **(1)** • so the titre will increase **(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) 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	**(2)**

(Total for Question 3 = 15 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)	An answer that makes reference to the following points: • easier to safely handle/weigh/transfer a solid (than a liquid) **(1)** • (only) phenylamine is toxic **and** corrosive **(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 Ignore phenylamine is more hazardous/has 2 more hazards Allow reverse argument	**(2)**

Question Number	Answer		Additional Guidance	Mark
4(b)	(Method 1) • calculation of moles of ethanoic anhydride	**(1)**	Example of calculation m =(1.08 x 2.0 =) 2.16 (g) **and** n =(2.16 ÷ 102.0 =) 0.021176/ 2.1176 x 10^{-2} (mol)	**(3)**
	• calculation of moles of phenylammonium chloride	**(1)**	n =(1.0 ÷ 129.5 =) 0.0077220/ 7.7220 x 10^{-3} (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 0.021176 > 0.0077220 (so in excess as 1:1 from equation)	
	(Method 2) • calculation of moles of phenylammonium chloride	**(1)**	n =(1.0 ÷ 129.5 =) 0.0077220/ 7.7220 x 10^{-3} (mol)	
	• calculation of volume of ethanoic anhydride (based on 1:1 molar ratio) or calculation of mass of ethanoic acid needed and used (based on 1:1 molar ratio)	**(1)**	m= 0.0077220 x 102.0 = 0.787644 (g) **and** V= (0. 787644 ÷ 1.08 =) 0. 7293 (cm^3) m(needed) = (0.0077220 x 102.0) = 0.787644 (g) **and** m(used) = (1.08 x 2.0 =) 2.16 (g)	
	• comparison of volume required in relation to volume used (so is in excess) or comparison of mass required in relation to mass used	**(1)**	2.0 > 0.7293 (cm^3) (so in excess) 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: • (because) the filter paper lying flat seals (all) the holes in the Buchner funnel **(1)** • the curled up filter paper allows the mixture down the sides (and through the holes in the Buchner funnel) so some of the solid is lost **(1)**	Allow to make a good seal Allow 'covers' for seals Accept reverse argument Allow solid is lost through the gap Allow reference to the mixture getting into the 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	**(2)**

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

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

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

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)** • because the 3500 – 3300 (cm^{-1}) and 3500 – 3140 (cm^{-1}) overlap **(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) **(1)**	Accept reference to phenylethanamide and phenylamine Allow both amines and amides have a peak in the range 3500 – 3300 (cm^{-1}) Allow single values 3500 – 3300 in the range of both amines and amides Do not award ranges that go below 3300 (cm^{-1}) when describing peak 1 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	**(3)**

(Total for Question 4 = 14 marks)

TOTAL FOR PAPER = 50 MARKS

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