



## Mark Scheme (Provisional)

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)	<ul style="list-style-type: none"> <li><math>\text{VO}_3^- + 2\text{H}^+ \rightarrow \text{VO}_2^+ + \text{H}_2\text{O}</math></li> </ul>	Allow multiples Ignore state symbols even if incorrect Do not award uncanceled $\text{SO}_4^{2-}$ ions	1

Question Number	Answer	Additional guidance	Mark
1(a)(ii)	<ul style="list-style-type: none"> <li>yellow</li> </ul>	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: <ul style="list-style-type: none"> <li>correct colours of the oxidation states of vanadium (1)</li> <li>correct explanation for first / initial green (1)</li> </ul>	<p>+5 (oxidation state of vanadium) is yellow <b>and</b> +4 is blue <b>and</b> +3 is green <b>and</b> +2 is violet            Allow starting colour/answer to (a)(ii) for yellow</p> <p>Initial green is due to mixture of <math>\text{VO}_2^+</math> and <math>\text{VO}^{2+}</math> (rather than <math>\text{V}^{3+}</math>)</p> <p>Accept initial green is due to mixture of +5 and +4 oxidation states / mixture of yellow and blue</p> <p>Allow vanadium cannot be oxidised from +3 to +4 in these conditions / by zinc</p> <p>If no other mark awarded, (the student is correct because) all oxidation states have the correct colours scores (1)</p>	2

Question Number	Answer	Additional guidance	Mark
1(a)(iv)	<p>An explanation which makes reference to the following:</p> <ul style="list-style-type: none"> <li>oxidation of vanadium (from +2 to +3) by oxygen/O<sub>2</sub> (1)</li> <li>oxygen/O<sub>2</sub> isn't a strong enough oxidising agent to oxidise vanadium(III) (under these conditions) (1)</li> </ul>	<p>Allow air for oxygen Allow aerial oxidation Do not award +2 to +4/+5</p> <p><b>Standalone mark</b> Allow oxygen/O<sub>2</sub> 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</p>	2

Question Number	Answer	Additional guidance	Mark
1(b)(i)	<p>Any two from:</p> <ul style="list-style-type: none"> <li>[CuCl<sub>4</sub>]<sup>2-</sup> (1)</li> <li>[Cu(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> (1)</li> <li>[Cu(H<sub>2</sub>O)<sub>5</sub>Cl]<sup>+</sup> (1)</li> </ul>	<p>Ignore missing square brackets</p> <p>Accept [CuCl<sub>3</sub>]<sup>-</sup> / [Cu(H<sub>2</sub>O)<sub>3</sub>Cl<sub>3</sub>]<sup>-</sup> Do not award [CuCl<sub>2</sub>]<sup>-</sup></p> <p>Allow [Cu(H<sub>2</sub>O)<sub>4</sub>]<sup>2+</sup></p> <p>Do not award any complexes containing NH<sub>3</sub>/NH<sub>4</sub><sup>+</sup></p> <p>Comment allow correct names: tetrachlorocuprate(II) hexaaquacopper(II) pentaquachlorocopper(II)</p>	2

Question Number	Answer	Additional guidance	Mark
1(b)(ii)	<ul style="list-style-type: none"> <li>turns (from blue to) green</li> </ul>	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: <ul style="list-style-type: none"> <li>(pale) blue precipitate (of copper(II) hydroxide)</li> </ul>	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: <ul style="list-style-type: none"> <li>(gas evolved is) ammonia</li> <li>(test for ammonia) turns (damp red) litmus paper blue <b>OR</b> produces white smoke with HCl</li> </ul>	(1) Accept $\text{NH}_3$ Allow just $\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O}$  Allow turns universal indicator paper blue  (1) Do not award white/misty fumes Ignore $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s})$	2

Question Number	Answer	Additional guidance	Mark
<b>1(c)</b>	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• (formation of) ethanoic acid / <math>\text{CH}_3\text{COOH}</math> (on addition of concentrated sulfuric acid) (1)</li> <li>• (formation of) ester / ethyl ethanoate (on addition of ethanol) (1)</li> <li>• Anion <b>Y</b><sup>-</sup> is <math>\text{CH}_3\text{COO}^-</math> / ethanoate (1)</li> </ul>	<p>Accept acetic acid Allow just carboxylic acid</p> <p>Accept <math>\text{CH}_3\text{COOC}_2\text{H}_5</math> Accept ethyl acetate Allow name or formula of any <b>ethyl</b> ester</p> <p>Accept salt is ammonium ethanoate/<math>\text{CH}_3\text{CO}_2\text{NH}_4</math> Accept ammonium acetate Allow name or formula of any carboxylate ion containing between one and four carbon atoms</p>	<b>3</b>

**(Total for Question 1 = 15 marks)**

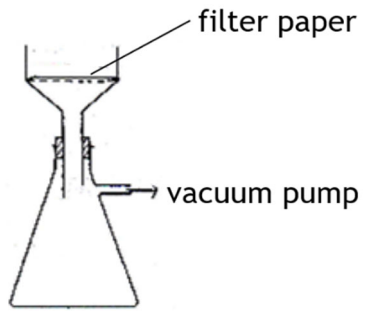


Question Number	Answer	Additional guidance	Mark
2(a)	Any one of: <ul style="list-style-type: none"> <li>quicker</li> <li>do not need the accuracy of a graduated pipette</li> </ul>	Allow volume is approximate/to 1SF Ignore there are not 8 cm <sup>3</sup> pipettes	1

Question Number	Answer	Additional guidance	Mark
2(b)	<ul style="list-style-type: none"> <li>dark blue</li> </ul>	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)	<ul style="list-style-type: none"> <li>ammonia (gas) is toxic</li> </ul>	Accept poisonous/corrosive/irritant for toxic Ignore harmful/dangerous/health hazard	1

Question Number	Answer	Additional guidance	Mark
2(d)	<ul style="list-style-type: none"> <li>the tetraamminecopper(II) sulfate-1-water/  <math>\text{Cu}(\text{NH}_3)_4\text{SO}_4 \cdot \text{H}_2\text{O}</math> is less soluble in (aqueous) ethanol (than water so crystallises)</li> </ul>	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: <ul style="list-style-type: none"> <li>Buchner funnel <b>and</b> labelled filter paper (1)</li> <li>Buchner flask <b>and</b> (rubber) seal (1)</li> <li>(side arm with) vacuum pump (1)</li> </ul>	Example of diagram:  <p>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</p> <p>Allow conical flask with side arm</p> <p>Allow vacuum/pump/reduced pressure/aspirator/suction            Ignore just water tap            Do not award pressure out/negative pressure</p>	3

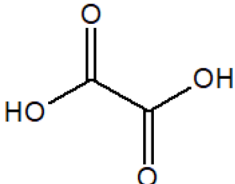
Question Number	Answer	Additional guidance	Mark
2(f)(i)	<ul style="list-style-type: none"> <li>to remove (soluble) impurities</li> </ul>	Ignore to wash the crystals	1

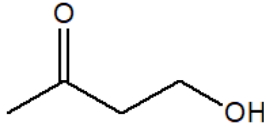
Question Number	Answer	Additional guidance	Mark
2(f)(ii)	<ul style="list-style-type: none"> <li>hot ethanol would dissolve the tetraamminecopper(II) sulfate-1-water/<math>\text{Cu}(\text{NH}_3)_4\text{SO}_4 \cdot \text{H}_2\text{O}</math></li> </ul> <p><b>OR</b></p> <p>so only a very small/the minimum amount of tetraamminecopper(II) sulfate-1-water/<math>\text{Cu}(\text{NH}_3)_4\text{SO}_4 \cdot \text{H}_2\text{O}</math> dissolves (in cold ethanol)</p>	<p>Allow product/salt/complex/crystals/precipitate/solid/it for tetraamminecopper(II) sulfate-1-water</p> <p>Allow just it is less soluble in cold ethanol Do not award insoluble in ethanol</p> <p>Ignore just to minimise loss of product</p>	1

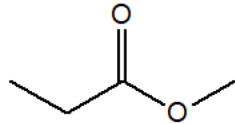
Question Number	Answer	Additional guidance	Mark
2(g)(i)	<ul style="list-style-type: none"> <li>• <math>M_r</math> values of <math>\text{CuSO}_4 \cdot 5\text{H}_2\text{O}</math> <b>and</b> <math>\text{Cu}(\text{NH}_3)_4\text{SO}_4 \cdot \text{H}_2\text{O}</math> (1)</li>   <li>• mols of <math>\text{CuSO}_4 \cdot 5\text{H}_2\text{O}</math> <b>and</b> mols <math>\text{Cu}(\text{NH}_3)_4\text{SO}_4 \cdot \text{H}_2\text{O}</math> <b>OR</b> theoretical mass <math>\text{Cu}(\text{NH}_3)_4\text{SO}_4 \cdot \text{H}_2\text{O}</math> (1)</li>   <li>• percentage yield to 2SF or 3SF (1)</li> </ul>	<p>Example of calculation:</p> <p><math>M_r \text{ CuSO}_4 \cdot 5\text{H}_2\text{O} = 249.6</math> Allow 249.5</p> <p><math>M_r \text{ Cu}(\text{NH}_3)_4\text{SO}_4 \cdot \text{H}_2\text{O} = 245.6</math> Allow 245.5</p> <p>Mols <math>\text{CuSO}_4 \cdot 5\text{H}_2\text{O}</math> = <math>\frac{2.17}{249.6}</math> (= <math>0.0086939 / 8.6939 \times 10^{-3}</math>)</p> <p>Mols <math>\text{Cu}(\text{NH}_3)_4\text{SO}_4 \cdot \text{H}_2\text{O}</math> = <math>\frac{2.54}{245.6}</math> (= <math>0.010342 / 1.0342 \times 10^{-2}</math>)</p> <p>Theoretical mass <math>\text{Cu}(\text{NH}_3)_4\text{SO}_4 \cdot \text{H}_2\text{O}</math> = <math>0.0086939 \times 245.6 = 2.1352</math> (g) TE on M1</p> <p>% yield = <math>0.010342 / 0.0086939 \times 100</math> = 118.96 = 119%/120%</p> <p><b>OR</b></p> <p>% yield = <math>2.54 / 2.1352 \times 100</math> = 119%/120%</p> <p>Allow 119.0% TE on M2</p> <p>Correct answer with no working scores (3)</p>	<b>3</b>

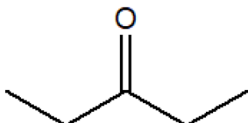
Question Number	Answer	Additional guidance	Mark
2(g)(ii)	An answer which makes reference to the following point: <ul style="list-style-type: none"><li data-bbox="389 357 645 389">• damp crystals</li></ul>	Allow wet/not properly dried/some ethanol/water remains Allow product etc for crystals Do not award it is a hydrated salt	<b>1</b>

**(Total for Question 2 = 13 marks)**

Question Number	Answer	Additional guidance	Mark
3(a)(i)	<ul style="list-style-type: none"> <li>(Compound) <b>E</b></li> </ul>	Accept correct structure: 	<b>1</b>

Question Number	Answer	Additional guidance	Mark
3(a)(ii)	<ul style="list-style-type: none"> <li>(Compound) <b>B</b></li> </ul>	Accept correct structure: 	<b>1</b>

Question Number	Answer	Additional guidance	Mark
3(a)(iii)	<ul style="list-style-type: none"> <li>(Compound) <b>F</b></li> </ul>	Accept correct structure: 	<b>1</b>

Question Number	Answer	Additional guidance	Mark
3(a)(iv)	<ul style="list-style-type: none"> <li>(Compound) <b>D</b></li> </ul>	Accept correct structure: 	<b>1</b>

Question Number	Answer	Additional guidance	Mark
<b>3(b)(i)</b>	An answer that makes reference to the following points: <ul style="list-style-type: none"> <li>• chemical test (1)</li> <li>• result of the selected test with <b>A</b> and <b>B</b> (1)</li> </ul>	<b>Result dependent on suitable test</b> If two or more tests given, all results must be correct to score (2)  Examples of correct answers:	<b>2</b>
	Chemical test (heat with) sodium dichromate(VI)/Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> <b>and</b> sulfuric acid/H <sub>2</sub> SO <sub>4</sub> Allow just acidified dichromate / H <sup>+</sup> and Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	Result with <b>A</b> and <b>B</b> (solution changes from orange to) green/blue with <b>B</b> (and no change with <b>A</b> )	
		OR	
	metal carbonate/metal hydrogencarbonate by name or formula	effervescence/fizzing/bubbles with <b>A</b> (and no change with <b>B</b> )	
		OR	
	magnesium/Mg	effervescence/fizzing/bubbles with <b>A</b> (and no change with <b>B</b> )	
		OR	
	ethanol/C <sub>2</sub> H <sub>5</sub> OH <b>and</b> a strong acid (by name or formula) <b>and</b> warm Allow just H <sup>+</sup> for strong acid	fruity smell with <b>A</b> (and no change with <b>B</b> )	
		OR	
	ethanoic acid/CH <sub>3</sub> COOH <b>and</b> a strong acid (by name or formula) <b>and</b> warm Allow just H <sup>+</sup> for strong acid	fruity smell with <b>B</b> (and no change with <b>A</b> )	
	Do not award sodium Do not award PCl <sub>5</sub> Do not award iodoform test Do not award Brady's reagent/2,4-DNP(H)		

Question Number	Answer	Additional guidance	Mark
3(b)(ii)	<p>An answer that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>suitable test (1)</li> <li>result of the selected test with <b>C</b> and <b>D</b> (1)</li> </ul>	<p><b>Result dependent on test</b></p> <p>(Warm with) iodine/I<sub>2</sub> <b>and</b> (aqueous) sodium hydroxide/NaOH/alkali  Allow iodoform test  Accept potassium iodide/KI <b>and</b> sodium chlorate((I))/NaClO</p> <p>(Pale) yellow precipitate with <b>C</b> (and no change with <b>D</b>)  Allow antiseptic smell with <b>C</b> (and no change with <b>D</b>)</p> <p>If no other mark awarded, Brady's reagent/2,4-DNP(H) <b>and</b> measure melting temperature of (purified orange) solid <b>and</b> compare with data book scores (1)</p>	2

Question Number	Answer	Additional guidance	Mark
3(c)(i)	<ul style="list-style-type: none"> <li>(the expansion of trapped) air</li> </ul>		1

Question Number	Answer	Additional guidance	Mark
3(c)(ii)	<ul style="list-style-type: none"> <li>heat is distributed more uniformly/evenly (by convection)</li> </ul>	<p>Allow the temperature is more even/uniform  Allow the temperature measurement is more accurate  Allow the temperature rises more gradually  Ignore references to evaporation</p>	1



Question Number	Answer	Additional guidance	Mark
3(c)(iii)	<ul style="list-style-type: none"> <li>the boiling temperature of compound <b>A</b> is higher than 100°C/water</li> </ul>	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 <b>A</b> Allow water boils below 120°C  Ignore just water boils at 100°C  Ignore references to evaporation	<b>1</b>

Question Number	Answer	Additional guidance	Mark
3(c)(iv)	<ul style="list-style-type: none"> <li>(boiling temperature depends on atmospheric) pressure (which) is variable</li> </ul>	Allow boiling temperature is pressure dependent Ignore references to variation in just conditions/temperature	<b>1</b>

Question Number	Answer	Additional guidance	Mark
3(d)(i)	<ul style="list-style-type: none"> <li>solid <b>M</b> (anhydrous) calcium chloride/CaCl<sub>2</sub> (1)</li> <li>solid <b>N</b> soda lime (1)</li> </ul>	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	<b>2</b>

Question Number	Answer	Additional guidance	Mark
3(d)(ii)	<ul style="list-style-type: none"> <li>• Mass of hydrogen</li> <li>or</li> <li>Moles hydrogen</li> <li>• Mass of carbon</li> <li>or</li> <li>Moles carbon (dioxide)</li> <li>• Mass of oxygen</li> <li>• Empirical formula</li> </ul>	<p>Example of calculation:</p> <p>Mass H = <math>\frac{2}{18} \times 1.28 = 0.14222</math> (g)</p> <p>or</p> <p>Moles H = <math>\frac{1.28}{18} \times 2 = 0.14222</math> (mols)</p> <p>Mass C = <math>\frac{12}{44} \times 3.14 = 0.85636</math> (g)</p> <p>or</p> <p>Moles C/CO<sub>2</sub> = <math>\frac{3.14}{44} = 0.071364</math> (mols)</p> <p>Mass O = <math>1.57 - 0.14222 - 0.85636 = 0.57142/0.57</math> (g)</p> <p>TE on M1 and M2 provided answer is positive</p> <p style="text-align: center;"> C : H : O  <math>\frac{0.85636}{12} : \frac{0.14222}{1} : \frac{0.57142}{16}</math>  0.071363 : 0.14222 : 0.035714  2 : 4 : 1 </p> <p>empirical formula is C<sub>2</sub>H<sub>4</sub>O</p> <p>TE on M1, M2 and M3</p> <p>Ignore SF except 1SF in mass and moles Ignore SF in ratio</p>	<b>4</b>

		<p>Max (2) (M3 and M4) if 1.28 g and 3.14 g confused giving empirical formula CH<sub>12</sub>O<sub>2</sub></p> <p>If no other marks awarded,  Mass/moles H = 0.348889  <b>and</b>  Mass C = 0.349091  or  Moles C = 0.029091 scores (1)</p> <p>Correct answer with no working scores (1)</p> <p>Comment  empirical formula is C<sub>2</sub>H<sub>4</sub>O can be awarded if seen in (d)(iv)</p>	
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Question Number	Answer	Additional guidance	Mark
3(d)(iii)	<ul style="list-style-type: none"> <li>(<i>m/z</i> =) 88</li> </ul>	Accept answer clearly annotated on mass spectrum	1

Question Number	Answer	Additional guidance	Mark
3(d)(iv)	<ul style="list-style-type: none"> <li>molecular formula</li> </ul>	$\left(x = \frac{M_r}{M_r(\text{C}_2\text{H}_4\text{O})} = \frac{88}{44} = 2\right)$ <p>molecular formula is C<sub>4</sub>H<sub>8</sub>O<sub>2</sub></p> <p>No TE on (d)(iii)</p>	1

Question Number	Answer	Additional guidance	Mark
<b>3(d)(v)</b>	<p>An answer which makes reference to the following points:</p> <ul style="list-style-type: none"> <li>• (Compound) <b>F</b> (1)</li> <li>• (as) molecular formula <math>C_4H_8O_2</math> / <math>M_r = 88</math> <b>and</b> (prominent) peak at <math>m/z = 29</math> (for <math>C_2H_5^+</math>) (1)</li> </ul>	<p>No TE on (d)(iv)</p> <p>Accept (prominent) peak at <math>m/z = 59</math> Accept does not have a peak at <math>m/z = 43/45</math></p> <p>Ignore reference to peaks at <math>m/z = 31/57</math></p> <p>If no other mark awarded, either of the following scores (1):</p> <p><b>B</b> as has molecular formula <math>C_4H_8O_2</math> / <math>M_r = 88</math></p> <p>OR</p> <p><b>D</b> as has a (prominent) peak at <math>m/z = 29</math></p>	<b>2</b>

**(Total for Question 3 = 22 marks)**

**Total for Paper = 50 marks**

